

DAIHATSU

F300

STARTING SYSTEM

OUTLINE OF STARTING SYSTEM	ST- 2
DESCRIPTION	ST- 5
PLANETARY TYPE STARTER	
MOTOR	ST-10
REDUCTION TYPE STARTER	
MOTOR	ST-24

WF290-ST001

STARTING SYSTEM

OUTLINE OF STARTING SYSTEM

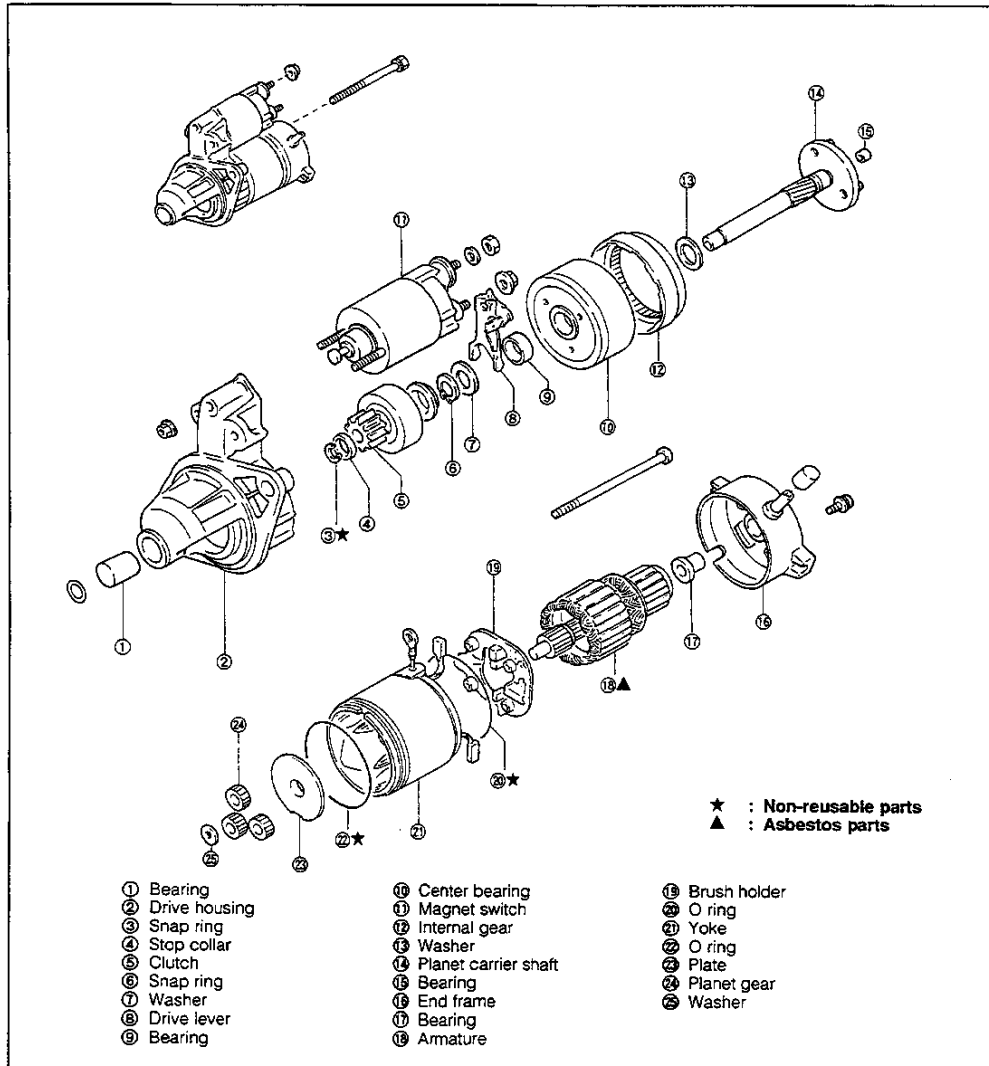
COMPONENTS

Planetary type starter motor

The starter motor consists of a solenoid switch and a motor.

The solenoid has electric contact points which supply power to the motor. The solenoid also has a shift fork (driver lever) which moves the motor pinion gear into mesh with the ring gear mounted on the engine flywheel.

The planetary type starter motor is a reduction type starter which employs a planetary gear set. Compared with the conventional starter motors, this reduction type starter motor features a smaller size and lighter weight.

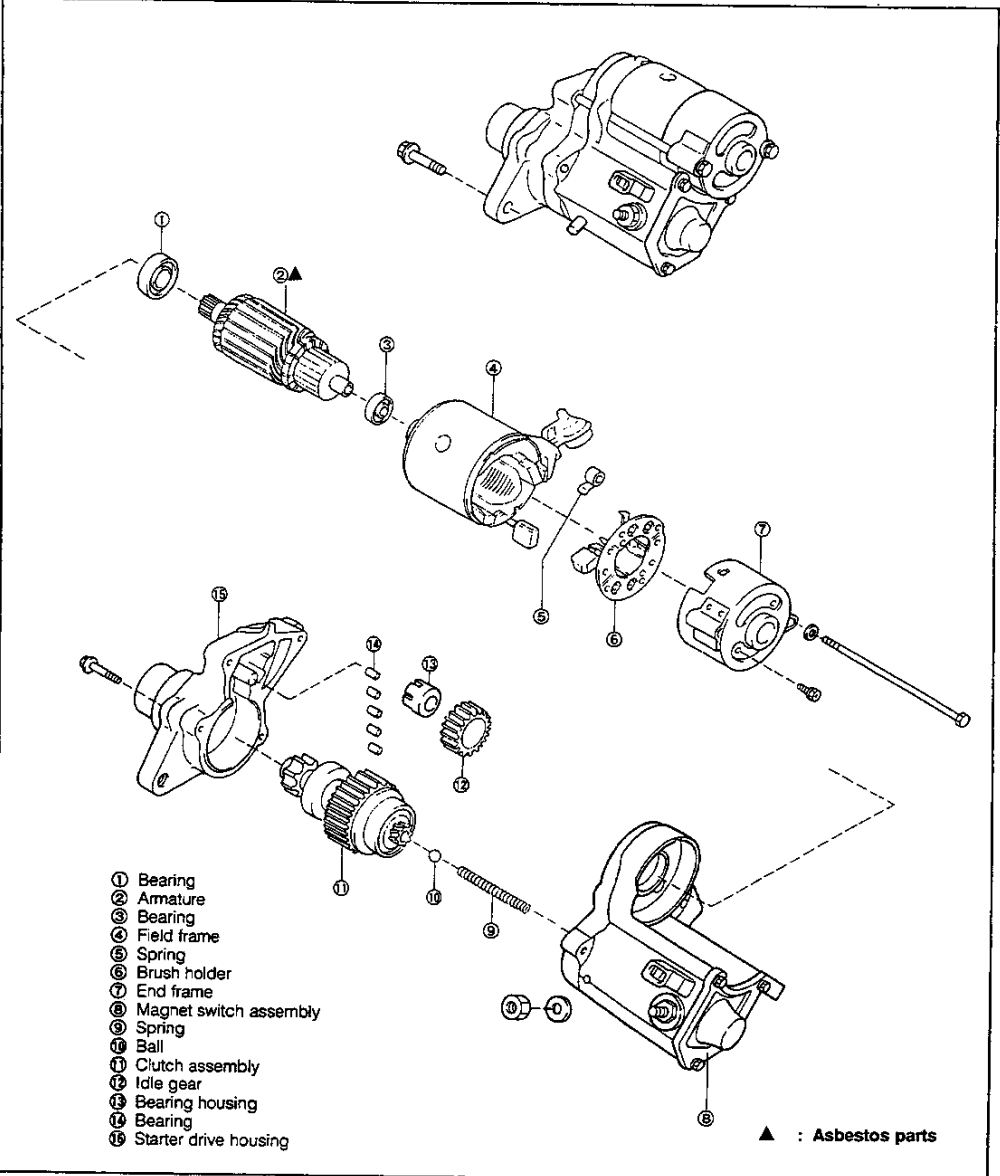


WFE90-ST002

STARTING SYSTEM

Reduction type starter motor

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.



