Starting System

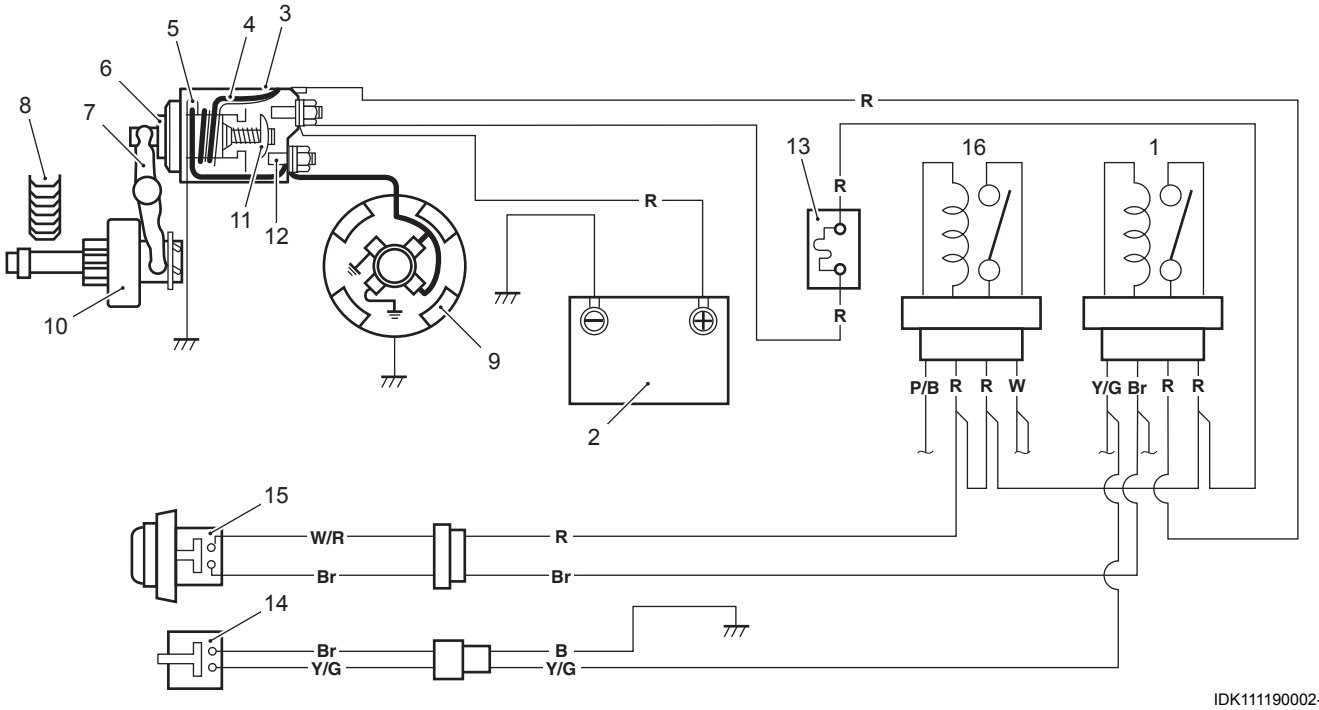
General Description

Electric Starter System Description

CENDK1111901001

The starting circuit consists of the battery, starting motor, starter button, neutral switch, starter relay 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 starter button is closed (Starter button depressed).
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 starter button is opened, at which time the torsion spring causes the pinion to disengage.

Starting system circuit for tiller handle model



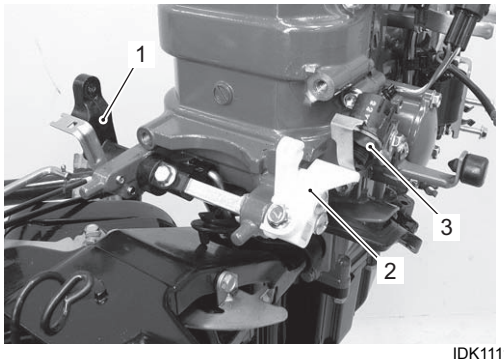
IDK111190002-03

1. Starter relay	5. Hold-in coil	9. Starter motor	13. 30 A Fuse
2. Battery	6. Plunger	10. Pinion and over-running clutch	14. Neutral switch
3. Magnetic switch	7. Shift lever	11. Movable contact	15. Starter button
4. Pull-in coil	8. Ring gear	12. Stationary contact	16. Battery relay

Start-In-Gear Protection System Description

CENDK1111901002

The neutral switch opens the starter circuit to prevent accidental engaging of starter motor whenever the shift is set in forward or reverse.
The switch is operated by clutch lever shaft through the clutch notch lever.



IDK111190009-01

1. Clutch lever shaft	3. Neutral switch
2. Clutch notch lever	

Component Location

Starting System Components Location

CENDK1111903001

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

Diagnostic Information and Procedures

Starter System Symptom Diagnosis

CENDK1111904001

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 starter button.	*Starter button inspection. Replace.*
	Open circuit between starter button and magnetic switch.	*Repair.*
	Lead wire disconnected or loose.	*Retighten.*
	Poor contacting action of starter button and magnetic switch.	*Replace. Starter button inspection. Magnetic switch inspection.*
	Defective starter motor relay.	*Starter motor relay inspection.*
	Open circuit in pull-in coil.	*Replace magnetic switch. Magnetic switch inspection.*
	Brushes are seating poorly or worn.	*Repair or replace. Brushes inspection.*
Motor not running. (Operating sound of magnetic switch heard.)	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.*
Starter motor running but too slow. (Low torque) (If battery and wiring are satisfactory, inspect starting motor.)	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.*

