

Starting System

General Description

Electric Starter System Description

CENDG2111901001

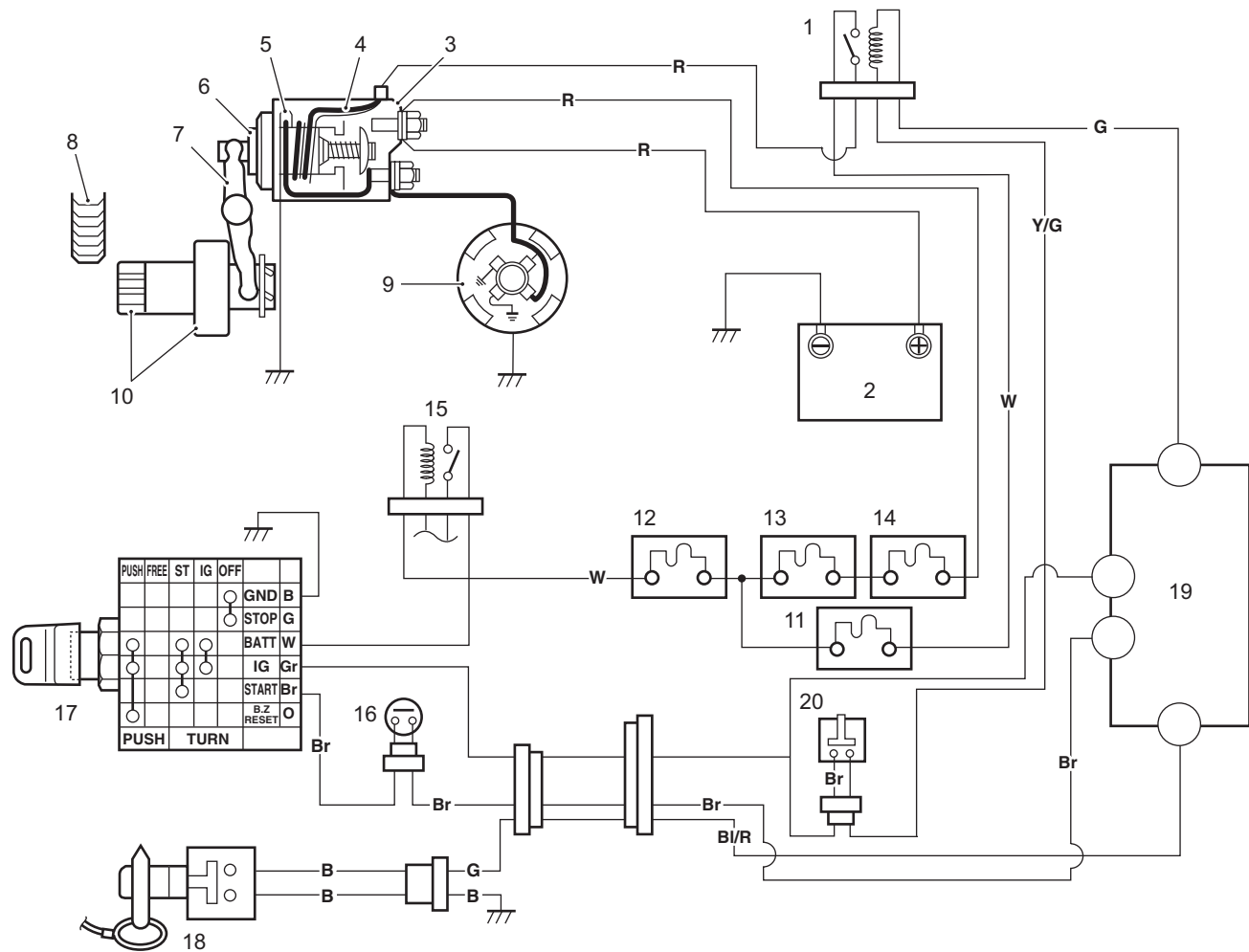
The starting circuit consists of the battery, starting motor, ignition switch, neutral switch, starter relay, ECM and related electrical wiring.

These components are connected electrically as shown in the figure below.

In the circuit shown in the 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.



IDG211190001-04

1. Starter relay	6. Plunger	11. 30 A Fuse (Starter)	16. Neutral switch
2. Battery	7. Shift lever	12. 30 A Fuse (ECM)	17. Ignition switch
3. Magnetic switch	8. Ring gear	13. 60 A Fuse (Load)	18. Emergency stop switch
4. Pull-in coil	9. Starter motor	14. 60 A Fuse (Main)	19. ECM
5. Hold-in coil	10. Pinion and over-running clutch	15. Main relay	20. Neutral switch

1I-2 Starting System:

Starter Motor Operation Condition Description

CENDG2111901002

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 the "ON" position.
 - Engine is not already operating.
- After returning the ignition key to the "ON" position from "START", the starter motor continues to run for 4 seconds until engine starts.

NOTE

The continuous operating time of the starter motor is set at five seconds.

When this time is exceeded, the starter motor will automatically stop.

If the motor stops, wait about ten seconds for the motor to cool down and try again.

Start-In-Gear Protection System Description

CENDG2111901003

To avoid accidental movement of the boat at the time of engine starting, the system prohibits starter motor operation when the shift lever is "IN" gear.

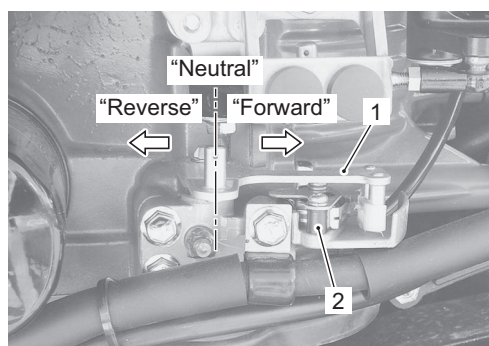
Control by Neutral Switch

A switch to detect "Neutral" gear position is located on the clutch lever holder and operated by the clutch control lever.

This ON/OFF type switch is ON in "Neutral" and OFF in "Forward" or "Reverse".

When attempting to start the engine, the ECM detects the shift position using the neutral switch.

When the neutral switch is OFF, the ECM does not provide a starter motor relay operating signal and fuel injector operating signal.



IDG211190002-03

1. Clutch lever

2. Neutral switch

Operation by neutral switch on engine starting

Shift position	Operation			
	Fuel injection	Ignition	High pressure fuel pump	Starter motor
Neutral	Yes	Yes	Yes	Yes
Forward/Reverse	No	No	Yes	No

Component Location

Starting System Components Location

CENDG2111903001

Refer to "Wiring Harness Routing Diagram" in Section 4A (Page 4A-3).

