

# STARTING SYSTEM

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ST

ST-2

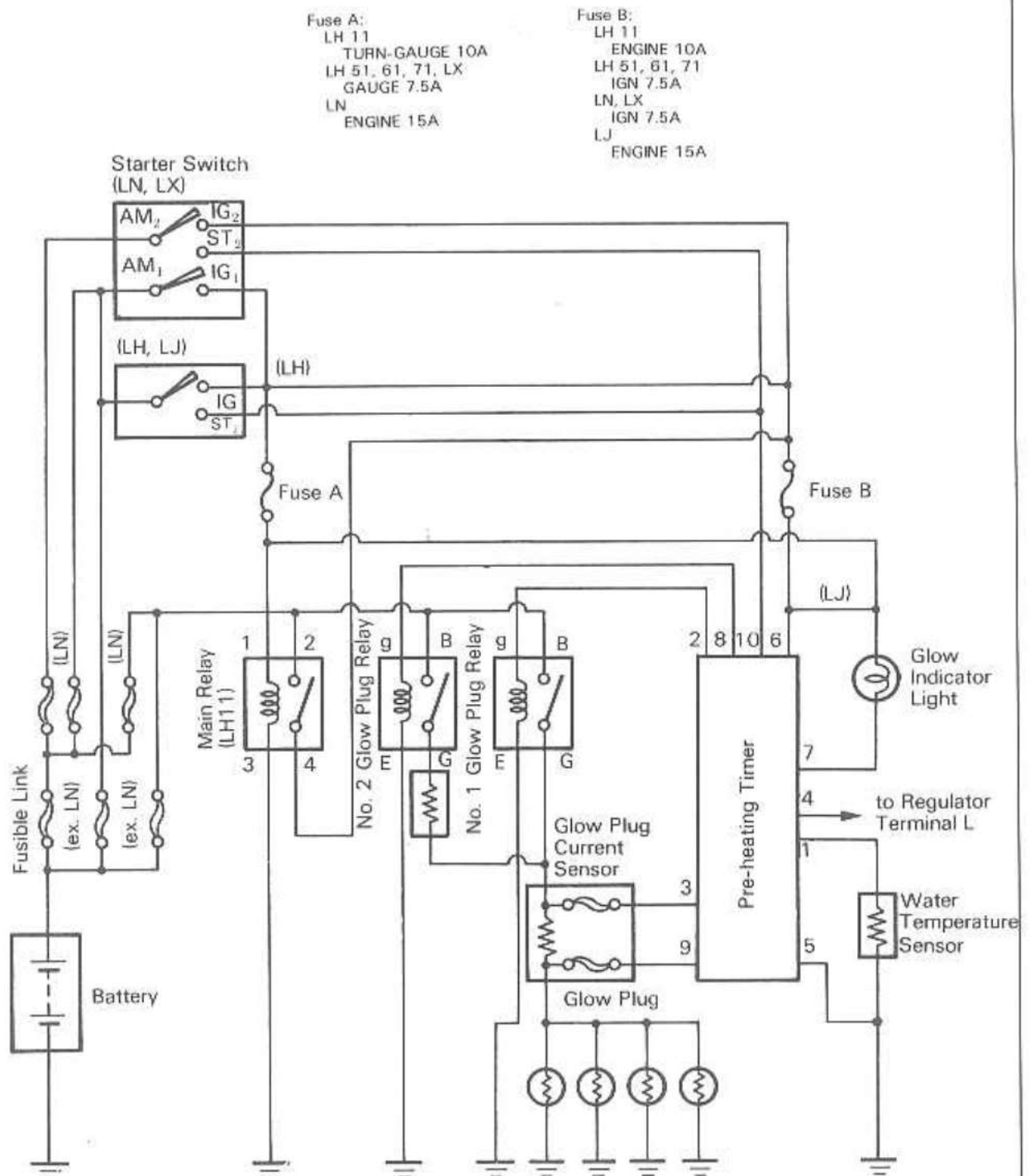
STARTING SYSTEM — Pre-heating System

# PRE-HEATING SYSTEM

## Super Glow Type

### [Europe (LH, LX, LN, LJ)]

### SYSTEM CIRCUIT

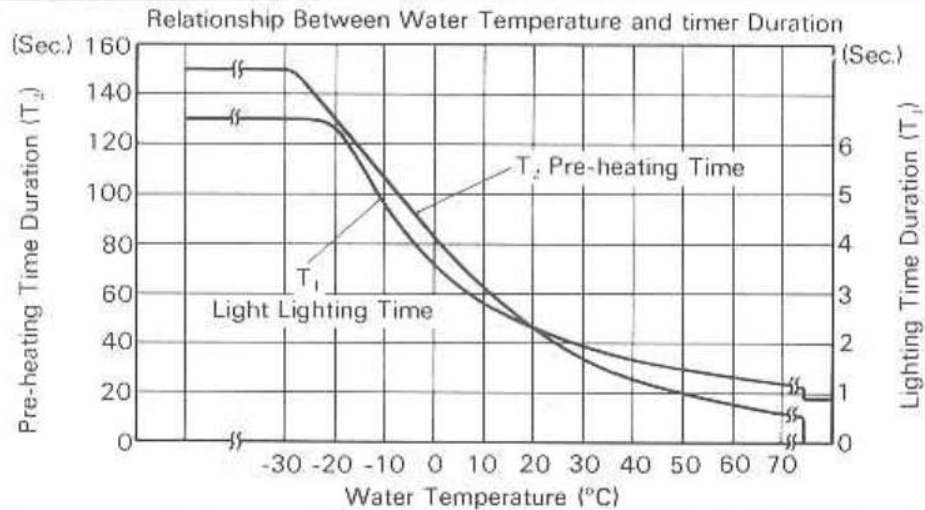


ST0067

## STARTING SYSTEM — Pre-heating System

ST-3

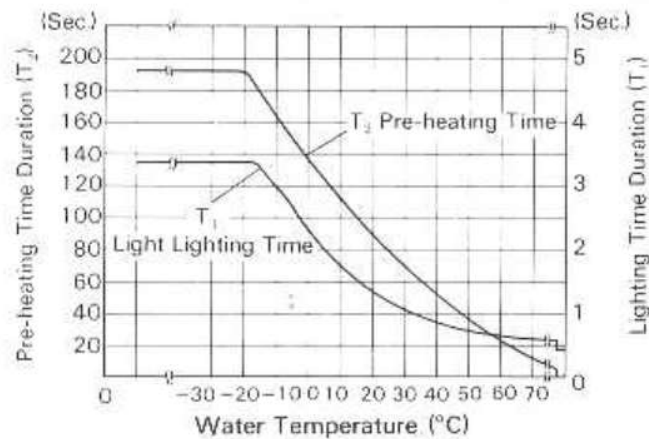
ex, LX



ST0048

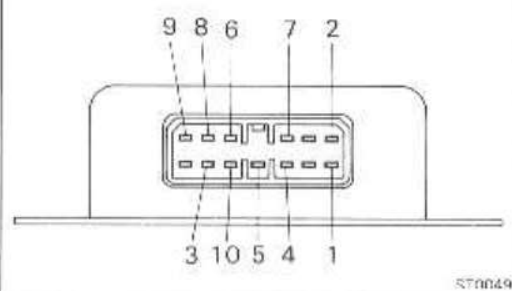
LX

Relationship Between Water Temperature and Timer Duration



ST0160

LH11, LN, LX, LJ



ST0049

INSPECTION OF COMPONENTS  
Pre-heating Timer

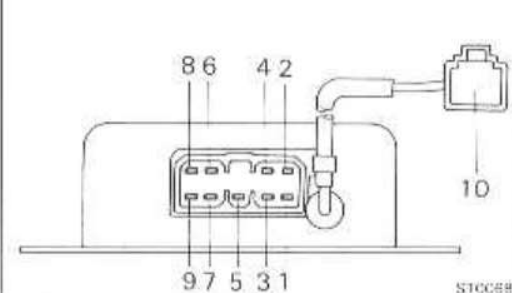
## LOCATION

LH 11, LX, LJ: Under the instrument panel on the passenger side.

LH 51, 61, 71: Under the instrument panel center.

LN: In the left cowl.

LH51, 61, 71



ST0088

Refer to Diesel Electrical System Diagnosis for inspection procedures. (See pages EM-11, 12)

## ST-4

## STARTING SYSTEM — Pre-heating System

## No. 1 and No. 2 Glow Plug Relay

## LOCATION

LN, LX: On the left fender apron in the engine compartment.

LH 11, 51, 61, 71 (No. 1): In the engine compartment on the left side.

LH 51, 61, 71 (No. 2): Under the instrument panel on the driver's side.

LH 11 (No. 2): Under the instrument panel on the passenger side.

## INSPECT NO. 1 AND NO. 2 GLOW PLUG RELAY

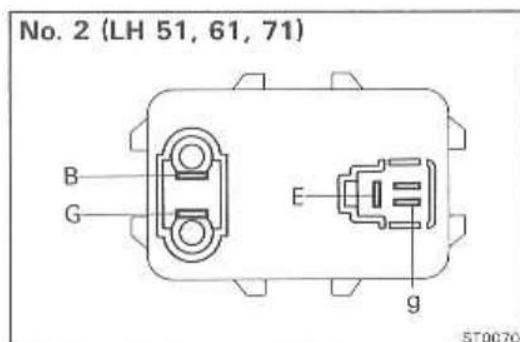
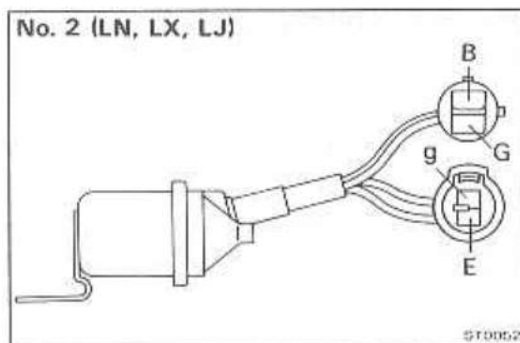
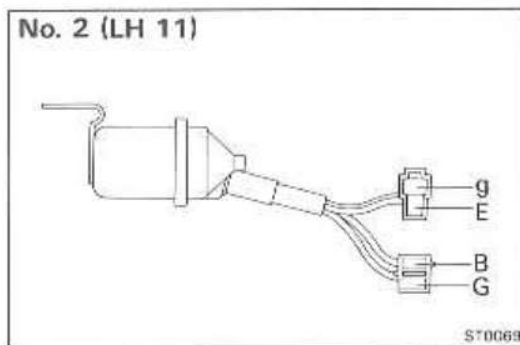
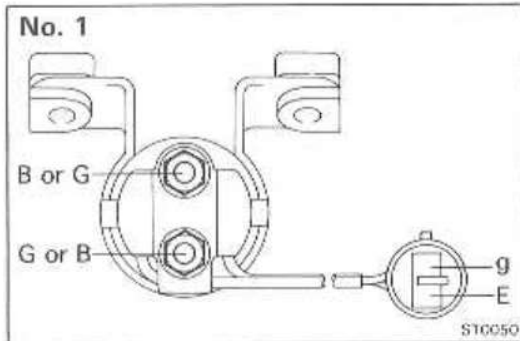
(a) Using an ohmmeter, check for continuity between the following terminals:

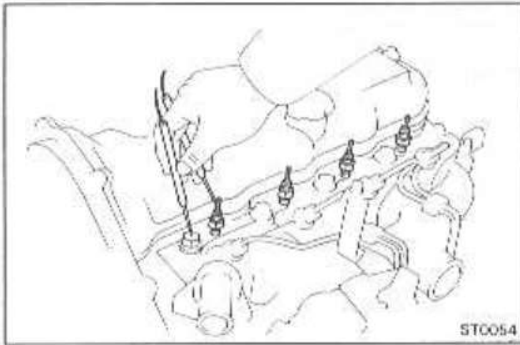
- E → g Continuity
- B → G No continuity

(b) Apply battery voltage between terminals E and g.