Starter System Troubleshooting

CENDK1111904002

⚠ CAUTION

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

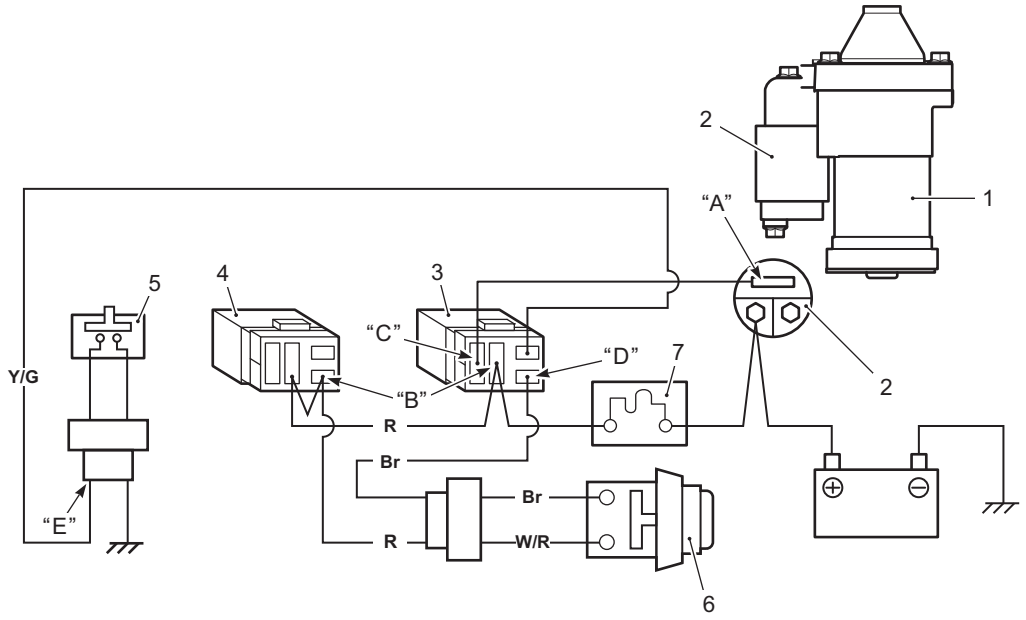
If any abnormality is found, immediately disconnect battery cables from the battery.

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.**
- **Fuse is not blown.**

Circuit check schematic



IDK111190003-03

1. Starter motor	4. Battery relay	7. Fuse
2. Starter motor magnetic switch	5. Neutral switch	
3. Starter motor relay	6. Starter button	

Starter Motor will Not Run

Step 1

1) Remove lower side cover.
   Refer to “Lower Side Cover Removal and Installation” in Section 2A (Page 2A-2).
2) Disconnect lead wire connector “A” from magnetic switch “S” terminal.
3) Measure voltage between lead wire connector “A” and body ground with starter button depressed.

Is voltage 12 V (battery voltage)?

Yes
- Faulty starter motor.
- Poor wire connection.
- Substitute a known-good motor and recheck.

No — Go to step 2.

Step 2

1) Disconnect lead wire connector from ECM, then remove ECM.
2) Pull starter motor relay out.
3) Check for relay “click” sound when starter button depressed.

Is a “click” sound heard?

Yes — Go to step 3.

No — Go to step 5.

Step 3

1) Measure voltage between “R” lead wire terminal “B” and body ground.

Is voltage 12 V (battery voltage)?

Yes — Go to step 4.

No — Open “R” lead wire circuit between magnetic switch and terminal “B”.

Step 4

1) Measure voltage between “R” lead wire terminal “C” and body ground with starter button depressed.

Is voltage 12 V (battery voltage)?

Yes — Go to step 5.

No — Poor contacting action of starter relay.

Step 5

1) Measure voltage between “Br” lead wire terminal “D” and body ground with starter button depressed.

Is voltage 12 V (battery voltage)?

Yes — Go to step 6.

No
- Faulty starter button.
- Open “R” lead wire circuit between starter motor relay and starter button.

Step 6

1) Disconnect neutral switch lead wire connector.
2) Measure voltage between “Y/G” lead wire terminal “E” of neutral switch connector (wire harness side) and body ground with starter button depressed.

Is voltage 12 V (battery voltage)?

Yes — Go to step 7.

No
- Faulty starter motor relay.
- Open “Y/G” lead wire circuit between starter motor relay and neutral switch.

Step 7

1) Inspect neutral switch.
   Refer to “Neutral Switch Inspection” (Page 1I-15).

Is result OK?

Yes — Intermittent trouble or poor harness lead wire connection.

No
- Faulty neutral switch.
- Poor switch lead wire connection.

Service Instructions

Starter Motor Removal and Installation

CENDK1111906001

Removal

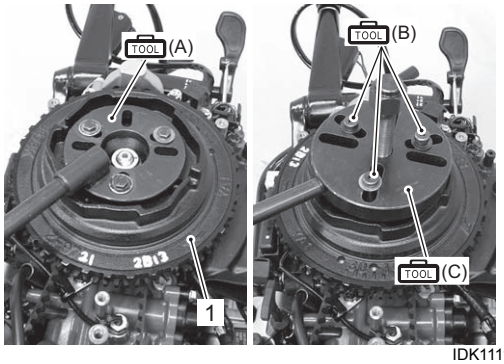
NOTICE

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.

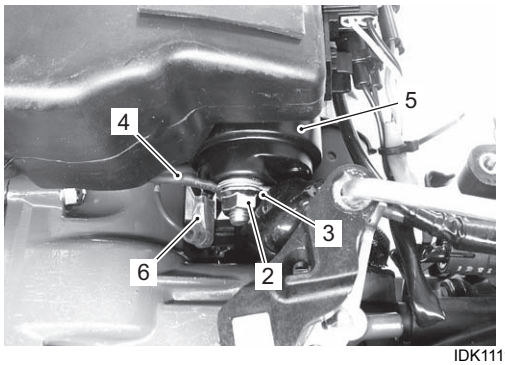
1) Remove the lower side cover.
   Refer to “Lower Side Cover Removal and Installation” in Section 2A (Page 2A-2).
2) Remove the recoil starter.
   Refer to “Recoil Starter Removal and Installation” in Section 1J (Page 1J-3).
3) Remove the flywheel (1).
   Refer to “Flywheel Removal and Installation” in Section 1K (Page 1K-4).