Diagnostic Information and Procedures

Starter System Troubleshooting

CENDG2111904001

▲ CAUTION

Failure to take proper precaution when starter system troubleshooting may result in personal injury and/or damage to electronic components.

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

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.
- Fuse is not blown.

Condition	Possible cause	Correction / Reference Item
Motor not running. (No operating sound of magnetic switch.)	Poor or broken battery connection.	Replace.
	Loose or corroded battery connection.	Repair or retighten.
	Weak or shorted battery.	Replace or recharge battery.
	Defective neutral switch.	Neutral switch inspection. Replace.
	Fuse blown.	Replace.
	Defective ignition switch.	Ignition switch inspection. Replace.
	Open circuit between ignition switch and magnetic switch.	Repair.
	Defective emergency stop switch.	Replace. Emergency stop switch inspection.
	Lead wire disconnected or loose.	Retighten.
	Poor contacting action of ignition switch and magnetic switch.	Replace. Ignition switch inspection. Magnetic switch inspection.
	Defective starter motor control relay.	Main relay and starter motor relay inspection.
	Defective ECM and its circuit.	Inspection of ECM and its circuit.
	Open circuit in pull-in coil.	Replace magnetic switch. Magnetic switch inspection.
Motor not running. (Operating sound of magnetic switch heard.)	Brushes are seating poorly or worn.	Repair or replace. Brushes inspection.
	Weak or shorted battery.	Replace or recharge battery.
	Battery voltage too low due to battery deterioration.	Replace battery.
	Loose or corroded battery connection.	Repair or retighten.
	Burnt main contact point, or poor contacting action of magnetic switch.	Replace magnetic switch. Magnetic switch inspection.
	Brushes are seating poorly or worn.	Replace or repair. Brushes inspection.
	Weakened brush spring.	Replace.
	Burnt commutator.	Replace armature. Commutator inspection.
	Shorted or open winding in armature.	Replace. Armature inspection.
	Excessive friction in engine.	Repair.

11-4 Starting System:

Condition	Possible cause	Correction / Reference Item
Starter motor running but too slow. (Low torque) <i>(If battery and wiring are satisfactory, inspect starting motor.)</i>	Insufficient contact of magnetic switch main contacts.	Replace magnetic switch. Magnetic switch inspection.
	Shorted armature.	Replace. Armature inspection.
	Dirty or corroded commutator.	Repair commutator or replace armature. Armature inspection.
	Worn brushes.	Replace brushes.
	Weakened brush spring.	Replace.
Starter motor running, but not cranking engine.	Worn pinion tip.	Replace over-running clutch.
	Poor sliding of over-running clutch.	Repair.
	Over-running clutch slipping.	Replace over-running clutch.
	Worn teeth of ring gear.	Replace flywheel.
Starter motor does not stop running.	Broken contact point of magnetic switch.	Replace magnetic switch.
	Short-circuit magnetic switch coil.	Replace magnetic switch.

Service Instructions

Starter Motor Removal and Installation

CENDG2111906001

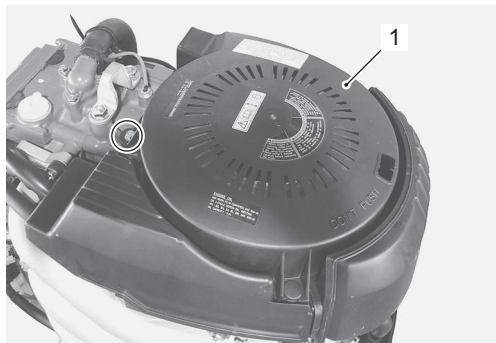
Removal

NOTICE

If the 12 V electrical system is shorted while servicing the starter motor, the engine electrical circuits could be damaged seriously.

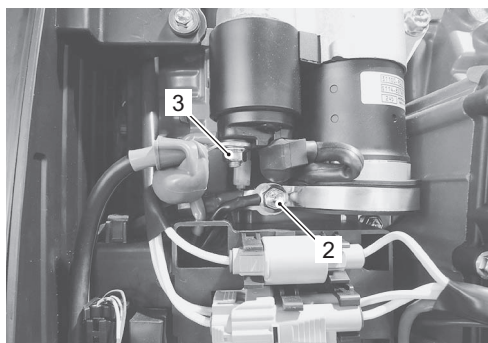
Prior to removing starter motor, disconnect the battery cable at the battery.

- 1) Remove bolt and ring gear cover (1).



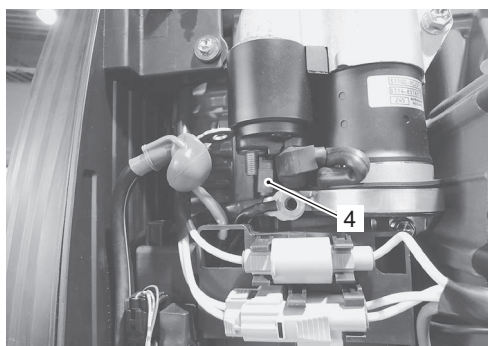
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- 2) Remove bolt (2) securing main harness GND lead wire and negative (–) battery cable. Remove nut (3) securing positive (+) battery cable and main harness (R) lead wire.



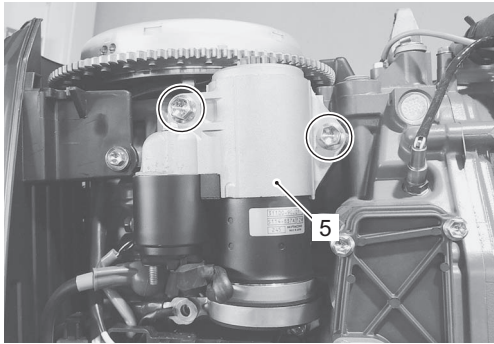
IDG211190004-02

- 3) Disconnect Red lead wire connector (4) from terminal "S" of starter magnetic switch.



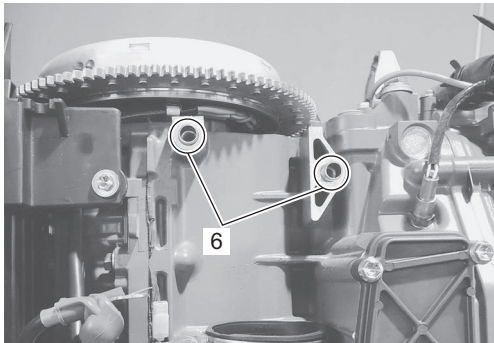
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- 4) Remove two bolts and starter motor (5).



IDG211190006-02

- 5) Remove the dowel pins (6).



