2. Starter Motor

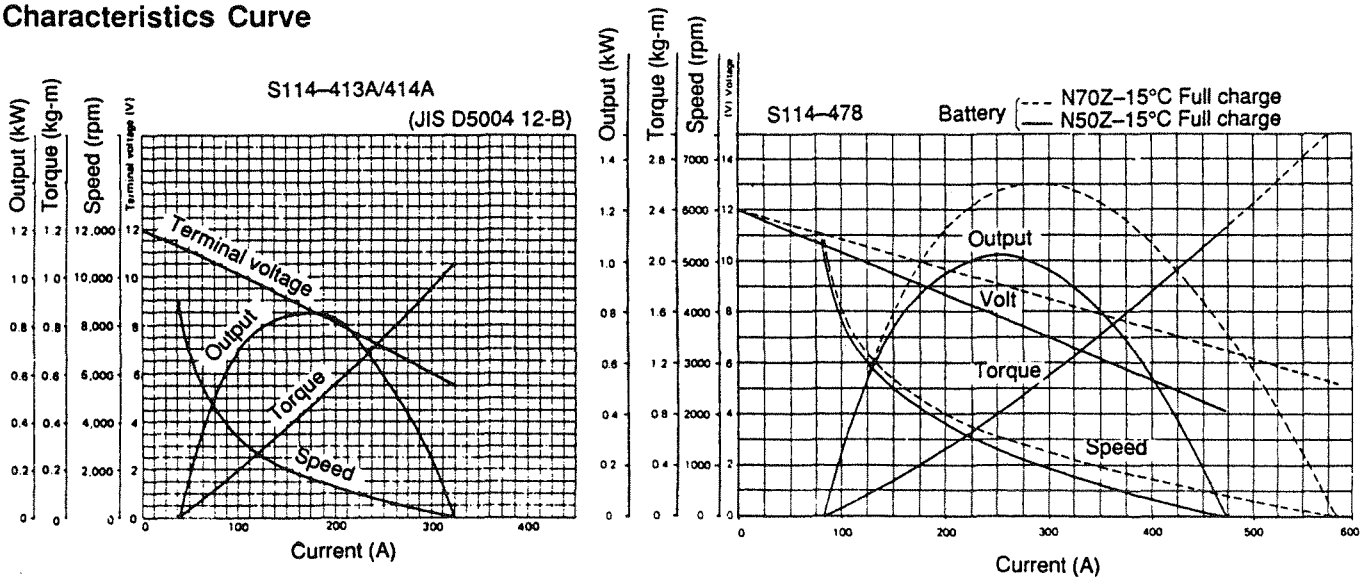
Type of starter motor

Starter motors are roughly divided into the common type (conventional type) and reduction type; they are subdivided into the Bendix type and magnetic shift type (The clutch is available in the roller clutch type and multi-plate clutch type.) depending on pinion engagement mechanisms. The L-A series uses the common type, magnetic shift system starter motor as standard.

1. Specifications and Performance

Engine model		L40AE-SE ~ L100AE-SE	L40AE-DE ~L100AE-DE	L75AE-SE~L100AE-SE (Optional)
Type		Conventional		Reduction type
Model		S114 – 413A	S114 – 414A	S114 – 478
Rating (sec.)		30		←
Output (V-kW)		12 – 0.8		12 – 1.2
Direction of rotation (viewed from pinion side)		Clockwise	Counterclockwise	Clockwise
Weight kg (lb.)		3.6 (7.9)		4.4 (9.7)
Clutch system		Over running		←
Engagement system		Magnetic shift		←
No. of pinion teeth		8		←
Pinion coming out voltage (V)		8		←
No-load	Terminal voltage (V)	11.5		12
	Current (A)	60 (Max.)		105 (Max.)
Loaded characteristics	Speed (rpm)	7000 (Min.)		4000 (Min.)
	Terminal voltage (V)	8		8.7
	Current (A)	200		←
	Torque kg-m (ft.-lb)	0.32 (2.31)/1850 rpm (Min.) (Min.)		0.46 (3.33)/1550 rpm (Min.) (Min.)

Characteristics Curve



2. Construction

The starter motor is composed of three major parts, as follows:

1) Magnetic switch

Moves plunger to engage and disengage pinion and, through the engagement lever, opens and closes the main contact (moving contact) to start and stop the starter motor.

2) Motor

A continuous current series motor which generates rotational drive power.

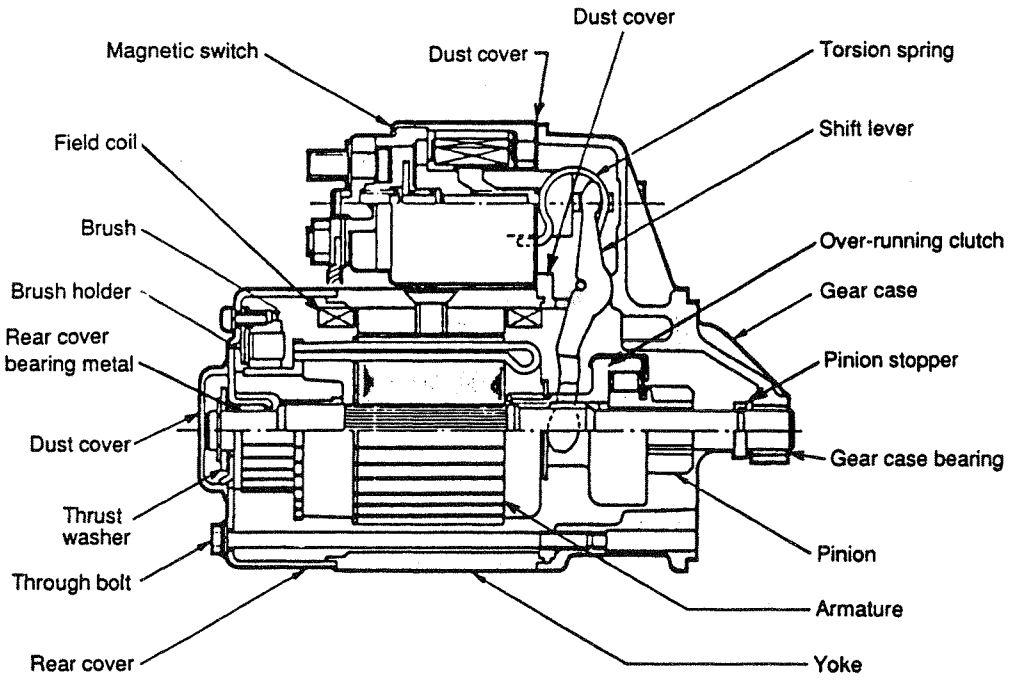
3) Pinion

Transfers driving power from motor to ring gear. An over-running clutch is employed to prevent damage if the engine runs too fast.

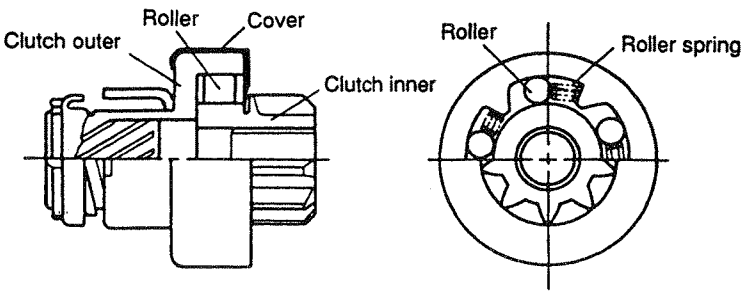
The overrun clutch is composed of the roller and clutch outer, as illustrated below. The roller is held down the roller in tapered part.

The overrun clutch is composed of the roller and clutch outer, as illustrated below. The roller is kept pressed by the roller spring. The clutch outer houses the roller in tapered part.

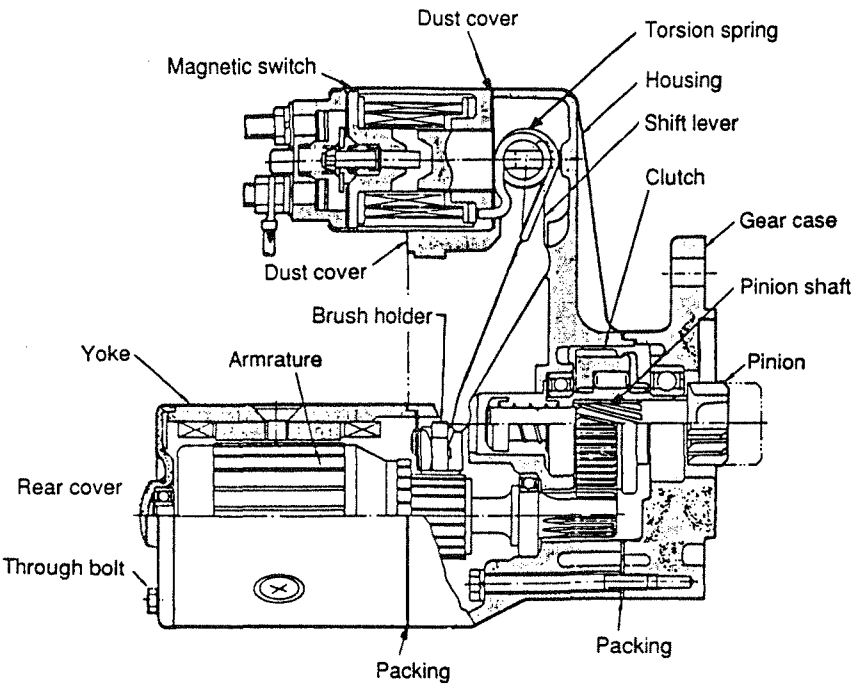
2.1 Conventional type starter motor (Standard electric starter)



Over-running clutch



2.2 Reduction type staretr motor (Option for L75AE-SE – L100AE-SE)

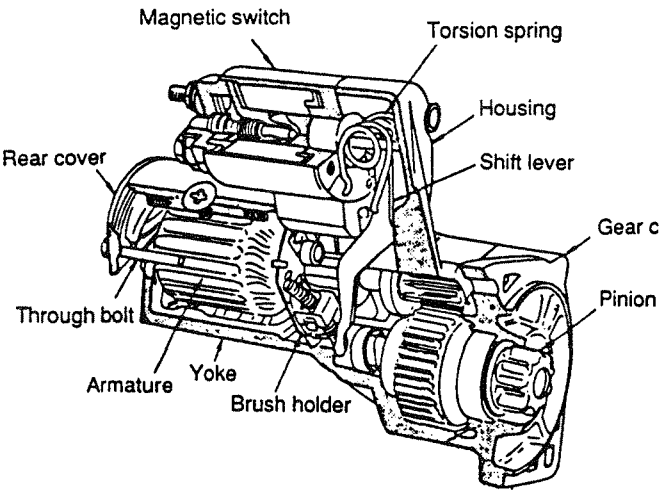


1) Construction of the reduction type starter motor

This motor is equipped with reduction gears between the armature and pinion; the reduction gears increase the torque of the motor before transmitting the torque to the pinion. The pinion and pinion shaft are shifted by the magnetic switch but the clutch assembly remains unmoved.