- B → G Continuity

If continuity is not as specified, replace the relay.



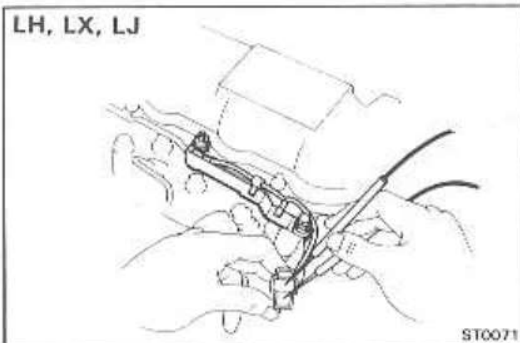
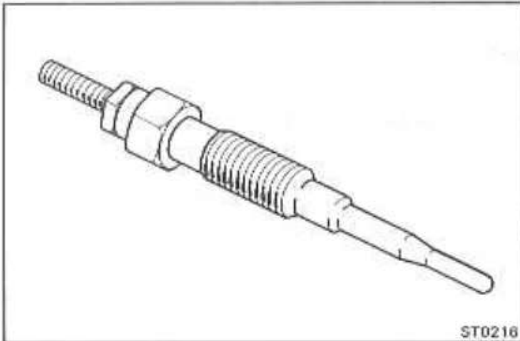
**STARTING SYSTEM — Pre-heating System****ST-5****Glow Plug****INSPECT GLOW PLUG**

Using an ohmmeter, check that there is continuity between the glow plug terminal and ground.

If there is no continuity, replace the glow plug.

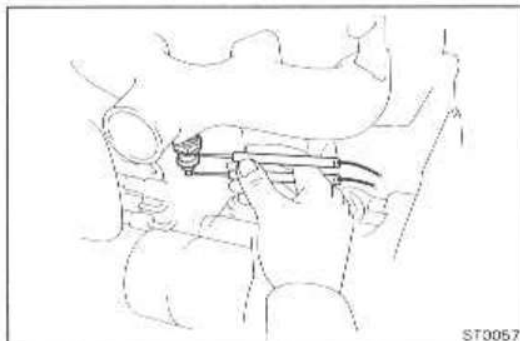
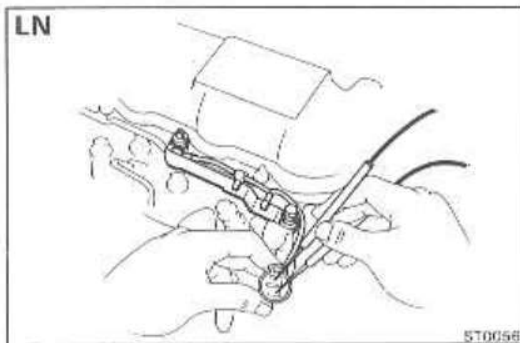
**NOTE:**

- 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****INSPECT 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.

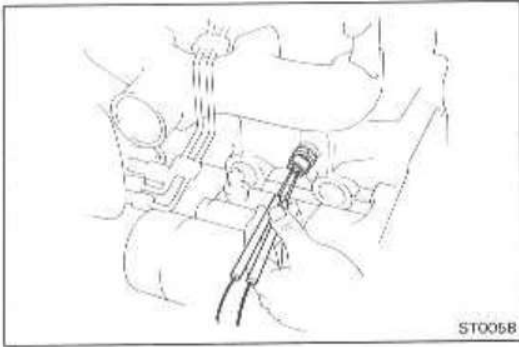
**Glow Plug Resistor****INSPECT GLOW PLUG RESISTOR**

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

If there is no continuity, replace the resistor.

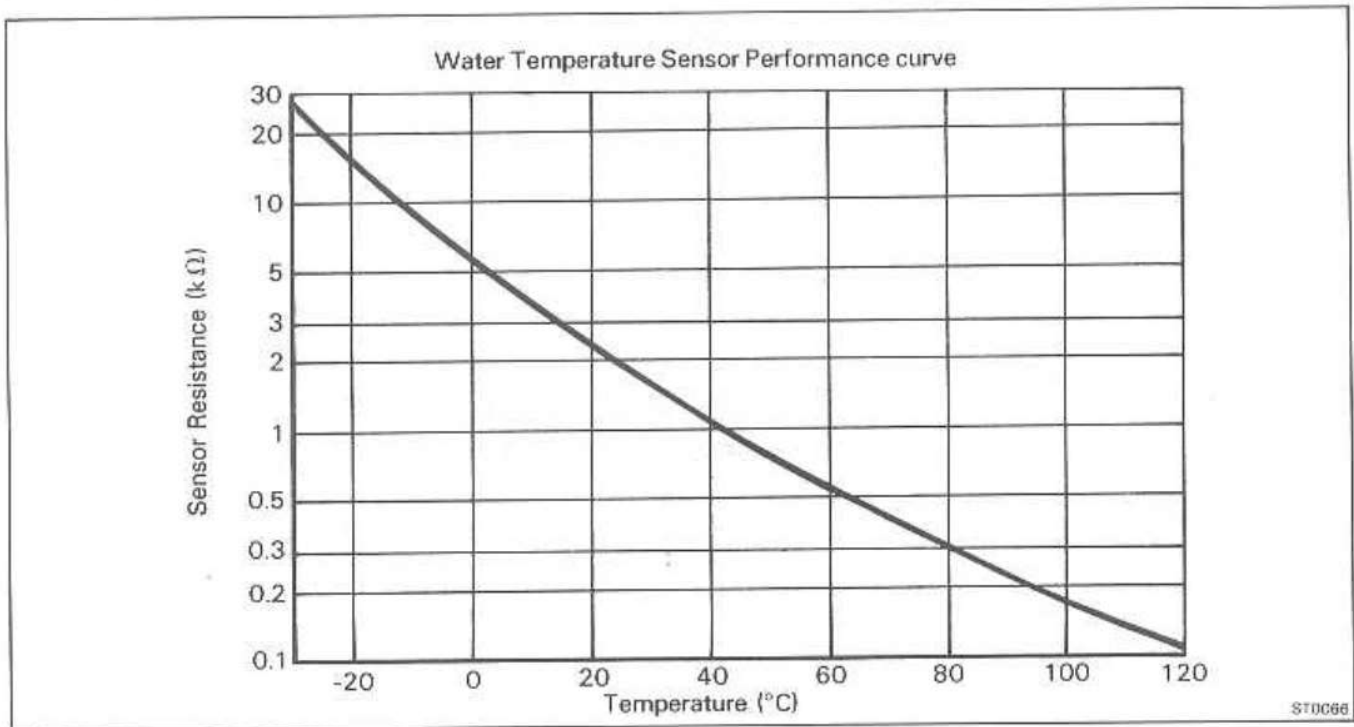
## ST-6

## STARTING SYSTEM — Pre-heating System

**Water Temperature Sensor****INSPECT WATER TEMPERATURE SENSOR**

Using an ohmmeter, check the resistance between the water temperature sensor terminals.

If the resistance is not as specified, replace the water temperature sensor.

**Main Relay**

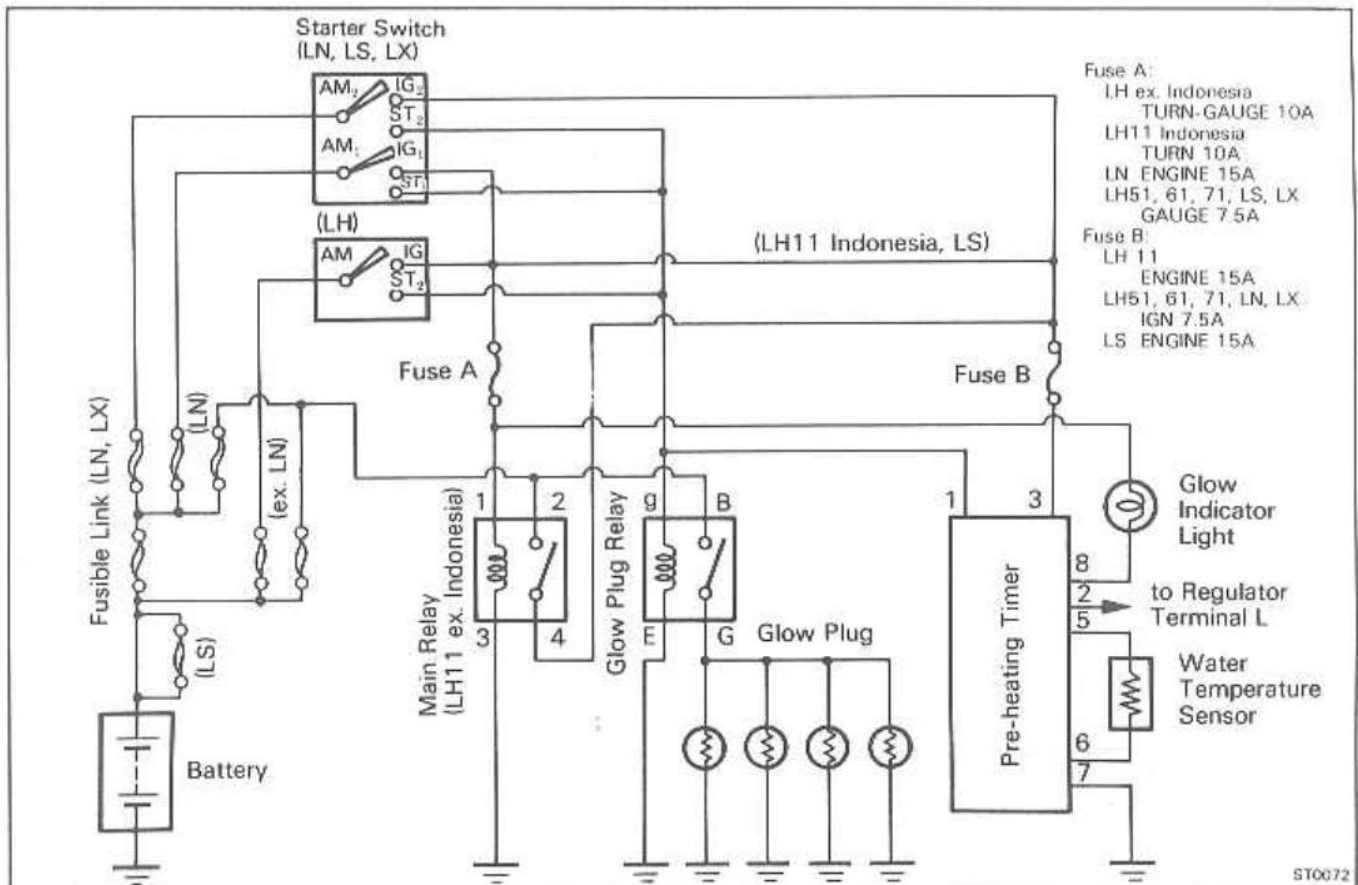
(See page CH-20)

## STARTING SYSTEM — Pre-heating System

ST-7

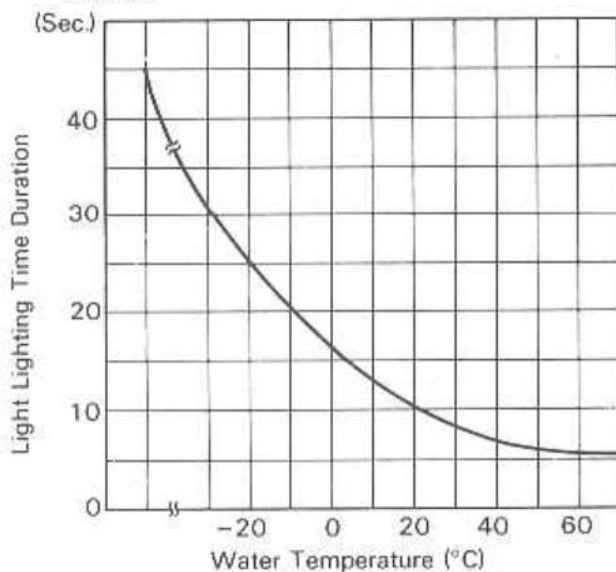
# Variable Delay Type [General Destinations (LH, LN, LX, LS)]

