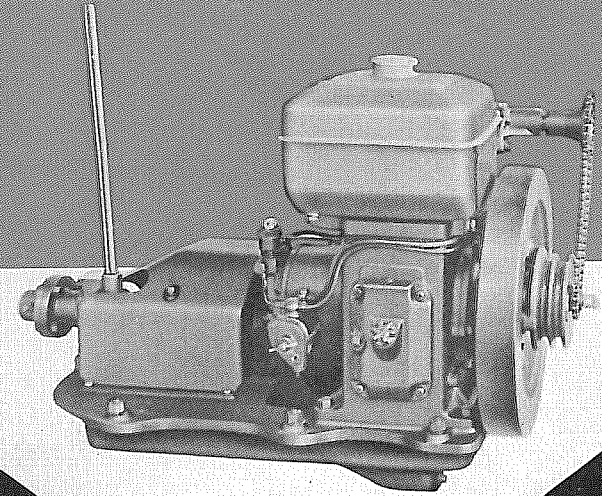


YANMAR

DIESEL ENGINES



**INSTRUCTION
BOOK**

MODEL

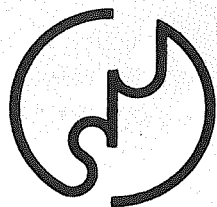
NTS85



YANMAR DIESEL ENGINE CO. LTD.

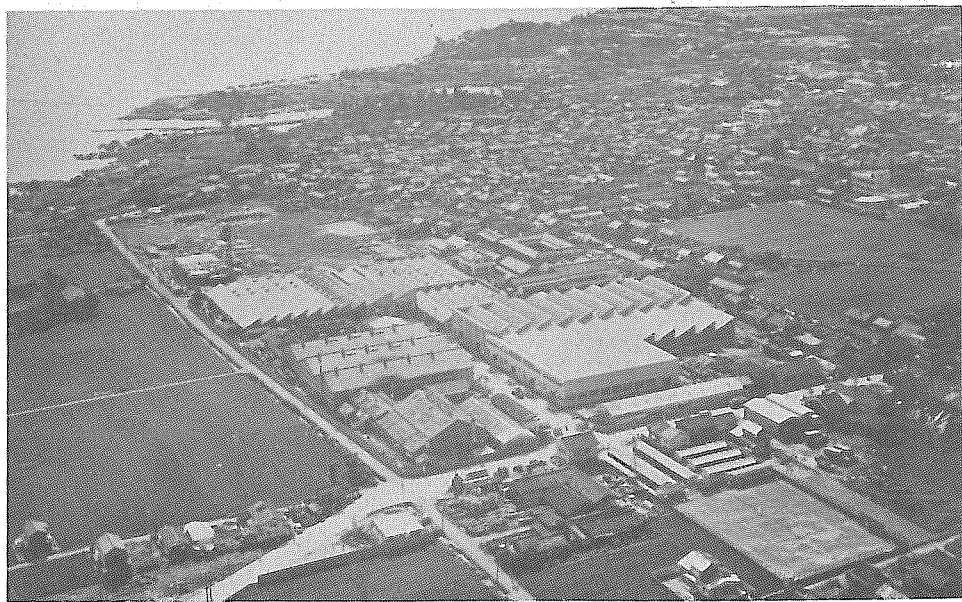
HEAD OFFICE
62, Chayamachi, Kita-ku
OSAKA, JAPAN
CABLE: YANMAR OSAKA

TOKYO OFFICE
1, 4-chome, Yaesu, Chuo-ku
TOKYO, JAPAN
CABLE: YANMAR TOKYO



A Diesel does a better job for a longer time at a lower cost

*Capitalized at ¥ 1,200,000,000
YANMAR's modern factories turn
out thousands of Diesel engines
monthly, ranging from 2~10 HP
for farming, 2~1000HP for prime
movers in general and 3~800 HP
for marine use.*



NAGAHAMA FACTORY Specialized in manufacturing small size diesel engines such as MODELS A and NT(S) series.

Thank You Very Much For Your
Patronage To Model NTS-85

MODEL NTS-85 is one of the smallest horizontal marine diesel engine.

We would like to show you here in brief how to handle, how to take care of, how to repair, and how to stock your MODEL NTS-85.



SPECIFICATIONS

MODEL NTS-85 is a four stroke, horizontal, water-cooled diesel engine.

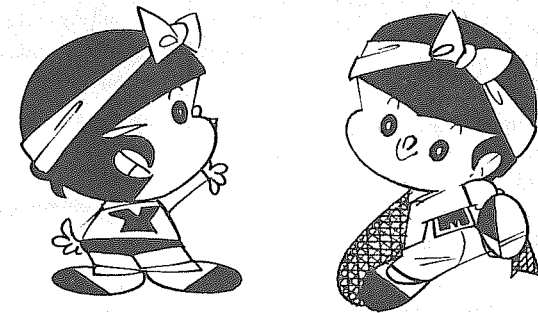
MODEL		NTS-85
No. of Cylinder		1
B.H.P.		4
R.P.M.	Crankshaft	1500
	Propeller	750
Lowest R.P.M.	Crankshaft	500
	Propeller	250
Bore × Stroke (mm)		85 × 100
Displacement (ltr)		0,567
Method of Starting		Hand
Method of Cooling		Water
Clutch Type		Expanding Type
Net Wt. in kg.		180

CONTENTS

Features	1
How to install engine	2
1. Check of accessories	2
2. Choice of engine wooden bed	3
3. Installation of engine	3
4. Propeller	4
5. Equipments	4
6. After launching	6
Cares to be taken in handling a brand new engine	7
Musts prior to operation	8
1. Lubrication	8
2. Supply of fuel oil	10
3. Injection tests	11
4. Stopping place of a clutch handle	12
5. Check from outside	13
Starting	14
1. How to start	14
2. When an engine starts	15
During operation	16
Stopping	18
Adjustment in disassembling and reassembling	19
1. Cautions for disassembling work	19
2. Cautions for reassembling work	20
Periodical check	21
Disassembling work of fuel injection valve	24
Disassembling work of fuel injection pump	25
Adjustment of speed regulation and operation equipment	27
Inspection of injection timing of fuel	29
Replacement of cylinder liner	30
Minute disassembling of the piston	31
Disassembling of clutch	32
Adjustment of Clutch	34

FEATURES

- (1) Most suitable for small boats.
- (2) Simplified clutch easy to operate.
- (3) Sensitive and accurate governor enables smooth running at a low speed as well as at a high speed.
- (4) Easy to start and simple to handle.
- (5) Well stands against sea breeze and sea water assures engine's function for a long time.
- (6) Extremely economical.
- (7) Remarkably durable and reliable.



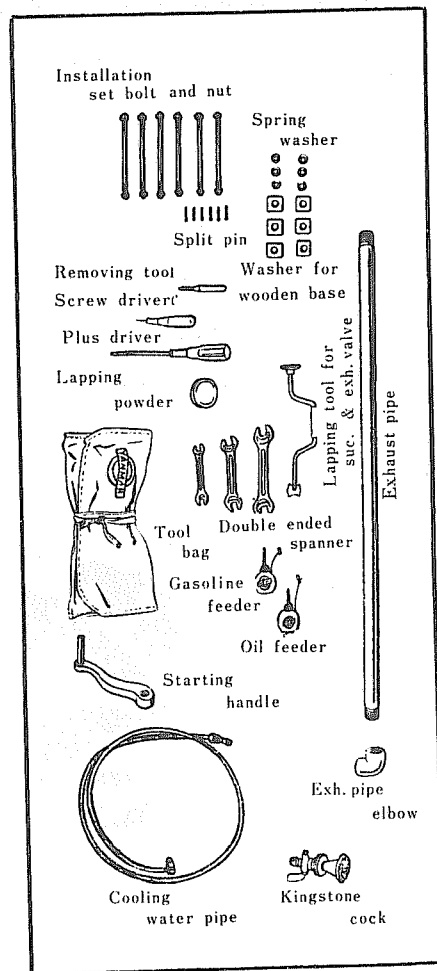
HOW TO INSTALL ENGINE

1. Check of accessories

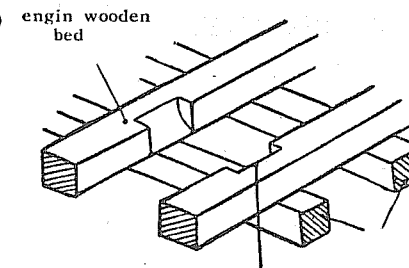
When an engine reaches you, check accessories. The following accessories are attached to each engine.