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Installation

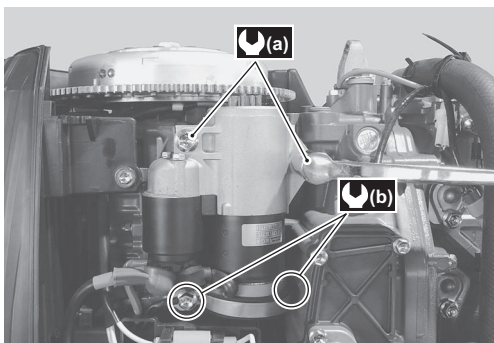
Installation is in the reverse order of removal with special attention to the following steps.

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

Tightening torque

Starter motor mounting bolt (a): 50 N·m (5.0 kgf-m, 36.0 lbf-ft)

Starter motor mounting bolt (b): 23 N·m (2.3 kgf-m, 16.5 lbf-ft)



IDG211190007-03

- Check to ensure that all removed parts are back in place.

Starter Motor Test

CENDG2111906002

▲ CAUTION

Sparks resulting from short circuit between the positive (+) and negative (–) terminals during connections to the battery could cause a burn.

Be careful not to short-circuit the positive (+) and negative (–) cables and connect them only to the correct terminals.

▲ CAUTION

If the cable used for the test is not adequately thick, the cable may become extremely hot due to large current flowing through it and you could get burned.

Be sure to connect the battery and the starting motor with a lead wire of the same size as original equipment.

NOTICE

If battery power is applied too long in any of the following tests, the coil of the magnetic switch may burn.

Each test must be completed within 3 – 5 seconds to avoid burning of the coil.

11-6 Starting System:

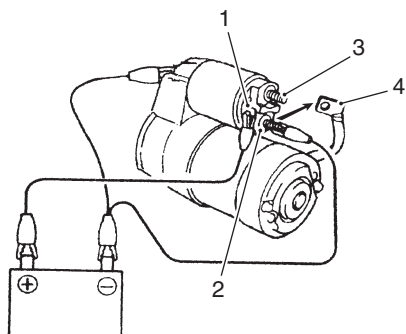
Pull-In / Hold-In Test

NOTE

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

Connect the battery to the magnetic switch as shown in the figure.

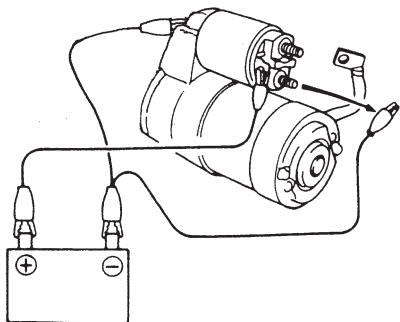
- Check that the plunger and pinion (over-running clutch) move outward. If the plunger and pinion don't move, replace the magnetic switch.



I9J011190002-02

1. Terminal "S"	3. Terminal "B"
2. Terminal "M"	4. Brush lead

- While connected as above with the plunger out, disconnect the negative lead from terminal "M". Check that the plunger and pinion remain out. If the plunger and pinion return inward, replace the magnetic switch.

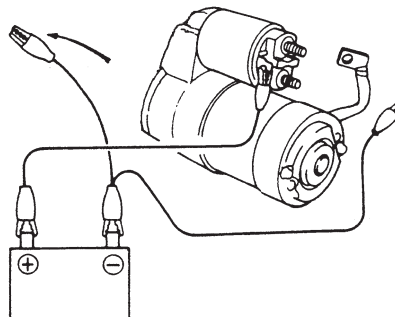


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Plunger and Pinion Return Test

Disconnect the negative lead from the switch/motor body.

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



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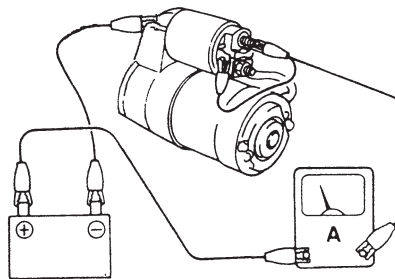
No-Load Performance Test

NOTE

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

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

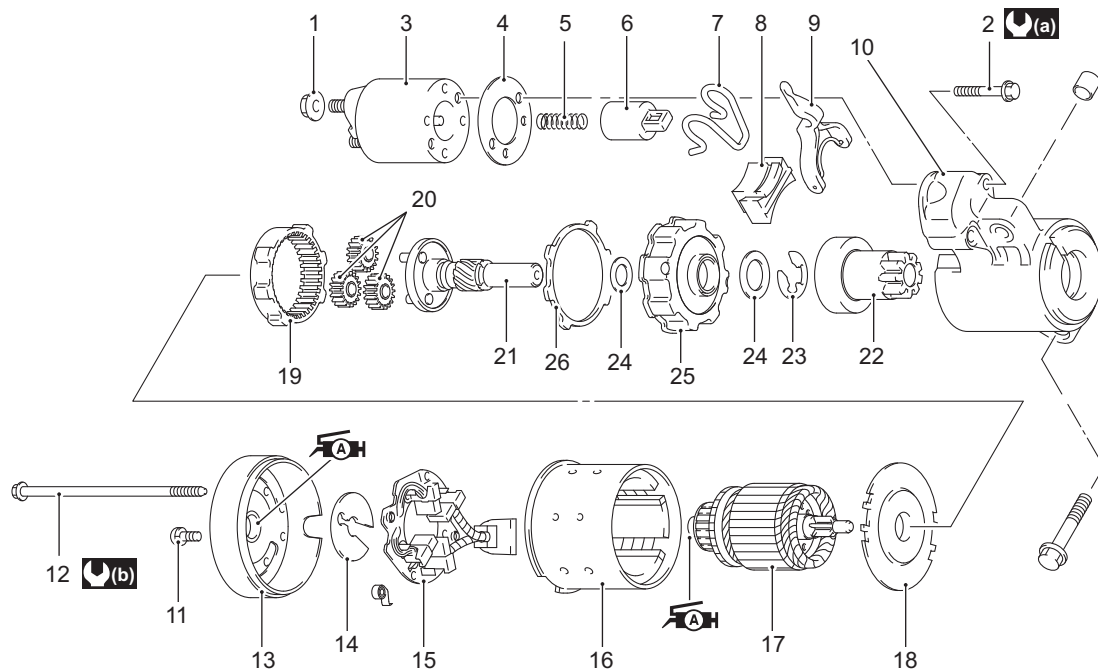
Specified current (No-load performance test)
Within 90 A at 11 V



