STARTING SYSTEM

STARTING SYSTEM CIRCUIT
(Conventional Type)

Fig. 9-1

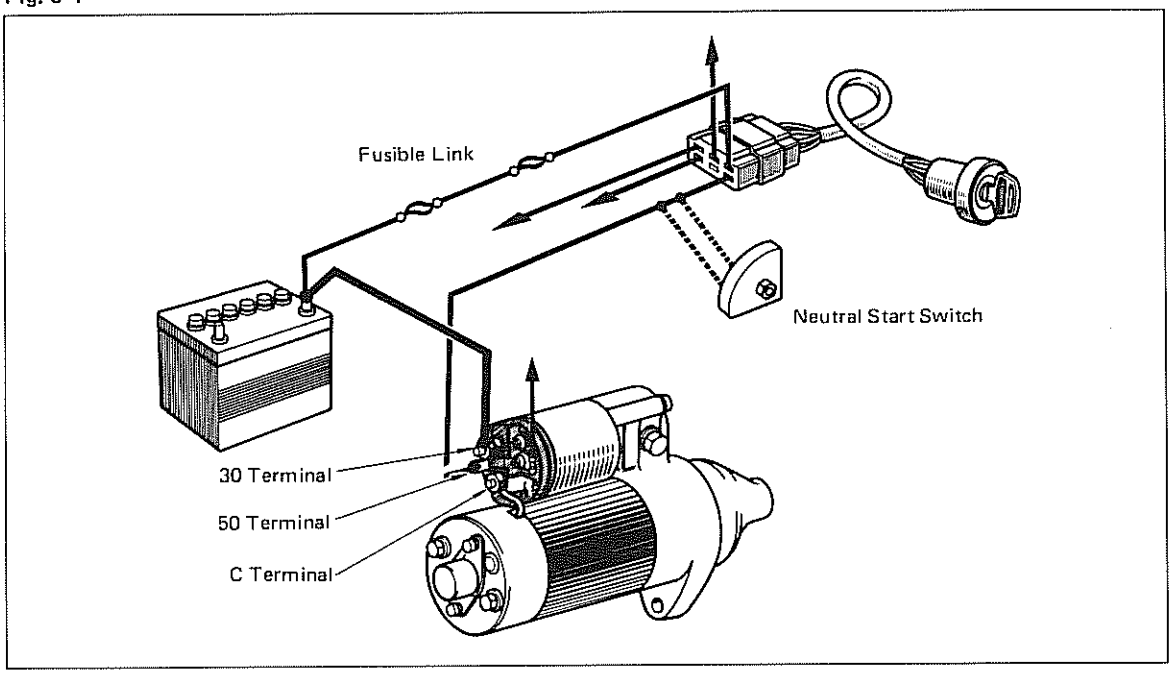


Fig. 9-2

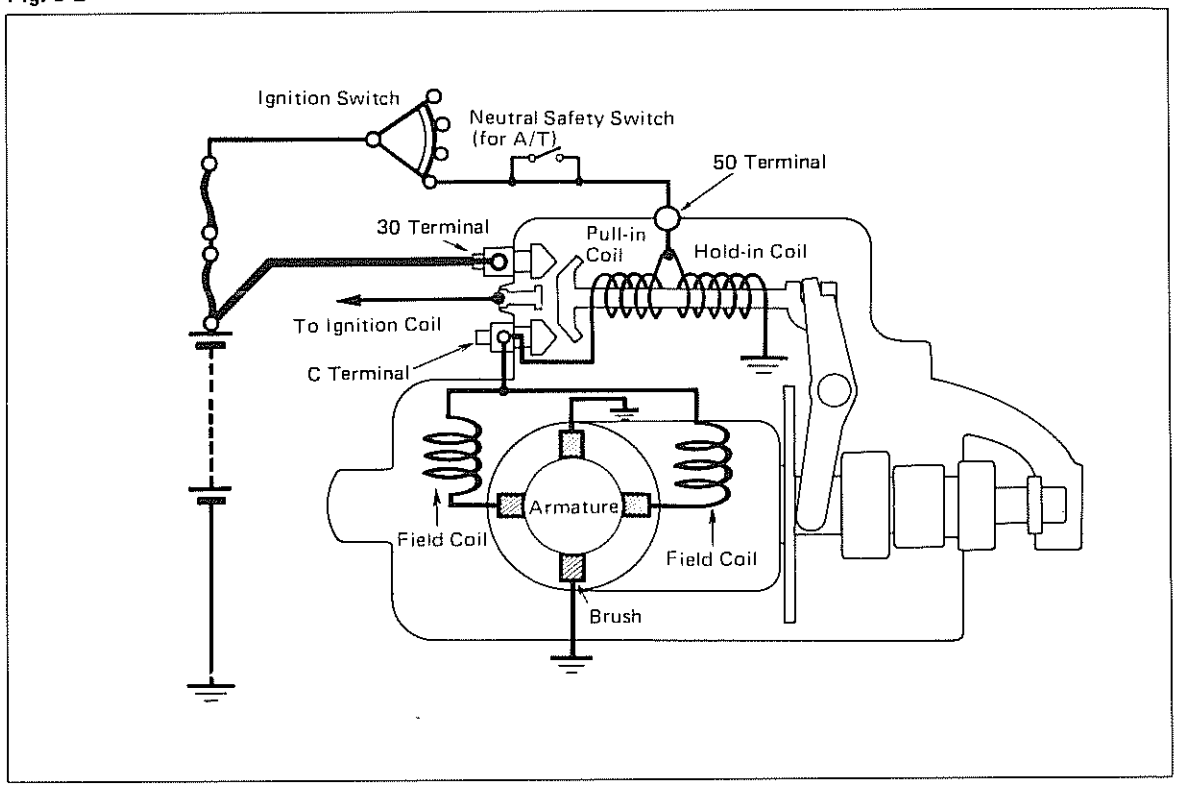
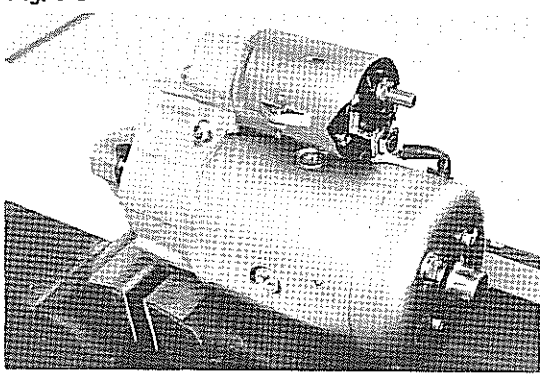


Fig. 9-3

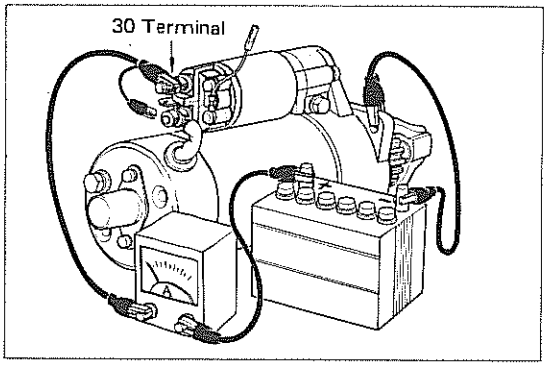


PERFORMANCE TEST

NO-LOAD PERFORMANCE TEST

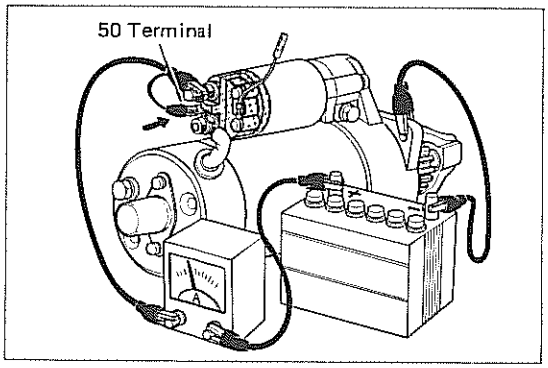
Secure the starter in a vise to prevent an accident.

Fig. 9-4



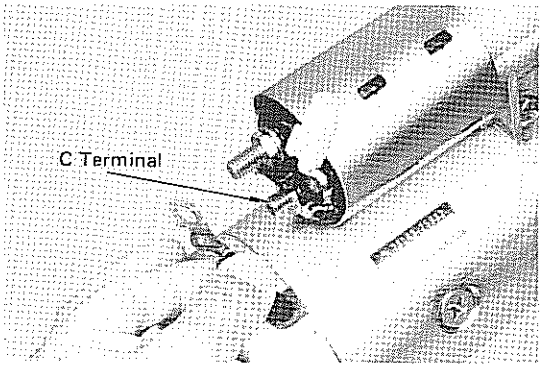
1. Connect the starter to a battery as shown in the figure .
   Positive side
   Battery (+)———Ammeter (+)
   Ammeter (–)——30 terminal
   Negative side
   Battery (–)———Starter body

Fig. 9-5



2. Connect 50 terminal.
   If the starter shows smooth and steady rotation with the pinion jumping out and draws less than specified current, it is satisfactory.
   Specified current: Less than 50A

Fig. 9-6

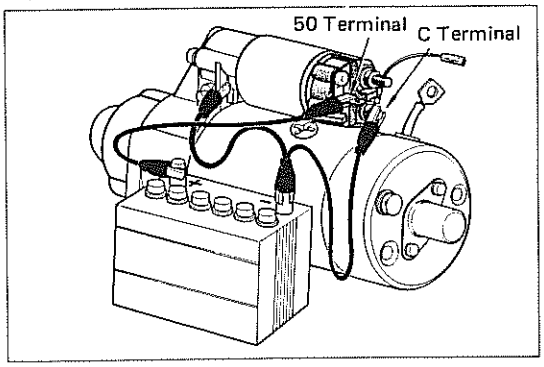


TEST MAGNETIC SWITCH

– Caution –
Each test must be performed within a short time (3 – 5 seconds) to prevent the coil from burning out.

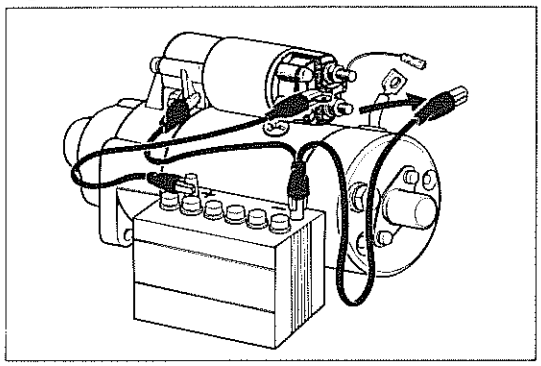
1. Disconnect C terminal.

Fig. 9-7



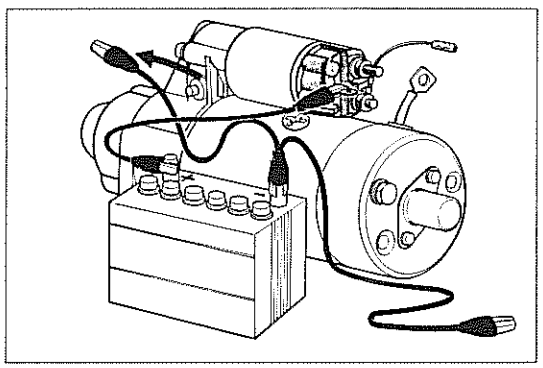
2. Pull-in test
Connect the magnetic switch to a battery as shown in the figure.
Negative side
Battery (–) ——→ Starter body and C terminal
Positive side
Battery (+) ——→ 50 terminal
If the pinion has definitely jumped out, the pull-in coil is satisfactory.

Fig. 9-8



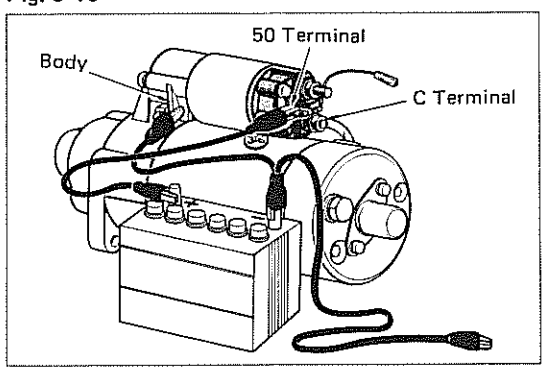
3. Hold-in test
Disconnect the C terminal. The pinion should remain projected.

Fig. 9-9



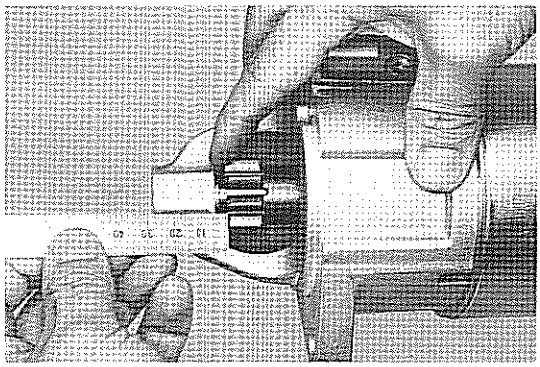
4. Check the plunger return.
When disconnecting the switch body, the pinion should return quickly.

Fig. 9-10



5. Check pinion clearance.
(1) Connect the field coil lead to C terminal.
(2) Connect the magnetic switch to a battery as shown in the figure.
Positive side
Battery (+) ——→ 50 terminal
Battery (–) ——→ Starter body

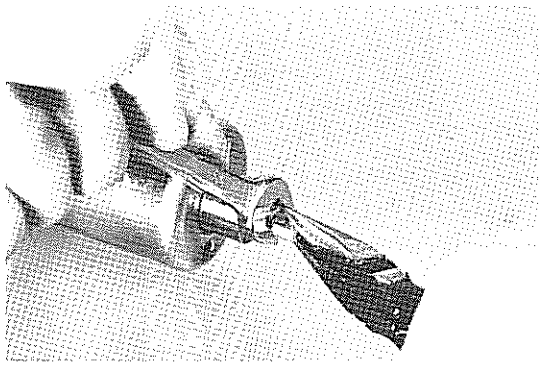
Fig. 9-11



(3) Move the pinion to the armature side to eliminate slack, and check the clearance between the pinion end and stop collar.

Standard clearance:
0.1 – 6.0 mm
(0.004 – 0.236 in.)

Fig. 9-12

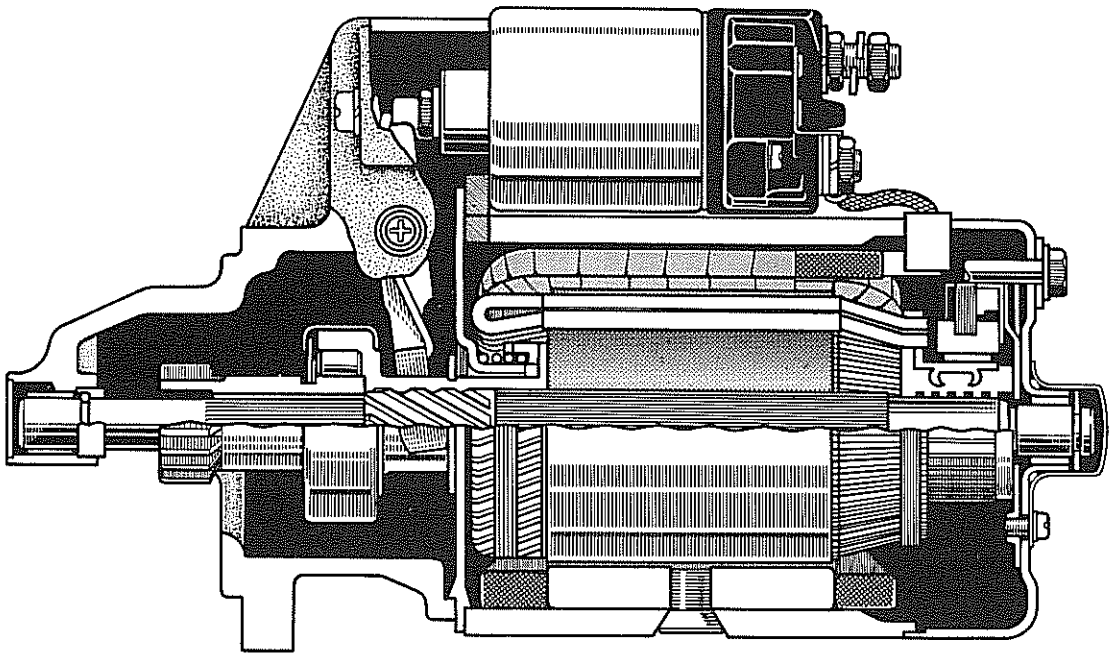


(4) Adjust if necessary after loosening the lock nut.

