

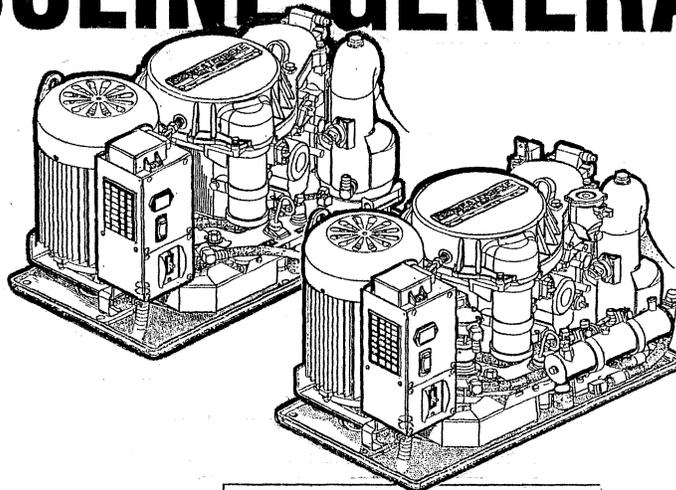


# **SERVICE MANUAL**

## **3.0 BPMG and 3.0 BCG**

### **60 and 50 HERTZ SINGLE PHASE**

# **GASOLINE GENERATORS**



**PUBLICATION NO. 52089**  
**REVISION 3**  
**APRIL 2018**



WESTERBEKE CORPORATION • 150 JOHN HANCOCK ROAD  
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**⚠ WARNING**

**Exhaust gasses contain Carbon Monoxide, an odorless and colorless gas. Carbon Monoxide is poisonous and can cause unconsciousness and death. Symptoms of Carbon Monoxide exposure can include:**

- **Dizziness**
- **Nausea**
- **Headache**
- **Weakness and Sleepiness**
- **Throbbing in Temples**
- **Muscular Twitching**
- **Vomiting**
- **Inability to Think Coherently**

**IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not restart until it has been inspected and repaired.**



**A WARNING DECAL is provided by WESTERBEKE and should be fixed to a bulkhead near your engine or generator. WESTERBEKE also recommends installing CARBON MONOXIDE DETECTORS in the living/sleeping quarters of your vessel. They are inexpensive and easily obtainable at your local marine store.**

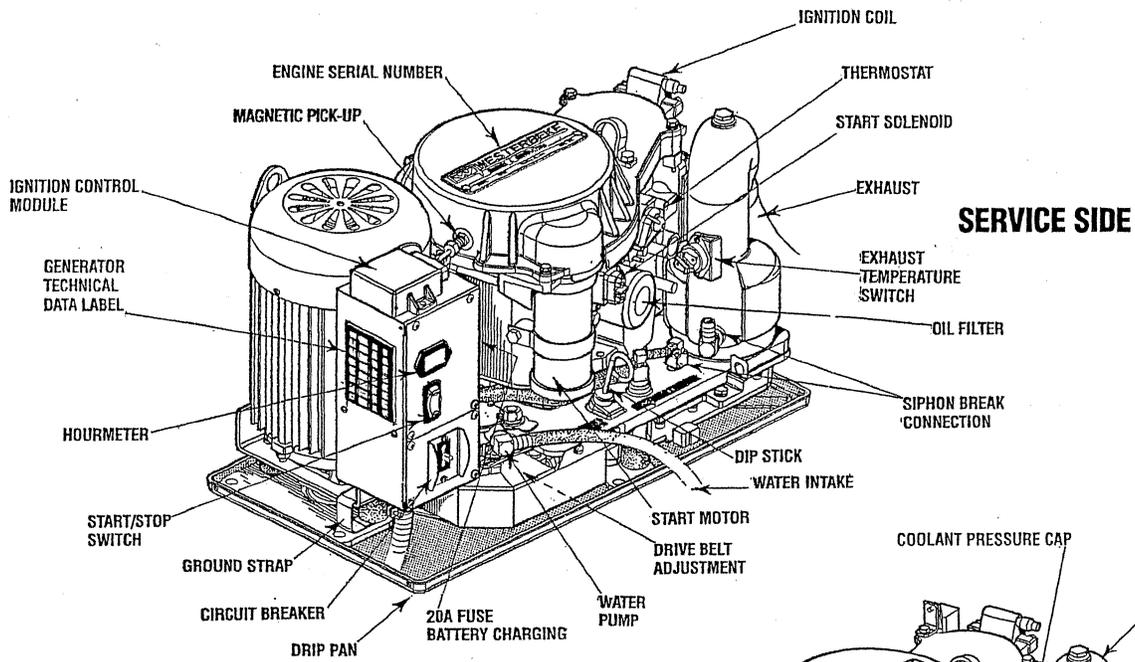
**CALIFORNIA  
PROPOSITION 65 WARNING**

**Marine diesel and gasoline engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.**

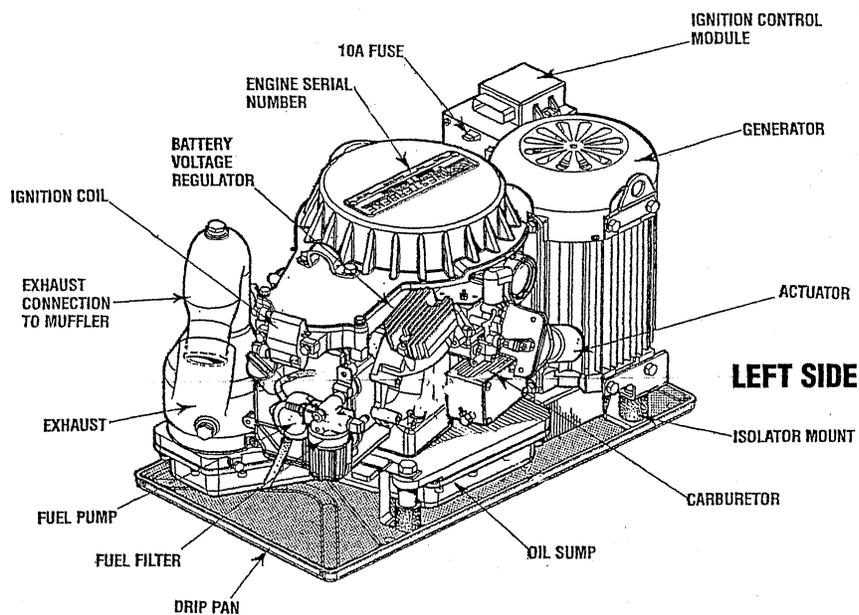
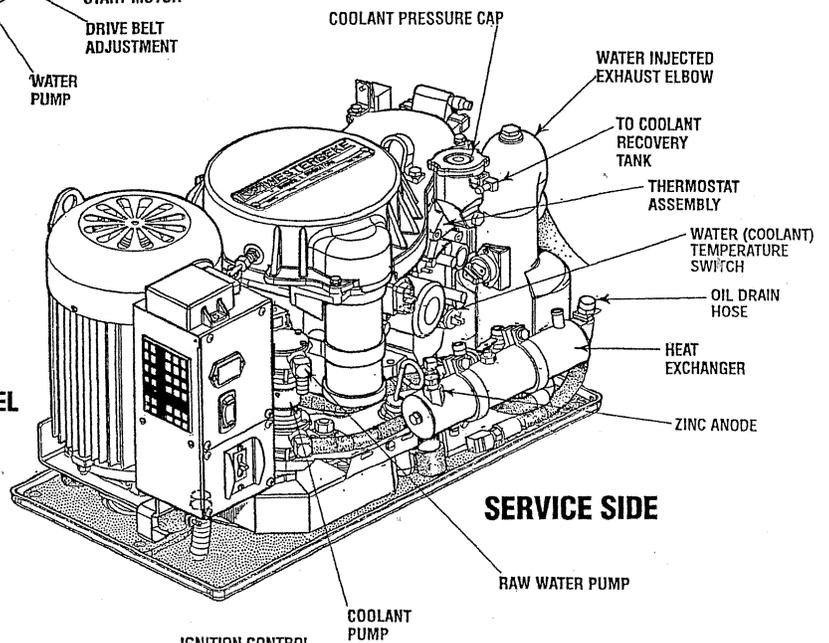
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# PARTS IDENTIFICATION



## FRESH WATER (COOLANT) MODEL



# TESTING FOR OVERHAUL

## HOW TO DETERMINE ENGINE OVERHAUL PERIOD

### Cause of Low Compression

Generally, the time at which an engine should be overhauled is determined by various conditions such as lowered engine power output, decreased compression pressure, and increased fuel and oil consumption. The lowered engine power output is not necessarily due to trouble with the engine itself, but is sometimes caused by improper oil, clogged filters or a faulty carburetor.

The decrease in compression pressure is caused by many factors. It is, therefore, necessary to determine a cause or causes on the basis of data produced by periodic inspection and maintenance. Oil analysis on a seasonal basis is a good means of monitoring engine internal wear. When caused by worn cylinders or piston rings, the following symptoms will occur:

- 1 Low engine power output
- 2 Increased fuel consumption
- 3 Increased oil consumption
- 4 Hard engine starting
- 5 Noisy engine operation

These symptoms often appear together. Symptoms 2 and 4 can result also from improper fuel regulation or a faulty carburetor. They are caused also by defective electrical devices such as the battery, starter or spark plugs. Therefore it is desirable to judge the optimum engine overhaul time by the lowered compression pressure caused by worn cylinders and pistons plus increased oil consumption. Satisfactory combustion is obtained only under sufficient compression pressure. If an engine lacks compression pressure, incomplete combustion of fuel will take place even if other parts of the engine are operating properly. To determine the period of engine overhaul, it is important to measure the engine compression pressure regularly. At the same time, the engine speed at which the measurement of compression pressure is made should be checked because the compression pressure varies with engine rpm. The engine rpm can be measured at the front end of the crankshaft.

**NOTE:** To test engine compression see the *ENGINE ADJUSTMENT* section of this manual.

## OVERHAUL CONDITIONS

Compression pressure tends to increase a little in a new engine until piston rings and valve seats have been broken in. Thereafter, it decreases gradually with the progress of wear of these parts.

When decrease of compression pressure reaches the repair limit, the engine must be overhauled.

The engine requires overhaul when oil consumption is high, blowby evident, and compression values are at minimum or below.

# TROUBLESHOOTING GUIDE 3.0 KW BPMG

When troubleshooting indicates an electrical problem, see the ELECTRICAL SYSTEM WIRING DIAGRAM, as this may reveal other possible causes of the problem which are not listed below.

The following troubleshooting tables are based upon certain engine problem indicators and the most likely causes of the problems

PROBLEM	PROBABLE CAUSE	PROBLEM	PROBABLE CAUSE
Engine does not crank.	<ol style="list-style-type: none"> <li>1. Voltage drop at starter solenoid terminal.</li> <li>2. Main 10 amp fuse blown.</li> <li>4. Battery is low or dead.</li> <li>5. Loose battery connections.</li> <li>6. Faulty wire connection.</li> <li>7. Faulty start switch.</li> <li>8. Faulty pc board</li> <li>9. Faulty starter solenoid</li> <li>10. Water filled cylinders.</li> </ol>	Engine misfires.	<ol style="list-style-type: none"> <li>1. Poor quality fuel.</li> <li>2. Faulty ignition control module.</li> <li>3. Dirty flame arrester.</li> <li>4. Faulty ignition wires.</li> <li>5. Spark plugs are worn.</li> <li>6. Binding actuator linkage.</li> <li>7. High exhaust back-pressure.</li> <li>8. Valve clearances are incorrect.</li> <li>9. Valve clearances are incorrect.</li> </ol>
Engine starts, runs and then shuts down.	<ol style="list-style-type: none"> <li>1. Faulty shutdown switch,(oil pressure, or exhaust temperature).</li> <li>2. Faulty overspeed switch.</li> <li>3. Dirty fuel/water separator filter.</li> <li>4. Clogged fuel line.</li> <li>5. Low oil level in sump.</li> <li>6. Faulty fuel pump.</li> <li>7. No fuel</li> <li>8. Clogged fuel filter</li> </ol>	Engine backfires.	<ol style="list-style-type: none"> <li>1. Faulty ignition control module.</li> <li>2. Incorrect timing.</li> <li>3. Engine is flooded. See <i>Engine is flooded under Engine cranks but fails to start.</i></li> <li>4. Dirty flame arrester.</li> <li>5. Faulty ignition coil.</li> <li>6. High exhaust back-pressure.</li> </ol>
Engine starts, runs but does not come up to speed.	<ol style="list-style-type: none"> <li>1. Faulty mag-pickup sensor.</li> <li>2. Electronic governor controller faulty,</li> <li>3. Fuel pump.</li> <li>4. Fuel supply to engine restricted.</li> <li>5. Actuator linkage binding.</li> <li>6. Actuator or electrical connections faulty.</li> <li>7. Air intake restricted.</li> <li>8. Exhaust restricted.</li> </ol>	Engine overheats.	<ol style="list-style-type: none"> <li>1. Blockage in cooling water flow: inspect the raw water intake, intake strainer, pump impellers, and look for broken or seperated hoses.</li> <li>2. Belts may be loose or broken.</li> <li>3. Obstructed by-pass hose.</li> </ol>
Engine cranks but fails to start. (Engine will crank for 15 seconds)	<ol style="list-style-type: none"> <li>1. Out of fuel.</li> <li>2. Engine is flooded.</li> <li>3. Faulty carburetor. (See <i>Carburetor page</i>)</li> <li>4. Faulty choke solenoid</li> <li>5. Faulty ignition coil.</li> <li>6. Bad spark plugs</li> </ol>	Low oil pressure.	<ol style="list-style-type: none"> <li>1. Low oil level.</li> <li>2. Wrong SAE type oil in the engine.</li> <li>3. Oil diluted with fuel.</li> <li>4. Relief valve is stuck.</li> <li>5. Faulty oil pump.</li> <li>6. Faulty engine bearings.</li> <li>7. Boat heeled over too much.</li> <li>8. Faulty oil filter.</li> </ol>
Engine hunts.	<ol style="list-style-type: none"> <li>1. Controller gain adjustment needed.</li> <li>2. Faulty fuel pump.</li> <li>3. Faulty PC board.</li> <li>4. Improper drive belt tension.</li> <li>5. Low DC battery voltage.</li> <li>6. High exhaust back pressure.</li> <li>7. Dirty fuel filter</li> <li>8. Generator overload.</li> <li>9. Valves need adjustment.</li> </ol>	High oil pressure.	<ol style="list-style-type: none"> <li>1. Dirty oil or wrong SAE type oil in the engine.</li> <li>2. Relief valve is stuck.</li> </ol>
		No DC charge to the starting battery.	<ol style="list-style-type: none"> <li>1. Faulty connections to battery charging control.</li> <li>2. 20 amp fuse blown/faulty.</li> <li>3. Faulty voltage regulator.</li> <li>4. Faulty magneto.</li> </ol>

# TROUBLESHOOTING GUIDE 3.0 KW BPMG

PROBLEM	PROBABLE CAUSE
<b>Blue Exhaust Smoke Discharge from the Engine</b>	<ol style="list-style-type: none"> <li>1. Lube oil is diluted.</li> <li>2. High lube oil level.</li> <li>3. Crankcase breather hose is clogged.</li> <li>4. Valves are worn or adjusted incorrectly.</li> <li>5. Piston rings are worn or unseated.</li> </ol>
<b>Black exhaust smoke Discharge from the Engine</b>	<ol style="list-style-type: none"> <li>1. Dirty flame arrester.</li> <li>2. Faulty carburetor.</li> <li>3. Idle mixture jet too rich.</li> <li>4. Accelerator diaphragm leaking.</li> <li>5. Valves are worn or incorrectly adjusted.</li> <li>6. Piston rings are worn or unseated.</li> </ol>
<b>Poor performance at generator speed</b>	<ol style="list-style-type: none"> <li>1. Contaminates in carburetor.</li> <li>2. Faulty fuel pump/contaminated.</li> <li>3. Electronic governor controller needs adjustment.</li> </ol>
<b>Starter stays energized after start</b>	<ol style="list-style-type: none"> <li>1. Faulty MPU suspected. Check MPU.</li> <li>2. Faulty starter solenoid.</li> </ol>
<b>Unit starts and runs at idle speed</b>	<ol style="list-style-type: none"> <li>1. Check MPU signal. 1.5 - 2.0 VAC cranking.</li> <li>2. Faulty overspeed board.</li> </ol>

**Note:** MPU voltages to PC board:  
 Cranking: 1.5 - 2.0 VAC  
 Running: 4.0 - 5.0 VAC  
 (2200 rpm)

# DISASSEMBLY / ASSEMBLY PROCEDURES

## DISASSEMBLY

- Before disassembly and cleaning, carefully check for defects which cannot be found after disassembly and cleaning.
- Drain water, fuel and oil before disassembly.
- Clean or wash the engine exterior.
- Do not remove or disassemble the parts that require no disassembly.
- Perform disassembly in a proper order using proper tools. Keep disassembled parts in order. Apply oil when necessary. Take special care to keep the fuel system parts from intrusion of dust and dirt.
- Parts must be restored to their respective components from which they were removed at disassembly. This means that all parts must be set aside separately in groups, each marked for its component, so that the same combination or set can be reproduced at assembly.
- Pay attention to marks on assemblies, components and parts for their positions or directions. Put on marks, if necessary, to aid assembly.
- Carefully check each part or component for any sign of faulty condition during removal or cleaning. The part will tell you how it acted or what was abnormal about it more accurately during removal or cleaning.

The parts assembled with the silicone can be easily disassembled without use of a special method. In some case however, the sealant between the joined surfaces may have to be broken by lightly striking with a mallet or similar tool. A flat and thin gasket scraper may be lightly hammered in between the joined surfaces. In this case, care must be taken to prevent damage to the joined surfaces. For removal of the oil pan, use a special "oil pan remover".

## ASSEMBLY

- Wash all parts, except for oil seals, O-rings, rubber sheets, etc., with cleaning solvent and dry them with pressure air.
- Always use tools that are in good condition and be sure you understand how to use them before performing any job.
- Use only good quality lubricants. Be sure to apply a coat of oil, grease or sealant to parts as specified.
- Be sure to use a torque wrench to tighten parts for which torques are specified.
- When the engine is assembled, new gaskets and O-rings must be installed.

## Surface Preparation

Thoroughly removes all substances deposited on the gasket application surfaces using a gasket scraper or wire brush. Check to ensure that the surfaces to which the silicone gasket is to be applied is flat. make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do not forget to remove the old sealant that remains in the bolt holes.

## GASKET INFORMATION

The engine has several areas where form-in-place RTV silicone gaskets are used such as LOCTITE 598 or GE RTV 100. To ensure that the gasket fully serves its purpose, it is necessary to observe some precaution when applying the gasket. Bead size, continuity and location are very important. Too thin a bead could cause leaks and too thick a bead could be squeezed out of location causing blocking or narrowing of the fluid feed lines. To eliminate the possibility of leaks from a joint, it is necessary to apply the gasket evenly without a break while observing the correct bead size.

The gasket material used in the engine is a room temperature vulcanization (RTV) type and is supplied in a 14oz (400 gram) applicator/tube. The RTV hardens as it reacts with the moisture in the atmospheric air and can be used for sealing both engine oil and coolant assemblies.

# APPLICATION OF SEALANTS AND LUBRICANTS

Parts Name	Items								Insulated Grease	Teflon Grease	Cold-resistant Lithium Grease	Grease for OBM	4st Engine Oil	Specified Gear Oil	Oil Compound Jyetsu-Silicone	Silicone Sealant	Remarks
	Three Bond 1342	Three Bond 1373B	Instantaneous Adhesive Three Bond 1741	Three Bond 1207B	Loctite 518	Bond G17	Loctite KS-64	Silicone Sealant 5900									
Engine block																	
Cylinder liner												●					Inside wall
Piston												●					Ring groove, Periphery
Piston ring												●					Periphery
Piston pin												●					Periphery
Connecting rod												●					Inside big and small ends
Metal (Cylinder block, crank case)												●					Both sides
Crank shaft (thrust place)												●					Sliding surfaces
Crank shaft oil seal										●							Lips
Crank case cylinder mating surface						●											Joint part
Valve (IN, EX)												●					Shaft, Stem head
Valve stem seal (IN, EX)												●					Lips
Retainer												●					Complete
Valve spring seat												●					Complete
Valve spring												●					Complete
Camshaft												●					Bearing, cam
Camshaft oil seal										●							Lips
Cam pulley bolt	●																Thread
Rocker arm												●					Bearing, Slipper
Rocker arm shaft												●					Shaft, side
Tappet adjust screw												●					Complete
Washer (rocker arm, t=0.5)												●					Complete
Washer (rocker arm, t=2.5)												●					Complete
Spring (rocker arm, free length 30 mm and 51 mm)												●					Complete
Fuel pump												●					Periphery of O-ring, end of plunger
Oil pump												●					2ml at Suction port and discharge port , Boss part O-ring
Oil pump O-ring (ø1.5 - 10.7)												●					
Oil pump O-ring (ø1.5 - 8.5)												●					
Oil pump O-ring (ø1.5 - 15.5)												●					
Oil pressure switch	●																Thread

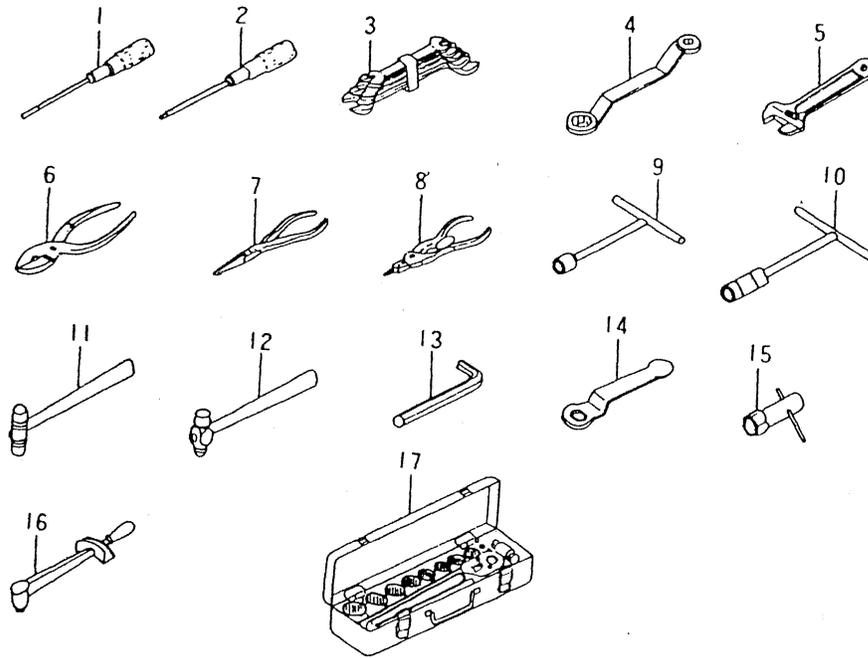
# APPLICATION OF SEALANTS AND LUBRICANTS

	Items											Remarks								
		Parts Name		Three Bond	Three Bond	Instantaneous Adhesive	Three Bond	Loctite	Bond	Insulated Grease	Teflon Grease		Cold-resistant Lithium Grease	Grease for OBM	4st Engine Oil	Specified Gear Oil	Oil Compound	Jyoetsu-Silicone	Loctite	Silicone Sealant
				1342	1373B	1741	1207B	518	G17											KS-64
Engine block	Oil filter												●						Seal	
	Oil filter bolt	●																	Thread	
	Plunger ass'y												●						Inside (Pour 1ml)	
	Filter cap, O-ring												●						Periphery	
	Solenoid switch								●										Terminal	
	Spark plug cap							●							●				Spark plug insertion part	
									●										High tention cord	
	Starter motor								●										Terminal	
													●						Spread at pinion part slightly	
	Starter case	●																	Bolt and screw for Reel	
												●							Friction plate, reel shaft part, Spiral spring, ratchet	
	Starter seal rubber				●															
Engine oil													●					Oil; at oil change 1000ml at overhaul 1200ml		
Oilpan gasket						●														
Bolt (upper pump case)	●																	Thread		
Upper pump case													●					Impeller sliding surfaces Joint part for water pipe guide		

# TORQUE SPECIFICATIONS

	Item	Thread size	Bolt or Nut	Tightening Torque		
				N-m	kg-m	lb-ft
Engine	Cylinder Block – Cylinder Head	M8 × 1.25	Bolt	28-30	2.8-3.0	20-22
		M6 × 1.0	Bolt	8-10	0.8-1.0	5.8-7.2
	Cylinder Block – Crank Case	M8 × 1.25	Bolt	23-25	2.3-2.5	17-18
		M6 × 1.0	Bolt	8-10	0.8-1.0	5.8-7.2
	Connecting Rod	M7 × 1.0	Bolt	11-13	1.1-1.3	8.0-9.4
	Tappet Lock Nut	M6 × 0.75	Nut	6-8	0.6-0.8	4.4-5.8
	Flywheel Cup	M16 × 1.5	Nut	70-90	7-9	51-65
	Drive (Timing) Pulley	M26 × 1.0	Nut	34-36	3.4-3.6	25-26
	Driven (Camshaft) Pulley	M6 × 1.0	Bolt	10-12	1.0-1.2	5.8-8.7
	Plunger Assembly	M16 × 1.5	–	19-21	1.9-2.1	12-15
	Oil Filter	M20 × 1.5	–	18	1.8	13
	Oil Pressure Switch	PT1/8	–	7-9	0.7-0.9	5-6
	Cylinder Head Cover	M6 × 1.0	Bolt	8-10	0.8-1.0	5.8-7.2
	Inlet Manifold	M6 × 1.0	Bolt	8-10	0.8-1.0	5.8-7.2
	Spark Plug	M12 × 1.25	–	15-20	1.5-2.0	11-15
	Engine Assembly	M8 × 1.25	Bolt	29-31	2.9-3.1	21-22

# REQUIRED TOOLS



- |  |  |
|--|--|
| 1. Straight-point screwdriver (200 mm) | 10. T-bar universal wrench (10 mm)           |
| – do. – (150 mm)                       | – do. – (12 mm)                              |
| – do. – (100 mm)                       | – do. – (13 mm)                              |
| 2. Phillips screwdriver (200 mm)       | 11. Plastic hammer                           |
| – do. – (150 mm)                       | 12. Hammer                                   |
| – do. – (100 mm)                       | 13. L-shape hexagon wrench (8 mm)            |
| 3. Set of wrenches (6 pieces)          | – do. – (10 mm)                              |
| 4. Box wrenches (10 × 13)              | 14. Box wrench (16 mm)                       |
| – do. – (17 × 21)                      | 15. Socket wrench (16 mm)                    |
| – do. – (21 × 23)                      | 16. Torque wrench (100 N – m)                |
| 5. Adjustable wrench (300 mm)          | – do. – (12 N – m)                           |
| 6. Pliers                              | – do. – (5 N – m)                            |
| 7. Needle-nose pliers                  | Pre-setting type box torque wrench           |
| 8. Snap ring pliers                    | (10 mm, 7N – m) .... for the tappet lock nut |
| 9. T-bar socket wrench (10 mm)         | 17. Socket wrench set                        |
| – do. – (12 mm)                        |  |
| – do. – (13 mm)                        |  |
| – do. – (17 mm)                        |  |

# USING SPECIAL TOOLS

## 5. How to Use Special Tools

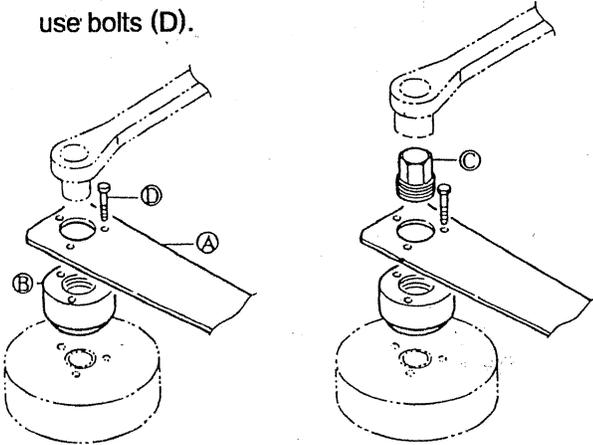
### 1. Flywheel cup puller

#### ① When disassembling

Fasten the tools **A** and **B** to the flywheel with the bolts **D**, and remove the magneto nut (right-hand screw) with the socket wrench of the correct size 24.