- (1) A set of bolts and nuts for engine installation set bolt (3/8) 6 pcs.
nut 6 pcs. (with split pins)
nut for do. 6 pcs.
spring washer 6 pcs.
washer for wooden base 6 pcs.
- (2) Tools for disassembling
 - a) double ended spanner, 10×12, 14×17, 19×21, 23×26, (each one piece)
 - b) screw driver 1 pc
 - c) plus driver 1 pc
 - d) oil feeder
 - e) gasoline feeder
 - f) removing tool for needle valve case and fuel valve strainer
 - g) lapping tool for suc. & exh. valve
 - h) lapping powder
 - i) tool bag
 - j) starting handle
- (3) cooling water pipe (0.394 inch dia., 3 feet long)
- (4) Kingstone cock
- (5) exhaust pipe (1 1/4 inch dia., 2 feet long)

Remarks: Tools for disassembling put in a tool bag are packed in a carton box together with set bolts and nuts, kingstone cock, and exhaust pipe elbow.



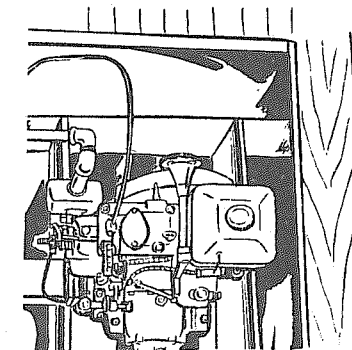
2. CHOICE OF ENGINE WOODEN BED



- (1) Make use of hard and well seasoned timber for the engine wooden bed. Unsatisfactory wooden bed causes excessive vibration, hampering operation at a high speed.
- (2) Use a timber of larger than 9 inches square and gouge it for flywheel.
- (3) An angle of inclination differs according to the shape of a boat and the place where the engine is installed, but it should be less than 8 degrees.
- (4) See to it that the engine bed covers as many ribs as possible, and is completely fixed to the hull. Also see that set bolts can be fastened tightly and that a spanner can be applied to nuts under the engine bed.
- (5) Adjust the surface of the engine bed very well so that a propeller shaft can be coupled exactly straight from the engine to the propeller.

3. Installation of Engine

- (1) Set the engine on the wooden bed after adjusting the wooden bed face.
- (2) Fasten set bolts even and tight. Don't forcibly fasten bolts placed improperly.
- (3) Before the propeller shaft (or an intermediate shaft, if any) is coupled to the engine, make sure if both centers of crankshaft and propeller shaft coincide.
Plane the bed when the engine's center is high, while inserting a plate between the engine and the bed when low.

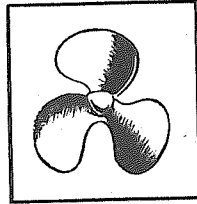


- (4) Make sure again if the propeller shaft runs exactly straight after a boat is set afloat.

4. PROPELLER

Choose a suitable propeller according to the shape and size of a boat. The standard propeller for Model NTS85 is of 15½ inches dia. with a pitch of 13 inches.

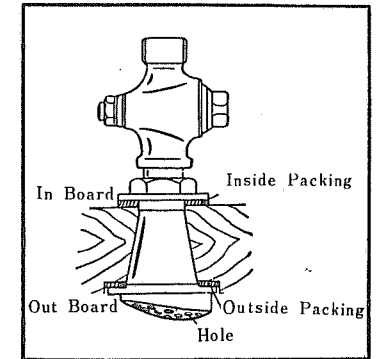
An excessively large propeller reduces the rotation of engine, not only making it impossible to get your required speed but shortening the engine life. Be careful not to place an overload on the engine. When color of exhaust air gets dark, an engine is overloaded.



5. Equipments

1. Cooling System

- (1) When fixing a kingstone cock, use a canvas packing in board, while canvas or rubber packing out board.
- (2) As one of the standard accessories, a 6-foot long cooling water pipe of 0.394 inch outside dia. is attached. Cut it into two pieces according to a distance from the kingstone cock to the cooling water pump inlet and a distance from the cooling water pump outlet to the outside of the boat.



2. Exhaust Pipe

- (1) Fix an exhaust pipe to the outlet of a cast iron box-shaped silencer which is provided on the cylinder head.
- (2) If the exhaust pipe must be bent, see to it that the radius is longer than 3½". Make use of an elbow attached.
- (3) Solder a pipe fitting to the kingstone cock side of a pipe cut. (kingstone side) Clean up inside the pipes before they are fixed.

MUSTS PRIOR TO OPERATION

1. Lubrication

a) Kinds of lubricating oil

Use lube oil of as high quality as possible. Use of lube oil with an antioxidant or with a purifier is most recommendable.

Lub. oil, DG grade of API, S.A.E. #30 is recommended to use. (S.A.E. #20 for winter)

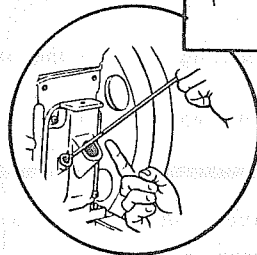
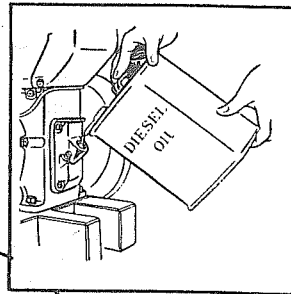
b) Lub. oil supply into crank case

Take off oil intake plug and supply lube oil. Check lube oil quantity by a lube oil level gauge and be sure that the level of lub. oil comes up to the top notch of the gauge.

Lub. oil quantity put in the crank case is:

When at the top notch
..... 2.1 liters

When at the bottom notch
..... 0.56 liters



c) Lubricate the oil cup of cylinder side cover and the bushing for pump driving.

d) Feed lube oil to two oil holes of a starting bearing stand at the upper part of the engine.

e) Feed lube oil to 4 oil holes of the cylinder bonnet.

f) Lubricating of chain gear and thrust shaft
1) Thrust grease into the grease cup provided at the end (flywheel side) of the crank shaft.

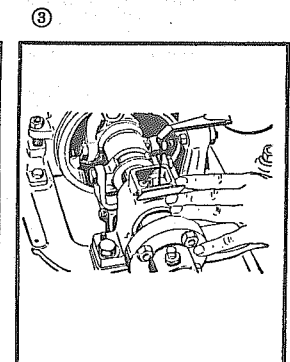
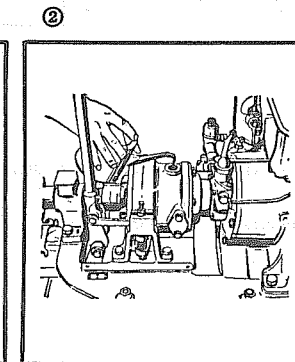
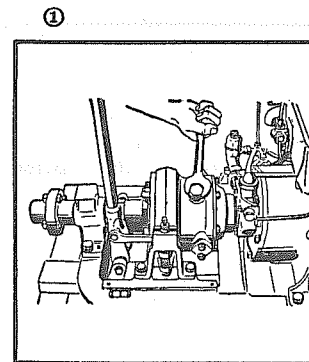
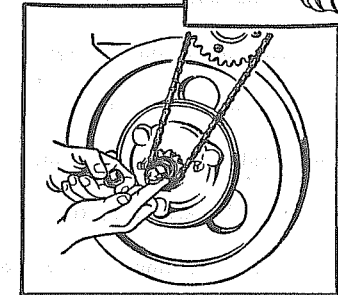
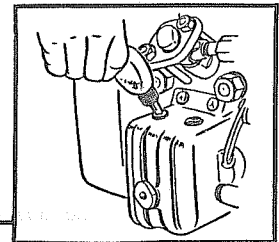
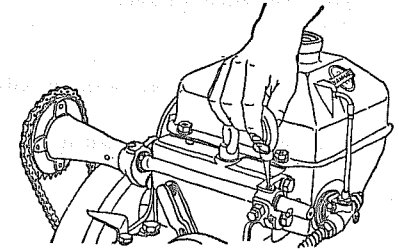
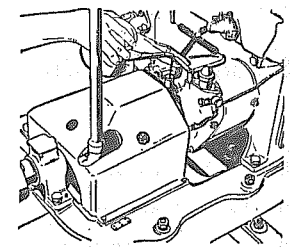
2) Thrust grease into the grease cup for the thrust shaft near the clutch handle.

g) Lubrication of clutch and reversing gear

1) Take off the cover of reversing gear housing and put in about 300 cc of lube oil.

2) Put lube oil into oil cup of thrust bearing mounting.

3) Lubricate once a while the roller of clutch shifter.



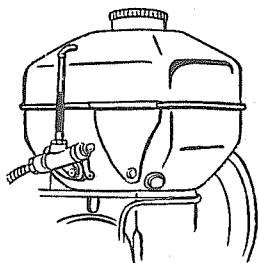
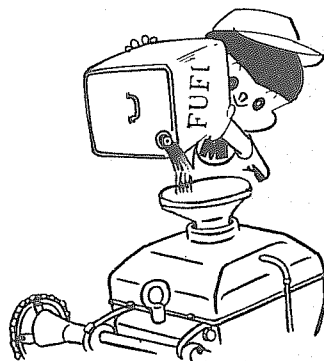
2. Supply of Fuel Oil

- (1) Diesel Oil, such as ASTM No. 2 is suitable for this engine.

