

ELECTRIC STARTER SYSTEM

OUTLINE

The starting circuit consists of the battery, starting motor, ignition switch, neutral switch, starter relay and related electrical wiring.

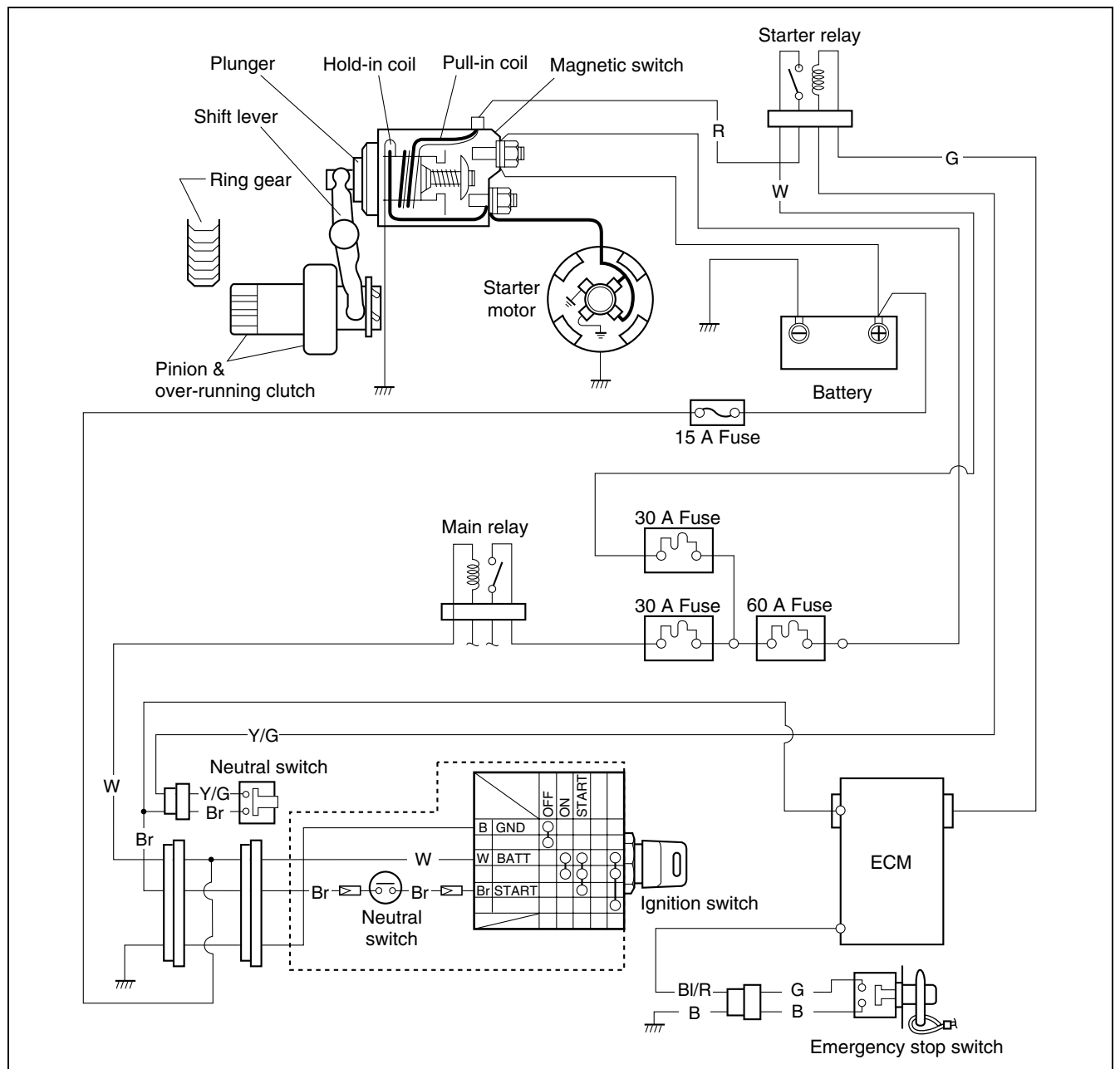
These components are connected electrically as shown in figure below.

STARTING SYSTEM CIRCUIT

In the circuit shown in figure below, the magnetic switch coils and starter relay coil are magnetized when the ignition switch is closed (turned to "START").

The resulting plunger and pinion shift lever movement causes the pinion to engage the engine flywheel gear, the magnetic switch main contacts to close, and engine cranking to take place.

When the engine starts, the pinion over-running clutch protects the armature from excessive speed until the switch is opened, at which time the torsion spring causes the pinion to disengage.



STARTER MOTOR OPERATION CONDITION

The starter motor relay is controlled by the ECM.

The starter motor relay will only engage when the ignition switch is turned to the "START" position if the all of the following conditions are satisfied.

- Lock plate is attached to emergency stop switch.
- Neutral switch is in "ON" position.
- Engine is not already operating.

NOTE:

If a failure exists in the Sub-battery cable or the 15 amp. fuse in its circuit, the starter motor relay circuit will not function.

STARTER ENGAGEMENT MECHANISM

A solenoid (electromagnetic force) type starter switch, utilizing a torsion spring and shift lever, engages the pinion gear to the flywheel.