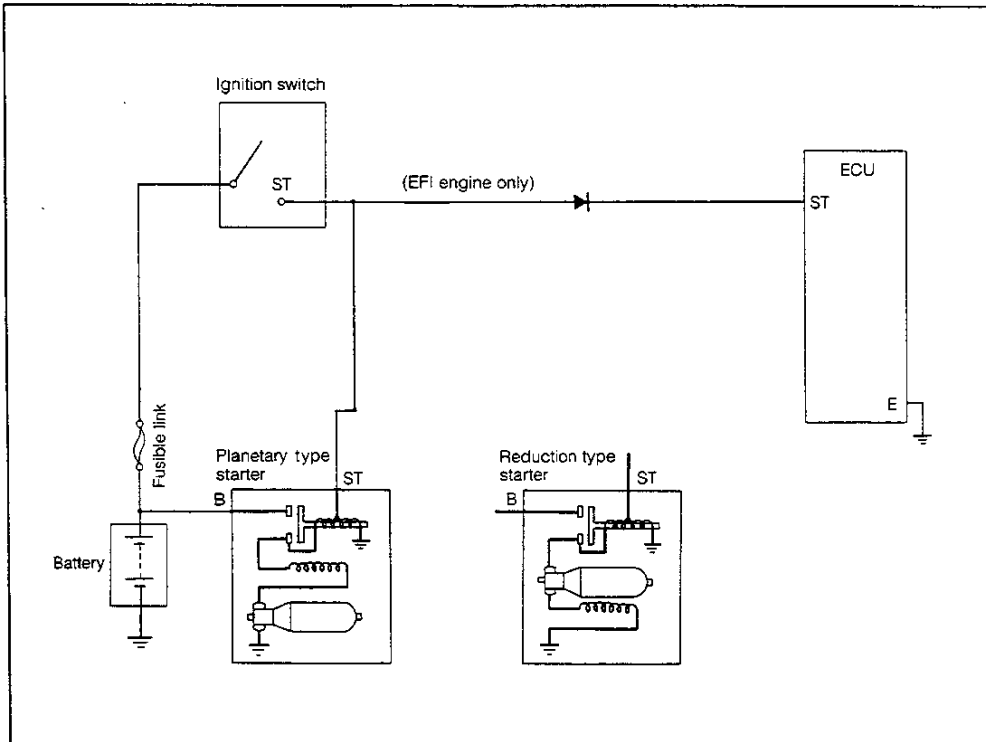
- ① Bearing
- ② Armature
- ③ Bearing
- ④ Field frame
- ⑤ Spring
- ⑥ Brush holder
- ⑦ End frame
- ⑧ Magnet switch assembly
- ⑨ Spring
- ⑩ Ball
- ⑪ Clutch assembly
- ⑫ Idle gear
- ⑬ Bearing housing
- ⑭ Bearing
- ⑮ Starter drive housing

▲ : Asbestos parts

WFES0-ST003

STARTING SYSTEM

STARTING SYSTEM CIRCUIT



WFE90-ST004

TROUBLE SHOOTING

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

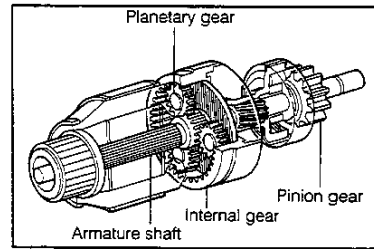
WFE90-ST005

STARTING SYSTEM

DESCRIPTION

PLANETARY TYPE STARTER MOTOR

The planetary starter motor consists of a motor and a solenoid switch in the same way as with the conventional starter motors. However, the starter motor of this type differs from the conventional type starter motors in that the revolution speed generated by the motor is reduced in the power train system.



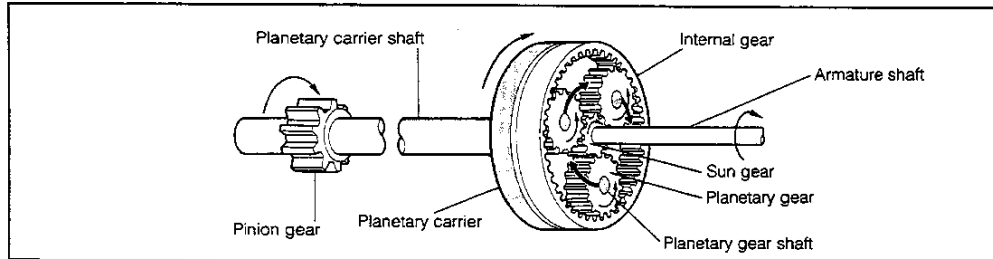
WFE90-ST006

The following shows how the torque is transmitted in the power train system.

(Here, it should be noted that the planetary carrier shaft, planetary carrier and planetary gear shaft is integral.)

- ① The torque generated at the armature is transmitted to the sun gear.
- ② When the sun gear is turned, the planetary gear turns on its own planetary gear shaft.
- ③ However, normally the internal gear is locked. As a result, the planetary gear starts to walk around the sun gear, while the planetary gear itself is turning on its own shaft.
- ④ In as much as the planetary carrier is integral with the planetary gear shaft, the torque is transmitted. Consequently, the pinion gear starts to turn.

Furthermore, the starter motor of this type is equipped with a buffer device. When an excessive torque is applied, it drives the internal gear, thereby relieving the excessive torque.

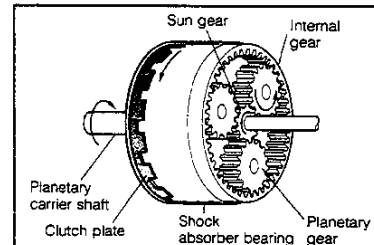


WFE90-ST007

The following is the description of the buffer function.

The internal gear is meshed with the clutch plate provided inside the shock absorber bearing.

Since the clutch plate is held in such a way that it turns when a torque in excess of a certain value is applied. Therefore, the internal gear turns together with the clutch plate, thereby reducing the torque excessively applied.



WFE90-ST008

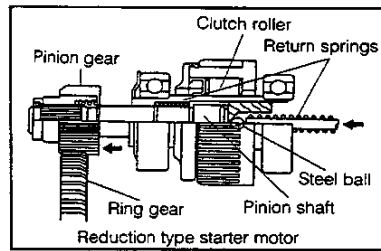
STARTING SYSTEM

PRINCIPLES OF OPERATION & STARTING SYSTEM CIRCUIT

The starter motor operations can be divided into two operations. When the ignition switch is set to the START (ST) position, current from the battery flows to the motor through the solenoid. The motor starts to rotate. Simultaneously, the pinion gear meshes with the ring gear by the magnetic force.

WFES0-ST009

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.



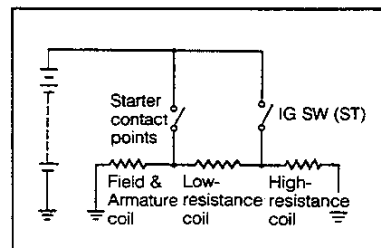
WFES0-ST010

The solenoid is composed of two coils. One is a low-resistance coil which moves the shift fork (which corresponds to the pinion shaft in the case of the reduction type starter motor). 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.

WFES0-ST011

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.



WFES0-ST012

STARTING SYSTEM

During the starting period, the low-resistance coil provides the solenoid with a large amount of current to move the shift fork or 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 is employed in the starting system so as to prevent burning.

The plunger of the solenoid has two functions: One is to move the shift fork or the pinion shaft. The other is to close the electric contact points, which takes place simultaneously 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, field coil and armature coils. As a result, the motor starts rotating. Simultaneously, the high-resistance coil is also energized. These two coils exert a 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 shift fork or the pinion shaft strongly, thereby making the pinion gear mesh with the ring gear. Simultaneously, the starter contact points close 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. (See the 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 shift fork or the pinion shaft which has been pushing the pinion gear returns 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.)

WF80-STD13

STARTING SYSTEM

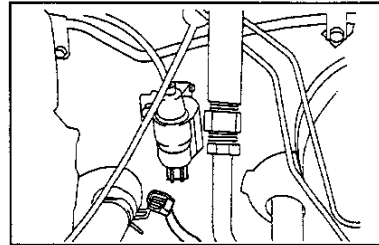
SERVICING INSTRUCTIONS OF STARTER

- (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 \ominus 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.

WFEGO-ST014

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.

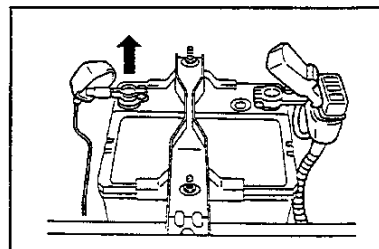


WFEGO-ST015

- (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.
- (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.

REMOVAL

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

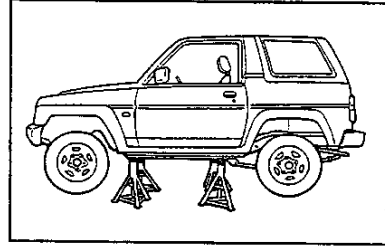


WFEGO-ST016

WFEGO-ST017

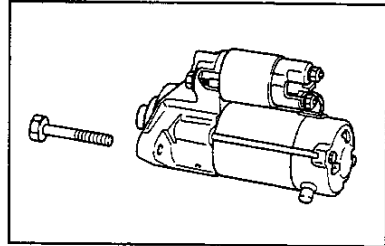
STARTING SYSTEM

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



WFE90-ST018

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



WFE90-ST019

STARTING SYSTEM

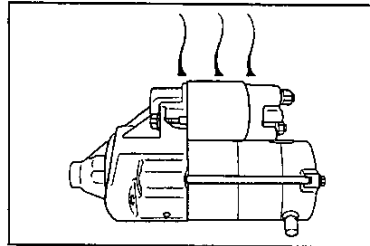
PLANETARY TYPE STARTER MOTOR UNIT CHECK OF PLANETARY TYPE STARTER MOTOR

CAUTION:

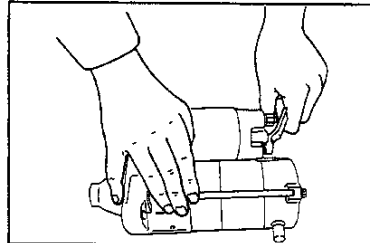
- Each of the following tests must be performed within three to five seconds. If you fail to observe this caution and the starter should be energized for more than this duration, the coil may be burnt out.