Next, screw tool **C** into tool **B** and tighten **C** with the socket wrench of the correct size 24.

The flywheel can be removed. Be sure to use bolts **D**.



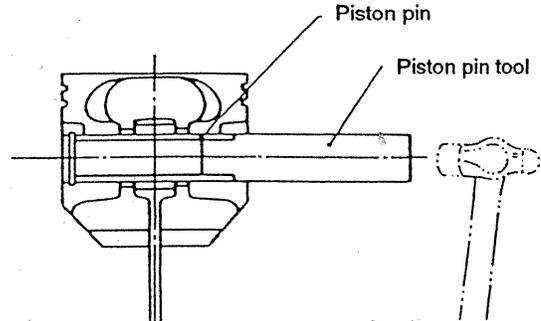
#### ② When reassembling

Before replacing the flywheel make sure that the magneto key has properly been set. After setting the washer and nut on the crank shaft, fasten tools **A** and **B** to the flywheel and tighten the nut.

Tightening torque: 70-90 N-m (7.0-9.0 kg-m)  
(51-65 lb-ft)

### 2. Piston pin tool

After removing the piston pin clip, insert the tip of the piston pin tool into the piston pin hole and lightly tap the other end of the tool with a hammer. Hold the piston with your hand to prevent damage to the connecting rod. (When inserting the piston pin again, take the same care as removing.)

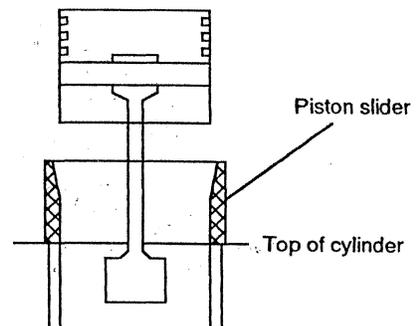


### 3. Piston slider

This tool is to be used for inserting the piston into the cylinder. After inserting the piston into the tapered end of the piston slider, set the piston slider together with the piston tightly on the top of the cylinder and insert the piston into the cylinder by pushing the piston crown with fingers.

#### Note:

Don't stop inserting the piston into the cylinder until all the piston rings enter the cylinder.



# SERVICE STANDARDS/REPAIR LIMITS/MAINTENANCE

Part Name	Check/Inspect	Standard Value/Maintenance	Repair Limit
Cylinder Head	<ol style="list-style-type: none"> <li>Carbon deposit on the combustion chamber</li> <li>Scratch depth and distortion of the mounting surface.</li> <li>Corrosion in the mated surface.</li> <li>Clogged cooling water passage.</li> </ol>	<ol style="list-style-type: none"> <li>Remove carbon deposit and clean.</li> <li>Scratch depth or distortion is 0.1mm (0.004in) or more.</li> <li>Repair or replace depending on the situation.</li> <li>Clean and remove foreign matters.</li> </ol>	<ol style="list-style-type: none"> <li>Repair (set #240-#400 sandpaper the surface plate and polish the surface for repair. Use #600 sandpaper for finishing).</li> </ol>
Cylinder	<ol style="list-style-type: none"> <li>Deposit in the water jacket.</li> <li>Wear of the inside cylinder diameter. Measure the bore with a cylinder gauge</li> <li>Seizure</li> <li>Scratch and wearing down in the cylinder liner.</li> <li>Mating surfaces of the cylinder and cylinder head. or more.</li> </ol>	<ol style="list-style-type: none"> <li>Clean and remove foreign matters.</li> <li>59.00mm (2.3228in)</li> <li>Replace or use an over-sized piston after boring the cylinder.</li> <li>When the liner cannot be repaired by means of #400-#600 sandpaper because it is extremely scratched or scored, or the difference between the maximum wear and minimum wear is 0.06mm (0.0024in) or more.</li> <li>When the depth of scratch or distortion in/of the mating surface is 0.1mm (0.004in)</li> </ol>	<ol style="list-style-type: none"> <li>59.06mm (2.3252in) or more (If wear is exceeding the repair limit, replace or bore the cylinder and finish by honing. Over-sized piston is 0.5mm. refer to item 4).</li> <li>Bore and hone to <math>\varnothing 59.5K0.01mm</math> (<math>\varnothing 2.3425 \pm 0.0004in</math>). Use oversize piston and rings.</li> <li>Use #400 sandpaper on the surface plate and polish the surface. Use #600 sandpaper for finishing.</li> </ol>
Piston	<ol style="list-style-type: none"> <li>Outside Diameter                             <ol style="list-style-type: none"> <li>Measure the diameter at a point 7mm above the lower end of the piston skirt.</li> <li>Piston Clearance</li> </ol> </li> <li>Carbon deposit on the piston crown and in the piston ring groove.</li> <li>Scratch on the sliding surface.</li> <li>Measurement of clearance between the piston ring and ring groove.</li> <li>Measurement of diameter of the piston pin hole.</li> </ol>	<ol style="list-style-type: none"> <li>Diameter: 58.960mm (2.3213in)</li> <li>Piston clearance: 0.020-0.055mm (0.0008-0.0022in)</li> <li>Remove carbon residuum and clean.</li> <li>Repair with #400-#600 sandpaper depending on the situation.</li> <li>Top: 0.04-0.08mm (0.0016-0.0031in) 2nd: 0.03-0.07mm (0.0012-0.0028in) Oil: 0.01-0.18mm (0.0004 - 0.0071in) <b>NOTE: To be replaced with a new oil ring, when replacing with new top and/or second rings. Sandpaper means water proof paper.</b></li> <li>Clearance between pin and hole Loose: 0.002-0.012mm (0.00008-0.00005in)</li> </ol>	<ol style="list-style-type: none"> <li>Outer Diameter: 58.90mm (2.3189in) or more.</li> <li>Piston Clearance: 0.15mm (0.0059in) or more</li> <li>Top: 0.10mm (0.004in) or more 2nd: 0.09mm (0.0035in) or more Oil: 0.21mm (0.0083in) or more</li> <li>0.04mm (0.0016in) or more</li> </ol>
Piston Ring	<ol style="list-style-type: none"> <li>End Gap <b>NOTE: Measurement of the end gap: when no ring gauge is available, measure the lower part of the cylinder bore.</b> <ol style="list-style-type: none"> <li>Top</li> <li>Second</li> <li>Oil</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>Replace with new piston ring if wear of the cylinder liner is within the repair limit.                             <ol style="list-style-type: none"> <li>Top: 0.15-0.35mm (0.006-0.014in)</li> <li>Second: 0.30-0.50mm (0.012-0.020in)</li> <li>Oil: 0.20-0.7mm (0.008-0.028in)</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>Top: 0.5mm (0.020in) or more</li> <li>Second: 0.7mm (0.028in) or more</li> <li>Oil Ring: to be replaced with a new oil ring, when replacing with new top and/or second rings. Sandpaper means water proof paper.</li> </ol>
Piston Pin	<ol style="list-style-type: none"> <li>Outer diameter</li> </ol>	<ol style="list-style-type: none"> <li>16.00mm (0.6299in)</li> </ol>	<ol style="list-style-type: none"> <li>15.97mm (0.629in) or less.</li> </ol>
Crankshaft	<ol style="list-style-type: none"> <li>Deflection of the crankshaft. Both the main bearings of the crankshaft should be supported with V-blocks.</li> <li>Outer diameter of the crankpin.</li> <li>Outer diameter of the bearing.</li> <li>Oil clearance of the bearing.</li> <li>Side clearance of the crankshaft.</li> </ol>	<ol style="list-style-type: none"> <li>Less than 0.05mm (0.002in)-both ends.</li> <li>29.98mm (1.1803in)</li> <li>31.99mm (1.2594in)</li> <li>0.012 - 0.044mm (0.0005 - 0.0017in)</li> <li>0.1 - 0.2mm (0.004 - 0.008in)</li> </ol>	<ol style="list-style-type: none"> <li>0.05mm (0.002in) or more.</li> <li>29.95mm (1.179in) or less.</li> <li>31.97mm (1.259in) or less.</li> <li>0.06mm (0.002in) or more.</li> <li>0.6mm (0.024in) or more.</li> </ol>

# SERVICE STANDARDS/REPAIR LIMITS/MAINTENANCE

Part Name	Check/Inspect	Standard Value/Maintenance	Repair Limit
Connecting Rod	<ol style="list-style-type: none"> <li>1. Inner diameter of the small end.</li> <li>2. Oil clearance of the big end.</li> <li>3. Side clearance of the big end.</li> </ol>	<ol style="list-style-type: none"> <li>1. 16.01mm (0.630in)</li> <li>2. 0.015 - 0.041mm (0.0006 - 0.0016in)</li> <li>3. 0.1 - 0.25mm (0.004 - 0.01in)</li> </ol>	<ol style="list-style-type: none"> <li>1. 16.04mm (0.631in) or more.</li> <li>2. 0.060mm (0.002in) or more.</li> <li>3. 0.6mm (0.024in) or more.</li> </ol>
Magneto	<ul style="list-style-type: none"> <li>● Initiation timing</li> <li>● Spark performance</li> <li>● Spark plug</li> <li>● Spark gap</li> <li>● Alternator output</li> <li>● Resistance of coils</li> </ul> <p>Between white wire and yellow wire</p> <p>Between red-white wire and black wire</p> <p>Between black-red wire and blue wire</p> <p>Between yellow-red wire and yellow-red wire</p> <ul style="list-style-type: none"> <li>● ESG for high speed</li> <li>● ESG for low speed</li> </ul>	<p>BTDC 5° - 5° (electric ignition advance)</p> <p>10mm (0.4in) or more/500 rpm (measured by genuine spark tester.</p> <p>NGK DCPR6E</p> <p>0.8 - 0.9mm (0.032 - 0.035in)</p> <p>12V, 130W (5000 rpm)</p> <p>0.27 - 0.41Ω</p> <p>148 - 222Ω</p> <p>12.5 - 18.8Ω</p> <p>1.40 - 2.10Ω</p> <p>Restricting at 6250 rpm</p> <p>Reducing at 2000rpm</p>	1.2mm 9 0.0047in) or more
Ignition Coil	<ul style="list-style-type: none"> <li>● Resistance of primary coil between black wire and orange wire</li> <li>● Resistance of secondary coil between high tension cord and core</li> </ul>	<p>0.26 - 0.35Ω</p> <p>6800 - 10200Ω</p>	
Battery	<p>Output</p> <p>Clutch</p> <ol style="list-style-type: none"> <li>1) Brush length</li> <li>2) Commutator under-cut</li> <li>3) Commutator diameter</li> </ol>	<p>12V - 70AH to 12V - 100AH</p> <p>12V 0.6KW</p> <p>Over-running clutch</p> <ol style="list-style-type: none"> <li>1) 12.5mm (0.49in)</li> <li>2) 0.5-0.8mm (0.02-0.03in)</li> <li>3) 30mm (1.18in)</li> </ol>	<ol style="list-style-type: none"> <li>1) 9.5mm (0.37in) or less</li> <li>2) 0.2mm (0.008in) or less</li> <li>3) 29 mm (1.14in) or less</li> </ol>
Fuse	Capacity	120A	
Thermostat	Operation of thermostat	<ul style="list-style-type: none"> <li>● Start to open: 60°C ± 1.5°C (140 ± 3°F)</li> <li>● Temperature at which valve opens full: 75°C (167°F)</li> </ul>	<p>If the valve opens at room temperature, replace the thermostat.</p> <p>While immersing the thermostat in water, raise the water temperature and check the temperature at which the valve opens.</p>
Pump Impeller	Worn-out, crack	Replace	
Pump Case Liner	Worn-out	Replace	
Guide Plate	Worn-out	Replace	
Intake Valve Exhaust Valve	<ol style="list-style-type: none"> <li>1) Valve Clearance</li> <li>2) Outer diameter of valve stem</li> <li>3) Inner diameter of valve guide</li> <li>4) Clearance to valve stem</li> <li>5) Contact width of valve seat</li> </ol>	<p>IN: 0.13 - 0.17mm (0.005 - 0.007in)</p> <p>EX: 0.18 - 0.22mm (0.007 - 0.008in)</p> <p>IN: 0.13 - 0.17mm (0.005 - 0.007in)</p> <p>EX: 0.18 - 0.22mm (0.007 - 0.008in)</p> <p>IN: 0.13 - 0.17mm (0.005 - 0.007in)</p> <p>EX: 0.18 - 0.22mm (0.007 - 0.008in)</p> <p>IN: 0.13 - 0.17mm (0.005 - 0.007in)</p> <p>EX: 0.18 - 0.22mm (0.007 - 0.008in)</p> <p>IN: 0.13 - 0.17mm (0.005 - 0.007in)</p> <p>EX: 0.18 - 0.22mm (0.007 - 0.008in)</p>	<p>5.46mm (0.215in) or less</p> <p>5.44mm (0.214in) or less</p> <p>5.55mm (0.218in) or more</p> <p>5.57mm (0.219in) or more</p> <p>0.07mm (0.0028in) or more</p> <p>0.10mm (0.004in) or more</p> <p>2.0mm (0.079in) or more</p> <p>2.0mm (0.079in) or more</p>
Valve Spring	Free length	35mm (1.38in)	33.5mm (1.319in) or less
Camshaft	<ol style="list-style-type: none"> <li>1) Height of cam (both IN and EX)</li> <li>2) Outer diameter of bearing</li> <li>3) Clearance of holder (bearing)</li> </ol>	<ol style="list-style-type: none"> <li>1) 23.90mm (0.94in)</li> <li>2) Pulley side: 17.98mm (0.708in) Oil pump side:: 15.97mm(0.629in)</li> <li>3) 0.02 - 0.05mm (0.0008 - 0.0020in)</li> </ol>	<ol style="list-style-type: none"> <li>1) 23.75mm (0.935in) or less</li> <li>2) 17.95mm (0.707in) or less 15.95mm (0.628in) or less</li> <li>3) 0.09mm (0.0035in) or more</li> </ol>
Rocker Arm and Shaft	<ol style="list-style-type: none"> <li>1) Inner diameter</li> <li>2) Outer diameter</li> <li>3) Shaft Clearance</li> </ol>	<ol style="list-style-type: none"> <li>1) 13.01mm (0.512in)</li> <li>2) 12.99mm (0.511in)</li> <li>3) 0.006 - 0.035mm (0.00024 -0.00138in)</li> </ol>	<ol style="list-style-type: none"> <li>1) 13.05mm (0.514in) or less</li> <li>2) 12.94mm (0.509in) or less</li> <li>3) 0.6 mm (0.0024in) or less</li> </ol>
Timing Belt	Tension and appearance	Wear, crack or lengthen-replace	

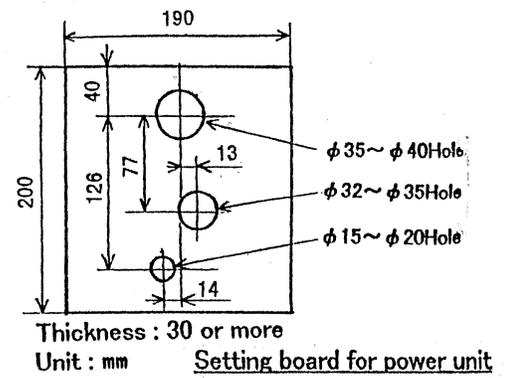
# SERVICE STANDARDS/REPAIR LIMITS/MAINTENANCE

Part Name	Check/Inspect	Standard Value/Maintenance	Repair Limit
Engine Block	<p>With de-compressor</p> <p>Without de-compressor (rocker arm in EX side is removed)</p>	<p>0.4 ± 0.1 MPa (5 ± 1 kg/cm<sup>2</sup>, 71 psi)</p> <p>0.93 ± 0.1 MPa (9.5 ± 1 kg/cm<sup>2</sup>, 135 psi)</p>	Pay heed to pressure leak in compression from the rotation, sliding and sealing parts.
Carburetor	<ul style="list-style-type: none"> <li>● Setting mark</li> <li>● Throttle/Venturi bore</li> <li>● Main jet (MJ)</li> <li>● Main air jet (MAJ)</li> <li>● Inner diameter of main nozzle</li> <li>● Slow jet (SJ)</li> <li>● Slow air jet (SAJ)</li> <li>● Opening angle of throttle (at W.O.T.)</li> <li>● Pilot screw (PS) - Blind</li> <li>● Fuel level (from flange surface to float bottom)</li> <li>● Resistance of PTC* heater for auto-bystarter at 20° C (68° F)</li> </ul> <p>(*PTC: positive temperature coefficient thermistor)</p> <ul style="list-style-type: none"> <li>● Idle speed (clutch in)</li> </ul>	<p>3H8A</p> <p>23/11.5mm</p> <p>#68</p> <p>#135</p> <p>2.2mm</p> <p>#42</p> <p>#115</p> <p>80°</p> <p>1-3/4</p> <p>14mm (0.55in)</p> <p>20Ω</p> <p>900 rpm</p>	
Oil Pump	<ol style="list-style-type: none"> <li>1) Inner diameter of pump body</li> <li>2) Clearance between outer rotor and body</li> <li>3) Height of outer rotor</li> <li>4) Clearance between rotor and body side</li> <li>5) Clearance between outer rotor and inner rotor</li> </ol>	<ol style="list-style-type: none"> <li>1) 29.04mm (1.143in) or more</li> <li>2) 0.36mm (0.014in) or more</li> <li>3) 14.96mm (0.589in) or less</li> <li>4) 0.11mm (0.0043in) or more (incl. wear of the pump cover)</li> <li>5) 0.16mm (0.006in) or more</li> </ol>	

# ENGINE DISASSEMBLY

Bolts, nuts, and washers are indicated by the symbols below.

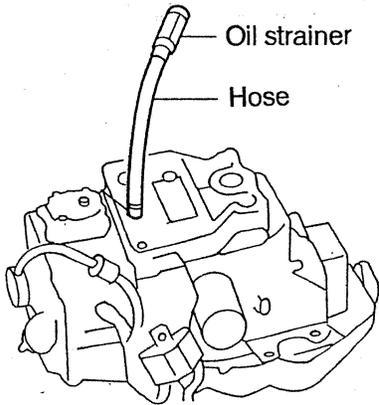
H820 – Hexagon headed bolt	Diameter 8 mm Length 20 mm
N8 – Normal hexagon nut	Diameter 8 mm
L8 – Hexagon lock nut	Diameter 8 mm
W6 – Plain washer	Diameter 6 mm
SW6 – Spring washer	Diameter 6 mm
Screw 620 – Pan headed screw	Diameter 6 mm Length 20 mm



## Removing Parts

### Oil strainer

- ① Cut the hose band and then remove the oil strainer with the hose from the nipple.



### Ignition coil

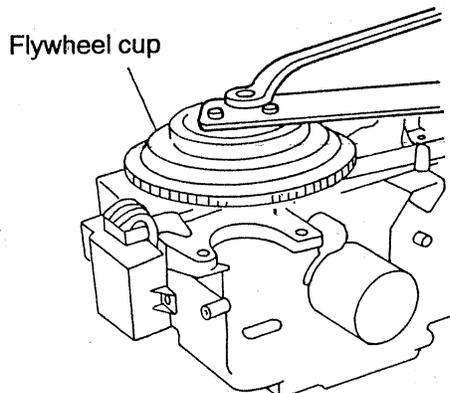
- ① Remove the plug cap from the spark plug.
- ② Remove the ignition coil fitting bolt and then remove ignition coil.

### C. D. Unit

- ① Remove the C.D. unit fitting bolt then remove the C.D. unit.

### Magneto flywheel cup

- ① Remove the flywheel cup with a special tool according to the instructions of "How to Use Special Tools".



### Alternator

- ① Remove the alternator fitting screw and then remove the alternator.

### Pulser coil

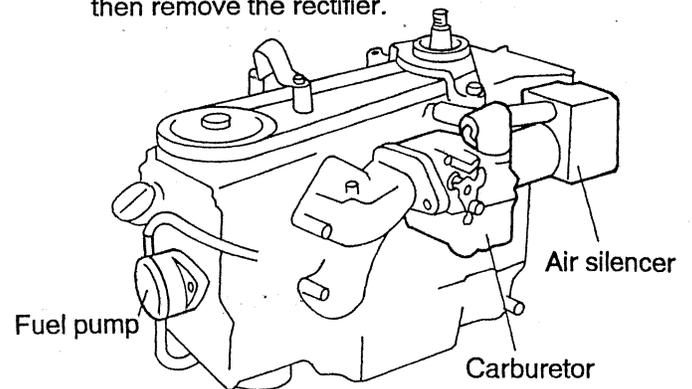
- ① Remove the pulser coil fitting screw and then remove the pulser coil.

### Stator motor and starter solenoid

- ① Remove the starter motor fitting bolt and then remove the starter motor.
- ② Pull the starter solenoid from the electric bracket.

### Rectifier

- ① Remove the rectifier fitting bolt then remove the rectifier.



### Carburetor

- ① Remove the carburetor fitting bolt and then remove the carburetor together with the air silencer, insulator and gaskets.