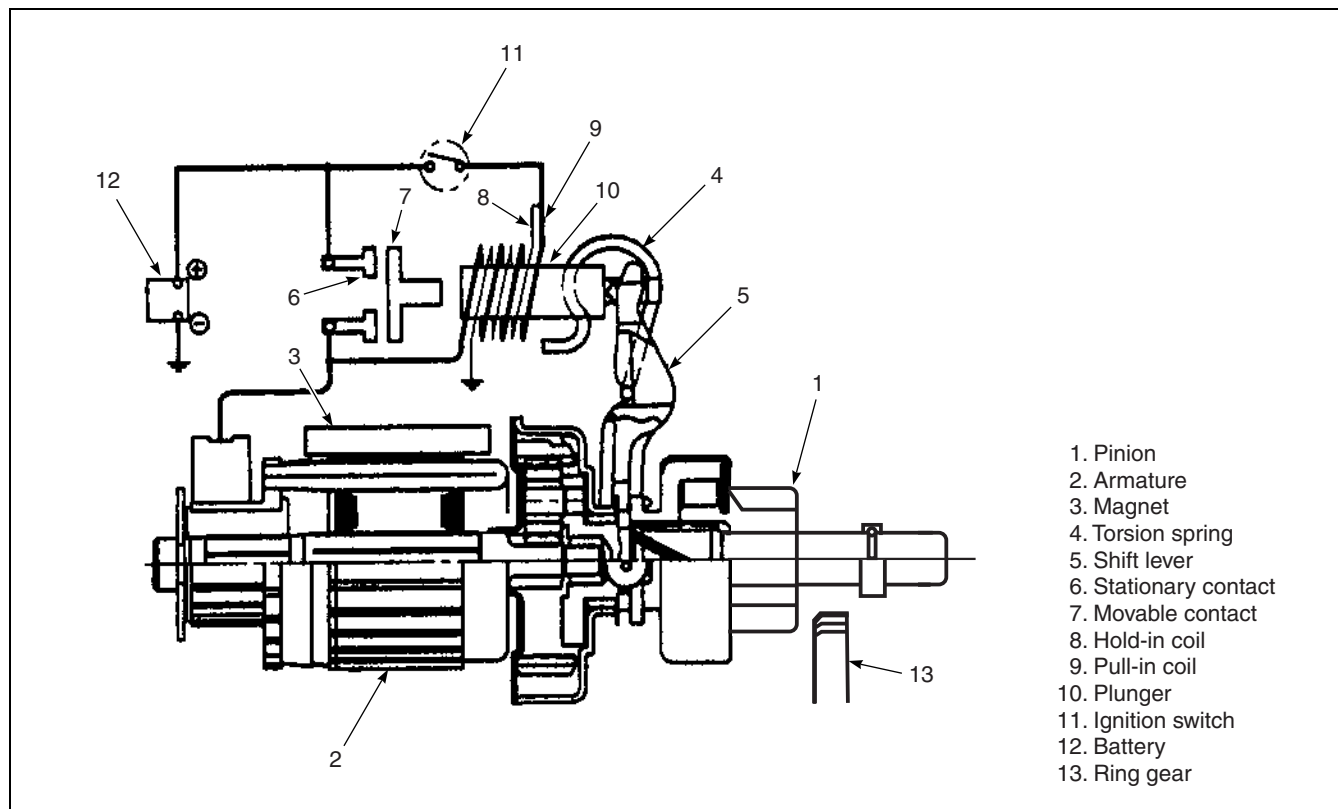
When the ignition key is turned to "START", current flows through the switch winding creating an electromagnet pulling the plunger in.

The shift lever, attached to the plunger, then pushes the pinion up into engagement with the flywheel. Plunger and shift lever movement also compresses the torsion spring, which applies pressure against the shift lever and pinion gear to maintain positive engagement.

Final plunger movement closes the starter switch contacts, which allows current to flow through the starter motor windings, rotating the starter motor armature, pinion gear and flywheel.

When the ignition key is released from start, current flow to the switch is shut off and electromagnetic force ceases. The torsion spring then pulls the plunger out, disengaging the pinion gear from the flywheel through the shift lever.

Movement of the plunger also opens the switch contacts, stopping current flow to the starter motor windings, shutting off the starter motor.



TROUBLESHOOTING

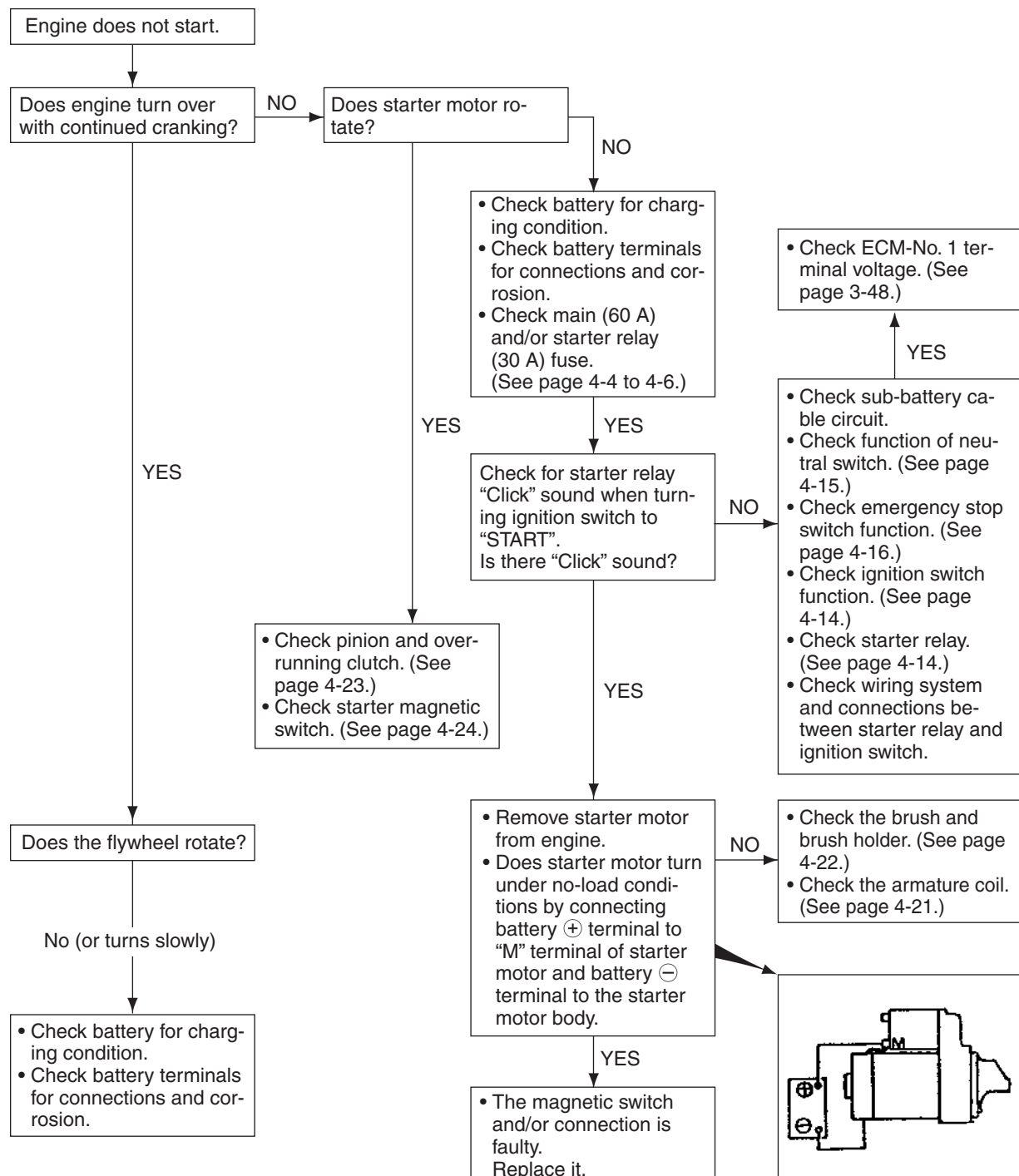
NOTE:

Before troubleshooting the electric starter system, make sure of the following:

- Battery is fully charged.
- All cables/wires are securely connected.
- Shift is in "NEUTRAL" position.
- Emergency stop switch lock plate is set in place.

