STARTING SYSTEM

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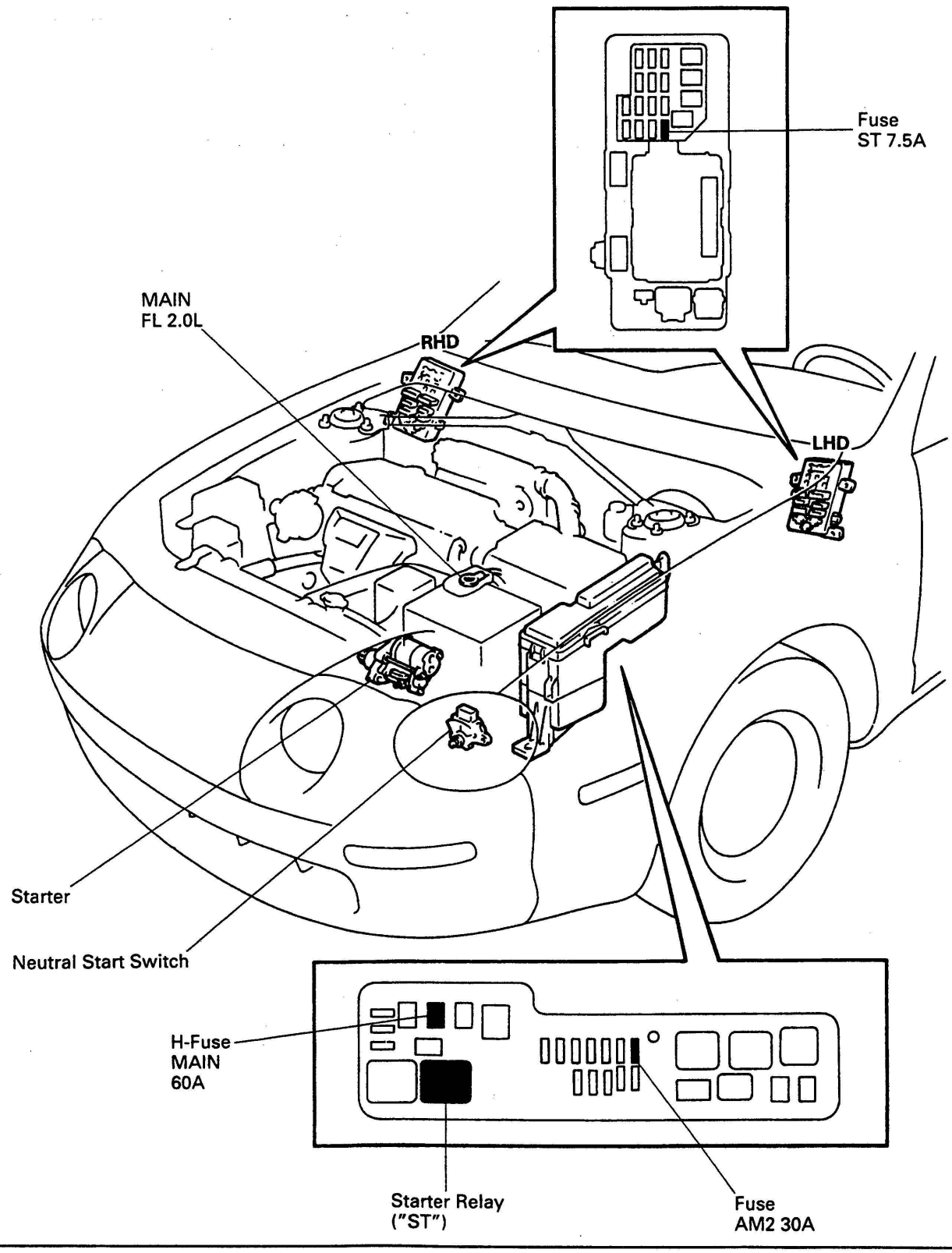
DESCRIPTION

ST07L-01

The starter is a reduction type with a small, high–speed motor used to drive the pinion gear.

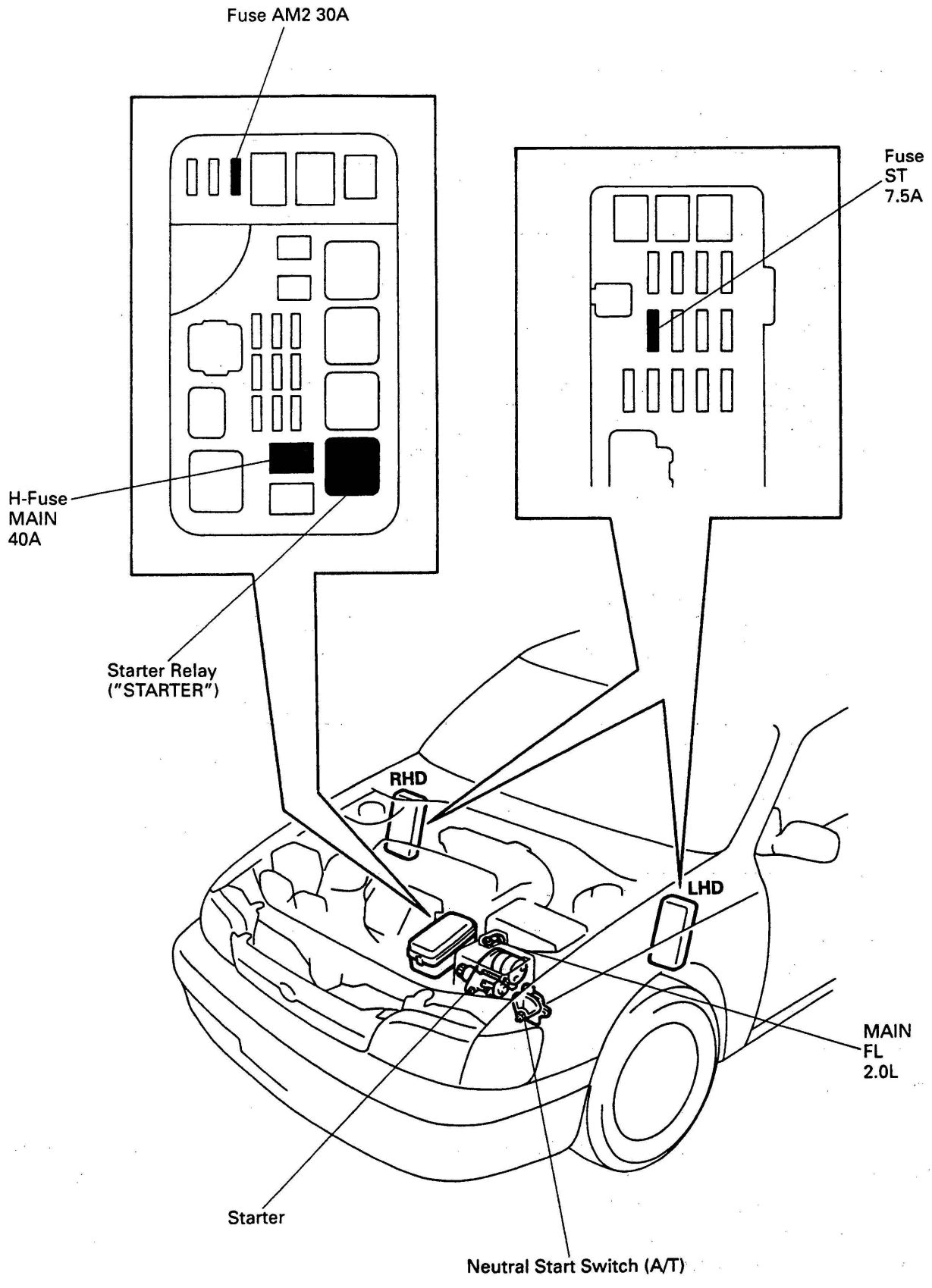
ST

ST202



P17235

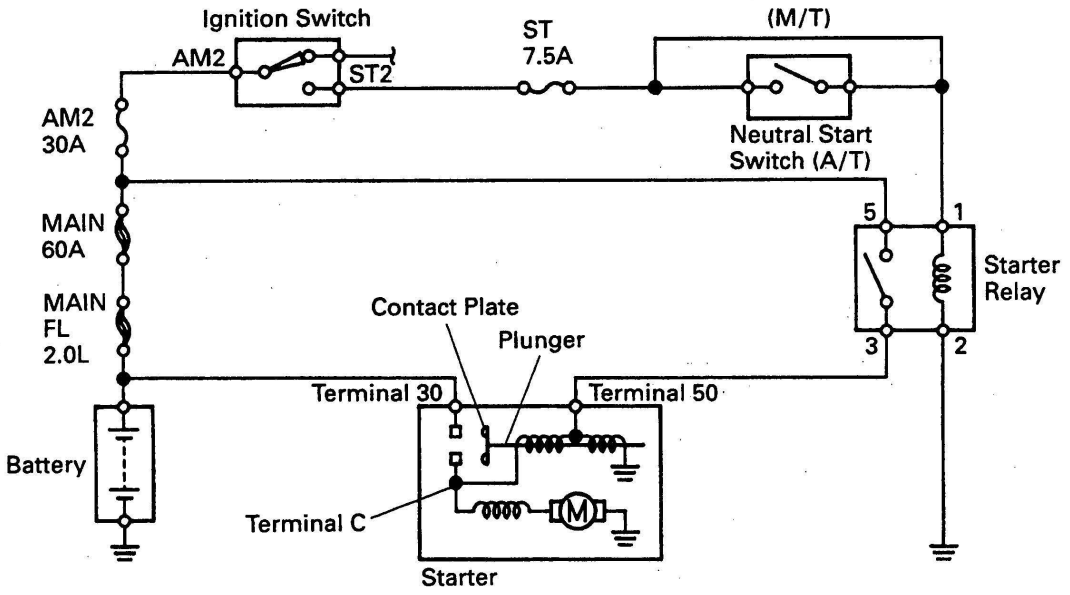
ST191


Fuse AM2 30A
Fuse
ST
7.5A
H-Fuse
MAIN
40A
Starter Relay
("STARTER")
RHD
LHD
MAIN
FL
2.0L
Starter
Neutral Start Switch (A/T)
P16426

