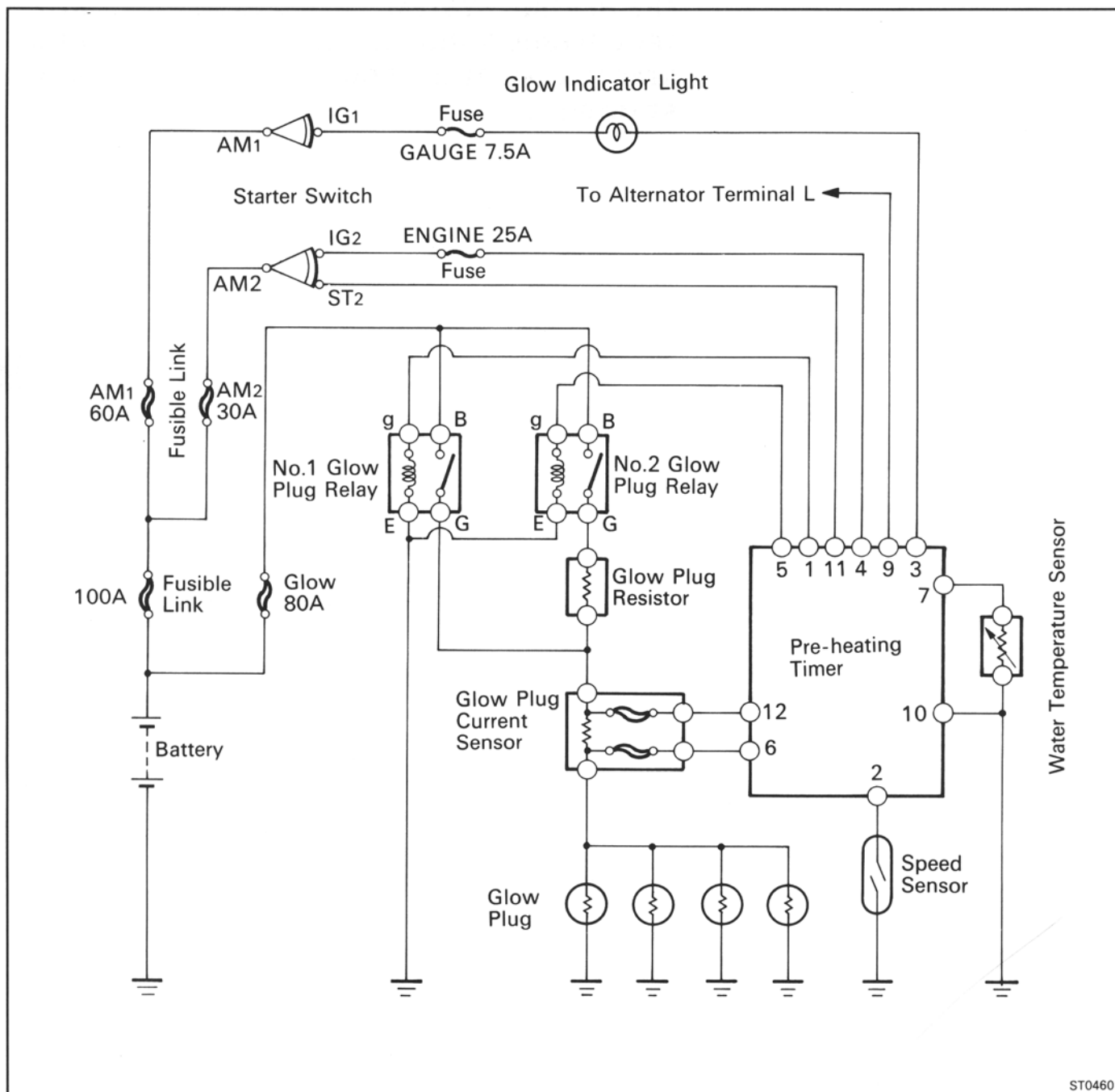


STARTING SYSTEM

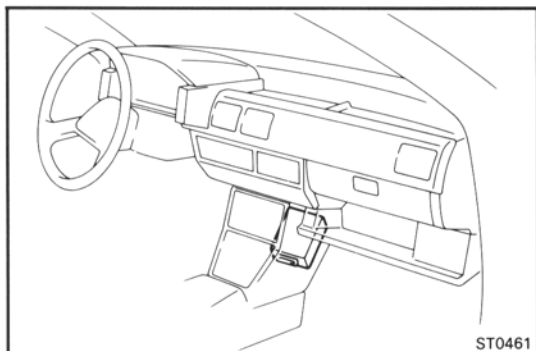
	Page
PRE-HEATING SYSTEM	ST-2
TROUBLESHOOTING	ST-6
STARTING SYSTEM CIRCUIT	ST-6
STARTER	ST-7

ST

PRE-HEATING SYSTEM Super Glow Type SYSTEM CIRCUIT



ST0460

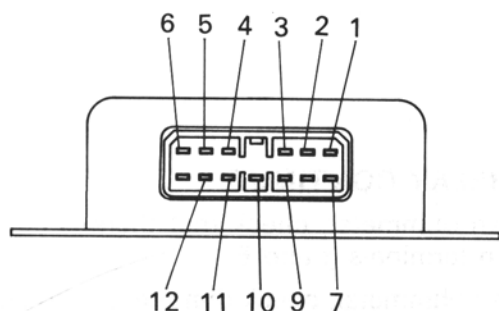


ST0461

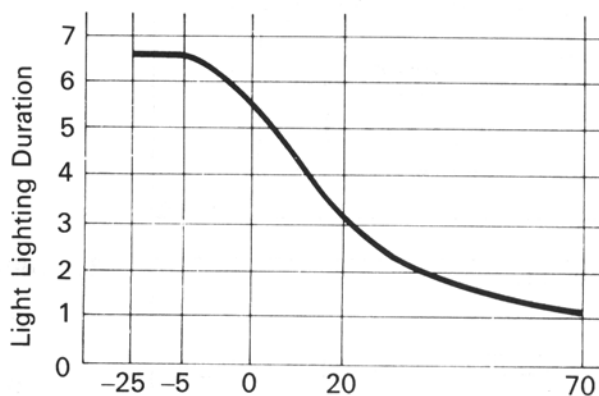
INSPECTION OF COMPONENTS Pre-heating Timer

LOCATION: Behind the front console box.

Refer to Diesel Electrical System Diagnosis for inspection procedures. (See pages EM-10 and 11)

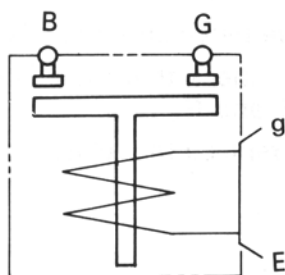


(Secs)



Water Temperature (°C)

ST0049 ST0462



ST0463

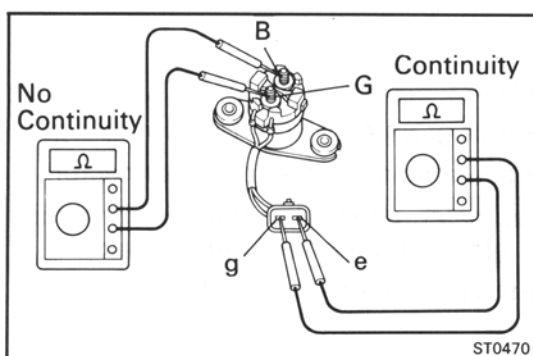
No.1 Glow Plug Relay

LOCATION: Near the battery.

1. INSPECT RELAY CONTINUITY

- Using an ohmmeter, check that there is continuity between terminals g and E.
- Using an ohmmeter, check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.