CAUTION

If any abnormality is found, immediately disconnect battery cables from battery.



INSPECTION

IGNITION SWITCH

TOOL 09930-99320: Digital tester

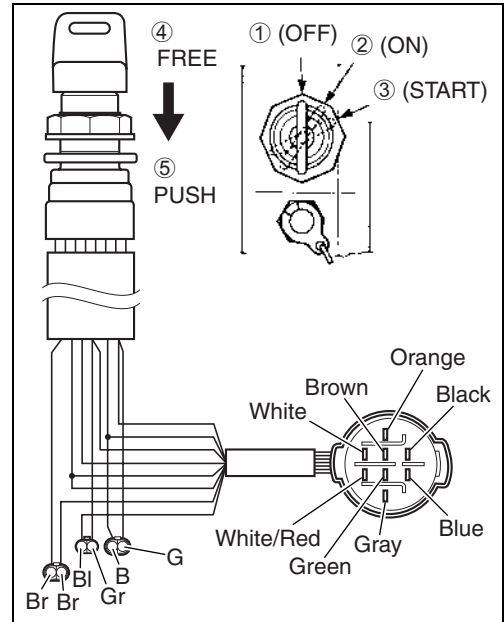
CONT Tester range: (Continuity)

1. Disconnect the ignition switch from remo-con box wiring harness.
2. Check continuity between wiring leads at the key positions shown in the chart.

Key Position	Switch Lead Wires					
	Black	Green	White	Gray	Brown	Orange
① OFF	○—○					
② ON			○—○			
③ START			○—○	○—○	○—○	
④ FREE						
⑤ PUSH			○—○	○—○	○—○	○—○

○—○: Continuity

If out of specification, replace ignition switch.



STARTER MOTOR RELAY

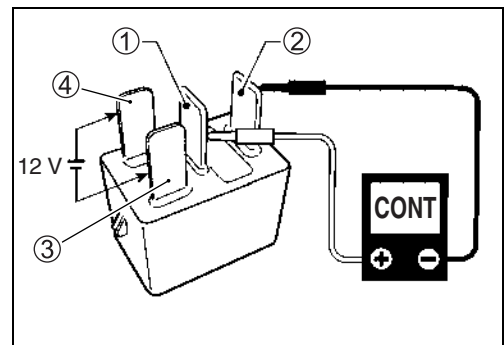
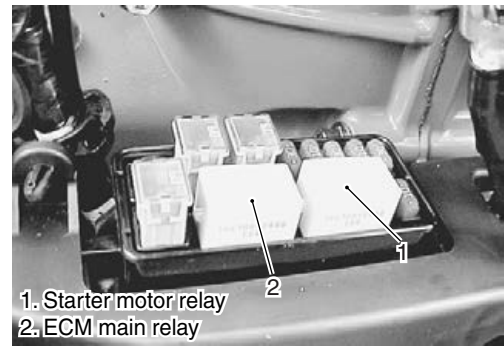
TOOL 09930-99320: Digital tester

CONT Tester range: (Continuity)

1. Disconnect starter motor relay from fuse box.
2. Check continuity between terminal ① and ② each time 12 V is applied. Connect positive + side to terminal ④, and negative - side to terminal ③.

Starter motor relay function:

12 V power	Continuity
Applied	Yes
Not applied	No



CAUTION

Be careful not to touch 12 V power supply wires to each other or with other terminals.

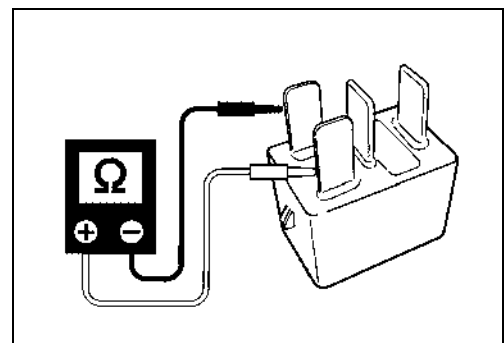
3. Measure resistance between relay terminals ③ and ④.

Ω Tester range: Ω (Resistance)

Starter motor relay solenoid coil resistance:


145 – 190 Ω

If out of specification, replace starter motor relay.



NEUTRAL SWITCH

Check for continuity/infinity of the neutral switch.

 **09930-99320: Digital tester**

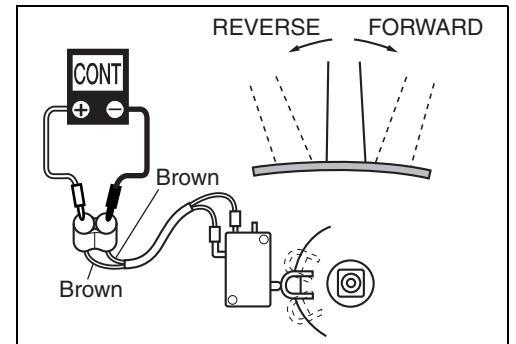
 **Tester range: ∞ (Continuity)**

Neutral switch in remo-con box

1. Disconnect neutral switch lead wire connector from ignition switch.
2. Check continuity/infinity between switch brown wire leads while operating remo-con handle.

Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity

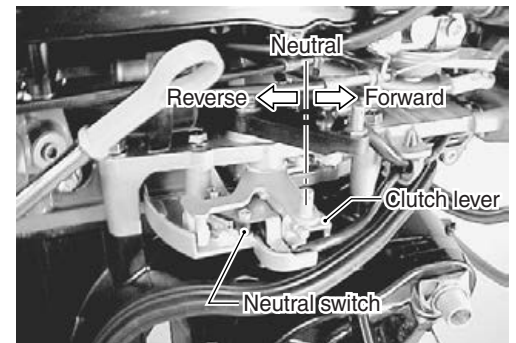
If out of specification, replace neutral switch.



Neutral switch on engine side

1. Disconnect neutral switch lead wire connector.
2. Check continuity/infinity between Yellow/Green and Brown lead wires while operating remo-con handle.

Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity

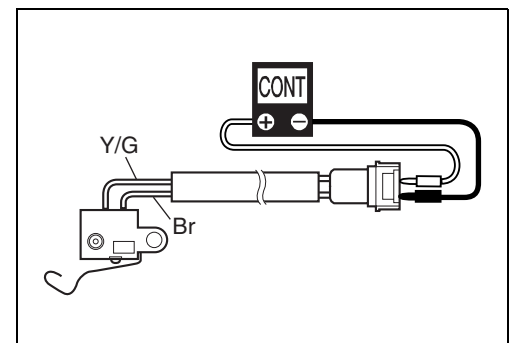


If out of specification:

- 1st Check remo-con cable adjustment, readjust if necessary.
- 2nd Check wire harnesses for open and short.
If wire harnesses are in good condition, replace neutral switch and recheck.


