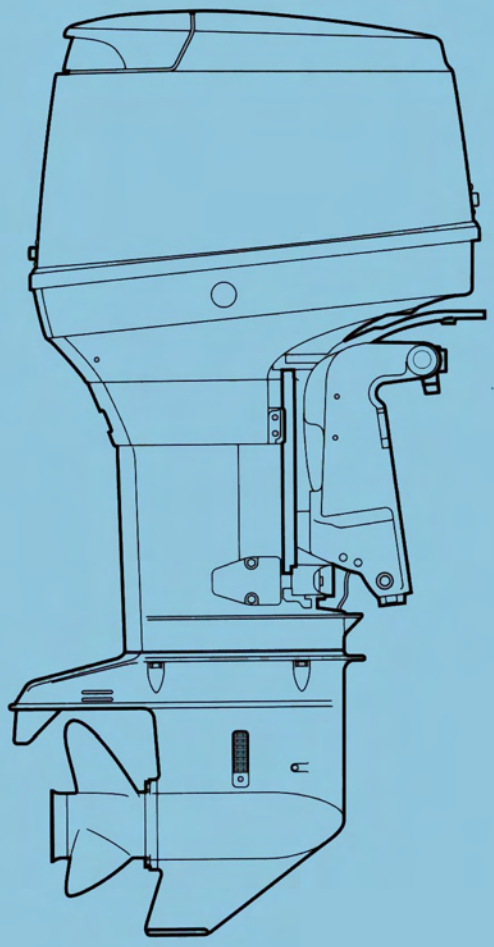
TOHATSU
OUTBOARD



TLDI
70B · 90B

SERVICE MANUAL

OB No. 003-21052-1

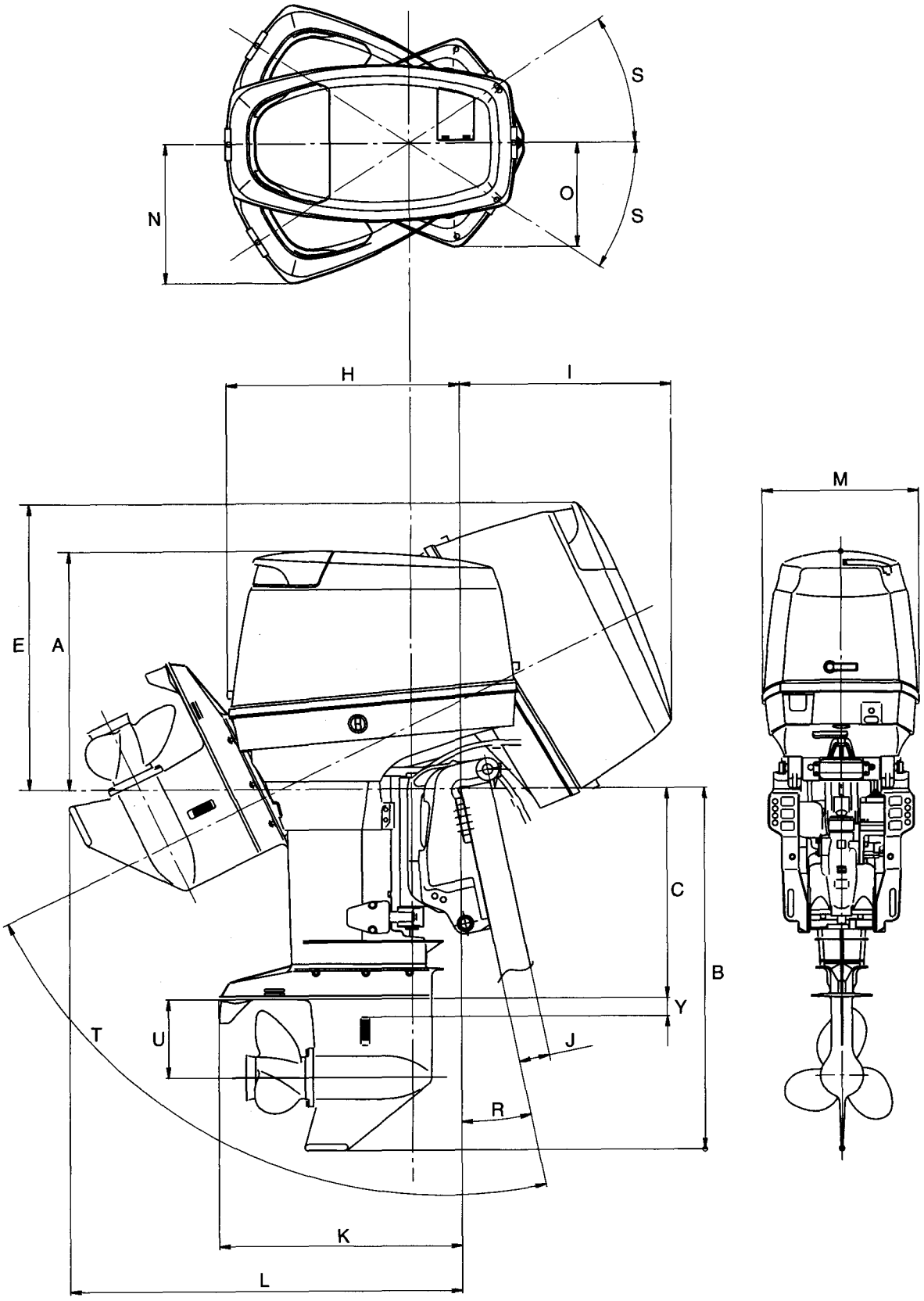
CONTENTS

Chapter 1 Specifications

1. Specifications

Item \ Model		70B	90B
		EPTO	
Overall length		747 mm (29.4 in)	
Overall width		390 mm (15.4 in)	
Overall height	(L)	1477 mm (58.1 in)	
	(UL)	1604 mm (63.1 in)	
Weight	(L)	143 kg (315 lb)	
	(UL)	146 kg (322 lb)	
Transom length (Apporox.)	(L)	517 mm (20.3 in)	
	(UL)	644 mm (25.3 in)	
Engine type		Two-stroke gasoline engine with direct fuel injection	
Piston displacement		1267 ml (77.3 cu.in)	
Bore & stroke		86 mm (3.39 in) × 72.7 mm (2.86 in)	
No. of cylinders		3	
Maximum output		51.5 kW (70PS)	66.2 kW (90PS)
WOT rpm range		5150~5850 rpm	
Trolling		700/800/900 rpm(3 stages variable)	
Idling		700/800/900 rpm(3 stages variable)	
Fuel consumption (approx.)		24.4 L/Hr (6.45 US gal)	30 L/Hr (7.93 US gal)
Starting system		Electric starter motor	
Intake system		Reed valve	
Induction system		5-port loop charge	
Exhaust system		Through hub	
Lubrication system		Oil injection	
Cooling system		Water-cooling	
Water temp. control		Thermostat (with pressure relief valve)	
Ignition system		Inductive ignition	
Ignition timing control		ECU	
Firing order		1-2-3	
Spark plug		NGK:PZFR6H	
Alternator		12V 280W (MAX.)	
Battery	more than 0°C(32°F)	12V 100AH(600CCA or 750MCA)	
	0°C(32°F) & Below	12V 120AH (700CCA or 850MCA)	
Trim angle		8° to 24°	
Trim angle steps		2	
Maximum tilt-up angle		75°	
Transom thickness		31 – 70 mm (1.22 – 2.76 in)	
Maximum steering angle		66°	
Gear shift		Dog clutch (F-N-R)	
Gear ratio		2.33 (12 : 28)	2.0 (13 : 26)
Throttle control		Remote control	
Fuel tank		25L (6.60 US gal)	
Oil tank		4L (4.2 US qt)	
Fuel		Unleaded regular gasoline	
Engine oil		Genuine MD Platinum or Equivalent	
Gear oil		Genuine gear oil or API GL5, SAE #80 to #90 900 ml (30.4 fl.oz)	

2. Dimensions



Dimensions

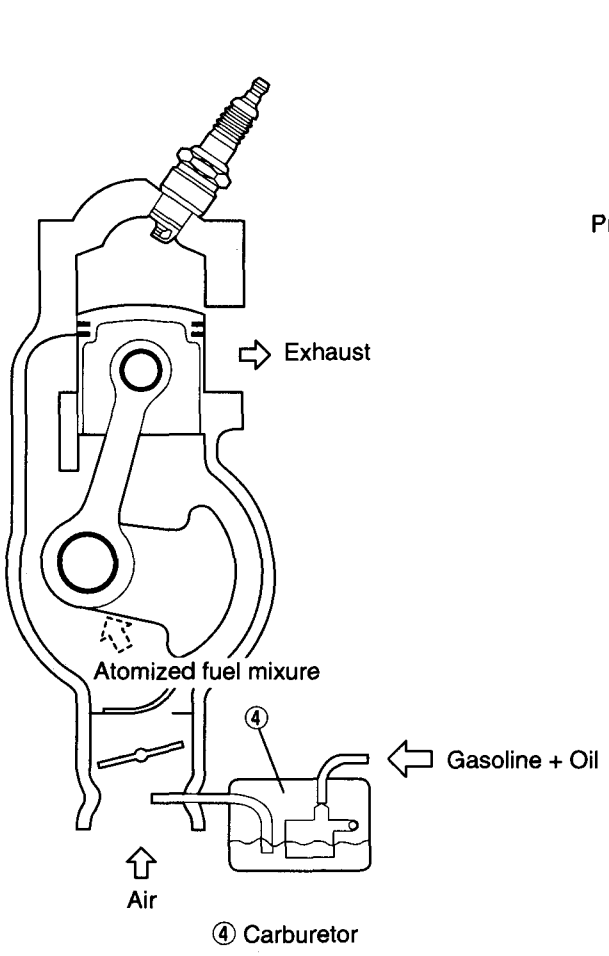
Item	Dimension	Remarks
A	586 mm (23.1 in)	
B	(L) 891 mm (35.1 in)	
	(UL) 1018 mm (40.1 in)	
C	(L) 517 mm (20.3 in)	
	(UL) 644 mm (25.3 in)	
E	705 mm (27.8 in)	
H	574 mm (22.6 in)	
I	522 mm (20.6 in)	
J	30-50 mm (1.2 – 19.7 in)	
K	599 mm (23.6 in)	
L	(L) 967 mm (38.1 in)	
	(UL) 1081 mm (42.6 in)	
M	390 mm (15.4 in)	
N	343 mm (13.5 in)	
O	235 mm (9.3 in)	
R	12deg.	
S	33deg.	
T	75deg.	
U	194 mm (7.6 in)	
Y	54 mm (2.1 in)	

3. What is TLDI ?

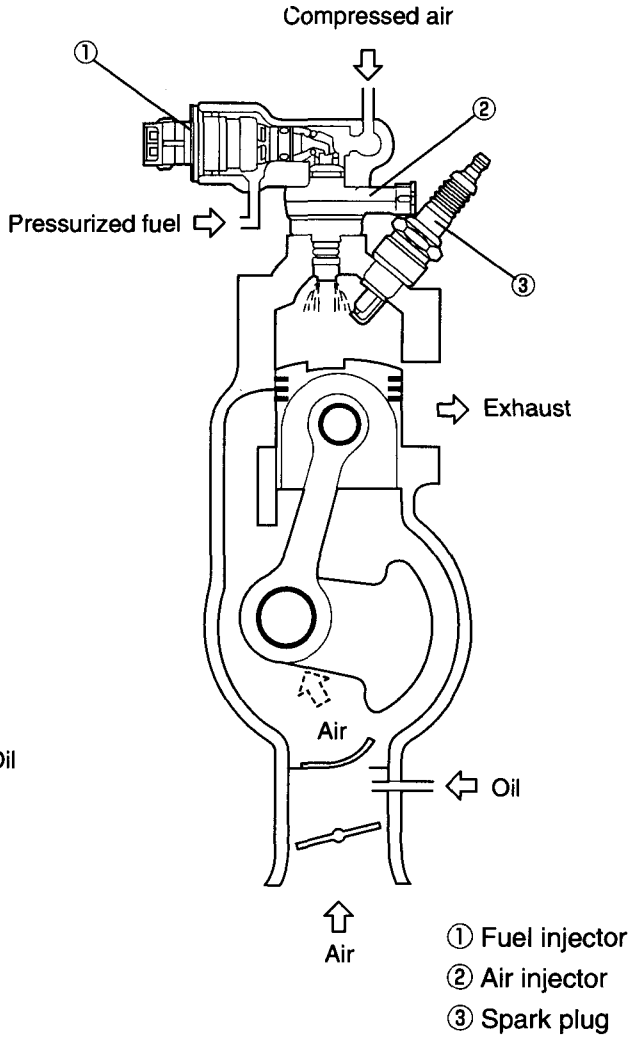
The abbreviation TLDI stands for Two-stroke Low-pressure Direct fuel Injection and is the name Tohatsu applies to direct fuel-injection system engines.

1. Two-Stroke Low-Pressure Direct fuel Injection (TLDI)
   TLDI is the name Tohatsu uses for two-stroke engines that utilize the air-assisted, low-pressure direct injection system.
   The air-assisted, low-pressure direct fuel injection system has been combined with the Inductive ignition system and Engine Control Unit (ECU), which performs precision control of fuel mixture, injection timing and ignition timing to maximize combustion efficiency in the TLDI engine. The result is excellent fuel economy and low emission maintaining superior advantage of powerful two-stroke engine characteristics.

2. Air-Assisted Low-Pressure Direct fuel Injection
   The air-assisted, low-pressure direct fuel injection process involves using an air compressor to pressurize the fuel supplied by the fuel pump to inject it directly into combustion chambers in the form of a finely atomized mixture to achieve maximum combustion efficiency.



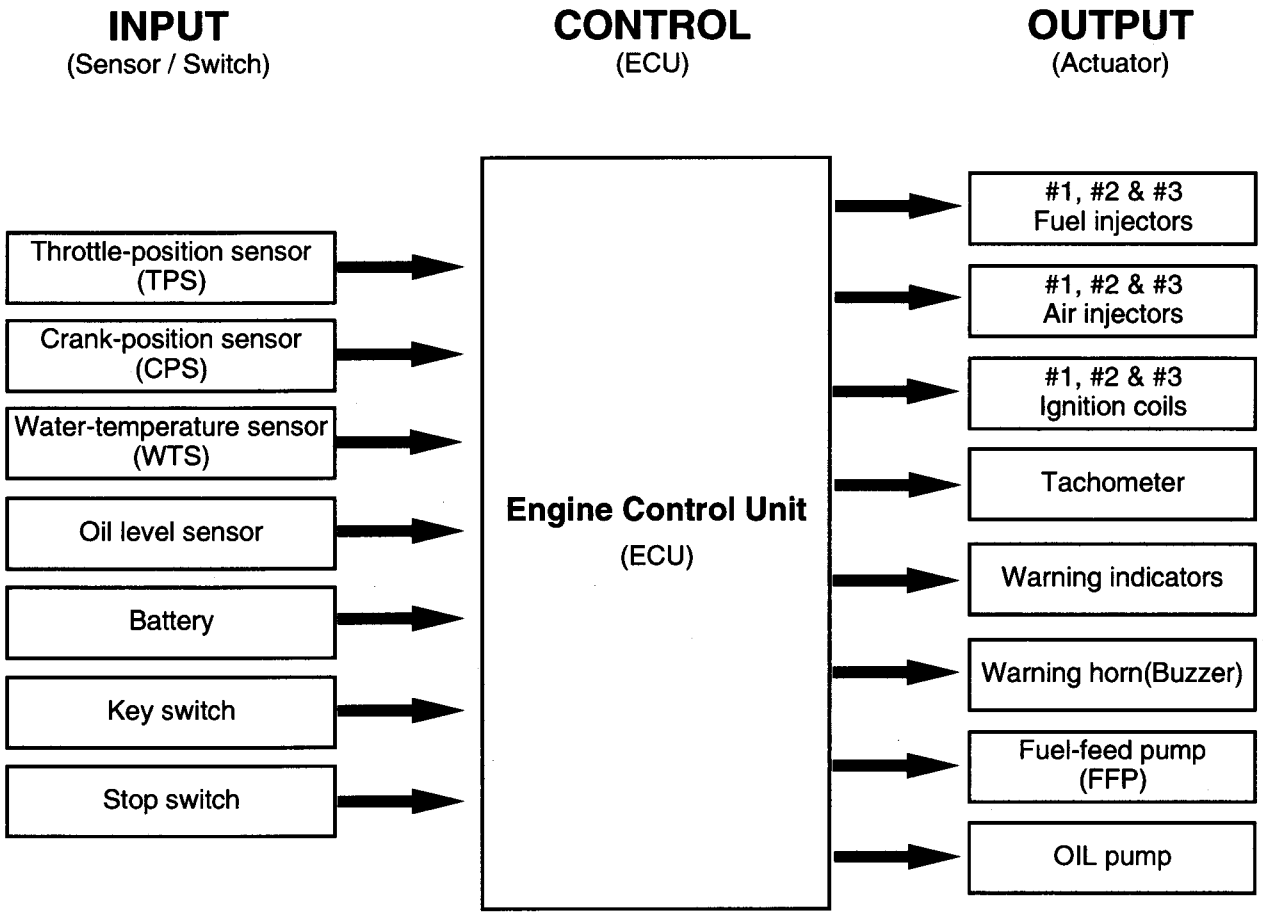
ENGINE WITH CARBURETOR



TLDI

3. ECU Control

With TLDI, a network of connected sensors enables the Engine Control Unit (ECU) to precisely regulates fuel mixture injection rate and ignition timing. The ECU also uses a stratified fuel feed process to provide lean combustion in the low-speed range, while utilizing more homogenized change to ensure the fuel mixture is distributed uniformly throughout the combustion chamber when operating in the high-speed range to ensure maximum combustion efficiency.

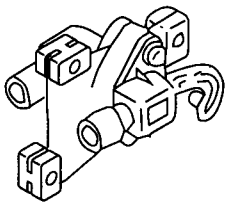


Inductive Ignition System(Battery Ignition System)

TLDI is now using the inductive ignition system to maximamize combustion efficiency and fuel economy, and to minimize exhaust emissions. The inductive ignition system offers even longer sparking period of time via spark plug than earlier TLDI models using L-CDI(Long Arc Duration CDI) which offers longer sparking period of time than the conventional CDI systems. The TLDI engine runs more smoothly for better running quality.

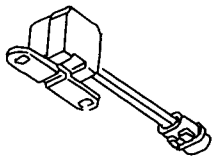
Throttle-Position Sensor (TPS)

Throttle-position sensor system is comprised of TPS1 and TPS2. These are used in combination to detect throttle butterfly valve position and advancer arm position to relay the information to and ECU.



Crank-Position Sensor (CPS)

Crank-position sensor is designed to sense the encoder located above the ring gear on the flywheel in order to detect crankshaft position and transmit the information to ECU.



Water-Temperature Sensor

Positioned on the water jacket installed on the cylinder, water-temperature sensor is used to detect temperature of cooling water in the cylinder and relay the information to ECU.

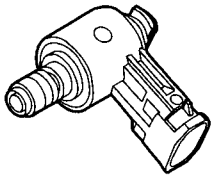
Oil Level Sensor

Oil level sensor is used to detect the level of remaining oil in oil tank and relay the information to the ECU.

The oil level sensor operates by turning on the oil level warning lamp on the tachometer and sounding the beeper in remote control when engine oil is low.

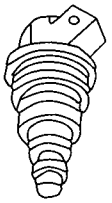
Air Injectors

Air injectors are used to inject a fine mist of fuel and compressed air into each combustion chamber. The ECU determines the mixture and timing for injecting fuel according to current engine operating conditions based on information relayed from the various sensors.