(1) Pull-in test

- ① Disconnect the lead wire from the magnetic switch terminal.

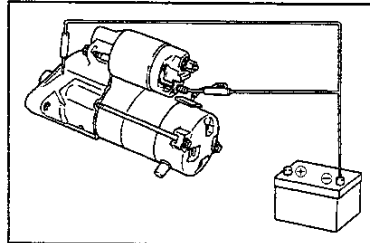


WFE90-ST020



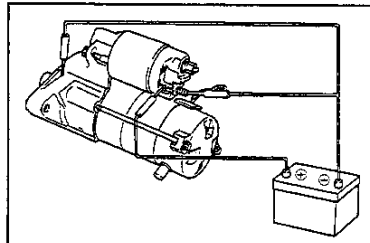
WFE90-ST021

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



WFE90-ST022

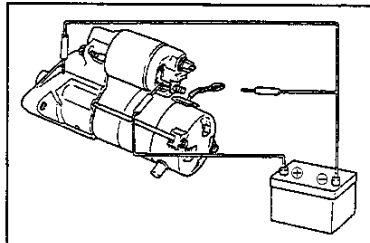
- ③ Connect the positive (+) terminal to the terminal ST. Ensure that the pinion is pushed outward. If the drive pinion fails to move out, replace the magnetic switch.



WFE90-ST023

(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.

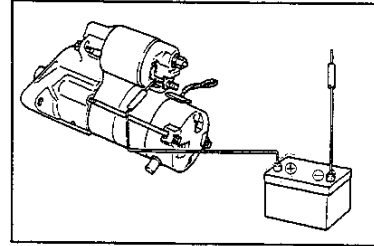


WFE90-ST024

STARTING SYSTEM

(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, replace the magnetic switch.



WFEB90-ST025

(4) No-load performance test

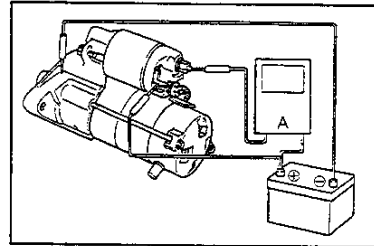
Connect the battery and an ammeter to the starter as shown in the right figure. Ensure that the starter rotates smoothly with the pinion moving out.

Measure the current the starter is drawing.

Specified Current: Less than 90A at 11.5V

NOTE:

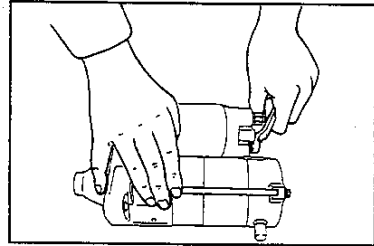
- Prior to the test, be sure to connect the lead wire to the magnetic switch.



WFEB90-ST026

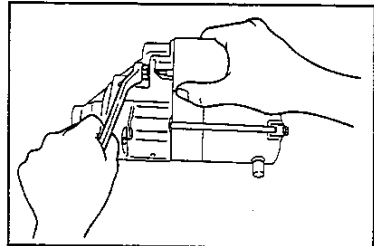
DISASSEMBLY OF PLANETARY TYPE STARTER MOTOR

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



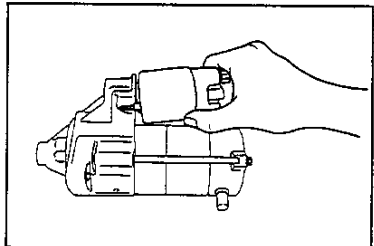
WFEB90-ST027

(2) Remove the attaching nut of the magnetic switch from the drive housing.



WFEB90-ST028

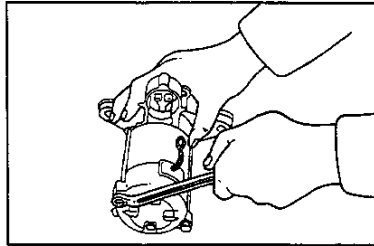
(3) Remove the magnetic switch from the drive housing.



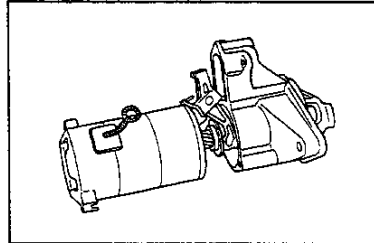
WFEB90-ST029

STARTING SYSTEM

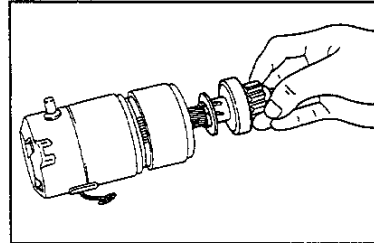
- (4) Remove the two through bolts from the commutator end frame.



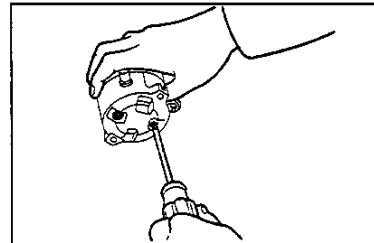
- (5) Remove the yoke with armature and the drive lever from the drive housing.



- (6) Separate the yoke with armature from the clutch with center bearing.
(7) Remove the "O" ring.



- (8) Remove the end frame cover by removing the two screws.

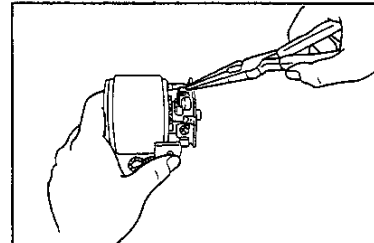


- (9) Remove the brushes from the brush holder by lifting the brush springs by means of nose pliers or the like.

NOTE:

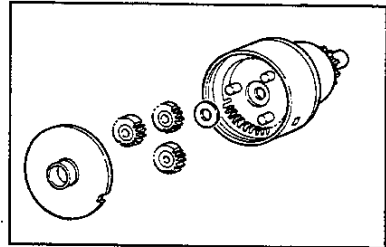
- Care must be exercised not to damage the brushes during the removal.

- (10) Then, remove the armature from the yoke.



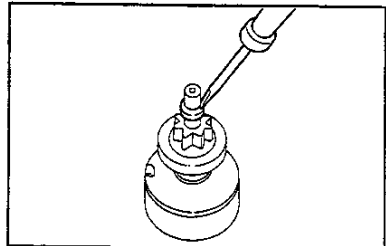
STARTING SYSTEM

- (11) Removal of planetary gear
- ① Remove the plate for starter armature.
 - ② Remove the three planetary gears.
 - ③ Remove the plate washer.



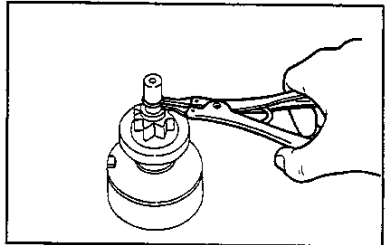
WFE90-ST035

- (12) Remove the stop collar from the snap ring by tapping the collar with a screwdriver or the like placed on it.



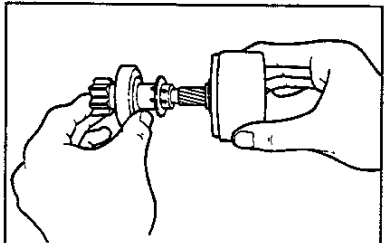
WFE90-ST036

- (13) Detach the snap ring by prying it off with snap ring pliers. Then, remove the collar.



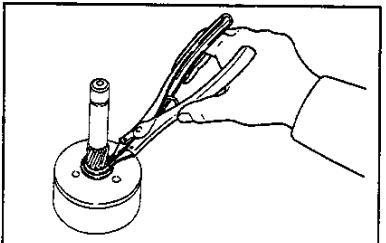
WFE90-ST037

- (14) Remove the clutch.



WFE90-ST038

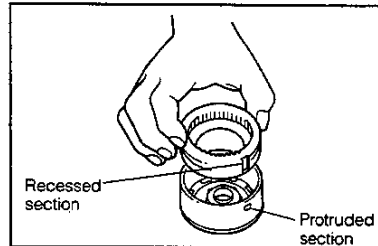
- (15) Detach the snap ring. Separate the center bearing from the planetary carrier shaft.



