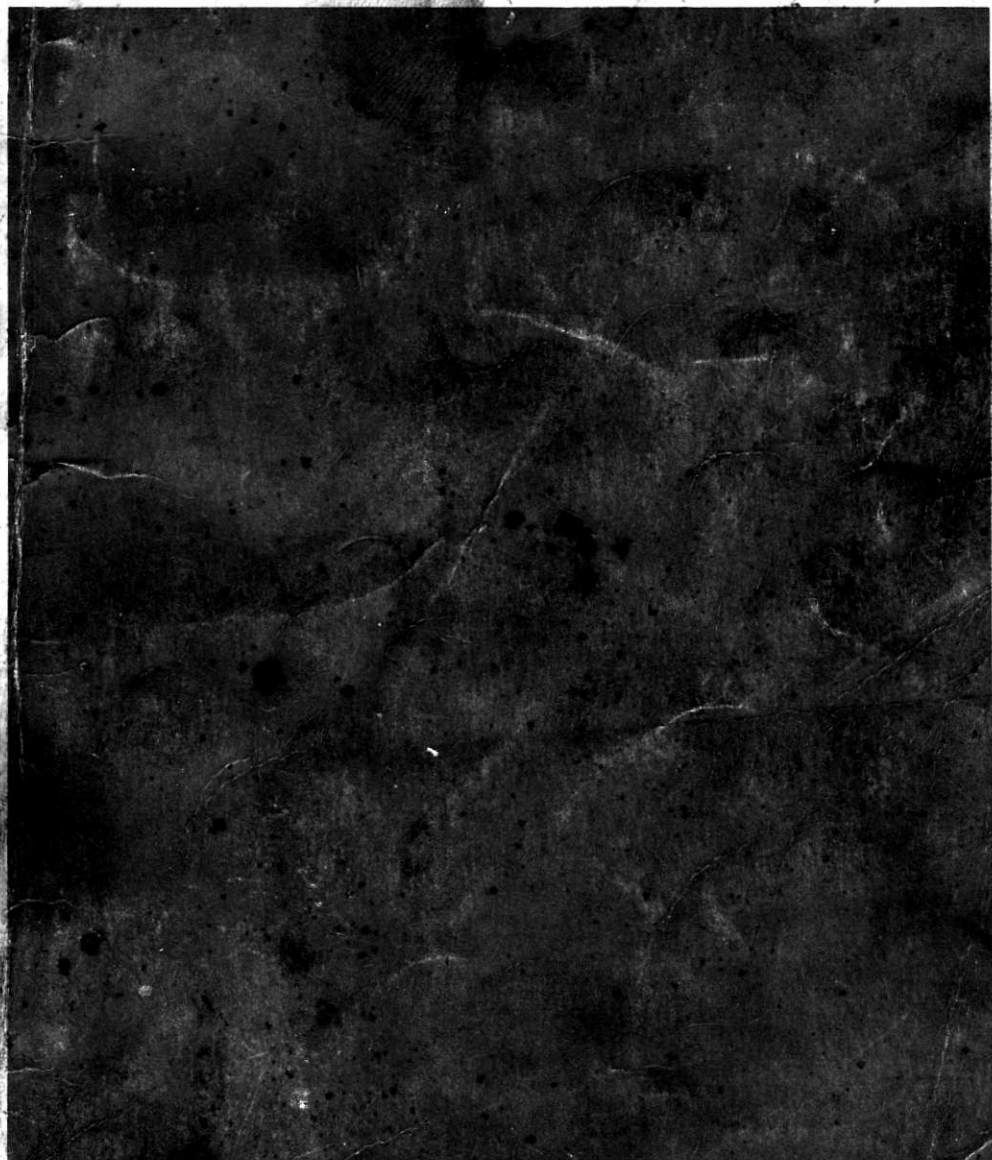


YANMAR DIESEL ENGINE
INSTRUCTION
MANUAL MODEL
YSE

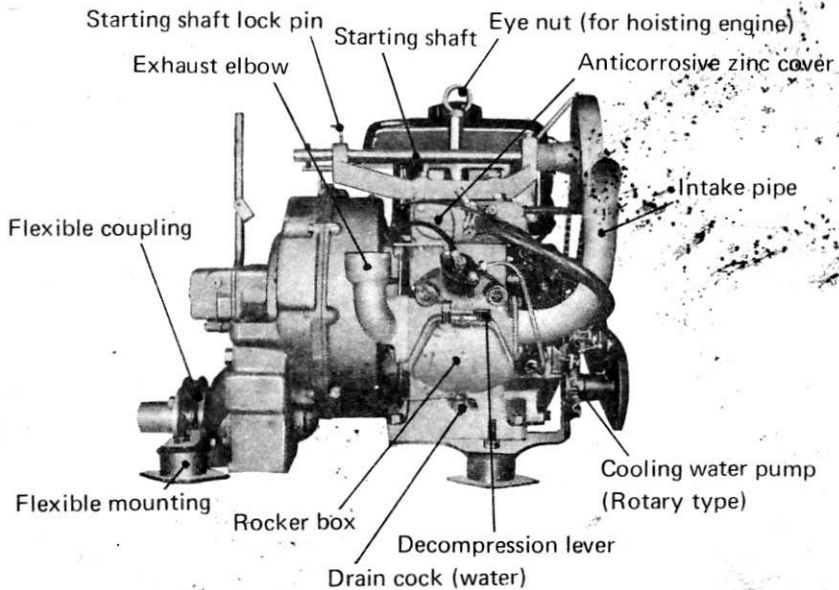
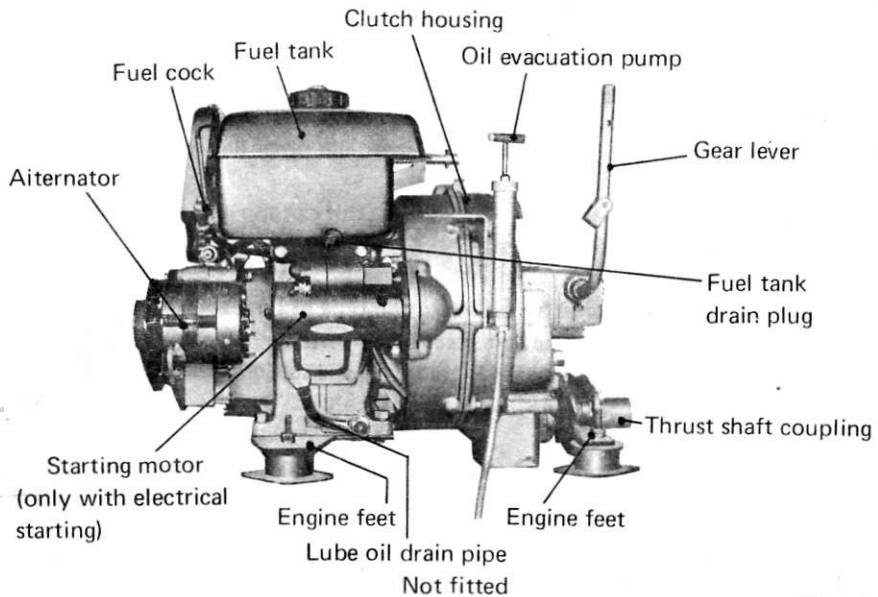


CONTENTS

1. Description	1
2. Installation	2
2-1 Engine Bed	2
2-2 Mounting	2
2-3 Cooling Water Supply System	3
2-4 Exhaust Pipe	4
2-5 Intake Pipe	5
2-6 Remote Control System	5
2-7 Electrical System	6
3. After Launching	9
4. Precautions With New Engine	10
5. Before Operation	11
5-1 Fuel Supply	11
5-2 Lube Oil Supply and Lubrication	12
5-3 Checking Fuel Injection	15
6. Starting	16
6-1 How to Start the Engine	16
6-2 After Starting	17
7. During Operation	18
8. Stopping	20
9. Periodical Checks	21
9-1 Daily	22
9-2 Every 100 Hours	23
9-3 Every 250 Hours	26
9-4 Every 500 Hours	27

10.	Adjustment, Stripping and Re-assembly	29
	10-1 Precautions during Stripping	29
	10-2 Precautions during Re-assembly	30
11.	Air Venting of Fuel Injection System	31
12.	Checking Fuel Injection Valve	33
13.	Adjusting Fuel Injection Regulator	35
14.	Checking and Adjusting Fuel Injection Timing	37
15.	Stripping and Re-assembly of Fuel Injection Pump	38
	15-1 Delivery Valve	39
	15-2 Regulator	39
	15-3 Plunger	40
16.	Checking Piston	41

1. DESCRIPTION OF PARTS



Note: Photo shows model YSE8 (type CX) with optional accessories attached.

2. INSTALLATION

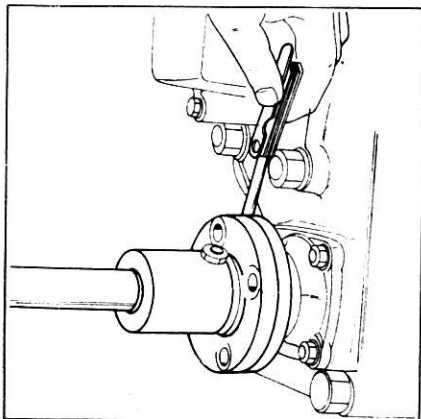
2-1 Engine Bed

- (1) Use hard, dry timber. An unstable engine bed causes excessive vibration, which may result in a broken propeller shaft and other damage.
- (2) Use timber of at least 9 cm (3 - 4") square. Cut out the necessary sections to accommodate the clutch case.
- (3) Angle of inclination varies according to the type of boat and the place of installation, but it should never exceed 15° . Installing at angle above this limit leads to excessive loss of H.P., reducing the speed of the boat, and to abnormal wear, impairing engine performance.
- (4) Make sure that the engine bed straddles as many ribs as possible, and secure it firmly to the hull. Leave enough space beneath the engine bed to permit tightening of the nuts for the engine set bolts.
- (5) Great care should be taken when installing the engine the propeller shaft and thrust shaft can be aligned properly.

2-2 Mounting

- (1) Mount the engine onto the bed.
- (2) Tighten the set bolts evenly and securely. Do not try to tighten them forcibly if the propeller shaft is not correctly aligned.

- (3) Before setting the propeller shaft (or intermediate shaft, if present) to the engine, firstly check the clearance at both shaft couplings. Measure the clearance at the top, bottom, left and right of the coupling flange with a thickness gauge, and repeat until the clearance does not exceed 0.2 mm at any point. If the center of the engine thrust shaft is too high, plane the engine bed; if it is too low, insert a floor plate between the engine and the bed.



