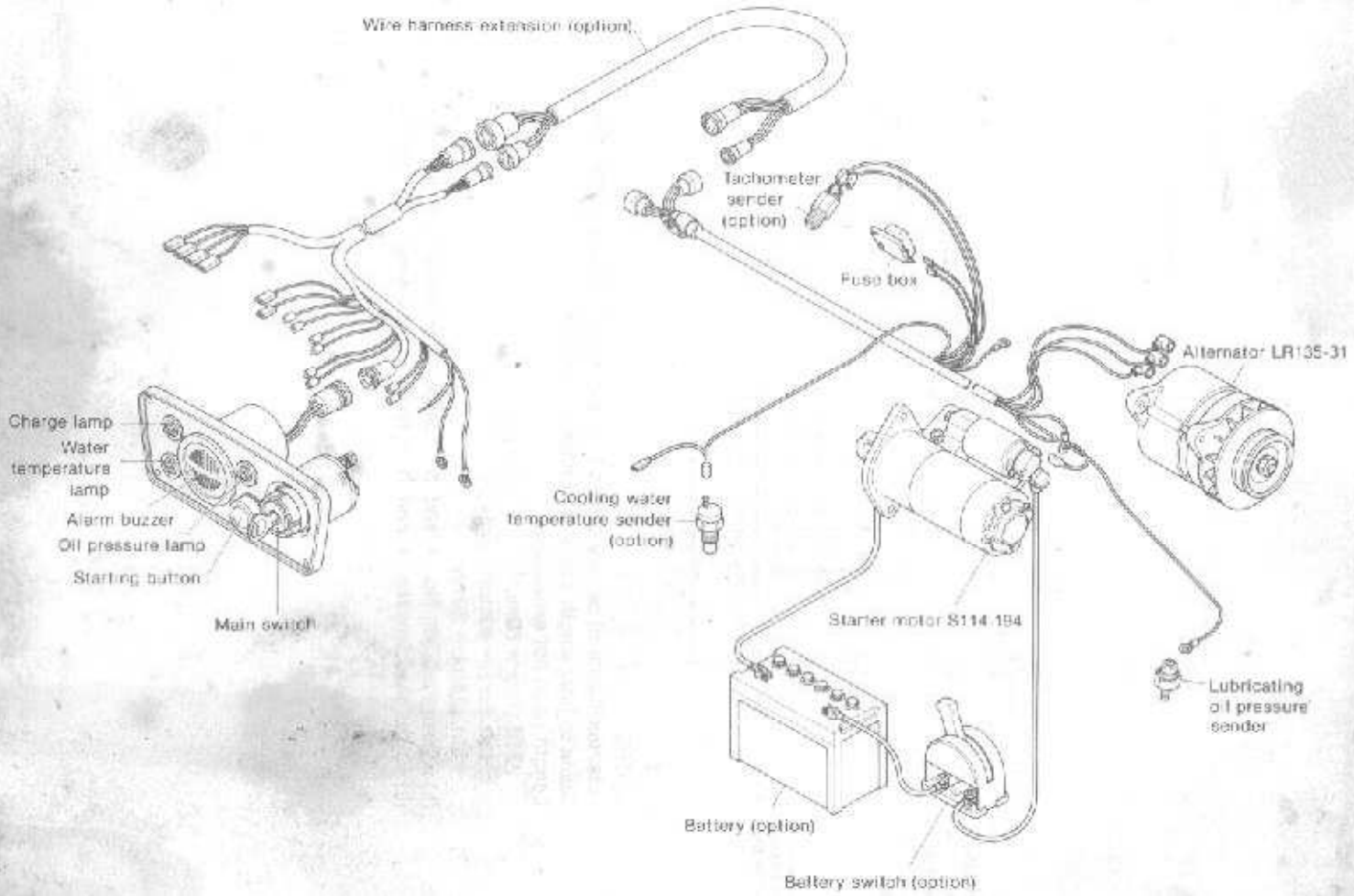
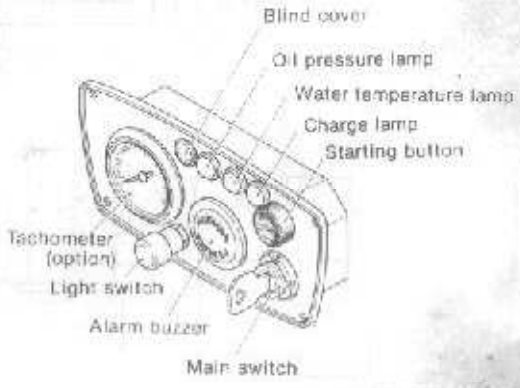
CHAPTER 11

ELECTRICAL SYSTEM

1. Composition

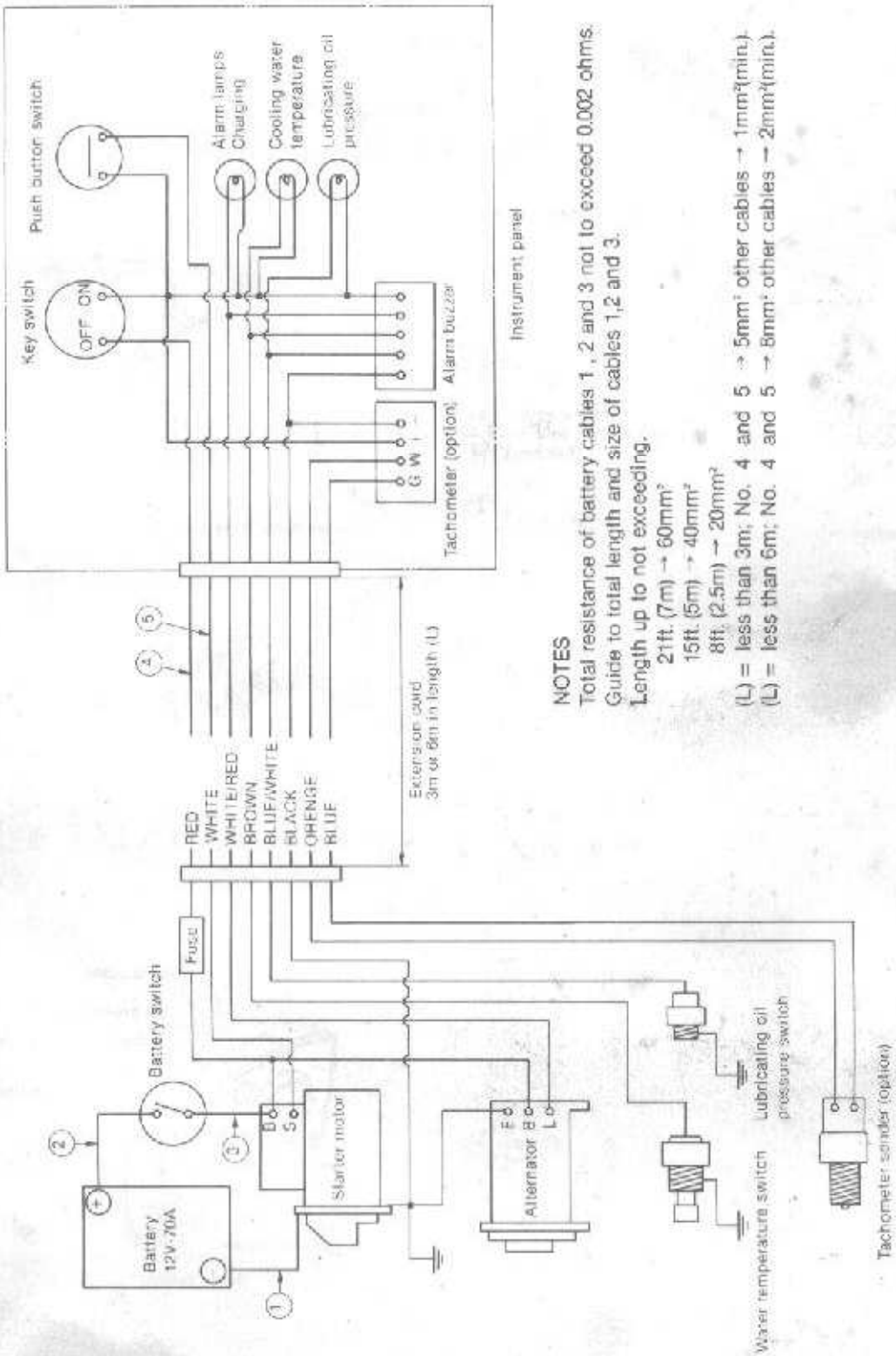
1-1. Composition





1-2 Connection diagram for electric equipment

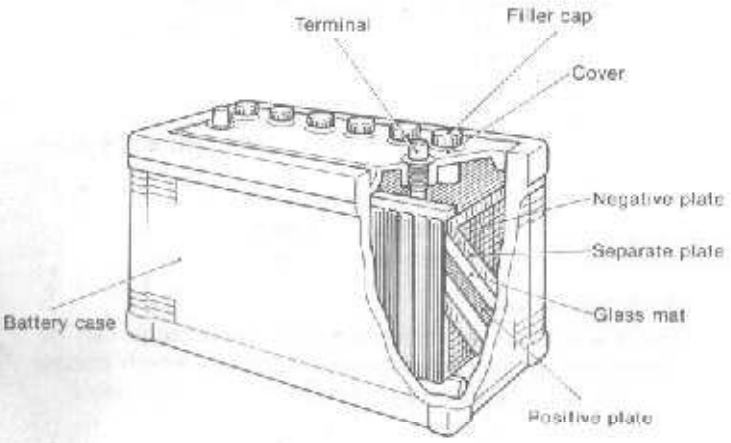
The electric equipment of the YSM models is broadly divided into 1) the starting devices, such as the starter, etc., and 2) charging devices, such as the alternator and 3) the various alarms, the connections of which are as shown in the diagram below.



NOTES
Total resistance of battery cables 1 , 2 and 3 not to exceed 0.002 ohms.
Guide to total length and size of cables 1,2 and 3.
Length up to not exceeding.
21ft. (7m) → 60mm²
15ft. (5m) → 40mm²
8ft. (2.5m) → 20mm²
(L) = less than 3m; No. 4 and 5 → 5mm² other cables → 1mm²(min.).
(L) = less than 6m; No. 4 and 5 → 8mm² other cables → 2mm²(min.).

2. Battery

2-1 Construction



The battery utilizes chemical action to convert chemical energy to electrical energy. This engine uses a lead acid battery which stores a fixed amount of power that can be used when required. After use, the battery can be recharged and used again.

As shown in the figure, a nonconductive container is filled with dilute sulfuric acid electrolyte. Lead dioxide positive plates and lead dioxide negative plates separated by glass mats are stacked alternately in the electrolyte. The positive and negative plates are connected to their respective terminals.

Power is removed from the battery by connecting the load across these two terminals.

When the battery is discharging, an electric current flows from the positive plates to the negative plates. When the battery is being charged, electric current is passed through the battery in the opposite direction by an external power source.

2-2 Battery capacity and battery cables

2-2.1 Battery capacity

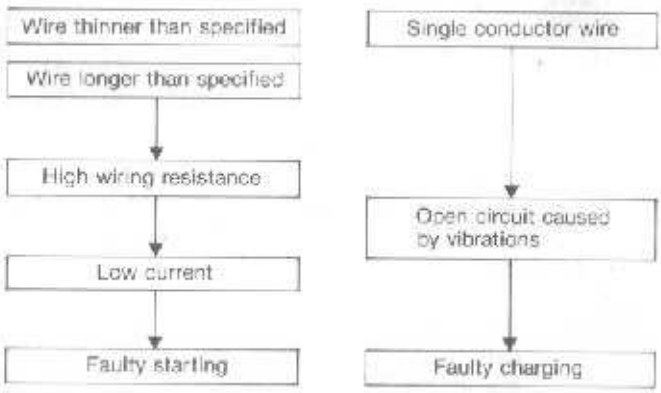
Since the battery has a minimum capacity of 12V, 70AH, it can be used for 100 ~ 150AH.

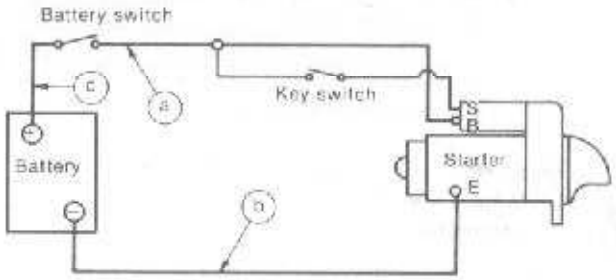
Minimum battery capacity	12V 70AH
Fully charged specific gravity	1.260

2-2.2 Battery cable

Wiring must be performed with the specified electric wire. Thick, short wiring should be used to connect the battery to the starter, (soft automotive low-voltage wire [AV wire]).

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





The overall lengths of the wiring between the battery (+) terminal and the starter (B) terminal, and between the battery (−) terminal and the starter (E) terminal should be based on the following table.

Voltage system	Allowable wiring voltage drop	Conductor cross-section area	a + b + c allowable length
12V	0.2V or less/100A	20mm² (0.031in.²)	Up to 2.5 m (98.43in.)
		40mm² (0.062in.²)	Up to 5 m (196.86in.)

2-3 Inspection

The quality of the battery governs the starting performance of the engine. Therefore the battery must be routinely inspected to assure that it functions perfectly at all times.

2-3.1 Visual inspection

(1) Inspect the case for cracks, damage and electrolyte leakage.
(2) Inspect the battery holder for tightness, corrosion, and damage.
(3) Inspect the terminals for rusting and corrosion, and check the cables for damage.
(4) Inspect the caps for cracking, electrolyte leakage and clogged vent holes.
Correct any abnormal conditions found. Clean off rusted terminals with a wire brush before reconnecting the battery cable.