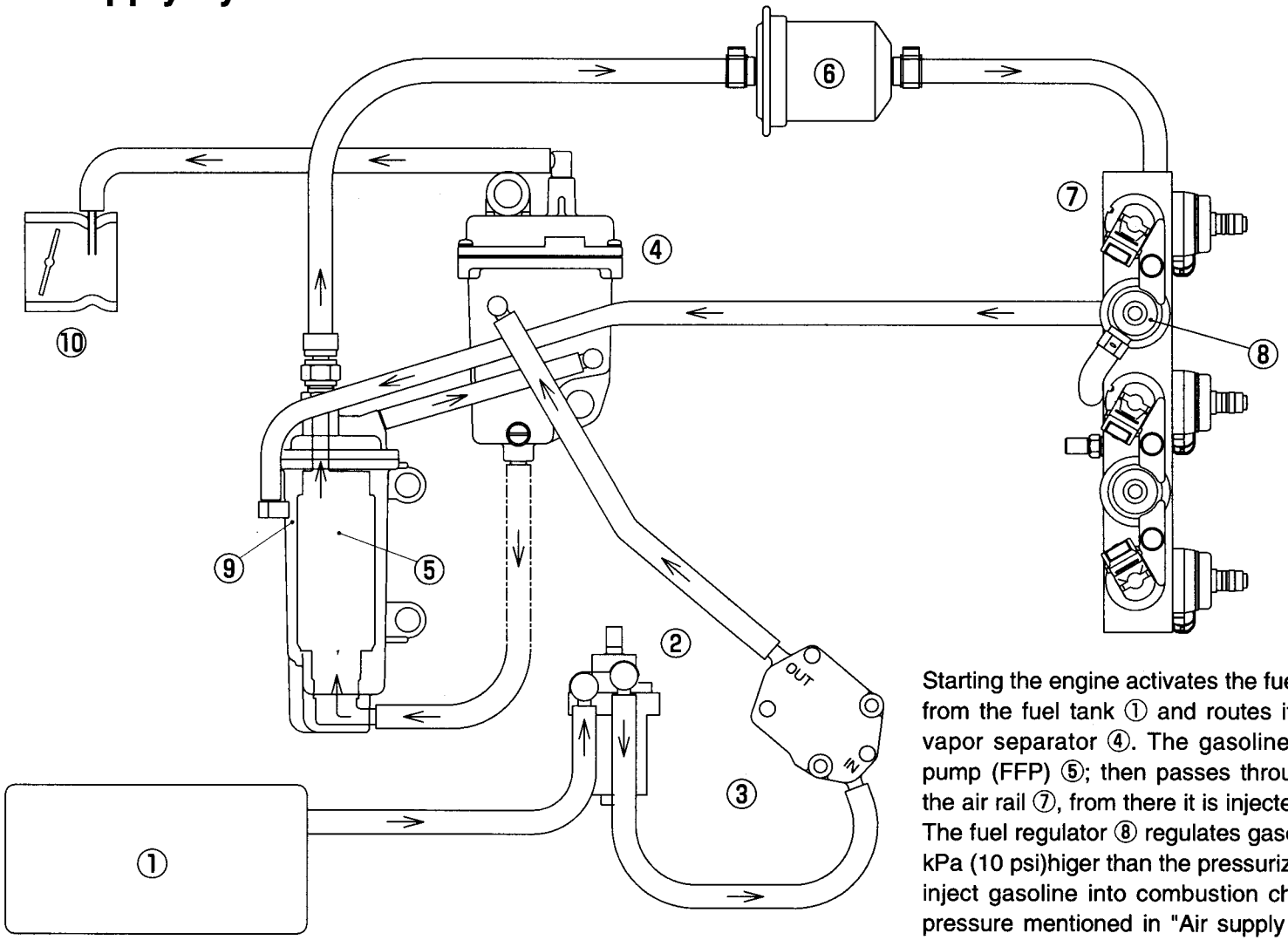


Fuel Injector

Fuel injectors supply the fuel in the air rail to the air injectors via the set pieces. The ECU determines the mixture for injecting fuel according to current engine operation based on information relayed from the various sensors.

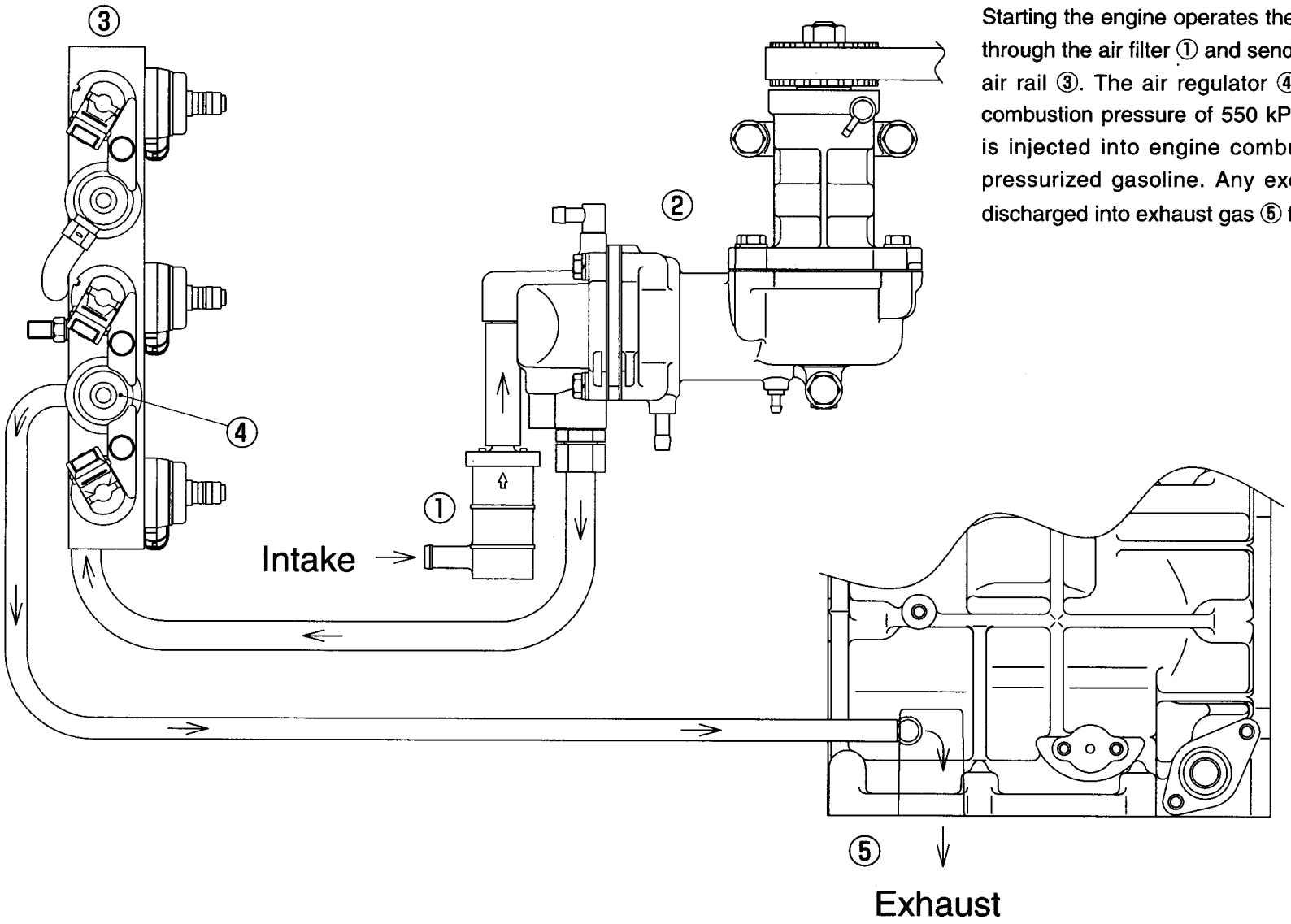


4. Fuel Supply System



Starting the engine activates the fuel pump ③, which draws gasoline from the fuel tank ① and routes it through the fuel filter ② to the vapor separator ④. The gasoline is pressurized in the fuel-feed pump (FFP) ⑤; then passes through the high-pressure filter ⑥ to the air rail ⑦, from there it is injected into the combustion chambers. The fuel regulator ⑧ regulates gasoline pressure so as to keep it 70 kPa (10 psi)higer than the pressurized air pressure (550kPa 80psi)to inject gasoline into combustion chamber after overcoming the air pressure mentioned in "Air supply system" as follows. Any excess gasoline is depressurized and diverted through the FFP case ⑨ and back to the vapor separator ④. The returned gasoline contains air bubbles left over from being pressurized at ⑤. These bleed from the top of the vapor separator ④ to the throttle body ⑩ and is fed to the air intake system.

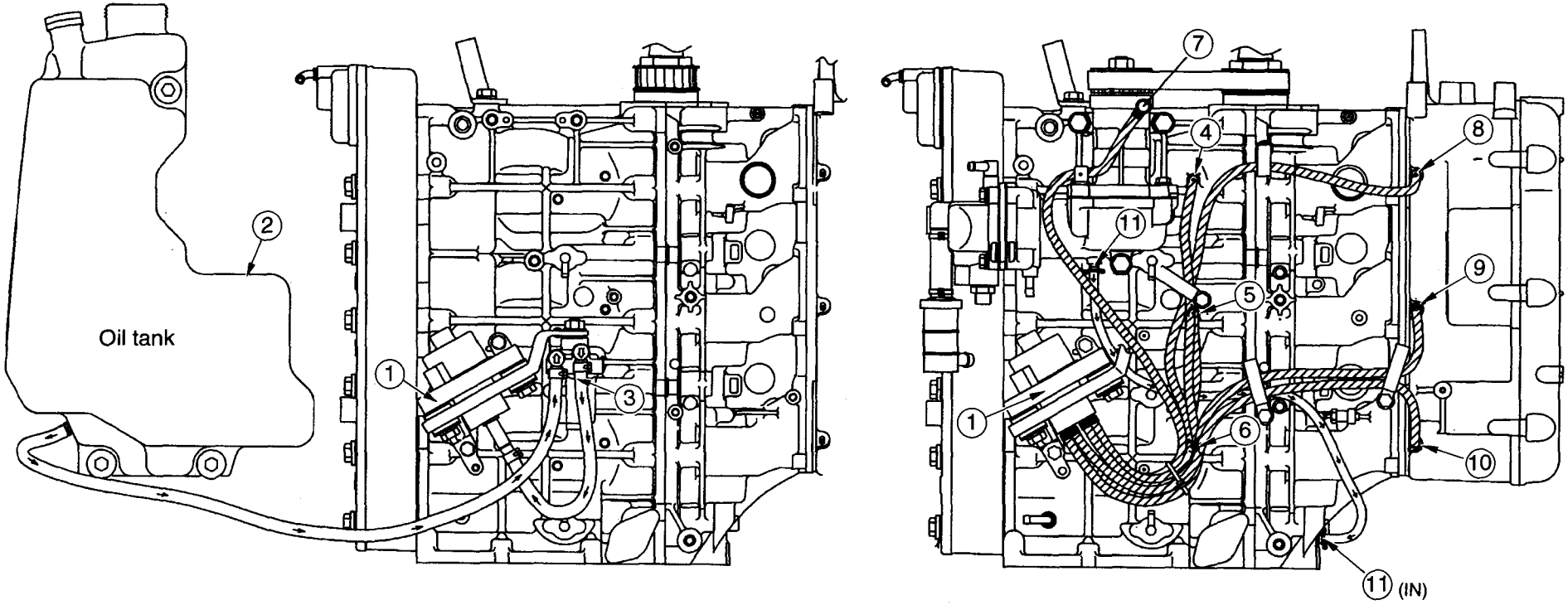
5. Air Supply System



Starting the engine operates the air compressor ②, draws air in through the air filter ① and sends compressed air through to the air rail ③. The air regulator ④ regulates air at the optimum combustion pressure of 550 kPa (80 psi) and the regulated air is injected into engine combustion chamber together with pressurized gasoline. Any excess air is depressurized and discharged into exhaust gas ⑤ from the bottom of the cylinder.

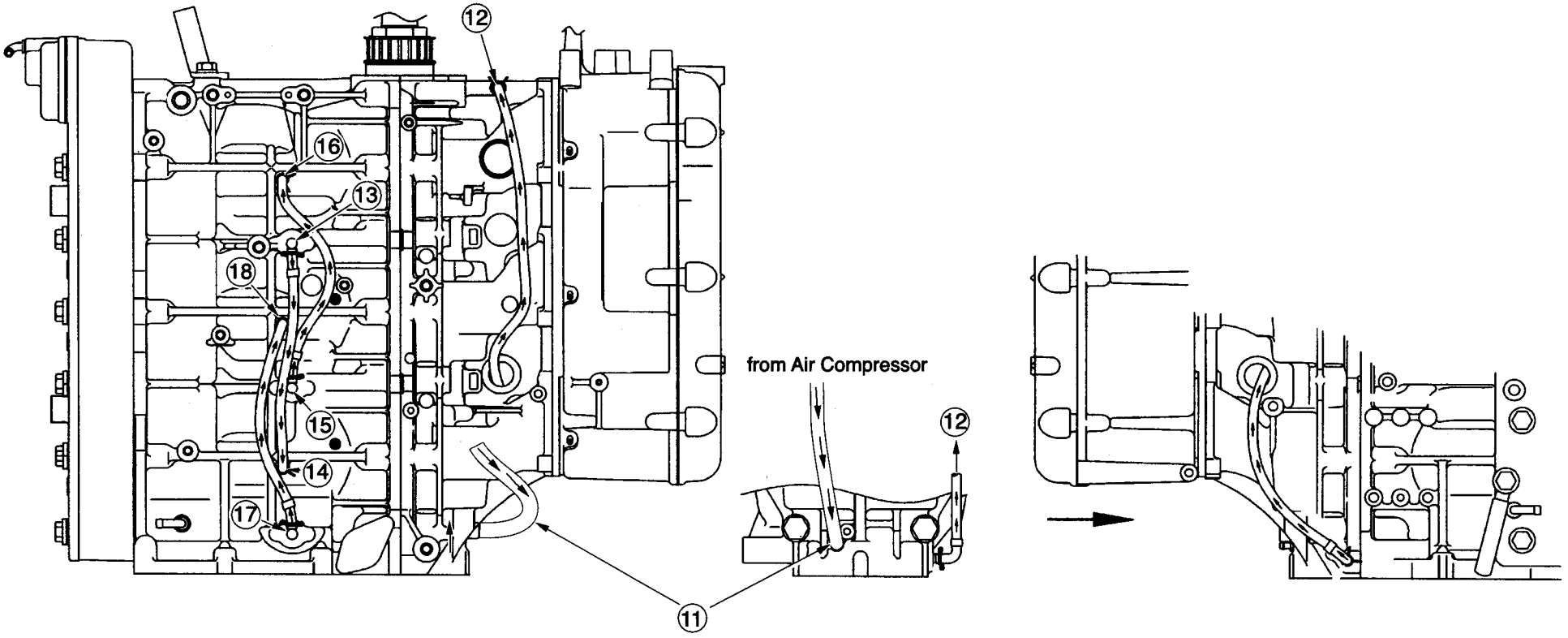
6. Oil Supply System

When the engine is started oil pump ① operation sends oil from the oil tank ② to the oil filter ③. There the oil is filtered and sent to the oil pump ① where it is separated and diverted into 7 ports and sent to the #1 cylinder ④ (crankcase housing), #2 cylinder ⑤ (crankcase housing), #3 cylinder ⑥ (crankcase housing), and air compressor ⑦, #1 air box ⑧, #2 air box ⑨ and #3 air box ⑩. The oil in the #1 cylinder (crankcase) ④, #2 cylinder (crankcase) ⑤ and #3 cylinder (crankcase) ⑥ lubricates each engine cylinder(crankcase), and the oil in the air compressor ⑦ lubricates the compressor and the oil in the #1 ⑧ / #2 ⑨ / #3 ⑩ air box lubricates each engine cylinder (crankcase) .



7. Recirculation System

After lubricating the air compressor ⑦, oil dischrged from the oil pump to the air compressor is diverted to the #3 crankcase ⑪. The oil is diverted to the #1 crankcase ⑫ (upper bearing) where it assists in lubricating the engine.
Oil that collects in the cylinder scavenging air passage is diverted from the #1 cylinder ⑬ (scavenging air passage) to the #3 cylinder liner ⑭, from the #2 cylinder ⑮ (scavenging air passage) to the #1 cylinder liner ⑯, and from the #3 cylinder ⑰ (scavenging air passage) to the #2 ⑱ where it assists in lubricating the engine.



Chapter 2 Service Information

1. General Precautions

Users of this manual should observe the following general precautions carefully when conducting disassembly and assembly work.

(1) The outboard engine remains hot for a time after it is shut off. Allow the engine to cool down before starting work.
(2) Make sure that the outboard motor is securely mounted on a work stand before starting work.
(3) TLDI utilizes high fuel pressure and air pressure. Be sure to release pressure from the fuel and air passages when working.
(4) Take care not to scratch or damage painted surfaces and the mating surfaces where cylinders, the cylinder head, the crankcase and other parts are joined.
(5) Always replace packing, gaskets, snap ring, O-rings and split pins with new ones when reassembling engine parts.
(6) When replacing, be sure to use Tohatsu genuine parts and lubricants or products recommended by Tohatsu.
(7) Always use the recommended special tools to ensure work is done properly.
(8) When disassembling and assembling components, make note of position marks, adding your own marks if none are provided, as a way to ensure the various parts and components are properly mated when being reassembled.
(9) To prevent smaller parts, such as bolts, nuts and washers from getting lost or damaged, where possible, lightly insert or tighten them back in their original locations.
(10) As normal practice, check disassembled parts for any wear or damage by first wiping them clean; then washing them in solvent.
(11) With reassembly operations it is essential to observe precise detail in centering, vacuum sealing, lubricating (with oil or grease), packing parts and components, and connecting wiring and piping. Also ensure there are no blockages in fluid lines.

1) When reassembling parts requiring numerous nuts and bolts (cylinder, crankcase, etc.), when the sequence in which bolts should be tightened is indicated with numbers follow the indicated sequence. When the sequence is not indicated, proceed as follows. Tighten the bolts in several stages, making sure to tighten each bolt equally. First tighten the inner bolts, then the outer bolts, moving diagonally or in a circular motion. This will ensure that engine parts are assembled evenly and securely. (Use the same procedure in the reverse sequence when disassembling the parts.)

2) When installing oil seals, be careful not to scratch or reverse the sides that mate with the shaft and always apply grease to the lip surfaces.

3) Confirm the correct quantity and thickness when applying sealant. Applying excessively will result in the excess portion being excreted into or outside of the case, potentially causing damage. Adhere strictly to the written instructions when applying adhesives.

4) Apply penetrating oil spray to nuts or bolts that are difficult to remove due to rust and wait 5 minutes before removing.

5) For the various inspection specifications, torque values, special tools, and the points where sealant, adhesive and grease are to be applied, refer to the relevant tables.

6) The various nuts, bolts and washers referred to in this manual are listed below.

Name	Type	Diameter	Length
H820	Hexagon bolt	8 mm (0.31 in)	20 mm (0.79 in)
N8	Hexagon Nut (Medium Height Nut)	8 mm (0.31 in)	
L8	Hexagon Nut (Thin Nut)	8 mm (0.31 in)	
W8	Plain washer	8 mm (0.31 in)	
SW8	Spring washer	8 mm (0.31 in)	
Screw 620	Pan head screw	6 mm (0.24 in)	20 mm (0.79 in)

(12) Observe all necessary safety procedures to prevent accidents and injury during work operations.

