DAIHATSU

ROCKY

STARTING SYSTEM

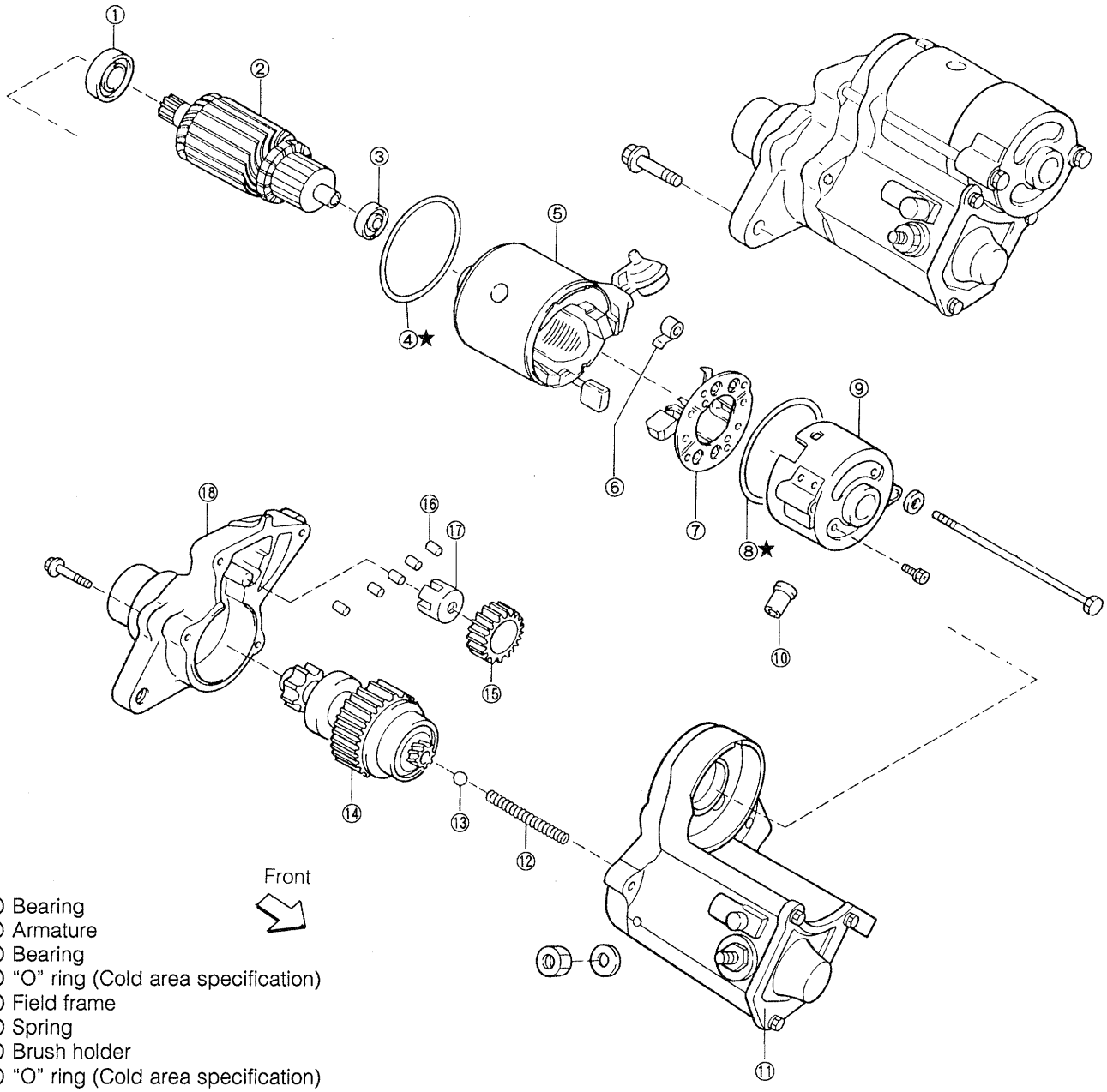
ST

WRU90-ST001

STARTER MOTOR

1. COMPONENTS

The starter consists of a solenoid switch and a motor. The power generated at the motor is transmitted to the clutch assembly through the idle gear. The rotation speed is reduced in accordance with the gear ratio between the drive gear provided at the motor and the clutch gear. On the other hand, the torque of the rotation increases.

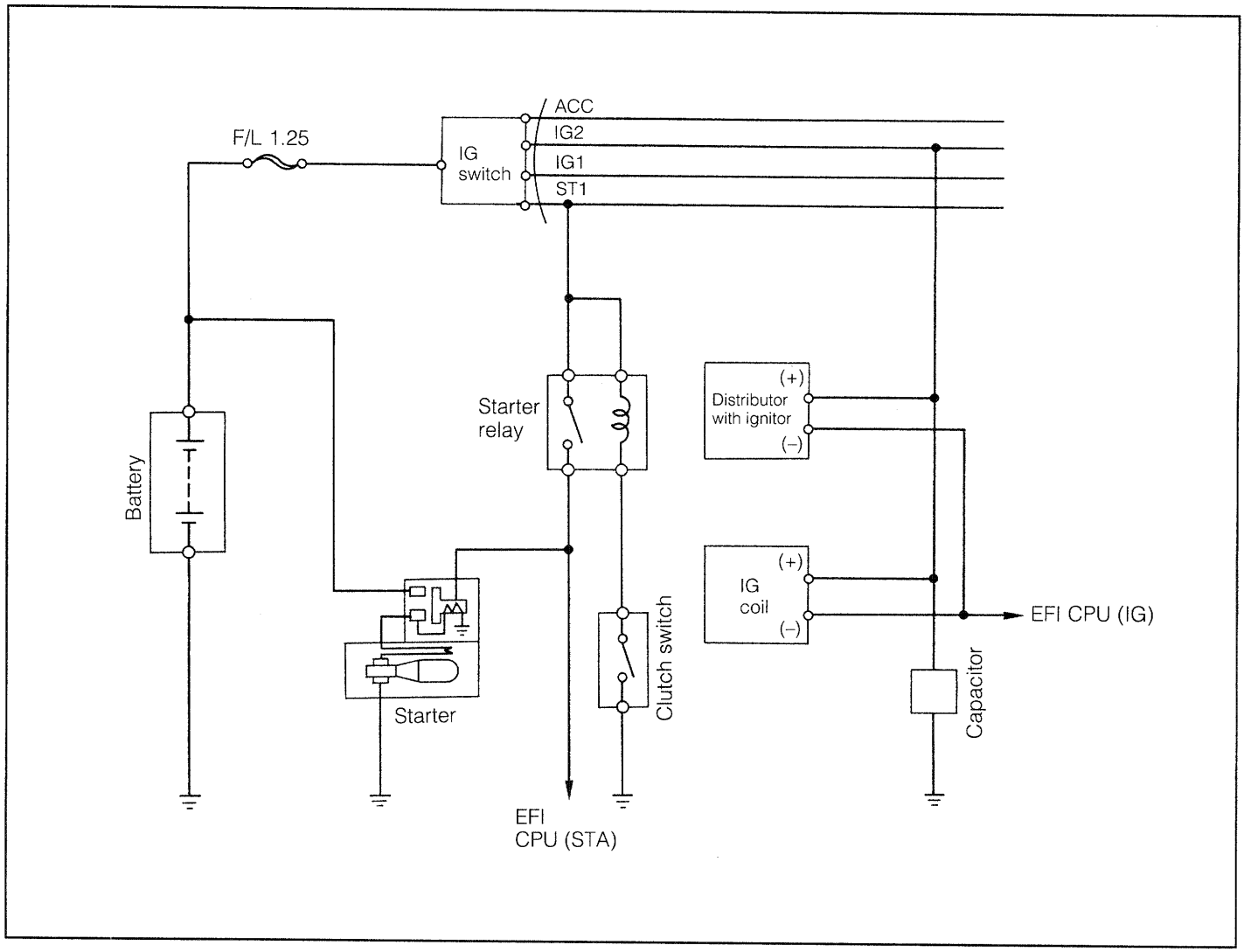


① Bearing
② Armature
③ Bearing
④ "O" ring (Cold area specification)
⑤ Field frame
⑥ Spring
⑦ Brush holder
⑧ "O" ring (Cold area specification)
⑨ End frame
⑩ Dust protector (Cold area specification)
⑪ Magnet switch assembly
⑫ Spring
⑬ Ball
⑭ Clutch assembly
⑮ Idle gear
⑯ Bearing
⑰ Bearing housing
⑱ Starter drive housing

★ : **Non reusable parts**

WRU90-ST002

2. STARTING SYSTEM CIRCUIT



WRU90-ST003

3. TROUBLE SHOOTING

Problem	Possible cause	Remedies
Engine will not crank.	Battery not fully charged.	Check specific gravity of battery electrolyte. Charge or replace battery.
	Battery cables loose, corroded or worn.	Repair or replace cables.
	Starter relay faulty.	Replace starter relay.
	Fusible link blown.	Replace fusible link.
	Starter faulty.	Repair starter.
	Ignition switch faulty.	Replace ignition switch.
	Clutch switch faulty.	Replace clutch switch.
Engine cranks slowly.	Battery not fully charged.	Check specific gravity of battery electrolyte. Charge or replace battery.
	Battery cables loose, corroded or worn.	Repair or replace cables.
	Starter faulty.	Repair starter.
Starter keeps running.	Starter faulty.	Repair starter.
	Ignition switch faulty.	Replace ignition switch.
	Short in wiring.	Repair or replace wiring.
Starter spins. – Engine will not crank.	Pinion gear teeth broken or faulty starter.	Repair starter.
	Flywheel teeth broken.	Replace flywheel.

