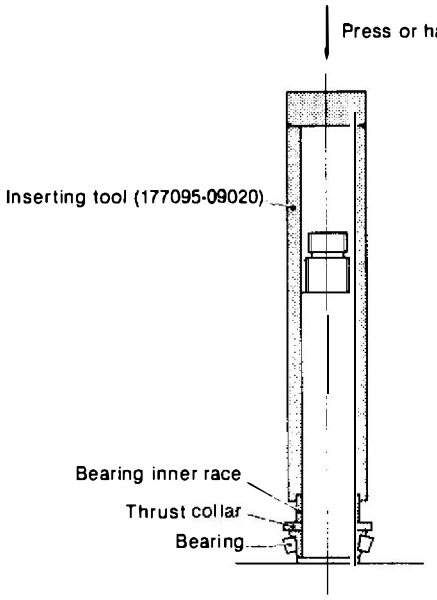
YANMAR
SERVICE MANUAL

MARINE DIESEL ENGINE

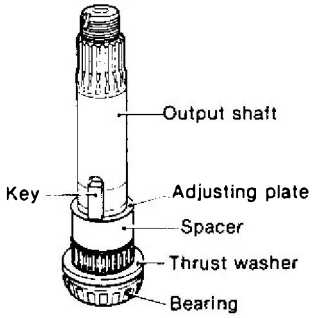
MODELS

1GM (10L)
2GM (F)(L)
3GM (D)(F)(L)
3HM (F)(L)

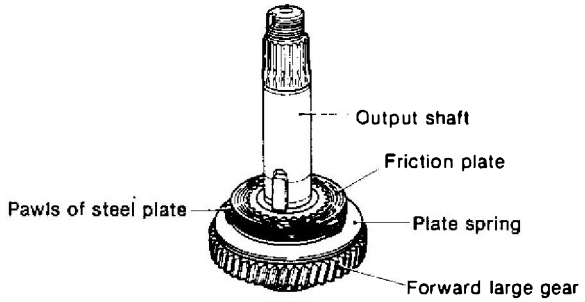
(8) Insert the thrust collar, with the sintered surface (brown surface) facing the gear side.
(9) Press the bearing inner race onto the output shaft, using an assembly tool.



(10) Insert the needle bearing.
(11) Insert the spacer and adjusting plate.
(12) Fit the key so that the fillet side is facing the threaded part of the output shaft.

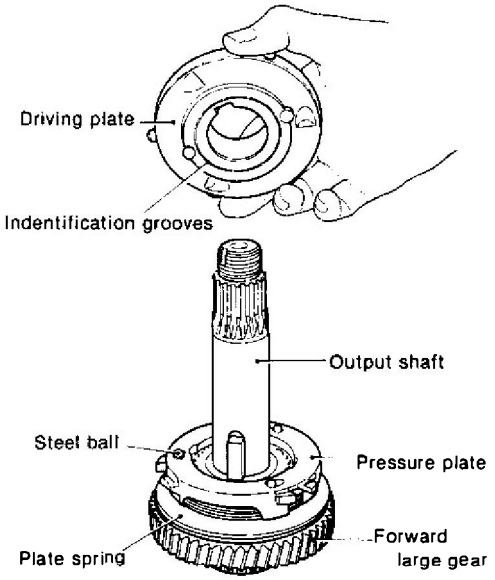


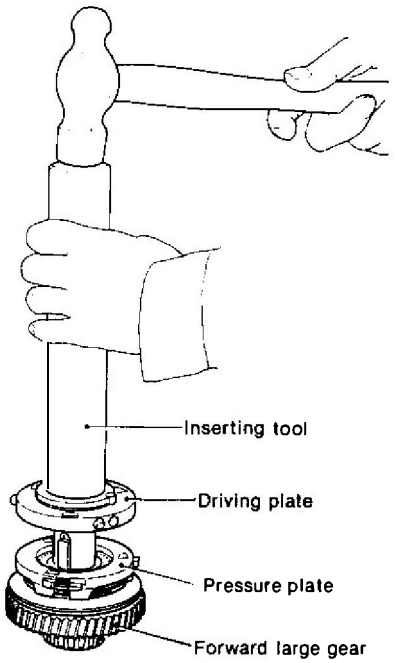
(13) Insert the forward large gear, together with the friction plates and steel plates. At this time, align the three pawls on the outside of the steel plates.



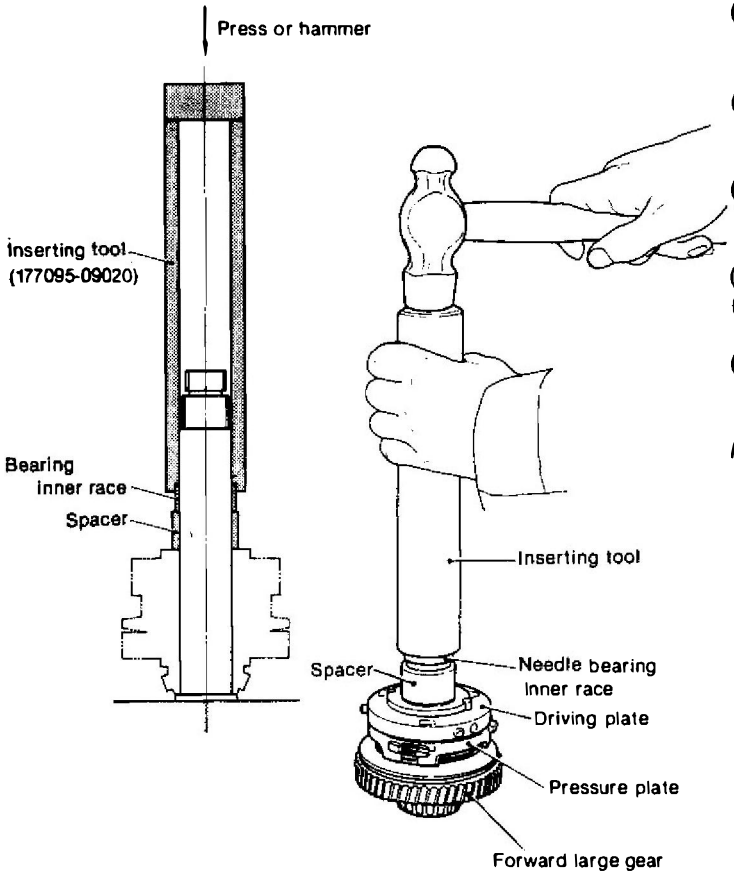
(14) Cover the friction plates and steel plates with the pressure plate so that the pawls of the steel plate fit into the three notches on the pressure plate.
(15) Insert the three steel balls into the three grooves in the pressure plate.
(16) Insert the drive plate into the output shaft so that the side with the identification groove faces the forward large gear side.

NOTE: Make sure that the three steel balls are in the three grooves of the driving plate.
At the same time, make sure that the pin for the driving plate fits into the groove of the torque limitter for the pressure plate.

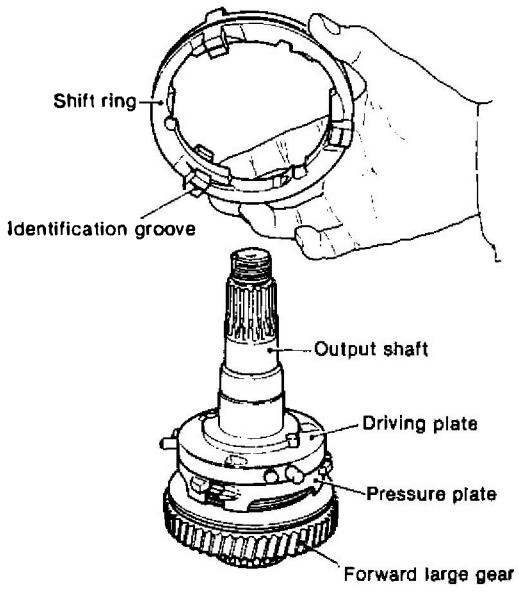




(17) Insert the adjusting plate and spacer.
(18) Press the bearing inner race, using an assembly tool.

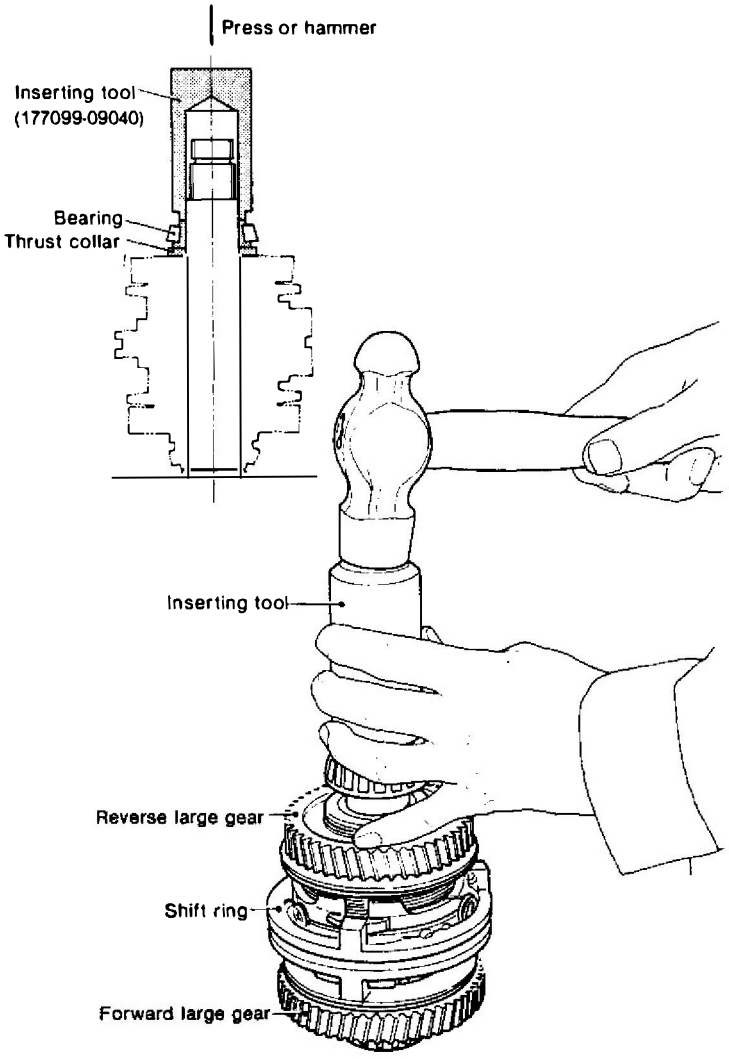


(19) Insert the knock pins and springs into the three holes around the circumference of the driving plate.
(20) Cover the driving plate with the shift ring so that the side with the identification groove faces the forward large gear side; install the ring so that the knock pins are pushed in.



(21) Insert the three steel balls into the three grooves in the driving plate.
(22) Place the pressure plate onto the driving plate so that the steel balls enter the three grooves of the pressure plate.
(23) Insert the three pressure plate return springs between the shift ring and the driving plate, and attach them to the small holes in the side of the pressure plate.
(24) Insert the reverse large gear [see step (6)] so that the three pawls of the steel plates enter the notches around the circumference of the pressure plate.
(25) Insert the needle bearing.
(26) Insert the thrust washer so that the sintered side (brown side) faces the gear side.
(27) Press the inner race of the bearing, using an assembly tool. At this time, make sure that the direction of the bearing is correct.

NOTE: The bearing inner race can be installed easily by preheating it to approximately 100°C.



(28) Insert the O-ring.
(29) With the shift ring in the reverse position, check the forward large gear to make sure it rotates smoothly. Next, with the shift ring in the forward position, check the reverse large gear to make sure it rotates smoothly.

6-3 Reassembling the Input shaft

Press the inner race of the bearing onto the input shaft. At this time, make sure that the direction of the bearing is correct.

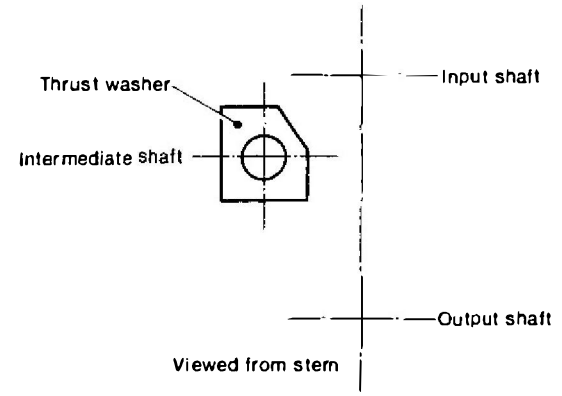
NOTE: The bearing inner race can be easily installed by preheating it to approximately 100°C.

6-4 Reassembling the intermediate shaft

NOTE: Assemble the intermediate shaft as described in section 6-5. (5).

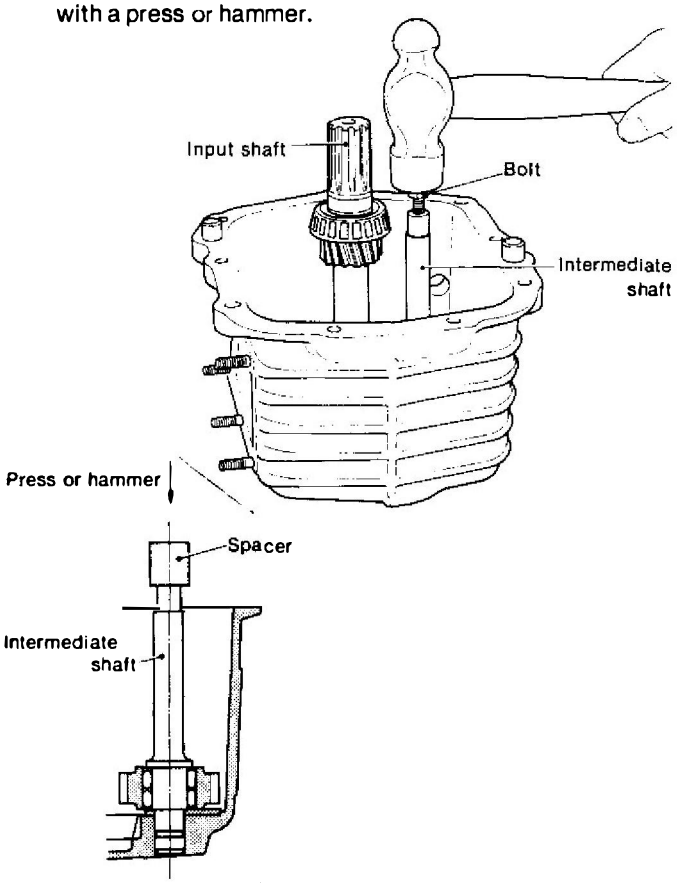
(1) Insert the needle bearing and idle gear on the intermediate shaft. Then insert the thrust washer.

NOTE: Pay careful attention to the assembling direction of the thrust washer.



(2) Insert the O-ring.

(3) Press the assembled intermediate shaft into the case with a press or hammer.



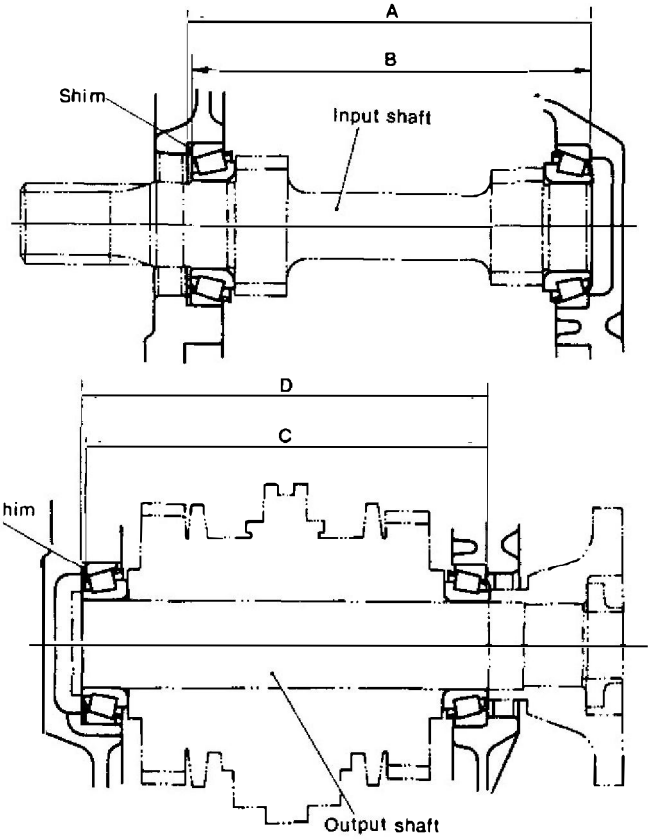
(4) Make sure that the idle gear rotates smoothly.

6-5 Installing the Input shaft and output shaft

(1) Determining the thickness of the input shaft adjusting plate and output shaft adjusting plate

NOTE: As mentioned in section 5-1. (13), when none of the parts are replaced, the adjusting plate can be reused without readjustment.

1) Measure length "A" "D" between the cases of each shaft of the case body and mounting flange.
2) Cover each bearing with the bearing outer race, and measure length "B" "C" between the bearings.



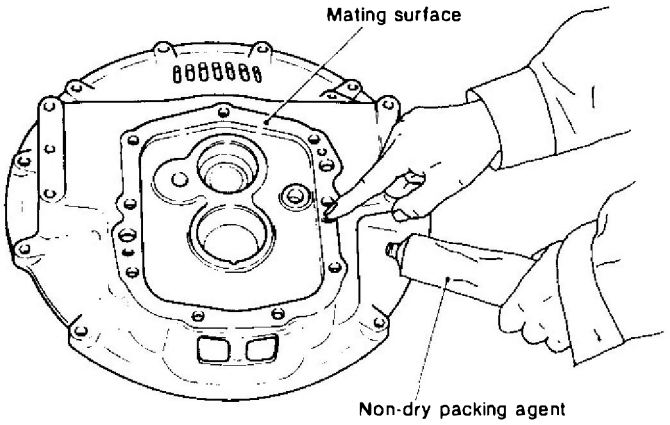
3) Adjust the input shaft adjusting plate thickness so that the clearance or tightening allowance is less than 0.05mm (0.0020in.).
4) Adjust the output shaft adjusting plate thickness so that the tightening allowance is within 0 ~ 0.1mm (0~0.0040in.).
5) Four adjusting plates of 1mm (0.0394in.), 0.5mm (0.0197in.), 0.3mm (0.0118in.) and 0.1mm (0.0040in.)are available.
Combine these plates to obtain the desired adjusting plate measurement.

(2) Insert the adjusting plate into the mounting flange, and press the outer race of the bearing.
Also, press the outer race of the bearing into the case.

NOTE: The outer race can be installed easily by heating the mounting flange and case to approximately 100°C, or by cooling the bearing outer race with liquid nitrogen, etc.

(3) Coat the circumference of the oil seal with a non-dry packing agent, and press it onto the mounting flange and case so that the spring part of the oil seal is inside the case.

(4) Coat the mating surfaces of the mounting flange and case with a non-dry packing agent.
Wipe off oil and dirt on the mating surface of the case and coat with a thin film of non-dry packing agent.

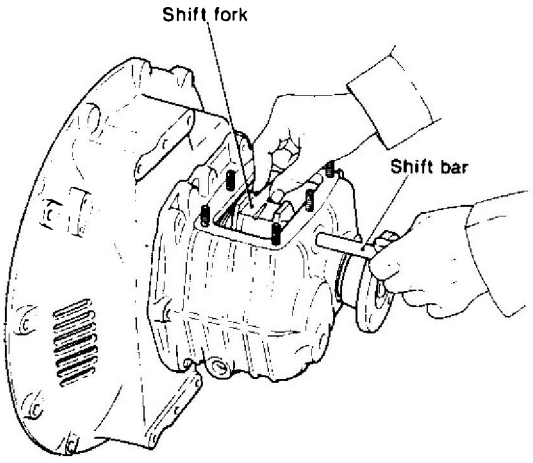


(5) Insert the input shaft into the case, assemble the intermediate shaft as described in section 6-4 and then insert the output shaft into the case.
(6) Align the mounting flange with the case, and insert the parallel pin by tapping the mounting flange with a plastic hammer.
(7) Insert the super lock washer and tighten the M10 bolt.
(8) Install the dipstick and packing.
(9) Install the drain plug and packing.

6-6 Reassembling and Installing the operating system

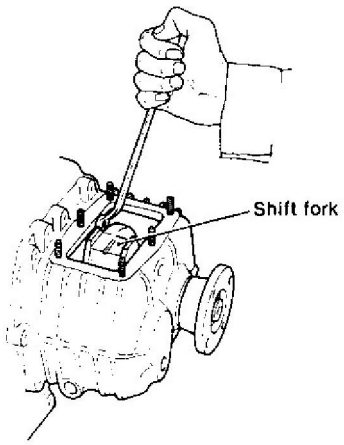
(1) Insert the shift fork into the case from the side, insert the shift bar.

NOTE: Insert the shift bar with the threaded end towards the outside (output shaft coupling side).



(2) Coat the threaded part of the shift bar plug with a non-dry packing agent and secure it to the case with a hexagonal bar spanner (width across flats: 8mm (0.3150in.).

NOTE: Put the shift fork into neutral before installing.



(3) Coat the circumference of the oil seal with a non-dry packing agent and press the seal to the case cover.
(4) Insert the spring into the shift cam.
(5) Insert the knock pin into the shift cam from the front end, and lock with the circlip.
(6) Insert the assembled shift cam into the case cover.
(7) Fit the shift lever to the shift cam, and tighten the M8 bolt.

NOTE: The shift cam must rotate smoothly.

(8) Replace the packing if it is damaged.
(9) Attach the case side cover together with the operating system to the case body.
At this time, make sure that the shift cam is fitted to the shift fork, and that the shift lever is in neutral.

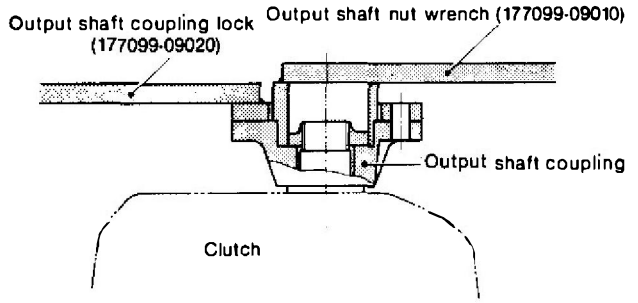
NOTE: Put the shift fork into neutral before installing.

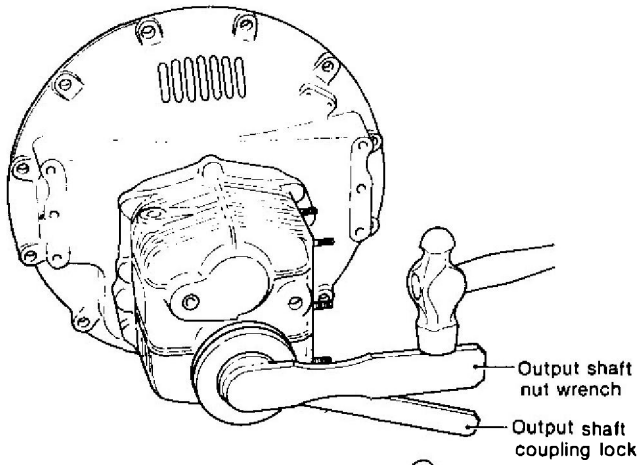
(10) Insert the super lock washer, and tighten the M8 nut.
(11) Shift the shift lever to forward and reverse to make sure that the lever operates normally.
If the lever does not operate normally, loosen the M8 nut, slide the case side cover forward, backward, and to the left and right, then re-tighten with the M8 nut in the position at which the lever operates normally.

