

TO INDEX

STARTING SYSTEM

ST

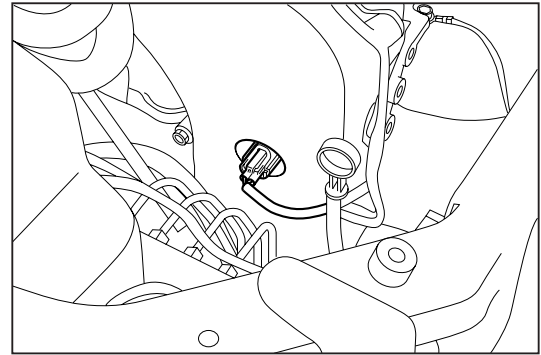
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MST00001-00000

IN-VEHICLE INSPECTION

STARTER

1. Place the shift lever to the neutral position. Apply the parking brake lever.
2. Disconnect the connector of the cam position sensor so that the engine will not start.
3. Set the ignition switch to the ST position. Check to see if the engine cranks.
4. If the engine will not crank, perform the following checks.
 - Inspect the battery for damage.
 - Charge the battery.
 - Perform harness continuity test.
5. If the engine still will not crank even after the checks above have been performed, remove the starter motor and perform the unit check.



MST00002-00001

WARNING:

- When removing the starter, firstly disconnect the negative terminal of the battery. Then, disconnect the positive terminals (+B, ST) at the starter side. Since the battery voltage is always applied to the starter +B terminal, failure to observe this removing sequence may lead to battery short, which is extremely dangerous.

CAUTION:

- If the starter terminals or connections between the battery terminals and the wires are loose, the connections may generate heat. Thus, loose terminals or connections are potentially-hazard. Be certain to securely tighten the terminals or wires.
- When installing the starter motor, install the starter motor in the clutch housing positively and be sure to tighten the attaching bolts to the specified torque. Improper installation can cause premature wear of the teeth of the pinion gear or ring gear and also can cause breakage of the clutch housing.

[Reference]

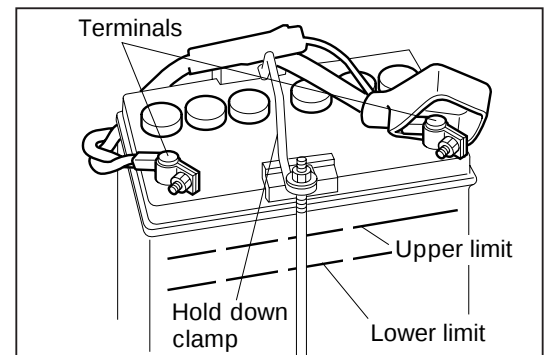
Starter Installing Torque: $39.0 \pm 7.8 \text{ N}\cdot\text{m}$

NOTE:

- With the cam position sensor connector disconnected, crank the engine. Then, the diagnosis code No. 13 will be detected.

After completion of the check, erase this code.

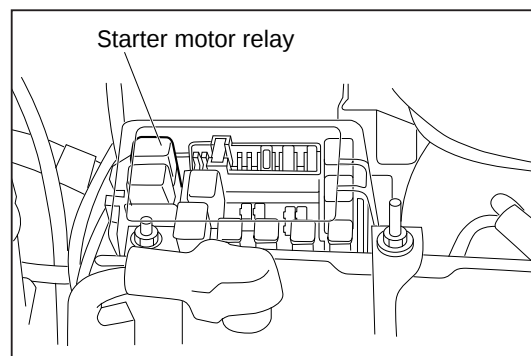
(For cancelling of diagnosis code refer to the EF section.)



MST00003-00002

STARTER MOTOR RELAY

1. Remove the lid of the relay box inside the engine compartment and pull out the starter motor relay.



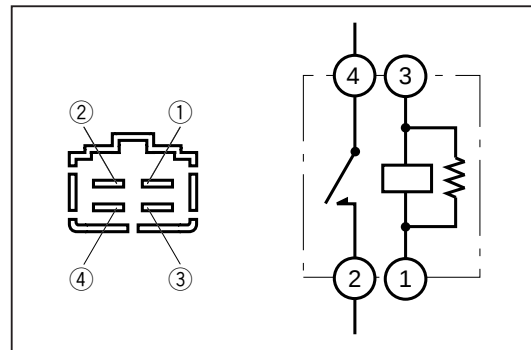
MST00004-00003

2. Inspection of relay continuity
 - (1) Check that there is continuity between the terminals ③ and ①.
Specified Value: 80 - 100 Ω

- (2) Check that there is continuity between the terminals ④ and ② when a voltage of 12 V is applied between the terminals ③ and ①.

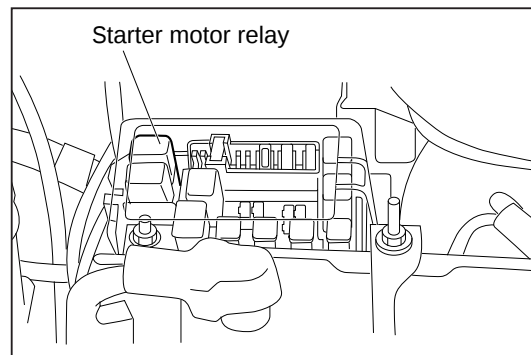
NOTE:

- If the trouble has not been solved by repairing the relay, check wire harness.