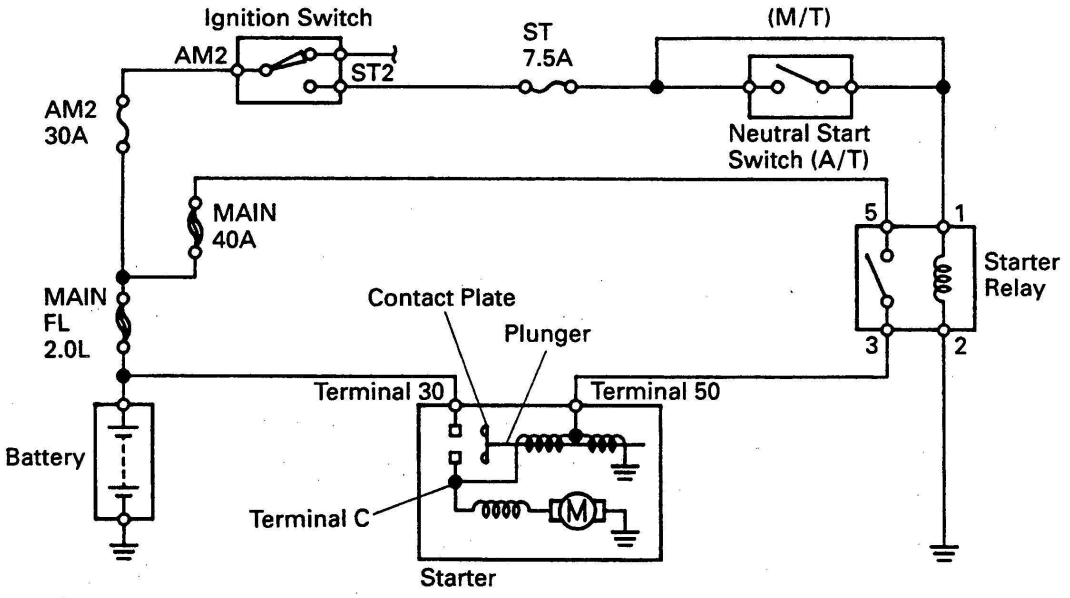
SYSTEM CIRCUIT

ST000-02

ST202



ST191



P16543
P16544

Z11791

OPERATION

ST00R-07

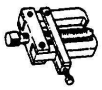
When the ignition switch is turned to START position, current flows from terminal 50 to the coil of the solenoid and the plunger is pulled by the magnetic force of the coil. When the plunger is pulled to the left, the contact plate of the plunger allows current from the battery to flow directly from terminal 30 to the motor, and the starter rotates.

When the engine is running and the ignition switch is returned to ON, the magnetic force of the coil disappears and the contact plate of the plunger is returned to its original position by the return spring. Battery voltage no longer flows from terminal 30, so the motor stops.

PREPARATION

SST (SPECIAL SERVICE TOOLS)

ST00S–0C

	09285–76010	Injection Pump Camshaft Bearing Cone Replacer	ST202: Armature front bearing
	09286–46011	Injection Pump Spline Shaft Puller	Armature bearing
	09820–00030	Alternator Rear Bearing Replacer	ST191: Armature front bearing

ST

RECOMMENDED TOOLS

ST00T–05

	09082–00050	TOYOTA Electrical Tester Set	

EQUIPMENT

ST00U–05

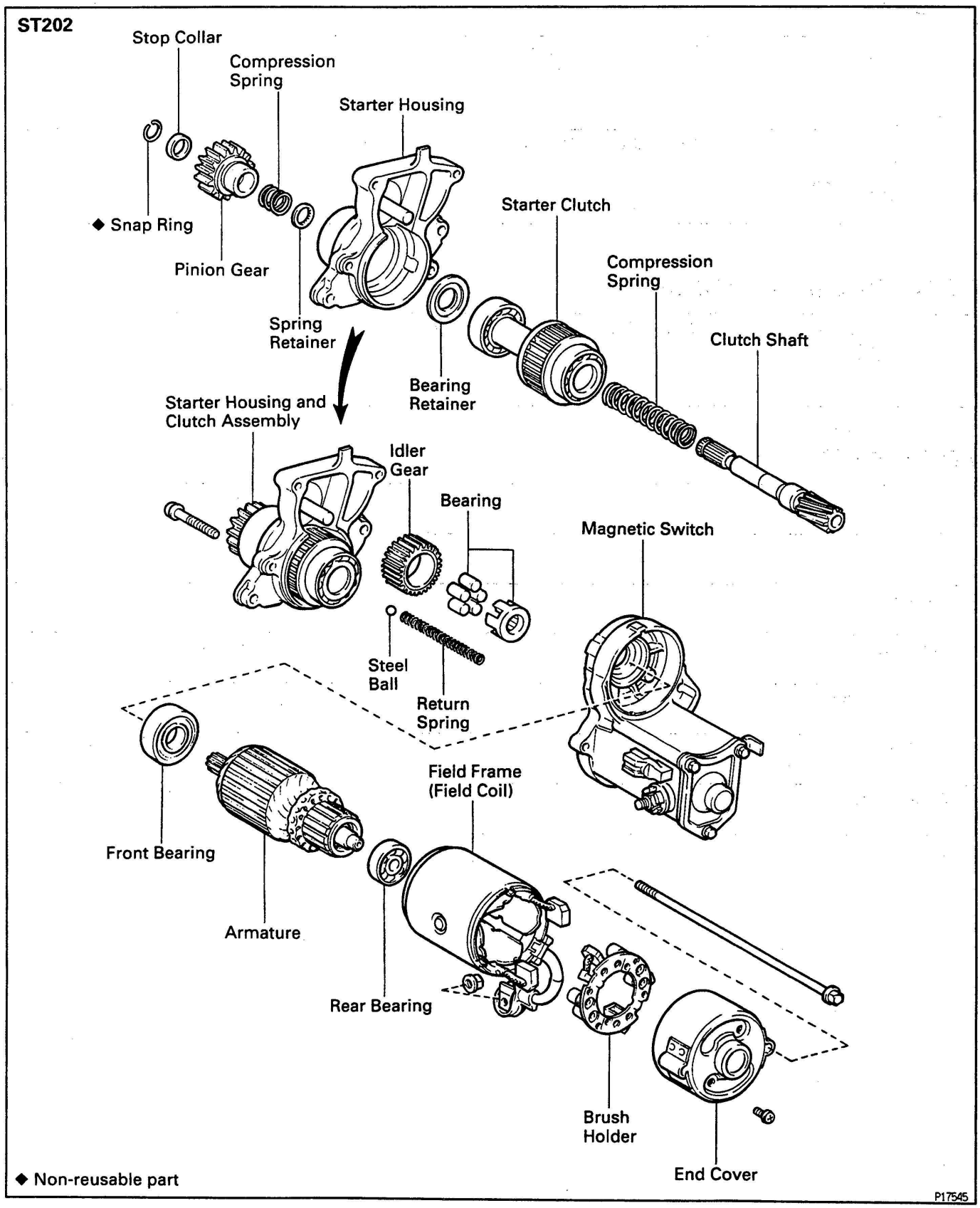
Dial indicator	Commutator
Magnetic finger	
Pull scale	Brush spring
Sandpaper	Commutator
Torque wrench	
V–block	
Vernier calipers	Commutator, Brush