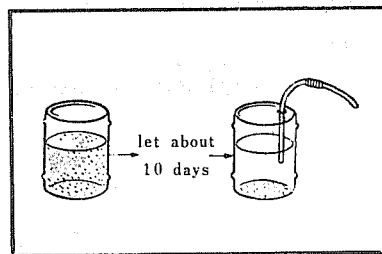
For further informations, please ask for your YANMAR dealers.

- (2) Fuel tank is fitted with an oil gauge.

Capacity of the fuel tank is abt. 11 litres



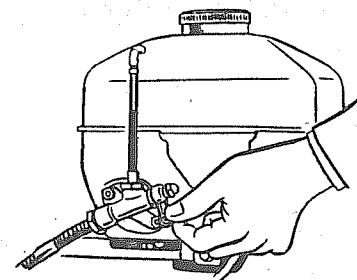
- (3) Water and dusts, if contained in fuel oil, prevent the engine from operating in good condition. Keep an oil drum stand still for a long while so that water and dusts in oil are deposited. Filter the supernatant oil by means of well meshed cotton cloth or glossy silk. Settling at a bottom damage the engine. Don't shake the oil drum.



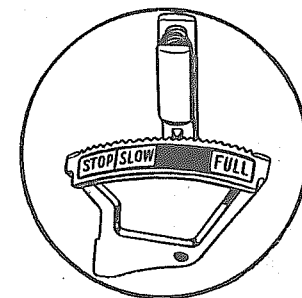
- (4) Drain out from time to time water and dusts deposited on the bottom of the fuel tank by means of a drain cock.

3. Injection Tests

- (1) Open the fuel oil cock to let fuel oil come into the fuel oil pump. Air in fuel oil pipe will automatically come out through fuel oil gauge.

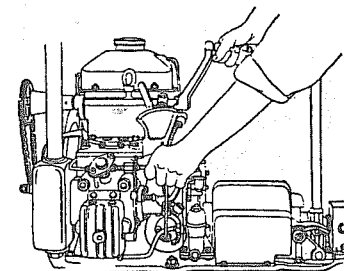


- (2) Set the regulator lever at around the center of the fan-shaped plate.

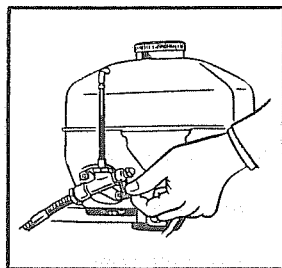


- (3) Keeping the decompression lever lifted up, wind the starting handle 5-6 times. It is all right if fuel injection sounds " brr brr brr ".

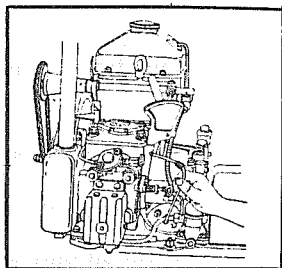
- (4) In case the injection sound of brr brr cannot be heard, there is air inside the fuel injection system including the fuel oil pump and the high pressure fuel pipe, and it must be taken away as illustrated in the next page.



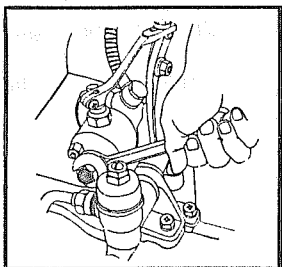
PRIMING OF FUEL INJECTION SYSTEM



(1) Lower down the fuel cock.

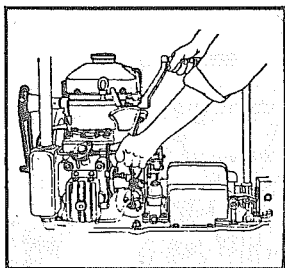


(2) Loosen the nipples at both ends of the high pressure pipe, and then put the speed regulator lever at around the center of the plate.

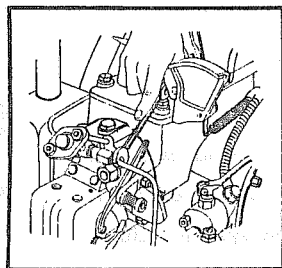


(3) Loosen the delivery valve holder. (Turn around the holder twice.) After fuel oil without bubbles comes out, fasten the holder tightly.

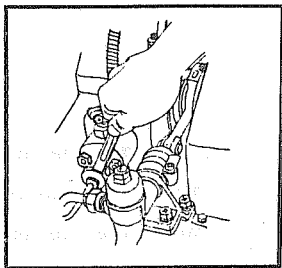
Fuel injection system includes a fuel tank, a fuel pump, fuel pipes and a fuel valve. If there is air inside the injection system, proper injection cannot be obtained. In such a case, make priming as illustrated.



(4) Set the high pressure pipe and fasten tightly the nipple of the fuel pump side.



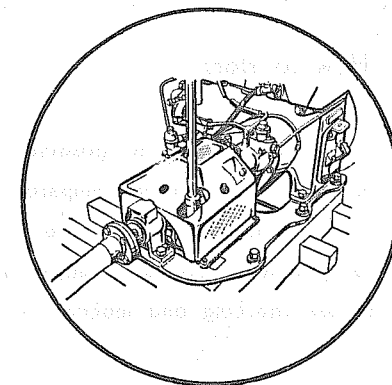
(5) Turn the flywheel around 20-30 times, and bubbles will come out of the air hole of the fuel strainer connected with the fuel valve. When fuel oil without bubbles comes out, tighten the nipple of fuel valve side.



(6) Turn the flywheel again. When fuel injection sounds brr... brr... brr..., there is no air inside the fuel injection system.

4. Stopping Place of Clutch Handle

Set the clutch handle at "OFF".



5. Check from outside

Check if there is any nut got off or loosened. Keeping the decompression lever lifted, turn around the starting handle and see if no abnormal sound is heard. Make this practice without fail, which smooths lubrication to every metal part.

STARTING

1. How to start

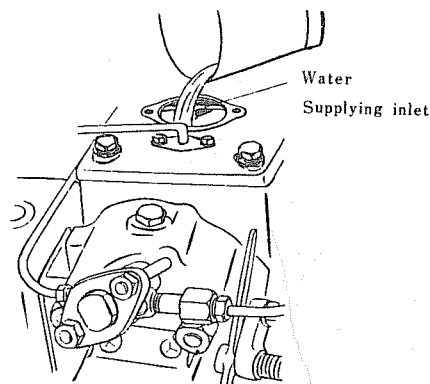
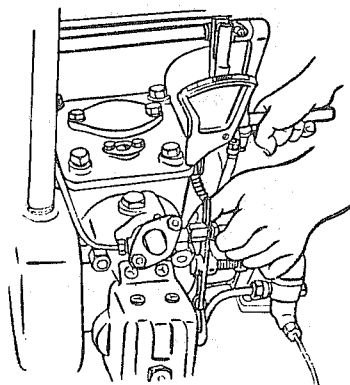
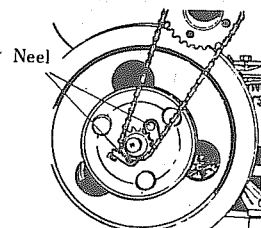
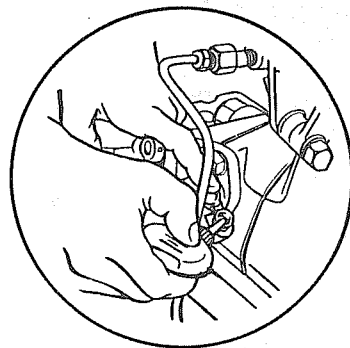
(1) Put few drops of gasoline into the gasoline cup. When temperature is high or the engine is warm, there is no need for gasoline. Excessive supply of gasoline causes knocking and leakage of pressure.

(2) Set the starting handle to the starting shaft. See that crow provided on a flywheel and that of a small chain gear are geared together. Gearing can be easily made by adjusting the flywheel manually.

(3) Pull up the decompression lever and turn around the starting handle 5-6 times.

(4) When the flywheel gets momentum, pull down the decompression lever, while continuing forcible turn of the flywheel for a moment. Then the engine starts.

(5) When it is hard to start at a low temperature, pour boiled water into a water inlet on the cylinder, thus warming the cylinder to make starting easier. (In this case kingstone cock is closed.)



2. When the engine starts.

(1) When the flywheel gets momentum, the gearing of the flywheel starting gear comes off. (Put off the starting handle and return it to its former place.) If the chain gear keeps turning around together, stop turning of the starting shaft by screwing in the bolt for a clutch side bearing stand.