WRU90-ST004

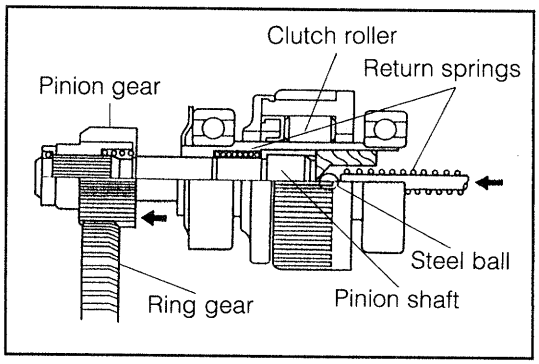
4. DESCRIPTION

Principles of operation & starting system circuit

The starter operations can be divided into two operations. When the clutch is depressed and the ignition switch is set to the START (ST) position, the current from the battery flows to the motor through the solenoid. The motor starts to rotate. This power is transmitted to the drive gear, idle gear and clutch gear. At the same time, the solenoid pushes the pinion shaft, thereby bringing the pinion gear into mesh with the ring gear.

WRU90-ST005

When the pinion gear has shifted into a complete mesh with the ring gear, the solenoid contact points are closed. The current from the battery now directly goes to the motor, thus supplying high power enough for cranking the engine. In this way, the starter motor begins cranking the engine.

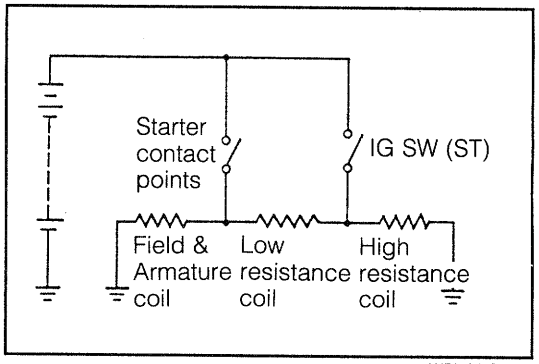


WRU90-ST006

The solenoid is composed of two coils. One is a low-resistance coil which moves the pinion shaft. The other is a high- resistance coil which retains the solenoid at the "start" position. The low-resistance coil is connected to the battery ground through the motor brush (and armature coil) and field coil. The high-resistance coil is directly grounded to the solenoid case.

WRU90-ST007

During the engine cranking, the solenoid is energized at the high-resistance coil alone. Since the low-resistance coil has the same potential at its both ends, no current flows. Consequently, the solenoid is retained at the "start" position by means of the high-resistance coil only. The right figure shows an equivalent circuit of the system.



WRU90-ST008

During the starting period, the low-resistance coil provides the solenoid with a large amount of current to move the pinion shaft. Afterward, however, it is no longer necessary to use a large amount of current to hold the solenoid. Therefore, the above-described circuit has been employed for the starting system so that no burning takes place.

The plunger of the solenoid has two functions; One is to move the pinion shaft and the other is to close the electric contact points, which is simultaneous with the first function. For positive contact, the contact points are connected to the plunger through a spring.

When the ignition switch is set to the start (ST) position, current from the battery goes to the low-resistance coil and the field and armature coils. As a result, the motor starts rotating. Simultaneously, the high-resistance coil is also energized. These two coils exert drawing force on the plunger, thus making the plunger overcome the force of a spring (a spring which is provided to return the plunger and differs from the aforesaid spring provided at the contact points). The plunger then moves the pinion shaft strongly and brings the pinion gear into mesh with the ring gear. Simultaneously, the starter contact points are closed and current is directly drawn from the battery. At this stage, the low-resistance coil has an equal potential at its both ends, as previously described. Hence, no current flows to the motor through the low-resistance coil.
After the engine has started, when the ignition switch is returned to the IG position, current to the solenoid is cut off (NOTE). The spring built in the solenoid returns the plunger, thereby opening the contact points and cutting the current to the motor. At the same time, the pinion shaft which has been pushing the pinion gear is returned to the original position by means of the aforesaid spring force. Consequently, the pinion gear is disengaged and separated from the ring gear.

This pinion gear's separation from the ring gear can not be performed positively and assuredly by the spring at the pinion shaft alone. To achieve positive separation, a screw-shaped spline is provided at the pinion shaft gear. After start of the engine, the rotation speed of the ring gear continues to increase. Consequently, it becomes possible for the ring gear to drive the pinion gear.
At this point, owing to the screw-shaped spline, the pinion gear is moved in such a direction that it tends to disengage from the ring gear. On the other hand, this screw-shaped spline helps the pinion gear to be pushed and moved into mesh with the ring gear during the starting period.

NOTE:
In fact, at this moment, the current to the solenoid goes to the starter contact points and passes in series through the low-resistance coil and the high-resistance coil. Consequently, electromagnet function continues and drawing forces are generated. However, the electromagnetic forces generated at the low-resistance and high-resistance coils counteract, for the winding direction of the coil is opposite to each other. As a result, no drawing force is produced.
On the other hand, when the ignition switch is set to the ON (ST/ON) position, a parallel circuit is formed. The electromagnetic forces generated at both coils are in the same direction, resulting in an increased drawing force.
Namely, the direction of the current at the low-resistance coil changes reversely when the ignition switch is switched between the ON and OFF states. (This explanation applies only to the instance when the ignition switch is changed from the ST position to the IG position.)

WRU90-ST009

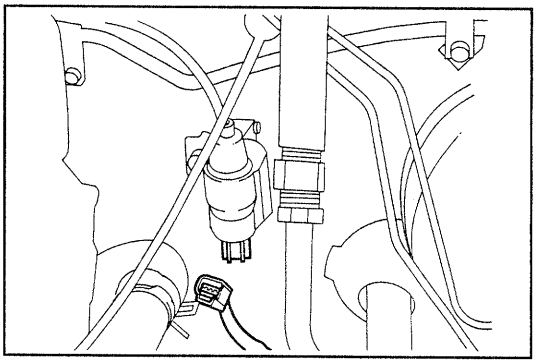
5. SERVICING INSTRUCTIONS OF STARTER

(1) When connecting the starter terminal or battery terminal, perform positive tightening so as to avoid poor connection.
If poor connection should exist, it presents the hazard of serious danger that a large amount of current flowing during starter operation can overheat the poor connection.
(2) When removing the starter, first disconnect the negative ⊖ terminal of the battery. Then, disconnect the terminals (+B, ST) at the starter side. Since the battery voltage is always applied to the starter +B terminal, failure to observe this removing sequence may lead to battery short, which is extremely dangerous.
(3) When installing the starter, install the starter in the clutch housing positively and be sure to tighten the attaching bolts to the specified torque. Improper installation can cause premature wear of the teeth of the pinion gear or ring gear and also can cause breakage of the clutch housing.

WRU90-ST010

6. IN-VEHICLE INSPECTION

(1) Place the shift lever to the neutral position. Apply the parking brake lever.
(2) Disconnect the ignition coil coupler so that the engine will not start.



WRU90-ST011

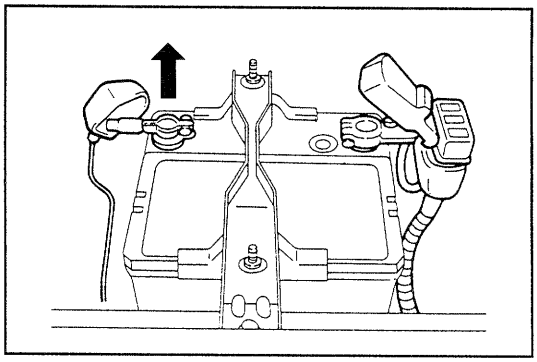
(3) Set the ignition switch to the ST position. Check to see if the engine cranks.
(4) If the engine will not crank, perform the following checks.
- Inspect the battery for damage. Charge the battery.
- Perform harness continuity test.
- Perform the clutch switch check. See page ST–18.