NOTE:

After installing neutral switch, check for correct function by operating remo-con handle.

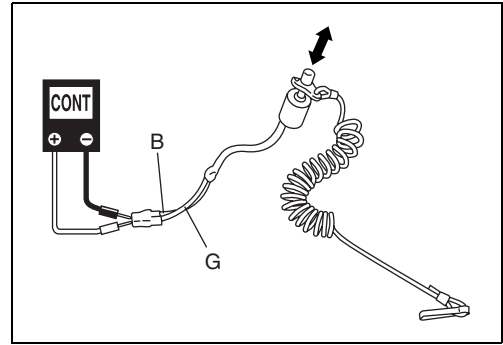


EMERGENCY STOP SWITCH

TOOL 09930-99320: Digital tester

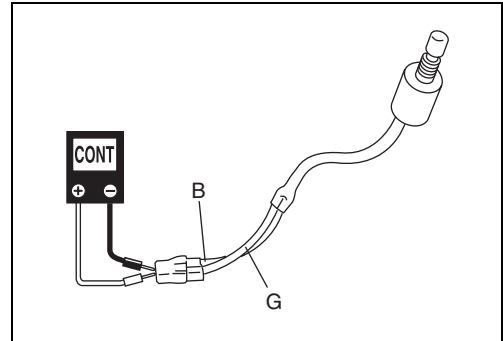
CONT Tester range:  (Continuity)

1. Disconnect the emergency stop switch lead wire.



2. Check continuity/infinity between the wiring leads under the condition shown below.

	Tester probe connection		Tester indicates
	Red (+)	Black (-)	
Lock plate installed	Green	Black	Infinity
Lock plate removed			Continuity



3. If out of specification, replace switch.

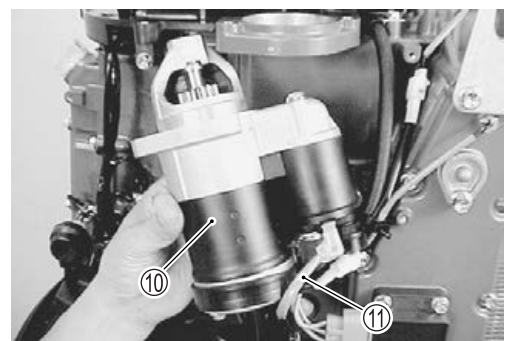
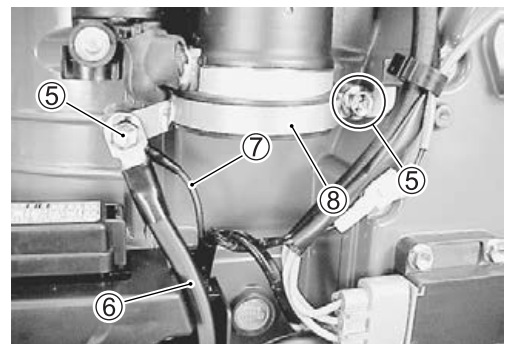
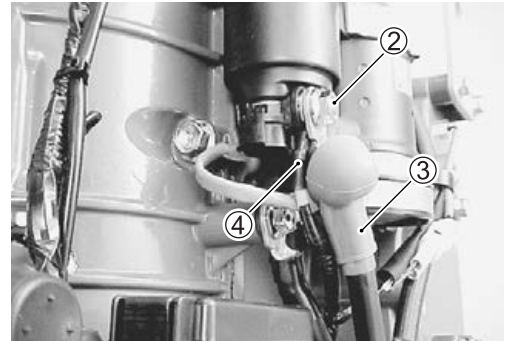
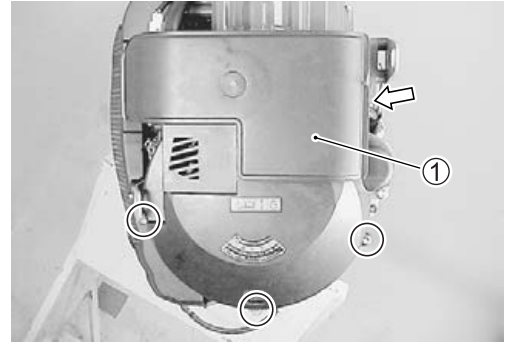
STARTER MOTOR

REMOVAL

Prior to removing starter motor:

- **Disconnect battery cables from battery.**

1. Remove bolts and ring gear cover with air intake silencer case ①. (See page 6-2.)
2. Remove nut ②, positive \oplus battery cable ③ and positive \oplus battery charge cable ④ from the starter motor magnetic switch.
3. Remove the two (2) bolts ⑤, negative \ominus battery cable ⑥, harness GND lead wire ⑦ and starter motor band ⑧.
4. Remove the two bolts ⑨ securing starter motor.
5. Remove the starter motor ⑩, then disconnect the red lead wire ⑪ from "S" terminal of starter magnetic switch.



INSTALLATION

Installation is reverse order of removal with special attention to the following steps.

- Install starter motor and tighten starter motor mounting bolts securely.

 **Starter motor mounting bolt: 23 N·m (2.3 kg·m, 16.5 lb-ft)**

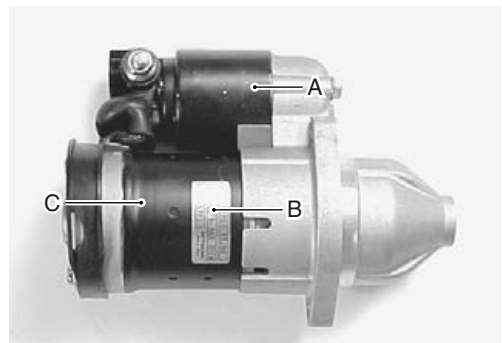
**DISASSEMBLY**

When overhauling starting motor, it is recommended that component parts be cleaned thoroughly.

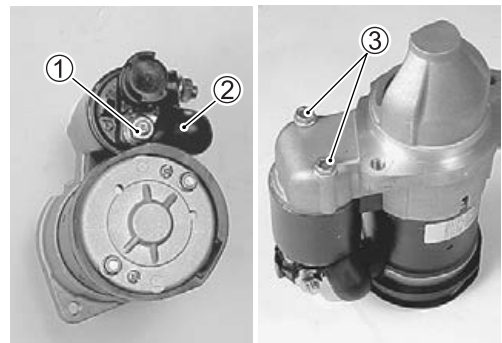
However, the yoke assembly, armature coil, over-running clutch assembly, magnetic switch assembly and rubber or plastic parts should not be washed in a degreasing tank or with a grease dissolving solvent. These parts should be cleaned with compressed air or wiped with clean cloth.