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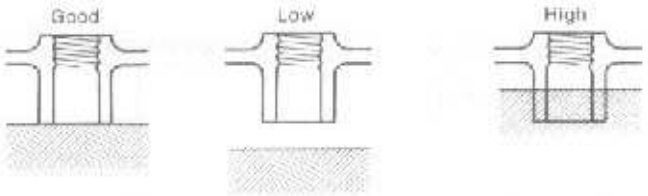
2-3.2 Checking the electrolyte

(1) Electrolyte level

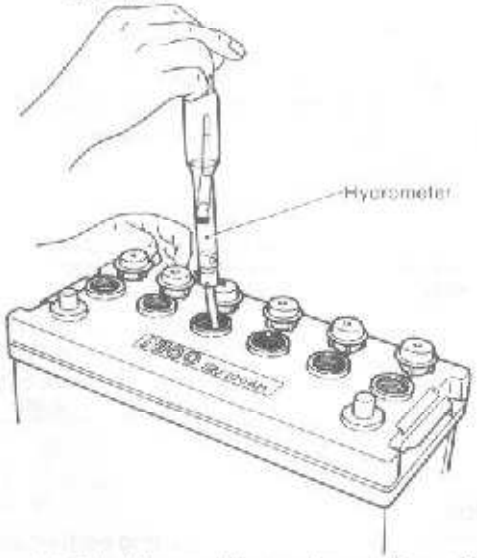


Check the electrolyte level every 7 to 10 days. The electrolyte must always be 10 ~ 20mm over the tops of the plates.

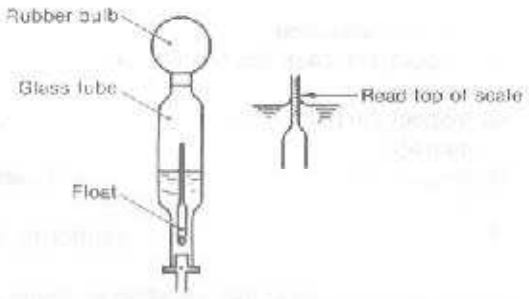
NOTES:
- The "LEVEL" line on a transparent plastic battery case indicates the height of the electrolyte.
- Always use distilled water to bring up the electrolyte level.
- When the electrolyte has leaked out, add dilute sulfuric acid with the same specific gravity as the electrolyte.

(2) Measuring the specific gravity of the electrolyte

1) Draw some of the electrolyte up into a hydrometer.



2) Take the specific gravity reading at the top of the scale of the hydrometer.



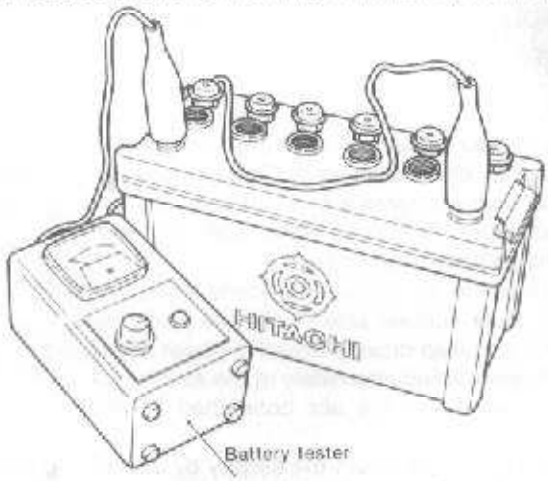
3) The battery is fully charged if the specific gravity is 1.260 at an electrolyte temperature of 20°C. The battery is discharged if the specific gravity is 1.200 (50%). If the specific gravity is below 1.200, recharge the battery.

4) If the difference in the specific gravity among the cells of the battery is +0.01, the battery is OK.

5) Measure the temperature of the electrolyte.
Since the specific gravity changes with the temperature, 20°C is used as the reference temperature.
Reading the specific gravity at 20°C
$S_{20} = St + 0.0007 (t - 20)$
S_{20}: Specific gravity at the standard emperature of 20°C
St: Specific gravity of the electrolyte at t°C
0.0007: Specific gravity change per 1°C
t: Temperature of electrolyte

2-3.3 Voltage test

Using a battery tester, the amount of discharge can be determined by measuring the voltage drop which occurs while the battery is being discharged with a large current.



(1) Connect the tester to the battery.
12V battery tester
Adjust the current (A).

(2) Connect the (+) lead of the tester to the (+) battery terminal, and the (−) tester lead to the (−) battery terminal.

(3) Push the TEST button, wait 5 seconds, and then read the meter.
- Repeat the test twice to make sure that the meter indication remains the same.

2-3.4 Washing the battery

(1) Wash the outside of the battery with a brush while running cold or warm water over the battery. (Make sure that no water gets into the battery.)

(2) When the terminals or other metal parts are corroded due to exposure to electrolyte leakage, wash off all the acid.

(3) Check the vent holes of the caps and clean if clogged.

(4) After washing the battery, dry it with compressed air, connect the battery cable, and coat the terminals with grease. Since the grease acts as an insulator, do not coat the terminals before connecting the cables.

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2-4 Charging

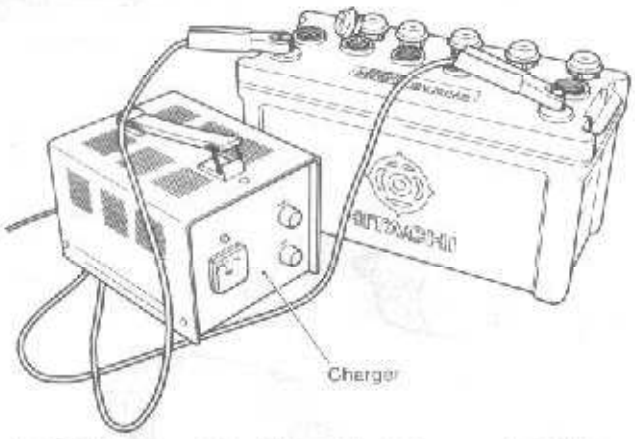
2-4.1 Charging methods

There are two methods of charging a battery: normal and rapid.
Rapid charging should only be used in emergencies.

- Normal charging... Should be conducted at a current of 1/10 or less of the indicated battery capacity (10A or less for a 100AH battery).
- Rapid charging... Rapid charging is done over a short period of time at a current of 1/5 ~ 1/2 the indicated battery capacity (20A ~ 50A for a 100AH battery). However, since rapid charging causes the electrolyte temperature to rise too high, special care must be exercised.

2-4.2 Charging procedure

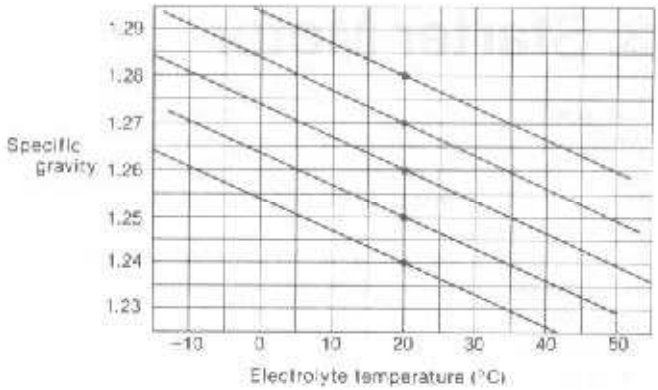
1. Check the specific gravity and adjust the electrolyte level.
2. Disconnect the battery cables.
3. Connect the red clip of the charger to the (+) battery terminal and connect the black clip to the (−) terminal.



4. Set the current to 1/10 ~ 1/5 of the capacity indicated on the outside of the battery.
5. Periodically measure the specific gravity during charging to make sure that the specific gravity remains at a high fixed value. Also check whether gas is being generated.

2-4.3 Charging precautions

1. Remove the battery caps to vent the gas during charging.
2. While charging, ventilate the room and prohibit smoking, welding, etc.
3. The electrolyte temperature should not exceed 45°C during charging.
4. Since an alternator is used on this engine, when charging with a charger, always disconnect the battery (+) cable to prevent destruction of the diodes.
   (Before disconnecting the (+) battery cable, disconnect the (−) battery cable [ground side].)

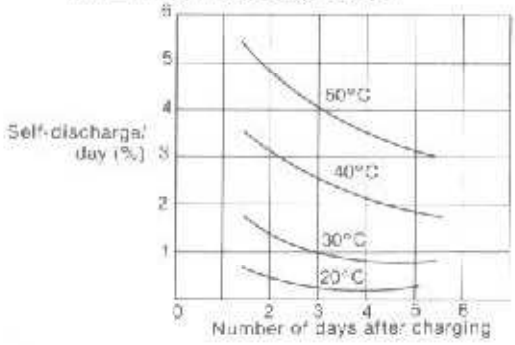


Electrolyte temperature and specific gravity

2-5 Battery storage precautions

The life of a battery depends considerably on how it is handled. Generally speaking, however, after about two years its performance will deteriorate, starting will become difficult, and the battery will not fully recover its original charge even after recharging. Then it must be replaced.

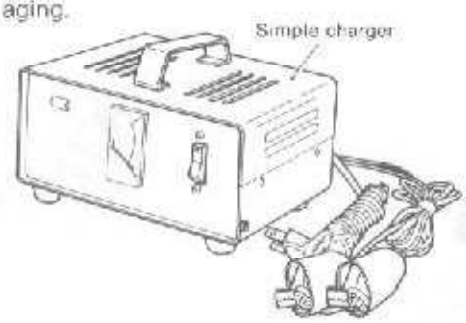
(1) Since the battery will self-discharge about 0.5%/day even when not in use, it must be charged 1 or 2 times a month when it is being stored.



(2) If charging by the engine alternator is insufficient because of frequent starts and stops, the battery will rapidly lose power.
Charge the battery as soon as possible after it is used under these conditions.

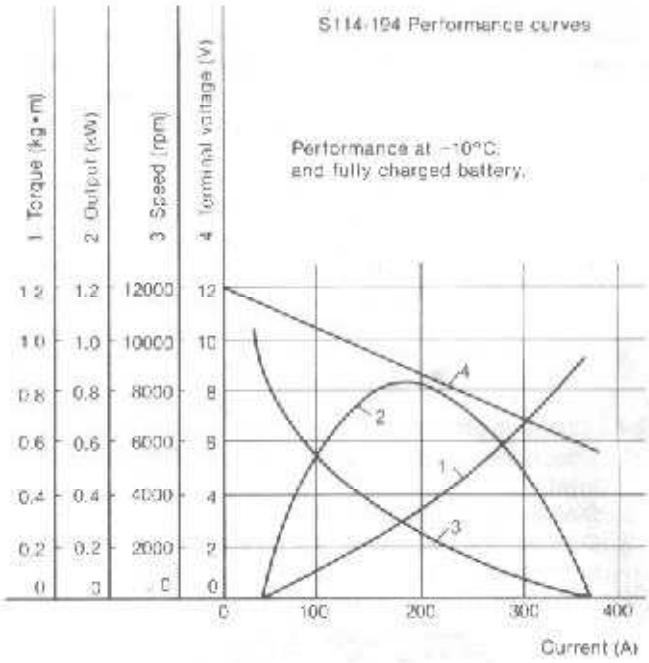
(3) An easy-to-use battery charger that permits home charging is available from Yanmar. Take proper care of the battery by using the charger as a set with a hydrometer.
When the specific gravity has dropped to about 1.16 and the engine will not start, charge the battery up to a specific gravity of 1.26 (24 hours).

(4) Before putting the battery in storage for long periods, charge it for about 8 hours to prevent rapid aging.



3. Starter Motor

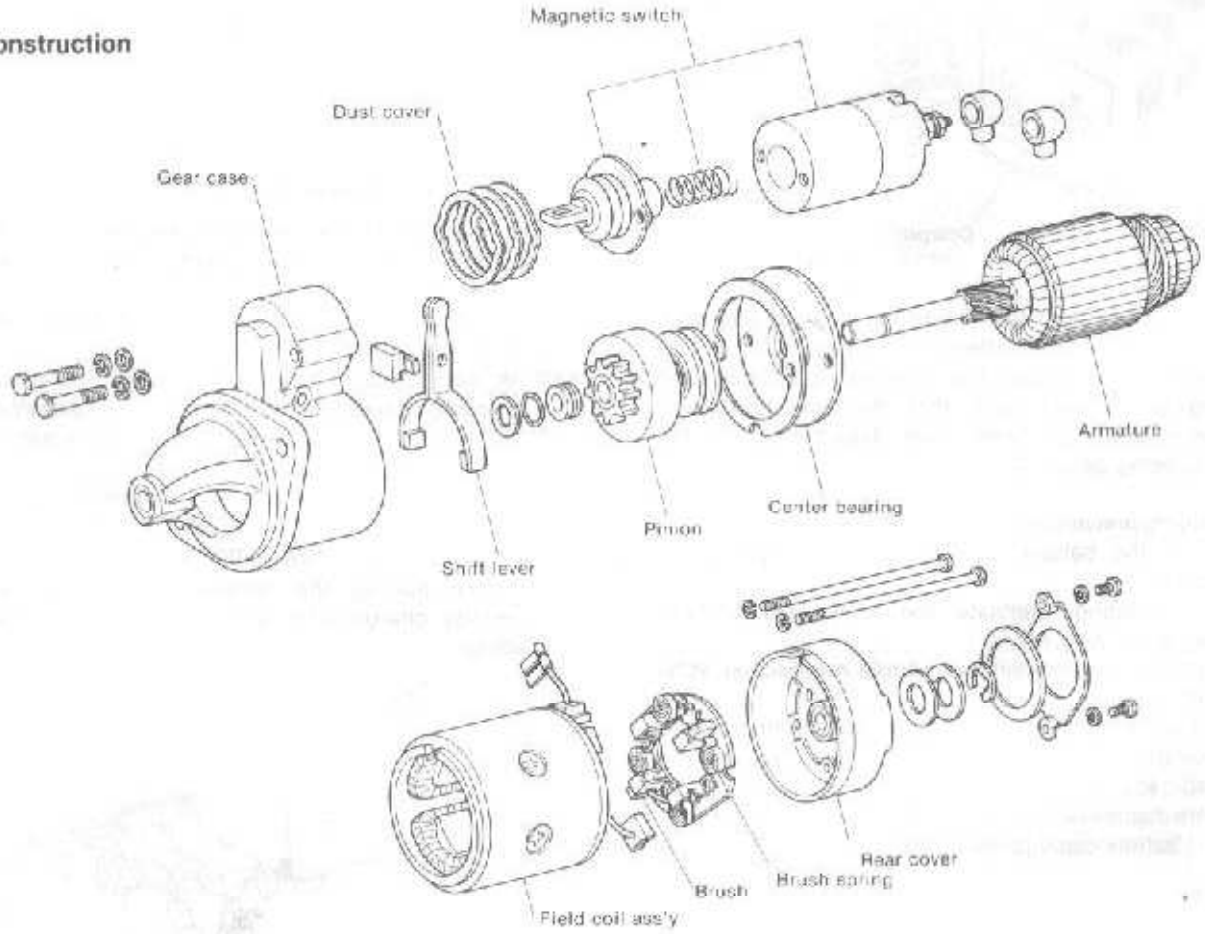
The starter motor is installed on the flywheel housing. When the starting button is pushed, the starter motor pinion flies out and engages the ring gear of the flywheel. Then the main contact is closed, current flows, and the engine is started.
After the engine starts, the pinion automatically returns to its initial position when the starting button is released. Once the engine starts, the starting button should be released immediately. Otherwise, the starter motor may be damaged or burned out.