Clearance	Stud
Too large	Screw in
Too small	Screw out

CUTAWAY VIEW

Fig. 9-13



STARTER

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 9-14

1. Insulator
2. Magnetic Switch
3. Bearing Cover & Lock Plate
4. Bolt
5. Commutator End Frame
6. Brush Holder
7. Yoke
8. Drive Lever Bolt
9. Armature & Drive Lever
10. Snap Ring
11. Stop Collar
12. Clutch with Pinion Gear
13. Center Bearing

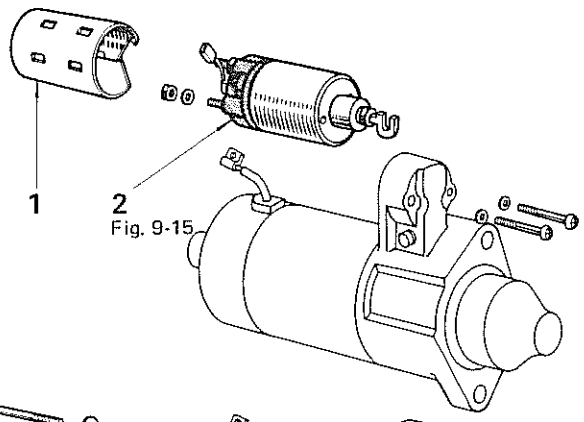


Fig. 9-15

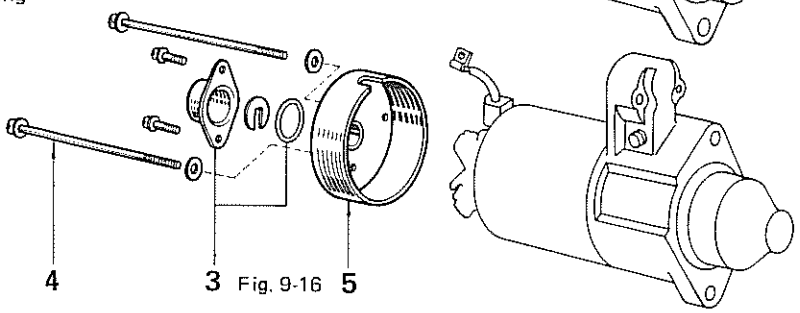


Fig. 9-16

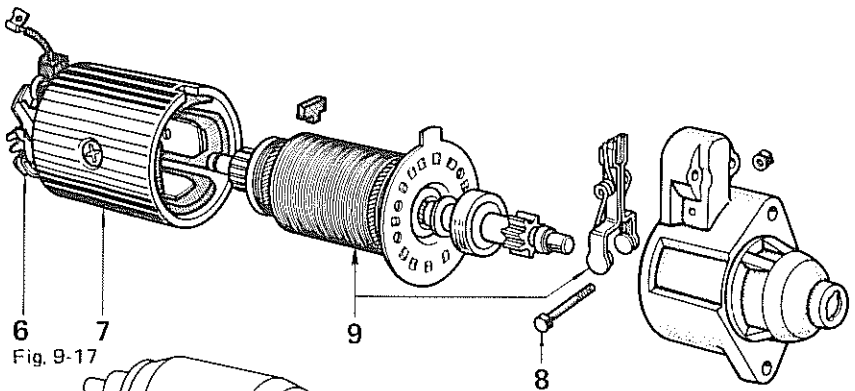


Fig. 9-17

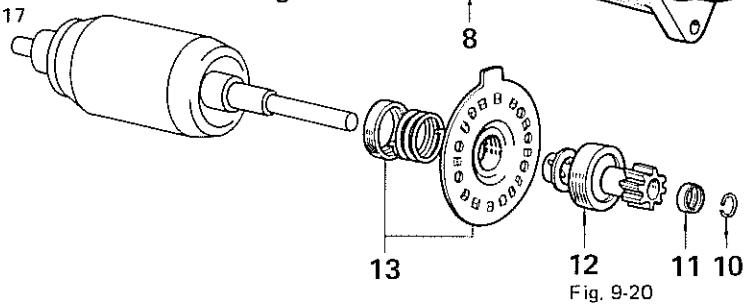
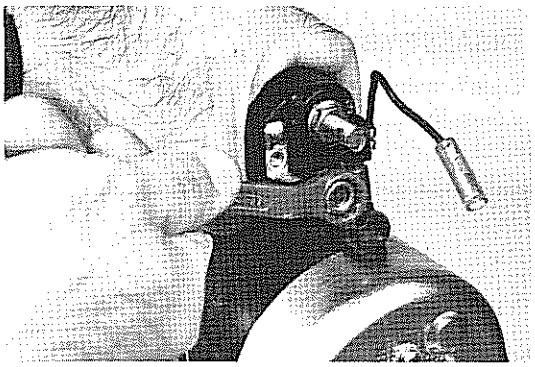


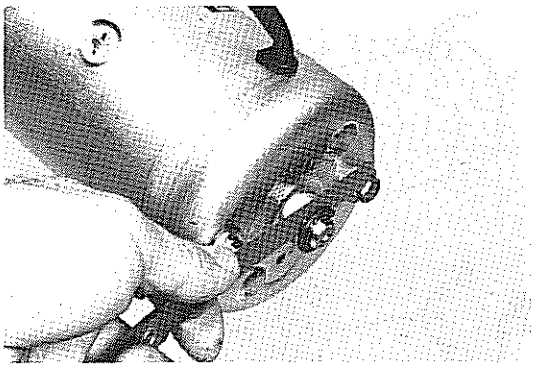
Fig. 9-18
9-19
Fig. 9-20

Fig. 9-15



Disconnect the lead wire before removing the magnetic switch.

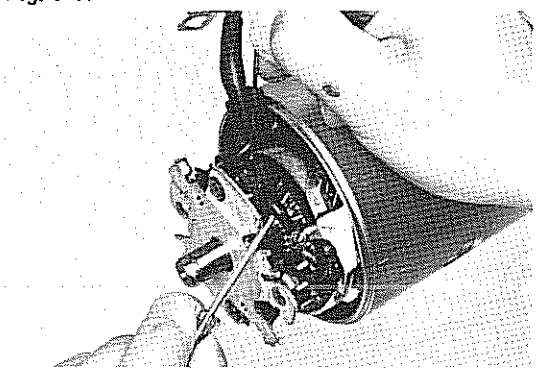
Fig. 9-16



Check the armature shaft thrust clearance.

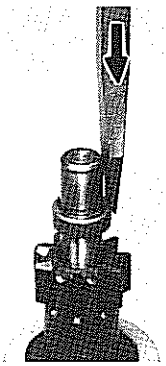
Thrust clearance limit: 0.1 mm (0.004 in.)

Fig. 9-17



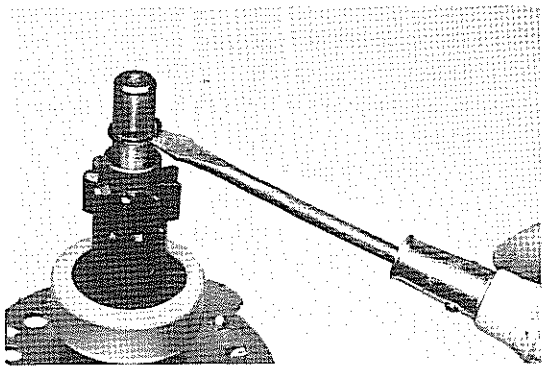
Take off the brushes and remove the brush holder.

Fig. 9-18



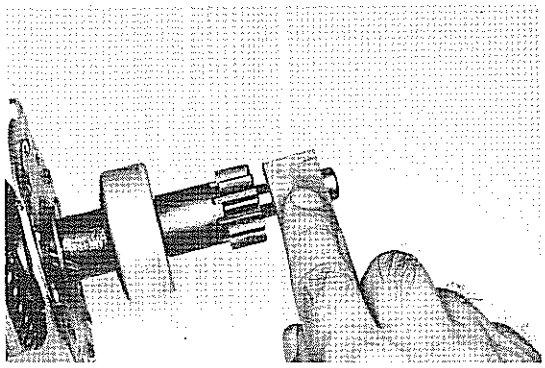
Tap in the stop collar with a screwdriver.

Fig. 9-19



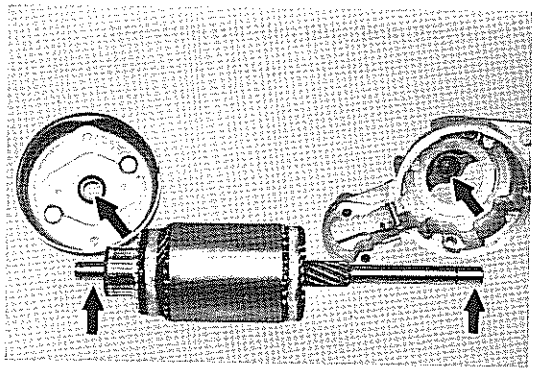
Pry off the snap ring with a screwdriver.

Fig. 9-20



If the pinion was difficult to pull out, smoothen it with an oil stone.

Fig. 9-21



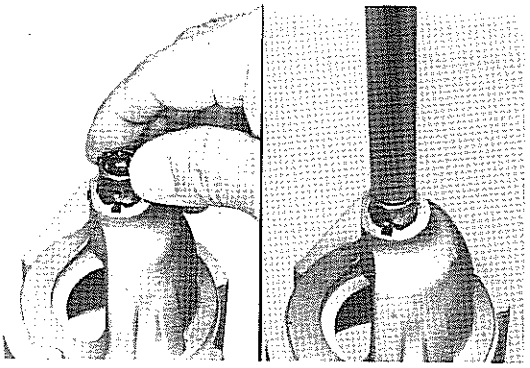
INSPECTION & REPAIR

Armature Shaft & Bearing

1. Inspect the armature shaft end, drive housing bushing and end frame bushing for wear or damage.

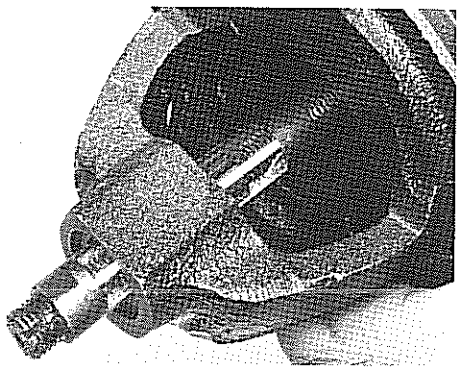
Oil clearance:
Limit 0.2 mm (0.01 in.)

Fig. 9-22



2. Bushing replacement.
   (1) Pry out the bushing cover and press out the bushing.
   (2) Align the bushing hole with the housing groove and press in a new bushing.

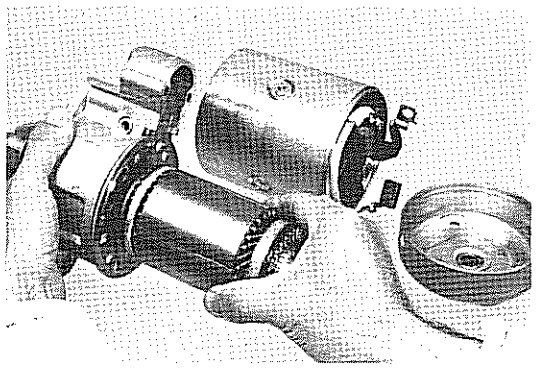
Fig. 9-23



(3) Ream the bushing to obtain the specified clearance.

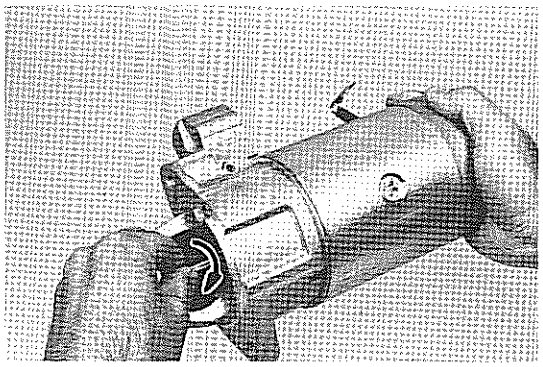
Oil clearance:
STD 0.035 – 0.077 mm (0.0014 – 0.0030 in.)

Fig. 9-24



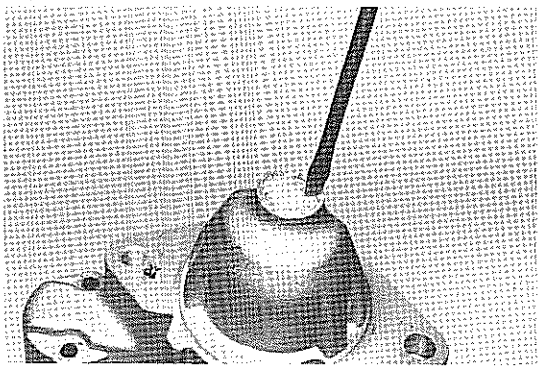
(4) Temporarily install the center bearing, armature shaft and end housing.

Fig. 9-25



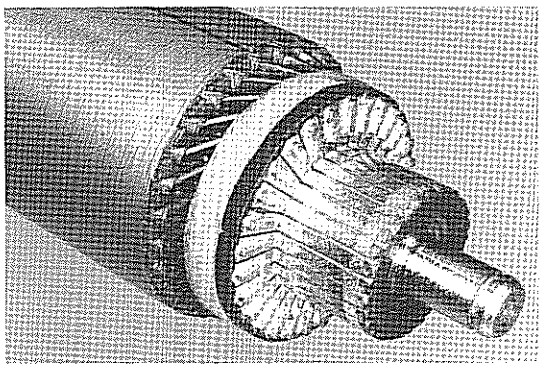
(5) Make sure the armature shaft rotates smoothly.

Fig. 9-26



(6) Clean the bore, and install a new bushing cover.

Fig. 9-27

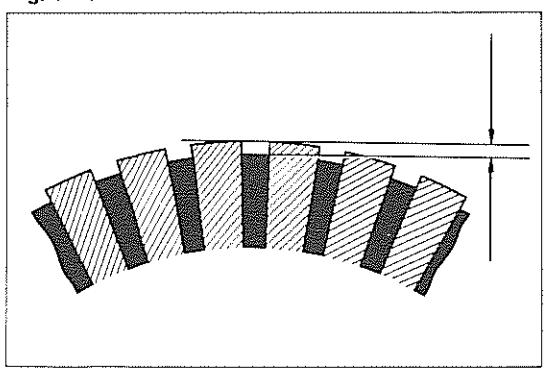


Commutator

Inspect for following items and repair or replace.