(5) If the starter motor still will not rotate even after the checks above have been performed, remove the starter motor and perform the unit check.

WRU90-ST012

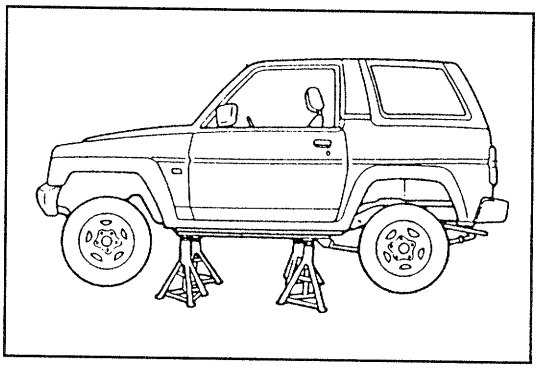
7. REMOVAL

(1) Disconnect the ground cable terminal from the negative (–) terminal of the battery.



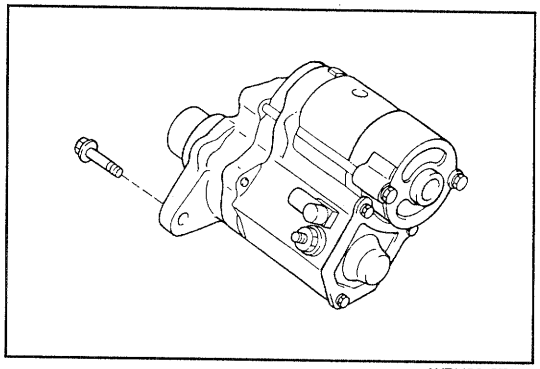
WRU90-ST013

(2) Jack up the vehicle and support it with safety stands.



WRU90-ST014

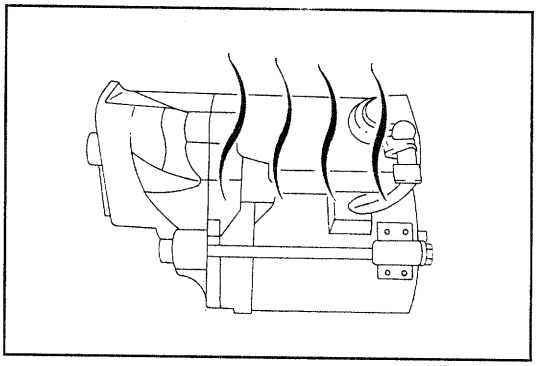
(3) Disconnect the starter terminals ST and B from the starter.
(4) Remove the starter motor from the clutch housing.



WRU90-ST015

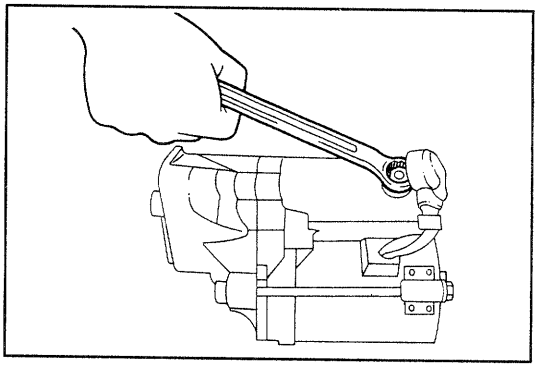
8. UNIT CHECK OF STARTER MOTOR ASSEMBLY

CAUTION:
Each of the following tests must be performed within three to five seconds. If you fail to observe this caution and the starter is energized for more than this duration, the coil may be burnt out.



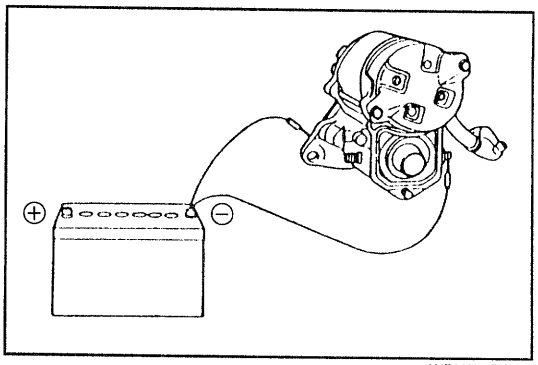
WRU90-ST016

(1) Pull-in Test
① Disconnect the lead wire from the magnetic switch terminal.



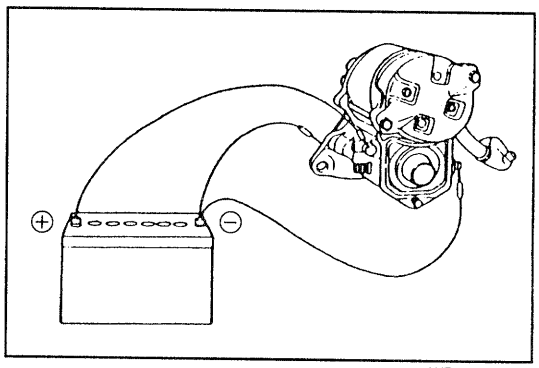
WRU90-ST017

② Connect the negative (–) terminal of the battery to the starter body and magnetic switch terminal.

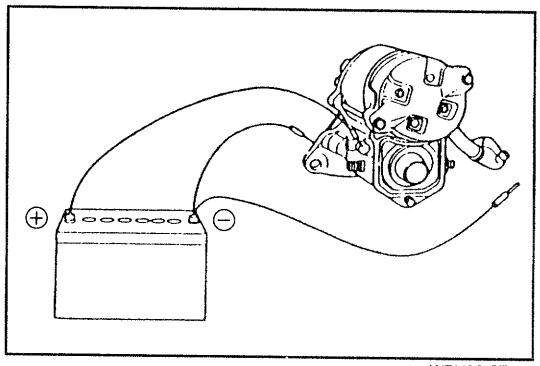


WRU90-ST018

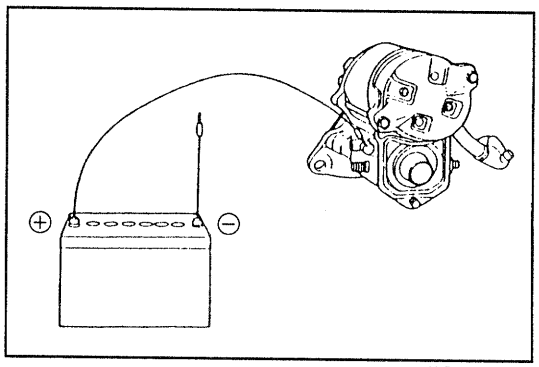
③ Connect the positive (+) terminal to the terminal ST. Ensure that the pinion is pushed outward.
If the drive pinion fails to move out, replace the magnetic switch.


WRU90-ST019

(2) Hold-in Test
After the check has been performed following the same procedure as with the pull-in test, disconnect the negative terminal of the magnetic switch terminal. Ensure that the drive pinion is held in a pushed-out state.
If the drive pinion fails to be held, replace the magnetic switch.

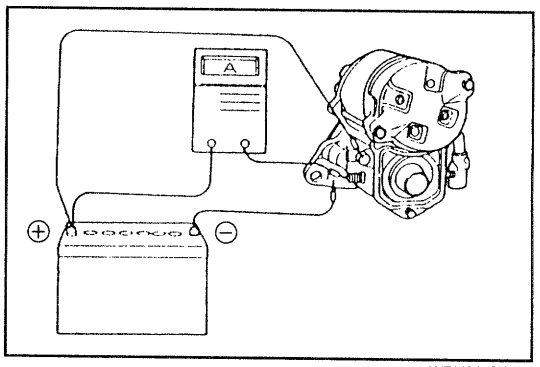

WRU90-ST020

(3) Inspection of Plunger Return
After the check has been performed following the same procedure as with the hold-in test, disconnect the ground terminal of the starter body. Ensure that the drive pinion is drawn into the drive housing.
If the drive pinion fails to be drawn into the drive housing, replace the clutch assembly and return spring.
NOTE:
Connect the lead wire to the magnetic switch terminal after inspection is carried out.


WRU90-ST021

(4) No-load Performance Test
Connect the battery and an ammeter to the starter as shown in the right figure. Ensure that the starter rotates smoothly with the pinion moving out.
Measure the current the starter is drawing:
Specified Current: Less Than 90A at 11.5V

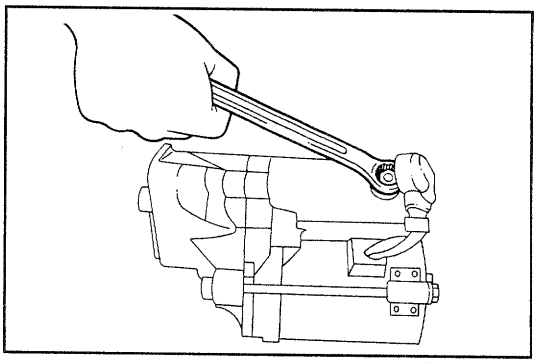
NOTE:
Prior to the test, be sure to connect the lead wire to the magnetic switch.