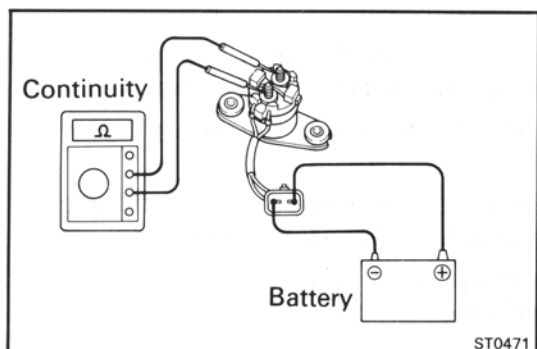


ST0470

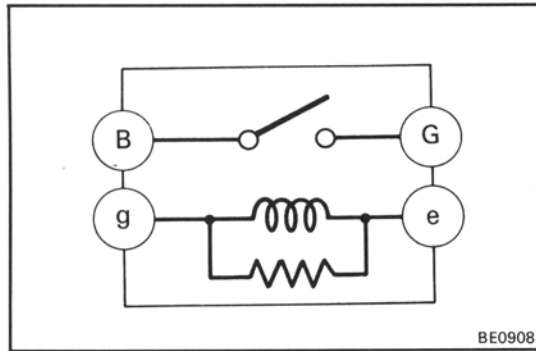
2. INSPECT RELAY OPERATION

- Apply battery voltage between terminals g and E.
- Using an ohmmeter, check that there is continuity between terminals B and G.

If there is no continuity, replace the relay.



ST0471



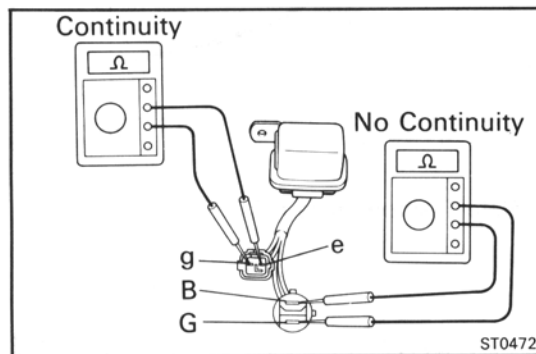
No. 2 Glow Plug Relay

LOCATION: Near the engine right mounting.

1. INSPECT RELAY CONTINUITY

- Using an ohmmeter, check that there is continuity between terminals g and E.
- Using an ohmmeter, check that there is no continuity between terminals B and G.

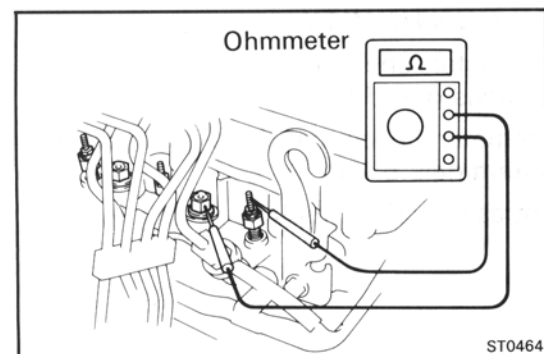
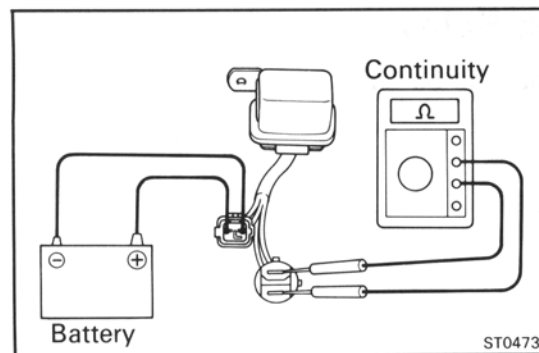
If continuity is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

- Apply battery voltage between terminals g and E.
- Using an ohmmeter, check that there is continuity between terminals B and G.

If there is no continuity, replace the relay.



Glow Plug

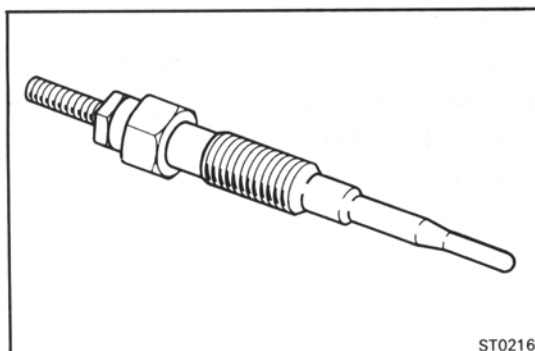
INSPECT GLOW PLUG

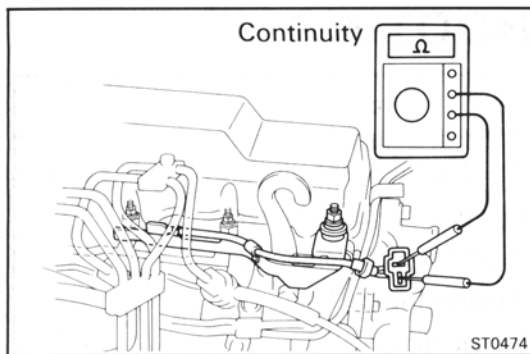
- Remove the four grommets from the glow plugs.
- Remove the five nuts and glow plug connector.
- Using an ohmmeter, check that there is continuity between the glow plug terminal and ground.

If there is no continuity, replace the glow plug.

NOTE:

- Be careful not to damage the glow plug pipes as it could cause an open circuit or shorten life of the plugs.
- Avoid getting oil and gasoline on the glow plugs when cleaning.
- During inspection, be sure to wipe any oil off the glow plug terminals and bakelite washer with a dry cloth.
- Be careful not to apply more than 7 volts to the glow plug as it could cause an open circuit.



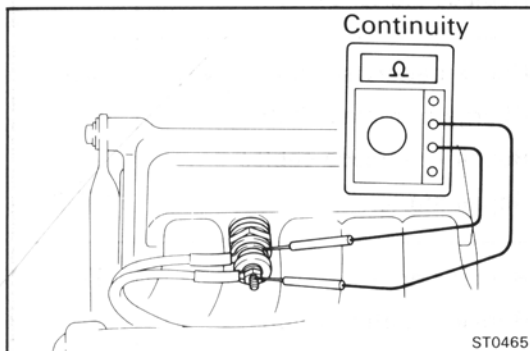


Glow Plug Current Sensor

INSPECTION GLOW PLUG CURRENT SENSOR

Using an ohmmeter, check that there is continuity between the current sensor terminals.

If there is no continuity, replace the current sensor.

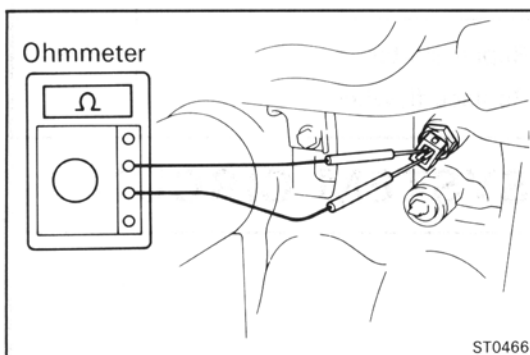


Glow Plug Resistor

INSPECT GLOW PLUG RESISTOR

Using an ohmmeter, check that there is continuity between the resistor terminals.

If there is no continuity, replace the resistor.

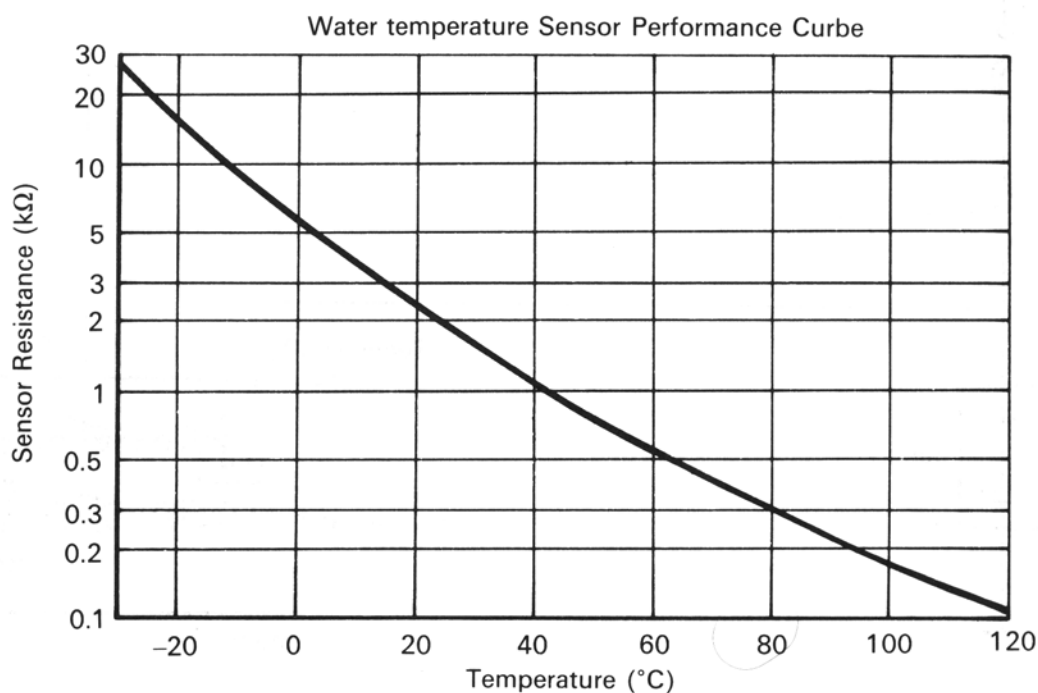


Water Temperature Sensor

INSPECT WATER TEMPERATURE SENSOR

Remove the connector and measure the resistance between the water temperature sensor terminals.