NOTE:

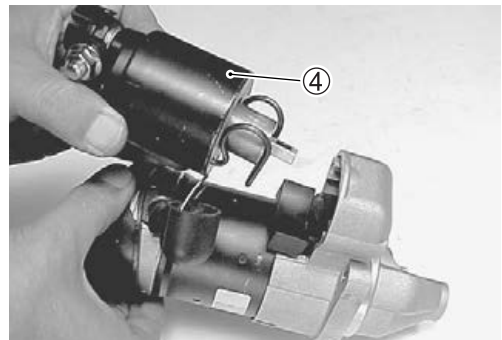
Before disassembling starting motor, be sure to put match marks at three locations (A, B and C) as shown in figure at right to avoid any possible component alignment mistakes.



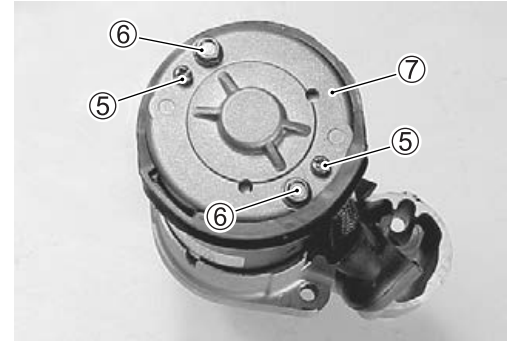
1. Remove nut ① from magnetic switch, then disconnect the connecting wire ②.
2. Remove two bolts ③ securing magnetic switch.



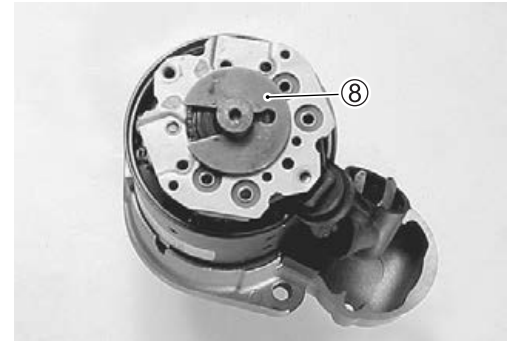
3. Remove the magnetic switch ④.



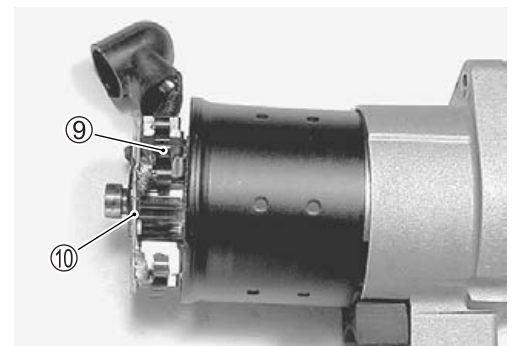
4. Remove screws ⑤, long through bolts ⑥ and rear cover ⑦.



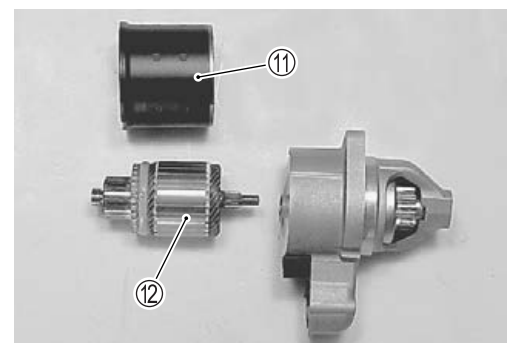
5. Remove thrust washer ⑧ with screwdriver.



6. Pull the brush spring ⑨ up to separate the brush from the surface of the commutator, then remove the brush holder ⑩.

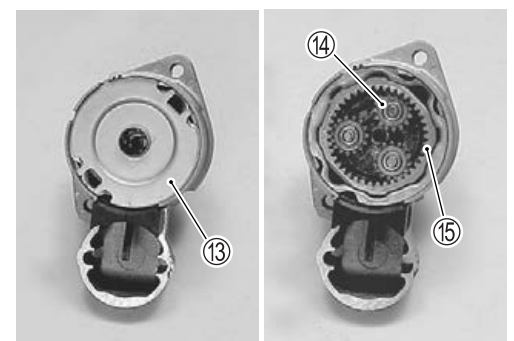


7. Remove the yoke ⑪ and armature ⑫.

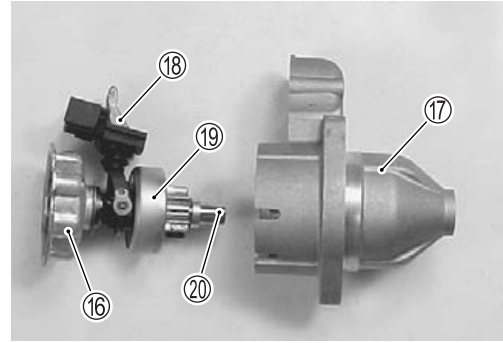


8. Remove the center cover plate ⑬.

9. Remove the planetary gears ⑭ and internal gear ⑮.



10. Remove the center bracket ⑯ (with shift lever ⑱, pinion ⑲ and pinion shaft ⑳) from front housing ⑰.



11. Remove the shift lever ⑱.



12. Push the pinion stopper ㉑ down, then remove stopper ring ㉒.

Remove the pinion stopper and pinion ⑲.

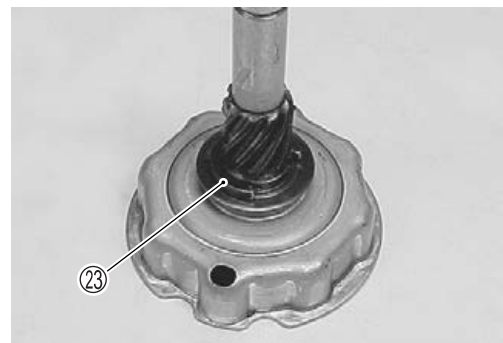
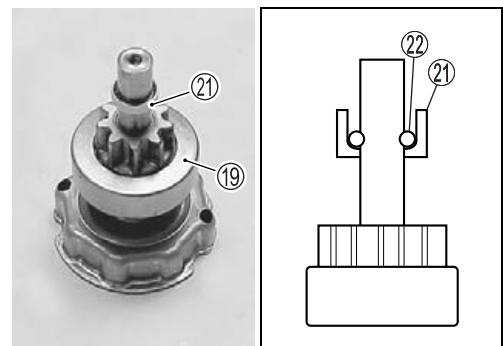
⚠ WARNING

Wear safety glasses when disassembling and assembling stopper ring.