(1) Circumscribed type

The armature shaft is equipped with a small gear at the end, which is constantly engaged with a large gear on the circumference of the clutch. Thus, the revolution of the armature is transmitted to the pinion through the reduction gears and the clutch assembly. While the engine is being cranked, the motor emits a slightly loud sound because of the built-in reduction gears. This does not mean, of course, a sign of trouble.

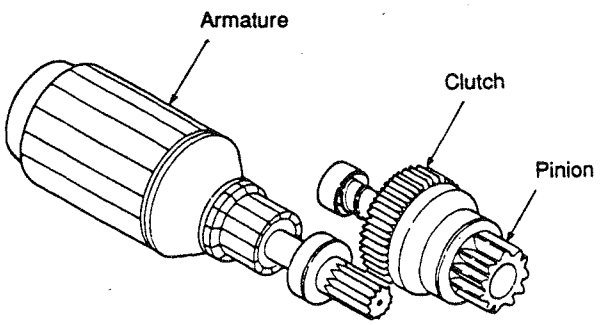


(2) Internal structure of reduction type

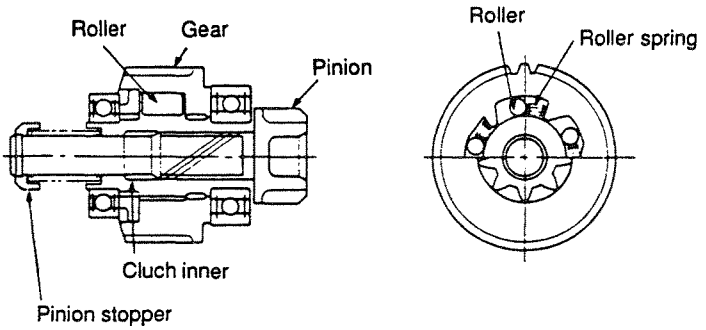
Illustration above shows the internal structure of the reduction type starting motor. This motor is similar to the magnetic shift type motor, except that it has a built-in reduction mechanism as its name implies.

In general type of starting motor, the armature is designed to turn at the same rpm as the pinion. However, the reduc-

tion type motor has its internal resistance reduced to about 25 – 33% of the coventional motor to a high-speed low torque motor while being a high torque motor by use of reduction gears.

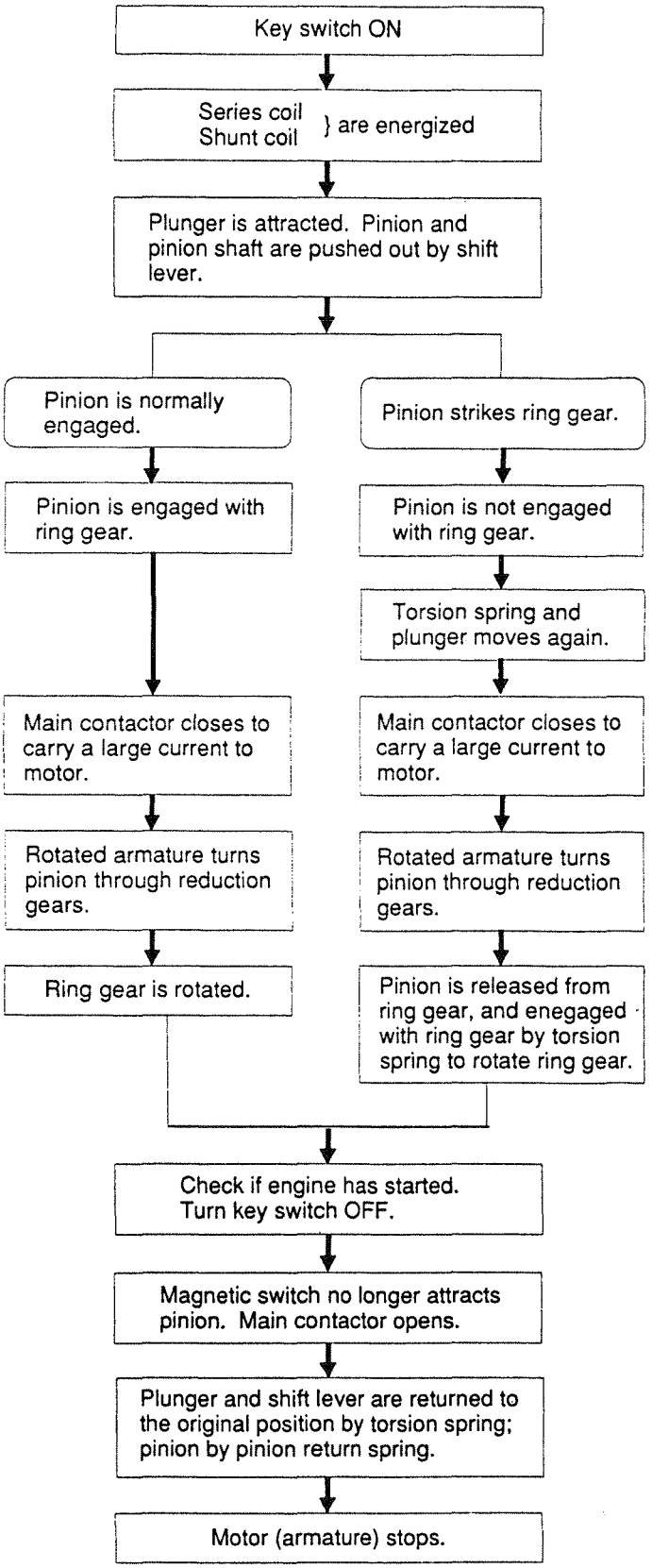


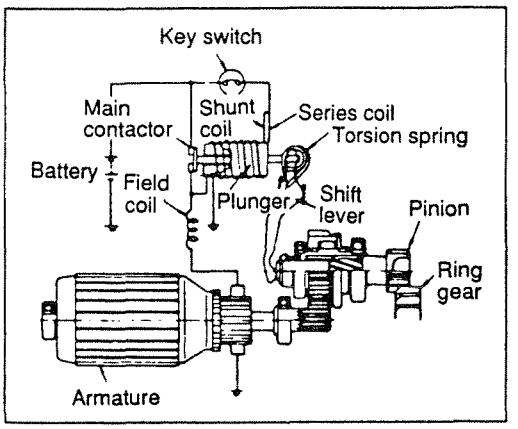
To prevent the motor from being affected by a shock when the engine starts and over-runs, the starter motor has an over-running clutch.



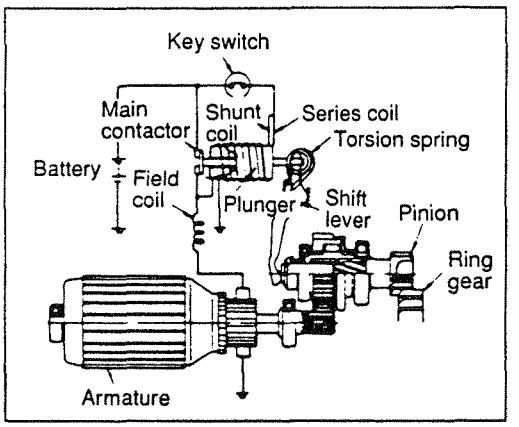
Over-running clutch

2) Operation

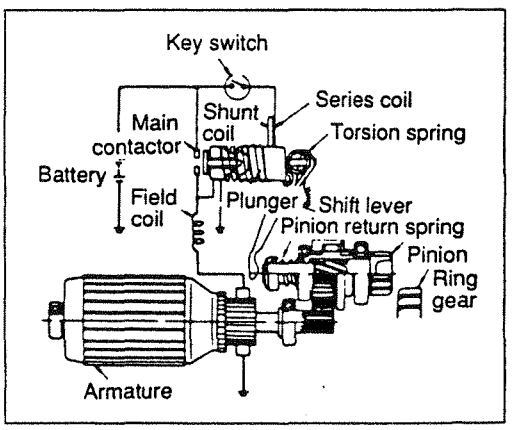




Pinion is engaged with ring gear



Ring gear is rotated



Key switch is turned off

3. Disassembly

3-1 Conventional starter motor (Standard)

1) Magnetic switch

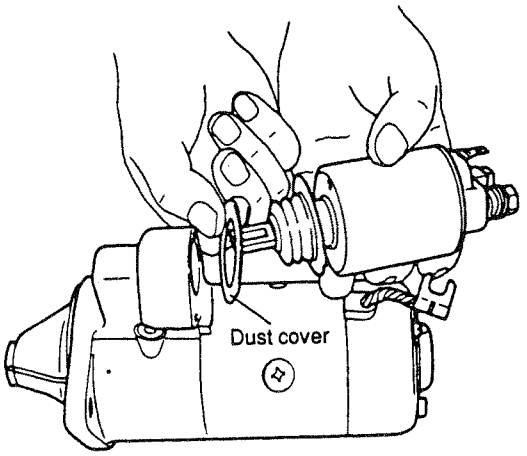
(1) Disconnect the magnetic switch wiring.

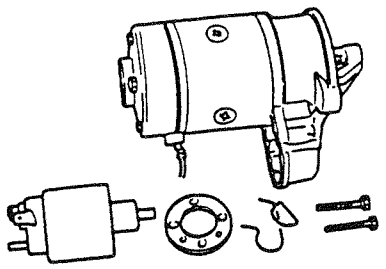
(2) Remove the magnetic switch mounting bolt.

(3) Remove the magnetic switch.

(4) Separate the switch shift lever

(5) Remove the torsion spring (for Reduction type Starter Motor only). Pull out the torsion spring on the magnetic switch.





- Check whether the dust cover is kept. It is prone to be lost.

2) Rear cover

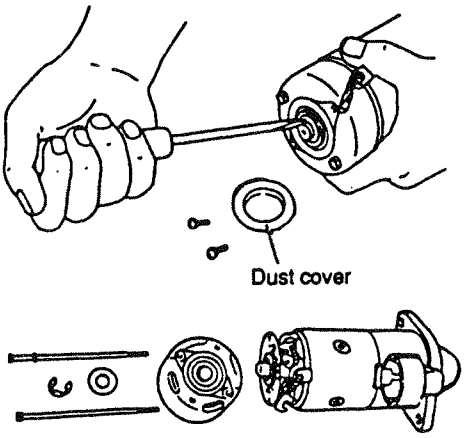
(1) Remove dust cover.

(2) Remove E-ring, and remove the thrust washer. Be careful not to lose the washer and shim.

(3) Remove the two through bolts holding the rear cover and the two screws holding the brush holder.

(4) Remove the rear cover.

- Make sure that the washer and shim are free from damage.
- Carefully keep the washer and shim until they are reassembled.



3) Brush holder

(1) Lift the (–) brush from the commutator.

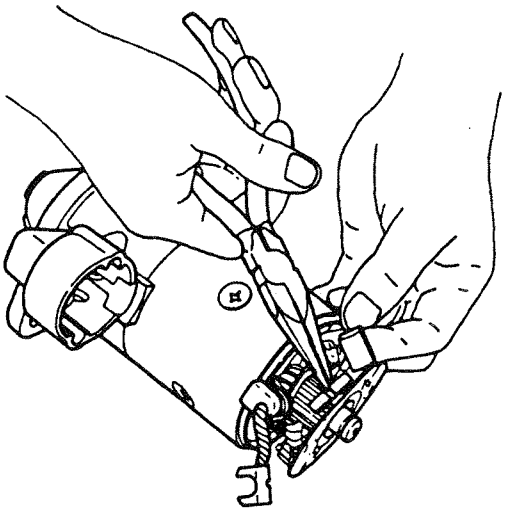
(2) Remove the (+) brush from the brush holder.