## SYSTEM CIRCUIT



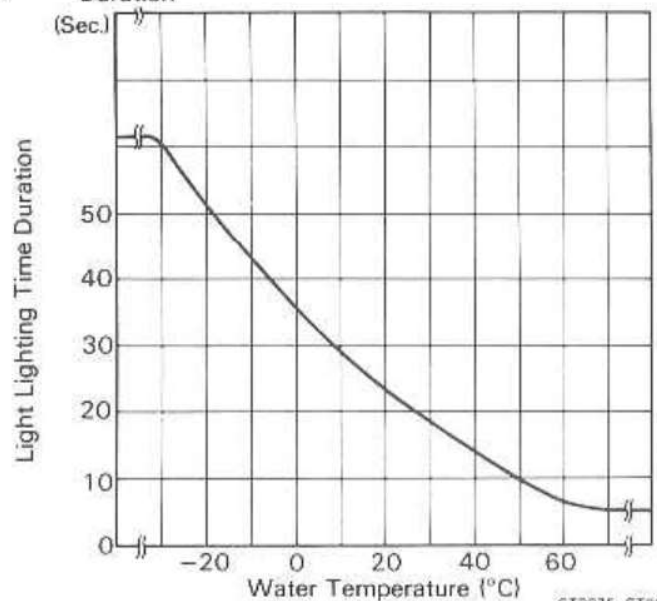
### LH11

Relationship Between Water Temperature and Timer Duration



### LH51, 61, 71, LN, LS, LX

Relationship Between Water Temperature and Timer Duration



ST0075 ST0074

## ST-8

## STARTING SYSTEM — Pre-heating System

## INSPECTION OF COMPONENTS

### Pre-Heating Timer

## LOCATION

LH11, LS, LX: Under the instrument panel on the passenger side.

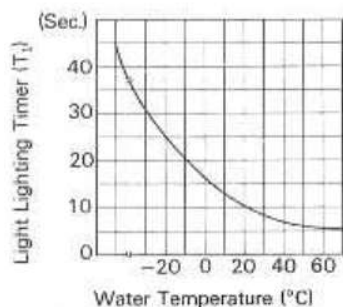
LH51, 61, 71: Under the instrument panel center.

LN: In the left cowl.

(a) Turn the starter switch "ON" and measure the lighting time of the glow indicator light.

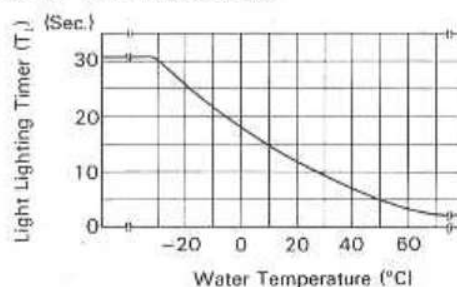
**Glow time at 20°C (68°F): 9 – 15 seconds**

LH 11

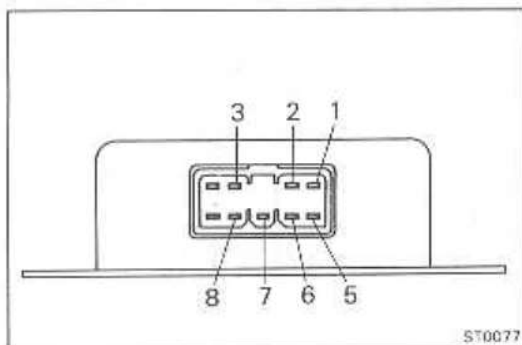


ST0075

LH51, 61, 71, LN, LS, LX



ST0162



ST0077

(b) Check that there is voltage at terminal 1 of the pre-heating timer when the starter switch is turned to "ON".

(c) Turn the starter switch to "START", and then check that there is no voltage at terminal 1.

### Glow Plug Relay

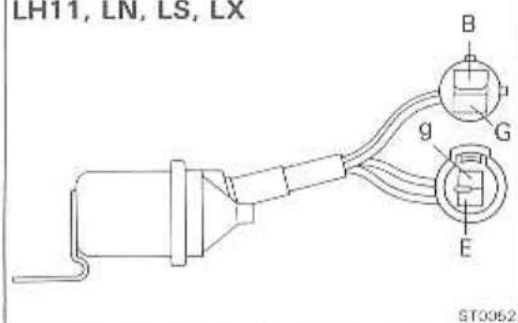
## LOCATION

LH11: Under the instrument panel on the passenger side.

LH51, 61, 71: Under the instrument panel center.

LN, LS, LX: On the left fender apron in the engine compartment.

LH11, LN, LS, LX



ST0062

### INSPECT GLOW PLUG RELAY

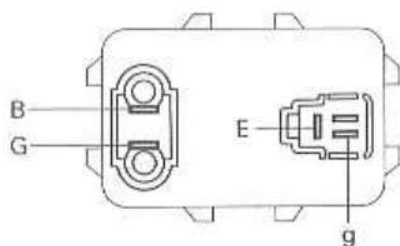
(a) Using an ohmmeter, check for continuity between the following terminals:

- E ↔ g Continuity
- B ↔ G No continuity

(b) Apply battery voltage between terminals E and g.

- B ↔ G Continuity

If continuity is not as specified, replace the relay.

**STARTING SYSTEM — Pre-heating System****ST-9****LH51, 61, 71**

ST0070

**Glow Plug**

(See page ST-5)

**Water Temperature Sensor**

(See page ST-6)

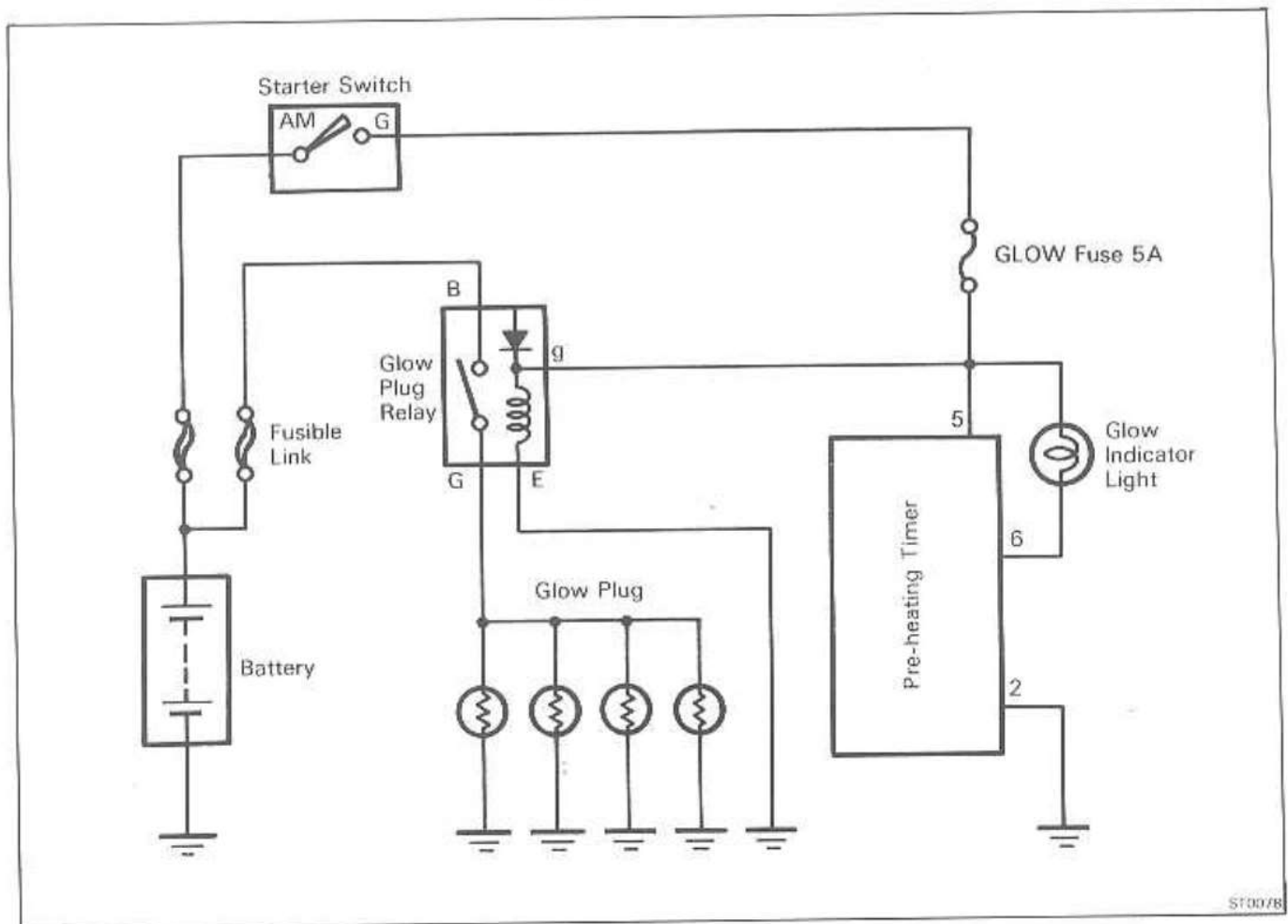
**Main Relay**

(See page CH-20)

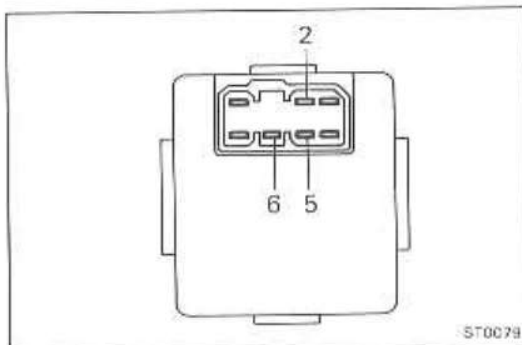
ST-10

STARTING SYSTEM — Pre-heating System

## Fixed Delay Type (LY) SYSTEM CIRCUIT



ST0078



ST0079

### INSPECTION OF COMPONENTS Pre-Heating Timer

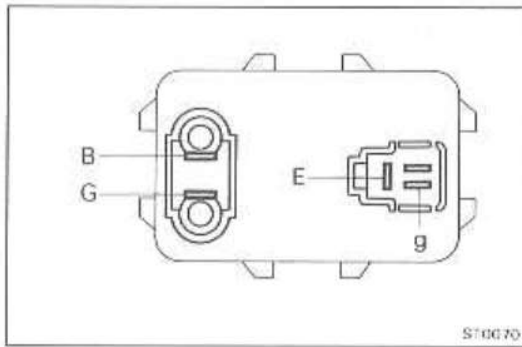
**LOCATION:** Under the instrument panel on the passenger side.

#### INSPECT PRE-HEATING TIMER

- (a) Turn the starter switch to "G" and measure the lighting time of the glow indicator light.

**Glow time at  $-25 - 60^{\circ}\text{C}$  ( $-13 - 140^{\circ}\text{F}$ ):**  
**15 - 19.5 seconds**

- (b) Check that there is voltage at terminal 5 of the pre-heating timer when the starter switch is turned to "G".