1. Dirty or burnt surface.
   Correct by sandpaper or lathe if necessary.

Fig. 9-28

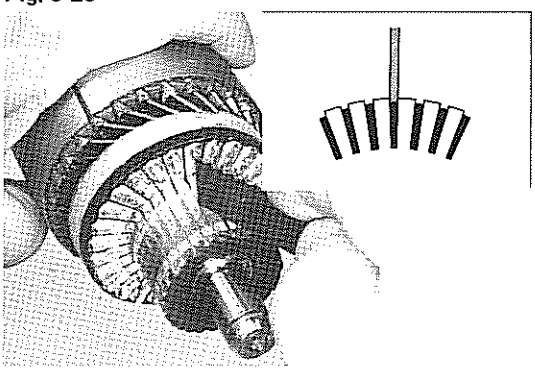


2. Depth of segment mica.

Mica depth:

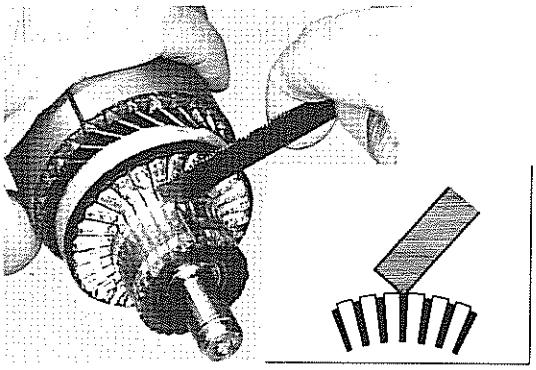
STD	**0.4 – 0.8 mm (0.02 – 0.03 in.)**
Limit	**0.2 mm (0.008 in.)**

Fig. 9-29



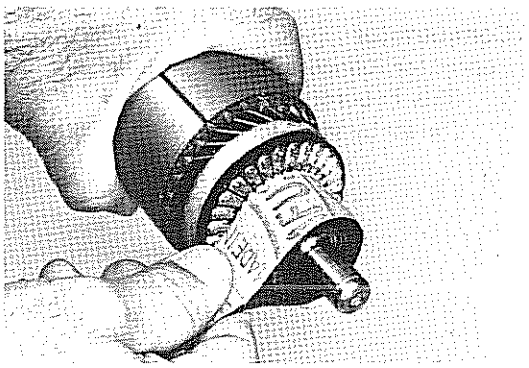
3. If the mica depth is below the limit, correct with a hacksaw blade.

Fig. 9-30



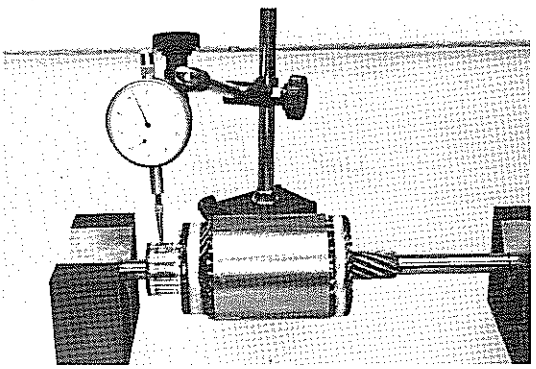
4. Smooth out the edge with a hacksaw blade.

Fig. 9-31



5. Use #400 sandpaper.

Fig. 9-32

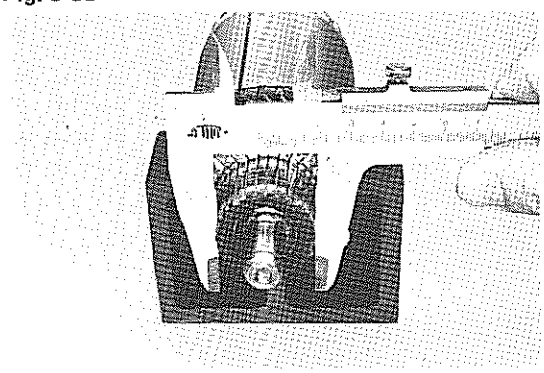


6. Runout: Correct on a lathe if it exceeds the limit.

Runout:

STD	**0.05 mm (0.002 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 9-33

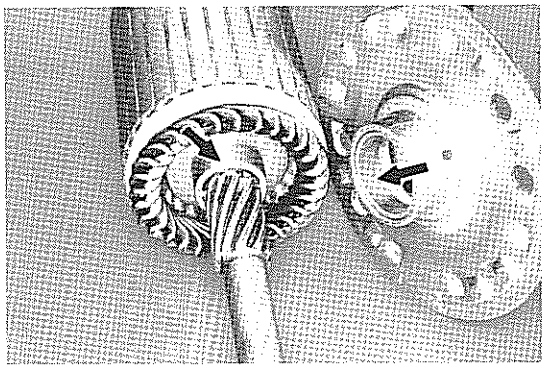


7. Surface wear: If below the limit, replace armature.

Commutator outer diameter:

STD	**32.7 mm (1.29 in.)**
Limit	**31 mm (1.2 in.)**

Fig. 9-34

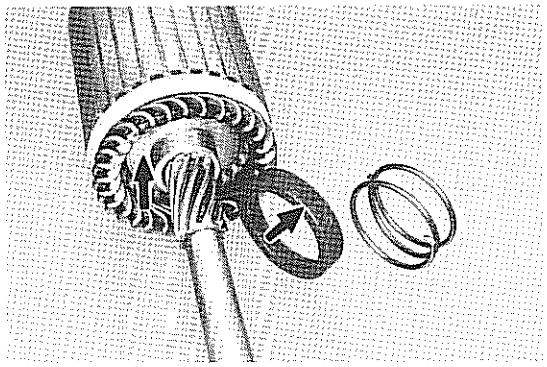


Center Bearing

1. Inspect center bearing for wear or damage.

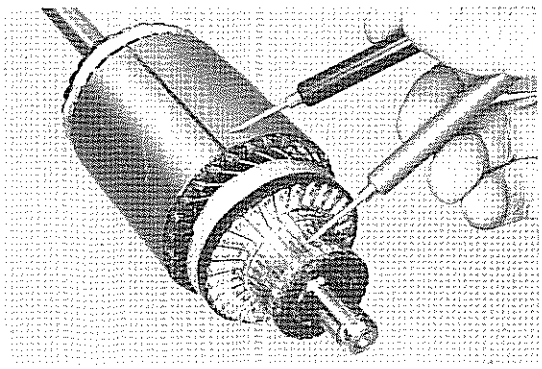
Clearance limit: 0.2 mm (0.01 in.)

Fig. 9-35



2. Inspect the holder for wear or damage.

Fig. 9-36

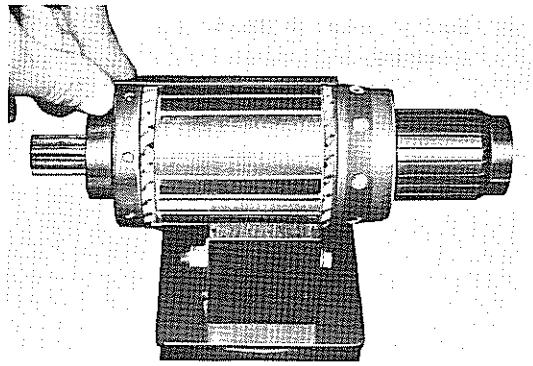


Armature Coil

1. Ground test

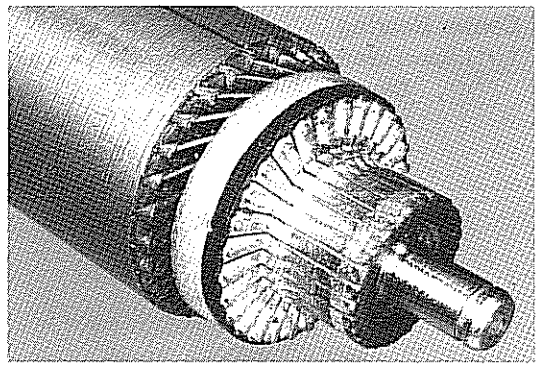
Check the commutator and armature coil core. If there is continuity, armature is grounded and must be replaced.

Fig. 9-37



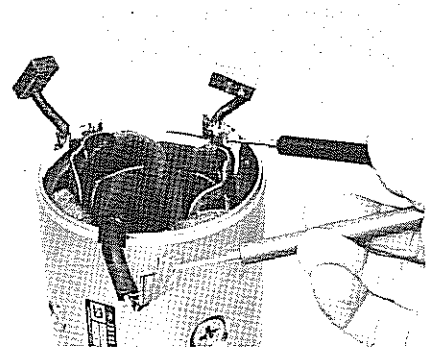
2. Short circuit test
Place the armature on the armature tester and hold a hacksaw blade against the armature core while turning the armature. If the hacksaw blade is attracted or vibrates, the armature is shorted and must be replaced.

Fig. 9-38



3. Solder condition
Check for continuity between the commutator and armature coil.

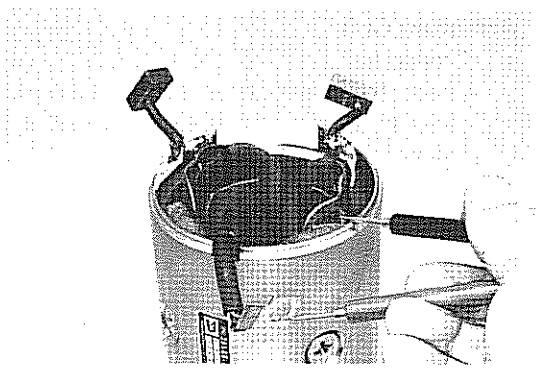
Fig. 9-39



Field Coil

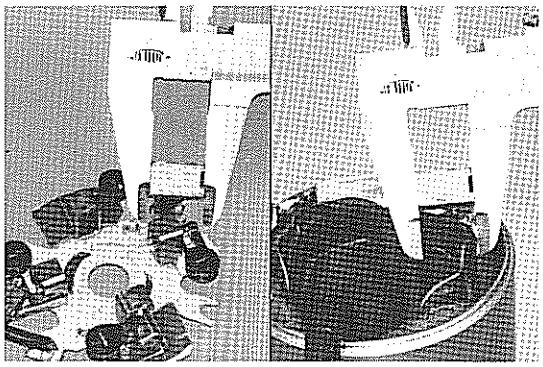
1. Open circuit test
Check for continuity between the lead wire and field coil brush soldered connection. If there is no continuity, there is an open circuit in field coil, and it should be replaced.

Fig. 9-40



2. Ground test
Check for continuity between field coil end and field frame.
If there is continuity, repair or replace field coil.

Fig. 9-41



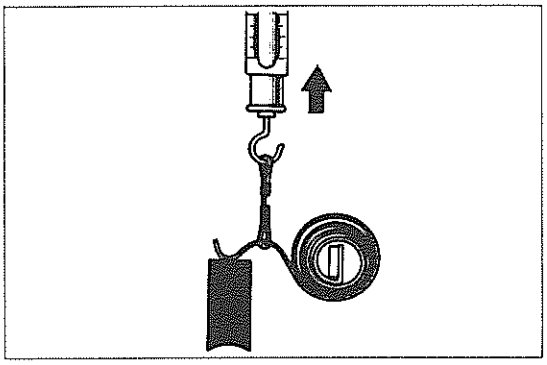
Brush

Measure the brush length and replace if below limit.

Brush length:

1.0 kw	STD	19 mm (0.7 in.)
	Limit	10 mm (0.4 in.)
0.8 kw	STD	16 mm (0.6 in.)
	Limit	10 mm (0.4 in.)

Fig. 9-42



Brush Spring

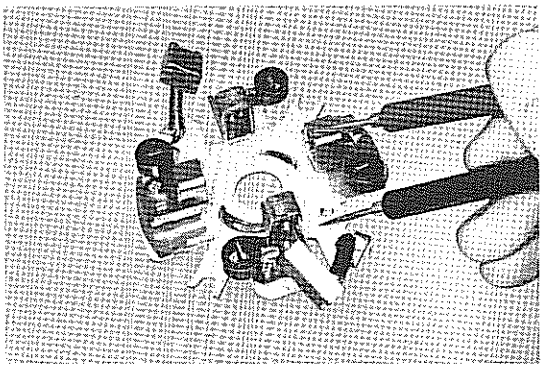
Measure the brush spring load with a pull scale. If the reading is below standard, replace the spring.

Tension: 3.2 – 4.0 kg (7.1 – 8.8 lb)

– Note –

Take the pull scale reading at the very instant the brush spring separates from the brush.

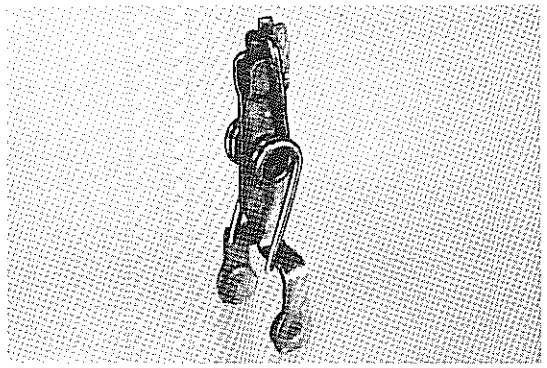
Fig. 9-43



Brush Holder

Check insulation between the (–) brush holder and (+) brush holder. Repair or replace if continuity is indicated.

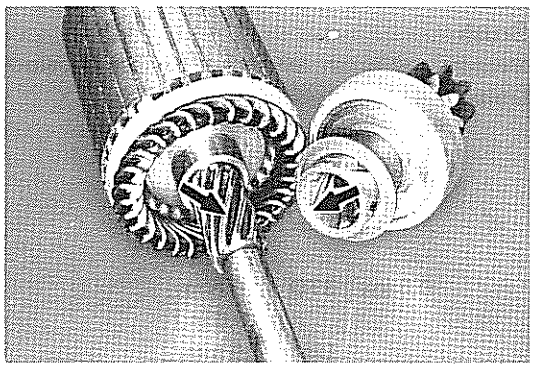
Fig. 9-44



Drive Lever

Inspect the drive lever and spring for wear. Replace if necessary.

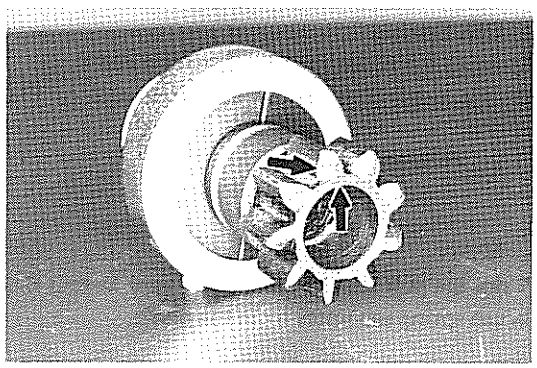
Fig. 9-45



Starter Clutch & Pinion Gear

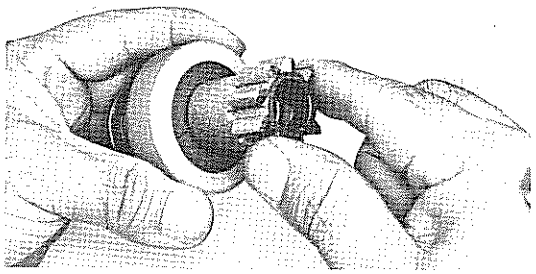
1. Inspect spline teeth for wear or damage. Replace if necessary.
2. Inspect pinion for smooth movement.

Fig. 9-46



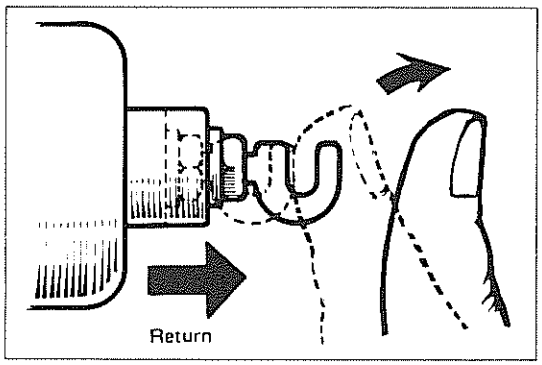
3. Inspect the pinion gear teeth and chamfer if worn or damaged.