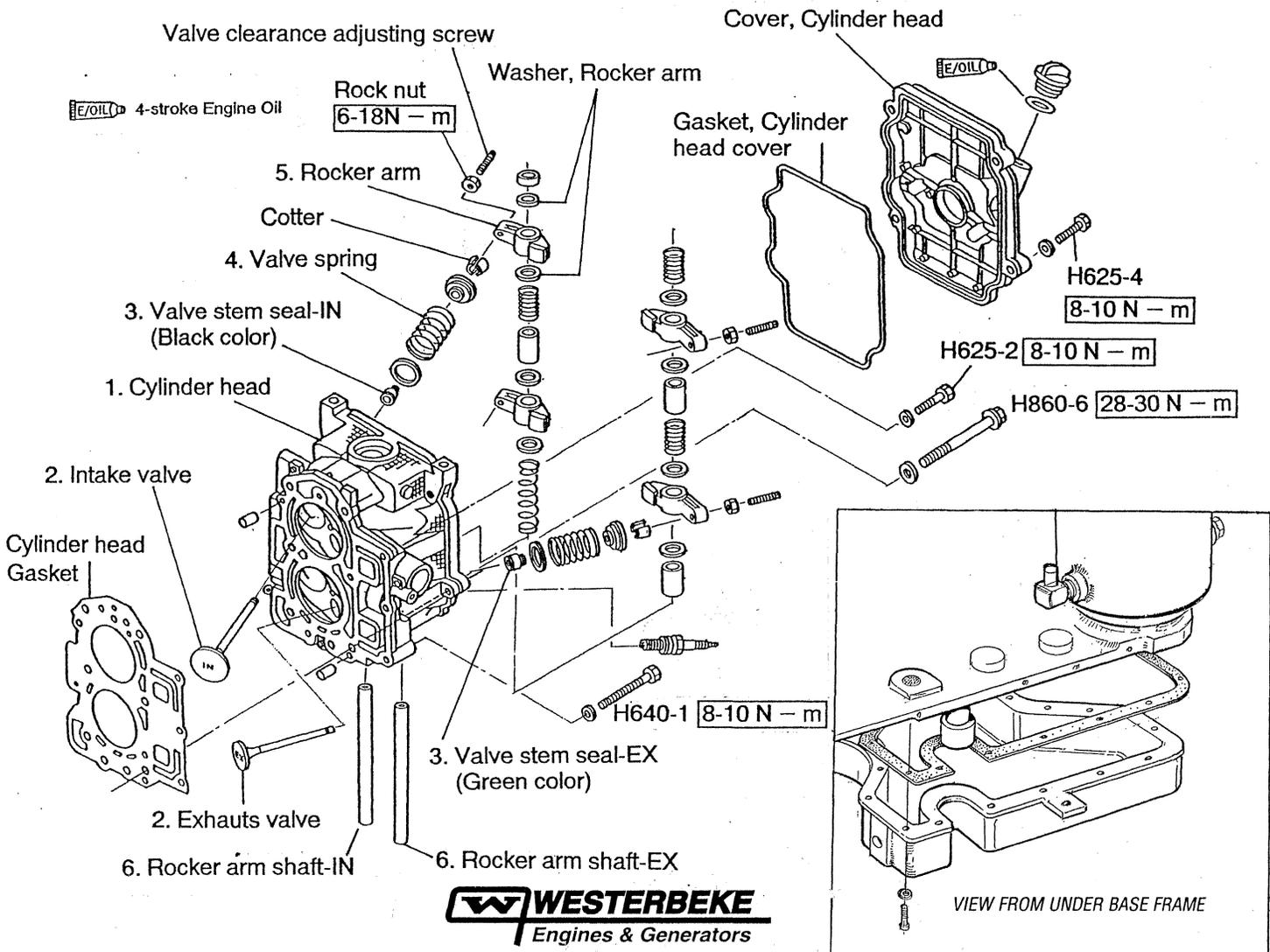
### Fuel pump

- ① Remove the fuel pump fitting bolt then remove the fuel pump.

# ENGINE DISASSEMBLY

## POWER UNIT Cylinder head, valves and relating parts

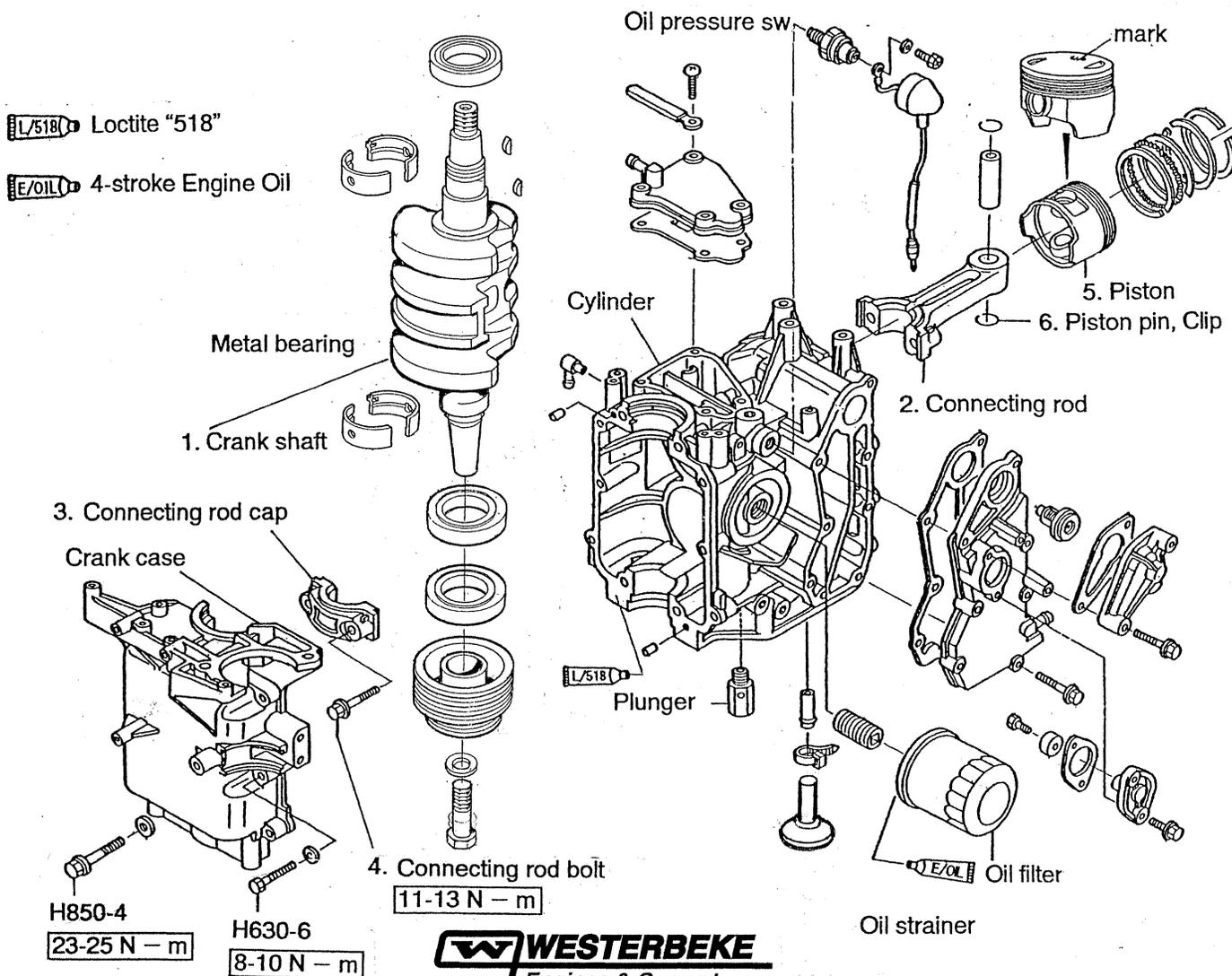
NO	Part name	Check point, etc.
	Gasket & O-ring	Note: Must be replaced by new parts whenever they are once removed for disassembling.
1	Cylinder head	<ul style="list-style-type: none"> <li>● Carbon deposit in combustion chamber</li> <li>● Surface width and roughness between valve seat and valve</li> <li>● Scratch or distortion</li> </ul>
2	Intake valve Exhaust valve	<ul style="list-style-type: none"> <li>● Surface width and roughness between valve seat and intake/exhaust valve</li> <li>● Carbon deposit</li> </ul>
3	Valve stem seal – IN Valve stem seal – EX	Black color: Wear of contact surface with valve stem Green color: Wear of contact surface with valve stem
4	Valve spring	● Weakness
5	Rocker arm	● Wear of three contact points: contact surface with cam, rocker arm shaft and rocker arm washer.
6	Rocker arm shaft	● Wear of contact surface with rocker arm



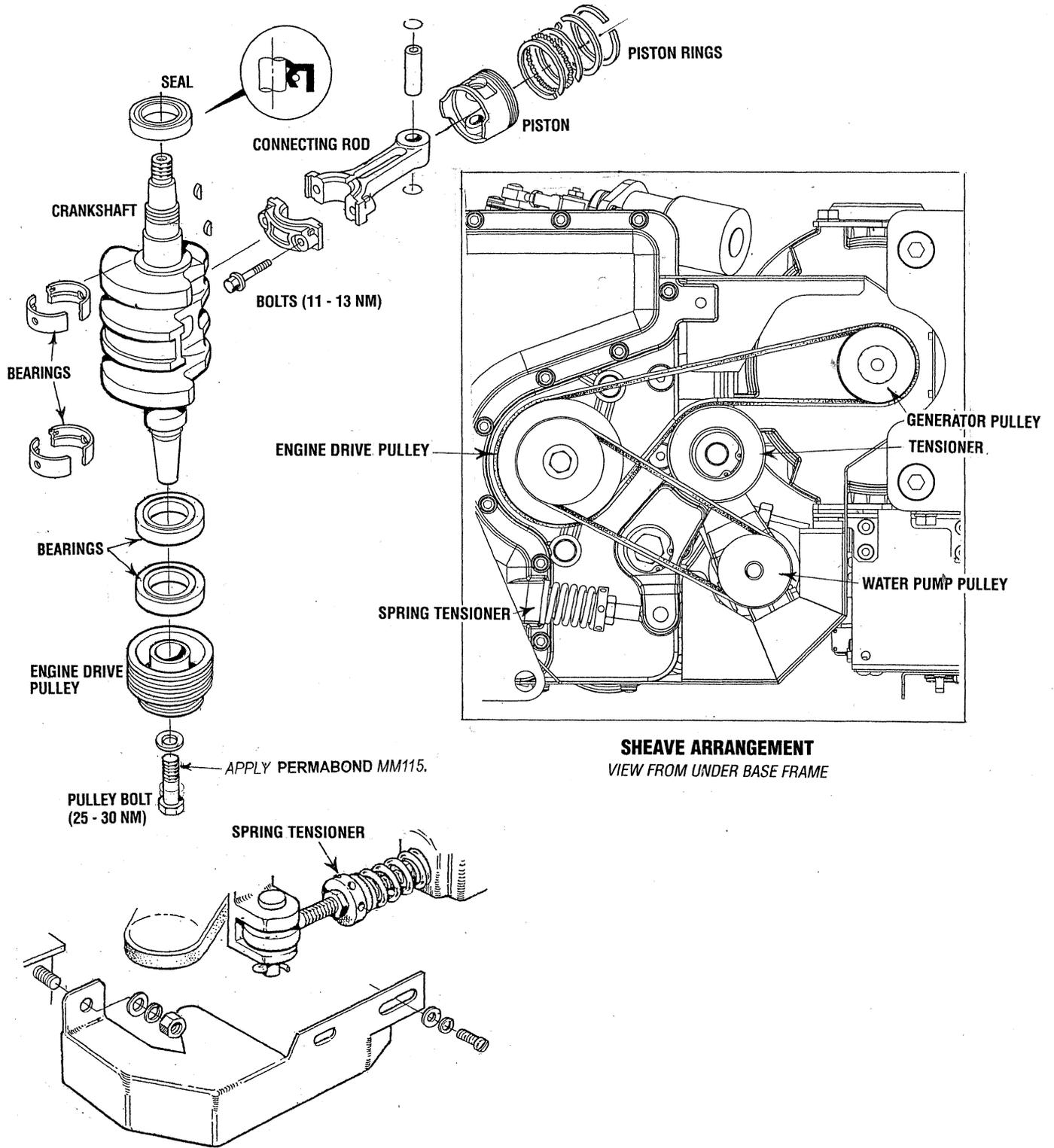
# ENGINE DISASSEMBLY

## POWER UNIT Crank shaft, pistons, cylinder/crank case and related parts

NO.	Part name	Check point, etc.
1	Crankshaft	<ul style="list-style-type: none"> <li>● Oil clearance at main bearings</li> <li>● Oil clearance at big end of connecting rod</li> </ul> Note: Align the tab of the metal bearing with the notch in the cylinder/crank case Note: There are two type of metal bearings (Thickness code: Black color and Brown color)
2	Connecting rod	Note: Pay attention to the connecting rod orientation for reassembling ("UP" mark must face the magneto side)
3	Connecting rod cap	Note: Mate the markings of the cap and connecting rod with each other ("UP" mark must face the magneto side)
4	Connecting rod bolt	Note: Tighten the bolts in careful manner; Gradually tighten the two bolts alternately several times so that they are evenly tightened.
5	Piston	Note: Pay attention to the piston direction ("UP" mark faces the magneto side)
6	Piston pin clip	Note: Don't use the clip that is once removed. Be sure to use a new part for reassembling.



# ENGINE DISASSEMBLY

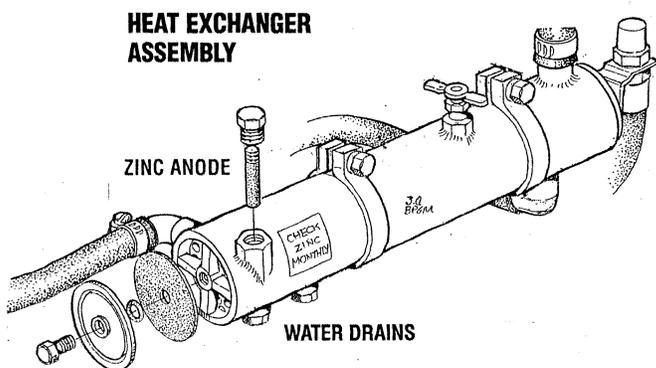


**SHEAVE ARRANGEMENT**  
VIEW FROM UNDER BASE FRAME

# ENGINE DISASSEMBLY

## POWER UNIT Cam shaft, oil pump and related parts

NO.	Part name	Check point, etc.
1	Cam shaft	● Smooth movement of decompressor weight Note: This part is very weak against impact.
2	Timing belt	Note: Be sure to keep clean free from oil and grease
3	Drive pulley	Note: Be sure to keep clean free from oil and grease Note: Pay attention of direction ("UP" mark faces the magneto side)
4	Driven pulley	Note: Be sure to keep clean free from oil and grease Note: Pay attention of direction ("UP" mark faces the magneto side)
5	Oil pump	



### HEAT EXCHANGER (FRESH WATER COOLED MODELS)

The heat exchanger should be removed, inspected, and cleaned. Install a new zinc and fresh hoses with new clamps at reassembly. If suspect, a local automotive radiator shop should be able to clean and pressure test the heat exchanger.

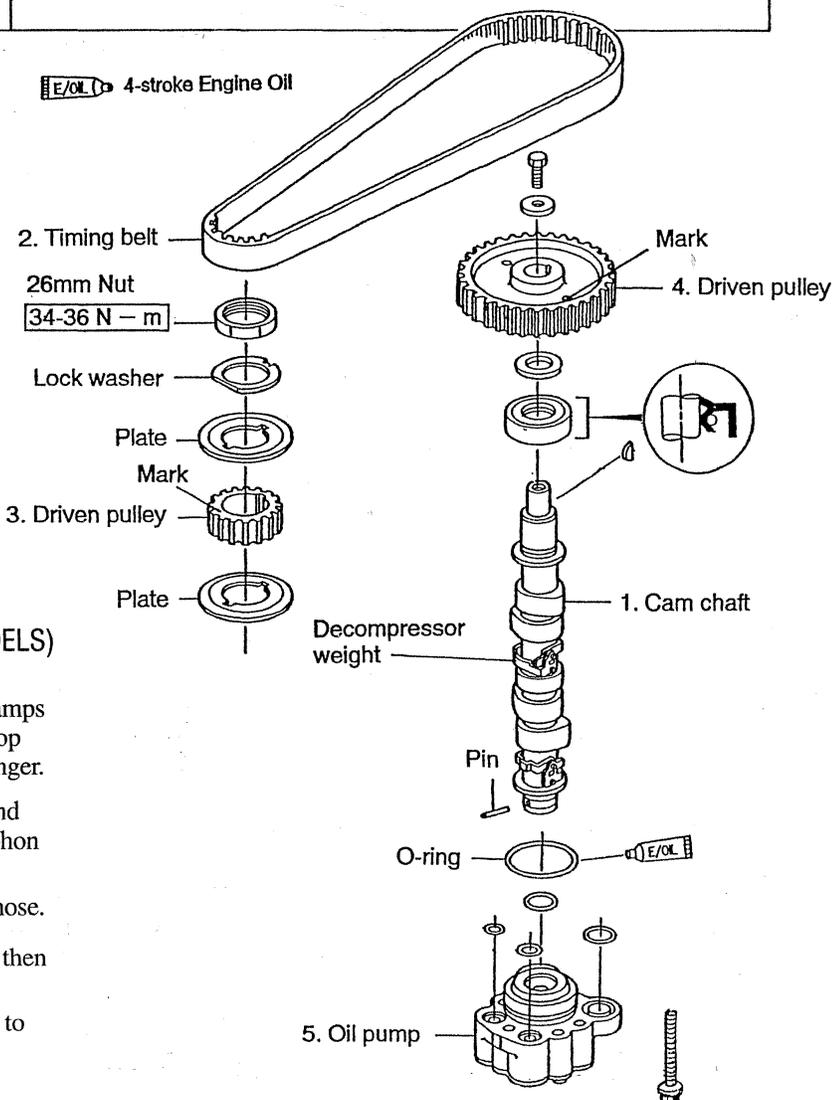
The water injected exhaust elbow should be removed and inspected for defects and corrosion. Also inspect the siphon break hose and its connections.

Flush out the coolant recovery tank and its connecting hose.

Loosen the raw water pump, remove the drive belt and then remove the raw water pump.

Remove the engines coolant pump. For servicing, refer to *COOLANT PUMP*.

Remove the thermostat assembly and clean the interior chambers. Inspect the seals in the pressure cap when reassembling. Replace the thermostat and gasket.



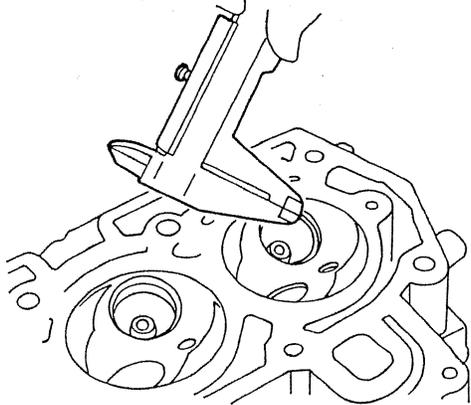
# INSPECTION AND MEASUREMENTS

## POWER UNIT

Measurement with vernier calipers

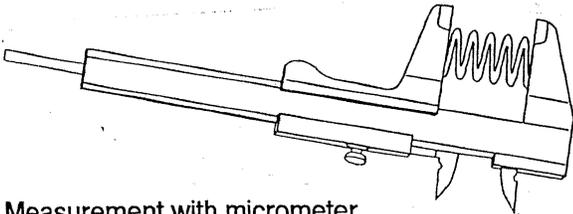
● Valve seat width

Standard value	Out of the limit to use
1.0 mm 0.0393 in	If 2.0 mm (0.079 in) or more, it needs replacement or repair.



● Valve spring free length

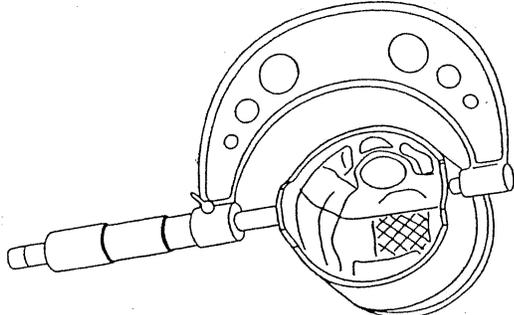
Standard value	Out of the limit to use
35 mm 1.38 in	If 33.5 mm (1.319 in) or less, it needs replacement.



Measurement with micrometer

● Outer diameter of piston skirt

Standard value	Out of the limit to use
58.960 mm 2.3213 in	If 58.90 mm (2.3189 in) or less, it needs replacement.

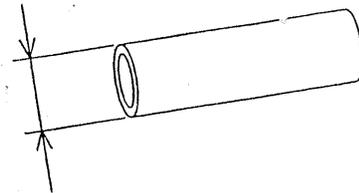


● Piston clearance (Clearance between piston and cylinder)

Standard value	Out of the limit to use
0.020 – 0.055 mm 0.0008 – 0.0022 in	If 0.15 mm (0.0059 in) or more, it needs replacement.

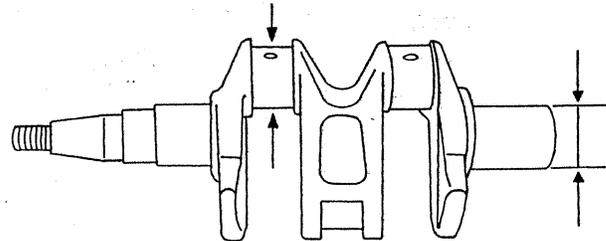
● Outer diameter of piston pin

Standard value	Out of the limit to use
16.00 mm 0.6299 in	If 15.97 mm (0.629 in) or less, it needs replacement.



● Outer diameter of crank pin

Standard value	Out of the limit to use
29.98 mm 1.1803 in	If 29.95 mm (1.179 in) or less, it needs replacement.



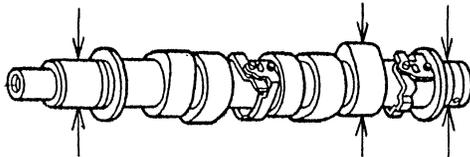
● Outer diameter of crank shaft in metal bearing

Standard value	Out of the limit to use
31.99 mm 1.2594 in	If 31.97 mm (1.259 in) or less, it needs replacement.

# INSPECTION AND MEASUREMENTS

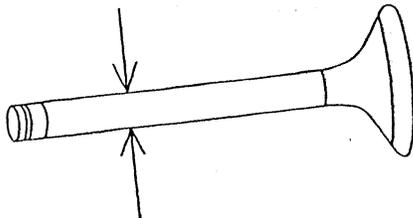
## ● Cam shaft

	Standard value	Out of the limit to use
Outer dia. in bearing (Upper)	17.98 mm 0.708 in	If 17.95 mm (0.707 in) or less, it needs replacement.
Outer dia. in bearing (Lower)	15.97 mm 0.629 in	If 15.95 mm (0.628 in) or less, it needs replacement.
Cam height IN & EX	23.90 mm 0.94 in	If 23.75 mm (0.935 in) or less, it needs replacement.



## ● Valve stem

	Standard value	Out of the limit to use
IN	5.48 mm 0.216 in	If 5.46 mm (0.215 in) or less, it needs replacement.
EX	5.46 mm 0.215 in	If 5.44 mm (0.214 in) or less, it needs replacement.

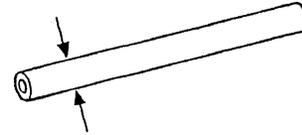


## ● Clearance between valve guide and valve stem

	Standard value	Out of the limit to use
IN	0.008 – 0.04 mm 0.003 – 0.0016 in	If 0.07 mm (0.0028 in) or more, it needs replacement.
EX	0.025 – 0.057 mm 0.0010 – 0.0022 in	If 0.10 mm (0.004 in) or more, it needs replacement.

## ● Outer diameter of rocker arm shaft

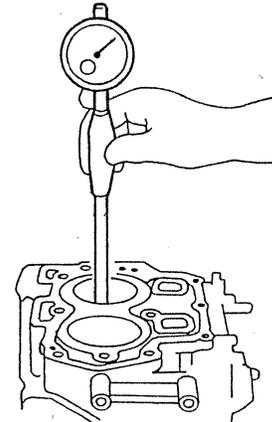
Standard value	Out of the limit to use
12.99 mm 0.511 in	If 12.94 mm (0.509 in) or less, it needs replacement.



Measurement with cylinder gauge

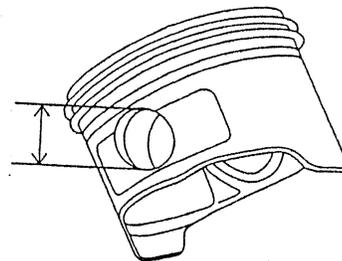
## ● Inner diameter of cylinder

Standard value	Out of the limit to use
59.00 mm 2.3228 in	If 59.06 mm (2.3252 in) or more, it needs replacement.



## ● Diameter of piston pin hole

Standard value	Out of the limit to use
16.002 mm 0.630 in	Depends on clearance between pin and hole.