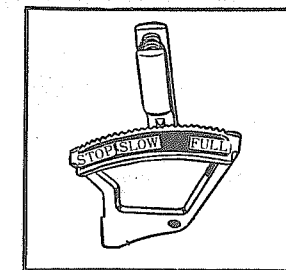
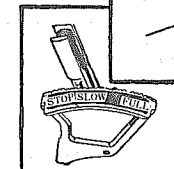
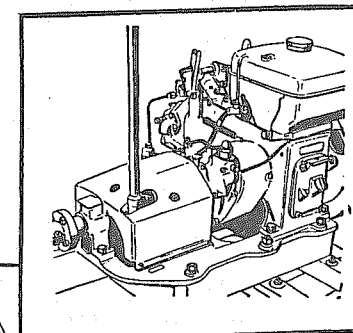
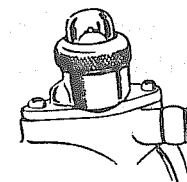
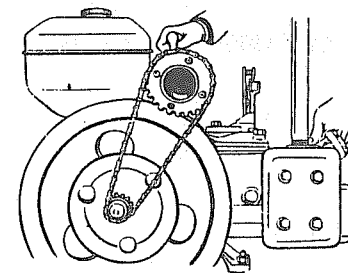
(2) Watch the oiler (sight glass) and see if lube oil comes up.

(3) Check if cooling water comes out of the water outlet outboard.

(4) Keep the engine idling for about 5 minutes with the clutch handle at neutral. This is for lubricating every metal part enough and is essential especially in cold season. Never set the clutch handle at ON immediately after starting, as otherwise you will have troubles including over-heat of moving parts and breakage.

When the engine is started for the first time after launch, idling must be made for 15-20 minutes. Then speed up gradually, beginning with slow speed (the yellow part of the fan-shaped plate).

(5) When nothing abnormal is observed, set the clutch handle at ON and increase the speed gradually until the regulator lever comes to the green part of the plate.



DURING OPERATION

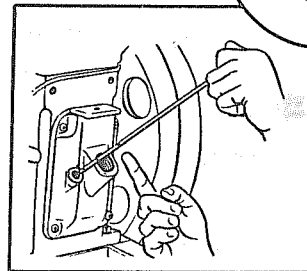
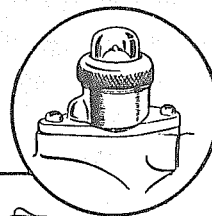
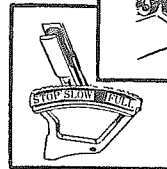
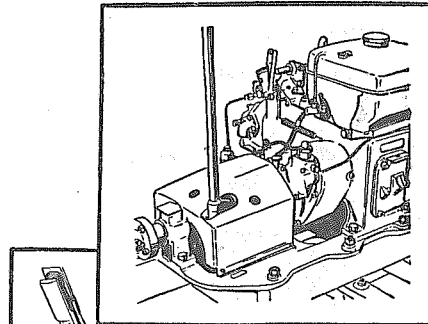
You are strongly advised not to make sudden changing of clutch from full speed "ahead" movement to "astern" movement except emergency case.

(1) The operation of clutch handle must always be made with the regulator handle set at low speed (yellow part of a plate). "Ahead" movement is done by turning clutch handle forward and "astern" by backward. The clutch and gear will be damaged if operated with the regulator handle set at highspeed.

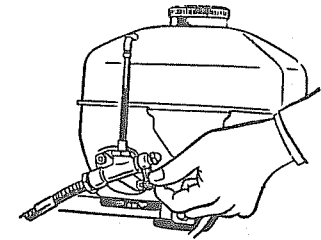
(2) Check if lube oil is coming up in the oiler (sight glass). Lube oil after long service is hard to come up. When lube oil does not come up well, supply fresh lube oil. But it is all right that oiler rotor turns slowly when engine runs at low speed. When bubbles are observed, it means insufficient quantity of oil in the crank case, or existence of air in the oil pump. In this case, check oil quantity and supply lube oil.

(3) Temperature outside the thrust bearing case and cylinder side cover is about 40-50°C (104-122°F) when the engine is operated at full speed. If they are too hot, it is attributed to the lack of lube oil or the arcuation of a propeller shaft.

(4) Check at times if water is coming out board from the water outlet, namely if the cooling water system operates well.

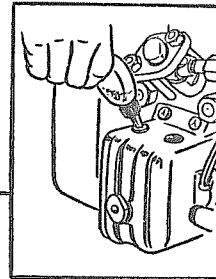


(5) Check the fuel oil gauge and supply fuel oil before the fuel tank becomes empty. A full tank of fuel oil is enough for about 8-10 hours operation.

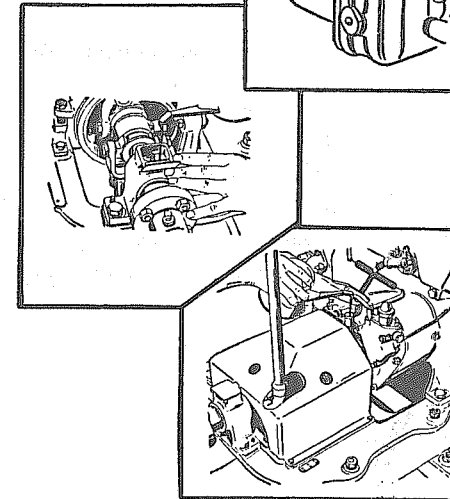


(6) Feed at times lube oil to the 4 oil holes on a cylinder bonnet (twice a day).

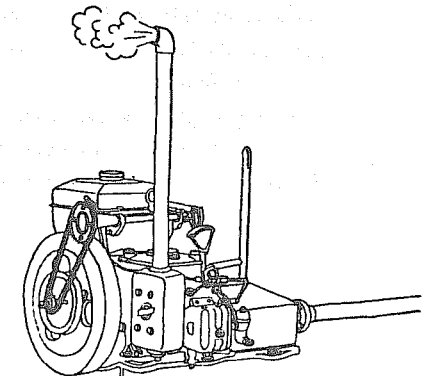
Lubricate the oil receiver of thrust bearing case and the oil cup of the water pump too.



(7) Watch if exhaust gas color is good. Whether or not fuel combustion is perfect can be judged by exhaust gas color. Don't keep running long when exhaust gas is sooty. "Always good exhaust gas color" should be a catchword for you and your engine.

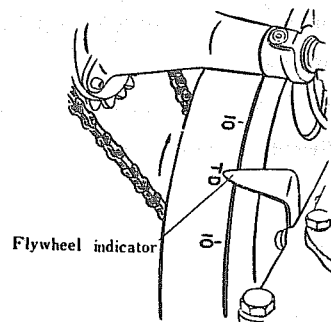
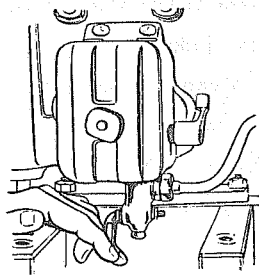
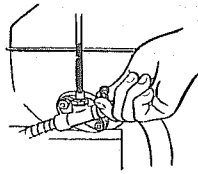
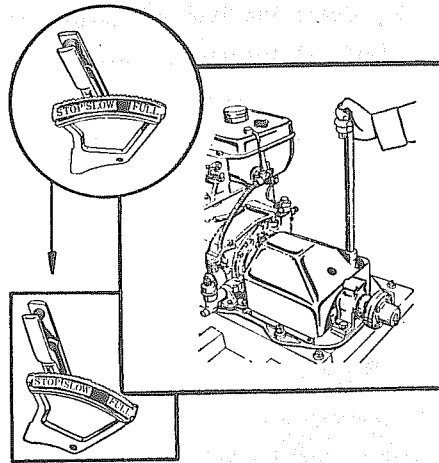


(8) It might happen that vibration becomes suddenly hard at a certain R.P.M. This is due to resonance of the engine and a boat at that R.P.M, and therefore don't operate the engine at such a R.P.M.



STOPPING

- (1) To slow down the speed of a boat running at a high speed, decrease the speed gradually.
- (2) To stop the engine, put the clutch handle at OFF and let the engine running idle for a while. Then set the regulator lever at STOP.
- (3) Stop feeding of fuel oil by pulling up the fuel cock handle.
- (4) In cold weather cooling water inside the engine will get frozen. Therefore, never fail to drain water out through the water drain cock beneath the cylinder. Cooling water inside, when got frozen, will sometimes break the engine.
- (5) Wipe off dusts and clean up the engine.
- (6) Keep both the suction and exhaust valves at closed position. To bring both valves to the closed position, turn the flywheel to such a position where pressure is felt and, at this point pull up the decompression lever and turn the flywheel again till the TD mark comes to the indicator as you see. If the valves are kept opened, damp might rust inside the engine.



1. Cautions for disassembling work :

Periodical check and maintenance are required to keep the engine in best condition. Proper maintenance is a key to secure the maximum durability of the engine.