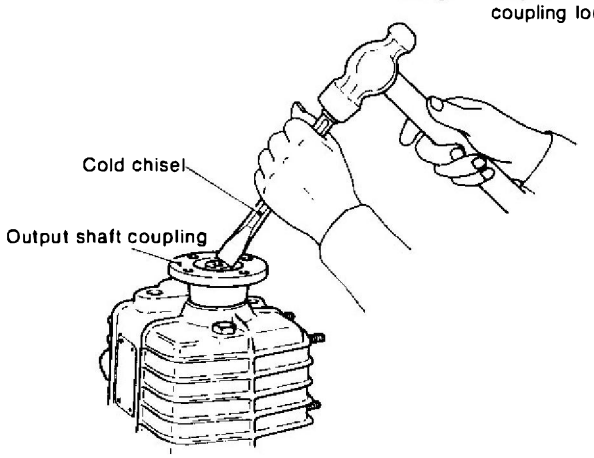
NOTE: If the lever operates normally a click will be heard when it is put into forward and reverse.

6-7 Installing the output shaft coupling

(1) Install the output shaft coupling on the output shaft.
(2) Tighten and caulk the output shaft lock nut, using the assembly tool.
Tightening torque.....9.5kg-m (68.7ft-lb)







(3) Shift the shift lever to the neutral position and make sure the clutch engages when the shift lever is put into forward and reverse.
The input/output shafts will not rotate smoothly if the side gap of the bearing is too small in relation to the thickness of the adjusting plate.

CHAPTER 9

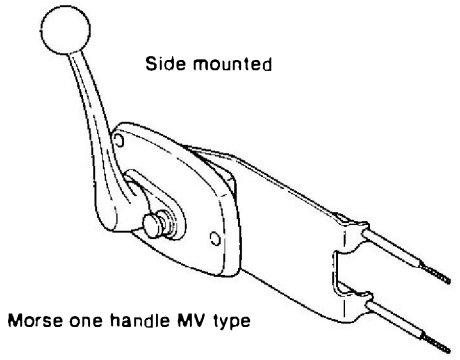
REMOTE CONTROL SYSTEM

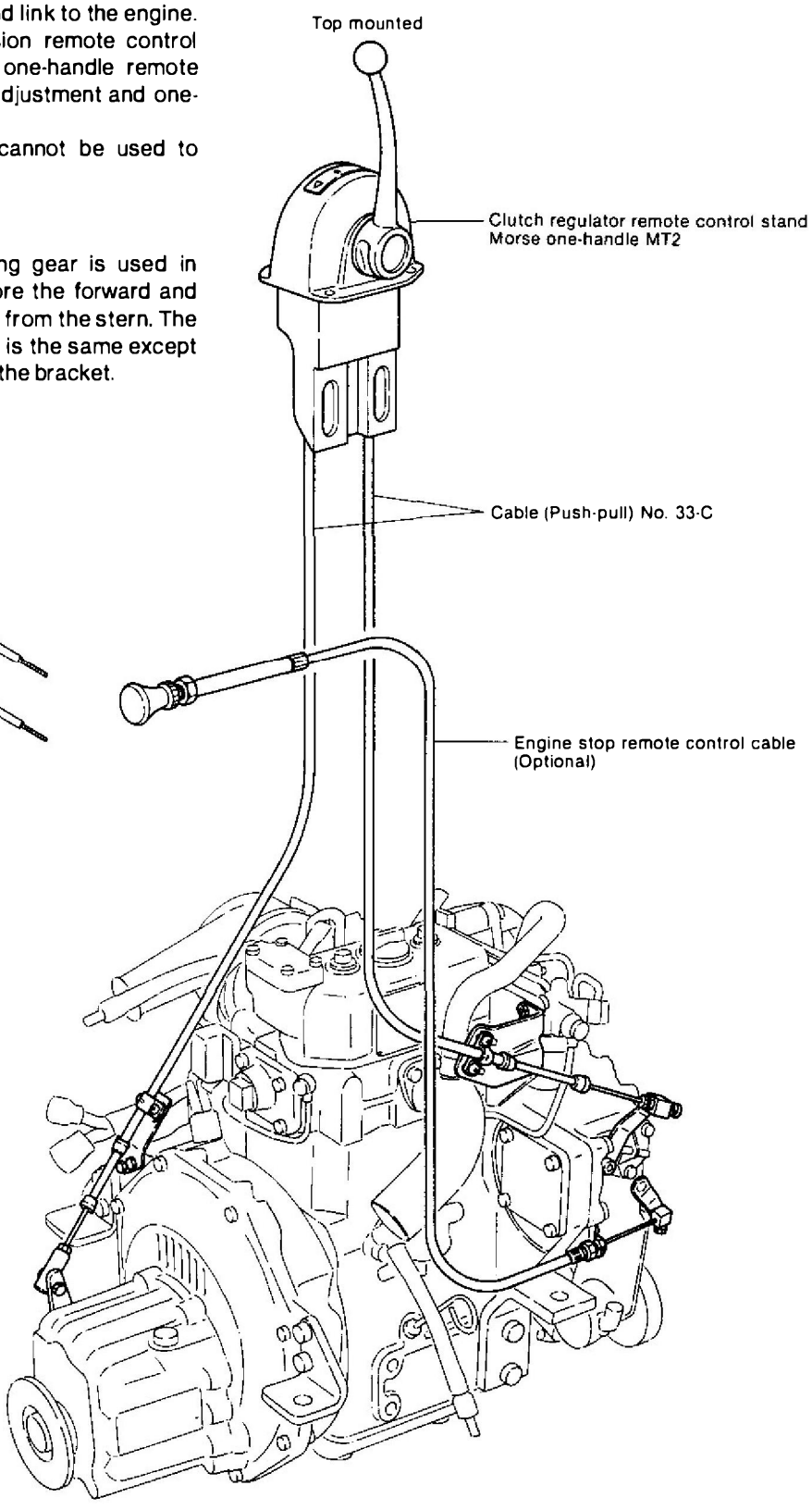
1. Construction

This engine is designed primarily for remote control operation. A remote control cable bracket can be installed by merely adding a remote control lever and link to the engine. Engine stop control and decompression remote control may also be installed, in addition to one-handle remote control, which permits engine speed adjustment and one-handle forward-astern switching.
For this engine, two-handle control cannot be used to replace one-handle control.

1-1 Models 1GM and 2GM

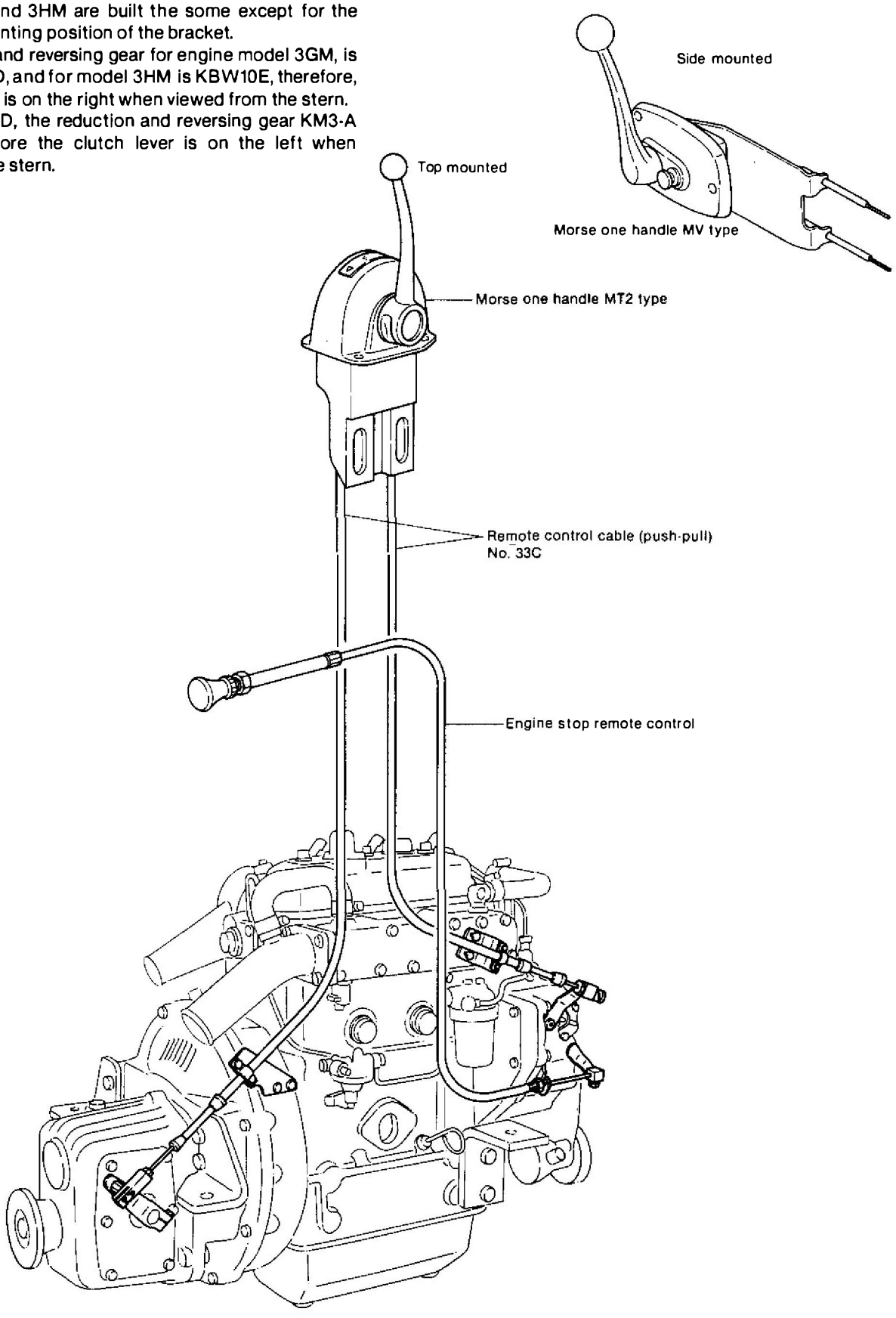
Model KM2A's reduction and reversing gear is used in model 1GM and 2GM engines, therefore the forward and reverse lever is on the left when viewed from the stern. The construction for models 1GM and 2GM is the same except forthe shape and mounting position of the bracket.





1-2 Models 3GM, 3HM and 3GMD

Models 3GM and 3HM are built the some except for the shape and mounting position of the bracket.
The reduction and reversing gear for engine model 3GM, is model KRW10D, and for model 3HM is KBW10E, therefore, the clutch lever is on the right when viewed from the stern.
On model 3GMD, the reduction and reversing gear KM3-A is used, therefore the clutch lever is on the left when viewed from the stern.

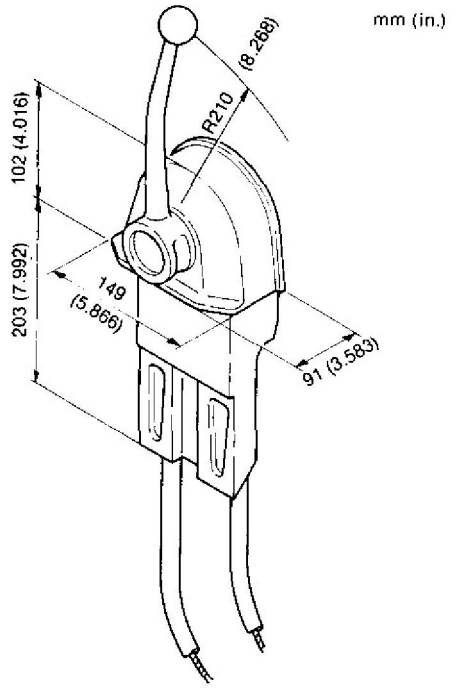


2. Clutch And Speed Regulator Remote Control

2-1 Construction

Both models of MT2 and MV morse one handle remote control can be used. They are optionally available.

2-1.1 MT2 type

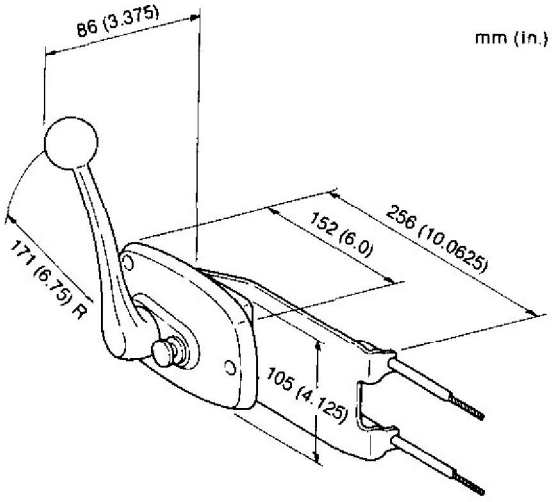


2-2.2 MV type

Newly expanded MV series controls include right and left hand models designed for easier installation and servicing. The MV control can be preassembled and installed without removing side panels.

Pull-out button disengages clutch for full throttle range in neutral for safe starting and warm-up.

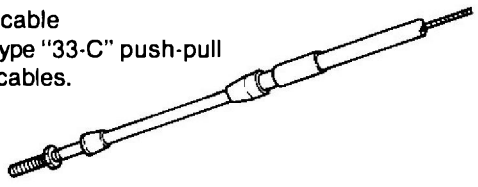
MV controls have forward, neutral and reverse detents; built-in friction to prevent throttle creep.



2-2 One-handle remote control composition

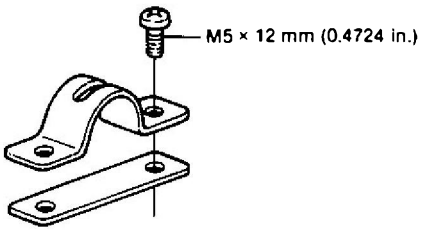
		1GM, 2GM,3GM(D)	3GM, 3HM
Speed control	Remote control cable	33-C	
	Clamp	YANMAR made	
Clutch control	Remote control cable	33-C	
	Clamp	YANMAR made	
	Spring joint	YANMAR made	—
	Clevis	—	YANMAR made

(1) Control cable
Morse Type "33-C" push-pull control cables.



Use only Super-Responsive Morse Control Cables. They are designed specifically for use with Morse control heads. This engineered system of Morse cables, control head and engine connection kits ensures dependable, smooth operation with an absolute minimum of backlash. The thread size on cable ends is 10-32. Travel is up to 3". The core is a solid wire, with a 3/32" diameter.

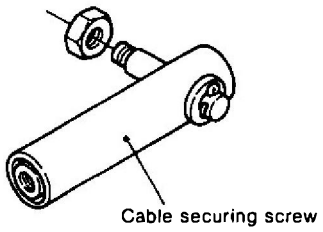
(2) Clamp
YANMAR cable clamps are standard parts, and are fitted to the brackets on the engine and clutch.



(3) Spring joint

The cone clutch is fitted to engine models 1GM, 2GM and 3GMD. The spring joint is fitted to the clutch lever, and is also connected to the control cable.

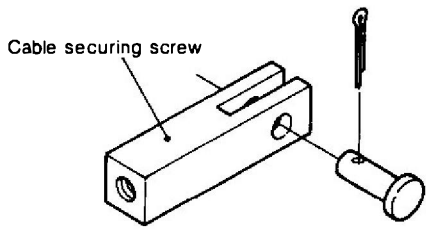
Cable securing screw.



(4) Clevis

The YANMAR clevis is attached to the clutch lever on models 3GM and 3HM.

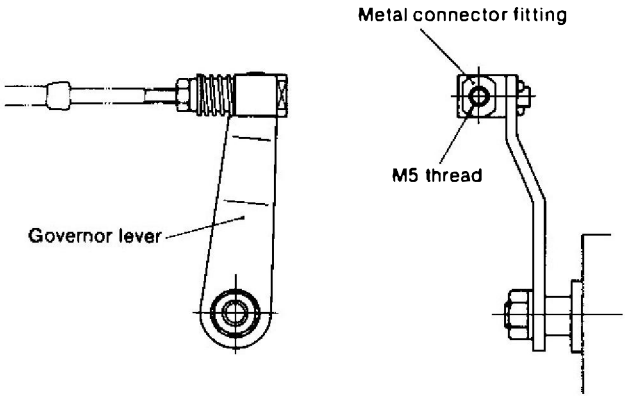
Cable securing screw.

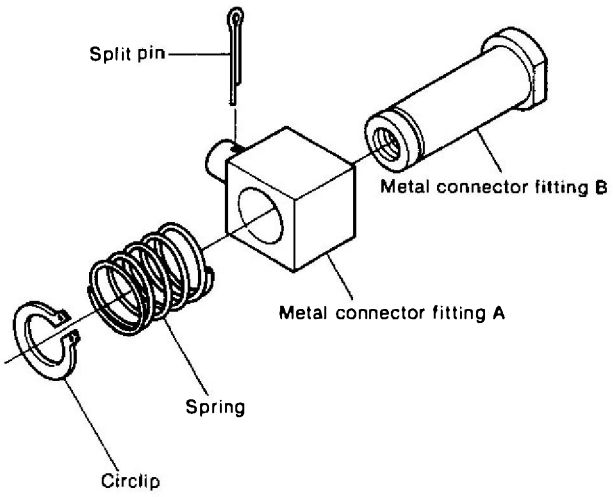


2-3 Engine side installation

The same governor lever is used in all 4 engine models, however, its operation angle is different depending on the model.

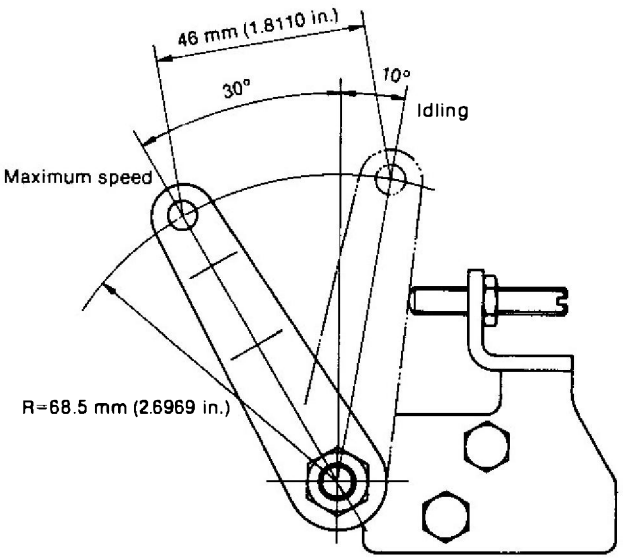
The connecting metal which fits with the damping spring is at the tip of the governor lever, and the cable has only to be screwed into this fitting.

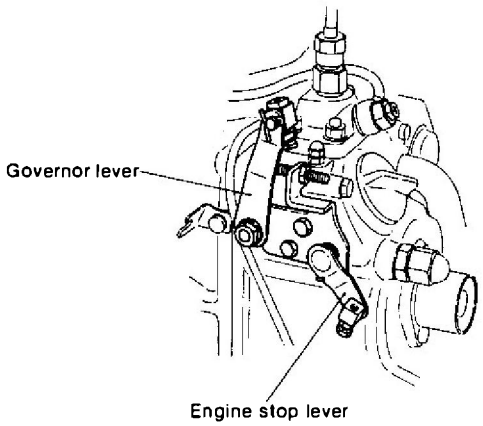




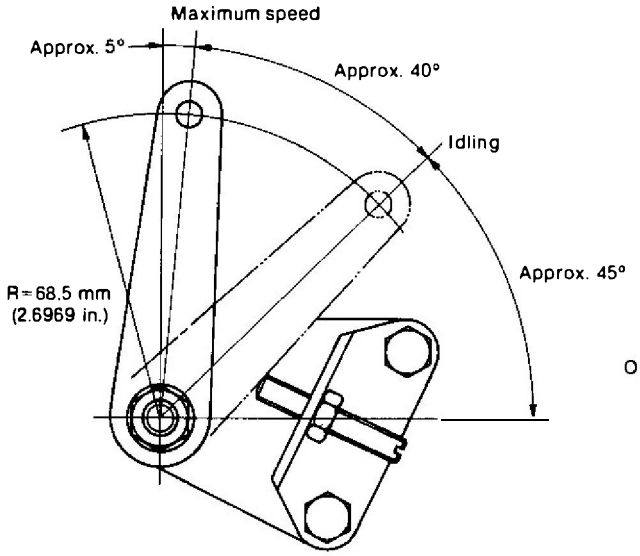
NOTE: When the push-pull cable is fitted, it must be fitted at the spring side.

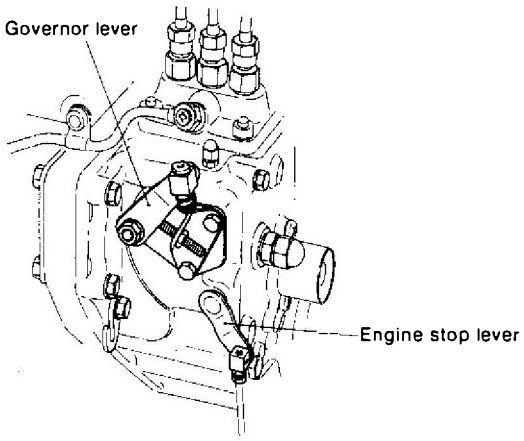
2-3. 1 Movement of leverfor modei 1GM



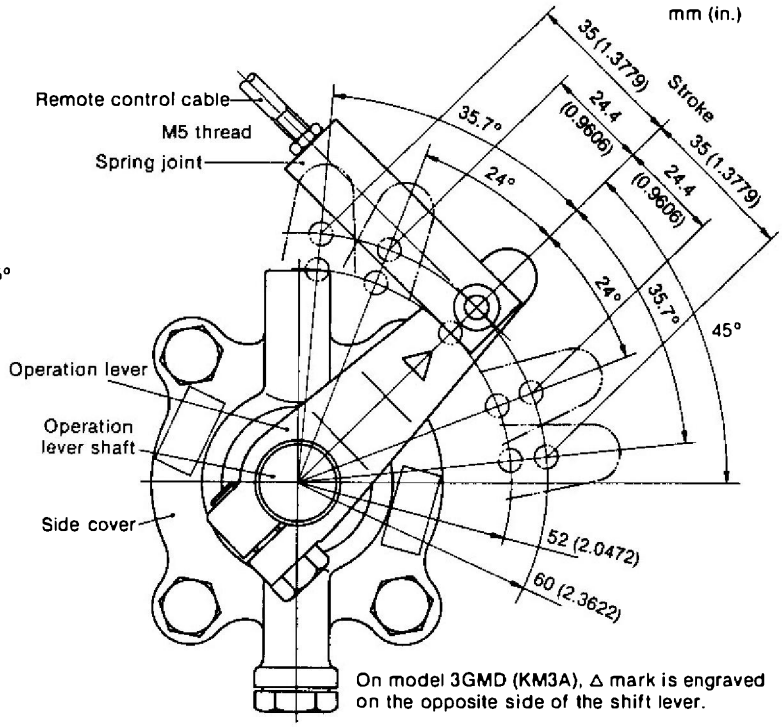


2-3. 2 Movement of lever for models 2GM, 3GM(D)and 3HM

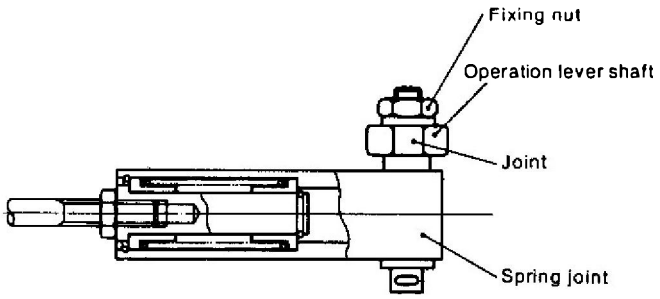




2-4. 1 For models 1GM, 2GM and3GMD



On model 3GMD (KM3A), △ mark is engraved on the opposite side of the shift lever.