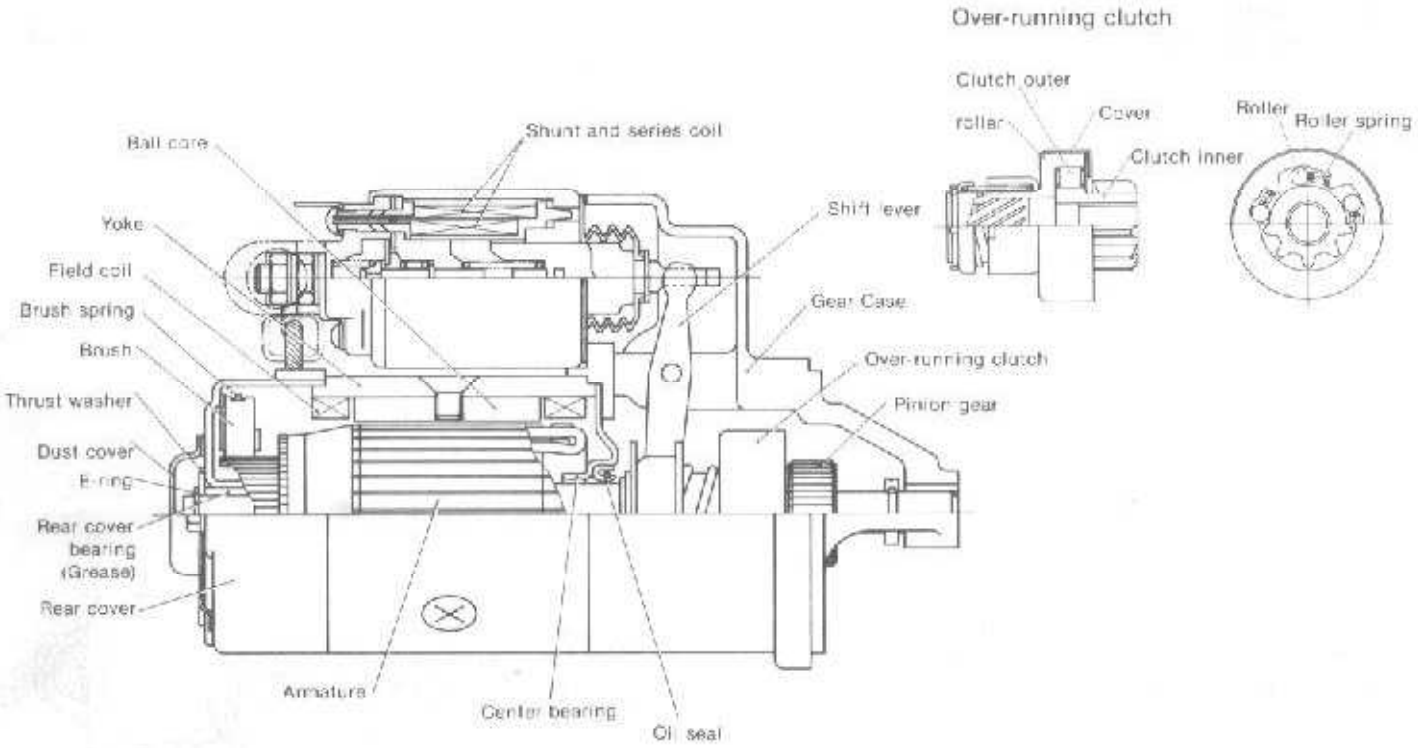


3-1 Specifications and Performance.

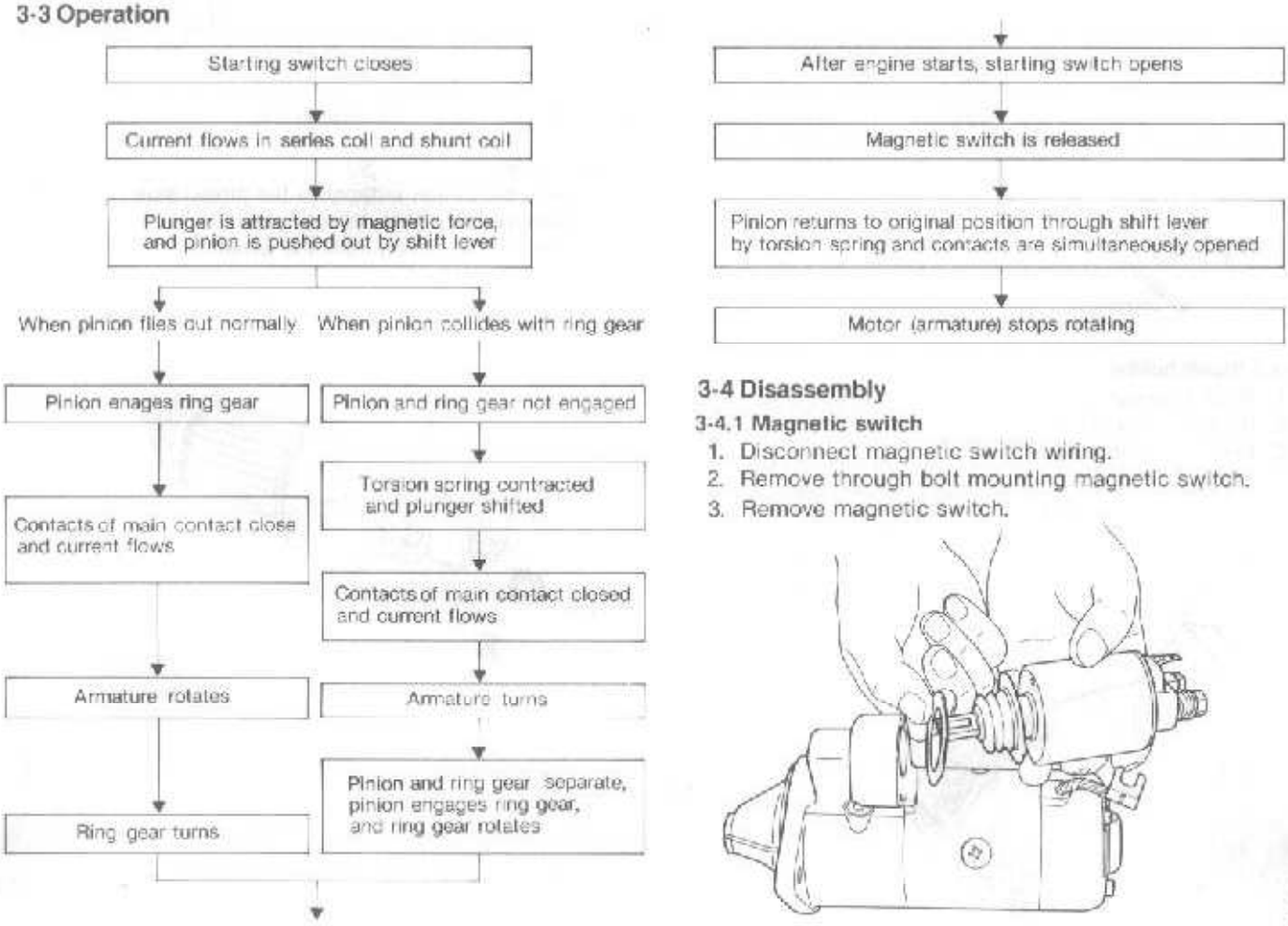
Model		S114-194
Rating (sec)		30
Output (kw)		1.0
Clutch system		Overrunning
Engagement system		Magnetic shift
Pinion flyout voltage (V)		5 or less
No-load	Terminal voltage (V)	12
	Current (A)	60 or less
	Speed (rpm)	7000 or greater

3-2 Construction





3-3 Operation



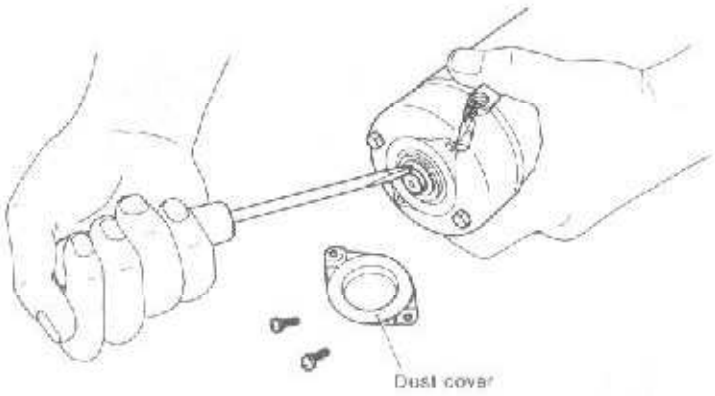
3-4 Disassembly

3-4.1 Magnetic switch

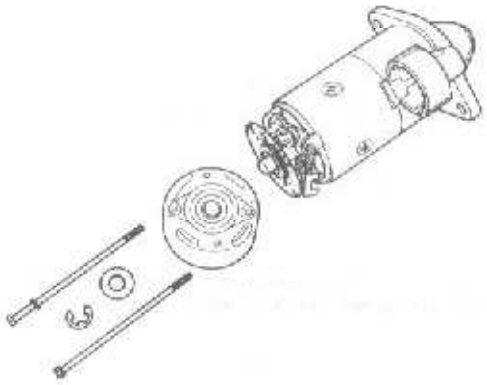
1. Disconnect magnetic switch wiring.
2. Remove through bolt mounting magnetic switch.
3. Remove magnetic switch.

3-4.2 Rear cover

1. Remove dust cover.

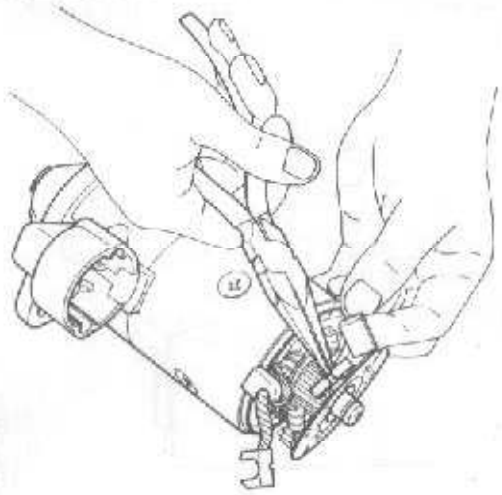


2. Remove E-ring, and remove thrust washer (be careful not to lose the washer and shim).
3. Remove the two through bolts holding the rear cover and the two screws holding the brush holder.
4. Remove rear cover.



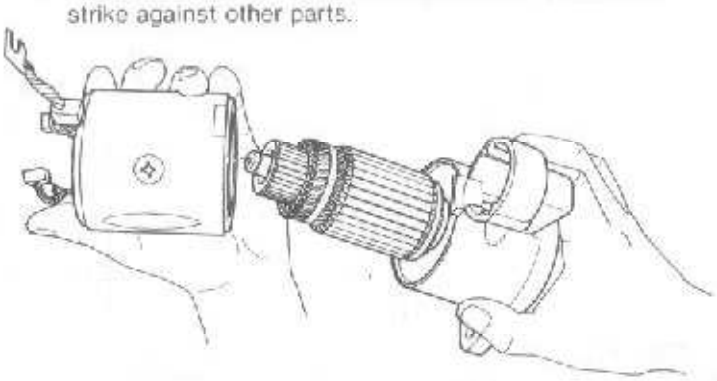
3-4.3 Brush holder

1. Float (−)brush from the commutator.
2. Remove (+)brush from the brush holder.
3. Remove brush holder.



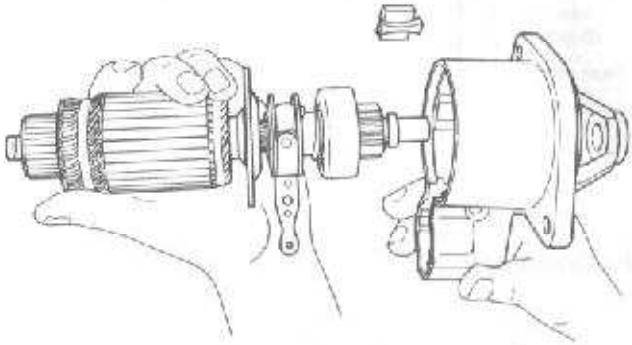
3-4.4 Yoke

1. Remove yoke. Pull it out slowly so that it does not strike against other parts.



3-4.5 Armature

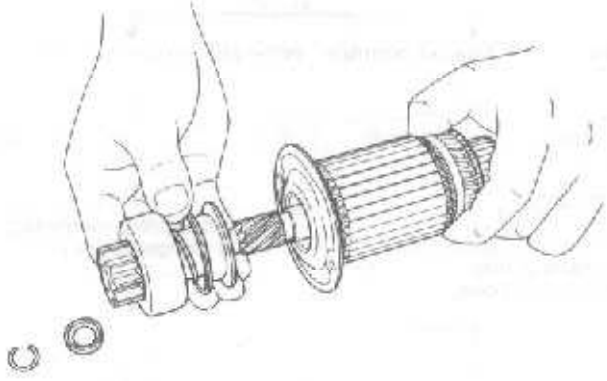
1. Slide pinion stopper to pinion side.



2. Remove the pinion stopper clip.

3-4.6 Pinion

1. Slide the pinion stopper to the pinion side.
2. Remove the pinion stopper clip.
3. Remove the pinion from the armature.