STARTER

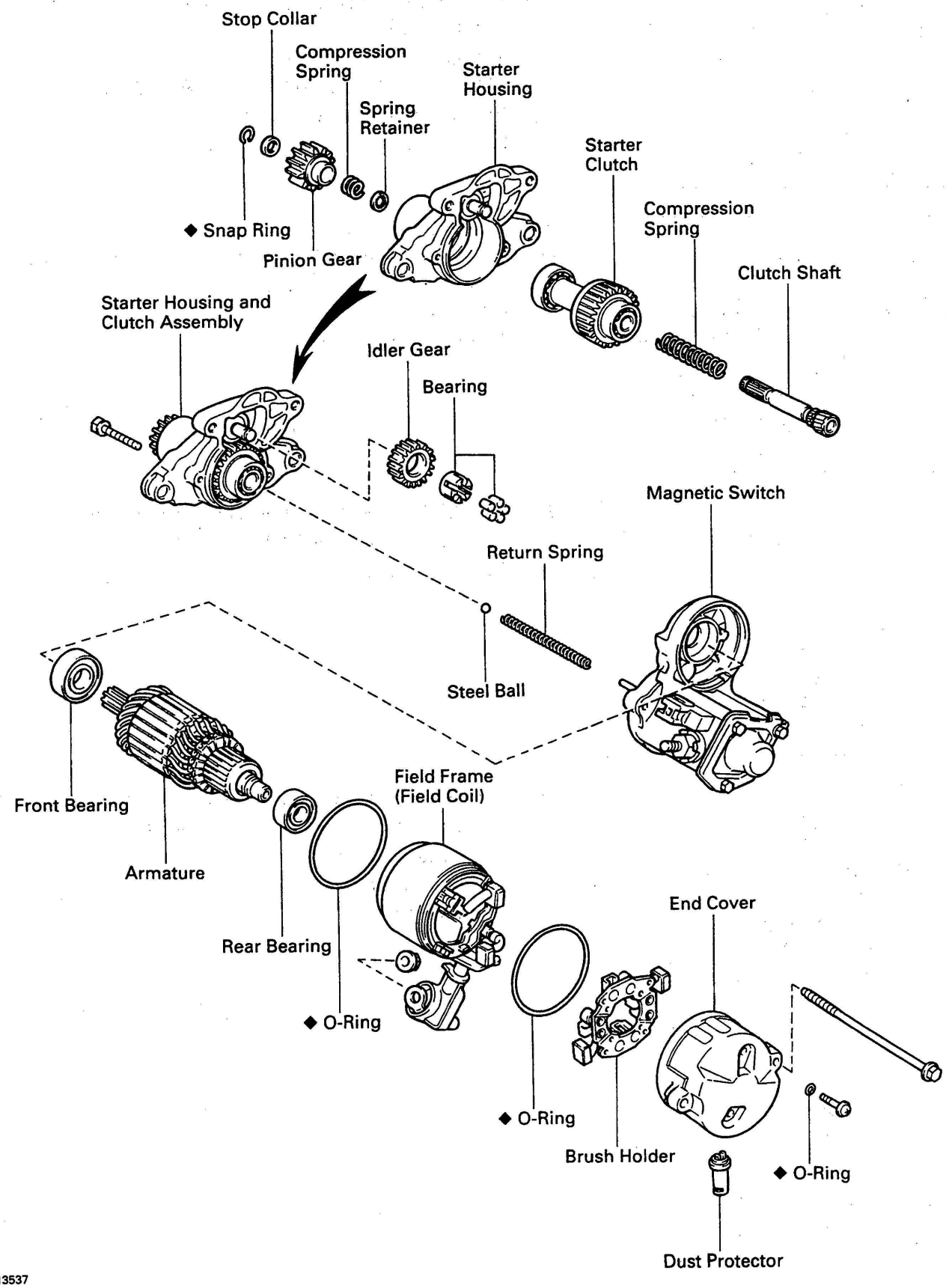
COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

ST07M-01

ST



ST191



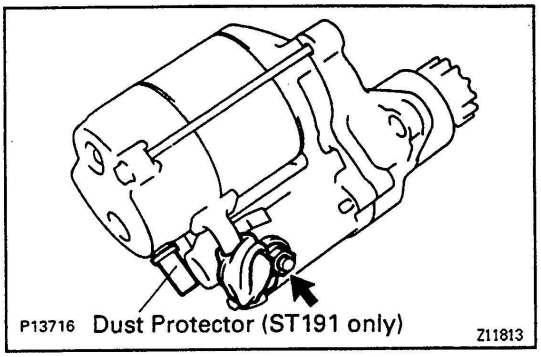
◆ Non-reusable part

Z12049

ST

ST1078–02

STARTER DISASSEMBLY

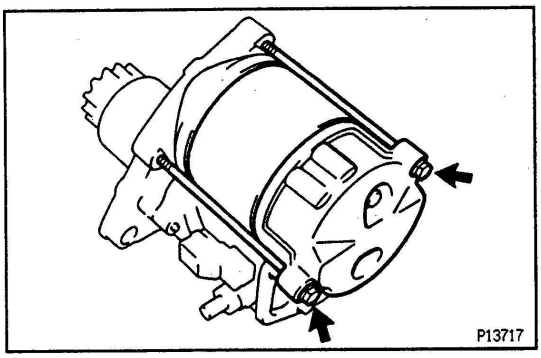


(See Components for Disassembly and Assembly)

1. ST191 only:
   REMOVE DUST PROTECTOR
2. REMOVE FIELD FRAME AND ARMATURE

(a) Remove the nut, and disconnect the lead wire from the magnetic switch terminal.

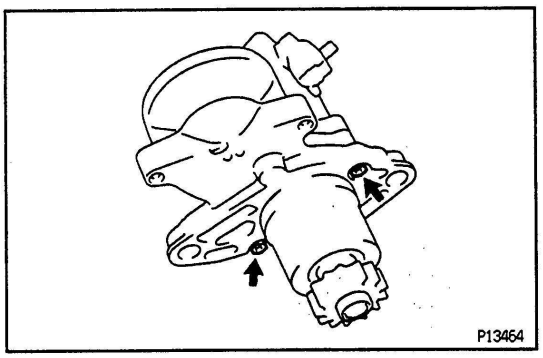
ST



(b) Remove the 2 through bolts.

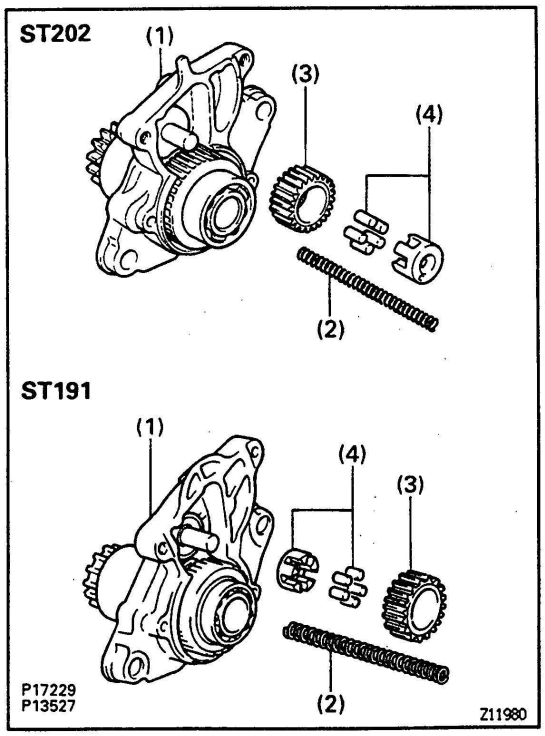
(c) Pull out the field frame together with the armature from the magnetic switch.

(d) ST191 only:
Remove the O–ring.

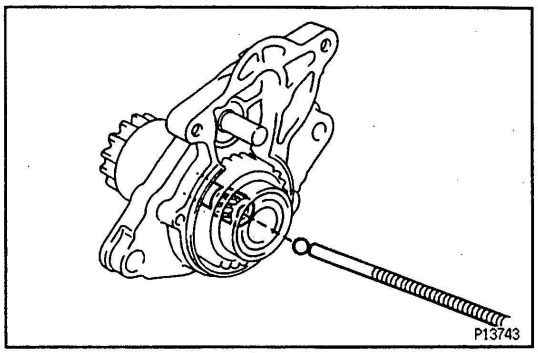


3. REMOVE STARTER HOUSING, CLUTCH ASSEMBLY AND GEAR

(a) Remove the 2 screws.

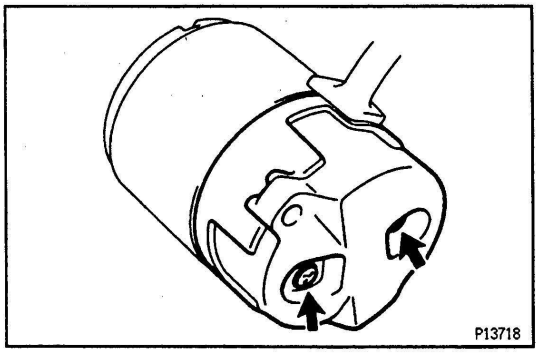


(b) Remove the following parts from the magnetic switch:
(1) Starter housing and clutch assembly
(2) Return spring
(3) Idler gear
(4) Bearing



4. REMOVE STEEL BALL

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

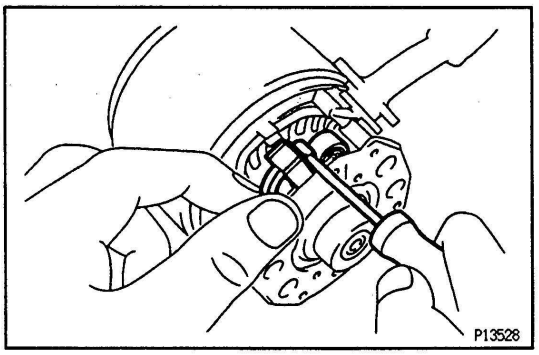


5. REMOVE BRUSH HOLDER

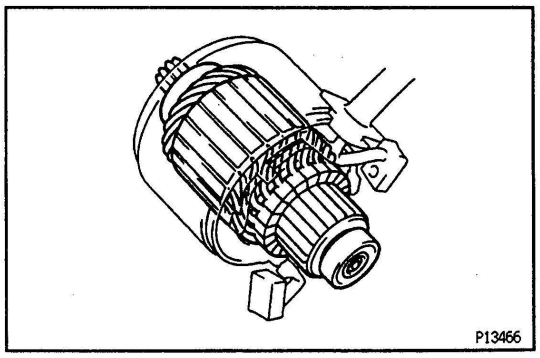
(a) ST202:
Remove the 2 screws and end cover from the field frame.

(b) ST191:
Remove the 2 screws, 2 O—rings and end cover from the field frame.

(c) ST191 only:
Remove the O—ring from the field frame.



(d) Using a screwdriver, hold the spring back and disconnect the brush from the brush holder. Disconnect the 4 brushes, and remove the brush holder.