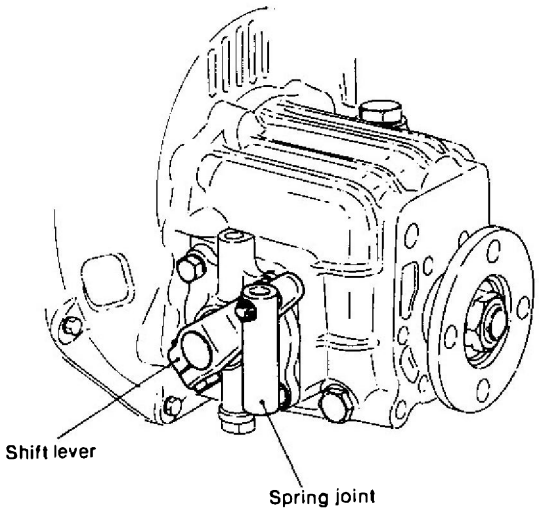
2-4 Setting the reduction and reversing gear side

Model KM2A reduction and reversing gear is used for engine models 1GM and 2GM, and model KM3A for engine model 3GMD.

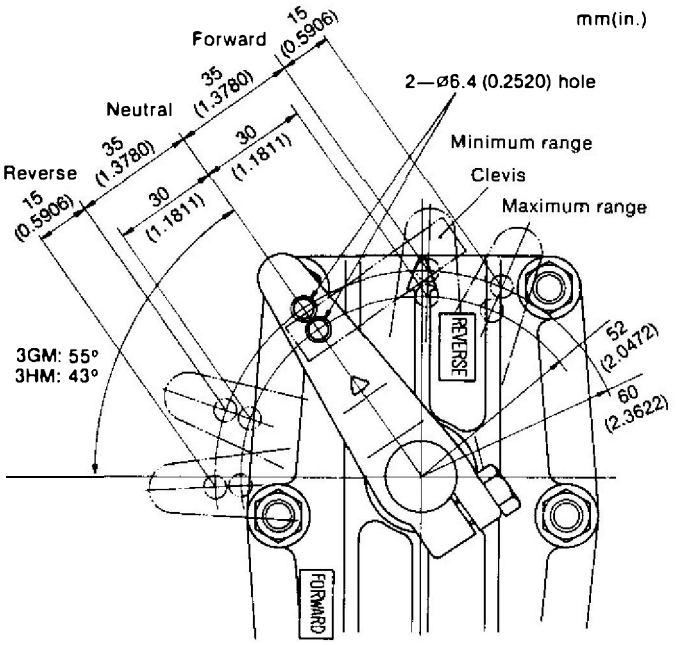
On these reduction and reversing gears, the spring joint is fitted to the control lever, and the remote control cable is connected to this joint.

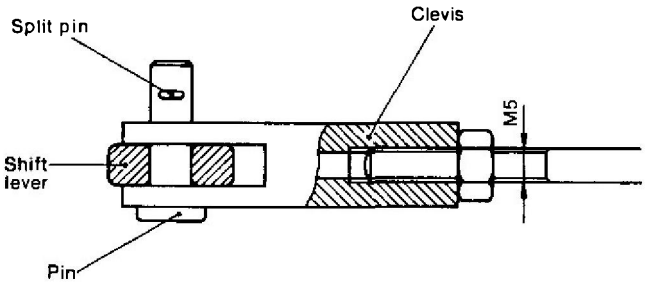
Reduction and reversing gear model KBW10D is used on engine model 3GM and KBW10E for engine model 3HM.

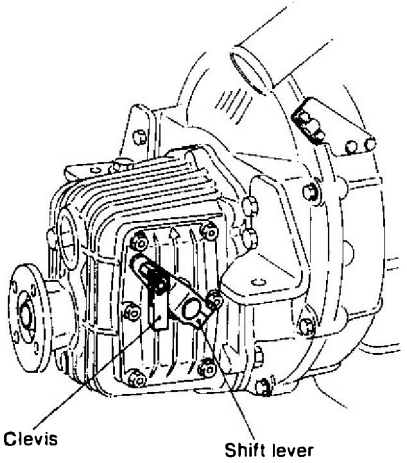
On these reduction and reversing gears, the clevis is attached to the clutch operating lever, and the remote control cable is connected to the clevis.



2-4. 2 For models 3GM and 3HM

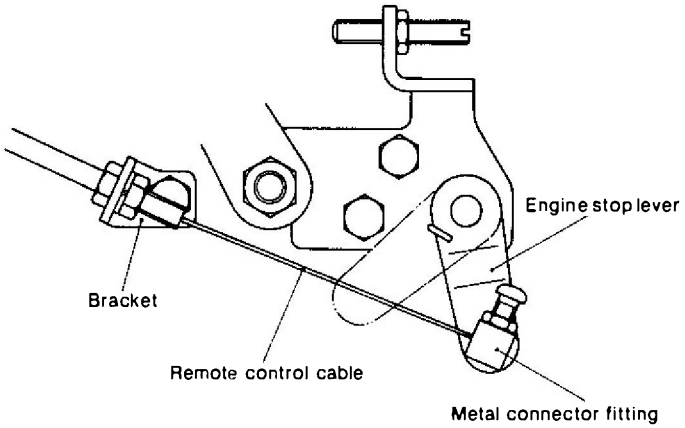




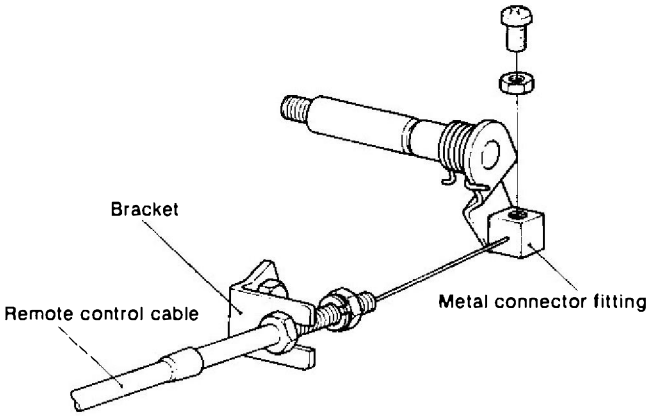


3. Engine Stop Remote Control

4-1 For modei 1GM

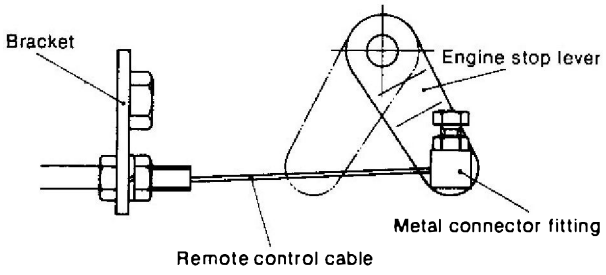


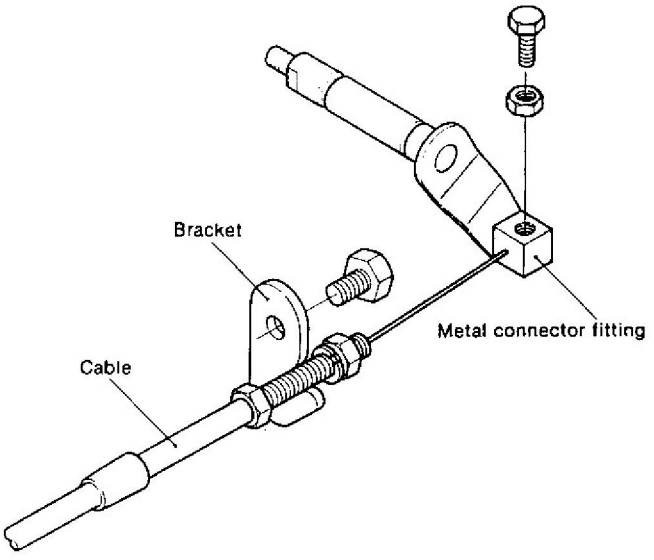
YANMAR made Ø1.5mm (0.05906 in.) option
Cable dia. Ø1.5 ~ Ø2.5mm (0.05906 ~ 0.0984 in.)



The metal connector fitting has a hole of 2.5mm (0.0984 in.) dia. to accommodate the cable, and cable of 1.5 ~ 2.5mm (0.05906 ~ 0.0984 in.) dia. can be used in the connector.

4-2 For modei 2GM, 3GM(D)and 3HM





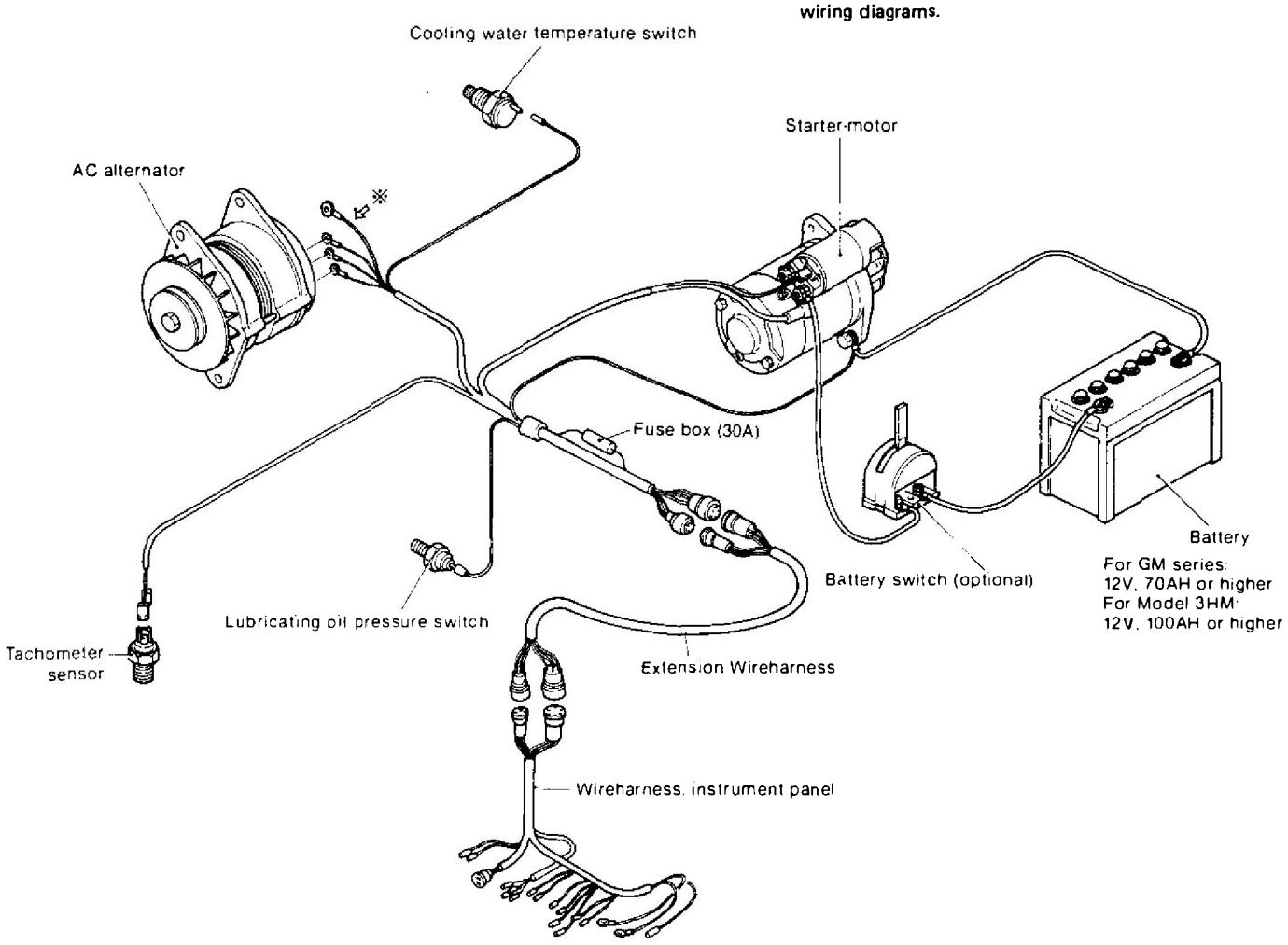
CHAPTER 10

ELECTRICAL SYSTEM

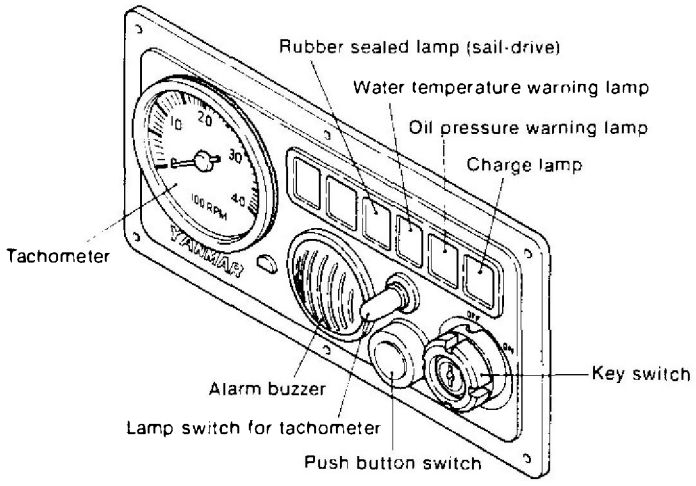
1. Electrical System

1-1 System diagram of electric parts

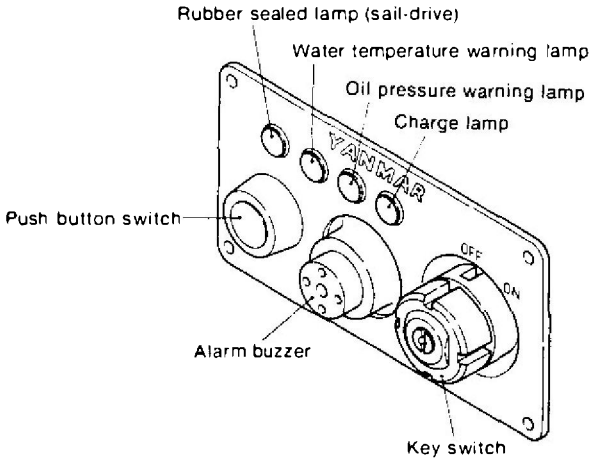
※ Additional terminal for new models.
For the applicable engine numbers, refer to the engines numbers specified under 1-2-2 and 1-2-4 wiring diagrams.



B-type instrument panel (large)

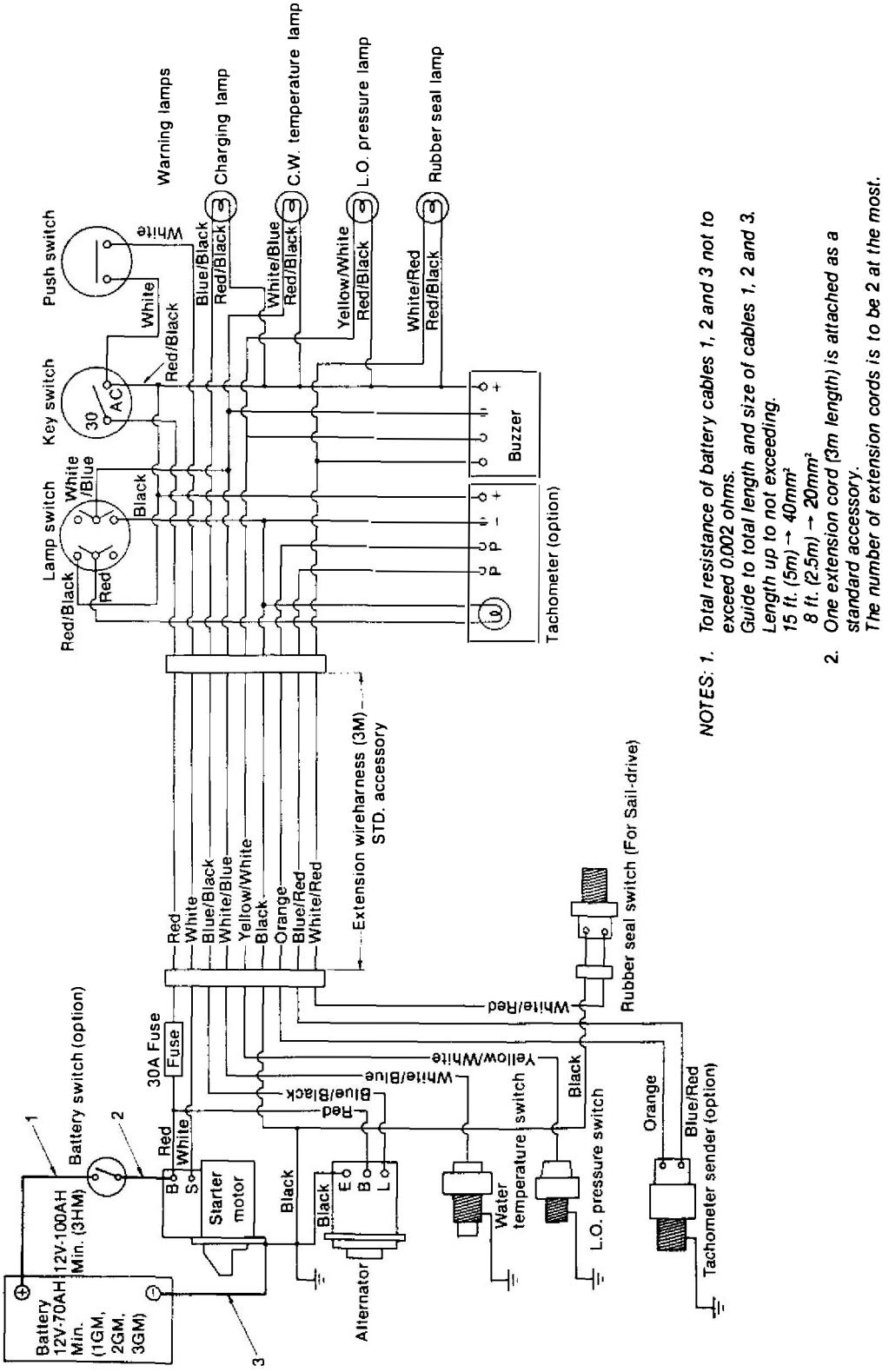


A-type instrument panel (small)

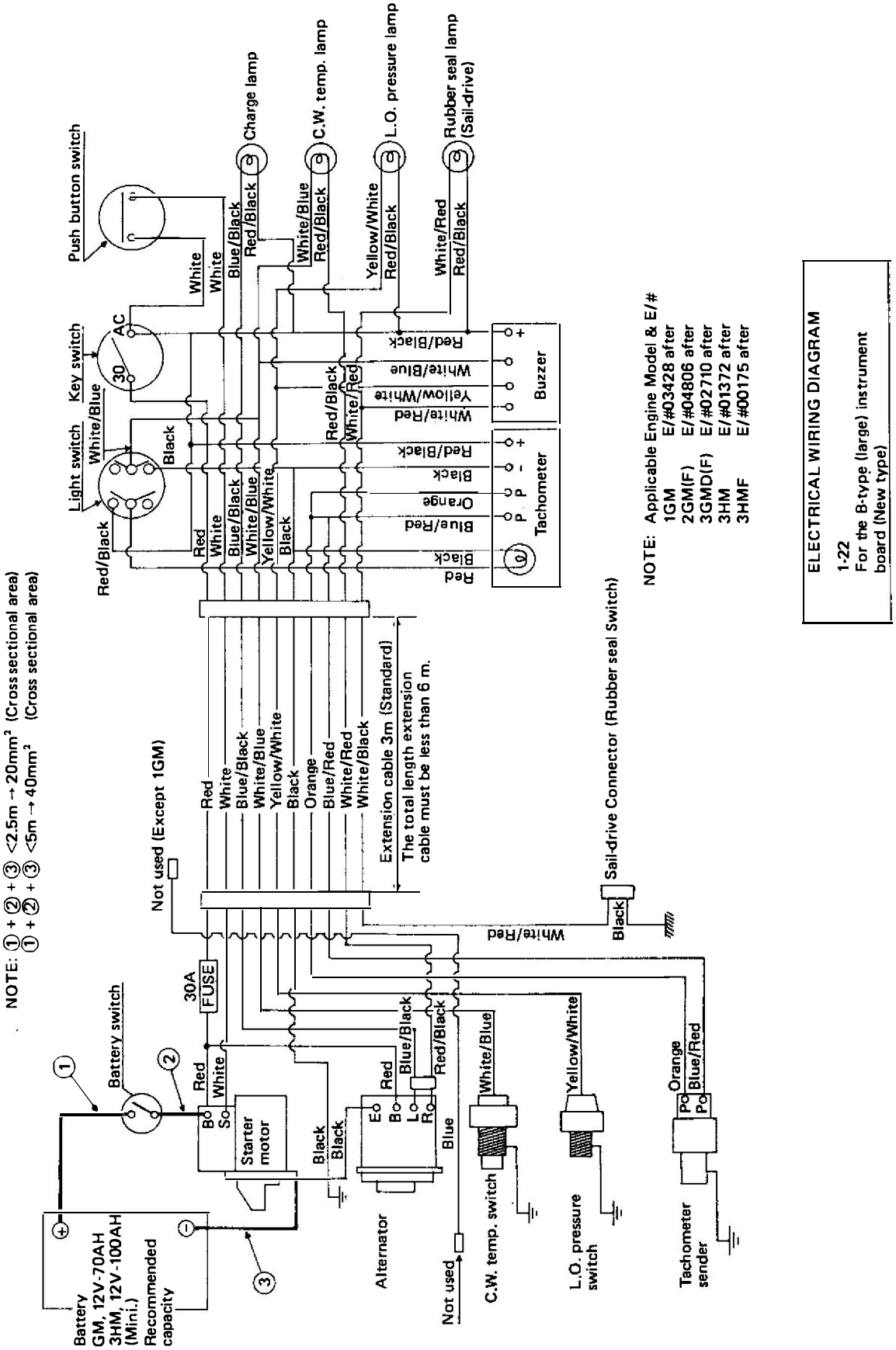


1-2 Wiring diagram

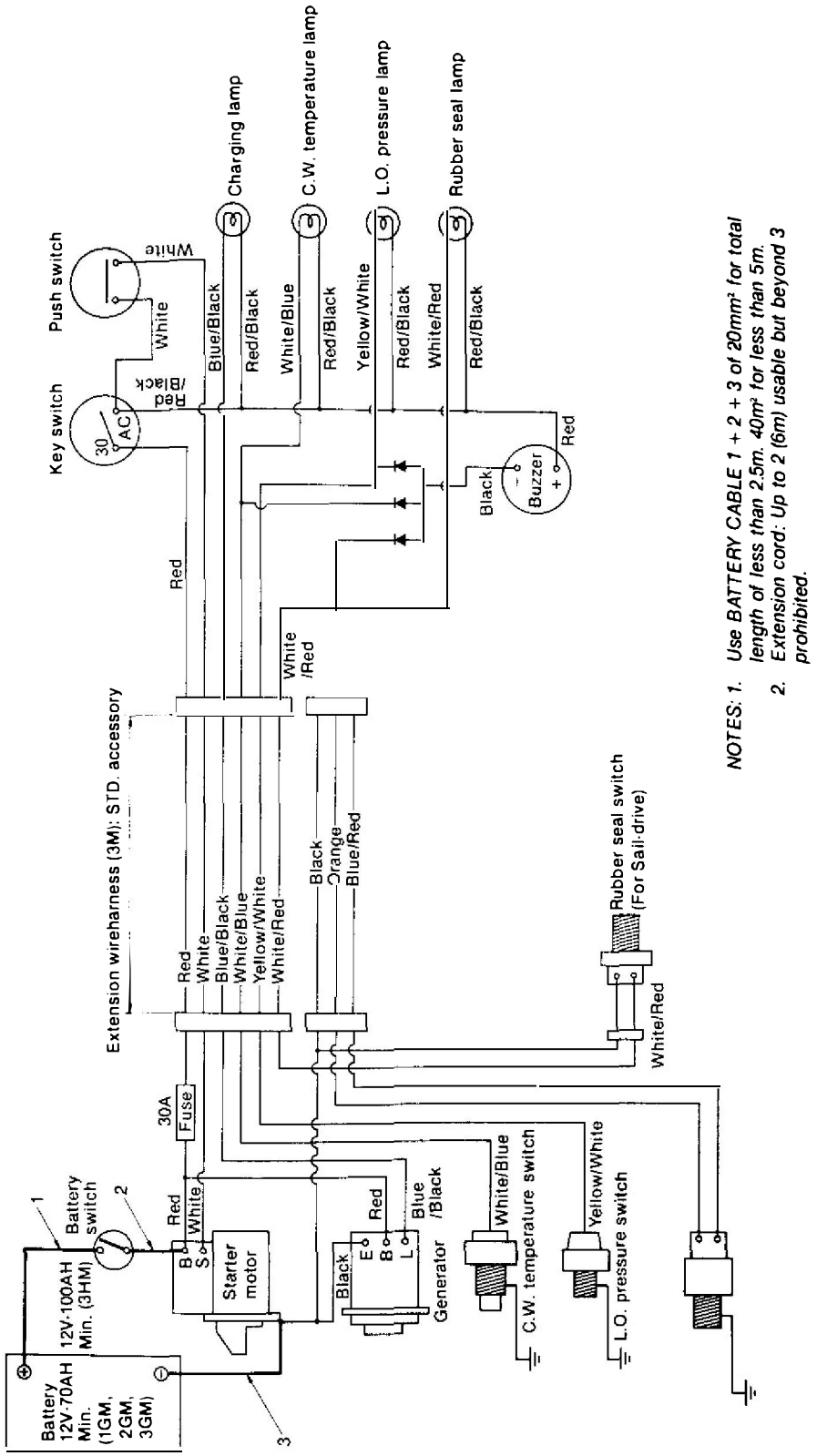
1-2-1 For the B-type (large) instrument board (Old type)



