

STARTING SYSTEM

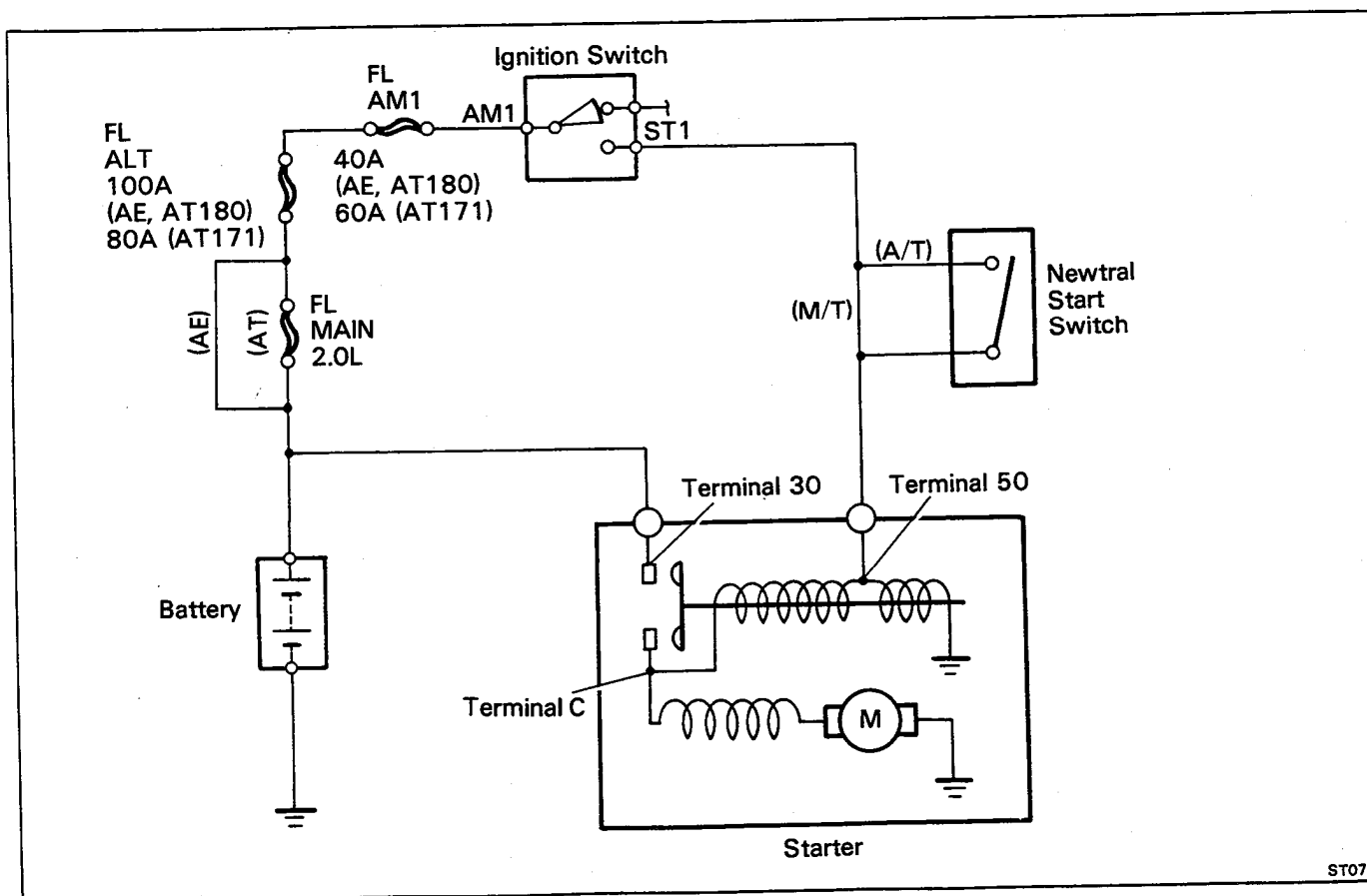
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REDUCTION TYPE STARTER	ST-17

ST

TROUBLESHOOTING

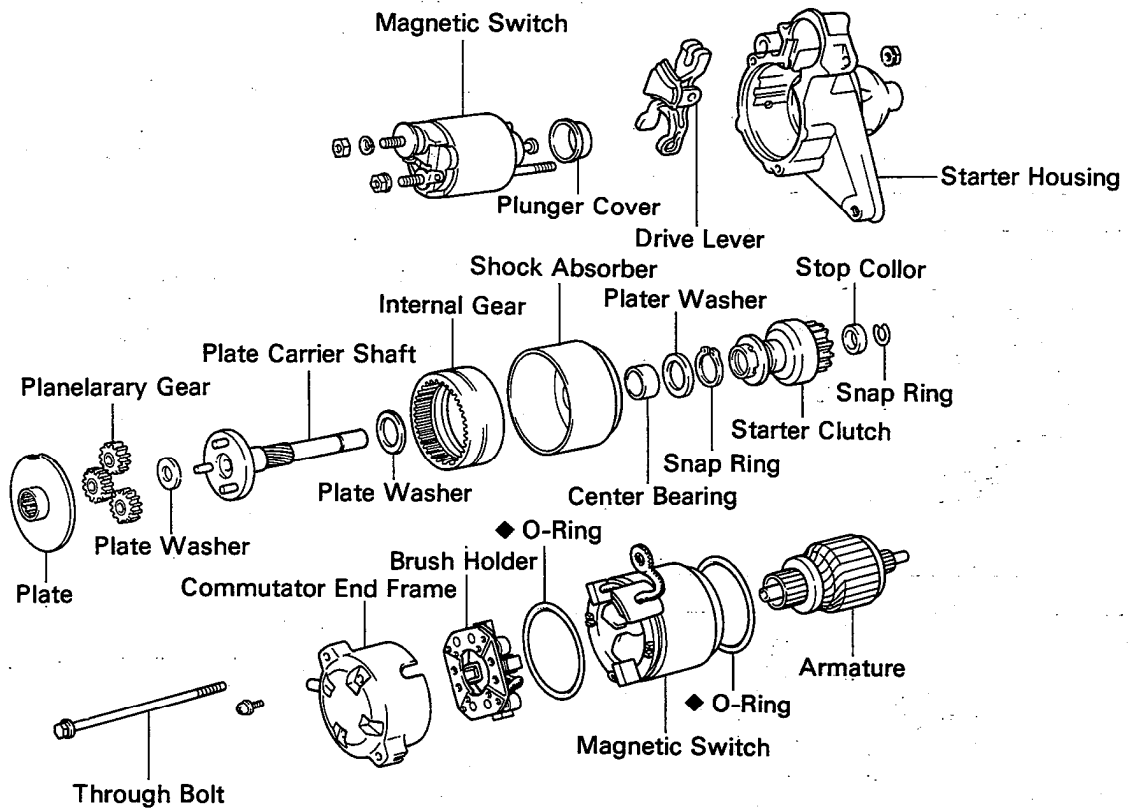
Problem	Possible cause	Remedy	Page
Engine will not crank	Battery charge low	Check battery specific gravity Charge or replace battery	CH-4 ST-3, 17
	Battery cables loose, corroded or worn	Repair or replace cables	
	Neutral start switch faulty (A/T)	Adjust or replace switch	
	Fusible link blown	Replace fusible link	
	Starter faulty	Repair starter	
	Ignition switch faulty	Replace ignition switch	
Engine cranks slowly	Battery charge low	Check battery specific gravity Charge or replace battery	CH-4 ST-3, 17
	Battery cables loose, corroded or worn	Repair or replace cables	
	Starter faulty	Repair starter	
Starter keeps running	Starter faulty	Repair starter	ST-3, 17
	Ignition switch faulty	Replace ignition switch	
	Short in wiring	Repair wiring	
Starter spins-engine will not crank	Pinion gear teeth broken or faulty starter	Repair starter	ST-3, 17
	Flywheel or drive plate teeth broken	Replace flywheel or drive plate	