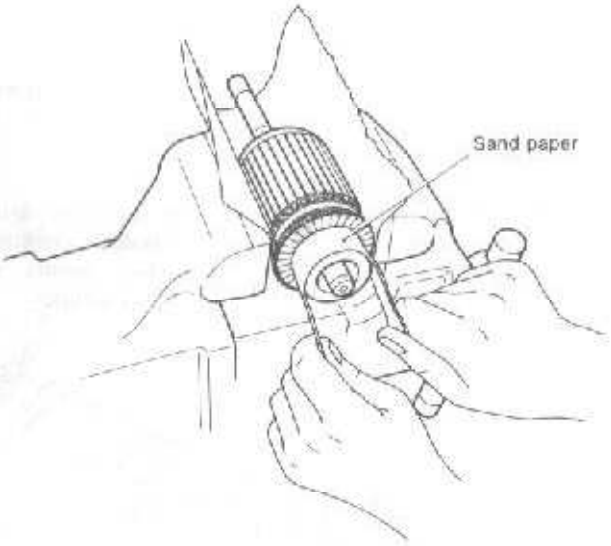


3-5 Inspection

3-5.1 Armature

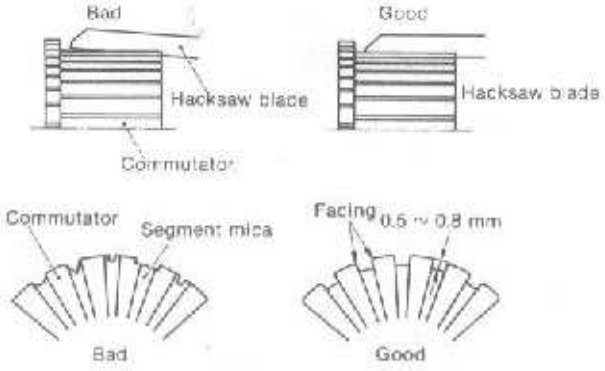
(1) Commutator

Inspect the surface of the commutator. If corroded or pitted, sand with #500 ~ #600 sandpaper. If the commutator is severely pitted, grind it to within a surface roughness of at least 0.4 by turning it on a lathe. Replace the commutator if damage is irrepairable.



(2) Mica undercut

Check the mica undercut, correct with a hacksaw blade when the undercut is too shallow.

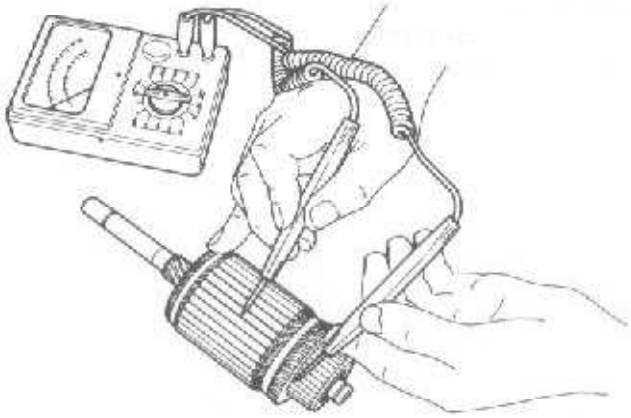


mm (in.)

	Maintenance standard	Repair limit
Mica undercut	0.2 (0.0079)	0.5 ~ 0.8 (0.0197 ~ 0.0315)

(3) Armature coil ground test

Using a tester, check for continuity between the commutator and the shaft (or armature core). Continuity indicates that these points are grounded and that the armature must be replaced.



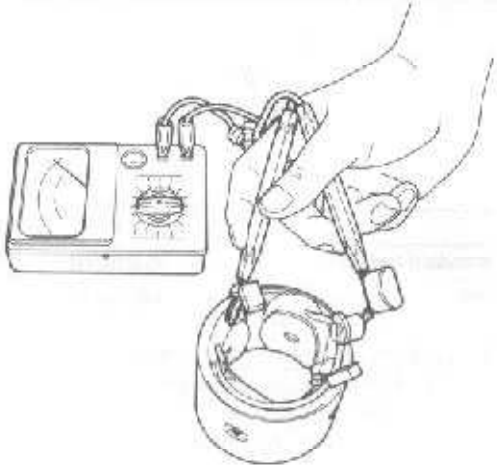
(4) Armature shaft

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

3-5.2 Field coil

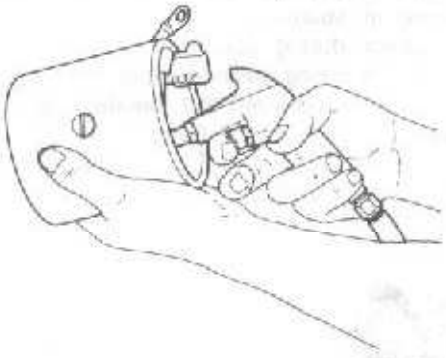
(1) Open test

Check for continuity between the terminals connecting the field coil brushes. Continuity indicates that the coil is open and that the coil must be replaced.



(2) Short test

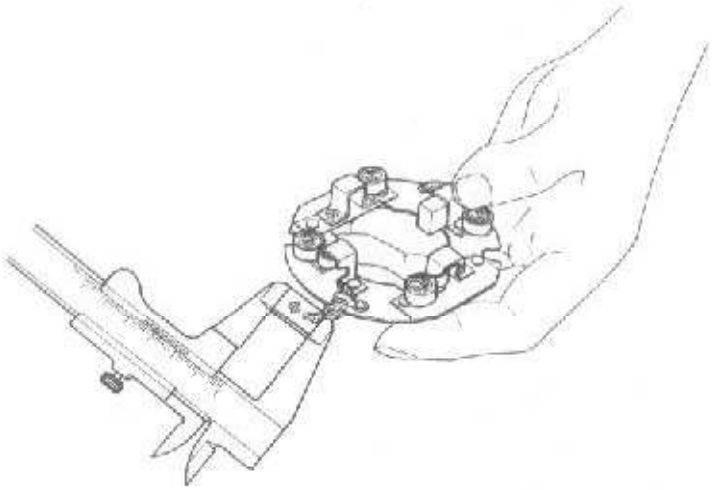
Check for continuity between the yoke and any field coil terminal. Continuity indicates that the coil is shorted and that it must be replaced.



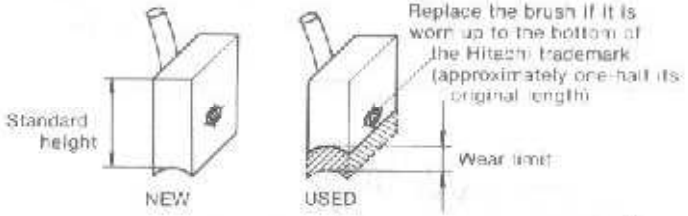
(3) Cleaning the inside of the yoke
If any carbon powder or rust has collected on the inside of the yoke, blow the yoke out with dry compressed air.
* Do not remove the field coil from the yoke.

3-5.3 Brush

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



(1) Brush dimensions
Replace brushes which have been worn beyond the specified wear limit.

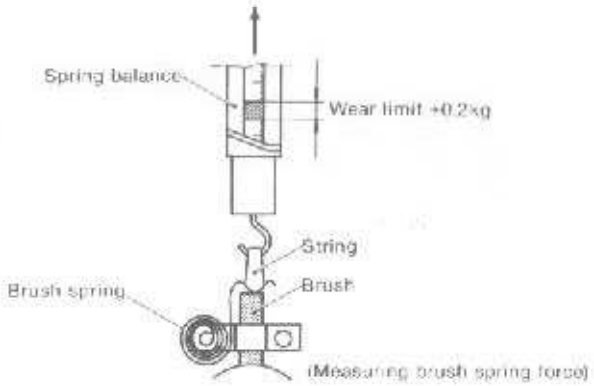


mm (in.)

	S114-194
Brush standard height	16 (0.6299)
Wear limit	4 (0.1575)

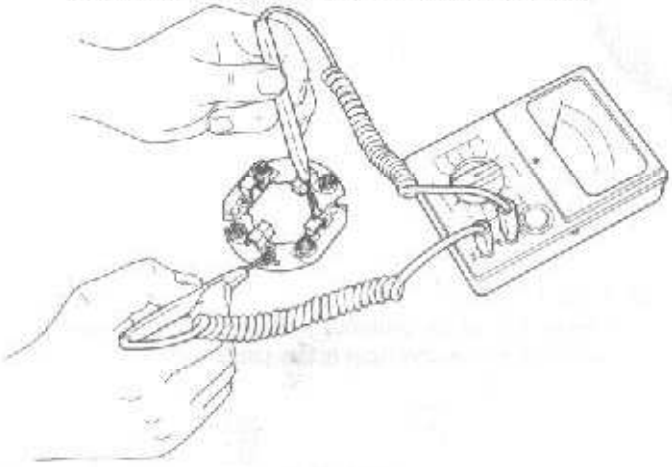
(2) Brush appearance and movement in brush holder
If the outside of the brush is damaged, replace it. If the movement of the brushes in the brush holder is hampered because the holder is rusted, repair or replace the holder.

(3) Brush spring
Since the brush spring pushes the brush against the commutator while the motor is running, a weak or defective 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.



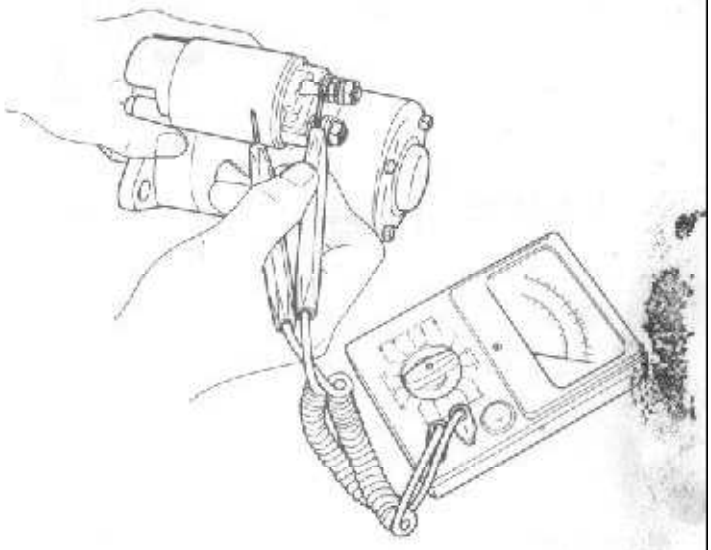
Standard spring load	1.6kg (3.527 lb)

(4) Brush holder ground test
Check for continuity between the insulated brush holder and the base of the brush holder assembly. Continuity indicates that these two points are grounded and that the holder must be replaced.

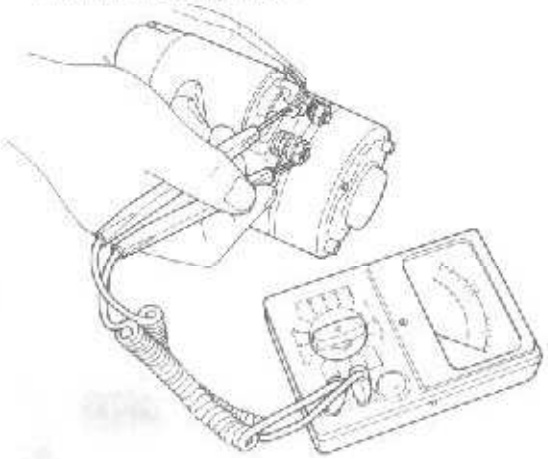


3-5.4 Magnetic switch

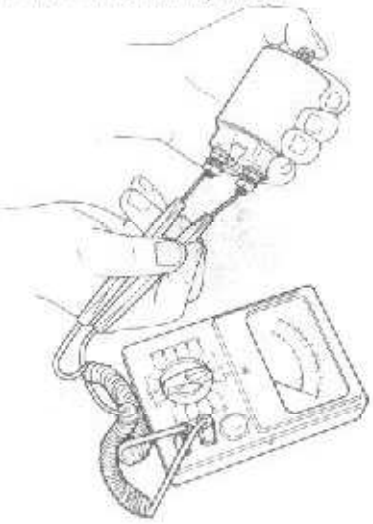
(1) Shunt coil continuity test
Check for continuity between the S terminal and the magnetic switch body (metal part). Continuity indicates that the coil is open and that the switch must be replaced.



(2) Series coil continuity test
Check for continuity between the S terminal and M terminal. Continuity indicates that the coil is open and that it must be replaced.



(3) Contactor contact test
Push the plunger with your finger and check for continuity between the M terminal and B terminal. Continuity indicates that the contact is faulty and that the contactor must be replaced.



3-5.5 Pinion

(1) Inspect the pinion teeth and replace the pinion if the teeth are 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.

3-6 Reassembly precautions

Lubrication

Lubricate each bearing and spline (points indicated GREASE in the construction drawing) with high quality "Hitachi Electrical Equipment Grease A".
The following lubricants may be used in place of Hitachi Electrical Equipment Grease A.

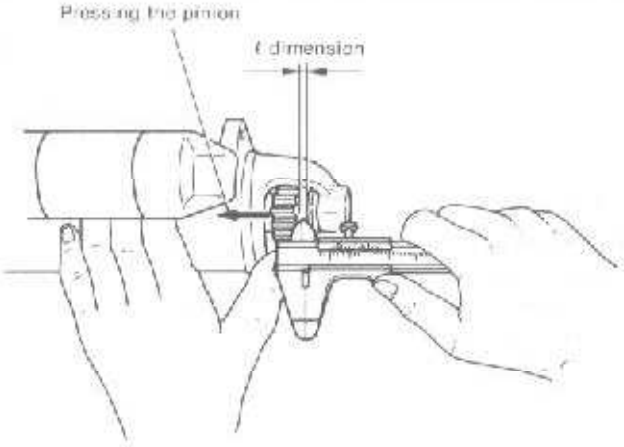
Magnetic switch plunger	Shell	Aeroshell No. 7
Bearing and spline	Shell	Albania Grease No. 2

3-7 Adjusting the starting motor

When the pinion is pushed out by the magnetic switch, the distance from the pinion stopper to the pinion is termed the *l* dimension, the standard for which is as listed below.

mm (in.)