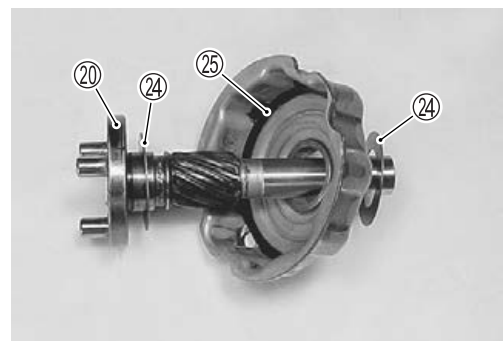
NOTE:

Using a screw-driver, pry off the stopper ring.

13. Remove the E-ring ㉓.



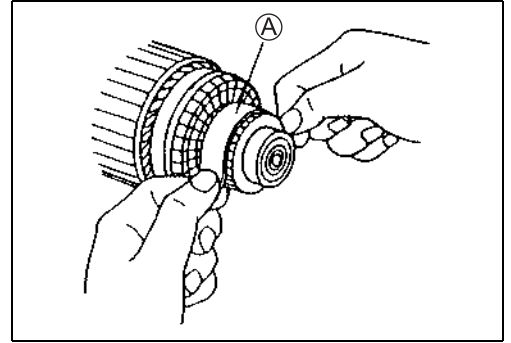
14. Remove the pinion shaft ⑳, washers ㉔ and rubber ring ㉕ from center bracket.



INSPECTION AND SERVICING

Armature and Commutator

- Inspect the commutator surface.
If surface is gummy or dirty, clean with #500 grit emery paper
Ⓐ.



- Measure commutator outside diameter.

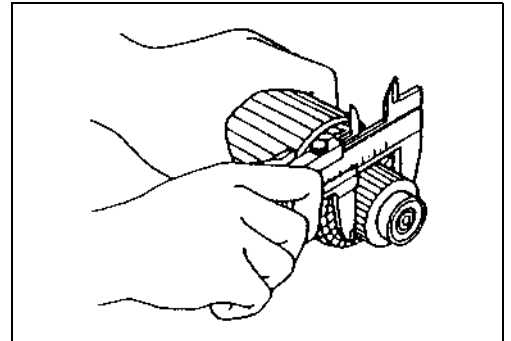
TOOL 09900-20101: Vernier calipers

Commutator outside diameter:

Standard: 29.0 mm (1.14 in)

Service limit: 28.0 mm (1.10 in)

If measurement exceeds service limit, replace armature.



- Check that mica (insulator) between the segments is undercut to specified depth.

Commutator undercut ①:

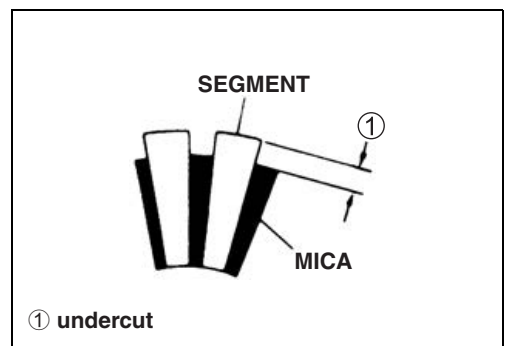
Standard: 0.5 – 0.8 mm (0.02 – 0.03 in)

Service limit: 0.2 mm (0.01 in)

If measurement exceeds service limit, cut to specified depth.

NOTE:

Remove all particles of mica and metal using compressed air.



① undercut

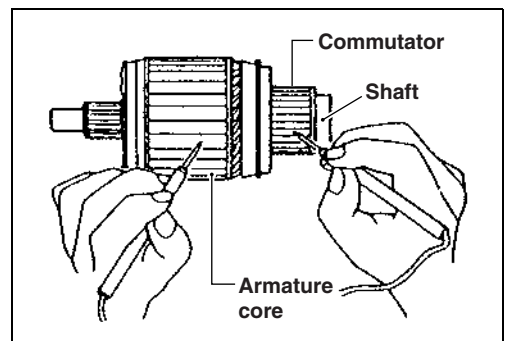
⚠ WARNING

Wear safety glasses when using compressed air.

- Check for continuity between the commutator and the armature core/shaft.
Replace armature if continuity is indicated.


TOOL 09930-99320: Digital tester

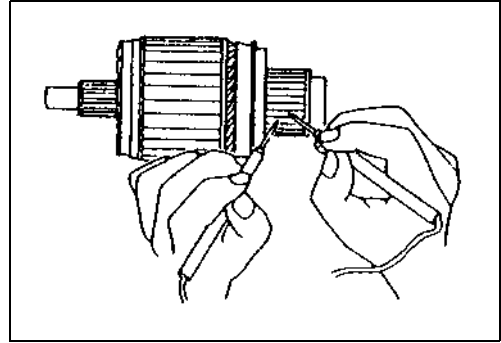
TESTER Tester range:  (Continuity)



- Check for continuity between adjacent commutator segments.
Replace armature if no continuity is indicated.

TOOL 09930-99320: Digital tester

CONT Tester range:  (Continuity)



BRUSHES

Check the length of each brush.

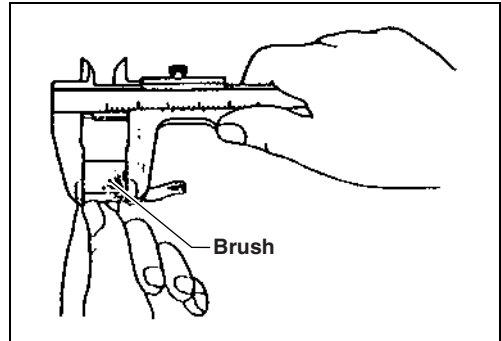
TOOL 09900-20101: Vernier calipers

Brush length:

Standard: 16.0 mm (0.63 in)

Service limit: 12.0 mm (0.47 in)


If brushes are worn down to the service limit, they must be replaced.



BRUSH HOLDER

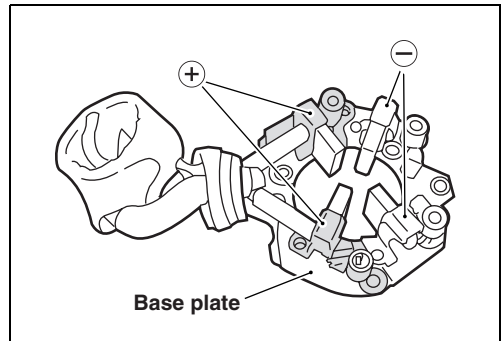
- Check brush holder continuity.

TOOL 09930-99320: Digital tester

CONT Tester range:  (Continuity)

Brush holder continuity:

Tester probe connection	Continuity
Brush holder positive ⊕ to Brush holder negative ⊖	No
Brush holder positive ⊕ to Base plate (ground)	No



Replace brush holder if the tester doesn't show the above.