WFE90-ST039

STARTING SYSTEM

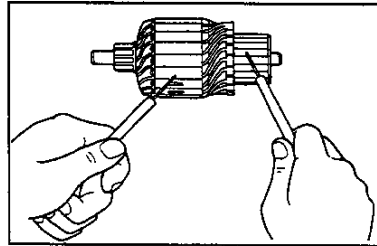
- (16) Remove the internal gear by aligning the recessed section provided at the outer periphery of the internal gear with the protruded section provided at the inner periphery of the center bearing.



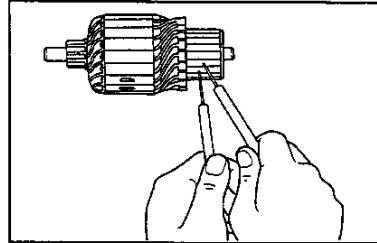
INSPECTION OF PLANETARY TYPE STARTER MOTOR

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.

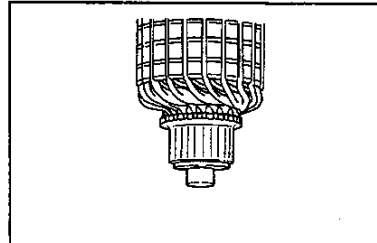


- (2) Check of commutator continuity
Check continuity between each adjacent segment of the commutator, using an ohmmeter.
If no continuity exists between any adjacent segments, replace the armature.



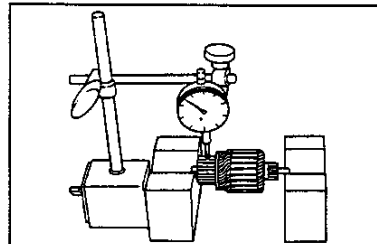
Check of commutator

- (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.



- (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

If the circle runout exceeds the allowable limit, turn down the commutator on a lathe.
At this point, care must be exercised to ensure that the commutator diameter is not less than the minimum requirement diameter of 27 mm.



STARTING SYSTEM

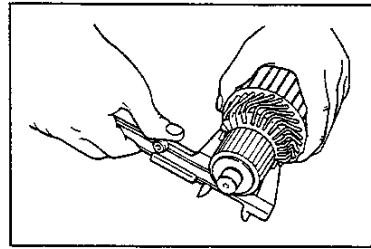
(3) Measurement of commutator diameter

Measure the commutator diameter by means of a micrometer or vernier calipers.

Standard Diameter: 28 mm

Minimum Diameter: 27 mm

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



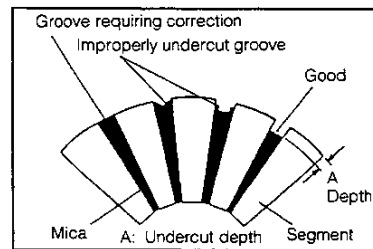
WFES0-ST045

(4) Check of commutator undercut

Measure the insulator groove depth between commutator segments.

Minimum Depth: 0.2 mm

If the insulator groove depth becomes less than the limit value, replace the commutator.



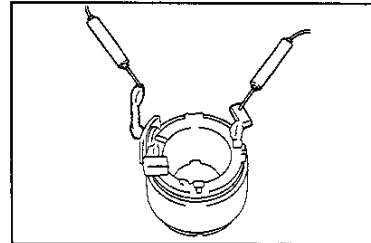
WFES0-ST046

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.

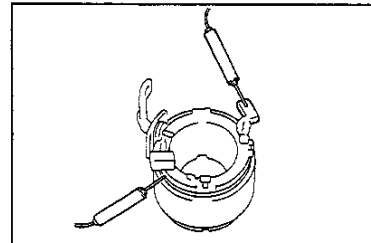


WFES0-ST047

(2) Field coil short test

Perform field coil short test at a point between the brush and the yoke proper, using an ohmmeter.

If no continuity exists, replace the yoke.



WFES0-ST048

Check of brushes

(1) Measurement of brush length

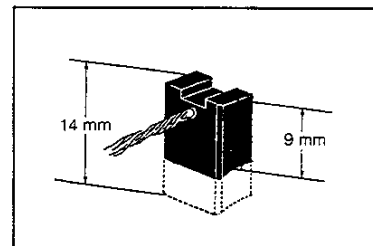
Measure the brush length, using vernier calipers.

Standard Length: 14 mm

Minimum Length: 9 mm

(2) Replacement of brush.

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



WFES0-ST049

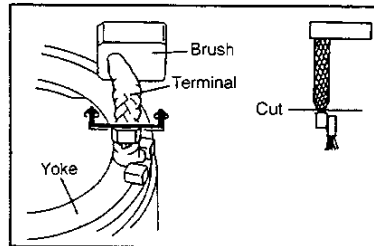
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(3) Procedure for brush replacement

- ① Cut the brush lead wire at the terminal side.

NOTE:

- Replacement can be made only for the two brushes at the yoke side (positive (+) side). The brush at the negative (-) side should be replaced together with the brush holder.



WFE90-ST050

- ② Remove welding traces with a file or the like to correct the brush terminal to the specified dimensions.

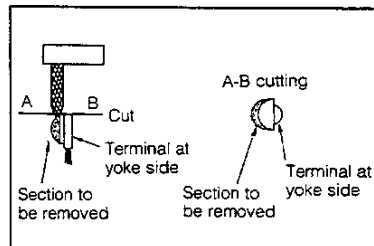
Specified Dimensions:

Thickness: 1.5 mm - 1.7 mm

Width: 5 mm

NOTE:

- Be sure to remove the section of the brush terminal as indicated in the right figure. Since the section to be removed is narrow, be very careful not to damage the field coil.

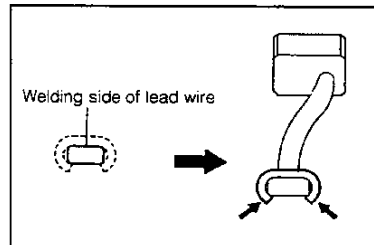


WFE90-ST051

- ③ Stack the plate section of a replacement brush onto the welding side of the lead wire. Make pressure connection over the overlaid section by pinching it with pliers.

NOTE:

- Be sure to take out the brush lead wire in the correct direction.

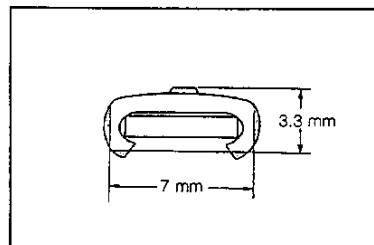


WFE90-ST052

- ④ Solder the pressure connection section. Correct the section, using a file or the like, so that the section conforms to the dimensions, as indicated in the right figure.

NOTE:

1. When performing the soldering, heat the section to be soldered thoroughly. Be very careful not to allow any solder to flow into the positive side lead wire.
2. Be sure to allow solder in a sufficient amount to flow into the inside of the plate.
3. Ensure that no solder oozes to the field side.



WFE90-ST053

Check of brush holder

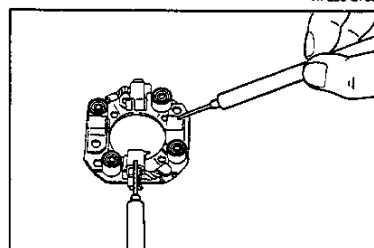
- (1) Check of brush holder for insulation

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

Insulation Resistance: 0.1 MΩ or more

- (2) Replacement of brush holder.

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

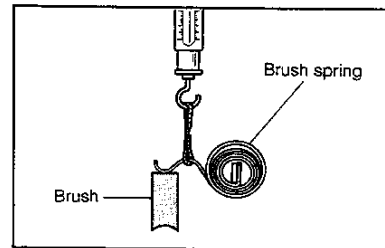


WFE90-ST054

STARTING SYSTEM

Check of brush spring

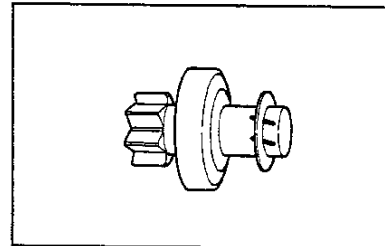
Measure the brush spring tension, using a spring scale.
Standard Tension: 15.7 N (1.6 kgf)



WF890-ST055

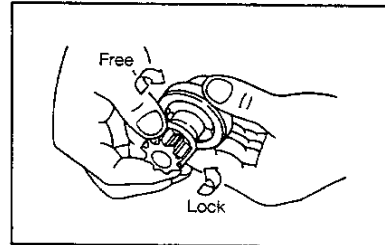
Check of clutch

- (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.