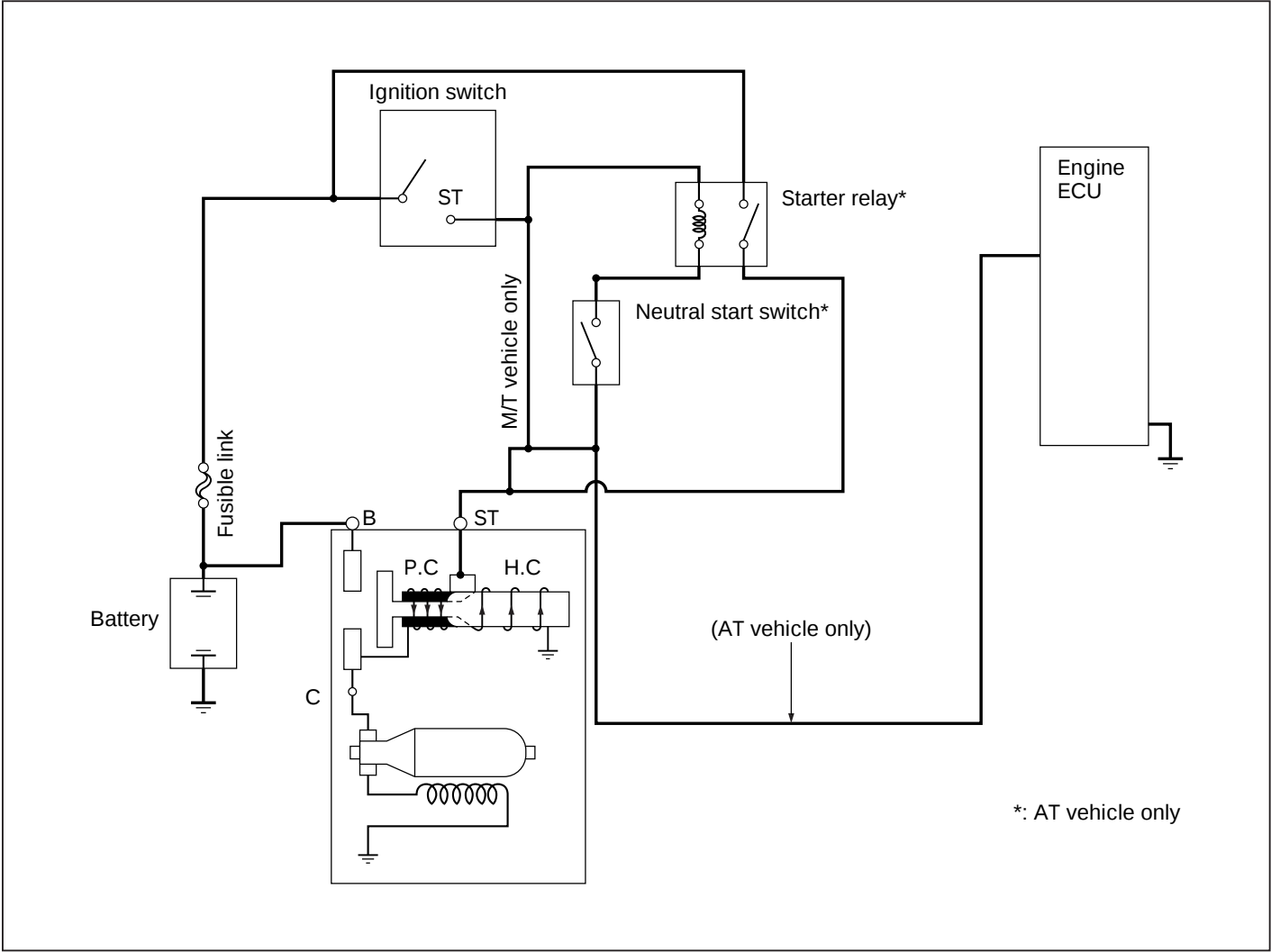
MST00005-00004

3. Install the starter motor relay to the relay box.



MST00007-00006

STARTING SYSTEM CIRCUIT

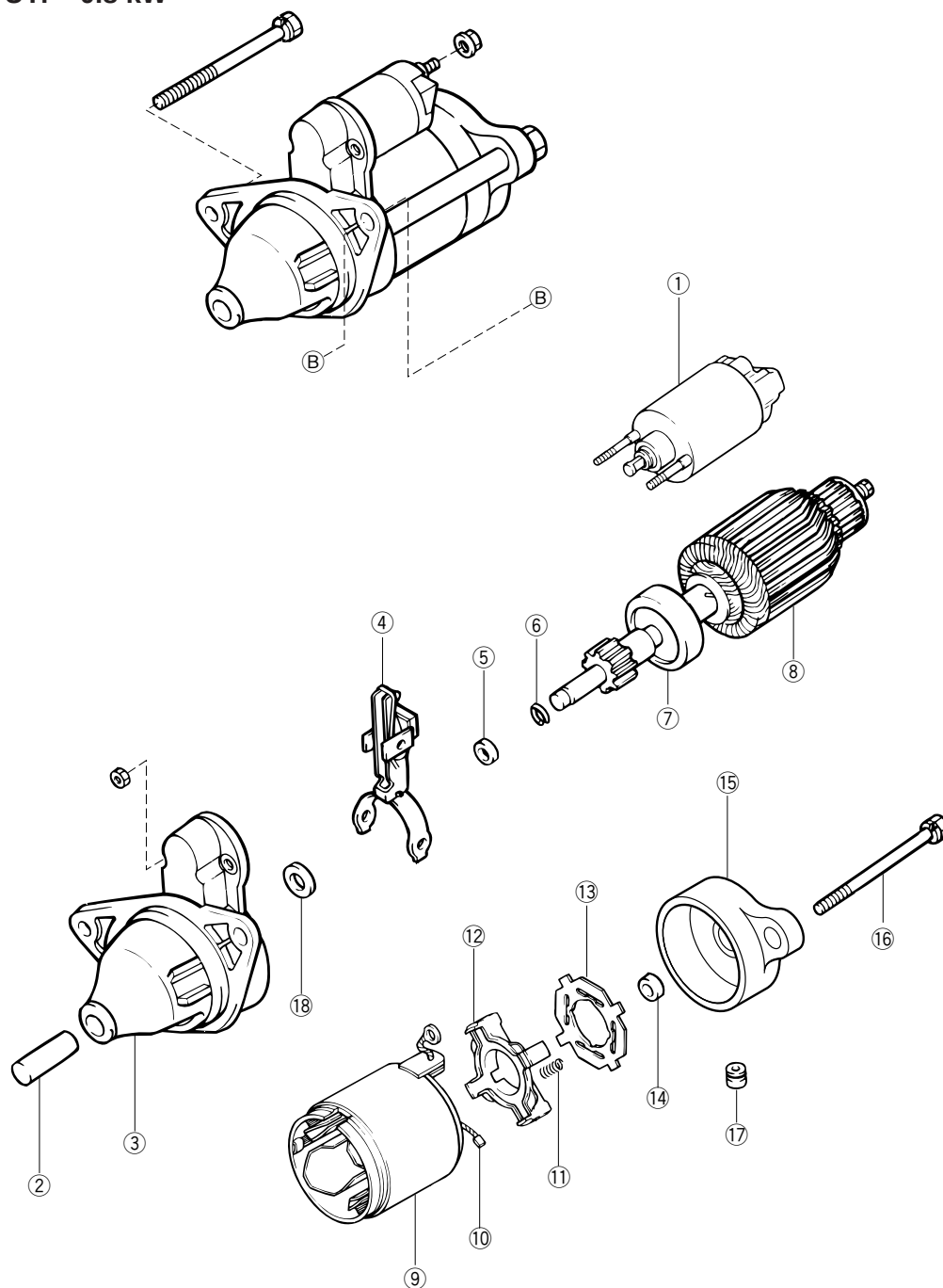


OUTLINE

In M100 series, the starter comes in two kinds; the conventional type and the planetary type. The conventional type has a rated output of 0.8 kW, while the planetary type has a output of 1.0 kW.

COMPONENTS

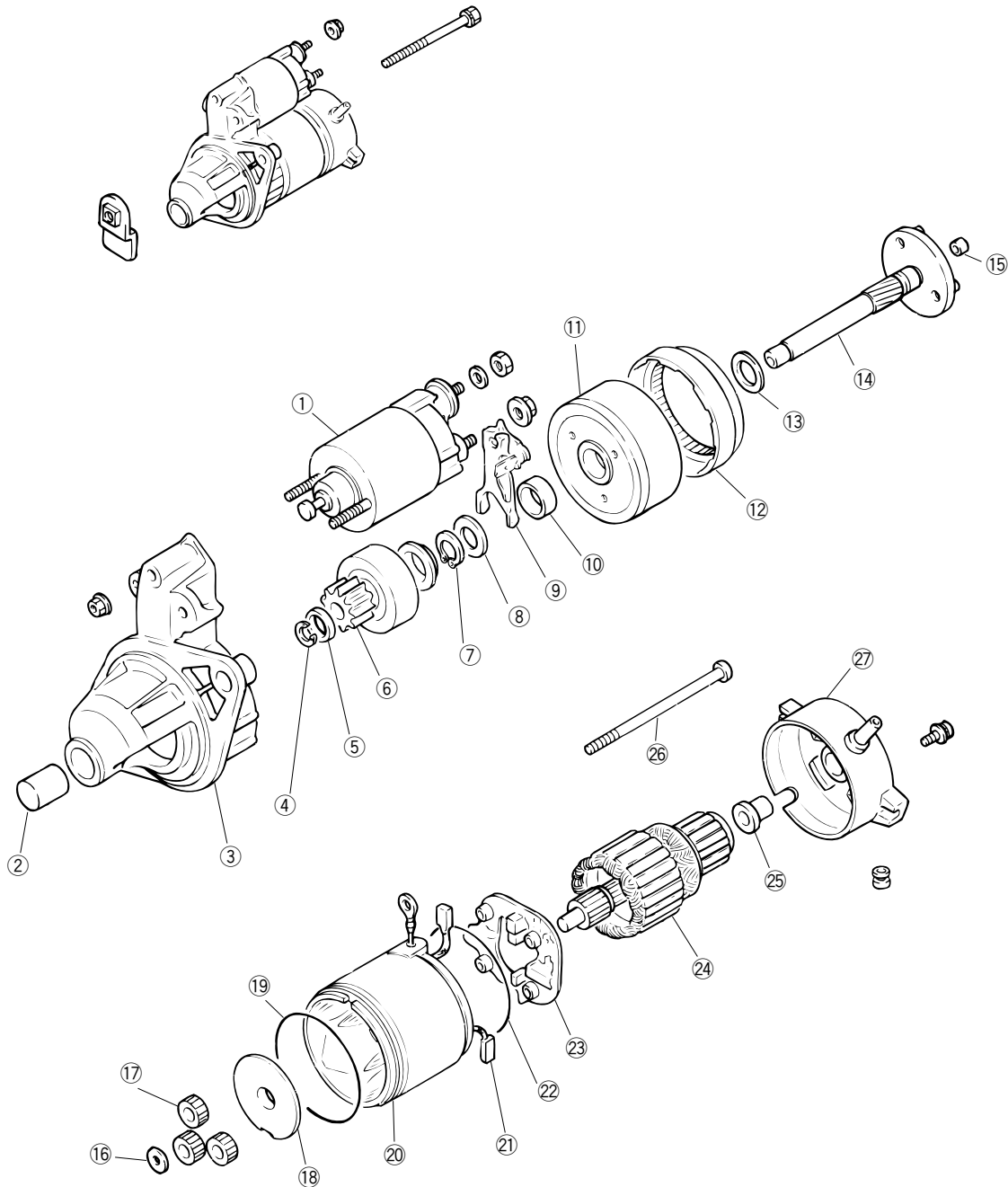
RATED OUTPUT: 0.8 kW



- ① Magnetic switch
- ② Bearing
- ③ Drive housing
- ④ Drive lever
- ⑤ Plate washer
- ⑥ Snap ring
- ⑦ Clutch
- ⑧ Armature
- ⑨ Yoke assembly

- ⑩ Brush
- ⑪ Spring
- ⑫ Brush holder
- ⑬ Insulator
- ⑭ Bearing
- ⑮ End frame
- ⑯ Through bolt
- ⑰ Dust protector
- ⑱ Plate washer

RATED OUTPUT: 1.0 kW



- ① Magnetic switch
- ② Cover
- ③ Drive housing
- ④ Snap ring
- ⑤ Pinion stop nut
- ⑥ Clutch
- ⑦ Snap ring
- ⑧ Washer
- ⑨ Drive lever
- ⑩ Oilless bearing
- ⑪ Center bearing & shock absorber
- ⑫ Internal gear
- ⑬ Washer
- ⑭ Planet carrier shaft

- ⑮ Bearing
- ⑯ Washer
- ⑰ Planet gear
- ⑱ Plate
- ⑲ O-ring
- ⑳ Yoke
- ㉑ Negative brush
- ㉒ O-ring
- ㉓ Brush holder
- ㉔ Armature
- ㉕ Oilless bearing
- ㉖ Through bolt
- ㉗ End frame

UNIT CHECK OF STARTER MOTOR

CAUTION:

- Each of the following tests must be performed within three to five seconds. If you fail to observe this caution and the starter should be energized for more than this duration, the coil may be burnt out.
- If the magnet switch should be tested as a unit, there is the possibility that the switch section is damaged. Hence, be sure to test it in the assembled state.