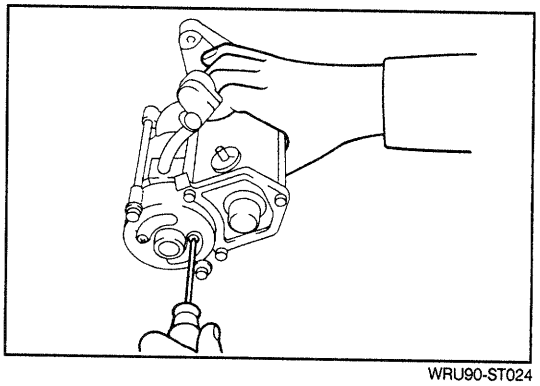
WRU90-ST022

9. DISASSEMBLY

(1) Disconnect the lead wire from the magnetic switch.

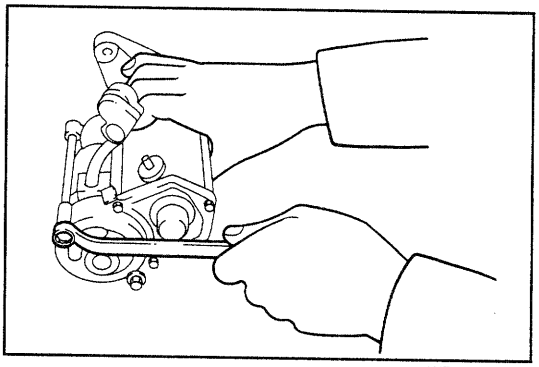

WRU90-ST023

(2) Remove the brush holder retaining screws from the commutator end frame.



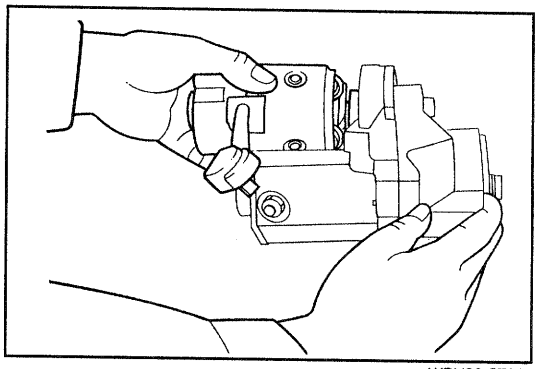
WRU90-ST024

(3) Remove the two through bolts from the commutator end frame.



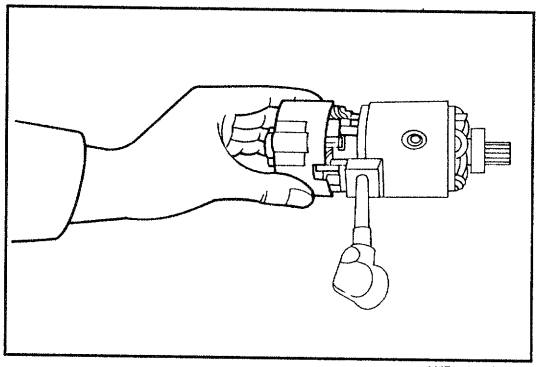
WRU90-ST025

(4) Remove the yoke together with the armature from the drive housing.
(5) Remove the "O" ring. (Cold area specification)



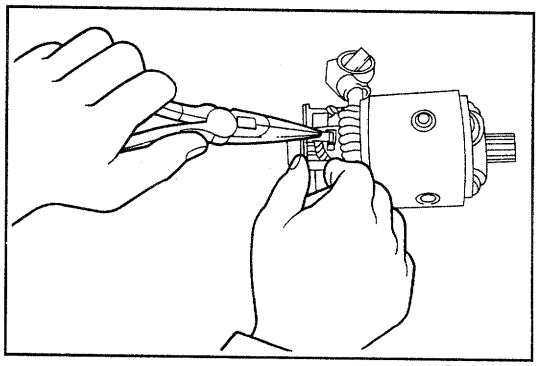
WRU90-ST026

(6) Remove the commutator end frame.



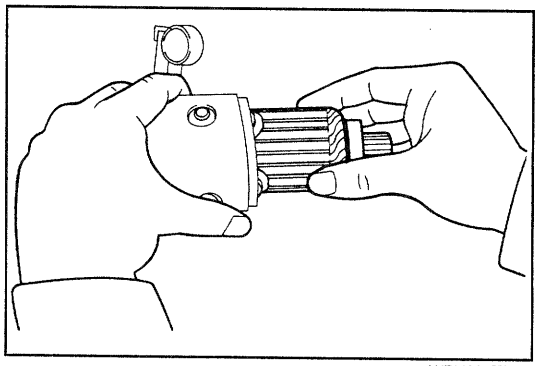
WRU90-ST027

(7) Remove the brushes from the brush holder by means of nose pliers or the like.
NOTE:
Care must be exercised not to damage the brushes during the removal.



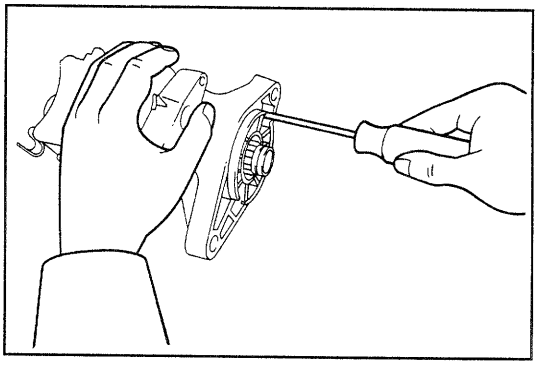
WRU90-ST028

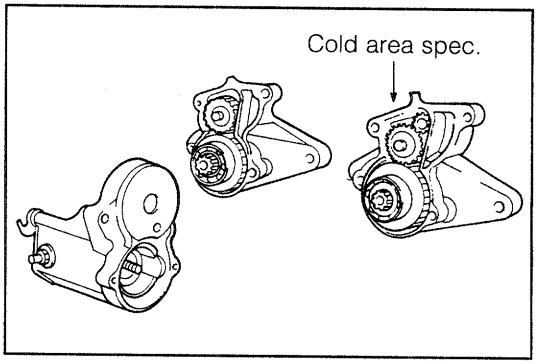
(8) Remove the armature from the yoke, being very careful not to damage the brushes.



WRU90-ST029

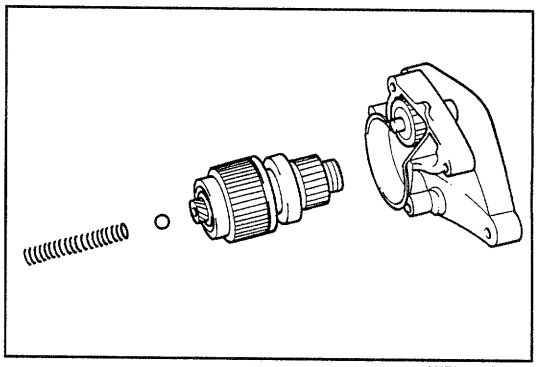
(9) Remove the starter switch assembly from the drive housing by removing the two screws.





WRU90-ST030

(10) Remove the clutch assembly from the drive housing.
(11) Remove the seal ball from the clutch assembly.
(12) Remove the return spring from the magnet switch assembly.

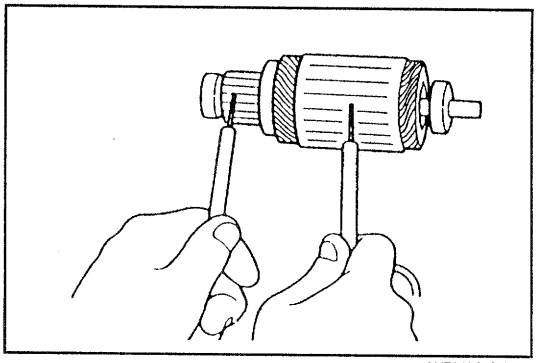


WRU90-ST031

10. INSPECTION

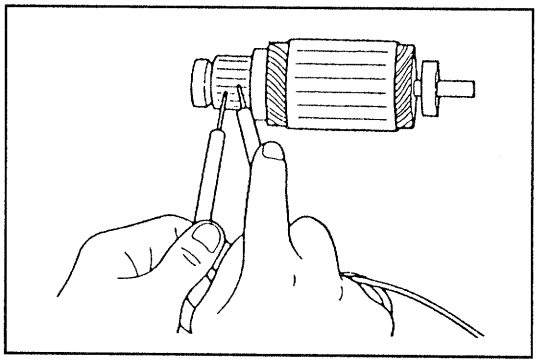
10-1 Check of Armature

(1) Check of armature insulation
Ensure that no continuity exists between the commutator and the armature coil, using an ohmmeter.
If continuity exists, replace the armature.