STARTING SYSTEM CIRCUIT

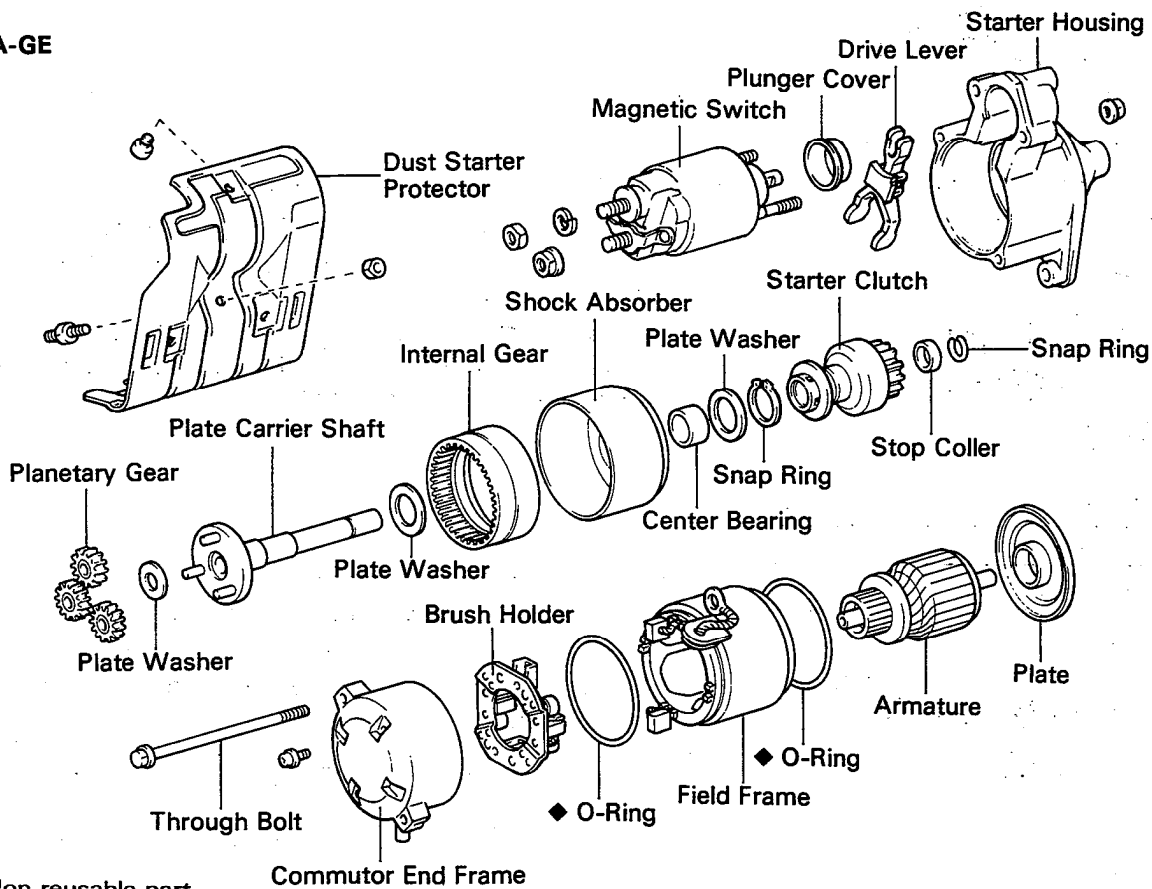


PLANETARY TYPE STARTER COMPONENTS

4A-FE

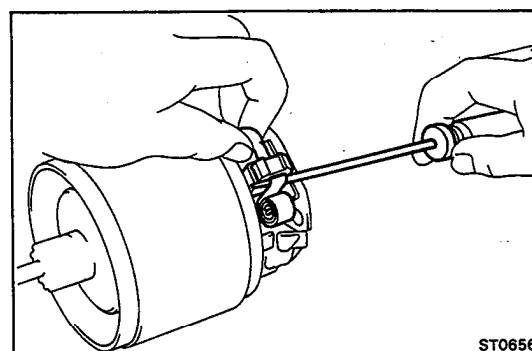
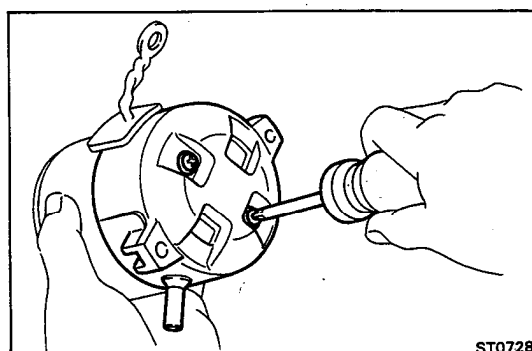
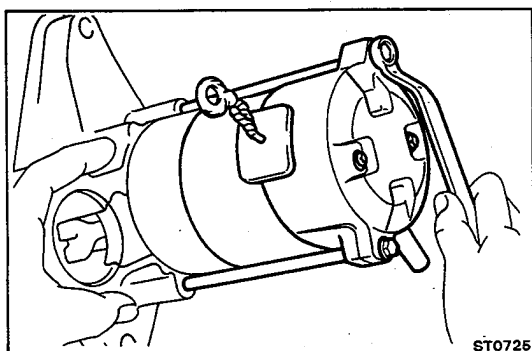
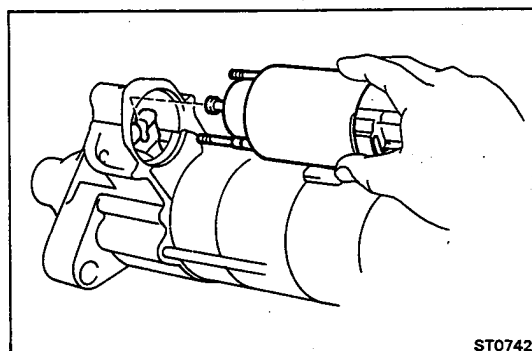
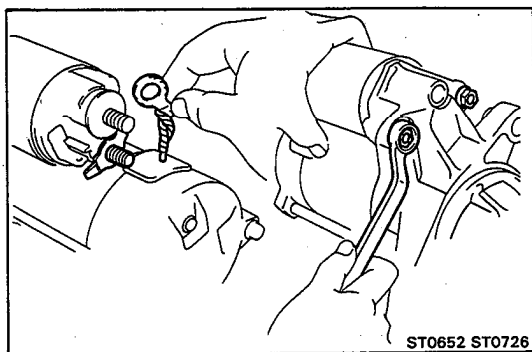


4A-GE



◆ Non reusable part

ST0719
ST0765



DISASSEMBLY OF PLANETARY TYPE STARTER

(See page ST-3)

1. (4A-GE) REMOVE DUST STARTER PROTECTOR

2. REMOVE MAGNETIC SWITCH

- Remove the nut, and disconnect the lead wire from the magnetic switch terminal.
- Loosen the two nuts holding the magnetic switch to the drive housing.
- Pull the magnetic switch and while lifting the front part of the magnetic switch, release the plunger hook from the drive lever, then release the magnetic switch.
- Remove the plunger cover.

3. REMOVE FIELD FRAME AND ARMATURE

Remove the two through bolts, and pull out the field frame together with the armature.

4. REMOVE COMMUTATOR END FRAME

Remove the two screws with O-rings and commutator end frame, and hold down the lead wire while releasing the commutator end frame.

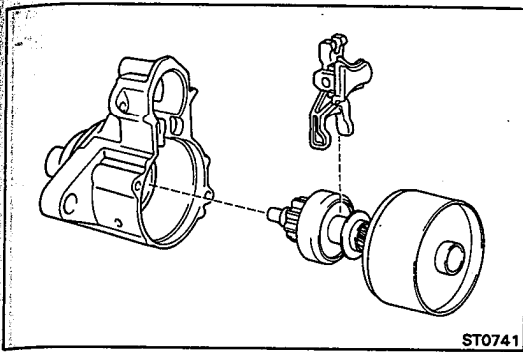
NOTICE: To avoid interference between the brush holder and the water outlet hose, pull the commutator end frame away at an angle.

5. REMOVE BRUSH HOLDER

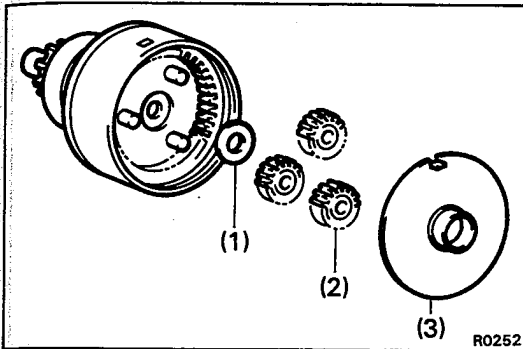
- Using a screwdriver, hold the spring back and disconnect the brush holder.
- Disconnect the four brushes, and remove the brush holder.

6. REMOVE ARMATURE FROM FIELD FRAME

7. REMOVE TWO O-RINGS FROM FIELD FRAME



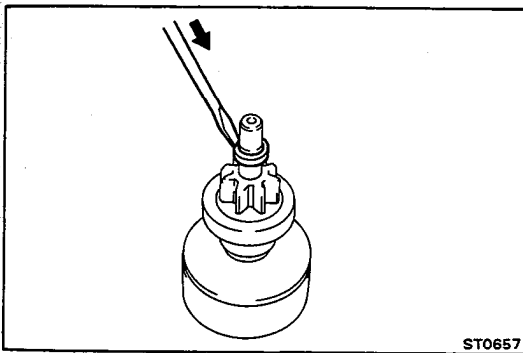
- 8. REMOVE DRIVE LEVER AND STARTER CLUTCH WITH SHOCK ABSORBER FROM STARTER HOUSING**



9. REMOVE PLANETARY GEARS

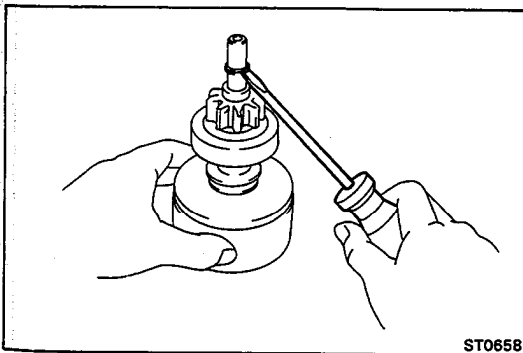
Remove the following parts from the shock absorber.

- (1) Plate
- (2) Three planetary gears
- (3) Plate washer

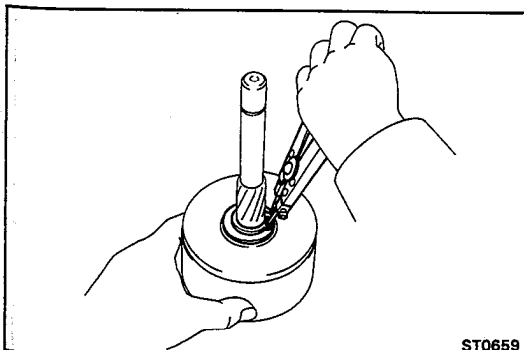


10. REMOVE STARTER CLUTCH

- (a) Using a screwdriver, tap the stop collar towards the starter clutch.

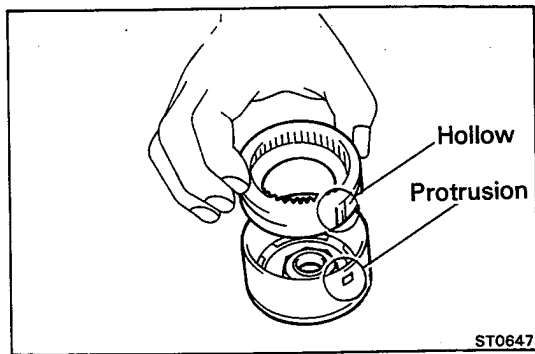


- (b) Using a screwdriver, pry off the snap ring.
(c) Remove the stop collar and starter clutch.



11. REMOVE PLANET CARRIER SHAFT AND INTERNAL GEAR

- (a) Using snap ring pliers, remove the snap ring and plate washer.
(b) Remove the planet carrier shaft and plate washer.

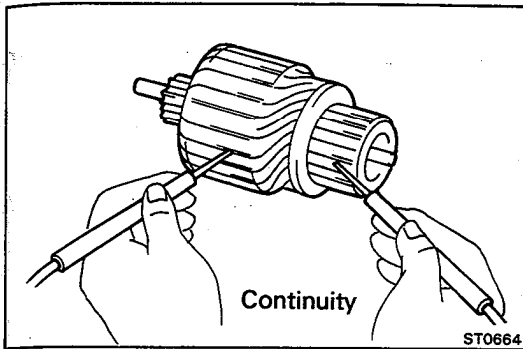


- (c) Align the hollow of the internal gear with the protrusion inside the shock absorber, and remove the internal gear.

INSPECTION OF PLANETARY TYPE STARTER**Armature Coil****1. INSPECT COMMUTATOR FOR OPEN CIRCUIT**

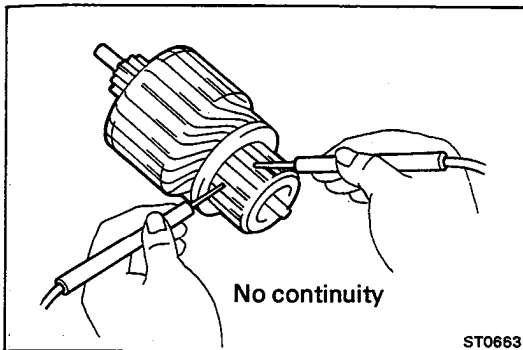
Using an ohmmeter, check that there is continuity between the segments of the commutator.

If there is no continuity, replace the armature.

**2. INSPECT COMMUTATOR FOR GROUND**

Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

If there is continuity, replace the armature.

**Commutator****1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACES**

If surface is dirty or burnt, correct with sandpaper (No.400) or a lathe.

2. INSPECT COMMUTATOR CIRCLE RUNOUT

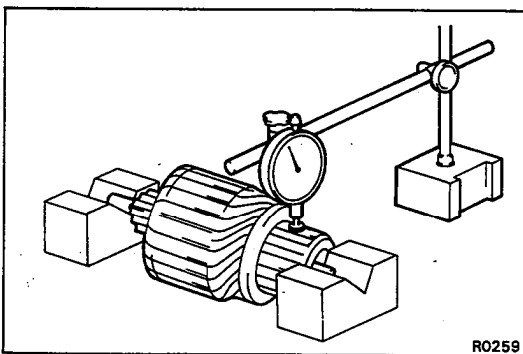
(a) Place the armature on V-blocks.

(b) Using a dial indicator, measure the circle runout.

Standard circle runout: 0.02 mm (0.0008 in.)