- (4) Re-check alignment after launching.

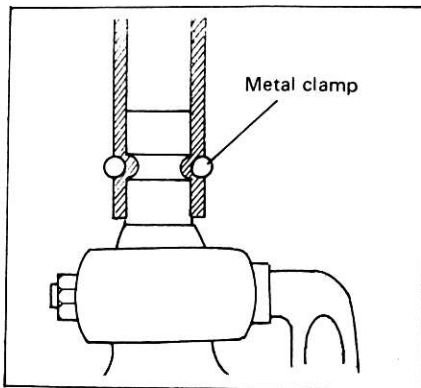
2-3 Cooling Water Supply System

- (1) Attach the V belt for the cooling water pump to the pulley in the center of the PTO shaft. Adjust the belt tension so that deflection is about 5 mm when the middle of the belt is pressed down with the thumb. Adjust by loosening the cooling water pump set bolts and re-positioning the pump.

NB: Operating the cooling water pump without water will result in damage to the rubber impeller. Do not operate until the water piping has been properly installed.

- (2) Fit the Kingston cock to the hull.
(See Illustration).
- (3) Measure the distances from the Kingston cock to the cooling water pump intake and from the engine cooling water outlet to the outside of the hull. Cut a rubber hose (i.d. 13 mm, o.d. 20 mm) into the correct length.

NB: The rubber hose is not supplied as standard.



- (4) Connect the Kingston cock to the cooling water pump intake with the one hose and engine cooling water outlet to the outside of the hull with the other hose as straight and short as possible. Then secure tightly with metal clamps.
- (5) Thermostat for cooling water is equipped as standard for better performance in cold weather.

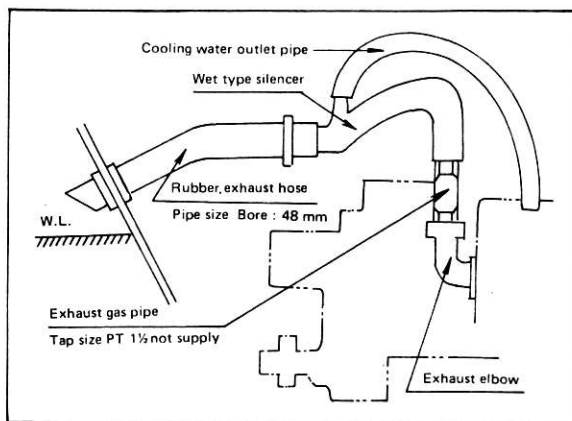
2-4 Exhaust Pipe

a) Dry type

- (1) Attach the dry type silencer to the exhaust flange on the cylinder head, then attach the exhaust pipe to the outlet of the silencer.
- (2) If it is necessary to bend the exhaust pipe, make sure the radius of the curvature is at least 100 mm.
- (3) Install the exhaust pipe center rest at an appropriate point on the hull.

b) Wet type (optional order)

- (1) Attach the exhaust gas pipe to the exhaust elbow, then attach the wet type silencer to the exhaust gas pipe.
- (2) Connect the outlet of the silencer to the outside of the hull with the rubber exhaust hose (i.d. 48 mm).
- (3) Connect the engine cooling water outlet to the water intake port of the wet type silencer with the rubber hose.



2-5 Intake Pipe

Fit an extension pipe to the intake pipe as shown in the figure. This permits fresh air to be sucked in from outside the engine room and prevents faults due to temperature rise caused by poor ventilation in the engine room.

Use a resin or iron pipe. Avoid irregular bends.

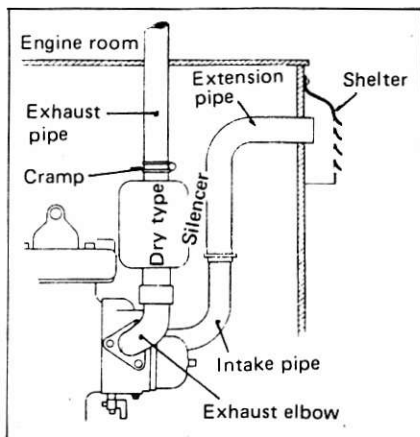
Outer diameter of intake pipe :

YSE8: 38.6 mm

YSE12: 42.7 mm

NB: Extension pipe is not supplied as standard.

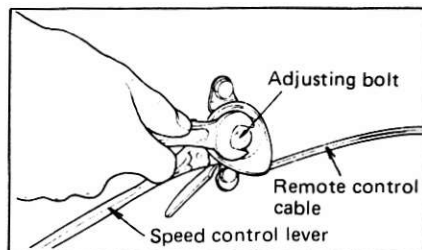
Attach a shelter over the intake port to prevent dirt and water from entering the pipe.



2-6 Remote Control System

2-6-1 Speed Control Lever

- (1) The speed control lever can be operated by means of the remote control cable. Install this in a convenient place.
- (2) Lay the remote control cable as straight as possible. Bends should have a radius of at least 30 cm.



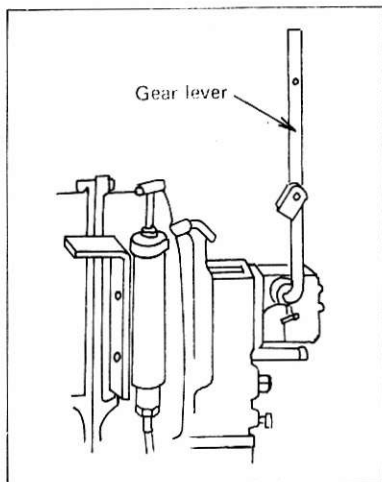
- (3) Grease the core of the remote control cable before installing.
- (4) Adjust operating strength by means of the adjusting bolts.

2-6-2 Decompression Lever

For remote control operation of the decompression lever, connect the wire to the small hole in the lever. Models YSE8 and YSE 12 (hand starting only) are equipped with remote control decompression handle. (3 meter cable is optional)

2-6-3 Gear Lever

A hole is provided in the gear lever to permit the attachment of a connecting rod for remote control operation. Please use it according to the conditions on your boat. It can be fitted to Morse type control cable if a bracket for oil evacuation pump is fitted (bracket and oil evacuation pump are available as optionals).



2-7 Electrical System (For YSE9X,Y and YSE12X,Y only)

2-7-1 Parts

The electrical system comprises the following: (1) Starter; (2) Alternator; (3) Dash panel; (4) Wire harness; (5) Starter cable (+), (-); (6) Battery; (7) Oil pressure warning light. Of these, the following must be purchased as optionals separately: Optional extras (Subject to any alteration without notice)

Charging alternator	12V. 25AMP.
Wire harness (for remote control)	3 m, for wire harness extension
Starter cable (+), (-)	
Battery	12V. 40Ah for frequent use 12V. 70Ah for boat not used daily
Oil pressure warning light	} Oil pressure warning for hydraulic light assembly
Pressure switch	
Oil pressure valve assembly	

2-7-2 Wiring

(1) Connect the wire harness and terminals as follows:

6-pole connector

Connect to instrument panel side*

4-pole connections	Connect to alternator side*
1-pole connection	Connect to starter side*
Green terminal	Join to oil pressure switch terminal screw (Pressure switch is optional extras)
Blue terminal	Join with starter cable (+) to starter magnet switch terminal bolt
Black terminal	Join with starter cable (-) terminal to starter set bolt and earth to body

* Please connect according to the color indication

Red female terminal	Connect to instrument panel side for work load under 10A.
---------------------	--

(2) Install the instrument panel in a convenient position. Three meters extension can be obtained if wire harness A is too short. Select a dry place free from excessive vibration.

(3) Connect the starter cables:

Starter cable (+)	Connect battery (+) terminal and starter terminal. Connect together with the blue cord round terminal of the wire harness (B)
-------------------	---

Starter cable (-)	Connect battery (-) terminal and starter set bolt (earth to body). Connect together with the black cord round terminal of the wire harness (B)
-------------------	--

(4) Make sure all terminals are securely connected, then coat with grease.

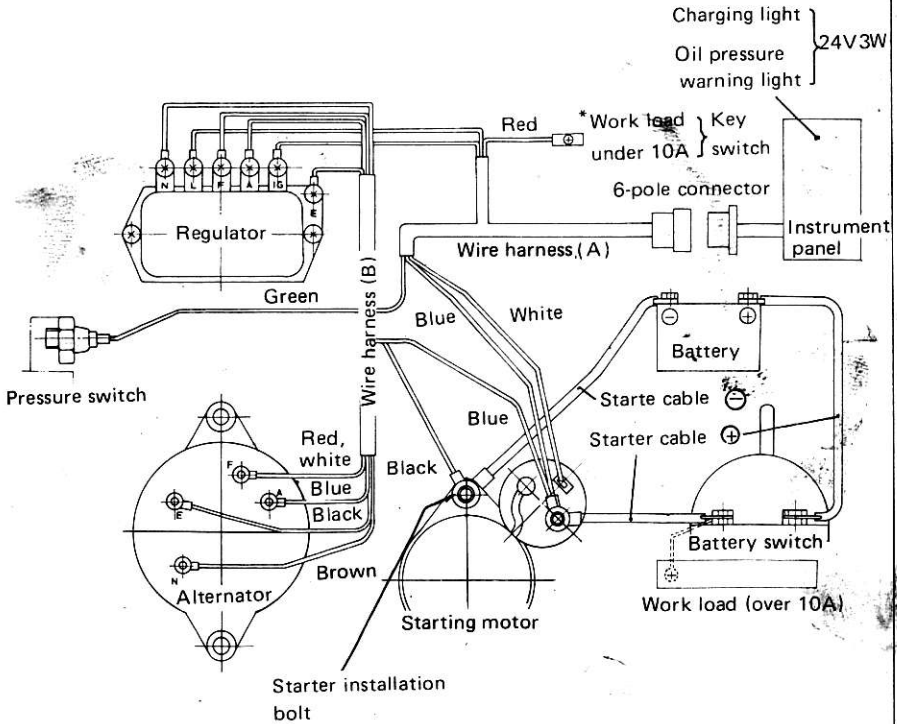
(5) Finally, check once more that all the connections have been made correctly.

2-7-3 Check

Prepare the engine for starting and turn the ignition key.
Check that operation is normal (see Section 7).

NB: Never operate engine with the starter cables disconnected from the battery, since this may cause the alternator to overheat dangerously. (Operation with the battery disconnected is permissible if the V belt driving the alternator is removed.)

Wiring Diagram for Models YSE8, YSE12



* As there is no earth, obtain earth connection from the engine or battery.