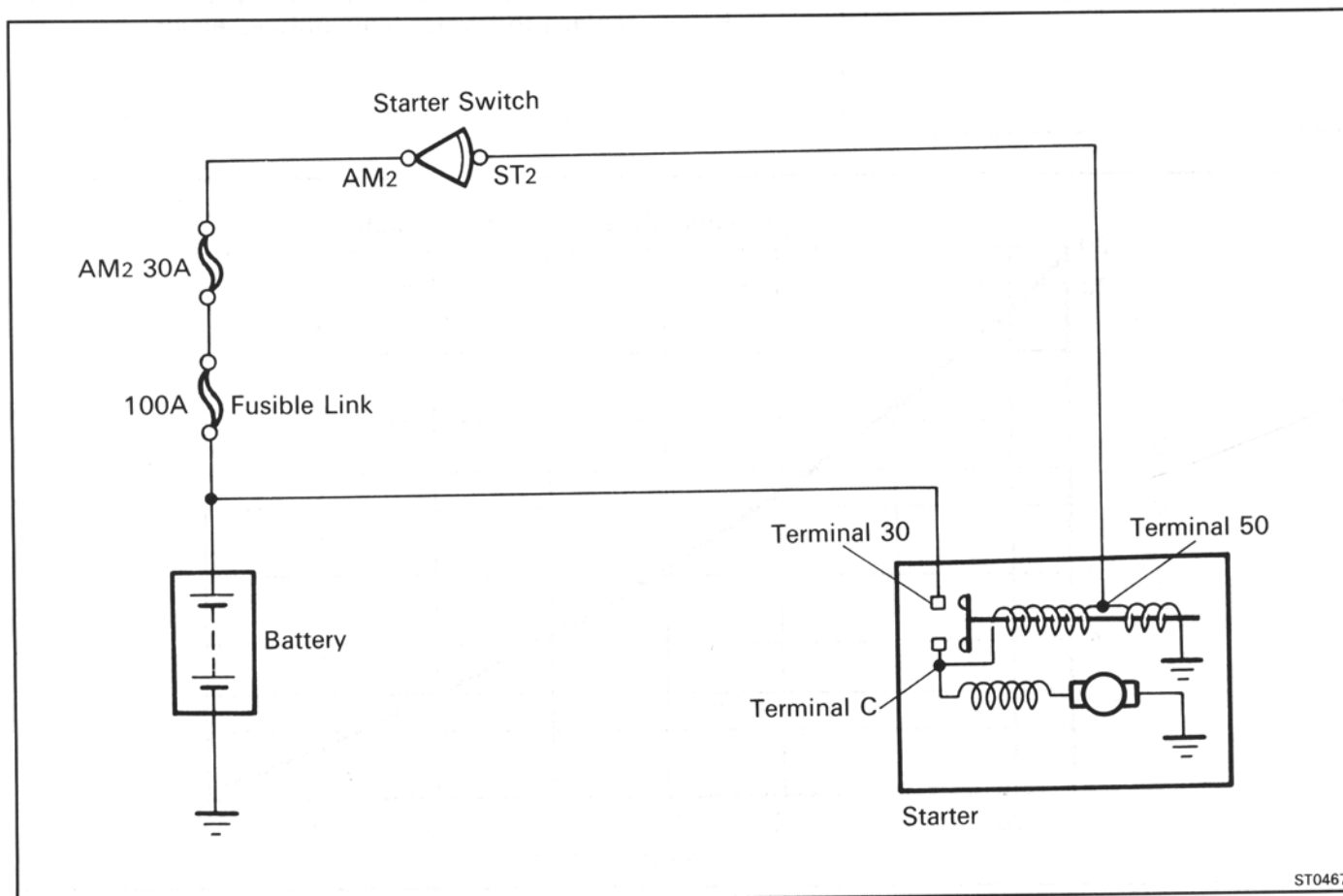
If each resistance value is not as shown in the graph below, replace the water temperature sensor.



TROUBLESHOOTING

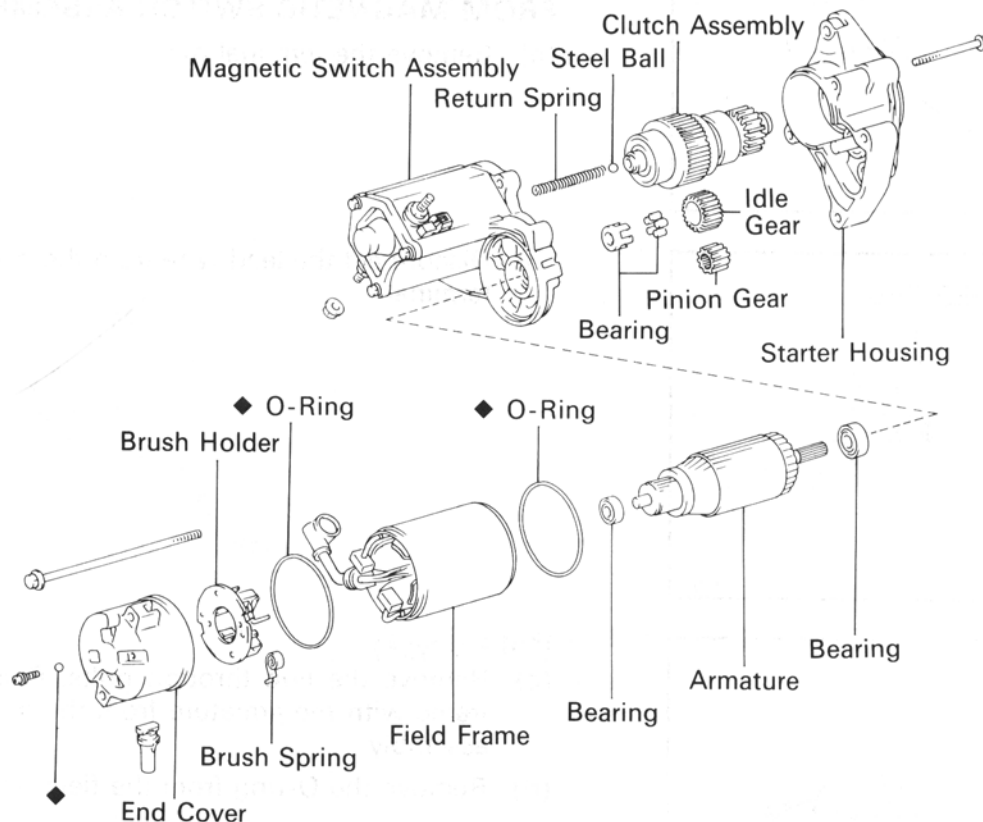
Problem	Possible cause	Remedy	Page
Engine will not crank	Battery charge low	Check battery specific gravity Charge or replace battery	CH-3
	Battery cables loose, corroded or worn Fusible link blown Starter faulty Starter switch faulty	Repair or replace cables Replace fusible link Repair starter Replace starter switch	ST-8
Engine cranks slowly	Battery charge low	Check battery specific gravity Charge or replace battery	CH-3
	Battery cables loose, corroded or worn Starter faulty	Repair or replace cables Repair starter	ST-8
Starter keeps running	Starter faulty Starter switch faulty Short in wiring	Repair starter Replace starter switch Repair wiring	ST-8
Starter spins - engine will not crank	Pinion gear teeth broken or faulty starter Flywheel teeth broken	Repair starter Replace flywheel	ST-8