(3) Remove the brush holder

- Number of brushes

  (+) brush: 2

  (–) brush: 1



(Reduction type)

(1) Removing yoke, armature, and brush holder.

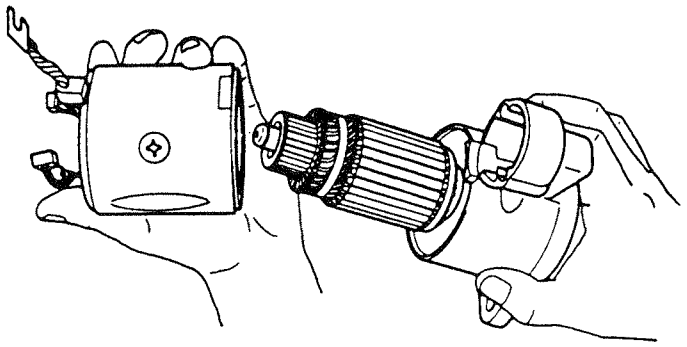
Pull out the yoke, armature, and brush holder simultaneously. Gently pull out the brush and commutator, avoiding interference with the

surrounding section.

4) Yoke

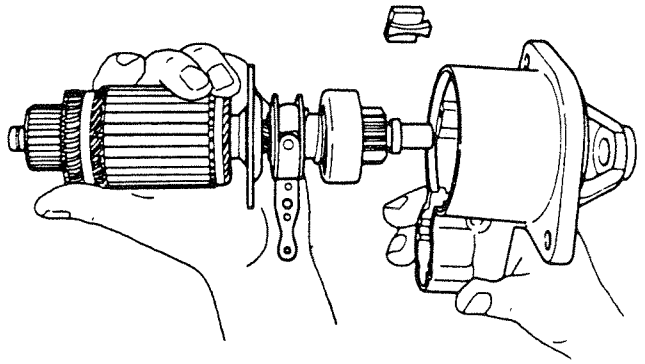
(1) Extract the yoke from the armature.

- Pull it out slowly so that it does not strike against other parts.



5) Armature

(1) Remove the armature from the gear case.

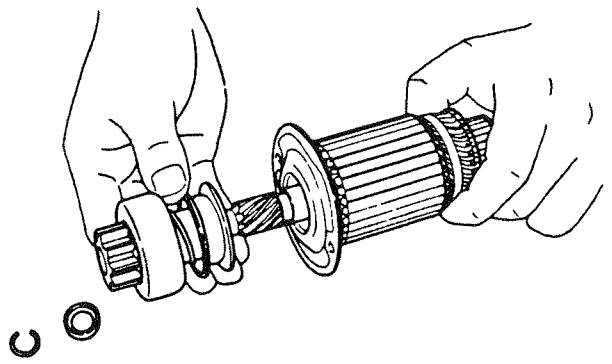


6) Pinion

(1) Slide the pinion stopper to the pinion side.

(2) Remove the pinion stopper clip using a screwdriver.

(3) Remove the pinion from the armature.



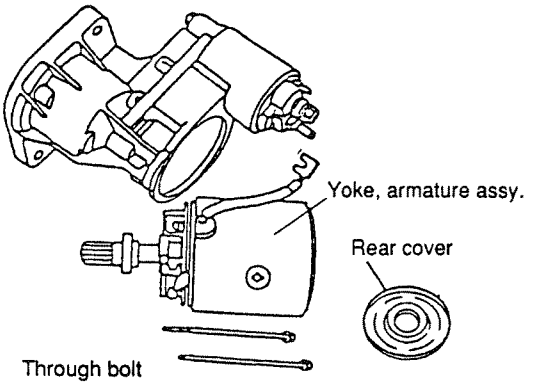
3-2 Reduction type (Option)

1) Wiring, Rear cover, yoke and armature

(1) Disconnect the magnetic swich wiring.

(2) Remove the two through bolts.

(3) Remove the rear cover, yoke and armature.

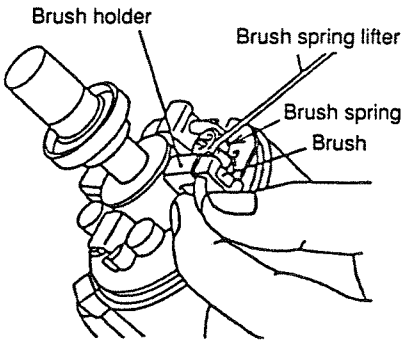


2) Brush, armature and yoke assy.

(1) Lift the brush spring using the brush spring lifter. Touch the brush spring to the side of the (–) brush and float the brush from the commutator.

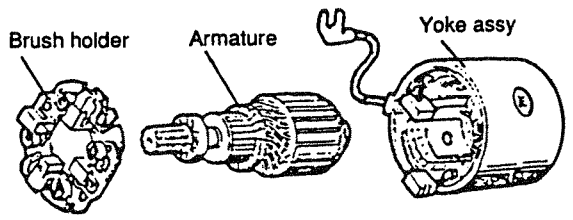
(2) Remove the (+) brush from the brush holder.

- Brush: (+) and (–) brush each 2 pcs.



(3) Remove the brush holder.

(4) Remove the armature and yoke assembly.

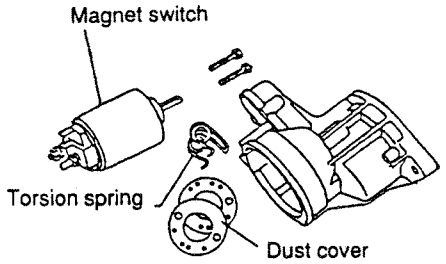


3) Magnetic switch

(1) Remove the magnetic switch mounting bolts.

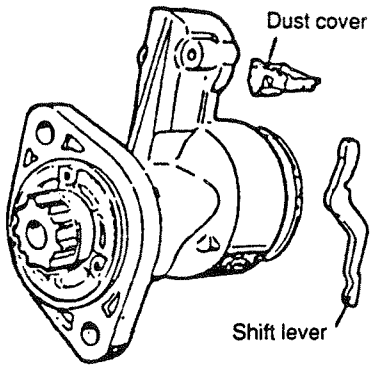
(2) Remove the magnetic switch.

(3) Separate the torsion spring from the magnetic switch.



4) Dust cover and shift lever

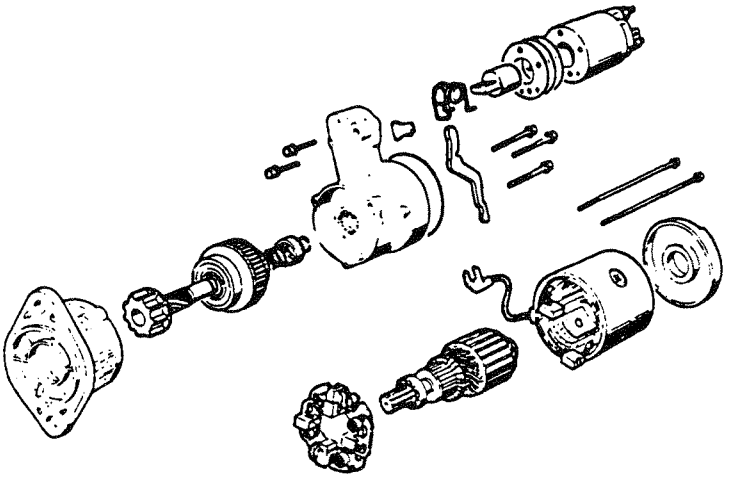
(1) Separate the dust cover and shift lever.



5) Clutch assembly (with pinion shaft)

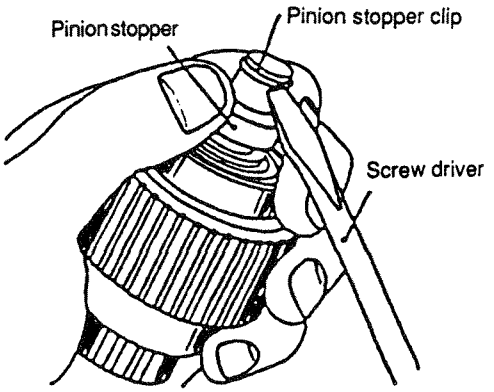
(1) Remove the gear case/housing mounting screws.

(2) Remove the clutch assembly (w/pinion shaft) from the gear case.

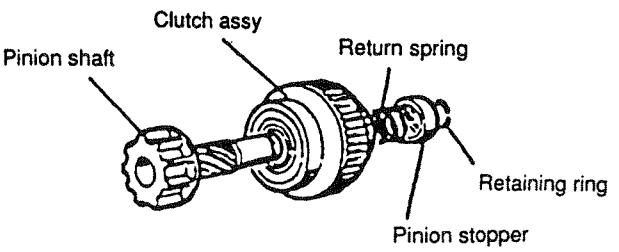


6) Clutch disassembly

(1) Move the pinion stopper toward the pinion and remove the pinion stopper clip with a minus screwdriver.



(2) Remove the pinion stopper and return spring, and the pinion shaft from the clutch assembly.



4. Inspection

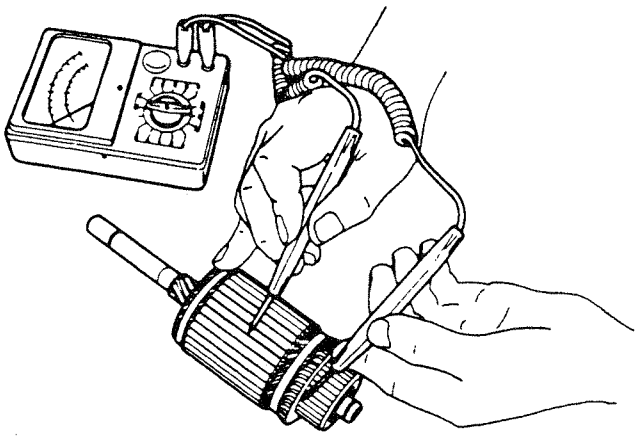
Check the reduction type starter motor in the same way as the conventional type.

1) Armature

(1) Armature coil ground test

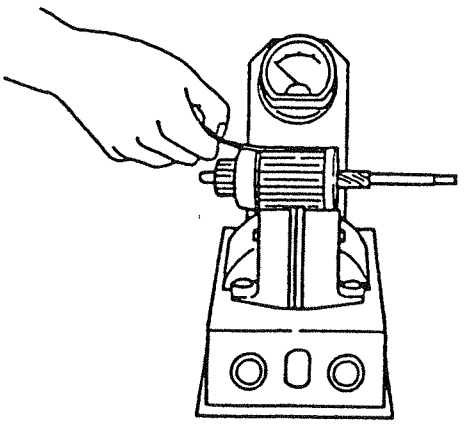
Use a circuit tester to check for the insulation between the commutator piece and the shaft (or armature core).

If an insulation failure is detected, replace the armature.