NOTE:

- Since the magnet switch can not be overhauled, replace it if it is malfunctioning.

Pull-in test

1. Disconnect the lead wire from the magnetic switch terminal.

2. Connect the negative (–) terminal of the battery to the starter body and magnetic switch terminal.

3. Connect the positive (+) terminal to the terminal ST. Ensure that the pinion is pushed outward. If the drive pinion fails to move out, replace the magnetic switch.

NOTE:

- The cause for the pinion to fail to pull in is open wire in the P.C. of the magnet switch or improper sliding of the plunger. Hence, replace the magnet switch.

Hold-in test

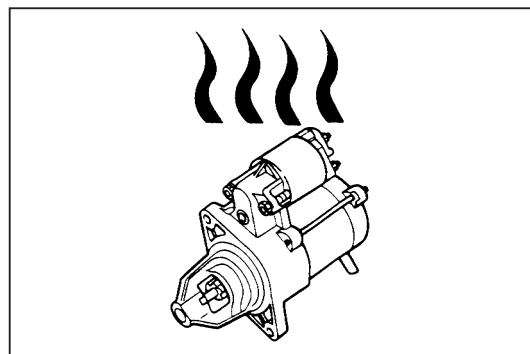
After the check has been performed following the same procedure as the pull-in test, disconnect the negative terminal of the magnetic switch terminal.

Ensure that the drive pinion is held in a pushed-out state.

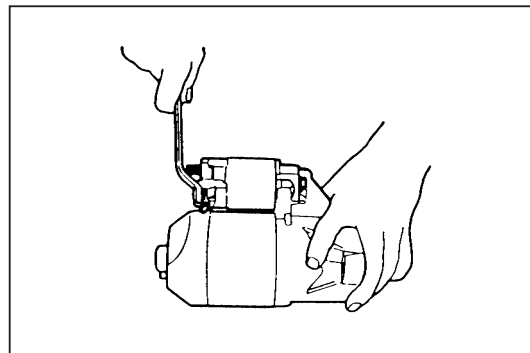
If the drive pinion fails to be held, replace the magnetic switch.

NOTE:

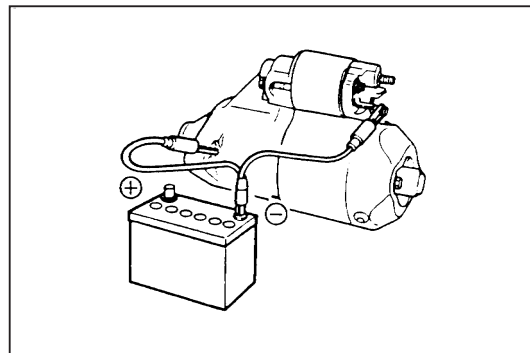
- The cause for the pinion to fail to be held is open wire in the P.C. of the magnet switch. Hence, replace the magnet switch.



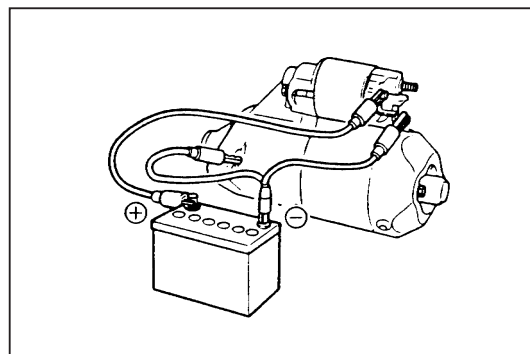
MST00010-00010



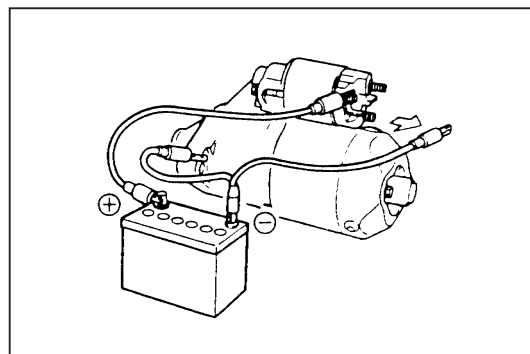
MST00011-00011



MST00012-00012



MST00013-00013



MST00014-00014

ST-8

Inspection of plunger return

After the check has been performed following the same procedure as the hold-in test, disconnect the ground terminal of the starter body. Ensure that the drive pinion is drawn into the drive housing.

If the drive pinion fails to be drawn, replace the magnetic switch.

NOTE:

- The cause for the pinion to fail to return is that either H.C. or P.C. of the magnet switch is grounded or shorted. Hence, replace the magnet switch.

No-load performance test

Connect the battery and an ammeter to the starter as shown in the right figure. Ensure that the starter rotates smoothly with the pinion moving out.

Measure the current the starter is drawing.

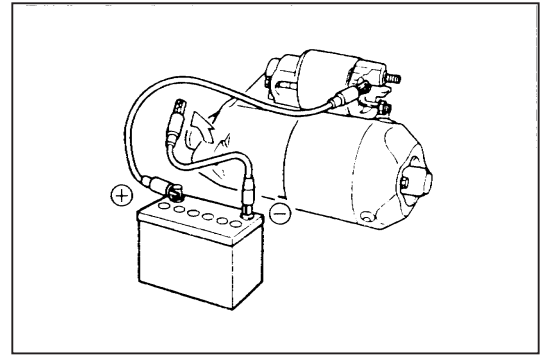
Specified Current:

0.8 kW TYPE 50A/11.5V

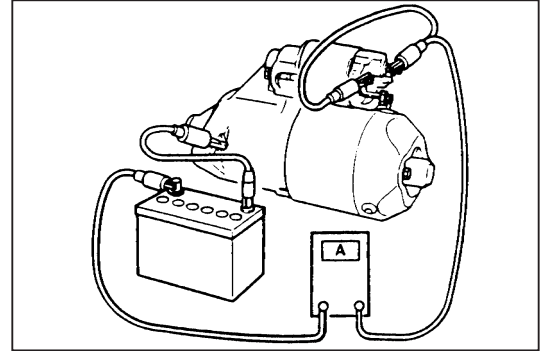
1.0 kW TYPE 90A/11.5V

NOTE:

- Prior to the test, be sure to connect the lead wire to the magnetic switch.



MST00015-00015

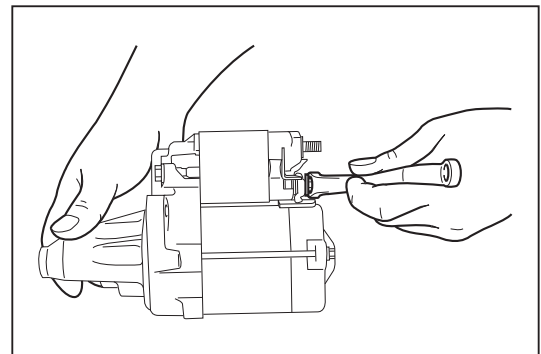


MST00016-00016

DISASSEMBLY

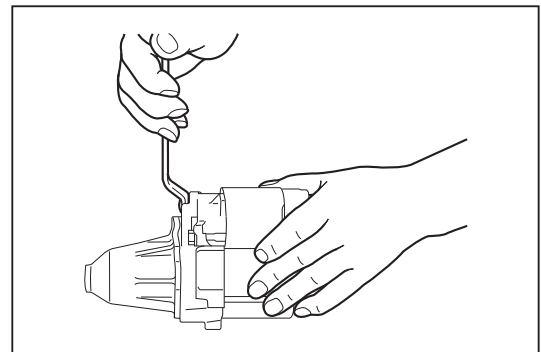
For 0.8 kW motor

1. Disconnect the lead wire from the magnetic switch.
2. Remove the attaching nut of the magnetic switch from the drive housing.