2. Specifications and Standards

	Description	Item to check	Standard values
Engine	Cylinder heads	• Combustion chamber carbon build up	
		• Mating surface scratches or distortion	• 0.03 mm (0.0012 in) or less for scratches • 0.03 mm (0.0012 in) or less for distortion
		• Corrosion	
		• Cooling water inlet blockage	
	Cylinder	• Mating surface scratches and wear	• 0.03 mm (0.0012 in) or less for scratches • 0.03 mm (0.0012 in) or less for distortion
		• Seizing, cylinder liner scratches and wear	• ø 86.05 mm (3.3878 in)
		• Water jacket internal build-up	
		• Engine anode	
	Piston	• Maximum diameter (Measure the external diameter at a point 11.5 mm above the lower edge of the piston skirt.)	• ø 85.89 mm (3.3815 in) (ø 86.36 mm (3.40 in) for 0.5 oversize piston)
		• Piston clearance (The gap between cylinder and piston)	• 0.13 – 0.19 mm (0.0051 – 0.0075 in)
		• Piston crown and ring groove carbon build-up	
		• Sliding surface scratches	
		• Piston ring and ring groove clearance	• Top: 0.04 – 0.08 mm (0.0016 – 0.0031 in) • Second: 0.03 – 0.07 mm (0.0012 – 0.0028 in) • Third: 0.03 – 0.07 mm (0.0012 – 0.0028 in)
		• Piston pin hole diameter	• 20 mm (0.78 in)
		• Piston pin and pin hole clearance	• -0.007 to 0.003 mm (-0.00028 – 0.00012 in) Tight Loose
	Piston ring	• Ring end gap Note: If a ring gauge is unavailable, measure the lower end of the cylinder bore where there is little wear.	• Top: 0.25 – 0.40 mm (0.0098 – 0.0157 in) • Second: 0.25 – 0.40 mm (0.0098 – 0.0157 in) • Third: 0.25 – 0.40 mm (0.0098 – 0.0157 in)
	Piston pin	• External diameter	• 20 mm (0.7874 in)
	Crankshaft	• Deflection • (Measure with both ends supported.)	• 0.05 mm (0.0020 in) or less
		• Bearing external diameter	• Upper area of #1: 36 mm (1.417 in) • Between #1 and #2, #2 and #3: 35 mm (1.378 in) • Lower area of #3: 40 mm (1.575 in)
		• Oil seal scratches	
	Connecting rod	• Loose rod	
		• Small-end diameter	• 25 mm (0.984 in)
		• Small-end area side gap	• 0.20 – 0.55 mm (0.008 – 0.022 in)
	Reed valve stopper	• Lift height	• 9.0 – 9.6 mm (0.354 – 0.378 in)
	Reed valve	• Fails to close, is worn or damaged	
	Engine block	• Compression Remove all three spark plugs and measure after warming with the throttle fully open.	• 0.9 MPa(9.2 kg/cm², 131 Psi)

Service limit	Servicing procedure
	• Clean and remove build up.
• Scratches or deflection of 0.03 mm (0.0012 in) or more	• Repair by polishing the surface plate, starting with #240 to #400 grit sandpaper and finishing with #600 grit sandpaper.
	• Repair or replace depending on the extent of damage.
	• Clean and remove obstruction.
• Scratches or deflection of 0.03 mm (0.0012 in) or more	• Repair by polishing the surface plate, starting with #240 to #400 grit sandpaper. (Finish with #600 grit sandpaper.)
• ø 86.11 mm (3.3902 in) or more • When the cylinder liner cannot be repaired using #400 to #600 grit sandpaper due to deep scratching or scuffing to the sliding surface in contact with the piston or when the difference between the minimum and maximum points of wear in the liner bore is 0.06 mm (0.0024 in) or more.	• Bore and hone to 0.5 oversize piston diameter (ø86.52 ± 0.01 mm: 3.4063 ± 0.0004 in). Check ports and grind if necessary. (Use 0.5 oversize pistons and piston rings.)
	• Clean and remove obstruction.
	• Replace if excessively worn.
• ø 85.81 (3.3783 in) or more	• Replace with new part.
• 0.30 mm (0.0118 in) or more	
	• Clean and remove build up.
	• Repair or replace depending on extent of damage. (Repair using #400 to #600 grit sandpaper.)
	• Replace with new part.
• 0.02 mm (0.0008 in) or more Loose	
• 0.8 mm (0.0315 in) or more • 0.8 mm (0.0315 in) or more • 0.8 mm (0.0315 in) or more	• Replace with new part provided cylinder liner wear has not exceeded the repair limit.
	• Replace with new part if outside standard values
• 0.05 mm (0.0020 in) or more	• Replace with new crankshaft assembly.
	• Replace with new part.
• 2 mm (0.0787 in) or more	• Replace with new crankshaft assembly.
• Outside standard values	• Repair to within standard values.
• When the end reed valve fails to close • Excessive wear on valve seat • Valve is damaged	• Replace entire valve assembly.
• When the difference in compression between cylinders exceeds 0.1 MPa (1.05 kg/cm, 15 psi) • When abnormally higher than standard value	• Remove carbon from piston crown and cylinder head. • Bore and hone to 0.5 oversize piston diameter (ø86.52 ± 0.01 mm : 3.4063 ± 0.0004 in). Check ports and grind if necessary. (Use 0.5 oversize pistons and piston rings.)

	Description	Item to check	Standard values
Fuel / air	Air Rail	• Wear and damage on O-rings	
	Air regulator	• Air pressure	• 550 kPa (5.6 kg/cm², 80 psi) ±7%
	Fuel regulator	• Fuel pressure	• Measured air pressure +70 kPa (0.71 kg/cm², 10 psi)± 10%
	Vapor separator	• Wear and damage on seal ring	
		• Float	
	Air compressor	• Cylinder bore	• 39.00 – 39.02 mm (1.535 – 1.536 in)
		• Piston diameter (maximum diameter) (Measure at a point 10 mm (0.393 in) above the lower edge of the piston skirt.)	• 38.97 – 38.99 mm (1.534 – 1.536 in)
		• Piston ring end gap	• Top: 0.10 – 0.25 mm (0.0039 – 0.0098 in) • Second: 0.10 – 0.25 mm (0.0039 – 0.0098 in)
		• Reed valve stopper lift clearance	• 1.7 – 2.3 mm (0.067 – 0.091 in)
		• Reed valve tip clearance	• 0.2 mm (0.008 in) or less
Electric parts	Drive belt	• Tension and appearance	
	Ignition coil	• Primary coil resistance (between L~B/R, B/W, B/G lines)	• 0.5Ω ± 10% (20°C, 68°F)
		• Secondary coil resistance (between high tension cord and B line)	• 13.5 kΩ ± 20% (20°C, 68°F)※
	Engine control unit (ECU)	• Low-speed ESG trigger	• App. 3,000 rpm
		• High-speed ESG trigger	• App. 6,000 rpm
	Magneto	• Sparking performance (Measured using spark tester)	• 10 mm (0.39 in) or more at 350 rpm
		• Sparking sequence	• #1 → #2 → #3
		• Alternator (max.)	• 280W
		• Charging performance	• 1,500 rpm 12V 16.5A or more • 5,500 rpm 12V 18.5A or more
		• Alternator coil resistance value (Y to Y wire)	• 0.44Ω ±15% (20°C, 68°F)
	Spark plug	• Standard plug	• NGK: PZFR6H
		• Plug gap	• 0.7 – 0.8 mm (0.0276 – 0.0315 in)
	Air injector	• Measured value for resistance between terminals	• 1.3 ±0.3Ω (20°C, 68°F)
		• Operating condition	
	Fuel injector	• Measured value for resistance between terminals	• 1.8 ±0.1Ω (20°C, 68°F)
	Fuel feed pump (FFP)	• Wear and damage on seals and grommets	
	Crank-position sensor	• Gap with encoder ring (flywheel)	• 0.5 mm – 0.9 mm (0.020 – 0.035 in)
		• Pickup coil resistance value (L wire to G wire)	• 531Ω ±15% (20°C, 68°F)
	Throttle position sensor (TPS)	• Measured values of resistance between connector terminals	• Between upper and lower terminals: 5.0Ω ±20% • Between upper and middle terminals: resistance value (kΩ)
	Water temperature sensor	• Measured value for resistance	• 2.6kΩ ±10% (20°C, 68°F) • 0.3kΩ ±5% (80°C, 176°F)
	Electric oil pump	• Measured value for resistance	• 1.96 ±0.12Ω (20°C, 68°F)
	Oil level sensor	• Measured value for resistance	• Sensor ON position: ∞ • Sensor OFF position: 0Ω
	Rectifiers	• Measured value for resistance between terminals	• Refer to tester checkpoint Table (Chapter 5)

	Fully closed	Fully opened
TPS1 TPS2	0.5 – 1	4 – 5

※The spark plug cap (5kΩ resistance) is assembled to the ignition coil with an adhesive agent . The resistance shall be measured with the spark plug cap assembled .

Service limit	Servicing procedure
• When parts are worn or damaged	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts are worn or damaged • When parts show deterioration or contamination by fuel	• Replace with new parts.
• When parts no longer conform to standard values	• Replace the nonconforming parts with new parts.
• When parts are worn, damaged or stretched out of shape	• Replace with new parts.
• When parts no longer conform to standard values	• Replace the nonconforming parts with new parts.
• Plug gap of 1.0 mm (0.039 in) or more • When electrodes show excessive wear	• Repair so that plugs conform to standard values. • Replace with new plug.
• When parts no longer conform to standard values • No clicking sound when 12 volts is applied to the terminal	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts are worn or damaged	• Replace with new parts.
• When parts no longer conform to standard values	• Repair so that parts conform to standard values.
• When the resistance value between upper and lower connectors is $\infty\Omega$ or 0Ω • When the resistance value between upper and middle connectors becomes erratic	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.

	Description	Item to check	Standard values
Electric parts	Starter motor	• Output	• 12V 1.0 kW
		• Brush length	• 14 – 15 mm (0.55 – 0.59 in)
		• Commutator under-cut	• 0.5 – 0.8 mm (0.0196 – 0.0314 in)
		• Commutator diameter	• 33 mm (1.299 in)
	Fuse	• Capacity	• 15A × 1, 25A × 1 • 30A × 1
Power trim and tilt	Pump assembly	• Relief valve opening pressure	• Tilted up: 8.8 – 11.8 MPa (90 – 120 kg/cm², 1280 – 1700 psi) • Tilted down: 3.9 – 7.4 MPa (40 – 75 kg/cm², 570 – 1070 psi)
		• Spool check valve opening pressure	• Upper chest: 0.24 MPa (2.4 kg/cm², 34 psi) • Lower chest: 0.12 MPa (1.2 kg/cm², 17 psi)
		• Oil quantity	• 682 ml (23.04 fl.oz)
		• Oil type	• Power Torque fluid (ATF Dexron III or equivalent product)
		• Oil filter	• 150 mesh
	Trim cylinder	• Piston external diameter	• 38.0 mm (1.5 in)
		• Piston rod external diameter	• 17.8 mm (0.7 in)
		• Stroke	• 96.9 mm (3.8 in)
	Tilt cylinder	• Shock absorber valve opening pressure	• 14.7 – 18.6 MPa (150 – 190 kg/cm², 2130 – 2700 psi)
		• Piston external diameter	• 45.0 mm (1.8 in)
		• Piston rod external diameter	• 19 mm (0.7 in)
		• Stroke	• 157.3 mm (6.2 in)
	Motor	• Rated timing	• 60 sec.
		• Rated voltage	• 12V (DC)
		• Output	• 400W
		• Direction of rotation	• Forward / reverse
Coolant	Thermostat	• Opening and closing of thermostat valve	• With wax-type pressure relief valve (PRV) • Valve start temperature: 60°C (140°F) • Valve full-open temperature: 75°C (167°F) or higher
	Pump impeller	• Wear and cracks	
	Pump case liner	• Wear	
	Guide plate	• Wear	
Lower unit	Anode	• Wear	
	Propeller shaft	• Damage to bearing	
		• Wear on lip of oil seal	
		• Backlash between bevel gears	
	Drive shaft	• Damage to bearing • Shaft run-out • Wear on lip of oil seal	• 0.3 mm (0.012 in) or less (Using both center holes for reference)
Others	Propeller	• Wear, warping, cracking, chipping	
	Oil seals	• Wear, damage	

Service limit	Servicing procedure
• 12 mm (0.47 in) or less	• Replace with new parts.
• 0.2 mm (0.008 in) or less	
• 32 mm (1.26 in) or less	
• When the fuse burns out	• After repairing the cause of the burn-out, replace with a new fuse.
• When the valve opens even slightly at ambient temperature	
• Check valve opening temperature by immersing the thermostat	
in water and gradually increasing water temperature	
• When the tips or upper and lower surface lip areas show wear, cracks or damage	• Replace with new parts.
	• Replace with new assembly.
	• Replace when wear is excessive.
	• Replace when wear is excessive.
• When anode shows excessive corrosion	• Replace with new parts.
	• Replace with new parts.
	• Adjust or replace with new parts.
•	• Replace with new parts.
• 0.4 mm (0.015 in) or more	• Repair so that parts conform to standard values or replace with new parts.
• When depth of wear is 0.1 mm (0.004 in) or more	• Replace with new parts.
	• Replace with new parts.
• When lip area shows deterioration, heat discoloration, or damage or when wear reduces interference to 0.5 mm (0.02 in) or less	• Replace with new parts.

3. Application Points of Sealant, Adhesive and Lubrication

Application points		Three Bond Thread Lock 1342	Three Bond Sealant 1107	Three Bond Thread Lock 1373B	Loctite Adhesive Adhesive 648 Primer 7471	Loctite Sealant 518	Three Bond Instant Adhesive 1741
Engine block	Piston						
	Piston pin						
	Piston ring						
	Cylinder liner						
	Small-end bearing						
	Big-end bearing						
	Main bearing, upper						
	Main bearing						
	Small-end bearing washer						
	Big-end bearing washer						
	Seal ring						
	Main bearing, upper						
	Main bearing, upper oil seal						
	Drive pulley				○		
	Pulley nut	○					
	Crankcase head O-ring						
	Crankcase shaft oil seal, lower						
	Air box bolt	○ (※2)					
	Throttle body bolt	○ (※2)					
	Driveshaft oil seal						
	Cylinder-crankcase mating surface					○	
	Water temperature sensor						
	Spark plug cap						
	Advancer arm						
	Throttle cam						
	Gearshift lever						
	Ball joint gap						
	Cable joint (gearshift lever)						
	Starter motor						
	Starter motor rubber						○
	Solenoid switch (starter motor), 2 locations						
	Solenoid switch (PTT), 6 locations						
Air rail	Air injector O-ring						
	Fuel injector O-ring						
	Fuel regulator O-ring						
	Air regulator O-ring						
	Compression seal						
	Plug O-ring						
	Air hose L Nipple O-ring						
	Fuel hose L Nipple O-ring						
	Valve assembly	○					

Three Bond Adhesive G17	Low temperature lithium grease LT-2	Oil Center Research cold resistant grease LOR #101	Specified OBM grease	Specified 2-stroke engine oil (MD Platinum)	Silicon grease, Shin-Etsu grease KS-64	Specified gear oil	Power trim & tilt fluid ※1	Remarks
				○				Ring groove, piston pin hole and skirt
				○				Skirt
				○				
				○				Inwall
				○				Sliding surface
				○				Sliding surface
				○				Sliding surface
				○				Sliding surface
				○				Sliding surface
				○				Sliding surface
				○				Sliding surface
				○				Sliding surface
		○						Lip area
								After treating the shaft and punched surface with primer, apply 648 to the punched surface
								Screw area
				○				
		○						Lip area (on oil seal in crankcase head)
		○						Lip area (on oil seal in crankcase head)
								Confirm thickness of coating
			○					O-ring
					○			Plug seat area
	○							Sliding surface
	○							Sliding surface
	○							Sliding surface
	○							Sliding surface
			○					Sliding surface
			b ○		a ○			a) Terminal, b) Pinion
								Glue to starter motor band
					○			Terminal
					○			Terminal
				○				O-Rings at two locations
				○				O-Rings at two locations
				○				O-Rings at two locations
				○				O-Rings at two locations
				○				Inside air rail at six locations
				○				Inside air rail at three locations
				○				O-Rings at two locations
				○				O-Rings at two locations
								Tapered screw

※1 Use ATF (Automatic Transmission Fluid) Dexron Ⅲ or equivalent.
※2 Apply Three Bond Thread Lock 1342 when reusing precoated bolts.

Application points		Three Bond Thread Lock 1342	Three Bond Sealant 1107	Three Bond Thread Lock 1373B	Loctite Adhesive Adhesive 648 Primer 7471	Loctite Sealant 518	Three Bond Instant Adhesive 1741
Air compressor	Piston						
	Cylinder						
	Piston pin						
	Piston ring						
	Oil ring						
	Big-end needle bearing						
	Housing oil seal						
	Crankshaft B/G						
	Collar O-ring						
	Adaptor hose joint	○					
Fuel Feed Pump (FFP) assembly	Adaptor hose joint	○					
	Cable terminal grommet						
	FFP upper grommet						
	FFP lower grommet						
	Pipe grommet						
Gear case and driveshaft housing	~~Bevel~~ gear B nut	○					
	Propeller shaft housing						
	Propeller shaft housing O-ring						
	Propeller shaft oil seal						
	Propeller shaft						
	Forward thrust washer						
	Water pump case, lower						
	Water pump case (lower) O-ring						
	Water pump case (lower) oil seal						
	Water pump case bolt						
	Water pipe grommet						
	Water pipe seal rubber, upper						
	Water pipe seal rubber, lower						
	Water pump seal guide rubber						
	Pump case liner						
	Gear case plate screw	○					
	Exhaust housing grommet						○
	Idling port grommet						○
	Trim tab retainer bolt						
	Driveshaft						
	Engine base gasket		○				
	Shift lever shaft holder retaining bolt	○					
	Shift lever shaft holder						
	Cam rod bushing						
	Cam rod bushing O-ring, 1.9 to 6.8						
	Cam rod bushing O-ring,3.5 to 27.7						
	Cam rod bushing stopper bolt						

Three Bond Adhesive G17	Low temperature lithium grease LT-2	Oil Center Research cold-resistant grease LOR #101	Specified OBM grease	Specified 2-stroke engine oil (MD Platinum)	Silicon grease, Shin-Etsu grease KS-64	Specified gear oil	Power trim & tilt fluid ※1	Remarks
				○				Apply to bother inner and outer surfaces
				○				Apply to bother inner and outer surfaces
				○				Apply to circumference
				○				Apply to circumference
				○				Apply to circumference
				○				Apply to sliding surface
		○						Fill in lip surface
				○				Apply to sliding surface
				○				Apply to sliding surface
								Apply to embedded section (M10P1.0)
								Apply to embedded section (M10P1.0)
				○				Apply to both inner and outer surfaces
				○				Apply to both inner and outer surfaces
				○				Apply to both inner and outer surfaces
				○				Apply to both inner and outer surfaces
								Apply after removing all grease from threading
			○					Lower inner surface
			○					
			○					Lip surface
			○					Spline surface
			○					Tapered surface
			○					Lower inner surface
			○					
			○					Lip surface
			○					Under-neck surface
			○					Upper surface
						○		Inner surface
a ○						b ○		a) Area that attaches to pump case, b) Interior
			○					Apply to entire surface
			○					Lightly on inner surface
								Screw area
								Apply to one of the mating surfaces
								Apply to one of the mating surfaces
			○					Stud bolt area
			○					Engine side Spline surface
								Screw area
			○					Sliding surface and inner surface (light coating)
			○					Circumfrance
						○		
			○					
			○					Under-neck surface

※Apply Three Bond Thread Lock 1342 when reusing precoated bolts.