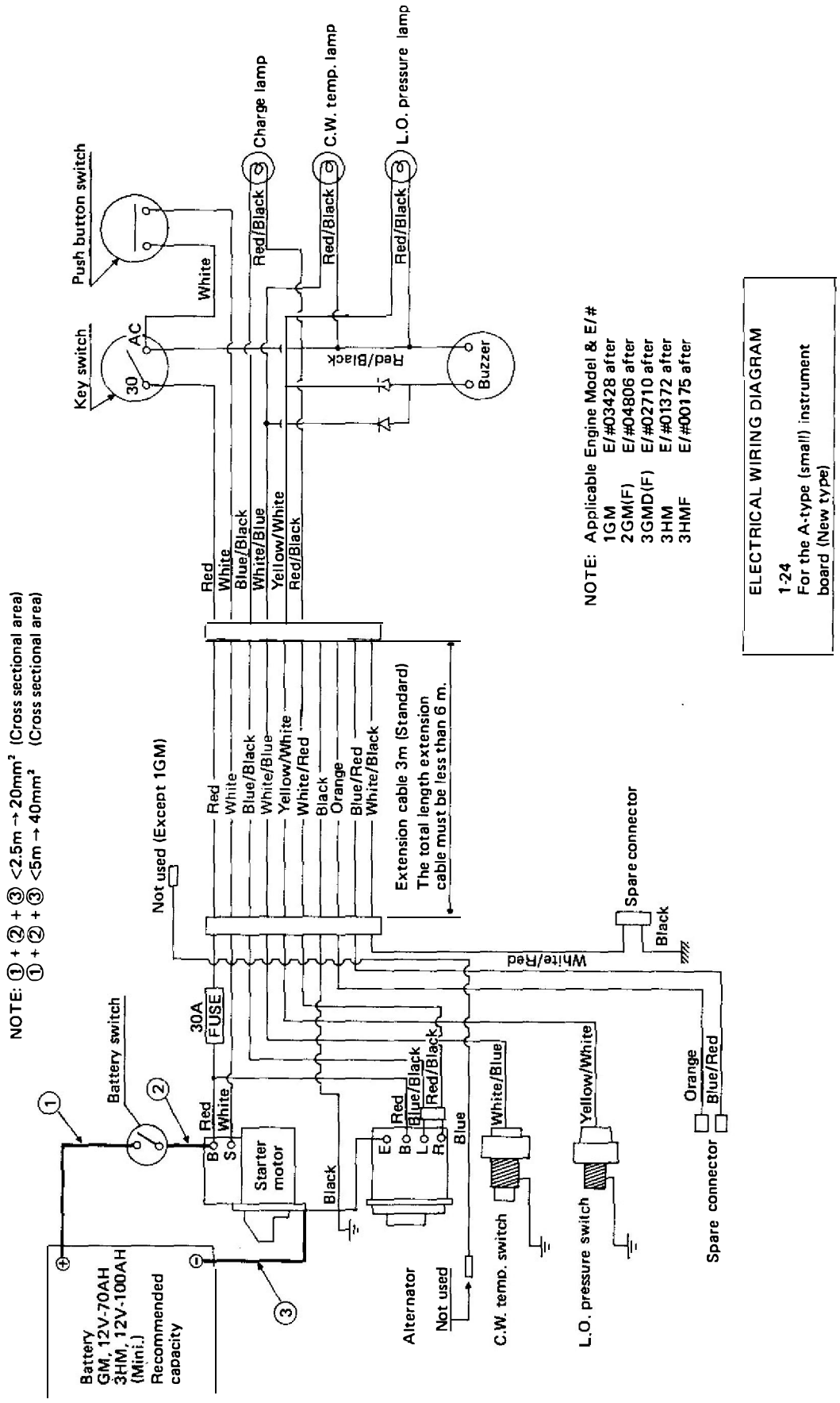
1-2.2 For the B-type (large) instrument board (New type)



1-2-3 For the A-type (small) instrument board (Old type)

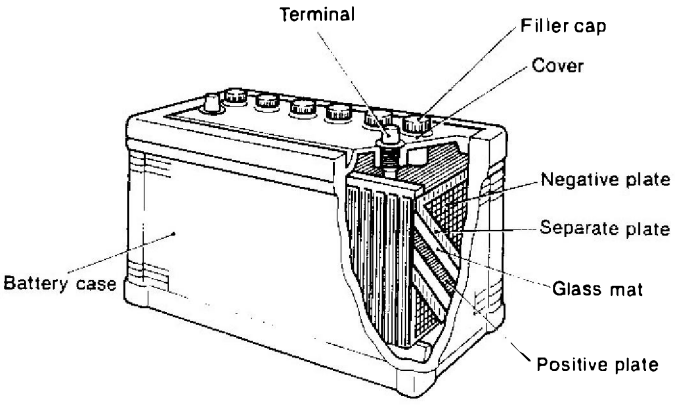


1-2.4 For the A-type (small) instrument board (New type)



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

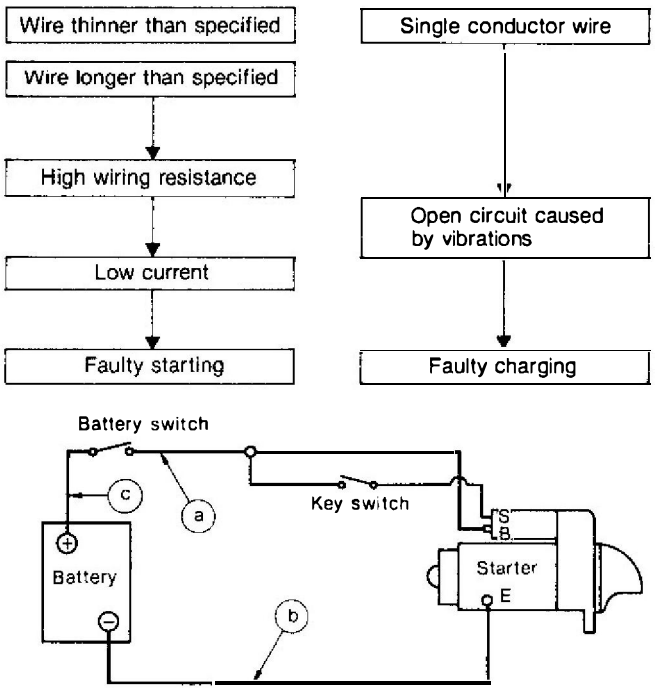
2-2.1 Battery capacity

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

	1GM, 2GM 3GM(D)	3HM
Minimum battery capacity	12V 70AH	12V 100AH
Fully charged specific gravity	1.26	1.26

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 (0.0311 in.²)	Up to 2.5m (98.43 in.)
		40mm² (0.062 in.²)	Up to 5m (196.87 in.)

NOTE: Excessive resistance in the key switch circuit (between battery and start (S) terminals) can cause improper pinion engagement. To prevent this, follow the wiring diagram exactly.

2-3 Inspection

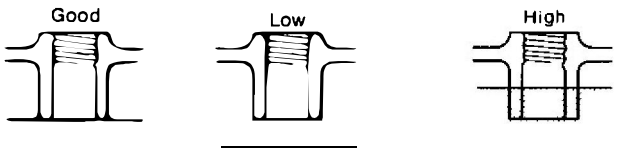
The quality of the battery governs the starting performance of the engine. Therefore the battery must be routinely inspected to assure that it functions perfectly at all times.

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.

2-3.2 Checking the electrolyte

(1) Electrolyte level

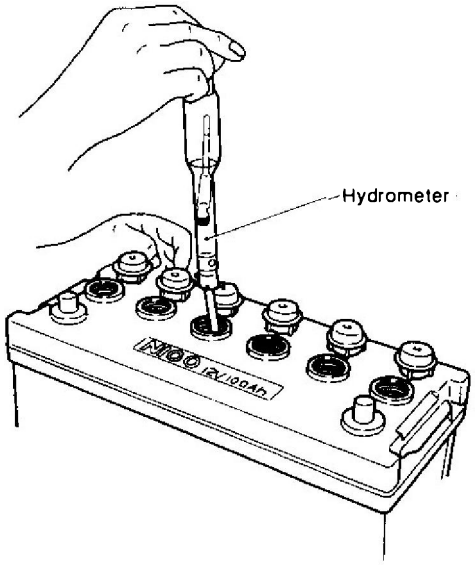


Check the electrolyte level every 7 to 10 days. The electrolyte must always be 10 ~ 20mm over the tops of the plates.

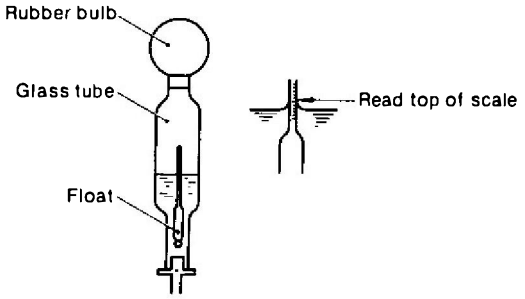
NOTES: 1) The "LEVEL" line on a transparent plastic battery case indicates the height of the electrolyte.
2) Always use distilled water to bring up the electrolyte level.
3) When the electrolyte has leaked out, add dilute sulfuric acid with the same specific gravity as the electrolyte.

(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.



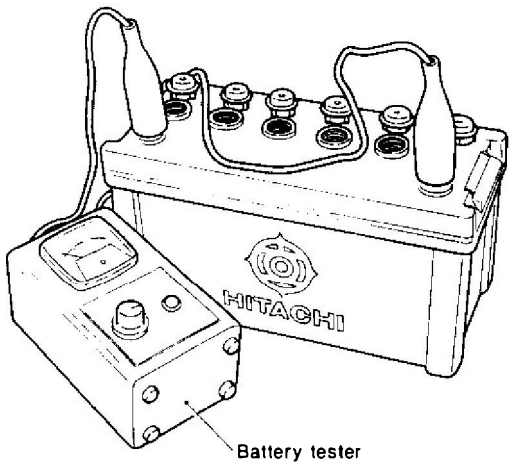
3) The battery is fully charged if the specific gravity is 1.260 at an electrolyte temperature of 20°C. The battery is discharged if the specific gravity is 1.200 (50%). If the specific gravity is below 1.200, recharge the battery.

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 temperature 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.

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.

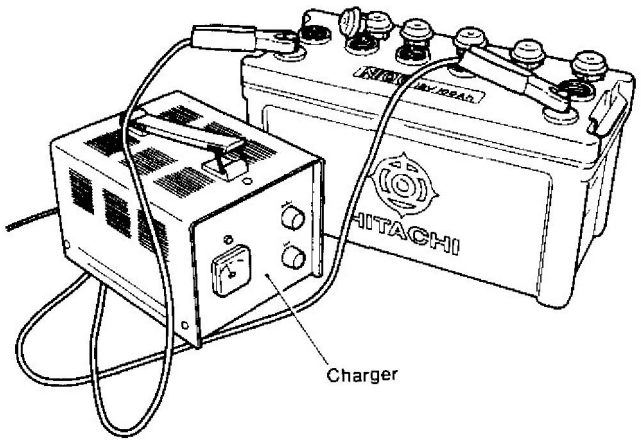
- Normal charging... Should be conducted at a current of 1/10 or less of the indicated battery capacity (10A or less for a 100AH battery).
- Rapid charging... Rapid charging is done over a short period of time at a current of 1/5 ~ 1/2 the indicated battery capacity (20A ~ 50A for a 100AH battery). However, 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.

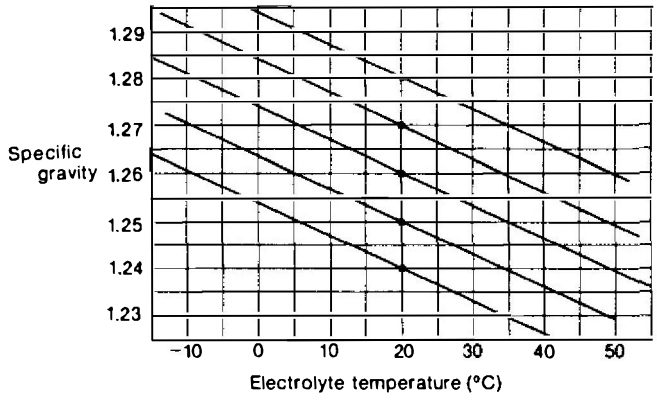
2-4.3 Charging precautions

(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].)

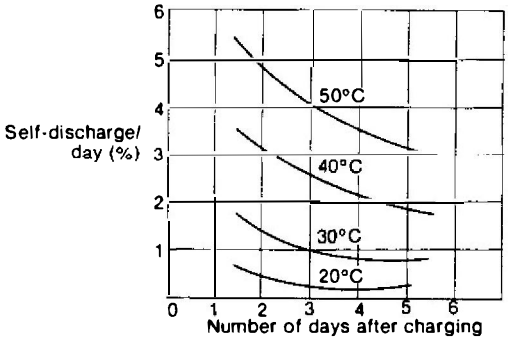


Electrolyte temperature and specific gravity

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.

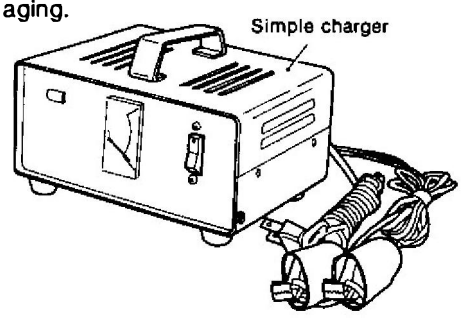
(1) Since the battery will self-discharge about 0.5%/day even when not in use, it must be charged 1 or 2 times a month when it is being stored.



(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.

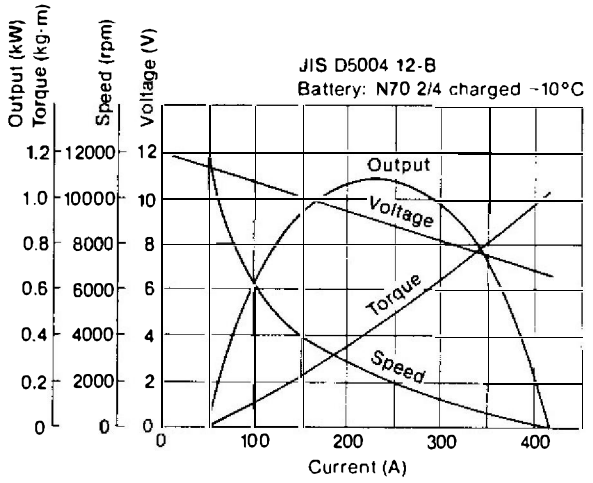


3. Starter Motor

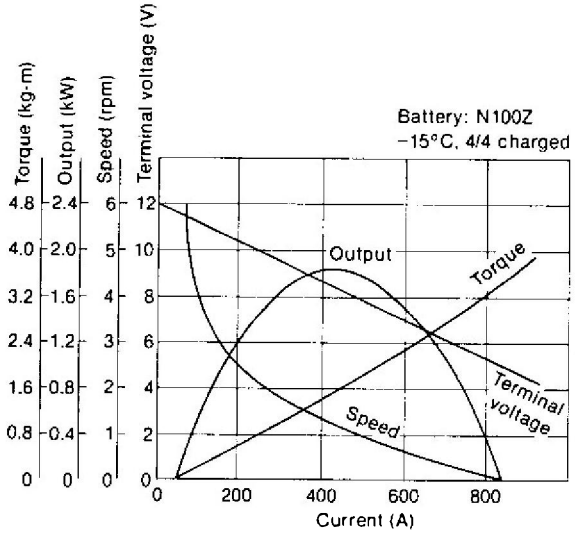
The starter motor is installed on the flywheel housing. When the starting button is pushed, the starter motor pinion flies out and engages the ring gear of the flywheel. Then the main contact is closed, current flows, and the engine is started.
After the engine starts, the pinion automatically returns 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.

Engine model		1GM, 2GM 3GM(D)	3HM
Model		S114-303	S12-79
Rating (sec)		30	30
Output (kW)		1.0	1.8
Direction of rotation (viewed from pinion side)		Clockwise	Clockwise
Weight kg (lb)		4.4 (9.7)	9.3 (20.5)
Clutch system		Overrunning	Overrunning
Engagement system		Magnetic shift	Magnetic shift
No. of pinion teeth		9	15
Pinion flyout voltage (V)		8 or less	8 or less
No-load	Terminal voltage (V)	12	12
	Current (A)	60 or less	90 or less
	Speed (rpm)	7000 or greater	4000 or greater
Loaded characteristics	Terminal voltage (V)	6.3	8.5
	Current (A)	460 or less	420
	Torque kg-m (ft-lb)	0.9 (6.51) or greater	1.35 (9.76) or greater



S114-303 Performance curves



S12-79 Performance curves

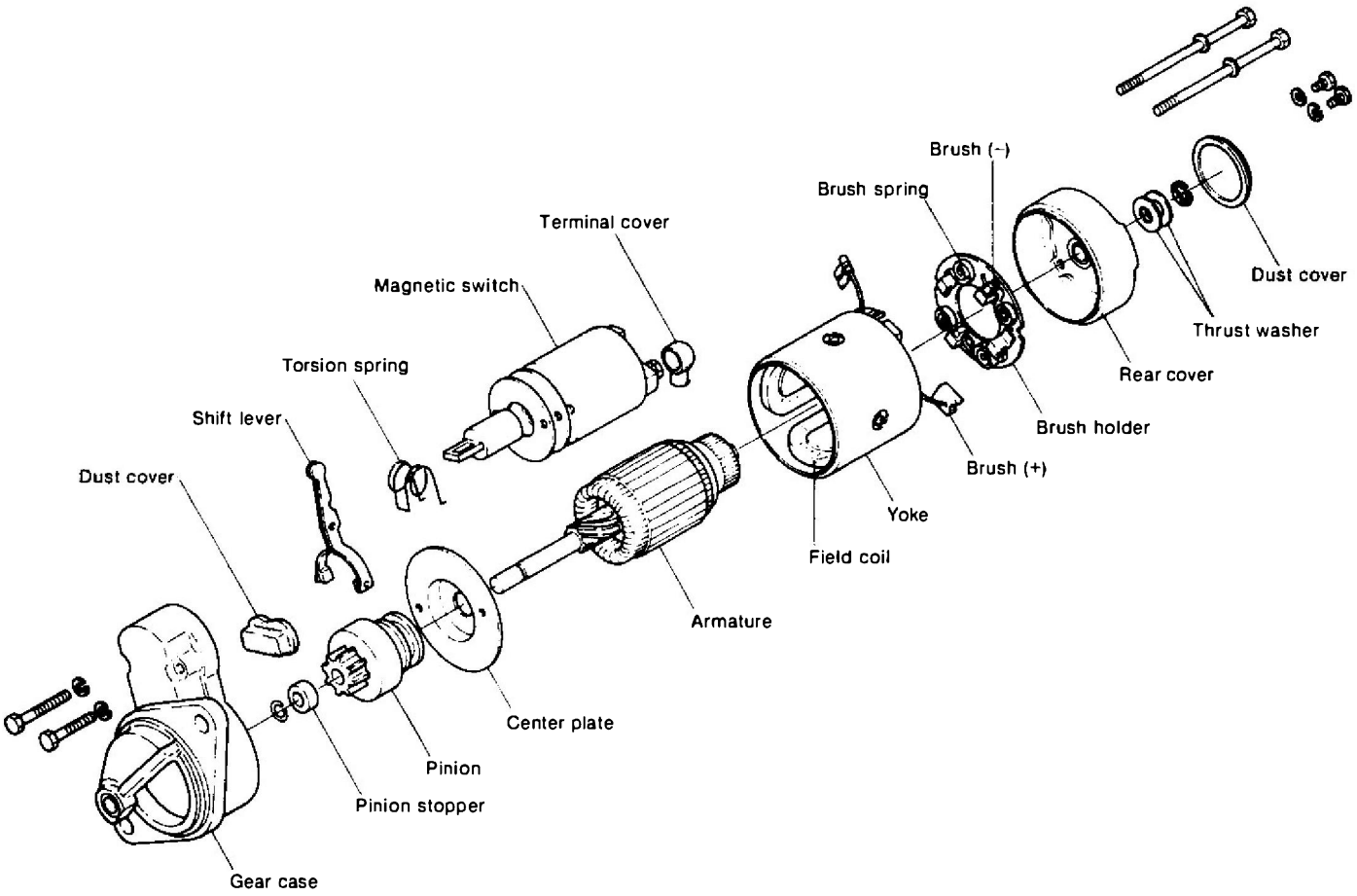
3-2 Construction

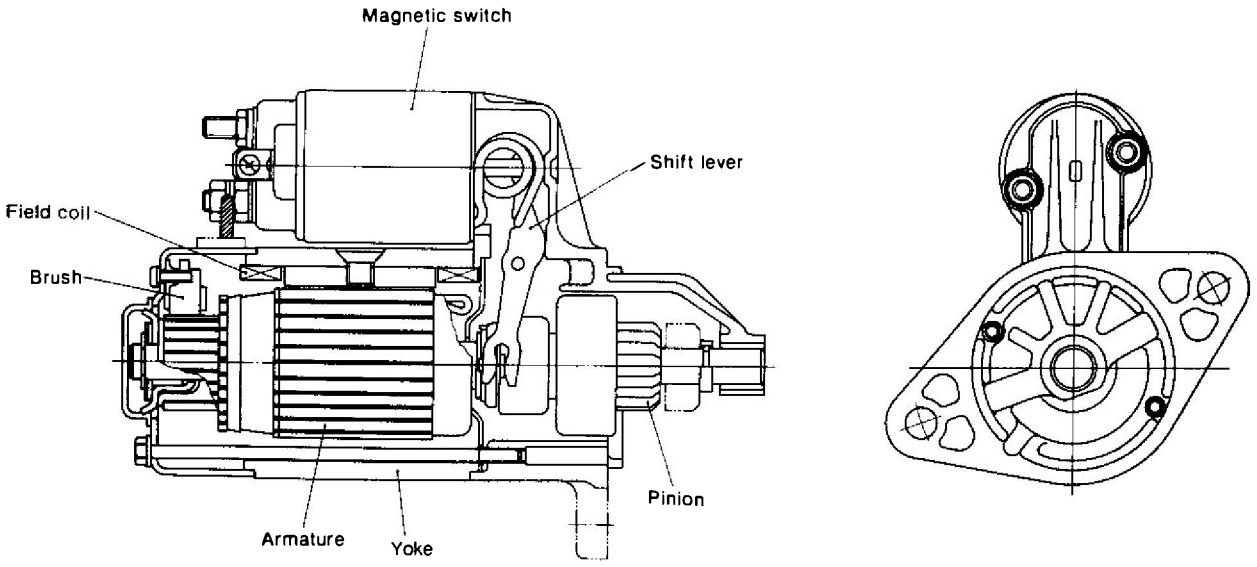
This starter motor described in this section is a conventional pre-engaged 4-brush 4-pole starter motor with a screw roller drive clutch.
The starter motor is composed of three major parts, as follows:

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

(2) Motor
A continuous current series motor which generates rotational drive power.