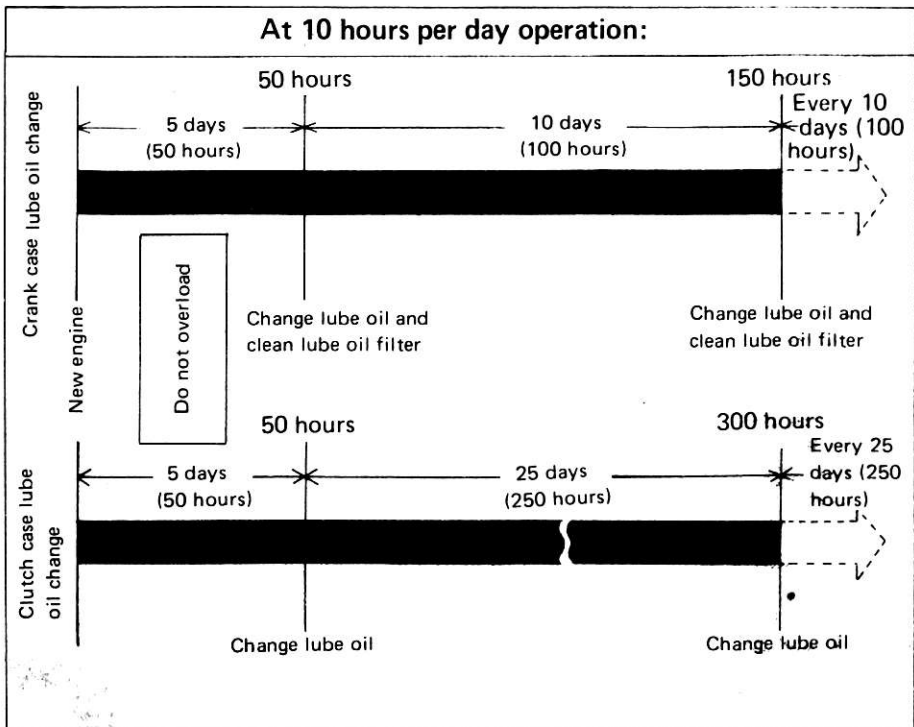
3. AFTER LAUNCHING

- (1) Check that there is no water or air leak from the gland of the stern tube or the Kingston cock joints.
- (2) Check that the engine set bolts and shaft coupling are securely tightened.
- (3) Release the compression with the decompression lever and gently turn the engine with the starting handle. Compare the resistance when the gear lever is in neutral position and when it is in the engaged position (forward or reverse). If there is no appreciable difference, alignment is correct; however, if the resistance against turning is much stronger when the clutch is engaged, re-check the alignment of the propeller shaft and the engine to avoid brakage of the propeller shaft and other possible breakdowns.

4. PRECAUTIONS WITH NEW ENGINE

Overloading the engine before it is properly run in shortens its life considerably. The first 150 hours of operation should be treated as a running-in period:

- (1) No overload allowed during the first 50 hours of running in period (Avoid operating at speed higher than DIN A rating speed with continuous black exhaust.)
- (2) After 50 hours of operation, change the lube oil in the crank case and clutch case. Also clean the lube oil filter.
- (3) Thereafter change the crank case lube oil every 100 hours and the clutch case lube oil every 250 hours of operation. This prolongs engine life.
- (4) To replace the lube oil, first discharge the old oil while the engine is still warm and clean the inside with light oil. Then add the new oil.



5. BEFORE OPERATION

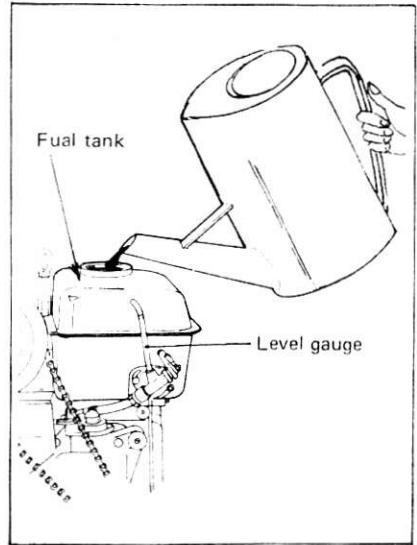
5-1 Fuel Supply

5-1-1 Fuel

Use diesel light oil (JIS K2204 or equivalent).

Recommended brand names of fuel.

Supplier	Brand Name
SHELL	Shell diesoline or local equivalent
CALTEX	Caltex diesel oil
MOBIL	Mobil diesel oil
ESSO	Esso diesel oil
B.P. (British Petroleum)	B.P. diesel oil



5-1-2 Fuel Tank Capacity

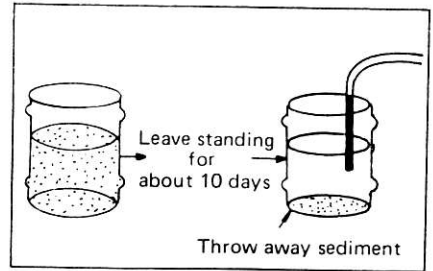
Fill the fuel tank with diesel fuel. Tank capacity is as follows:

YSE8	6.5 /
YSE12	9.5 /

5-1-3 Removing Water and Dirt Present in Fuel

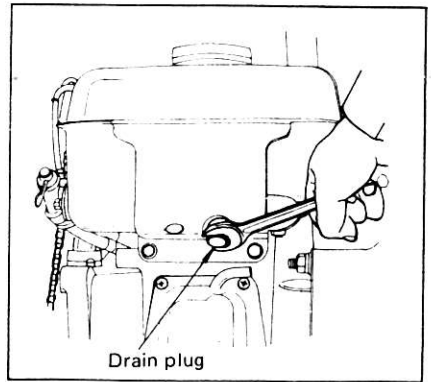
- (1) Water and dirt, which lead to malfunctioning of the engine, are sometimes present in the fuel oil.

- (2) Leave the drum standing for about 10 days to allow any water and dirt to sink to the bottom. Filter the oil through a clean, finely woven cotton or silk cloth. Avoid rocking or shaking the drum.



5-1-4 Draining Fuel Tank

To remove the water and dirt accumulated in the bottom of the fuel tank, drain from the drain plug every day before filling fuel oil.



5-2 Lube Oil Supply and Lubrication

Lube Oil

Recommended brand names of lube oil for crankcase and gear box.

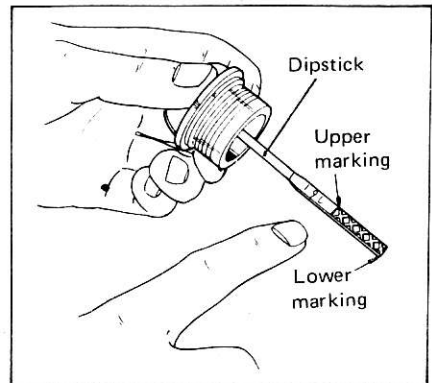
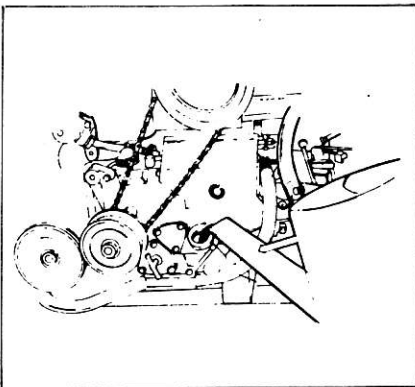
Supplier	Brand Name	SAE No.			
		below 10°C	10 - 20°C	20 - 35°C	over 35°C
SHELL	Shell Rotella Oil	10W 20/20W	20/20W	30 40	50
	Shell Talona Oil	10W	20	30 40	50
	Shell Rimula Oil	20/20W	20/20W	30 40	

CALTEX	RPM Delo Marine Oil	10W	20	30 40	50
	RPM Delo Multi-Service Oil	20/20W 10W	20	30 40	50
MOBIL	Delvac Special	10W	20	30 40	
	Delvac 20W-40	20W-40	20W-40		
	Delvac 1100 Series	10W 20-20W	20-20W	30 40	50
	Delvac 1200 Series	10W 20-20W	20-20W	30 40	50
ESSO	Estor HD	10W	20	30 40	
	Esso Lube HD		20	30 40	50
	Standard Diesel Oil	10W	20	30 40	50
B.P. British Petroleum	B.P. Energol ICM B.P. Vanellus B.P. Energol DS3 B.P. Vanellus S3	20W.30	20W.30	30 40	50

Remarks: The viscosity grade of the lube oil should be chosen to suit the ambient air temperature.

5-2-1 Crank Case

Remove the oil filter cap and fill with lube oil up to the upper marking on the dipstick. To check the level, simply insert the dipstick without screwing in the cap. Avoid overfilling and underfilling.



The volume of lube oil is as follows:

YSE8	1.9 l
YSE12	3.3 l

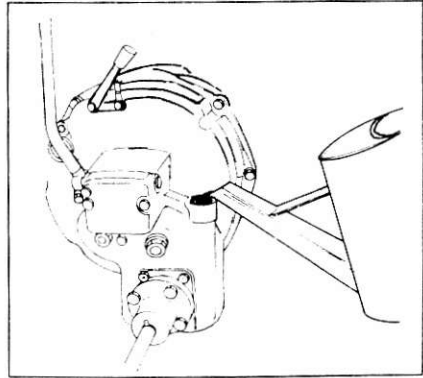
5-2-2 Clutch Case

Remove the lube oil filler cap and fill with lube oil up to the upper marking on the dipstick. Use the same oil as for the crank case.

The volume of lube oil is as follows:

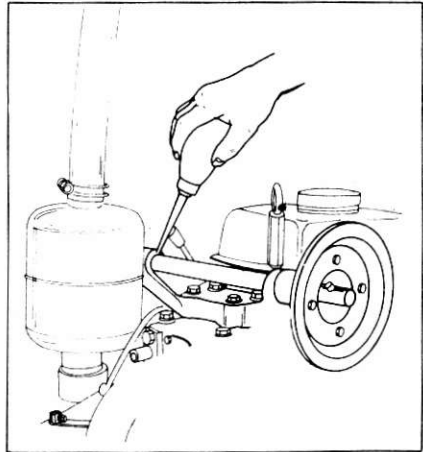
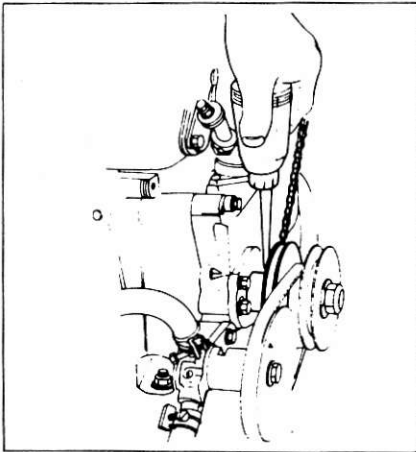
YSE8	0.8 l
YSE12	0.7 l

The correct oil level can only be determined when the ship is level.