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Starter Motor Components

CENDG2111906003



IDG211190008-02

1. Nut	9. Shift lever	17. Armature	25. Center bracket
2. Bolt	10. Front housing	18. Center cover plate	26. Rubber ring
3. Magnetic switch	11. Screw	19. Internal gear	⚙️(a) : 7 N·m (0.7 kgf-m, 5.1 lbf-ft)
4. Gasket	12. Through bolt	20. Planetary gear	⚙️(b) : 5.5 N·m (0.55 kgf-m, 4.0 lbf-ft)
5. Spring	13. Rear cover	21. Pinion shaft	⚙️ : Apply grease.
6. Plunger	14. Thrust washer	22. Pinion	
7. Torsion spring	15. Brush holder	23. E-ring	
8. Rubber packing	16. Yoke	24. Washer	

Starter Motor Disassembly and Assembly

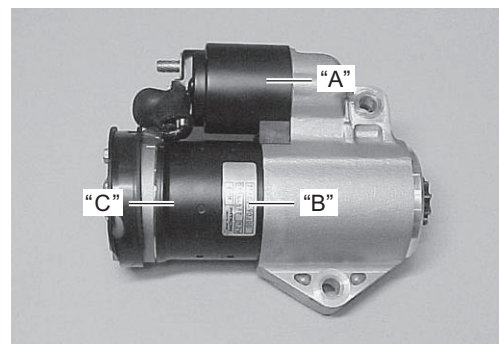
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Disassembly

When overhauling the starting motor, it is recommended that the 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

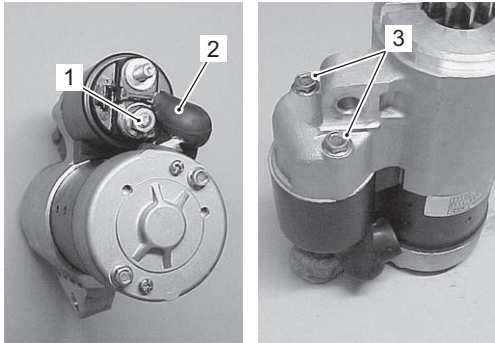
Before disassembling the starting motor, be sure to put match marks at three locations ("A", "B" and "C") as shown in the figure at right to avoid any possible component alignment mistakes.



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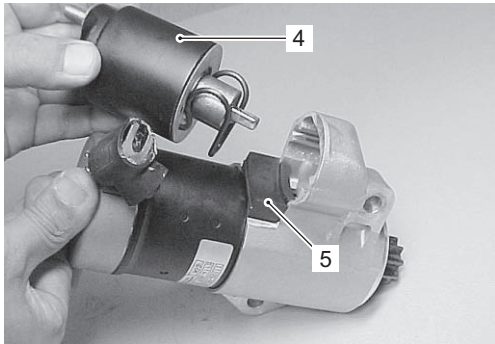
11-8 Starting System:

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



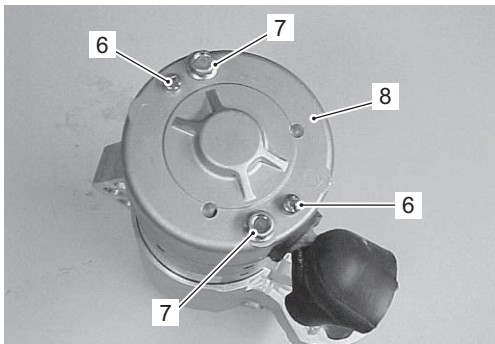
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- 3) Remove the magnetic switch (4) and rubber packing (5).



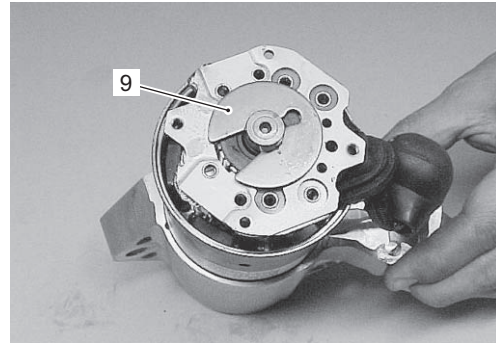
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- 4) Remove screws (6), long through bolts (7) and the rear cover (8).



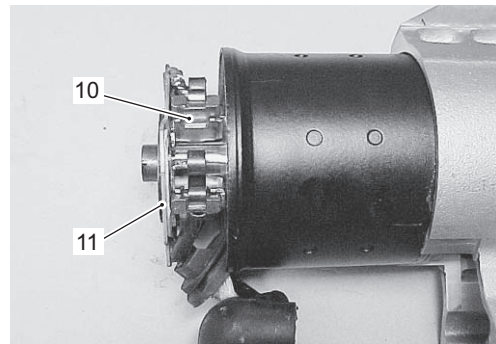
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- 5) Remove thrust washer (9) with a screwdriver.



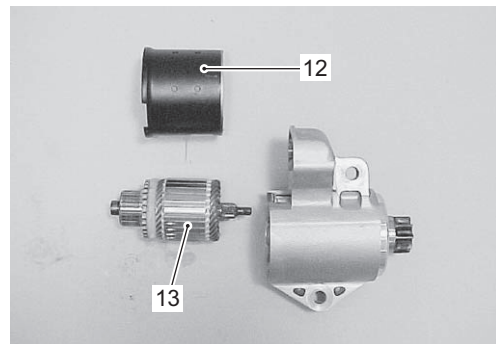
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- 6) Pull the brush spring (10) up to separate the brush from the surface of the commutator, then remove the brush holder (11).



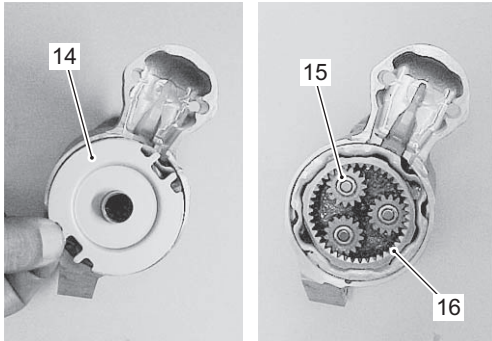
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- 7) Remove the yoke (12) and armature (13).



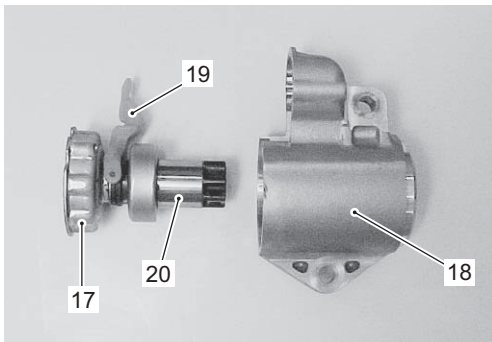
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- 8) Remove the center cover plate (14).
- 9) Remove the planetary gears (15) and internal gear (16).