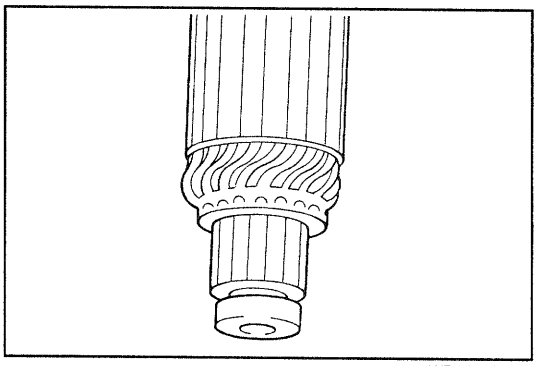
WRU90-ST032

(2) Check of commutator continuity
Check continuity between each adjacent segment of the commutator, using an ohmmeter.
If no continuity exists between any adjacent segments, replace the armature.


WRU90-ST033

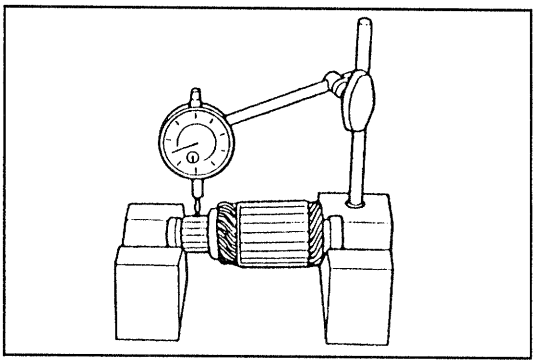
10-2 Check of Commutator

(1) Check each contact surface of the commutator segments with the brushes for burning.
If the surfaces are dirty or burnt, correct the commutator surfaces, using abrasive paper (No. 400) or a lathe.


WRU90-ST034

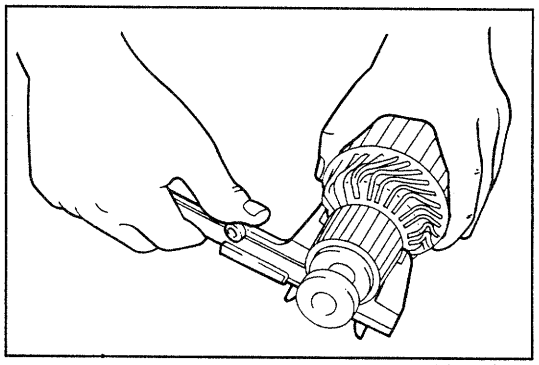
(2) Check of commutator for circle runout
Support the armature at its both ends on a Vee block.
Check the commutator for circle runout, using a dial gauge.
Circle Runout Limit: 0.05 mm (0.002 inch)

If the circle runout exceeds the allowable limit, turn down the commutator on a lathe.

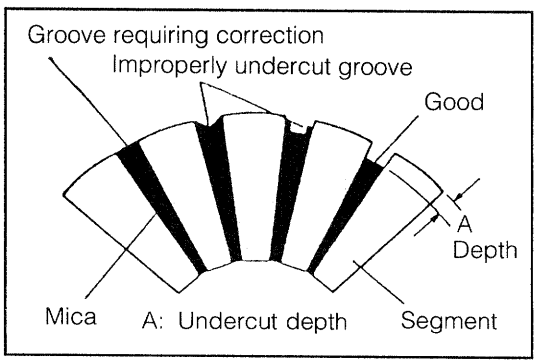

WRU90-ST035

(3) Measurement of commutator diameter
Measure the commutator diameter by means of a micrometer or vernier calipers.
Standard Diameter: 30.0 mm (1.181 inch)
Minimum Diameter: 29.0 mm (1.142 inch)

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


WRU90-ST036

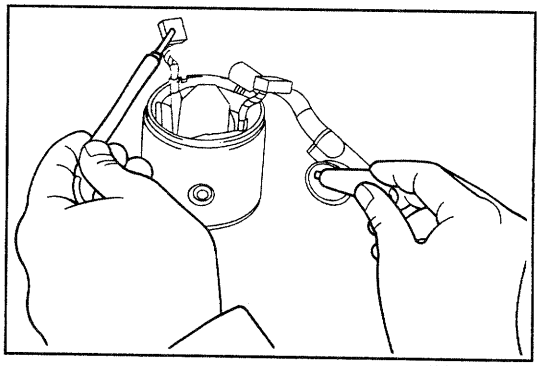
(4) Check of commutator undercut
If the depth of the insulator groove between commutator segments is less than 0.2 mm (0.0079 inch), it is necessary to undercut the insulator so that the groove depth may become 0.5 - 0.8 mm (0.020 - 0.031 inch).



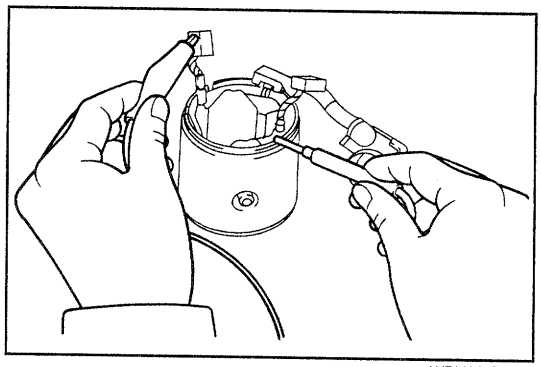
WRU90-ST037

10-3 Check of Field Coil

(1) Field coil continuity test
Perform field coil continuity test at a point between the lead wire and the brush, using an ohmmeter.
If no continuity exists, replace the yoke.


WRU90-ST038

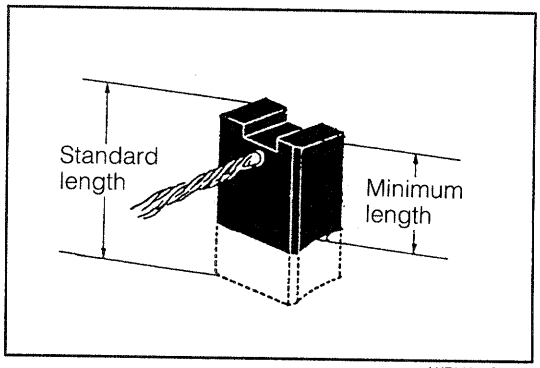
(2) Field coil short test
Perform field coil short test at a point between the brush and the yoke proper, using an ohmmeter.
If continuity exists, replace the yoke.


WRU90-ST039

10-4 Check of Brushes

Measurement of brush length
Measure the brush length, using vernier calipers.

Standard Length:
13.0 mm (0.51 inch)
15.0 mm (0.59 inch) Cold area specification
Minimum Length:
11.3 mm (0.44 inch)
11.0 mm (0.43 inch) Cold area specification



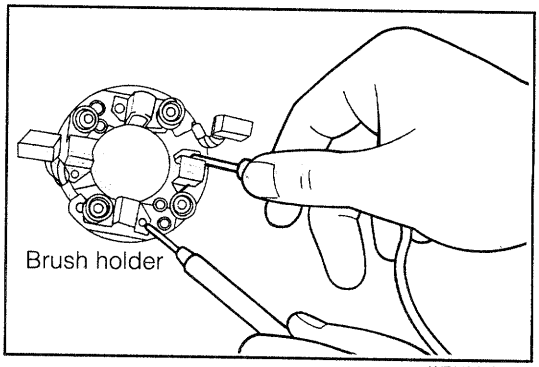
WRU90-ST040

If the length is less than the minimum requirement, replace the brush holder or the yoke, as required.

10-5 Check of Brush Holder

Check of brush holder for insulation
Measure the insulation between the positive and negative terminals of the brush holder, using an ohmmeter.