Maximum circle runout: 0.05 mm (0.0020 in.)

If the circle runout is greater than maximum, correct it on a lathe.

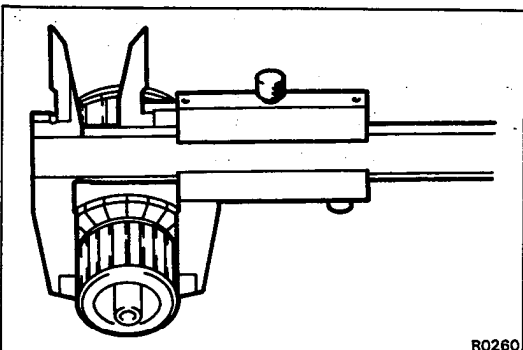
**3. INSPECT COMMUTATOR DIAMETER**

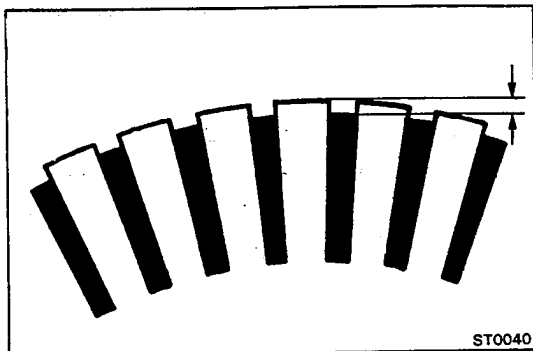
Using vernier calipers, measure the diameter.

Standard diameter: 28.0 mm (1.10 in.)

Minimum diameter: 27.0 mm (1.06 in.)

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





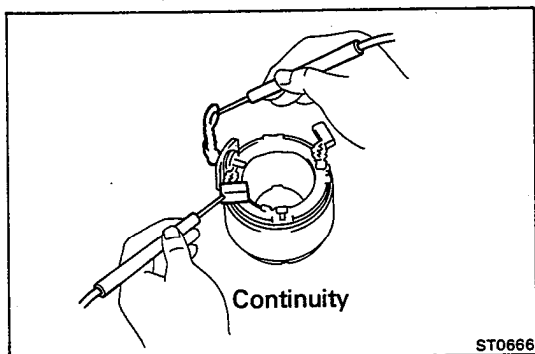
4. INSPECT UNDERCUT DEPTH

Check that the undercut depth is clean and free of foreign particles. Smooth out the edge.

Standard undercut depth: 0.6 mm (0.024 in.)

Minimum undercut depth: 0.2 mm (0.008 in.)

If the undercut depth is less than minimum, correct with a hacksaw blade and smooth out the edge.

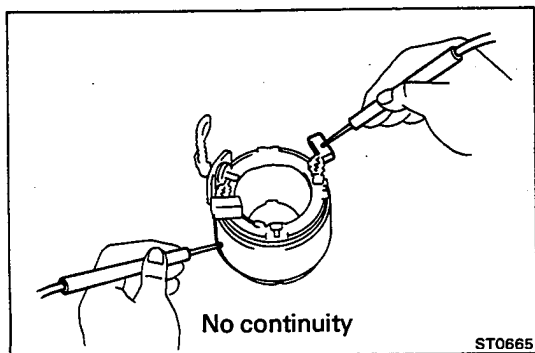


Field Coil (Field Frame)

1. INSPECT FIELD COIL FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.

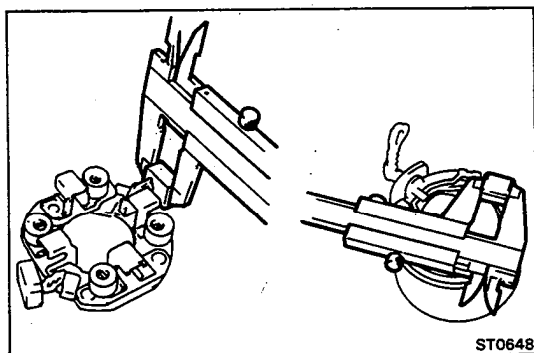
If there is no continuity, replace the field frame.



2. INSPECT FIELD COIL FOR GROUND

Using an ohmmeter, check that there is no continuity between the field coil end and field frame.

If there is continuity, replace the field coil.



Brushes

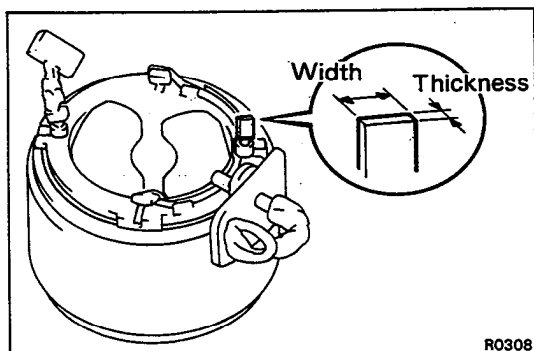
INSPECT BRUSH LENGTH

Using vernier calipers, measure the brush length.

Standard length: 14.0 mm (0.551 in.)

Minimum length: 9.0 mm (0.354 in.)

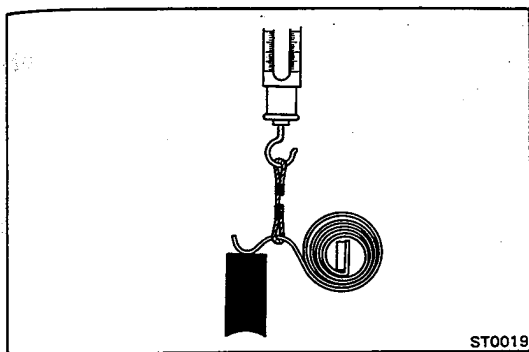
If the length is less than minimum, replace the brush (field frame side) or brush holder, and dress with an emery cloth.



If replacing the brush, adjust the terminal to specification after removing the brush.

Specified width: 5.0 mm (0.197 in.)

Specified thickness: 1.5 – 1.7 mm
(0.059 – 0.067 in.)



ST0019

Brush Springs

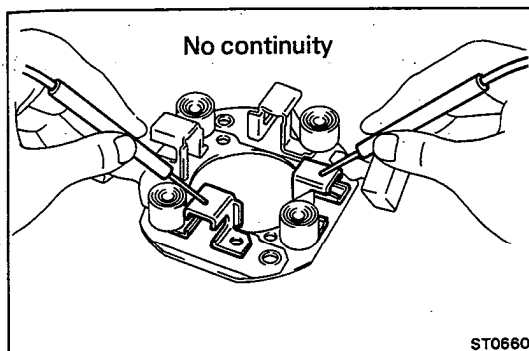
INSPECT BRUSH SPRING LOAD

Take the pull scale reading the instant the brush spring separates from the brush.

Standard installed load: 1.6 kg (3.5 lb, 16N)

Minimum installed load: 0.9 kg (2.0 lb, 9N)

If the installed load is less than minimum, replace the brush springs.



ST0660

Brush Holder

INSPECT BRUSH HOLDER INSULATION

Using an ohmmeter, check that there is no continuity between the positive (+) and negative (-) brush holders.

If there is continuity, repair or replace the brush holder.

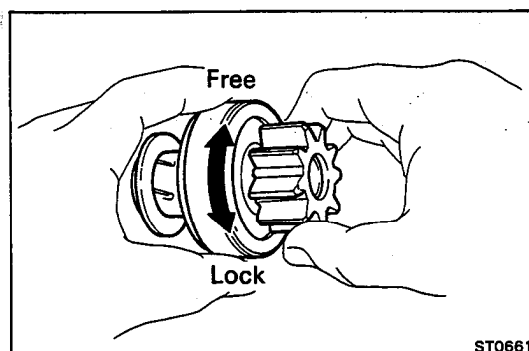
Starter Clutch and Gears

1. INSPECT GEAR TEETH

Check the gear teeth on the planetary gear, internal gear and the starter clutch for wear or damage.

If the gear is damaged, replace it.

If the starter clutch teeth are damaged, replace the starter clutch and also inspect the flywheel ring gear for wear or damage.

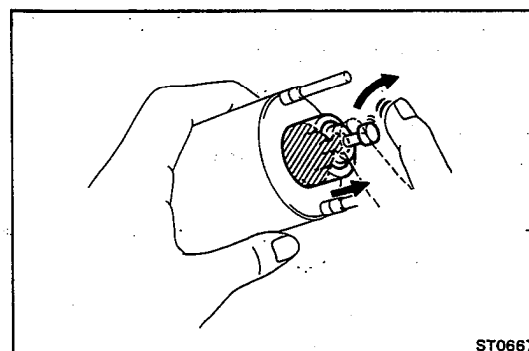


ST0661

2. INSPECT STARTER CLUTCH

Rotate the clutch pinion gear clockwise and check that it turns freely. Try to rotate the pinion counterclockwise and check that it locks.

If necessary, replace the starter clutch.



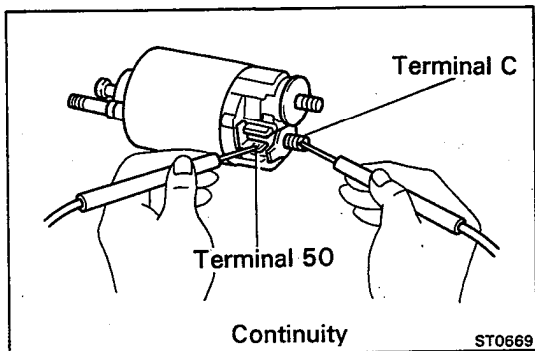
ST0667

Magnetic Switch

1. INSPECT PLUNGER

Push in the plunger and replace it. Check that it returns quickly to its original position.

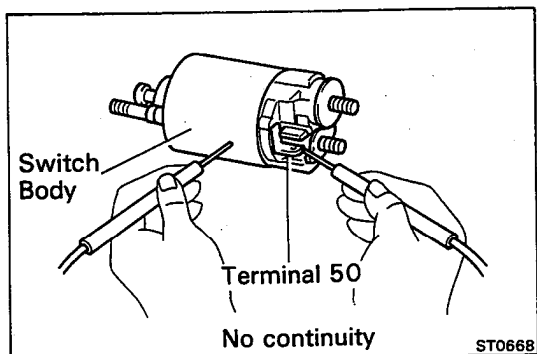
If necessary, replace the magnetic switch.



2. PERFORM PULL-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check that there is continuity between terminal 50 and terminal C.

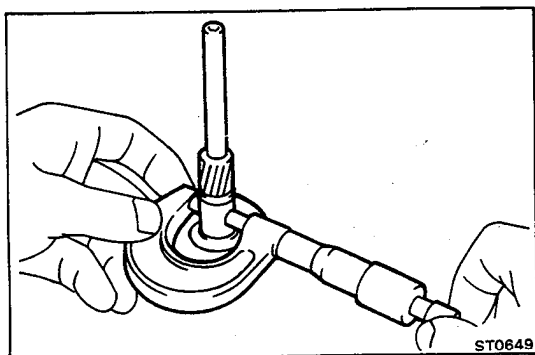
If there is no continuity, replace the magnetic switch.



3. PERFORM HOLD-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check that there is continuity between terminal 50 and the switch body.

If there is no continuity, replace the magnetic switch.



Planet Carrier Shaft and Center Bearing

1. INSPECT PLANET CARRIER SHAFT AND CENTER BEARING

- (a) Using a micrometer, measure the outer diameter of the surface in contact with the center bearing of the planet carrier shaft.