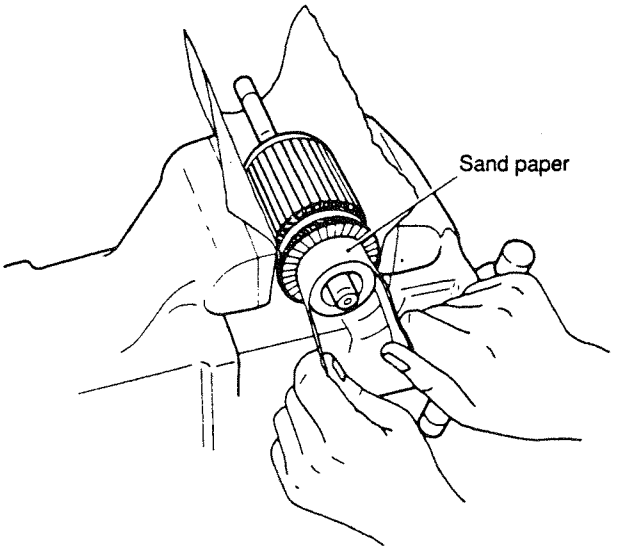
a) Armature coil shortcircuit test

Place the iron piece (a saw-like one) on the armature fitted to the layer short tester and turn the armature by hand. If the iron piece vibrates, it implies a short circuit and the armature should be replaced.



b) Commutator

Inspect the surface of the commutator. If it is corroded or pitted, grind with #500 ~ #600 sandpaper. Replace the commutator if damage is irreparable.

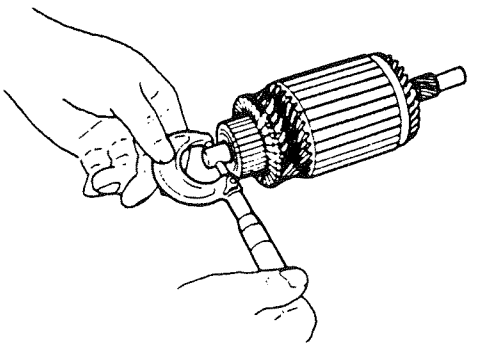


	Maintenance standard	Wear limit
Commutator outside diameter	*See separate service data (P.83).*	
Commutator run-out		

c) Armature shaft outside diameter

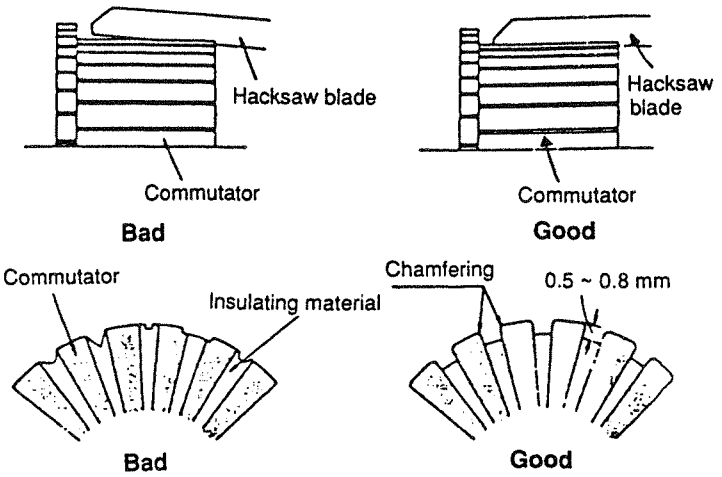
Measure the outside diameter of the armature shaft at four locations: front, center, end, and pinion. Replace the armature if the shaft is excessively worn.

Check the bend of the shaft; replace the armature if the bend exceeds 0.08 mm (0.0031 in.)



(2) Depth of commutator insulating material

Check the insulating material for depth. The depth is within a range from 0.5 to 0.8 mm, the commutator is acceptable. Correct with a hacksaw blade when the under cut is too shallow (0.2 mm tolerable limit)



mm (in.)

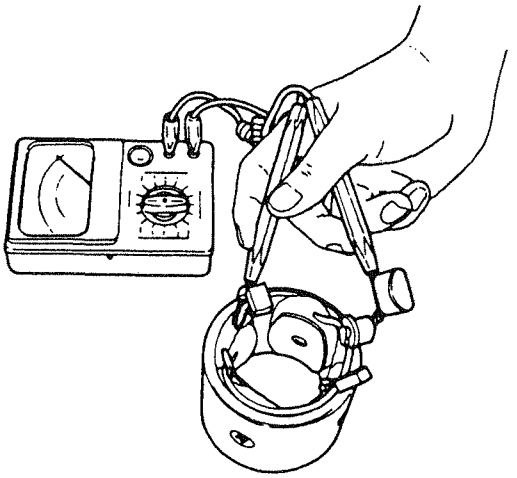
	Maitenance standard	Repair limit
Insulating material	*See separate service data (P.83).*	

2) Field coil

(1) Open test

Check the field coil for disconnection and grounding.

Check the continuity between the terminals connecting the field coil brushes. Continuity indicates the coil is opened. If not, replace the coil.



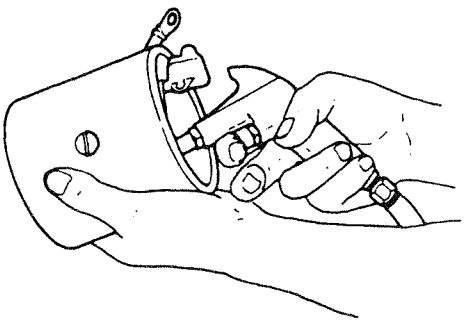
(2) Short-circuit test

Check the continuity between the yoke and any field coil terminal. Continuity indicates that the coil is shorted and it must be replaced.

(3) Cleaning the inside of the yoke

If any carbon powder or rust has been deposited in the yoke, blow the yoke out with dry compressed air.

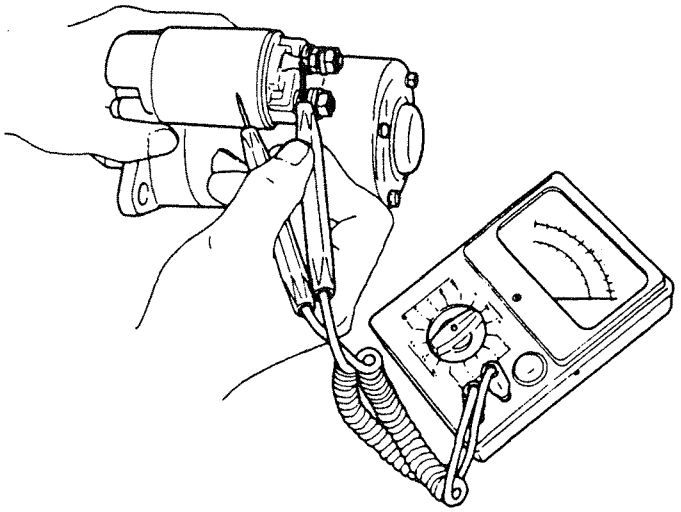
* Do not remove the field coil from the yoke.



3) Magnetic switch

(1) Shunt coil cotinuity test

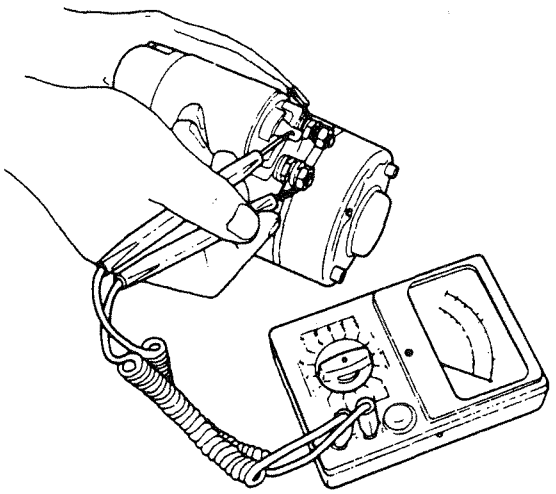
Check the continuity between the C terminal and the magnetic switch body (metal part). If discontinuity is detected replace the magnetic switch, whose shunt coil is disconnected.



Coil resistance (at 20°C)	1.13Ω (Reduction type: 0.6Ω)

(2) Series coil continuity test

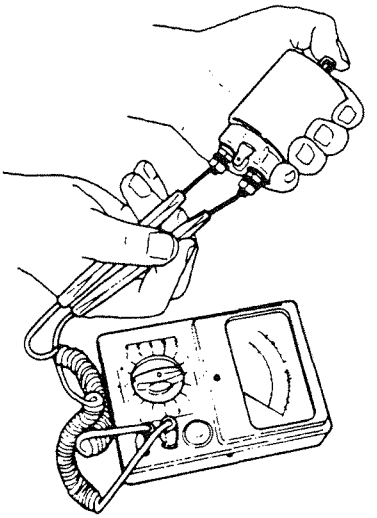
Check the continuity between the terminal C and M of the magnetic switch is detected.



Coil resistance (at 20°C)	0.33Ω

(3) Contact test of contactor

Push the plunger with your finger and check the continuity between the M terminal and B terminal. If discontinuity, the contact is faulty and that the contactor must be replaced.



4) Pinion

(1) Inspect the pinion teeth and replace the pinion if the teeth is excessively worn or damaged.

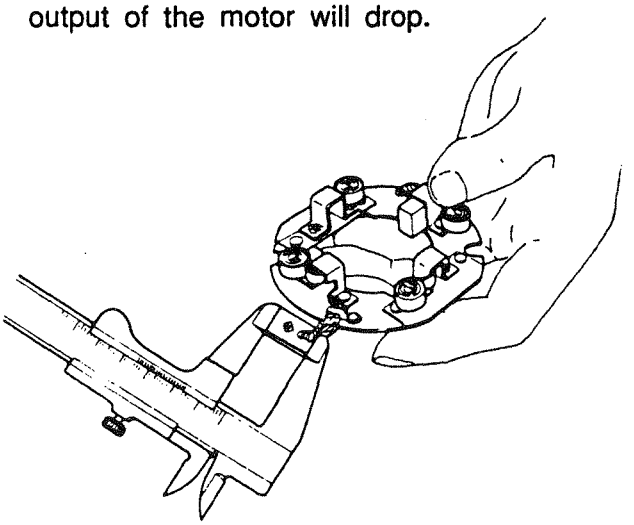
(2) Check if the pinion slides smoothly; replace the pinion if faulty

(3) Inspect the springs and replace if faulty.

(4) Replace the clutch if it slips or seizes.

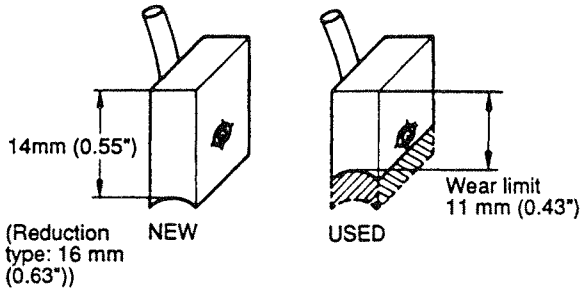
5) Brush

The brushes are quickly worn down by the motor. When the brushes are deflective, the output of the motor will drop.