STARTING SYSTEM CIRCUIT

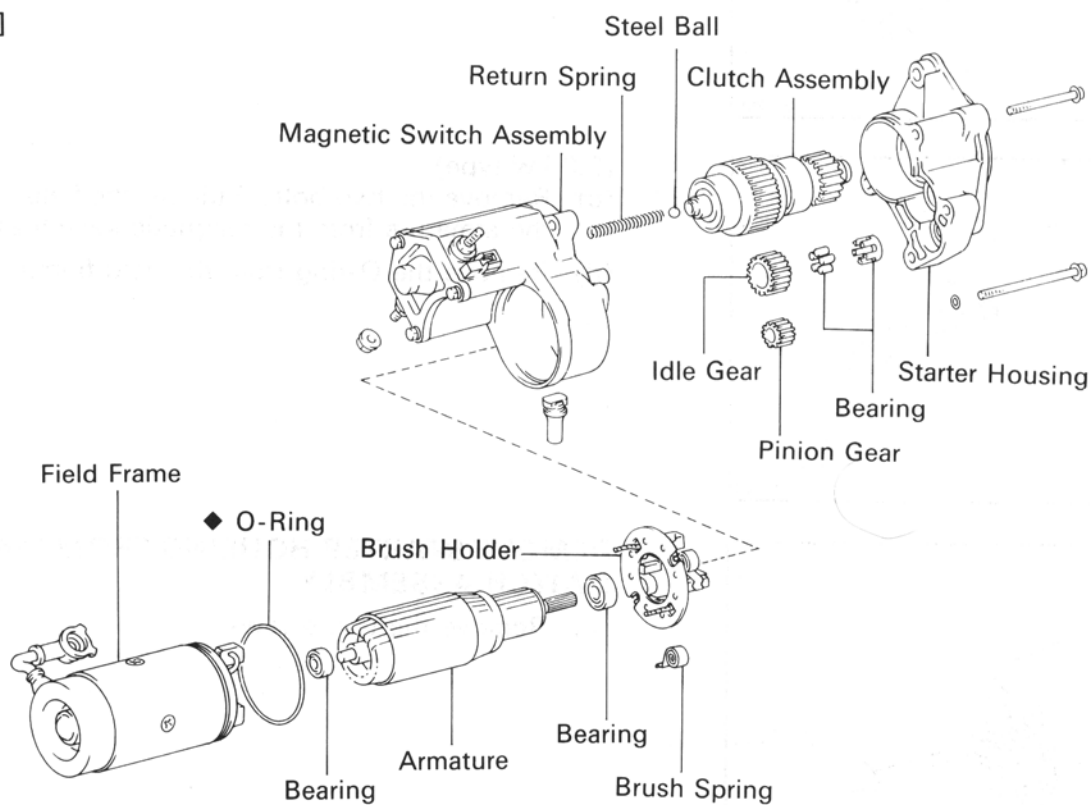


STARTER COMPONENTS

[1.4 kW]

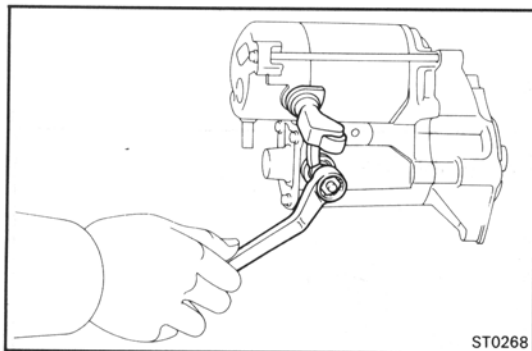


[2.0 kW]



◆ Non-reusable part

ST0476
ST0477

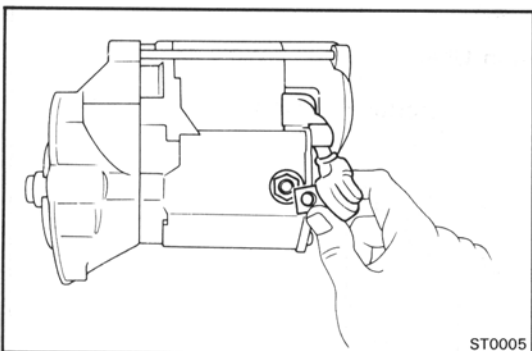


DISASSEMBLY OF STARTER

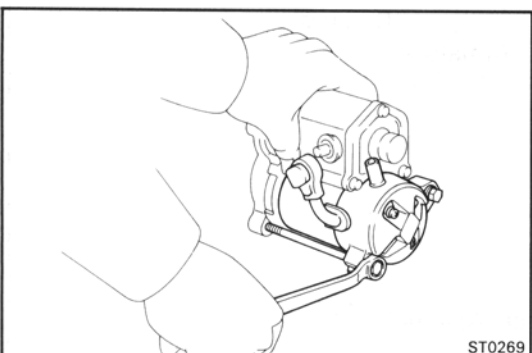
(See page ST-7)

1. REMOVE FIELD FRAME WITH ARMATURE FROM MAGNETIC SWITCH ASSEMBLY

(a) Remove the terminal nut.



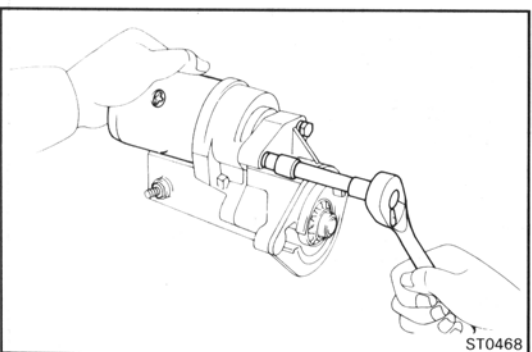
(b) Disconnect the lead wire from the magnetic switch terminal.



(1.4 kw type)

(c) Remove the two through bolts. Pull out the field frame with the armature from the magnetic switch assembly.

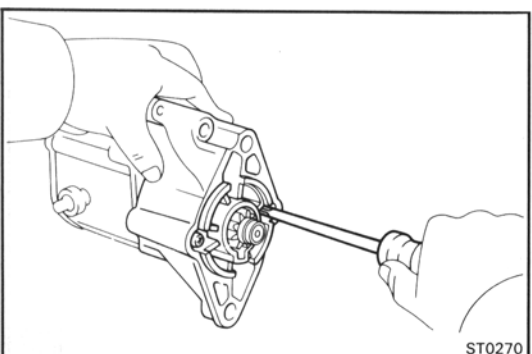
(d) Remove the O-ring from the field frame.



(2.0 kw type)

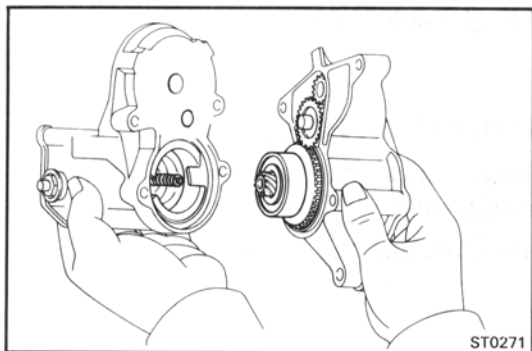
(c) Remove the two bolts. Pull out the field frame with the armature from the magnetic switch assembly.

(d) Remove the O-ring from the field frame.



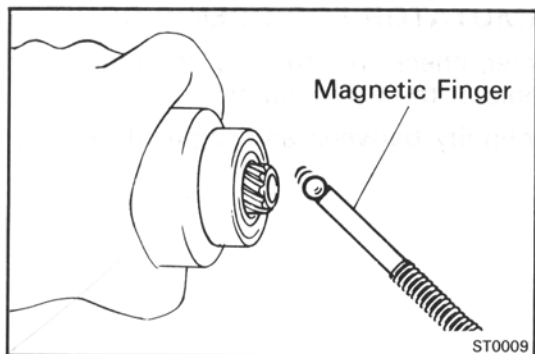
2. REMOVE STARTER HOUSING FROM MAGNETIC SWITCH ASSEMBLY

(a) Remove the two screws.