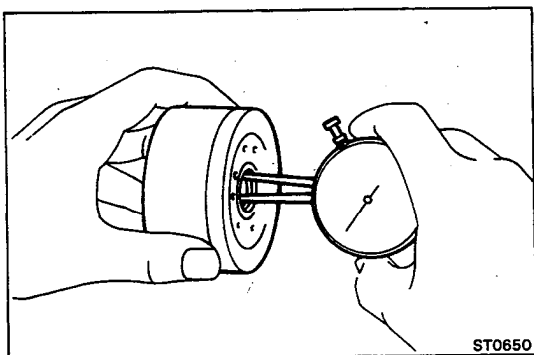
Standard shaft diameter:

14.035 – 15.000 mm (0.5526 – 0.5906 in.)

- (b) Using a caliper gauge, measure the inside diameter of the center bearing.

Center bearing inside diameter:

15.000 – 15.035 mm (0.5906 – 0.5919 in.)



- (c) Subtract the planet carrier shaft diameter from the bearing inside diameter measurement.

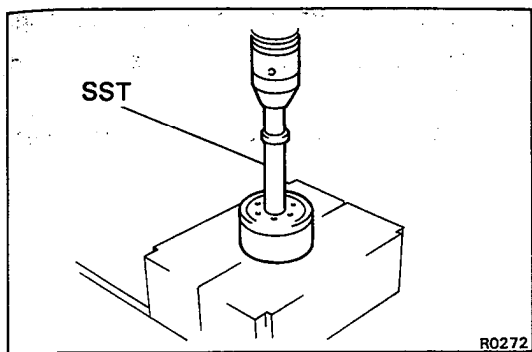
Standard center bearing oil clearance:

0.03 mm (0.0012 in.)

Maximum center bearing oil clearance:

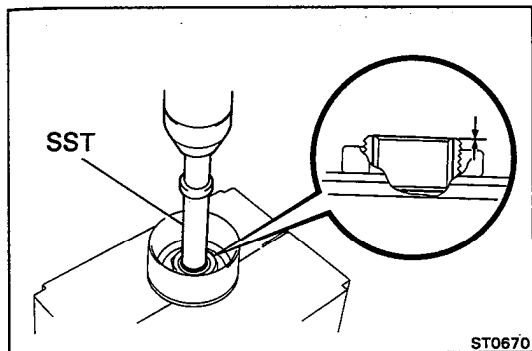
0.1 mm (0.004 in.)

If the clearance is greater than maximum, replace the planet carrier shaft and center bearing.



2. IF NECESSARY, REPLACE CENTER BEARING

- (a) Using SST and a press, press out the center bearing.
SST 09221-25024 (09221-00090)



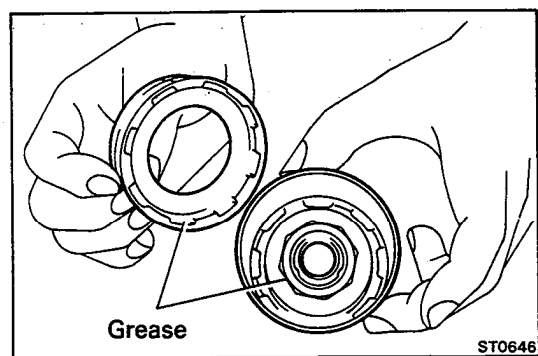
- (b) Using SST and a press, press in a new center bearing to the position shown in the illustration.

SST 09221-25024 (09221-00090)

ASSEMBLY OF PLANETARY TYPE STARTER

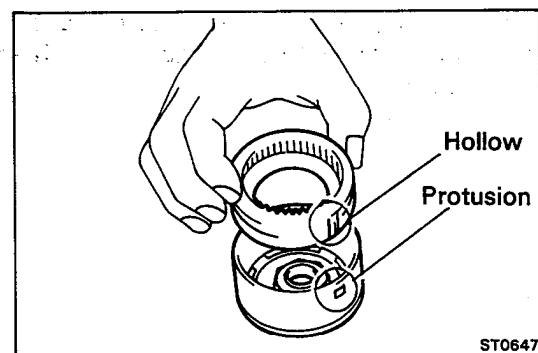
(See page ST-3)

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

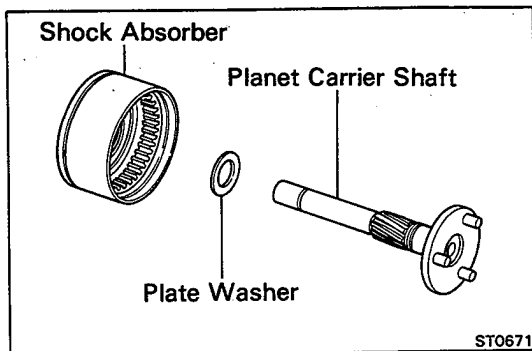


1. INSTALL INTERNAL GEAR AND PLANET CARRIER SHAFT

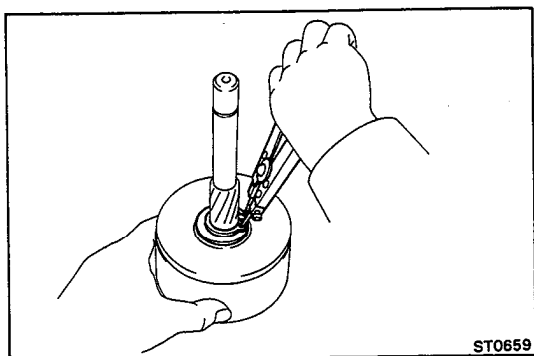
- (a) Apply grease to the internal gear touching the shock absorber and planetary gears.



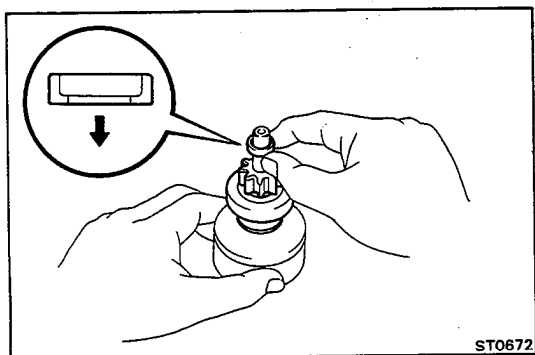
- (b) Align the hollow of the internal gear with the protrusion inside the shock absorber.
- (c) Insert and turn the internal gear so that it interlocks with the shock absorber.



- (d) Apply turbine oil with additives to the center bearing.
- (e) Apply grease to the plate washer, and install it to the planet carrier shaft.
- (f) Install the planet carrier shaft to the shock absorber.

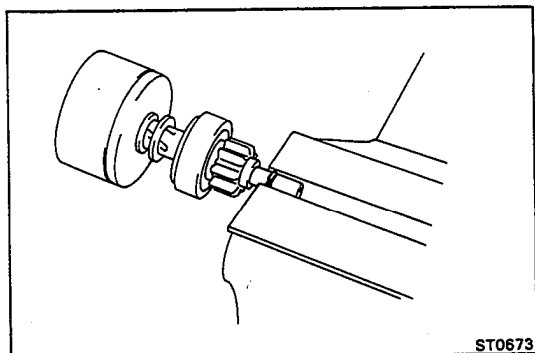


- (g) Using snap ring pliers, install the plate washer and snap ring.

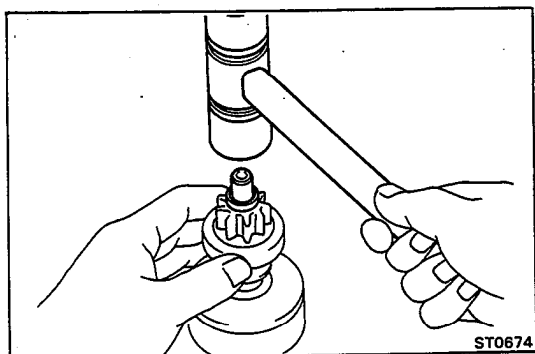


2. INSTALL STARTER CLUTCH

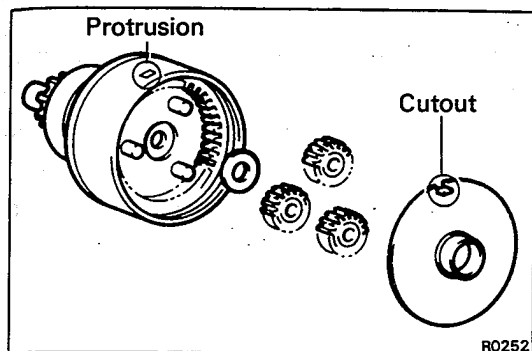
- (a) Apply grease to the bushing and spline of the starter clutch stop collar.
- (b) Place the starter clutch and stop collar on the planet carrier shaft.



- (c) Apply grease to the snap ring, and install it to the planet carrier shaft groove.
- (d) Using a vise, compress the snap ring.

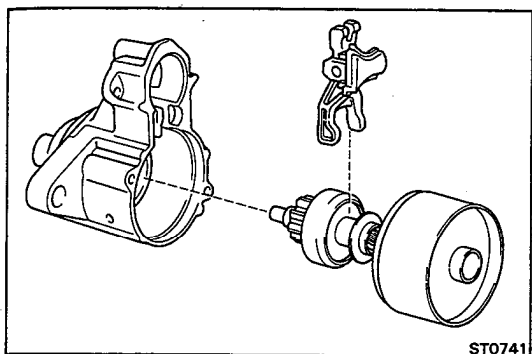


- (e) Hold the starter clutch, tap the planet carrier shaft and install the stop collar onto the snap ring with a plastic-faced hammer.



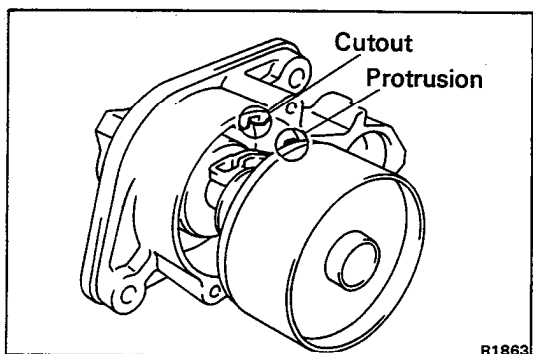
3. INSTALL PLANETARY GEARS

- Apply grease to the planetary gears and flange pin parts of the planet carrier shaft.
- Install the plate washer and three planetary gears.
- Align the cutout of the plate with the protrusion inside the shock absorber, and install the plate.

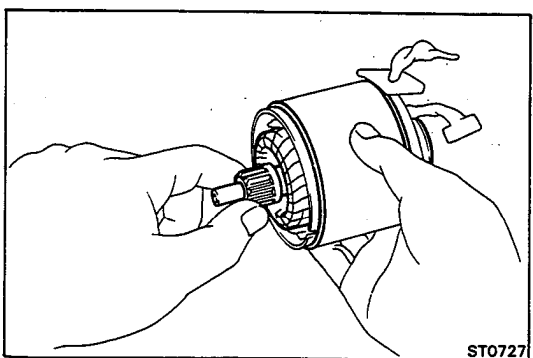


4. INSTALL DRIVE LEVER AND STARTER CLUTCH WITH SHOCK ABSORBER

- Apply turbine oil with additives to the bearing of the starter drive housing.
- Apply grease to the drive lever touching the starter pivot part of the drive lever.
- Install the drive lever to the starter clutch.