Cautions for disassembling work are as follows :

- (1) Before disassembling the engine, please study constructions of each part and their performances to avoid any waste of time or damage of parts, touching those parts which are supposed not to be touched. Also keep good records of original status of engine before disassembling so as to reassemble the same perfectly.
- (2) Prepare work table or board to place the removed parts. Wash the parts cleanly and put them on the table by items according to the disassembling order.
- (3) Most adequate tool must be used when disassembling.
- (4) Bolts, nuts or adjusting liners should be kept together so that you can save time to look for possible missing parts.
- (5) Check these joint marks carefully when disassembling and if no mark is found at the place considered it is necessary, please place some appropriate joint marks by yourself.
- (6) Attention must be paid to any wear or crack on each part.

2. Cautions for reassembling work :

For reassembling of the engine, a reverse course of disassembling work order be taken, but do not forget necessary lubrication.

Cautions for reassembling are as follows :

- (1) Every part must be washed and cleaned. The center should be kept correctly by matching marks or knocks of the parts exactly.
- (2) When tightening bolt and nut, do not tighten one side only, but tighten both side evenly.
- (3) Do not adjust the clearance of bearing by tightening the bolt. It should be done by pulling out or putting in the liner, and the required clearance should be left.
- (4) Split pin and packing must be renewed, and DON'T reuse old ones.
- (5) Bent the end of split pin without fail after inserted the same.
- (6) Clean lubricating oil should be fed by hand to these slipping parts such as piston and bearing. Do not use rags.
- (7) After the engine is reassembled, check if there is any contacting or touching places by revolving the flywheel.
- (8) Before starting engine, check if the cooling water pipe, fuel oil pipe and lubricating oil pipe are not leaking.
- (9) These joint marks of the speed adjusting gear, adjustment of governor and fuel injector, adjustment of fuel injection timing and adjustment of valve clearance (valve setting) must be checked very carefully.

When you complete the reassembling work recheck all parts if nothing is wrong. Feed lubricating oil and fuel, and then make a trial run of the engine.

In case the cylinder liner or piston is replaced, at least 3 hours trial run is required for lapping purpose.

During the engine is operated, check if there is any irregularity and if find anything wrong, it must be repaired.

As to the method of operation, please refer to page 16 (Subject : During Operation)

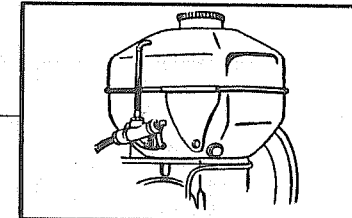
PERIODICAL CHECK :

Periodical check of the engine is absolutely necessary to keep it always in good condition.

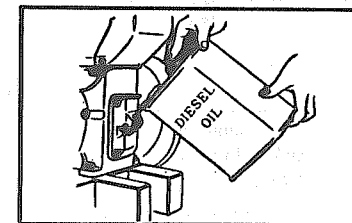
The periodical check will differ according to the using conditions, fuel to be supplied and quality of lubricating oil, and it is difficult to standardize.

The followings are for general cases :

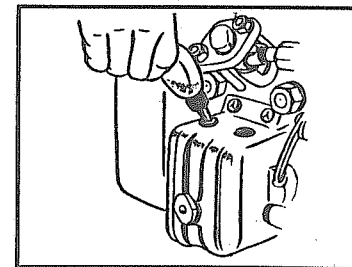
Daily check



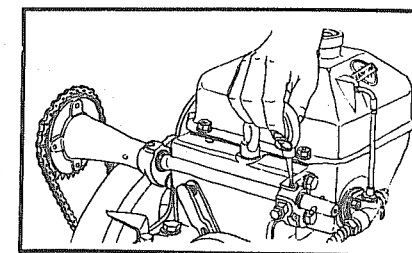
Check up fuel (supply.)



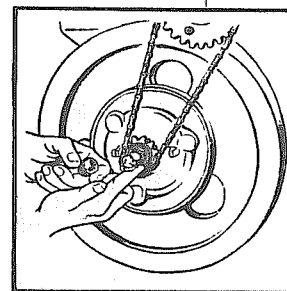
Check up lubricating oil (supply.)



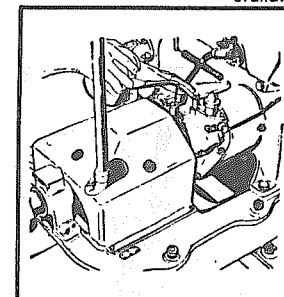
Feed grease to valve lever.



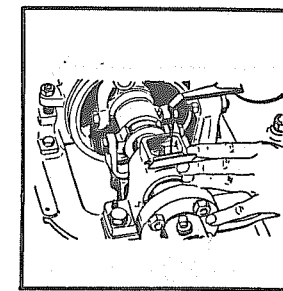
Oiling to the supporter for starting shaft stand.



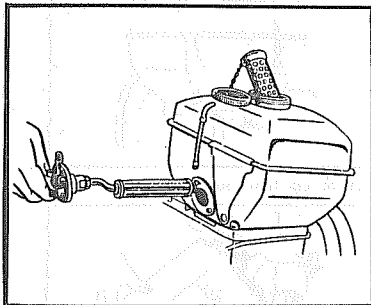
Supply grease to the grease cup of the free wheel of chain wheel.



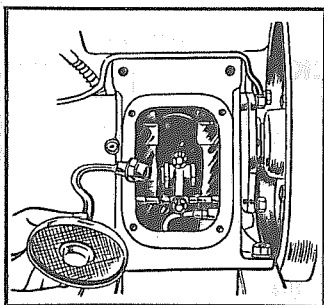
Feed oil to the bush for driving pump through the oil cup on the top.



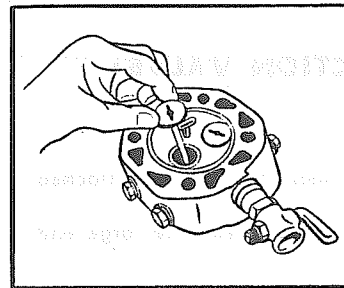
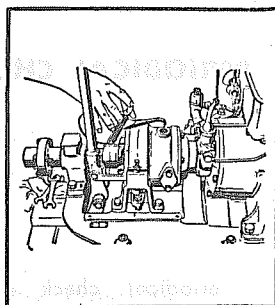
Feed oil to the oil-pit of thrust bearing mounting.



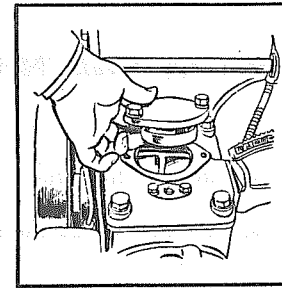
Wash and clean the strainer of fuel tank filter and fuel oil cock filter.



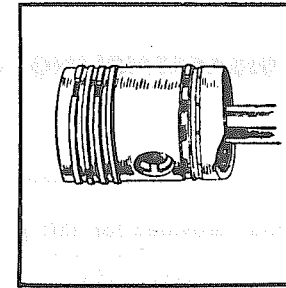
Drain old lubricating oil out of the crank case, clutch case and replace with fresh oil.



Take off cylinder head and clean up its surface and valve top scrubbing off carbon accumulated.



The zinc attached inside the cylinder head cover is to protect the portions affected by water from electrolytic etching. Check the protective zinc and replace it if necessary.



The top piston ring which is electroplated with chromium is to protect the liner from abrasion and to extend its longevity. Therefore you had better replace it with new one each 700 hours before electroplate gets worn. Also check if there is vertical scratches or gas leaks for the other rings.

Every 50 hours :

Every 500 hours :

Every 700 hours :

Every 250 hours :

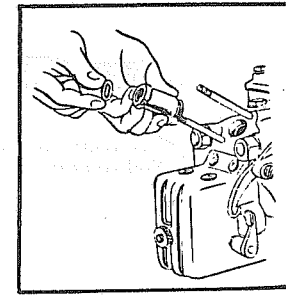
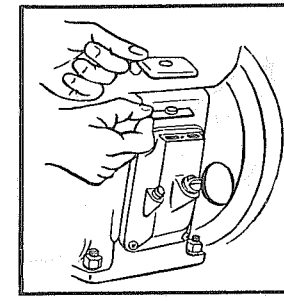
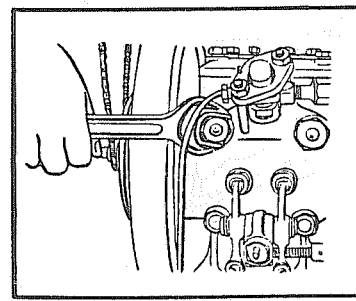
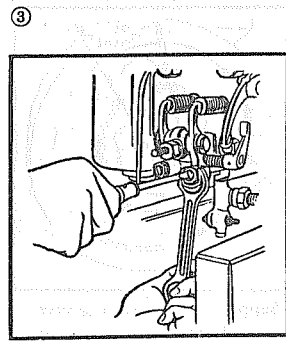
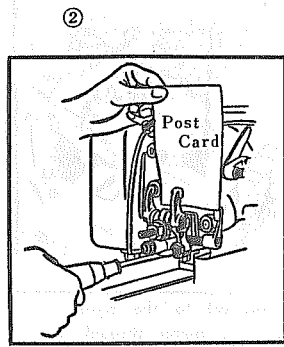
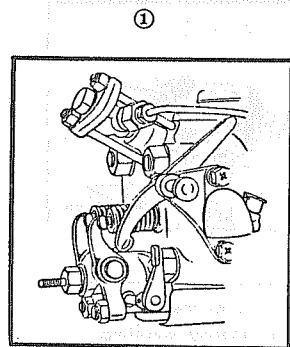
Check and adjust the clearance of suction & exhaust valves.