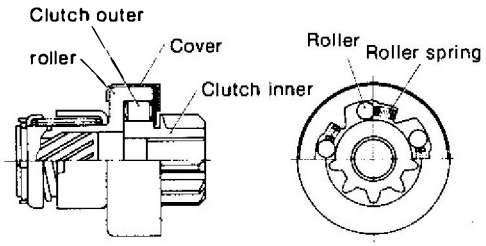
(3) Pinion
Transfers driving power from motor to ring gear. An overspeed clutch is employed to prevent damage if the engine should run too fast.


Brush (-)
Brush spring
Terminal cover
Magnetic switch
Dust cover
Thrust washer
Torsion spring
Rear cover
Shift lever
Brush holder
Brush (+)
Dust cover
Yoke
Field coil
Armature
Center plate
Pinion
Pinion stopper
Gear case

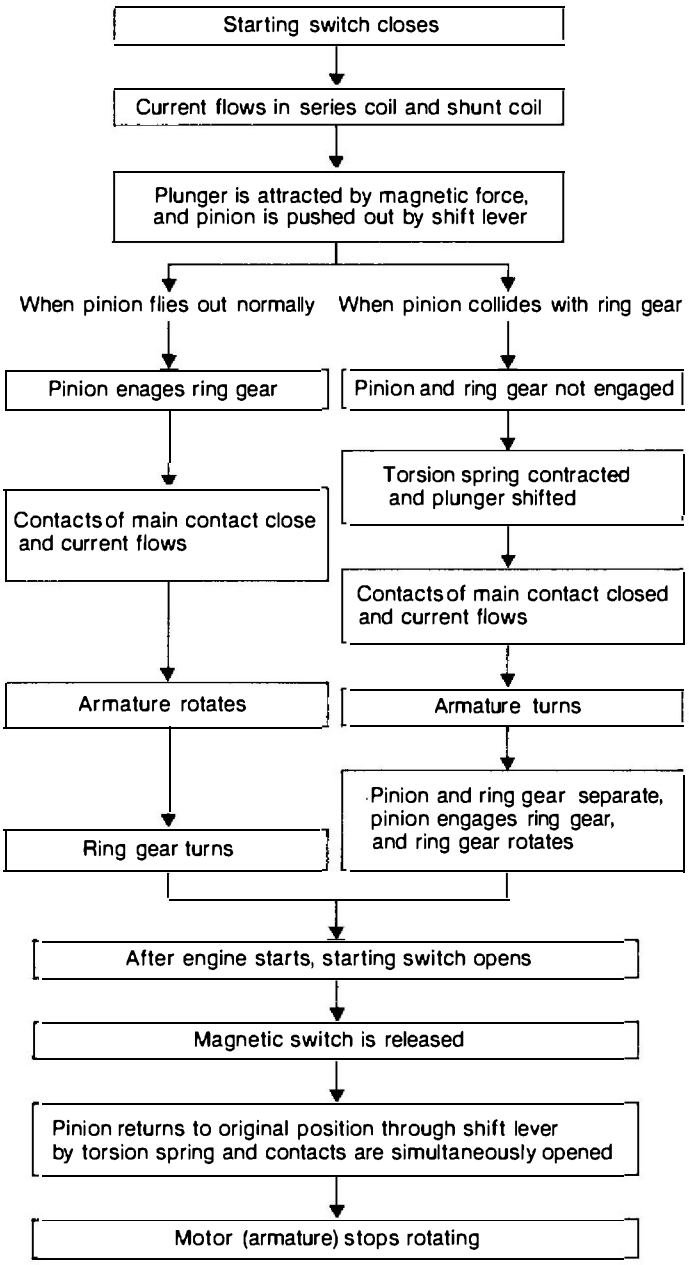

Magnetic switch
Shift lever
Field coil
Brush
Pinion
Armature
Yoke

To prevent the motor receiving a shock which will occur as the engine starts and over-runs, this starter motor is installed with an over-running clutch.

Over-running clutch



3-3 Operation



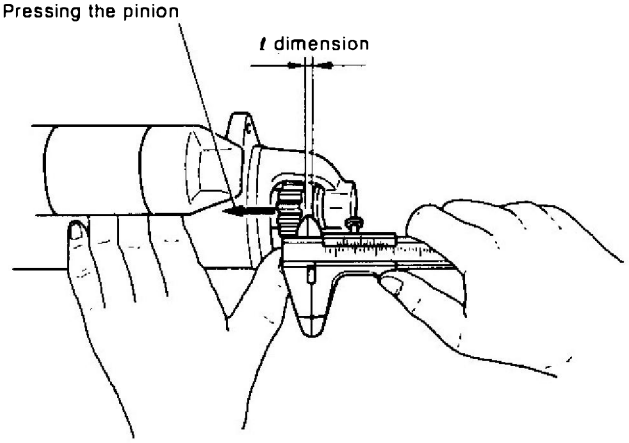
3-4 Adjustment and performance test

3-4.1 L-size measurement (gap between pinion and pinion stopper)

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

mm (in.)

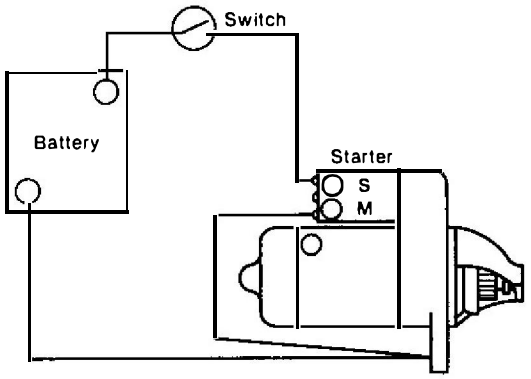
	Starter motor	*l* dimension
1GM, 2GM, 3GM(D)	S114-303	0.3 ~ 2.5 (0.0118 ~ 0.0984)
3HM	S12-79	0.2 ~ 1.5 (0.0079 ~ 0.0591)



Measuring of *l* dimension

3-4.2 Pinion movement

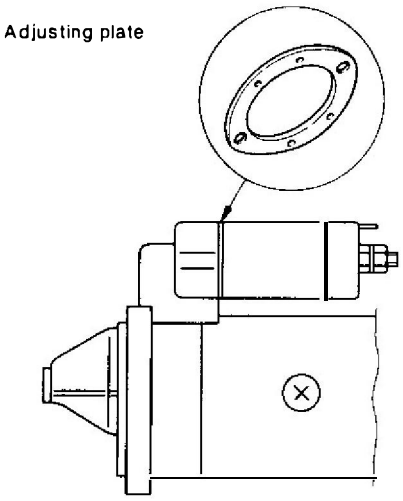
After complete assembly of the starter motor, connect up the motor as in Fig.



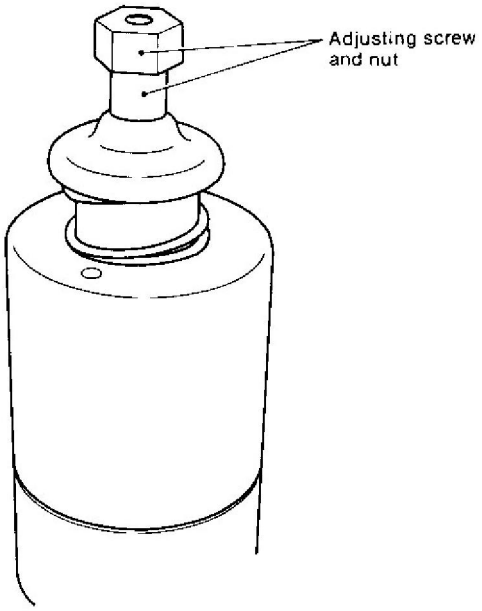
3-4.3 Plunger movement

Adjustment made by adjusting stroke of magnetic plunger to the prescribed value.

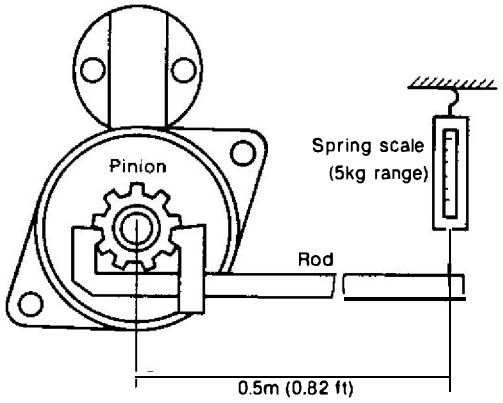
(1) Shim adjusting type (S114-303)
Adjust the ℓ-dimension installing shim (Adjusting plate) at the magnetic switch attach section.
There are two kind of shim [Thickness 0.5mm (0.0197in.), 0.8mm (0.0315in.)]



(2) Adjusting screw type (S12-79)
Adjust the ℓ-dimension by adjusting screw and nut.

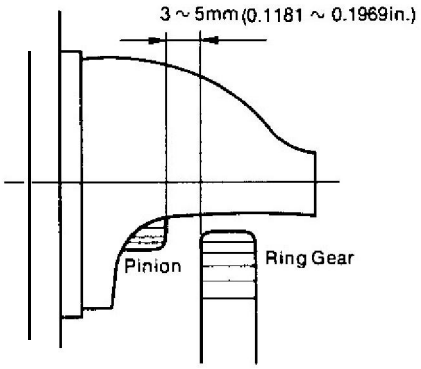


3-4.4 Pinion lock torque measurement



3-4.5 Mesh clearance

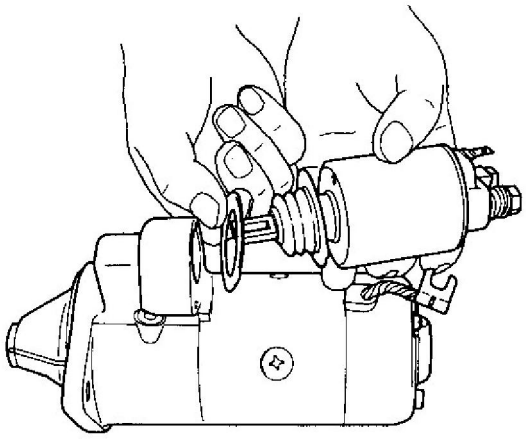
Mesh clearance is the distance between the flywheel ring gear and starter motor pinion in the rest position. This clearance should be between 3mm (0.1181in.) to 5mm (0.1969in.).



3-5 Disassembly

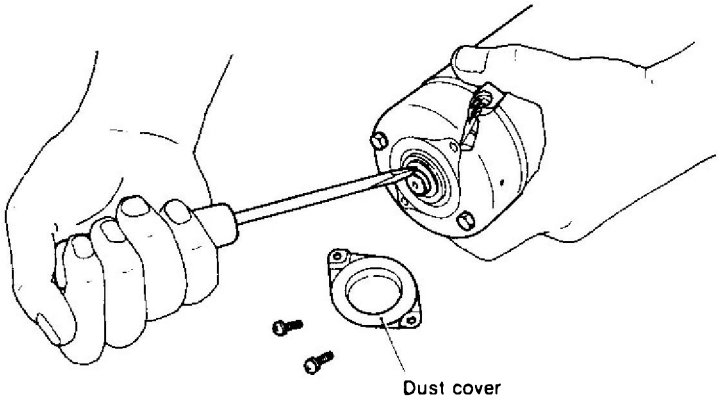
3-5.1 Magnetic switch

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

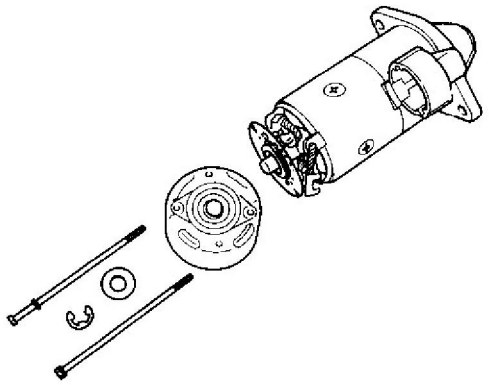


3-5.2 Rear cover

(1) Remove dust cover.

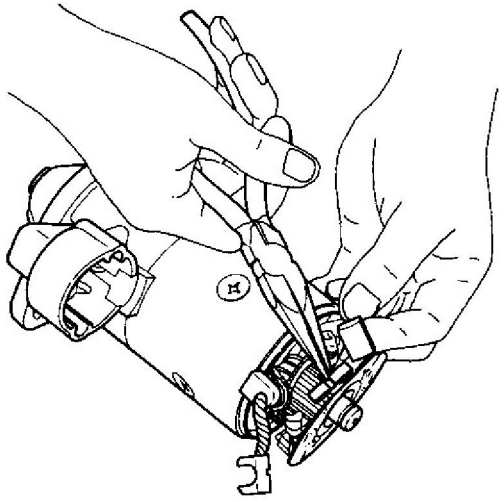


(2) Remove E-ring, and remove thrust washer (be careful not to lose the washer and shim).
(3) Remove the two through bolts holding the rear cover and the two screws holding the brush holder.
(4) Remove rear cover.



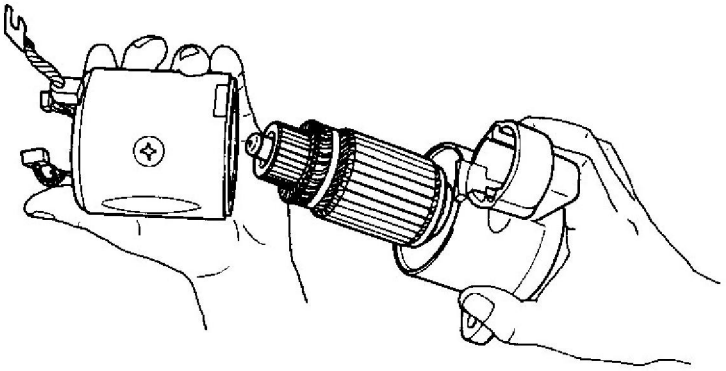
3-5.3 Brush holder

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



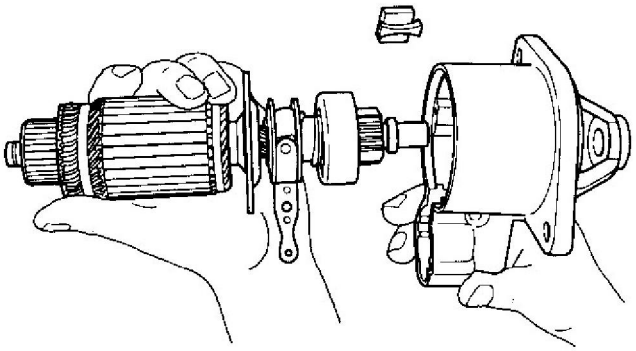
3-5.4 Yoke

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



3-5.5 Armature

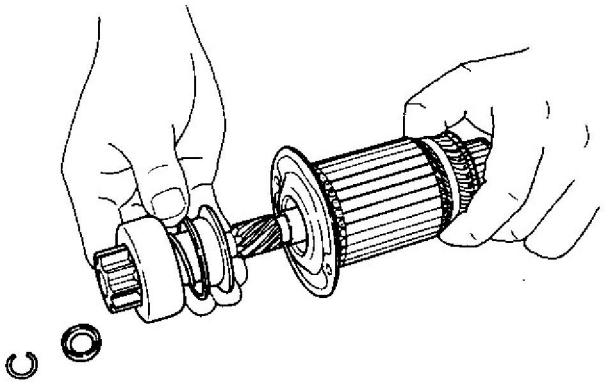
(1) Slide pinion stopper to pinion side.



(2) Remove the pinion stopper clip.

3-5.6 Pinion

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

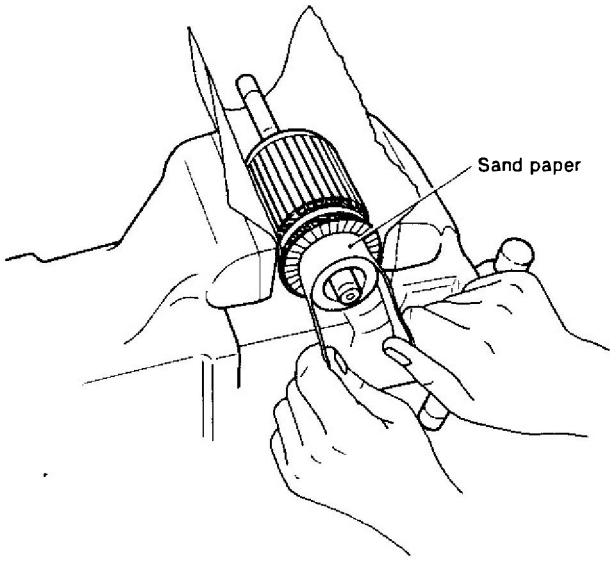


3-6 Inspection

3-6.1 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 irreparable.

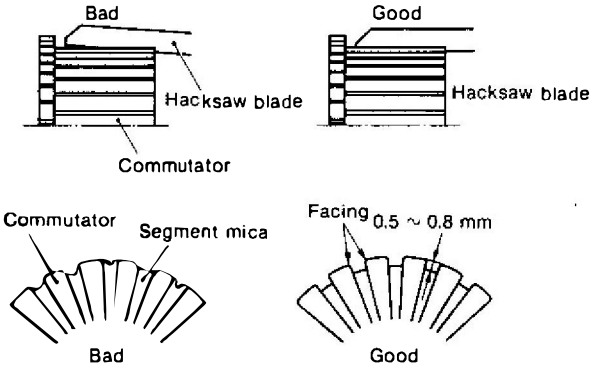


mm (in.)

Applicable model	1GM, 2GM, 3GM(D)		3HM	
	S114-303		S12-79	
	Maintenance standard	Wear limit	Maintenance standard	Wear limit
Commutator outside diameter	ø33 (1.299)	ø32 (1.260)	ø43 (1.693)	ø40 (1.575)
Commutator run-out	Within 0.03 (0.0012)	0.2 (0.0079)	Within 0.03 (0.0012)	0.2 (0.0079)
Difference between maximum diameter and minimum diameter	Repair limit 0.4 (0.0157)	Repair accuracy 0.05 (0.002)	Repair limit 0.4 (0.0157)	Repair accuracy 0.05 (0.002)

(2) Mica undercut

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



mm (in.)

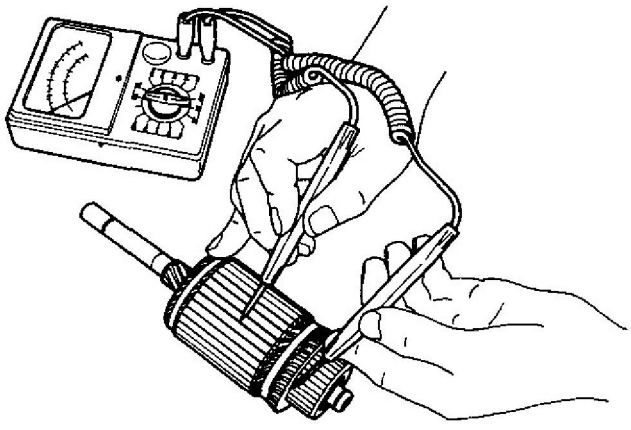
	Maintenance standard	Repair limit
Mica undercut	0.2 (0.0079)	0.5 ~ 0.8 (0.0197 ~ 0.0315)

(3) Armature coil ground test

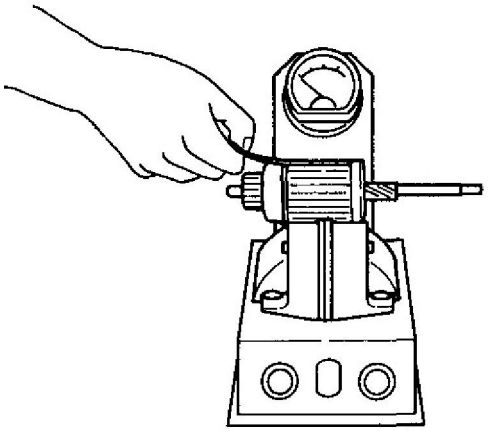
Using a tester, check for continuity between the commutator and the shaft (or armature core). Continuity indicates that these points are grounded and that the armature must be replaced.

1) Short test...existence of broken or disconnected coil.
2) Insulation test...between commutator and armature core or distortion shaft.

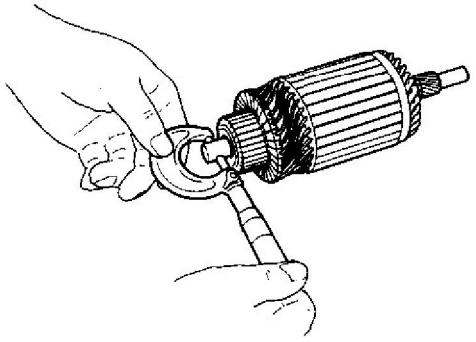
Checking commutator for insulation defects.



Checking armature windings for insulation faults.

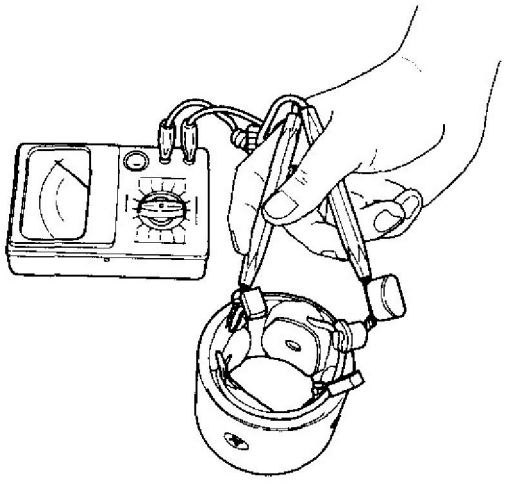


(4) Armature shaft outside diameter
Measure the outside diameter of the armature shaft at four locations: front, center, end, and pinion. Replace the armature if the shaft is excessively worn.
Check the bend of the shaft; replace the armature if the bend exceeds 0.08mm (0.0031 in.)