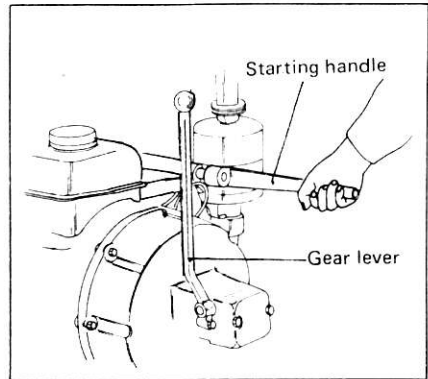
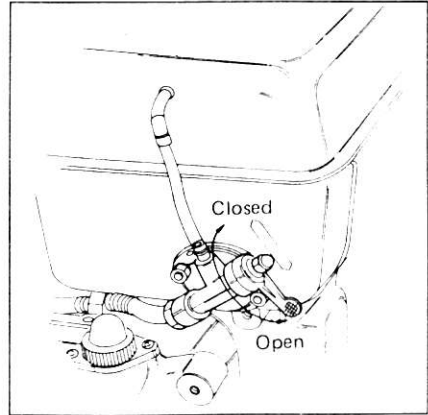
5-2-3 Lubrication

Lubricate the starting chain, chain wheel bearing and starting shaft bearing with lube oil before operation.



5-3 Checking Fuel Injection

- (1) Open the fuel cock. The fuel is fed through the fuel filter to the fuel injection pump.
- (2) Set the speed control lever to LOW and the gear lever to NEUTRAL.
- (3) Raise the decompression lever and turn the starting handle 5 or 6 times. Check that you can hear fuel being injected.
- (4) If you cannot hear fuel being injected like squeasing noise, air is present in the fuel injection system and must be vented. Refer to Section 12.



6. STARTING

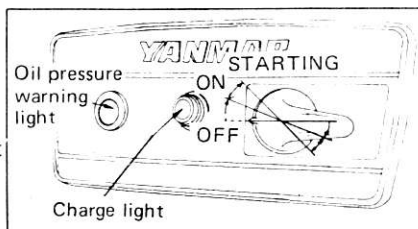
6-1 How to Start the Engine

6-1-1 Manual Starting

- (1) Set the speed control lever to LOW.
- (2) Raise the decompression lever and turn the starting handle vigorously 5 or 6 times until the flywheel gains momentum.
- (3) Release the decompression lever and continue turning the starting handle a further 2 or 3 turns. The engine must start.

6-1-2 Electric Starting

- (1) Set the speed control lever to LOW.
- (2) When insert the ignition key and turn it to the ON position, the charge lamp (red) and the oil pressure warning light (red) light up. If the lights do not behave correctly, check the electrical system.
- (3) Raise the decompression lever. When turn the ignition key to the STARTING position, the charge lamp (red) is up and the oil pressure warning light (red) goes out. This turns the starter.
- (4) Hold the key in this position for about 5 seconds until the engine gains momentum, then release the decompression lever. The engine now starts. Release the key immediately, so that it returns to the ON position. As engine speed increases, the charge light (red) and the oil pressure warning light (red) go out.
- (5) If the engine fails to start even when the key is held in the STARTING position for 10 seconds, return it to the original position and allow 30 seconds for the battery voltage recovers. Holding the key in the STARTING position continuously leads to faults in the circuit.
- (6) If the engine still fails to start, check fuel injection and compression.

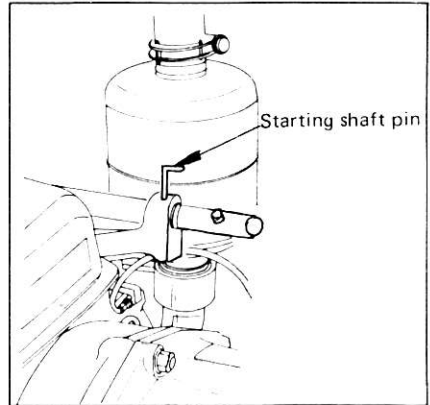


6-1-3 Starting in Cold Weather

In especially cold weather, pour about 0.5cc of gasoline through the intake pipe before starting. Take care not to add too much gasoline, as this causes knocking and compression leakage. Instead of gasoline, Yanmar Aerosol (extra) can also be used. Neither need be used when the engine is warm.

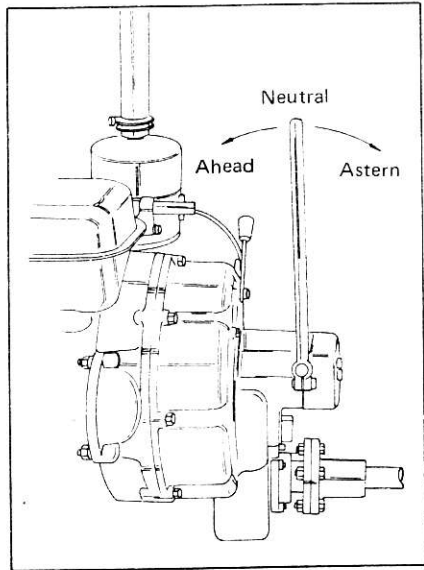
6-2 AFTER Starting

- (1) As the engine gains speed, the starting chain gear disengages. Remove the starting handle and fix the pin to the starting shaft.
- (2) Check the visual oil pressure indicator to see that lube oil is circulating properly. With engines using electric starting and equipped with an oil pressure switch, check that the oil pressure warning light (red) is off.
- (3) Check that cooling water is coming out of the cooling water outlet. If it is not, stop the engine and check the water system for blockages; continuing operation in this condition results in wear to the impeller in the cooling water pump. If cooling water circulation is bad, remove the pump intake pipe and prime.
- (4) With engines using electric starting, check that the charge light is off. This light goes out at about 650 rpm and begins charging.
- (5) Allow the engine to idle for about 5 minutes with the gear lever in the NEUTRAL position. This allows lube oil to circulate to all metal parts, and is especially necessary in cold weather. Putting the engine into gear immediately after starting can cause seizure and damage to moving parts. When operating for the first time after launching, let the engine idle for 20 minutes, then gradually increase engine speed.
- (6) After checking that operation is normal, engage the gear lever and gradually increase engine speed.
- (7) Finally, check that no abnormal noise, water or oil leaks are present.



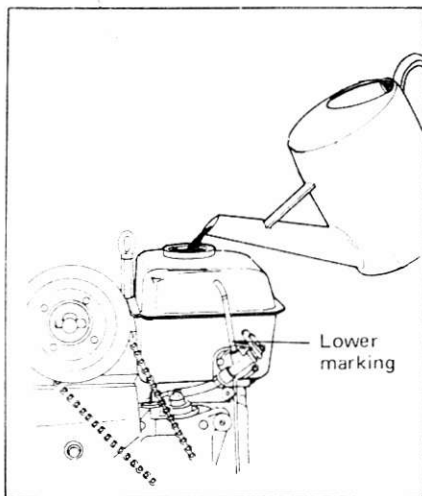
7. DURING OPERATION

- (1) Never operate the gear lever before first reducing engine speed to SLOW. Changing gear at high engine speeds damages the friction discs and accelerates wear. Sudden changes from full speed ahead to astern must always be avoided except in emergencies. The clutch should be engaged gently and disengaged quickly. Adjust the speed of the boat with the accelerator lever; never slip the clutch.



- (2) If the oil pressure sight rotar tends to rotate slowly or stop, lube oil is not circulating properly. But this is not applied in the case of low speed operation. Bad circulation indicates that the lube oil is old and needs changing. With engines equipped with an oil pressure switch, circulation is normal if the oil pressure warning light is off.
- (3) Check occasionally that cooling water is coming out of the cooling water pipe outlet. If the flow of water is low or intermittent, stop the engine and check the piping system and the cooling water pump.
- (4) With engines using electric starting, check that the charge light is OFF. If it lights up, there is a fault in the charging circuit; check and repair.

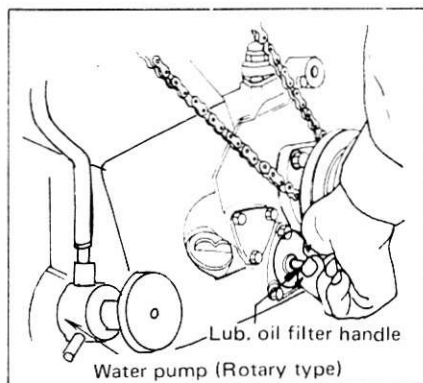
- (5) Check the fuel oil level in the tank and add fuel when it approaches the lower marking on the fuel gauge. Operating with insufficient fuel can result in air entering the fuel injection system, stopping the engine. Depending on the load, a full fuel tank lasts for 3 - 5 hours of operation.



- (6) Once a day, turn the lube oil filter handle several times. This removes dirt adhering to the filter plates.

- (7) Check the color of the exhaust. Black exhaust indicates that the engine is being overloaded, and operation must never be continued for long period in this condition.

- (8) Depending on the installation and structure of the hull, vibration may occur when engine speed reaches a certain level; this is due to resonance of the engine and the hull. Note the conditions under which this occurs and avoid running the engine at that particular speed.

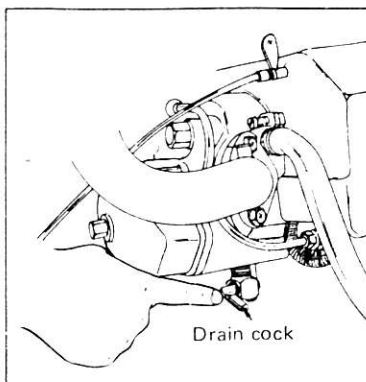


- (9) Check for water, gas and oil leak.