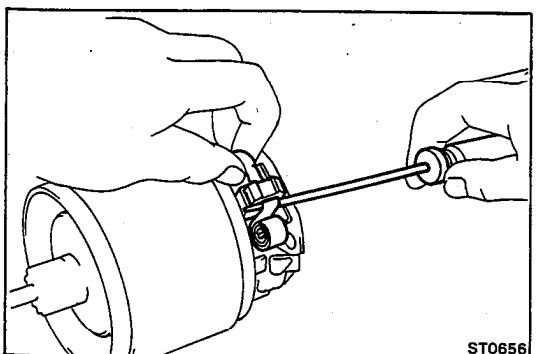


- Align the protrusion of the shock absorber with the cutout of the drive housing and install them.



5. INSTALL NEW O-RINGS TO FIELD FRAME

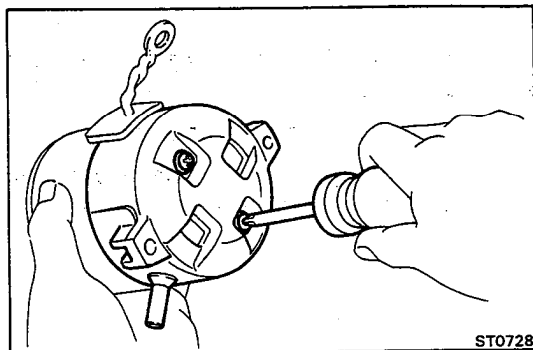
6. PLACE ARMATURE INTO FIELD FRAME



7. INSTALL BRUSH HOLDER

- Place the brush holder in position on the armature.
- Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Connect the four brushes.

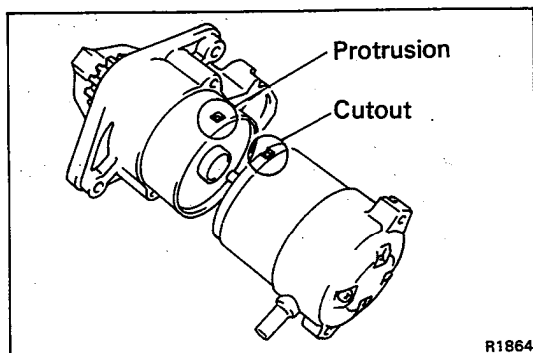
HINT: Check that positive (+) lead wires are not grounded.



8. INSTALL COMMUTATOR END FRAME

- (a) Apply turbine oil with additives to the bearing of the end frame.
- (b) Install the end frame with new two screws with O-rings.

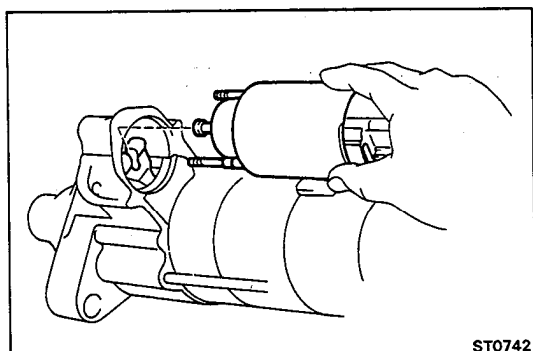
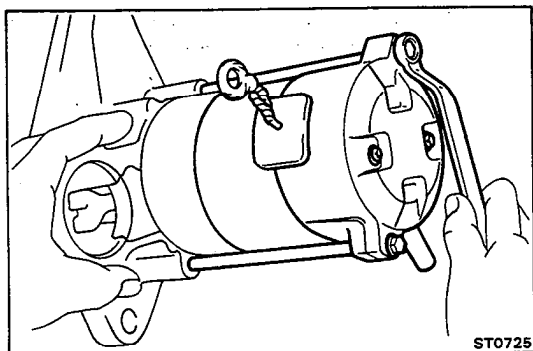
NOTICE: To avoid interference between the brush holder and the water outlet hose, pull the commutator end frame away at an angle.



9. INSTALL FIELD FRAME AND ARMATURE ASSEMBLY

- (a) Align the cutout of the field frame with the protrusion of the shock absorber.

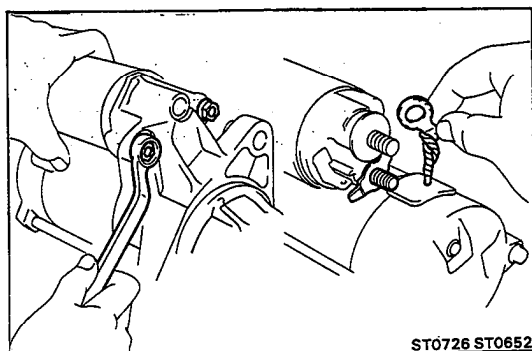
- (b) Install the field frame and armature assembly with the two through bolts.



10. INSTALL MAGNETIC SWITCH

- (a) Install the plunger cover to the magnetic switch.
- (b) Hang the plunger of the magnetic switch to the drive lever from the upper side.

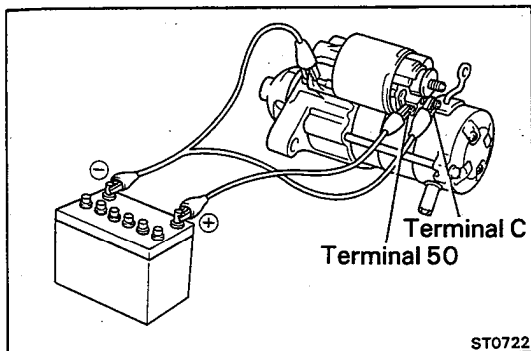
- (c) Install the magnetic switch with the two nuts.
- (d) Connect the lead wire to terminal C, and install the nut.



11. (4A-GE) INSTALL DUST STARTER PROTECTOR

PERFORMANCE TEST OF PLANETARY TYPE STARTER

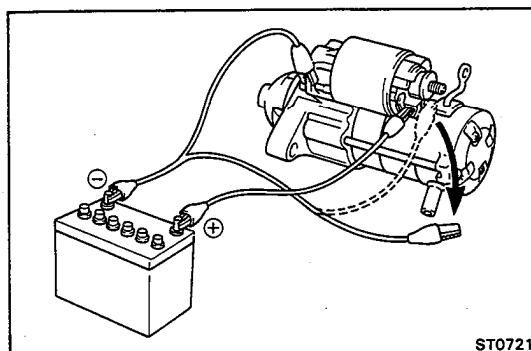
NOTICE: These testes must be performed within 3 to 5 seconds to avoid burning out the coil.



1. PERFORM PULL-IN TEST

- (a) Disconnect the field coil lead from terminal C.
- (b) Connect the battery to the magnetic switch as shown. Check that the clutch pinion gear moves outward.

If the clutch pinion gear does not move, replace the magnetic switch.

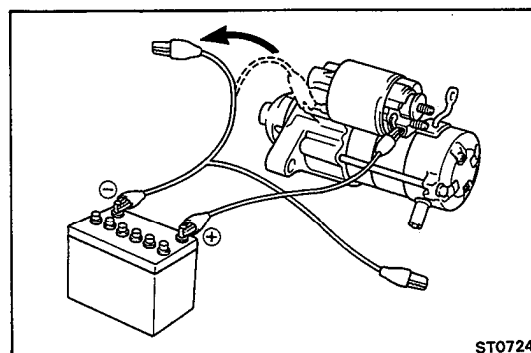


2. PERFORM HOLD-IN TEST

With the battery connected as above and with the pinion out, disconnect the negative (-) lead from terminal C.

Check that the clutch pinion remains out.

If the clutch pinion gear returns inward, replace the magnetic switch.

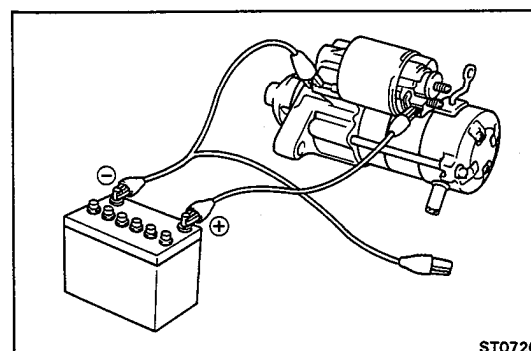


3. INSPECT CLUTCH PINION GEAR RETURN

Disconnect the negative (-) lead from the switch body.

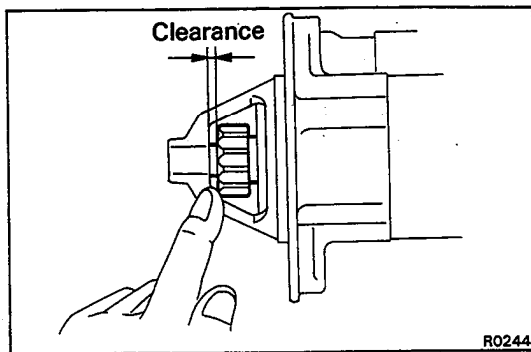
Check that the clutch pinion gear returns inward.

If the clutch pinion does not return, replace the magnetic switch.



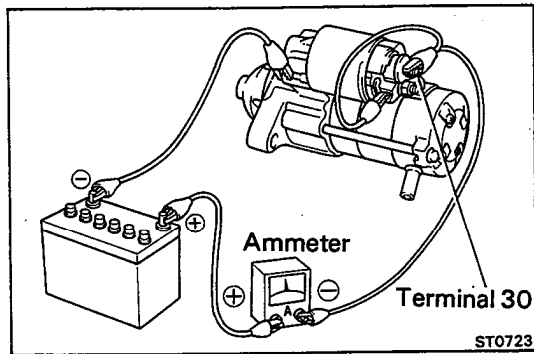
4. INSPECT CLUTCH PINION GEAR CLEARANCE

- (a) Connect the battery the magnetic switch as shown.



- (b) Move the pinion gear toward the armature to remove slack and measure the clearance between the pinion gear end and stop collar.

Standard clearance: 1 – 5 mm (0.04 – 0.20 in.)