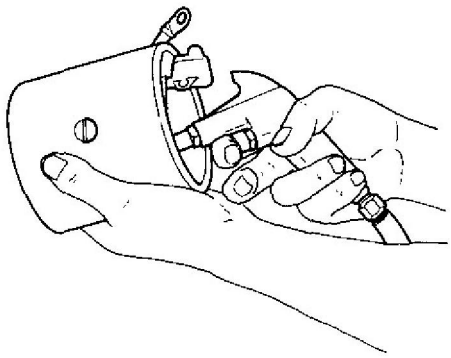
3-6.2 Field coil

(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.



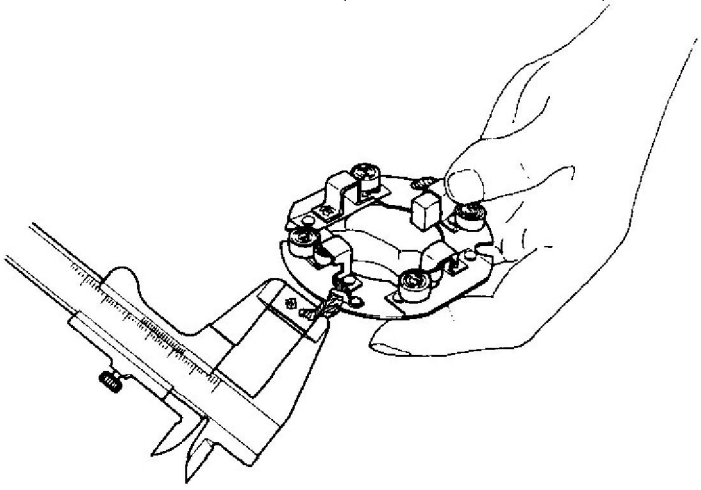
(2) Short test
Check for continuity between the yoke and any field coil terminal. Continuity indicates that the coil is shorted and that it must be replaced.

(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.

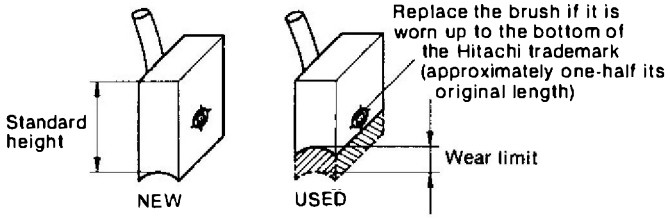


3-6.3 Brush

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.

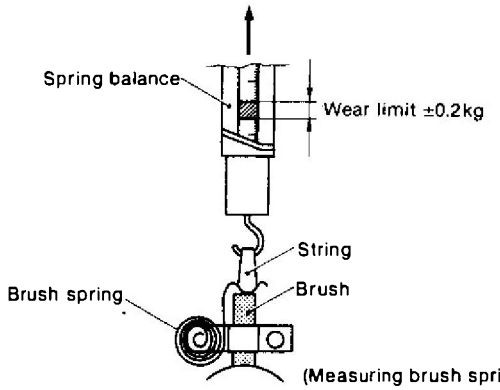


mm (in.)

	S114-303	S12-79
Brush standard height	16 (0.6299)	22 (0.8661)
Wear limit	4 (0.1575)	8 (0.3150)

(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.

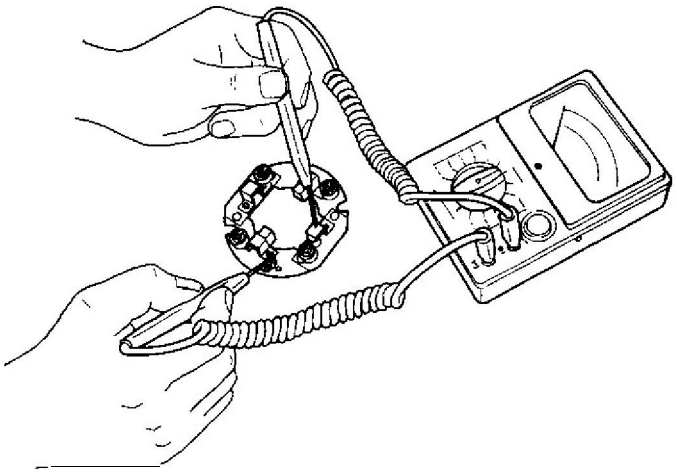
(3) Brush spring
Since the brush spring pushes the brush against the commutator while the motor is running, a weak or defective spring will cause excessive brush wear, resulting in sparking between the brush and the commutator during operation. Measure the spring force with a spring balance; replace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



(Measuring brush spring force)

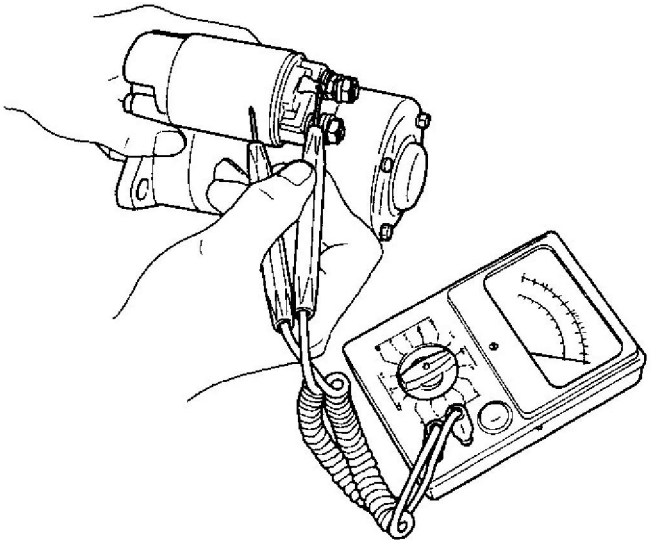
	S114-303	S12-79
Standard spring load	1.6kg (3.527 lb)	0.85kg (1.8737 lb)

(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.



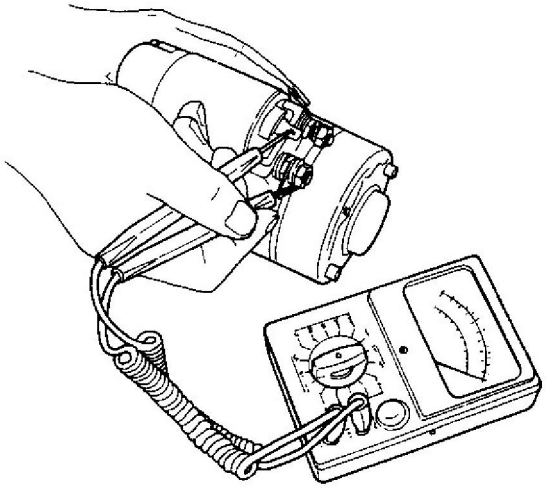
3-6.4 Magnetic switch

(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.



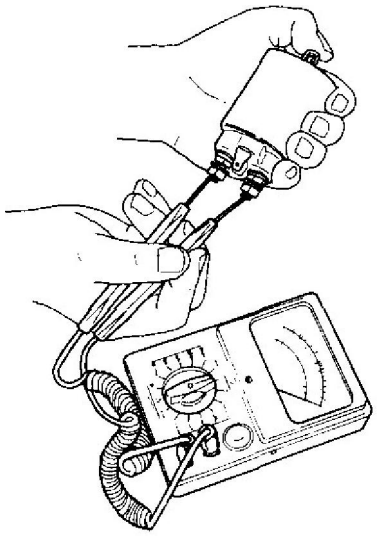
	S114-303	S12-79
Coil resistance (at 20°C)	0.694Ω	0.590Ω

(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.



	S114-303	S12-79
Resistance value (at 20°C)	0.324Ω	0.267Ω

(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.



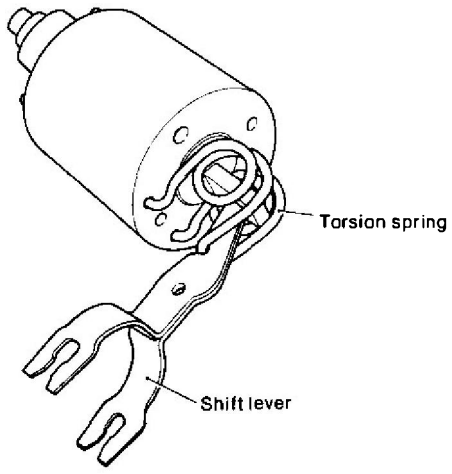
3-6.5 Pinion

(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.

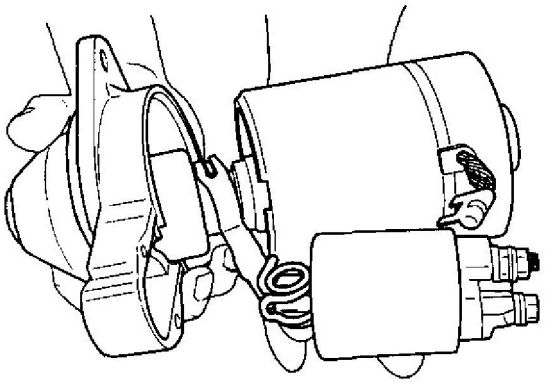
3-7 Reassembly precautions

Reassemble the starter motor in the reverse order of disassembly, paying particular attention to the following:

(1) 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.



(2) Mounting the magentic switch
Attach the shift lever to the pinion; assemble the gear case as shown below.
Do not forget to install the dust cover before assembling the gear case.
After reassembly, check by conducting no-load operation.



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

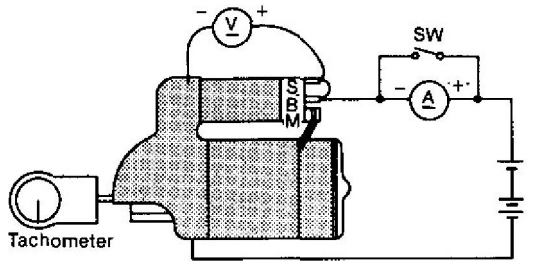
Magnetic switch plunger	Shell	Aeroshell No. 7
Bearing and spline	Shell	Albania Grease No. 2

3-8 Testing

3-8.1 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.

3-9 Maintenance standard

				S114-303	S12-79
Brush	Standard spring load		kg (lb)	1.6 (3.527)	0.85 (1.8737)
	Standard height		mm (in.)	16 (0.6299)	22 (0.8661)
	Wear limit		mm (in.)	12 (0.472)	8 (0.3150)
Magnetic switch	Series coil resistance		Ω	0.324	0.267
	Shunt coil resistance		Ω	0.694	0.590
Commutator	Outside diameter	Maintenance standard	mm (in.)	ø33 (1.299)	ø43 (1.193)
		Wear limit	mm (in.)	ø32 (1.260)	ø40 (1.575)
	Difference between maximum diameter and maximum diameter	Repair limit	mm (in.)	0.4 (0.0157)	
		Repair accuracy	mm (in.)	0.05 (0.002)	
	Mica undercut	Maintenance standard	mm (in.)	0.2 (0.0079)	
		Repair limit	mm (in.)	0.5 ~ 0.8 (0.0197 ~ 0.0315)	
Standard dimension	Rear side bearing	Shaft diameter	mm (in.)	12.450 ~ 12.468 (0.4902 ~ 0.4909)	14.950 ~ 14.968 (0.5886 ~ 0.5893)
		Bearing inside diameter	mm (in.)	12.500 ~ 12.527 (0.4921 ~ 0.4932)	15.000 ~ 15.018 (0.5906 ~ 0.5913)
	Intermediate bearing	Shaft diameter	mm (in.)	—	20.250 ~ 20.268 (0.7972 ~ 0.7980)
		Bearing inside diameter	mm (in.)	—	20.500 ~ 20.518 (0.8071 ~ 0.8080)
	Pinion sliding section	Shaft diameter	mm (in.)	12.450 ~ 12.468 (0.4902 ~ 0.4909)	13.950 ~ 13.968 (0.5492 ~ 0.5499)
		Pinion inside diameter	mm (in.)	12.530 ~ 12.550 (0.4933 ~ 0.4941)	14.030 ~ 14.050 (0.5524 ~ 0.5531)
	Pinion side bearing	Shaft diameter	mm (in.)	12.450 ~ 12.468 (0.4902 ~ 0.4909)	13.950 ~ 13.968 (0.5492 ~ 0.5499)
		Bearing inside diameter	mm (in.)	12.500 ~ 12.527 (0.4921 ~ 0.4932)	14.000 ~ 14.018 (0.5512 ~ 0.5519)

3-10 Various problems and their 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

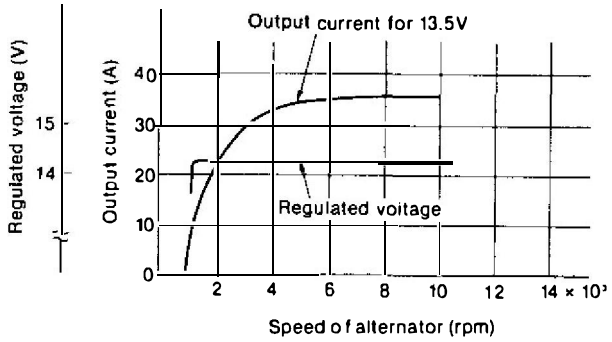
The alternator serves to keep the battery constantly charged. It is installed on the cylinder block by a bracket, and is driven from the V-pulley at the end of the crankshaft by a V-belt.
The type of alternator used in this engine is ideal for high speed engines having a wide range of engine speeds. 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 Features

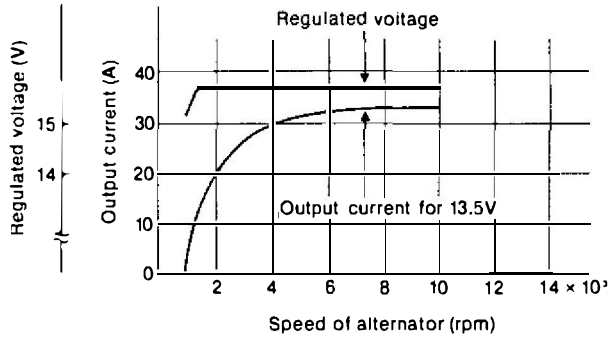
The alternator contains a regulator using an IC, and has the following features.
(1) The IC regulator, which is self-contained, has no moving part (mechanical contact point), therefore it has superior features such as, freedom from vibration, no fluctuation of voltage during use, and no need for readjustment.
Also, it is of the over-heating compensating type and can automatically adjust the voltage to the most suitable level depending on the operating temperature.
(2) The regulator is integrated within the alternator to simplify external wiring.
(3) It is an alternator designed for compactness, light weight, and high output.
(4) A newly developed U-shaped diode is used to provide increased reliability and easier checking and maintenance.
(5) As the alternator is to be installed on board, the following countermeasures are taken to provide salt-proofing.
1) The front and rear covers are salt-proofed.
2) Salt-proof paint is applied to the diode.
3) The terminal, where the harness inboard is connected to the alternator, is nickel plated.

4-3 CharacteristicsCS

(Old type)



(New type)

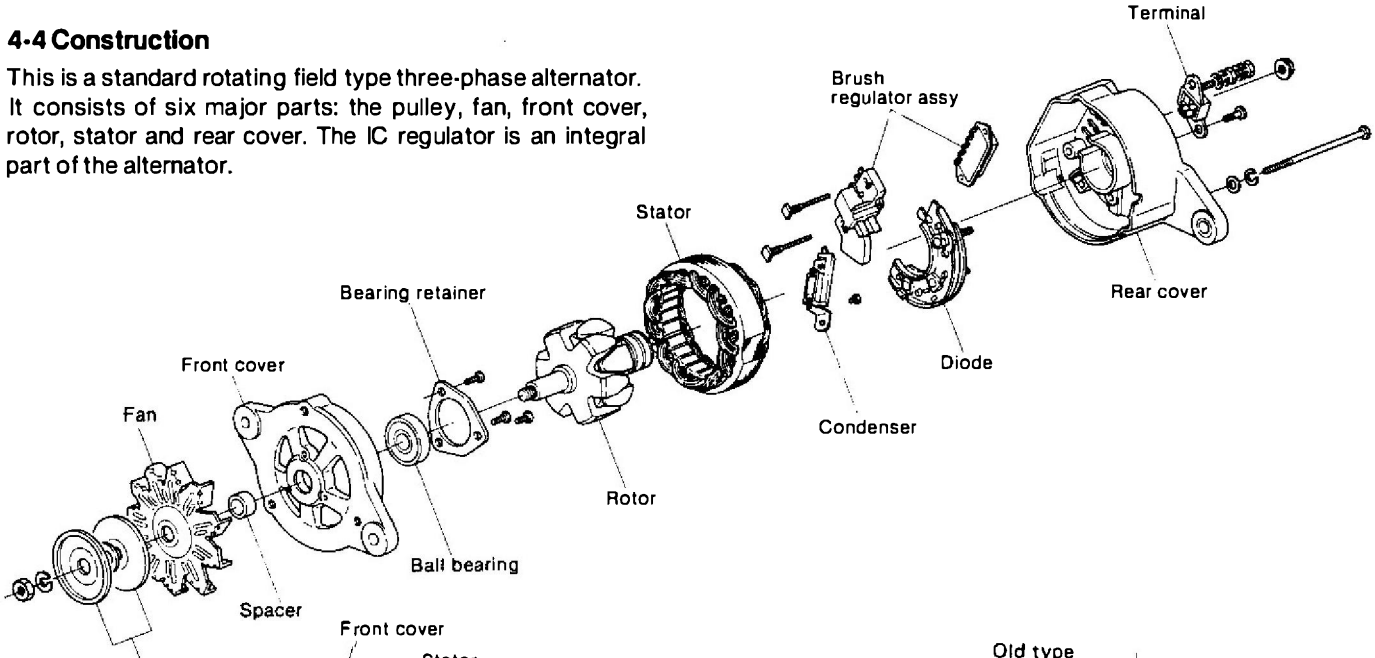


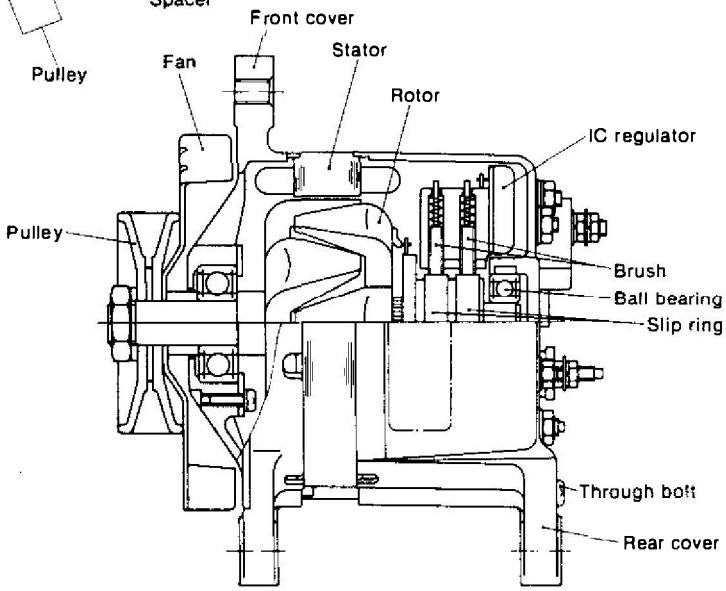
4-2 Specifications

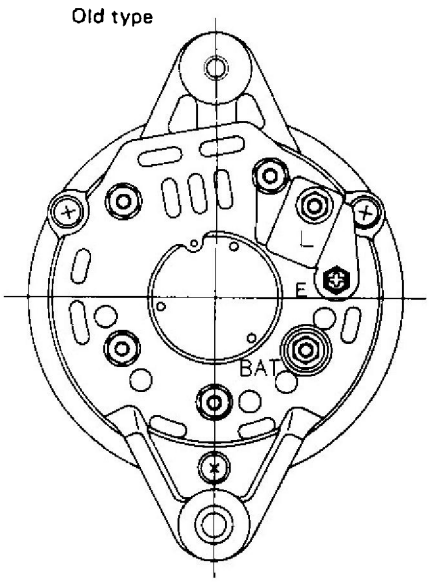
	Old type	New type	Remarks
Model of alternator	LR135-74	LR135-105	Design changed for Feb. 1, 1982 Applicable Eng. Model/Number. 1GM and after; 2GM(F) #04806 "; 3GMD(F) #02710 "; 3HM # #01372 "; 3HMF #00175 "
Model of IC regulator	TR1Z-49	TR1Z-63	
Battery voltage	12V	12V	
Nominal output	12V 35A	12V, 35A	
Earth polarity	Negative earth	Negative earth	
Direction of rotation (viewed from pulley end)	Clockwise	Clockwise	
Weight	3.5kg (7.7 lb)	3.5 kg (7.7 lb)	
Rated speed	5000 rpm	5000 rpm	
Operating speed	1000 ~ 8000 rpm	900 ~ 8000 rpm	
Speed for 13.5V	1000 rpm or less	900 rpm or less	
Output current (when heated)	2500 rpm 27.5±2A (5000 rpm 35±2A)	5000 rpm 32±2A	
Regulated voltage	14.3±0.3V (at 20°C, Full battery)	14.5±0.3V (at 20°C, Full battery)	
Standard temperature/ voltage gradient	-0.0136V/°C	-0.01V/°C	

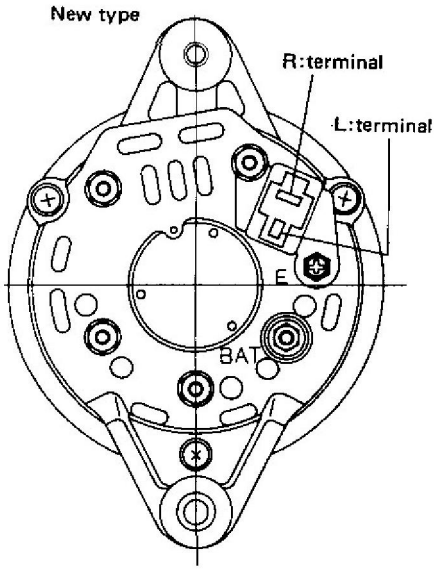
4-4 Construction

This is a standard rotating field type three-phase alternator. It consists of six major parts: the pulley, fan, front cover, rotor, stator and rear cover. The IC regulator is an integral part of the alternator.



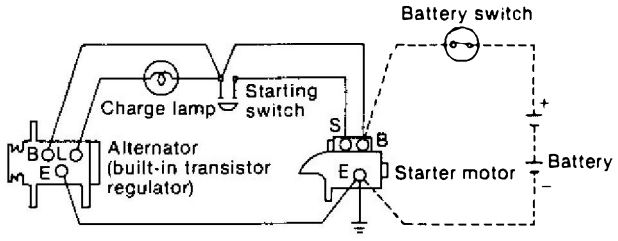






4-5 Wiring

(1) Wiring diagram



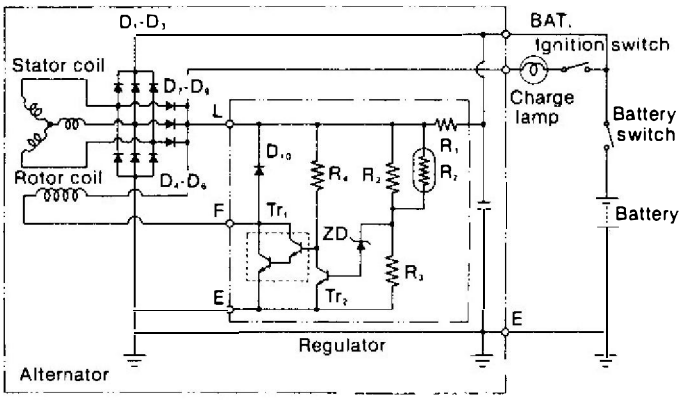
(2) Terminal connections

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

4-6 Circuit diagram

4-6.1 Circuit diagram



BAT: Battery output terminal
L: Charge lamp terminal
E: Earth
$D_1 \sim D_6$: Diodes for rectifying the output current
$D_7 \sim D_9$: Diodes for switching the charge lamp
D_{10}: Diode for protecting the IC
ZD: Zener diode
Tr_1, Tr_2: Transistors
$R_1 \sim R_3$: Resistors
F: Rotor current
Rn: Thermistor (resistors with current/temperature gradient)

4-6.2 Principle of IC regulator function

The IC regulator controls the output voltage of the alternator by switching the rotor current (exciting current) on or off by means of the transistor Tr_1 which is connected in series with the rotor coil.