(1) Brush dimensions

Replace brushes which have been worn beyond the specified wear limit.

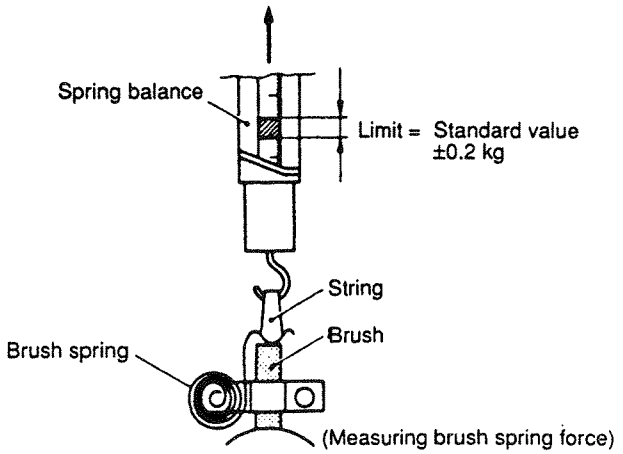


(2) Brush appearance and movement in brush holder

If the outside of the brush is damaged, replace it. If the movement of the brushes in the brush holder is hampered because the holder is rusted, repair or replace the holder.

(3) Brush spring

Since the brush spring pushes the brush against the commutator while the motor is running, a weak or delective spring will cause excessive brush wear, resulting in sparking between the brush and the commutator during operation. Measure the spring force with a spring balance; replace the spring when the difference between the standard value and the measured value exceeds ±0.2kg.



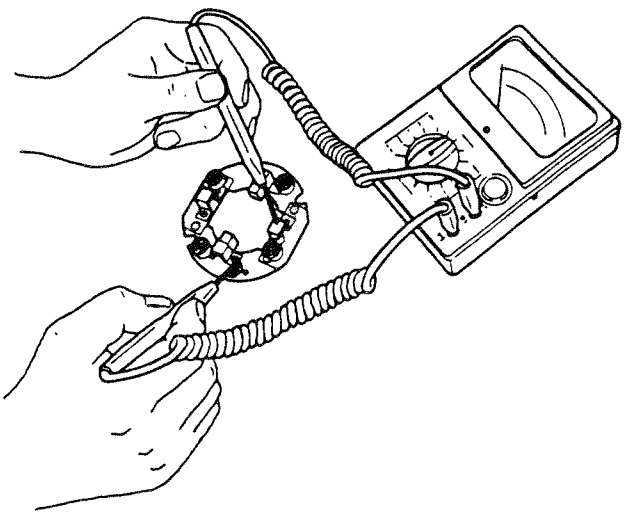
Standard spring load	*2.0 kg*

CAUTION:

Whenever overhauling the motor or removing the brush, apply high quality grease to the specified greasing point. This extends the service life of the bearing on the brush side, although the bearing uses an oilless alloy.

(4) Brush holder ground test

Check the continuity between the insulated brush holder (+) and the base ((–) grounding) of the brush holder assembly. Continuity indicates that these two points are grounded and that the holder must be replaced.



5. Adjustment and Performance test

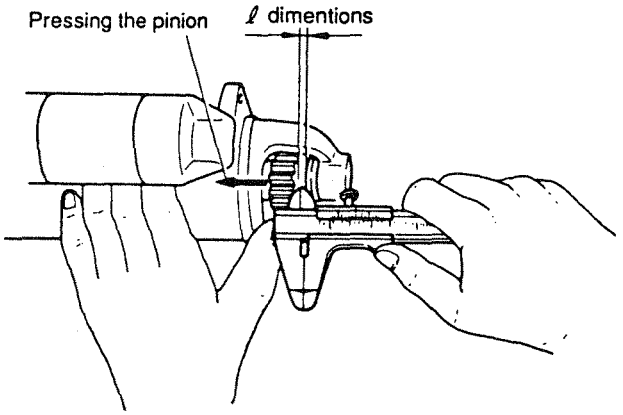
1) ℓ-size measurement (gap between pinion and pinion stopper)

[Conventional starter motor]

When the pinion is at the projected position, measure the gap between pinion and pinion stopper. This measurement should be made with the pinion pressed back lightly to take up any play in engagement linkage.

mm (in.)

ℓ dimension
0.3 – 2.5 (0.012 – 0.098)



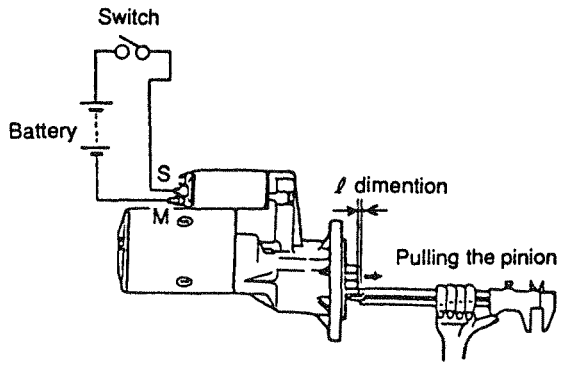
Measuring of ℓ dimension

[Reduction type]

Connect the wiring as shown in the sketch below. Turn on the switch and measure the ' ℓ ' distance in the pinion thrust direction.

mm (in.)

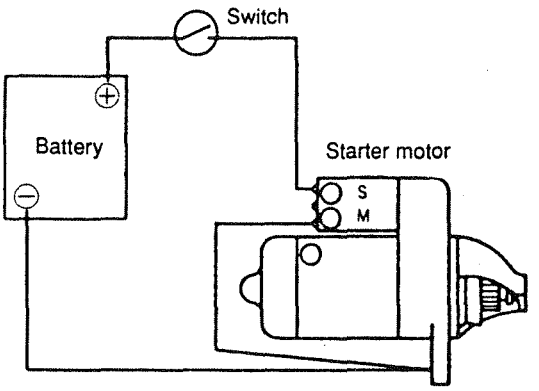
ℓ dimension
0.3 – 1.5 (0.012 – 0.059)



Measuring of ℓ dimension

2) Pinion movement

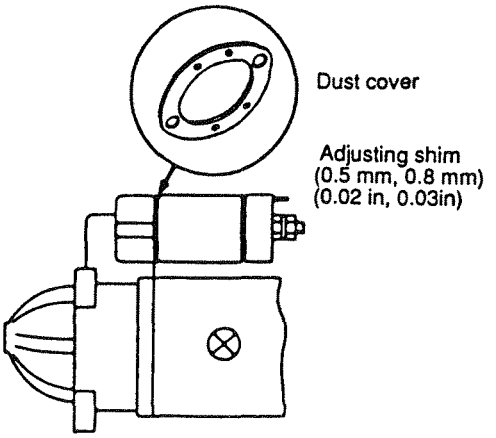
To measure the ℓ dimension, connect the ⊕ wire of the battery to the S terminal, and the ⊖ wire to the starter motor. When attracting the plunger and pushing out the pinion with the shift lever, push (or draw) the pinion by finger in the arrow direction. Make sure the pinion does not chatter before, the measurement.



3) Plunger movement (Applicable also to the reduction type)

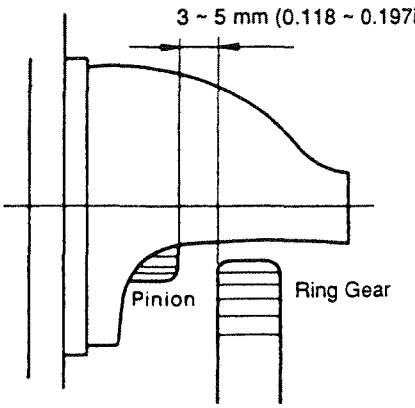
Adjustment the stroke of magnetic plunger to the prescribed value. Adjust the ℓ dimension installing shim (adjusting plate) on the magnetic switch board.

There are two types of shim: 0.5 mm (0.0197 in.) and 0.8 mm (0.0315 in.) in thickness.



4) Mesh clearance (Applicable also to the reduction type)

Mesh clearance is the distance between the flywheel ring gear and starter motor pinion in the rest position. This clearance must be 3 mm (0.1181 in.) to 5 mm (0.1969 in.).



6. Reassembly precautions

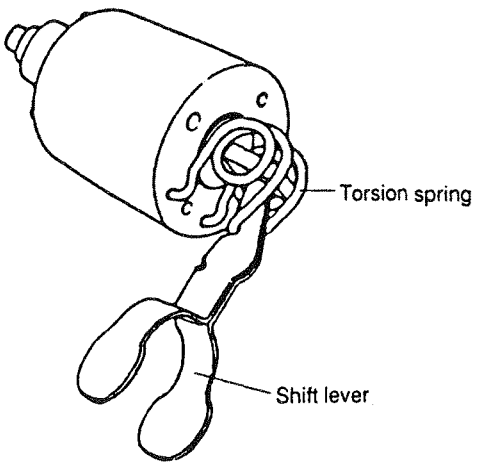
When reassembling the starter motor in the reverse order of diassembly, paying a special attention to the following points:

(1) Where to grease

- Gears in the gear case
- Operating part of the shift lever
- Sliding part of the pinion
- Plunger sliding part of the magnetic switch

(2) Torsion spring and shift lever

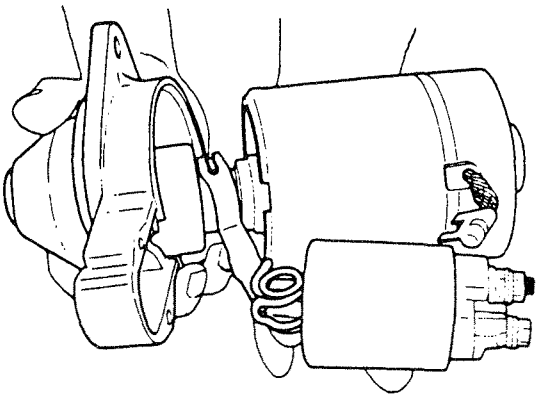
Hook the torsion spring into the hole in the magnetic switch and insert the shift lever into the notch in the plunger of the magnetic switch (through the torsion spring).



(3) Mounting the magnetic switch

Attach the magnetic switch and shift lever assembly to the gear case. Fix the magnetic switch with M6 lock bolts.

Be sure to install the dust cover before assembling the gear case (Tightning torque: 65 – 80 kg-cm (4.71 – 5.80 lb-ft)). After reassembly, check by conducting no-load operation.



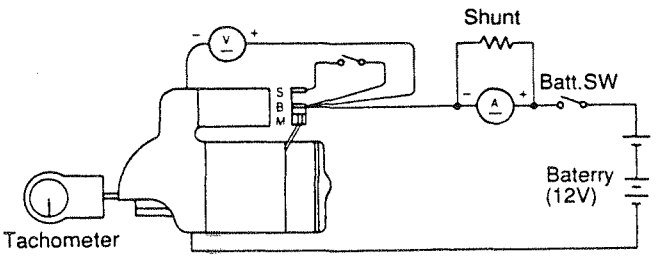
7. Characteristics test

The some characteristics can be checked easily by the no-load test procedure described below.

- The test should be carried out immediately because the rating of the starter motor is 30 seconds.