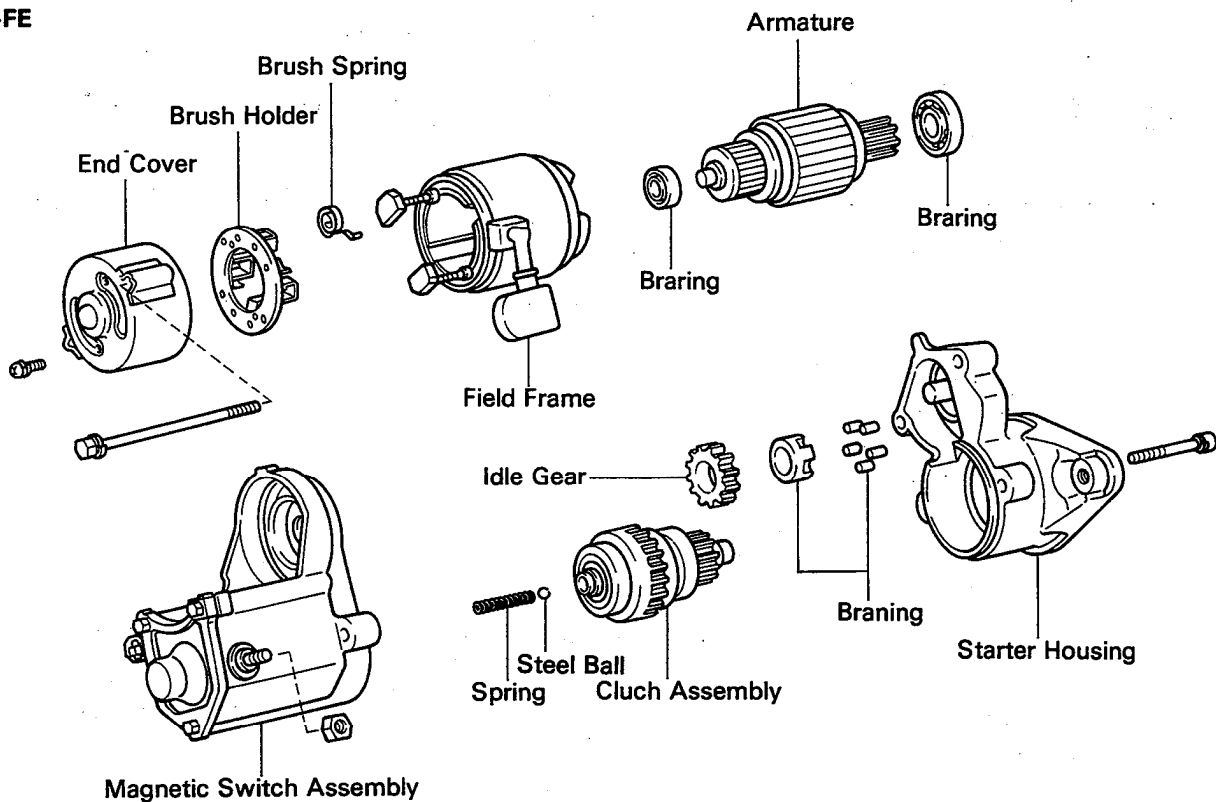
5. PERFORM NO-LOAD PERFORMANCE TEST

- (a) Connect the field coil lead terminal C. Check that the lead is not grounded.
- (b) Connect the battery and ammeter to the starter as shown.
- (c) Check that the starter rotates smoothly and steadily with the clutch pinion gear moving out. Check reading on the ammeter.

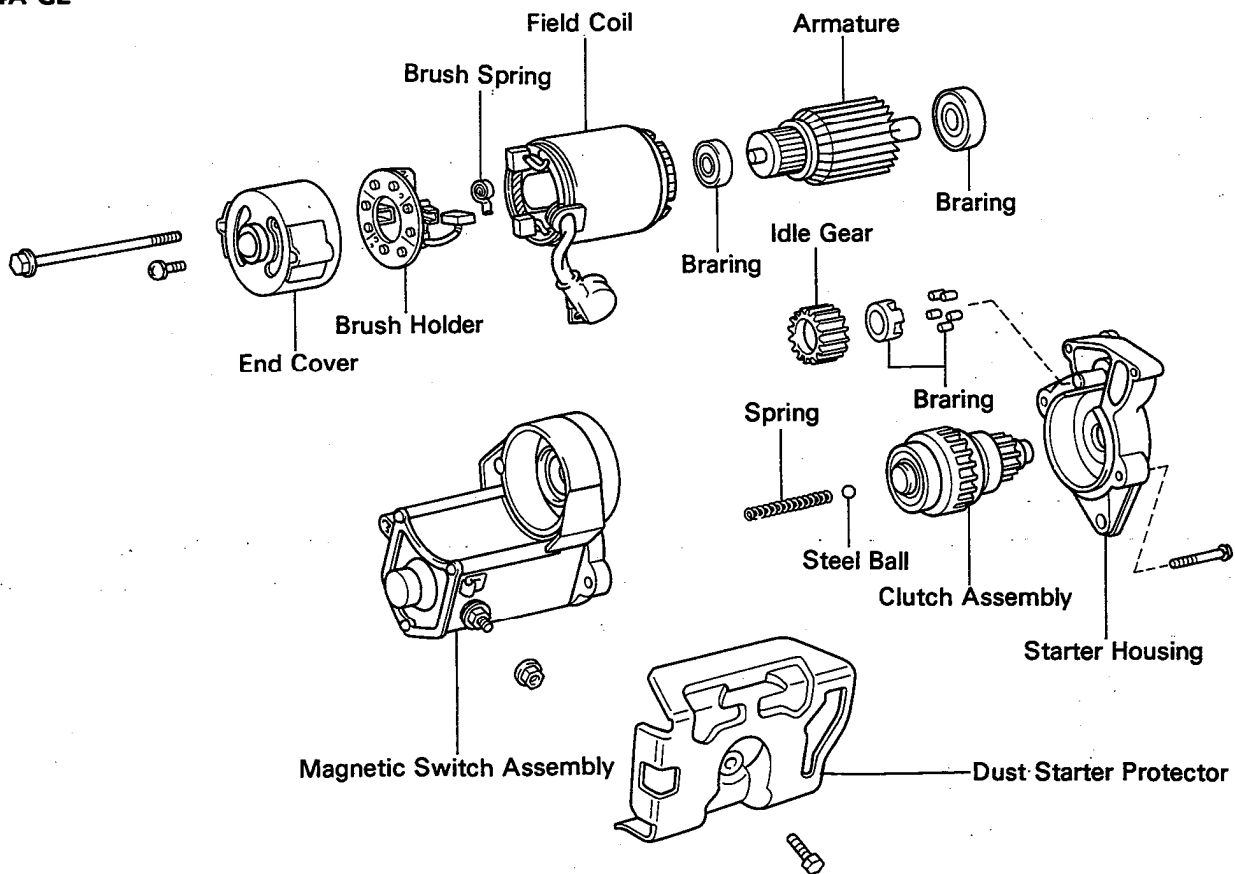
Specified current. 90A or less at 11.5V

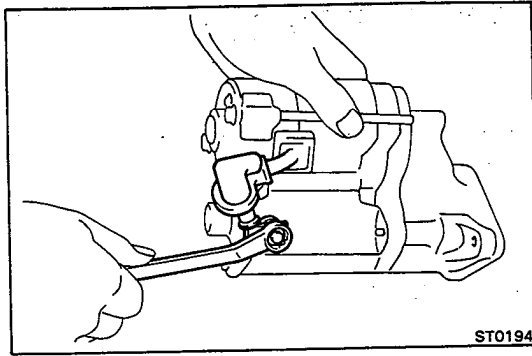
REDUCTION TYPE STARTER COMPONENTS

4A-FE



4A-GE

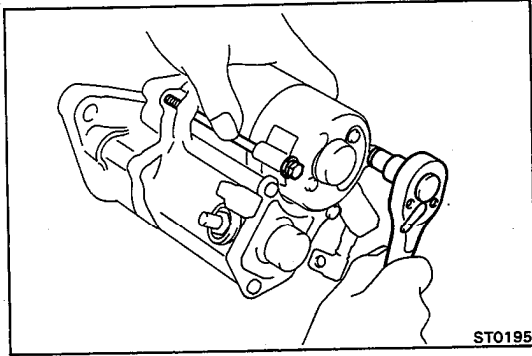




DISASSEMBLY OF REDUCTION TYPE STARTER

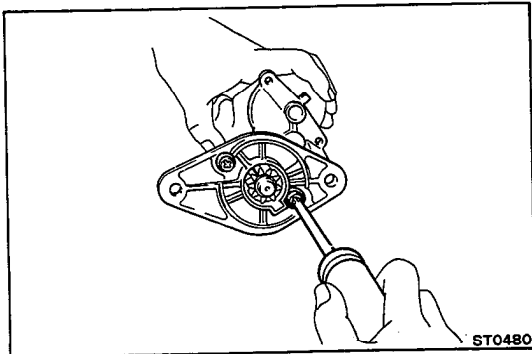
(See page ST-17)

1. (4A-GE)
REMOVE DUST STARTER PROTECTOR



2. REMOVE FIELD FRAME WITH ARMATURE FROM MAGNETIC SWITCH

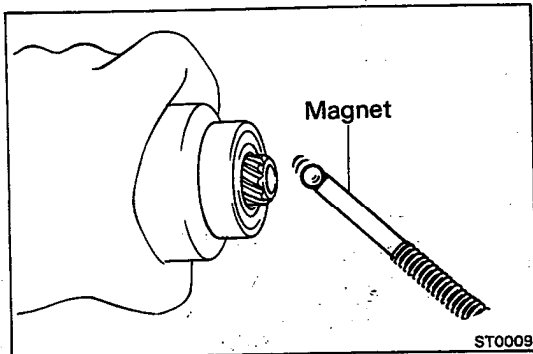
- (a) Remove the nut. Disconnect the lead wire from the magnetic switch terminal.
- (b) Remove the two through bolts. Pull out the field frame with the armature from the magnetic switch.



3. REMOVE STARTER HOUSING FROM MAGNETIC SWITCH ASSEMBLY

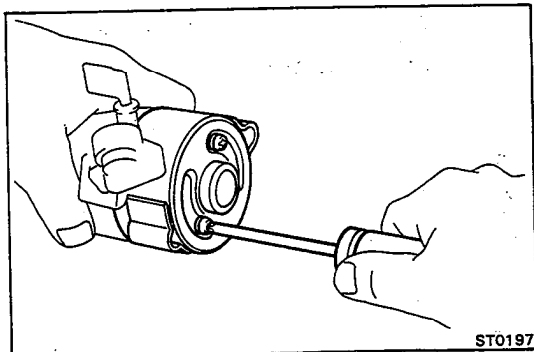
Remove the two screws and remove the starter housing with the idler gear and clutch assembly.

4. REMOVE CLUTCH ASSEMBLY AND IDLER GEAR FROM STARTER HOUSING



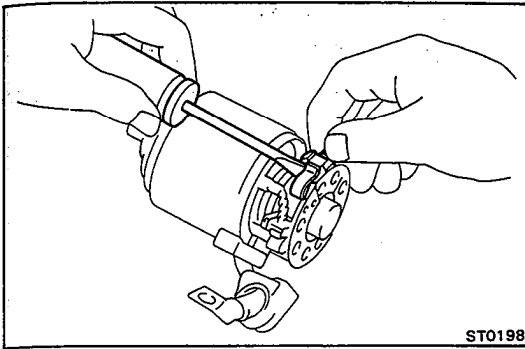
5. REMOVE STEEL BALL AND SPRING

Using a magnetic finger, remove the spring and steel ball from the clutch shaft hole.



6. REMOVE BRUSHES AND BRUSH HOLDER

- (a) Remove the two screws and end cover from the field frame.



- (b) Using a screwdriver or steel wire separate the brush springs, and remove the brushes from the brush holder.
- (c) Pull the brush holder off the armature.