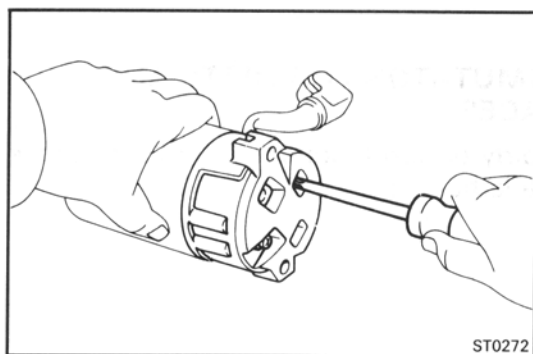
- (b) Remove the starter housing with the pinion gear, idler gear, bearing and clutch assembly.

3. REMOVE CLUTCH ASSEMBLY AND GEARS FROM STARTER HOUSING



4. REMOVE STEEL BALL AND SPRING

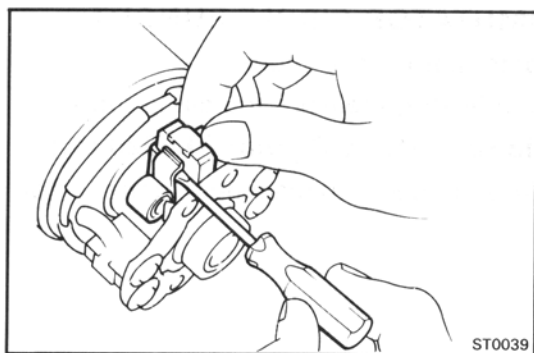
Using a magnetic finger, remove the spring and steel ball from the clutch shaft hole.



5. REMOVE BRUSHES AND BRUSH HOLDER

(1.4 kw type)

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

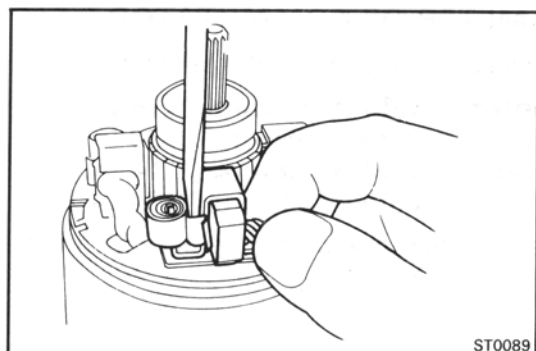


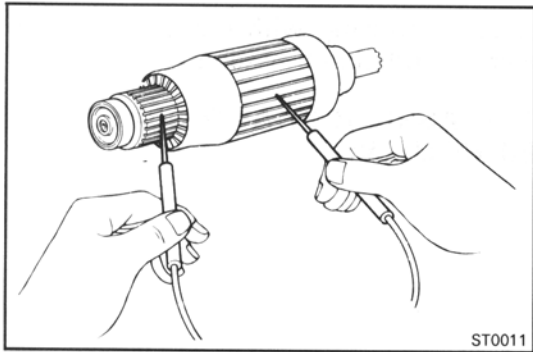
- (c) Using a screwdriver, hold the spring back and disconnect the brush from the brush holder. Disconnect the four brushes and remove the brush holder.
- (d) Pull the brush holder off the field frame.

(2.0 kw type)

- (a) Using a screwdriver, hold the spring back and disconnect the brush from the brush holder. Disconnect the four brushes and remove the brush holder.
- (b) Pull the brush holder off the field frame.

6. REMOVE ARMATURE FROM FIELD FRAME





ST0011

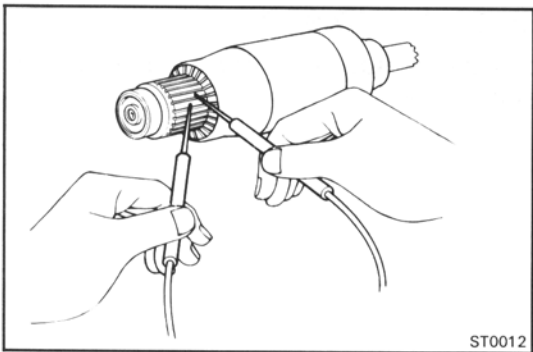
INSPECTION OF STARTER

Armature Coil

1. 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.



ST0012

2. INSPECT COMMUTATOR FOR OPEN CIRCUIT

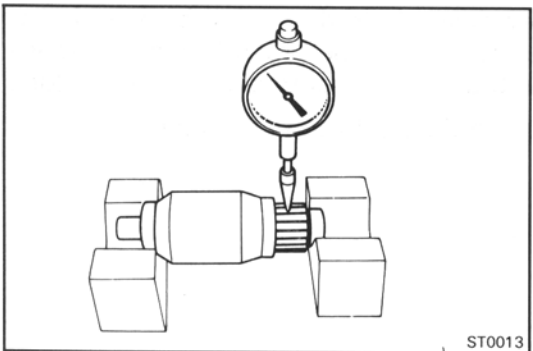
Using an ohmmeter, check that there is continuity between the segments of the commutator.

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 it with sandpaper (No.400) or on a lathe.



ST0013

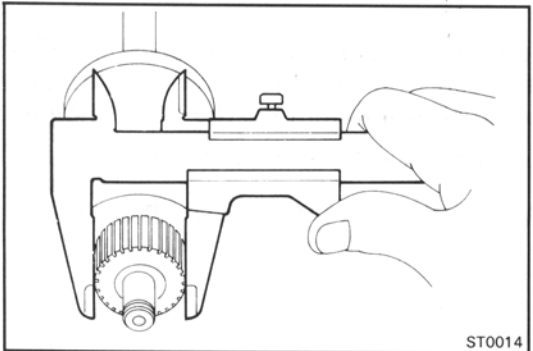
2. INSPECT COMMUTATOR CIRCLE RUNOUT

(a) Place the commutator on V-blocks.

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

Maximum circle runout: 0.05 mm (0.0020 in.)

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



ST0014

3. MEASURE DIAMETER OF COMMUTATOR

Using calipers, measure the commutator diameter.

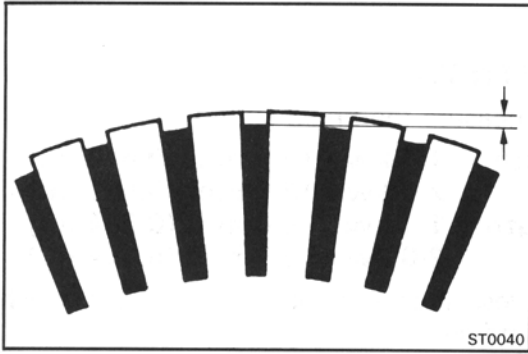
Standard diameter: 1.4 kw 30 mm (1.18 in.)

2.0 kw 35 mm (1.38 in.)

Minimum diameter: 1.4 kw 29 mm (1.14 in.)

2.0 kw 34 mm (1.34 in.)

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



4. INSPECT UNDERCUT DEPTH OF SEGMENT

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

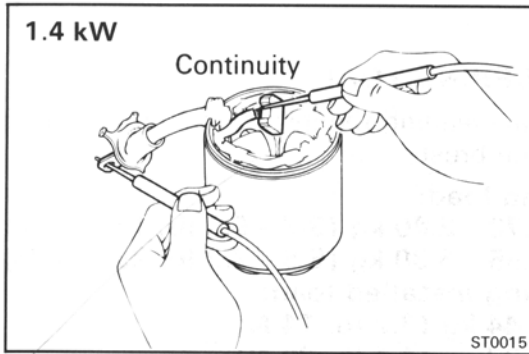
Standard undercut depth:

1.4 kw 0.6 mm (0.024 in.)

2.0 kw 0.7 mm (0.028 in.)

Minimum undercut depth: 0.2 mm (0.008 in.)