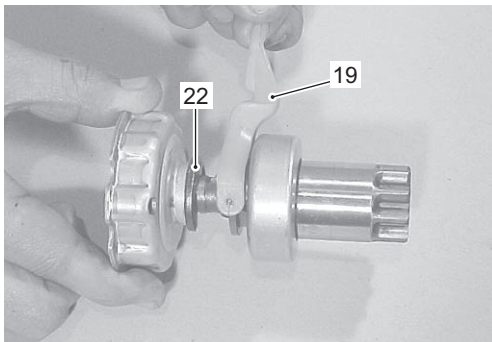
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- 10) Remove the center bracket (17) (with shift lever (19), pinion (20) and pinion shaft (21)) from front housing (18).



IDG211190017-01

- 11) Remove the shift lever (19) and E-ring (22).

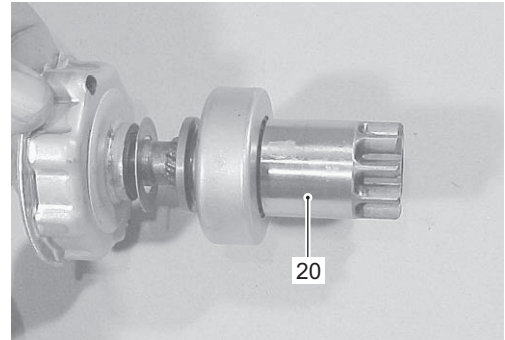


IDG211190018-01

- 12) Remove the pinion (20).

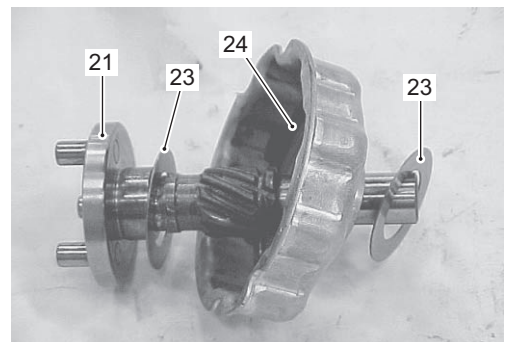
NOTE

To remove the pinion, hold the pinion shaft and pull the pinion up while turning it. Repeat this process several times then the pinion will be removed.



IDG211190019-01

- 13) Remove the pinion shaft (21), washers (23) and rubber ring (24) from the center bracket.

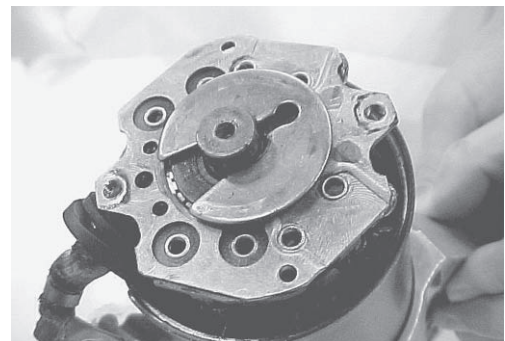


IDG211190020-01

Assembly

Assembly is in the reverse order of disassembly with special attention to the following steps. Reassemble the starter motor, refer to "Starter Motor Components" (Page 11-7).

- When installing the armature, use care to avoid breaking the brushes.



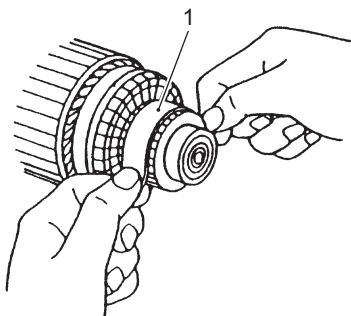
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Starter Motor Components Inspection and Servicing

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Armature and Commutator

- Inspect the commutator surface. If surface is gummy or dirty, clean with # 500 grit emery paper (1).



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- Measure the commutator outside diameter. If the measurement exceeds the service limit, replace the armature.

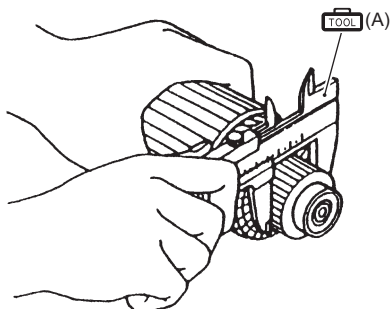
Special tool

TOOL (A): 09900–20101 (Vernier calipers (150 mm))

Commutator outside diameter

Standard: 29.0 mm (1.14 in.)

Service limit: 28.0 mm (1.10 in.)



I9J011190023-01

- Check that the mica (insulator) (2) between the segments (3) is undercut to specified depth “a”. If the measurement exceeds the service limit, cut to the specified depth.

⚠ WARNING

Failure to following proper precautions during use of the compressed air may cause severe personal injury.

Wear safety glasses when using compressed air.

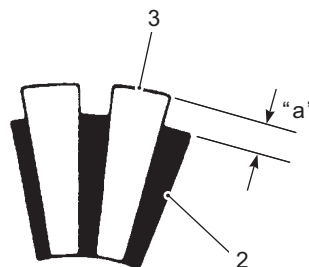
NOTE

Remove all particles of mica and metal using compressed air.

Commutator undercut “a”

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

Service limit: 0.2 mm (0.01 in.)



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2. Mica

3. Segment

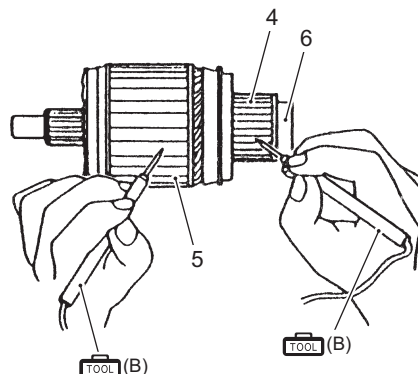
- Check for continuity between the commutator (4) and the armature core (5)/shaft (6). Replace the armature if continuity is indicated.

Special tool

TOOL (B): 09930–99320 (Digital tester)

Tester knob indication

Continuity (•)))



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4. Commutator

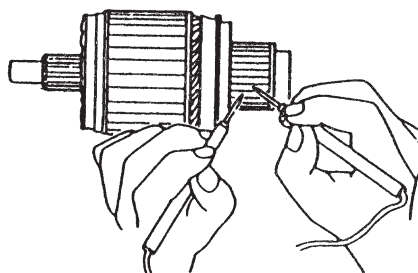
5. Armature core

6. Shaft

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

Tester knob indication

Continuity (•)))



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Brushes

Check the length of each brush (1).