When the output voltage of the alternator is within the regulated values, transistor Tr_1 is "ON" but when the voltage is outside the regulated value, the Zener diode ZD comes "ON", and regulates the output voltage rise by turning transistor Tr_1 "OFF".

The output voltage is kept within the regulated values by repeating the "ON"—"OFF" operation.

4-7 Alternator handling precautions

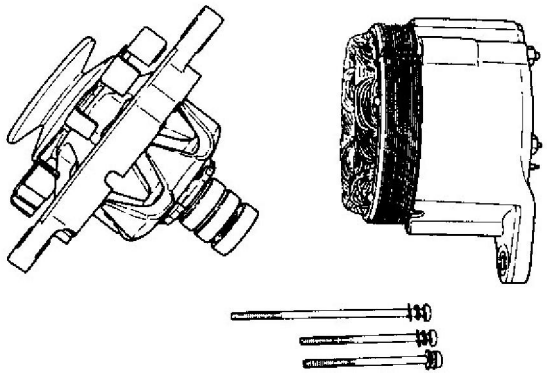
(1) Pay attention to the polarity of the battery; be careful not to connect it in reverse polarity. If the battery is connected in reverse polarity, the battery will be shorted by the diode of the alternator, an overcurrent will result, the diodes and transistor regulator will be destroyed, and the wiring 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 meter.

4-8 Alternator disassembly

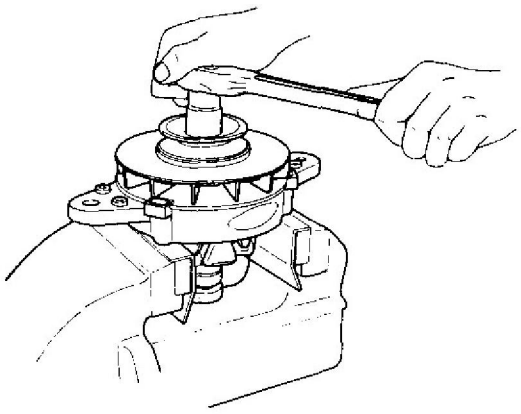
Disassemble the alternator as follows.

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

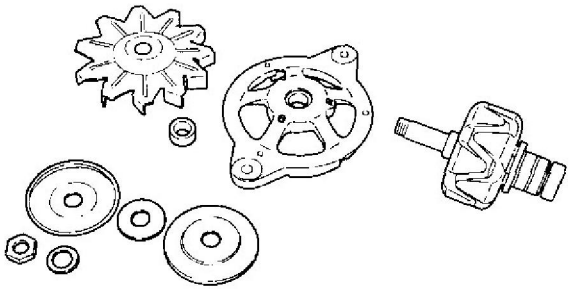
(1) Remove the cover attached to the rear cover, remove the through bolts, and disassemble into front and rear sides.



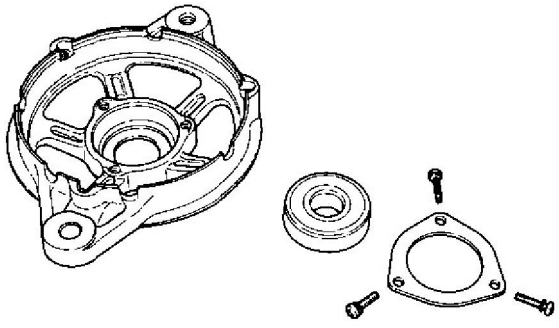
(2) When disassembling the front side pulley and fan, front cover and rotor, clamp the rotor in a vice within copper plates and loosen the pulley nut, as shown in the figure.



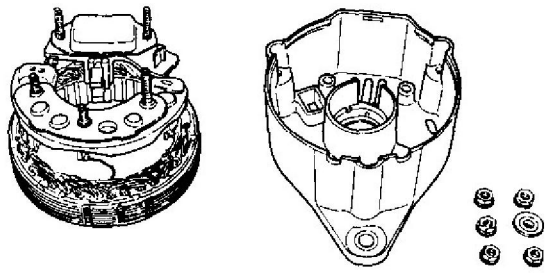
(3) When the fan and pulley have been removed, the rotor can be pulled from the front cover by hand.



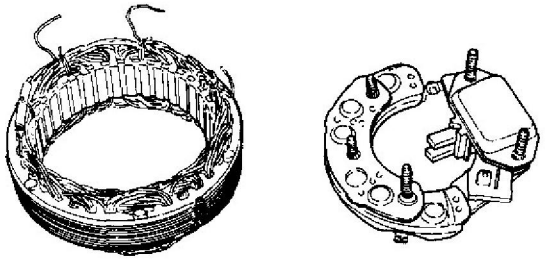
(4) Next, remove the bearing attached to the front cover. Loosen the bearing protector mounting bolts (M4) and pull the bearing by applying pressure to the bearing from the front cover.



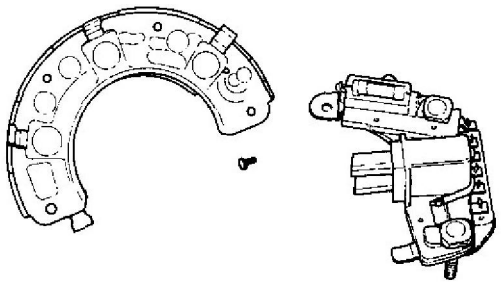
(5) Remove the nut at the threaded part of the BAT terminal on the rear cover, the fixing nut of the diode, and the bolt of E terminal.
After removing the L terminal assembly, separate the alternator into rear cover and stator (with attached diode and brush holder).



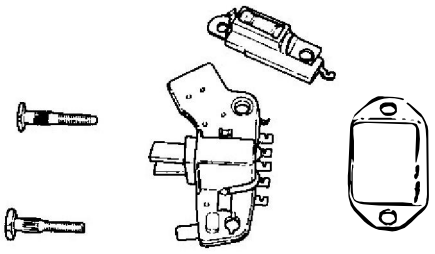
(6) Unsolder the lead wire connection and remove the diode assembly together with the regulator assembly.



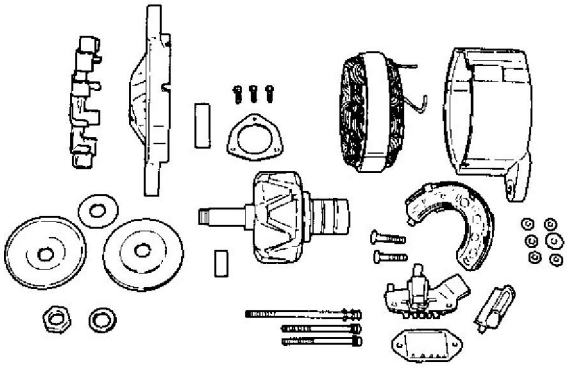
(7) Separate the diode assembly and the brush regulator assembly by removing the 3mm dia rivet which connects these two parts and then unsolder the L terminal connection.



(8) When replacing the IC regulator, it can be removed by unsoldering the regulator's terminals and removing two bolts. Never remove these two bolts except when the regulator is replaced.



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

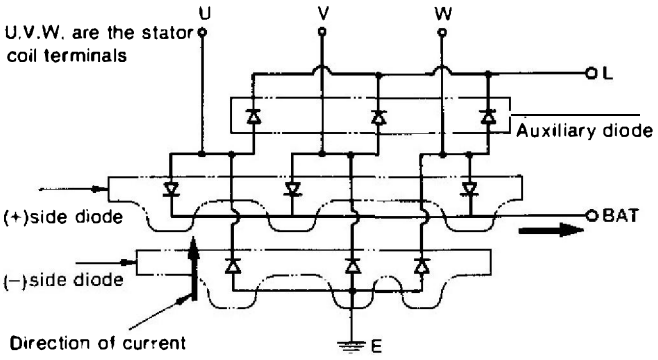


4-9 Inspection and adjustment

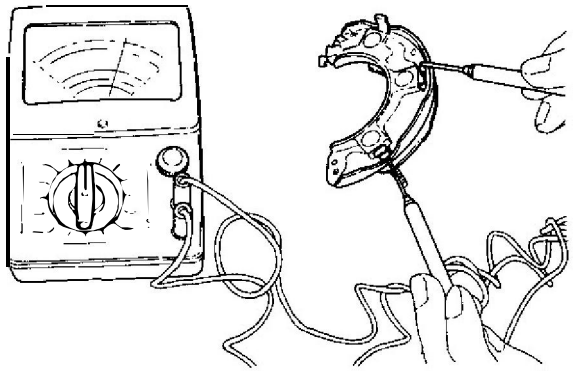
4-9.1 Diodes

Between terminal		BAT (+ side diode)	
	Tester pin	(+)side	(−)side
U.V.W	(+)side	—	Continuity No
	(−)side	Continuity Yes	—

Between terminal		E (− side diode)	
	Tester pin	(+)side	(−)side
U.V.W	(+)side	—	Continuity Yes
	(−)side	Continuity No	—



Electric current flows only in one direction in the diode as shown on the previous page. By testing the continuity between terminals (e.g. BAT and U) with the continuity tester, (as shown in the picture), the diode is determined as usable when the continuity is "Yes", but is faulty when it "No".
Connect the tester in the reverse way, and then the diode is usable when continuity is "No", but faulty when "Yes". If a faulty diode is found in this test, replace it with a complete new diode assembly.
As the auxiliary diode does not have a terminal, check the continuity between its ends.



Diode short test

CAUTION: If a high voltage meter 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 meter, etc.

4-9.2 Rotor

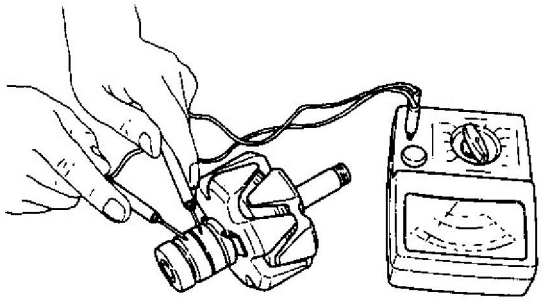
(1) Slip ring wear
Because the slip rings wear very little, the diameter of the rings must be measured with a micrometer. Replace the rings (rotor assembly) when wear exceeds the maintenance standard by 1mm. (0.0393in.)

mm (in.)

	Maintenance standard	Wear limit
Slip ring outside diameter	ø31.6 (1.2441)	ø30.6 (1.2047)

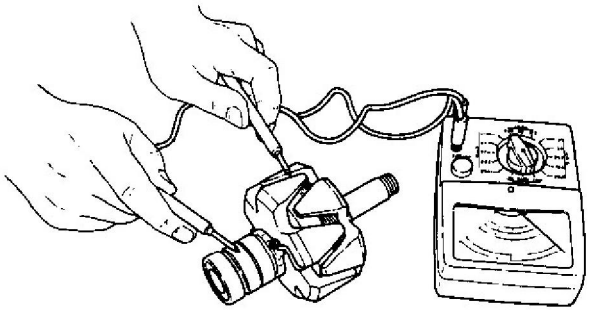
(2) Slip ring roughness
The slip ring should be smooth with no surface oil, etc. If the surface of the rings is rough, polish with #500 ~ #600 sandpaper, and if the surface is soiled, clean with a cloth dipped in alcohol.

(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 extremely 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.



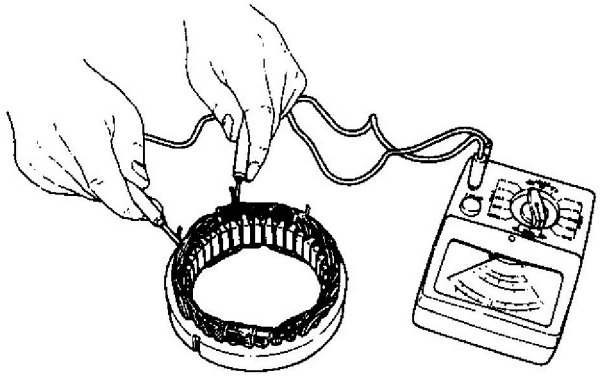
Resistance value	Approx. 3.3Ω (at 20°C)	LR135-74
Resistance value	Approx. 3.1Ω (at 20°C)	LR135-105

(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.
Usable if the continuity is "No".
If "Yes", replace it as the rotor coil is grounded.



4-9.3 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.

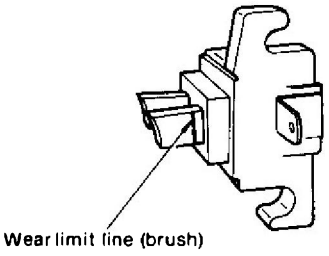


Resistance value	Approx. 0.15Ω (at 20°C) 1-phase resistance	LR135-74
Resistance value	Approx. 0.16Ω (at 20°C) 1-phase resistance	LR135-105

(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.

4-9.4 Brush

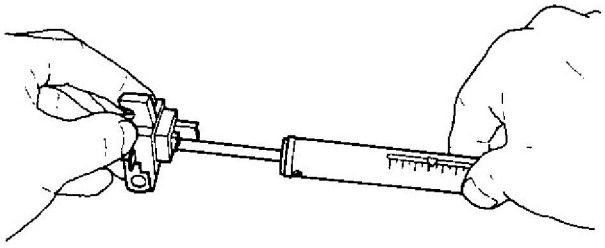
(1) Brush wear
Check the brush length.
The brush wears very little, but replace the brush if worn over the wear limit line printed on the brush.

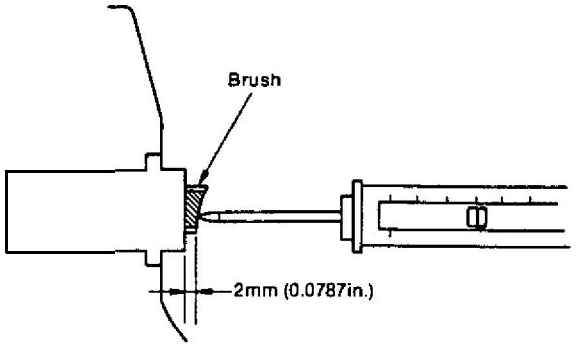


mm(in.)

	Maintenance standard	Wear limit
Brush length	16 (0.6299)	9 (0.3543)

(2) Brush spring pressure measurement.
Measure the pressure with the brush protruding 2mm 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)

4-9.5 Checking IC regulator unit

Connect the wiring as shown in the diagram below using a variable register, two 12V batteries, register and ammeter.

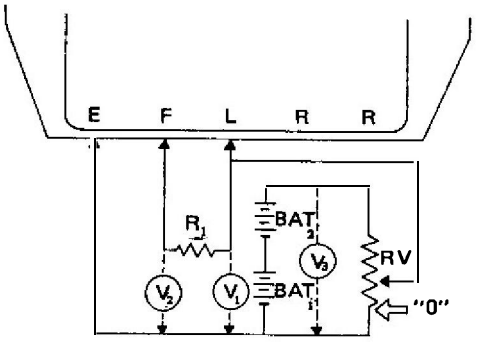
(1) Prepare the following measuring devices

1) Resistor (R_1) 100Ω 2W – 1
2) Variable resistor (Rv) 0-300Ω 12W – 1
3) Battery (BAT_1, BAT_2) 12V – 2
4) DC voltmeter 0 ~ 30V 0.5 class – 1
   (to measure at 3 points)

(2) Check the regulator in the following sequence.

1) Check V_3 (total voltage of BAT_1 plus BAT_2).
   When the value is between 20V and 26V, BAT_1 and BAT_2 are normal.
2) When measuring V_2 (Voltage between F – E terminals), shift the variable resistor gradually from the "0" position. Check if the V_2 voltage charges sharply from below 2.0V to over 2.0V.
   If there is no sharp voltage change, the regulator is faulty and must be replaced.
   When there is sharp voltage change, stop the variable registor at that point.
3) Measure V_1 (voltage between L – E terminals).
   The V_1 voltage is the regulated voltage of the regulator
   ...Confirm that the value is within the standard range.

Adjusted voltage	14.3±0.3V (at 20°C, with 2 batteries)

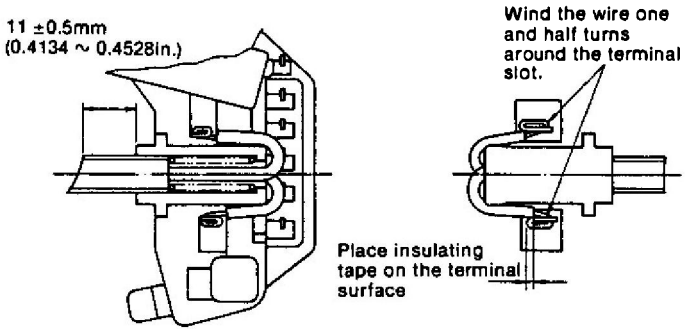


4-10 Reassembly precautions

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

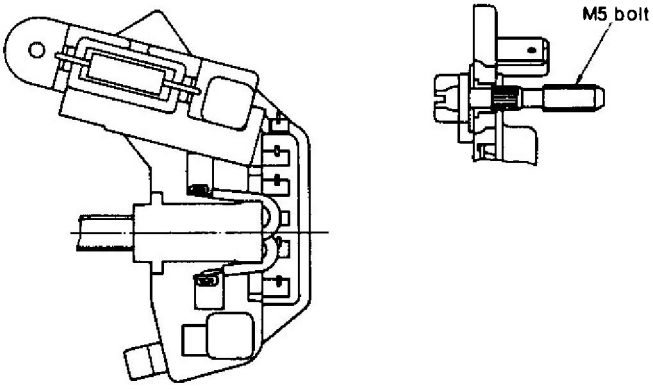
(1) Brush regulator assembly

1) Soldering the brush
   Solder the brush after setting it as shown in the figure. Take care that solder does not flow into the pig-tail (lead wire).



NOTES: 1) Use non-acid flux for soldering.
2) The temperature of the soldering bit is to be 300 to 350°C.

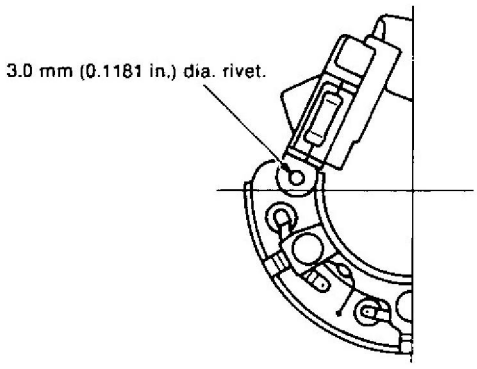
2) Assembly of IC regulator
   Place the IC regulator on the brush holder as shown in the figure, and insert the M5 bolt.
   After inserting the bolt, solder the brush holder to the IC regulator.



NOTES: 1) Insertion pressure is 100 kg (220.5 lbs)
2) Insert vertically.

(2) Connecting the brush regulator assembly to the diode.

1) Fixing with rivet
   Insert a 3mm dia. rivet as shown in the figure, and fix it by using the appropriate tool



Rivetting pressure	500 kg (1102 lbs)

(3) Assembling rear cover
Assemble the rear cover after inserting the pin from outside and fitting the brush into the brush holder.

(4) Tightening torque of each part kg-cm (ft-lb)

Fixing flange holder	32 ~ 40 (2.31 ~ 2.89)
Fixing diode	32 ~ 40 (2.31 ~ 2.89)
Fixing bearing retainer	16 ~ 20 (1.16 ~ 1.45)
Tightening pulley nut	350 ~ 400 (25.32 ~ 28.93)
Tightening through bolt	32 ~ 40 (2.31 ~ 2.89)

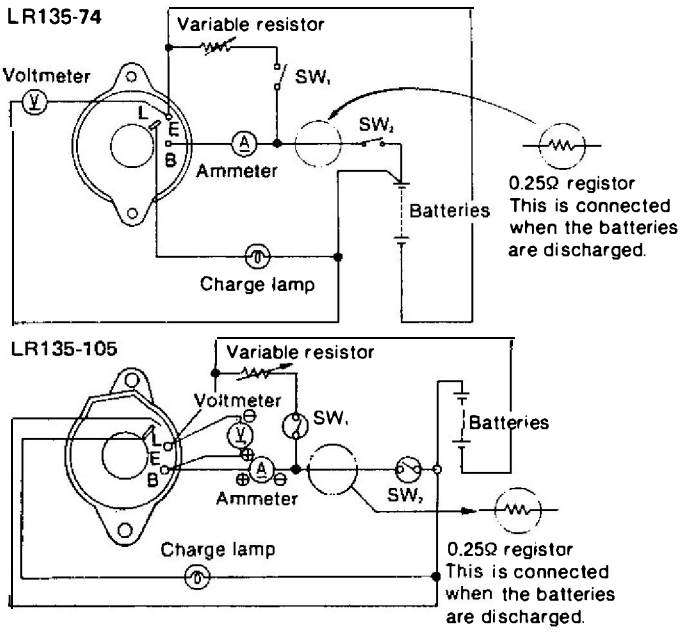
4-11 Alternator performance test

4-11.1 Test equipment

Test equipment	Quantity	Specifications
Battery	1	12V
DC voltmeter	1	0 ~ 30V Range 0.5
DC ammeter	1	0 ~ 50A Range 1.0
Variable resistor	1	0 ~ 0.25Ω capacity: 1 kW
Switch	2	Switch capacity: 40A
Tachometer	1	
0.25Ω resistor	1	25W

4-11.2 Performance test circuit

When the circuit is connected the charge lamp will light.



4-11.3 Performance test

(1) Speed measurement at 13.5V.
1) Run the alternator up to a speed of approx. 1500 rpm with SW_1 and SW_2 open.
Then reduce speed gradually and measure the rpm when the voltage reaches 13.5V.
2) This value is called the "rpm at 13V" and is acceptable if 1000 rpm or below.
(The alternator speed at which the lamp goes on or off is 1500 rpm, or 1000 rpm or below, respectively, and there are different conditions for each of the two cases.)

(2) Voltage measurement. Acceptable within the range of 14.3 ±1.3V and when the generator rpm is 5000, SW, is open and SW_2 is closed, the temperature is 20°C and using two batteries.
(Confirm that the ammeter is 5A or below. If over 5A, connect the 0.25Ω resistor.)

(3) Measurement of output current
1) In the circuit shown in figure, set the variable resistor at the minimum value, close SW_2 and SW_1, and run the alternator.
2) While keeping the voltage at 135V by adjusting the variable resistor, increase the alternator speed, and measure the current at 2500 rpm and 5000 rpm.

Acceptable current values	27.5A at 2500 rpm	
	35A at 5000 rpm	LR135-74
	32A at 5000 rpm	LR135-105

(4) Remarks on performance test
a) For the test leads, use cable with a cross-sectional area of 8mm² or more and with a length not exceeding 2.5m between the alternator B terminal and the positive terminal of the battery, and between the S terminal and the negative terminal of the battery.
b) Switches with low contact resistance are to be used in the circuit.