Application points		Three Bond Thread Lock 1342	Three Bond Sealant 1107	Three Bond Thread Lock 1373B	Loctite Adhesive Adhesive 648 Primer 7471	Loctite Sealant 518	Three Bond Instant Adhesive 1741
Gear case and drive shaft housing	Gear case lubricating oil						
	Shift assist assembly	b ○					
	Gear case bolt						
	Extension housing bolt						
	Propeller shaft housing bolt	○ (※2)					
	Seal rubber (for apron)						○
	Set rubber (for apron)						○
Stern bracket section	Bracket bolt						
	Bracket bolt cap						
	Stern bracket washer						
	Swivel bracket						
	Steering shaft						
	Steering shaft bushing						
	Steering shaft seal ring						
	Thrust plate						
	Mounting bolt, upper	○					
	Mounting bolt, lower			a ○			
	Mounting bracket						
	Tilt stopper lip						○
	Tilt stopper						
Motor cover, upper	Filler lid hinge						
	Hook lever						
	Hook lever bushing						
	Hook level seal ring						
	Filler lid seal rubber						○
PTT section	PTT trim receiver						
	PTT upper cylinder pin						
	Tilt rod nut	○					
	PTT assembly bolt						
	Tilt rod nut	○					
	PTT sensor bolt	○					
	PTT switch						
	PTT oil						
Remote control	Bolt (shift lever)	○					
	Shift lever						
	Shift rod grommet						
	Bushing, 10.2 – 12 – 29.5						
	Drag link						
	Control box						
Nipples		○					

Three Bond Adhesive G17	Low temperature lithium grease LT-2	Oil Center Research cold-resistant grease LOR #101	Specified OBM grease	Specified 2-strole engine oil (MD Platinum)	Silicon grease, Shin-Etsu grease KS-64	Specified gear oil	Power trim & tilt fluid ※1	Remarks
						○		Oil capacity approx. 900 ml (30.4 fl.oz).
			a ○					a) Sliding surface and inner surface, b) Cap screw surface.
			○					Under-neck surface
			○					Under-neck surface
								Under-neck surface
			○					Fill with grease, apply grease to tapped hole
			○					Inner surface
			○					Both surfaces
			○					Fill interior with grease
			○					Sliding surface
			○					Sliding surface
			○					
			○					Sliding surface
								Screw surface
			b ○					a) Screw surface, b) Outer circumference
			○					Spline area
			○					Sliding surface
			○					Sliding surface
			○					Sliding surface
			○					Sliding surface
			○					Sliding surface
○								Apply to one of the mating surfaces
			○					Pinhead
			○					
								Screw area
			○					Under-neck surface
								Screw area
					○			Terminal
							○	Use ATF Dexron Ⅲ or equivalent product
								Screw surface
			○					Sliding surface
			○					Opening for rod
			○					
			○					Sliding surface
			○					Sliding surface
								Each press-in port

*1. Use ATF(Automatic transmission fluid) DEXRON Ⅲ or equivalent.

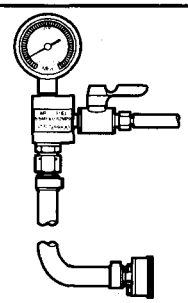
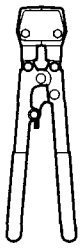
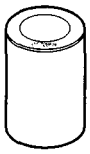
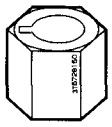
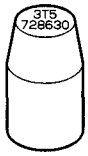
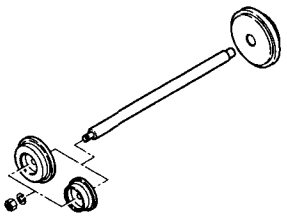
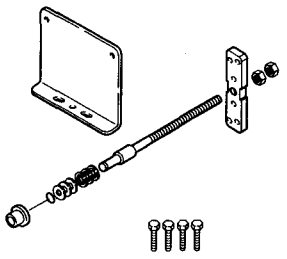
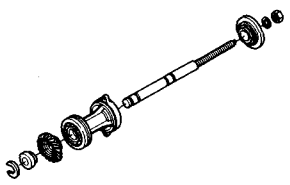
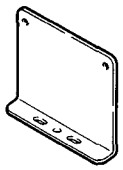
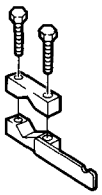
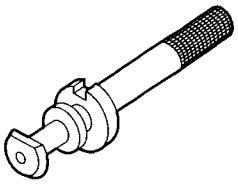
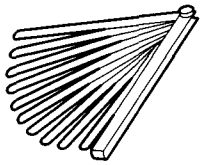
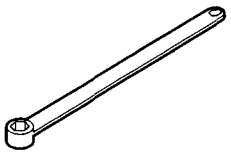
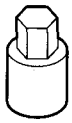
4. Torque Table

	Item	Part to tighten	Initial torque N-m (kg-m)	Full torque N-m (kg-m)	ft-lb
Engine	Cylinder head cover to cylinder head	Bolt (M6)	① 2.0 – 2.9 (0.2 – 0.3)	④ 4.6 – 6.3 (0.5 – 0.6)	3.6 – 4.3
	Cylinder head cover cylinder head to cylinder block	Bolt (M8)	②12 – 15 (1.2 – 1.5)	③ 29 – 34 (3.0 – 3.5)	22 – 25
	Crankcase	Bolt (M8)	12 – 15 (1.2 – 1.5)	24 – 26 (2.4 – 2.6)	17 – 19
		(M10)	17 – 23 (1.7 – 2.3)	37 – 41 (3.8 – 4.2)	28 – 30
		Nut (M10)	17 – 23 (1.7 – 2.3)	37 – 41 (3.8 – 4.2)	28 – 30
	Exhaust cover	Bolt (M8)	5.9 – 7.8 (0.6 – 0.8)	13 – 15 (1.3 – 1.5)	9.4 – 11
	Compressor head	Bolt (M6)	—	7.8 – 9.8 (0.8 – 1.0)	5.8 – 7.2
	Air box	Bolt (M6)	—	7.8 – 9.8 (0.8 – 1.0)	5.8 – 7.2
	Throttle body	Bolt (M6)	—	7.8 – 9.8 (0.8 – 1.0)	5.8 – 7.2
	Water temperature sensor	—	—	20 – 23 (2.0 – 2.3)	14 – 17
	Driven pulley	Nut 10 (M10)	—	44 – 49 (4.5 – 5.0)	32 – 36
	Drive pulley	Nut 10 (M10) (M30)	—	90 – 110 (9 – 11)	65 – 80
	Flywheel	Nut 18 (M18)	—	140 – 160 (14 – 16)	102 – 116
	Hose joint adapter	—	—	14 – 16 (1.4 – 1.6)	10 – 12
	Hose joint nut	—	—	14 – 16 (1.4 – 1.6)	10 – 12
	Spark plug	—	—	25 – 29 (2.5 – 3.0)	18 – 22
	Valve core (included in valve assembly)	—	—	0.4 – 0.6 (0.04 – 0.06)	0.3 – 0.4
Lower unit	Engine mounting bolt (cylinder block to engine base to driveshaft housing)	—	—	24 – 26 (2.4 – 2.6)	17 – 19
	Fuel connector	—	—	4.9 – 6.9 (0.5 – 0.7)	3.6 – 5.1
	Shift lever shaft holder	Bolt (M8)	—	5.9 – 7.8 (0.6 – 0.8)	4.3 – 5.8
	Lanyard stop switch	—	—	2.0 – 2.5 (0.2 – 0.25)	1.4 – 1.8
	Mount rubber, upper	Bolt (7/16)	—	39 – 49 (4.0 – 5.0)	29 – 36
	Mount rubber, lower	Nut, 12 (M12)	—	29 – 34 (3.0 – 3.5)	22 – 25
	Stern bracket	Nylon nut 7/8	—	24 – 26 (2.4 – 2.6)	17 – 19
	Gear case	Bolt (M8)	—	24 – 26 (2.4 – 2.6)	17 – 19
		Bolt (M10)	—	37 – 41 (3.8 – 4.2)	28 – 30
	Bevel gear B	Nut, Bevel gear B (M12)	—	98 – 120 (10 – 12)	72 – 87
Power trim and tilt	Oil reserve bolt	—	—	4 – 6 (0.4 – 0.6)	2.9 – 4.3
	Oil reserve cap	—	—	5 – 10 (0.5 – 1.0)	3.6 – 7.2
	Manual valve	—	—	3 – 4 (0.3 – 0.4)	2.2 – 2.9
	Motor assembly bolt	—	—	3 – 4 (0.3 – 0.4)	2.2 – 2.9
	Oil pump bolt	—	—	7 – 10 (0.7 – 1.0)	5.1 – 7.2
	Trim rod guide	—	—	75 – 81 (7.5 – 8.1)	54 – 59
	Tilt rod guide	—	—	108 – 147 (10.8 – 14.7)	78 – 107
Standard torque	M4 (0.16 in)	—	—	1 – 2 (0.1 – 0.2)	1
	M5 (0.20 in)	—	—	3 – 4 (0.3 – 0.4)	2 - 3
	M6 (0.24 in)	—	—	5 – 6 (0.5 – 0.6)	3 – 5
	M8 (0.31 in)	—	—	11 – 15 (1.1 – 1.5)	8.0 – 11
	M10 (0.39 in)	—	—	23 – 30 (2.3 – 3.1)	17 – 22

Remarks: Tightening order of cylinder head cover and cylinder head is ①⇒②⇒③⇒④

5. Special Tools

(1) List of Special Tool

			
Pressure gauge assembly 3T5-72880-0	Crimping pliers 3T5-72864-0	Drive pulley press 3T5-72868-0	Piston slider 3T5-72871-0
For measuring air rail fuel and air pressure.	For crimping OETIKER make clamps.	For press fitting in the drive pulley.	For installing the piston in the air compressor.
			
Crankshaft holder 3T5-72815-0	O-ring setting tool (ø24) 3T5-72863-0	Bearing outer race press-fit kit 3B7-72739-0	Backlash measuring tool A kit 3B7-72234-0
For removing and tightening on the pulley nut.	For installing O-rings on the fuel injectors.	For applying pressure on bevel bearing A outer race.	For measuring backlash between bevel gears A and B.
			
Backlash measuring tool B kit 3B7-72255-0	Dial gauge plate 3B7-72729-0	Clamp assembly 3B7-72720-0	
For measuring backlash between bevel gears B and C.	For attaching the dial gauge when measuring backlash.	Dial gauge contact shoe for use when measuring backlash.	
			
Shimming gauge 3B7-72250-0	Filler gauge 353-72251-0	Bevel gear B nut wrench 3B7-72231-0	Bevel gear B nut socket 3B7-72232-0
For positioning bevel gear B.	For measuring clearances.	For removing and installing bevel gear B nut.	

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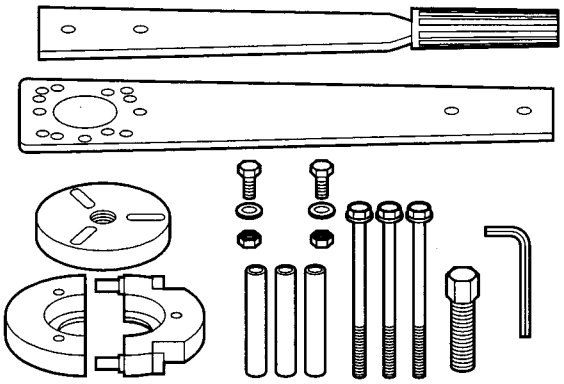
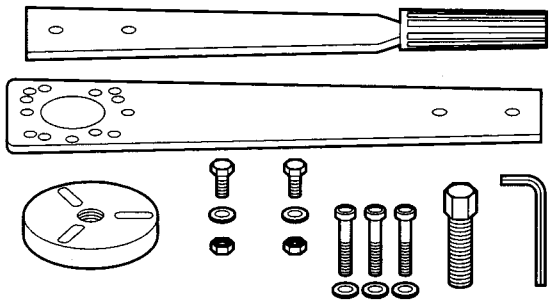
<tr><td> 
Drive pulley puller assembly
3T5-72890-0</td><td colspan="2"> 
Flywheel puller kit
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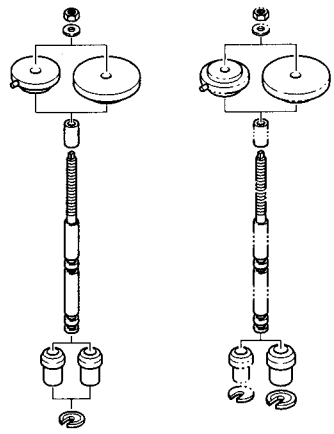
<tr><td>For removing drive pulley.</td><td colspan="2">For removing and installing flywheel.</td></tr>
<tr><td> 
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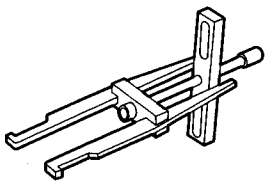
3C7-72700-0</td><td> 
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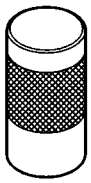
3B7-72224-0</td><td> 
Bevel gear A bearing set tool
3B7-72719-0</td></tr>
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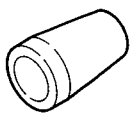
<tr><td> 
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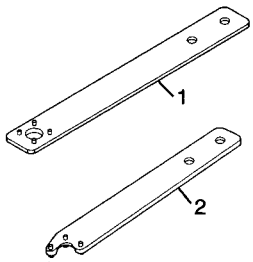
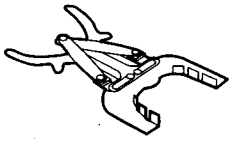
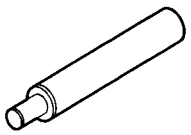
345-72229-0</td><td> 
1. Trim rod guide wrench
3B7-72792-0
2. Tilt rod guide wrench
3C8-72791-0</td><td> 
Piston ring tool
353-72249-0</td><td> 
Piston pin tool
353-72215-0</td></tr>
<tr><td>For installing clutch pin snap ring.</td><td>For removing and installing PT&T piston rod assembly.</td><td>For removing and installing piston ring.</td><td>For removing and installing piston pin.</td></tr>
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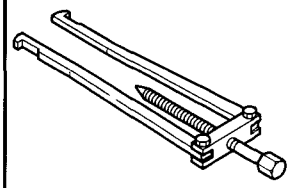
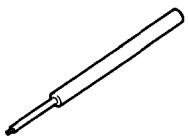
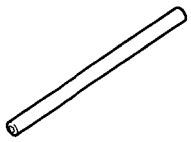
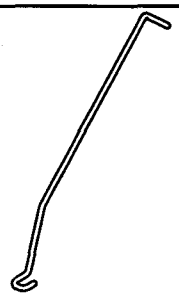
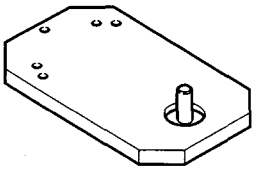
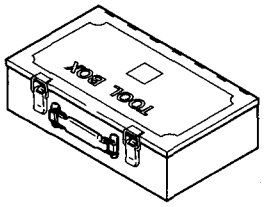
 Propeller shaft housing puller assembly 353-72252-0	 Spring pin tool A 369-72217-0	 Spring pin tool B 369-72218-0	 Shift rod joint puller 353-72248-0
For removing propeller shaft housing.	For removing and installing spring pin.		Used to raise the shift rod when the gear case shift position is configured in a "Figure R." * Not required for configuring in the normal position.
 Power head stand 353-72247-1	 Tool box 353-72254-0		
_____	_____		

2. Using the Special Tool

① Pressure Gage Assembly

Measuring Fuel and Air Pressure

1. Mover the lever for cock (3T5-72883-0) to position A shown in the figure below.
2. Screw adapter B (3T5-72884-0) into either the air or fuel pressure measuring valves located on the air rail.

Caution:

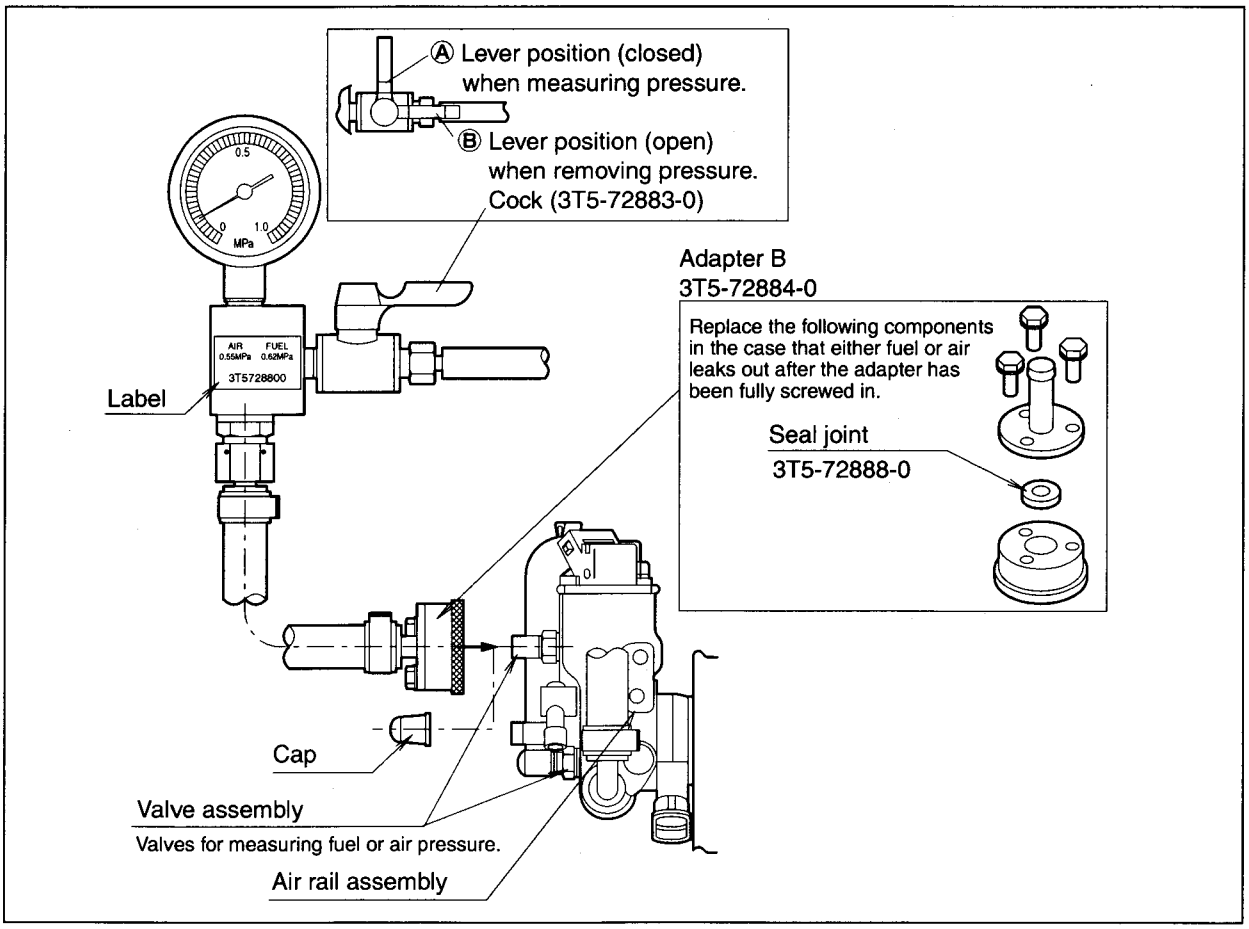
A small amount of fuel will spurt out as the adapter is inserted in the fuel measuring valve.

3. With the ignition key set the OFF position, turn it to START to activate the starter motor and turn over the engine for approximately 15 seconds. (Once the engine starts, allow it to idle at 700 rpm for approximately for 15 minutes.)
4. If both fuel and air pressure values fall within the standard (rated) range, engine operation is normal. (If not, service the engine by referring to the relevant sections in this manual.)