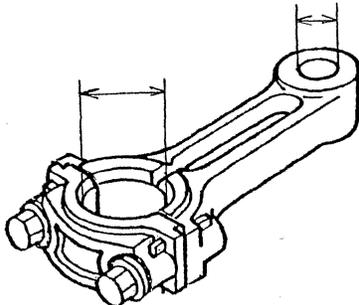
## ● Clearance between piston pin and piston pin hole

Standard value	Out of the limit to use
0.002 – 0.012 mm 0.00008 – 0.0005 in	If 0.04 mm (0.0016 in) or more, it needs replacement.

# INSPECTION AND MEASUREMENTS

● Oil clearance at big end of connecting rod

Standard value	Out of the limit to use
0.015 – 0.041 mm 0.0006 – 0.0016 in	If 0.060 mm (0.002 in) or more, it needs replacement.

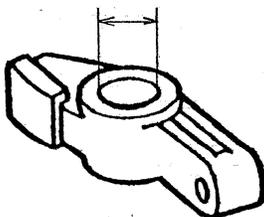


● Inner diameter of small end of connecting rod

Standard value	Out of the limit to use
16.01 mm 0.630 in	If 16.04 mm (0.631 in) or more, it needs replacement.

● Inner diameter of rocker arm

Standard value	Out of the limit to use
13.01 mm 0.512 in	If 13.05 mm (0.514 in) or more, it needs replacement.

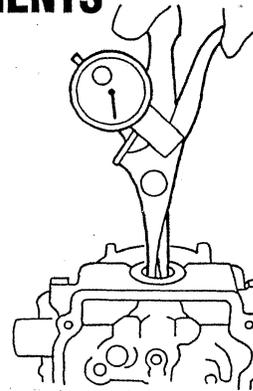


● Oil clearance between rocker arm and shaft

Standard value	Out of the limit to use
0.006 mm – 0.035 mm 0.00024 – 0.00138 in	If 0.06 mm (0.0024 in) or more, it needs replacement.

● Inner diameter (bearing) of cam shaft holder

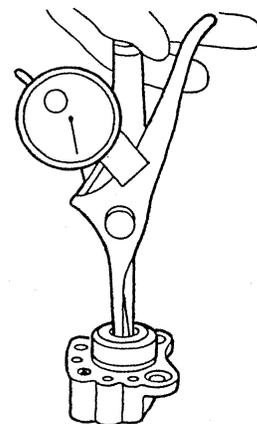
	Standard value
Upper (Cylinder head)	18.01-18.025 mm 0.709 – 0.710 in
Lower (Oil pump)	



● Oil clearance between cam shaft and holder

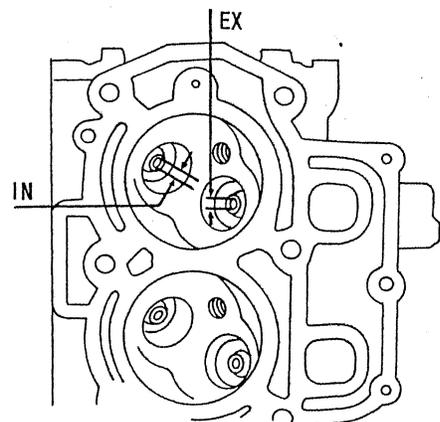
	Standard value	Out of the limit to use
Upper	0.02 – 0.05 mm 0.0008 – 0.0020 in	0.09 mm (0.0035 in) or more
Lower	0.02 – 0.05 mm 0.0008 – 0.0020 in	0.09 mm (0.0035 in) or more

If the oil clearance is out of the limit, replace cylinder head and/or cam shaft and/or oil pump.



● Inner diameter of valve guide

	Standard value	Out of the limit to use
IN	5.51 mm 0.217 in	If 5.55 mm (0.218 in) or more, it needs replacement.
EX	5.51 mm 0.217 in	If 5.57 mm (0.219 in) or more, it needs replacement.

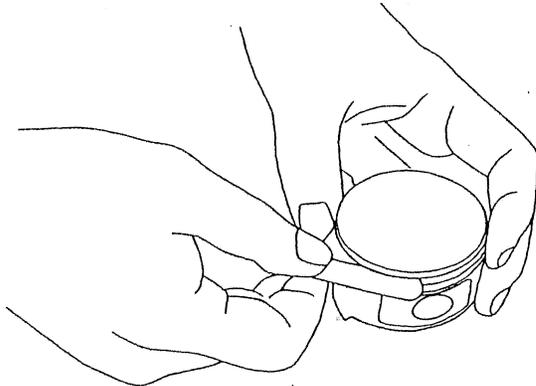


# INSPECTION AND MEASUREMENTS

Measurement with thickness gauge

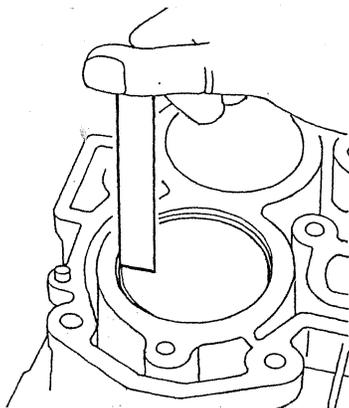
● Clearance between piston ring and ring groove

	Standard value	Out of the limit to use
Top	0.04 – 0.08 mm 0.0016 – 0.0031 in	If 0.10 mm (0.004 in) or more, it needs replacement.
Second	0.03 – 0.07 mm 0.0012 – 0.0028 in	If 0.09 mm (0.0035 in) or more, it needs replacement.
Oil	0.01 – 0.18 mm 0.0004 – 0.0071 in	If 0.21 mm (0.0083 in) or more, it needs replacement.



● Piston ring end gap

	Standard value	Out of the limit to use
Top	0.15 – 0.35 mm 0.006 – 0.014 in	If 0.5 mm (0.020 in) or more, it needs replacement.
Second	0.30 – 0.50 mm 0.012 – 0.020 in	If 0.7 mm (0.028 in) or more, it needs replacement.
Oil	0.20 – 0.70 mm 0.008 – 0.028 in	

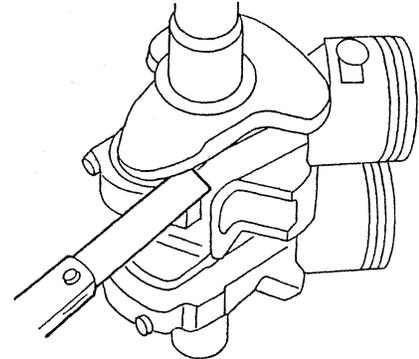


Note:

- Set the piston ring by pressing it in the piston crown side.
- To be replaced with a new oil ring when replacing with new top and/or second rings.

● Side clearance at big end of connecting rod

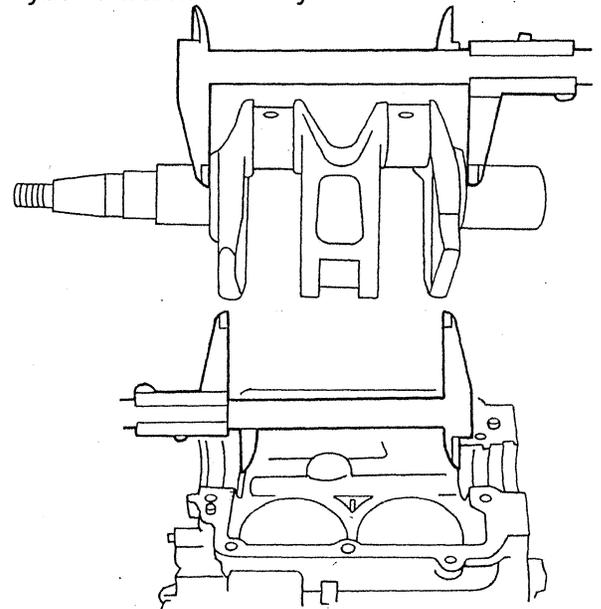
Standard value	Out of the limit to use
0.1 – 0.25 mm 0.004 – 0.01 in	If 0.6 mm (0.024 in) or more, it needs replacement.



● Side clearance of crankshaft

Standard value	Out of the limit to use
0.1 – 0.3 mm 0.004 – 0.012 in	0.6 mm (0.024 in) more

If the side clearance is out of the limit, measure length of the crankcase (cylinder side) and the crankshaft and replace crankshaft and/or cylinder-crankcase ass'y.



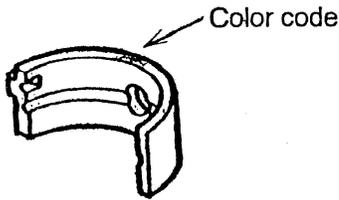
	Standard value
Crankshaft length	126.8 – 126.9 mm 4.992 – 4.996 in
Crankcase length	127.0 – 127.1 mm 5.000 – 5.004 in



# INSPECTION AND MEASUREMENTS

## ● Metal bearing thickness code

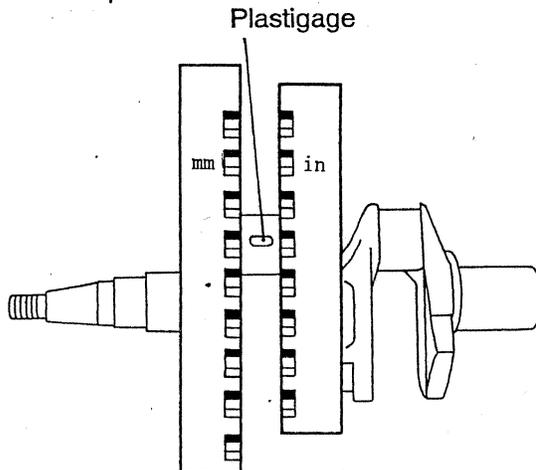
The codes are painted on the side of the bearing.



Color code	Thickness
Brown	1.488 – 1.494 mm 0.0586 – 0.0588 in
Black	1.494 – 1.500 mm 0.0588 – 0.0590 in

## ● Oil clearance at big end of connecting rod

- 1) Wipe oil out of the crank pin and big end bearing of connecting rod.
- 2) Set the Plastigage to the crank pin and fit it to the connecting rod. Tighten the bolt with the specified torque.



Tightening torque: 11-13 N-m (1.1-1.3 kg-m)  
(8.0-9.4 lb-ft)

Note:

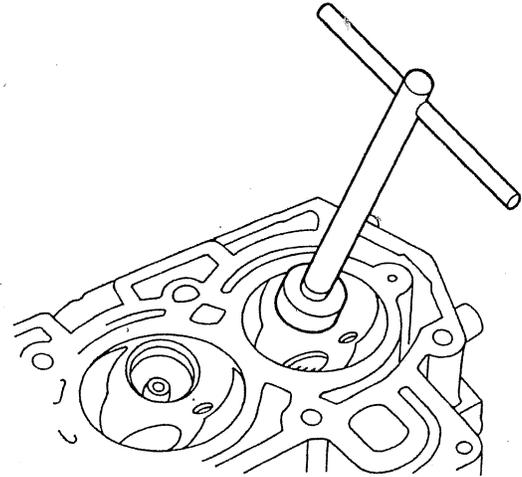
Do not turn the connecting rod.

- 3) Remove the connecting rod and check the Plastigage reading.

Standard value	Out of the limit to use
0.015 – 0.041 mm 0.0006 – 0.0016 in	If 0.06 mm (0.002 in) or less, it needs replacement

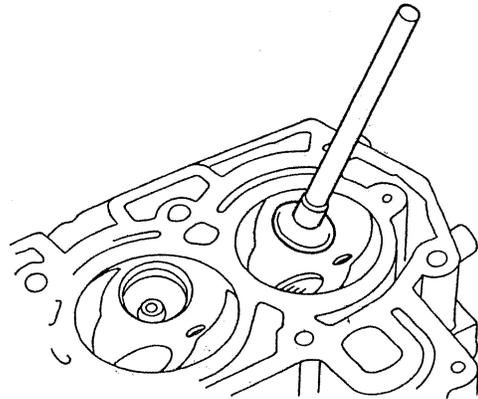
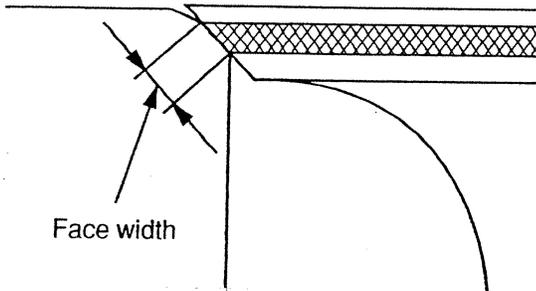
## ● Repair of valve seat

- 1) Plane the valve seat face with the 45° valve seat cutter.
- 2) Depending on the situation (the contact position of the seat is too high or too low), use the 30° cutter or 60° cutter and then repair the surface area with the 45° cutter.



- 3) Apply Prussian Blue compound (or equivalent) evenly on the seat face. While turning the valve with the valve lapper, check face width between the valve and valve seat. If necessary, repair the face width with the valve seat cutter.

# INSPECTION AND MEASUREMENTS



	Standard value	Limit that needs repair
IN	1.0 mm 0.04 in	2.0 mm or more 0.08 in
EX	1.0 mm 0.04 in	2.0 mm or more 0.08 in

4) After repair of the valve seat, lap the valve for good fitting.

Apply lapping compound thinly on the seat and lap the valve while turning and tapping it with the valve lapper.

Remarks: Since the lapping compound is supplied in a set of three grades (coarse, medium and fine), lap the valve with all of them in order from coarse, medium and fine.

## Notes:

- When using lapping compound of a different grade, completely wipe out the previously used compound beforehand.
- After lapping is complete, wash the valve and valve seat after completely wiping the compound out of them.

# ASSEMBLY

## POWER UNIT

### Reassembling Engine

Reassemble the engine in the reverse order of disassembling with careful attention to the following points.

#### (1) Cylinder head and related parts

##### ● Valve stem seal

- There are two kinds of valve stem seals, namely, the valve stem seal for the intake valve is identified by the black color while the other for the exhaust valve is identified by the green color.
- On installing the valve stem seal to the cylinder head, apply the engine oil for the 4-stroke cycle engine to the insertion point. For setting the valve stem seal, press it into the valve guide with fingers.

##### ● Intake valve, Exhaust valve

- The intake valve and exhaust valve are different from each other, namely the intake valve is identified by the "IN" mark while the exhaust valve is identified by the "EX" mark.
- Apply the engine oil for the 4-stroke cycle engine to the valve stem. Then, insert the valve into the valve guide while twisting it.
- After setting the cotter on-to the valve stem, tap the valve shaft end with a small plastic hammer several times for stabilizing the cotter in setting.
- After reassembling the valves, apply the engine oil for the 4-stroke cycle engine to the upper side of the retainer and its periphery.

##### ● Cam shaft

- Carefully press the oil pump pin so that it does not come out of the cam shaft.
- When reassembling the cam shaft to the cylinder head, apply the engine oil for the 4-stroke cycle engine to the cam and bearing beforehand and then insert the cam shaft into the cylinder head from the oil pump side while twisting it with care not to turn over the oil seal lip.

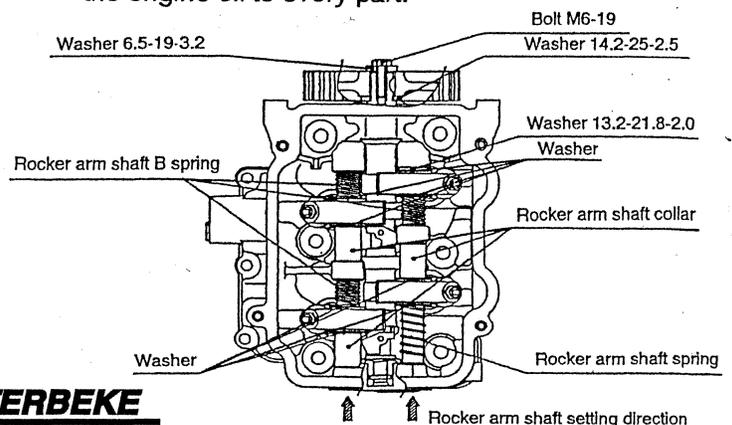
##### ● Rocker arm

- Temporarily set the tappet adjusting screw and tappet adjusting nut to the rocker arm.

#### Note:

Set the tappet adjusting nut with the chamfered side down.

- Apply the engine oil for the 4-stroke cycle engine to the rocker arm shaft.
- Set the rocker arm shaft from the side of the oil pump of the cylinder head. Pay heed to orientation of the rocker arm shaft so that the tapped hole side is positioned in the oil pump side.
- Set the rocker arm shaft spring, washer, rocker arm, rocker arm shaft collar to the rocker arm shaft from the bottom side in this order.
- When setting the above-mentioned parts, apply the engine oil to every part.



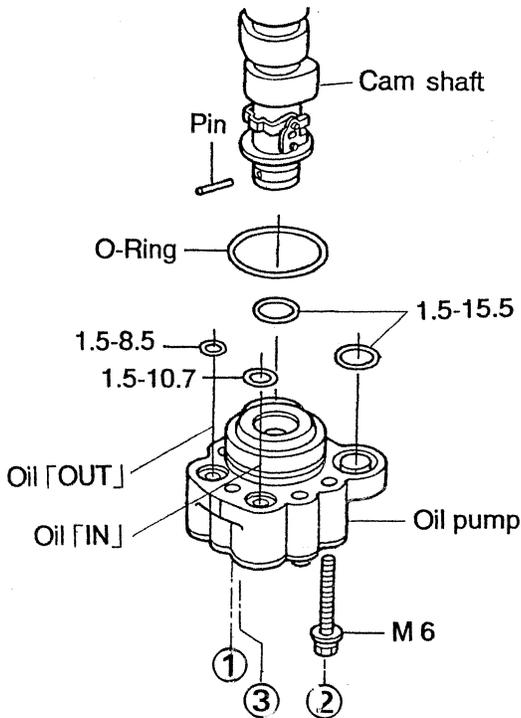
# ASSEMBLY

## ● Oil pump

- Pour the engine oil of approximately 2.0 ml into the oil pump through the inlet and outlet ports.
- Apply the engine oil for the 4-stroke cycle engine to the O-rings (1.5-10.7ø, 1.5-8.5ø, 1.5-15.5ø) and the O-ring at the boss before setting them in the oil pump.
- When assembling the oil pump to the cylinder head, carefully set it so that the cam shaft pin and the notch on the oil pump shaft meet each other.
- Fasten the oil pump with the three M6 bolts with the tightening torque and in the tightening order specified below.

Tightening order: ①, ② and ③

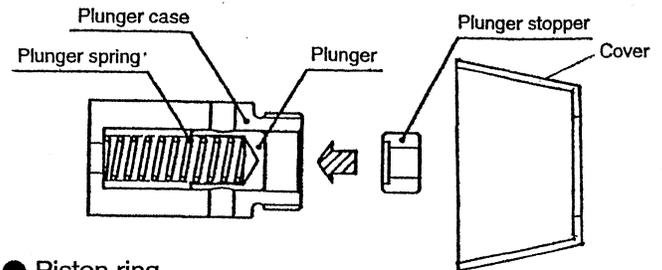
Tightening torque: 5-6 N – m (0.5-0.6 kg – m)



## ● Plunger

- When setting the plunger stopper into the plunger case, pay attention to the orientation of the plunger stopper so that it is set as shown.
- When assembling the plunger assembly to the cylinder, fasten it together with the cover.

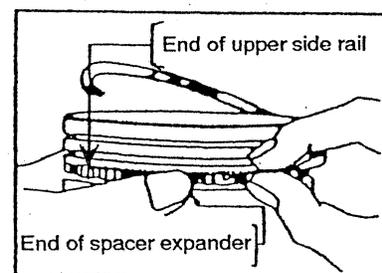
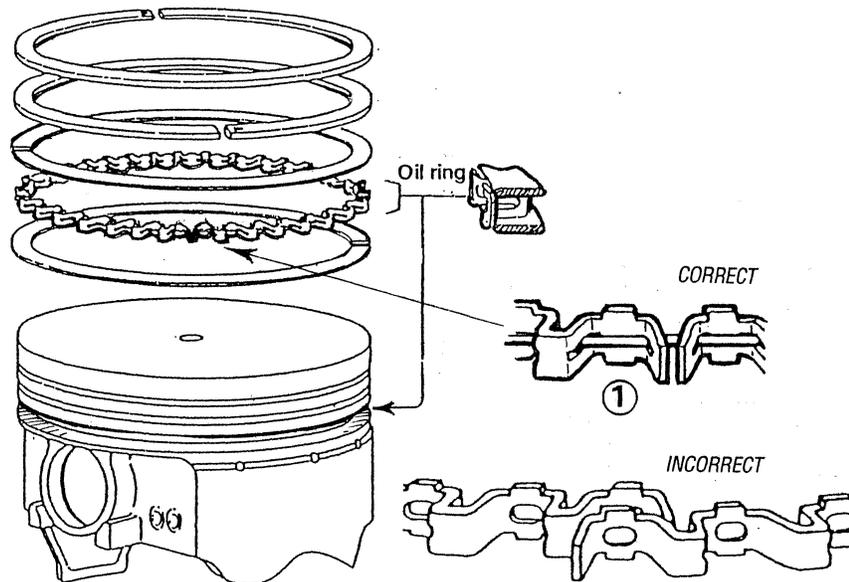
Tightening torque: 19-21 N–m (1.9-2.1 kg–m)  
(12-15 lb – ft)



## ● Piston ring

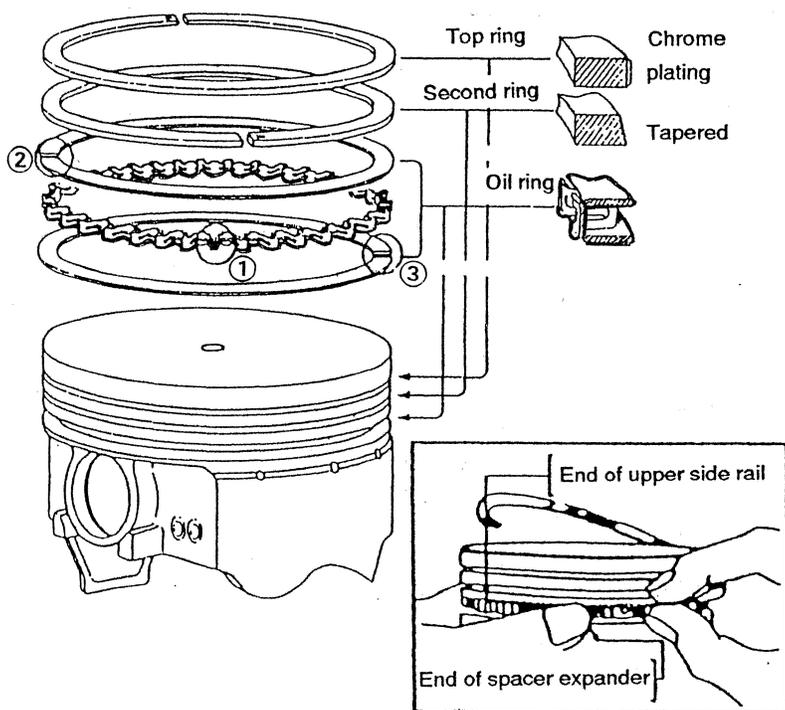
### Fitting oil rings to piston

1. Set the spacer expander in the oil ring groove, and check to see if both the ends of it correctly link with each other as shown in ①.



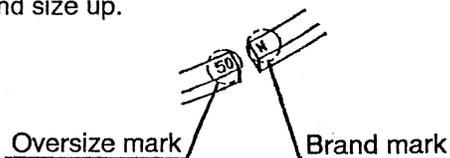
# ASSEMBLY

2. While holding down the slit of the spacer expander with a thumb, set the upper rail as its slit is deviated from the slit of the spacer expander at an angle of 90° in the counterclockwise direction. ②
3. In the same manner as the preceding step, set the lower rail as its slit is deviated from the slit of the spacer expander at an angle of 90° in the clockwise direction. ③



## Fitting compression rings to piston

Fit the compression rings onto the piston in the correct order to start with the lower ring. Set each compression ring with the side marked with the brand and size up.

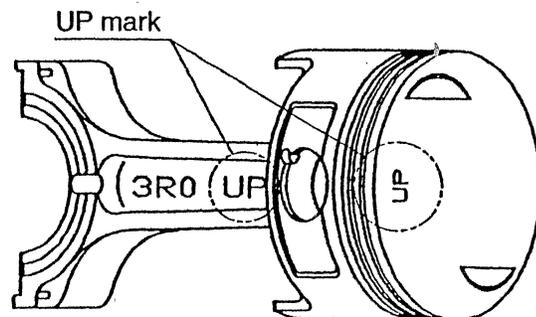


## Check of correct setting of each piston ring

1. Check to see if the slit of each piston ring is not set in the piston thrust direction or piston pin direction.
2. After the assembling work is complete, make sure that each piston ring is set as shown once again.