Insulation Resistance: 100 MΩ or more

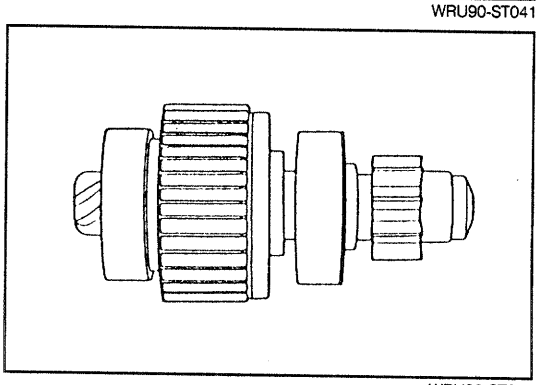


WRU90-ST041

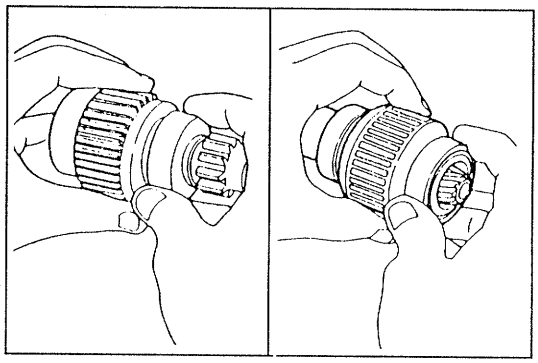
If the insulation resistance is less than the specification, replace the brush holder.

10-6 Inspection of Clutch

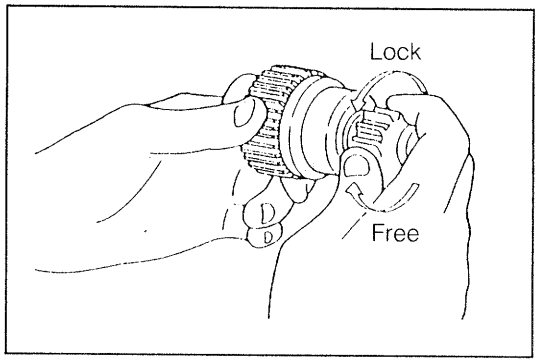
(1) Inspection of pinion gear and spline teeth
Check the teeth of the pinion gear and spline for wear or damage.
If the teeth exhibit any damage, replace the clutch. Also, inspect the flywheel ring gear for wear or damage.


WRU90-ST042

(2) Check of bearing
Lightly turn the bearing hand. Ensure that the bearing turns smoothly.


WRU90-ST043

(3) Check of starter clutch
While holding the clutch, turn the pinion clockwise. Ensure that the pinion turns smoothly.
Turn the pinion counterclockwise. Ensure that the pinion is locked.
If the check results are unsatisfactory, replace the starter clutch.

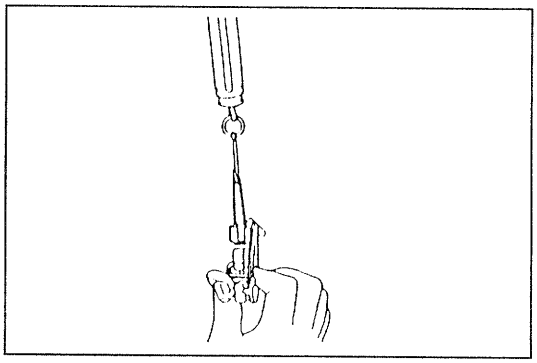


WRU90-ST044

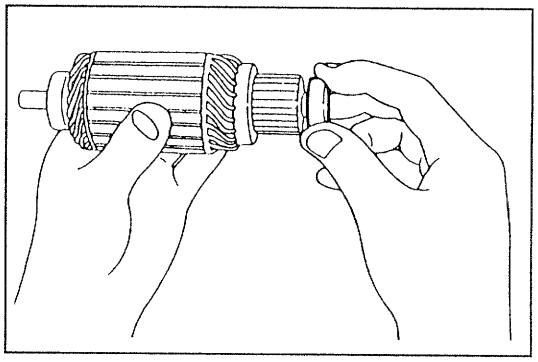
10-7 Check of Brush Spring
Measure the brush spring tension, using a spring scale.

Tension with Spring Installed:
1.93 - 2.36 kg (4.26 - 5.20 lb)

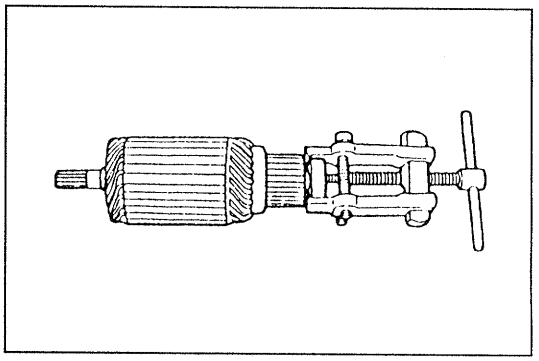
If the spring tension is less than the specification, replace the spring.


WRU92-ST074

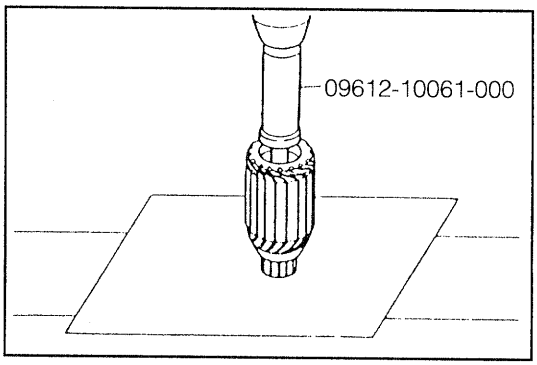
10-8 Inspection of Bearings
(1) Inspection of bearings
Turn the bearing while applying force to it by your hand. Ensure that the bearing turns smoothly. If the bearing fails to turn smoothly, replace the bearing.


WRU90-ST046

(2) Replacement of bearings (Only when bearing is faulty.)
① Remove the bearing, using an armature bearing puller.


WRU90-ST047

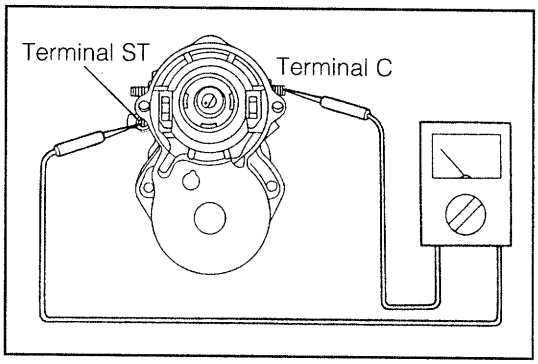
② Press the bearing into the armature shaft, using a press in conjunction with the SST.
SST: 09612-10061-000



WRU90-ST048

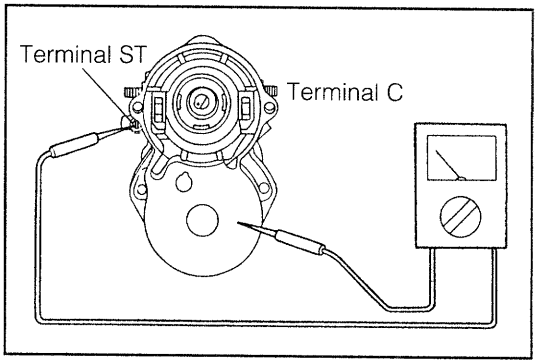
10-9 Check of Magnetic Switch

(1) Pull-in coil test
Using an ohmmeter, ensure that continuity exists between the terminal ST of the starter and the terminal C.
If no continuity exists, replace the magnetic switch.



WRU90-ST049

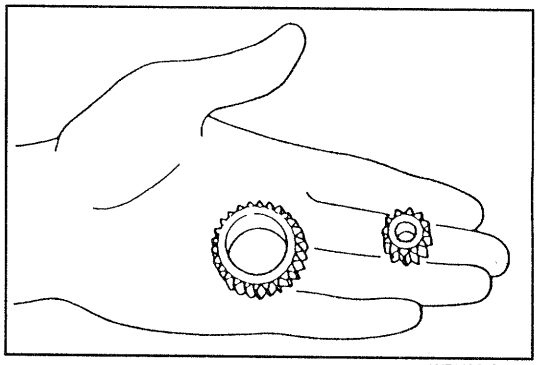
(2) Hold-in coil test
Ensure that continuity exists between the terminal ST of the magnetic switch and the switch body.
If no continuity exists, replace the magnetic switch.



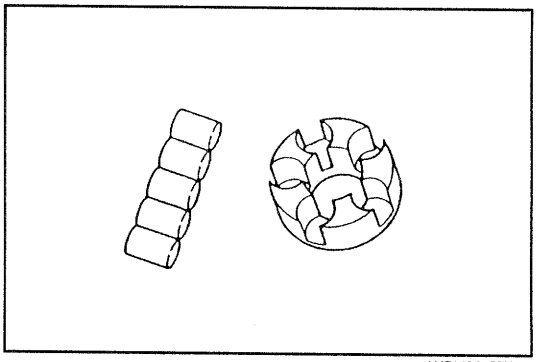
WRU90-ST050

10-10 Inspection of Gears

(1) Inspect the starter drive gear (cold area specifications) and starter idle gear for damage or wear.
Replace the gear which exhibits damage or wear.