WF890-ST056

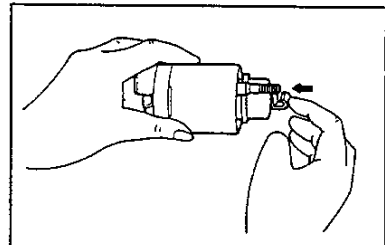
- (2) Check of starter clutch
While holding the clutch, turn the pinion clockwise. Ensure that the pinion turns smoothly.
Turn the pinion counterclockwise. Ensure that the pinion is locked.
If the check results are unsatisfactory, replace the starter clutch.



WF890-ST057

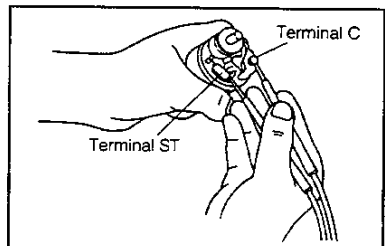
Check of magnetic switch

- (1) Plunger check
Push in the plunger with your fingers and release your fingers. Ensure that the plunger returns quickly to the original position. If the plunger exhibits poor returning or fails to return, replace the magnetic switch.



WF890-ST058

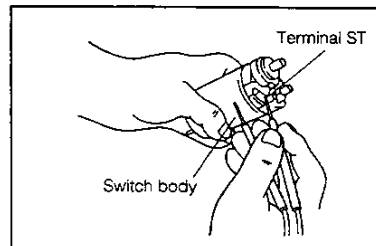
- (2) Pull-in coil open circuit test
Using an ohmmeter, ensure that continuity exists between the terminal ST and terminal C.
If no continuity exists, replace the magnetic switch.



WF890-ST059

STARTING SYSTEM

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

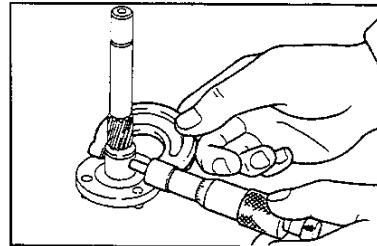


WF90-ST060

Check of bearing

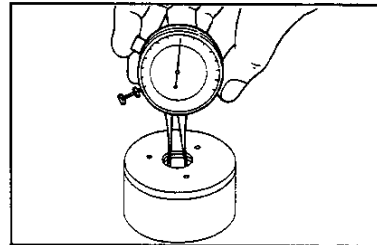
Center bearing

- (1) Measure the outer diameter of the center bearing sliding section of the planetary carrier shaft.
Specified Value: 15 mm



WF90-ST061

- (2) Measure the inner diameter of the center bearing so as to determine the clearance.
Specified Value: 0.04 mm
Allowable Limit: 0.15 mm



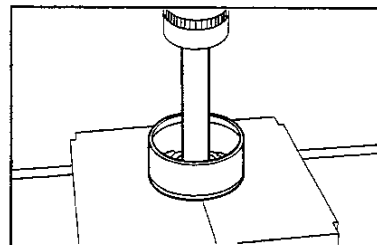
WF90-ST062

If the clearance exceeds the allowable limit, replace the oilless bearing or the planetary carrier shaft.

- (3) Bearing replacement
① Remove the bearing, using a suitable tool in combination with a press or the like.

NOTE:

- When pulling out the bearing, be sure to remove it from the inside.

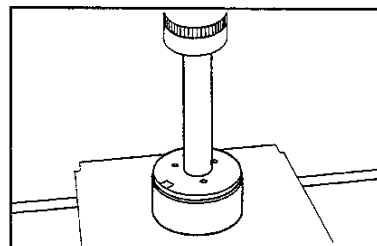


WF90-ST063

- ② Install the bearing, using a suitable tool in combination with a press or the like.

NOTE:

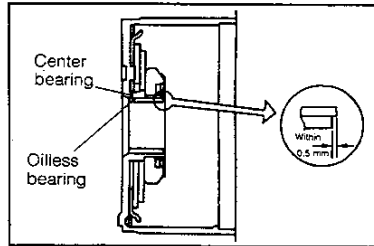
- When installing the bearing, be sure to install it from the outside.



WF90-ST064

NOTE:

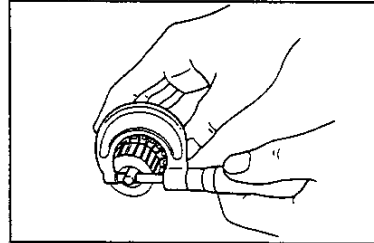
- The bearing should be driven into position in such a way that the bearing is recessed within 0.5 mm from the edge of the center bearing.



WFES0-ST065

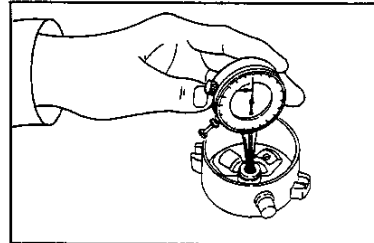
End frame bearing

- (1) Measure the outer diameter of the end frame sliding section of the armature shaft.
Specified Value: 7 mm



WFES0-ST066

- (2) Measure the inner diameter of the end frame bearing so as to determine the clearance.
Specified Value: 0.04 mm
Allowable Limit: 0.15 mm



WFES0-ST067

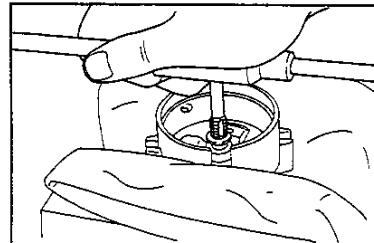
If the clearance exceeds the allowable limit, replace the oilless bearing or the armature.

(3) Bearing replacement

- ① Remove the bearing, using a tap having an outer diameter of 8 mm.

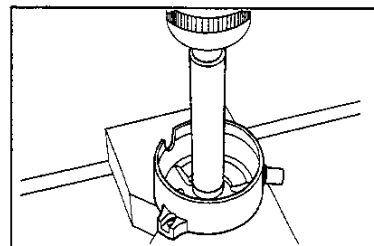
NOTE:

- Be certain to clamp the end frame in a vise with a cloth interposed so that no scratch may be made on the end frame.



WFES0-ST068

- ② Install a new bearing, using a suitable tool in combination with a press or the like.



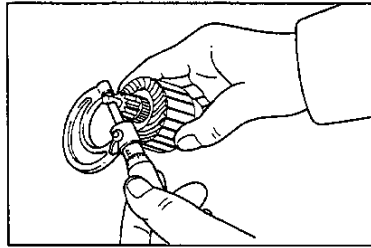
WFES0-ST069

STARTING SYSTEM

Planetary carrier shaft bearing

- (1) Measure the outer diameter of the front sliding section of the armature shaft.

Specified Value: 7 mm



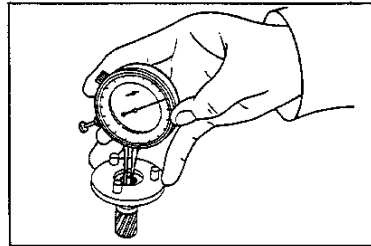
WFEB0-ST070

- (2) Measure the inner diameter of the planetary carrier shaft bearing so as to determine the clearance.

Specified Value: 0.04 mm

Allowable Limit: 0.15 mm

If the clearance exceeds the allowable limit, replace the oilless bearing or the armature.



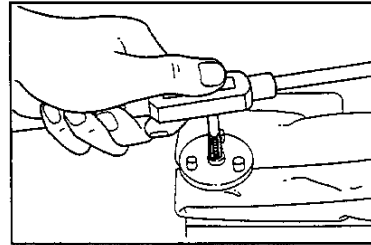
WFEB0-ST071

- (3) Bearing replacement

- ① Remove the bearing, using a tap having an outer diameter of 8 mm.

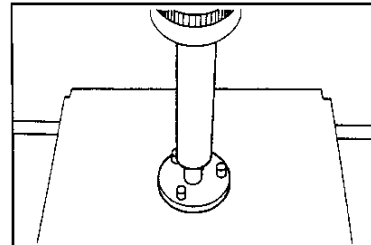
NOTE:

- Be certain to clamp the planetary carrier shaft in a vice with a cloth interposed so that no scratch be made on the planetary carrier shaft.



WFEB0-ST072

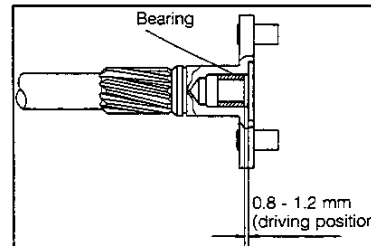
- ② Install a new bearing, using a suitable tool in combination with a press or the like.



WFEB0-ST073

NOTE:

- The bearing should be driven into the position, as indicated in the right figure.



WFEB0-ST074

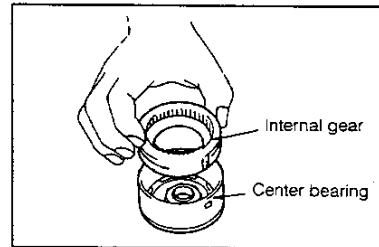
STARTING SYSTEM

ASSEMBLY OF PLANETARY TYPE STARTER MOTOR

NOTE:

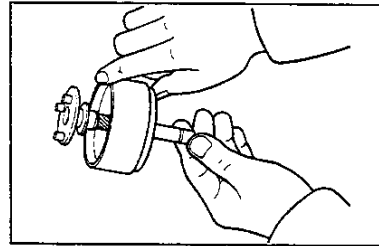
- Use high-temperature grease to lubricate the bearings and sliding parts when assembling the starter motor.