## ● Piston and Connecting rod

- Assemble the connecting rod and connecting rod cap to each other as they were put together before removing. (Before removing the connecting rod cap, be sure to leave a marking at a mated point between the connecting rod and connecting rod cap as a reference for reassembling.)

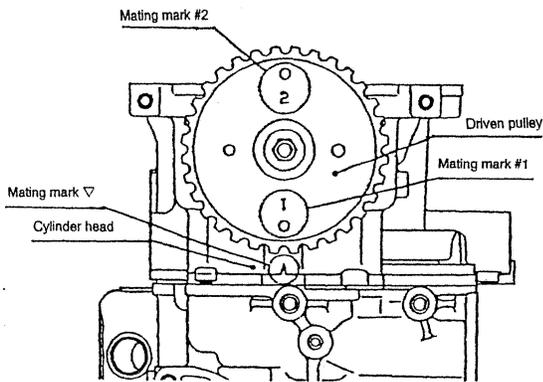
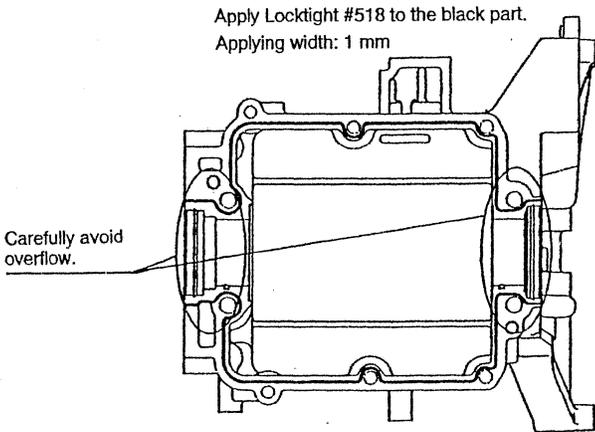


- The upper sides of the connecting rod cap, connecting rod and piston are identified by the "UP" mark.
- For inserting the piston and connecting rod assembly into the cylinder, use the piston slider. Apply the engine oil for the 4-stroke cycle engine to the cylinder liner, piston rings before inserting the assembled piston.

# ASSEMBLY

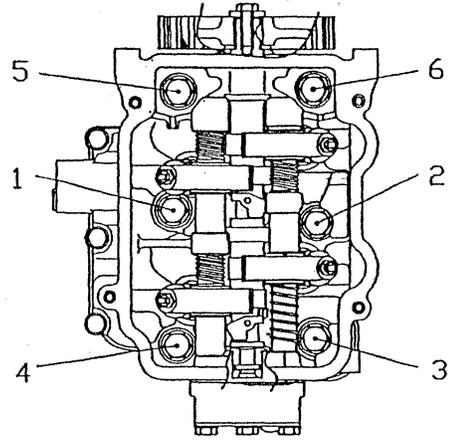
## ● Cylinder and Crank case

- When fitting the metal bearing to the cylinder and crank case, set the tab in the notch.
- Apply the engine oil for the 4-stroke cycle engine to the metal bearing.
- Degrease the mating surface between the cylinder and crank case.
- Apply the Locktight #518 to either of the cylinder and crank case with careful attention to the applying part and width so as to avoid overflow.



## ● Fitting cylinder head to cylinder

- Before fitting the cylinder head to the cylinder, set the piston at the top dead center.
- When fastening the cylinder head, carefully tighten the bolts with the specified tightening torque and in the correct order.



Tightening torque:

M8 bolt: 28-30 N – m (2.8-3.0 kg – m)

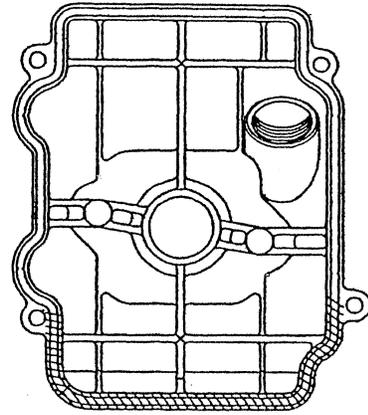
(20-22 lb – ft)

M6 bolt: 8-10 N – m (0.8-1.0 kg – m)

(5.8-7.2 lb – ft)

## ● Cylinder head cover

- Fit the gasket to the cylinder head cover and apply the Three Bond #1207B to the shaded part shown.



Apply the sealant to the shaded part.  
Shaded part (Part shown by slanted lines)

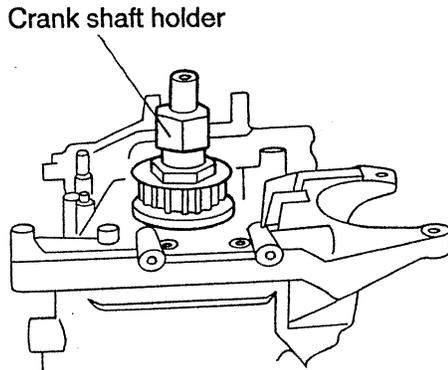
Tightening torque: 8-10 N – m (0.8-1.0 kg – m)

(5.8-7.2 lb – ft)

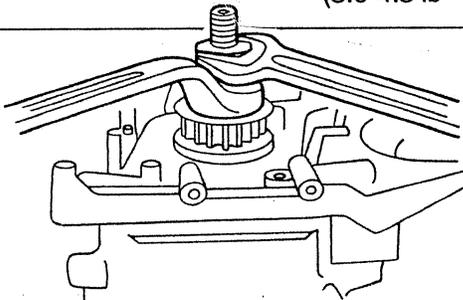
# ASSEMBLY

## ● Fuel pump

- Make sure that the marks "2" and "0" on the driven pulley and the mark "▽" on the cylinder head are aligned in a straight line.
- Apply the engine oil for the 4-stroke cycle engine to the top of the plunger and O-ring of the fuel pump.



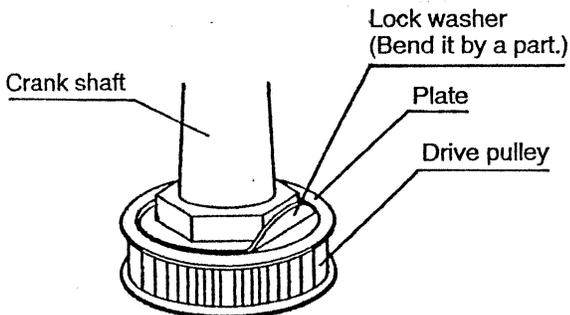
Tightening torque: 5-6 N – m (0.5-0.6 kg – m)  
(3.6-4.3 lb – ft)



## ● Drive pulley

- For tightening the nut to fasten the drive pulley, use the crank shaft holder.

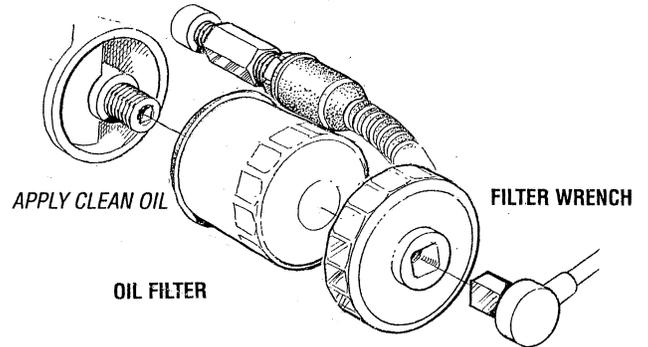
Tightening torque: 34-36 N – m (3.4-3.6 kg – m)  
(25-26 lb – ft)



- After tightening the nut, bend up the lock washer by a part.

## ● Oil filter

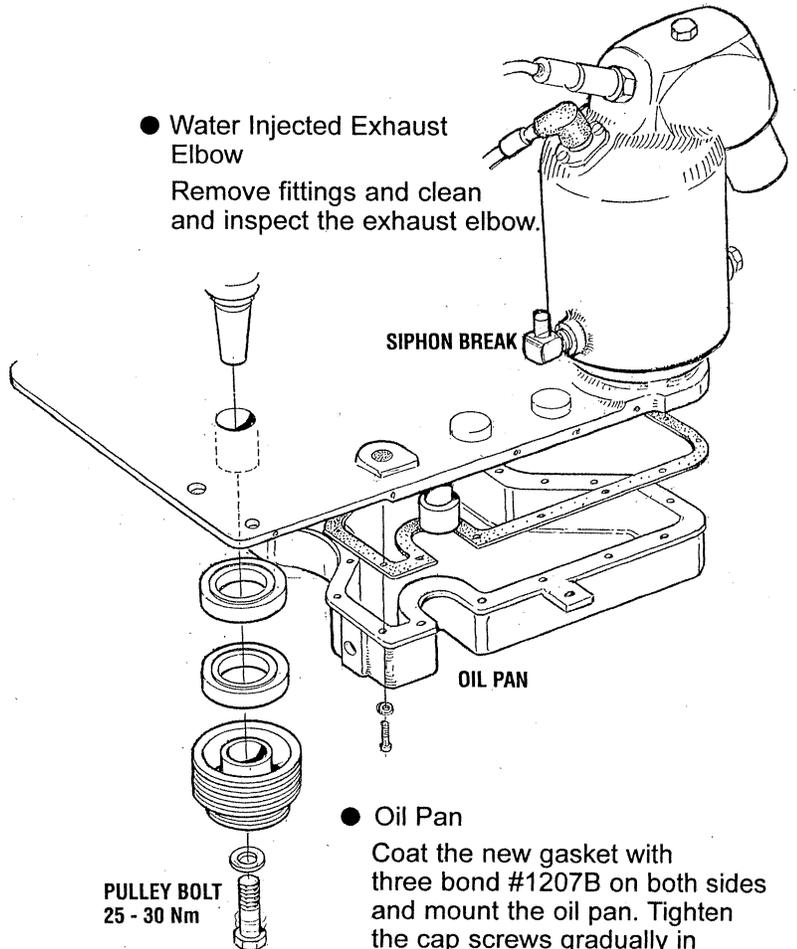
- Apply the engine oil for the 4-stroke cycle engine to the rubber seal of the oil filter.



Tightening torque: 18 N – m (1.8 kg – m)  
(13 lb – ft)

## ● Water Injected Exhaust Elbow

- Remove fittings and clean and inspect the exhaust elbow.



## ● Oil Pan

- Coat the new gasket with three bond #1207B on both sides and mount the oil pan. Tighten the cap screws gradually in opposing order.

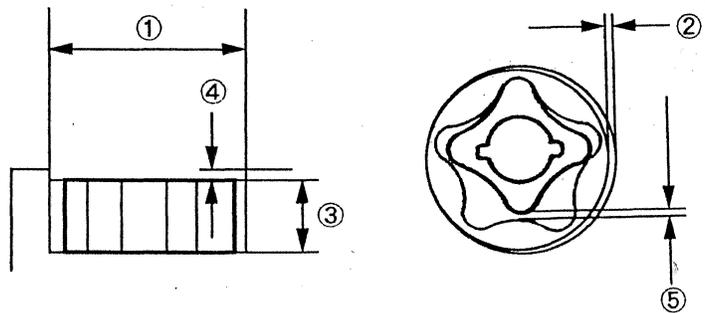
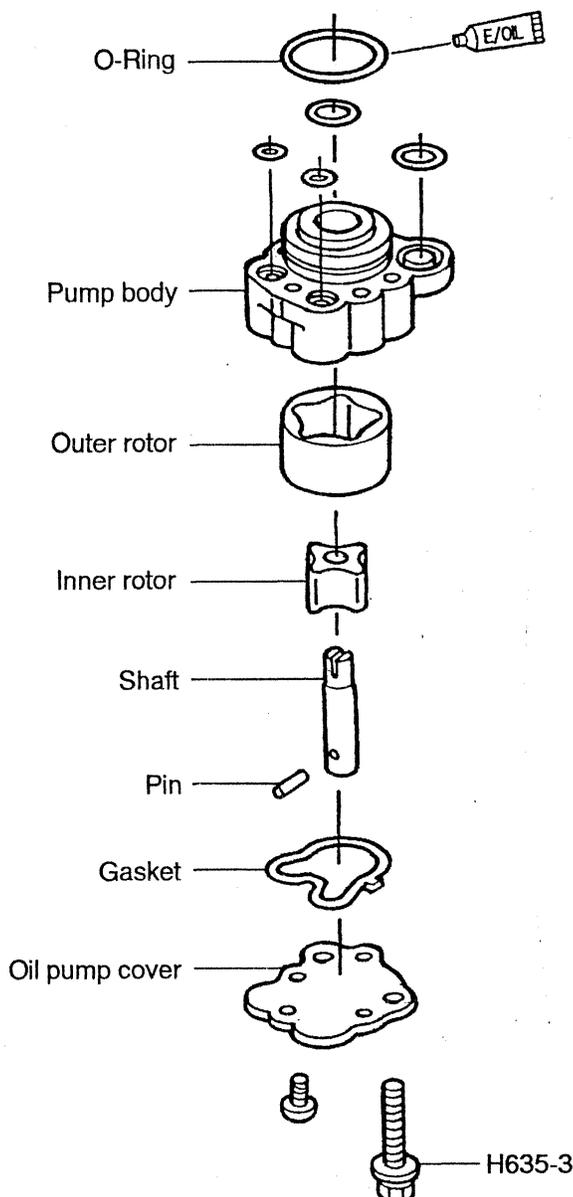
Torque at 28 - 30 Nm (20 - 22 lb-ft)

# LUBRICATION SYSTEM

## OIL PUMP

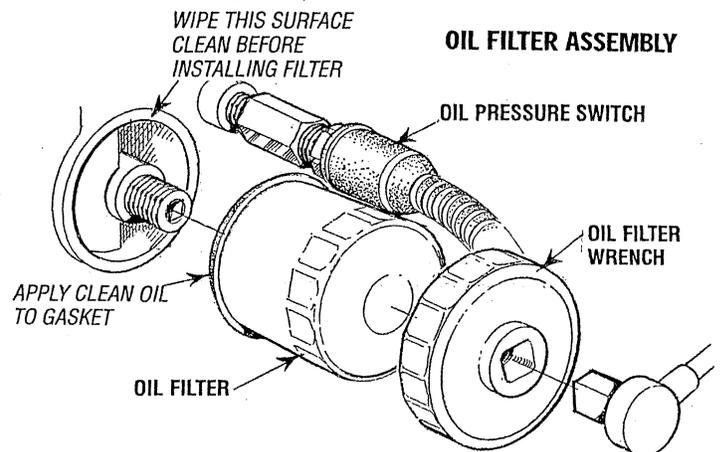
Using a micrometer, cylinder gauge, depth gauge and feeler gauge, measure the following oil pump clearances. Replace if worn or out of specification.

① Inner diameter of pump body	29.04 mm (1.143 in) or more
② Clearance between outer rotor and body	0.36 mm (0.014 in) or more
③ Height of outer rotor	14.96 mm (0.589 in) or less
④ Clearance between rotor and body side	0.11 mm (0.0043 in) or more (incl. wear of the pump cover)
⑤ Clearance between outer rotor and inner rotor	0.16 mm (0.006 in) or more



### OIL INSPECTION

Always observe the old oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic if water is present in the oil. Water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or a siphoning through the water cooling circuit into the exhaust, filling it up into the engine. Use an oil test kit and send a sample of the engine oil to a qualified oil test lab for analysis.



# FUEL SYSTEM

## FUEL PUMP

### DISASSEMBLY

Before disassembly, make an aligning line on the outside of fuel pump for correctly reassembling.

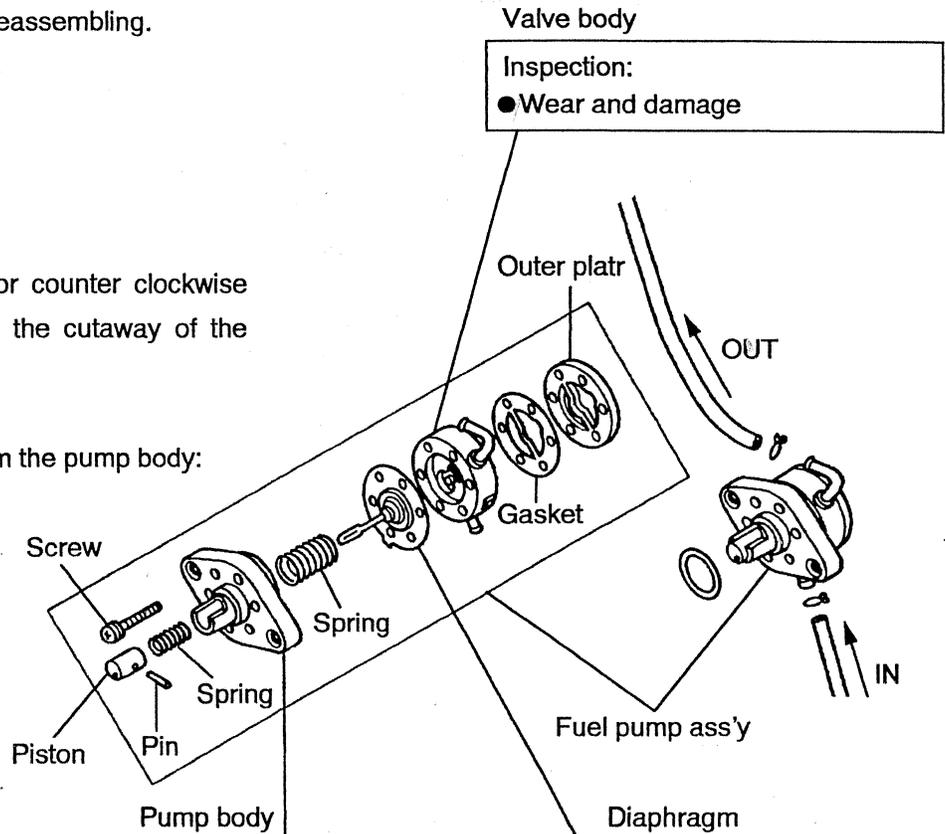
① Remove screw, and take off:

- Outer plate
- Gasket
- Valve body

② Turn the piston clockwise or counter clockwise until you look the pin from the cutaway of the pump body.

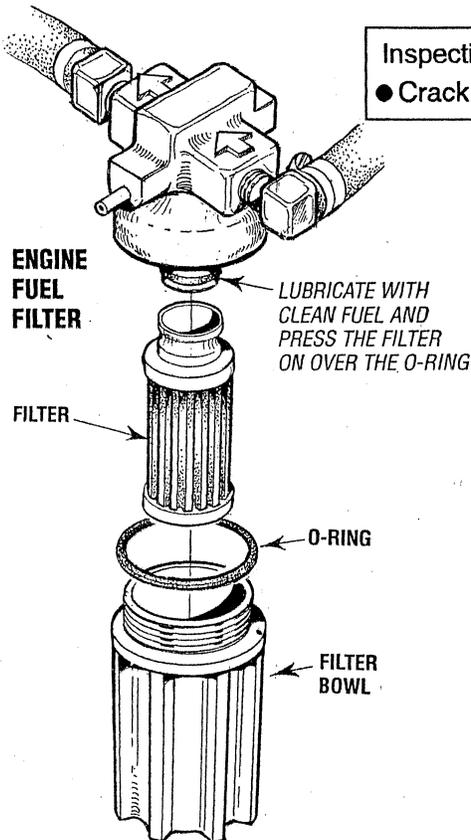
③ Pull the pin, and remove from the pump body:

- Piston
- Spring
- Diaphragm
- Spring



Inspection:  
● Crack and damage

Inspection:  
● Burst, crack and swelling

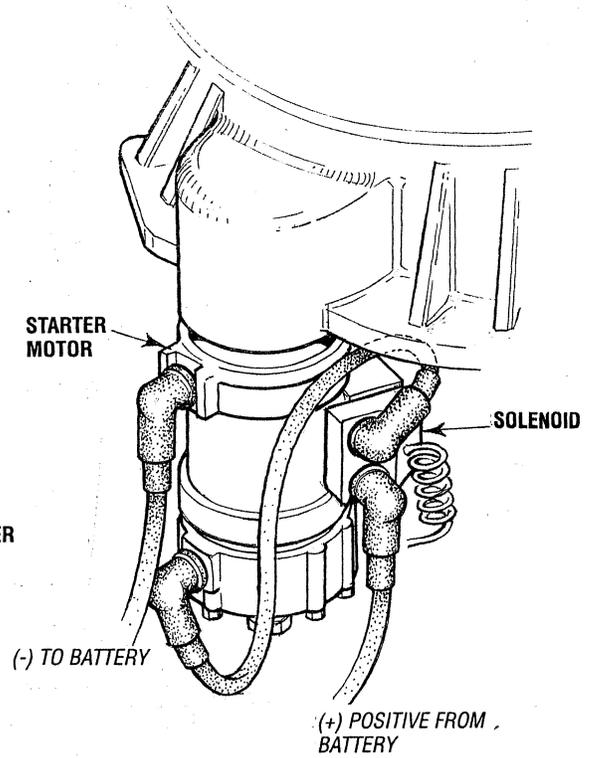
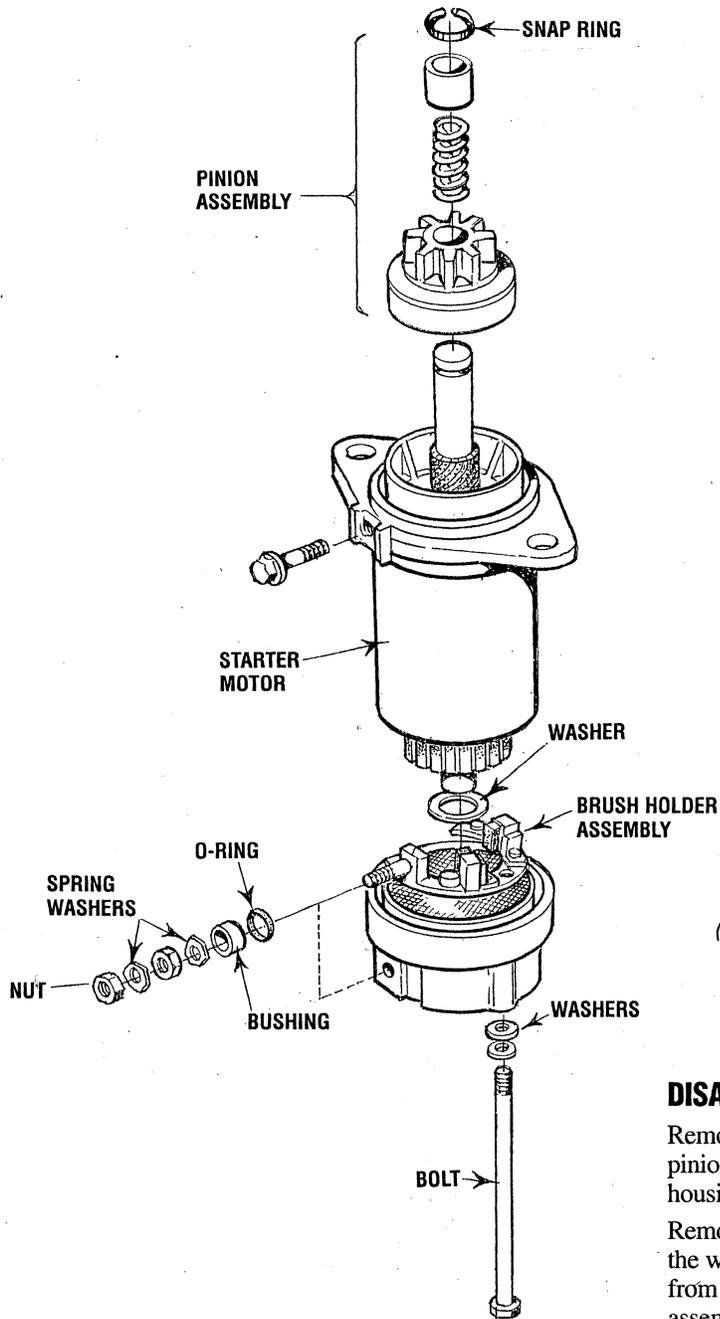


### REASSEMBLY

Reassembly is reverse order of disassembly

Note:  
After connecting the diaphragm rod to the piston with pin, align the diaphragm holes (6) to the pump body holes so that the pin will not come out through pump body cutaway.