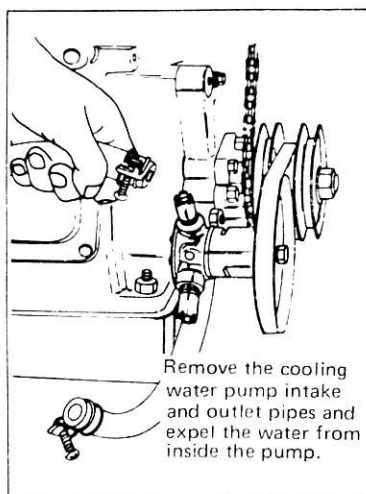
8. STOPPING

- (1) Always reduce speed gradually.
- (2) To stop the engine, put the gear lever in NEUTRAL, let the engine idle, then set the speed control lever to STOP. Avoid stopping the engine by means of the decompression lever; this causes fuel to accumulate in the combustion chamber and can result in accidents at the next time of starting.
- (3) With engines using electric starting, turn the key OFF. Remove the key and attach the supplied rubber cap.
- (4) Close the fuel cock.

- (5) In cold weather, drain off the cooling water to prevent freezing: Close the lever on the Kingston cock and drain off the water from inside the engine through the drain cock underneath the cylinder head; loosen and remove the cooling water pump intake and outlet pipes drain off the water from inside the pipes, then turn the engine several times with the starting handle to discharge the water from inside the cooling water pump.



- (6) Wipe off any dirt while the engine is still warm.
- (7) Stop the engine at the compression stroke by turning it with the starting handle until resistance is felt. Do not use the decompression lever. At this position, the intake and exhaust valves are closed, protecting the cylinder and valve seats from moisture.



- (8) If necessary, cover the mouth of the exhaust pipe with an empty can to prevent rain water from entering the engine.

9. PERIODICAL CHECKS

Regular checking is vital if the engine is to be kept in good condition. Schedules vary according to operating conditions, type of fuel oil and lube oil used, etc., but the chart below will serve as a rough guide. For further details refer to the relevant paragraphs.

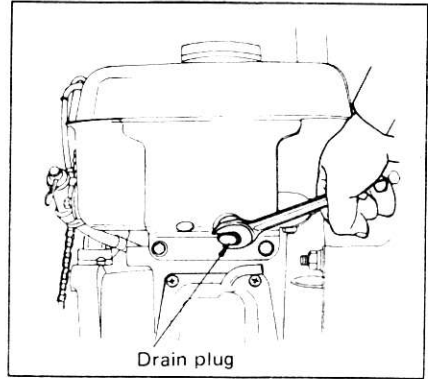
Items to check		Daily	Every 100 hours	Every 250 hours	Every 500 hours
Fuel oil	Check and refill	<input type="radio"/>			
	Drain fuel tank	<input type="radio"/> (Before refilling)			
	Clean and replace fuel filter element		(Clean) <input type="radio"/>	(Replace) <input type="radio"/>	
Lube oil	Check oil level in crank case and clutch case	<input type="radio"/>			
	Lubrication (starting shaft chain, etc.)	<input type="radio"/>			
	Turn lube oil filter handle	<input type="radio"/>			
	Disassemble and clean lube oil filter		<input type="radio"/>		
	Change lube oil in crank case		<input type="radio"/>		
	Change lube oil in clutch case			<input type="radio"/>	
Cooling water	Drain	<input type="radio"/> (After operation in cold weather)			
	Check cooling water circulation	<input type="radio"/>			
Fuel injection pump, fuel injection valve	Check fuel injection sound	<input type="radio"/>			
	Adjust fuel injection regulator				<input type="radio"/>
	Check fuel injection timing				<input type="radio"/>
	Clean needle valve				<input type="radio"/>
Cylinder head	Re-tighten		<input type="radio"/>		
	Adjust intake and exhaust valve clearance			<input type="radio"/>	
	Clean combustion surface				<input type="radio"/>
	Clean precombustion chamber				<input type="radio"/>
	Lap intake and exhaust valves				<input type="radio"/>
	Check valve stems and valve guides				<input type="radio"/>
Clean breather valve			<input type="radio"/>		
Check belt tension (cooling water pump and generator belts)			<input type="radio"/>		
Replace anticorrosive zinc					<input type="radio"/>
Disassemble piston, check rings					<input type="radio"/>

9-1 Daily

9-1-1 Fuel and Lube Oil

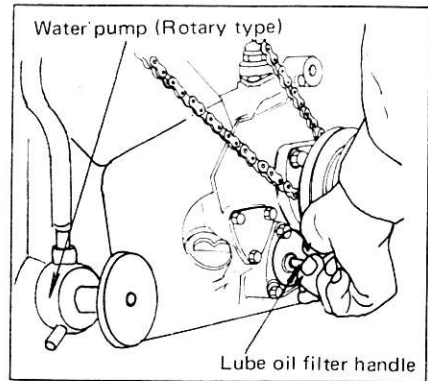
- (1) Open the drain plug on the fuel tank and remove the dirt and water accumulated at the bottom of the tank.

NB: With engines using electric starting, first cover the starter and alternator with a sheet of vinyl to protect them from oil.



Drain plug

- (2) Check the fuel oil level in the tank and refill if necessary.
- (3) Check the lube oil level in the crank case and clutch case. Refill up to the upper marking on the dipstick.
- (4) Turn the handle of the lube oil filter on the outlet side several times to the left or right.



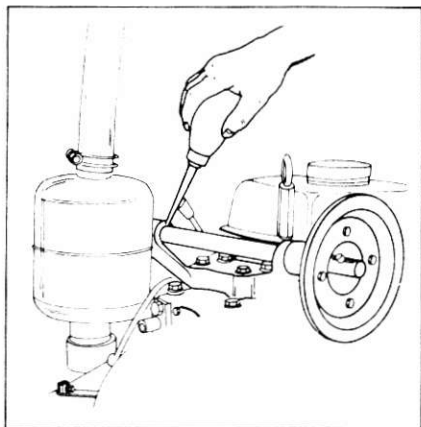
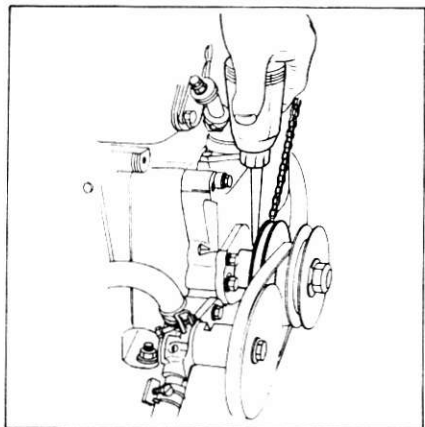
Lube oil filter handle

9-1-2 Cooling Water

Check water flow from the cooling water pump. Also check for water leaks.

9-1-3 Lubrication

Lubricate the starting chain, starting chain free gear metal and starting shaft bearing with a small amount of oil.

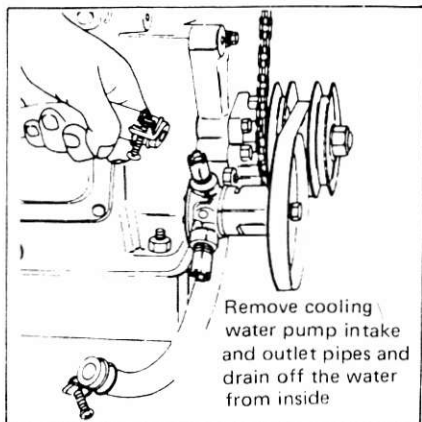
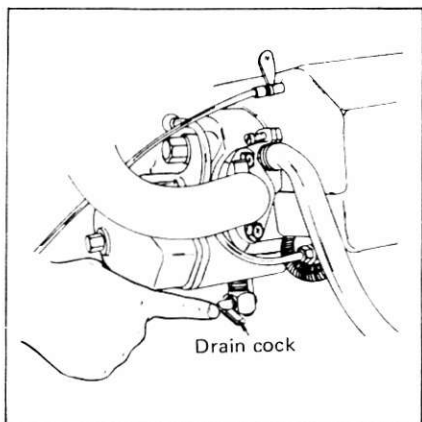


9-1-4 Fuel Injection Sound

Crank the engine before starting and check that fuel injection is normal.

9-1-5 Draining Off the Cooling Water

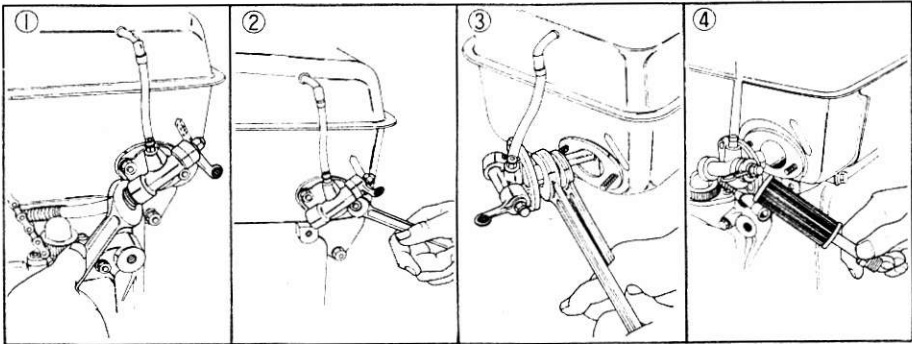
In cold weather, drain off the cooling water after operation. Drain off the water from inside the cylinder through the drain cock, remove the cooling water pump intake and outlet pipes and expel the water from inside the pump (see Section 8).



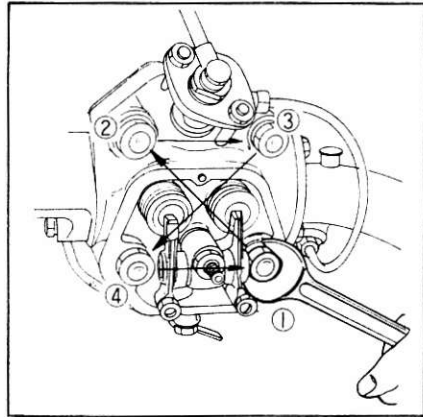
9-2 Very 100 Hours

9-2-1 Remove the fuel oil filter and wash it in kerosene. The filter is located below the fuel cock. Strip as follows:

- (1) Remove the fuel oil pipe and unscrew the 2 nuts securing the fuel cock set bolt.
 - (2) Pull out the fuel cock and remove it. Leave the oil gauge attached.
 - (3) Insert a 17 mm spanner at the back of the fuel cock and a 19 mm spanner at the hexagonal section on the filter side. Loosen and remove.
- To assemble, follow the reverse procedure. Take special care with the O rings on the fuel cock joint surface.