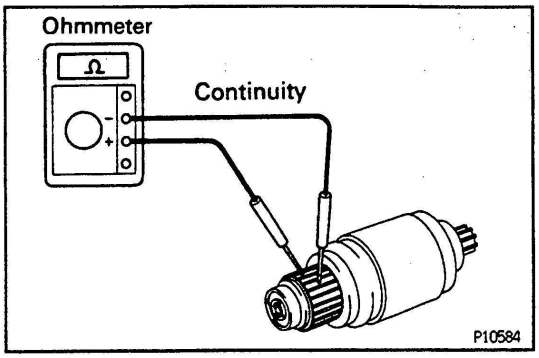


6. REMOVE ARMATURE FROM FIELD FRAME

ST07N-01

STARTER INSPECTION AND REPAIR

Armature Coil

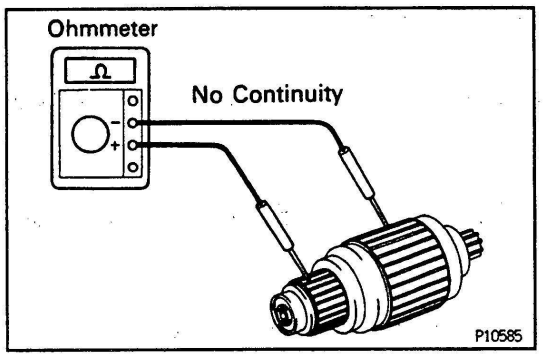


1. INSPECT COMMUTATOR FOR OPEN CIRCUIT

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

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

ST



2. INSPECT COMMUTATOR FOR GROUND

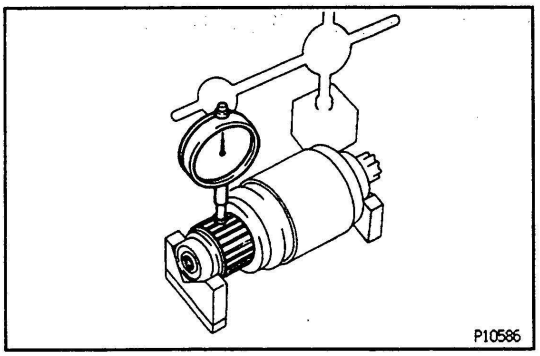
Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

If there is continuity, replace the armature.

Commutator

1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACES

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



2. INSPECT COMMUTATOR CIRCLE RUNOUT

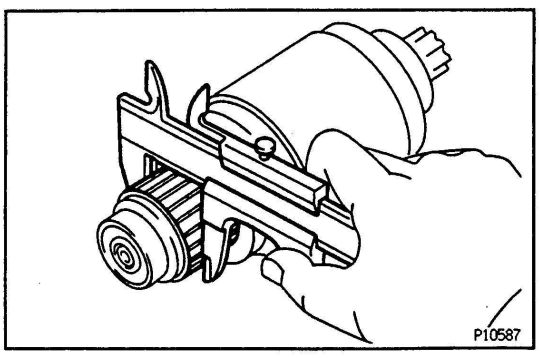
(a) Place the commutator on V–blocks.

(b) Using a dial gauge, 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.



3. INSPECT COMMUTATOR DIAMETER

Using a vernier caliper, measure the commutator diameter.

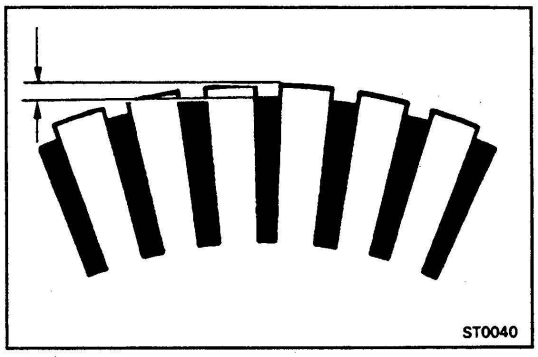
Standard diameter:

30 mm (1.18 in.)

Minimum diameter:

29 mm (1.14 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 materials. Smooth out the edge.

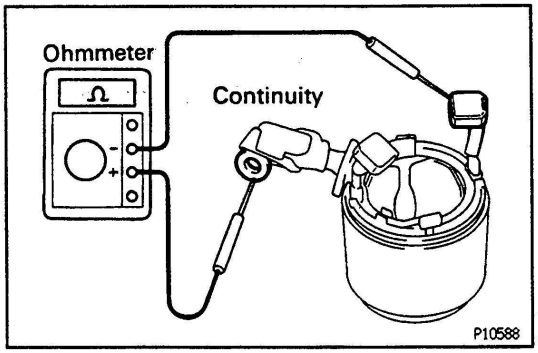
Standard undercut depth:

0.6 mm (0.024 in.)

Minimum undercut depth:

0.2 mm (0.008 in.)

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



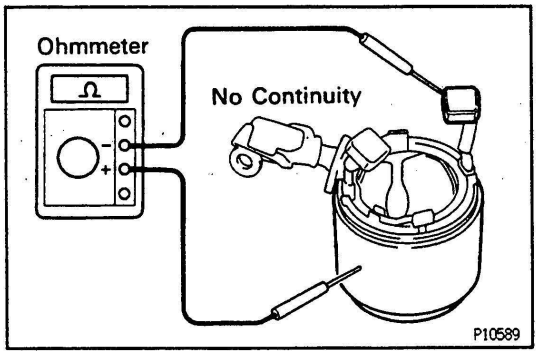
Field Coil (Field frame)

ST

1. INSPECT FIELD COIL FOR OPEN CIRCUIT

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

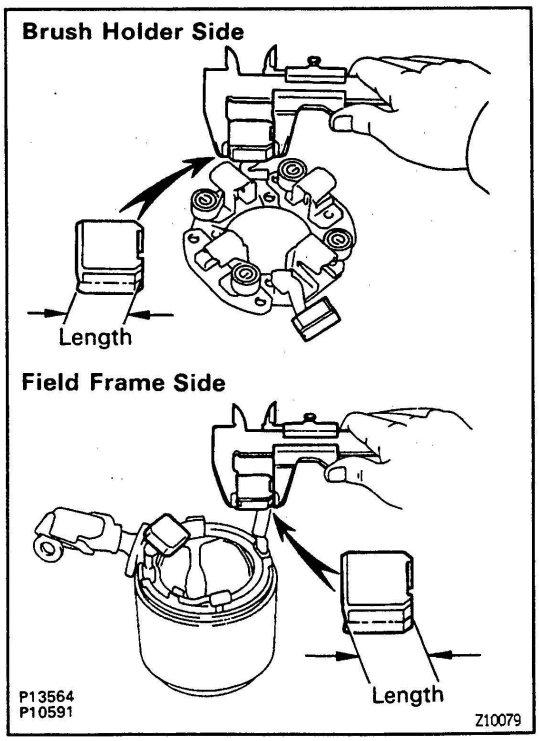
If there is no continuity, replace the field frame.



2. INSPECT FIELD COIL FOR GROUND

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

If there is continuity, replace the field frame.



Brushes

INSPECT BRUSH LENGTH

Using a vernier caliper, measure the brush length.

Standard length:

ST202: 13.0 mm (0.512 in.)

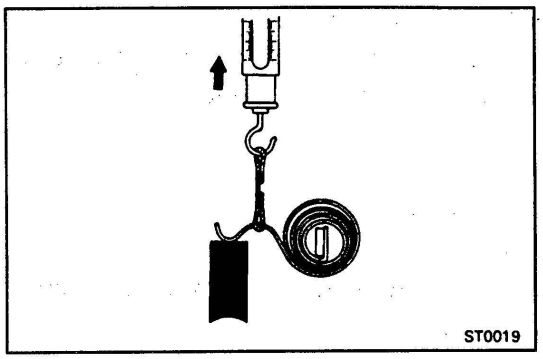
ST191: 15.0 mm (0.591 in.)

Minimum length:

ST202: 8.0 mm (0.315 in.)

ST191: 8.5 mm (0.335 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:

ST202

11.8 – 20.6 N (1.20 – 2.10 kgf, 2.6 – 4.6 lbf)

ST191 (1.2 kW)

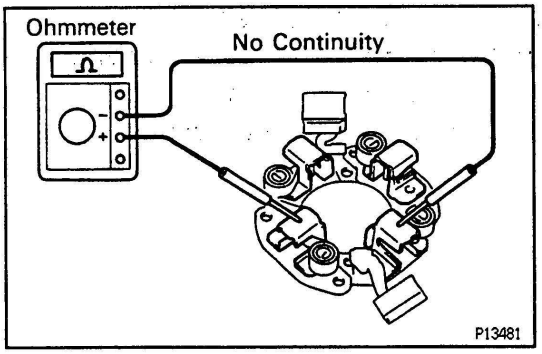
9.8 – 16.7 N (1.00 – 1.70 kgf, 2.2 – 3.7 lbf)

ST191 (1.4 kW)

11.8 – 20.6 N (1.20 – 2.10 kgf, 2.6 – 4.6 lbf)

If the installed load is not as specified, replace the brush springs.

ST



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.

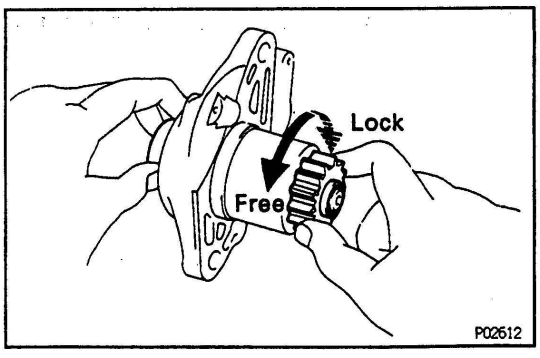
Clutch and Gears

1. **INSPECT GEAR TEETH**

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

If damaged, replace the gear or clutch assembly.

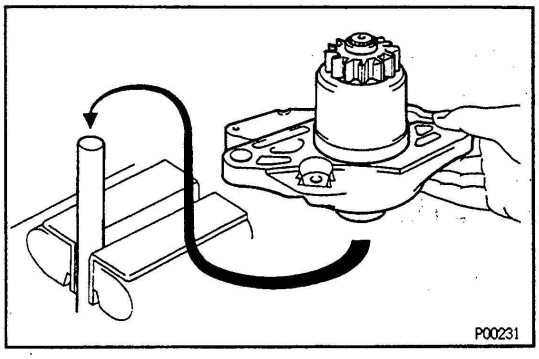
If damaged, also check the ring gear of the flywheel/drive plate for wear or damage.