# STARTER MOTOR



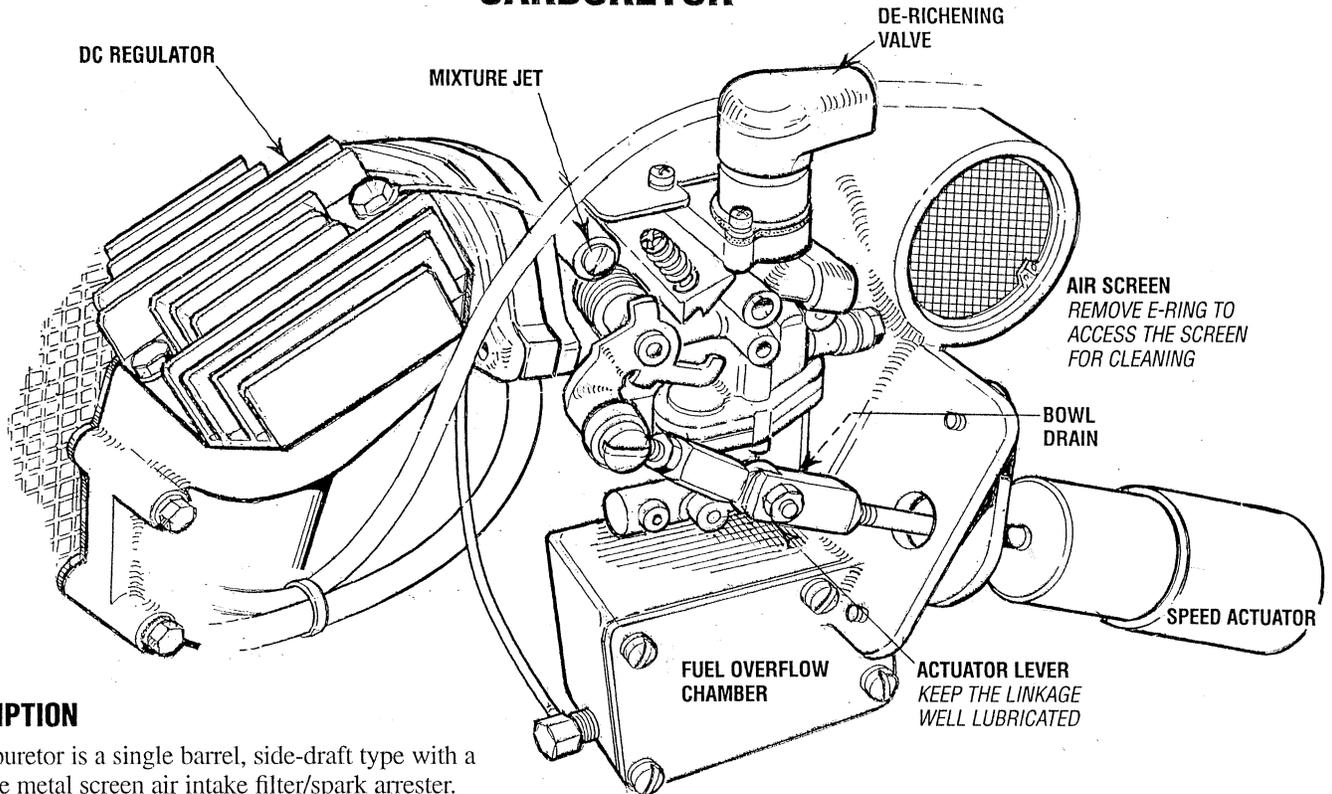
## DISASSEMBLY

Remove the snap ring from the end of the shaft and the pinion assembly can be disassembled from the front of the housing.

Remove the long bolts from the motor base and disconnect the wiring connection hardware. This will separate the base from the housing allowing access to the brush holder assembly.

**NOTE:** This exploded view is to enable the customer to inspect clean and possibly repair this starter motor, but parts are no longer available for this model motor.

# CARBURETOR



## DESCRIPTION

The carburetor is a single barrel, side-draft type with a cleanable metal screen air intake filter/spark arrester.

The choke is operated by a 12 VDC solenoid. The choke solenoid is activated when the start switch is depressed and is controlled by the I.C.M.

## Air Screen/Flame Arrester

The air screen can easily be removed. Clean after the first 50 hours of operation and every 100 hours from then on. Clean the air screen in a water soluble cleaner such as GUNK.

## Fuel Overflow Chamber

Excess fuel drains into the fuel overflow chamber but is drawn out again at start-up. This chamber should be kept free of contaminants. Cleaning every 250 operating hours should be sufficient unless there is a fuel problem.

## Idler Mixture Jet

Adjustment is performed with the generator operating. Screw the jet slowly in until it seats, then back it out 2 to 3 turns. Maximum adjustment is 5 turns.

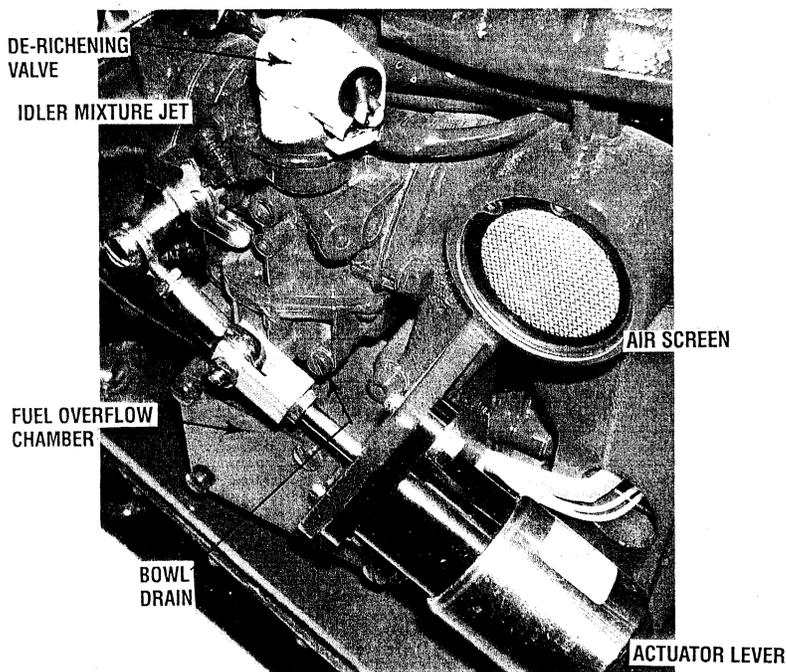
**NOTE:** An idle mixture jet adjusted too far off its seat can induce a sooty exhaust discharge at engine start-up and shut-down.

## De-Richening Valve

The de-richening valve closes off a fuel port that is supplying additional fuel on a cold start after start up. This is a thermal electric device that slowly moves a needle outward when DC power is applied after start up to close this fuel port. To check this valve, remove from the carburetor (cold) and apply DC voltage across its electrical connections. The device should get hot and the needle will slowly move outward. The device will remain hot during engine operation.

## Carburetor Bowl Drain

A bowl drain slotted plug is located on the lower right corner of the carburetor bowl. This is located just inboard of the actuators ball joint/clevis.,



CARBURETOR WITH SPEED ACTUATOR

# RAW WATER PUMP

## DESCRIPTION

Coolant (fresh water) cooled generators have dual water pumps while the raw water cooled models use a single water pump. The pumps are essentially the same. The upper pump mounts to the top of the lower pump and has a tang on the shaft that fits into the shaft of the lower pump. Both pumps are driven simultaneously by the engines drive belt.

The following instructions apply to either pump.

## PUMP OVERHAUL

### Disassembly

The pump, when removed from the engine will have the hose attachment nipple threaded into the inlet and outlet ports of the pump along with a drive pulley attached to the shaft of the pump. Remove these attachments noting their positions before starting the pump disassembly.

1. Remove the four cover plate screws, cover plate, and sealing O-ring.

### Dual Pumps

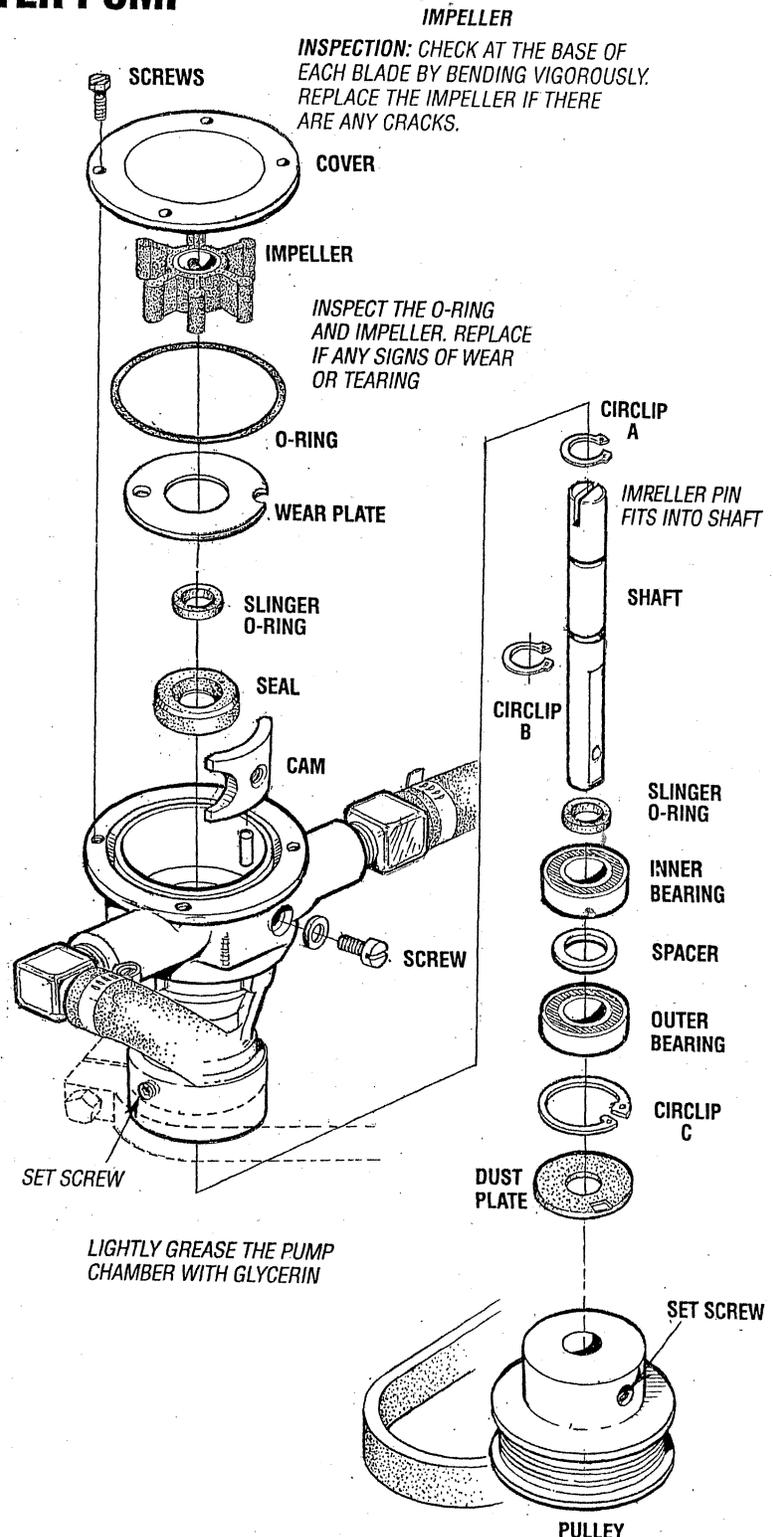
Remove the cover screws and the cover will separate the upper pump (raw water) from the fresh water (coolant) pump as shown in the illustration.

Remove the wear plate to expose the impeller. Notice the direction the impeller blades are working in so as to install the replacement impeller with blades working in the same direction.

2. Remove the impeller using a pair of pliers, grasping the hub and pulling it out of the pump with a twisting motion.
3. Remove the screw and sealing washer that hold the cam in place. Remove the cam and inner wear plate behind it.
4. Remove the brass circlip A and brass plate found behind the wear plate.
5. Remove the dust plate and circlip B.
6. Support the pump body on an arbor press and with a drift, carefully press the shaft and bearing assembly out of the pump body out the pulley end.
7. Remove the slinger O-ring from the shaft.
8. Support the outer bearing and push the shaft out of the bearing.
9. Remove the spacer and circlip C.
10. Support the inner bearing and push the shaft out of the bearing.
11. Remove the two piece ceramic shaft water seal.

### Inspection

Inspect all parts and replace those showing wear and corrosion.



# RAW WATER PUMP

## Reassembly

Wipe the inside surface of the pump dry. Apply a film of glycerin supplied in the impeller kit to the inside pump surfaces and to the exposed area of the shaft lip seal.

1. Install a new shaft seal in the pump body. Apply some glycerin to the lip of the seal.
2. Install the circlip shaft. Support the outer bearing and push the shaft into the bearing until the bearing contacts the circlip.
3. Install the spacer against the circlip. Support the inner bearing and push the shaft into the bearing until it contacts the spacer.
4. Warming the pump body should aid in installing the shaft and bearing assembly. Support the pump body on an arbor press. With a twisting motion, install the shaft and bearing assembly into the pump until the inner bearing seats and the outer bearing should just clear the boss for circlip B. Rotate the shaft. It should turn freely.
5. Install circlip B and push the shaft assembly until the outer bearing just contacts circlip B and install the dust plate. Rotate the shaft. It should turn freely.
6. Put some glycerin on the outer surface of the ceramic seal seat and slide it over the shaft white ceramic facing out and seat it in the body of the pump. Place some glycerin on the inner area and with a twisting motion slide it over the shaft until the ceramic of the spring seal touches the white ceramic face.
7. Install the brass plate and circlip A.
8. Install the wear plate, locking it in position on the dowel pin.

### Dual Pumps

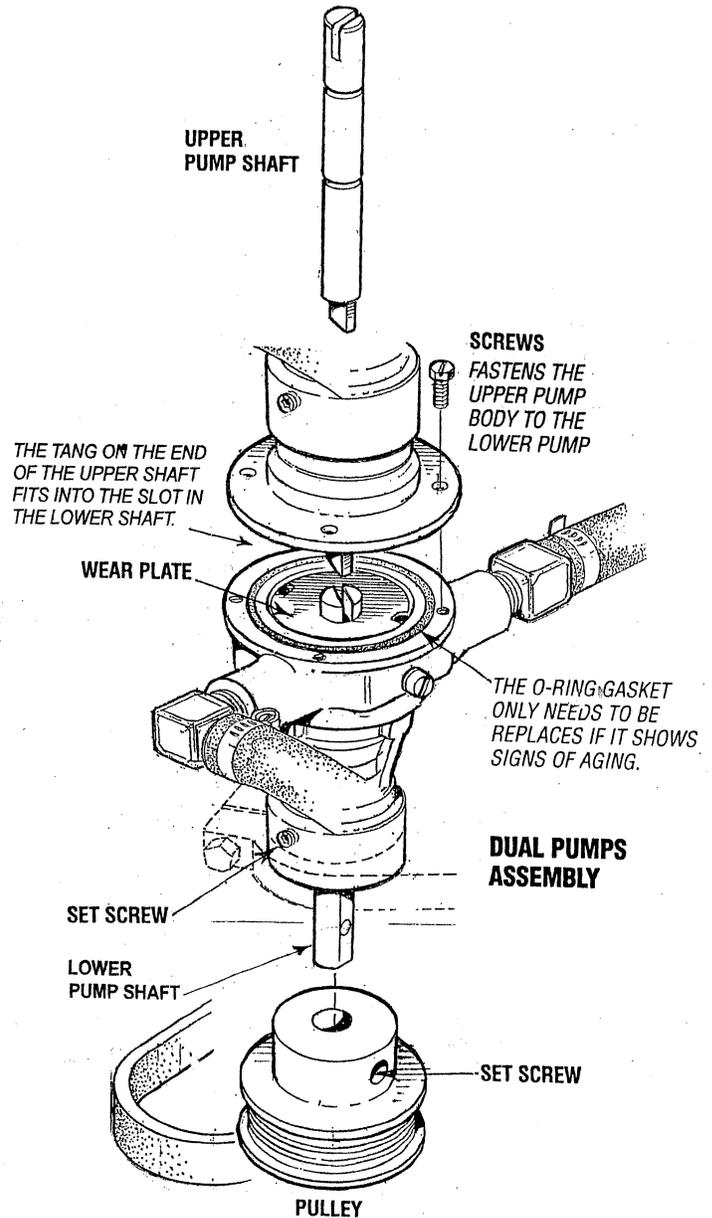
The wear plate is assembled above the impeller.

9. Install the cam and place some gasket cement on the threads of the screw that secures it in place.
10. Place some glycerin on the inner surface of the pump, the inner surface of the cover and the cover sealing O-ring and with a twisting motion install the impeller on the shaft of the pump. Install the covers O-ring and cover and secure the cover with the four cover screws.

**NOTE:** Install the new impellers with a rotating motion so the blades are working in the same direction of those of the removed impeller.

### Dual Pumps

Assemble the upper pump to the lower pump as illustrated making sure the mounting screws are tight.



# ENGINE TUNING

## TEST RUN AND INSPECTION AFTER COMPLETE ASSEMBLY

After reassembly, the engine must be tuned. This will ensure that the engine operates at its maximum efficiency.

- Mount the engine on a test bench.
- Connect the electrical wiring. refer to the *WIRING DIAGRAM*.
- Connect the air intake line to the air cleaner.
- Connect the exhaust.
- Fill the engine cooling system with coolant and the engine oil sump with lube oil.
- Connect the fuel lines.
- Crank the engine with the starter (non-ignition operation) for about twenty seconds. This will pre-lubricate the engine internal components.
- Start the engine and allow it to run five minutes.
- Remove the cylinder head cover while the engine is running.
- Check that the engine oil is continuously circulating from the oil pump to the valve rockers through the cylinder head.  
If there is no oil circulation or if the oil circulation is sluggish, stop the engine and make the appropriate repairs and adjustments.
- Re-install the cylinder head cover.
- Check the engine for oil, fuel, coolant, and air intake leakage.
- Check for abnormal noise and odor.
- Check for abnormal electrical charging.
- Check the engine fastening parts for looseness.
- Check the operation of the start/stop switch and LED panel lights.
- Adjust the engine speed to the specified value for generator operation.
- Stop the engine to complete the tuning procedure.
- Additional tightening after test run. Check the tightening condition of respective bolts and nuts after test run, and additionally tighten them with the specified tightening torques.

# ENGINE ADJUSTMENTS

## ENGINE COMPRESSION TEST

To check the engine's compression pressure, warm up the engine, then shut it down.

1. Remove both spark plug caps and both spark plugs.
2. Install a compression adapter and gauge in a spark plug hole.
3. Close the thru hull valve (seacock).
4. Crank the engine several times quickly so that the gauge pointer reaches it's maximum.

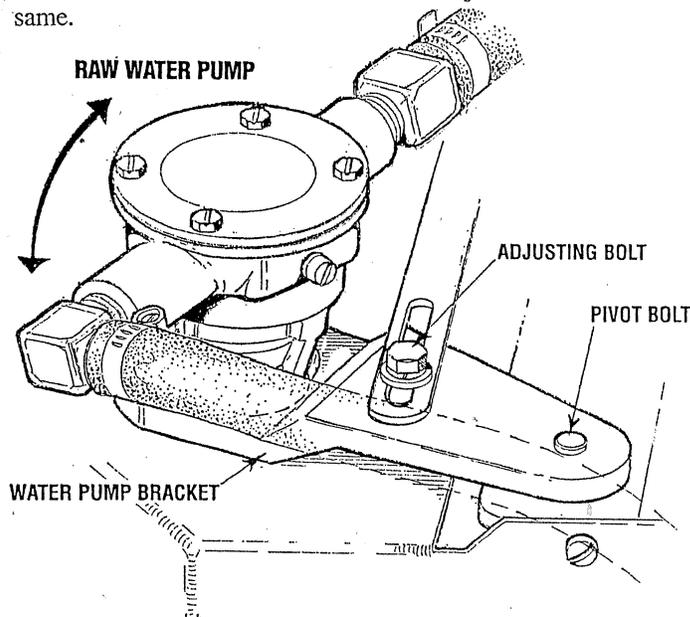
**STANDARD COMPRESSION PRESSURE AT 500 RPM:**  
**71 psi, (5.1 kgf/CM<sup>2</sup>), (0.50 MPa) with decompressor**  
**186 psi, (13.8 kgf/cm<sup>2</sup>), (1.35 MPa) without decompressor**

5. Test the compression pressure on the other cylinder. If either cylinder is below the standard try adding a small amount of engine oil through the spark plug hole and repeat the test.
  - (a) If additional oil causes an increase of pressure, the piston ring and/or cylinder may be worn or damaged.
  - (b) If additional oil does not increase compression pressure suspect poor valve contact, valve seizure or valve wear.
6. Reinstall the two plugs, connect the wires and open the thru hull valve (seacock).

## WATER PUMP BELT

To remove, replace or adjust the belt, loosen the pivot bolt and release the adjusting bolt. Slide the water pump bracket to slacken the belt for removal. When replacing and adjusting the belt, set the belt very tight and tighten the bolt and nut.

The dual water pumps on the *FRESH WATER COOLED MODELS* use the same drive belt and the adjustment is the same.



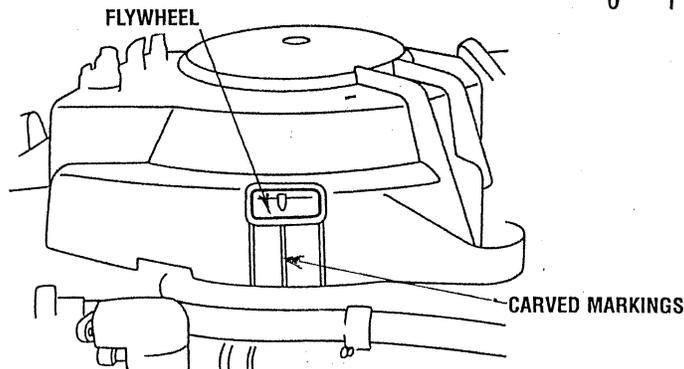
**NOTE:** The adjustment is the same for the *FRESH WATER COOLED MODEL* dual pumps.

## IGNITION TIMING

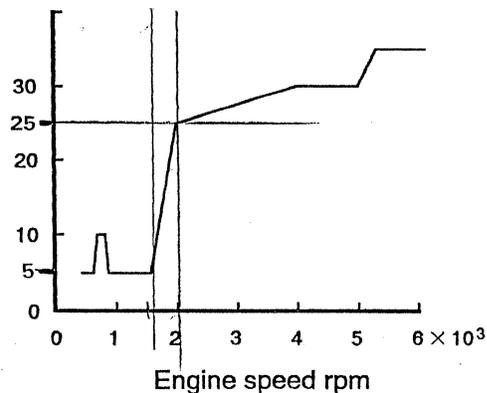
The magneto employs the electric ignition advance system that advances ignition timing with an increase of engine speed. While running the engine, check the ignition timing with a timing light.

There are nine (9) markings (TDC, ATDC 5° and BTDC 5°, 10°, 15°, 20°, 25°, 30°, 35) on the flywheel cup.

Check the timing while observing the position of the carved marking on the starter case.



BTDC  
IGNITION TIMING  
IN DEGREES

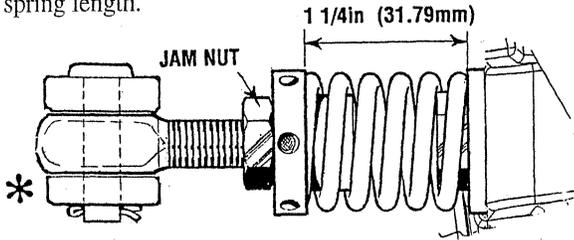


# ENGINE ADJUSTMENTS

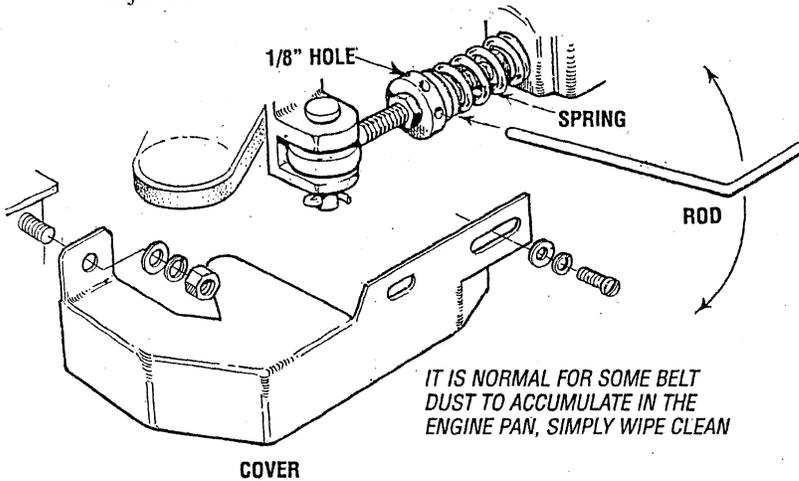
## ADJUSTING THE DRIVE BELT

The engine's drive belt is located under the engine. To access the belt, for inspection and/or adjustment, remove the cover as shown. Inspect the belt for wear along the edges and for proper belt tension (belt should be tight).

The belt tension can be checked by measuring the spring length.