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

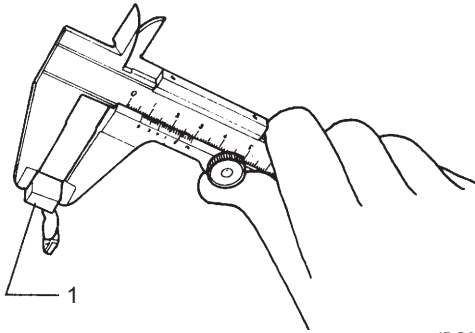
Special tool

TOOL (A): 09900-20101 (Vernier calipers (150 mm))

Brush length

Standard: 16.0 mm (0.63 in.)

Service limit: 12.0 mm (0.47 in.)



IDG211190033-01

Brush Holder

Check brush holder continuity.

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

Special tool

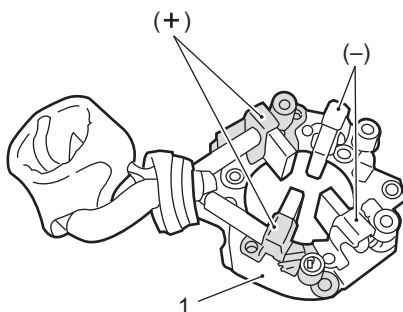
TOOL : 09930-99320 (Digital tester)

Tester knob indication

Continuity (•)))

Brush holder continuity

	Continuity
Brush holder positive (+) to brush holder negative (-)	No
Brush holder positive (+) to base plate (ground)	No



1. Base plate

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Shift Lever

Inspect the shift lever for wear. Replace if necessary.

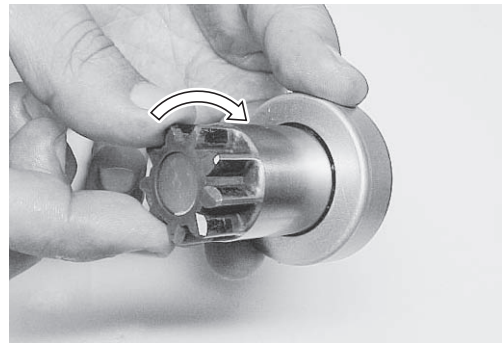


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Pinion and Over-Running Clutch

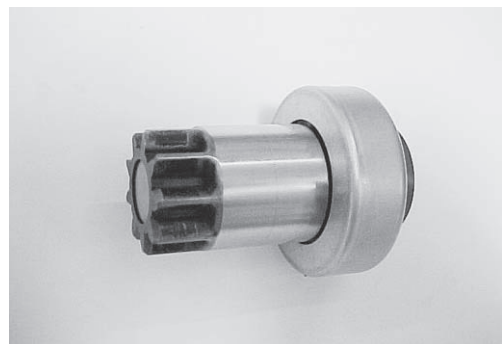
- Inspect the pinion for wear, damage or other abnormal conditions.

Check that the clutch locks up when turned in the direction of drive and rotates smoothly in reverse direction. Replace if necessary.



IDG211190023-01

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

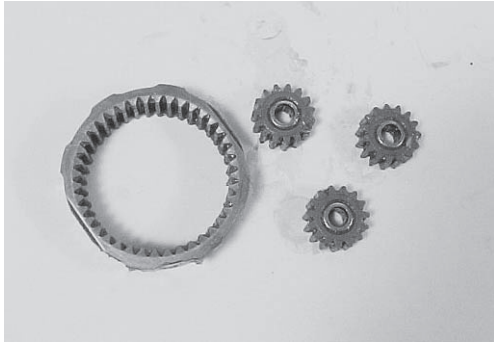


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11-12 Starting System:

Gear

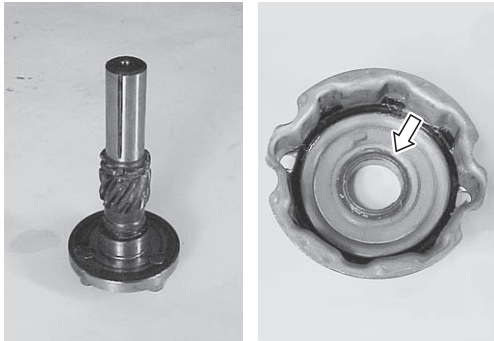
Inspect planetary gears and internal gear for wear, damage or other abnormal conditions.
Replace if necessary.



IDG211190025-01

Pinion Shaft / Pinion Shaft Bushing

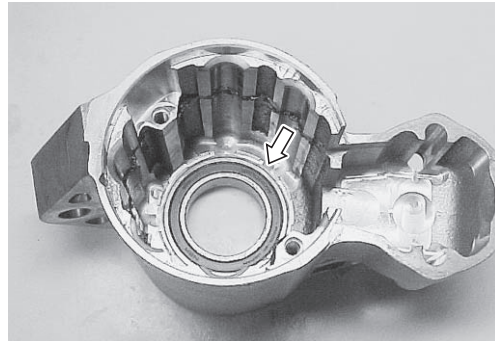
- Inspect the pinion shaft for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect the pinion shaft bushing for wear or other damage. Replace if necessary.



IDG211190026-01

Front Housing

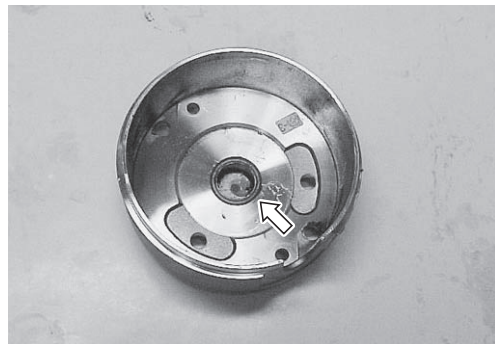
- Inspect the front housing for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect the bearing for wear or other damage. Replace if necessary.



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Armature Shaft Bush

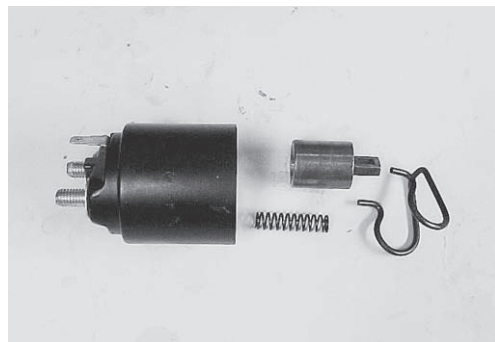
Inspect the bushing for wear or other damage.
Replace if necessary.



IDG211190028-01

Plunger

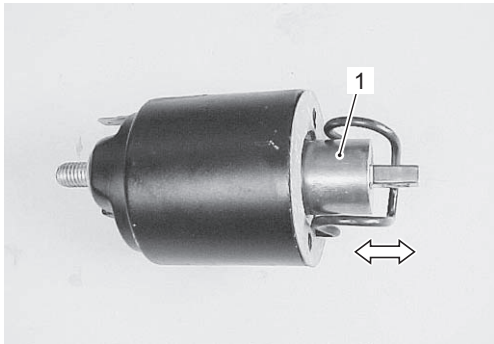
Inspect the plunger for wear or other damage.
Replace if necessary.