WRU90-ST051

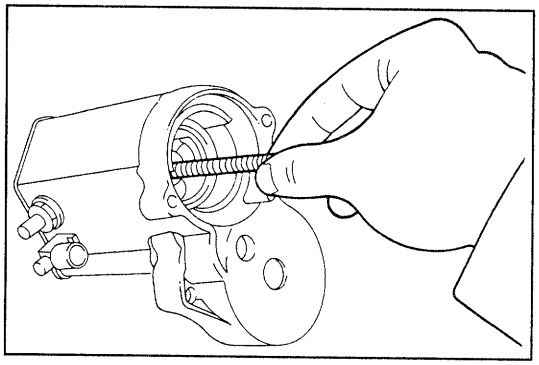
(2) Inspect the starter idle gear bearing and bearing housing for damage or wear.
Replace the clutch or retainer, as required.


WRU90-ST052

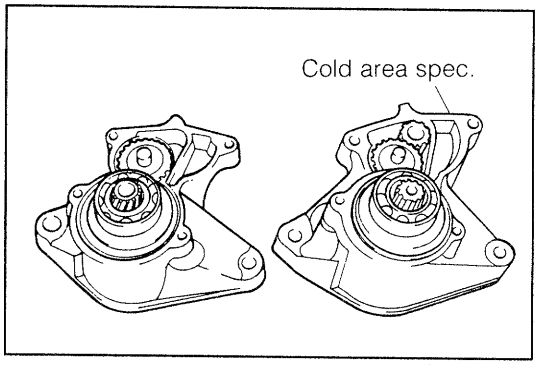
11. ASSEMBLY

NOTE:
Use high-temperature grease to lubricate the bearings and gears when assembling the starter.

(1) Install the return spring in the starter switch assembly.

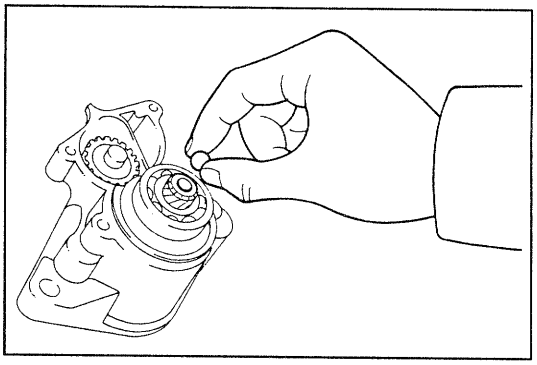

WRU90-ST053

(2) Assemble the clutch housing, idle gear, clutch and drive gear (cold area specifications) in the starter drive housing.

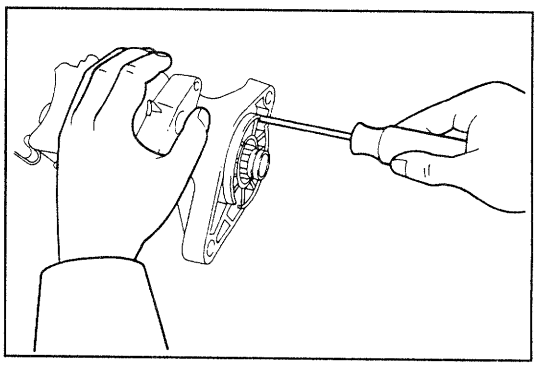


WRU90-ST054

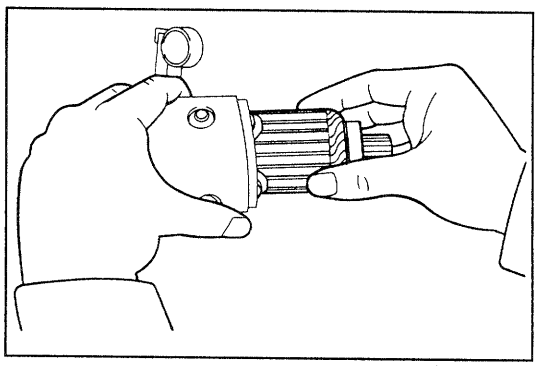
(3) Fit the steel ball in the starter clutch assembly.


WRU90-ST055

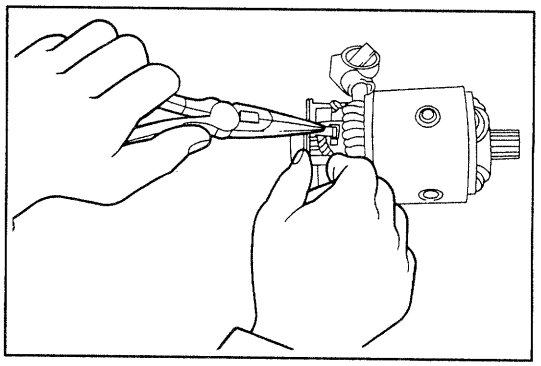
(4) Install the starter magnetic switch assembly in the starter drive housing. Secure the switch assembly with the two screws.


WRU90-ST056

(5) Insert the armature into the yoke.

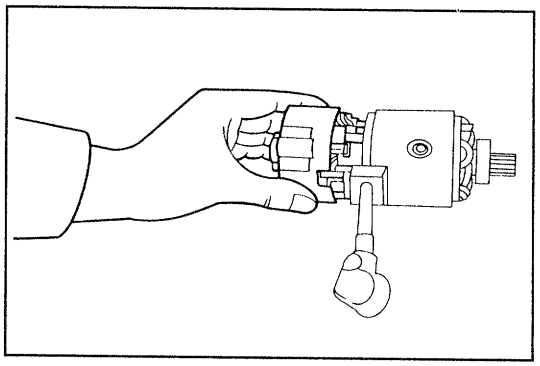

WRU90-ST057

(6) While the brush holder is held in a raised state by means of a screwdriver or nose pliers, insert the brushes.



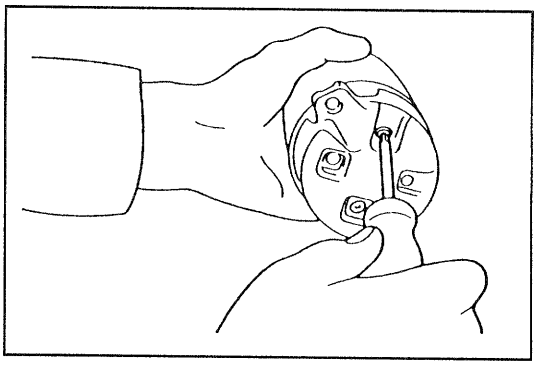
WRU90-ST058

(7) Attach the commutator end frame to the yoke with a new "O" ring (Cold area specification) interposed.



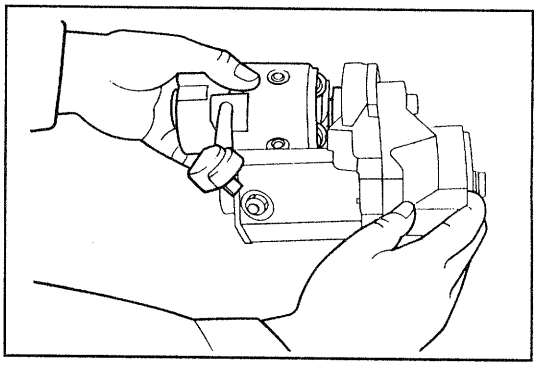
WRU90-ST059

(8) Install the brush holder on the end frame, using the two screws.



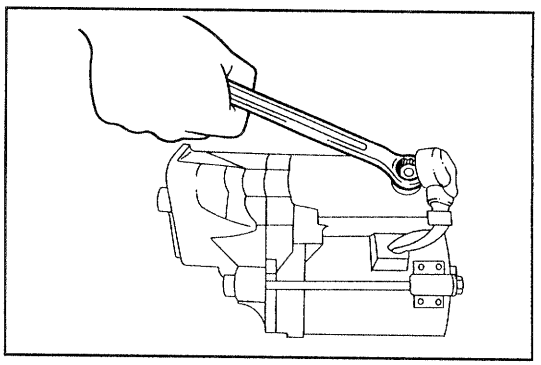
WRU90-ST060

(9) Install the yoke on the drive housing. Make sure that the cut-out marks are aligned with each other. Secure the yoke with the two through bolts.