PRESSURE	Rated value (kPa, psi)	Rated range (kPa, psi)	Remarks
AIR PRESSURE	550, 80	550 ± 30, 80 ± 4	Pressure falls when engine stops turning over.
FUEL PRESSURE	620, 90	620 ± 30, 90 ± 4	

5. When finished measuring, turn the lever to position B (open) to relieve internal pressure; then remove adapter B from the measuring valve.

It is important to have a container handy. Once fuel measuring completes and the lever is set to position B (open), a certain amount of fuel will spurt out from the hose (98AB-5-0200). Be sure to point the hose (98AH-8-1000) on the cock side lower than valve position and drain all remaining fuel prior to removing adapter B.



② Crankshaft Holder (3T5-72815-0)

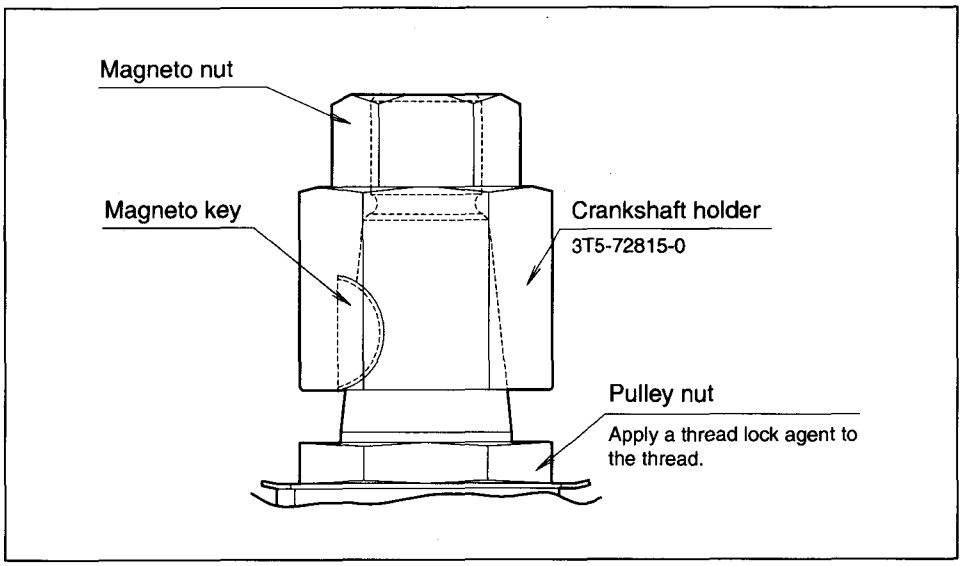
Removing Pulley Nut

1. Disassemble the flywheel. (Refer to section ① of this chapter.)
2. Install the magneto key and crankshaft holder for this engine.
3. Use the magneto nut to secure the crankshaft holder in place. (The magneto nut is threaded clockwise.)
4. Using two 36 mm wrenches, attach one to the crankshaft holder and use the other to loosen the pulley nut.

Installing Pulley Nut

1. Apply thread lock (Three Bond #1342) to the thread area.
2. Screw the pulley nut onto the crankshaft by hand.
3. Install the engine's magneto key; then install the crankshaft holder.
4. Use the magneto nut to secure the crankshaft holder in place.
5. Using two 36 mm wrenches, attach one to the crankshaft holder and use the other to tighten on the pulley nut, adjusting it to the torque shown below.

Tightening Torque: 90 to 110 N-m (9 to 11 kg-m) = [65 to 80 lb-ft]



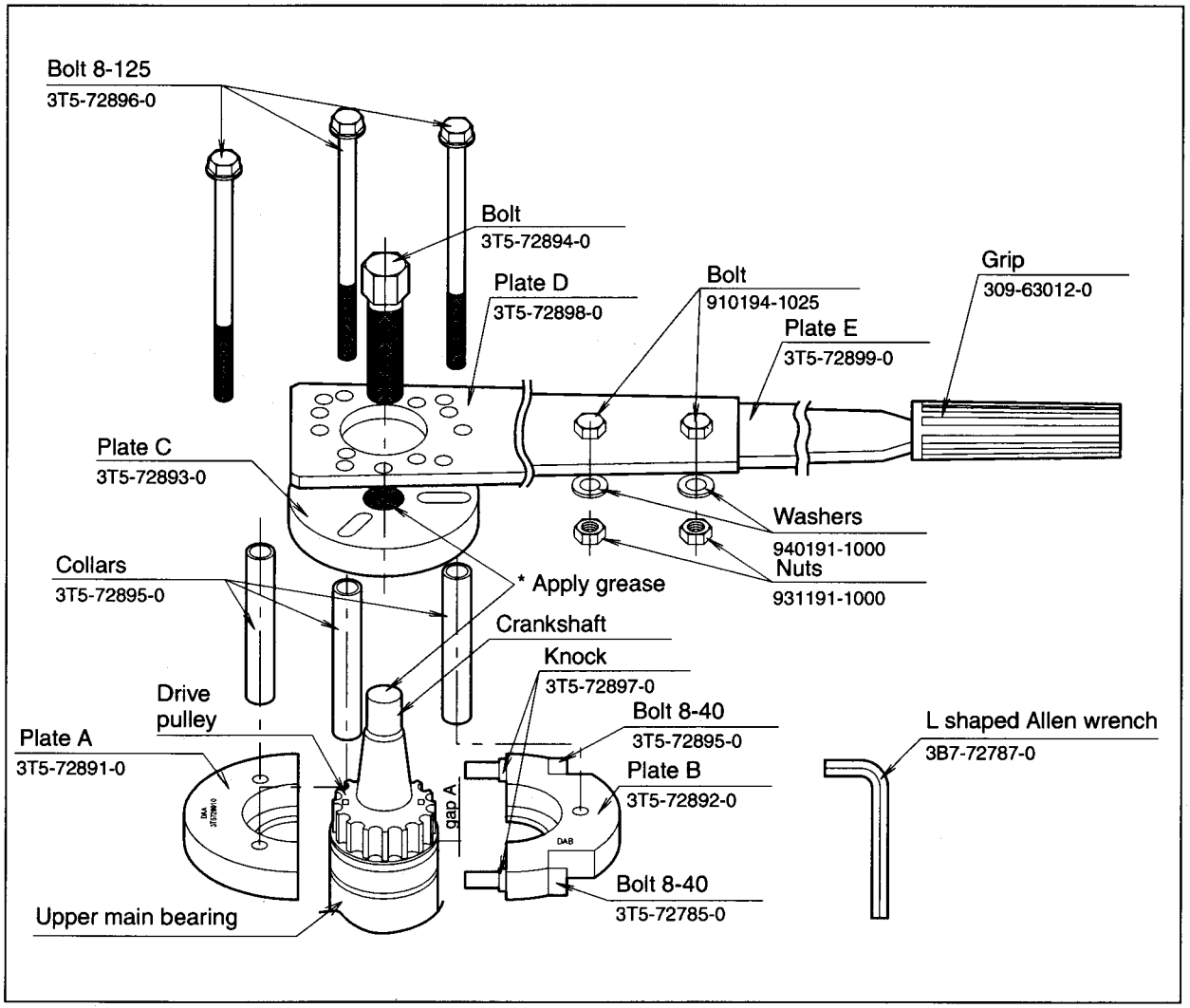
③ Drive Pulley Puller Assembly

Removing Drive Pulley

Begin the disassembly operation by removing the crankshaft from the power unit.

1. Remove pulley nut. (Refer to section ② of this chapter.)
2. Move the upper main bearing towards the crankshaft end in order to create a gap with the drive pulley.
3. Insert plate A (3T5-72891-0) and plate B (3T5-72892-0) into the gap by mating the two knock studs (3T5-72897-0) on plate B with plate A and tightening evenly the 8-40 bolts (3B7-72785-0) on both sides using the Allen wrench (3B7-72787-0).
4. Insert the three collars (3T5-72895-0) between plate C (3T5-72893-0) and the already joined plates A and B.
5. Using a 19 mm socket wrench, turn the bolt (3T5-72894-0) until the drive pulley comes away.

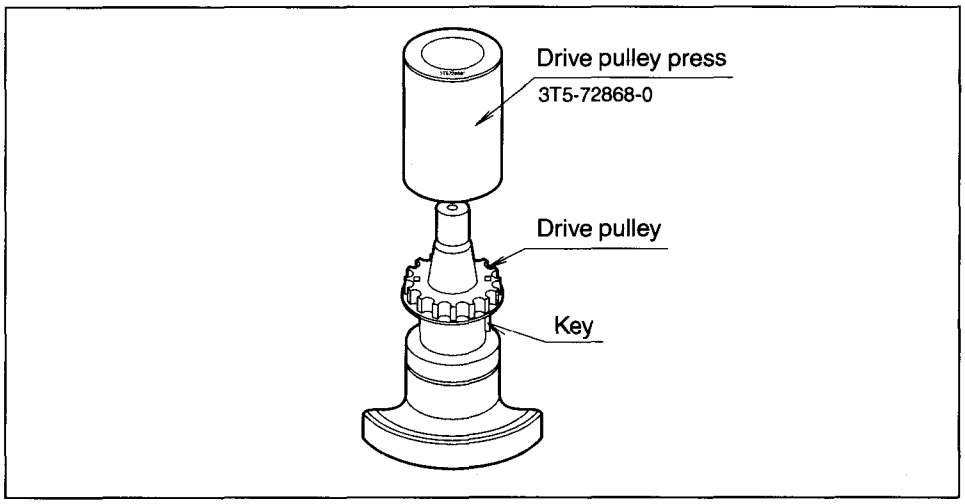
Note: Apply Tohatsu grease to the sections in the diagram marked by the asterisk (*).



④ Drive Pulley Press (3T5-72868-0)

Inserting Drive Pulley

1. Remove any oil or grease from crankshaft and drive pulley hole. Apply Loctite Primer 7471; wait 5 minutes; then apply Loctite 648 to the hole.
2. Insert the half moon key in the crankshaft and install the drive pulley.
3. Position the drive pulley press above the drive pulley.
   With the wide-open end of the press facing downward, place down over the drive pulley.
4. Tapping lightly on the top center area of the press with a hammer, press fit the drive pulley in place.
   (The beginning half is designed to insert easily, the remaining half requires press fitting.)

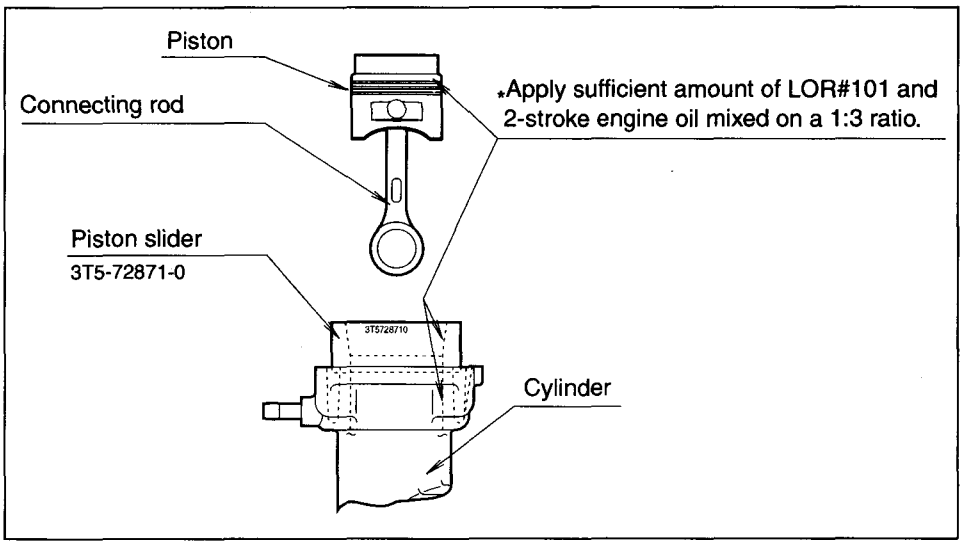


⑤ Piston Slider (3T5-72871-0)

Installing Air Compressor Piston

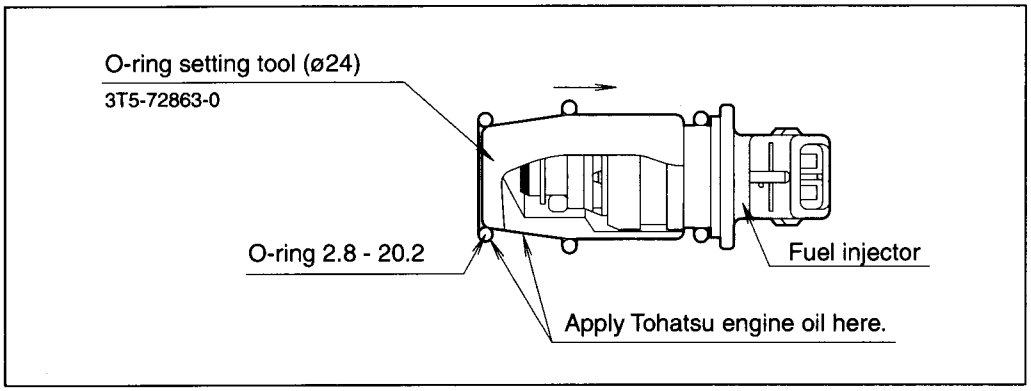
1. Apply sufficient amount of LOR#101 and 2-stroke engine oil mixed on a 1:3 ratio to the exterior of the piston, the interior of the piston slider and the interior of the compressor rings.
2. Place the piston with piston ring installed on the tapered part of the piston slider, line up the assembly with the top surface of the cylinder and press piston into the cylinder by hand.
3. Press the piston down in a single firm motion until it is properly inserted.

Note: If the piston ring should get caught part way through, repeat the operation from step 2.



⑥ O-ring Setting Tool (ø24) (3T5-72863-0)

Install the fuel injector 2.8-20.2 O-rings (3T5-10304-0).
Apply engine oil to both the O-rings and the O-ring setting tool.
Position the O-ring setting tool in place; then install O-rings by sliding them on.



⑦ Crimping Pliers (3T5-72864-0)

This tool is used to install the specified clamps on the fuel and air system hoses. It is intended for use with the following parts.

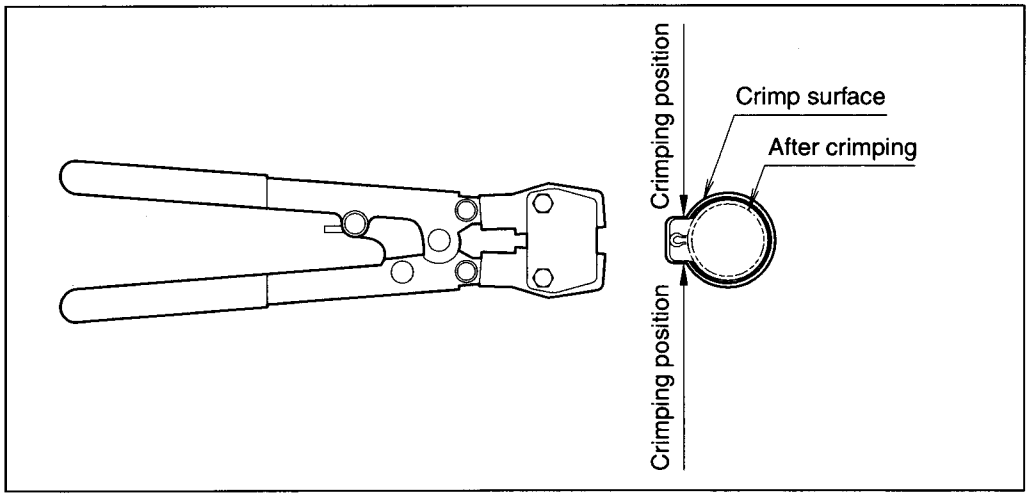
1. Fuel Hose Assembly (3T5-10089-0)
   Clamp 21/32 (385-10086-0): Installed at four locations on the hose connecting FFP case assembly to high-pressure fuel filter and the hose connecting high-pressure fuel filter to air rail assembly.
2. Air Hose Assembly (3T5-10088-0)
   Clamp 1/12 (3T5-10087-0): Installed at two locations on hose connecting air compressor to air rail assembly.
3. Clamp 29/64 (3T5-10091-0): Installed at two locations on hose connecting L nipple on air rail to fuel regulator.

Clamp Crimping Procedure

Crimping is performed by applying crimping forced to the locations indicated by arrows in the figure below. The crimping tool is designed to not open until it has crimped all the way.

Caution:

- Be sure to use new clamps.
- Note that the highly pressurized fuel or high temperature, highly pressurized air flowing through the hoses are liable to leak if the clamps are not firmly crimped in place.



Chapter 3 Inspection and Maintenance

1. Periodic Inspections

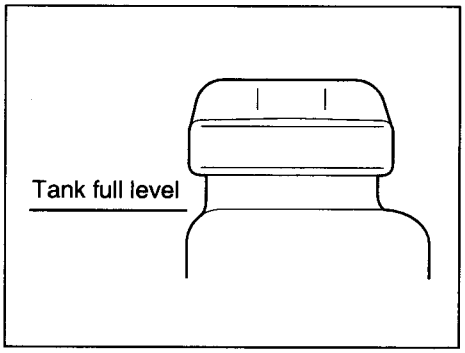
Category	Inspection points	Inspection intervals							Inspection procedure	Remarks
		10 hrs. or bimonthly	30 hrs or monthly	50 hrs. or 3 months	100 hrs. or 6 months	Yearly	1.5 years	200 hrs. or 2 years		
Fuel and compression systems	High press. Fuel filter			O	O	O	O	Replace	Inspect	Entire cartridge
	Piping		O	O	O	O	O	Replace	Wear on pipes & leaking connectors	
	Fuel tank				O	O	O	O	Clean	Including filter
	Air filter					O		Replace		
	Drive belt					O		Replace		
	Fuel pressure					O		O		
	Air pressure		O			O		O		
Ignition system	Spark plug		O		O	O	O	O	Remove carbon Spark gap	0.7-0.8 mm (0.0276 - 0.0315 in)
Starting system	Starter motor		O		O	O	O	O	Salt deposits & battery cables	
	Battery	O	O	O	O	O	O	O	Mountings, fluid & spec, gravity levels	
Lower unit	Propeller	O	O	O	O	O	O	O	Bending, chipping, or wear on blades: check bushing	
	Gear oil	Replace		O	O	O	O	O	Replenish or change oil, check for water leakage	
	Water pump			O	O	Replace	O	Replace	Wear and cracks on impeller & liner	
Oil systems	Oil tank	O			O	O	O	O	Oil leaks, damage, faulty clip: wash filter	
	Oil pipes	O			O	O	O	O		
	Oil filters	O		O	O	O	O	O		
Warning system				O	O	O	O	O		
Nuts and bolts		O	O	O	O	O	O	O	Tighten	
Sliding & rotating parts, grease nipples				O	O	O	O	O	Apply or inject grease	
Power trim & tilt		O			O	O	O	O	Check & replenish oil; manually operate	
Anodes				O	O	O	O	O	Check for corrosion, warping and wear	

Note: The manual recommends the engine be overhauled after every 300 hours of operation.

2. Engine Oil System

Bleeding Air From Oil Pump

IMPORTANT: The air may not bleed out properly if the oil in the tank is too low. Make sure to fill the tank prior to bleeding air from the piping.

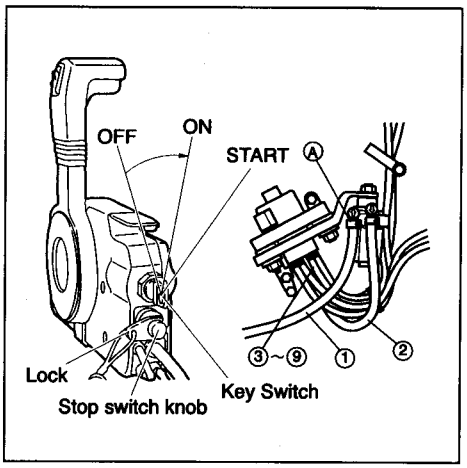


Bleeding Air From Oil Pump / oil line

Conduct a visual check of the clear vinyl pipes connecting the oil pump to the oil tank to inspect for the presence of air. Bleed hoses if necessary.