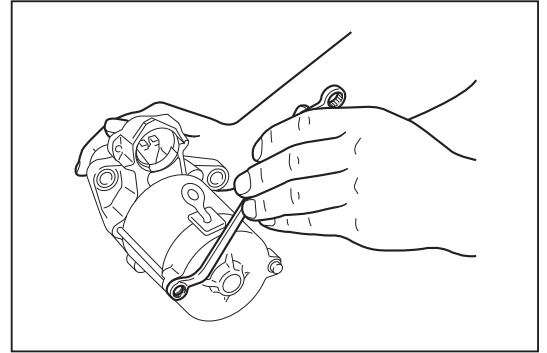
MST00017-00017

3. Remove the magnetic switch from the drive housing.

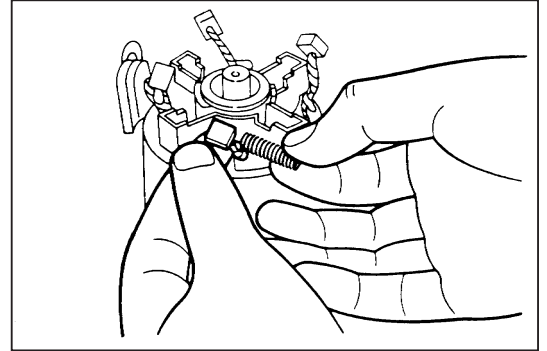


MST00018-00018

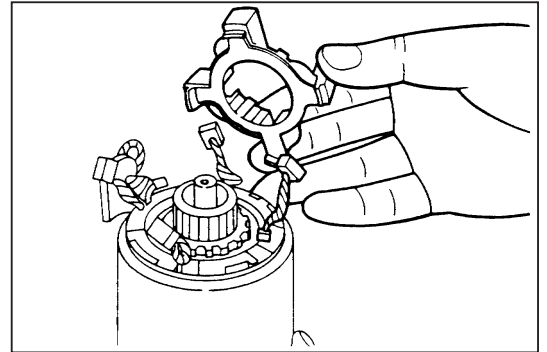
4. Remove the end frame cover by removing the two screws.



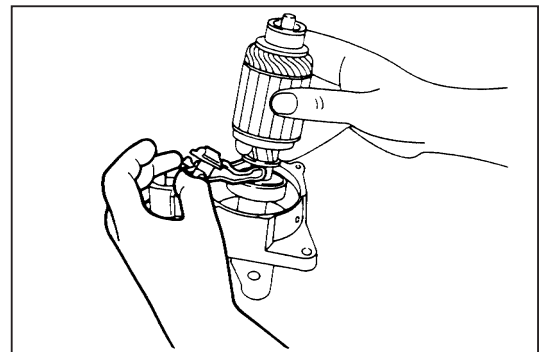
5. Remove the insulator from the brush holder.
6. Remove the brush spring and brush from the brush holder.



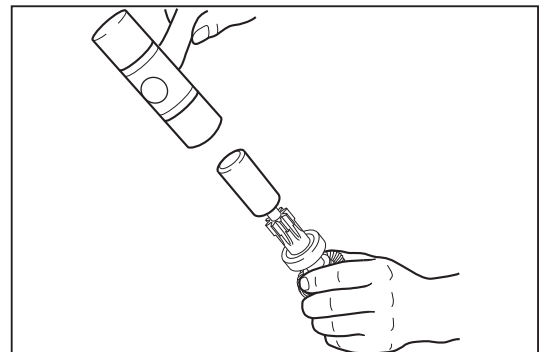
7. Remove the brush holder from the yoke.



8. Remove the yoke from the armature.
9. Remove the drive lever and the armature from the drive housing.

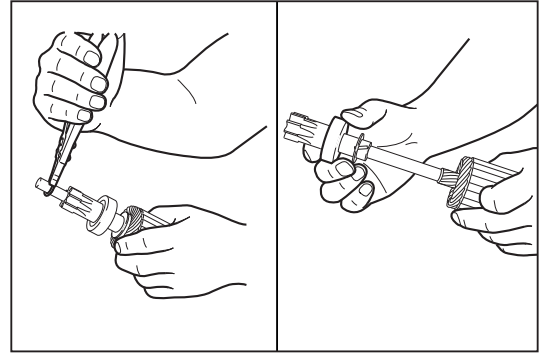


10. Cover the SST as shown in the figure. Lightly tap it to remove the pinion stop nut from the snap ring.
SST: 09238-87701-000



ST-10

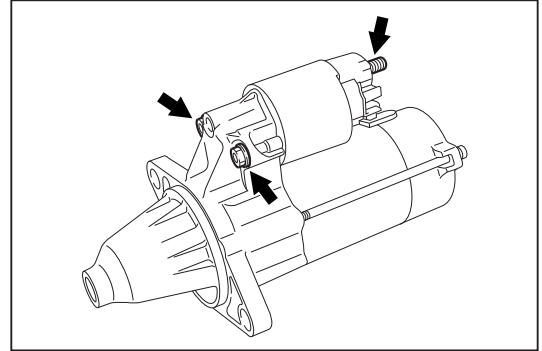
11. Detach the snap ring by prying it off with snap ring pliers.
12. Remove the clutch assembly from the shaft.



MST00024-00024

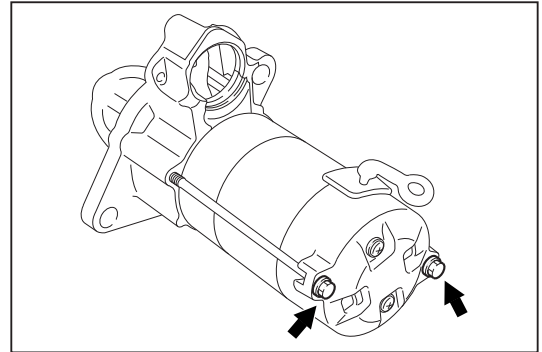
For 1.0 kW motor

1. Disconnect the lead wire from the magnetic switch.
2. Remove the attaching nut of the magnetic switch from the drive housing.
3. Remove the magnetic switch from the drive housing.



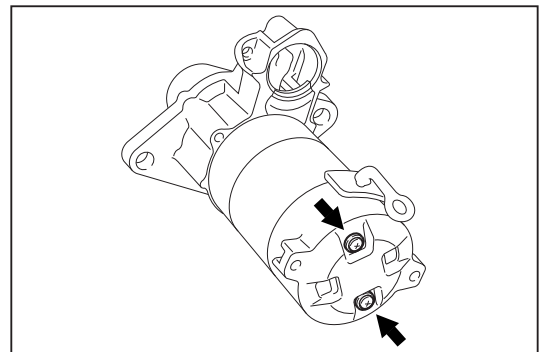
MST00025-00025

4. Separate the drive housing and yoke by removing the two through bolts.



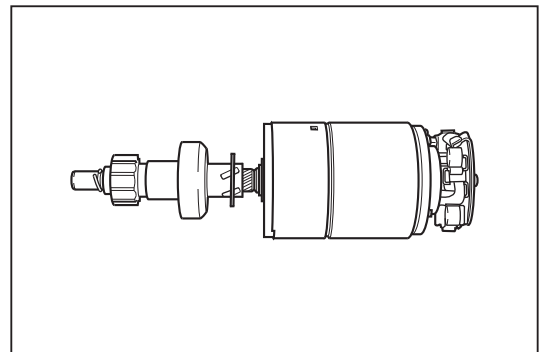
MST00026-00026

5. Separate the rear end frame and yoke by removing the two screws.



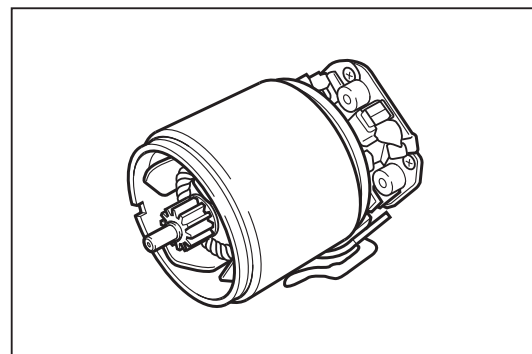
MST00027-00027

6. Separate the yoke and center bearing.



MST00028-00028

7. Pull out the armature from the yoke.

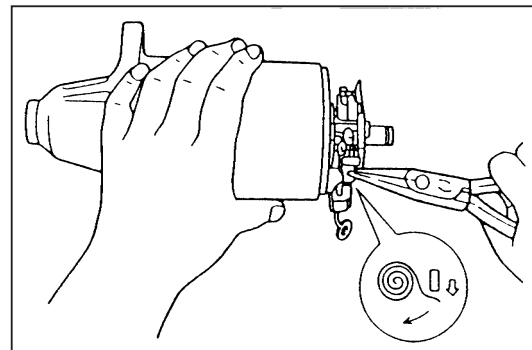


MST00029-00029

8. Remove the brushes from the brush holder by lifting the brush springs by means of nose pliers or the like.

NOTE:

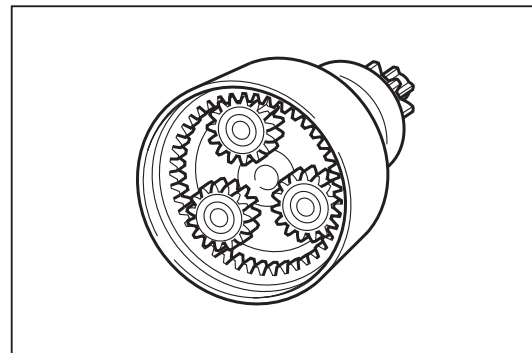
- Care must be exercised not to scratch the commutator during the removal.