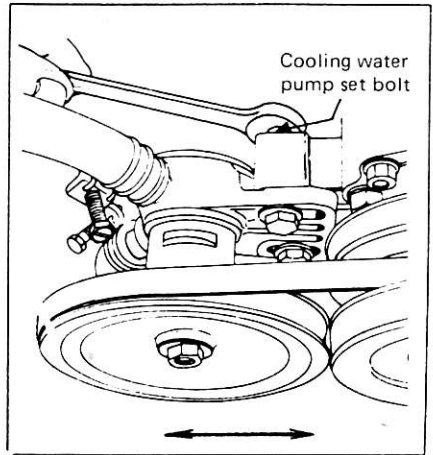
9-2-2 Re-tighten the cylinder head lock-nuts. Using a single spanner, tighten them securely and evenly as shown in the diagram.



Tightening torque:

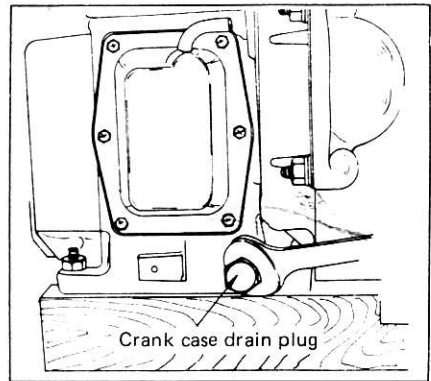
YSE8	8.8 kg-m	63.7 ft-lb
YSE12	12.4 kg-m	79.7 ft-lb

9-2-3 Check the tension of the cooling water pump and generator V belts. Press down with the thumb in the center of the belts; normal deflection is about 5 mm. To re-adjust the tension, loosen the set bolts of the cooling water pump (or alternator) and re-position it.

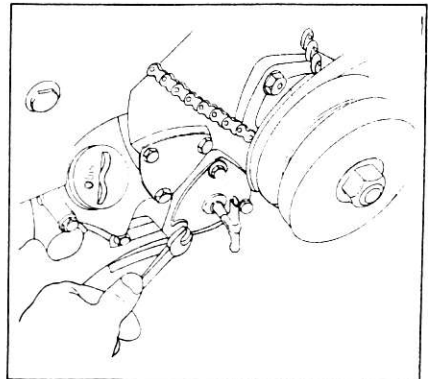


9-2-4 Drain off the lube oil from inside the crank case and wash the interior with light oil. Then fill with lube oil. (This should be performed after the first 50 hours of operation in the case of a new engine.)

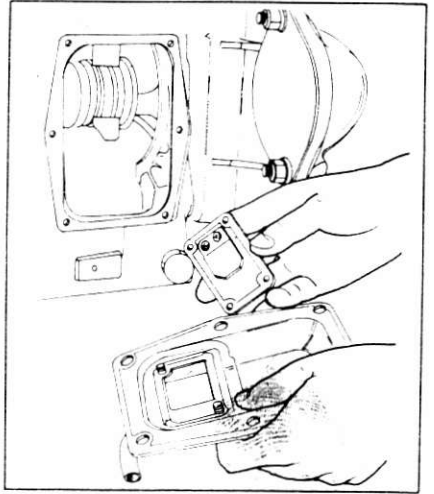
- (1) Drain off the old lube oil after first running the engine until it is warm. The drain plug is located below the rear cylinder cover.
- (2) Remove the rear cylinder cover and wash the inside of the crank case with light oil before filling with new oil.



9-2-5 Clean the inside of the lube oil filter. Remove the 3 filter cover set bolts and pull out the filter. Wash thoroughly with light oil. Brush off dirt adhering to the filter plates.



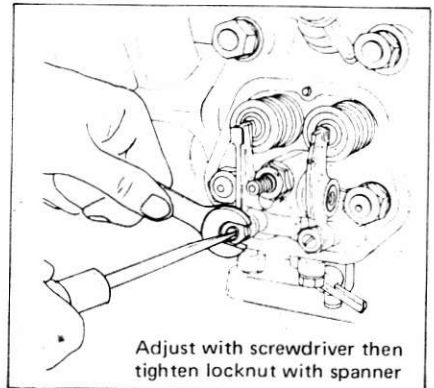
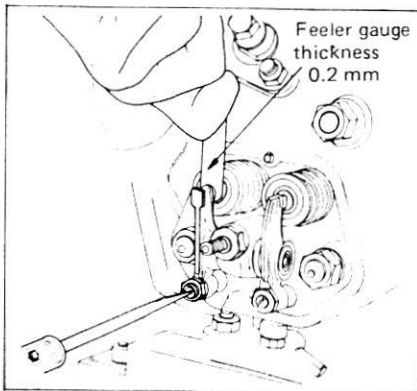
- 9-2-6 Clean the breather valve.
The breather valve is attached to the inside of the rear cylinder cover. Remove the breather valve assembly from the cover and, without stripping, wash it thoroughly in light oil.



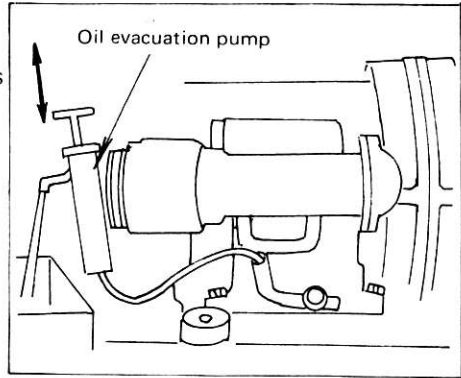
9-3 Every 250 Hours

- 9-3-1 Check intake and exhaust valve-tip and rocker arm clearances.

- (1) Checking valve clearance should be done when the engine is cold.
- (2) Remove the rocker box cover and rotate the engine manually until compression occurs. This closes the intake and exhaust valves.
- (3) Check the clearance between each valve-tip and rocker arm with a feeler gauge. Normal clearance is 0.2 mm.
- (4) If necessary, adjust the clearance by means of the adjusting screw below the rocker arm. Tighten the locknut securely after adjustment.



- 9-3-2 Change the lube oil in the crank case. Pump out the old oil from the crank case while the engine is still warm. Refill with new lube oil.

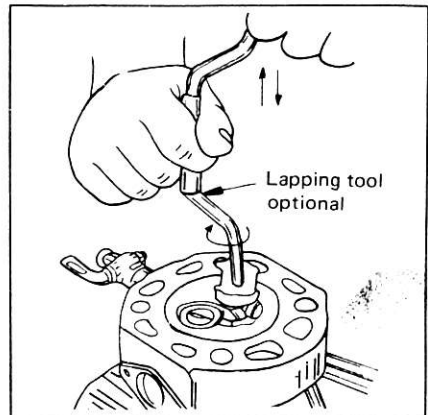


9-4 Every 500 Hours

- 9-4-1 Strip and clean the cylinder head and lap the valve seats. (Consult your dealer if possible.)

- (1) Remove the cylinder head and strip the precombustion chamber, valve springs and valves.
- (2) Remove rust and carbon deposited inside the precombustion chamber, on the valve seats, on the cylinder head joint surface and on the top of the piston. Take care not to damage the metal surfaces.
- (3) Check the clearance between the valve stems and valve guides. If clearance is excessively wide, the cylinder head must be replaced. Also check that there is sufficient lube oil inside the rocker arm chamber.

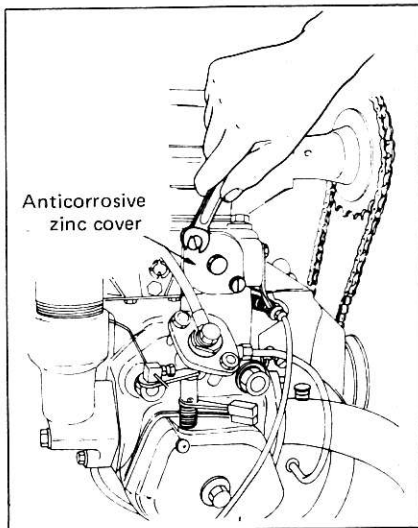
- (4) Lap the valve seats. First remove the roughest parts with coarse lapping powder. Then lap with a fine lapping powder and finish with lube oil.



- 9-4-2 Replace the fuel filter element.

- 9-4-3 Disassemble the fuel injection valve and clean the needle valve. Check fuel injection after re-assembly (see Section 13).
- 9-4-4 Adjust the governor lever (fuel injection regulator). For details, see Section 14.
- 9-4-5 Check fuel injection timing (see Section 15).

- 9-4-6 Replace the anticorrosive zinc. Remove the anticorrosive zinc cover located at the side of the cooling water outlet pipe (cylinder side) and replace the zinc.
Anticorrosive zinc prevents electrolytic corrosion inside the engine. Failure to replace it regularly leads to serious damage.



- 9-4-7 Take out the piston and remove carbon deposits. Also replace the piston rings (see Section 17). (Consult your dealer if possible.)



10. ADJUSTMENT, STRIPPING AND RE-ASSEMBLY

10-1 Precautions During Stripping

Periodical checks, adjustments and maintenance help ensure that the engine is kept in good condition at all times. In this way, faults can be repaired in their early stages before develop into serious breakdowns. Regular visual checking of the various parts of the engine is also important.

About once a year, the engine must be stripped and overhauled. When stripping, be sure to observe the following: (This applies to engines of commercial application).

- (1) Before stripping, thoroughly study the structure and function of each part so as not to waste time or cause damage by touching unnecessary parts. Make a note of the method of assembly of each part and be sure you know how to re-assemble it.
- (2) Prepare a board on which to arrange the stripped parts.. Wash all parts thoroughly, and place them on the board in the correct order.
- (3) Use the proper tools. Take care not to damage or scratch the parts.
- (4) To avoid losing parts, screw nuts, washers, etc., onto the bolts to which they belong when placing them on the board.
- (5) During stripping, note the position of alignment marks. The following parts have alignment marks: Connecting rod BIG end, camshaft gear and crankshaft gear, joint for thrust shaft and propeller shaft (or intermediate shaft). Where necessary, make your own alignment marks.
- (6) Repair worn sections, hammer marks, scratches and other minor damage. It is not necessary to remove large scratches entirely, but be sure to smooth down all rough edges.
- (7) Clean the inside of the crank case and other parts which are normally difficult to reach.

10-2 Precautions During Re-assembly

In general, re-assembly follows Stripping procedure in reverse. Note the following:

- (1) Wash all parts thoroughly and align all setting marks to ensure correct centering.
- (2) Tighten all nuts and bolts evenly.
- (3) Replace all split pins, claw washers and packings.
- (4) Make sure that split pins fit tightly into the holes, and split the ends after attaching. Also be sure to bend claw washers properly.
- (5) Smear the all bearings and other sliding and interlocking parts with lube oil. Apply manually; do not use a cloth.
- (6) Give special attention to the governor gear alignment marks and to the adjustment of the governor and the fuel injection system. Also take care to adjust fuel injection timing and valve clearance correctly.
- (7) Be sure to align all alignment marks (on connecting rod BIG end, gears, etc.).
- (8) After re-assembly, turn the engine with the starting handle and check that no abnormal noise or abrasion is produced.
- (9) Check that there are no leaks in the cooling water, fuel and lube oil pipe systems.