   Special tool
   (A): 09930–39520 (Flywheel holder)
   (B): 09930–39210 (Flywheel remover bolt)
   (C): 09930–39411 (Flywheel remover)



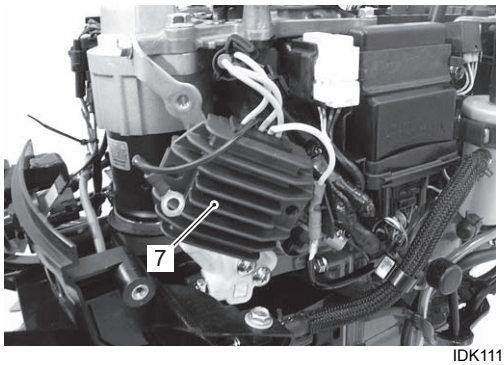
IDK111190010-01

4) Remove nut (2) and positive (+) battery cable (3), positive (Red) cable (4) from the magnetic switch (5) of starter motor.
   Disconnect the red lead wire (6) from “S” terminal of starter magnetic switch.



IDK111190011-02

5) Remove the two bolts securing rectifier and regulator (7).

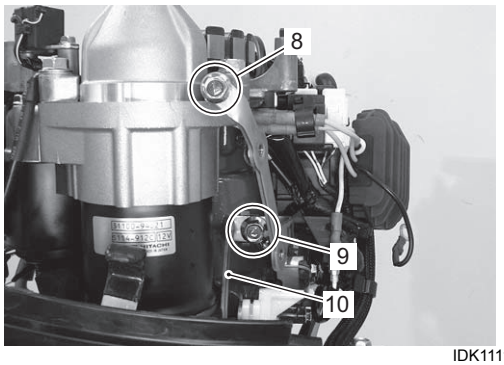


IDK111190012-01

6) Remove the bolt (8) securing rectifier bracket.
   Loosen the bolt (9) securing starter motor band (10).

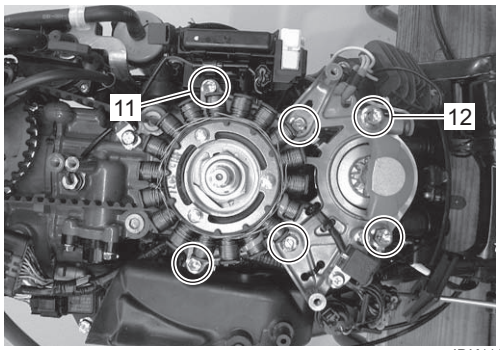
NOTE

Complete removal of the starter motor band bolts is not required.



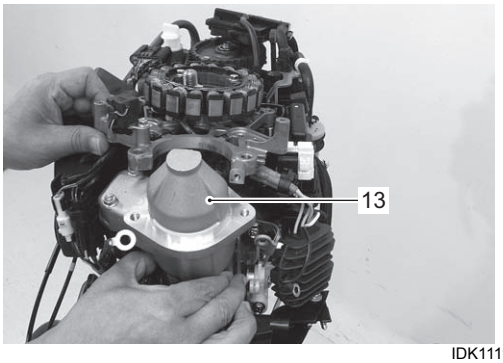
IDK111190013-01

7) Remove the four bolts (11) securing stator base.
8) Remove the two bolts (12) securing starter motor.



IDK111190014-01

9) Lift up the stator base, then remove the starter motor (13).



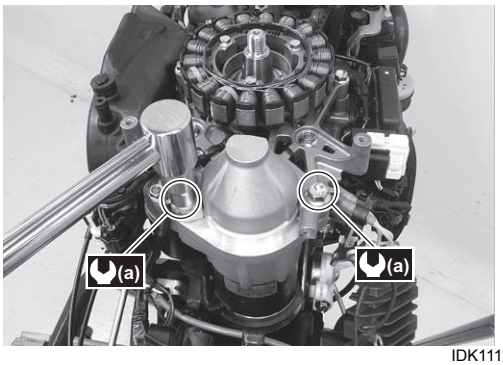
IDK111190015-01

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): 23 N·m (2.3 kgf-m, 16.5 lbf-ft)



IDK111190016-01

- Install flywheel and tighten flywheel nut to specified torque.
  Refer to “Flywheel Removal and Installation” in Section 1K (Page 1K-4).

  Tightening torque
  Flywheel nut: 90 N·m (9.0 kgf-m, 65 lbf-ft)

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

Starter Motor Test

CENDK1111906002

⚠ 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.

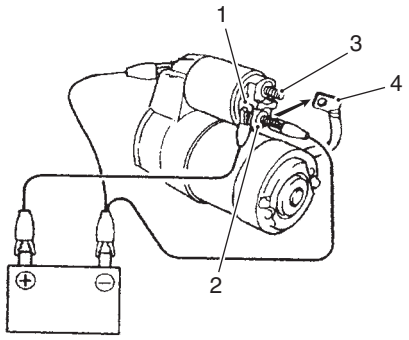
Pull-In / Hold-In Test

NOTE

Before testing, disconnect the brush lead from terminal “M”.

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

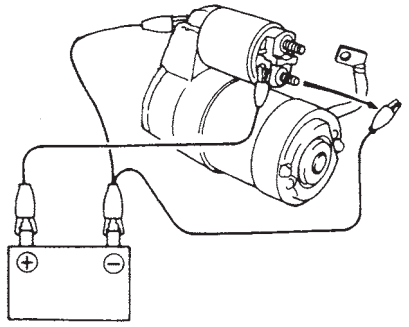
- Check that the plunger and pinion (over-running clutch) move outward.
  If the plunger and pinion don’t move, replace the magnetic switch.



I9J011190002-02

1. Terminal “S”	3. Terminal “B”
2. Terminal “M”	4. Brush lead

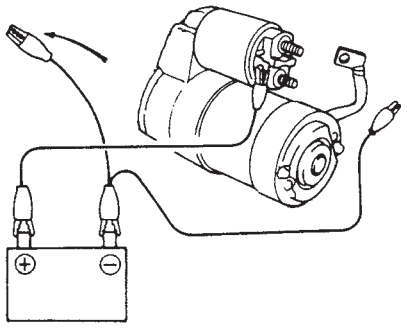
- While connected as above with the plunger out, disconnect the negative lead from terminal “M”. Check that the plunger and pinion remain out. If the plunger and pinion return inward, replace the magnetic switch.



I9J011190003-01

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.