1) No-load test

Fix a starter motor on a test bench. Connect wiring to the motor as illustrated. Close the switch, and current flows through the motor, which is rotated at no-load. Measure working current, voltage, and motor revolutions. Check whether the specified characteristics are satisfied.



8. Maintenance Standards

Measuring position/item			Unit	S114–413A, 414A	S114–478
Brush	Standard spring load		kg (lb)	1.8–2.2 (3.77–4.85)	
	Standard height		mm (in.)	14 (0.551)	16 (0.630)
	Wear limit		mm (in.)	11 (0.433)	
Magnetic switch	Series coil resistance		Ω	0.33	
	Shunt coil resistance		Ω	1.13	0.6
Commutator	Outside diameter	Standard	mm (in.)	33 (1.299)	30 (1.181)
		Wear limit	mm (in.)	32 (1.260)	29 (1.142)
	Off-set	Standard	mm (in.)	0.05 (0.002)	0.03 (0.0012)
		Repair limit	mm (in.)	0.4 (0.015)	0.2 (0.008)
	Mica depth	Standard	mm (in.)	0.5–0.8 (0.02–0.03)	
		Repair limit	mm (in.)	0.2 (0.008)	
Standard dimension	Brush side bearing	Shaft diameter	mm (in.)	12.450–12.468 (0.490–0.491)	—
		Bearing inside diameter	mm (in.)	12.500–12.518 (0.492–0.493)	—
	Pinion sliding section	Shaft diameter	mm (in.)	12.450–12.468 (0.490–0.491)	—
		Pinion inside diameter	mm (in.)	12.53–12.55 (0.493–0.494)	—
	Pinion side bearing	Shaft diameter	mm (in.)	12.450–12.468 (0.490–0.491)	—
		Bearing inside diameter	mm (in.)	12.500–12.518 (0.492–0.493)	—
	Clutch bearing	Front (Pinion side)	—	—	6004DDU
		Rear	—	—	6904ZZ
	Armature bearing	Front (Pinion side)	—	—	6903Z
		Rear	—	—	608Z

3. Generator (Dynamo), Regulator and Rectifier

The standard dynamo for the L-A type engine manufactured to the electric starting specification is rated at 12 V and 3A. Optionally available are dynamos of the 12 V system, which are rated at 1A, 1.7A and 15A. Also available are dynamos rated at 12V-35W, 12V-40W, 6V-15W, which are used exclusively for lighting of engines to the recoil, S specification.

- Recoil specification: L40AE – L70AE

1. Specifications

Model		GP9585	GP9589	GP9587	GP9595"	GP9591
Type		Magnet system	←	←	←	←
Combination	Regulator	(1)	—	RS5112 (2)	RS5112 (3)	—
	Rectifier	ZR2117 (Half wave)	ZR2120 (Full wave)	—	—	—
Output at 3600 rpm (V/A) (20°C)	DC	13/1.0 – 1.3	13/1.6 – 1.8	13/2.6 – 3.3	12/14.8 – 16	—
	AC votage (4)	—	13V/25W lamp- 12.5~15V	13V/40W	—	6V/15W lamp –7±0.5V
Direction of rotation		Clockwise or counterclockwise	←	←	←	←
At charging start (rpm)		≤ 1500/at 13 V	—	—	≤1000/at 12 V	—
Regulated voltage on regulator		—	—	14.5±0.5V	←	—
Permissible ambient temp. (°C)		–20 – +65	←	←	←	←
Color	Covered wire (2-wrie)	Green/White and Green/White	←	←	←	Red and Black
	Tube	Black	Gray	Black	Yellow	Yellow
Remark		for electric starting	for electric starting or for lighting of engines to the recoil, S-spec.	for electric starting (standard) or for lighting of engines to the recoil, S-spec.	for electric starting	only for light-ing of engines to the recoil, S-spec.

Notes:

The dynamo may be combined with:–

(1) RS5133 type regulator (with a built-in safety relay drive circuit).

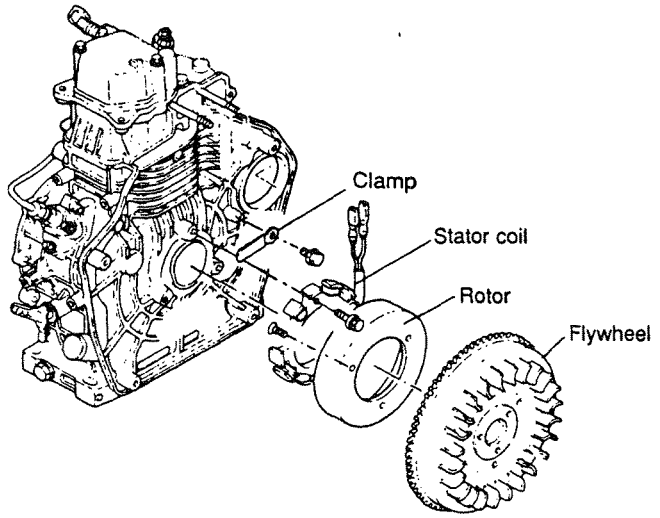
(2) RS2190 type regulator (without the charge lamp circuit), or

(3) RS5110 type regulator (with a built-in safety relay drive circuit), and

(4) The dynamo used only for lighting of engines to the recoil, S-spec. is equipped with neither a regulator nor rectifier, and outputs AC voltage.

2. Construction

The dinamo is composed of the starter coil and rotor; the stator is bolted to the cylinder block, and the rotor to the flywheel.



3. Generator check

Follow the directions to check whether the generator works normally.

(1) Disconnect the generator output from the regulator, with the generator left coupled with the engine.

(2) Connect the generator output to a volt/ammeter.

(3) Set the volt/ammeter to the 100 VAC range.

(4) Start the engine and check the volt/ammeter.

(5) When the volt/ammeter reads the specified value, the generator is in normal operation. (Measure voltage between the connectors.)

Voltage (VAC)

	GP9585	GP9589	GP9587	GP9595	If the voltage is too low or 0V, the magnet is demagnetized or disconnected.
3750 rpm	Approx. 35.7	Approx. 53.8	Approx. 45.4	Approx. 41.5	
3200 rpm	Approx. 30.3	Approx. 46	Approx. 39	Approx. 35.5	

① Stator coil continuity test

Disconnect the green/white wire to the dynamo or red and black connectors. Check the stator coil for continuity using a circuit tester. If continuity is not detected (∞Ω), replace the stator coil, which is disconnected

⚠ Note

When the megger is used, short the circuit within 1 or less second.

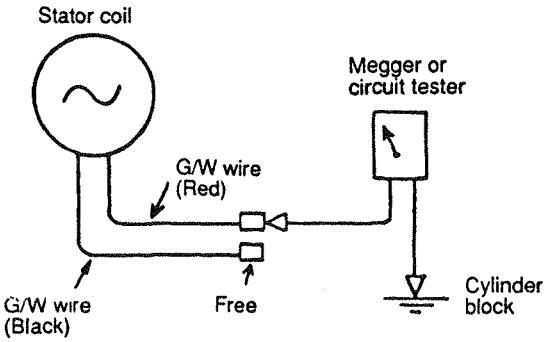
② Coil insulation test

Remove the green and white, or red and black conductors from the dynamo.

1. Connect a cable from the megger (or circuit tester) to the G/W wire or red connector.
2. Connect the other cable from the megger (or circuit tester) to the cylinder block for 1 or less second, and check the indicator of the megger (or circuit tester).

   If there is continuity (the registance is zero), replace the stator coil.

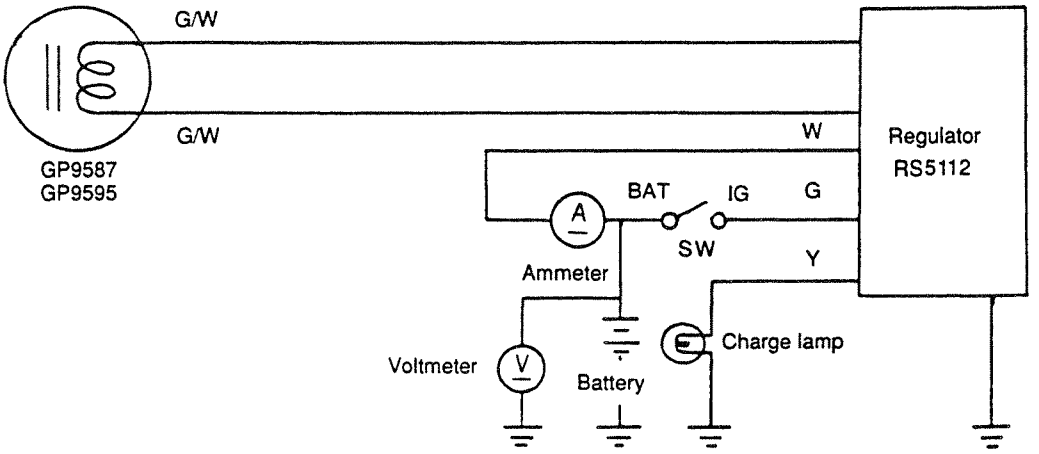
Tester's reading	Continuity	Evaluation	
∞	NO	Normal	—
0Ω	YES	Abnormal	Replace the stator coil



③ Inspection of dynamo /regulator (combination)

To inspect the dynamo/regulator, connect a voltmeter and ammeter to the dynamo/regulator circuit, as illustrated below.

Use a battery capable of running the engine.



Relationship between charge current and battery terminal voltage (at 3600rpm)

	Evaluation	Cause
14V or less — 2A or more (GP9587); 13.5 A or more (GP9595)	Normal	——
14 ~ 15V (within a range of voltages regulated by the regulator) — 2~0.2A (GP9587); 13.5 ~ 0.3A (GP9595)	Normal	——
15V or more (reference) — 2A or more (GP9587); 13.5A or more (GP9595)	Abnormal	Replace the regulator, which is faulty.
15V or less; charge current 0A		The regulator or dynamo is faulty, or wires are improperly connected.
A charge current flows but the battery fails to attain a desired terminal voltage. (The battery is discharged.)		Replace the battery, which is faulty.

④ Inspection of discrete regulator (simplified inspection)

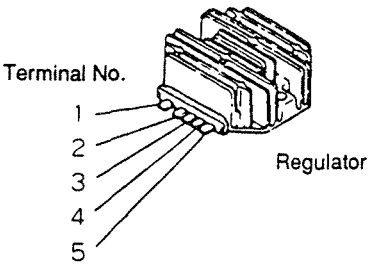
Check the continuity between the terminals on a discrete regulator listed the table below. The continuity between the regulator case and each terminal must also be checked. The values in the table were obtained in the normal condition. Note that this simplified inspection is not intended to detect all failures and trouble in the regulator.