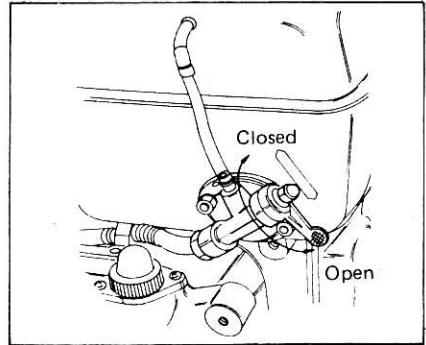
When re-assembly is complete, check once more that everything is normal. Then supply fuel and lube oil and carry out a test operation. If the cylinder liners or piston have been replaced, allow at least 3 hours operation for fitting. Repair any faults detected at this time.

11. AIR VENTING OF FUEL INJECTION SYSTEM

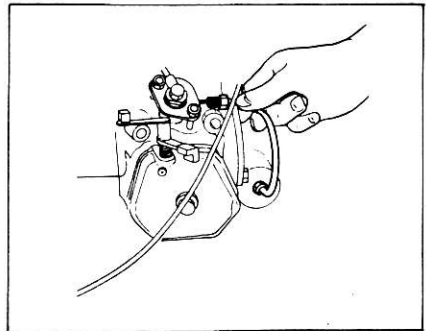
The fuel injection system comprises the fuel tank, the fuel injection pump, the fuel injection pipe and the fuel injection valve. Fuel is not injected if air is present anywhere in this system.

Air enters the system when fuel runs out and when the fuel injection pump is stripped. It should be bented as follows:

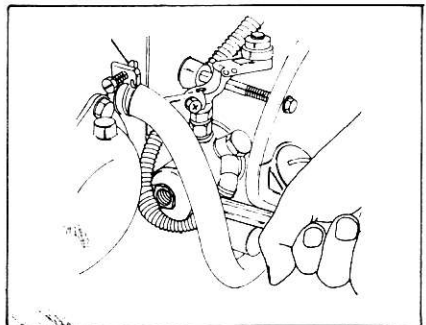
- (1) Replace the fuel cock in the open position.



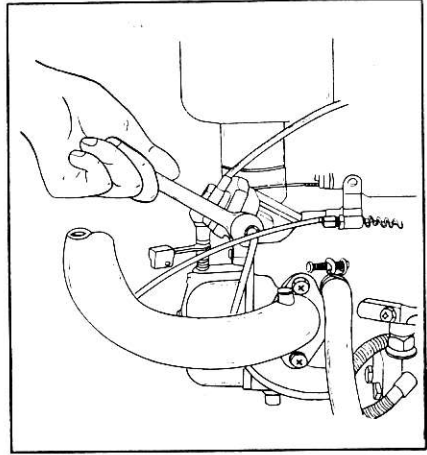
- (2) Loosen the nipples at each end of the fuel injection pipe. Set the governor lever to LOW.



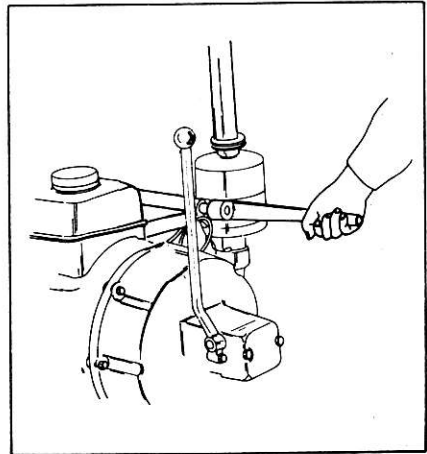
- (3) Loosen the delivery valve holder (by about two turns), and when bubble-free fuel comes out, securely tighten the delivery valve holder, and then, after attaching the injection pipe, securely tighten the fuel pump side nipple.



- (4) Now turn the engine with the starting handle about 30 times. Oil is circulated and comes out from the nipple on the injection valve side. When no more air bubbles are present in the oil, tighten the nipple.



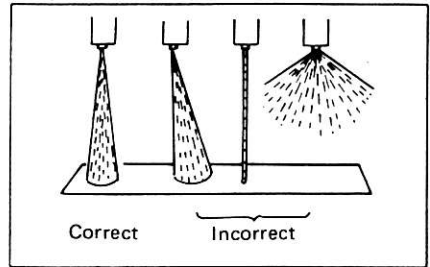
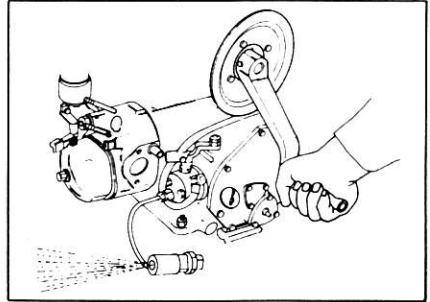
- (5) Continue turning the engine until you hear the sound of fuel being injected. This indicates that the air has been completely vented.



12. CHECKING FUEL INJECTION VALVE

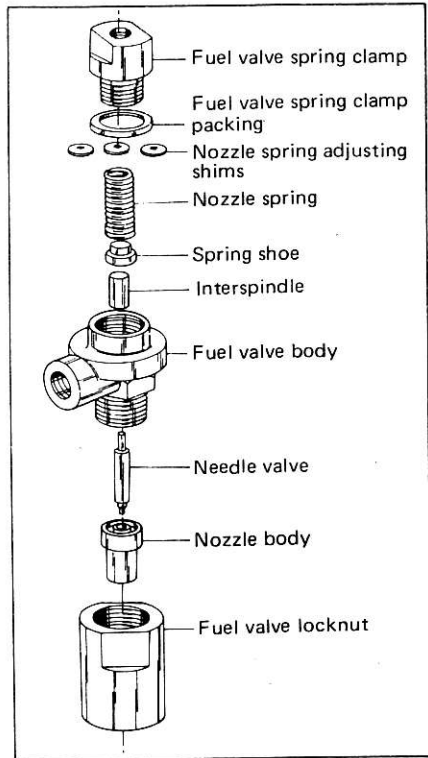
Bad exhaust color and reduced output power are often the result of unsatisfactory fuel injection. Check as follows:

- (1) Remove the fuel injection pipe and take out the fuel injection valve assembly from the cylinder head.
- (2) Install the valve outside the engine as shown in the illustration.
- (3) Vent the air from the fuel injection system (see Section 12).
- (4) After air venting, turn the starting handle and observe the atomization of the fuel as it is injected from the nozzle. Keep your face well clear.
- (5) Normally, fuel is injected in a fine, cone-shaped spray (see illustration).



If fuel atomization is abnormal, strip the fuel injection valve assembly and check that the nozzle valve has not seized due to dirt, etc., in the nozzle body. The needle valve should move smoothly inside the nozzle body; after stripping, wash these parts in light oil and re-assemble, taking care to keep them clean. Then check fuel atomization once more as explained above. If injection is still faulty, have your local dealer replace the injection valve assembly or adjust the fuel injection pressure. (Standard fuel injection pressure: 160 kg/cm²)

Fuel injection valve diagram.

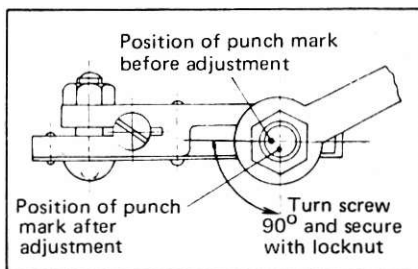


13. ADJUSTING FUEL INJECTION REGULATOR

The function of the governor is to react accurately to variations in the load on the engine. The fuel injection regulator transmits the action of the governor to the fuel injection pump by regulating the amount of fuel supplied, thereby maintaining stable operation at all times. The regulator must be adjusted whenever the fuel pump is stripped and when fuel injection sound becomes indistinct after long periods of operation.

When fuel injection sound is indistinct, adjust as follows:

- (1) Loosen the connecting screw locknut.
- (2) Turn the connecting screw 90° counterclockwise, so that the punch mark comes to the near side.
- (3) Tighten the locknut securely.

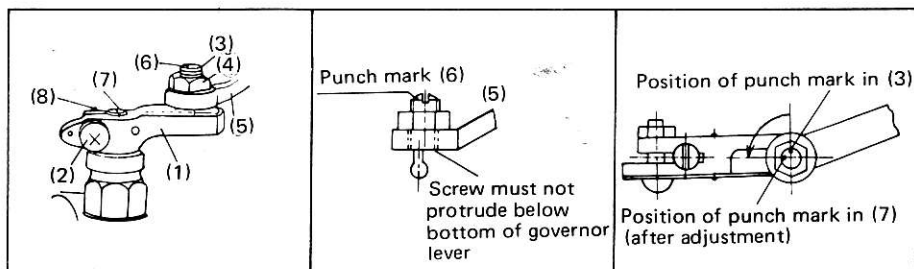


If adjustment again becomes necessary, or if the fuel injection pump has been stripped, adjust as follows:

- (1) Loosen screw (2) and locknut (4).
- (2) Set the speed control lever to HIGH.
- (3) Screw in connecting screw (3), making sure that its bottom end does not protrude below the bottom surface of the governor lever (5). Set the punch mark (6) to the cylinder side so that the groove in the screw head is parallel to the pump adjusting lever (1).
- (4) Insert a screwdriver into the groove on the top of the regulator spindle (7) and screw clockwise until it tightens lightly.
- (5) Tighten screw (2), holding the pump regulator lever with your left hand to prevent it moving. Secure with locknut (8).

- (6) Turn the engine by hand and listen for the sound of fuel being injected. If no sound is heard, the cause is probably one of the following: insufficient air venting, regulator spindle not screwed in far enough, wear in valve seat of regulator needle valve.
- (7) Now turn the connecting screw (3) 90° counterclockwise so that the groove is at right angles to the pump adjusting lever (1).
- (8) Tighten locknut (4).

Run the engine and check operation. If it is still unsatisfactory, repeat the adjustment.