Hose ① (Oil tank – Oil filter)
a. Fill the oil tank with Genuine MD Platinum or equivalent.
b. Provide an clean drain pan. Remove the hose at Ⓐ.
c. Drain the oil into the drain pan till all the air babbles are comletely bled. Then replace the hose and clip.

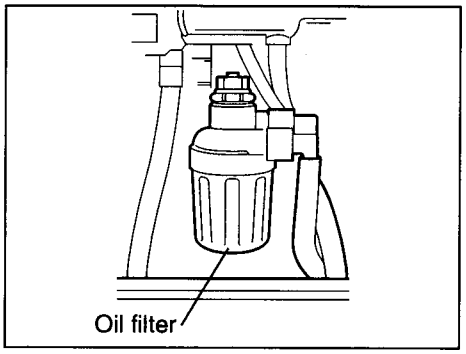
Hose ②–⑨ (Oil filter – Oil pump – Cylinder)
a. Turn on the key switch.
b. Remove the lock of safety stop switch wihtin a second after buzzer sounds off.
c. Remove lock of the switch. Pull and release the safety stop switch knob 2 times rapidly within 2 sec.
d. Buzzer should sound 3 times and oil pump starts to bleed oil for about one minute.
e. Turn off the key switch after bleeding the air from oil.



Important: When the engine is brand new and when the bleeding air from oil pump / oil line with operating the key switch as above, the engine oil is automatically increased to protect engine.
During this period, the additional amount of oil is supplied. The additional oil supply will be automatically finished after total 2 hours engine operation is completed at 3000rpm or highter.
Oil supply will be normal after then.

Oil Filter and Oil Tank

Check the oil filter for water and foreign matter.
If present, disconnect all piping connecting the oil tank to the oil pump from the outboard engine and remove all oil and any water or foreign matter.
Reconnect oil tank and add new oil; then repeat the same air bleeding procedure used on the oil pump.

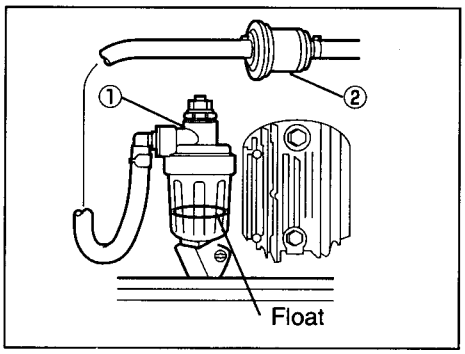


3. Fuel System

Replacing Engine Fuel Filter

① Fuel filter (Detachable type)

The red ring ① floats when water is present. If it floats, remove cup and empty out the water.



② High-Pressure Fuel Filter (Disposable type)

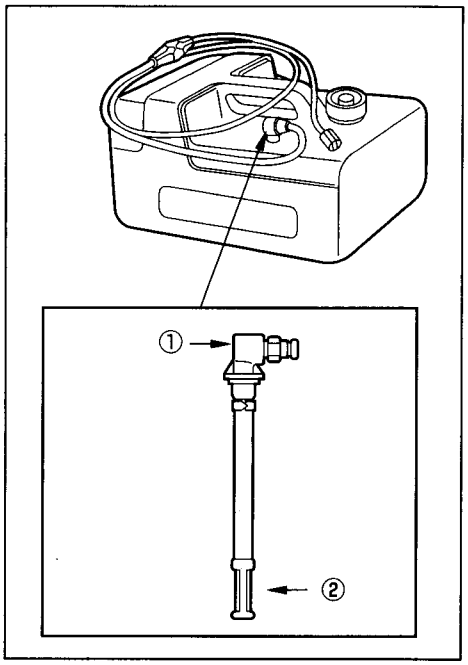
Refer to maintenance chart.

Cleaning Fuel Tank Filter

① Fuel pickup elbow

② Filter

Turn ① to the left to remove and clean ②.



Cleaning Fuel Tank

Clean the fuel tank whenever there is a build-up of water or foreign matter.

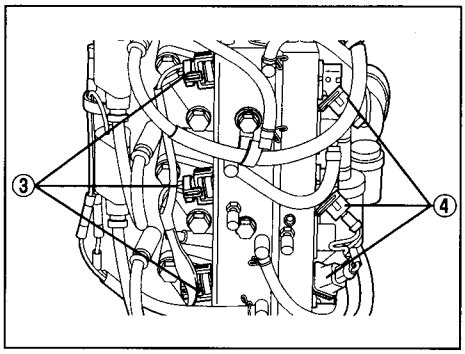
4. Compression System

Measuring Procedures

Use the following procedures to measure the compression of the individual cylinders.

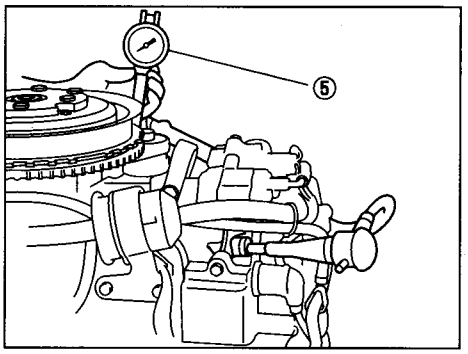
1. Fully charge the engine battery.
2. Start engine and idle for 3 minutes to warm.
3. Unlock the stop switch.
4. Remove all spark plugs.
5. Remove all air injector ③ and fuel injector ④ connectors.

Accurate compression readings are only possible when all ③ & ④ connectors are disconnected. It should also be noted that the ECU records detailed information on which connectors were disconnected during each inspection. Refer to the section on the TLDI self-diagnosing function for more information.



6. Attach the compression gauge ⑤ into the spark plug hole (only one at a time).
7. Use the starter motor to turn over the engine.

Engine speed: approx. 400 rpm for at least 5 seconds



(Note that throttle position does not affect compression readings.)

- Measure the compression for all cylinders.
- Confirm that all compression readings conform to specifications.

Rated compression: 900 kPa (9.2 kg/cm², 131 psi) ±10%

Results and Steps to Take

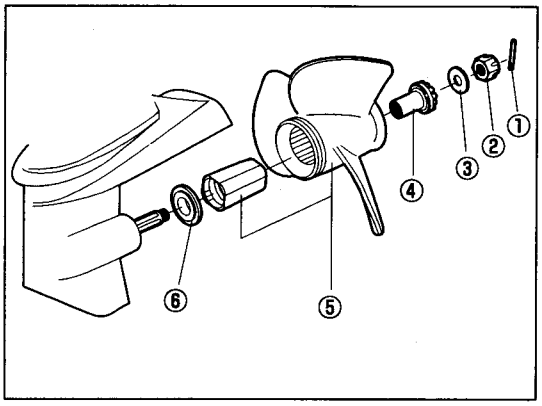
Repair or replace components as necessary when the readings fall under the following categories.

- Below specified compression:
- Difference between cylinders exceeds 103 kPa (1.05 kg/cm², 15 psi)
- Compression is abnormally high.

5. Gear Case Area

Replacing Propeller

Worn or bent propeller blades will not only affect performance and can also lead to engine damage.



- Move the shift lever to the neutral position; stop the engine, then replace the propeller.
- Be sure to wear a thick pair of gloves and proceed carefully.

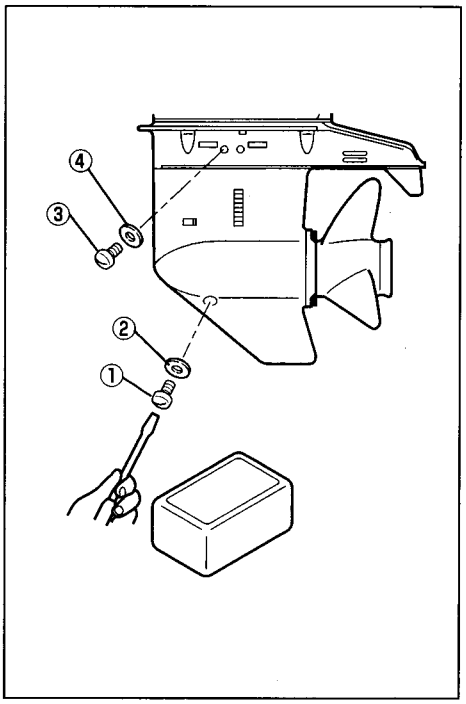
Remove following components.

① Split pin ⇨ Replace with new pin
② Propeller nut
③ Washer
④ Adapter
⑤ Propeller and drive sleeve
⑥ Thrust holder

Replacing Gear Oil

- Place an clean drain pan under the lower unit and remove following components.

① Lower oil plug
② Lower gasket ⇨ Replace with new gasket

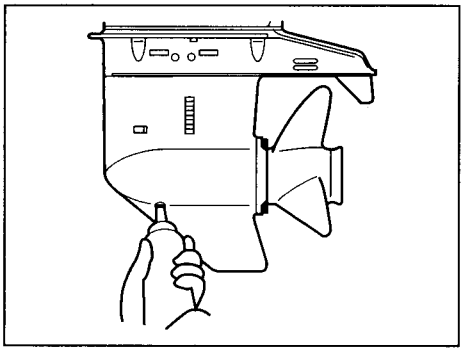


- Next, remove the following components (③,④) and drain oil completely.

③ Upper oil plug
④ Upper gasket ⇨ Replace with new gasket

- Insert the gear oil container nozzle into the lower oil plug hole and squeeze the container until oil overflows from the upper oil plug hole.

Oil: Genuine gear oil or GL5, SAE#80, #90
Capacity: 900ml, 30.4 US fl. oz (approx.)

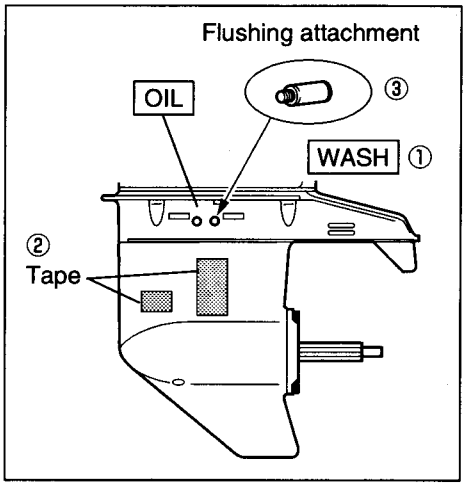


- First tighten the upper oil plug ③ with upper gasket ④, then reinstall the lower oil plug ① with lower gasket ②.

6. Flushing

Take care not to come into contact with the propeller while it is in motion. Be sure to remove the propeller when operating the engine on land.

Be sure not to operate the engine in confined areas, such as a boat house, as the exhaust fumes contain toxic carbon monoxide gas.



Washing With Flushing Attachment (Hose adapter)

Remove following components.

- Propeller and thrust holder, etc.

① Water plug

Install following components.

② Tape: at 2 locations (on water strainer)

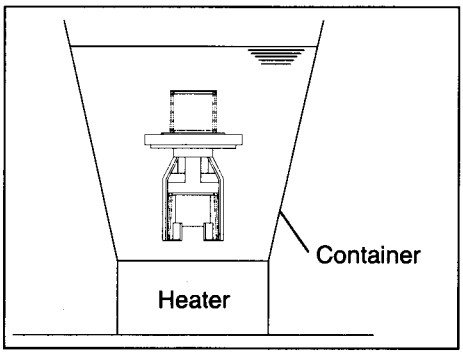
③ Flushing attachment

- Connect a hose to tap water and insert the end of the hose into ③.
- Move the gearshift lever to the neutral position and start the engine.
- Confirm that a steady stream of water is coming from the cooling water check port; then operate the engine at low speed for 3 to 5 minutes.
- Stop the engine, turn off the water supply, remove the flushing attachment ③ and tape, reinstall the water plug ①; then reinstall the propeller assembly.

7. Cooling System

Thermostat test

- Place the thermostat into a suitable container and add either cold or warm water.
- Heat the water in the container and confirm that the thermostat valve operates when the temperature rises.



Valve opening temperature	60°C (140°F)
Valve full open temperature	75°C (167°F)
Valve full open lift	3 mm (0.12 in) or more

Replace if not functioning properly.

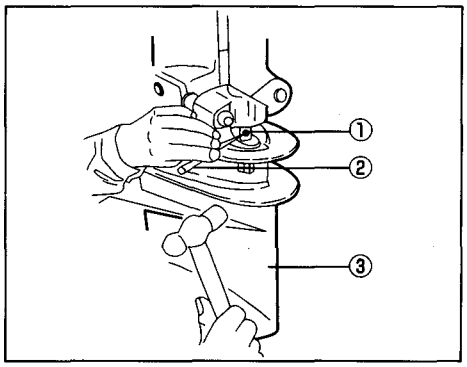
Inspecting Water Pump

Remove following component.

① Split pin

Special tool	② Spring tool A
	345-72227-0

• Remove the gear case assembly from the drive shaft housing.



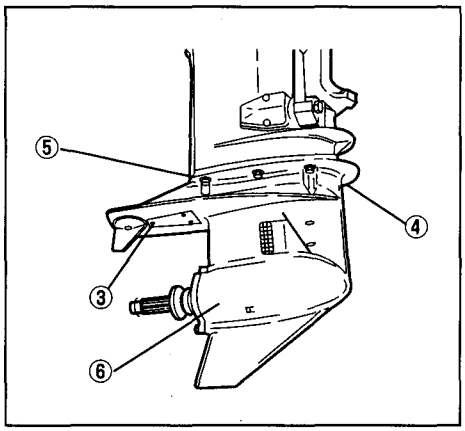
Remove following components:

③ Gear case plate

④ Bolt: type H835 at 4 locations

⑤ Bolt: type H1040 at 3 locations

⑥ Gear case assembly (Pull downward to remove.)



⑦ Bolt: type H885 at 4 locations

⑧ Washer: at 4 locations

Inspect following components.

⑨ Upper pump case

⑩ Pump case liner

⑪ Pump impeller ⇨ Replace with new part.

⑫ Key

⑬ Seal ⇨ Replace with new part.

⑭ Guide plate

⑮ Gasket ⇨ Replace with new part.

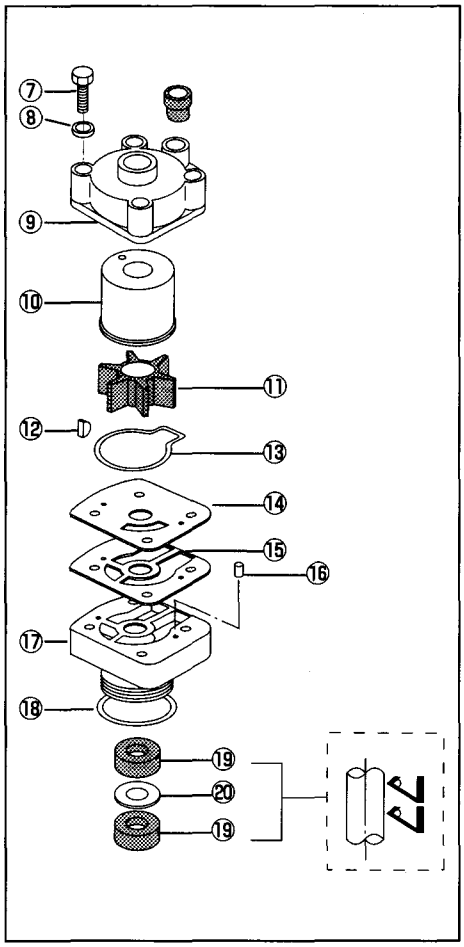
⑯ Knock-out pin

⑰ Lower pump case

⑱ O-ring

⑲ Oil seal

⑳ Shim

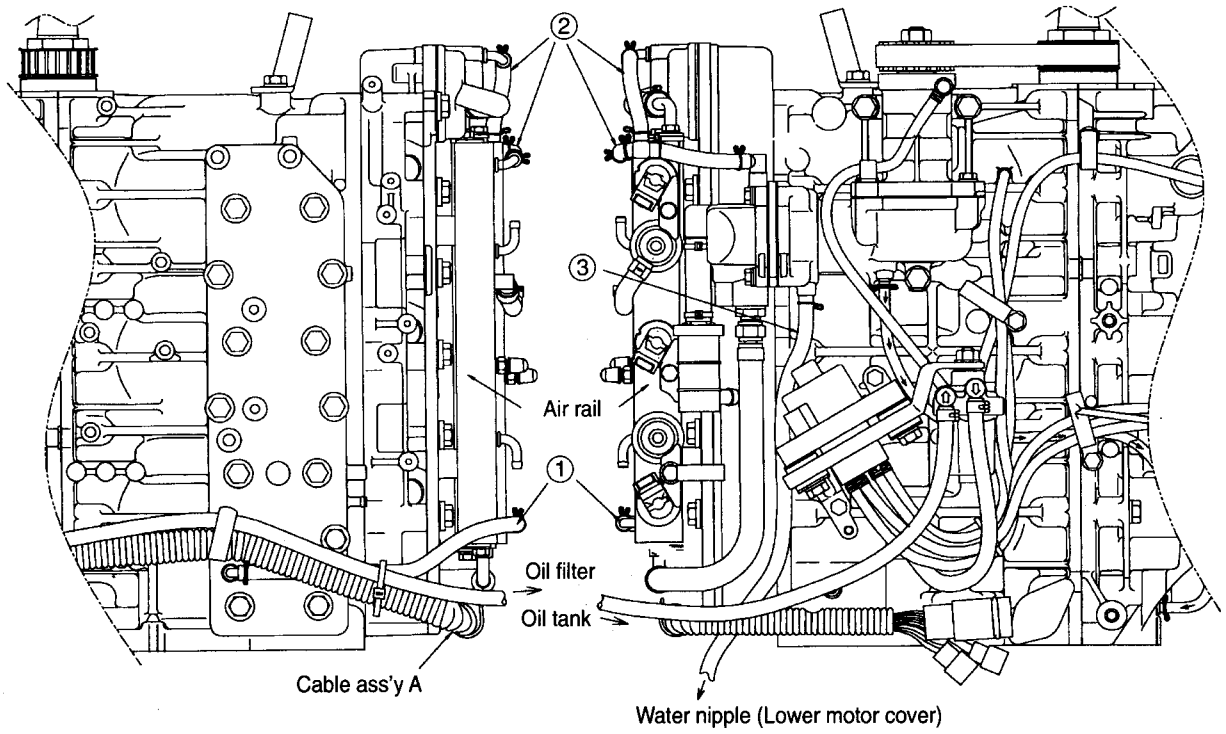


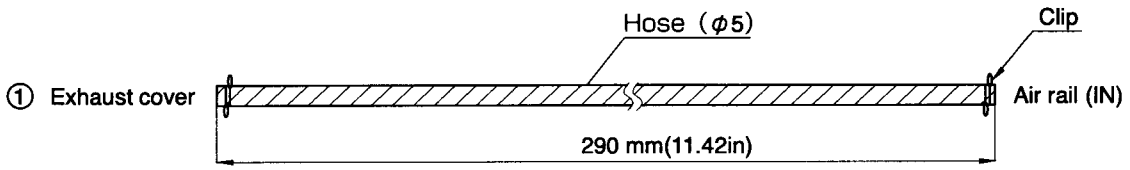
Inspection Procedure

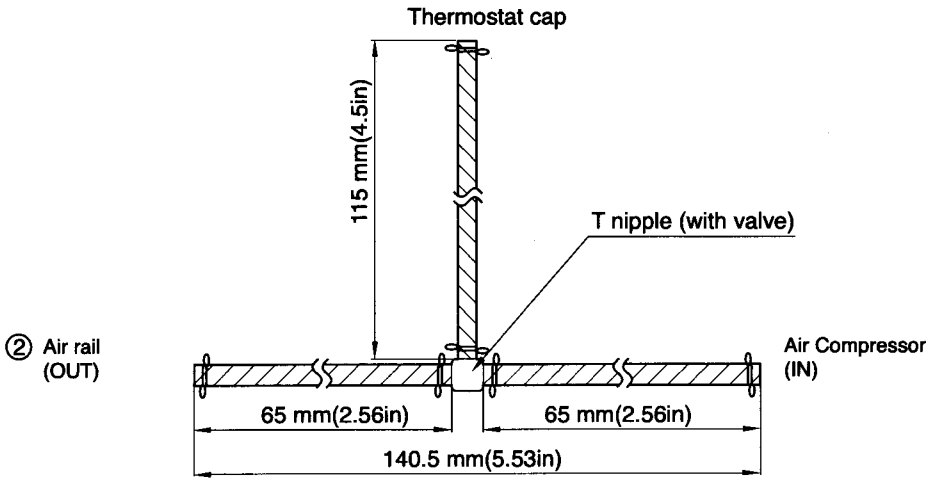
⑥ to ⑮: Replace with new components if worn or damaged.