Fig. 9-47



4. Rotate pinion. It should turn free in clockwise direction and lock when turned counterclockwise.

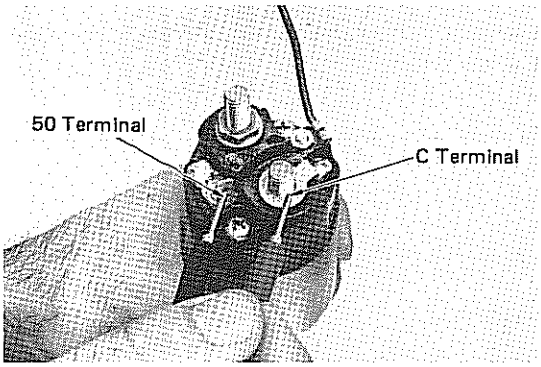
Fig. 9-48



Magnetic Switch

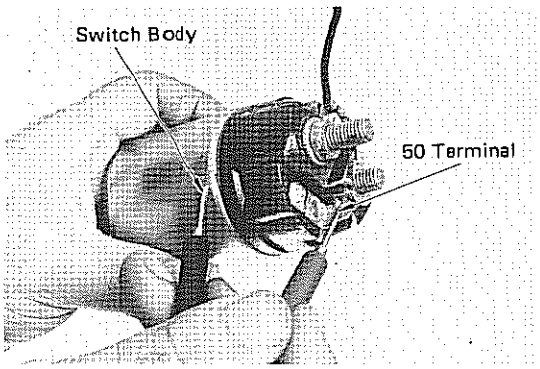
1. Push in the plunger and release it.
   The plunger should return quickly to its original position.

Fig. 9-49



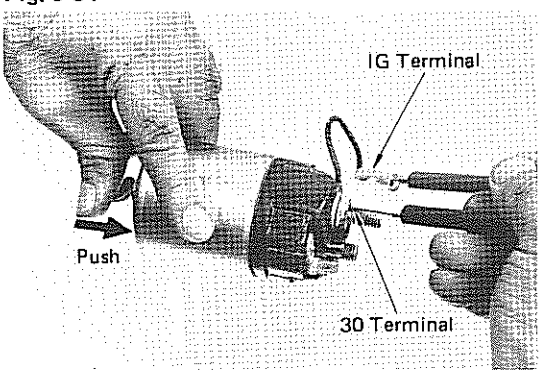
2. Pull-in coil open circuit test
Check for continuity between the 50 terminal and C terminal.

Fig. 9-50



3. Hold-in coil open circuit test
Check for continuity between the 50 terminal and switch body.

Fig. 9-51



4. I.G. terminal continuity test
Push in the plunger until it stops. Check for continuity between 30 terminal and lead wire.

– Note –
Perform the switch operation test after assembling it to the motor.

ASSEMBLY

Assemble the parts in the numerical order shown in the figure.

Fig. 9-52

1. Center Bearing (for 1.0 kw)
2. Clutch with Pinion Gear
3. Stop Collar
4. Snap Ring
5. Drive Lever & Housing
6. Drive Lever Bolt
7. Armature
8. Yoke
9. Brush Holder
10. Commutator End Frame
11. Bolt
12. Lock Plate & Cover
13. Magnetic Switch
14. Insulator

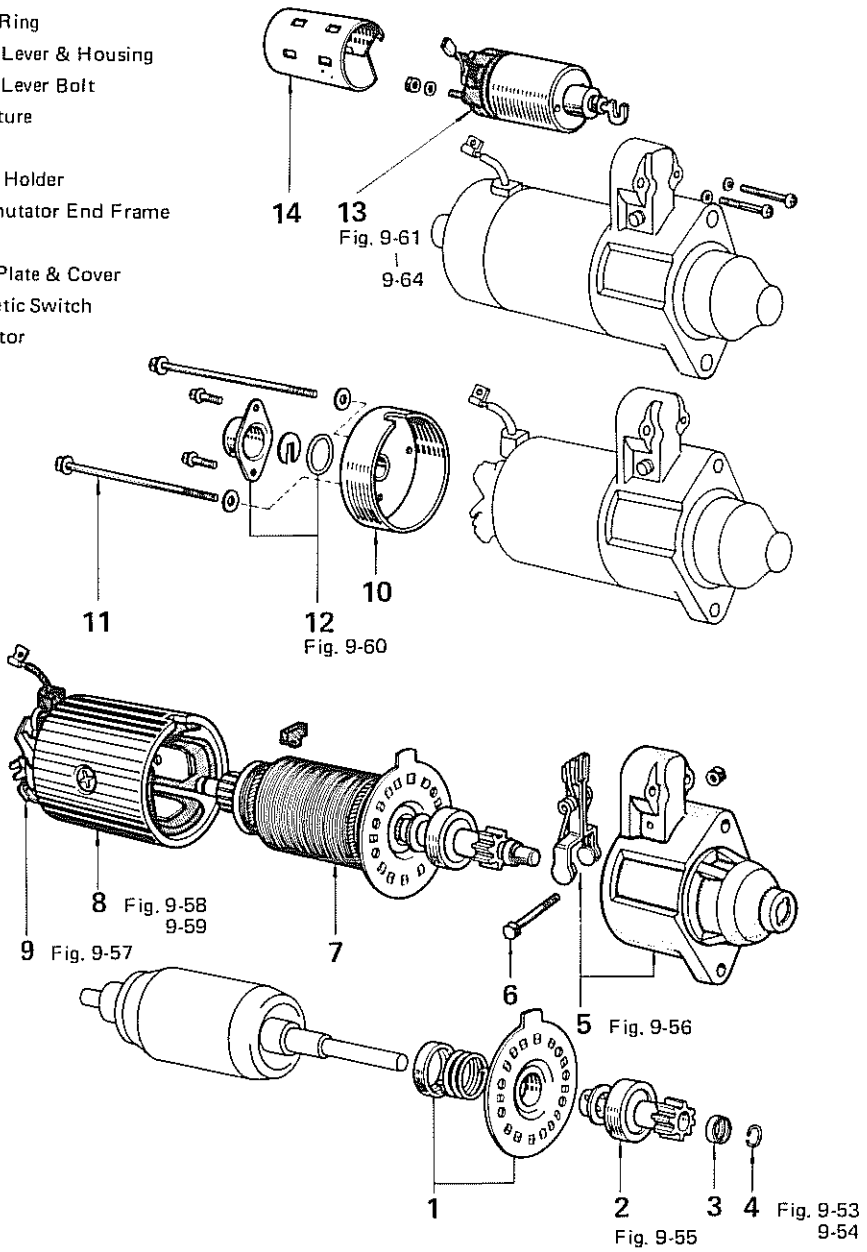
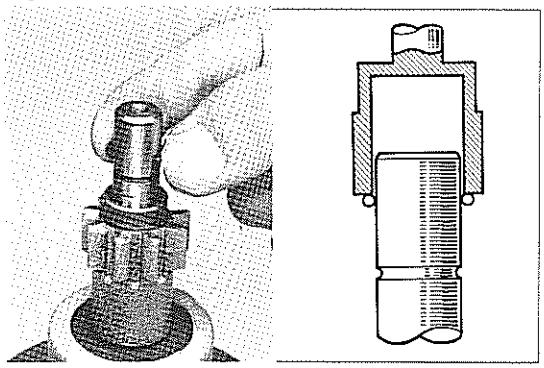
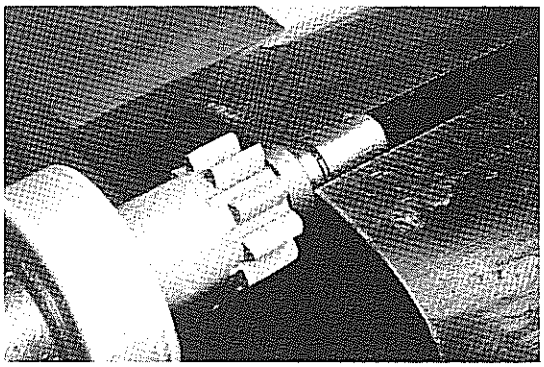


Fig. 9-53



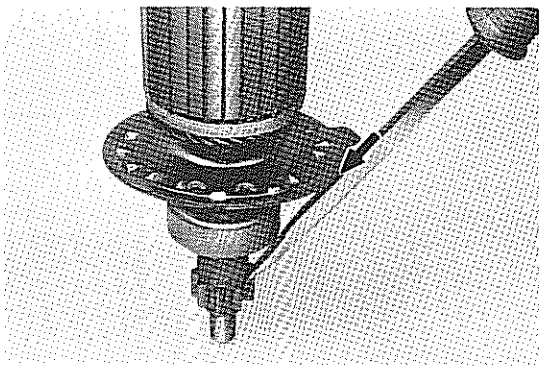
Drive in the snap ring with 14 mm socket wrech, then fit it into shaft groove.

Fig. 9-54



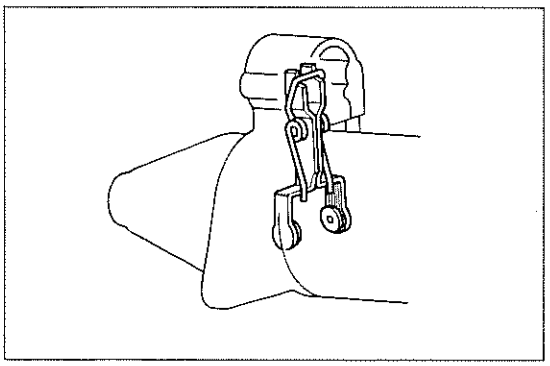
Compress the snap ring with a vise.
Make sure that the snap ring fits correctly.

Fig. 9-55



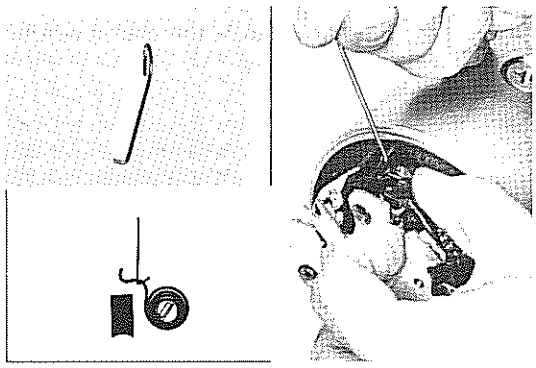
Tap the pinion to slide the stop collar onto the snap ring.

Fig. 9-56



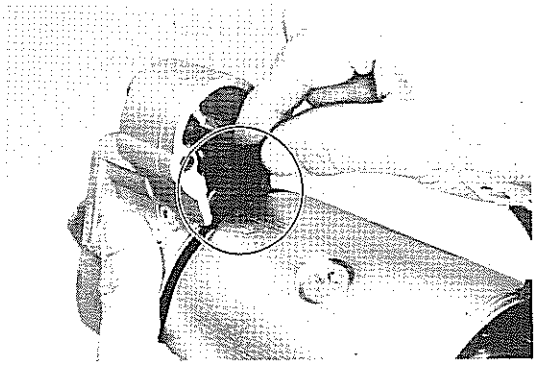
Assemble the drive lever in the direction as shown in the figure.

Fig. 9-57



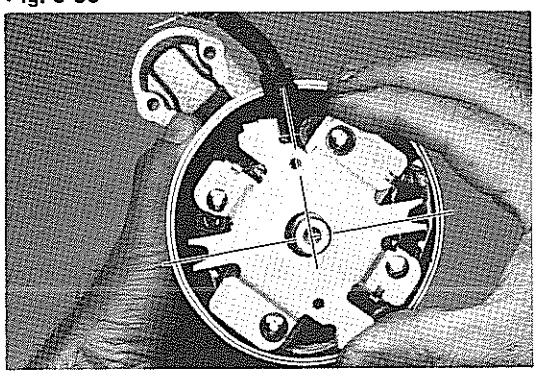
Assemble the brushes, being careful not to damage them.

Fig. 9-58



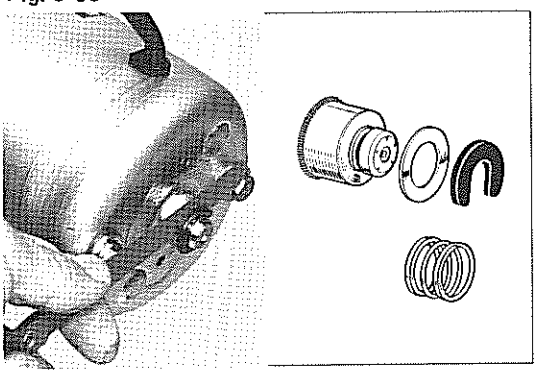
Match the noctch in the yoke with the tab on the rubber plate and assemble the yoke with the drive housing.

Fig. 9-59



After installation, position the holder as shown in the figure.

Fig. 9-60

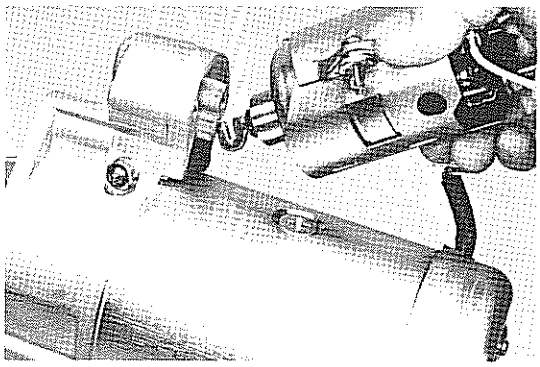


Install the lock plate and measure the armature shaft thrust clearance. If clearance exceeds the specified value, correct by increasing the number of shims.

Thrust clearance: 0.035 – 0.077 mm (0.0014 – 0.0030 in.)

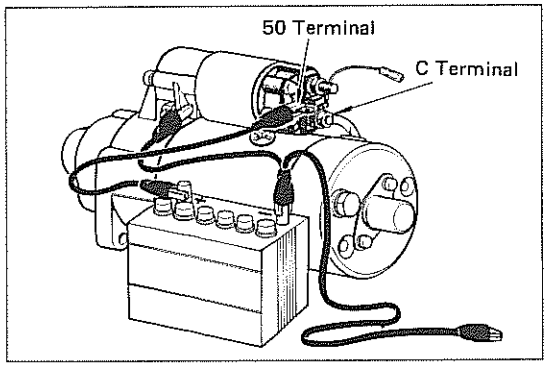
Adjusting shim thickness:
0.5 mm (0.02 in.)

Fig. 9-61



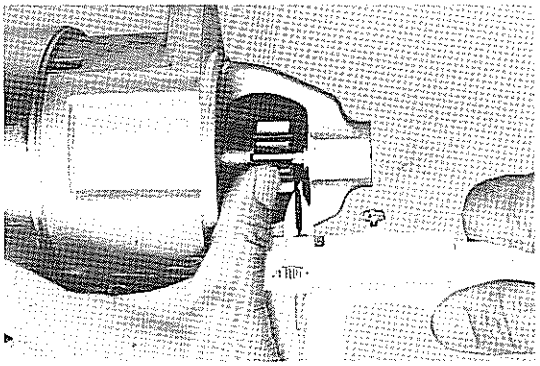
Hook the magnetic switch onto the drive lever spring from underneath.

Fig. 9-62



Check the pinion clearance.
Connect the field coil lead to C terminal.
Connect the magnetic switch to a battery as shown in the figure.
positive side
Battery (+) —— 50 terminal
Battery (–) —— Starter body

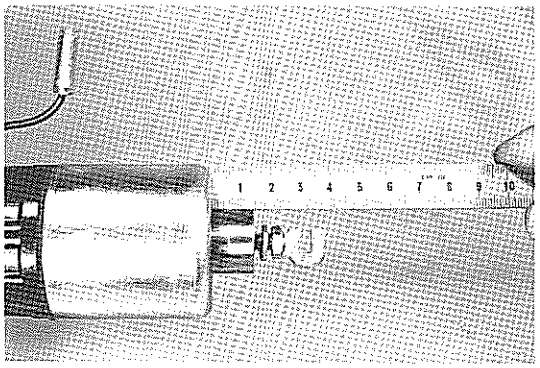
Fig. 9-63



Move the pinion to the armature side to eliminate the slack, and check the clearance between the pinion end and stop collar.

Standard clearance: 0.1 – 4.0 mm (0.004 – 0.157 in.)

Fig. 9-64



Measure the distance from the switch mounting surface to the stud end.

Stud length:
STD approx. 34 mm (1.3 in.)

To adjust, loosen the lock nut and screw the stud in or out.