MST00030-00030

9. Remove the plate from the center bearing.

10. Remove the planet gears.

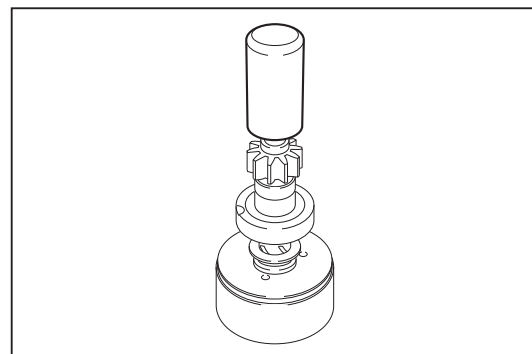


MST00031-00031

11. Cover the SST as shown in the figure. Lightly tap it to remove the pinion stop nut from the snap ring.

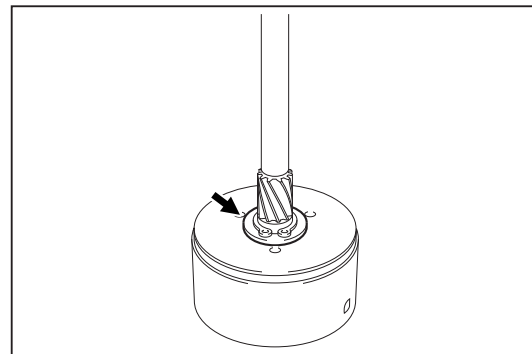
12. Remove the snap ring from the shaft. Remove the clutch assembly from the shaft.

SST: 09238-87701-000



MST00032-00032

13. Remove the snap ring. Pull out the shaft from the center bearing.

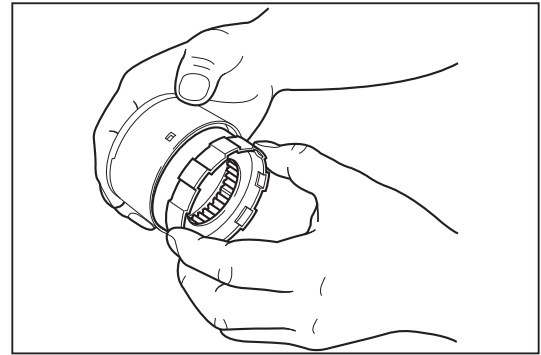


MST00033-00033

14. Pull out the internal gear from the center bearing.

NOTE:

- When the internal gear is removed, align the recess provided at the circumference of the center bearing with the recess provided at the circumference of the internal gear.

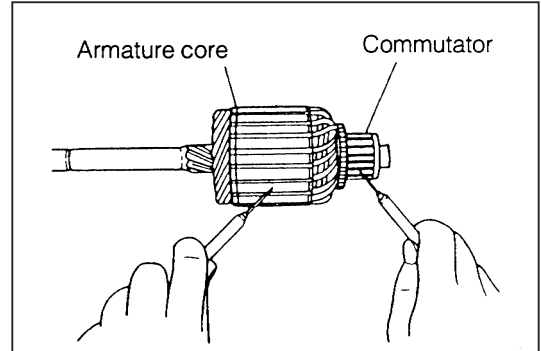


MST00034-00034

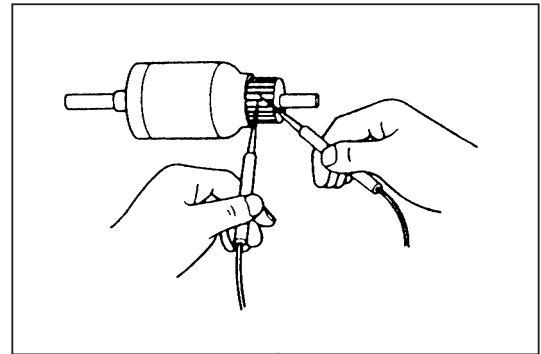
INSPECTION

Armature

1. Check of armature insulation
Ensure that no continuity exists between the commutator and the armature coil, using an ohmmeter. If continuity exists, replace the armature.
2. Check of commutator continuity
Check continuity between respective adjacent segments of the commutator, using an ohmmeter. If no continuity exists between any adjacent segments, replace the armature.



MST00035-00035



MST00036-00036

Check of commutator

1. Check each contact surface of the commutator segments with the brushes for burning. If the surfaces are dirty or burnt, correct the commutator surfaces, using abrasive paper (No.400) or a lathe.
2. Check of commutator for circle runout
Support the armature at its both ends on a Vee block. Check the commutator for circle runout, using a dial gauge.

Standard Circle Runout:

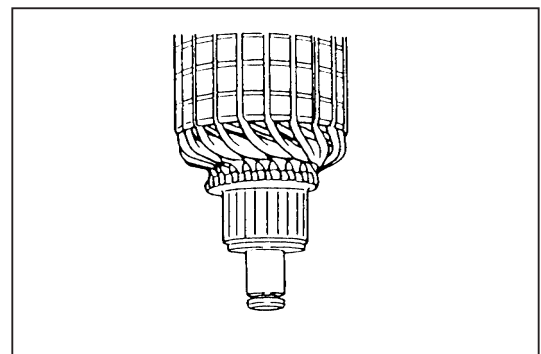
0.8kW TYPE : 0.05 mm

1.0kW TYPE : 0.02 mm

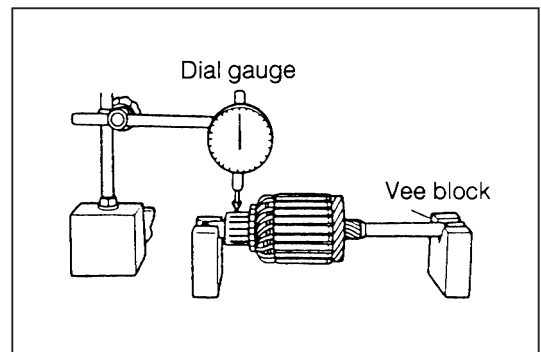
Limit:

0.8kW TYPE : 0.40 mm

1.0kW TYPE : 0.05 mm



MST00037-00037



MST00038-00038

If the circle runout exceeds the allowable limit, turn the commutator on a lathe.

At this point, care must be exercised to ensure that the commutator diameters are not less than the minimum required diameter of 27 mm.

3. Measurement of commutator diameter

Measure the commutator diameter by means of a micrometer or vernier calipers.

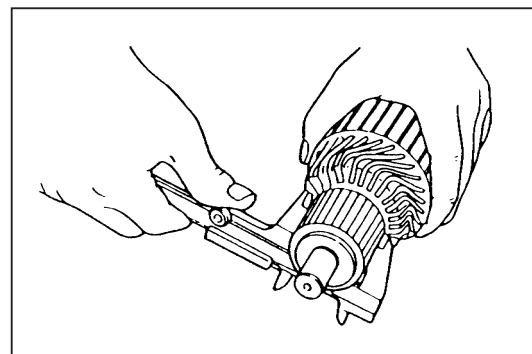
Standard Diameter: 28 mm

Minimum Diameter: 27 mm

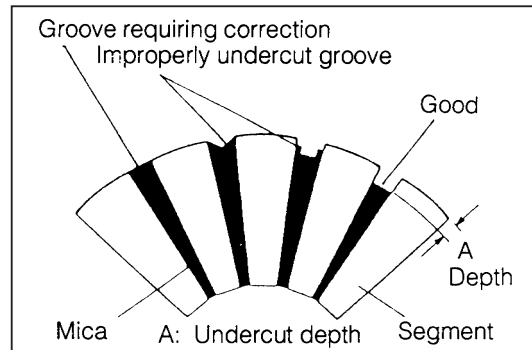
If the commutator diameter is less than the minimum diameter, replace the armature.

4. Check of commutator undercut

If the depth of the insulator groove between commutator segments is less than 0.2 mm, it is necessary to undercut the insulator so that the groove depth may become 0.45 - 0.75 mm.



MST00039-00039



MST00040-00040

Check of field coil

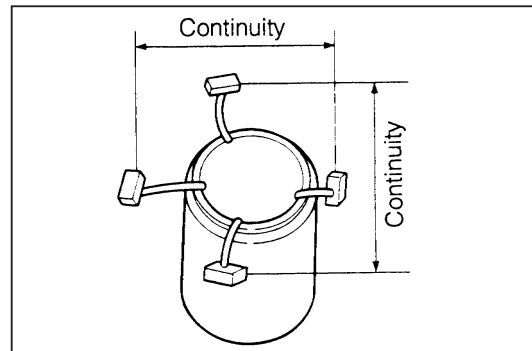
1. Field coil continuity test

Perform field coil continuity test at a point between the lead wires (brush), using an ohmmeter.

If no continuity exists, replace the yoke.

0.8kW TYPE : 4 lead wires are available

1.0kW TYPE : 2 lead wires are available

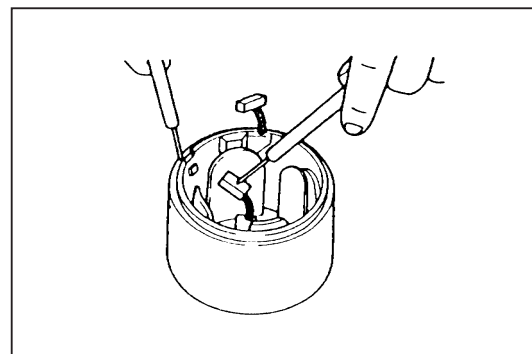


MST00041-00041

2. Field coil short test

Perform field coil short test at a point between the brush and the yoke proper, using an ohmmeter.