I9J011190004-01

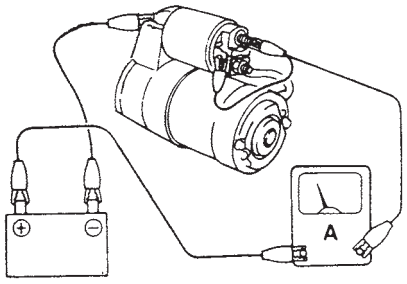
No-Load Performance Test

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.

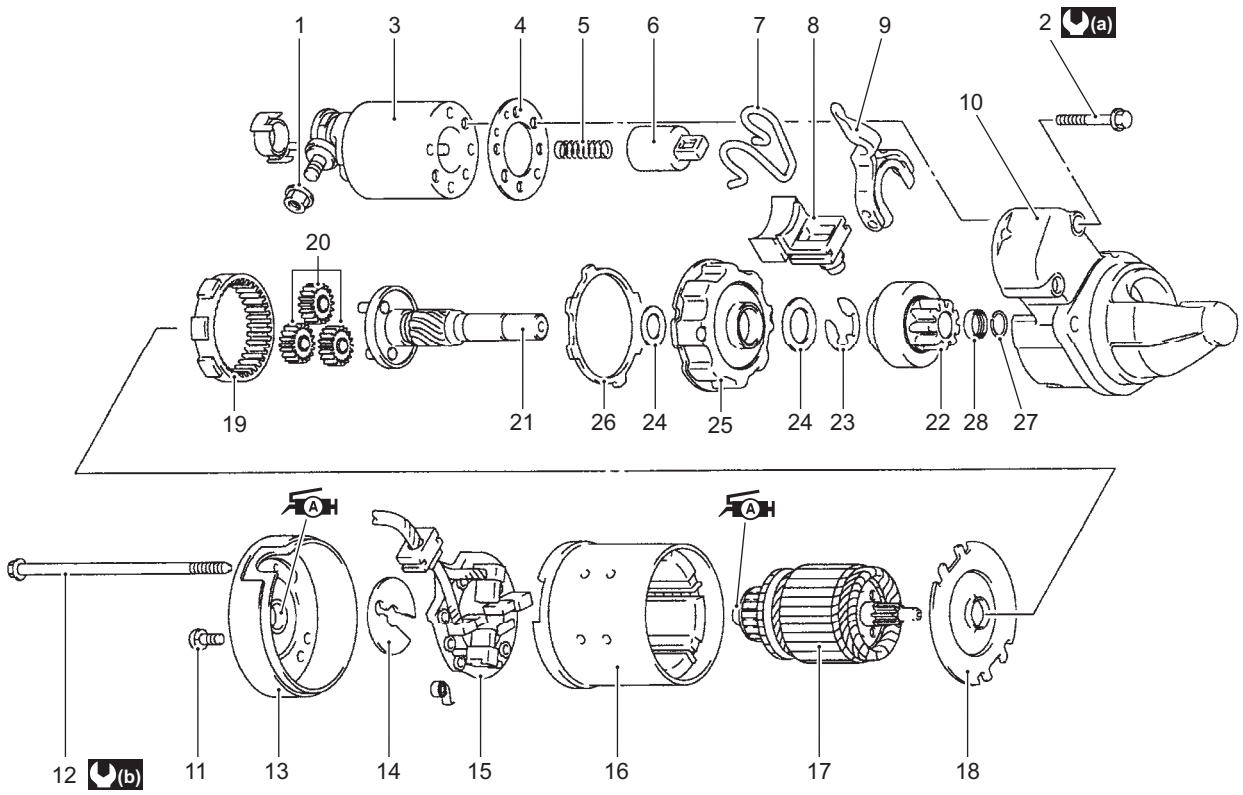
Specified current (No-load performance test)
Within 90 A at 11 V



I9J011190005-01

Starter Motor Components

CENDK1111906003



I9J011190006-02

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	27. Stopper ring
4. Gasket	12. Through bolt	20. Planetary gear	28. Pinion stopper
5. Spring	13. Rear cover	21. Pinion shaft	(a) : 7 N·m (0.7 kgf-m, 5.1 lbf-ft)
6. Plunger	14. Thrust washer	22. Pinion	(b) : 5.5 N·m (0.55 kgf-m, 4.0 lbf-ft)
7. Torsion spring	15. Brush holder	23. E-ring	A : Apply grease.
8. Rubber packing	16. Yoke	24. Washer	

Starter Motor Disassembly and Assembly

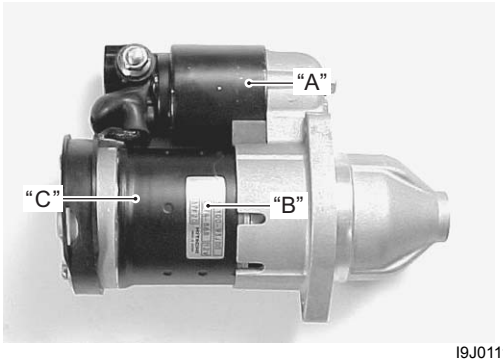
CENDK1111906004

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.

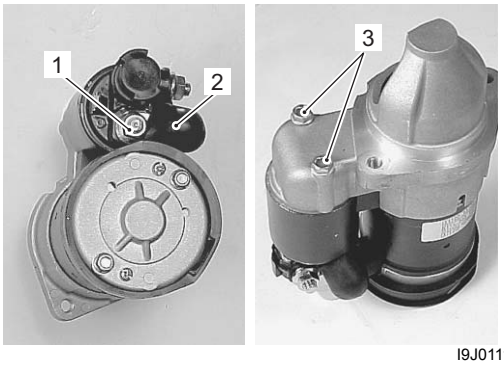
NOTE

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.



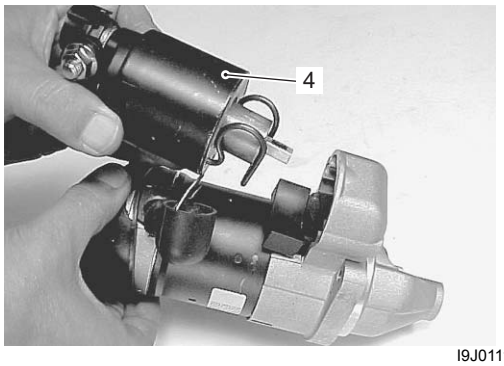
I9J011190007-01

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



I9J011190008-01

3) Remove the magnetic switch (4).