REDUCTION TYPE STARTING SYSTEM CIRCUIT

Fig. 9-65

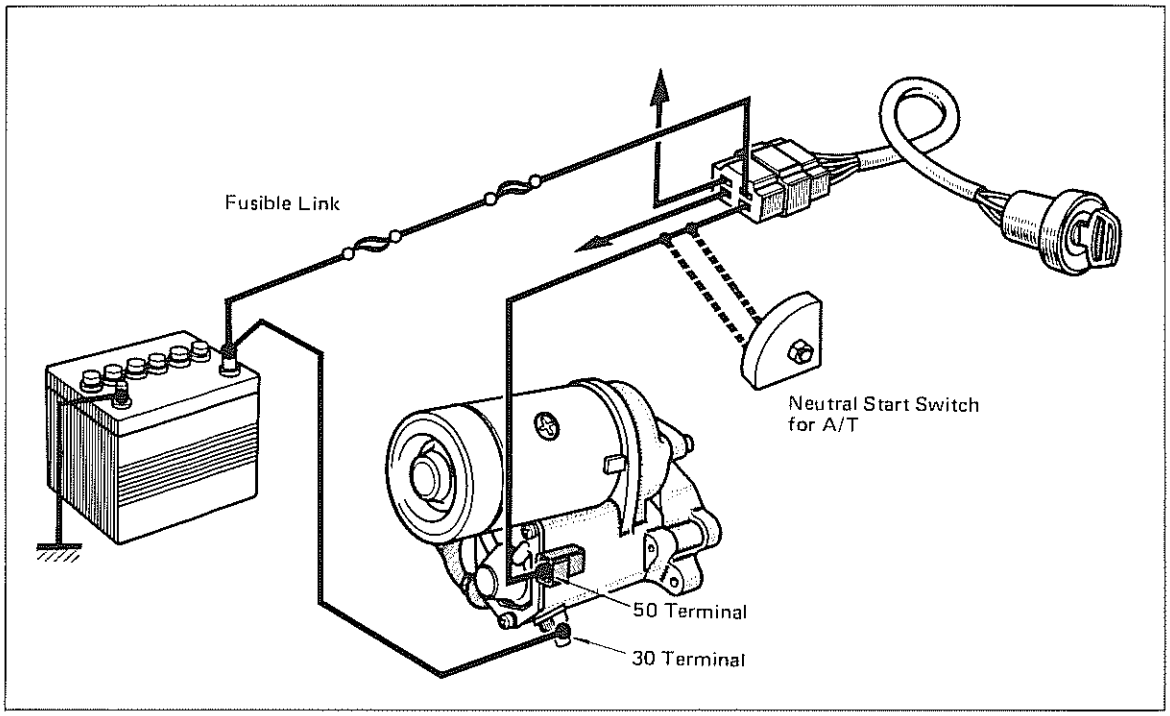


Fig. 9-66

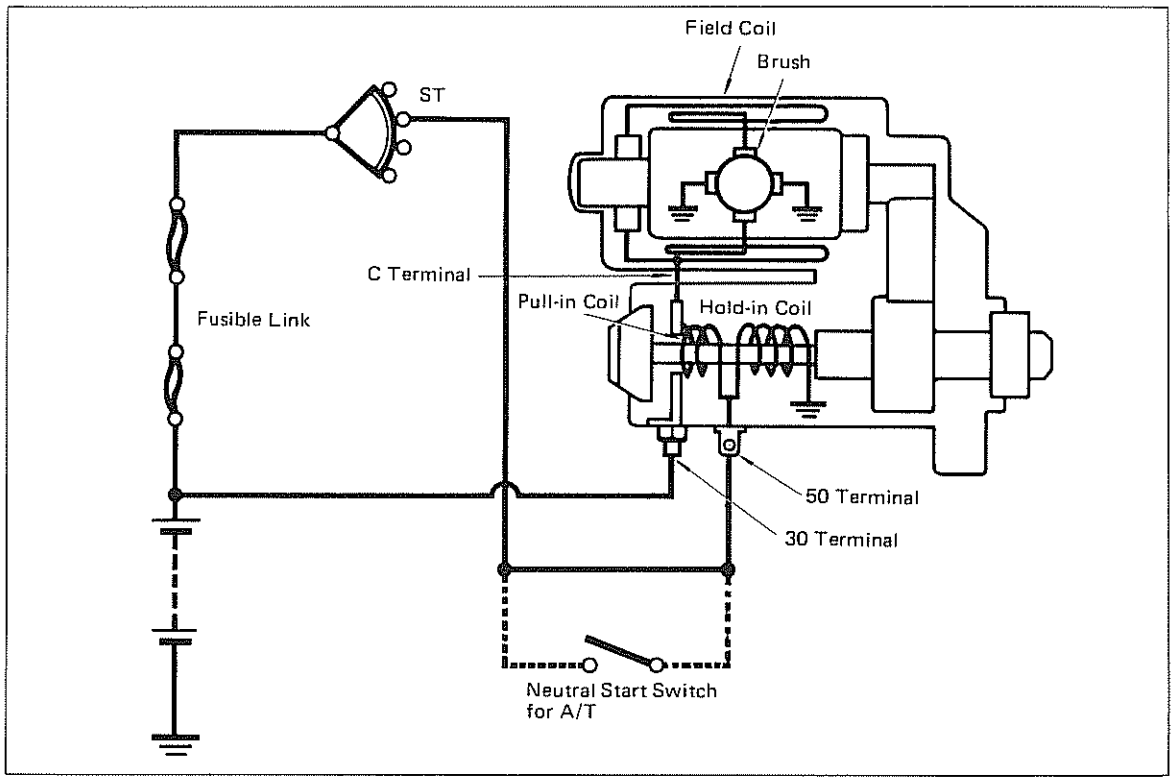
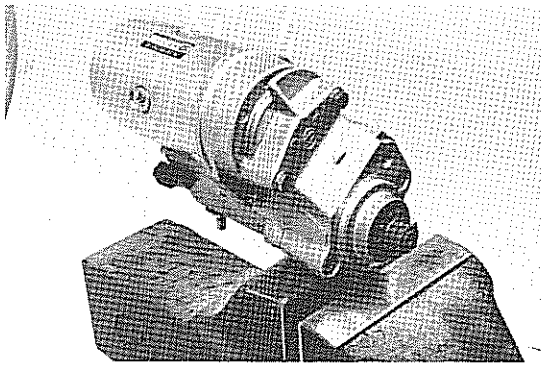


Fig. 9-67

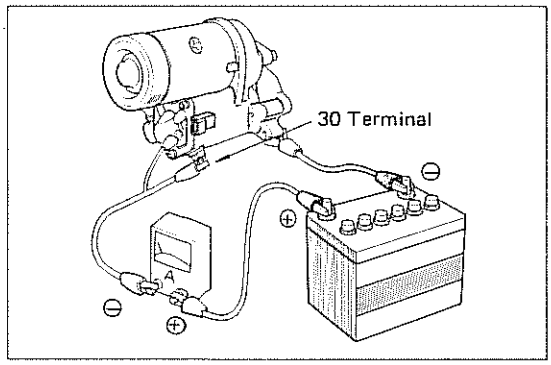


PERFORMANCE TEST

NO-LOAD PERFORMANCE TEST

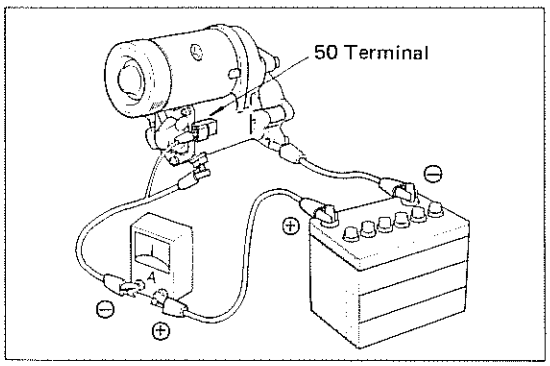
1. Secure the starter in a vise to prevent an accident.

Fig. 9-68



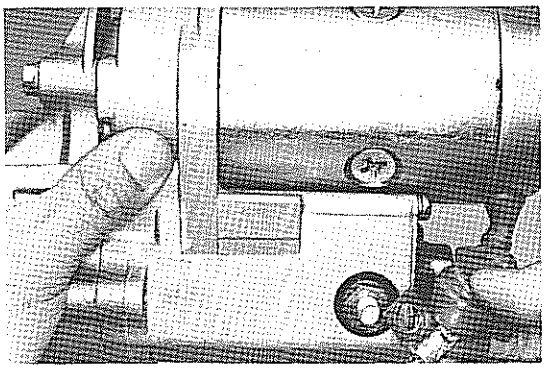
2. Connect the starter to a battery as shown in the figure.
   Positive side
   Battery (+) ——— Ammeter (+)
   Ammeter (–) ——— 30 terminal
   Negative side
   Battery (–) ——— Starter housing

Fig. 9-69



3. Connect the positive wire to the 50 terminal.
   If the starter shows smooth and steady rotation with the pinion jumping out and draws less than specified current, it is satisfactory.
   Specified current: Less than 90A

Fig. 9-70

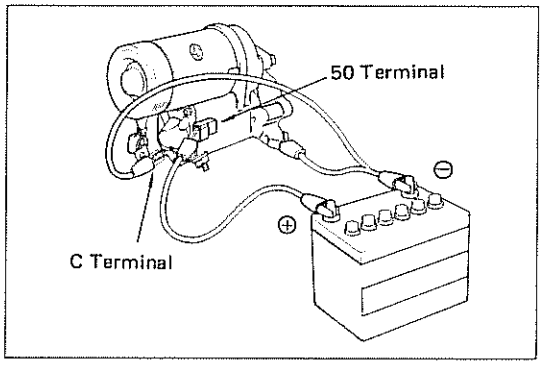


TEST MAGNETIC SWITCH

– Caution –
Each test must be performed within a short time (3 – 5 seconds) to prevent the coil from burning out.

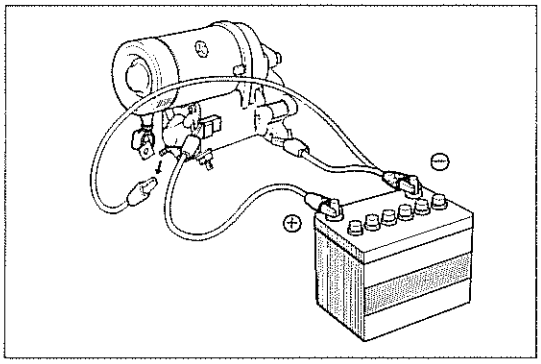
1. Disconnect the C terminal.

Fig. 9-71



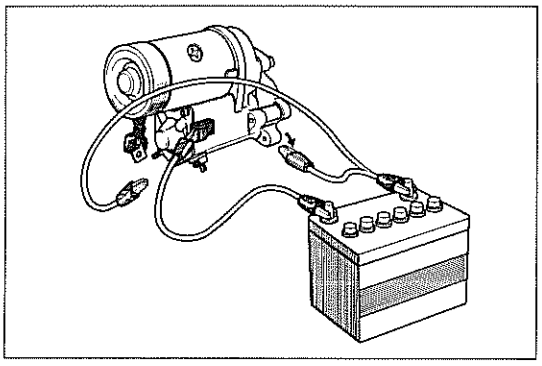
2. Test the pull-in coil.
Connect the magnetic switch to a battery as shown in the figure. The pinion should jump out.
Negative side
Battery (–) ——— Starter housing and C terminal
Positive side
Battery (+) ——— 50 terminal

Fig. 9-72



3. Test the hold-in coil.
With the same connections as in the Pull-in coil test, disconnect the C terminal.
At this time, the pinion should remain projected.

Fig. 9-73

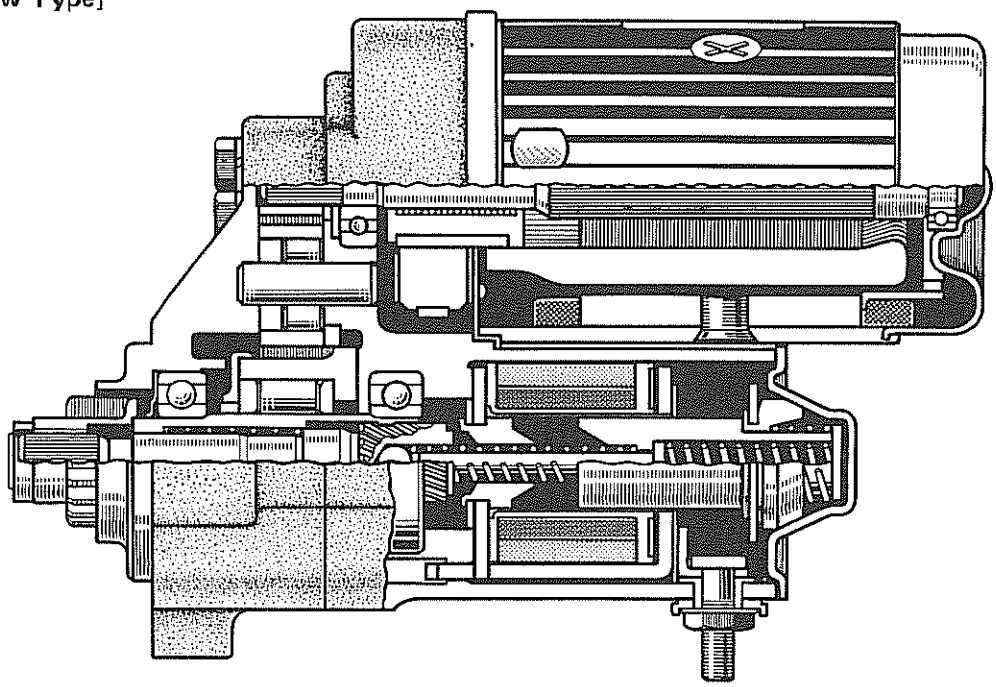


4. Check pinion return.
When disconnecting the cable from starter housing, the jumped-out pinion should return quickly.

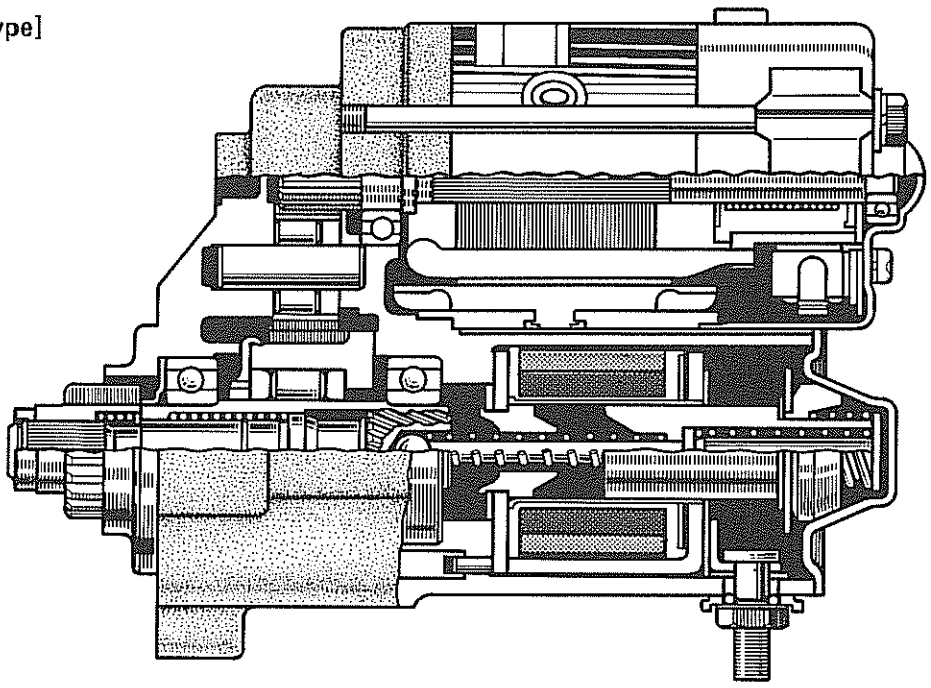
CUTAWAY VIEW

Fig. 9-74

[1.4 kw Type]



[0.9 kw Type]