4-12 Standards of adjustment

	LR135-74	LR135-105
Standard height of brush	16mm (0.6299in.)	
Limit of reduced height	9mm (0.3543in.)	
Strength of brush spring	255 ~ 345g (0.56 ~ 0.76 lb)	
Standard dimension of shaft at front end	15mm (0.5906in.)	
Part No. of ball bearing	6302 BM	
Standard dimension of shaft at rear end	12mm (0.4724in.)	
Part No. of ball bearing	6201 SD	
Resistance of rotor coil (at 20°C)	3.3Ω	3.1Ω
Resistance of stator coil single phase (at 20°C)	0.15Ω	1.6Ω
Standard O.D. of slip ring	31.6mm (1.244in.)	
Limit of reduced size (diameter)	1mm (0.0394in.)	
Limit of swing correction	0.3mm (0.0118in.)	
Accuracy of swing correction	0.05mm (0.0070in.)	

4-13 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

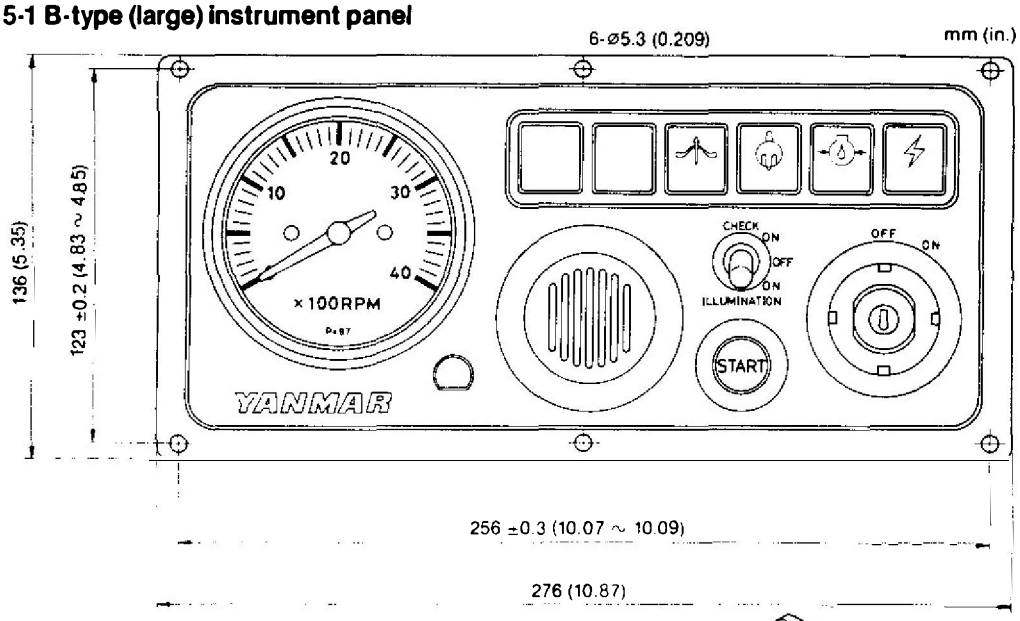
Problem	Cause	Corrective action
Battery	Electrolyte low or unsuitable	Add distilled water Adjust specific weight Replace
Transistor regulator	Regulator transistor shorted	Replace regulator

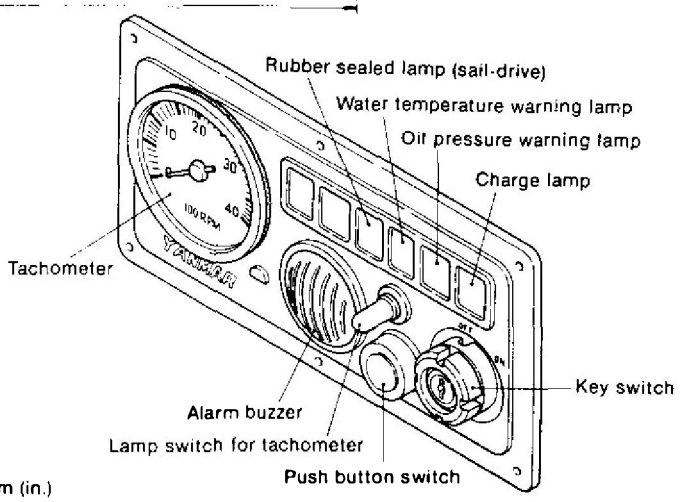
(4) Current charge unstable

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

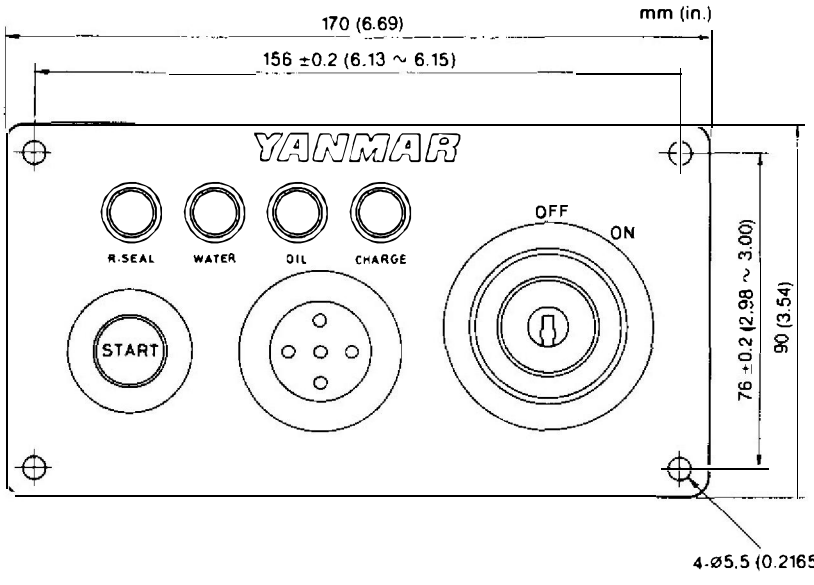
5. Instrument Panel

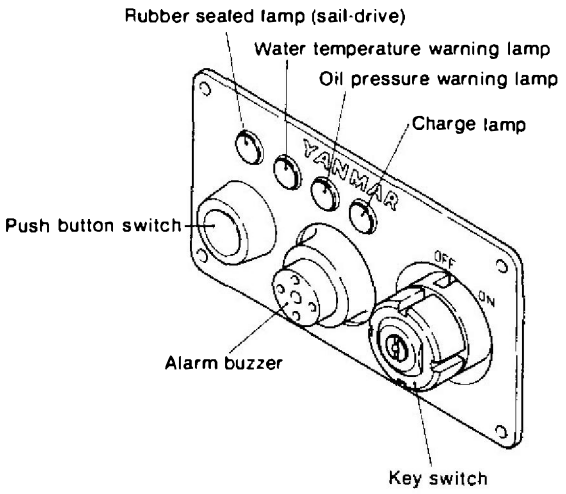
5-1 B-type (large) instrument panel





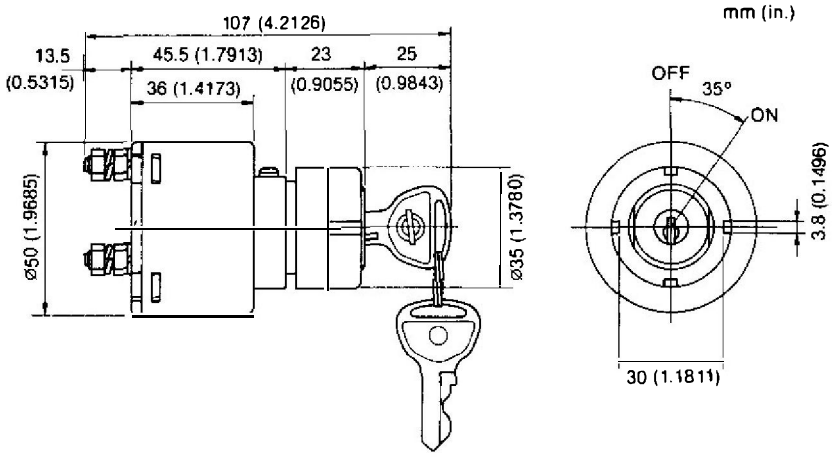
5-2 A-type (small) instrument panel





5-3 Key switch

(1) Construction and dimensions of key switch.

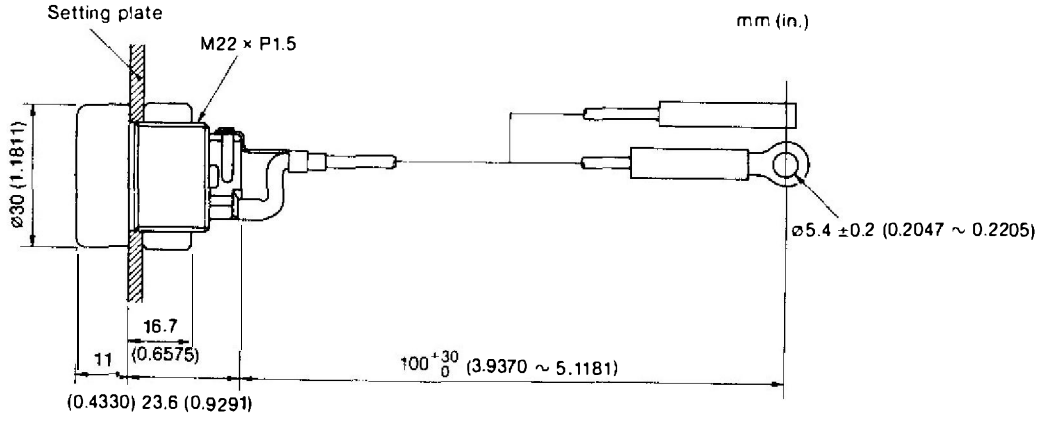


(2) Specifications of key switch

	1GM, 2GM, 3GM(D), 3HM
Rated voltage	DC 12V
Rated current	25A
Range of operating voltage	DC 10 ~ 30V
Part No.	124070-91250

5-4 Push button switch

(1) Construction and dimensions of key switch.



(2) Specifications of push button switch

	1GM, 2GM, 3GM(D), 3HM
Rated voltage	DC 12V
Rated load	20A (within 30 seconds)
Part No.	124070-91300

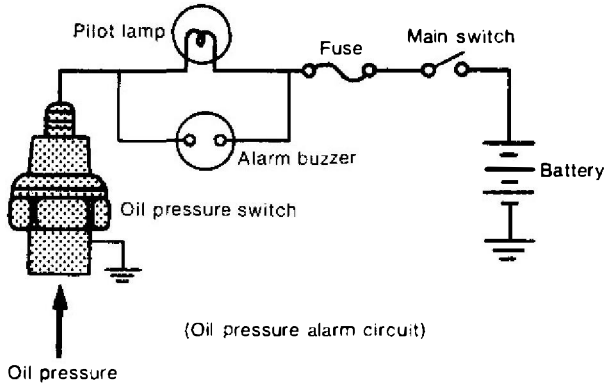
5-5 Warning devices

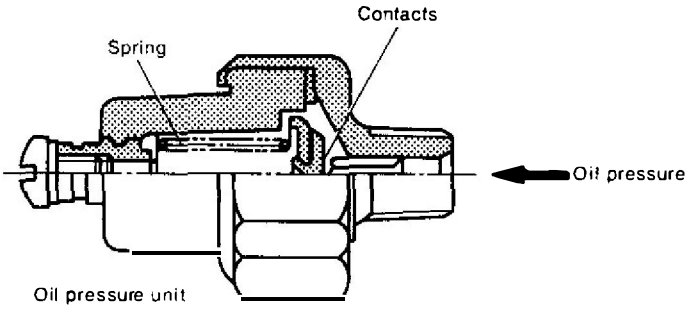
5-5.1 Oil pressure alarm

If the engine oil pressure is below 0.2 ±0.1 kg/cm² (1.422 ~ 4.266 lb/in²), 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

	1GM, 2GM, 3GM(D), 3HM
Part No.	124060-39451
Rated voltage	12V
Operating pressure	0.2 ±0.1 kg/cm² (1.422 ~ 4.266 lb/in.²)
Lamp capacity	5W



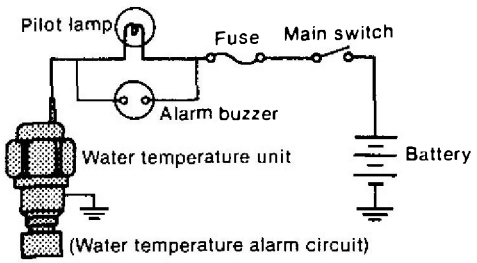


Inspection

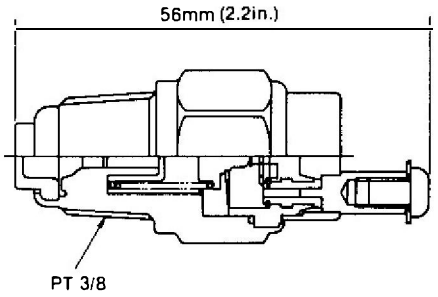
Problem	Inspection item	Inspection method	Corrective action
Lamp not illuminated when main switch set to ON	1. Oil pressure lamp blown out	(1) Visual inspection (2) Lamp not illuminated even when main switch set to ON position and terminals of oil pressure switch grounded	Replace lamp
	2. Operation of oil pressure switch	Lamp illuminated 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

5-5.2 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	Response time	Indication color	Parts code
ON	OFF				
60 ±2°C	53°C or more	DC 12V 1A	Within 60 sec.	Yellow	127610-91340

Pilot lamp: 12V, 3.4W
Alarm buzzer: 12V, W

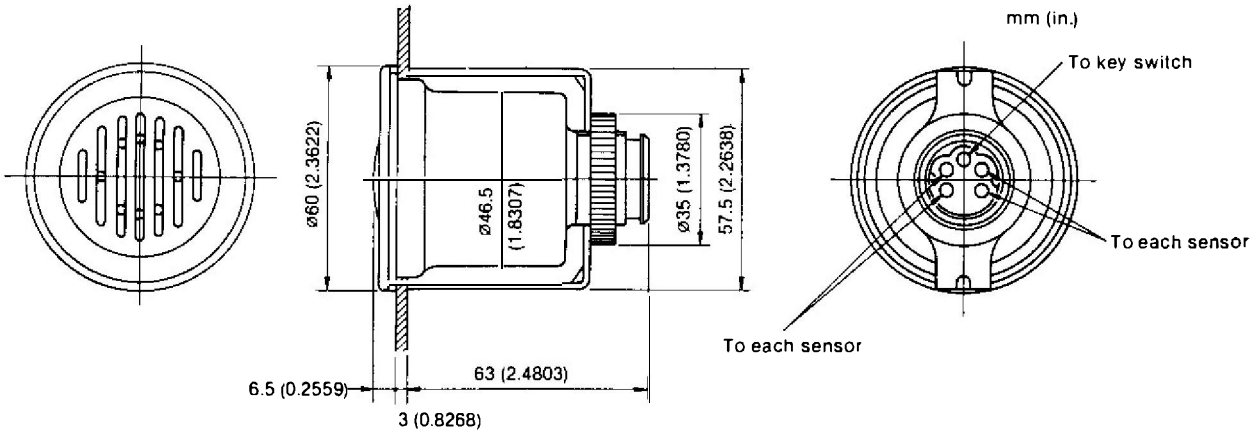
The parts of the alarm circuit which must be checked are the open pilot bulb, fuse, and wiring. To check, disconnect the wiring at the water temperature unit side and ground the cord—the pilot lamp is normal if the pilot lamp illuminates. Moreover, be sure the check the color of the code after replacing.

5-6 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.

5-6.1 Buzzer for B-type instrument boad

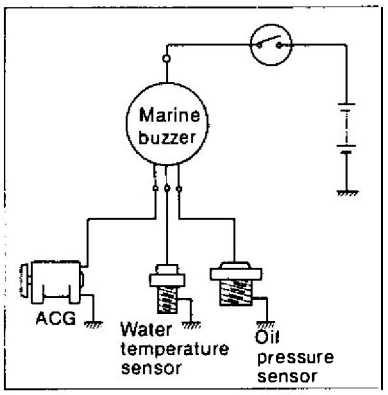
(1) Construction



(2) Specifications

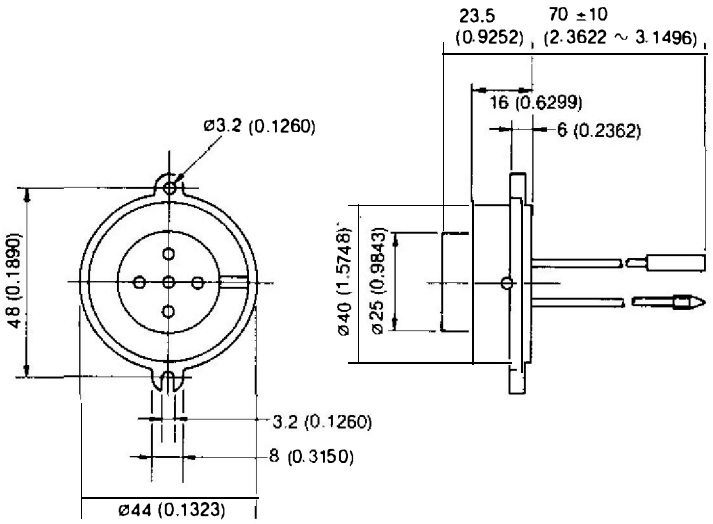
Model	WI1-05
Voltage	12V
Current consumption	100mA or below [at 12V, 15 ~ 30°C (59 ~ 86°F)]
Range of operating voltage	10 ~ 15V
Sound output	75dB (A) [at 1m, 12V, 15 ~ 30°C (59 ~ 86°F)]
Frequency	3 ±0.5kHz [at 12V, 15 ~ 30°C (59 ~ 86°F)]
Weight	0.2kg (0.44 lb)
Part No.	104271-91351

(3) Wiring diagram



5-6.2 Buzzer for A-type instrument panel

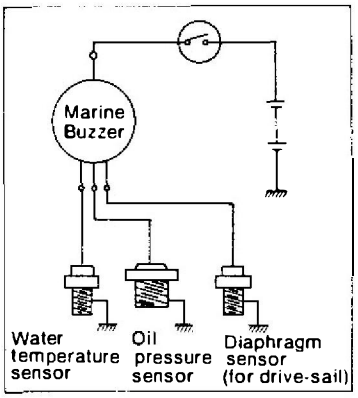
(1) Construction



(2) Specifications

Operating voltage	DC 10 ~ 15V
Rated voltage	DC 12V
Current	50 mA or below
Lead wire	49N (5kgf) or more, 15 seconds
Voltage for starting action	1V or more
Basic frequency of sound	$3.0^{+1.10}_{-0.5}$ kHz
Sound output	θ = 0 ~ 45° 70dB or below
Current consumption	50 mA or below

(3) Wiring diagram



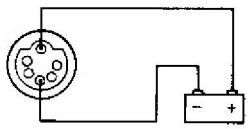
5-6.3

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

* The condition of the lamp can be checked by using the check switch.

5-7

Fault	Diagnosis		Remedy
Warning lamp does not light.	Check if there is a loose or open-circuit connection at the coupling connector between the instrument panel and the relay harness.	Yes	Make good the connection.
	↓ No		
	Take out the lamp from P box case and check if it is unserviceable.	Yes	Replace the lamp. (G-1 amp 12V 3.4W)
	↓ No		
	It must be an open-circuit connection in the harness.		Replace the harness.
Buzzer does not sound.	Check if there is a loose or open-circuit connection at the coupling connector between the instrument panel and the relay harness.	Yes	Make good the connection.
	↓ No		
	Check if the buzzer is serviceable. (Fig.)  DC 12V		Replace the buzzer.
	↓ Yes		
	It must be an open-circuit connection in the harness.		Replace the harness.
Other switches and items do not operate.	Check if there is a loose or open-circuit connection at the coupling connector between the instrument panel and the relay harness.		Make good the connection.
	↓ No		
	Check the continuity of the individual switch when the switch is closed by the tester.		Replace the defective item.
	↓ OK		
	It must be an open-circuit connection in the harness.		Replace the harness.

6. Tachometer

6-1 Construction of tachometer

The tachometer indicates the number of revolutions per minute by means of an electrical input signal which is generated as a pulse signal from the magnetic pickup sender (MPU sender).
The function of the sender is to convert the rotary motion into an electrical signal by means of a counting action of the number of teeth of the ring gear fitted to the flywheel housing.

Tachometer

Ring gear

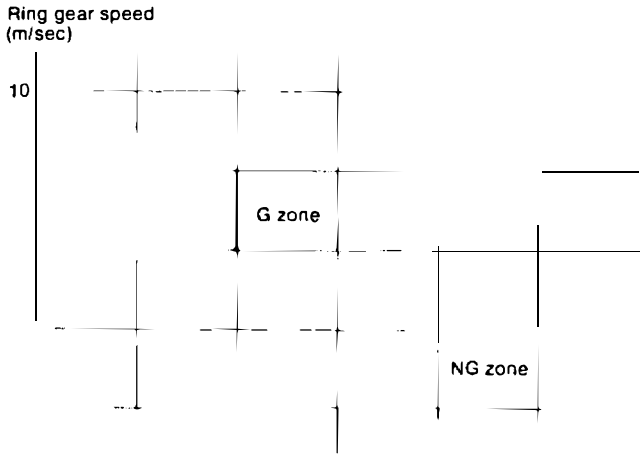
Sender unit

6-2 Specifications and dimensions of tachometer

(1) Specifications

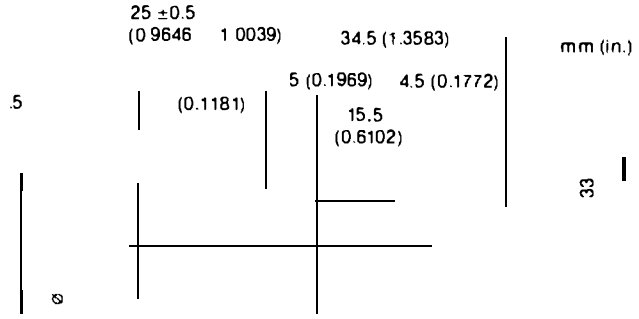
		1GM, 2GM, 3GM(D)	3HM
Rated voltage		DC 12V	
Range of operating voltage		10 ~ 15V	
Illumination		3.4W/12V	
Ring gear	No. of teeth	97	114
	Module	2.54	2.54
Part No. of tachometer		128170-91100	128870-91100
Part No. of sender unit		128170-91160	128170-91160

(2) Sensitivity limit of sender unit



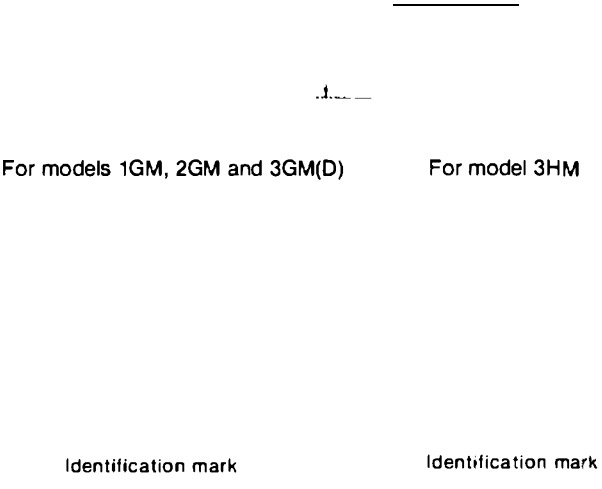
Sender unit and ring gear clearance C (mm)

(3) Dimensions of sender unit



M18 × P1.5

(4) Dimensions and shape of tachometer



For models 1GM, 2GM and 3GM(D)

Identification mark

For model 3HM

Identification mark