IDG211190029-01

Magnetic Switch

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



IDG211190030-01

1. Plunger

Pull-in coil open circuit test

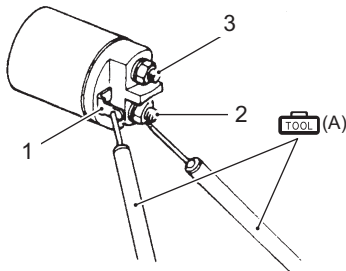
Check for continuity across the magnetic switch "S" terminal (1) and "M" terminal (2).
If no continuity exists, the coil is open and should be replaced.

Special tool

TOOL (A): 09930-99320 (Digital tester)

Tester knob indication

Continuity (•)))



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1. Terminal "S"	3. Terminal "B"
2. Terminal "M"	

Hold-in coil open circuit test

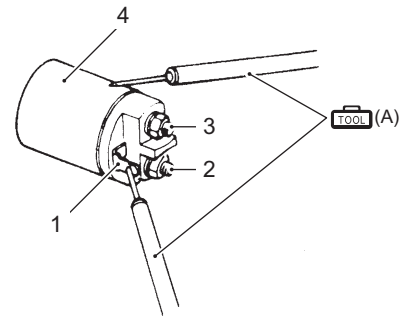
Check for continuity across the magnetic switch "S" terminal (1) and coil case (4).
If no continuity exists, the coil is open and should be replaced.

Special tool

TOOL (A): 09930-99320 (Digital tester)

Tester knob indication

Continuity (•)))



I9J011190039-01

1. Terminal "S"	3. Terminal "B"
2. Terminal "M"	4. Coil case

Contact points test

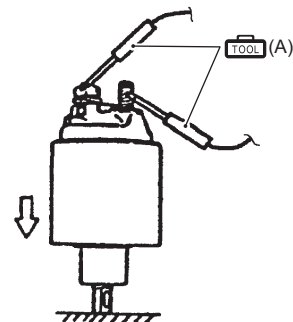
Put the plunger on the under side and then push the magnetic switch down.
At this time, check for continuity between terminal "B" and terminal "M".
Continuity indicates proper condition. If no continuity exists, replace the magnetic switch and/or plunger.

Special tool

TOOL (A): 09930-99320 (Digital tester)

Tester knob indication

Continuity (•)))



I9J011190040-01

1I-14 Starting System:


Ignition Switch Inspection

CENDG2111906006

Inspect the ignition switch using the following procedures:

- 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.
- 3) If out of specification, replace the ignition switch.

Special tool

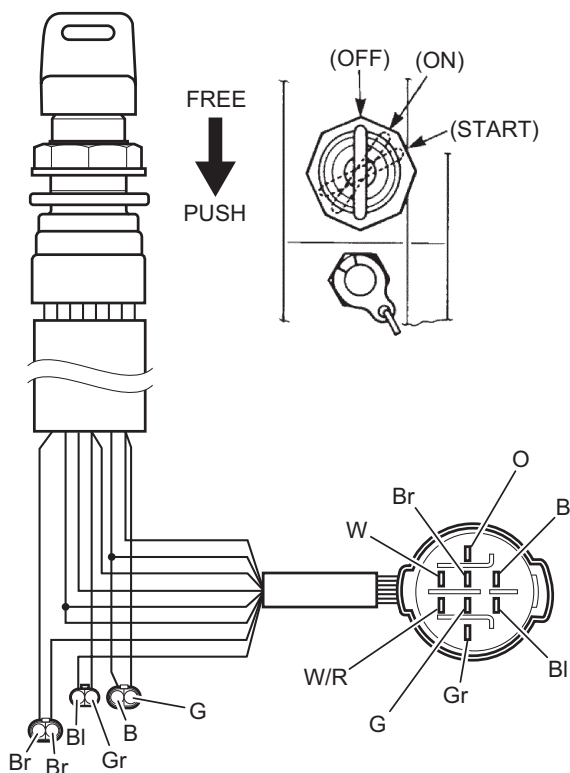
 : 09930-99320 (Digital tester)

Tester knob indication

Continuity (•)))

Key position	Switch lead wires					
	B	G	W	Gr	Br	O
OFF	○—○					
ON			○—○			
START			○—○—○			
FREE						
PUSH			○—○—○—○			

○—○ : Continuity
IDG211190040-01



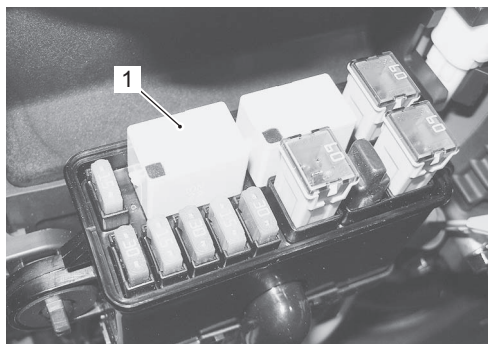
I9J011190042-02

Starter Motor Relay Inspection

CENDG2111906007

Inspect the starter motor relay using the following procedures:

- 1) Disconnect the starter motor relay from the fuse box.



IDG211190034-01

1. Starter motor relay


- 2) Check continuity between terminal (2) and (3) each time 12 V power supply is applied to terminal (4) and (5).
Connect the positive (+) lead to terminal (5), and negative (–) lead to terminal (4).

NOTICE

If the 12 V power supply wire is connected to wrong terminal or touched to each other, the power supply wire, tester may be damaged.

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

Special tool

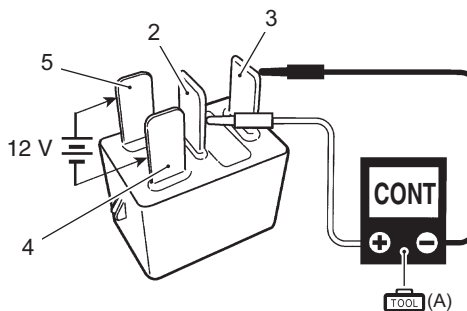
 (A): 09930-99320 (Digital tester)

Tester knob indication

Continuity (•)))

Starter motor relay function

	Continuity
12 V power applied	Yes
12 V power not applied	No



IDG211190039-01

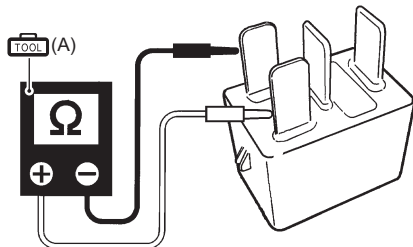
- 3) Measure the resistance between relay terminals (4) and (5).
If out of specification, replace starter motor relay.