7. REMOVE ARMATURE FROM FIELD FRAME

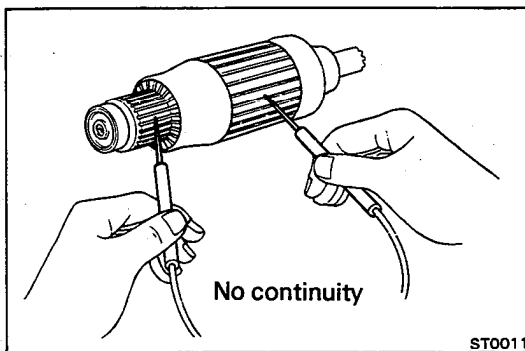
INSPECTION OF STARTER

Armature Coil

1. INSPECT THAT COMMUTATOR IS NOT GROUNDED

Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

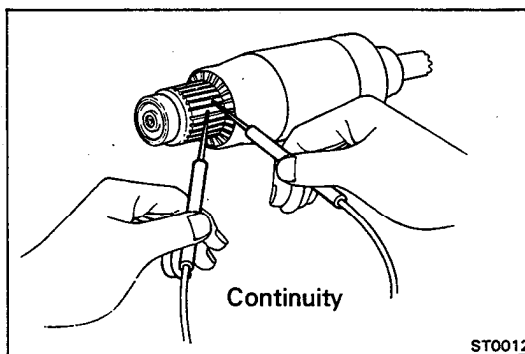
If there is continuity, replace the armature.



2. INSPECT COMMUTATOR FOR OPEN CIRCUIT

Using an ohmmeter, check for continuity between the segments of the commutator.

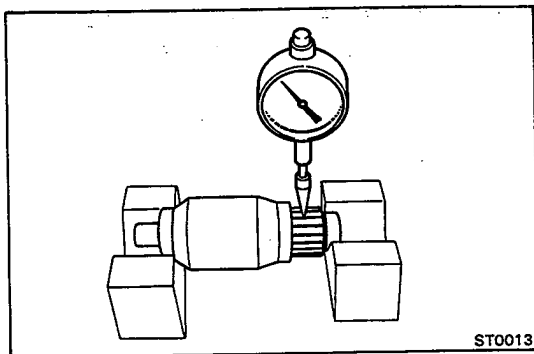
If there is no continuity between any segment, replace the armature.



Commutator

1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACES

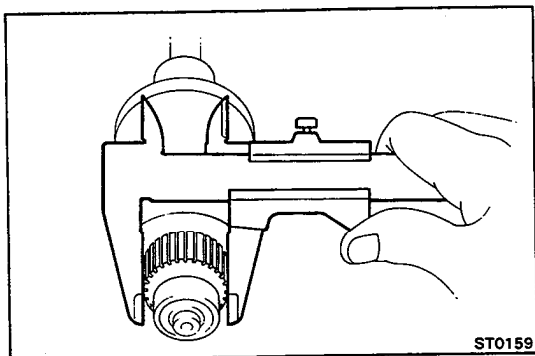
If the surface is dirty or burnt, correct with sandpaper (No.400) or a lathe.



2. INSPECT COMMUTATOR RUNOUT

Maximum circle runout: 0.05 mm (0.0020 in.)

If the circle runout is greater than maximum, correct it with a lathe.

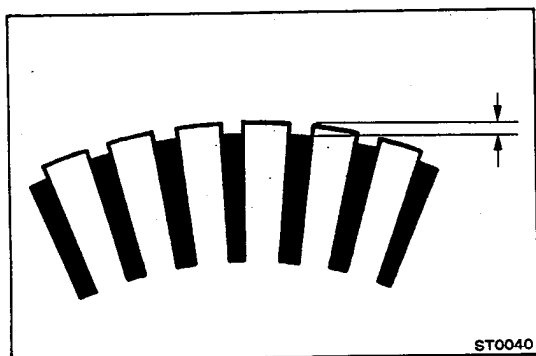


3. MEASURE DIAMETER OF COMMUTATOR

Standard diameter: 30 mm (1.18 in.)

Minimum diameter: 29 mm (1.14 in.)

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



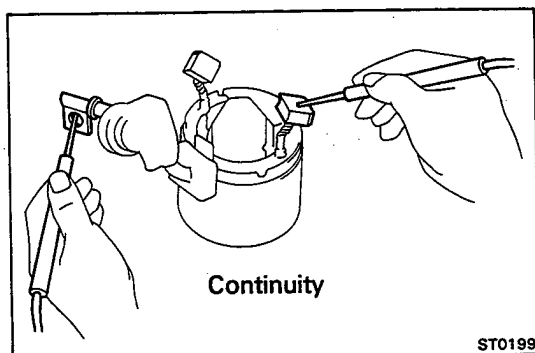
4. CHECK SEGMENT

Check that the segment is clean and free of foreign particles.

Standard undercut depth: 0.6 mm (0.24 in.)

Minimum undercut depth: 0.2 mm (0.008 in.)

If the undercut depth is less than minimum, correct it with a hacksaw blade and smooth out the edge.

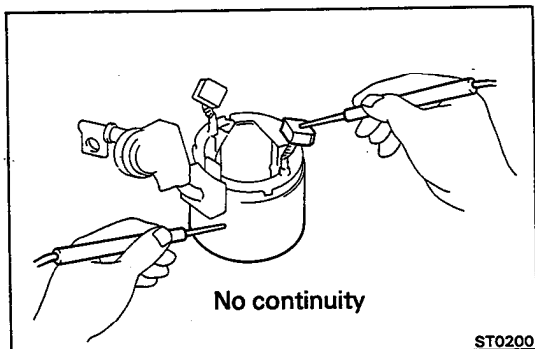


Field Coil

1. INSPECT FIELD COIL FOR OPEN CIRCUIT

Using an ohmmeter, check for continuity between the lead wire and field coil brush lead.

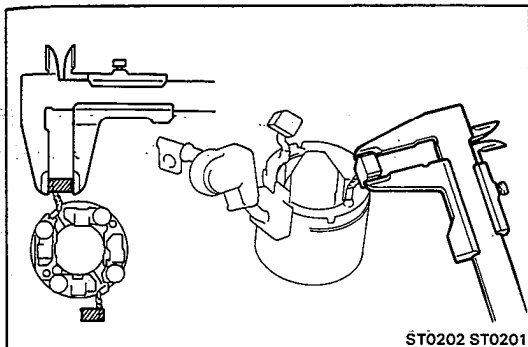
If there is no continuity, replace the field frame.



2. INSPECT THAT FIELD COIL IS NOT GROUNDED

Using an ohmmeter, check for no continuity between the field coil end and field frame.

If there is continuity, repair or replace the field frame.



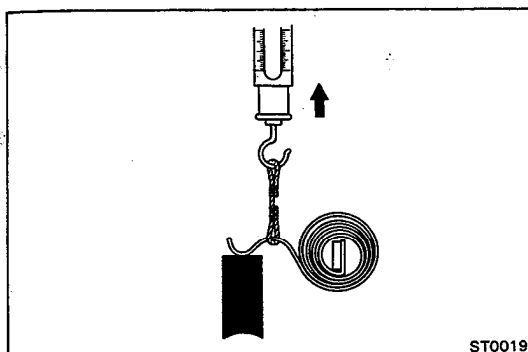
Brushes

MEASURE BRUSH LENGTH

Standard length: 13.5 mm (0.531 in.)

Minimum length: 8.5 mm (0.335 in.)

If the length is less than minimum, replace the brush and dress with an emery cloth.



Brush Spring

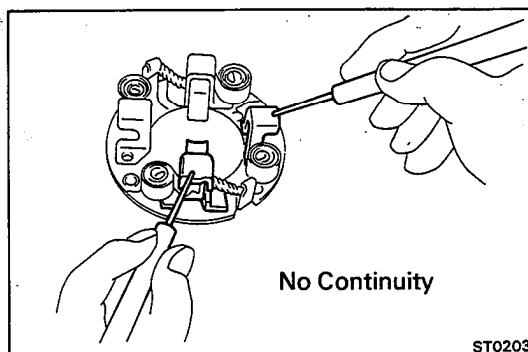
MEASURE BRUSH SPRING LOAD WITH PULL SCALE

Take the pull scale reading the instant the brush spring separates from the brush.

Standard Installed load: 1.785 – 2.415 kg

(3.9 – 5.3 lb, 18 – 24 N)

If the installed load is less than minimum, replace the brush springs.



Brush Holder

INSPECT INSULATION OF BRUSH HOLDER

Using an ohmmeter, check for continuity between the positive and negative brush holders.

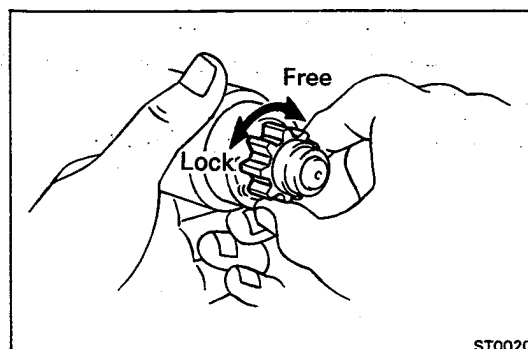
If there is continuity, repair or replace the brush holder.

Clutch and Gears

1. INSPECT GEAR TEETH

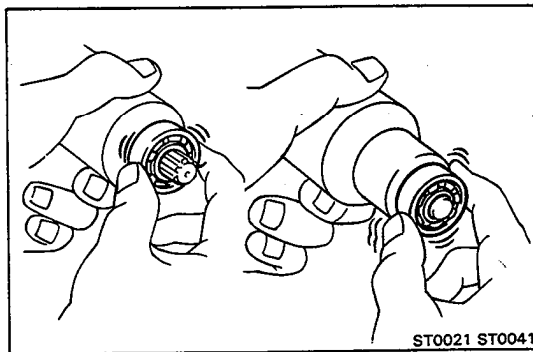
Check the gear teeth on the pinion gear, idler gear and clutch assembly for wear or damage.

If damaged, replace, and also check the flywheel ring gear for wear or damage.



2. INSPECT CLUTCH

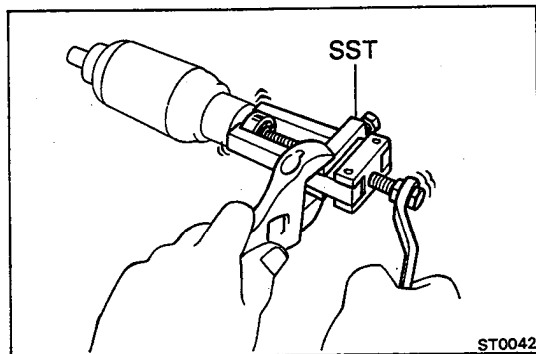
Rotate the pinion clockwise and check that it turns freely. Try to rotate the pinion counterclockwise and check that it locks.



Bearings

1. INSPECT BEARINGS

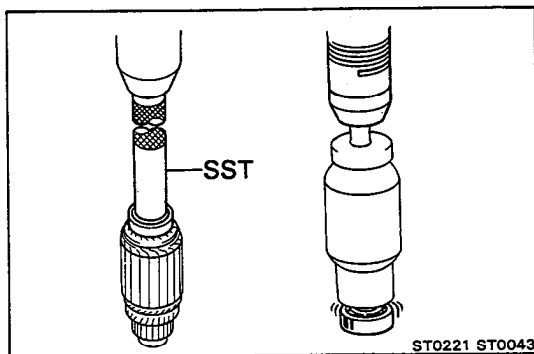
Turn each bearing by hand while applying inward force. If resistance is felt or if the bearing sticks, replace the bearing.



2. IF NECESSARY, REPLACE BEARINGS

- (a) Using SST, remove the bearing from the armature shaft.
- (b) Using SST, remove the other bearing from the opposite side.