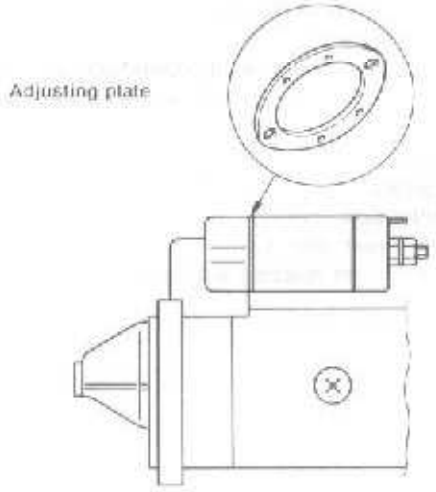
	S114-195
Dimension	0.3 ~ 1.5 (0.0118 ~ 0.0590)



Measuring of *l* dimension

***l* dimension**

Before measuring the *l* dimension, connect the ⊕ battery cable to terminal S and the ⊖ battery cable to the motor body. By attracting the plunger and by causing the shift lever to push out the pinion, measure the *l* dimension by pressing the pinion in the direction of the arrow to eliminate play, as shown in the diagram.
If the *l* dimension is outside the standard value, adjust it with an adjusting plate inserted in the section where the magnet switch is installed. The adjusting plate comes in two types; one is 0.5 mm (0.019 in.) thick and the other 0.8 mm (0.031 in.)



3-8 Handling the starting motor

3-8.1 Fitting the starting motor into place

The normal size of the gap between the pinion and the ring gear is 3 to 5 mm (0.118 ~ 0.197in.).
Be sure to tighten the wiring securely.

3-8.2 Precautions for starting the motor

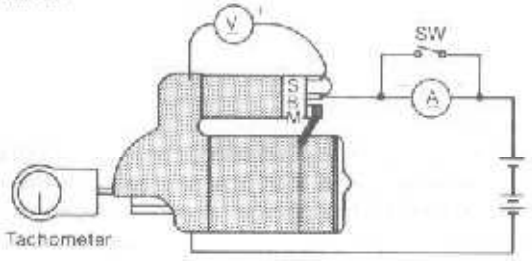
(1) Pay attention to the charge condition of the battery. Undercharging makes it difficult to start the engine.
(2) After the motor has been started, immediately turn off the starting switch.
(3) If the engine will not start even though the starting switch has been turned on, turn it off and on for about 10 seconds.
(4) When re-turning on the starting switch, wait until the starting motor stops.
(5) During engine operation never turn on the starting switch.

3-9 Testing

3-9.1 No load test

Test procedure

(1) Connect the positive side of the ammeter (A) to the positive terminal of the battery, and connect the negative side of the ammeter to the B terminal of the starter.



(2) Connect the negative terminal of the battery to the body of the starter.
(3) Connect the positive side of the voltmeter (V) to the B terminal of the starter, and connect the negative side of the voltmeter to the body of the starter.
(4) Attach the tachometer.
(5) Connect the B terminal of the starter to the S terminal of the magnetic switch.

- The magnetic switch should begin operating, and the speed, current, and voltage should be the prescribed values.
- A fully charged battery must be used.
- Since a large current flows when the starter is operated, close the protection circuit switch before initial operation, then open the switch and measure the current after the starter reaches a constant speed.

3-10 Standards for servicing the starting motor

mm (in.)

			S114-194
Brush	Standard strength of spring		1.8kg (3.52 lb.)
	Standard height/limit of reduction in dimension		16/4 (0.63/0.157)
Magnetic switch resistance at 20°C		Series coil/shunt coil	0.324/0.694 Ω
Commutator	Outside diameter	Standard outside diameter/ limit of reduction in size	33/2 (1.299/0.078)
	Difference between maximum and minimum diameters	Limit of correction/ Accuracy of correction	0.4/0.05 (0.015/0.002)
	Mica undercut	Limit of correction/ Accuracy of correction	0.2/0.5 ~ 0.8 (0.008/0.019 ~ 0.031)
Standard dimensions	Brush side bearing	Shaft diamer/Hole diameter	ø0.492 $^{-0.0015}_{-0.002}$ ø0.492 $^{+0.0011}_{0}$
	Intermediate bearing	Shaft diamer/Hole diameter	ø0.687 $^{+0.0008}_{-0.0008}$ ø0.693 $^{+0.021}_{0}$
	Pinion slide way	Shaft diamer/Hole diameter	ø0.492 $^{-0.0015}_{-0.002}$ ø0.492 $^{+0.0011}_{0}$
	Pinion side bearing	Shaft diamer/Hole diameter	ø0.492 $^{-0.0015}_{-0.002}$ ø0.492 $^{+0.0011}_{0}$

3-11 Various problems and there remedies

(1) Pinion fails to advance when the starting switch is closed

Problem	Cause	Corrective action
Wiring	Open or loose battery or switch terminal	Repair or retighten
Starting switch	Threaded part connected to pinion section of armature shaft is damaged, and the pinion does not move	Repair contacts, or replace switch
Starter motor	Threaded part connected to pinion section of armature shaft is damaged, and the pinion does not move	Replace
Magnetic switch	Plunger of magnetic switch malfunctioning or coil shorted	Repair or replace

(2) Pinion is engaged and motor rotates, but rotation is not transmitted to the engine

Problem	Cause	Corrective action
Starting motor	Overrunning clutch faulty	Replace

(3) Motor rotates at full power before pinion engages ring gear

Problem	Cause	Corrective action
Starter motor	Torsion spring permanently strained	Replace

(4) Pinion engages ring gear, but starter motor fails to rotate

Problem	Cause	Corrective action
Wiring	Wires connecting battery and magnetic switch open or wire connecting ground, magnetic switch and motor terminals loose	Repair, retighten, or replace wire
Starter motor	Pinion and ring gear engagement faulty Motor mounting faulty Brush worn or contacting brush spring faulty Commutator dirty Armature, field coil faulty Field coil and brush connection loose	Replace Remount Replace Repair Repair or replace Retighten
Magnetic switch	Contactor contact faulty Contactor contacts pitted	Replace Replace

(5) Motor fails to stop when starting switch is opened after engine starts

Problem	Cause	Corrective action
Starting switch	Switch faulty	Replace
Magnetic switch	Switch faulty	Replace

4. Alternator

The alternator serves to keep the battery constantly charged. It is installed on the cylinder block by a bracket, and is driven from the V-pulley at the end of the crankshaft by a V-belt.
The type of alternator used in this engine is ideal for high speed engines having a wide range of engine speeds. It contains diodes that convert AC to DC, and an IC regulator that keep the generated voltage constant even when the engine speed changes.

4-1 Specifications

Type	Alternator	LR135-31
	Regulator	TR1Z-28
Battery voltage		12V
Output current		35A/5000rpm
Polarity		2-wire system
Direction of rotation		CW as viewed from pulley side
Regulated voltage		14.3 −0.3V
Speed at 13V		1000rpm or less
Weight		3.8kg (8.377lb)

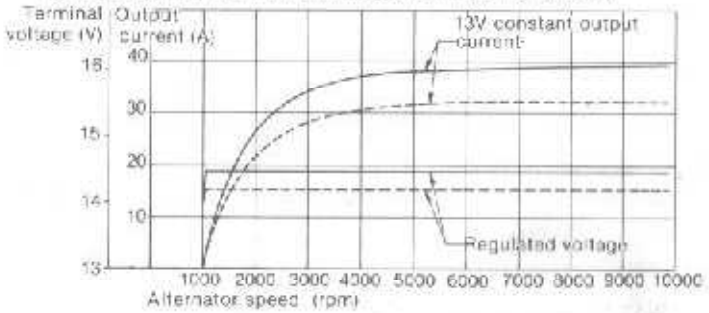
CW: Clockwise

4-2 Characteristics

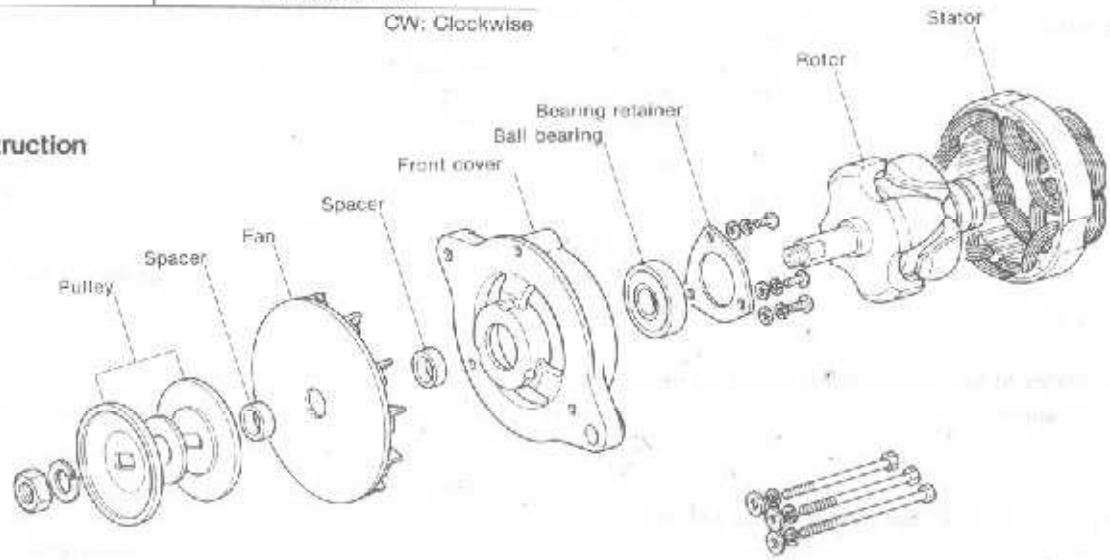
LR135-31

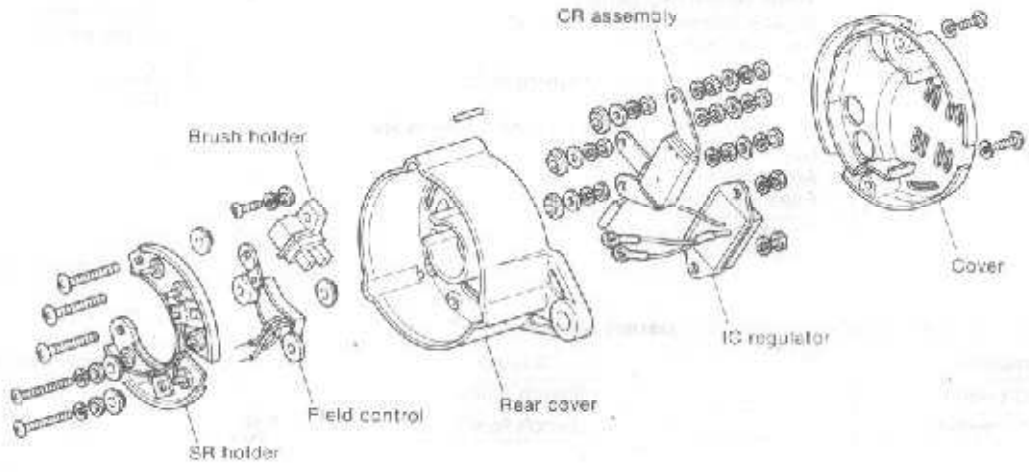
Standard speed characteristic of 12V-35A Alternator with IC regulator.

—Cold
...Warm ('Warm' is the state of the engine reached after a temperature rise test is conducted at a constant 5000 rpm maximum output.)

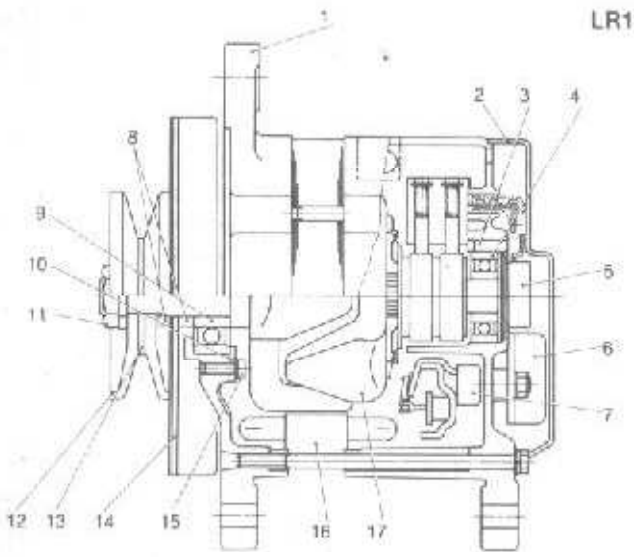


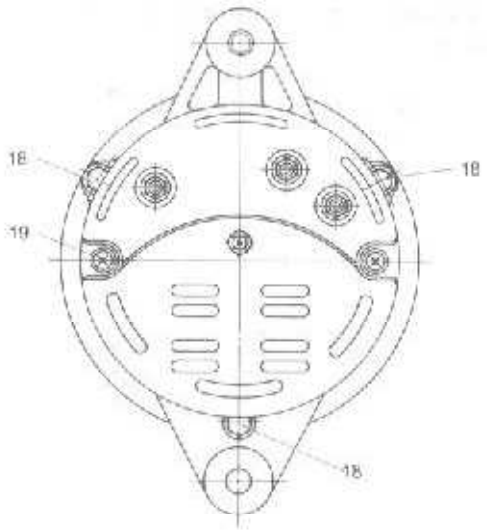
4-3 Construction





LR135-31

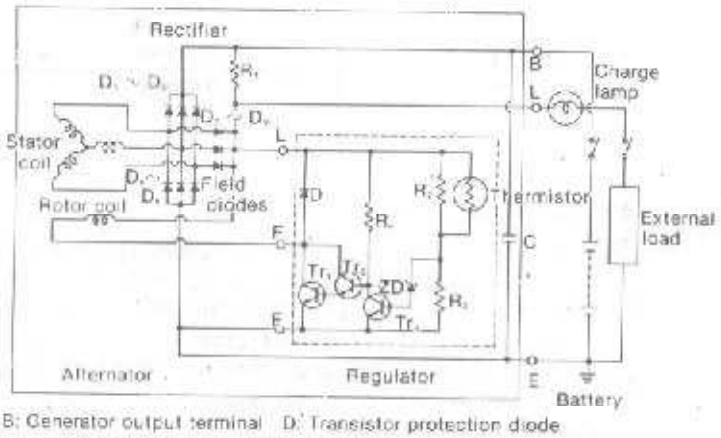




1 Front cover assembly
2 Cover
3 Pin (nylon resin)
4 Ball bearing
5 CR assembly
6 IC regulator
7 Field control unit
8 Spacer
9 Ball bearing
10 Bearing retainer
11 Pulley nut
12 Pulley
13 Pulley spacer
14 Fan
15 Screw
16 Stator assembly
17 Rotor assembly
18 Through bolt
19 Screw

4-4 Operation (LR135-31)

4-4.1 Circuit diagram

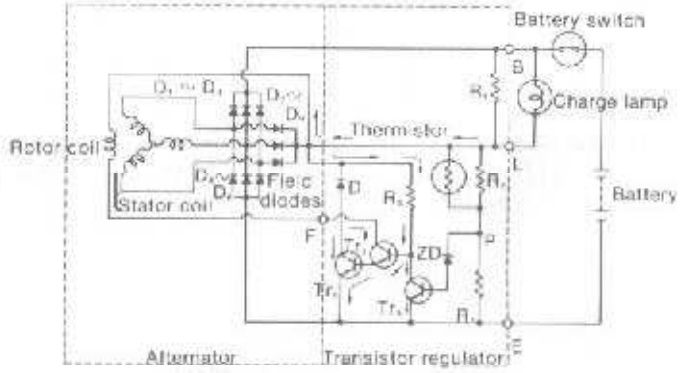


B: Generator output terminal D: Transistor protection diode
L: Charge lamp terminal ZD: Zener diode
E: Ground (battery (−)) terminal
$Tr_1 \sim Tr_3$: Transistor $D_1 \sim D_5$: Output rectification diodes
$R_1 \sim R_5$: Resistor
$D_1 \sim D_3$: ON/OFF operation of charge lamp and rotor coil current
field supply diodes C: Condenser

Basically, this circuit consists of an output Tr_1 transistor that turns the alternator rotor coil current on and off, a Tr_2 transistor that passes the base current to Tr_1, a Tr_3 control transistor that controls Tr_1, a zener diode ZD, and resistors R_1, R_2, R_3, and R_4, which pass on the current when the battery voltage reaches the regulated voltage, and a thermistor, as shown in the above figure.