To adjust the clearance of valves, first take off the bonnet of valve lever chamber, and set the clearance between valve and valve lever to be 0.2-0.3 mm (about as thick as 2 post cards) under the condition that the both suction and exhaust valves are closed. Loosen the nut of setbolt and adjust the clearance revolving the adjusting screw for valve lever (Fig. 2). If the clearance is adjusted, tighten the adjusting screw with the nut (Fig. 3).

Nuts for cylinder cover bolts should be tightened thoroughly and evenly. Other important setbolts & nuts also be tightened thoroughly.

Wash cover and valve of air breather.

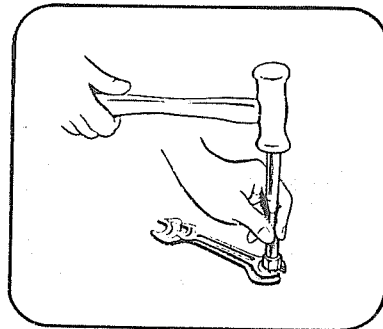
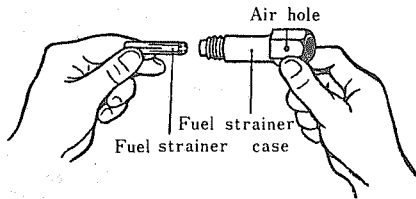
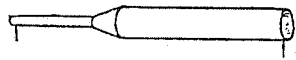
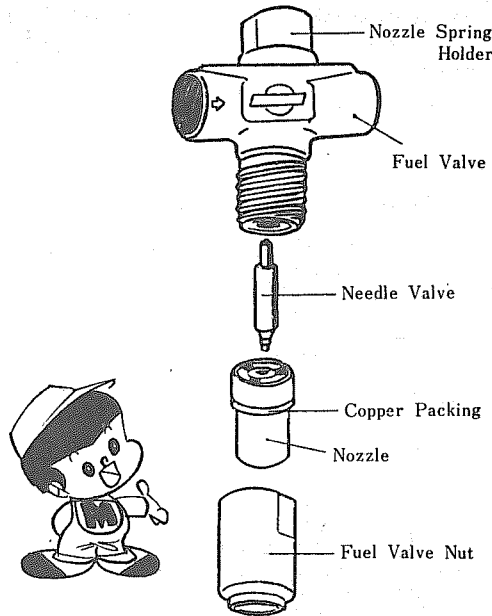
Clean up the fuel injection valve and inside the pre-combustion chamber.



DISASSEMBLING WORK OF FUEL INJECTION VALVE :

When you take out fuel strainer from fuel strainer case, use the attached tool provided for this purpose. The tool can be used in two ways : the large end is for taking out needle valve from fuel injector body and the small end is for the fuel strainer from its case.

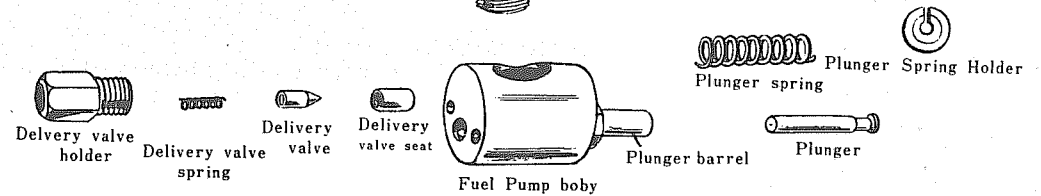
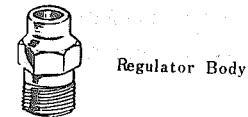
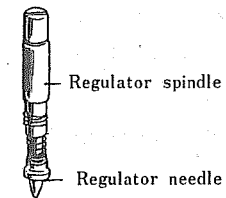
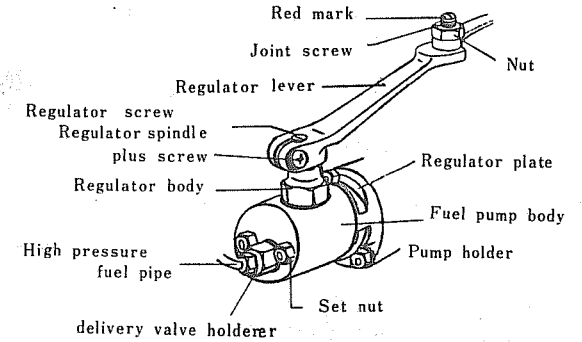
These needle valve and nozzle are machined precisely, so be careful to keep it free from dusts. It is recommended to loose needle valve spring holder when assembling them (do not take it off completely).



DISASSEMBLING WORK OF FUEL OIL PUMP

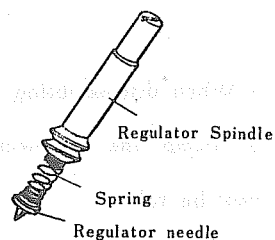
When disassembling the fuel oil pump the following steps must be taken :

- Take off high pressure fuel pipe (1).
- Loosening screw, take off regulator lever (2) from regulator spindle (6).
- Delivery valve and seat can be taken off if remove the delivery valve holder (3).
- Take off the regulator body (1) first, and then take off regulator needle.
- The pump body can easily be pulled out to right-ward if take out the set nut.

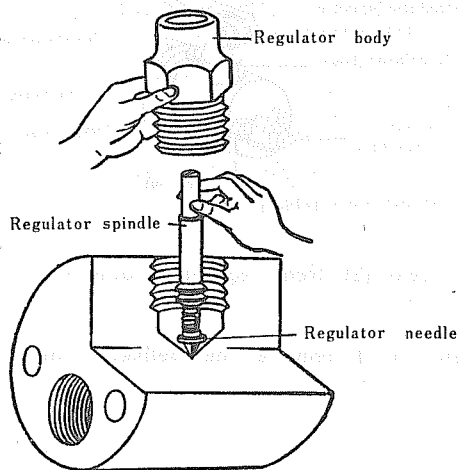


For reassembling work, take reverse course of the disassembling, but to assemble regulator needle please take the following steps:

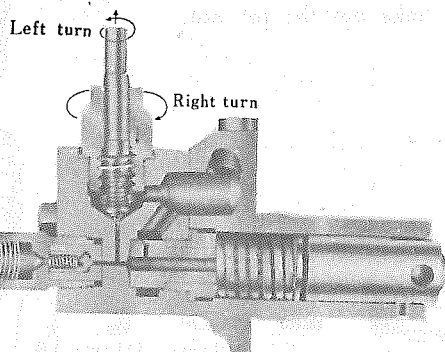
- (1) Connect regulator needle and regulator spindle by spring as the drawing shows.



- (2) Place the top of regulator needle slowly on the valve seat of pump body (otherwise it would be difficult to put the top of needle right on the valve seat)



- (3) As indicated in illustration, revolve the regulator body clockwise and revolve the regulator spindle slightly counter-clockwise, and repeat this action. If screw in the regulator body only, the regulator spindle may possibly push the regulator needle into the pump body.



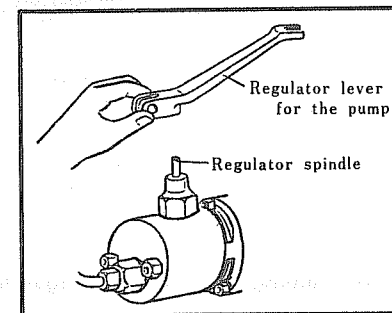
- (4) Making sure that the regulator spindle revolves smoothly, then fasten the regulator body tightly.

ADJUSTMENT OF GOVERNOR LEVER

The speed regulation and operation equipment is equivalent to the nerves system of a human body. The governor catches increase and decrease of engine load accurately, and the governor system conveys adjustment automatically.

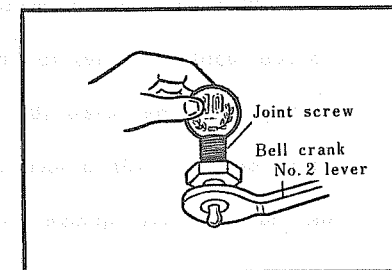
Adjustment of the system should be done by the following steps:

- (1) Set the governor lever at operating position.