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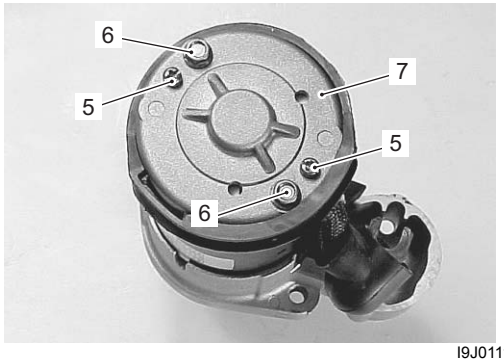
4) Remove screws (5), long through bolts (6) and the rear cover (7).



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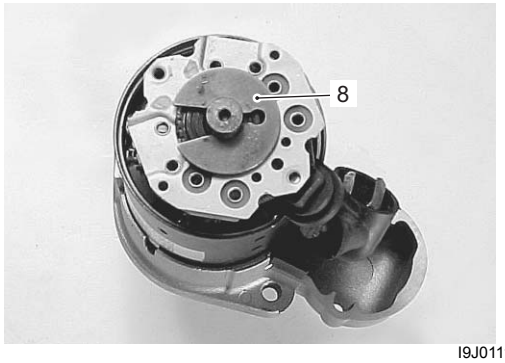
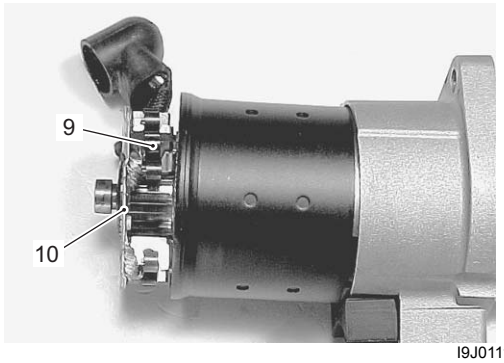
5) Remove thrust washer (8) with a screwdriver.



I9J011190011-01

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



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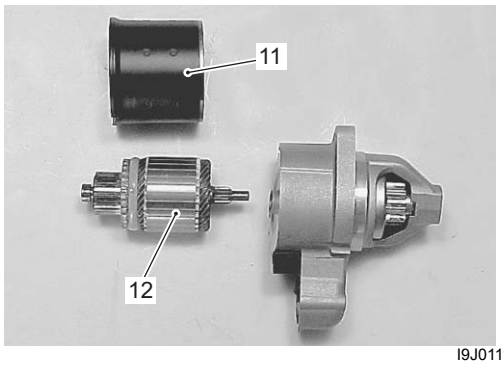
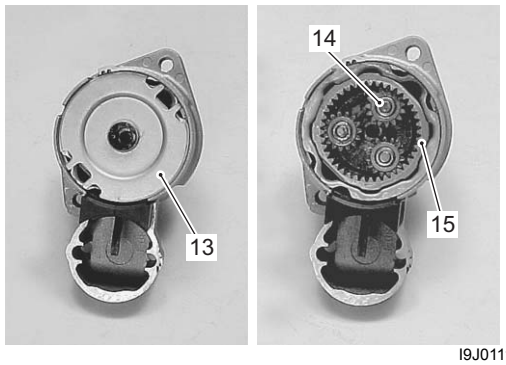
7) Remove the yoke (11) and armature (12).



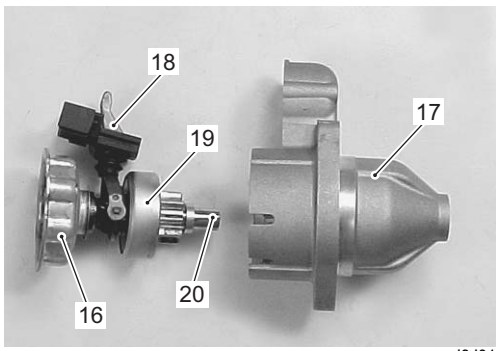
I9J011190013-01

8) Remove the center cover plate (13).
9) Remove the planetary gears (14) and internal gear (15).



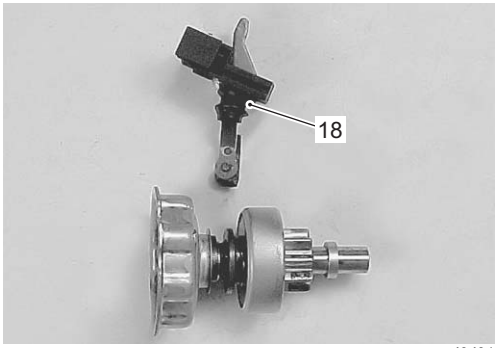
I9J011190014-01

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



I9J011190015-02

11) Remove the shift lever (18).



I9J011190016-01

⚠ WARNING

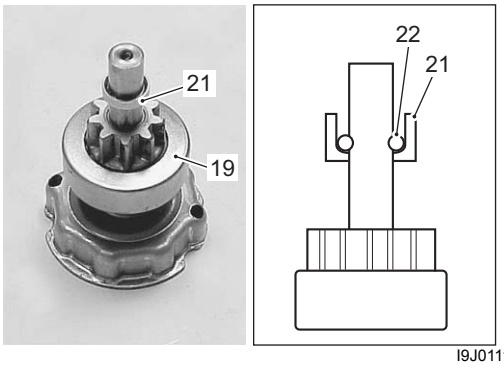
Failure to take proper precautions when removing stopper ring can cause personal injury.

Wear safety glasses when disassembling and assembling the stopper ring.

NOTE

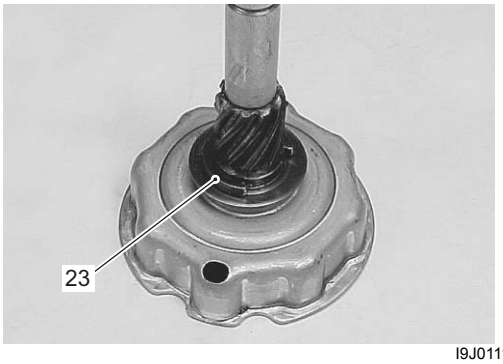
Using a screw-driver, pry off the stopper ring.