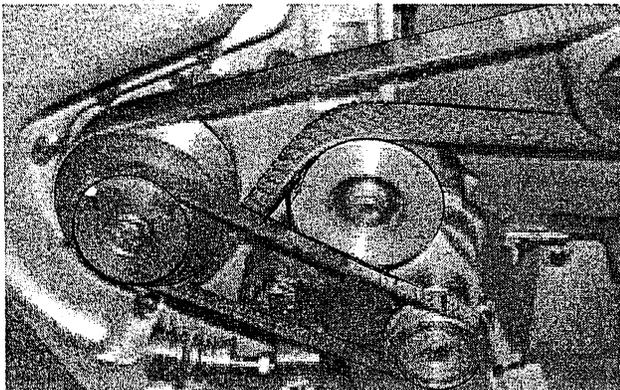


To set the spring tension at 1-1/4", release the jam nut and use a rod such as an allen wrench to turn the adjusting nut (as shown) to tighten or loosen the spring tension, which in turn adjusts the tension on the belt.



IT IS NORMAL FOR SOME BELT DUST TO ACCUMULATE IN THE ENGINE PAN, SIMPLY WIPE CLEAN

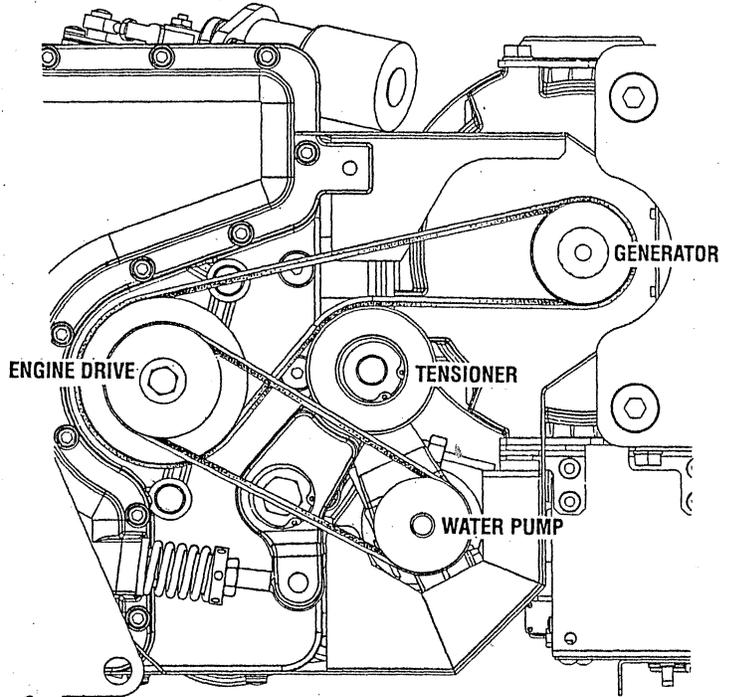
COVER



BELT ASSEMBLY VIEWED FROM BELOW

**\* IMPORTANT:** REFER TO THE WESTERBEKE SERVICE BULLETIN (LAST PAGE IN THIS MANUAL) FOR THE ADDITION OF A SPACER ON THE 3.0BCG MODEL.

BELT ASSEMBLY VIEWED FROM BENEATH



## OIL PRESSURE

The lubricating system is a pressure feeding system using an oil pump. The engine oil is drawn from the oil sump by the oil pump, which drives the oil, under pressure, through the oil filter and various lubricating parts in the engine. The oil then returns to the oil sump to repeat the continuous cycle. When the oil pressure exceeds the specified pressure, the oil pushes open the relief valve in the oil pump and returns to the oil sump, keeping the oil pressure within it's specified range.

## TESTING OIL PRESSURE

To test the oil pressure, remove the oil switch and install a mechanical oil pressure gauge in it's place, it will be necessary to connect the two switch wires together for the engine to run. After warming up the engine, with the engine speed at 2200 rpm, read the oil pressure gauge.

**OIL PRESSURE:** between 30 and 40 psi at 2200 rpm

**NOTE:** A newly starter (cold) engine may have an oil pressure up to 40 psi. A warmed engine can have an oil pressure as low as 30 psi. Oil pressure will vary depending on the load placed on the generator.

## OIL PRESSURE SWITCH/SENSOR

The generator is fitted with an oil pressure shutdown switch. Should the engine's oil pressure drop below the safe minimum, the switch will shut the engine down to prevent damage by interrupting the DC voltage to the ignition coil.

**NOTE:** The specified minimum oil pressure is 5 psi. A gradual loss of oil pressure usually indicates worn bearings. For additional information on low oil pressure readings, see the ENGINE TROUBLESHOOTING chart.

# ENGINE ADJUSTMENTS

## SPARK PLUGS

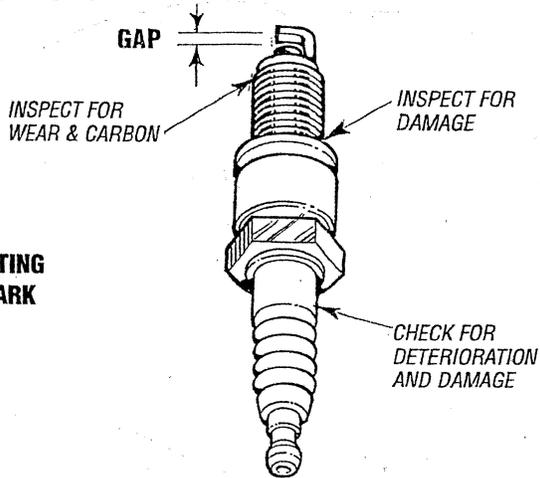
The spark plugs should be cleaned and re-gapped after the first 50 hour break-in period, then inspected every 250 hours thereafter and replaced as needed.

**⚠ WARNING:** Do not remove the spark plugs while the engine is hot. Allow the engine to cool before removing them.

SPARK PLUG GAP: 0.032 – 0.035in. (0.8 - 0.9mm).

SPARK PLUG TORQUE: 11 – 15 lb-ft (15 – 26 Nm).

**NOTE:** Loctite Anti-Seize applied to the threaded portion of the spark plugs will retard corrosion, making future removal of the spark plugs easier.



### INSPECTING THE SPARK PLUGS

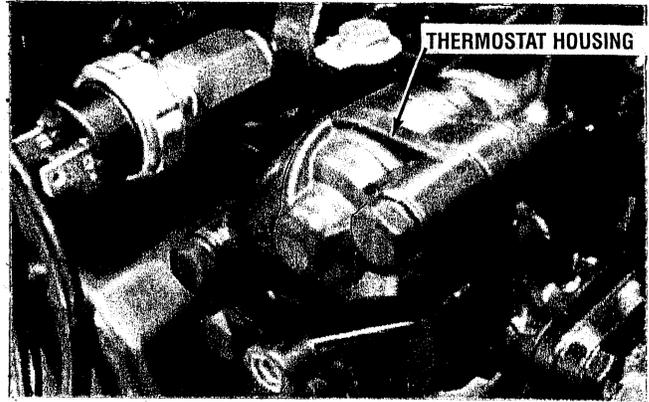
## CHOKE SOLENOID

The choke solenoid is a 12 volt DC operated unit that is an integral part of the carburetor. When the engine is cold, extra fuel is supplied to the engine. The choke is controlled by the ignition control module and requires no adjustments.

## ZINC ANODE [Raw Water Cooled Models]

The zinc anode is located just below the thermostat cover and next to the oil filter. The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the raw water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced as required. Spare anodes should be carried on board.

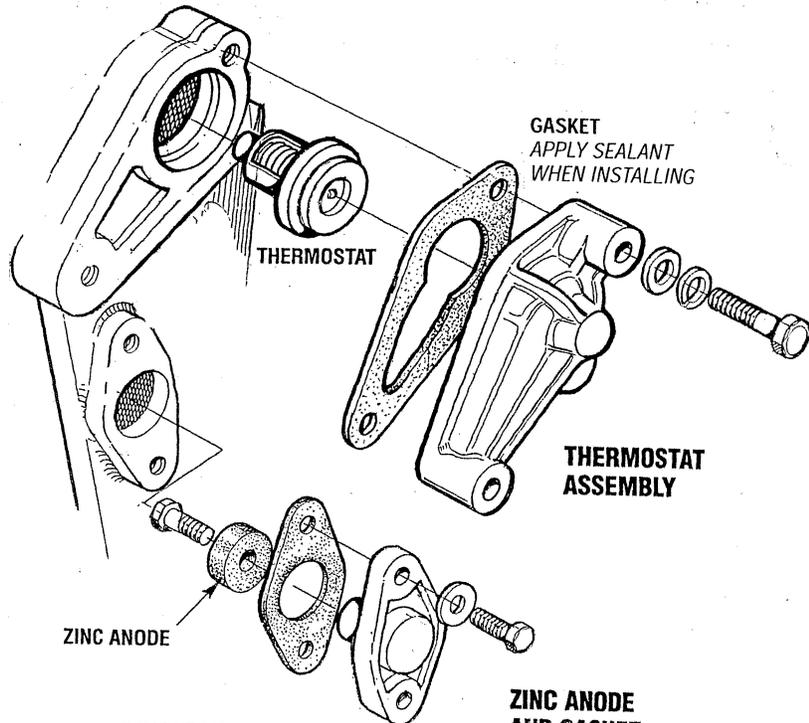
**NOTE:** Refer to the Cooling System pages for Fresh Water Cooled Thermostat and Zinc Anode assemblies.



## THERMOSTAT [Raw Water Cooled Models]

A thermostat controls the coolant temperature as the raw water continuously flows through the closed cooling circuit. When the engine is first started, the closed thermostat prevents the water from flowing (some water is by-passed around the thermostat to provide coolant circulation in the engine block). As the engine warms up, the thermostat gradually opens. The thermostat is accessible and can be checked, cleaned, or replaced easily. Carry a spare thermostat and gasket.

If you suspect a faulty thermostat, place it in a pan of water and bring to a boil. A working thermostat should open when heated and close when cold.



THE GASKET IS SEALED TO THE CASTING AND, UNLESS DAMAGED, CAN BE LEFT IN POSITION. ADD SEALANT TO THE GASKET SURFACE WHEN REASSEMBLING THE COVER.

# ENGINE ADJUSTMENTS

## INSPECTION/REPLACING OF THE TIMING BELT

If cracks, wear, lengthening or other damage is found, replace the timing belt.

**LIMIT OF ELONGATION: MORE THAN 10mm (0.4 IN) DEFLECTION BY PUSHING WITH YOUR FINGER**

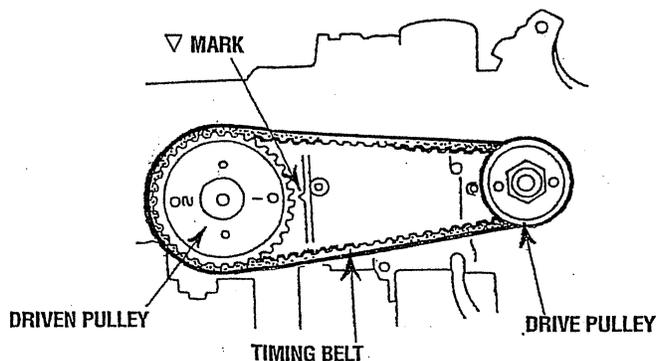
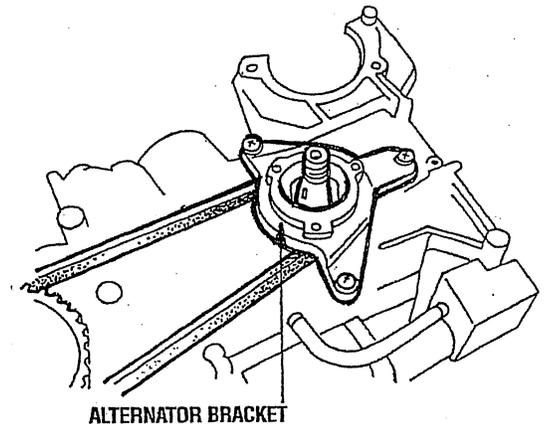
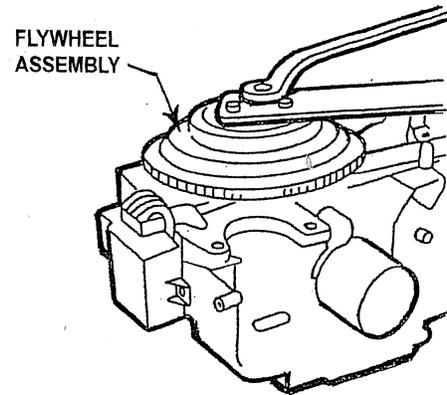
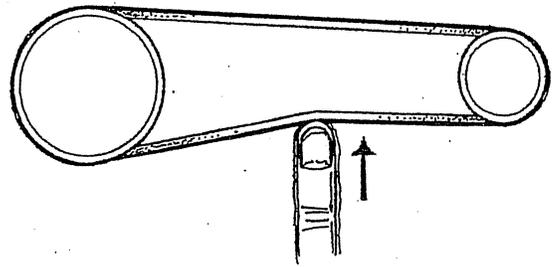
### Replacement of the Timing Belt

1. Remove the parts in the following order:
  - a. Spark Plugs
  - b. Voltage Regulator
  - c. Unplug MPU
  - d. Unplug Cam Sensor
  - e. Flywheel Housing
  - f. Flywheel assembly
  - g. Alternator Bracket

2. Turn the crankshaft and align "○" mark on the drive pulley and the "○" mark on the cylinder head.
3. Remove the timing belt from the driven pulley side.
4. Install the timing belt from the drive pulley side.

**NOTE:** After installing the timing belt, when the aligning "○" mark on the drive pulley with "○" on the cylinder block. Please confirm that the "1 & ○" or "2 & ○" mark on the driven pulley are aligned with the "▽" mark on the cylinder head.

**NOTE:** Always keep the timing belt away from any oil and grease.

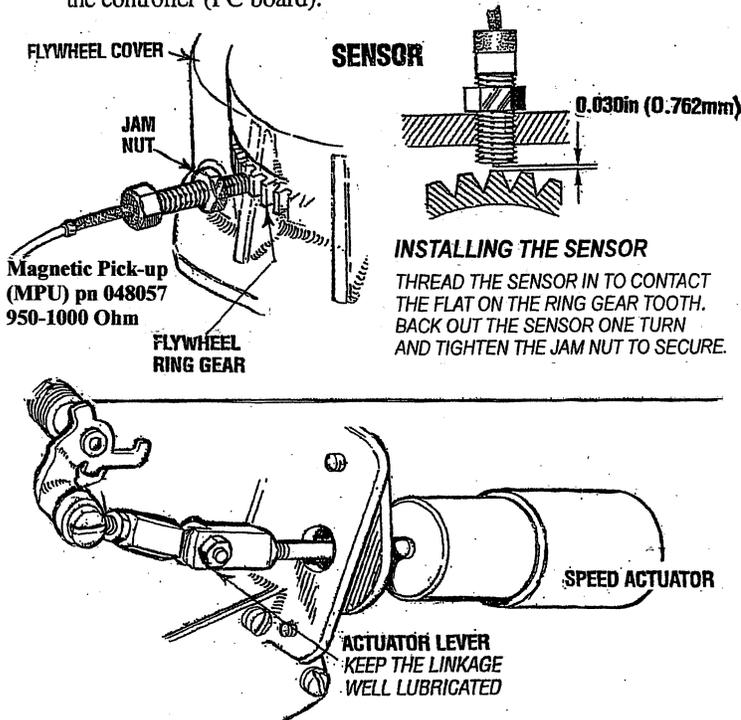


# ELECTRONIC GOVERNOR

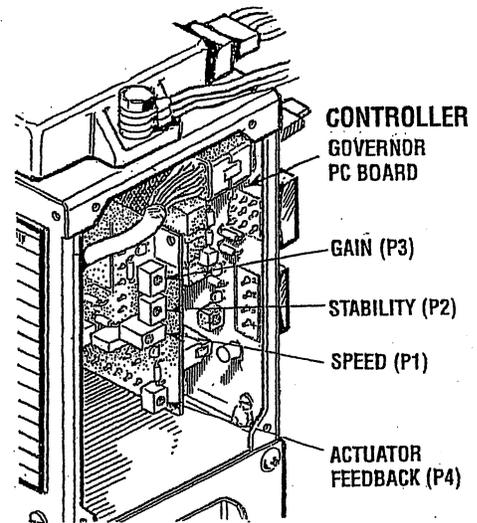
## DESCRIPTION

The system is composed of three basic components.

1. **Controller.** The PC board that governs the system is located in the control panel.
  2. **Sensor.** Mounted on the flywheel cover, the sensor measures the speed of the engine (via the ring gear).
  3. **Actuator.** Electronically controls the carburetor throttle.
- The sensor and actuator are wired thru the wiring harness to the controller (PC board).



CONTROL PANEL (INTERIOR VIEW)



## Before starting the engine

- Remove all loads and turn off the AC circuit breaker to insure that loads will not be subjected to voltage variations while these adjustments are made.
- Decrease the speed pot to prevent overspeed at start up.
- Turn the other adjustment pots to the middle position.

Start the engine, monitor speed and adjust to the hertz rating of the unit by adjusting the **SPEED (P1)** as needed. Verify that the AC voltage output is in the correct range.

Decreasing the gain (**P3**) dampens no load hunting. With the engine running at no load and proper speed, manually bump the throttle lever to cause hunting. If necessary, decrease the gain in small increments to eliminate hunting.

After the engine's no load speed and gain are set correctly, the AC circuit breaker can be turned on and the ship's load applied. In the event of speed variations with loads applied, the stability (**P2**) pot may need adjustment. This adjustment also changes how the engine responds to generator load changes.

If the range of adjustment of either gain (**P3**) or stability (**P2**) pots do not correct engine hunting, the actuator feedback (**P4**) pot can be increased. This adjustment dampens the signals to the throttle control actuator. Increasing this adjustment will decrease the amount of throttle control resolution. Because of this, it is recommended the adjustment be made in very small increments. The gain and stability pots may now need to be readjusted.

Most hunting problems occur because of mechanical problems with the linkage between the actuator and the carburetor. Insure that the linkage is free of any debris or corrosion and that it moves freely. It is recommended that the linkage be lubricated with a graphite lubricant. Do not use oil because it tends to collect dirt and dust.

**NOTE:** Adjustments to one parameter may affect others, such as speed. It may be necessary to readjust some pots throughout this process.

## ADJUSTMENT PROCEDURE

**Speed.** This adjustment is used to raise or lower the engine's speed. This generator engine is set to run at 2200 RPM.

**Gain.** Adjusts the overall set of the engine. If too low, the engine seems sluggish, to high causes the engine to hunt.

**Stability.** Adjusts the engine's response to generator load changes.

**Alternator Feedback.** Adjusts the stability of the speed signal to the throttle actuator.

**NOTE:** These adjustments are extremely delicate and require proper meters for measuring voltage and RPM'S.

## ADJUSTING THE CONTROLLER PODS

Following are the basic procedures for adjusting the speed (**P1**), stability (**P2**), gain (**P3**), and actuator feedback (**P4**) pots.

The adjusting pots (except speed) have physical internal stops. Turn to the right (clockwise) to increase, turn to the left (counter-clockwise) to decrease.



# 3.0 KW GENERATOR SPECIFICATIONS

## ENGINE SPECIFICATIONS

Engine Type	Two cylinder, four stroke gasoline engine.
Bore & Stroke	2.32 x 2.36 inches (59 x 60 mm)
Total Displacement	20.01 Cubic Inches (.33 liter)
Bearings	Two main bearings.
Valve System	Overhead cam-cross flow.
Compression Ratio	9:1
Firing Order	1 - 2
Aspiration	Naturally aspirated.
Direction of Rotation	Counterclockwise viewed from the back end.
Inclination	25° maximum angle of operation
Dry Weight	165 lbs (75 Kg)
Governor	Electronic

## FUEL SYSTEM

Fuel Pump	Mechanical fuel pump.
Fuel	Unleaded 89 octane or higher gasoline.
Ignition Timing	BTDC 25° (not adjustable).
Ignition Coil	12 volt.
Flame Arrester	Metal screen type.
Carburetor	Single barrel side draft.
Fuel Consumption (Full Load)	0.4 GPH @ 2200 RPM/25 Amps
Ignition Timing	12-Volt flywheel magneto.

## ELECTRICAL SYSTEM

Start Motor	12-Volt Direct Drive-Remote Solenoid
Starting Battery	12-Volt, (-) negative ground
Battery Capacity	600-900 Cold Cranking Amps (CCA)
Battery Charging	11 Amp
DC Amperage Draw	70 Amps DC Cranking

## LUBRICATION SYSTEM

Type	Wet sump system trochoid type pump.
Oil Filter	Fuel flow, paper element, spin-on disposals.
Oil Capacity	1.5 qts. (91.4 L)
Oil Grade	API Service Category SJ, SL, SM, SN or better SAE 10W-30 or 15W-40

## COOLING SYSTEM

General	Water cooled via raw water pump.
Raw Water Pump	Positive displacement type, rubber impeller, belt driven.
Raw Water Flow (into water injected exhaust elbow)	1.75 GPM (before thermostat opens) 2.0 GPM (thermostat open)
Operating Temperature	140°F (60°C)

## AC GENERATOR (SINGLE PHASE)

Type	Permanent magnet generator (two pole) Brushless/capacitor (two pole)
Speed	3600 RPM / 60Hz. 3000 RPM / 50 Hz.
3.0 Kw	3.0 KW - 60 Hz single phase, 120 volts 2 wire, 25 amp. 3.0 KW - 50 Hz single phase, 230 volts 2 wire, 13 amp.

## TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.032 - 0.035in (0.8 - 0.9mm)
Spark Plug Torque	11 - 15 lb-ft (15 - 20 Nm)
Bolt Torque	See <i>TORQUING THE CYLINDER HEAD.</i>

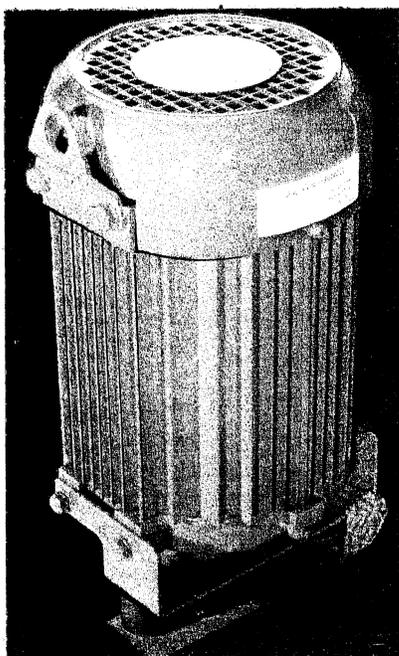
## AIR REQUIREMENTS

Engine Combustion	13 CFM (0.287 cmm)
Generator Cooling	200 CFM (5.66 cmm)

## FRESH WATER COOLED MODELS

Cooling System	Fresh water cooled block, thermostatically controlled thru a heat exchanger.
Fresh Water (coolant) Pump	Positive displacement, rubber impeller belt driven
Raw Water Pump	Positive displacement, rubber impeller belt driven
Raw Water Flow (into water injected exhaust elbow)	2.5 - 3.0 GPM 9.5 - 11.3 LPM
Operating Temperature	180°F (82°C)

# AC GENERATOR



## PERMANENT MAGNET GENERATOR

Engine rpm at 2200

Generator turns at 3600 (60 Hz), 3000 (50Hz)

60Hz 120 volts/25 amps, 50 Hz 230 volts/13 amps

**⚠ WARNING:** Do not attempt to make adjustments or repairs to the generator. The generator is maintenance free. If the generator fails (no ac output), contact your WESTERBEKE dealer or distributor.

## Required Operating Speed

Run the generator first with no load applied, then at half the generator's capacity, and finally loaded to its full capacity as indicated on the generator's data plate. The output voltage should be checked periodically to ensure proper operation of the generating plant and the appliances it supplies. To monitor voltage and load, check it with a portable meter and amprobe.

## Generator Maintenance

Maintaining reasonable cleanliness is important. Connections of terminal boards and rectifiers may become corroded, and insulation surfaces may start conducting if salts, dust, engine exhaust, carbon, etc. are allowed to build up. Clogged ventilation openings may cause excessive heating and reduced life of windings.

In addition to periodic cleaning, the generator should be inspected for tightness of all connections, evidence of overheated terminals and loose or damaged wires.

## MOTOR DATA

The power required to start an electric motor is considerably more than is required to keep it running after it is started. Some motors require much more current to start than others. Split-phase (AC) motors require more current to start, under similar circumstances, than other types. They are commonly used on easy-starting loads, such as washing machines, or where loads are applied after the motor is started, such as small power tools. Because they require 5 to 7 times as much current to start as to run, their use should be avoided, whenever possible, if the electric motor is to be driven by a small generator. Capacitor and repulsion-induction motors require from 2 to 4 times as much current to start as to run. The current required to start any motor varies with the load connected to it. An electric motor connected to an air compressor, for example, will require more current than a motor to which no load is connected.