2. **INSPECT CLUTCH PINION GEAR**

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

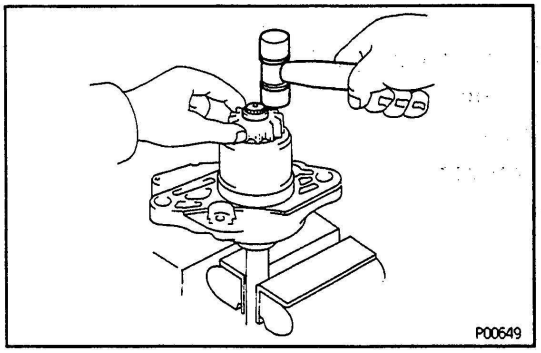
If necessary, replace the clutch assembly.



3. IF NECESSARY, REPLACE CLUTCH ASSEMBLY

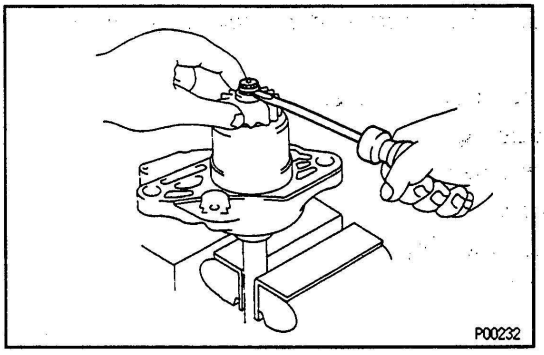
A. Disassemble starter housing and clutch assembly

(a) Mount a brass bar in a vise, and install the starter housing and clutch assembly onto the brass bar.

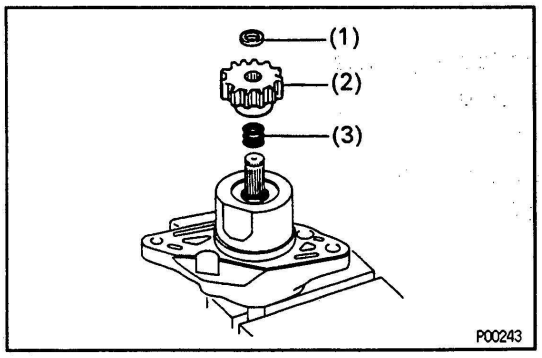


(b) Push down the pinion gear.

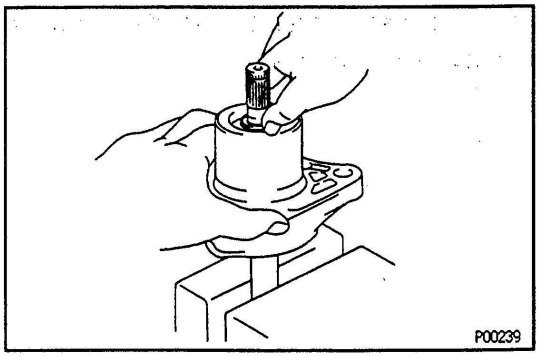
(c) Using a plastic–faced hammer, tap down the stop collar.



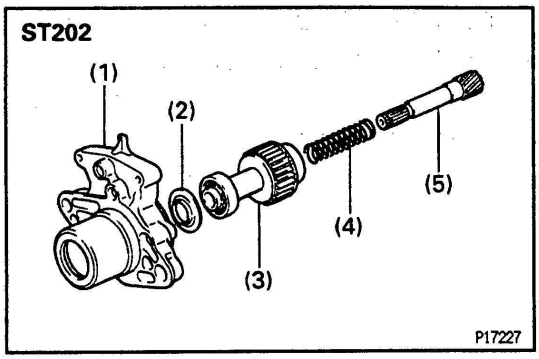
(d) Using a screwdriver, pry out the snap ring.



(e) Remove the following parts:
- (1) Stop collar
- (2) Pinion gear
- (3) Compression spring

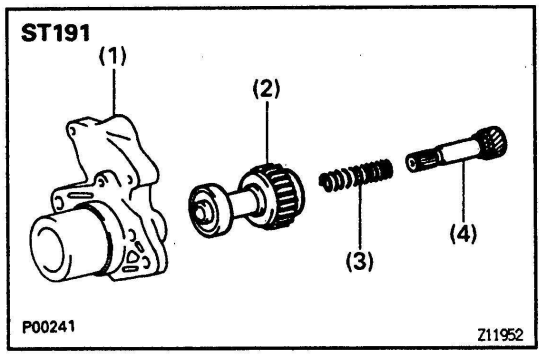


(f) Push down the starter housing, and remove the spring retainer.

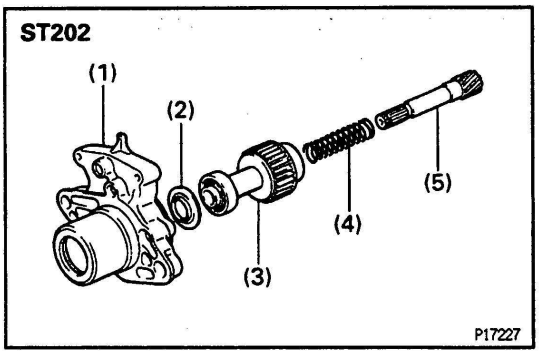


(g) ST202:
Disassemble the following parts:
(1) Starter housing
(2) Bearing retainer
(3) Starter clutch
(4) Compression spring
(5) Clutch shaft

ST

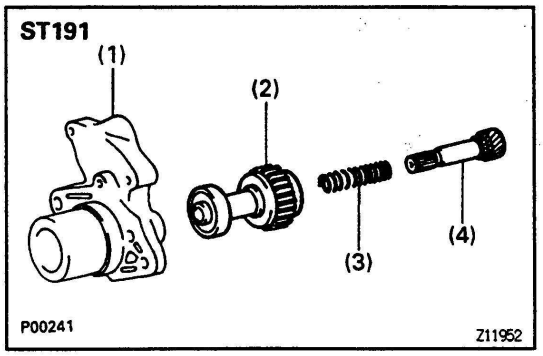


(h) ST191:
Disassemble the following parts:
(1) Starter housing
(2) Starter clutch
(3) Compression spring
(4) Clutch shaft

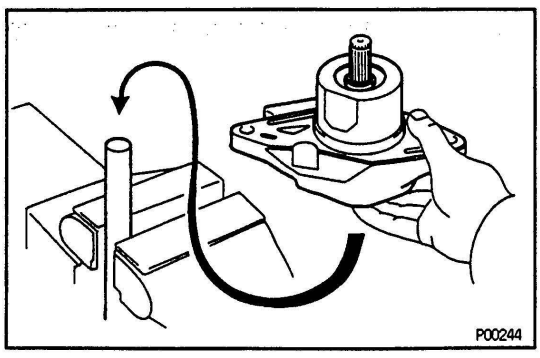


B. Assemble starter housing and clutch assembly

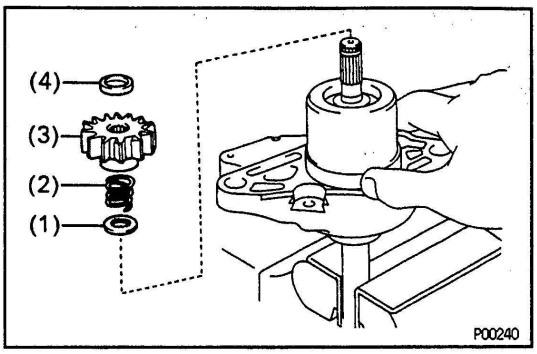
(a) ST202:
Assemble the following parts:
(1) Starter housing
(2) Bearing retainer
(3) Starter clutch
(4) Compression spring
(5) Clutch shaft



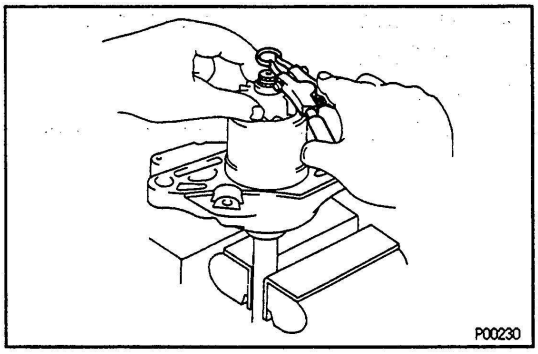
(b) ST191:
Assemble the following parts:
(1) Starter housing
(2) Starter clutch
(3) Compression spring
(4) Clutch shaft



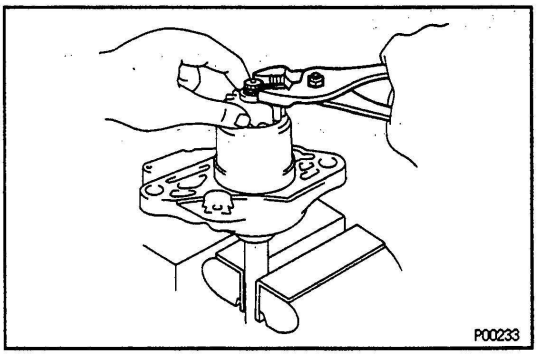
(c) Mount a brass bar in a vise, install the starter housing and clutch assembly onto the brass bar.