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

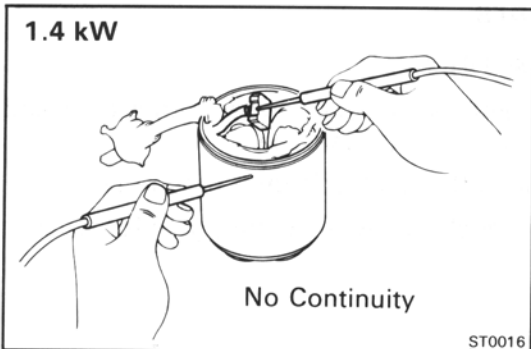
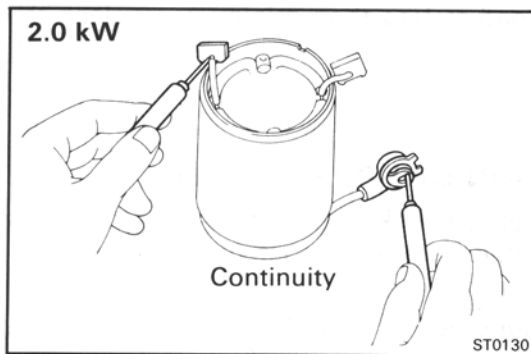


Field Frame (Field Coil)

1. INSPECT FIELD COIL FOR OPEN CIRCUIT

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

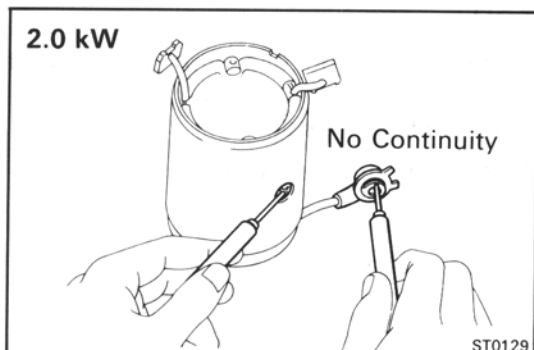
If there is no continuity, replace the field frame.

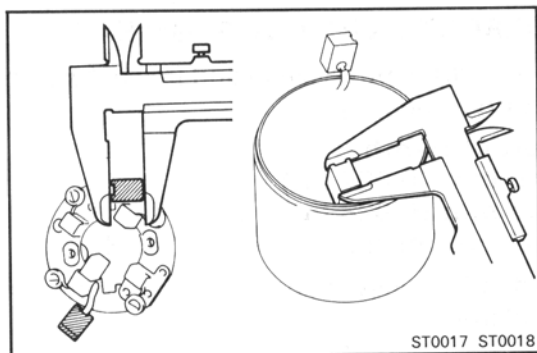


2. INSPECT THAT FIELD COIL IS NOT GROUNDED

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

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





Brushes

INSPECT BRUSH LENGTH

Using calipers, measure the brush length.

Standard length:	1.4 kw	15.5 mm (0.610 in.)
	2.0 kw	15.0 mm (0.591 in.)
Minimum length:	1.4 kw	10.0 mm (0.394 in.)
	2.0 kw	9.0 mm (0.354 in.)

If the length is less than minimum, replace the brush holder and field frame.

Brush Springs

INSPECT BRUSH SPRING LOAD

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

Spring installed load:

1.4 kw	1.70 – 2.40 kg (3.7 – 5.3 lb, 17 – 24 N)
2.0 kw	2.55 – 3.30 kg (5.6 – 7.3 lb, 25 – 32 N)

Minimum Spring installed load:

1.4 kw	1.44 kg (3.2 lb, 14 N)
2.0 kw	2.0 kg (4.4 lb, 20 N)

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

Brush Holder

INSPECT INSULATION OF BRUSH HOLDER

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.

Clutch and Gears

1. INSPECT GEAR TEETH

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

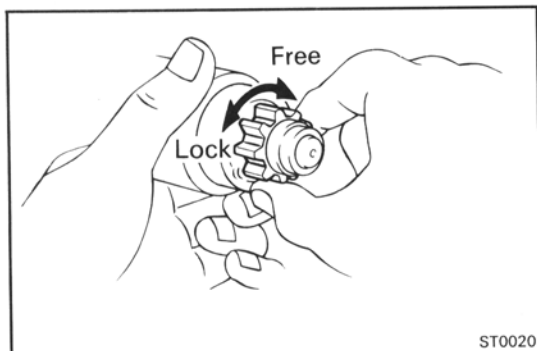
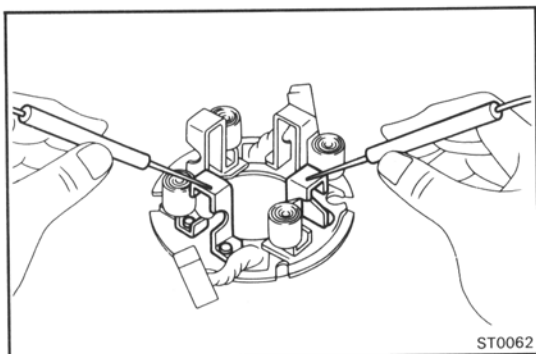
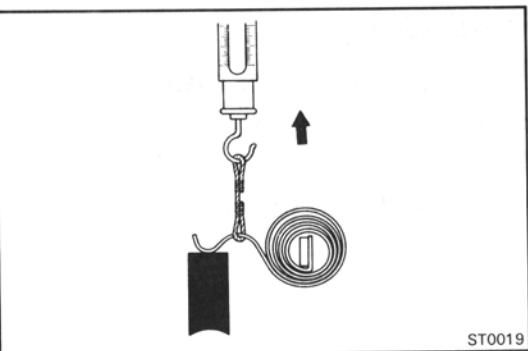
If damaged, replace the gear or clutch assembly.

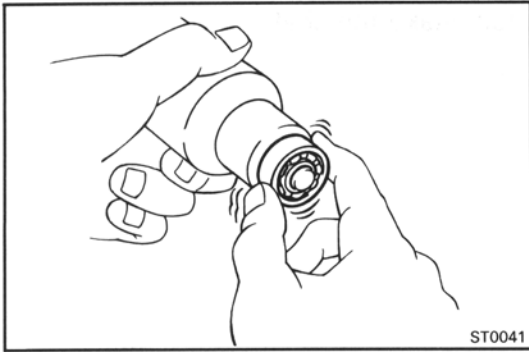
If damaged, also check the flywheel ring gear for wear or damage.

2. INSPECT CLUTCH

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

If necessary, replace the clutch assembly.

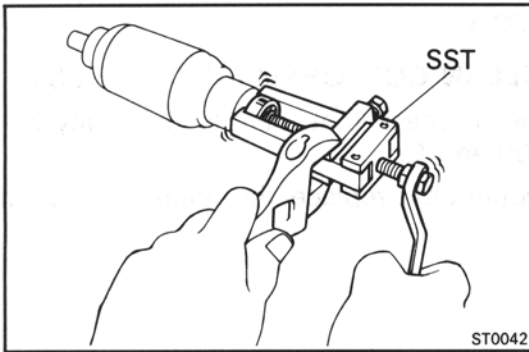




Bearings

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

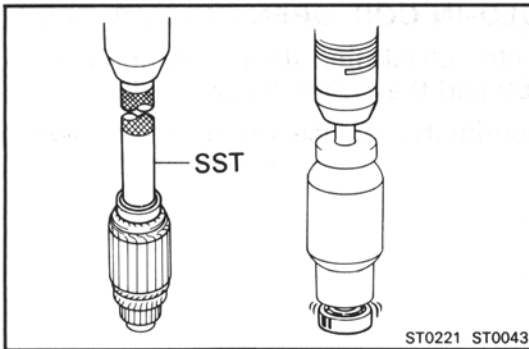
(1.4 kw)

- (a) Using SST, remove the front (large) bearing from the armature shaft.

SST 09286-46011

- (b) Using SST, remove the rear (small) bearing from the opposite side.

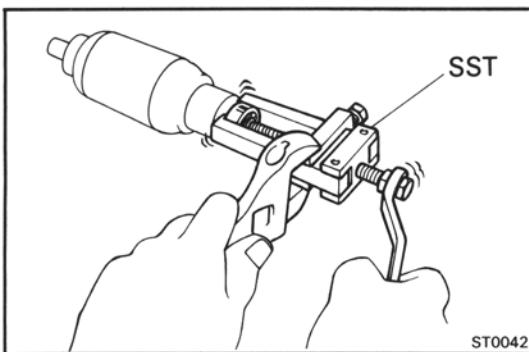
SST 09286-46011



- (c) Using SST and a press, press in a new front (large) bearing.