4-4.2 Description of operation

(1) Initial excitation

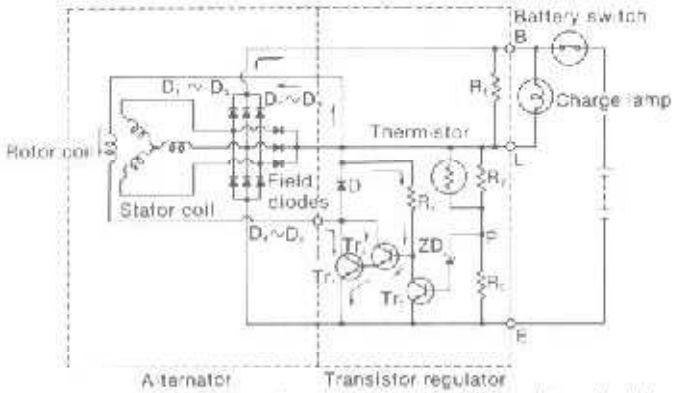


When the battery switch is closed, current flows into Tr_2 and Tr_1, and the charge lamp lights up. At this time, the voltage at point P is lower than the zener voltage and current does not flow through the ZD (zener diode). Therefore, the base current does not flow through Tr_3, and Tr_3 is turned OFF.

The resistor R_1 is inserted in series with the charge lamp to prevent interruption of the rotor coil current if the charge lamp blows out, and to reduce the rise in speed (speed automatically adjusted) caused by the increase in the initial exciting current.

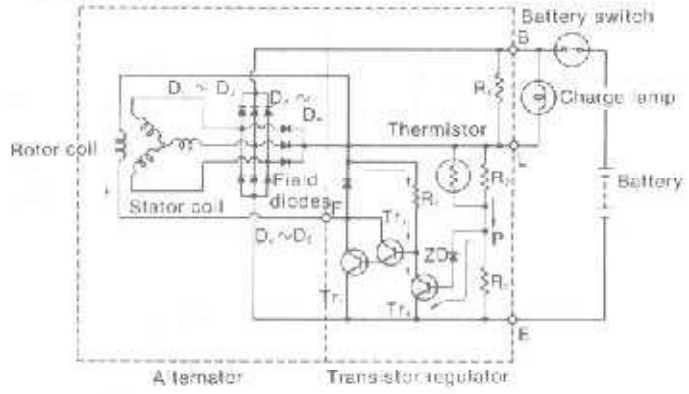
(2) Initial rotation

The alternator consists of field diodes (D7 ~ D9). When the alternator is operated, generation begins. When the speed of the alternator rises until its output voltage exceeds the battery terminal voltage, battery charging beings.



At this stage, the voltages at terminal B and terminal L are equal, and the charge lamp goes out to indicate that charging has begun. When charging begins, the Tr_3 base current, Tr_1 base current, and Tr_2 collector current (rotor coil current) are supplied from the alternator through D7 ~ D9 (field diodes). Since R_3 and R_4 are selected so that the voltage across P-E turns the ZD (zener diode) ON when the voltage across B-E exceeds the regulated voltage of the regulator, when the ZD (zener diode) is conducting, current flows through the path indicated above.

(3) Operation



A Tr_1 collector-emitter voltage of at least 0.6V is necessary to allow the base current to flow through Tr_3 and Tr_1. But since the Tr_3 collector-emitter voltage is about 0.3V when Tr_3 is conducting, the Tr_2 and Tr_3 base current is interrupted, Tr_1 and Tr_2 are turned OFF, and current does not flow through the rotor coil.

When the rotor coil current is stopped, the alternator output voltage drops, the voltage across P-E applied to the ZD (zener diode) drops below the zener voltage, the zener diode is turned OFF, and the Tr_3 base current is interrupted.

As a result, Tr_3 is turned OFF, the base voltage of Tr_2 rises, and base current begins to flow through Tr_1.

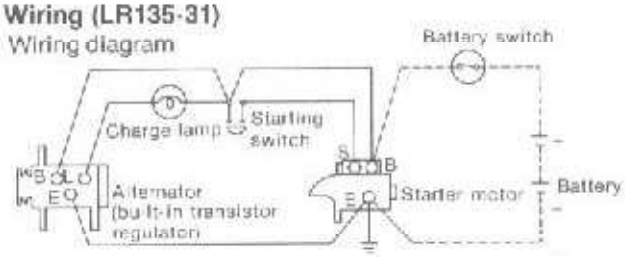
This causes Tr_1 to conduct and the rotor coil current to begins to flow again.

As can be seen from the above description, when the output voltage of the generator is lower than the regulated voltage the Tr_1 output transistor conducts and rotor coil current flows. When the alternator output voltage is higher than the regulated voltage, control transistor Tr_3 conducts, output transistor Tr_1 is turned OFF, and the rotor coil current is interrupted.

The battery charging voltage is kept constant by turning the output transistor ON and OFF repeatedly in this manner.

4-5 Wiring (LR135-31)

(1) Wiring diagram



(2) Terminal connections

The alternator has the following terminals. Connect these terminals as indicated below.

Symbol	Terminal name	Connection to external wiring
B	Battery terminal	To battery (+) side
E	Ground terminal	To battery (−) side
L	Lamp (charge) terminal	To charge lamp terminal

The IC regulator terminals are as follows:

Symbol	Lead color
B	W (white)
E	B (black)
L	L (red)

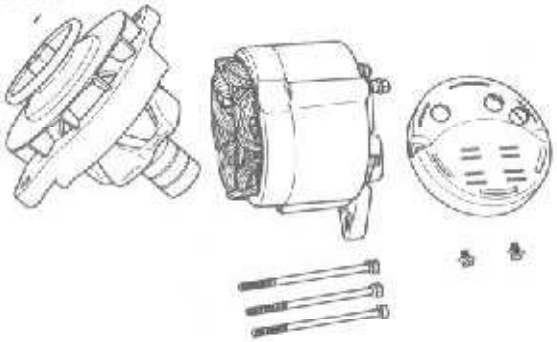
4-6 Alternator handling precautions

(1) Pay attention to the polarity of the battery; be careful not to connect it in reverse polarity. If the battery is connected in reverse polarity, the battery will be shorted by the diode of the alternator, an overcurrent will result, the diodes and transistor regulator will be destroyed, and the wiring harness will be burned.
(2) Connect the terminals correctly.
(3) When charging the battery from outside, such as during rapid charging, disconnect the alternator B terminal or the battery terminals.
(4) Do not short the terminals.
(5) Never test the alternator with a high voltage megger.

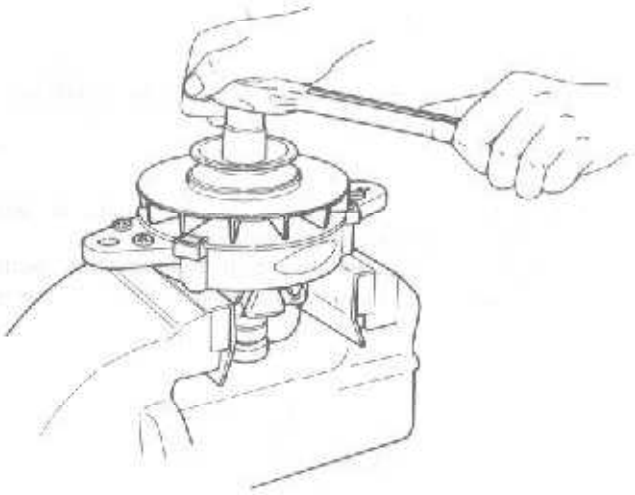
4-7 Alternator disassembly

Disassemble the alternator as follows.
The major points of disassembly are the removal of the cover, the separation of the front and rear sides, and detailed disassembly.

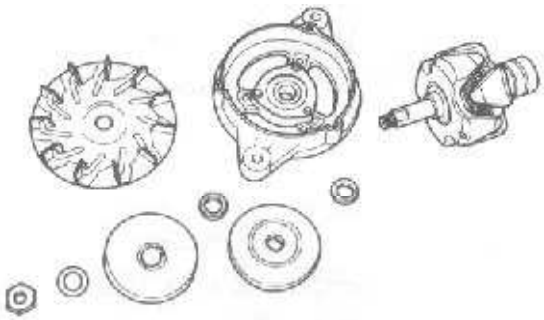
(1) Remove the cover attached to the rear cover, remove the through bolts, and disassemble into front and rear sides.



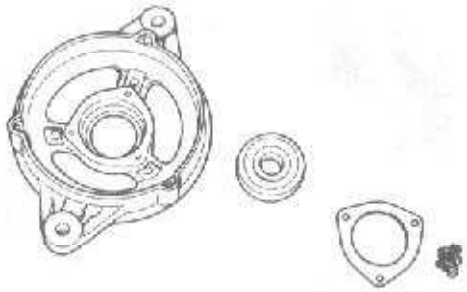
(2) Then when disassembling the front side pulley and fan, front cover and rotor, clamp the rotor in a vice through the copper plates and loosen the pulley nut, as shown in the figure.



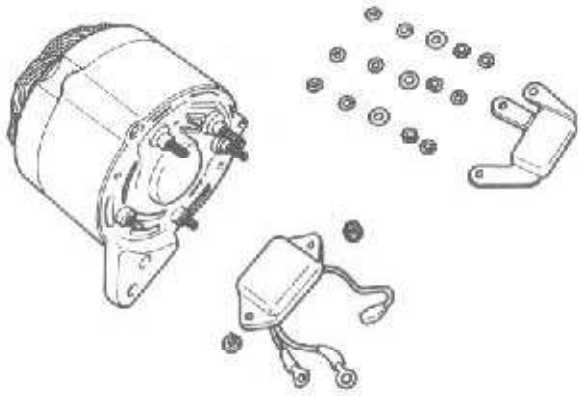
(3) When the fan and pulley have been removed, the rotor can be pulled from the front cover by hand.



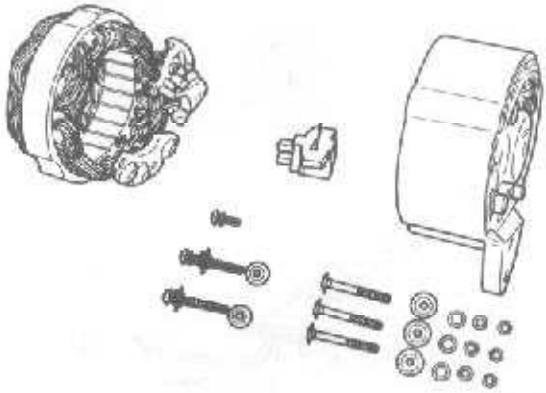
(4) Next, remove the bearing attached to the front cover. Loosen the bearing protector mounting bolts and pull the bearing by applying pressure to the bearing from the front cover.



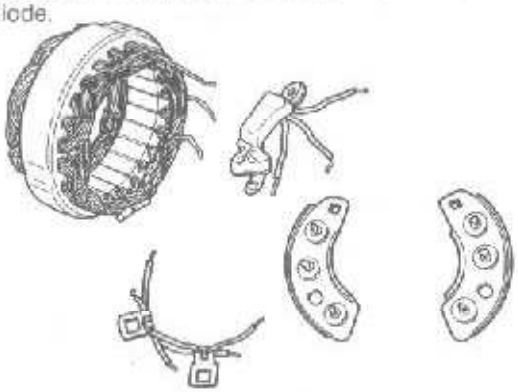
(5) Disassemble the rear side.
First, disconnect the resistor and IC regulator from the terminals.



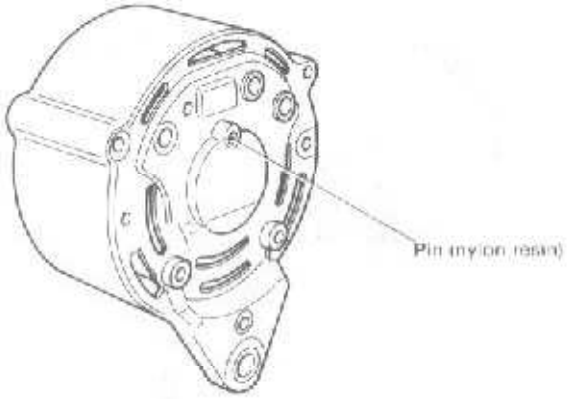
(6) Remove the bolts holding the SR holder and brush holder, remove the B.E.L. terminal nuts, and disassemble into the rear cover and stator (with SR holder).



(7) Melt the solder connecting the stator and the diode, and break it down to the stator, SR holder and auxiliary diode.



(8) Pull out the pin (nylon resin) inserted into the brush cover mounting section of the rear cover, and disassemble the rear cover.