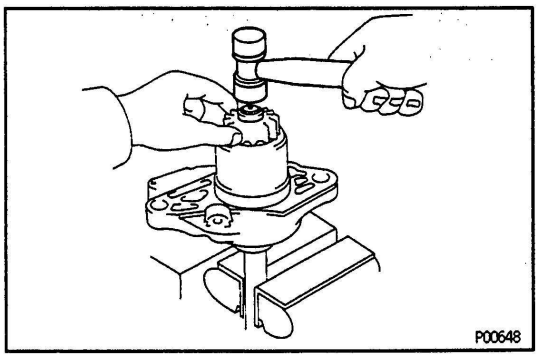
(d) Push down the starter housing, and install the following parts:
(1) Spring retainer
(2) Compression spring
(3) Pinion gear
(4) Stop collar



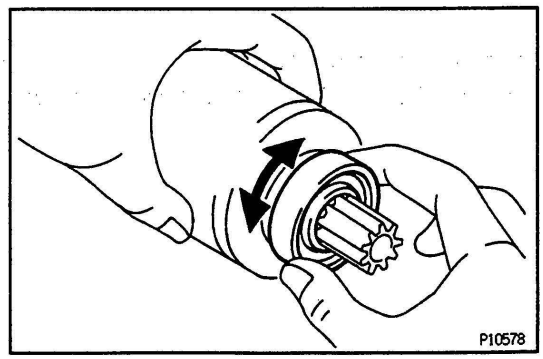
(e) Push down the pinion gear.
(f) Using snap ring pliers, install a new snap ring.



(g) Using pliers, compress the snap ring.
(h) Check that the snap ring fits correctly.



(i) Remove the starter housing and clutch assembly from the brass bar.
(j) Using a plastic–faced hammer, tap the clutch shaft and install the stop collar onto the snap ring.

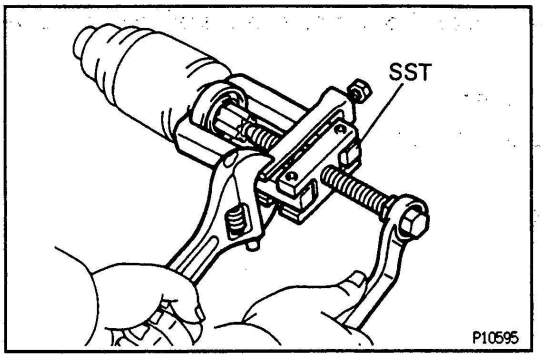


Bearings

1. INSPECT FRONT BEARING

Turn each bearing by hand while applying inward force.

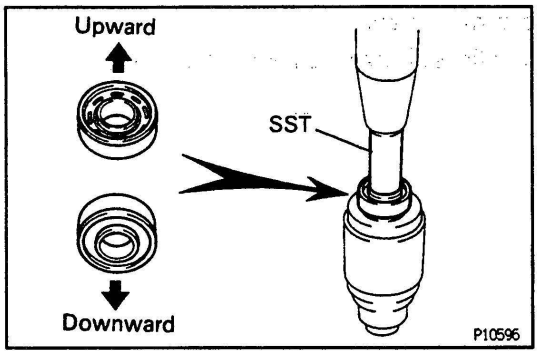
If resistance is felt or the bearing sticks, replace the bearing.



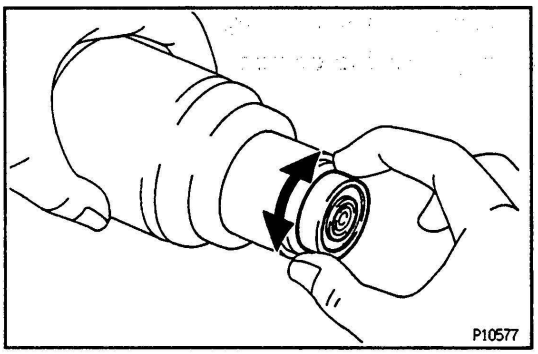
2. IF NECESSARY, REPLACE FRONT BEARING

(a) Using SST, remove the bearing.
SST 09286–46011

ST

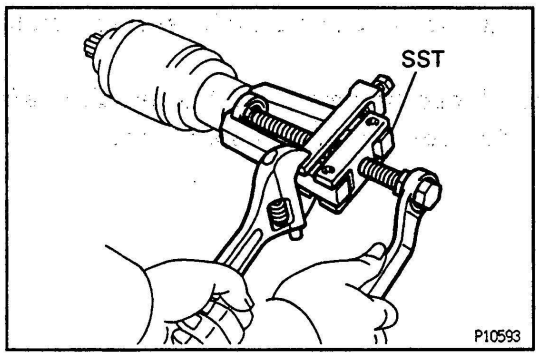


(b) Using SST and a press, press in a new bearing.
SST (ST202) 09285–76010
SST (ST191) 09820–00030
NOTICE: Be careful of the bearing installation direction.



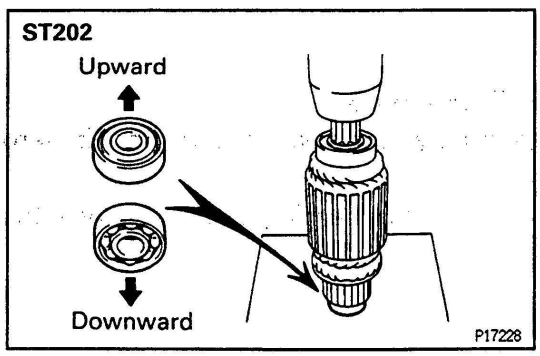
3. INSPECT REAR BEARING

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

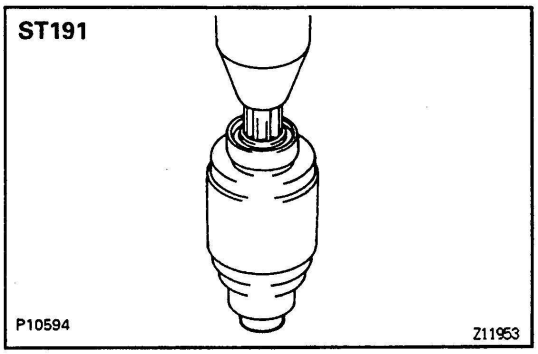


4. IF NECESSARY, REPLACE REAR BEARING

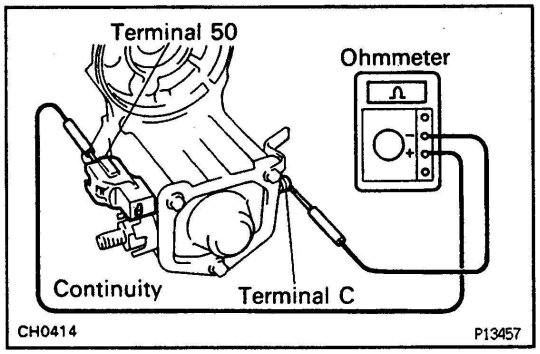
(a) Using SST, remove the bearing.
SST 09286–46011



(b) ST202:
Using a press, press in a new bearing.
NOTICE: Be careful of the bearing installation direction.

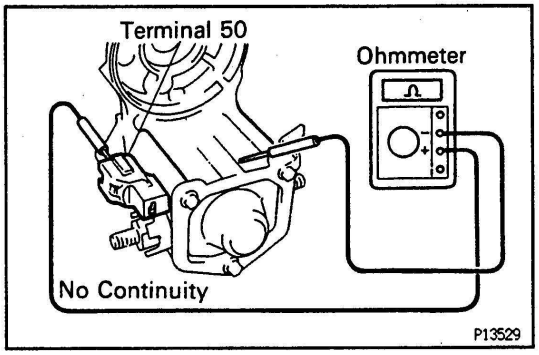


(c) ST191:
Using a press, press in a new bearing.



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.

ST

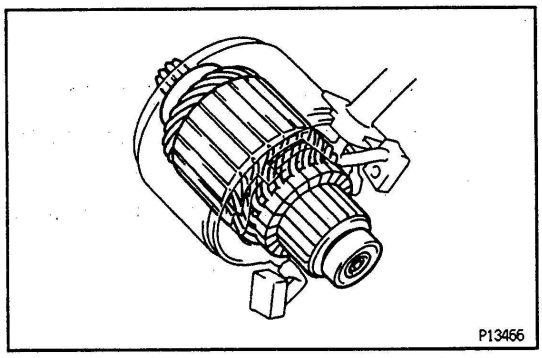
ST07A-02

STARTER ASSEMBLY

(See Components for Disassembly and Assembly)

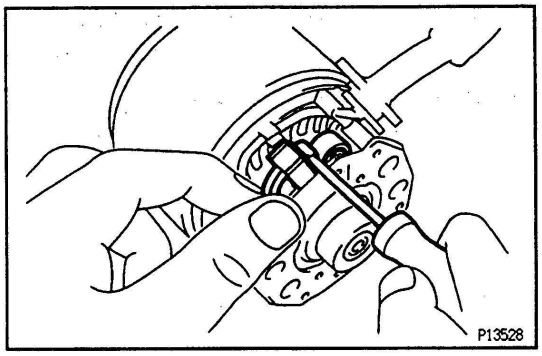
HINT: Use high–temperature grease to lubricate the bearings and gears when assembling the starter.