**STARTING SYSTEM — Pre-heating System****ST-11****Glow Plug Relay**

**LOCATION:** On the windshield wiper motor bracket.

**INSPECT GLOW PLUG RELAY**

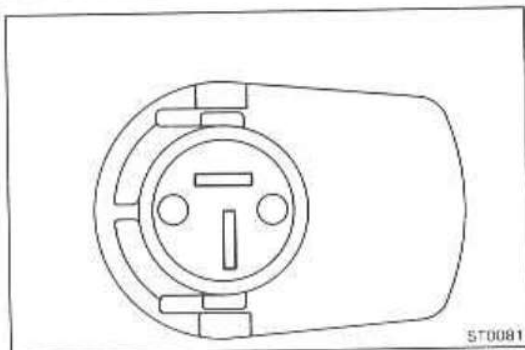
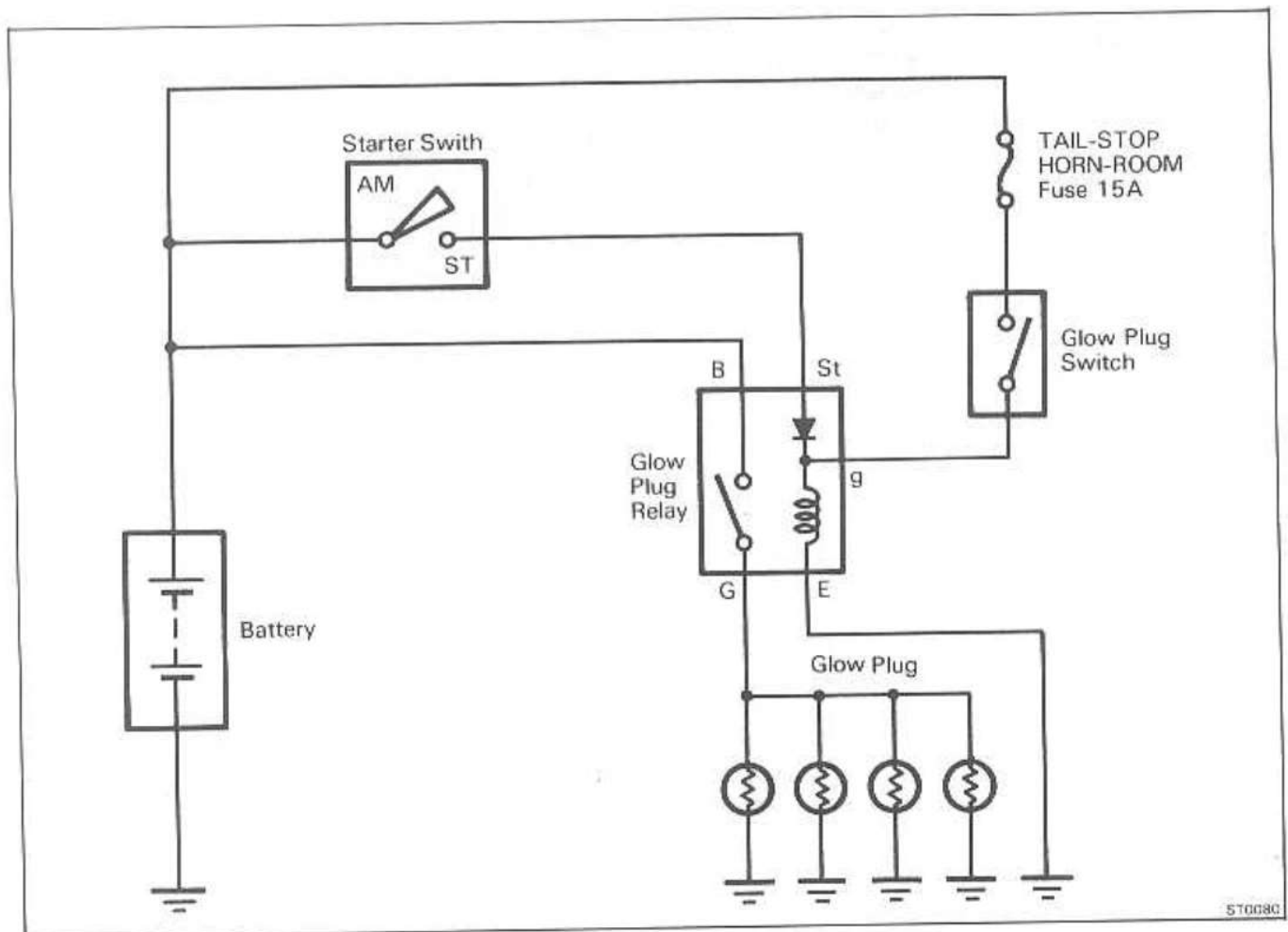
- (a) Using an ohmmeter, check for continuity between the following terminals:
  - **E ↔ g    Continuity**
  - **B ↔ G    No continuity**
- (b) Apply battery voltage between terminals E and g.
  - **B ↔ G    Continuity**

ST-12

### STARTING SYSTEM — Pre-heating System

## Manual Type (LF)

### SYSTEM CIRCUIT



## INSPECTION OF COMPONENTS

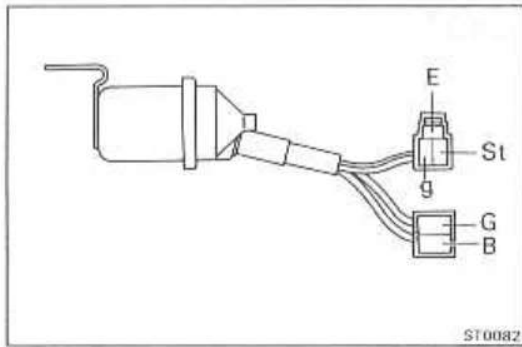
### Glow Plug Switch

### INSPECT GLOW PLUG SWITCH

Check for continuity between terminals.

| Switch position \ Terminal | B                                                                                     | g                                                                                     |
|----------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| OFF                        |                                                                                       |                                                                                       |
| ON                         |  |  |

If continuity is not as specified, replace the switch.

**STARTING SYSTEM — Pre-heating System****ST-13****Glow Plug Relay**

**LOCATION:** On the left fender apron in the engine compartment.

**INSPECT GLOW PLUG RELAY**

- (a) Using an ohmmeter, check for continuity between the following terminals.

• **E → g    Continuity**

• **E → St**

Positive (+) test probe to terminal St

Negative (–) test probe to terminal E

**Continuity**

Positive (+) test probe to terminal E

Negative (–) test probe to terminal St

**No continuity**

• **B → G    No continuity**

- (b) Apply battery voltage between terminals E and g.

• **B → G    Continuity**

- (c) Apply battery voltage between terminals E and St.

• **B → G**

Battery positive (+) terminal to terminal St

Battery negative (–) terminal to terminal E

**Continuity**

If continuity is not as specified, replace the relay.

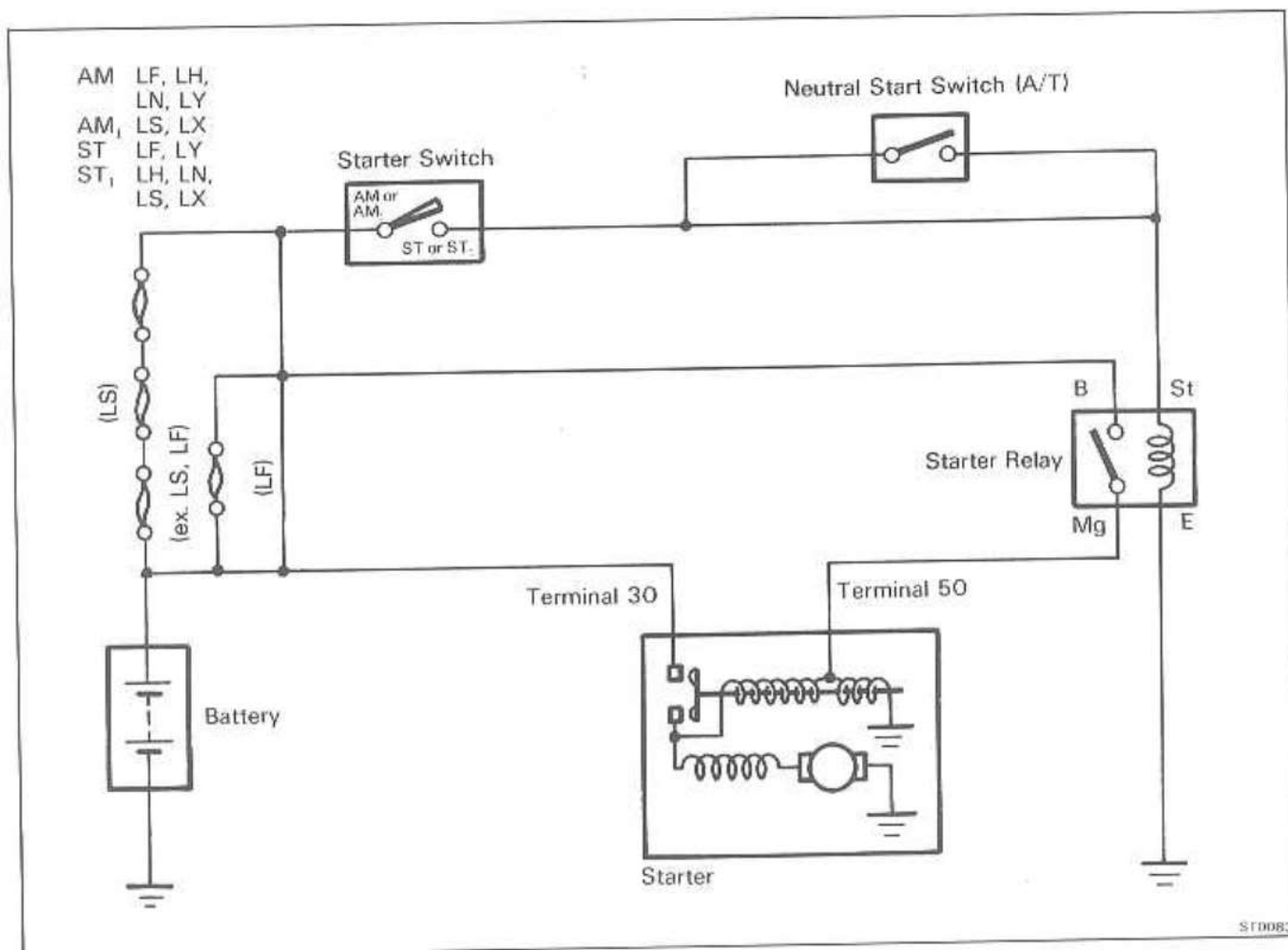
ST-14

## STARTING SYSTEM — Troubleshooting, Starting System Circuit

## TROUBLESHOOTING

| Problem                               | Possible cause                             | Remedy                                                      | Page  |
|---------------------------------------|--------------------------------------------|-------------------------------------------------------------|-------|
| Engine will not crank                 | Battery charge low                         | Check battery specific gravity<br>Charge or replace battery | CH-5  |
|                                       | Battery cables loose, corroded or worn     | Repair or replace cables                                    |       |
|                                       | Fusible link blown                         | Replace fusible link                                        |       |
|                                       | Starter relay faulty                       | Check relay                                                 | ST-27 |
|                                       | Starter faulty                             | Repair starter                                              | ST-15 |
|                                       | Starter switch faulty                      | Replace starter switch                                      |       |
| Engine cranks slowly                  | Battery charge low                         | Check battery specific gravity<br>Charge or replace battery | CH-5  |
|                                       | Battery cables loose, corroded or worn     | Repair or replace cables                                    |       |
|                                       | Starter faulty                             | Repair starter                                              | ST-15 |
| Starter continues to run              | Starter faulty                             | Repair starter                                              | ST-15 |
|                                       | Starter switch faulty                      | Replace starter switch                                      |       |
|                                       | Short in wiring                            | Repair wiring                                               |       |
| Starter spins - engine will not crank | Pinion gear teeth broken or faulty starter | Repair starter                                              | ST-15 |
|                                       | Flywheel teeth broken                      | Replace flywheel                                            |       |