- (2) Set the regulator spindle (6) with governor lever (2). (Just set, but do not tighten them,)

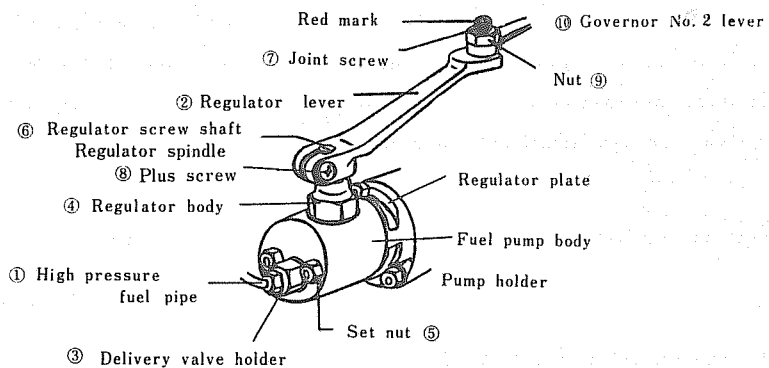
- (3) Screw in the joint screw (7) to the Bell crank No. 2 lever and place between fork of the regulator lever (2).



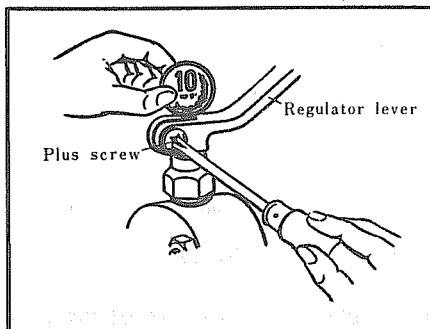
But do not screw in too much, otherwise the bottom end would touch the lever (2).

Keep the red mark of screw head (7) toward the bow. (Opposit side of clutch)

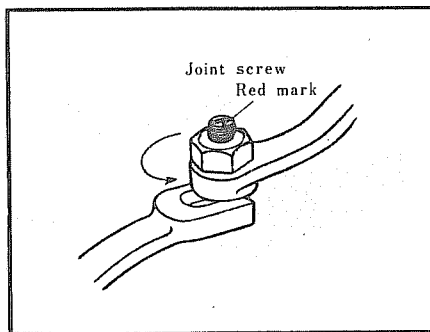
(The ball attached to the bottom of connecting screw is located sliding from the center of screw, but it is right below the red mark.)



(4) Turning lightly the regulator spindle (6) clock-wise by means of a coin until it comes to the end, then set the screw (8) by a driver and fix it with a locknut. Thus, the regulator spindle and the regulator lever are fixed together.



(5) Revolving connecting screw (7) toward reverse side (about 180°) using a coin and bring the red dot mark to the quarter.



(6) Tighten with nut perfectly.

INSPECTION OF INJECTION TIMING OF FUEL :

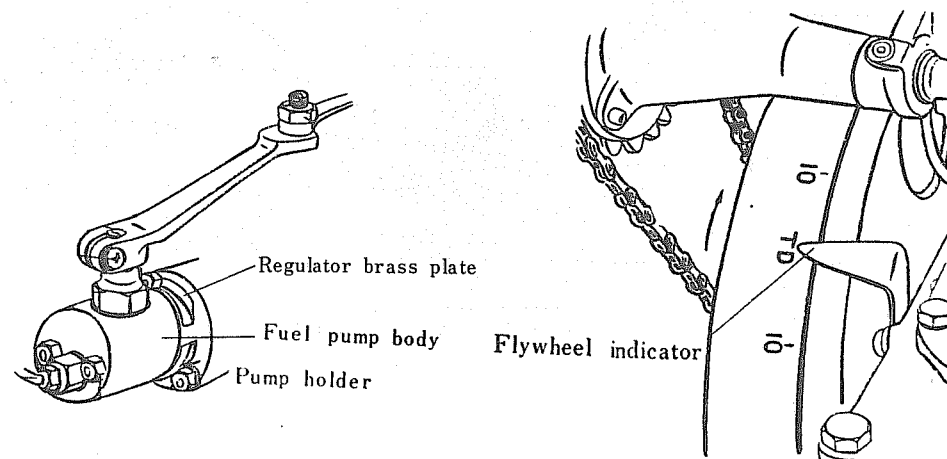
The most adequate starting position of fuel injection for this engine is 8° - 13° before Top Dead Centre of crankshaft revolving angle. The Top Dead Centre can be found by "TD" mark of the flywheel. When "TD" mark meets with indication pin of the flywheel, both suction and exhaust valves are at completely closed position which is on compression stroke.

When the flywheel is moved toward the direction of arrow, injection can be seen a little before the "TD" mark.

Thus you can find the position of fuel injection. (These are indication of 10° on both sides of "TD" mark)

Adjustment of injection starting position shall be done by means of the adjusting brass plates which are inserted between the fuel oil pump mounting and engine body. The injection timing will be quickened by reducing the plates and be delayed by increasing.

Decrease and increase of adjusting plates of 0.1 mm thick can adjust 1° and by 0.2 mm can adjust 2° of injection starting positions.



REPLACEMENT OF CYLINDER LINER :

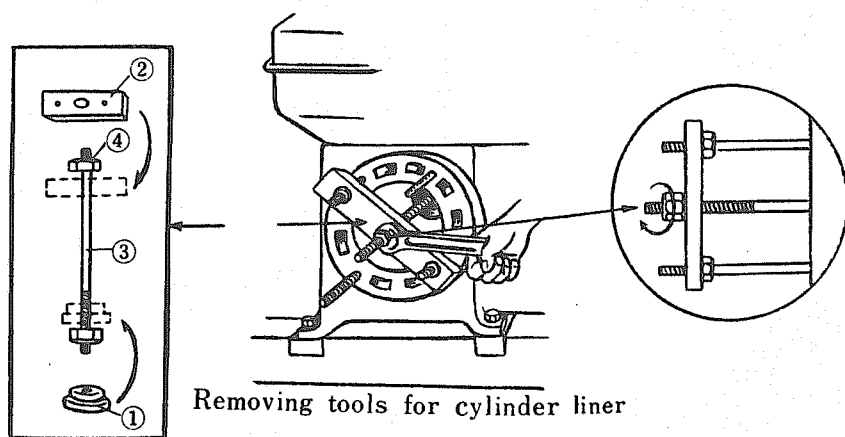
When replacing the cylinder liner, put the round plate of liner removing tool at the bottom of the liner and set the metal plate (2) on cylinder head setbolt, and then connect both with the rod (3) and slowly fasten the upper nut (4).

Clean up the inner surface of the cylinder and the outer surface of the liner taking off dust and paint before inserting a new liner.

Put the rubber packing in the groove of liner, be careful not to twist, and paint it.

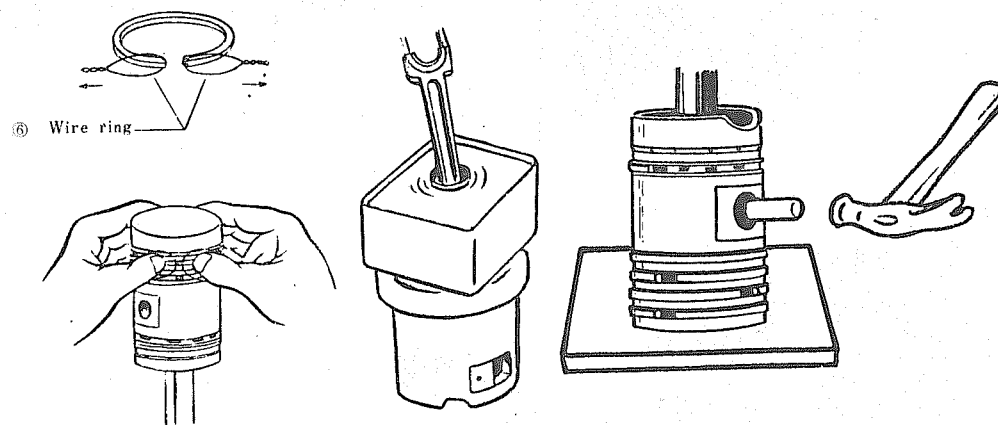
Insert the liner and tap by wood hammer.

Put cylinder head on and fasten 4 nuts evenly, thus the liner will be inserted completely.

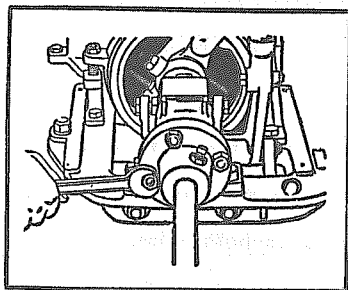


MINUTE DISASSEMBLING OF PISTON :

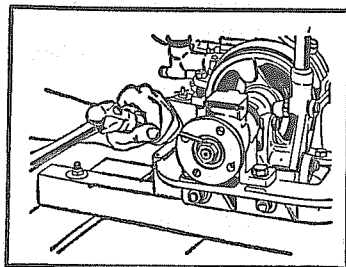
- (1) Take off cylinder head and setnuts of the connecting rod, then, you can take out piston together with the connecting rod toward cylinder head.
- (2) When removing the piston ring, prepare some rings with tag wire and hook the end of piston ring by the said wire rings and take off the ring upward widening the piston ring to both sides.
- (3) As both ends of the piston pin hole are made narrow under normal temperature, when to take the piston pin out of the piston, first take off the piston pin circlips of both sides and hold the piston in light oil temperature of which is about 80°C for about 10 minutes, then you can take out the piston pin very easily.