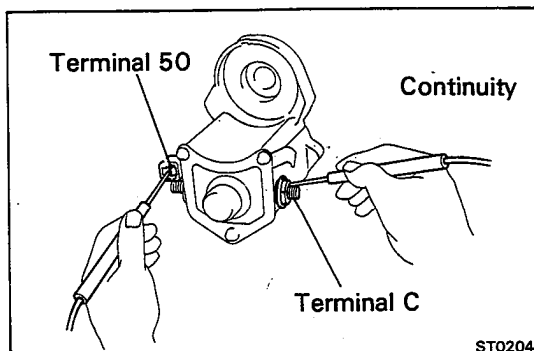
SST 09286-46011



- (c) Using SST and a press, install a new front bearing onto the shaft.

SST 09285-76010

- (d) Using a press, install a new rear bearing onto the shaft.

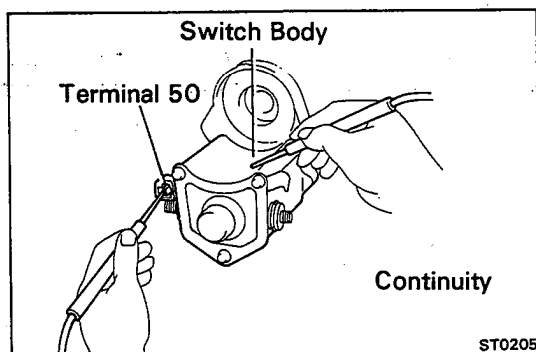


Magnetic Switch

1. PERFORM PULL-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check for continuity between terminal 50 and terminal C.

If there is no continuity, replace the magnetic switch.



2. PERFORM HOLD-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check for continuity between terminal 50 and the switch body.

If there is no continuity, replace the magnetic switch.

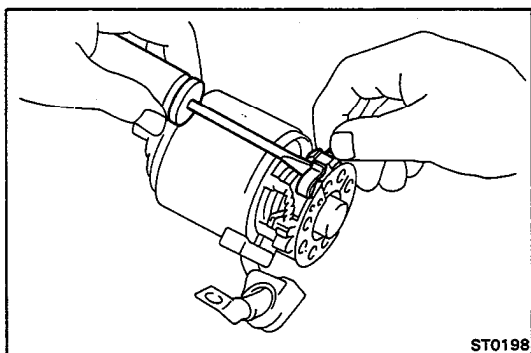
ASSEMBLY OF REDUCTION TYPE STARTER

(See page ST-17)

HINT: Use high-temperature grease to lubricate the bearings and gears when assembling the starter.

1. PLACE ARMATURE INTO FIELD FRAME

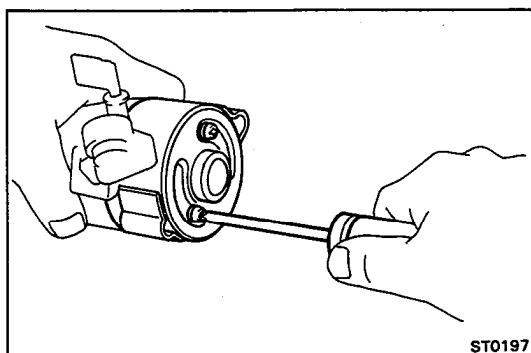
Apply grease to the armature bearings and insert the armature into the field frame.



2. INSTALL BRUSH HOLDER AND BRUSHES

- (a) Using a screwdriver, hold the brush spring back, and install the brush into the brush holder. Install the four brushes.

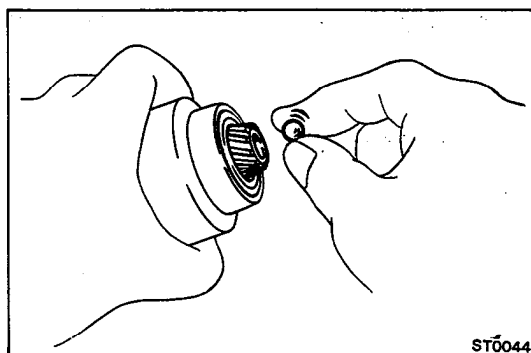
HINT: Make sure that the positive lead wires are not grounded.

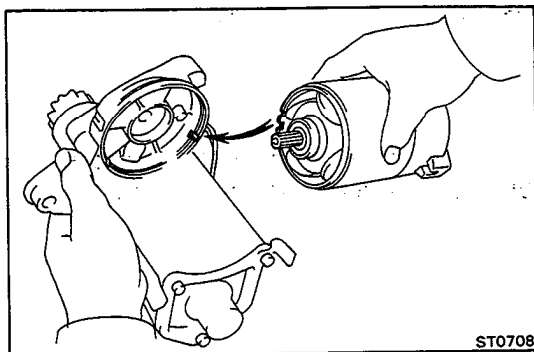


- (b) Install the end cover to the field frame.

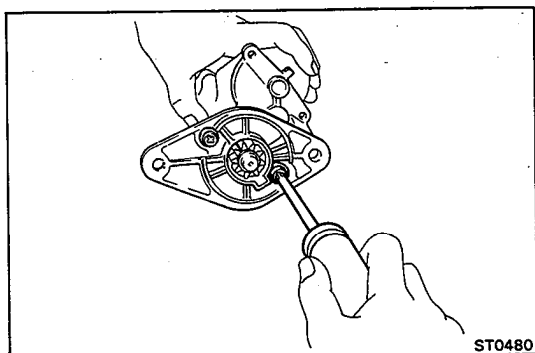
3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

Apply grease to the ball and spring and insert them into the clutch shaft hole.

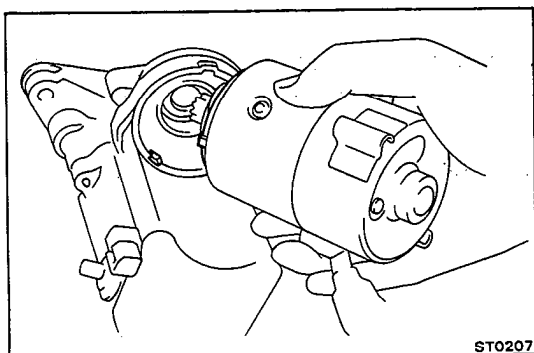


**4. INSTALL GEAR AND CLUTCH ASSEMBLY**

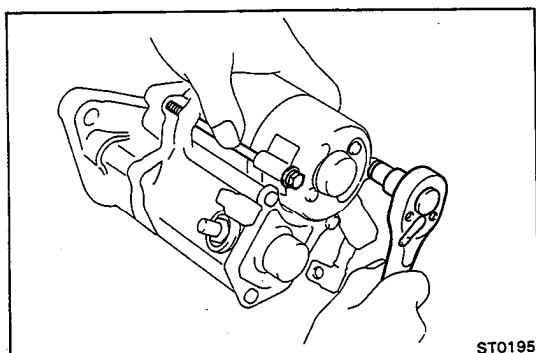
- (a) Apply grease to the gear and clutch assembly.
- (b) Place the clutch assembly, idler gear and bearing in the starter housing.

**5. INSTALL STARTER HOUSING**

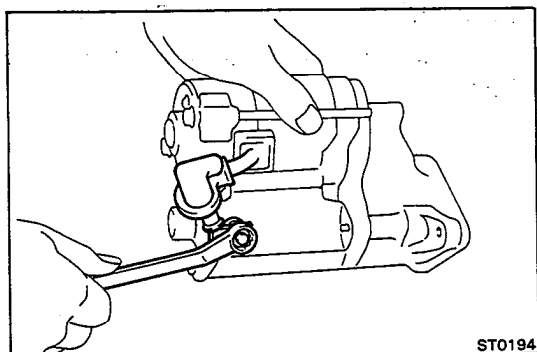
Place the starter housing on the magnetic switch and install the two screws.

**6. INSTALL FIELD FRAME WITH ARMATURE IN MAGNETIC SWITCH**

- (a) Match the protrusion of the field frame with the magnetic switch.

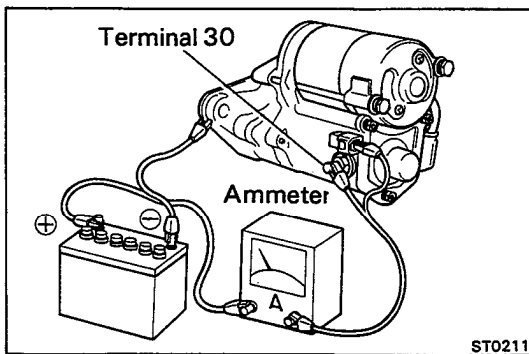
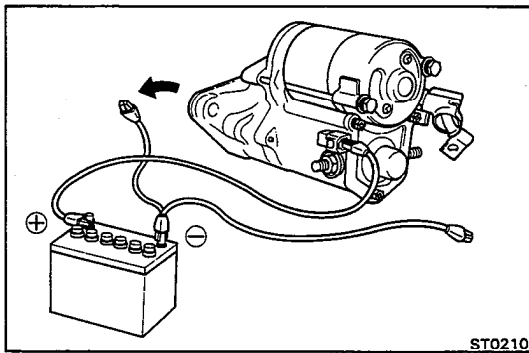
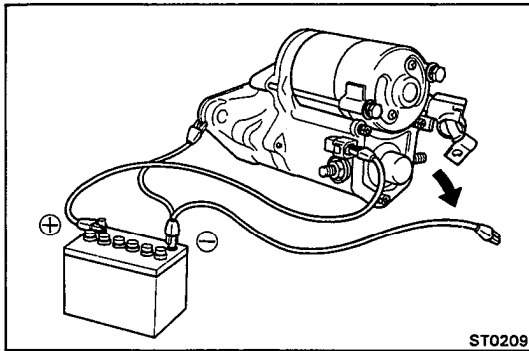
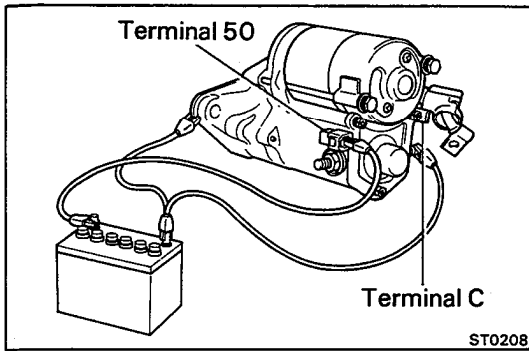


- (b) Install the two through bolts.



- (c) Connect the coil lead to the terminal on the magnetic switch.

7. (4A-GE) INSTALL DUST STARTER PROTECTOR



PERFORMANCE TEST OF STARTER

NOTICE: These tests must be performed within 3 to 5 seconds to avoid burning out the coil.

1. PERFORM PULL-IN TEST

- Disconnect the field coil lead from terminal C.
- Connect the battery to the magnetic switch as shown.
- Check that the plunger moves outward.

If the plunger does not move, replace the magnetic switch.

2. PERFORM HOLD-IN TEST

- While connected as above with the plunger out, disconnect the negative lead from terminal C.
- Check that the plunger remains out.

If the plunger returns inward, replace the magnetic switch.

3. INSPECT PLUNGER RETURN

- Disconnect the negative lead from the switch body.
- Check that the plunger returns inward.

If the plunger does not return, replace the magnetic switch.

4. PERFORM NO-LOAD PERFORMANCE TEST

- Connect the battery and ammeter to the starter as shown.
- Check that the starter rotates smoothly and steadily with the pinion moving out.
- Check that the ammeter reads the specified current.

Specified current: Less than 90 A at 11.5 V