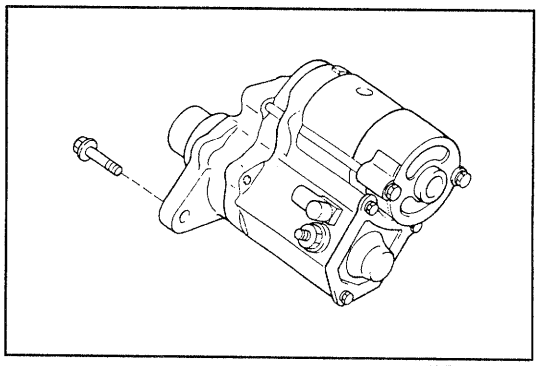
WRU90-ST061

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



WRU90-ST062

12. INSTALLATION


WRU90-ST063

(1) Install the starter motor to the clutch housing.
(2) Tighten the attaching bolts of the starter motor to the specified torque.
    Tightening Torque: 5.0 - 7.0 kg-m
    (36.2 - 50.6 ft-lb, 49.0 - 68.6 N·m)

(3) Connect the starter terminals B and ST of the alternator wire to the starter.
(4) Install the engine undercover.
(5) Jack up the vehicle. Remove the safety stands from the vehicle. Then, remove the jack.
(6) Connect the ground cable terminal to the negative (–) terminal of the battery.

CLUTCH SWITCH

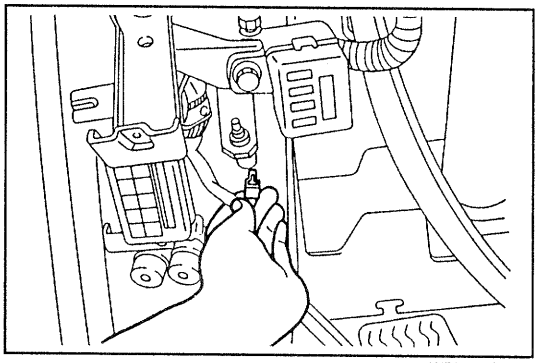
1. INSPECTION OF CLUTCH SWITCH

(1) Inspection of clutch pedal
  ① Ensure that the clutch pedal installation height is correct.
  ② Ensure that the clutch pedal free travel is correct.
(2) Inspection of clutch start system
  ① Ensure that the engine will not start when the clutch pedal is released.
  ② Ensure that the engine can start when the clutch pedal is depressed fully.
  Adjust or replace the clutch switch, as required.

2. REMOVAL

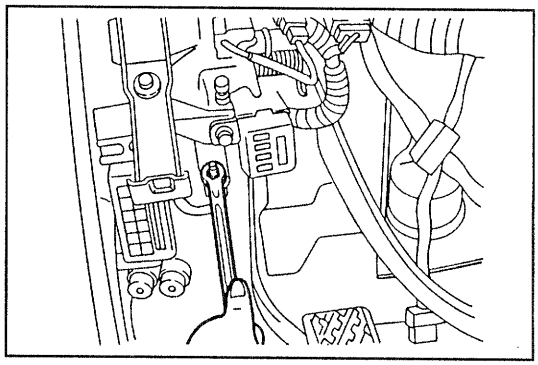
(1) Disconnect the coupler of the clutch switch.

WRU90-ST064



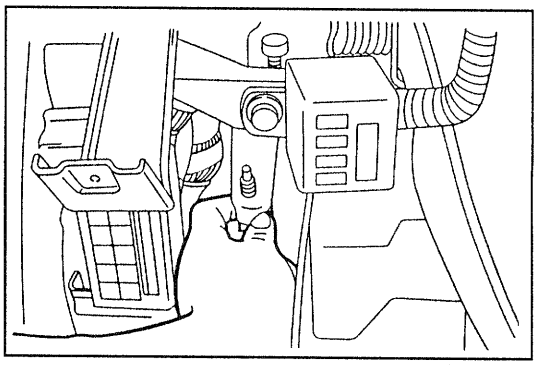
WRU90-ST065

(2) Remove the attaching nut of the clutch switch.



WRU90-ST066

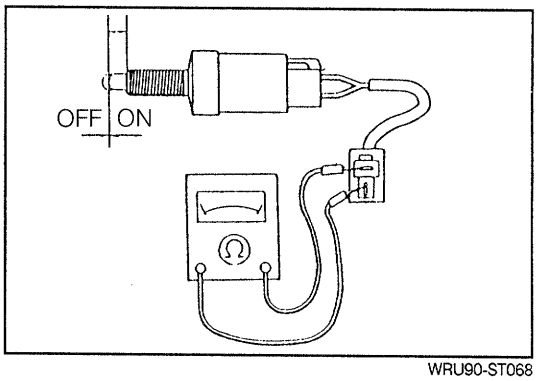
(3) Remove the clutch switch from the pedal bracket by turning the clutch switch.



WRU90-ST067

3. INSPECTION

Unit inspection of clutch switch (if necessary)
(1) Disconnect the coupler of the clutch switch. Connect an ohmmeter.
(2) When the clutch switch is pressed (in the ON state), ensure that there is continuity between both poles.
(3) When the clutch switch is released (in the OFF state), ensure that there is no continuity between both poles.
(4) Securely connect the coupler of the clutch switch.
  Tightening torque: 1.8 - 3.0 kg-m
  (13.0 - 21.7 ft-lb, 17.7 N·m)



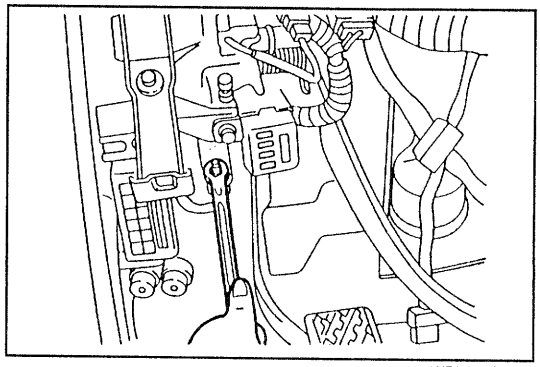
WRU90-ST068

4. INSTALLATION

(1) Install the clutch switch to the pedal bracket. Tighten the attaching nut to the specified torque.

Tightening Torque: 1.8 - 3.0 kg-m (13.0 - 21.7 ft-lb, 17.7 - 29.4 N·m)

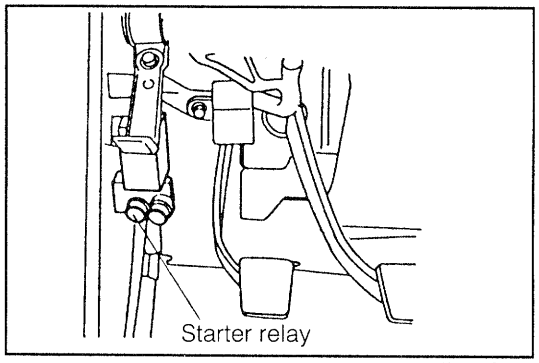
(2) Connect the coupler to the clutch switch.



WRU90-ST069

STARTER RELAY

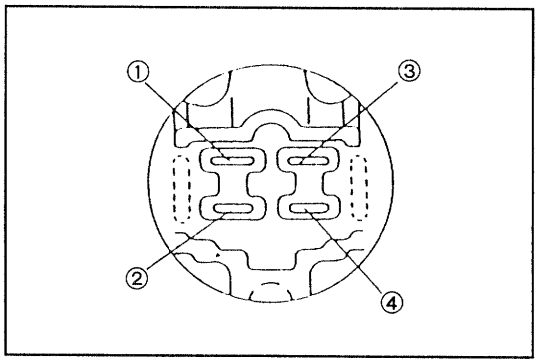
(1) Remove the starter relay.



WRU90-ST070

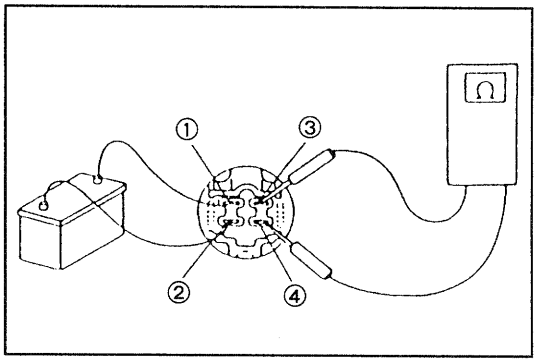
(2) Inspection of relay continuity
   1) Ensure that the resistance between the terminals ① and ② meets the specification.
      Specified Resistance: 40 - 100Ω

      If the resistance does not conform to the specification, replace the relay with a new one.
   2) Ensure that no continuity exists between the terminals ① and ③ and between the terminals ① and ④.
      If continuity exists, replace the relay with a new one.
   3) Ensure that no continuity exists between the terminals ② and ③ and between the terminals ② and ④.



WRU90-ST071

(3) Inspection of relay operation
   Apply the battery voltage across the terminals ① and ②. Ensure that there is continuity between the terminals ③ and ④.



WRU90-ST072

(4) Installation of starter relay
   1) Install the starter relay to the cowl side.
   2) Connect the starter relay connector.

WRU90-ST073