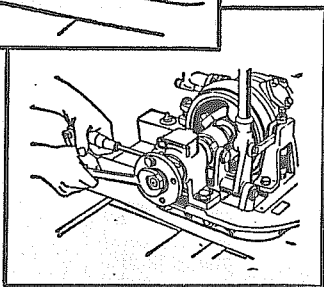
DISASSEMBLING OF CLUTCH :



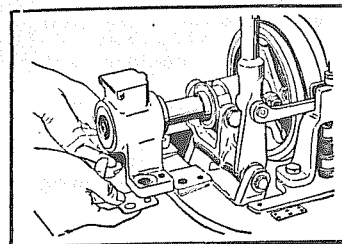
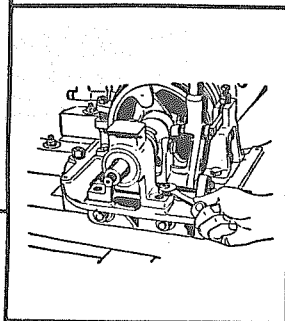
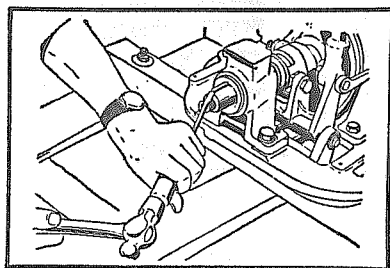
1. Take off coupling bolts as the picture shows, and pull the propeller shaft backward.



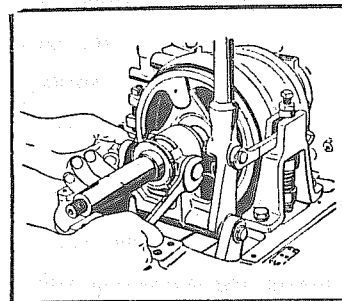
2. The engine side coupling can be pulled out by unbending the washer and taking off the nut.



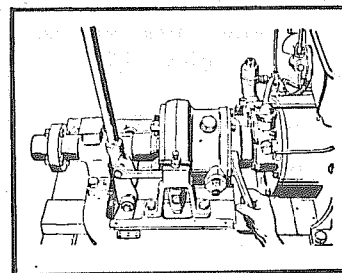
3. Take off the key, then thrust bearing comes out together with adjusting plates. Be careful not to miss the plates.



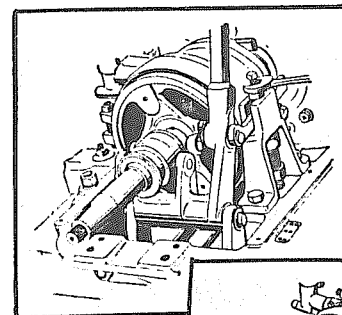
4. Remove knockpin and setbolt of thrust bearing mounting, then pull out the mounting from the thrust shaft. Be careful not to miss adjusting liners equipped under the mounting.



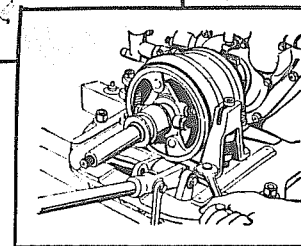
5. Take away clutch cover.



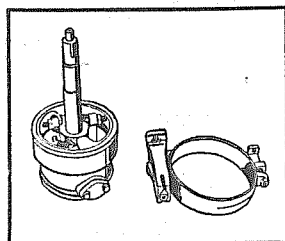
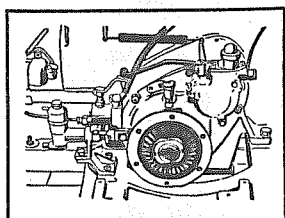
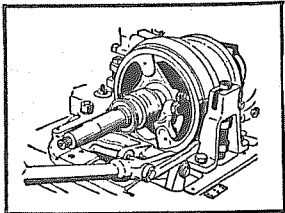
6. Drain lub. oil out of the reversing gear box.



7. Remove the setbolt of reversing gear box.



8. Remove clutch handle setbolts and when you pulling up the thrust shaft toward propeller side, reversing gear box, brake band, handle, thrust shaft and expanding ring come out as an assembled group.



9. Place the reversing gear box as the picture shows, and the brake band is taken away upward together with handle and its assembly, and the thrust shaft, accordingly reversing gear shaft, can be taken away with expanding ring.

The expanding rings, consisting of 2 pieces, must have contact with the reversing gear body. In other words, two thirds of each expanding ring must have contact with gear. If the contacting face is small or if there is slipping trace is found on the outer face of expanding ring (contacting with reversing gear box), you have to adjust it. Otherwise there will be fear of slipping.

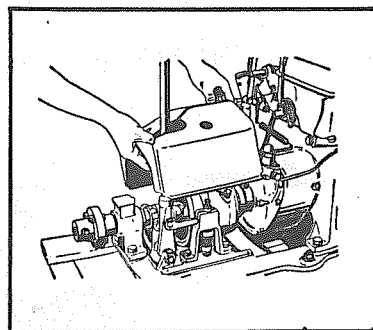
Note : Reassembling of clutch shall be done in the reverse way of disassembling. In reassembling, brake band and gear box must have the clearance of about 0.5 mm.

ADJUSTMENT OF CLUTCH

After the reassembling is done, it is necessary to adjust the clearances between expanding ring and gear box, and between gear box and brake band.

When after a long time operation there are any trouble with expanding ring, gear box, and brake band, the friction efficiency will come down and will be a cause of slipping.

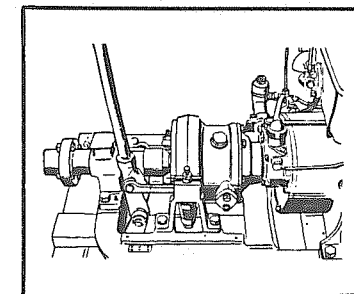
The adjusting shall be done following to the next steps after taking away clutch cover.



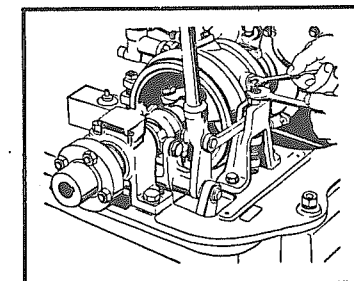
A. Adjustment of Brake Band

The brake band is put in a good condition by adjusting the brake band set screw (viewed from propeller side) with spanner & screw driver.

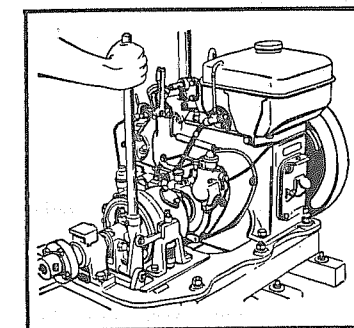
(1) put clutch handle in "astern" position.



(2) untighten the locknut and adjust bolts.



(3) put clutch handle on and off (ahead-neutral-astern)

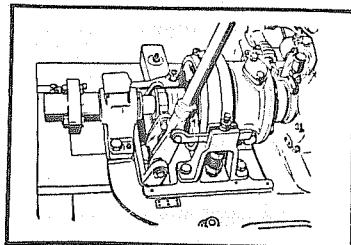


(4) Tighten locknut, keeping the set screw unmoved.

B. Adjustment of Expanding Ring

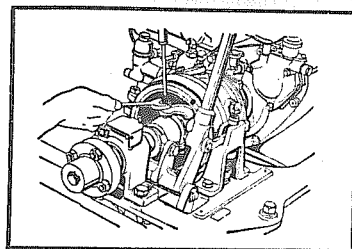
The expanding ring can be adjusted by two bolts.

- (1) Put clutch handle in "ahead" position.

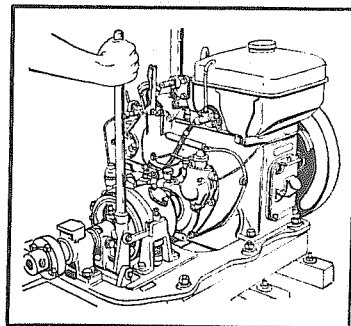


- (2) Adjust two bolts evenly.

NOTE: Uneven tightening of bolts will cause slip, sticking and breakage of clutch system.



- (3) put clutch handle in "ahead," "neutral," and "astern" positions.



- (4) Keeping the bolts unmoved, and tighten them.

To make sure, put the clutch handle on ahead, neutral, and astern positions several times, and check its hardness and or if there is any contact with brake band, expanding ring and gear box. If there is not unusual contact at all, your adjustment is through.

Then put clutch cover on.