SST 09201-41020

- (d) Using a press, press in a new rear (small) bearing.



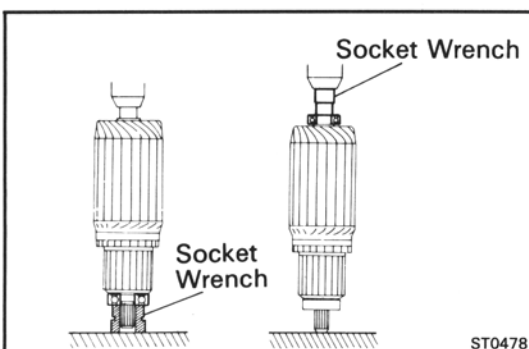
(2.0 kw)

- (a) Using SST, remove the front (large) bearing from the armature shaft.

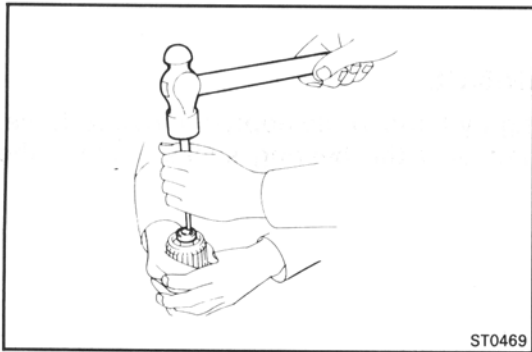
SST 09820-00021

- (b) Using SST, remove the rear (small) bearing from the opposite side.

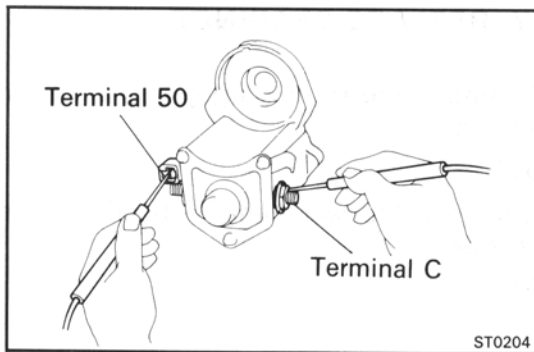
SST 09286-46011



- (c) Using a press and socket wrench, install a new front (large) and rear (small) bearings.



(d) Using a punch, stake the shaft.

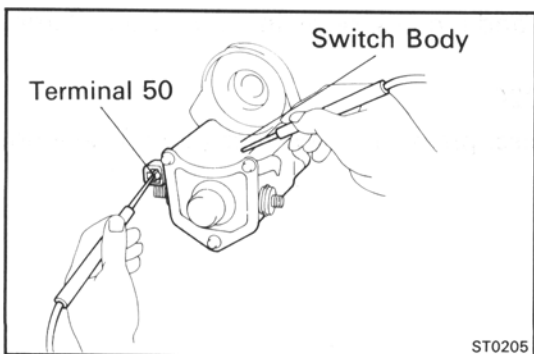


Magnetic Switch

1. PERFORM PULL-IN COIL OPEN CIRCUIT TEST

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

If there is no continuity, replace the magnetic switch assembly.



2. 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 assembly.

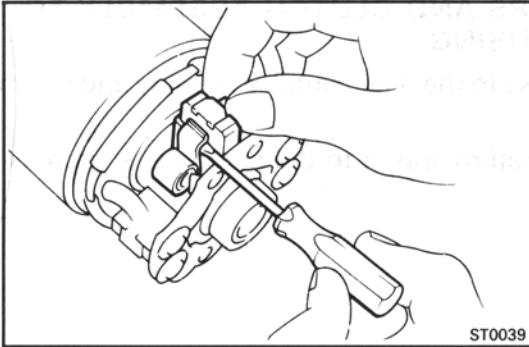
ASSEMBLY OF STARTER

(See page ST-7)

NOTE: 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.



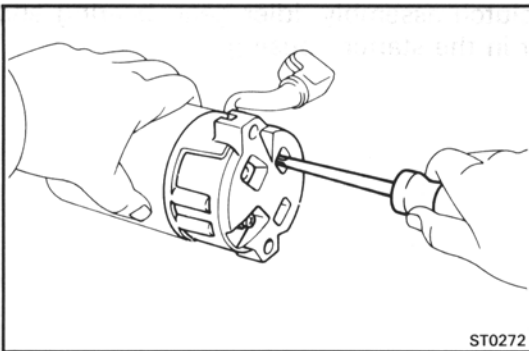
2. INSTALL BRUSH HOLDER AND BRUSHES

(1.4 kw)

(a) Place the brush holder over the field frame.

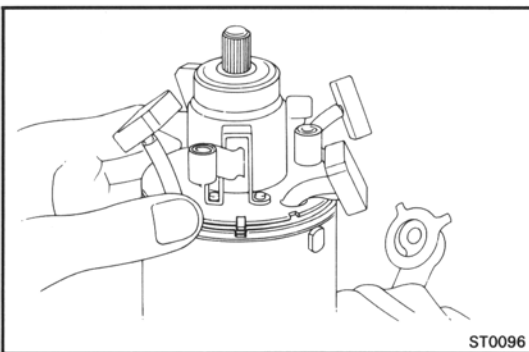
(b) Using a screwdriver, hold the brush spring back, and install the brush into the brush holder. Install the four brushes.

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



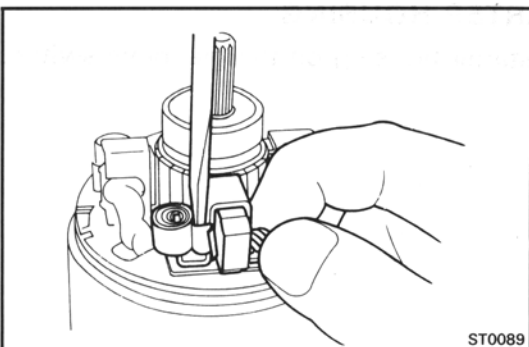
(b) Place the O-ring on the field frame.

(c) Install the end cover to the field frame with two screws.



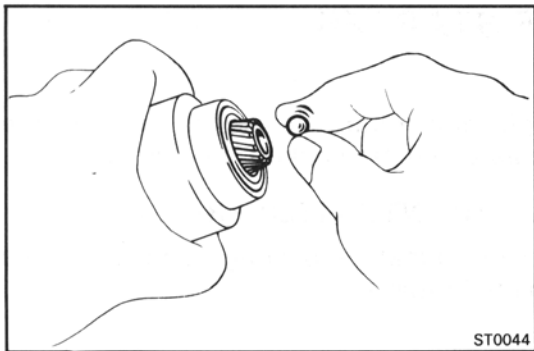
(2.0 kw)

(a) Place the brush holder on the armature shaft and align the tab of the holder with the notch of the field frame.



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

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



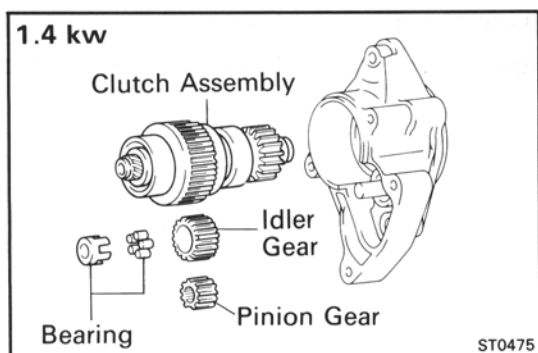
3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

- (a) Apply grease to the steel ball.
- (b) Insert the steel ball into the clutch shaft hole.

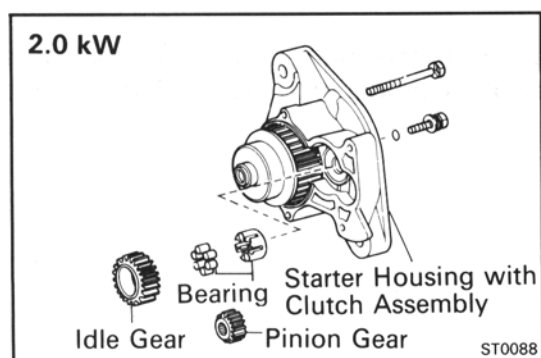


4. INSTALL GEARS AND CLUTCH ASSEMBLY TO STARTER HOUSING

- (a) Apply grease to the gear, clutch assembly and return spring.
- (b) Install the return spring to the magnetic switch assembly.