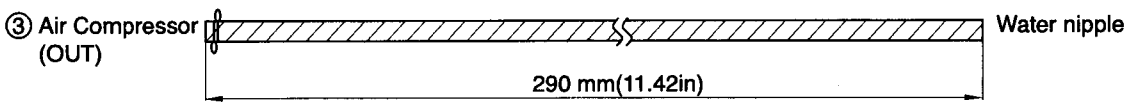
⑮ Be sure to confirm the correct oil seal direction.

Overview of Cooling System







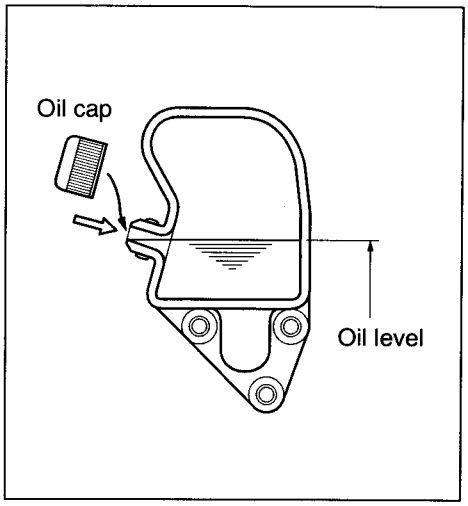


8. Power Trim and Tilt System

Checking Oil Level

Note that the oil level is checked by first tilting up the outboard engine (see figure), so that the reserve tank is in a perpendicular position. To check level, turn the oil plug counterclockwise to remove it; then confirm that oil level is even with the bottom of the oil plug hole.

When replenishing oil, add until oil begins to overflow from the oil plug hole.



Caution:

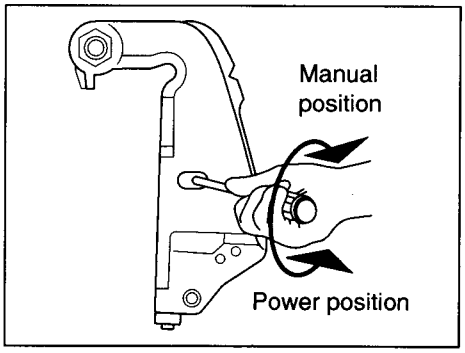
In order to avoid damage and accidental injury that can occur when the tilted up (for storage and inspections etc.) outboard engine accidentally tilts back down, be use to insert the tilt stopper when tilted up.

Oil Type

Use DEXTRON Ⅲ or equivalent automatic transmission fluid (ATF).
Nisseki Mitsubishi Power Torque Fluid is used in the equipment supplied with this engine.

Note that the presence of air in the oil can cause the engine to not tilt up and down properly.

If this occurs, bleed out the air using the following procedure.



- With the outboard engine installed on the boat, turn the manual valve to the MANUAL position (counter clockwise) and move the engine the full tilt up and down stroke 5 or 6 times; then turn the manual valve back to the POWER position (clockwise).

9. Air Rail Pressure

Fuel pressure and air pressure inspection

Special tool	Pressure gauge assembly
	3T5-72880-0

Adjust the lever on cock (3T5-72883-0) to position A shown in the figure below.
Screw adapter B (3T5-72884-0) into either the air pressure measuring valve or fuel pressure measuring valve located on the air rail.

Caution:

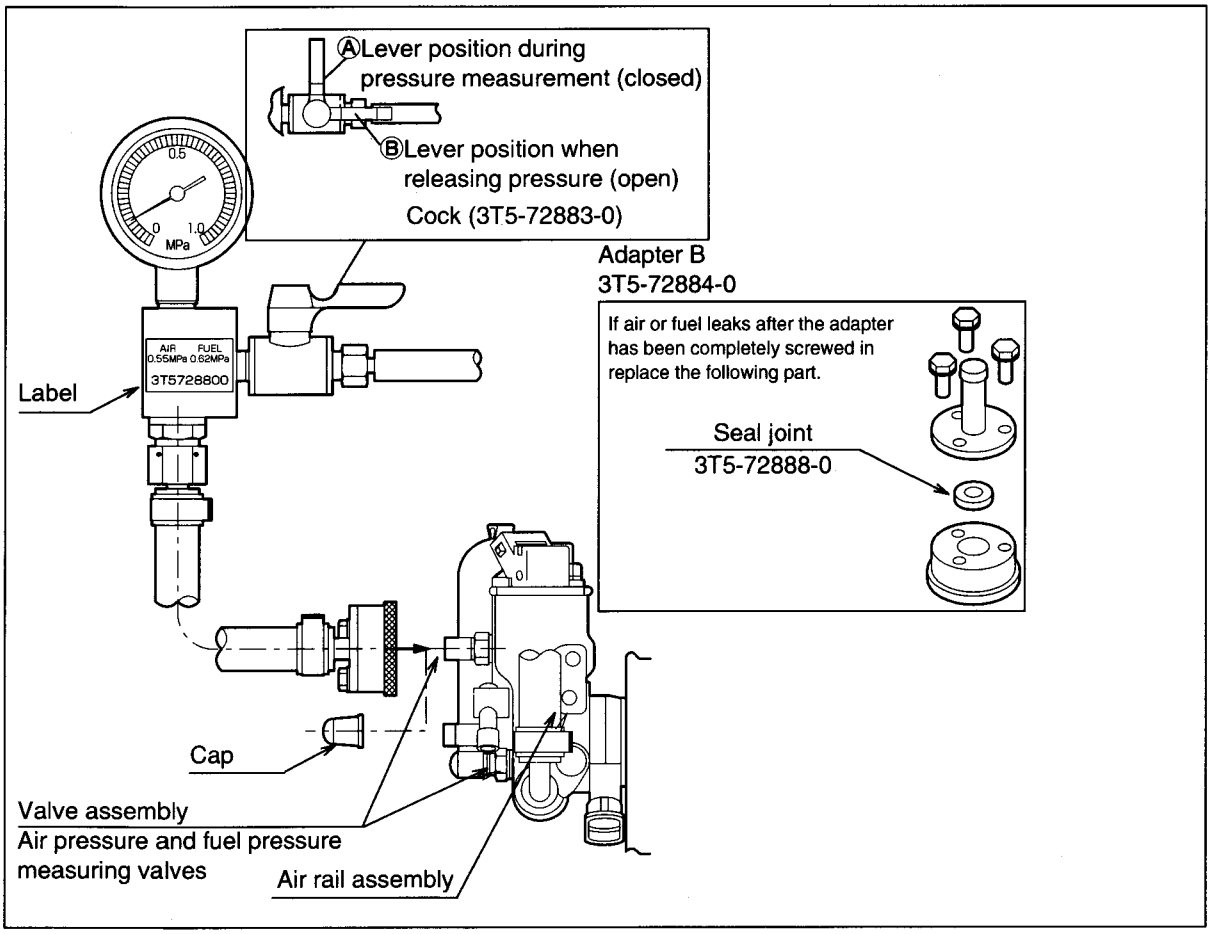
When the adapter is inserted into the fuel measurement valve a small amount of fuel will spurt out.

With the ignition key set in the OFF position, turn the key to START to activate the starter motor. Turn over the engine for about 15 seconds. (Once the engine starts, allow it to idle at 700 rpm for about 15 seconds.)
If both air pressure and fuel pressure fall within the standard (rated) range, the fuel and air systems are operating normally.
(If the pressure falls outside the standard (rated) range), refer to this service manual and perform the required maintenance.)

Pressure rating	Rated value (kPa)	Rated range (kPa)	Remarks
Air pressure	550 (80 psi)	550 ± 30 (4.3 psi)	Pressure gradually falls after engine stops.
Fuel pressure	620 (90 psi)	60 – 80 (8.5 – 11.4 psi) higher than air pressure	

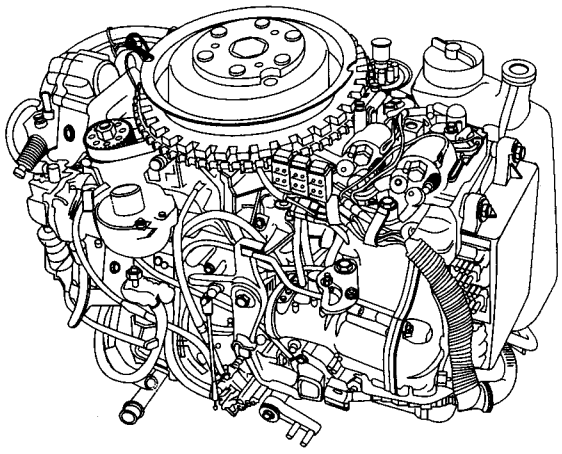
After measuring, adjust the key switch to the OFF position and set the cock lever to position B (open) to release internal pressure. Then, remove adapter B from the measuring valve.

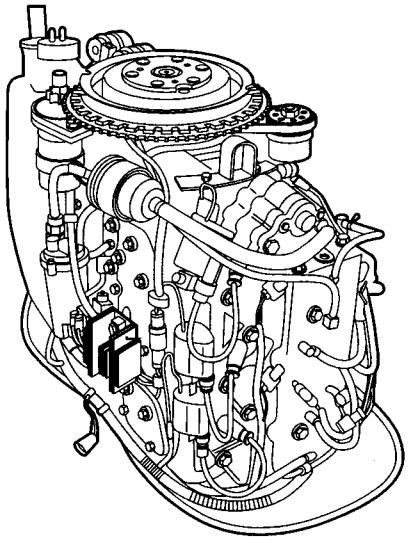
After fuel pressure measurement is complete and the cock lever is set to the B position (open) fuel spurts out from the end of the hose (98AB-5-0200). For this reason it is important to have a drain pan nearby to catch the fuel. Also, be sure to position the hose (98AH-8-1000) leading to the cock lower than the valve position and completely drain any remaining fuel before removing adapter B.



Chapter 4 Power Unit

1. Power Unit

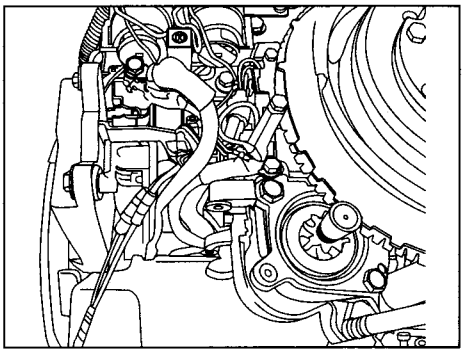




1) Removing Power Unit

Disassemble following components.

- Fuel connecter
- Battery
- Remove throttle cable from advancer arm.
- Remove gearshift cable from gearshift arm.



Disassemble following component.

- Ring gear cover

First disassemble oil tank, then disconnect battery cable.

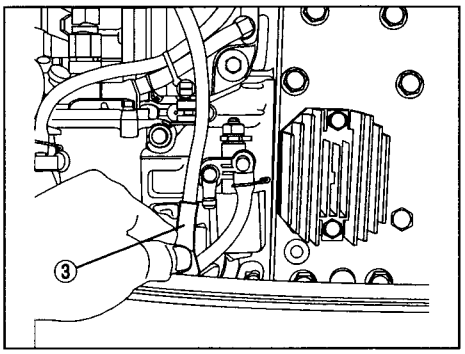
① Battery cable terminal ⊕

② Battery cable terminal ⊖

③ Fuel hose (detach from strainer inlet)

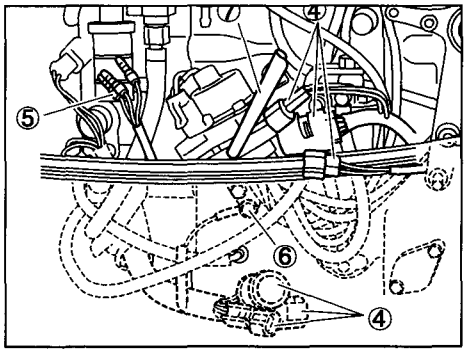
After disassembling above components, temporarily plug the oil tank.

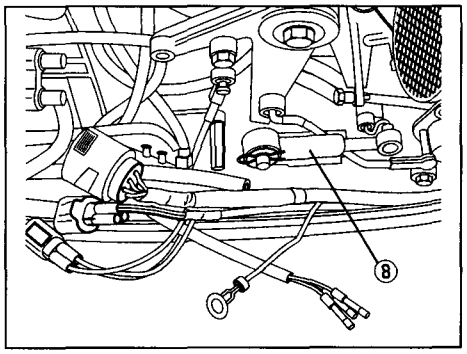
④ Remove PTT wiring from PTT solenoid switch. (blue and green wires).



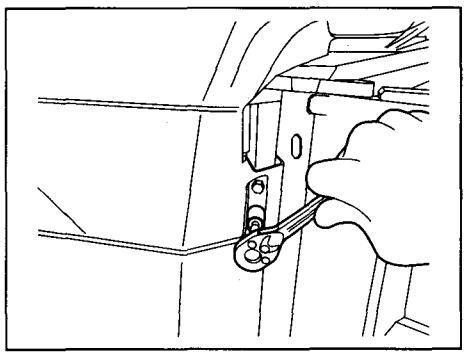
Disassemble following components.

④ Wire harness connectors: 3 locations
⑤ PTT switch connectors: 3 locations
⑥ Remove cylinder lower cover ground connector from cylinder.
⑦ Detach water hose from compressor.
⑧ Remove gearshift rod joint from gearshift lever.



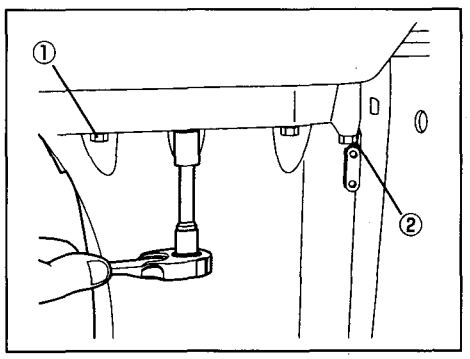


Disassemble apron (splash pan) .

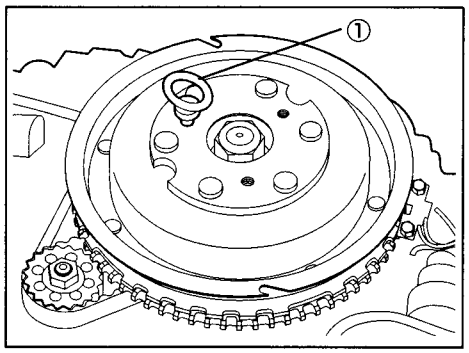


Remove engine mounting bolts.

① Bolt: type H8105 at 6 locations
② Bolt: type H8115 at 2 locations

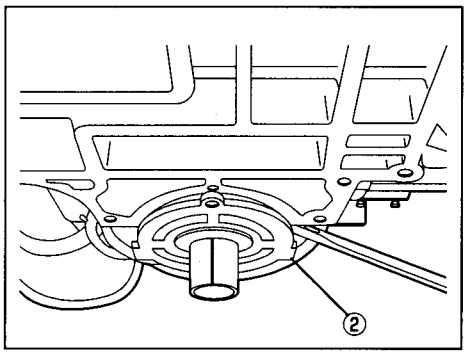


Secure eyebolts ① to the flywheel; then use an appropriate hoist to suspend the power unit while keeping it in the horizontal position.



Suspend slowly, taking care not to catch the power unit on any of the wiring or hoses.

② Remove crankcase head.
Remove with caution by gently inserting a flathead screwdriver in the groove.



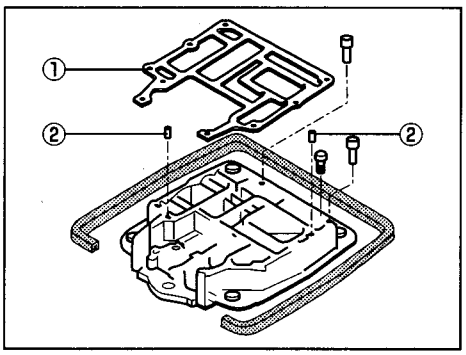
nspect following components.

- Oil seals: at 2 locations
- O-rings
- Replace any damaged components.

2) Installing Power Unit

Install following components.

- Install engine base gasket. ⇨ Replace with new gasket.
- Knock pin

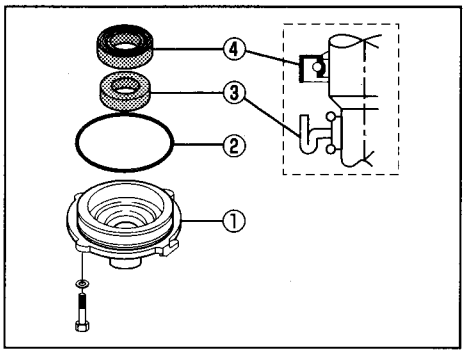


Secure eyebolts to flywheel; then use an appropriate hoist to suspend the power unit while keeping it in the horizontal position.

Apply Three Bond #1107 (Sealant) to both sides of engine base gasket.

With power unit suspended, install the following components.

① Crankcase head
② O-ring
③ Oil seal
④ Oil seal



Apply a sufficient amount of heat-resistant grease (LOR #101) to the entire circumference of the oil seal lip.
Apply a sufficient amount of the recommended grease to the O-rings.
Refer to servicing information (section 3 in chapter 2).

Place power unit on to engine base.

Take care that none of the wiring or hoses gets caught between the power unit and engine base mating faces.

Referring to section (1), assemble power unit in the reverse order of the procedures described there.

2. Other Components

1) Electrical System

Removing CPS *, Flywheel and Alternator

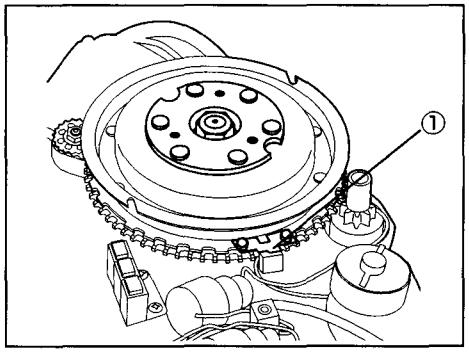
Remove following component.

① CPS

* CPS: abbreviation for crank position sensor.