12) Push the pinion stopper (21) down, then remove the stopper ring (22). Remove the pinion stopper and pinion (19).



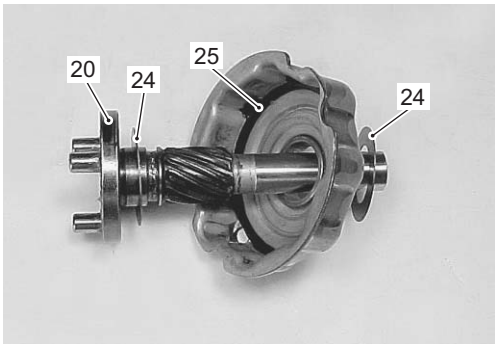
I9J011190017-01

13) Remove the E-ring (23).



I9J011190019-01

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



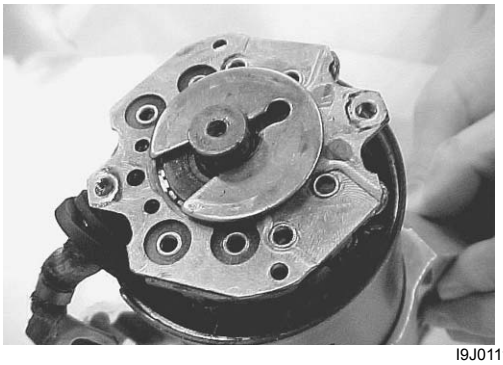
I9J011190020-01

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 1I-8).

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



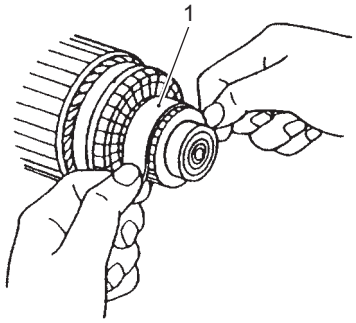
I9J011190021-01

Starter Motor Components Inspection and Servicing

CENDK1111906005

Armature and Commutator

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

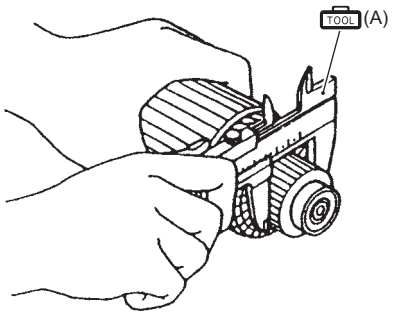


I9J011190022-01

- 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) between the segments is undercut to specified depth.
  If the measurement exceeds the service limit, cut to the specified depth.

⚠ WARNING

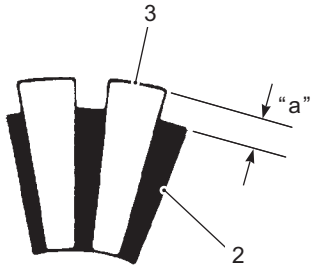
Failure to following proper precautions during use of the compressed air may cause severe personal injury.

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.)



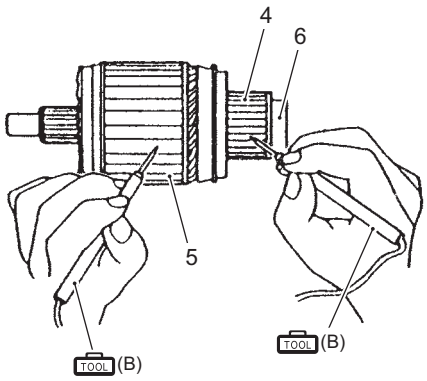
I9J011190024-01

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)

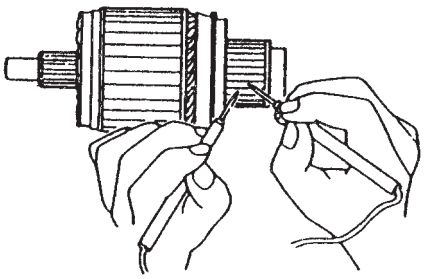
  Tester knob indication
  Continuity (•))))



IDK111190004-01

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

  Tester knob indication
  Continuity (•))))

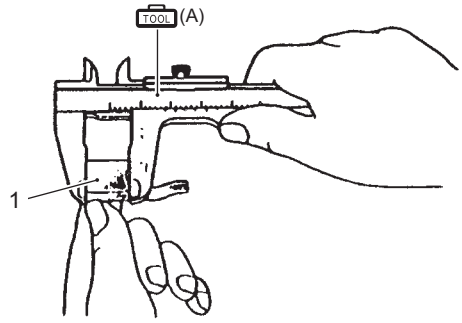


I9J011190026-01

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.)



I9J011190027-01

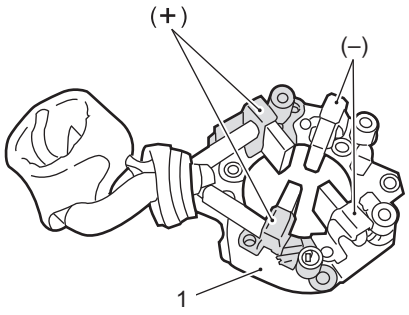
Brush Holder
Check brush holder continuity.
Replace the brush holder if the tester doesn't show the below.

Special tool
TOOL : **09930–99320 (Digital tester)**

Tester knob indication
Continuity (•))))

Brush holder continuity

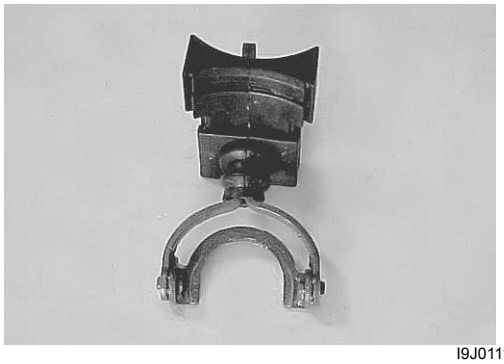
	Continuity
Brush holder positive (+) to brush holder negative (–)	**No**
Brush holder positive (+) to base plate (ground)	**No**



IDK111190005-01

1. Base plate

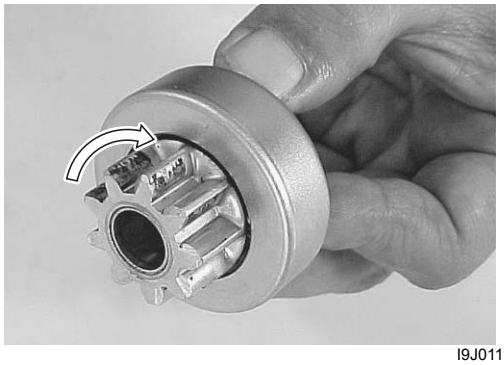
Shift Lever
Inspect the shift lever for wear. Replace if necessary.