(1) Install the internal gear by aligning the recessed section provided at the outer periphery of the internal gear with the protruded section provided at the inner periphery of the center bearing.



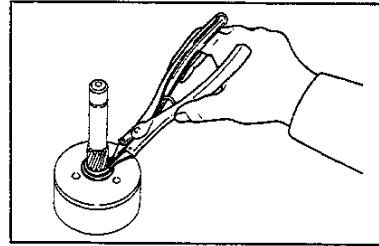
WFES90-ST080

(2) Put the plate washer onto the planetary carrier shaft. Then, install the center bearing to the planetary carrier shaft.



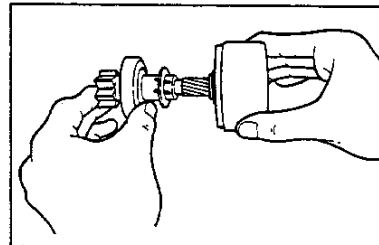
WFES90-ST081

(3) Install the plate washer in place. Install the snap ring.



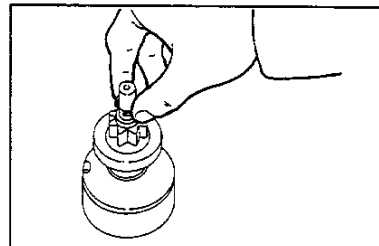
WFES90-ST082

(4) Install the clutch.



WFES90-ST083

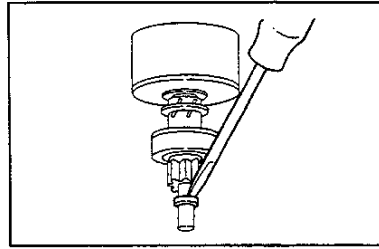
(5) Install the stop collar and a new snap ring. Compress the snap ring, using a vise or the like.



WFES90-ST084

STARTING SYSTEM

- (6) Tap the collar so that it may come onto the snap ring, using a screwdriver.



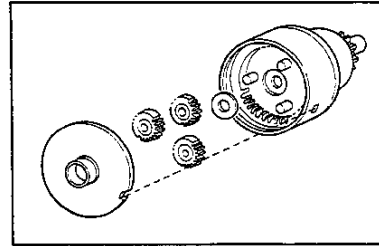
WFES0-ST085

- (7) Installation of planetary gear

- ① Install the plate washer.
- ② Install the three planetary gears.
- ③ Install the plate for starter armature.

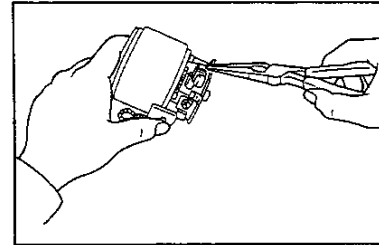
NOTE:

- Be certain to install the plate, aligning with the mate mark on the center bearing.



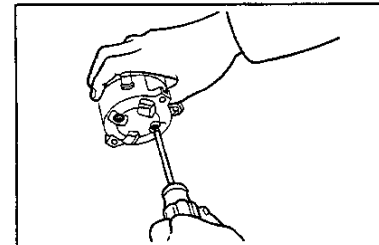
WFES0-ST086

- (8) Install the yoke to the armature. Install the brushes to the brush holder while lifting the brushes by means of nose pliers or the like.



WFES0-ST087

- (9) Install the commutator end frame, together with a new "O" ring, to the yoke by means of the two screws.

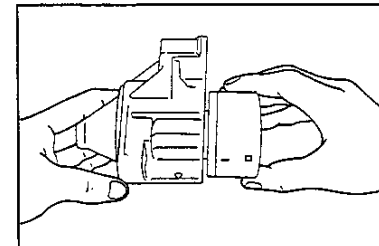


WFES0-ST088

- (10) Install the drive lever and the clutch with center bearing to the drive housing.

NOTE:

- Apply high-temperature grease to the sliding section of the drive lever.
- Make sure to align the mate mark of the drive housing with that of the yoke during the assembly.



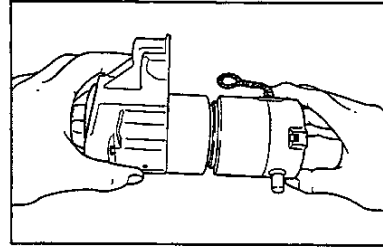
WFES0-ST089

STARTING SYSTEM

- (11) Install the armature with yoke and a new "O" ring to the drive housing.

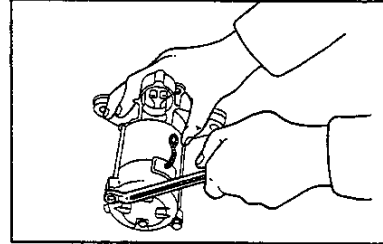
NOTE:

- Make sure to align the mate mark of the center bearing with that of the yoke during the assembly.



WFE90-ST090

- (12) Install the two through-bolts.

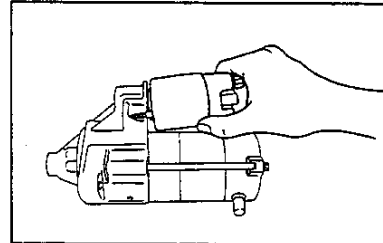


WFE90-ST091

- (13) While hooking the magnetic switch over the drive lever, install the magnetic switch onto the drive housing. Secure the magnetic switch with the two nuts.

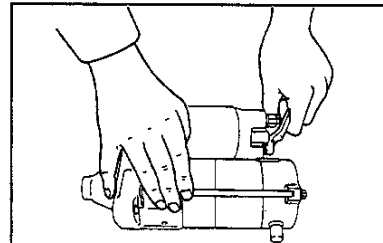
NOTE:

- Be sure to install the rubber boot in the spring section securely.



WFE90-ST092

- (14) Connect the lead wire to the magnetic switch.



WFE90-ST093

STARTING SYSTEM

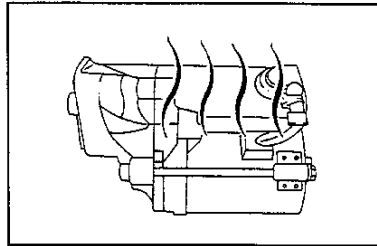
REDUCTION TYPE STARTER MOTOR UNIT CHECK OF REDUCTION TYPE STARTER MOTOR

CAUTION:

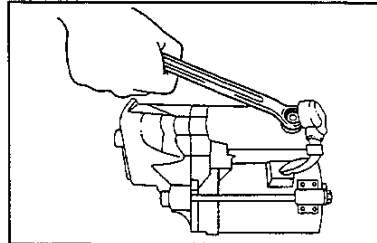
- Each of the following tests must be performed within three to five seconds. If you fail to observe this caution and the starter is energized for more than this duration, the coil may be burnt out.

(1) Pull-in Test

- ① Disconnect the lead wire from the magnetic switch terminal.

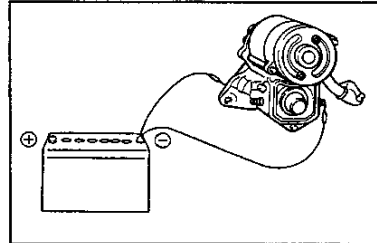


WFEB0-ST094



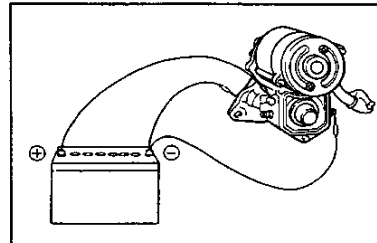
WFEB0-ST095

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



WFEB0-ST096

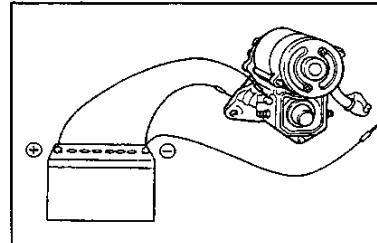
- ③ Connect the positive (+) terminal to the terminal ST. Ensure that the pinion is pushed outward. If the drive pinion fails to move out, replace the magnetic switch.



WFEB0-ST097

(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.



WFEB0-ST098

STARTING SYSTEM

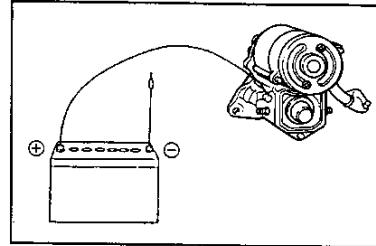
(3) Inspection of Plunger Return

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.