BRUSH SPRING

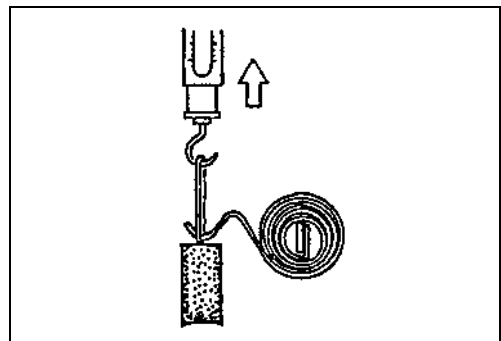
Inspect brush spring for wear, damage or other abnormal conditions.

Check the brush spring tension.

Replace if necessary.

Brush spring tension

Standard: 15 – 18 N (1.5 – 1.8 kg, 3.3 – 4.0 lbs)



SHIFT LEVER

Inspect shift lever for wear.
Replace if necessary.

**PINION AND OVER-RUNNING CLUTCH**

- Inspect pinion for wear, damage or other abnormal conditions. Check that clutch locks up when turned in direction of drive and rotates smoothly in reverse direction. Replace if necessary.



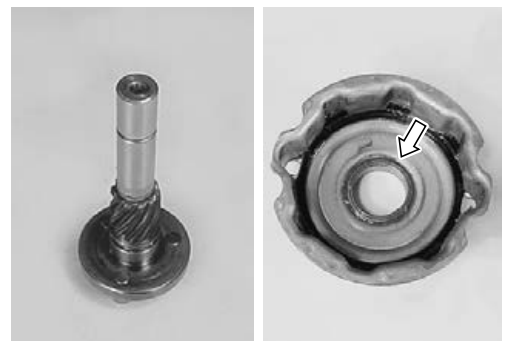
- Inspect spline teeth for wear or other damage. Inspect pinion for smooth movement. Replace if necessary.

**GEAR**

- Inspect planetary gears and internal gear for wear, damage or other abnormal conditions. Replace if necessary.

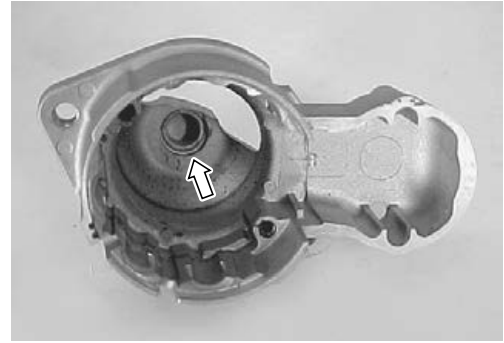
**PINION SHAFT/PINION SHAFT BUSH**

- Inspect pinion shaft for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect pinion shaft bush for wear or other damage. Replace if necessary.



FRONT HOUSING

- Inspect front housing for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect bush for wear or other damage. Replace if necessary.



ARMATURE SHAFT BUSH

Inspect bush for wear or other damage.
Replace if necessary.



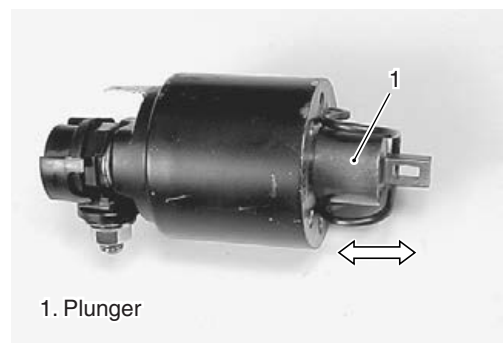
PLUNGER

Inspect plunger for wear or other damage.
Replace if necessary.




MAGNETIC SWITCH

Push in plunger and release. The plunger should return quickly to its original position.
Replace if necessary.



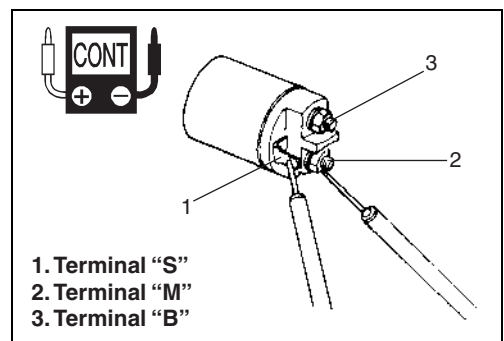
Pull-in coil Open circuit Test

 **09930-99320: Digital tester**


 **Tester range:**  (Continuity)

Check for continuity across magnetic switch “S” terminal and “M” terminal.

If no continuity exists, the coil is open and should be replaced.



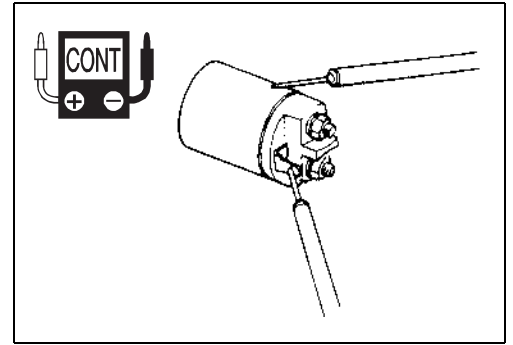
Hold-in coil Open circuit Test

 **09930-99320: Digital tester**

 **Tester range:  (Continuity)**

Check for continuity across magnetic switch “S” terminal and coil case.

If no continuity exists, the coil is open and should be replaced.

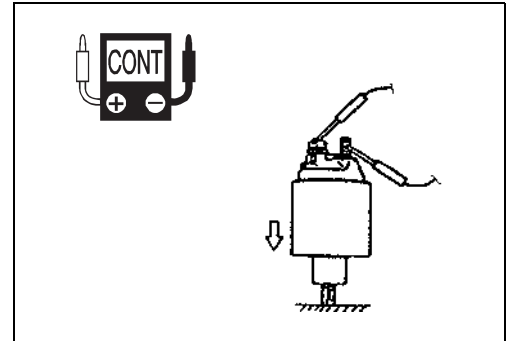
**Contact points Test**

 **09930-99320: Digital tester**

 **Tester range:  (Continuity)**

Put the plunger on the under side and then push the magnetic switch down. At this time, check for continuity between terminal “B” and terminal “M”.

Continuity indicates proper condition. If no continuity exists, replace the magnetic switch and/or plunger.



ASSEMBLY

Assembly is reverse order of disassembly with special attention to the following steps.