Notes:

1. *Use a tester at a range of 1Ω.*
   ON: The pointer moves
   OFF: The pointer does not move
2. *Be sure to inspect a desired regulator while checking it agaunst a normal one.*

RS5112

Tester \ Red lead wire (+)	1	2	3	4	5	6
Black lead wire (–) 1		1 OFF	2 OFF	3 OFF	4 OFF	5 OFF
Black lead wire (–) 2	6 ON		7 OFF	8 OFF	9 OFF	10 OFF
Black lead wire (–) 3	11 ON	12 OFF		13 OFF	14 OFF	15 OFF
Black lead wire (–) 4	16 OFF	17 OFF	18 OFF		19 OFF	20 OFF
Black lead wire (–) 5	21 ON	22 ON	23 ON	24 OFF		25 ON
Black lead wire (–) Case	26 OFF	27 OFF	28 OFF	29 OFF	30 OFF	



Symptom	Faulty point No.	Probable cause
The charge lamp does not turn off.	24: ON	The harness between the charge lamp and terminal No.4 of the regulator is likely to interfere with the body.
The fusible link is fused.	5: OFF, 26: ON	The battery is likely to be connected in reverse.
	5: ON, 26: ON	The regulator is likely to be poorly insulated within it or the battery is likely to be connected in reverse.
The battery is insufficiently charged or the charge lamp does not turn off.	6: OFF, 11: OFF	In the regulator the circuit is likely to be opened because of poor soldering.
The battery is insufficiently charged or the charge lamp turns off at higher revolutions of the engine.	6 or 11: OFF	In the regulator the circuit is likely to be opened because of poor soldering.
The battery is insufficiently charged or the charge lamp does not turn on.	10 or 15: ON	The battery is likely to be connected in reverse.

RS2190

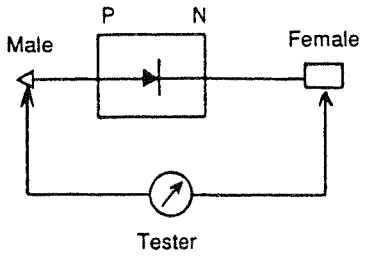
Tester \ Red lead wire (+)	1	2	3	4	5
Black lead wire (–) 1		ON	ON	OFF	ON
Black lead wire (–) 2	OFF		OFF	OFF	ON
Black lead wire (–) 3	OFF	OFF		OFF	ON
Black lead wire (–) 4	OFF	OFF	OFF		OFF
Black lead wire (–) 5	OFF	OFF	OFF	OFF	

Note:

Terminal Nos. are the same as those listed above.

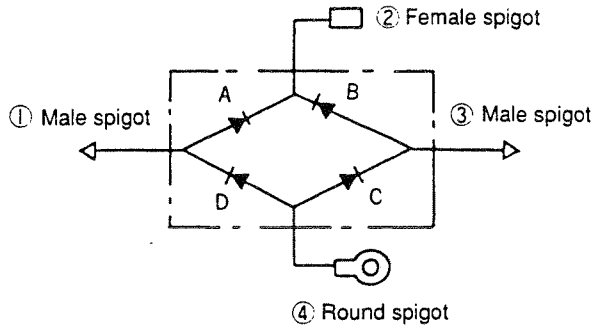
⑤ Inspection of rectifier

(1) ZR2117 (Half-wave rectifier)



Terminal	Male	Female	Continuity (Normal)	
Tester	+ (Red)	– (Black)	No	Replace the rectifier if the left require-ments are not met.
	– (Black)	+ (Red)	Yes	

(2) ZR2120 (Full- and half-wave rectifier)

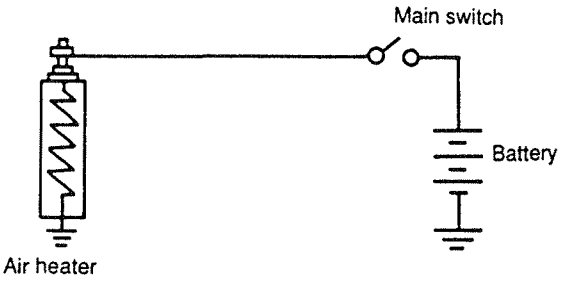


Terminal	Diode A		Diode B		Diode C		Diode D		Continuity (Normal)	
	①	②	②	③	③	④	④	①		
Tester	+	–	–	+	–	+	+	–	No	Replace the rectifier if the left requirements are not met.
	–	+	+	–	+	–	–	+	Yes	

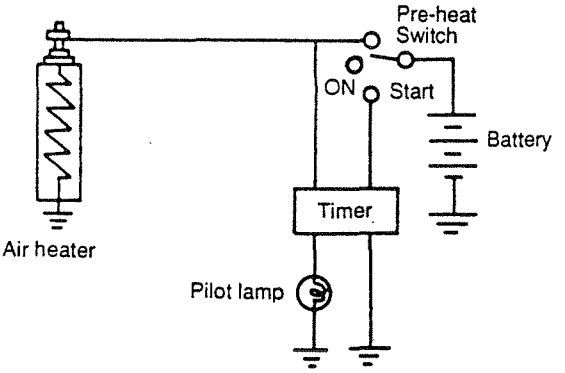
4. Air Heater (Optional)

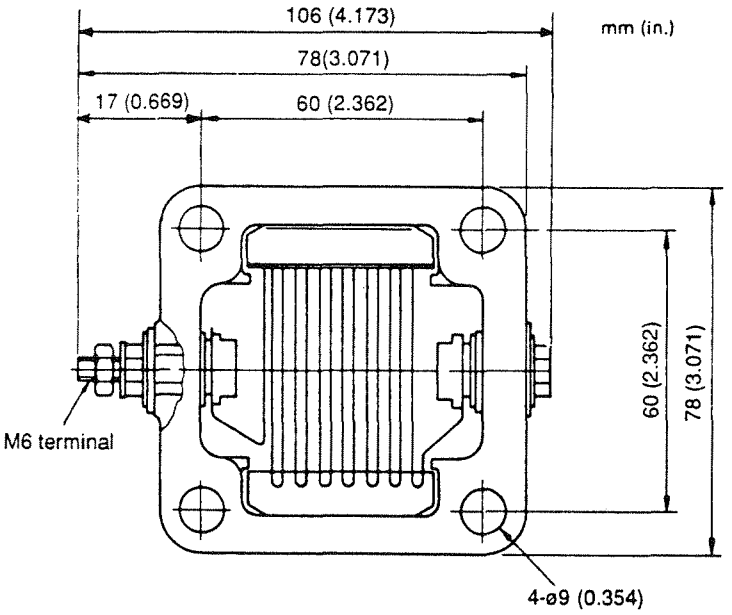
An air heater is available for warming intake air during starting in cold weather. The air heater is mounted on the end of the intake bend.
The device is operated by the key switch on the instrument panel.
A timer is used for the pre-heating. When the air heater key switch is turned on, the pilot lamp lights. The timer is set so that the pilot lamp goes off 15 sec. after the system is turned on. When the pilot lamp goes off, once turn the key switch off. Then, turn the key switch to the START position to start the engine.
An air heater system circuit consists of an air heater, pilot lamp and timer.

Air heater system circuit (without timer)



Air heater circuit (with timer)





Rated output	400W
Rated current	33.3A
Rated voltage	DC 12V
Rated operating time	Pre-heating: 15 sec. Engine operation: 30 sec. max. Engine stop: 30 sec.
Range of operating temperature	–30°C (–22°F) or higher
Earth polarity	Negative earth/Body earth

5. Battery

The battery is used to start the engine (or to bear a lamp load) and must be well charged. Do not use a poorly charged battery which may be unable to attain the motor revolutions required to start the engine at low temperature.

1. Battery capacity and battery cables

1) Battery capacity

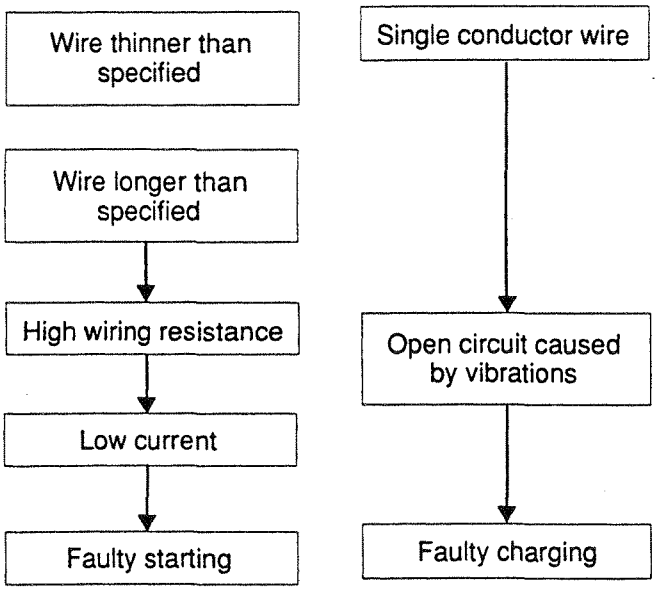
Recommended battery capacity (20 hrs rating) Ambient temperature

	18AH	24AH	30AH	35AH	40AH	45AH
L40AE/L48AE	−10°C (14°F) or higher		−30°C (−22°F) or higher			
L60AE/L70AE		−10°C (14°F) or higher		−30°C (−22°F) or higher		
L75AE ~ L100AE	—	—	—	−10°C (14°F) or higher		−30°C(−22°F) or higher

2) Battery cable

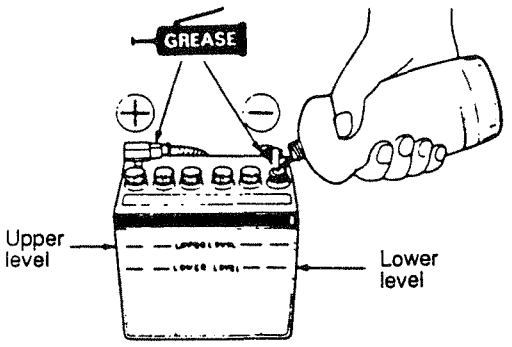
To connect the battery to the starter, thick and short wires must be used. (low-voltage cables for automobile [AV wire]).

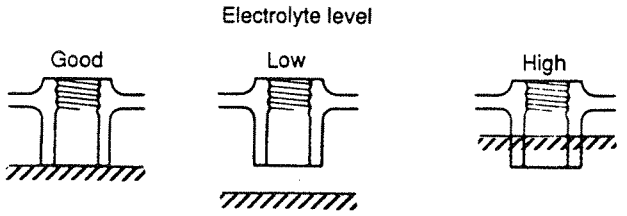
Using wire other than that specified may cause the following troubles:

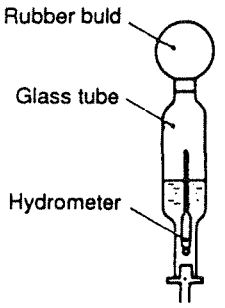


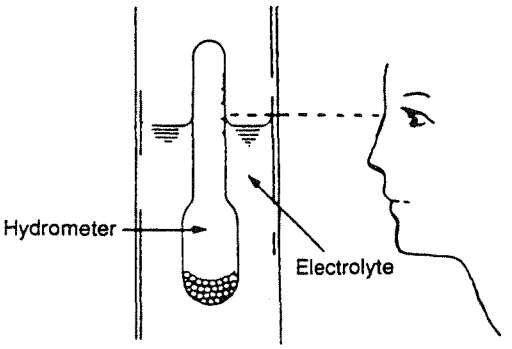
2. Battery inspection

(1) Check the electrolyte level in each cell. If the level is insufficient, add distilled water to attain the upper limited level.









Check the electrolyte level every 7 to 10 days. The electrolyte must be kept 10 – 20 mm (0.3937 – 0.7874 in.) over the top of the plates.