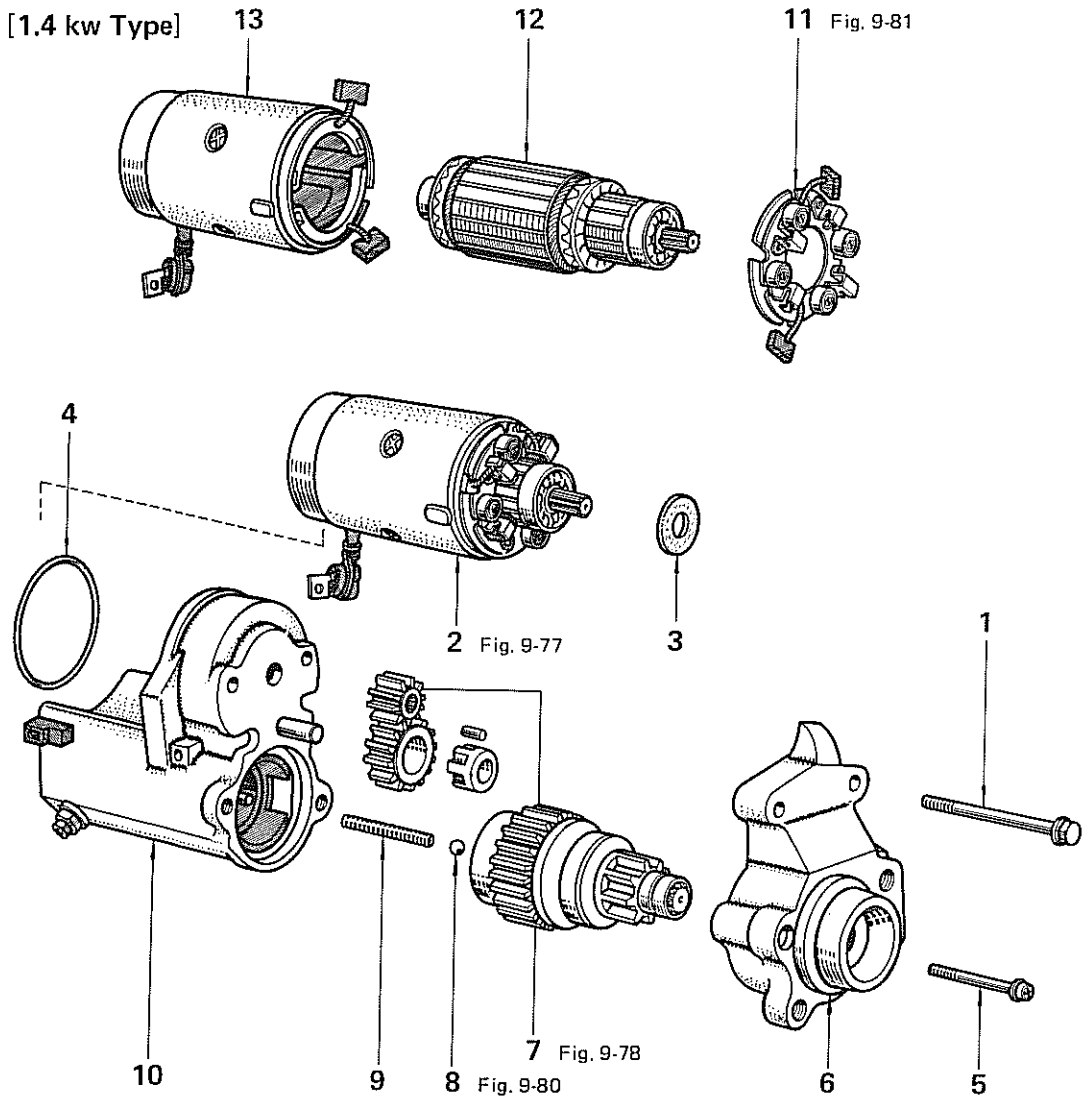


REDUCTION TYPE STARTER

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 9-75

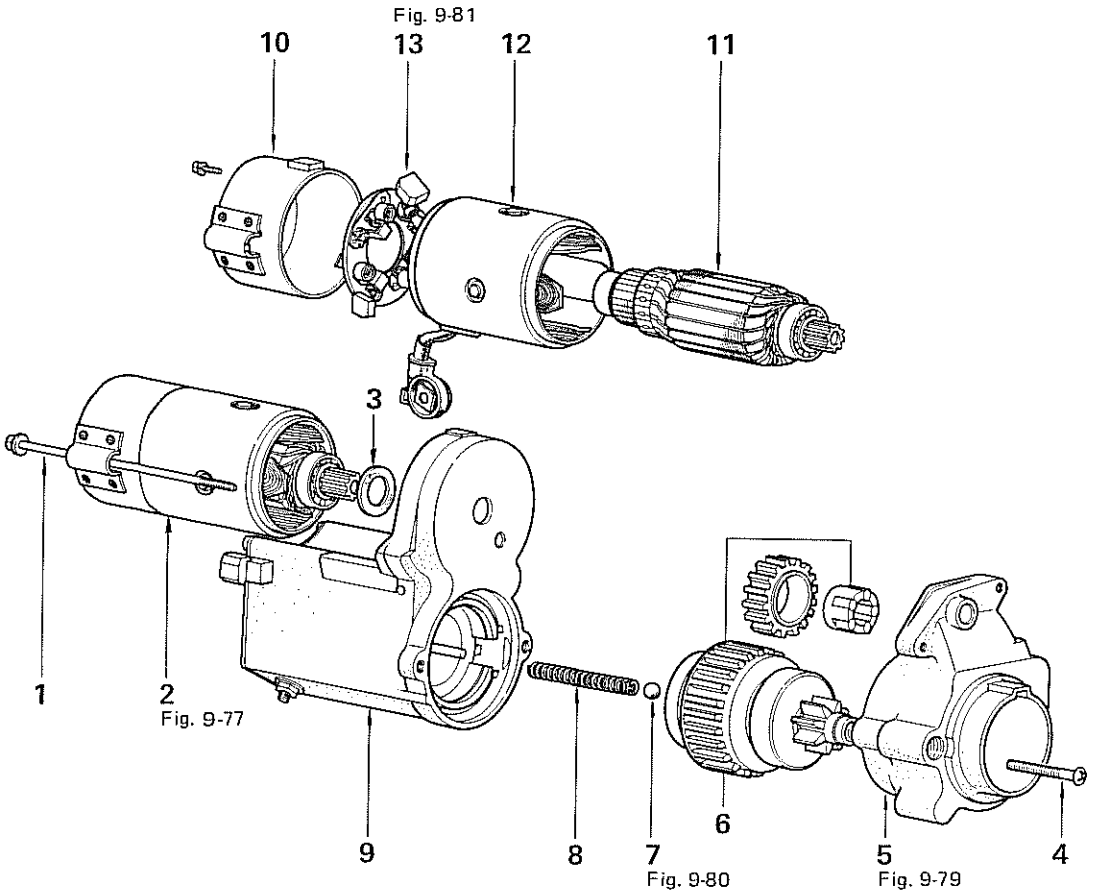


1. Bolt
2. Armature & Field Frame
3. Felt Seal
4. O Ring
5. Bolt
6. Starter Housing
7. Clutch, Idler Gear & Pinion Gear
8. Steel Ball
9. Plunger Return Spring
10. Magnetic Switch
11. Brush Holder
12. Armature
13. Field Frame

Disassemble the parts in the numerical order shown in the figure.

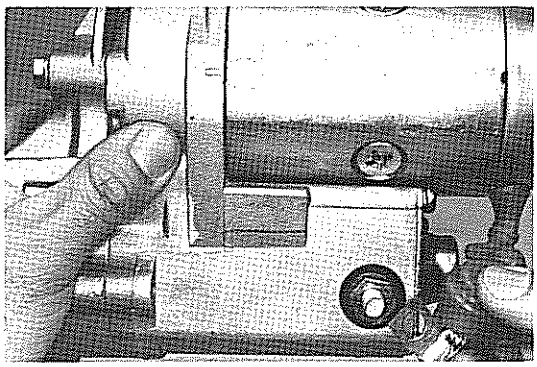
Fig. 9-76

[0.9 kw Type]



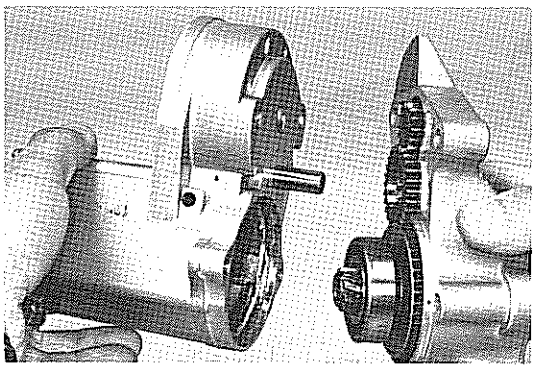
1. Through Bolt
2. Field Frame
3. Felt Seal
4. Bolt
5. Starter Housing
6. Clutch & Idler Gear
7. Steel Ball
8. Plunger Return Spring
9. Magnetic Switch
10. End Cover
11. Armature
12. Field Frame
13. Brush Holder

Fig. 9-77



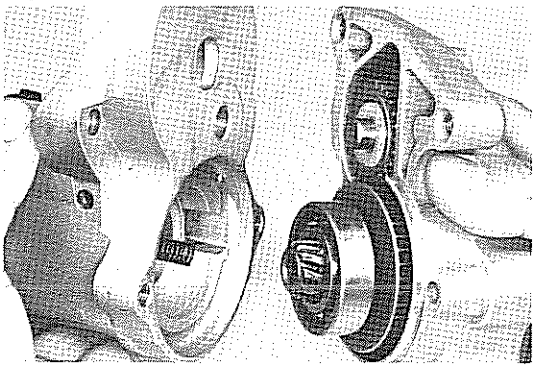
Disconnect the lead wires from the magnetic switch.

Fig. 9-78



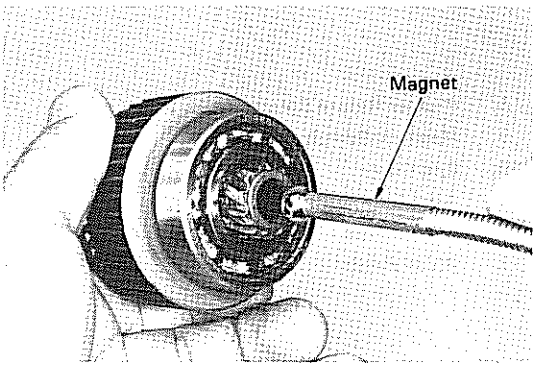
[In case of 1.4 kw type]
Remove the starter housing together with the pinion gear, idler gear and clutch.

Fig. 9-79



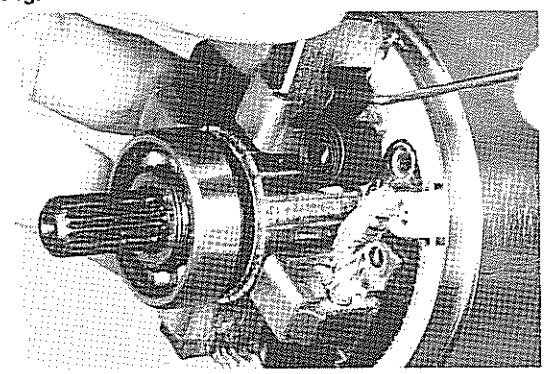
[In case of 0.9 kw type]
Remove the starter housing together with the idler gear and clutch.

Fig. 9-80



Remove the steel ball from the clutch shaft hole with a magnet.

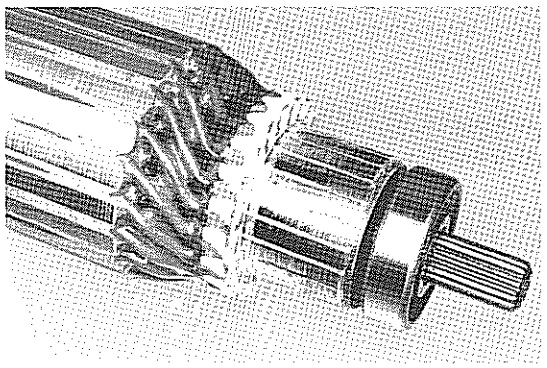
Fig. 9-81



Lift up the brush spring and pull out the brush from the brush holder.

– Caution –
Use care not to damage the brush and commutator. Also avoid getting oil or grease on them.

Fig. 9-82



INSPECTION & REPAIR

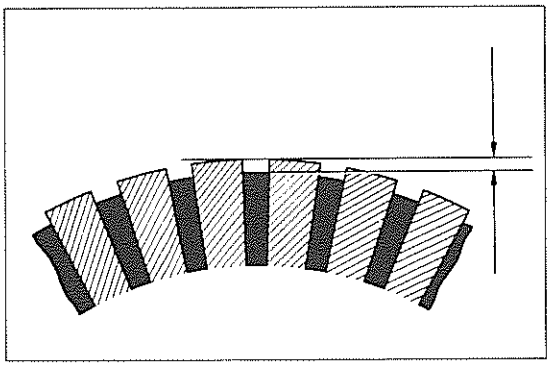
Wipe off dirt and gease from the disassembled parts.

Commutator

Inspect for the following items and repair or replace as necessary.

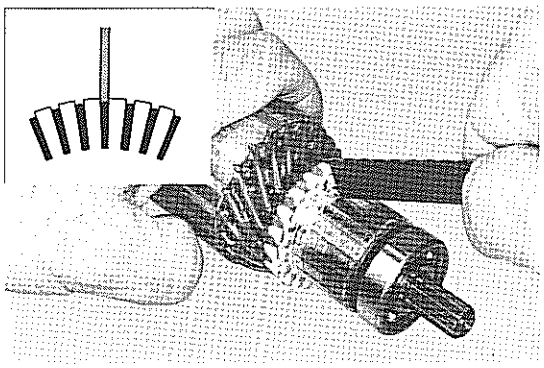
1. Dirty or burnt surface:
   Correct with sandpaper or a lathe if necessary.

Fig. 9-83



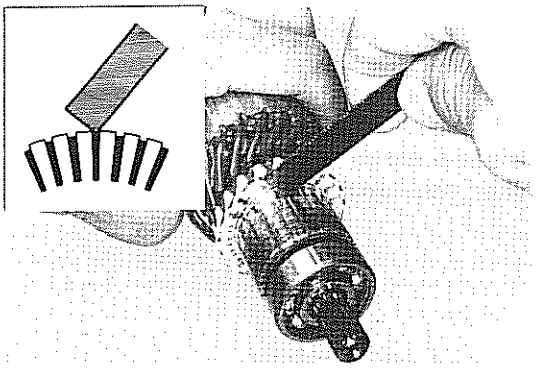
2. Depth of segment (Mica depth):
   Mica depth:
   STD 0.45 – 0.75 mm (0.018 – 0.030 in.)
   Limit 0.2 mm (0.01 in.)

Fig. 9-84



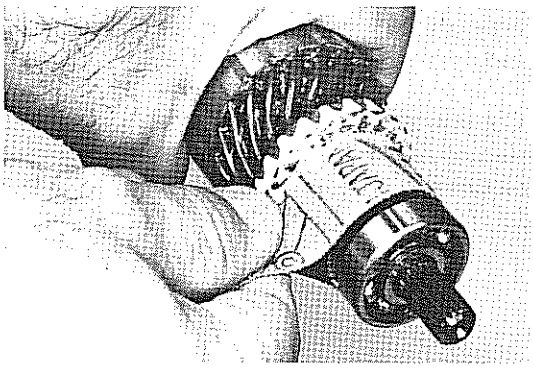
3. If the mica depth is below the limit, correct with a hacksaw blade.

Fig. 9-85



4. Smooth out the edge with a hacksaw blade.

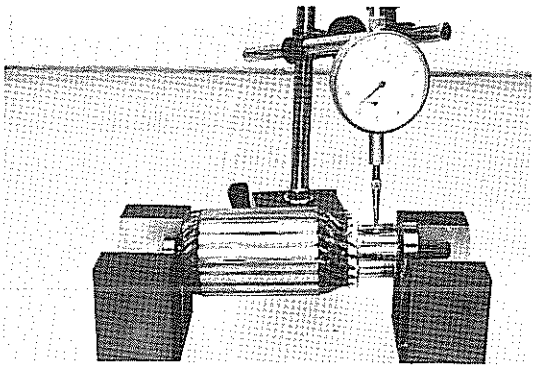
Fig. 9-86



5. After correcting, eliminate chips with sandpaper.

– Note –
Use # 400 sandpaper.