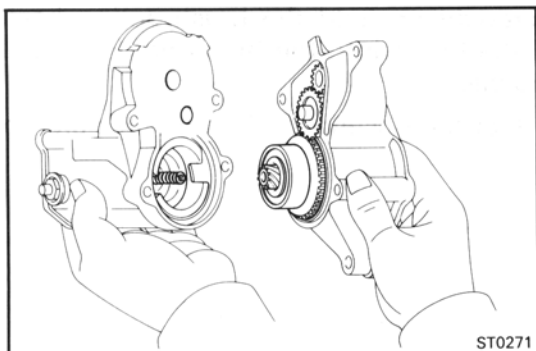


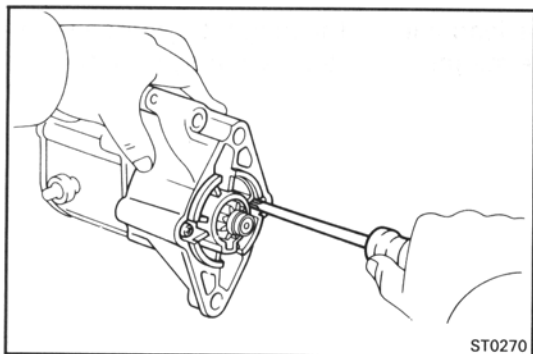
- (c) Place the clutch assembly, idler gear, bearing and pinion gear in the starter housing.



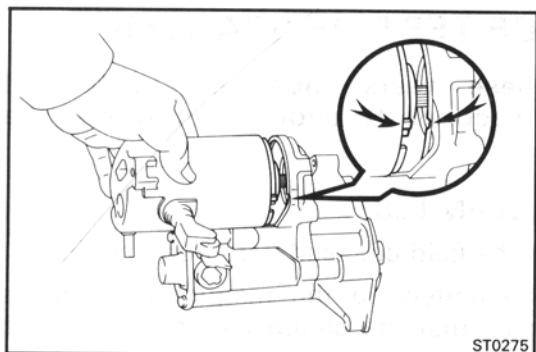
5. INSTALL STARTER HOUSING

- (a) Place the starter housing on the magnetic switch.





(b) Install the two screws.

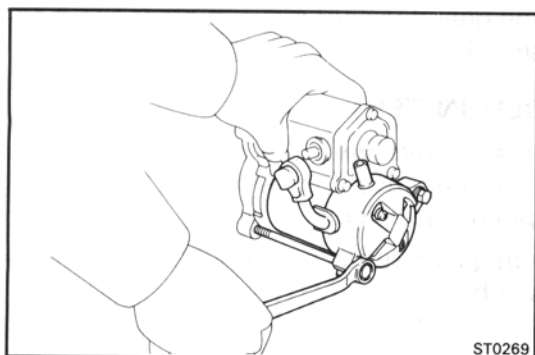


6. INSTALL FIELD FRAME WITH ARMATURE TO MAGNETIC SWITCH ASSEMBLY

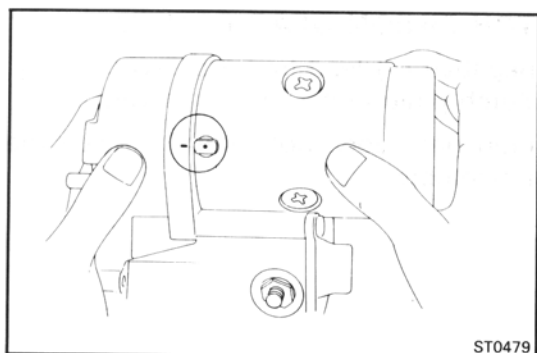
(a) Place the O-ring on the field frame.

(1.4 kw)

(b) Align the protrusion of the field frame with the cutout of the magnetic switch assembly.

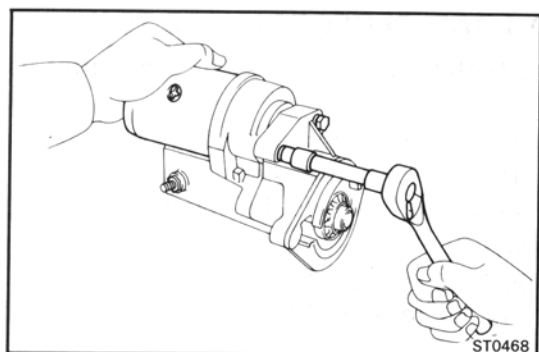


(c) Install the two through bolts.

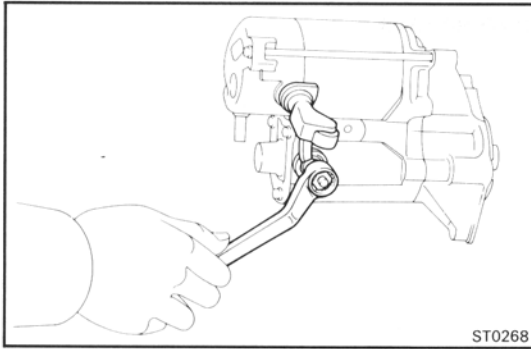


(2.0 kw)

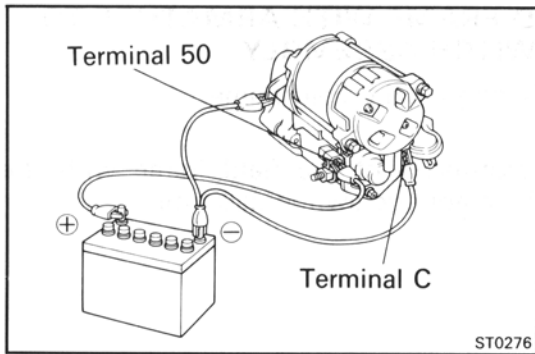
(b) Align the bolt anchor of the field frame with the mark on the magnetic switch assembly and insert the field frame with the armature.



(c) Install the two bolts.



- (d) Connect the lead wire to the magnetic switch terminal C on the magnetic switch assembly with the nut.



PERFORMANCE TEST OF STARTER

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

1. PERFORM PULL-IN TEST

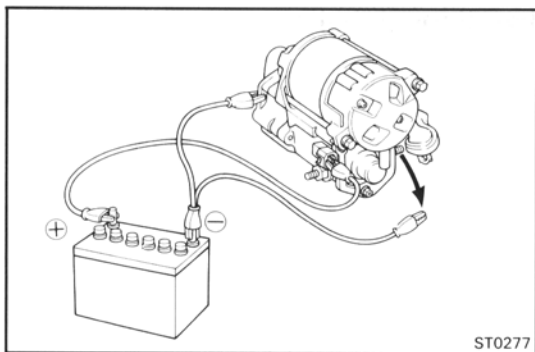
- Disconnect the field coil lead wire from terminal C.
- Connect the battery to the magnetic switch as shown. Check that the clutch pinion gear moves outward.

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

2. PERFORM HOLD-IN TEST

While connected as above with the clutch pinion gear out, disconnect the negative (-) lead from terminal C. Check that the pinion gear remains out.

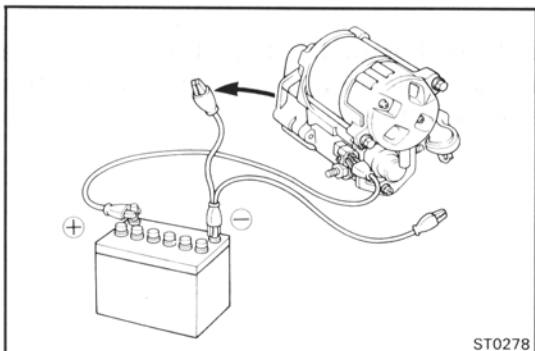
If the clutch pinion gear returns inward, replace the magnetic switch assembly.



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 gear does not return, replace the magnetic switch assembly.



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 gear moving out. Check that the ammeter reads the specified current.

Specified current:

1.4 kw 90A or less at 11.5 V
2.0 kw 120A or less at 11.5 V