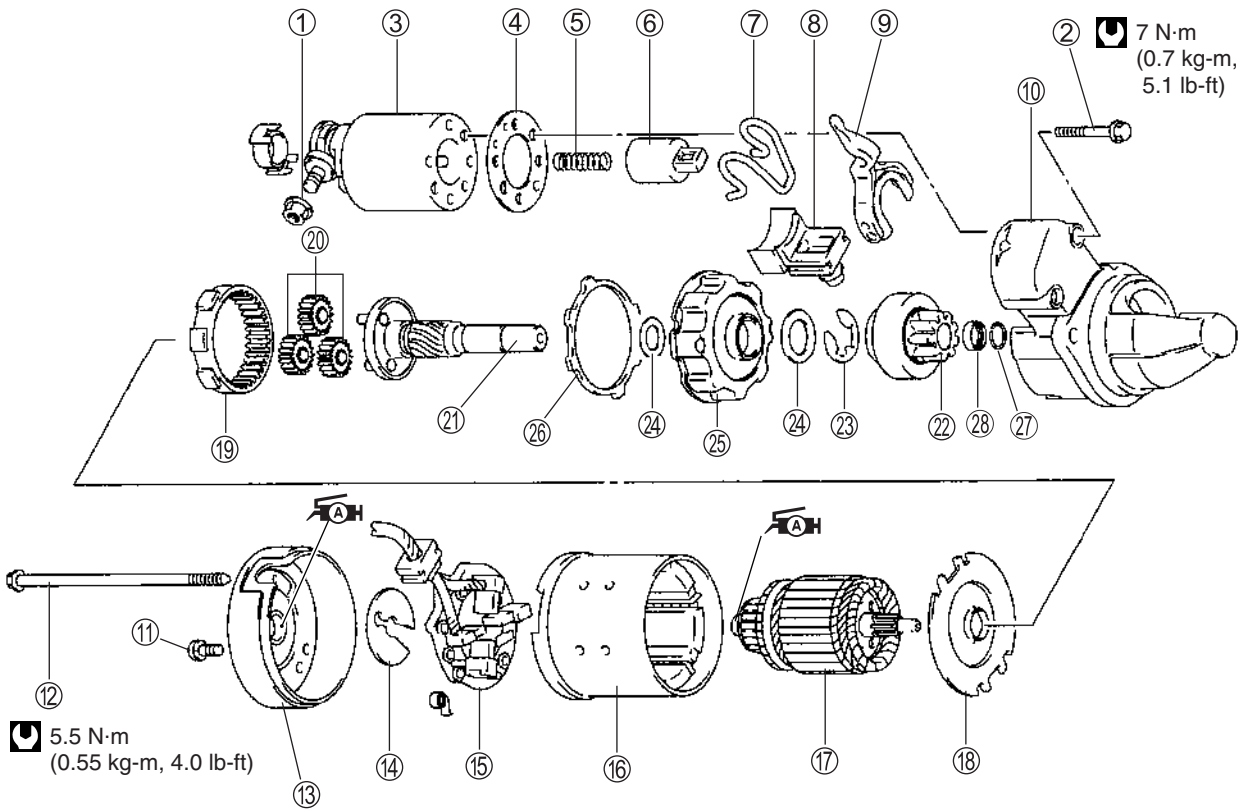
CAUTION

When installing armature, use care to avoid breaking brushes.



When installing pinion shift lever, refer to figure in construction diagram for installation direction.

Construction diagram



- | | | |
|-------------------|----------------------|------------------|
| ① Nut | ⑪ Screw | ⑳ Pinion shaft |
| ② Bolt | ⑫ Through bolt | ㉑ Pinion |
| ③ Magnetic switch | ⑬ Rear cover | ㉒ E-ring |
| ④ Gasket | ⑭ Thrust washer | ㉓ Brush holder |
| ⑤ Spring | ⑮ Brush holder | ㉔ Washer |
| ⑥ Plunger | ⑯ Yoke | ㉕ Center bracket |
| ⑦ Torsion spring | ⑰ Armature | ㉖ Rubber ring |
| ⑧ Rubber packing | ⑱ Center cover plate | ㉗ Stopper ring |
| ⑨ Shift lever | ㉘ Internal gear | ㉚ Pinion stopper |
| ⑩ Front housing | ㉙ Planetary gear | |

PERFORMANCE TEST**CAUTION**

Each test must be performed within 3 – 5 seconds to avoid coil damage from overheating.

⚠ WARNING

When performing the following test, be sure to connect the battery and the starting motor with a lead wire of the same size as original equipment.

PULL-IN/HOLD-IN TEST

Connect battery to magnetic switch as shown in figure.

- Check that plunger and pinion (over-running clutch) move outward.

If plunger and pinion don't move, replace magnetic switch.

NOTE:

Before testing, disconnect brush lead from terminal "M".

- While connected as above with plunger out, disconnect negative lead from terminal "M".

Check that plunger and pinion remain out.

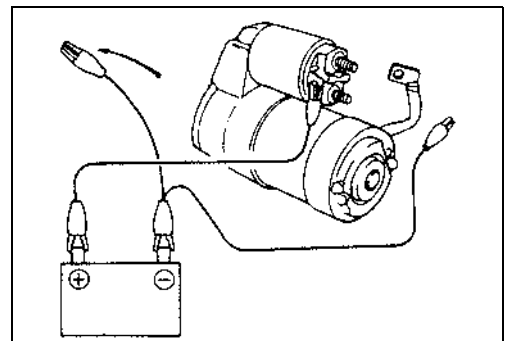
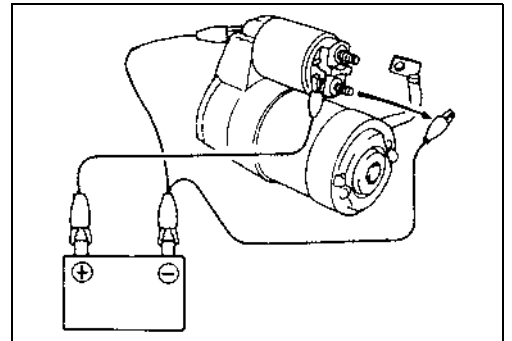
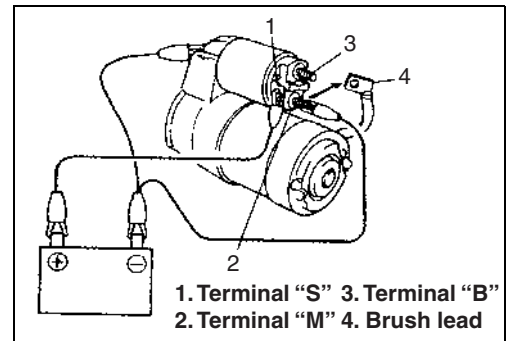
If plunger and pinion return inward, replace magnetic switch.

PLUNGER AND PINION RETURN TEST

Disconnect negative lead from switch/motor body.

Check that plunger and pinion return inward.

If plunger and pinion don't return inward, replace magnetic switch.



NO-LOAD PERFORMANCE TEST

CAUTION

Before performing following test, secure the starter motor to the test bench.

1. Connect battery and ammeter to starter motor as shown.
2. Check that starter rotates smoothly and steadily with pinion moving out. Check that ammeter indicates specified current.

No load current: Within 90 A at 11 V