Fig. 9-87

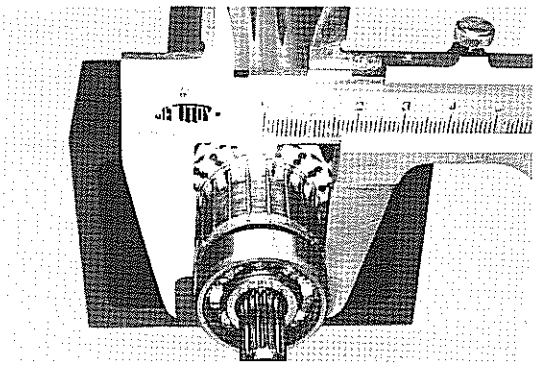


6. Runout: Correct on a lathe if it exceeds the limit.

Runout:

STD	**Less than 0.02 mm (0.001 in.)**
Limit	**0.05 mm (0.002 in.)**

Fig. 9-88

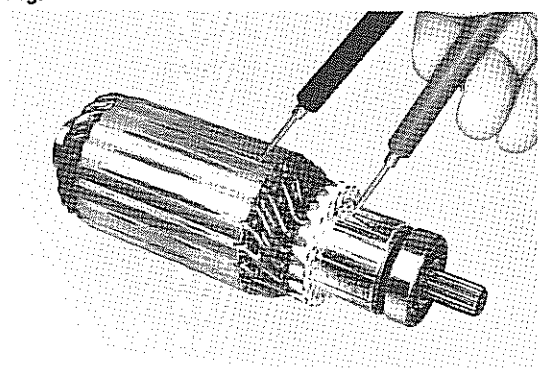


7. Surface wear: If below the limit, replace armature.

Diameter:

STD	**30 mm (1.2 in.)**
Limit	**29 mm (1.1 in.)**

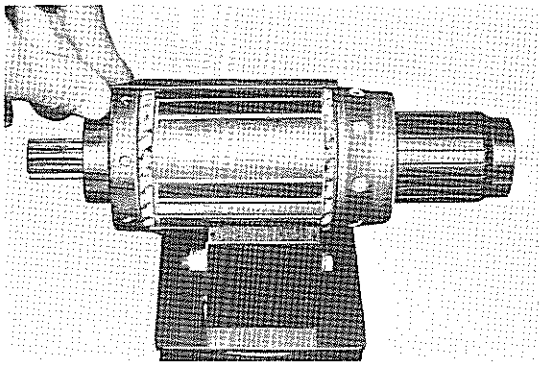
Fig. 9-89



Armature Coil

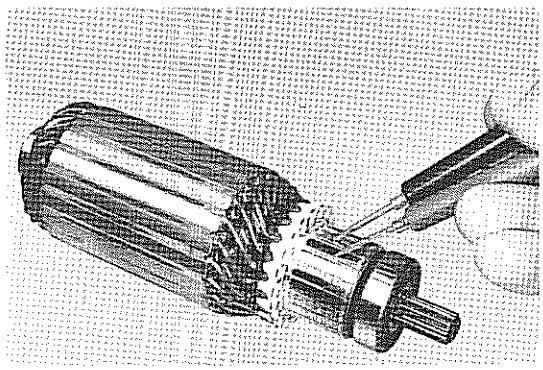
1. Ground test
   Using an armature tester or a circuit tester, check the commutator and armature coil core. If there is continuity, the armature is grounded and must be replaced.

Fig. 9-90



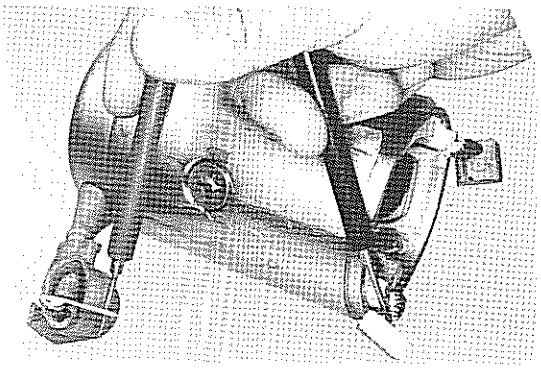
2. Short circuit test
   Place the armature on the armature tester and hold a hacksaw blade against the armature core while turning the armature. If the hacksaw blade is attracted or vibrates, the armature is shorted and must be replaced.

Fig. 9-91



3. Open circuit test
   Using the armature tester or a circuit tester, check for continuity between the segments. If there is no continuity at any test point, there is an open circuit and armature must be replaced.

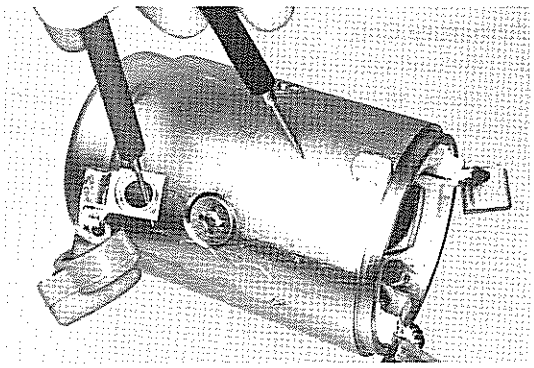
Fig. 9-92



Field Coil

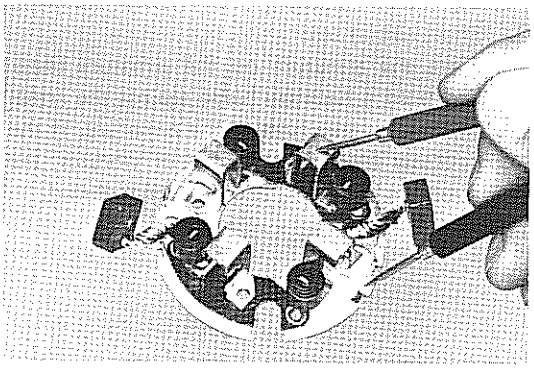
1. Open circuit test
   Check for continuity between the lead wire and field coil brush lead. If there is no continuity, there is an open circuit in the field coil, and it should be replaced.

Fig. 9-93



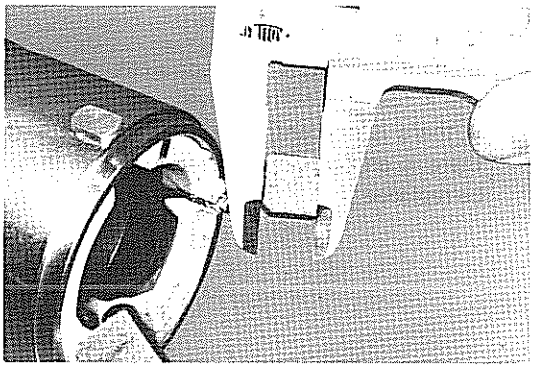
2. Ground test
Check for continuity between the field coil end and field frame.
If there is continuity, repair or replace the field coil.

Fig. 9-94



Brush Holder
Check insulation between the (+) and (–) brush holders. Repair or replace if continuity is indicated.

Fig. 9-95

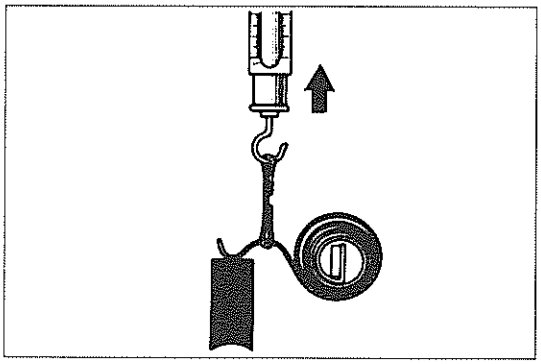


Brush
Measure the brush length. Replace if below the limit.

Brush length:

STD	**13.5 mm (0.53 in.)**
Limit	**10 mm (0.4 in.)**

Fig. 9-96

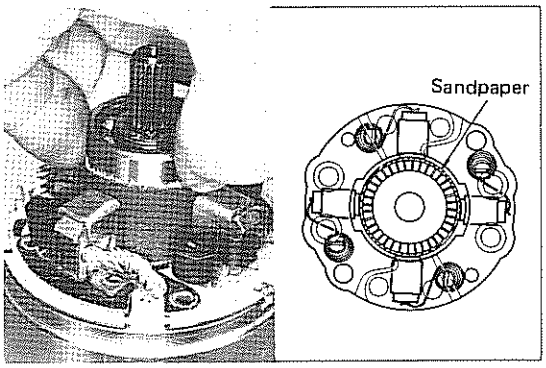


Brush Spring
1. Measure the brush spring load with a pull scale. If the reading is below standard, replace the spring.

Tension: 3.2 – 4.0 kg (7.1 – 8.8 lb)

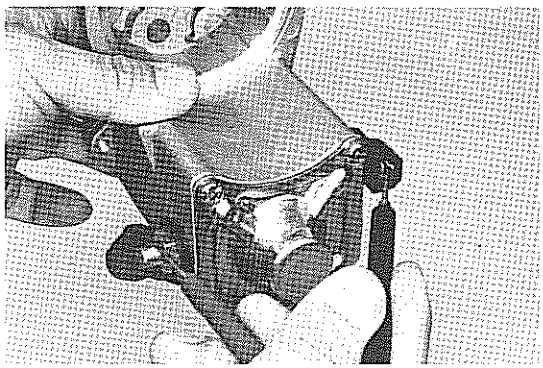
– Note –
Take the pull scale reading at the very instant the brush spring separates from the brush.

Fig. 9-97



2. Using # 400 sandpaper, clean or fit the brushes to make proper contact with the commutator.

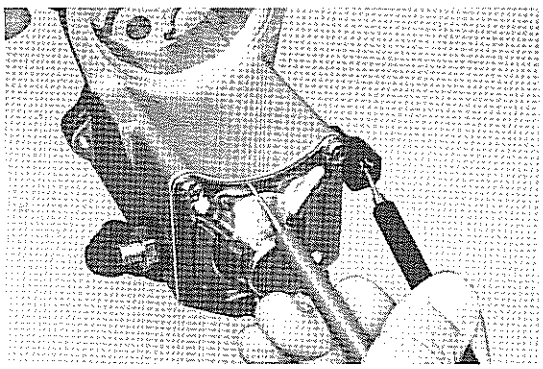
Fig. 9-98



Magnetic Switch

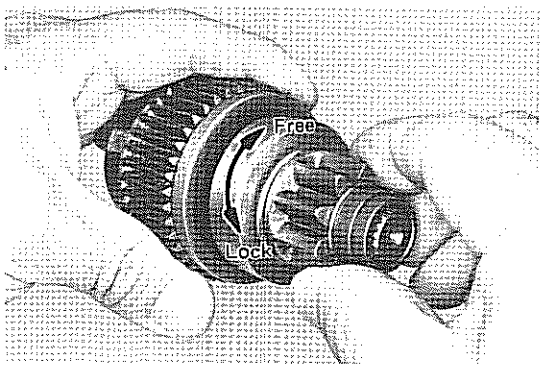
1. Pull-in coil open circuit test
   Check for continuity between 50 terminal and C terminal.

Fig. 9-99



2. Hold-in coil open circuit test
   Check for continuity between 50 terminal and the magnetic switch body.

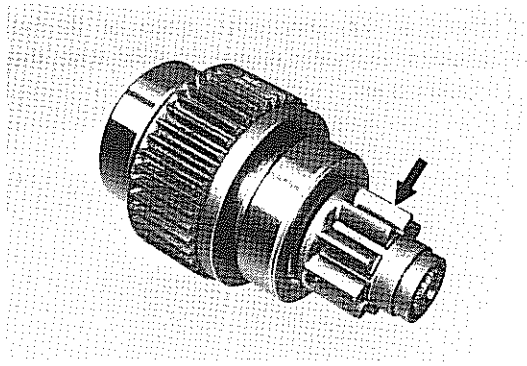
Fig. 9-100



Clutch

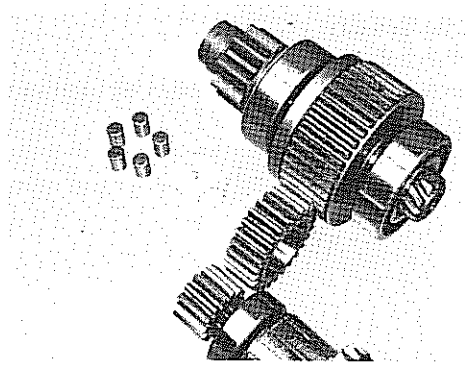
1. Rotate pinion. It should turn free in clockwise direction and lock when turned counterclockwise.

Fig. 9-101



2. Inspect the gear teeth for wear or damage. Also inspect the flywheel ring gear for same.

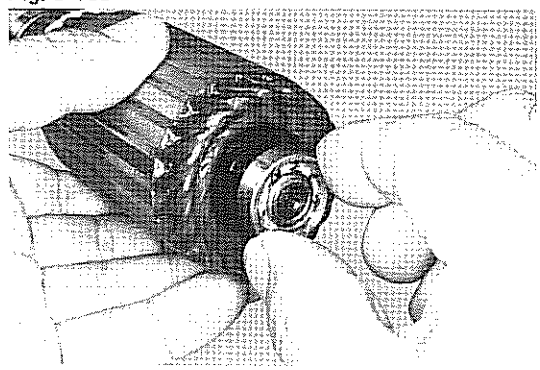
Fig. 9-102



Gear

Inspect the gears for wear or damage.

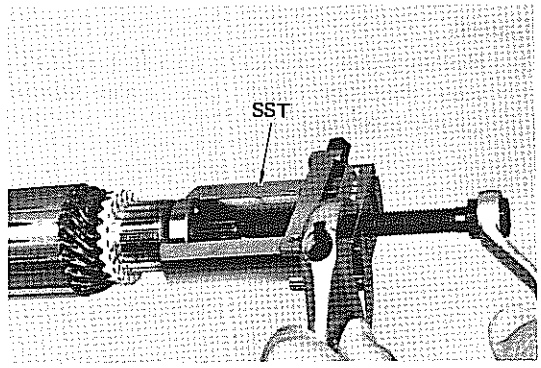
Fig. 9-103



Bearing

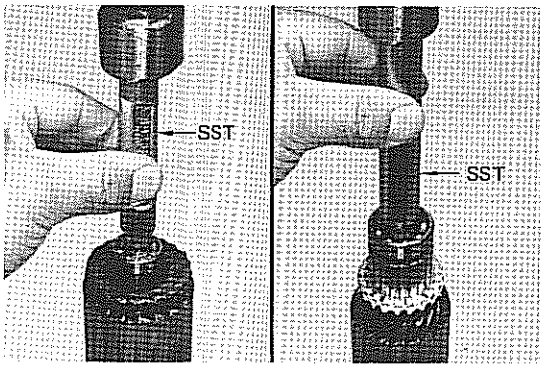
1. Inspect the bearing for wear or damage.