## STARTING SYSTEM CIRCUIT

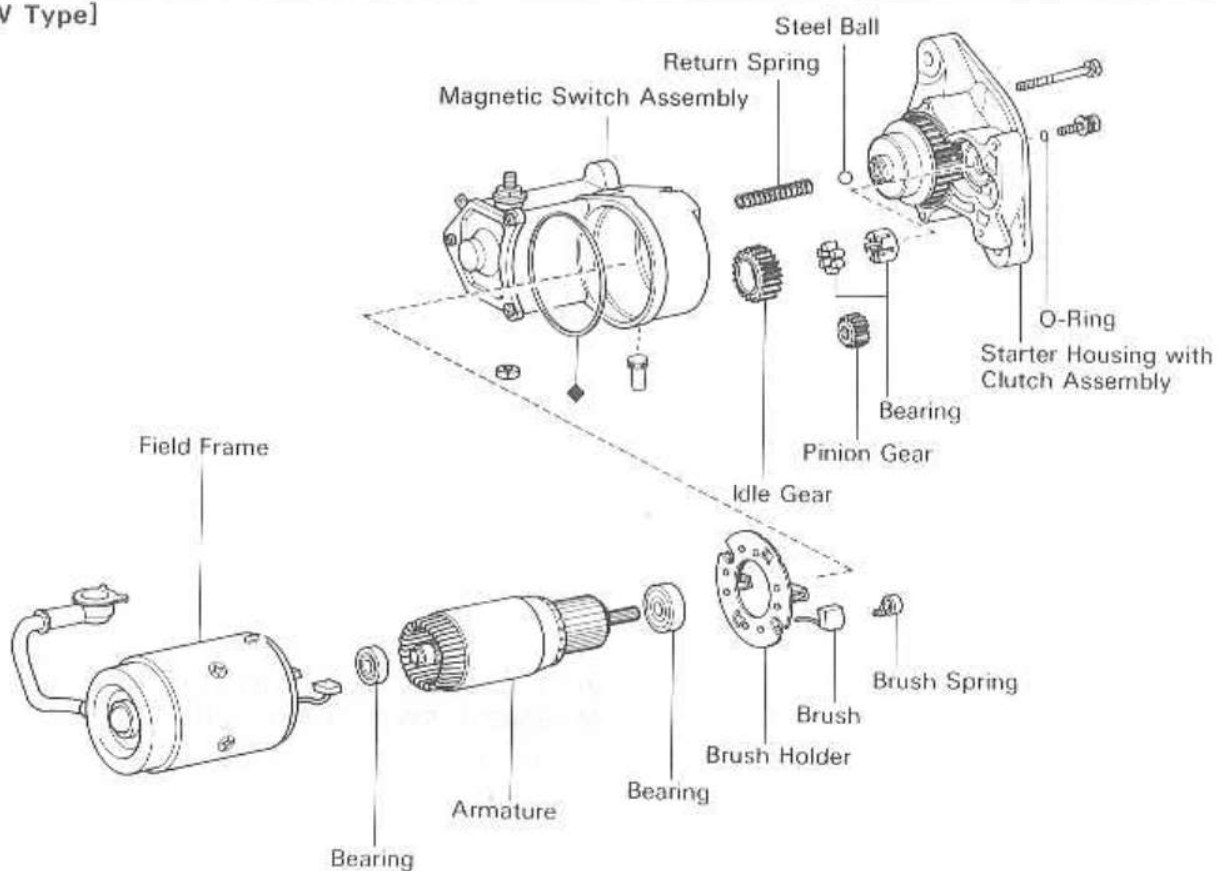


## STARTING SYSTEM — Starter

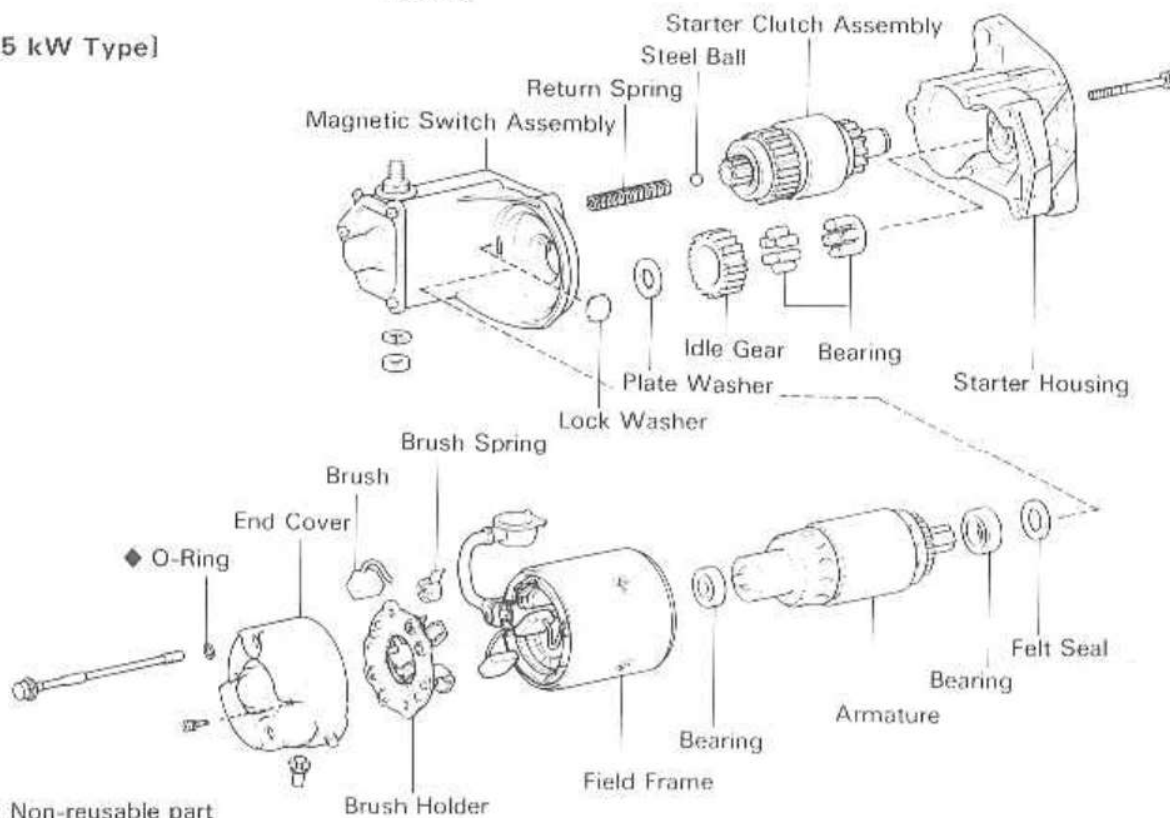
ST-15

# STARTER COMPONENTS

[2.0 kW Type]



[2.5 kW Type]

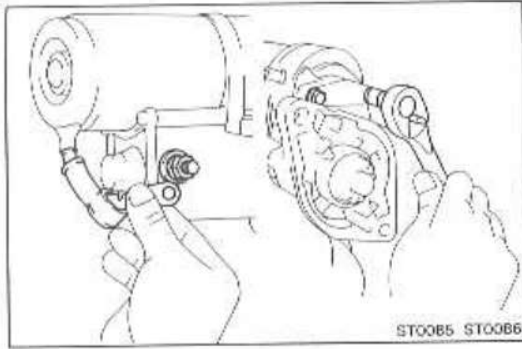


◆ : Non-reusable part

ST0084  
ST0026

## ST-16

## STARTING SYSTEM — Starter

**DISASSEMBLY OF STARTER**

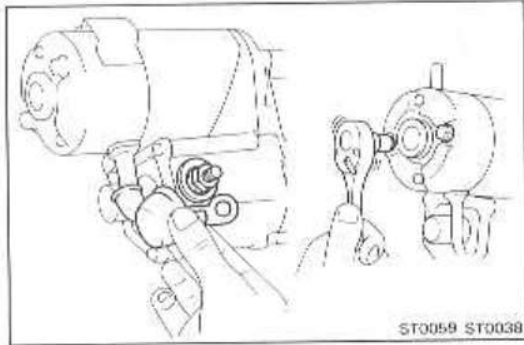
(See page ST-15)

**1. REMOVE FIELD FRAME WITH ARMATURE FROM MAGNETIC SWITCH  
[2.0 kW TYPE]**

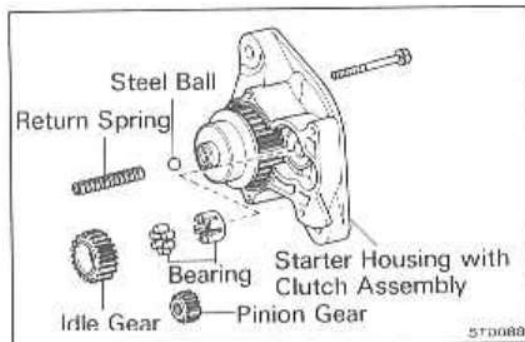
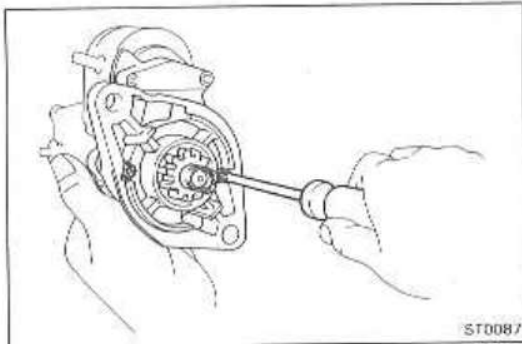
- (a) Remove the nut. Disconnect the lead wire from the magnetic switch terminal.
- (b) Remove the two bolts, plate washers and O-rings. Pull out the field frame with the armature.
- (c) Remove the O-ring from the field frame.

**[2.5 kW TYPE]**

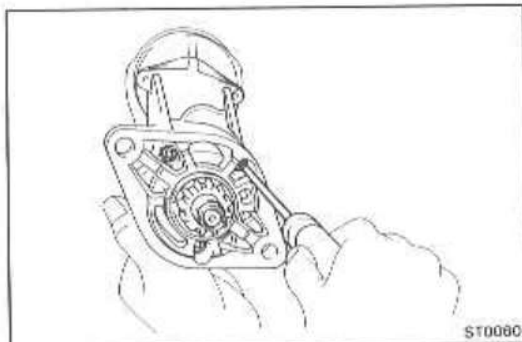
- (a) Remove the nut and spring washer. Disconnect the lead wire from the magnetic switch terminal.
- (b) Remove the two through bolts, plate washers and O-rings. Pull out the field frame with the armature.
- (c) Remove the felt seal and lock plate.

**2. [2.0 kW TYPE]  
REMOVE STARTER HOUSING, IDLE GEAR AND PINION GEAR WITH CLUTCH ASSEMBLY FROM MAGNETIC SWITCH ASSEMBLY**

- (a) Remove the two screws.
- (b) Remove the following parts:
  - (1) Starter housing with clutch assembly
  - (2) Return spring
  - (3) Idle gear
  - (4) Bearing
  - (5) Pinion gear

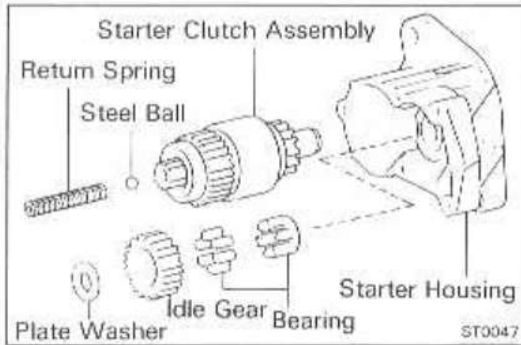
**[2.5 kW TYPE]  
REMOVE STARTER HOUSING, STARTER CLUTCH ASSEMBLY AND IDLE GEAR FROM MAGNETIC SWITCH ASSEMBLY**

- (a) Remove the three screws.