If continuity exists, replace the yoke



MST00042-00042

Check of brushes

1. Measurement of brush length

Measure the brush length, using vernier calipers.

Standard Length:

0.8kW TYPE: 10 mm

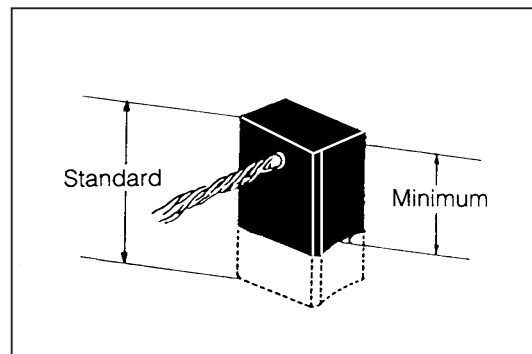
1.0kW TYPE: 14 mm

Minimum Length:

0.8kW TYPE: 7.8 mm

1.0kW TYPE: 11.1 mm

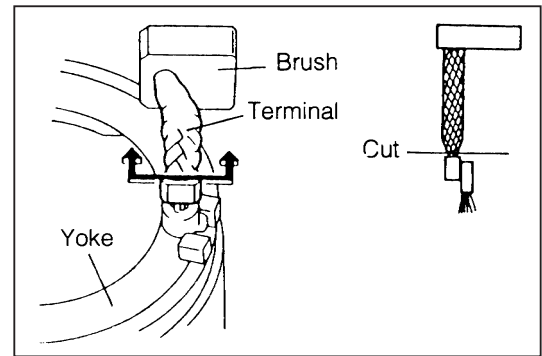
If the length is less than the minimum requirement, replace the brush holder or the yoke, as required.



MST00043-00043

2. Procedure for brush replacement

(1) Cut the brush lead wire at the terminal side.



MST00044-00044

(2) Remove welding traces with a file or the like to correct the brush terminal to the specified dimensions.

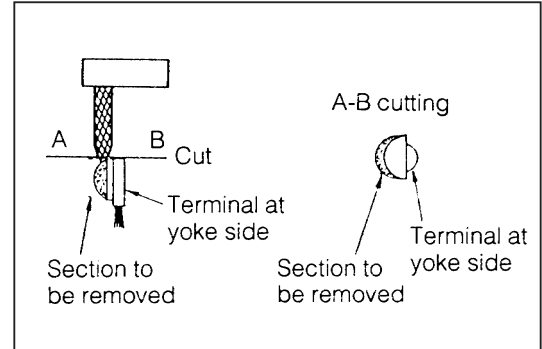
Specified Dimensions:

Thickness: 1.3 - 1.5 mm

Width: 5 mm

NOTE:

- Be sure to remove the section of the brush terminal as indicated in the right figure. Since the section to be removed is narrow, be very careful not to damage the field coil.

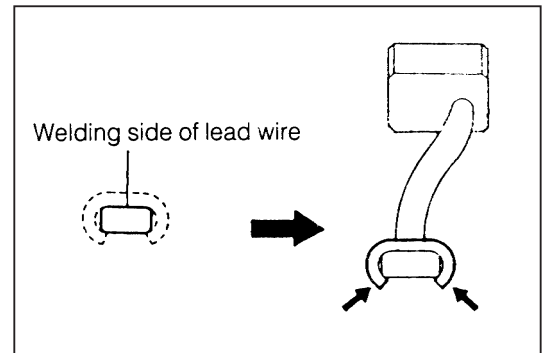


MST00045-00045

(3) Stick the plate section of a replacement brush onto the welding side of the lead wire. Make pressure connection over the overlaid section by pinching it with pliers.

NOTE:

- Be sure to take out the brush lead wire in the correct direction.

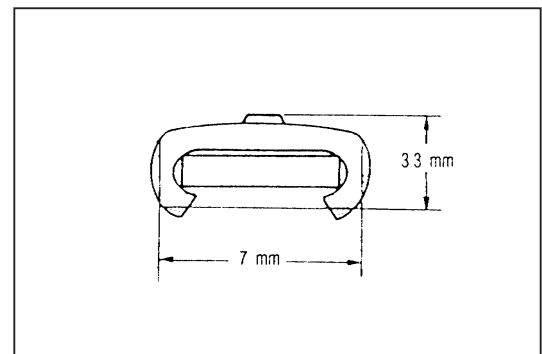


MST00046-00046

(4) Solder the pressure connection. Correct the section, using a file or the like, so that the section conforms to the dimensions, as indicated in the right figure.

NOTE:

- When performing the soldering, heat the section to be soldered thoroughly. Be very careful not to allow any solder to flow into the positive side lead wire.
- Be sure to allow solder in a sufficient amount to flow into the inside of the plate.
- Ensure that no solder oozes to the field side.



MST00047-00047

Check of brush holder (Only for 1.0 kW TYPE)

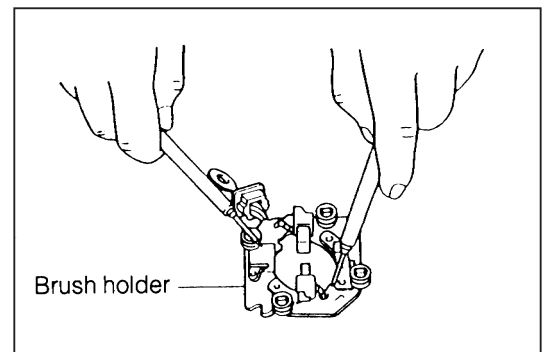
1. Check of brush holder for insulation

Measure the insulation between the positive and negative terminal of the brush holder, using an ohmmeter.

Insulation Resistance: 100 MΩ or more

2. Replacement of brush holder

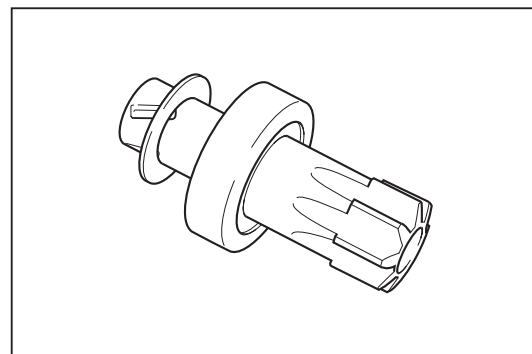
If the insulation resistance is less than the specification, replace the brush holder.



MST00048-00048

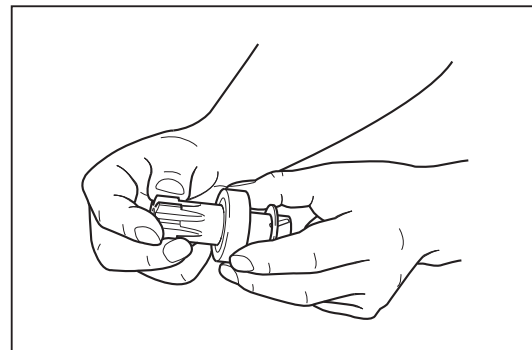
Check of clutch

1. Inspection of pinion gear and spline teeth
Check the teeth of the pinion gear and spline for wear or damage.
If any damage exists, replace the clutch. Also, inspect the flywheel ring gear for wear or damage.



MST00049-00049

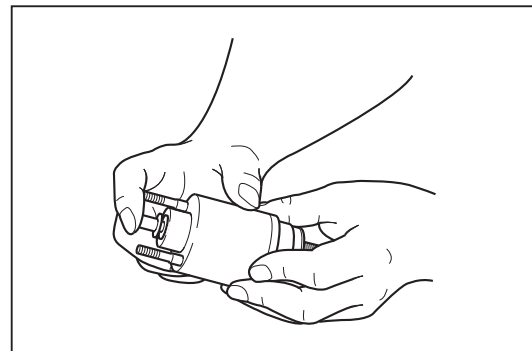
2. Check of starter clutch
While holding the clutch, turn the pinion clockwise. Ensure that the pinion turns smoothly.
Turn the pinion counterclockwise. Ensure that the pinion is locked.
If the check results are unsatisfactory, replace the starter clutch.



MST00050-00050

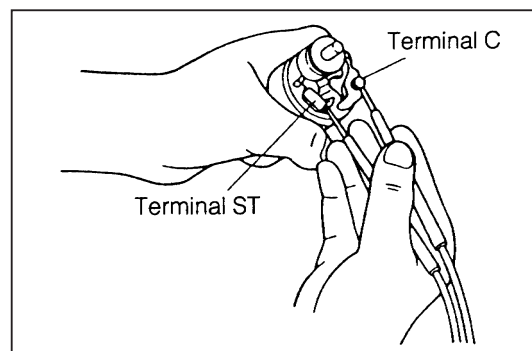
Check of magnetic switch

1. Plunger check
Push in the plunger with your fingers and release your fingers. Ensure that the plunger returns quickly to the original position. If the plunger exhibits poor returning or fails to return, replace the magnetic switch.