Fig. 9-104



2. Replace armature bearing if defective.
   (1) Remove the bearing with SST.
   SST [09286-46011]

Fig. 9-105



(2) Replace the front bearing, and drive in the rear bearing with SST.
SST [09285-76010]

Fig. 9-106

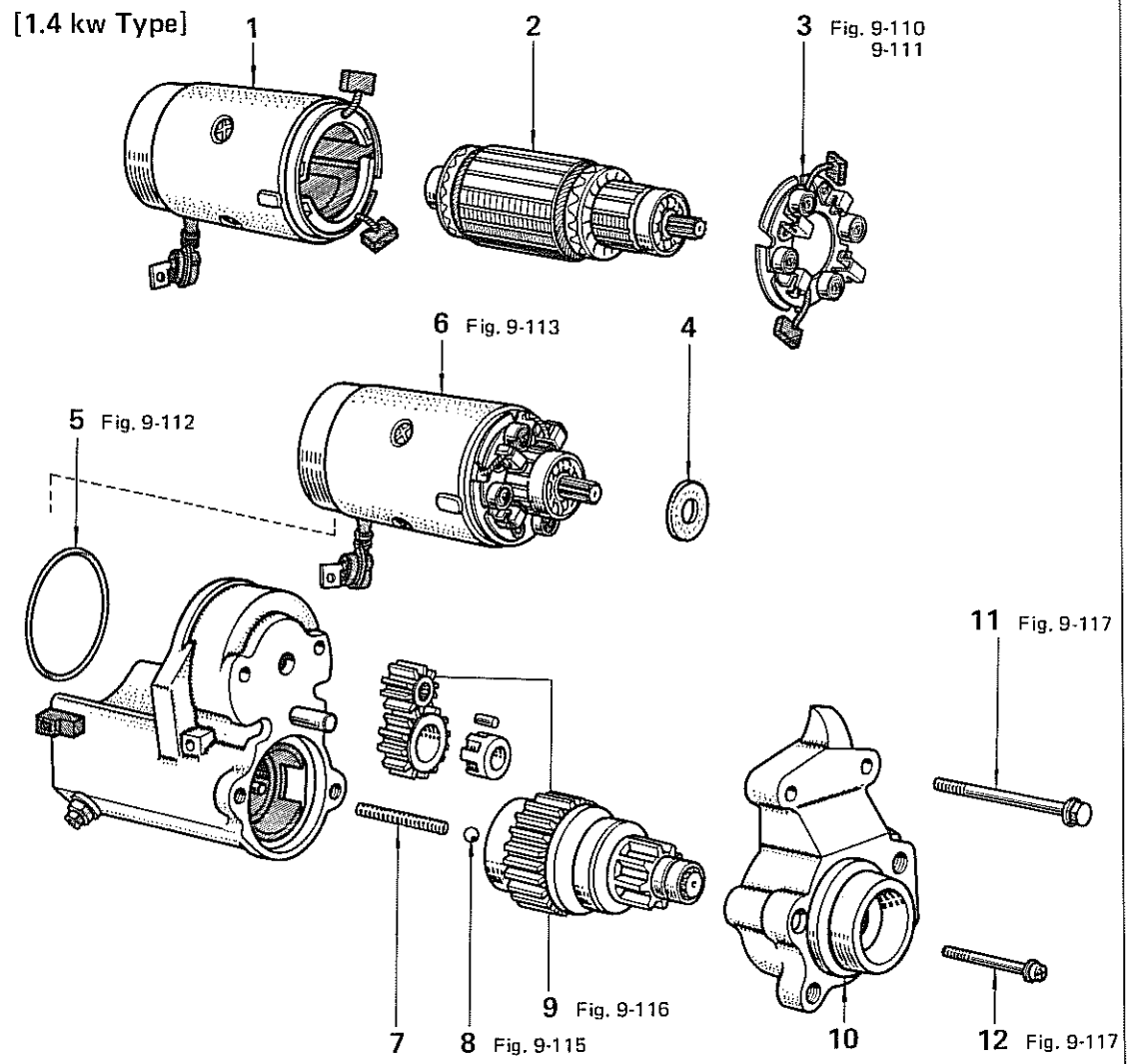
Starter Housing
Inspect for wear or damage.

ASSEMBLY

– Note –
When assembling, lubricate the bearings and gears with high temperature grease.

Assemble the parts in the numerical order shown in the figure.

Fig. 9-107

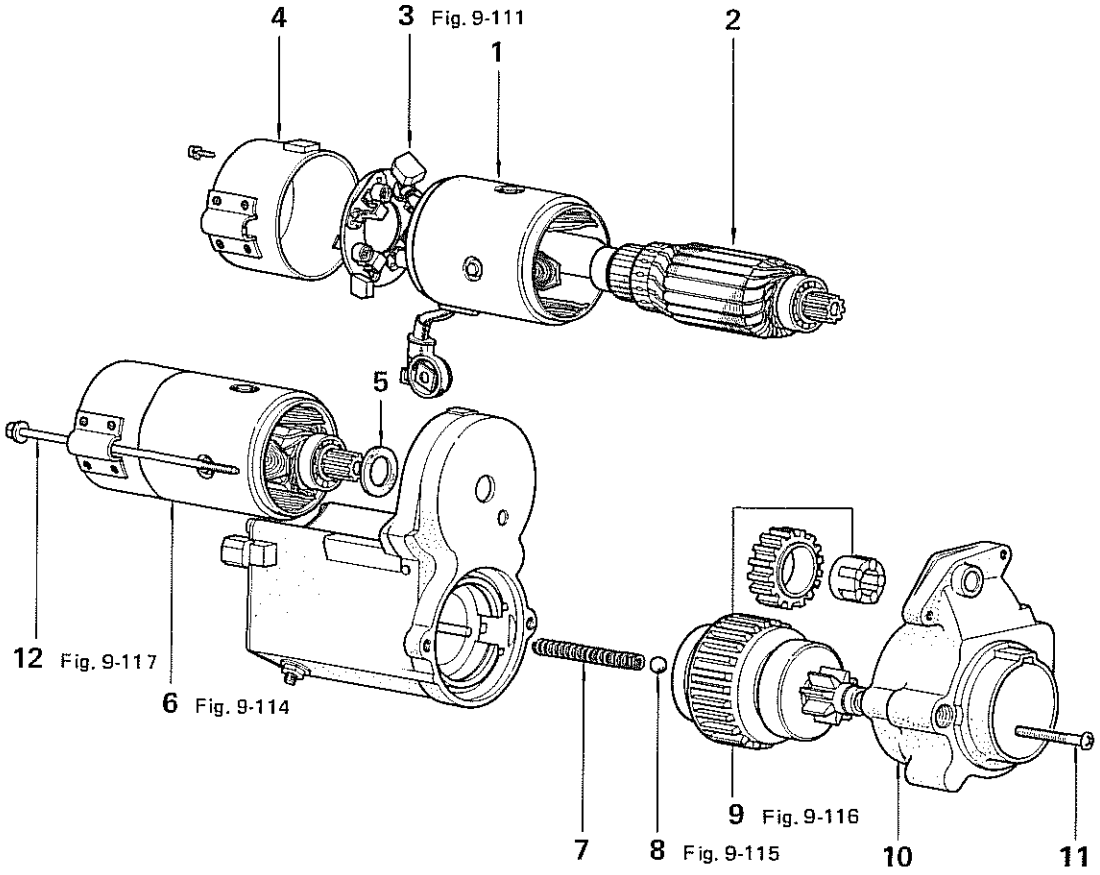


1. Field Frame
2. Armature
3. Brush Holder
4. Felt Seal
5. O Ring
6. Armature & Field Frame
7. Plunger Return Spring
8. Steel Ball
9. Clutch, Idler Gear & Pinion Gear
10. Starter Housing
11. Through Bolt
12. Bolt

Assemble the parts in the numerical order shown in the figure.

Fig. 9-108

[0.9 kw Type]



1. Field Frame
2. Armature
3. Brush Holder
4. End Cover
5. Felt Seal
6. Field Frame & Armature
7. Plunger Return Spring
8. Steel Ball
9. Clutch & Idler Gear
10. Starter Housing
11. Bolt
12. Through Bolt

Use high temperature grease to lubricate bearings and gears as shown in the figure below.

Fig. 9-109

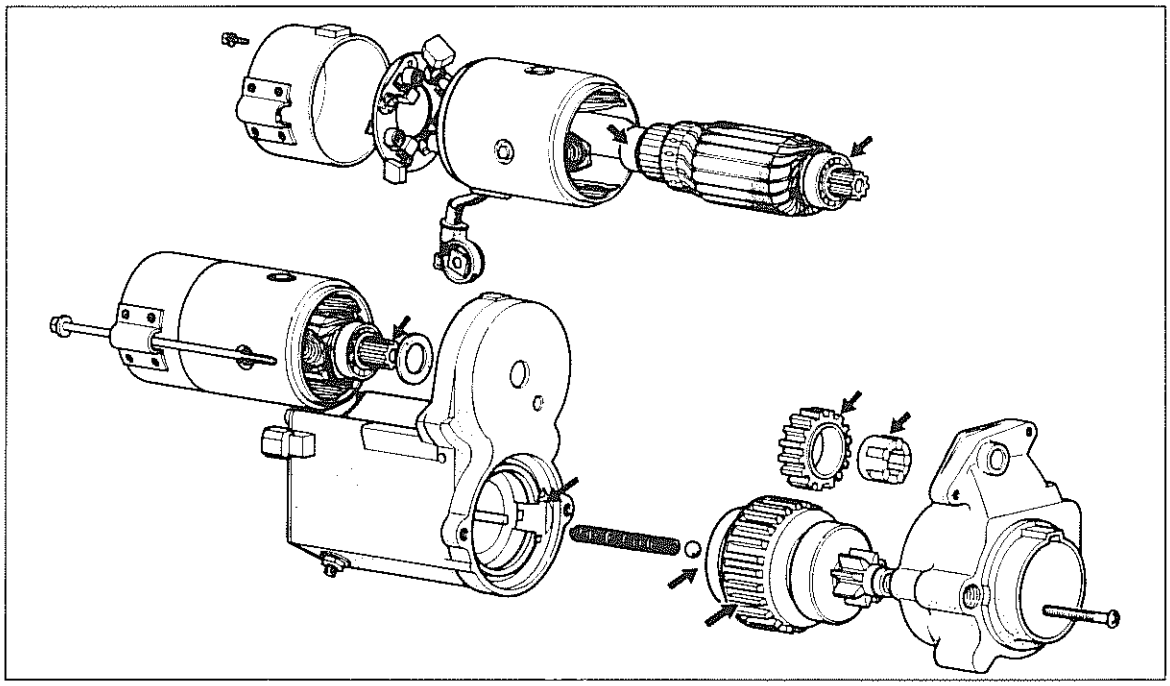
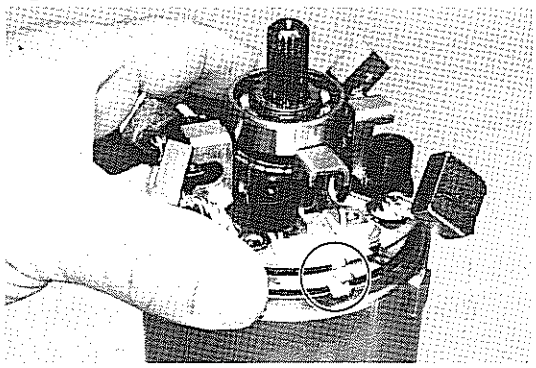
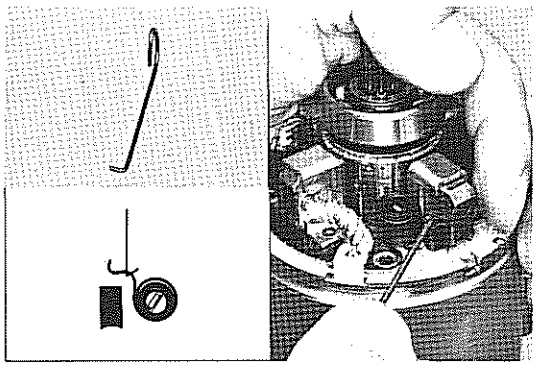


Fig. 9-110



Align the brush holder tab with the notch in the field frame.

Fig. 9-111

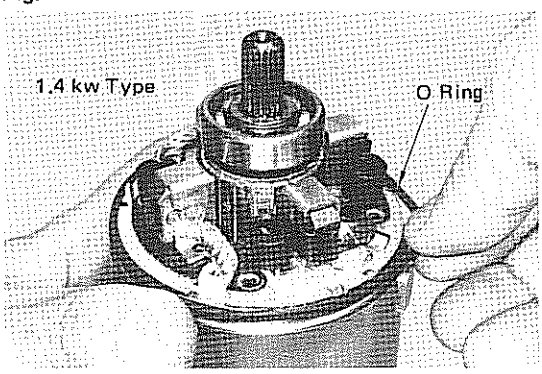


Fit four brushes into the brush holder, using care not to damage them.

– Note –

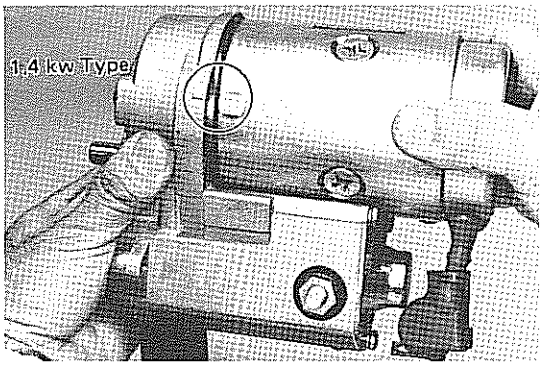
Check to see that the (+) lead wires are not grounded.

Fig. 9-112



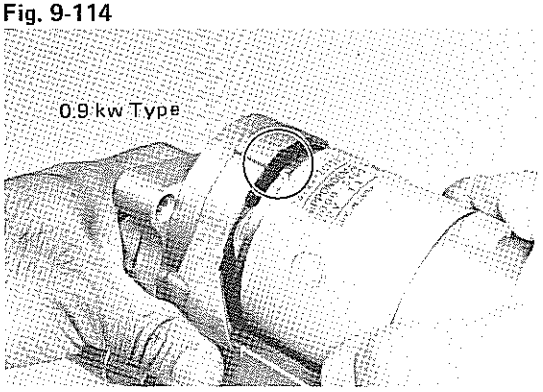
Install the O ring around the brush holder.

Fig. 9-113



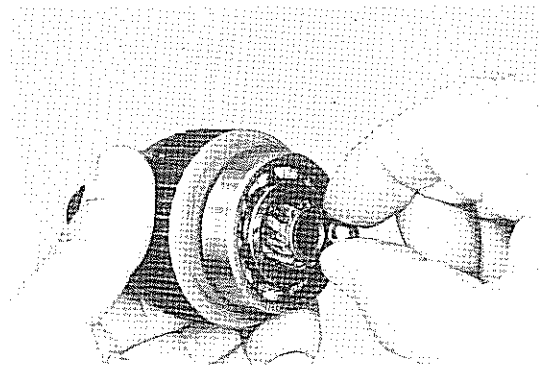
Face the field coil lead wire towards the magnetic switch, and install the field frame with the armature, aligning the bolt anchors with the mark on the magnetic switch.

Fig. 9-114



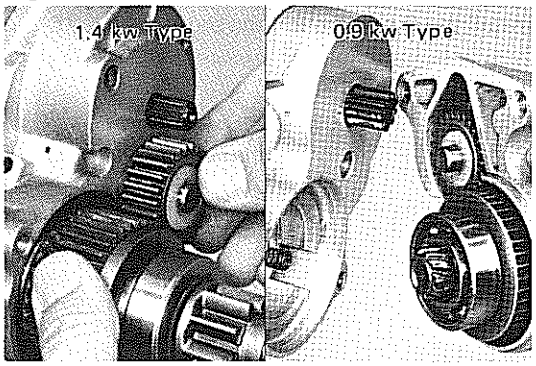
Match the protrusion of the yoke core with the starter housing notch.

Fig. 9-115



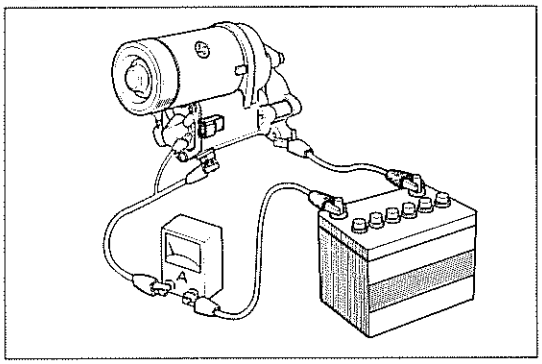
Apply grease and insert the ball into the clutch shaft hole.

Fig. 9-116



Install the idler gear roller bearing in the direction shown in the figure.

Fig. 9-117



PERFORMANCE TEST (NO-LOAD)

Connect the starter to a battery. If the starter shows smooth and steady rotation with the pinion jumping out and draws less than specified current, it is satisfactory.

Specified current: Less than 80A