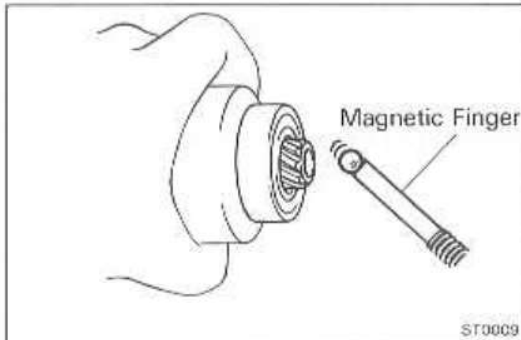
## STARTING SYSTEM — Starter

ST-17

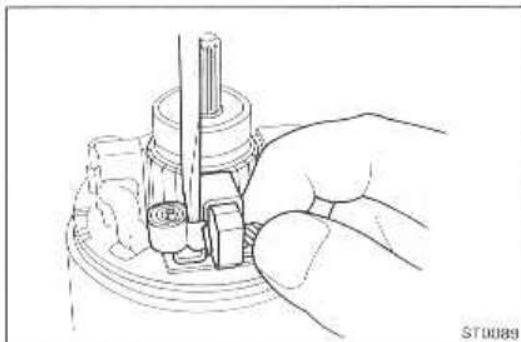


(b) Remove the following parts:

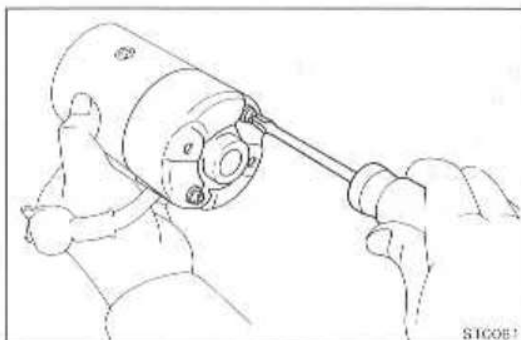
- (1) Starter housing
- (2) Clutch assembly
- (3) Return spring
- (4) Plate washer
- (5) Idle gear
- (6) Bearing

**3. REMOVE STEEL BALL**

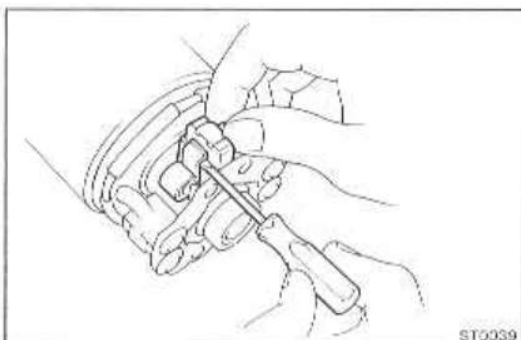
Using a magnetic finger, remove the steel ball from the clutch shaft hole.

**4. REMOVE BRUSHES AND BRUSH HOLDER [2.0 kW TYPE]**

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

**[2.5 kW TYPE]**

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

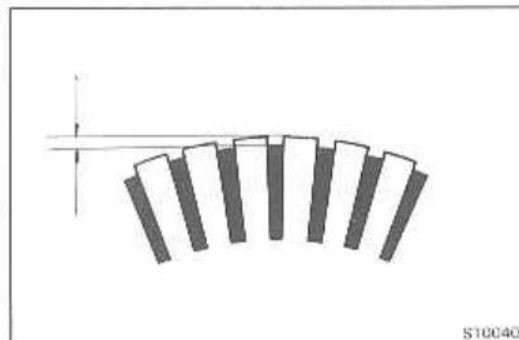
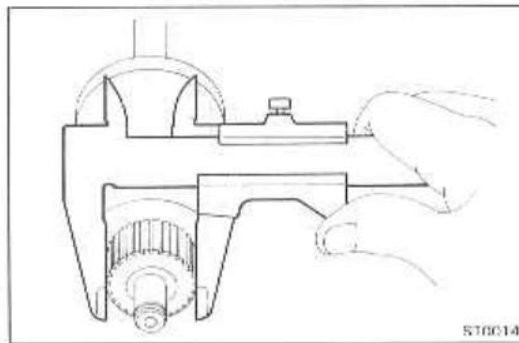
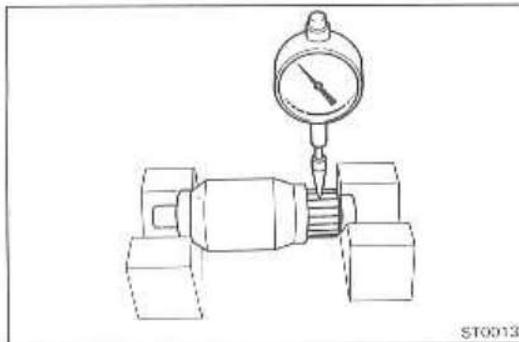
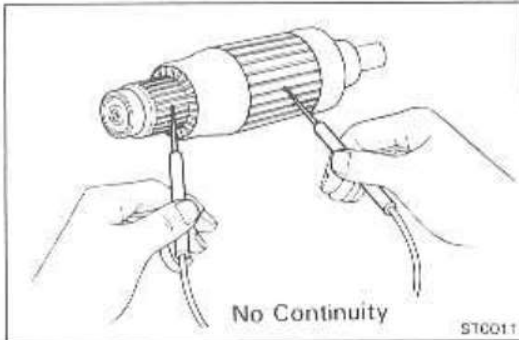
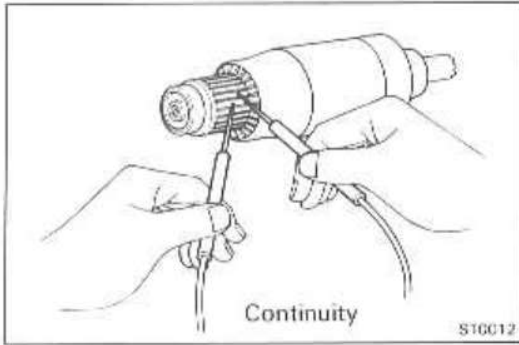


- (b) Using a screwdriver, hold the brush spring back, and remove the brush from the brush holder. Remove the four brushes.
- (c) Pull the brush holder off the field frame.

**5. REMOVE ARMATURE FROM FIELD FRAME**

## ST-18

## STARTING SYSTEM — Starter



## INSPECTION OF 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 DIRT AND BURNS

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

### 2. INSPECT COMMUTATOR CIRCLE RUNOUT

Maximum circle runout: 0.05 mm (0.0020 in.)

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

### 3. INSPECT DIAMETER OF COMMUTATOR

Standard diameter:

2.0 kW type 35 mm (1.38 in.)

2.5 kW type 36 mm (1.42 in.)

Minimum diameter:

2.0 kW type 34 mm (1.34 in.)

2.5 kW type 35 mm (1.38 in.)

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

### 4. INSPECT UNDERCUT DEPTH

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

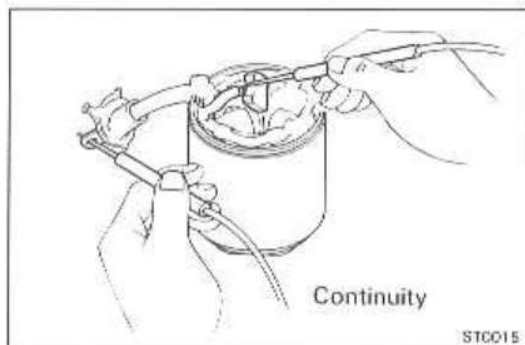
Standard undercut depth: 0.7 – 0.9 mm  
(0.028 – 0.035 in.)

Minimum undercut depth: 0.2 mm (0.008 in.)

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

## STARTING SYSTEM — Starter

ST-19

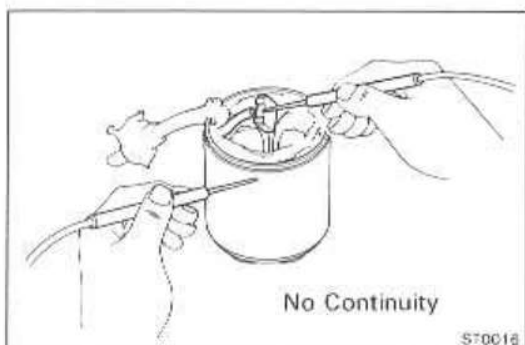


## Field Coil

## 1. INSPECT FIELD COIL FOR OPEN CIRCUIT

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

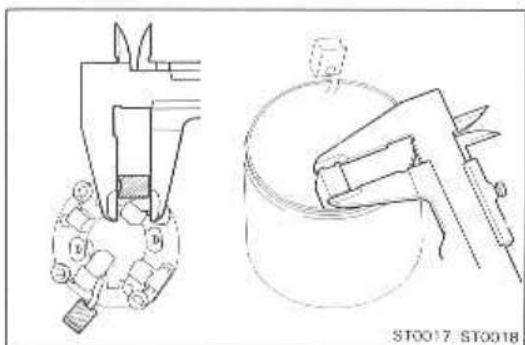
If there is no continuity, replace the field coil.



## 2. INSPECT FIELD COIL FOR GROUND

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

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



## Brushes

## INSPECT BRUSH LENGTH

Standard length:

2.0 kW type 15.0 – 15.5 mm (0.591 – 0.610 in.)

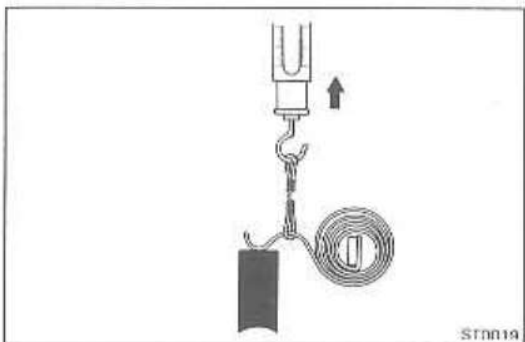
2.5 kW type 20.5 – 21.0 mm (0.807 – 0.827 in.)

Minimum length:

2.0 kW type 9.5 mm (0.374 in.)

2.5 kW type 13.0 mm (0.512 in.)

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



## Brush Springs

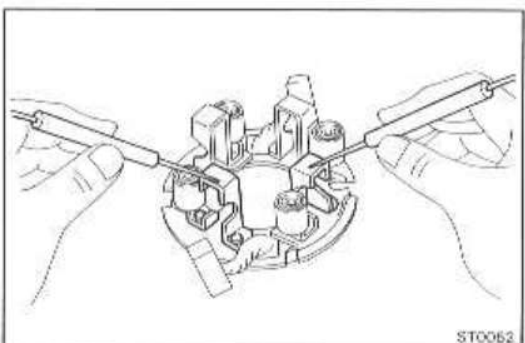
## INSPECT BRUSH SPRING LOAD

NOTE: Take the pull scale reading at the very instant the brush spring separates from the brush.

Spring installed load:

2.0 kW type 2.7 – 3.3 kg  
(6.0 – 7.3 lb, 26 – 32 N)

2.5 kW type 3.2 – 4.0 kg  
(7.1 – 8.8 lb, 31 – 39 N)



## 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.

## ST-20

## STARTING SYSTEM — Starter

**Clutch and Gears****1. INSPECT GEAR TEETH**

Check the gear teeth on the pinion gear, idler gear and clutch assembly for wear or damage. Replace if damaged. If damaged, also check the flywheel ring gear for wear or damage.

**2. INSPECT CLUTCH**

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

If necessary, replace the clutch assembly.