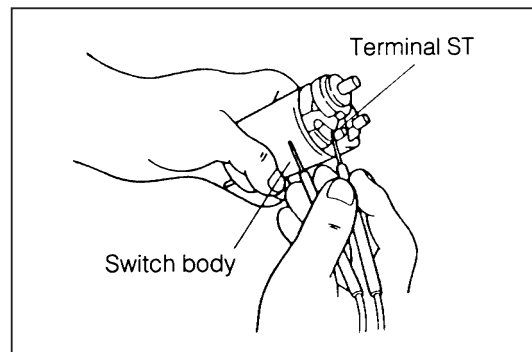
MST00051-00051

2. Pull-in coil open circuit test
Using an ohmmeter, ensure that continuity exists between the terminal ST and the terminal C.
If no continuity exists, replace the magnetic switch.



MST00052-00052

3. Hold-in coil open circuit test
Ensure that continuity exists between the terminal ST and the switch body.
If no continuity exists, replace the magnetic switch.



MST00053-00053

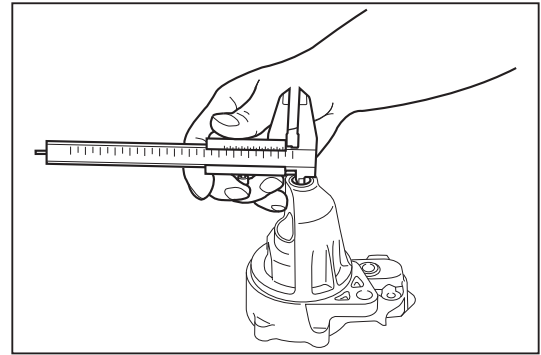
ST-16

Check of bearing (Only for 0.8kW TYPE)

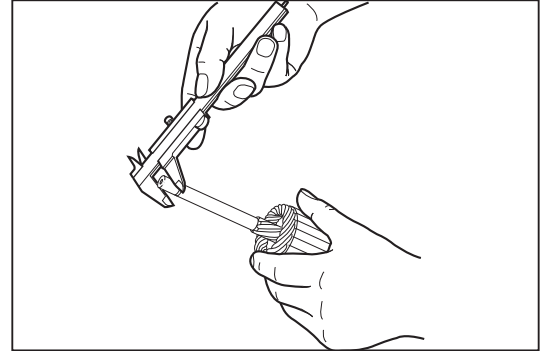
1. Remove the bearing, using a suitable tool in combination with a press or the like.

NOTE:

- When pulling out the bearing, be sure to remove it from the inside.
2. Measure the inner diameter of the bushes of the drive housing and commutator end frame.
 3. Measure the outer diameter of the armature bearing section.



MST00054-00054



MST00055-00055

4. Determine the clearance by subtracting the outer diameter of the armature bearing section from the diameter of the drive shaft.

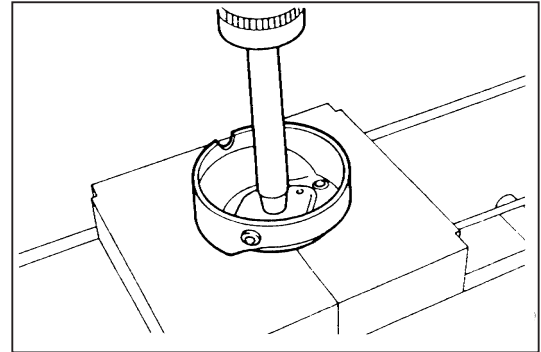
Standard Clearance: 0.02 - 0.07 mm

Limit: 0.15 mm

If the clearance exceeds the limit, replace the drive housing bearing (bush).

SST: 09301- 87601- 000

(Round rod of 15mm outer dia.)



MST00056-00056

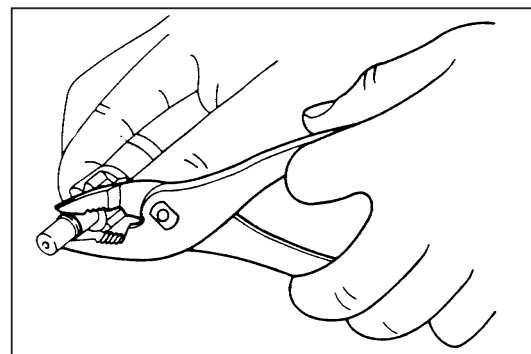
ASSEMBLY

NOTE:

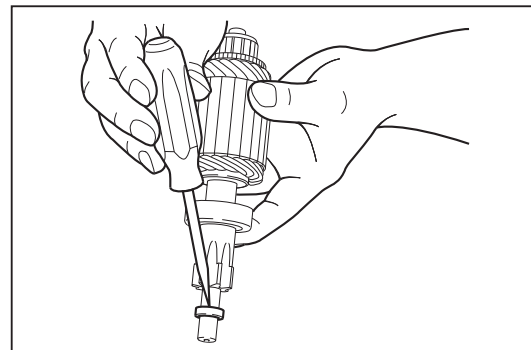
- Use high-temperature grease to lubricate the bearings and sliding parts when assembling the starter motor.

For 0.8 kW motor

1. Install the clutch on the armature shaft.
2. Install the pinion stop nut on the armature shaft.
3. Fit the new snap ring onto the armature shaft.
4. Tap the pinion so that the pinion stop nut may come onto the snap ring, using a screwdriver.



MST00057-00057

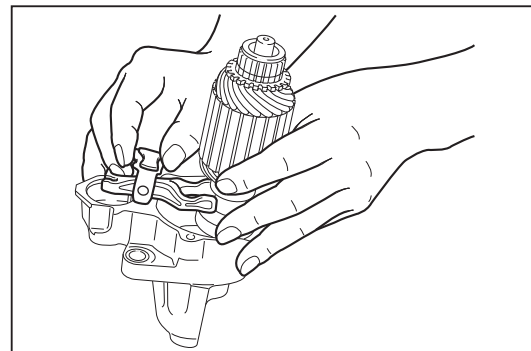


MST00058-00058

5. Install the drive lever and armature in the drive housing.

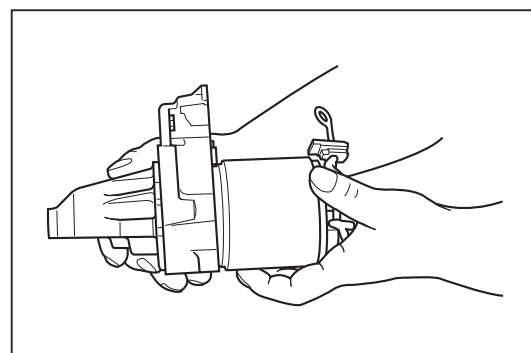
NOTE:

- Apply high-temperature grease to the sliding sections of the armature shaft and drive lever.



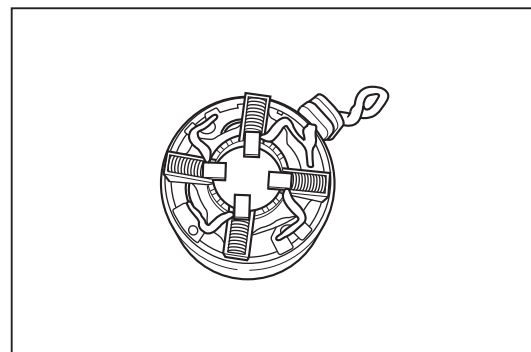
MST00059-00059

6. Install the yoke in the drive housing.



MST00060-00060

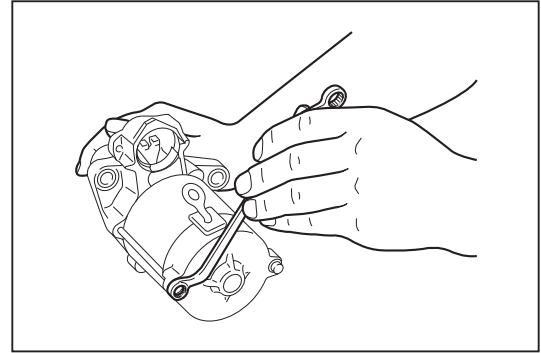
7. Install the brush holder over the armature shaft.
8. Install the brush and brush spring in the brush holder.



MST00061-00061

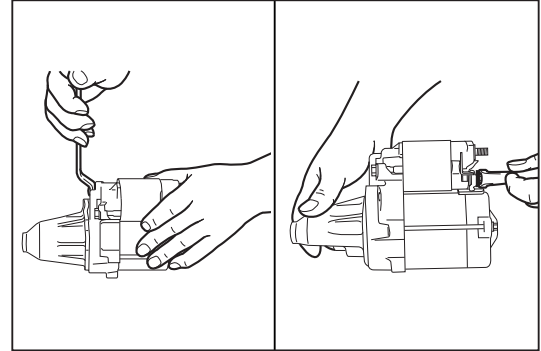
ST-18

9. Install the insulator on the brush holder.
10. Attach the end frame to the yoke assembly.



MST00062-00062

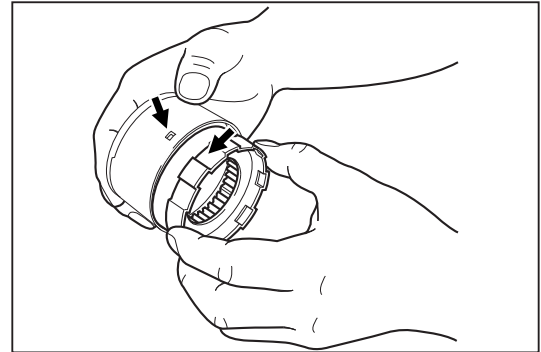
11. While hooking the magnetic switch over the drive lever, install the magnetic switch onto the drive housing. Secure the magnetic switch with the two nuts.
12. Connect the lead wire to the magnetic switch.