WF890-ST099

(4) No-load Performance Test

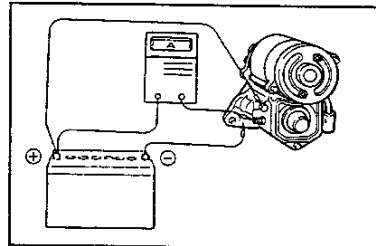
Connect the battery and an ammeter to the starter as shown in the right figure. Ensure that the starter rotates smoothly with the pinion moving out.

Measure the current the starter is drawing:

Specified Current: Less Than 90A at 11.5V

NOTE:

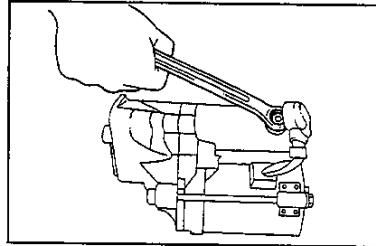
- Prior to the test, be sure to connect the lead wire to the magnetic switch.



WF890-ST100

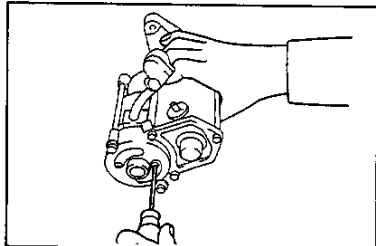
DISASSEMBLY OF REDUCTION TYPE STARTER MOTOR

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



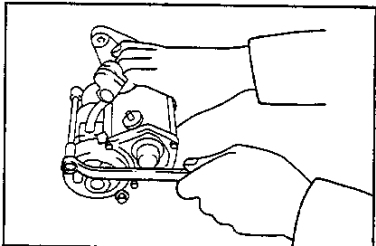
WF890-ST101

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



WF890-ST102

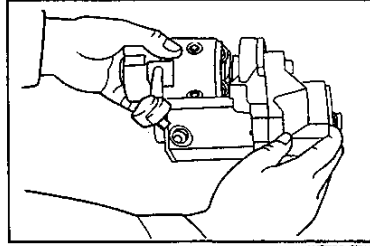
(3) Remove the two through bolts from the commutator end frame.



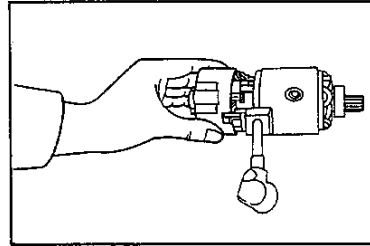
WF890-ST103

STARTING SYSTEM

- (4) Remove the yoke together with the armature from the drive housing.



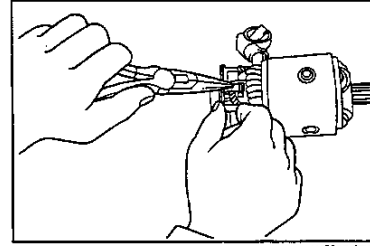
- (5) Remove the commutator end frame.



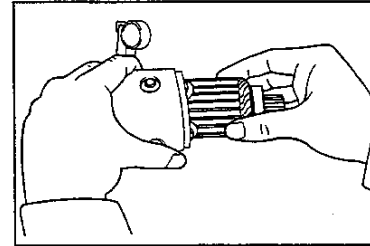
- (6) Remove the brushes from the brush holder by means of nose pliers or the like.

NOTE:

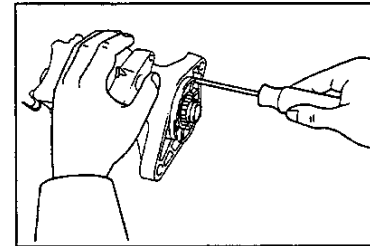
- Care must be exercised not to damage the brushes during the removal.



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

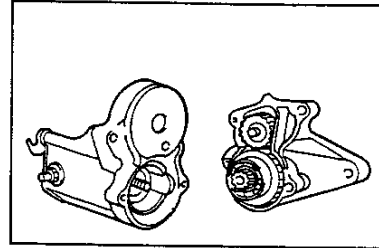


- (8) Remove the starter switch assembly from the drive housing by removing the two screws.

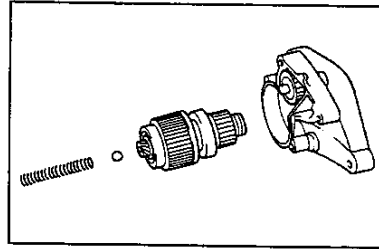


STARTING SYSTEM

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



WF890-ST109

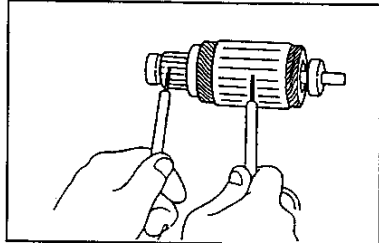


WF890-ST110

INSPECTION

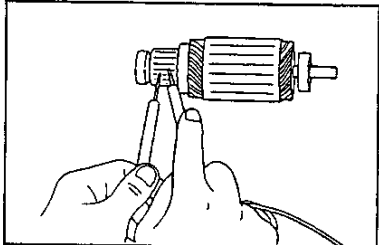
Check of armature

- (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.



WF890-ST111

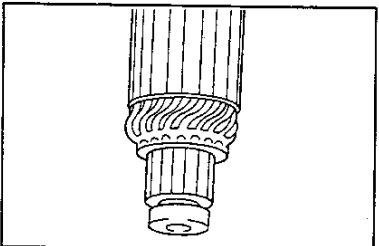
- (2) Check of commutator continuity
Check continuity between each adjacent segment of the commutator, using an ohmmeter.
If no continuity exists between any adjacent segments, replace the armature.



WF890-ST112

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.

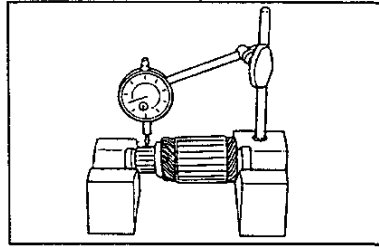


WF890-ST113

STARTING SYSTEM

- (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.

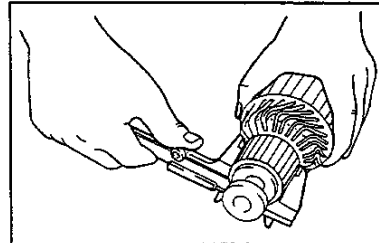


WFEB0-ST114

- (3) Measurement of commutator diameter
Measure the commutator diameter by means of a micrometer or vernier calipers.

Standard Diameter: 30.0 mm
Minimum Diameter: 29.0 mm

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

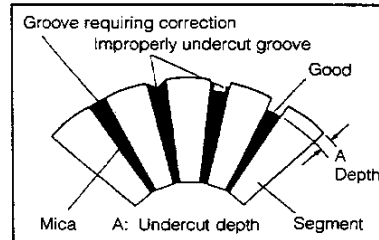


WFEB0-ST115

- (4) Check of commutator undercut
Measure the insulator groove depth between the commutator segments.

Minimum Depth: 0.2 mm

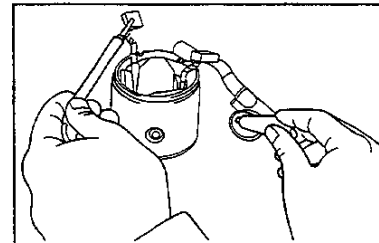
If the insulator groove depth becomes less than the limit value, replace the commutator.



WFEB0-ST116

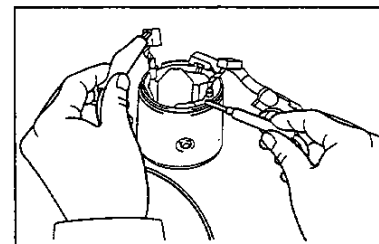
Check of field coil

- (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.



WFEB0-ST117

- (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.



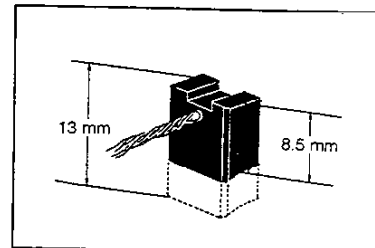
WFEB0-ST118

STARTING SYSTEM

Check of brushes

Measurement of brush length
Measure the brush length, using vernier calipers.
Standard Length: 13.0 mm
Minimum Length: 8.5 mm

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

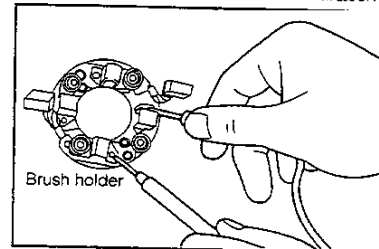


WFE90-ST11

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: 10 M Ω or more

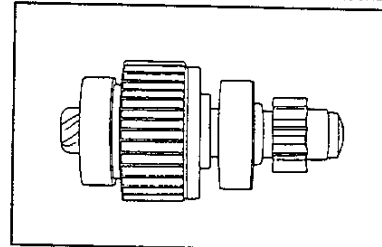
If the insulation resistance is less than the specification, replace the brush holder.