I9J011190029-01

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.

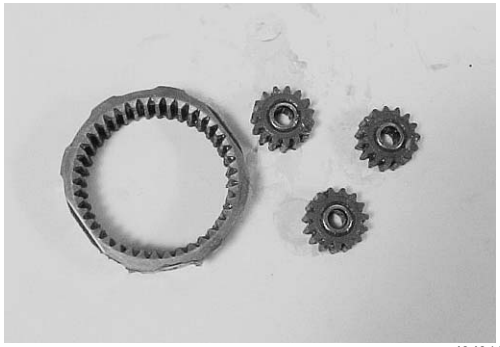


I9J011190030-01

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

I9J011190031-01

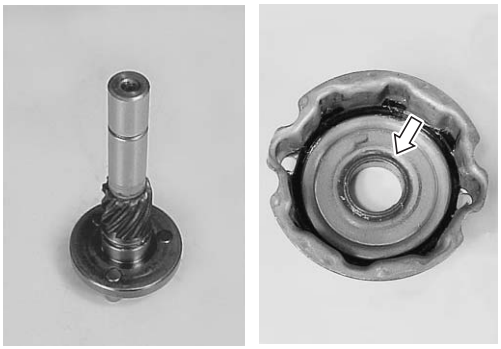
Gear
Inspect planetary gears and internal gear for wear, damage or other abnormal conditions.
Replace if necessary.



I9J011190032-01

Pinion Shaft / Pinion Shaft Bushing

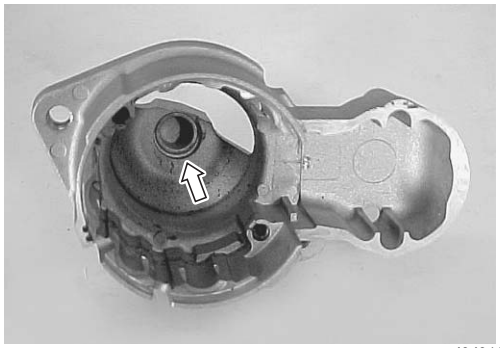
- Inspect the pinion shaft for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect the pinion shaft bushing for wear or other damage.
  Replace if necessary.



I9J011190033-01

Front Housing

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



I9J011190034-01

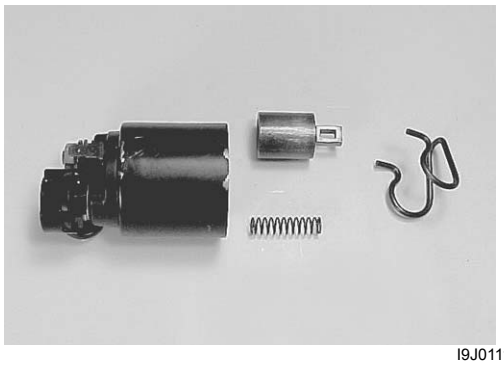
Armature Shaft Bush

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

I9J011190035-01

Plunger

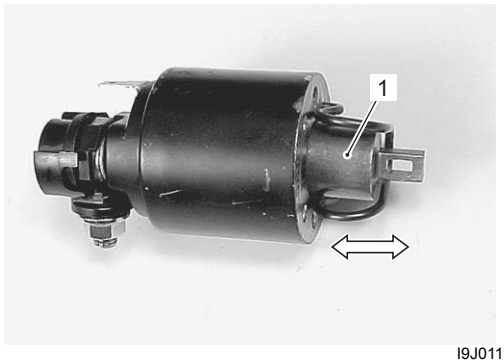
Inspect the plunger for wear or other damage.
Replace if necessary.



I9J011190036-01

Magnetic Switch

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



I9J011190037-01

1. Plunger	

Pull-in coil open circuit test

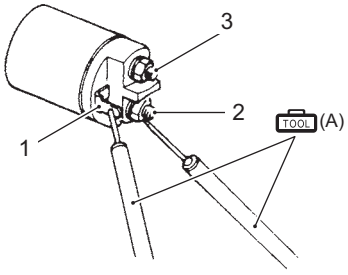
Check for continuity across the magnetic switch “S” terminal (1) and “M” terminal (2).
If no continuity exists, the coil is open and should be replaced.

Special tool

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

Tester knob indication

Continuity (•)))



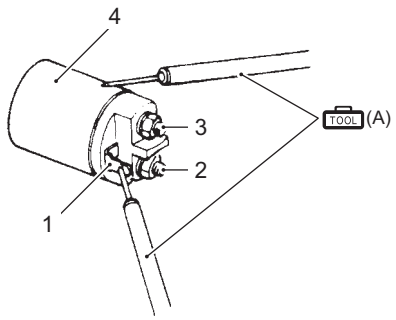
I9J011190038-02

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
(A): 09930–99320 (Digital tester)

Tester knob indication
Continuity (•))))



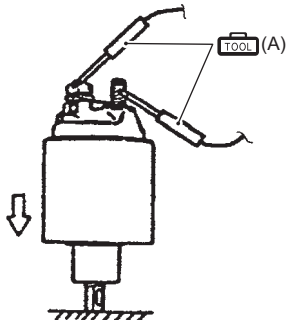
I9J011190039-01

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
(A): 09930–99320 (Digital tester)

Tester knob indication
Continuity (•))))