**3. [2.0 kW TYPE]  
IF NECESSARY, REPLACE CLUTCH ASSEMBLY**

- (a) Push down the pinion gear and, using a plastic hammer, tap in the stop collar.

- (b) Using a screwdriver, pry out the snap ring.

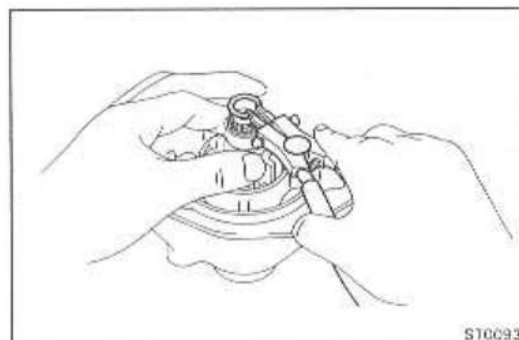
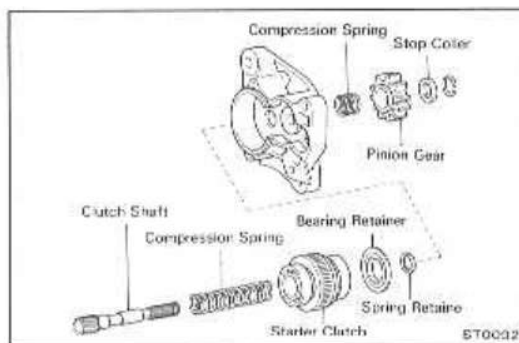
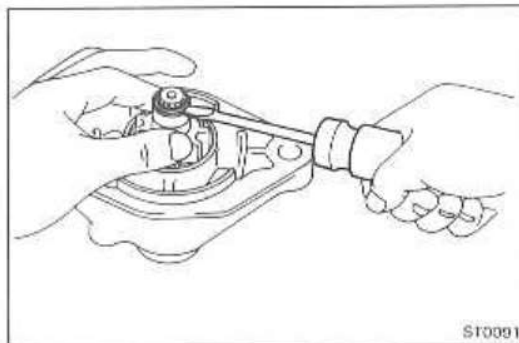
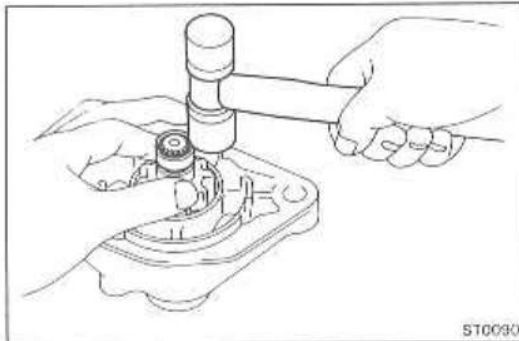
- (c) Remove the following parts from the starter housing:

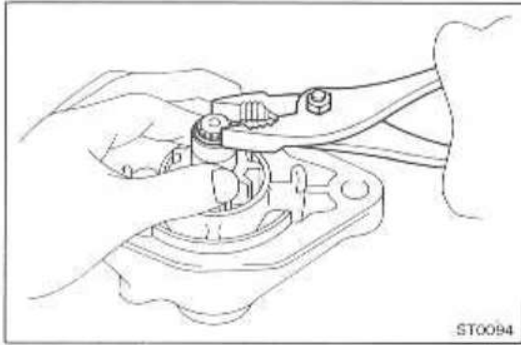
- (1) Stop collar
- (2) Pinion gear
- (3) Compression spring
- (4) Spring retainer
- (5) Bearing retainer
- (6) Starter clutch
- (7) Compression spring
- (8) Clutch shaft

- (d) Assemble the clutch shaft, compression spring, starter clutch, bearing retainer and spring retainer, and install them to the starter housing.

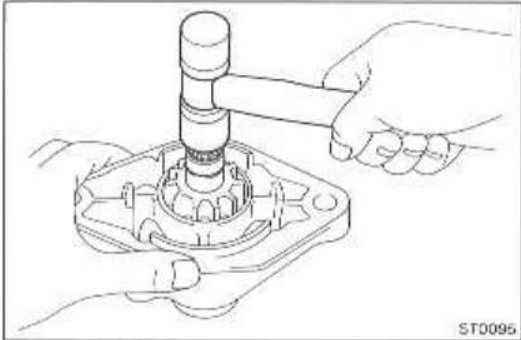
- (e) Install the compression spring, pinion gear and stop collar.

- (f) Push down the pinion gear and, using snap ring pliers, install the snap ring.

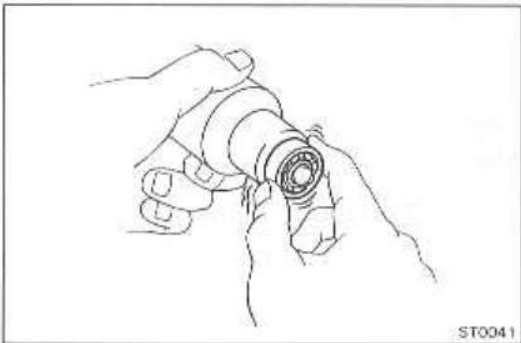


**STARTING SYSTEM — Starter****ST-21**

- (g) Using pliers, compress the snap ring. Make sure that the snap ring fits correctly.

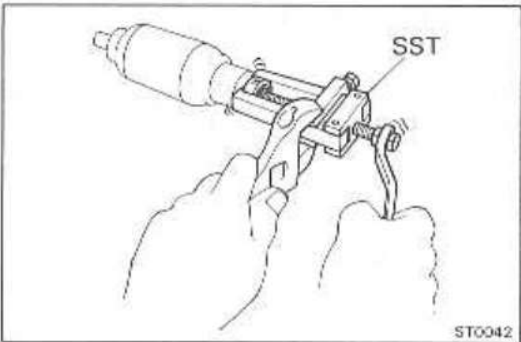


- (h) Using a plastic hammer, tap the clutch shaft and install the stop collar onto the snap ring.

**Bearings****1. INSPECT BEARINGS**

Turn each bearing by hand while pushing inward.

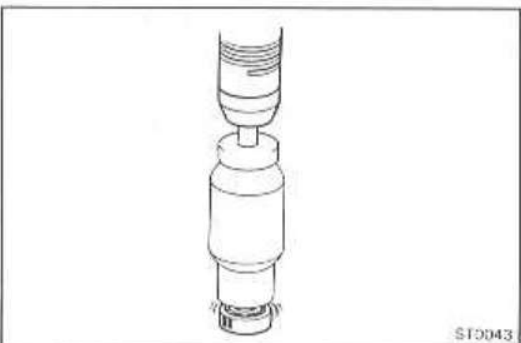
If resistance is felt or if the bearing sticks, replace the bearing.

**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.

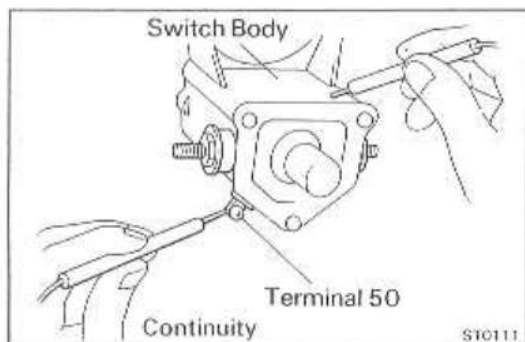
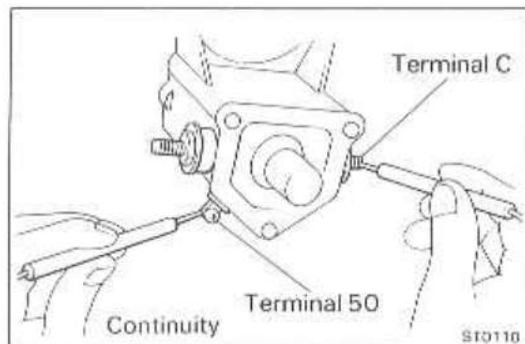
SST 09286-46011



- (c) Using a press, install the bearings onto the shaft.

## ST-22

## STARTING SYSTEM — Starter

**Magnetic Switch****1. PERFORM PULL-IN COIL OPEN CIRCUIT TEST**

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

If there is no continuity, replace the magnetic switch.

**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.

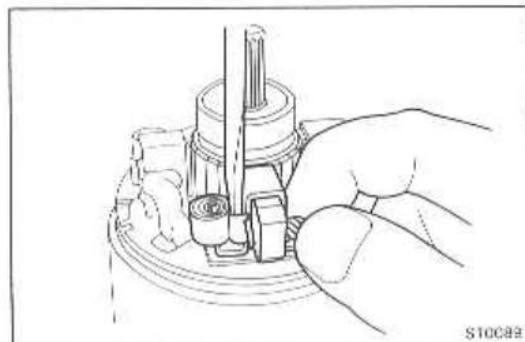
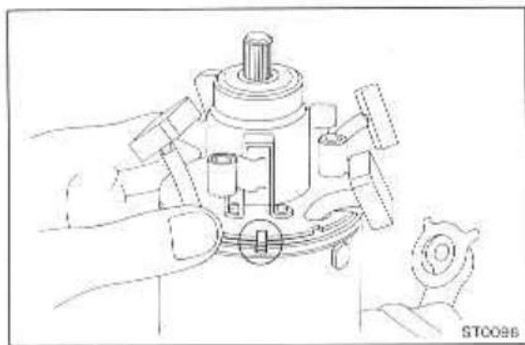
**ASSEMBLY OF STARTER**

(See page ST-15)

**NOTE:** Use No. 50 Denso 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 [2.0 kW TYPE]**

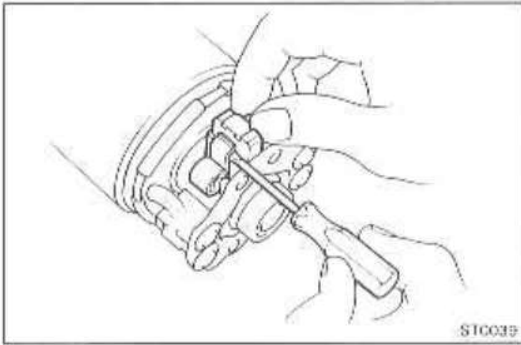
(a) Place the brush holder on the armature shaft and align the tab of the holder with the notch of the field frame.

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

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

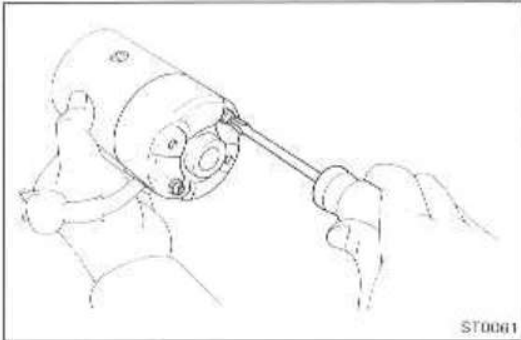
## STARTING SYSTEM — Starter

ST-23

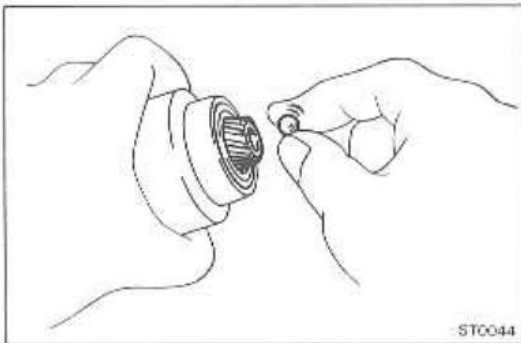
**[2.5 kW TYPE]**

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

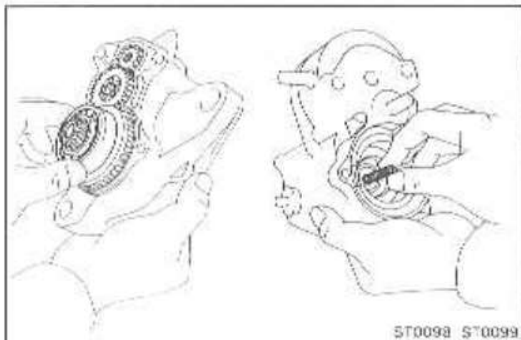
NOTE: Check that the positive lead wires are not grounded.