(2) Check the battery case for loose parts, cracks or flaws.

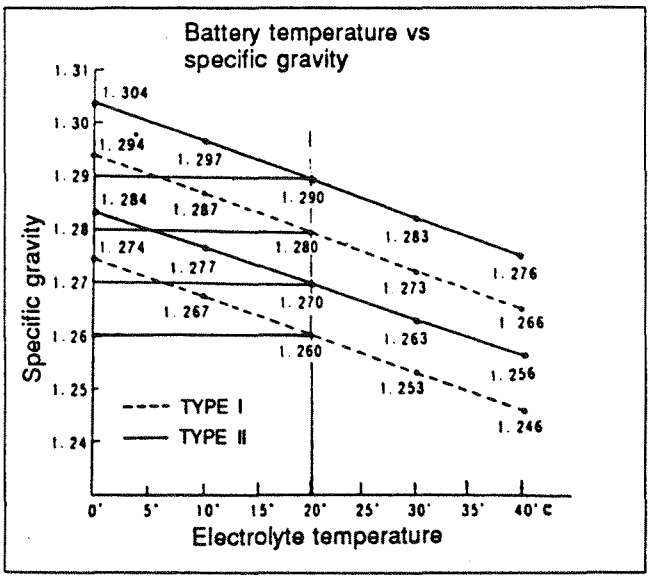
(3) Check the battery terminals for looseness and rusting.

(4) Check the battery cap for clogged vent holes.

(5) Test each cell by drawing electrolyte into the hydrometer.

Specific Gravilty: 1.27 – 1.29 (Type II)
1.26 – 1.28 (Type I)

Variation of Specific Gravity with Temperature



Note:

- Do not overfill the battery. Wipe up spilled electrolyte at once and flush well with water.
- The specific gravity varies with the temperature as shown in the accompanying table.
- The battery must be replaced if sulfation is evident.
- The battery must be replaced if there are pastes settled on the bottom of each cell.

WARNING

1. *Carfully protect yourself and your clothes against the battery electrolyte which is diluted sulfuric acid hard enough to injure the skin and eyes. If any injury is anticipated, consult the doctor at once.*
2. *When using the dynamos (combined with a regulator) on the engine, carefully check the battery for terminal voltage. If the terminal voltage is too low, the regulator works so that the dynamo fails to supply the voltage (about 6V or more) required to charge the battery. If so, use a battery charger.*

3. Battery charging

1) Remove the battery; remove the cap from each cell.
2) Connect the charger positive (+) cable to the battery positive terminal.
3) Connect the charger negative (–) cable to the battery negative terminal.

- Charging current:
  Battery current 20 hrs. rating ~ 10 hrs. rating.

Example: 20 hrs. rating 45 AH, battery
(45 ÷ 20) – (45 ÷ 10) = 2.25A – 4.5A

Charging:

Charging the battery until specific gravity is 1.270 – 1.290 at 20°C (68°F). (Incase of the battery of Type 1: 1.260 – 1.280)

WARNING

- *Before charging remove the cap from each cell.*
- *Keep fire and sparks from a charging battery.*
- *Turn power on/off at the charger, not at the battery terminals.*
- *Discontinue charging if the electrolyte temperature exceeds 45°C (113°F).*

CAUTION:

Quick-charging should only be done in an emergenecy; slow-charging is preferred.

After installing the battery, coat the terminals with clean grease.

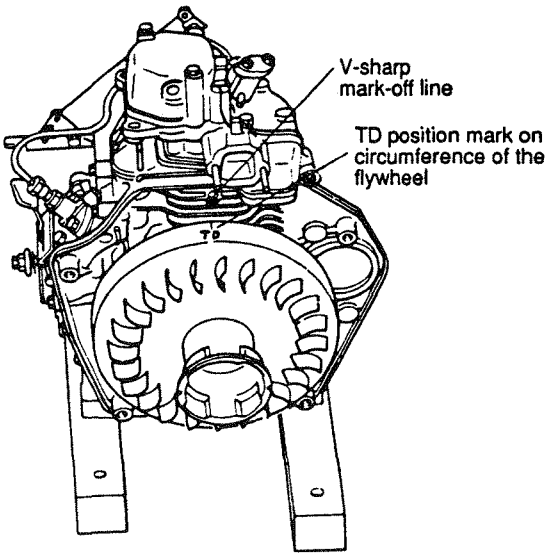
4.13 ADJUSTMENT

1. Adjustment of fuel injection timing

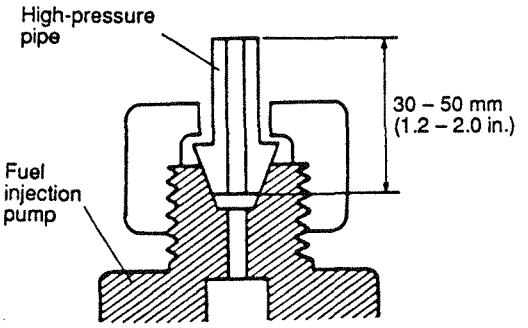
Fuel injection timing must be precise. If it is too early or too late, a host of trouble will result in: difficulty in starting, knocking, lowered output, poor exhaust color, etc. Correctly adjust the governor linkage assembly and the injection pressure before adjusting the injection timing. When the engine is used for long periods of time, the injection pump plunger wears out and distorts the timing.

If the plunger is worn, replace it and read-just the injection timing.

1) How to check the injection timing.
   - Set the speed control handle to "Run".
   - Remove the fuel injection pipe, and install the injection timing measurement pipe.
   - Match the TD position mark on the flywheel with the V notch line on the cylinder body fin.
   - Turn the flywheel first clockwise then couterclockwise about 30° from the TD mark to make sure fuel is injected. (If it is not, turn the flywheel once).
   - Turn the flywheel slowly untill fuel flows out of the pipe. When the fuel begins to flow, check the angle using the mark on the flywheel.
   - Repeat three or four times to make sure the reading is correct.



(TD position mark)



(Measurement pipe)

2) How to adjust the injection timing
   - Remove the fuel injection pump and base.
   - Add or remove adjusting shims.

   If the timing is fast, add shims.

   If the timing is slow, remove shims.

   Each 0.1 mm (0.0039 in.) changes the timing by 1 degree (FID).

	L40AE–L70AE	L75AE–L100AE
Injection timing (FID bTDC) deg.	13–15	12–14

2. Bleeding air from fuel system

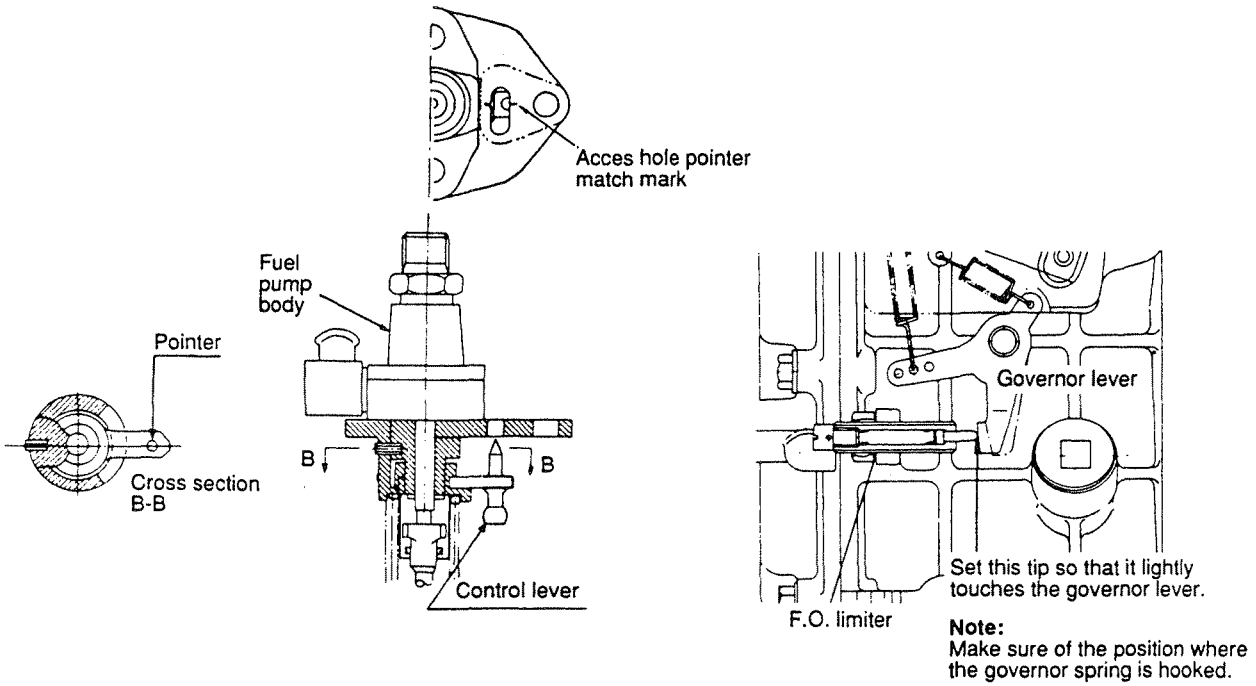
Air can enter the fuel oil pipe system when the engine is first installed, the fuel oil pipe is removed, etc. Bleed the air according to the following instructions:

1) Place the speed control handle in the run position.
2) Open all cocks of the fuel system.
3) Set the decompression lever to the position Non-compression.
4) Make sure that fuel comes out from the fuel injection nozzle while pulling the recoil starter, it can be heard injection sound. Loosen the delivery valve holder to bleed the air easily. Retighten it to 300 – 350 kg-cm (21.7 – 25.3 lb-ft) with a torque wrench.

3. Fuel injection volume limitation

1) Adjustment before shipment. The control lever is fixed after the rated revolutions and injection quatity have been checked with the pump installed on the special-purpose pump drive table. Then, a mark-off line is marked on the spring sheet to line up with the edge of the control lever.

The access hole has an access hole pointer match mark. Make sure the mark-off line matches the edge of the control lever.



(Fuel injection volume limitation adjustment)

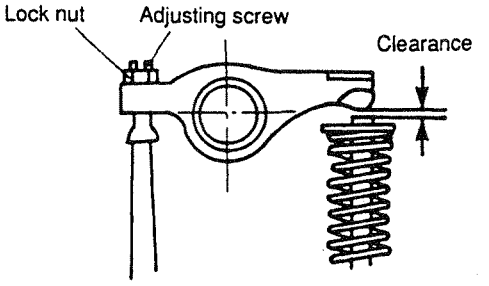
4. Adjusting the clearance on intake/ exhaust valve head

Check the clearance at the disassembly and reassembly, and every 500 hours of operation. Then adjust it if necessary.

Intake/exhaust valve head clearance mm(in.)	0.10 – 0.15 (0.0039 – 0.0059) (cold state)

1) Adjustment

Adjust the clearance with a thickness guage.



Clearance: 0.10 -0.15 mm (cold state) (0.0039–0.0059in.)

(Adjusting the valve head clearance)

CAUTION:

Make sure each cylinder is in the T.D.C before adjusting the clearance. This way the intake/ exhaust rocker arms will not move even if the crankshaft is turned clockwise or counterclockwise from the TD mark.