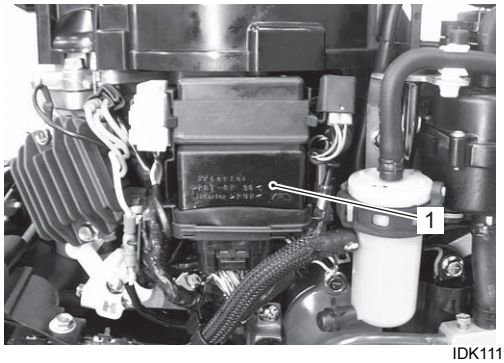
I9J011190040-01

Starter Motor Relay Inspection

CENDK1111906007

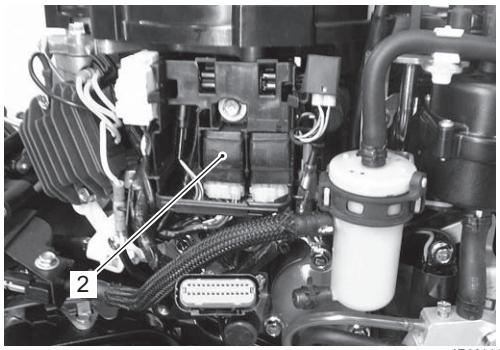
Inspect the starter motor relay using the following procedures:

1) Disconnect lead wire connector from ECM (1), then remove ECM.

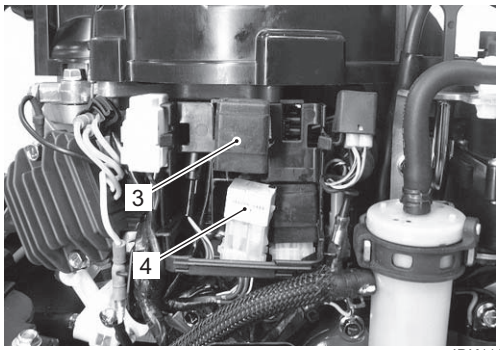


IDK111190017-01

2) Pull out the starter motor relay and relay cover (2) from electric parts holder. Remove the relay cover (3), then disconnect the starter motor relay (4) from the lead wire connector.



IDK111190018-01



IDK111190019-01

3) Check continuity between terminal (5) and (6) each time 12 V power supply is applied to terminal (7) and (8).
Connect the positive (+) lead to terminal (8), and negative (–) lead to terminal (7).

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.

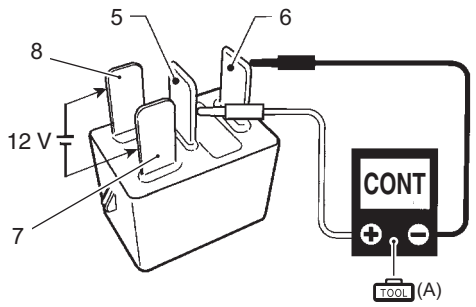
Be careful not to touch 12 V power supply wires to each other or with other terminals.

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

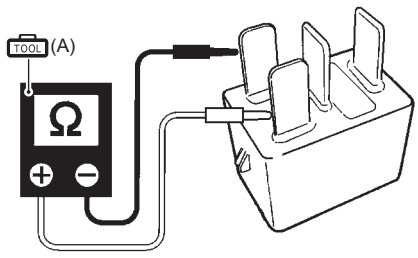


IDK111190001-01

4) Measure the resistance between relay terminals (7) and (8).
If out of specification, replace starter motor relay.

Tester knob indication
Resistance (Ω)

Starter motor relay solenoid coil resistance
Standard: 145 – 190 Ω



I9J011190044-02

5) Reinstall parts removed earlier.

Neutral Switch Inspection

CENDK1111906008

Check for continuity / infinity of the neutral switch.

Special tool
(A): 09930–99320 (Digital tester)

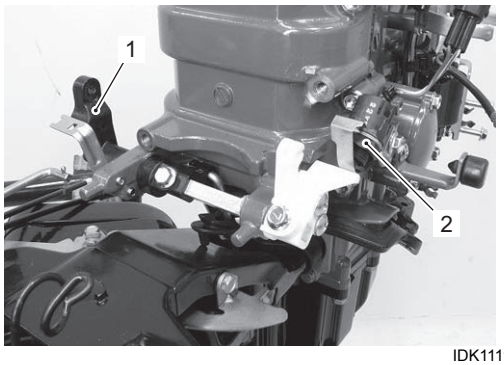
Tester knob indication
Continuity (•))))

1) Disconnect lead wire connector from ECM, then remove ECM.
2) Disconnect the neutral switch lead wire connector.
3) Check continuity / infinity between the Yellow / Green and Brown lead wires while operating the shift lever.

Special tool
(A): 09930–99320 (Digital tester)

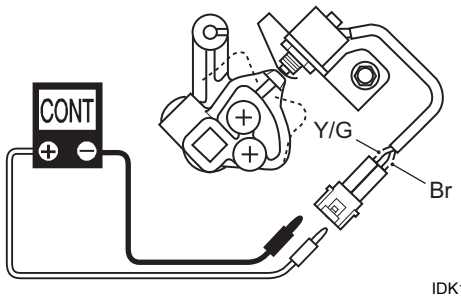
Neutral switch function

Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity



IDK111190020-01

1. Clutch shaft	2. Neutral switch



IDK111190006-01

4) If out of specification:
   - 1st:
     Check switch position adjustment, readjust if necessary.
   - 2nd:
     Replace the neutral switch and recheck.

NOTE

After installing the neutral switch, check for correct function by operating the shift lever.

Starter Button Inspection

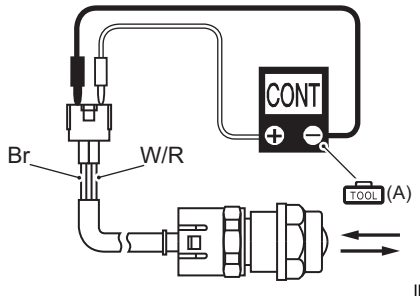
CENDK1111906009

1) Disconnect the starter button lead wire connector.
2) Check the continuity / infinity between the wiring leads under the condition shown below.

Special tool
(A): 09930–99320 (Digital tester)

Tester knob indication
Continuity (•))))

	Tester probe connection		Tester indicates
	Red (+)	Black (–)	
Starter button not depressed	W/R	Br	Infinity
Starter button depressed			Continuity



IDK111190008-01

3) If out of specifications, replace the starter button.