ST



1. PLACE ARMATURE INTO FIELD FRAME

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

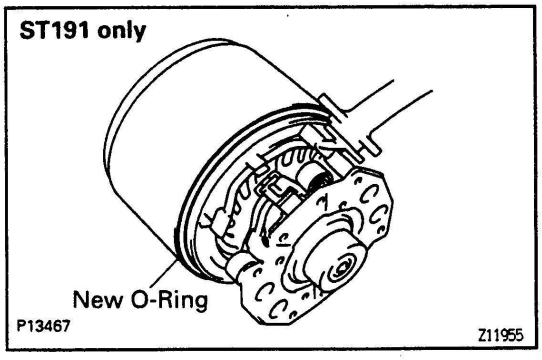


2. INSTALL BRUSH HOLDER

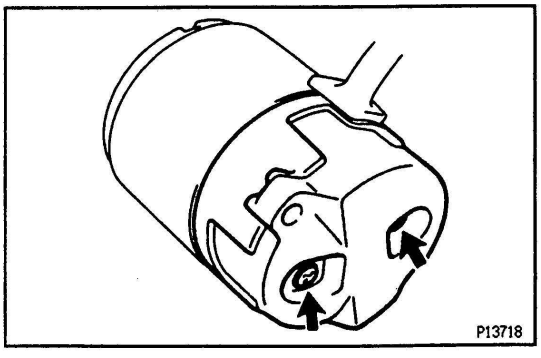
(a) Place the brush holder on the armature.

(b) Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Connect the 4 brushes.

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



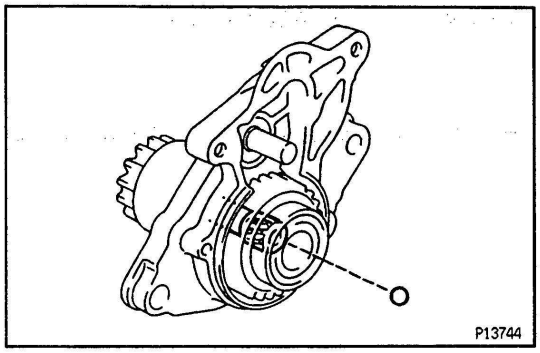
(c) ST191 only:
Install a new O–ring to the groove of the field frame.



(d) ST191 only:
Install a new O–ring to the screw.

(e) Install the end cover to the field frame with the 2 screws.

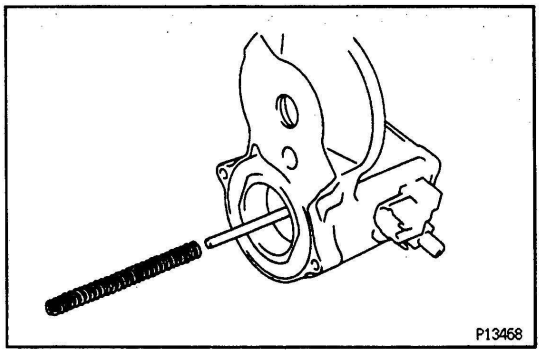
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)



3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

(a) Apply grease to the steel ball.

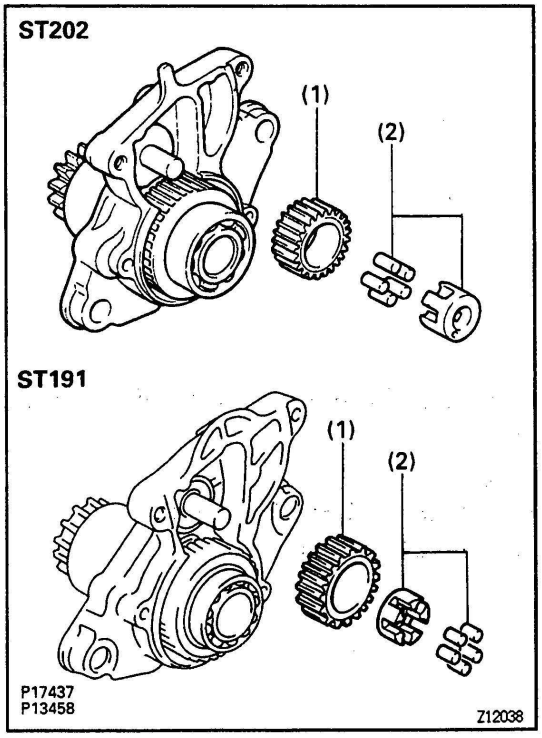
(b) Insert the steel ball into the clutch shaft hole.



4. INSTALL STARTER HOUSING, CLUTCH ASSEMBLY AND GEAR

(a) Apply grease to the return spring.

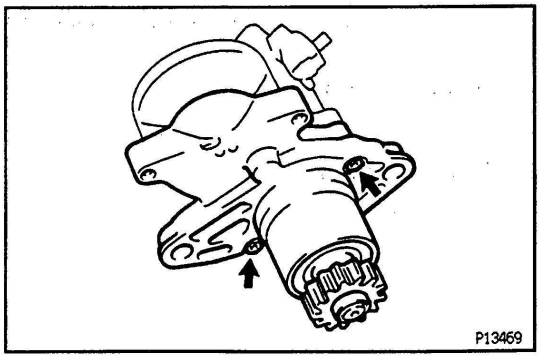
(b) Insert the return spring into the magnetic switch hole.



(c) Place the following parts in position on the starter housing:

(1) Idler gear

(2) Bearing

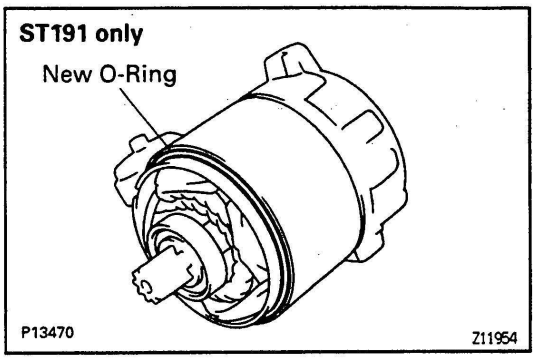


(d) Install the starter housing to the magnetic switch with the 2 screws.

Torque:

ST202: 9.3 N·m (95 kgf·cm, 82 in.·lbf)

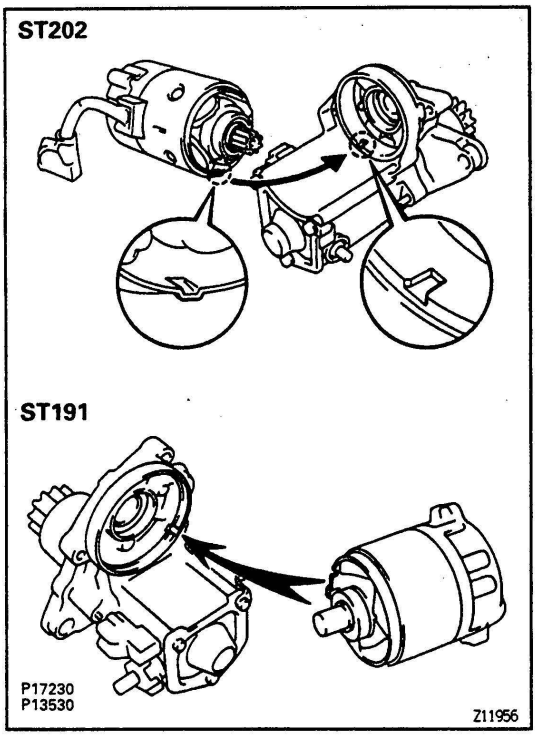
ST191: 5.9 N·m (60 kgf·cm, 52 in.·lbf)



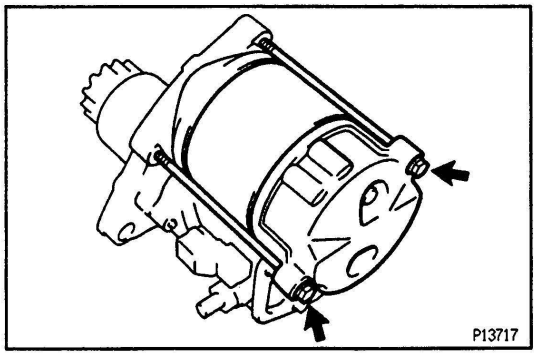
5. INSTALL FIELD FRAME AND ARMATURE ASSEMBLY

(a) ST191 only:
Install a new O–ring to the groove of the field frame.

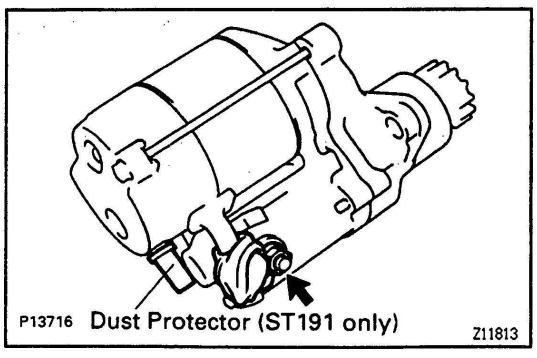
ST



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



(c) Install the field frame and armature assembly with the 2 through bolts.
Torque:
ST202: 9.3 N·m (95 kgf·cm, 82 in.·lbf)
ST191: 5.9 N·m (60 kgf·cm, 52 in.·lbf)



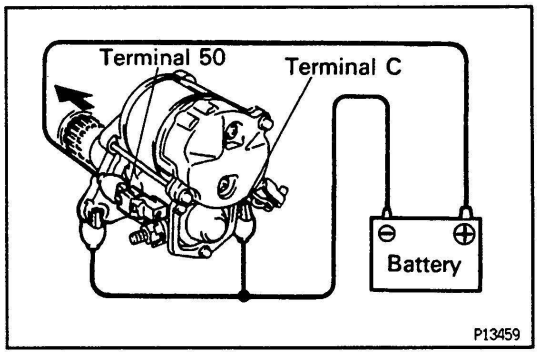
(d) Connect the lead wire to terminal C, and install the nut.
Torque: 7.9 N·m (81 kgf·cm, 70 in.·lbf)

6. ST191 only:
INSTALL DUST PROTECTOR

ST010-0J

STARTER PERFORMANCE TEST

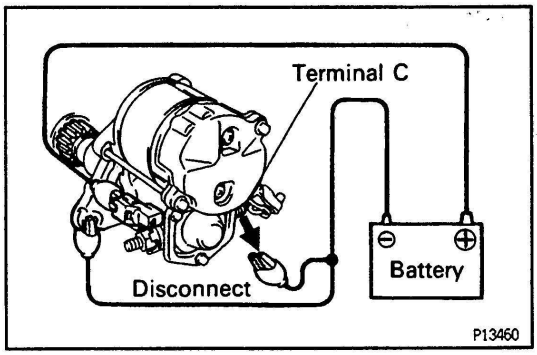
NOTICE: These tests must be performed within 3 to 5 seconds to avoid burning out the coil.