WFE90-ST120

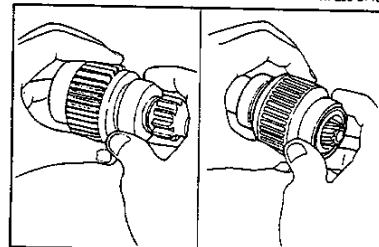
Inspection of clutch

(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.



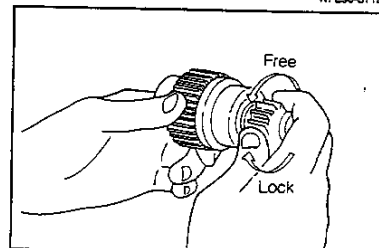
WFE90-ST121

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



WFE90-ST122

(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.



WFE90-ST123

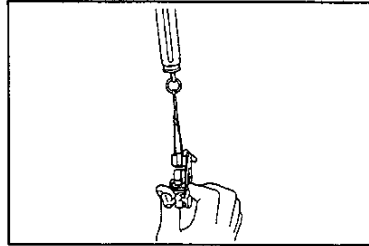
STARTING SYSTEM

Check of brush spring

Measure the brush spring tension, using a spring scale.

Tension with Spring Installed: 17.51 - 23.69 N
(1.785 - 2.415 kgf)

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

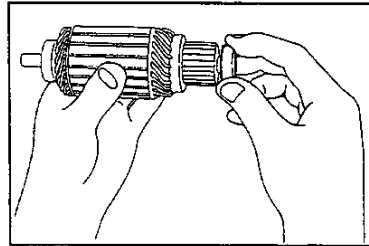


WFEB0-ST0124

Inspection of bearings

(1) Inspection of bearings

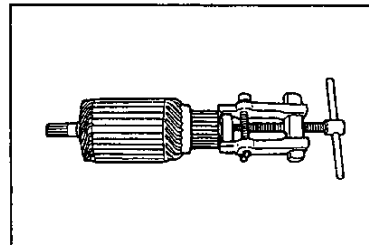
Turn the bearing while applying force to it by your hand. Ensure that the bearing turns smoothly. If the bearing fails to turn smoothly, replace the bearing.



WFEB0-ST125

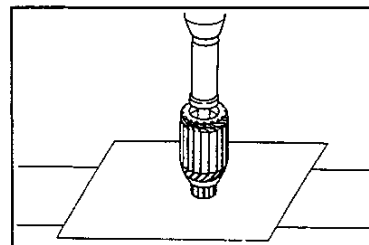
(2) Replacement of bearings (Only when bearing is faulty.)

① Remove the bearing, using an armature bearing puller.



WFEB0-ST126

② Press the bearing into the armature shaft, using a press in conjunction with the suitable tool.

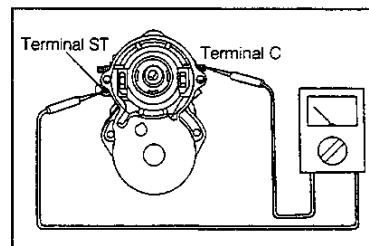


WFEB0-ST127

Check of magnetic switch

(1) Pull-in coil test

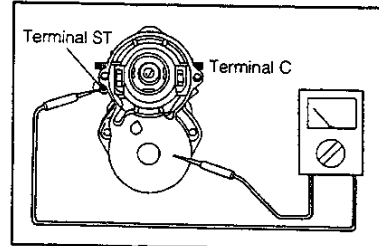
Using an ohmmeter, ensure that continuity exists between the terminal ST of the starter and the terminal C. If no continuity exists, replace the magnetic switch.



WFEB0-ST128

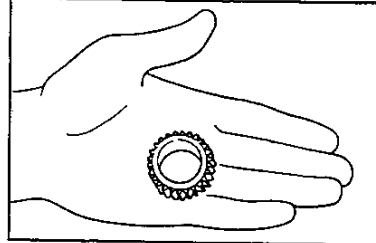
STARTING SYSTEM

- (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.

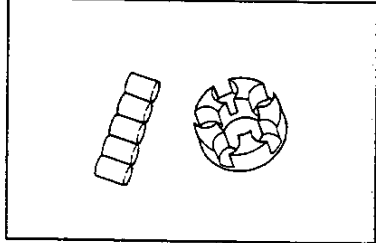


Inspection of gears

- (1) Inspect the starter idle gear for damage or wear.
Replace the gear which exhibits damage or wear.



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

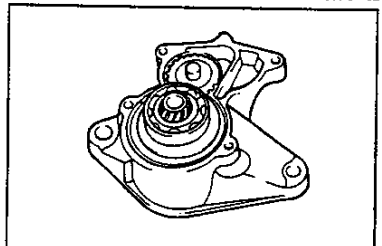
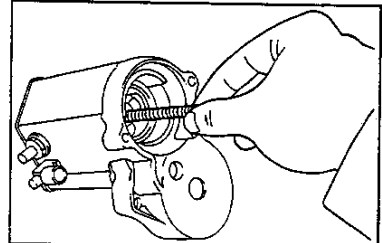


ASSEMBLY OF REDUCTION TYPE STARTER MOTOR

NOTE:

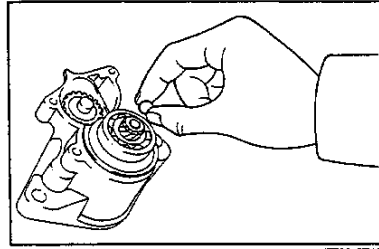
- Use high-temperature grease to lubricate the bearings and gears when assembling the starter.

- (1) Install the return spring in the starter switch assembly.
- (2) Assemble the clutch housing, idle gear and the clutch in the starter drive housing.

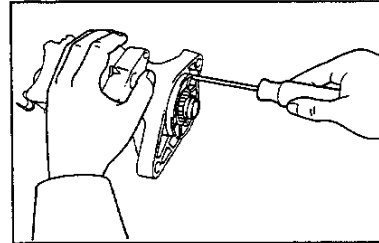


STARTING SYSTEM

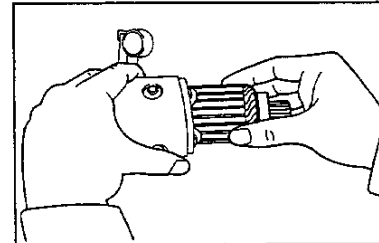
(3) Fit the steel ball in the starter clutch assembly.



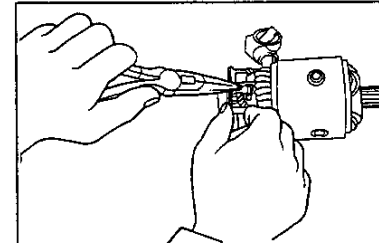
(4) Install the starter magnetic switch assembly in the starter drive housing. Secure the switch assembly with the two screws.



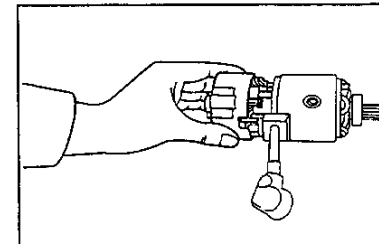
(5) Insert the armature into the yoke.



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

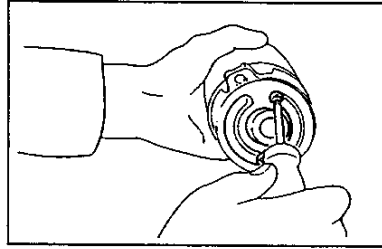


(7) Install the commutator end frame to the yoke.



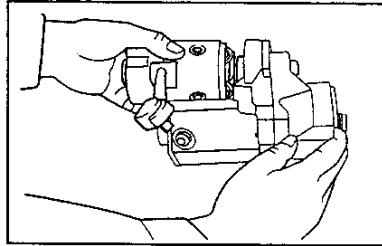
STARTING SYSTEM

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



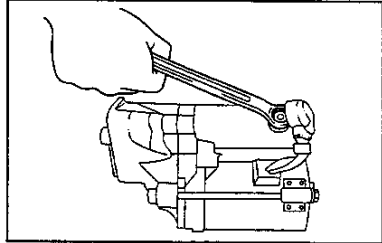
WFES0-ST139

- (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.



WFES0-ST140

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



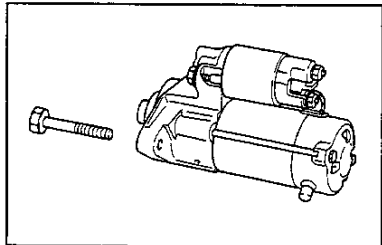
WFES0-ST141

INSTALLATION

- (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.



WFES0-ST142