Tester knob indication

Resistance (Ω)

Starter motor relay solenoid coil resistance

Standard: 145 – 190 Ω



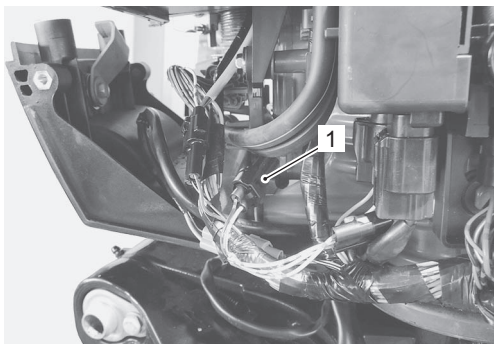
19J011190044-02

Neutral Switch (Engine Side) Removal and Installation

CENDG2111906010

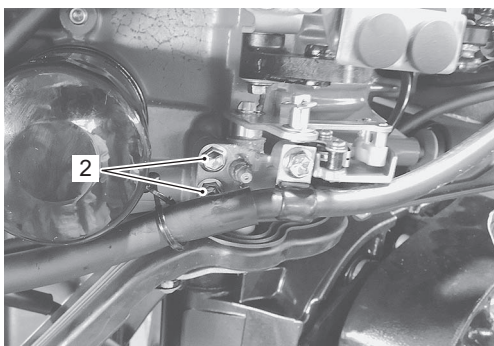
Removal

- 1) Remove the lower side covers.
Refer to "Lower Side Cover Removal and Installation" in Section 2A (Page 2A-3).
- 2) Disconnect the neutral switch lead wire connector (1).



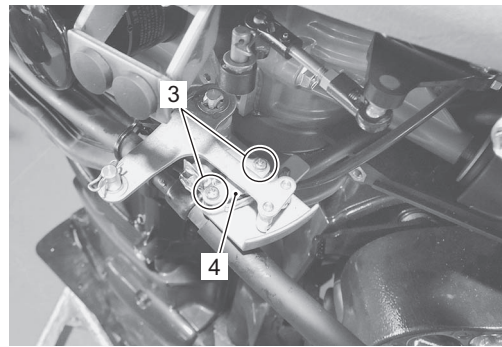
IDG211190035-01

- 3) Remove two bolts (2) securing clutch lever holder.



IDG211190036-01

- 4) Remove two screws (3) and neutral switch (4) from clutch lever holder.




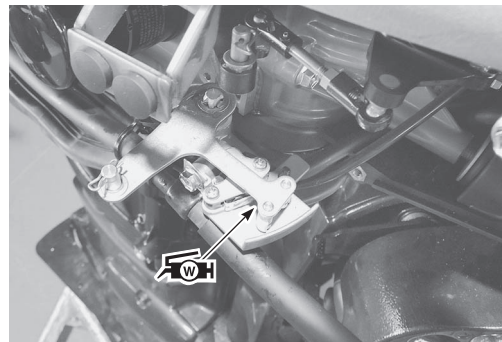
IDG211190037-01

Installation

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

- Check wiring harness routing.
Refer to "Wiring Harness Routing Diagram" in Section 4A (Page 4A-3).
- Apply water resistant grease to the switch lever.

 **Grease 99000-25350 (SUZUKI Water Resistant Grease EP2 (250 g))**



IDG211190038-01


- Install lower side covers.
Refer to "Lower Side Cover Removal and Installation" in Section 2A (Page 2A-3).

Neutral Switch Inspection

CENDG2111906008

Check for continuity/infinity of the neutral switch.

Special tool

 (A): 09930-99320 (Digital tester)

Tester knob indication

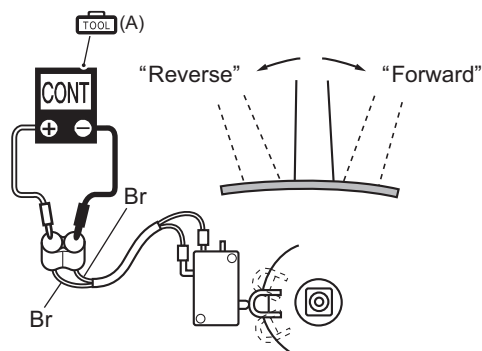
Continuity (•)))

Neutral Switch in Remo-Con Box

- 1) Disconnect the neutral switch lead wire connector from the ignition switch.
- 2) Check continuity/infinity between the switch brown wire leads while operating the remo-con handle. If out of specification, replace the neutral switch.

Neutral switch function

Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity




19J011190045-03

Neutral Switch on Engine Side

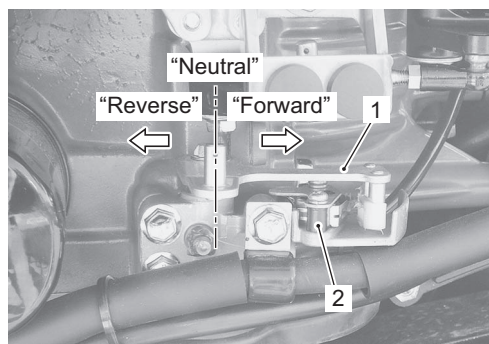
- 1) Disconnect the neutral switch lead wire connector.
- 2) Check continuity/infinity between the Yellow/Green and Brown lead wires while operating the remo-con handle.

Special tool

 (A): 09930-99320 (Digital tester)

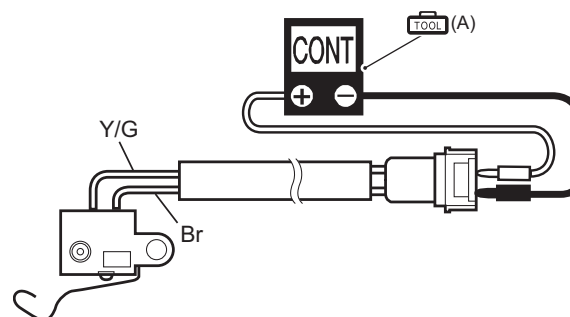
Neutral switch function

Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity



IDG211190002-03

1. Clutch lever 2. Neutral switch



19J011190047-03

3) If out of specification:

- 1st:
Check the remo-con cable adjustment, readjust if necessary.
- 2nd:
Check the wire harnesses for open and short circuits.
If the wire harnesses are in good condition, replace the neutral switch and recheck.
Refer to "Neutral Switch (Engine Side) Removal and Installation" (Page 11-15).

NOTE

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