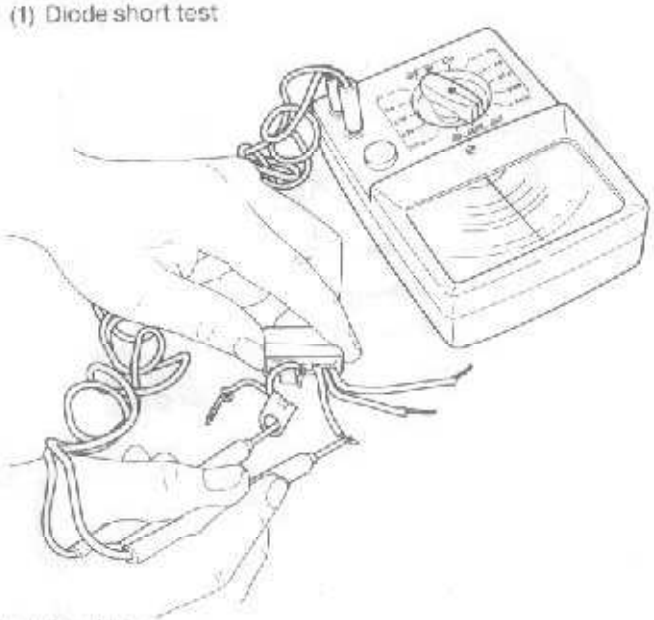


(9) When (1)—(8) above are completed, the alternator is completely disassembled.

4-8 Inspection and adjustment

4-8.1 Diodes

(1) Diode short test



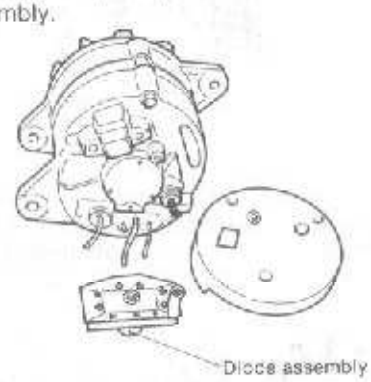
A set of 6 diodes and a set of 3 moulded diodes (field diodes) are used. The (+) diodes and (−) diodes of the six diode set conduct in opposite directions. (See the figure below.) Replace the diodes that conduct in both directions and the diodes that do not conduct in both directions.

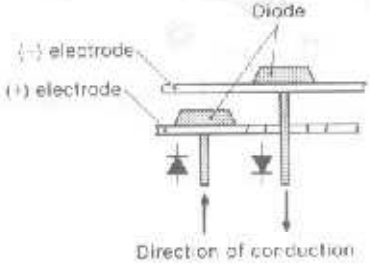
Test for the continuity of each diode.

CAUTION: If a high voltage megger is used, a high voltage will be applied to the diode and the diode will be destroyed. Therefore, never test the diodes with a high voltage megger, etc.

(2) Replacement

1) Remove the cover.
2) Unsolder the diode assembly wiring. (CAUTION: Hold the diode with needle nose pliers so that the heat of the soldering iron is not transmitted to the diode.)
3) Remove the diode assembly mounting nut and bolt, and remove the diode ass'y.
   Remove the nut and bolt holding the diode assembly in place, and then remove the diode assembly.





4-8.2 Rotor

(1) Slip ring wear

Because the slip rings wear very little, the diameter of the rings must be measured with a micrometer. Replace the rings (rotor assembly) when wear exceeds the maintenance standard by 1 mm.

mm (in.)

	Maintenance standard	Wear limit
Slip ring outside diameter	ø31 (1.2205)	ø30 (1.1811)

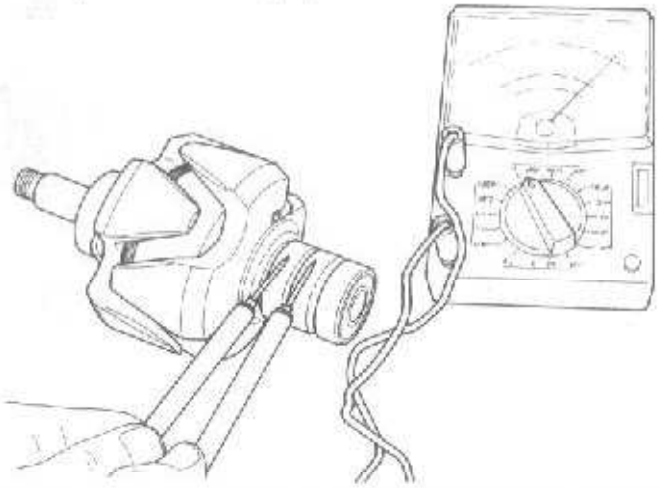
(2) Slip ring roughness

The slip ring should be smooth with no surface oil, etc. If the surface of the rings is rough, polish with #500 ~ #600 sandpaper, and if the surface is soiled, clean with a cloth dipped in alcohol.

(3) Rotor coil short test

Check the continuity between the rotor coil and slip ring with a tester. The resistance should be near the prescribed value.

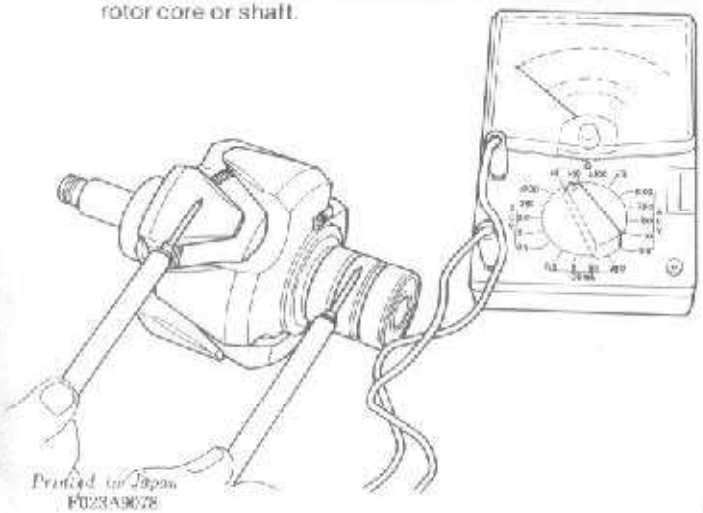
If the resistance is extemely low, there is a layer short at the rotor coil; if the resistance is infinite, the coil is open. In either case, replace the rotor.



Resistance value:	Approx 3.83 ±0.15Ω (at 20°C)

(4) Rotor coil ground test

Check the rotor coil for grounding with a tester, or by checking the continuity between one slip ring and the rotor core or shaft.



4-8.3 Stator coil

(1) Stator coil short test

Check the continuity between the terminals of the stator coil. Measure the resistance between the output terminals with a tester. The resistance should be near the prescribed value.

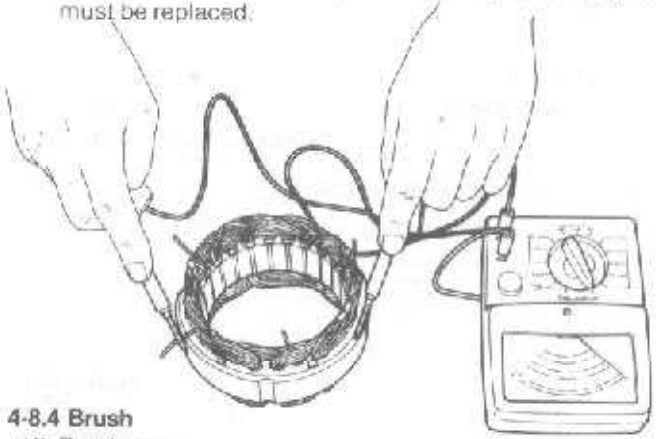
If the stator coil is open, indicated by infinite resistance, it must be replaced.

Resistance value	Approx 0.128Ω (at 20°C) 2-phase resistance

(2) Stator coil ground test

Check the continuity between one of the stator coil leads and the stator core.

The stator coil is good if the resistance is infinite. If the stator core is grounded, indicated by continuity, it must be replaced.

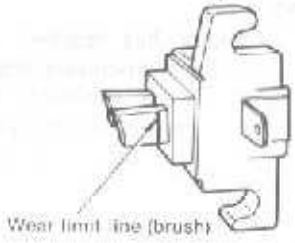


4-8.4 Brush

(1) Brush wear

Check the brush length.

The brush wears very little, but replace the brush if worn over the wear limit line printed on the brush.



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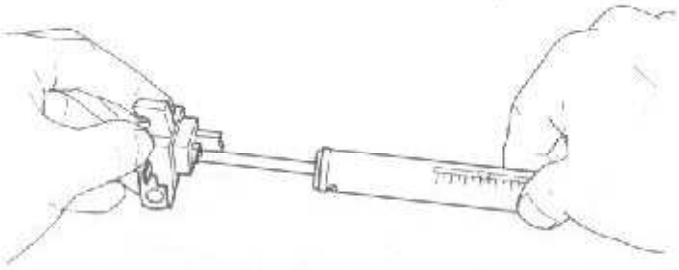
F023A9078

mm(in.)

	Maintenance standard	Wear limit
Brush length	14.5 (0.5709)	7.0 (0.2756)

(2) Brush spring pressure measurement
Measure the pressure with the brush protruding 2 mm from the brush holder, as shown in the figure. The spring is normal if the measured value is over 150 gr. Confirm that the brush moves smoothly in the holder.



Brush spring strength	300 ±45g (0.562 ~ 0.761 lb.) (New brush)

4-9 Reassembly precautions

After inspection and servicing, reassemble the parts in the reverse order of disassembly, paying careful attention to the following items:

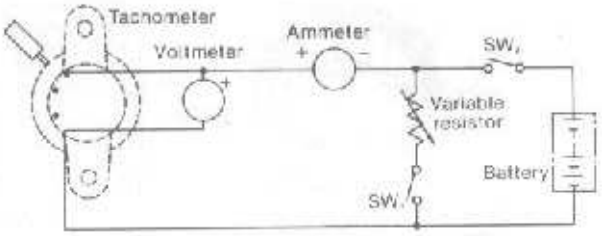
(1) When soldering the stator coil leads and diodes, hold them with needle nose pliers and solder quickly.
(2) Be sure that the insulation bushings, etc. are installed correctly when installing the terminal bolts and SR holder mounting screw.

4-10 Alternator performance test

4-10.1 Test equipment

Test equipment	Quantity	Specifications
Battery	1	12V
DC voltmeter	1	0 ~ 50V Range 0.5
DC ammeter	1	0 ~ 50A Range 1.0
Variable resistor	1	0 ~ 1Ω capacity 1 kW
Switch	2	Switch capacity: 40 A

4-10.2 Performance test circuit



4-10.3 Performance test

(1) Speed measurement at 13 V (26 V rise speed)
(a) Start the alternator slowly after opening SW1 and closing SW2.
(b) After the alternator has reached a speed of approximately 500 rpm, open switch SW2.
(c) Gradually increase the alternator speed while watching the voltmeter, and read the speed on the tachometer when the voltage reaches 13 V.
(d) The speed at this time is 1,000 rpm or less, and is the 13 V rise speed.

(2) Output current measurement
(a) Set the resistance of the variable resistor in the circuit in the figure to maximum, and drive the alternator after closing SW1 and SW2.
(b) Increase the alternator speed to 5,000rpm by adjusting the variable resistor, maintaining the voltage at 13 V.
(c) Measure the deflection of the ammeter at this time.
(d) An output current of 31 A is normal.

(3) Performance test precautions
(a) Connect the alternator A terminal and battery (+) terminal, and the E terminal and battery (−) terminal with 2.5m or less of wiring having a cross-sectional area of 8 mm² or more.
(b) Check the wires for correct or loose connection.

4-11 Alternator troubleshooting and repair

(1) Failure to charge

Problem	Cause	Corrective action
Wiring, current	Open, shorted, or disconnected	Repair or replace
Alternator	Open, grounded, or shorted coil Terminal insulator missing Diode faulty	Replace Repair Replace
Transistor regulator	Transistor regulator faulty	Replace regulator

(2) Battery charge insufficient and discharge occurs easily

Problem	Cause	Corrective action
Wiring	Wiring shorted or loose, wiring thickness or length unsuitable	Repair or replace Replace
Generator	Rotor coil layer short Stator coil layer short; One phase of stator coil open Slip ring dirty V-belt loose Brush contact faulty Diode faulty	Replace Replace Clean or polish Retighten Repair Replace

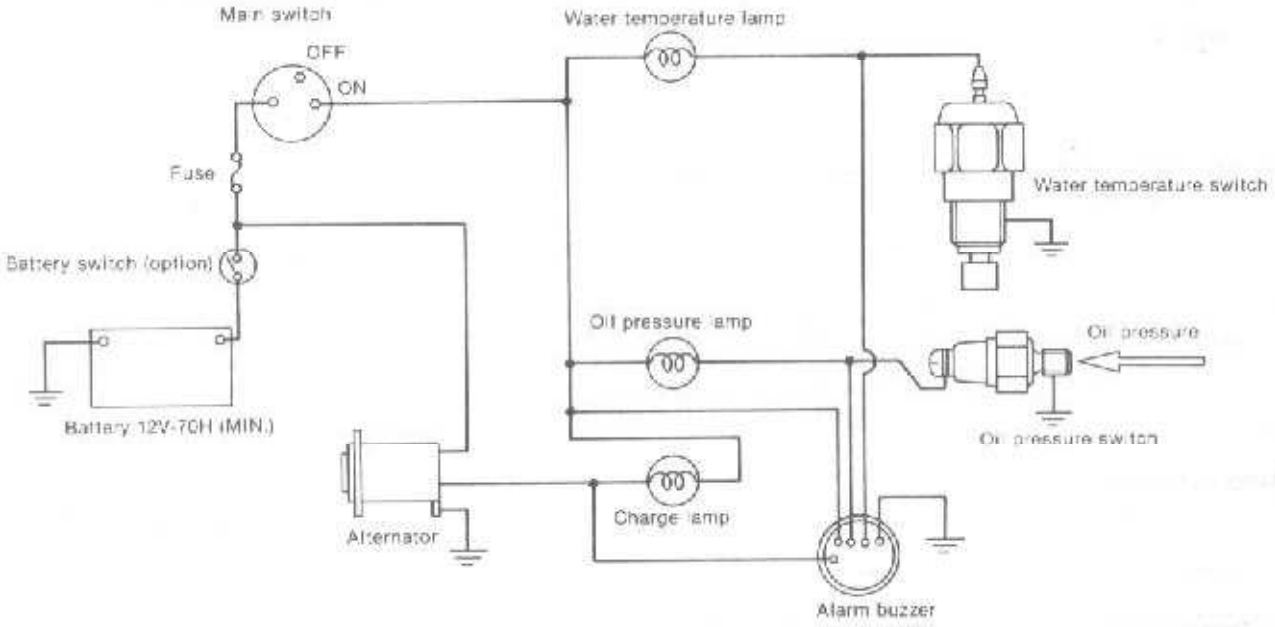
(3) Battery overcharged

Problem	Cause	Corrective action
Battery	Electrolyte low or unsuitable	Add distilled water Adjust specific weight Replace
Transistor regulator	Regulator transistor shorted	Replace regulator.