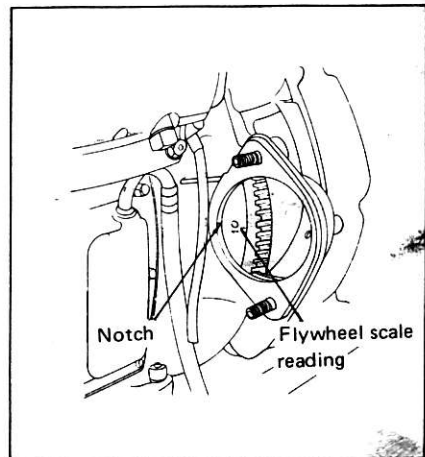
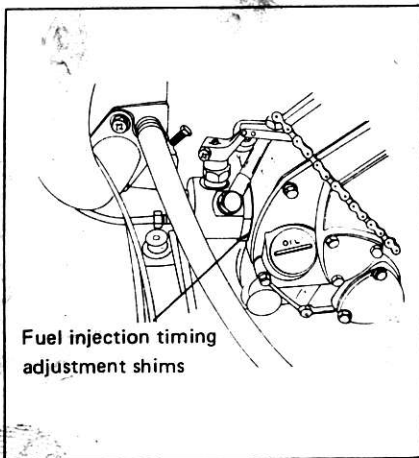
14. CHECKING AND ADJUSTING FUEL INJECTION TIMING

The fuel injection starting position for this engine is 8° - 12° before T.D.C. (angle of crankshaft rotation). Check the timing as follows:

- (1) Remove the cover of the starter mounting hole located behind the crank case.
- (2) Set the speed control lever to HIGH.
- (3) Raise the decompression lever and gently turn the engine manually. At compression stroke, lock through the open hatch and stop when the scale readings on the flywheel come into view.
- (4) Turn the PTO shaft or starting shaft in the direction of rotation, and stop immediately you hear the sound of fuel being injected. Read off the scale readings by the notch in the edge of the starter mounting hole. Repeat several times and calculate the average reading.

Fuel injection should start 8° - 12° before the T.D.C. mark. If timing is too late or too early, adjust by reducing or increasing the adjustment shims between the fuel injection pump body and the cylinder body.

One 1 mm adjustment shim alters the timing by 1° , one 2 mm adjustment shim by 2° . If timing is advanced, add shims; if timing is delayed, remove plates.

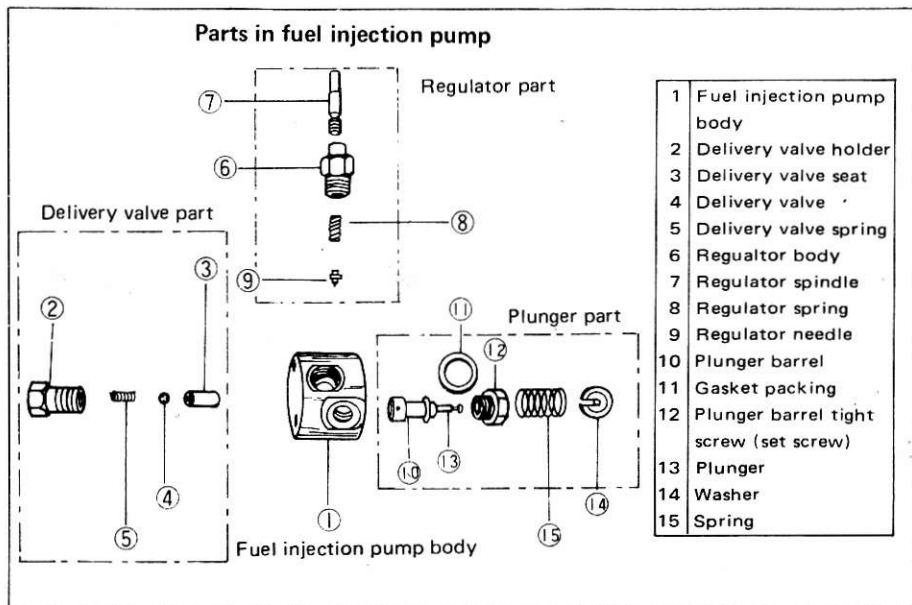


15. STRIPPING AND RE-ASSEMBLY OF FUEL INJECTION PUMP

The fuel injection pump should only be stripped for the purpose of replacing worn parts (plunger assy., delivery valve assy., regulator needle, etc.). If fuel injection fails to occur after air venting or adjustment of the fuel injection regulator, the delivery valve may be stripped for cleaning or replacement.

Most faults in the fuel injection system result from the use of impure fuel and failure to clean the fuel filter regularly. Regular maintenance is vital.

The instructions given here are intended only to acquaint the user with the structure of the fuel injection pump. As stated above, stripping should never be attempted unless absolutely necessary.



The fuel injection pump consists of four sections: the pump body (1), the delivery valve assembly (2) - (5), the regulator assembly (6) - (9) and the plunger assembly (10) - (15).

15-1 Delivery Valve

How to take apart

- (1) Remove the fuel injection pipe.
- (2) Remove the delivery valve holder (2). This reveals the delivery valve seat (3) which accommodates the delivery valve (4) and the delivery valve spring (5).

Assembly

- (1) Wash all parts carefully and assemble inside the delivery valve holder. Be sure to mount the parts in the correct order.
- (2) Re-attach the delivery valve holder to the fuel pump body. Follow by air venting (see Section 12).

15-2 Regulator

How to take apart

- (1) Loosen the pump adjusting lever set bolt and remove from the regulator spindle (7).
- (2) Loosen the regulator body (6) and remove it from the fuel pump body (1). Regulator spring (8) and regulator needle (9) can now be removed.

Assembly

- (1) Wash all parts carefully and firstly assemble the regulator part. First smear a small amount of engine oil onto the screw section of the regulator spindle. Assemble the regulator spring (8) and regulator needle (9) at the tip of the spindle.
- (2) Insert the regulator spring (8) and regulator needle (9) in the regulator body (6), and screw **slightly** the regulator spindle (7) in the regulator body from opposite side. If the regulator spindle is screwed up deeply, the regulator needle seat may be damaged.
- (3) Screw the regulator spindle and check that it rotates smoothly. Then gently screw down clockwise.

- (4) Insert the fuel pump adjusting lever into the top of the regulator spindle, then adjust the fuel regulator as explained in Section 14.

15-3 Plunger

How to take apart

- (1) Remove the fuel injection pipe and the pump adjusting lever.
- (2) Remove the delivery valve holder (2) and remove the delivery valve assembly.
- (3) Remove the two fuel pump body set bolts evenly and remove the fuel pump body. Parts (13) - (15) can now be stripped.
If the plunger is not worn (i.e. does not need replacing), it is not necessary to go further. If the plunger is to be replaced, however, continue as follows:
- (4) Attach the fuel pump body to the cylinder body in reverse with the set bolts.
- (5) Fit an offset wrench (19 mm) carefully onto the plunger barrel set screw (12) and undo. (Using a spanner is likely to damage the nut.)

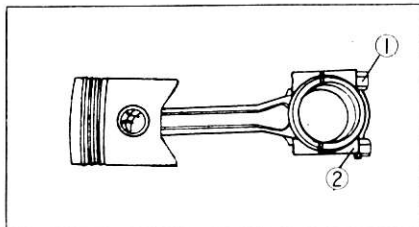
Assembly

- (1) Replace plunger barrel (10), plunger (13) and the gasket packing (11) and wash all parts in clean oil.
- (2) Attach the fuel pump body to the cylinder body in reverse, as above. Secure the plunger barrel (10) with the set screw (12); make sure that the fuel holes in the plunger barrel are positioned horizontally. Secure with the plunger mounted inside the plunger barrel. Use the off set wrench, as above.
- (3) Check that the plunger moves easily. If it is stiff, loosen the set screw and re-position.
- (4) Attach the plunger spring (15) and washer (14) and hold the fuel injection pump against the cylinder body. Secure with the set bolts. Be sure to tighten these evenly.

16. CHECKING PISTON

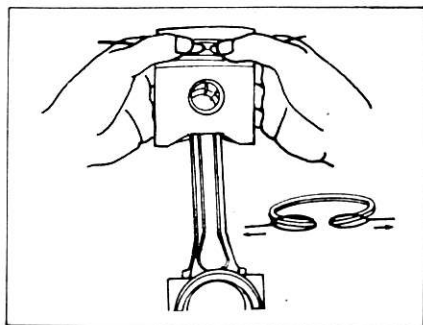
Checking the piston and replacement of the piston rings should be carried out as follows:

- (1) Remove the rocker arm chamber and the cylinder head. Remove carbon from the top of the cylinder liner.
- (2) Remove the rear cover of the cylinder.
- (3) Remove connecting rod bolt (1). (No lock washer is used.)
- (4) Remove the cap (2) of the crank pin metal and rotate the flywheel until the piston is in the T.D.C. position.
- (5) Place a hammer handle against the end of the connecting rod and knock out the piston assembly towards the cylinder head.



Checking Piston

Examine the outer surface of the piston and smooth down rough parts with oil-stone. Remove the piston rings with a loop of wire as illustrated. Clean out the carbon from the ring grooves and wash in light oil. Take care not to scratch the grooves.



Piston Rings

The first ring is chrome-plated for maximum protection against wear. When the plating peels, the ring must be replaced. Replace other rings if vertical scratches are present on the sliding surface or if there are traces of gas leaks. Worn piston rings cause compression leaks and gas leaks, leading to reduced output power, starting faults and deterioration of lube oil.

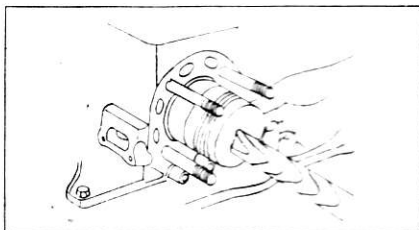
Attaching Piston Rings

Attach the rings using the wire loop above. Make sure that the mark in each piston ring is on the cylinder head side, and take care not to damage or distort the rings by opening them too far. Check that the rings turn smoothly in the ring grooves; if they do not, clean the grooves once more.

Inserting Piston

Using the special tool, insert the piston as follows:

- (1) Set the flywheel to the T.D.C. position.
- (2) Coat the piston with new lube oil and position the piston ring ends at 90° intervals.
- (3) Insert the piston as illustrated with the JIG end mark to the top. Hammering in the piston damages the piston rings.
- (4) When the BIG end of the connecting rod fits into the crank, push in the piston while turning the flywheel.
- (5) Attach the BIG end metal cap with the mark upwards. Coat the metal with new lube oil.



NB: Check that the metal is present when inserting the piston.

- (6) Insert the connecting rod bolts and tighten securely.

Tightening torque:

YSE8	3.0 kg-m	21.7 ft-lb
YSE12	3.5 kg-m	25.3 ft-lb