In general, the current required to start 115-Volt motors connected to medium starting loads will be approximately as follows:

MOTOR SIZE (HP)	AMPS FOR RUNNING (AMPERES)	AMPS FOR STARTING (AMPERES)
1/6	3.2	6.4 to 22.4*
1/4	4.6	9.2 to 32.2*
1/3	5.2	10.4 to 72.8*
1/2	7.2	14.4 to 29.2*
3/4	10.2	20.4 to 40.8*
1	13	26 to 52

**\*NOTE:** In the above table the maximum Amps for Starting is more for some small motors than for larger ones. The reason for this is that the hardest starting types (split-phase) are not made in larger sizes.

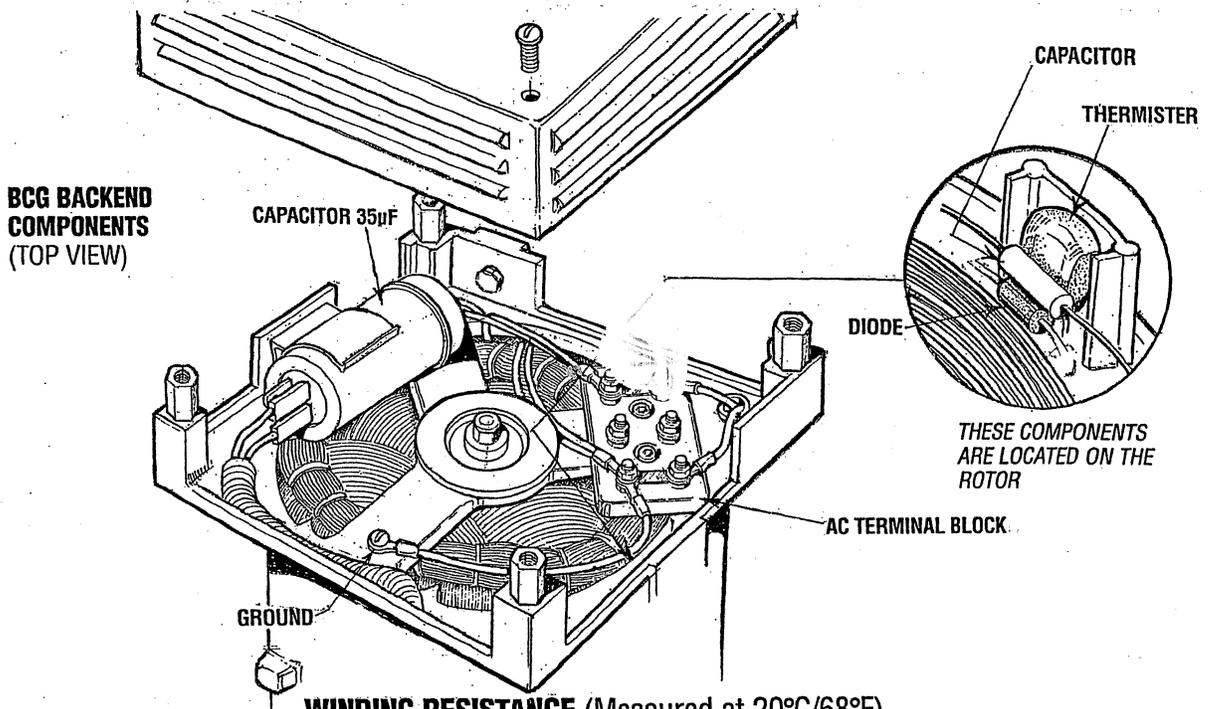
Because the heavy surge of current needed for starting motors is required for only an instant, the generator will not be damaged if it can bring the motor up to speed in a few seconds. If difficulty is experienced in starting motors, turn off all other electrical loads and, if possible, reduce the load on the electric motor.

## GENERATOR FAILURE

Should a failure occur in the permanent magnet generator, contact your Westerbeke dealer or the Westerbeke factory.

**NOTE:** It would be important to inspect the pulley and drive belt under the generator base frame.

# BCG WINDING RESISTANCES/INTERNAL WIRING DIAGRAM

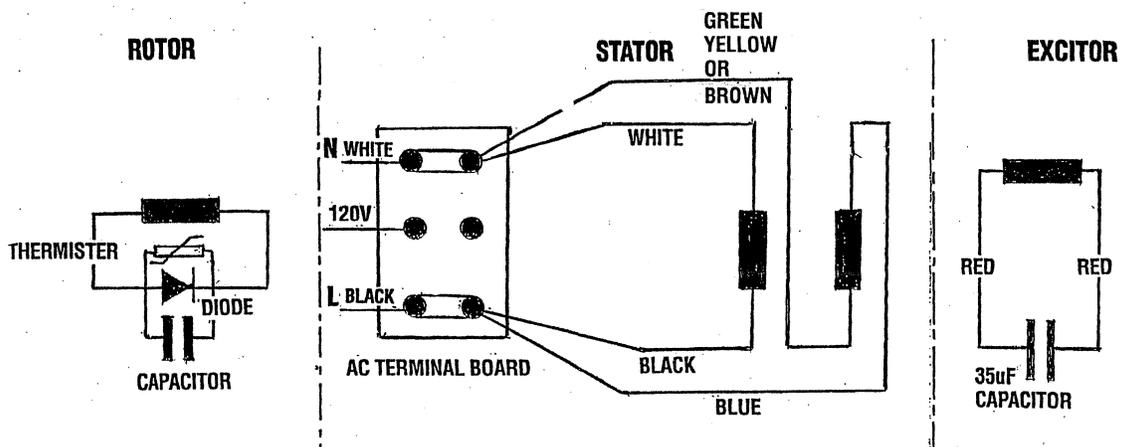


**WINDING RESISTANCE** (Measured at 20°C/68°F)

60 Hertz Models : Stator Winding 0.93 Ohm/winding.  
Rotor Winding - 4.0 Ohm  
Excitor Winding - 2.0 Ohm  
Capacitor Rating - 34 µF

50 Hertz Models : Stator Winding 1.35 Ohm/winding.  
Rotor Winding - 4.0 Ohm  
Excitor Winding - 2.5 Ohm  
Capacitor Rating - 31.55 µF

## BCG INTERNAL WIRING DIAGRAM



## BY-PASSING THE OVERSPEED BOARD

An unwanted shutdown or if the engine runs 10-15 seconds and then shuts down can be caused by a faulty over-speed board.

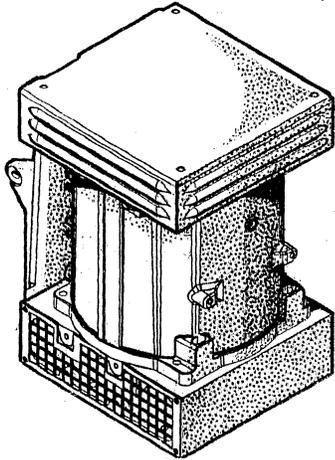
1. Refer to the Wiring Diagram in this manual.
2. Unplug the brown #6 wire that connects between pin #12 of the 15 pin plug connector and the ignition module. The wire plug connection is in the harness between the two components.
3. Without unplugging any connections on the coil relay, place a jumper between connection #30 and #87.

4. Manually controlling #30 and #87, start the engine physically controlling the actuator/throttle keeping the engine speed at a low comfortable range. If the engine continues to run more than 15 seconds, a faulty overspeed board exists.

**NOTE:** The above should only be performed as a test. The generator with a by-passed overspeed board should not be run under normal use. This can present a hazard.

# BCG/BPMG DESCRIPTION and TROUBLESHOOTING

REFER ALSO TO THE SPECIFICATION PAGE



## BRUSHLESS CAPACITOR GENERATOR (BCG)

Engine RPM at 2200  
generator turns at  
3600 (60Hz) 3000 (50Hz)  
60Hz 120 Volts/25 Amps  
50Hz 230 Volts/13 Amps

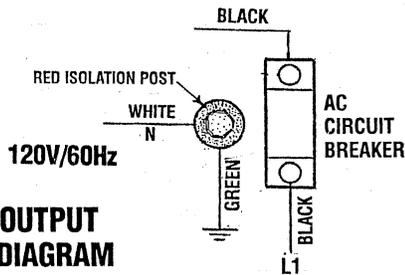
**NOTE:** Refer to the following page for the BCG Internal Wiring Schematic and BCG Winding Resistances.

## TROUBLESHOOTING CHART (BCG)

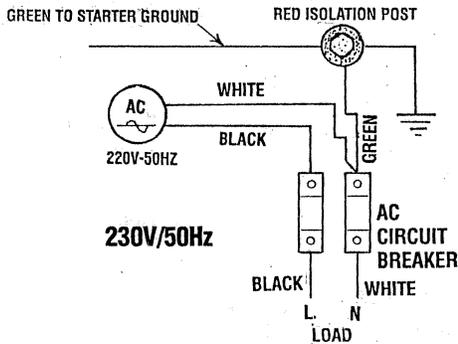
CAUSE	FAULT
No AC Output Voltage	<ol style="list-style-type: none"> <li>1. Shorted Stator.</li> <li>2. Open Stator.</li> <li>3. Shorted Rotor Diode.</li> <li>4. Shorted Rotor Thermister.</li> <li>5. Shorted Rotor Capacitor.</li> <li>6. Open Rotor Diode.</li> </ol>
Residual Voltage Line - Neutral at No Load	<ol style="list-style-type: none"> <li>1. Faulty Capacitor.</li> <li>2. Open Exciter Winding.</li> <li>3. Shorted Exciter Winding.</li> </ol>
Low AC Output Voltage 60 - 100 Volts	<ol style="list-style-type: none"> <li>1. Faulty Rotor Diode.</li> <li>2. Faulty Rotor Winding.</li> <li>3. Faulty Exciter Capacitor.</li> </ol>
AC Voltage Drop with Inductive Load	<ol style="list-style-type: none"> <li>1. Faulty Rotor Diode.</li> <li>2. Faulty Exciter Capacitor.</li> <li>3. Amperage Overload.</li> </ol>

Refer to the following page for the BCG Internal Wiring Schematic and the BCG Winding Resistances.

DIAGRAMS ARE FOR BOTH MODELS



## BCG/BPMG AC OUTPUT CONNECTIONS DIAGRAM



## TROUBLESHOOTING CHART (BPMG)

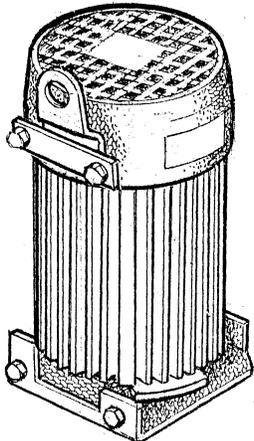
CAUSE	FAULT
No AC Output Voltage	<ol style="list-style-type: none"> <li>1. Shorted Stator Winding.</li> <li>Open Stator Winding.</li> </ol>
Low AC Output Voltage 60 - 100 Volts	<ol style="list-style-type: none"> <li>1. Faulty Rotor.</li> </ol>
Voltage Drop Under Load	<ol style="list-style-type: none"> <li>1. Generator Overload.</li> </ol>

## WINDING RESISTANCE (Measured at 20°C/68°F)

PM (Permanent Magnet) stator winding resistance 0.4 ohm hertz model resistance is measured between line and neutral. 50 hertz models is 0.8 ohm.

**NOTE:** The permanent magnet style generator can not be disassembled. If an electrical fault should occur, the generator must be replaced.

**NOTE:** It would be important to inspect the pulley and drive belt under the generator base frame.

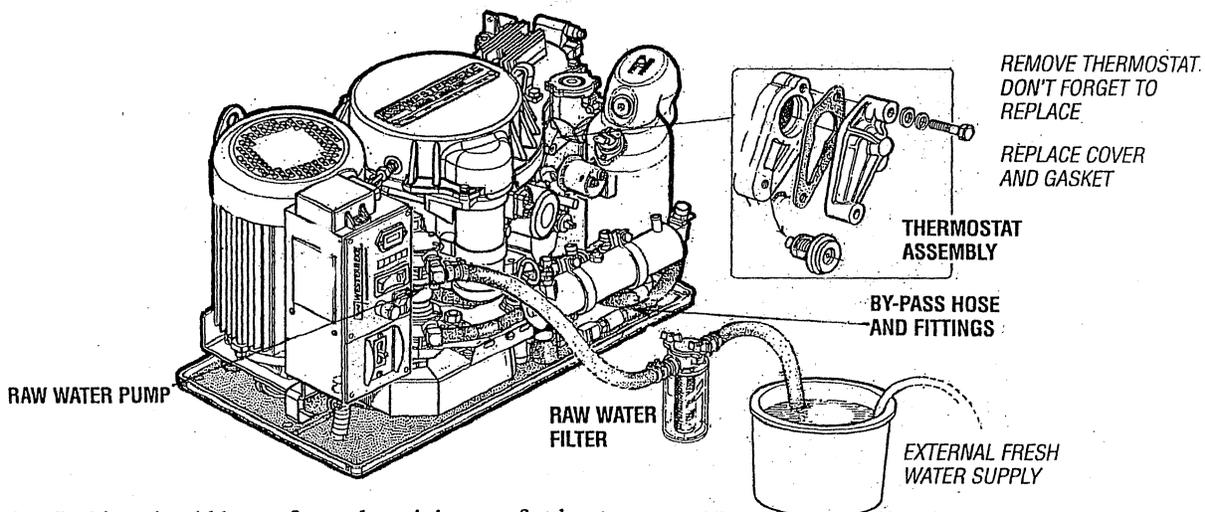


## PERMANENT MAGNET IR GENERATOR (BPMG)

Engine RPM at 2200  
generator turns at  
3600 (60Hz) 3000 (50Hz)  
60Hz 120 Volts/25 Amps  
50Hz 230 Volts/13 Amps

# FLUSHING THE COOLING SYSTEM

## RAW WATER COOLED



Engine flushing should be performed a minimum of at least twice per operating season. More often in those areas where the unit is not subject to winter storage. In those locations where the unit is used year round, flushing the unit every 4 months is recommended.

This procedure is best accomplished by disconnecting the water intake hose from the vessels thru-hull fitting. **Close the intake valve before disconnecting the hose.** Insert the hose end into a large container of fresh water.

Before starting the engine, remove the engine thermostat (replace the gasket and cover). This will ensure a full flow of water thru the engine. **Re-install the thermostat once flushing is complete.**

**NOTE:** Prior to flushing the engine, inspect the coolant by-pass hose and its attachment fittings to insure that there are no obstructions occurring in the fittings or the hose.

Provide an external fresh water supply for the bucket to maintain the water level in the bucket while the unit is being operated during the flushing process.

**CAUTION:** Do not connect an external fresh water supply directly to the engine's cooling system. This can cause flooding of the engine resulting in internal damage.

Run the unit for 10 minutes or longer to adequately flush the cooling system.

the fresh water will flush out the engines water passages and exhaust lines. If the engine is being stored and there is a probability of freezing, flush the engine with fresh water and then prior to shutting the unit down substitute the fresh water supply with a concentrated antifreeze mixture and run this through the engine to provide freeze and corrosion protection for both the engine and exhaust system.

When recommissioning, make certain the valves and seacocks are open so the engine will quickly receive fresh water.

# ENGLISH TO METRIC CONVERSION CHART

<b>Multiply Temperature</b>	<b>By</b>	<b>To get equivalent number of:</b>
Degree Fahrenheit (°F)	$(°F-32) \div 1.8$	Degree Celsius (°C)
<b>Multiply Acceleration</b>	<b>By</b>	<b>To get equivalent number of:</b>
Foot/second <sup>2</sup> (ft/sec <sup>2</sup> )	0.3048	Meter/second <sup>2</sup> (m/s <sup>2</sup> )
Inch/second <sup>2</sup> (in./sec <sup>2</sup> )	0.0254	Meter/second <sup>2</sup> (m/s <sup>2</sup> )
<b>Multiply Torque</b>	<b>By</b>	<b>To get equivalent number of:</b>
Pound-inch (lb-in.)	0.11298	Newton-meters (N·m)
Pound-foot (lb-ft)	1.3558	Newton-meters (N·m)
<b>Multiply Power</b>	<b>By</b>	<b>To get equivalent number of:</b>
Horsepower (hp)	0.746	Kilowatts (kW)
<b>Multiply Pressure or Stress</b>	<b>By</b>	<b>To get equivalent number of:</b>
Inches of water (in. H <sub>2</sub> O)	0.2491	Kilopascals (kPa)
Pounds/square in. (lb/in. <sup>2</sup> )	6.895	Kilopascals (kPa)
<b>Multiply Energy or Work</b>	<b>By</b>	<b>To get equivalent number of:</b>
British Thermal Unit (Btu)	1055	Joules (J)
Foot-pound (ft·lb)	1.3558	Joules (J)
kilowatt-hour (kW·hr)	3,600,000. or 3.6 x 10 <sup>6</sup>	Joules (J = one W/s)
<b>Multiply Light</b>	<b>By</b>	<b>To get equivalent number of:</b>
Foot candle (fc)	1.0764	Lumens/meter <sup>2</sup> (lm/m <sup>2</sup> )
<b>Multiply Fuel Performance</b>	<b>By</b>	<b>To get equivalent number of:</b>
Miles/gal (mile/gal)	0.4251	Kilometers/liter (km/L)
Gallons/mile (gal/mile)	2.3527	Liter/kilometer (L/km)
<b>Multiply Velocity</b>	<b>By</b>	<b>To get equivalent number of:</b>
Miles/hour (mile/hr)	1.6093	Kilometers/hour (km/hr)

<b>Multiply Length</b>	<b>By</b>	<b>To get equivalent number of:</b>
Inch (in.)	25.4	Millimeters (mm)
Foot (ft)	0.3048	Meters (m)
Yard (yd)	0.9144	Meters (m)
Mile (mile)	1.609	Kilometers (km)
<b>Multiply Area</b>	<b>By</b>	<b>To get equivalent number of:</b>
Inch <sup>2</sup> (in. <sup>2</sup> )	6452	Millimeters <sup>2</sup> (mm <sup>2</sup> )
Inch <sup>2</sup> (in. <sup>2</sup> )	6.45	Centimeters <sup>2</sup> (cm <sup>2</sup> )
Foot <sup>2</sup> (ft <sup>2</sup> )	0.0929	Meters <sup>2</sup> (m <sup>2</sup> )
Yard <sup>2</sup> (yd <sup>2</sup> )	0.8361	Meters <sup>2</sup> (m <sup>2</sup> )
<b>Multiply Volume</b>	<b>By</b>	<b>To get equivalent number of:</b>
Inch <sup>3</sup> (in. <sup>3</sup> )	16387	Millimeters <sup>3</sup> (mm <sup>3</sup> )
Inch <sup>3</sup> (in. <sup>3</sup> )	16.387	Centimeters <sup>3</sup> (cm <sup>3</sup> )
Inch <sup>3</sup> (in. <sup>3</sup> )	0.0164	Liters (L)
Quart (qt)	0.9464	Liters (L)
Gallon (gal)	3.785	Liters (L)
Yard <sup>3</sup> (yd <sup>3</sup> )	0.7646	Meters <sup>3</sup> (m <sup>3</sup> )
<b>Multiply Mass</b>	<b>By</b>	<b>To get equivalent number of:</b>
Pound (lb)	0.4536	Kilograms (kg)
Ton (ton)	907.18	Kilograms (kg)
Ton (ton)	0.907	Tonne (t)
<b>Multiply Force</b>	<b>By</b>	<b>To get equivalent number of:</b>
Kilogram (kg)	9.807	Newtons (N)
Ounce (oz)	0.2780	Newtons (N)
Pound (lb)	4.448	Newtons (N)

# STANDARD AND METRIC CONVERSION DATA

## LENGTH-DISTANCE

Inches (in) x 25.4 = Millimeters (mm) x .0394 = Inches

Feet (ft) x .305 = Meters (m) x 3.281 = Feet

Miles x 1.609 = Kilometers (km) x .0621 = Miles

## DISTANCE EQUIVALENTS

1 Degree of Latitude = 60 Nm = 111.120 km

1 Minute of Latitude = 1 Nm = 1.852 km

## VOLUME

Cubic Inches (in<sup>3</sup>) x 16.387 = Cubic Centimeters x .061 = in<sup>3</sup>

Imperial Pints (IMP pt) x .568 = Liters (L) x 1.76 = IMP pt

Imperial Quarts (IMP qt) x 1.137 = Liters (L) x .88 = IMP qt

Imperial Gallons (IMP gal) x 4.546 = Liters (L) x .22 = IMP gal

Imperial Quarts (IMP qt) x 1.201 = US Quarts (US qt) x .833 = IMP qt

Imperial Gallons (IMP gal) x 1.201 = US Gallons (US gal) x .833 = IMP gal

Fluid Ounces x 29.573 = Milliliters x .034 = Ounces

US Pints (US pt) x .473 = Liters (L) x 2.113 = Pints

US Quarts (US qt) x .946 = Liters (L) x 1.057 = Quarts

US Gallons (US gal) x 3.785 = Liters (L) x .264 = Gallons

## MASS-WEIGHT

Ounces (oz) x 28.35 = Grams (g) x .035 = Ounces

Pounds (lb) x .454 = Kilograms (kg) x 2.205 = Pounds

## PRESSURE

Pounds Per Sq In (psi) x 6.895 = Kilopascals (kPa) x .145 = psi

Inches of Mercury (Hg) x .4912 = psi x 2.036 = Hg

Inches of Mercury (Hg) x 3.377 = Kilopascals (kPa) x .2961 = Hg

Inches of Water (H<sub>2</sub>O) x .07355 = Inches of Mercury x 13.783 = H<sub>2</sub>O

Inches of Water (H<sub>2</sub>O) x .03613 = psi x 27.684 = H<sub>2</sub>O

Inches of Water (H<sub>2</sub>O) x .248 = Kilopascals (kPa) x 4.026 = H<sub>2</sub>O

## TORQUE

Pounds-Force Inches (in-lb) x .113 = Newton Meters (Nm) x 8.85 = in-lb

Pounds-Force Feet (ft-lb) x 1.356 = Newton Meters (Nm) x .738 = ft-lb

## VELOCITY

Miles Per Hour (MPH) x 1.609 = Kilometers Per Hour (KPH) x .621 = MPH

## POWER

Horsepower (Hp) x .745 = Kilowatts (Kw) x 1.34 = MPH

## FUEL CONSUMPTION

Miles Per Hour IMP (MPG) x .354 = Kilometers Per Liter (Km/L)

Kilometers Per Liter (Km/L) x 2.352 = IMP MPG

Miles Per Gallons US (MPG) x .425 = Kilometers Per Liter (Km/L)

Kilometers Per Liter (Km/L) x 2.352 = US MPG

## TEMPERATURE

Degree Fahrenheit (°F) = (°C X 1.8) + 32

Degree Celsius (°C) = (°F - 32) x .56

## LIQUID WEIGHTS

Diesel Oil = 1 US gallon = 7.13 lbs

Fresh Water = 1 US gallon = 8.33 lbs

Gasoline = 1 US gallon = 6.1 lbs

Salt Water = 1 US gallon = 8.56 lbs

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# SERVICE BULLETIN

DATE: 24-Apr-15

BULLETIN NUMBER: 276

SUBJECT: Generator Drive Belt Performance

## MODELS

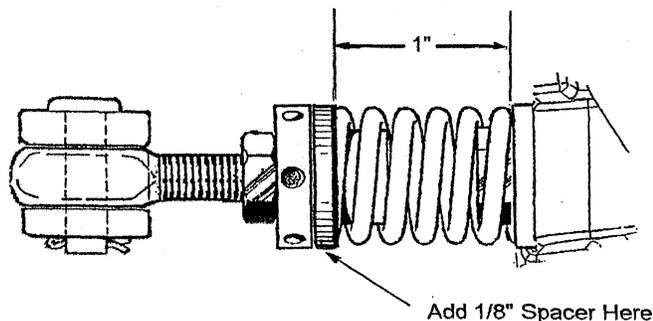
AFFECTED: 3.5 SBCG and 3.0 BCG Gasoline Generators

DETAIL: Generator drive belt life performance improvements include a belt tension adjustment change, the addition of a spring spacer, and a new idler pulley. 3.5 SBCG generators produced on or after manufacturing date code OD (April 2015) will have these changes. Changes made are enhancements, modification to existing products in the field is not covered under warranty.

Manufacturing of new products includes, for optimum belt break in, adjusting the belt to a dimension of 1" in our assembly process as illustrated below. After the first hour of run time, if necessary, it is adjusted again to 1" prior to releasing the unit for shipment.

Important Note: Maximum performance of the drive belt and prevention of potential failure due to incorrect tension requires the belt be to adjusted to 1" at the recommended 50 hour maintenance service.

Generator drive belts for regular maintenance replacement (part numbers remain the same) will be sold as a kit with instructions that includes the required spring spacer. Replacing the pulley is not required. Initial adjustment of the belt with the spacer installed is 1". After running the unit for 1 hour, varying AC loads in the process, the belt must be adjusted again to 1". After 50 hours run time, or during the next scheduled service, inspection and adjustment to 1" is required to ensure proper belt tension.



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