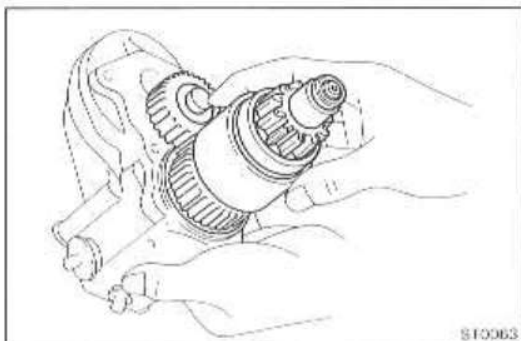
- (c) Install the end cover with the two screws.

**3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE**

Apply grease to the ball, and insert it into the clutch shaft hole.



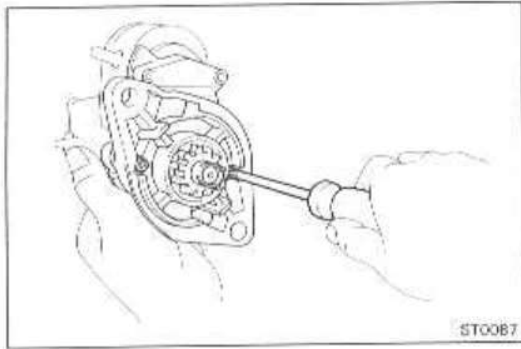
**4. [2.0 kW TYPE]  
INSTALL IDLE GEAR, BEARING, PINION GEAR AND  
RETURN SPRING TO STARTER HOUSING AND  
MAGNETIC SWITCH ASSEMBLY**

**[2.5 kW TYPE]**

**INSTALL RETURN SPRING, STARTER HOUSING,  
PLATE WASHER, IDLE GEAR AND BEARING TO  
MAGNETIC SWITCH ASSEMBLY**

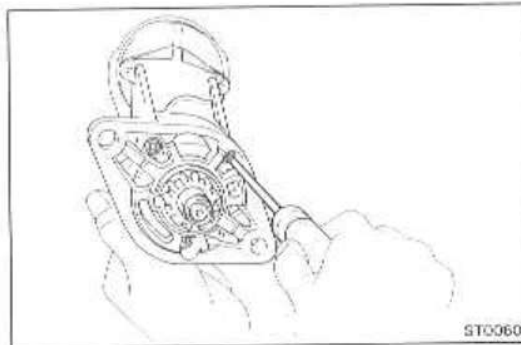
## ST-24

## STARTING SYSTEM — Starter



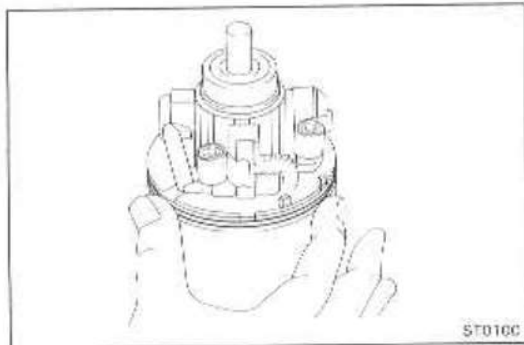
### 5. INSTALL STARTER HOUSING [2.0 kW TYPE]

Install the starter housing to the magnetic switch assembly with the two screws.



### [2.5 kW TYPE]

Install the starter housing to the magnetic switch assembly with the three screws.



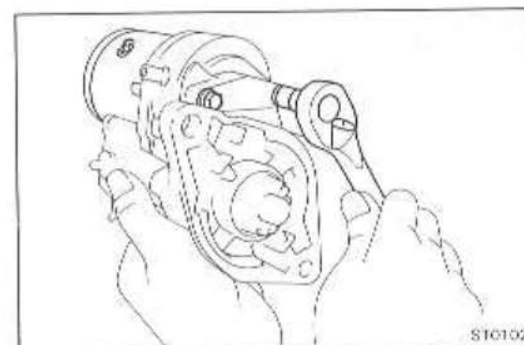
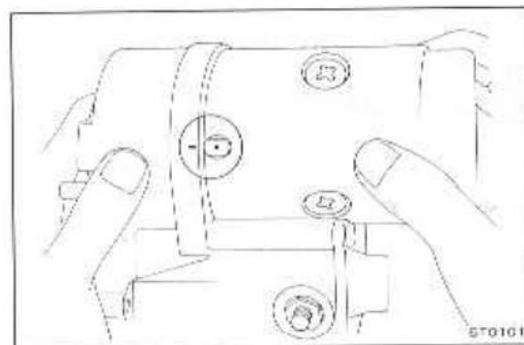
### 6. INSTALL FIELD FRAME WITH ARMATURE IN MAGNETIC SWITCH [2.0 kW TYPE]

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

(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.

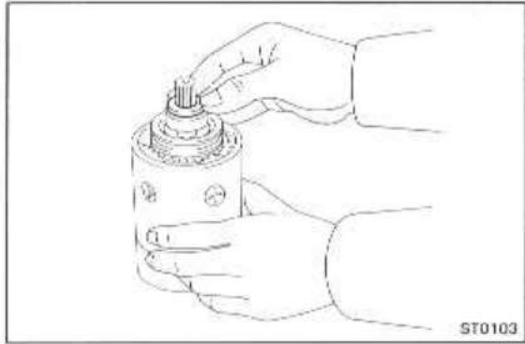
(c) Install the two bolts with the plate washers and O-rings.

(d) Connect the lead wire to the magnetic switch terminal.

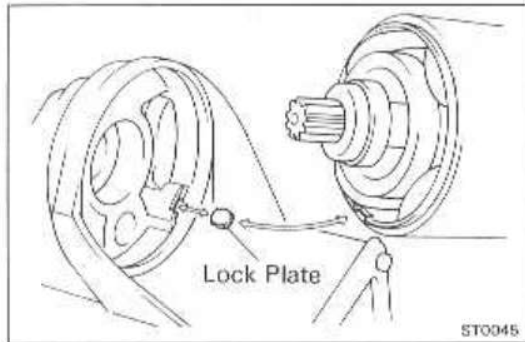


## STARTING SYSTEM — Starter

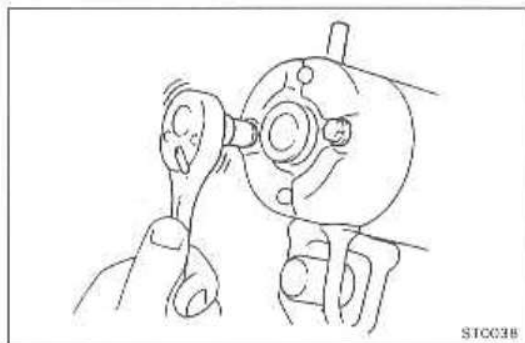
ST-25

**[2.5 kW TYPE]**

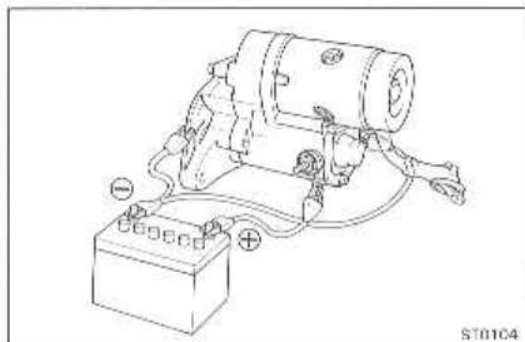
- (a) Place the felt seal on the armature shaft.



- (b) Place the lock plate on the magnetic switch.  
(c) Align the lock plate with the notch on the field frame and insert the field frame with the armature.



- (d) Install the two through bolts with the plate washers and O-rings.  
(e) Connect the lead wire to the magnetic switch terminal.

**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**

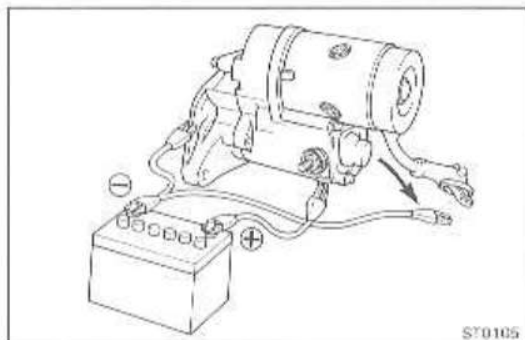
- (a) Disconnect the lead wire from terminal C.  
(b) Connect the battery to the magnetic switch as shown. Check that the plunger moves outward.

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

**2. PERFORM HOLD-IN TEST**

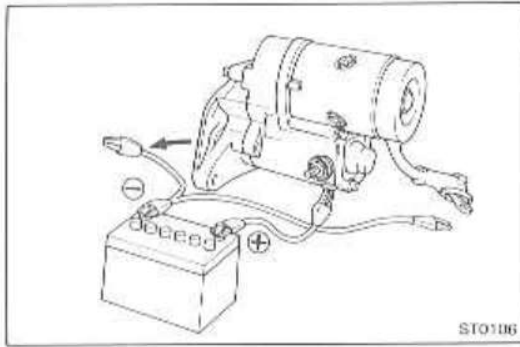
While connected as above with the plunger out, disconnect the negative lead from terminal C. Check that the plunger remains out.

If the plunger returns inward, replace the magnetic switch.



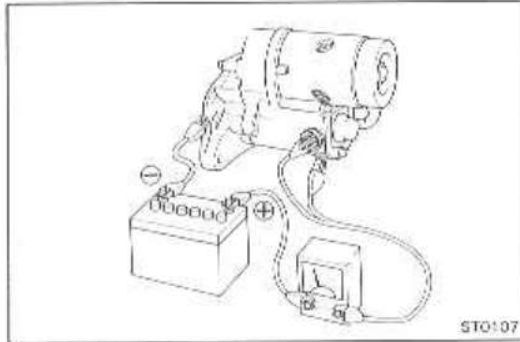
## ST-26

## STARTING SYSTEM — Starter

**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 lead wire to terminal C.
- Connect the battery and an 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:**

2.0 kW type    less than 120 A at 11.5 V  
2.5 kW type    less than 180 A at 11.0 V

## STARTING SYSTEM — Starter Relay

ST-27

## STARTER RELAY

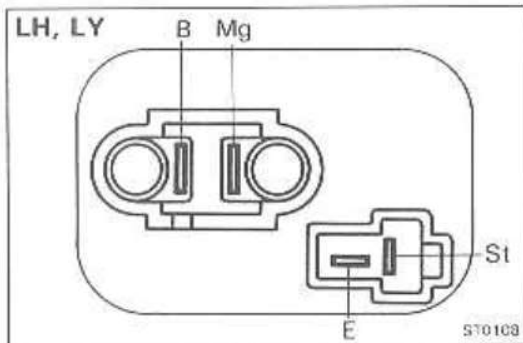
## LOCATION

LH 11: Under the instrument panel on the passenger side.

LF, LN, LS, LX: On the left fender apron in the engine compartment.

LH 51, 61, 71: Under the combination meter

LY: Under the instrument panel on the passenger side.



## INSPECTION OF STARTER RELAY

## INSPECT STARTER RELAY

(a) Using an ohmmeter, check for continuity between the following terminals:

- E ↔ St Continuity
- B ↔ Mg No continuity

(b) Apply battery voltage between terminals E and St.

- B ↔ Mg Continuity

If continuity is not as specified, replace the relay.