MST00063-00063

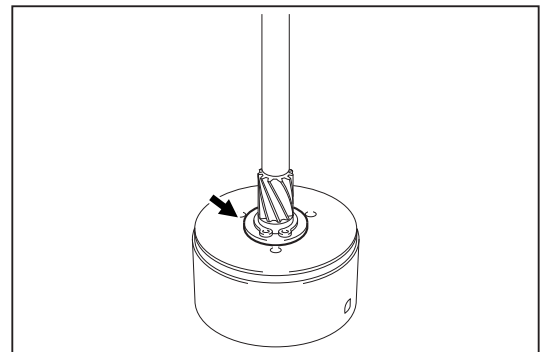
For 1.0 kW motor

1. Place the internal gear into the center bearing.
NOTE:
 - When the internal gear is placed, align the recess provided at the circumference of the center bearing with the recess provided at the circumference of the internal gear.



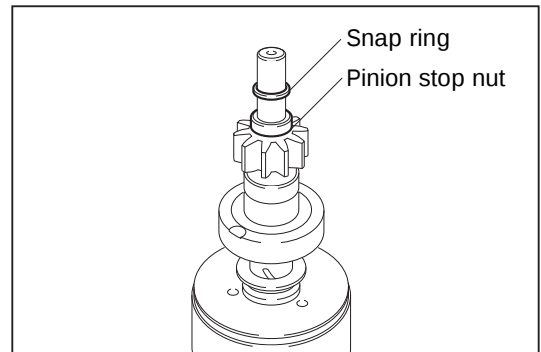
MST00064-00064

2. Place the planet carrier shaft into the center bearing with the washers.
Clamp it with the snap ring.



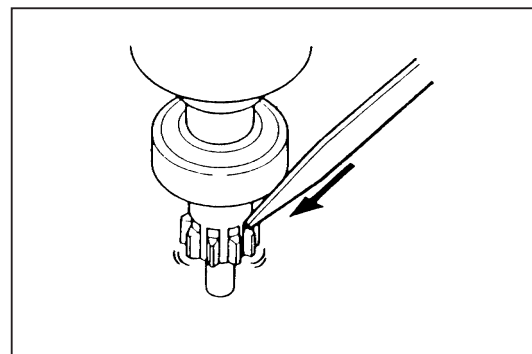
MST00065-00065

3. Pass the pinion stop nut through the center bearing shaft. Then, attach the snap ring to the shaft groove.



MST00066-00066

4. Tap the pinion so that the pinion stop nut may come onto the snap ring, using a screwdriver.

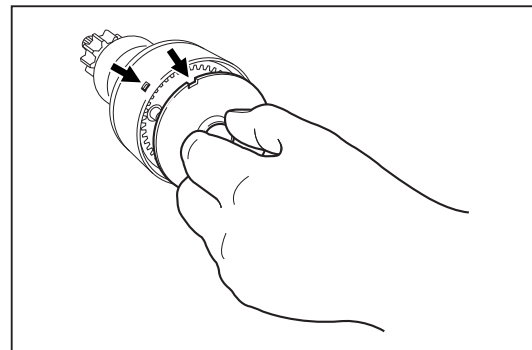


MST00067-00067

5. Install the planet gear to the planet carrier.

NOTE:

- Apply high-temperature grease to the gear sections of the planet gears.



MST00068-00068

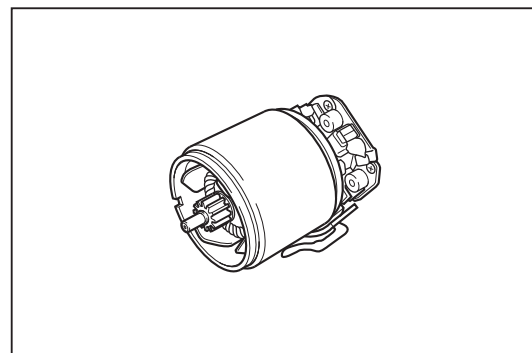
6. Install the plate to the center bearing.

NOTE:

- During the installation, be sure to align the recess provided at the circumference of the plate with the recess provided at the circumference of the center bearing.

7. Place the armature in the yoke.

8. Place the brush in the brush holder.

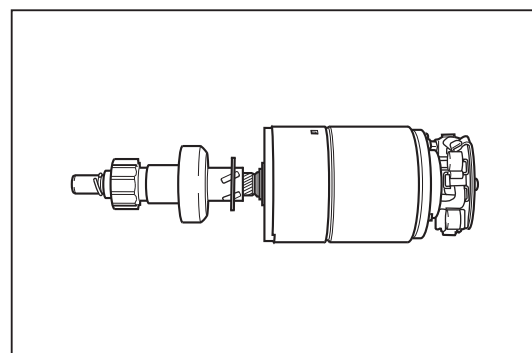


MST00069-00069

9. Connect the center bearing with the yoke.

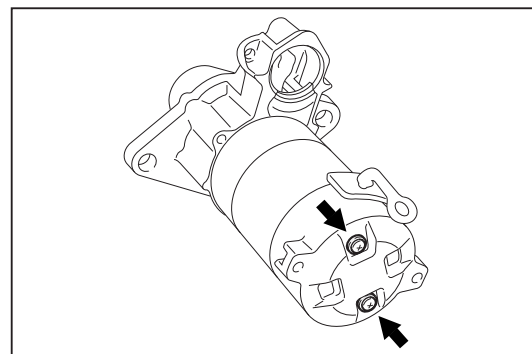
NOTE:

- During connection, be sure to align the recess sections at the connecting section.



MST00070-00070

10. Install the rear end frame to the yoke.



MST00071-00071

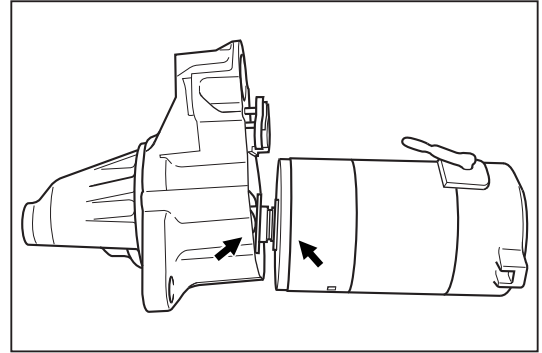
ST-20

11. Install the drive lever and armature in the drive housing.

NOTE:

- Apply high-temperature grease to the sliding sections of the armature shaft and drive lever.
- Align the protrusion of the center bearing with the recess of the drive housing.

12. Tighten the through bolt.



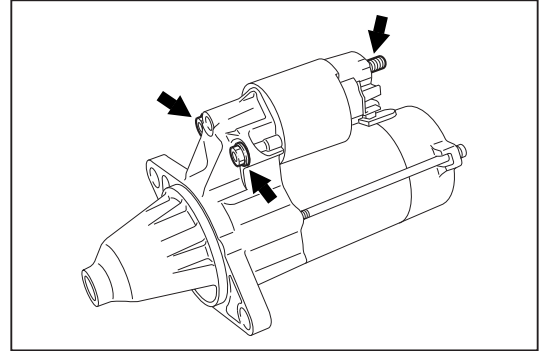
MST00072-00072

13. While hooking the magnetic switch over the drive lever, install the magnetic switch onto the drive housing. Secure the magnetic switch with the two nuts.

NOTE:

- Be sure to install the rubber boot in the spring section securely.

14. Connect the lead wire to the magnetic switch.



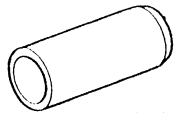
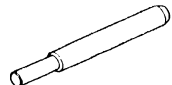
MST00073-00073

SPECIFICATIONS

Starter type		Planetary type (Cold spec.)	Conventional
Rated voltage and output power		12 V - 1.0 kW	12 V - 0.8 kW
No-load characteristic at 11.5 V		Less than 90 A	Less than 50 A
Brush length	Specified value	14.0 mm	10.0 mm
	Allowable limit	11.1 mm	7.8 mm
Commutator	Outer diameter	Specified value	28 mm
		Allowable limit	27 mm
	Undercut depth	Specified value	0.45 - 0.75 mm
		Allowable limit	0.2 mm
	Maximum circle runout	Specified value	0.02 mm
		Allowable limit	0.05 mm

MST00074-00000

SSTs

Shape	Part number	Part name
	09238-87701-000	Remover & replacer
	09301-87601-000	Clutch guide tool

MST00075-00074

TIGHTENING TORQUE

Tightening components	Tightening torque	
	N·m	kgf·m
Starter motor × Engine	39.0 ± 7.8	4.0 ± 0.8

MST00076-00000