1. PERFORM PULL–IN TEST

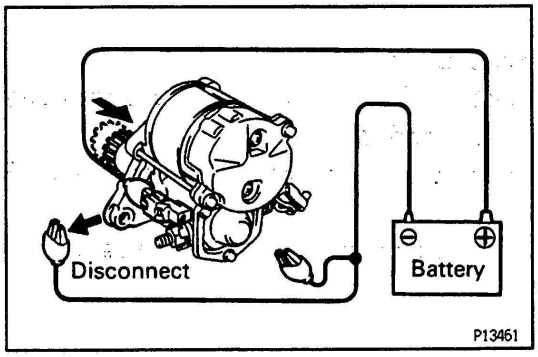
(a) Disconnect the field coil lead wire from terminal C.

(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 assembly.



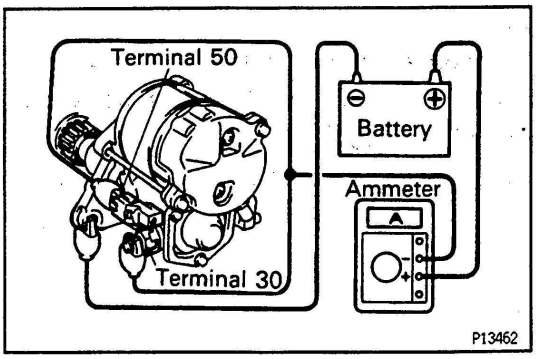
2. PERFORM HOLD–IN TEST

With battery 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.



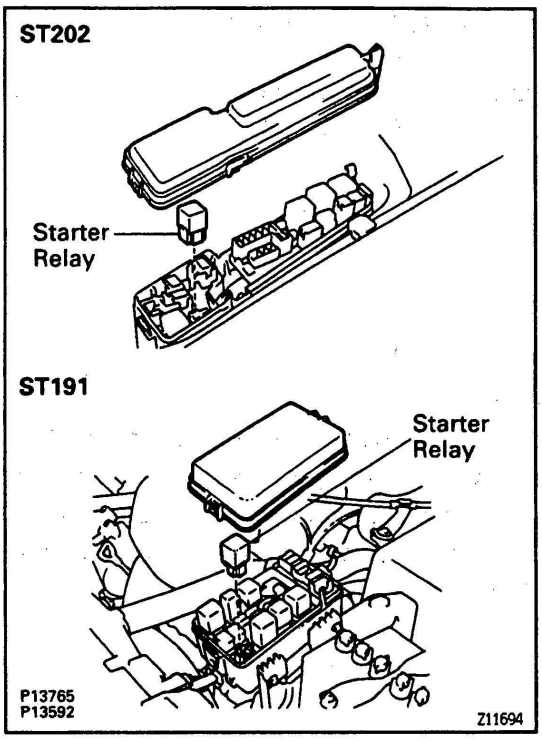
4. PERFORM NO–LOAD PERFORMANCE TEST

(a) Connect the battery and ammeter to the starter as shown.

(b) Check that the starter rotates smoothly and steadily with the pinion gear moving out. Check that the ammeter shows the specified current.

Specified current:

90 A or less at 11.5 V

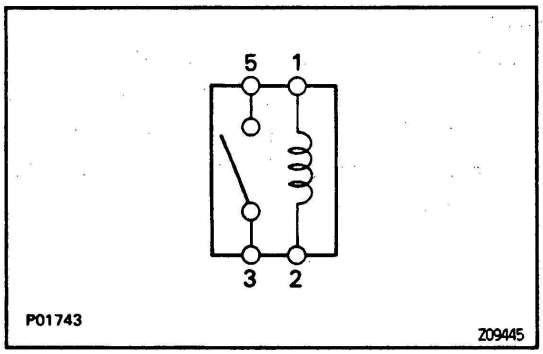


STARTER RELAY

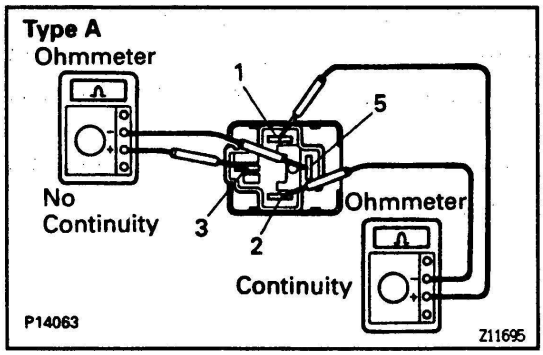
ST07P-01

STARTER RELAY INSPECTION

1. **REMOVE STARTER RELAY**
   ("ST" for ST202)
   ("STARTER" for ST191)
   LOCATION: See page ST–2 and 3



2. **INSPECT STARTER RELAY**



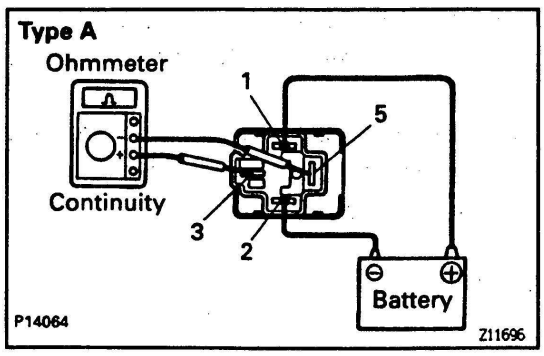
Type A

A. Inspect relay continuity

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

(b) Check that there is no continuity between terminals 3 and 5.

If continuity is not as specified, replace the relay.

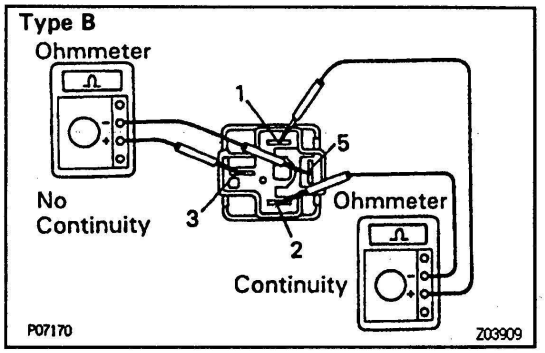


B. Inspect relay operation

(a) Apply battery voltage across terminals 1 and 2.

(b) Using an ohmmeter, check that there is continuity between terminals 3 and 5.

If operation is not as specified, replace the relay.



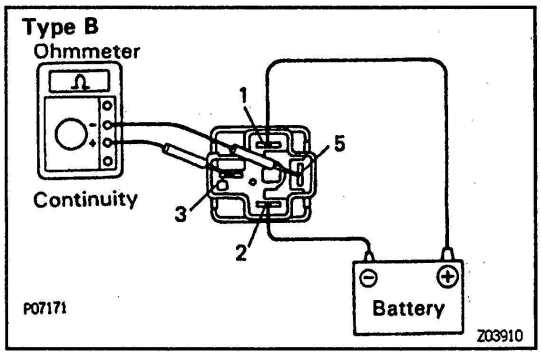
Type B

A. Inspect relay continuity

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

(b) Check that there is no continuity between terminals 3 and 5.

If continuity is not as specified, replace the relay.



B. Inspect relay operation

(a) Apply battery voltage across terminals 1 and 2.

(b) Using an ohmmeter, check that there is continuity between terminals 3 and 5.

If operation is not as specified, replace the relay.

3. REINSTALL STARTER RELAY

ST

SERVICE SPECIFICATIONS

SERVICE DATA

ST015-00

Starter	Rated voltage and output power		ST202	12 V 1.0 kW
			ST191	12 V 1.2 kW
				12 V 1.4 kW
	No-load characteristics		Current	90 A or less at 11. 5 V
			rpm	3,000 rpm or more
	Brush length	ST202	STD	13.0 mm (0.512 in.)
			Limit	8.0 mm (0.315 in.)
		ST191	STD	15.0 mm (0.591 in.)
			Limit	8.5 mm (0.335 in.)
	Spring installed load		ST202	11.8 – 20.6 N (1.20 – 2.10 kgf, 2.6 – 4.6 lbf)
			ST191 (1.2 kW)	9.8 – 16.7 N (1.00 – 1.70 kgf, 2.2 – 3.7 lbf)
			ST191 (1.4 kW)	11.8 – 20.6 N (1.20 – 2.10 kgf, 2.6 – 4.6 lbf)
	Commutator			
	Diameter		STD	30 mm (1.18 in.)
			Limit	29 mm (1.14 in.)
	Undercut depth		STD	0.6 mm (0.024 in.)
			Limit	0.2 mm (0.008 in.)
	Circle runout		Limit	0.05 mm (0.0020 in.)

ST016-0F

TORQUE SPECIFICATIONS

Part tightened		N·m	kgf·cm	ft·lbf
End cover x Brush holder		1.5	15	13 in.·lbf
Starter housing x Magnetic switch	ST202	9.3	95	82 in.·lbf
	ST191	5.9	60	52 in.·lbf
End cover x Starter Housing	ST202	9.3	95	82 in.·lbf
	ST191	5.9	60	52 in.·lbf
Lead wire of field frame x Magnetic switch		7.9	81	70 in.·lbf
Starter x Transaxle		39	400	29