(4) Current charge unstable.

Problem	Cause	Corrective action
Wiring	Wiring shorted at a break in the covering due to hull vibration or intermittent contact at break	Repair or replace
Alternator	Layer short Balance spring damaged Slip ring dirty Coil open	Replace Replace Replace Repair or replace

5. Alarm Circuit

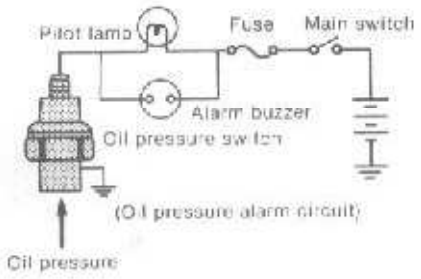


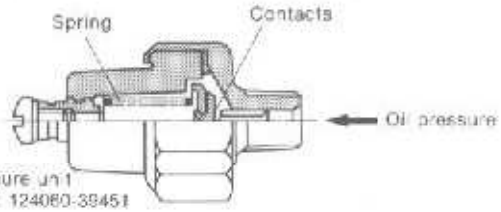
Connection diagram of alarm circuit

In order to indicate whether or not the lubricating oil is being fed to each engine section properly during engine operation, and whether or not the temperature of cooling water is normal, alarm lamps have been provided in the operating room and their switches have been arranged on the engine side of the room. If any abnormal condition is noted, the proper lamp will come on and also a buzzer will sound to give warning.

5-1 Oil pressure alarm

If the engine oil pressure is below 0.2 ±0.1 kg/cm², with the main switch in the ON position, the contacts of the oil pressure switch are closed by a spring, and the lamp is illuminated through lamp → oil pressure switch → ground circuit system. If the oil pressure is normal, the switch contacts are opened by the lubricating oil pressure and the lamp remains off.





Oil pressure unit specifications

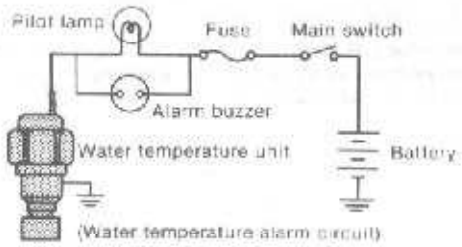
Rated voltage	12 V
Operating pressure	0.2 ±0.1 kg/cm² (1.422 ~ 4.266 lb/in²)
Lamp capacity	3W

Inspection

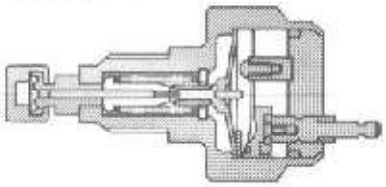
Problem	Inspection item	Inspection method	Corrective action
Lamp not illuminated when main switch set to ON	1. Fuse blown out	Visual inspection	Replace fuse (20A)
	2. Oil pressure lamp blown out	(1) Visual inspection (2) Lamp not illuminated even when main switch set to ON position and terminals of oil pressure switch grounded	Replace lamp
	3. Operation of oil pressure switch	Lamp illuminates when checked as described in (2) above	Replace oil pressure switch
Lamp not extinguished while engine running	1. Oil level low	Stop engine and check oil level with dipstick	Add oil
	2. Oil pressure low	Measure oil pressure	Repair bearing wear and adjust regulator valve
	3. Oil pressure faulty	Switch faulty if abnormal at (1) and (2) above	Replace oil pressure switch
	4. Wiring between lamp and oil pressure switch faulty	Cut the wiring between the lamp and switch and wire with separate wire	Repair wiring harness

5-2 Cooling water temperature alarm

A water temperature lamp and water temperature gauge, backed up by an alarm in the instrument panel, are used to monitor the temperature of the engine cooling water. A high thermal expansion material is set on the end of the water temperature unit. When the cooling water temperature reaches a specified high temperature, the contacts are closed, and an alarm lamp and buzzer are activated at the instrument panel.



Water temperature switch



Operating temperature		Current capacity
ON	OFF	
60 ±2°	56 ±2°	DC12V, 7A

Pilot lamp: 12 V, 3 W
Alarm buzzer: 12 V, 1 W

Water temperature unit
Part No.: 46150-004530

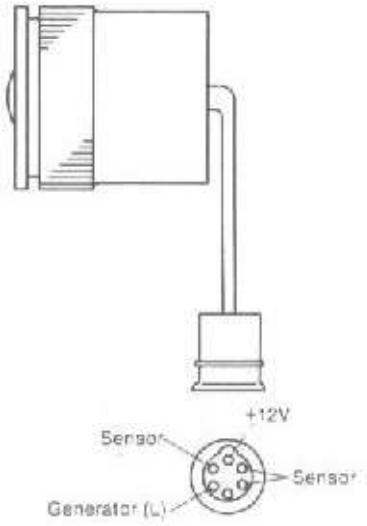
The parts of the alarm circuit which must be checked are the open pilot bulb, fuse, and wiring. To check, disconnect the wiring at the water temperature unit side and ground the cord—the pilot lamp is normal if the pilot lamp illuminates. Moreover, be sure to check the operating temperature of the unit after replacing.

5-3 Alarm buzzer

The alarm buzzer sounds when the engine oil pressure, cooling water temperature, or charging becomes abnormal. The trouble source is indicated by illumination of the appropriate alarm lamp simultaneously with the sounding of the buzzer.

Type	WH-02
Voltage	10 ~ 15V
Current drain	100mmA
Sound level	75dB(A) at 1m
Weight	0.2kg

Part No.: 124271-91350



Normal operation is as follows:

	Alarm buzzer	Charge lamp	Oil pressure lamp	Water temperature lamp
Main switch ON, engine stopped	Alarm	Illuminated	Illuminated	Extinguished
Main switch ON, engine running	No alarm	Extinguished	Extinguished	Extinguished
Key switch OFF, engine stopped	No alarm	Extinguished	Extinguished	Extinguished

5-4 Charge lamp

If the voltage generated by the alternator exceeds that of the battery terminal during engine operation, charging of battery takes place and the charge lamp goes out. If any abnormal condition develops in the charging circuit during engine operation, the lamp will go on and an alarm buzzer will sound.

Inspection

Problem	Inspection item	Inspection method	Remedy
Lamp not illuminated when main switch set to ON	1. Fuse is blown.	Visual inspection (20A fuse)	Replace 20A fuse.
	2. Charge lamp is burnt out.	1. Visual inspection 2. Turn ON key switch, remove L terminal cord of alternator, and ground the cord. Lamp will not come on.	Replace lamp.
	3. Regulator operation.	Inspection according to procedures given in (2) causes lamp to come on.	Replace regulator within alternator.
Lamp not extinguished while engine running.	1. Alternator operation.	(1) By turning ON the key switch make sure of the battery voltage across the F terminal cord of the alternator and earthing conductor. (2) The no-load voltage developed by the alternator is low. (same procedures as those for measuring 13V. [see page]).	When the voltage is 0, check for fuse and battery capacity. Refer to the sections on the inspection and servicing of the alternator.

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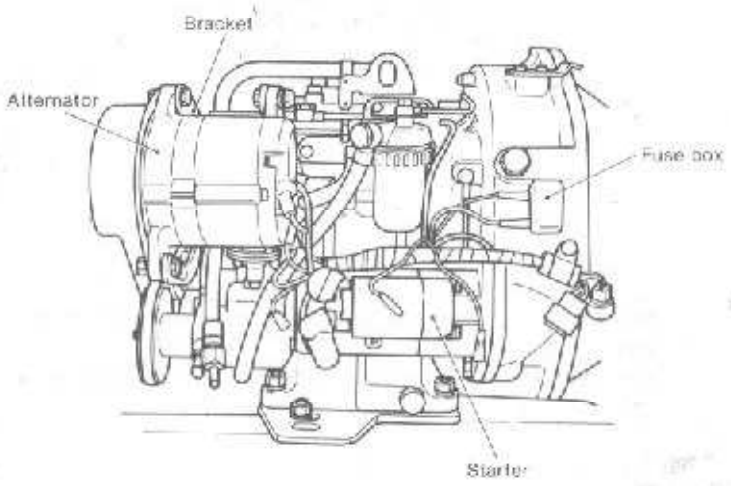
6. Other Electric Equipment

6-1 Fuse

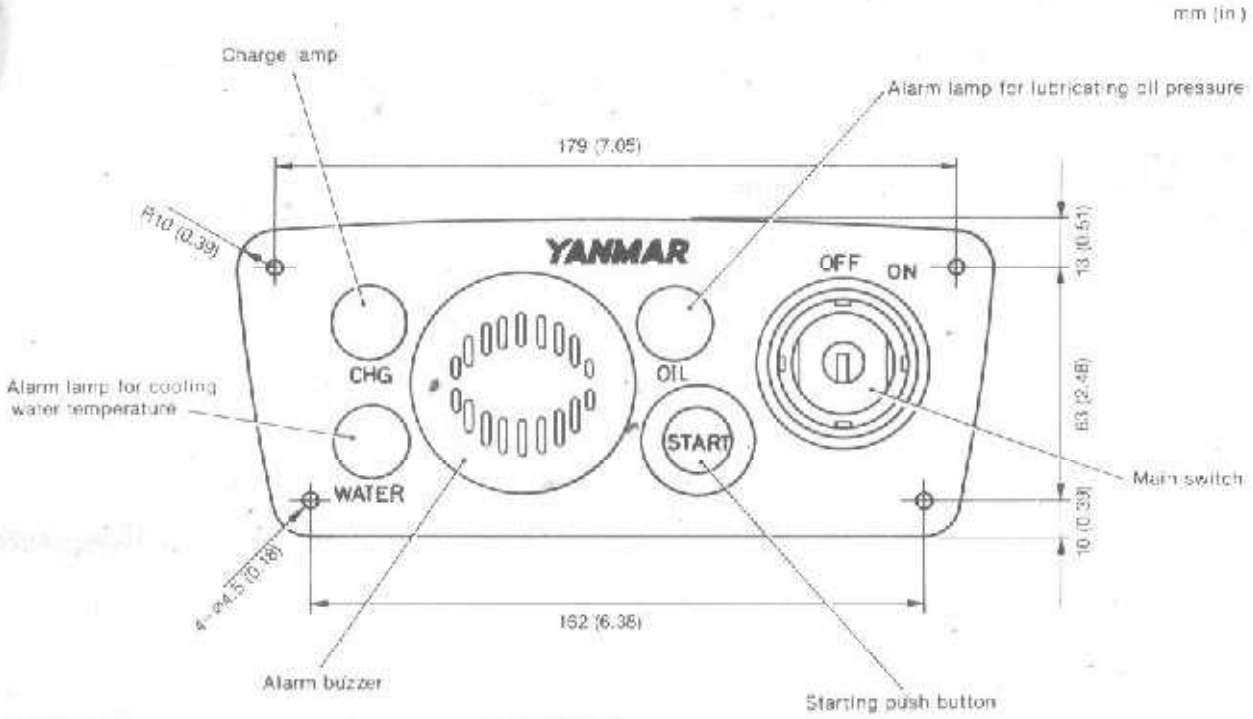
The fuse is installed in order to protect the circuit of each electric device from overloading. If it is blown during engine operation, install a new fuse with a rated capacity after thoroughly checking each circuit for abnormal signs.

Tubular fuse for motorcars		
Outside dimensions (mm)	Diameter of socket	$\phi 6.5\ ^{-0}_{-0.2}$
	Length	$30\ ^{+5}$
Capacity		20A



Note: Be sure to use 20A fuses.

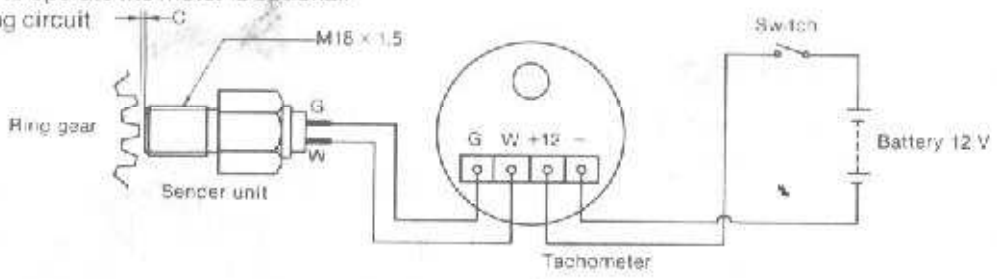
6-2 Instrument panel



6-3 Tachometer

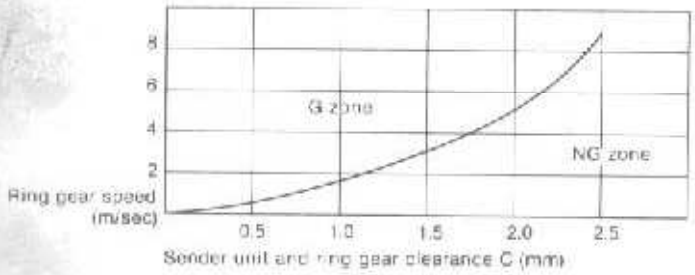
A tachometer that monitors ring gear speed and converts it to frequency to operate the meter is optional.

(1) Operating circuit



	Sender unit	Tachometer	
		YSM8-R	YSM12-R
Yanmar No.	124070-91160	124070-91100	104571-91100
VDO (West Germany) Part No.	340.804/007/007	430.230/019/001	430.230/019/002

(2) Sender unit sensitivity limits



	YSM8-R	YSM12-R
No. of ring gear teeth	114	126
Module	2.54	2.54
Tachometer frequency	6,650 Hz	7,350 Hz