Flywheel

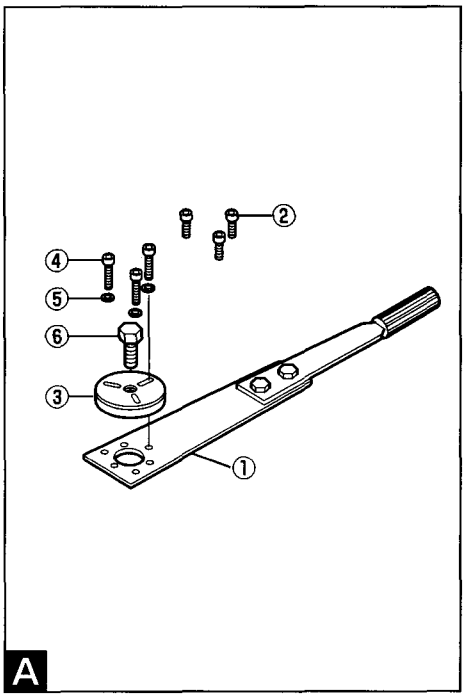
Special tool	● Flywheel puller kit 3C7-72211-1



A : Caution:

- Because the flywheel is screwed in very tight, a special tool is required to remove and replace it. Working without using the special tool poses danger of personal injury or damage to the flywheel or electrical components including the coil.
- When loosening or tightening the flywheel nut, it is necessary to install powerhead on the upper casing or on the powerhead stand (353-72247-1). So as to fix powerhead firmily.

Refer to the table below for specifications for the special tool for use in removing or installing flywheel.



Tool		Part number	Quantity	Inscription
Flywheel puller kit	① to ⑥	3C7-72211-1	1 kit	
Bolt M8 × 25 mm	②	3B7-72786-0	3	
Flywheel puller plate	③	3B7-72781-2	1	FCD
Bolt M8 × 40 mm	④	3B7-72785-0	3	
Washer	⑤	940194-0800	3	
Pressing bolt	⑥	3B7-72784-0	1	FCC

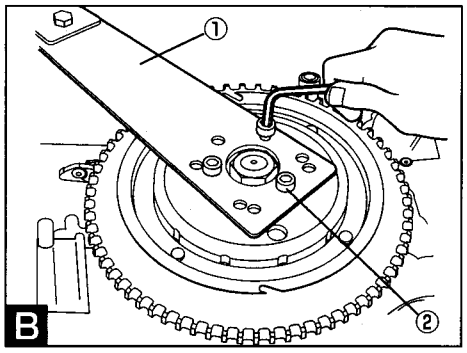
Removing flywheel

Warning:

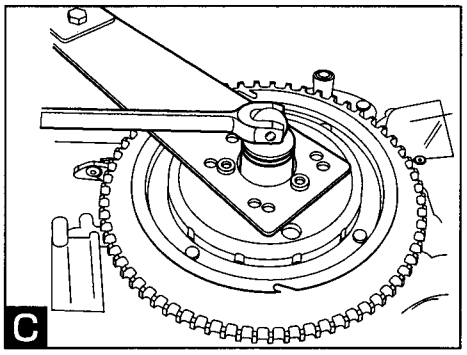
> Be sure to disable the ignition system to ensure that the engine does not accidentally start while flywheel is being removed.

1. Remove ring gear cover.

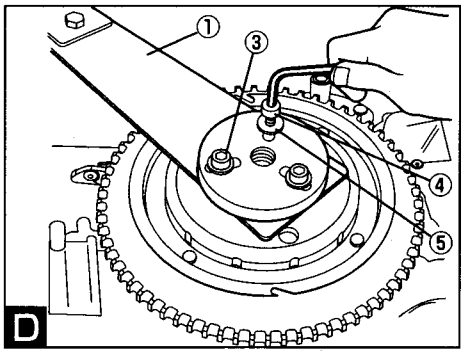
B : 2. Using the bolt ②, attach the puller ① to the flywheel .



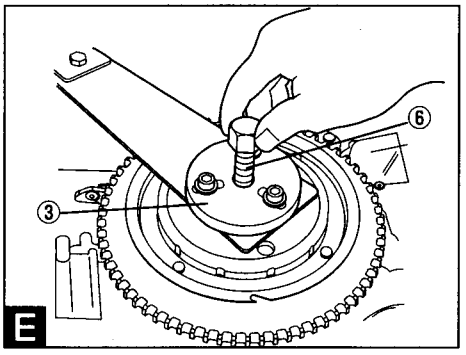
C : 3. Grasp puller handle and remove flywheel nut using a socket wrench.
Note: The nut is a right-hand thread nut.



D : 4. Using the bolt ④ and washer ⑤, attach the puller ① and plate ③ to the flywheel.

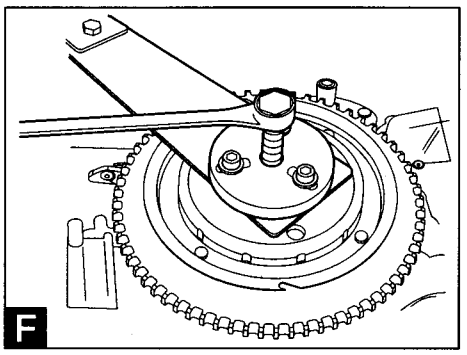


E : 5. Attach the pressing bolt ⑥ to the plate ③.



F : 6. Grasp the puller handle and tighten the pressing bolt until the flywheel separates.
Inspection Procedure

1. Check for cracks or breaks, on the flywheel teeth or for wear or metal deposits on the tapered area.
2. Check for damage to the crankshaft screws or metal deposits on the tapered area.
3. Check for damage to the flywheel key or key grooves.



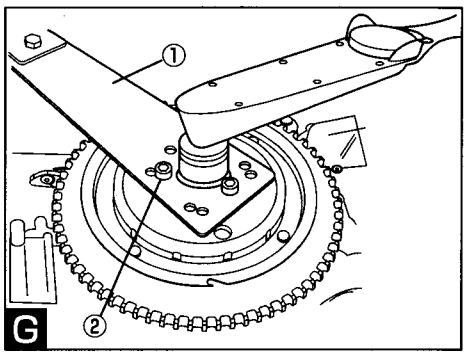
Replacing Flywheel

1. Using a solvent, completely degrease the crankshaft and tapered area of the flywheel.

2. Make sure that the flywheel key is inserted in the crankshaft.

3. Matching up the flywheel key and the flywheel key groove, attach the flywheel to the crankshaft. Then, attach the flywheel washer.

G : 4. Using the bolt ②, attach the puller ① to the flywheel. Grasp the puller handle and tighten the flywheel nut to the specified torque.



Torque
140 – 160 N-m (14 – 16 kg-m) [100 – 116 ft-lb]

5. Install the ring gear and cover.

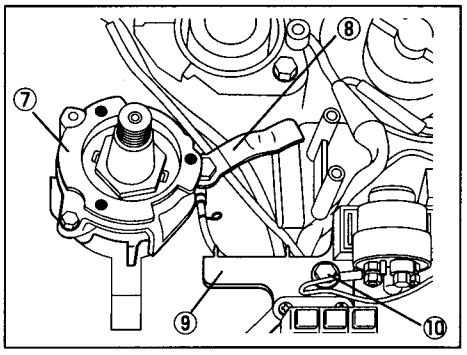
Romove alternator coil and then disassemble following components.

⑦Coil bracket

⑧Cable clamp

⑨Solenoid switch bracket

⑩Bolt: type H625 at 3 locations



Removing ECU*

* ECU is an abbreviation for engine control unit.

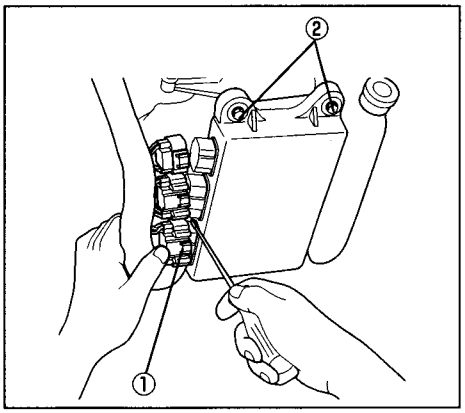
Disassemble following components.

①ECU connector

While pressing down on the hook, remove it by prying gently with a flathead screwdriver.

② Mount bolts: type H630 at 3 locations

Remove bolts from 2 of the upper 3 locations. Then remove the ECU by pulling it upwards.



The collar used on the ECU rubber mount differs in length from the one used on the oil tank.

③Clamp

Removing Harness Assembly

Remove following components.

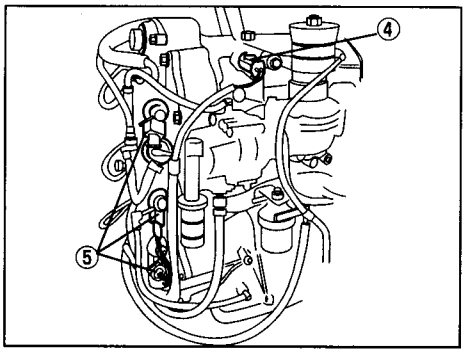
Remove harnesses in order starting from remote control side.

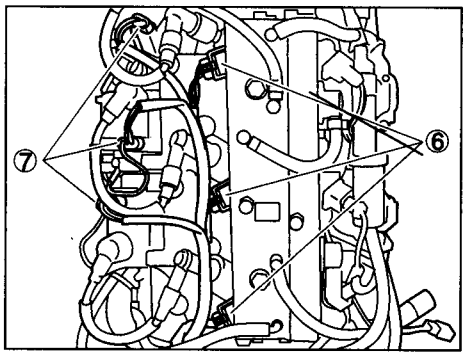
④ Water temperature sensor connector
- Remove by pressing down on hook and pulling out connector.

⑤ Fuel injector connector
- Remove by pressing down on wire hook and pulling out connector.

⑥ Air injector connector
- Remove by pressing open the claws on either side with a flathead screwdriver and pulling out.

⑦ Bullet connectors for ignition coils

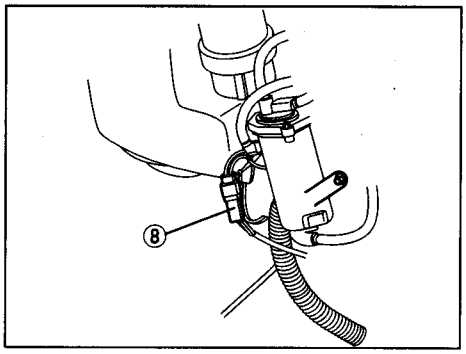




Remove following components.

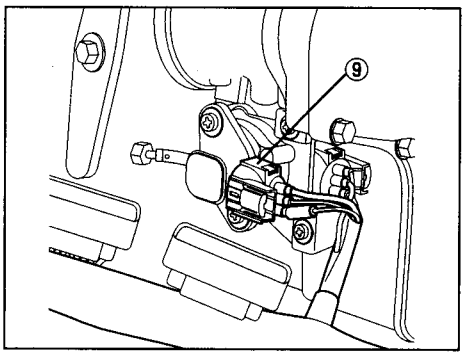
⑧ FFP * connector
- Remove by pressing down on hook and pulling out connector.

* FFP: abbreviation for fuel-feed pump.



⑨ TPS * connector
- Remove by pressing down on hook and pulling out connector.

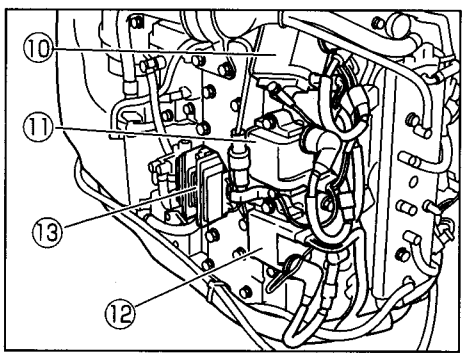
* TPS: abbreviation for throttle position sensor.



Removing Ignition Coil and Rectifier Regulator

Remove following components.

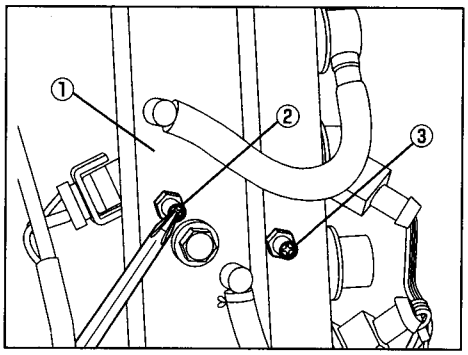
⑩ Ignition coil #1
⑪ Ignition coil #2
⑫ Ignition coil #3
⑬ Rectifier regulator



2) Air Supply System

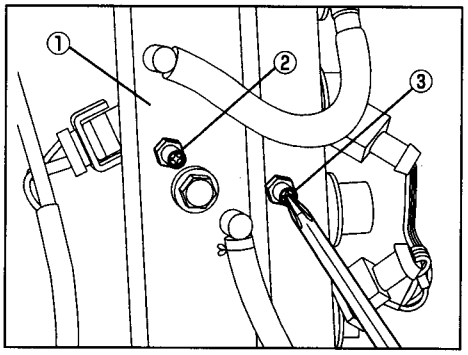
Prior to Removing Peripheral Components

1 Press on the core of the air valve ② located on the air rail ① to release pressure from the air lines.



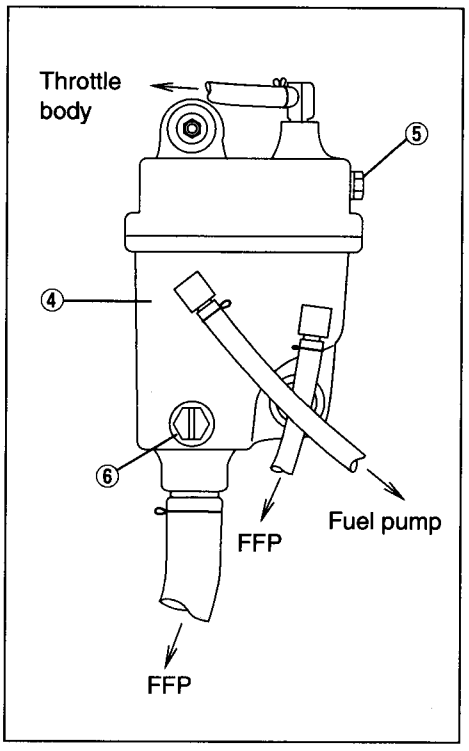
2 Press on the core of the fuel valve ③ located on the air rail ① to release pressure from the fuel lines.

> Be sure to cover the fuel valve with a clean cloth, as fuel will spurt out when pressure is released



3 After loosening the plug ⑤ on the upper section of the vapor separator ④ in order to release pressure, loosen the drain plug ⑥ on the lower section and drain out the fuel.

> Hold a cloth against the drain plug to absorb the fuel as it drains out.



Removing Air Compressor

Remove following components.

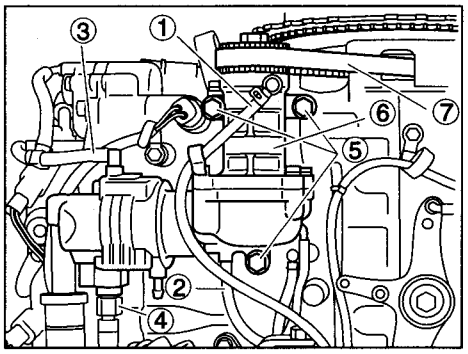
① Detach the oil pipe on the compressor side.

② Detach recirculation pipe on the compressor side.

③ Detach cooling water pipe on compressor side.

④ Remove air hose on compressor side.

⑤ Compressor bolts: at 3 locations



Remove following components.

⑥ Air compressor

> The air compressor is held in place by two knock pins, these should be removed with a gentle tilting motion.

⑦ Drive belt

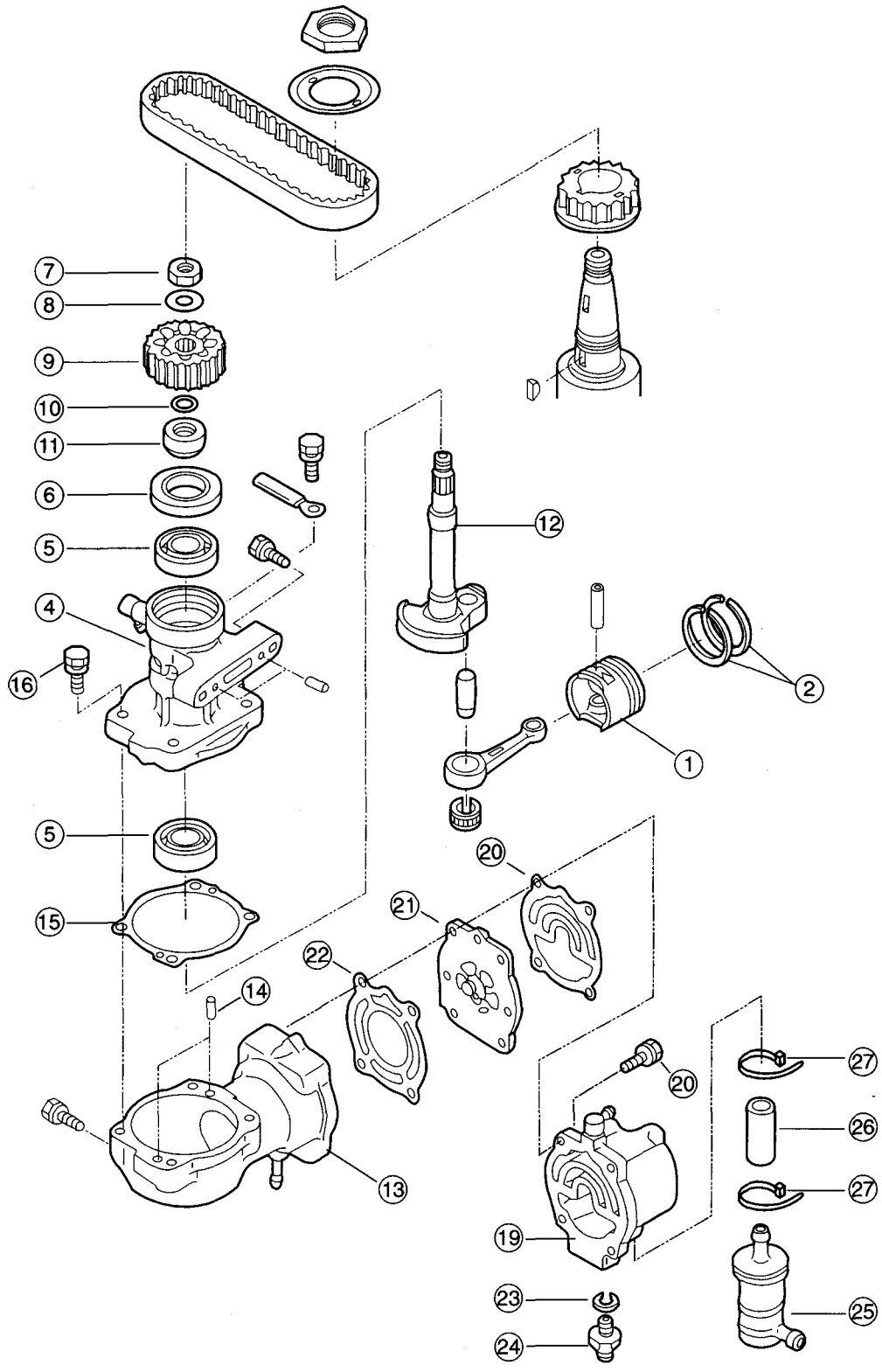
> Be sure to apply markings that identify the top and bottom sides in cases when the drive belt is being reused.

Inspecting Drive Belt

> • Check for wear and damage.
> • Check for missing teeth.
> • Check for presence of oil.
> Replace in cases where even the slightest defect is found.

Air Compressor Configuration

AIR COMPRESSOR



Inspecting Air Compressor

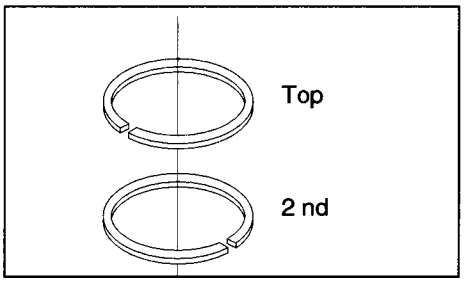
No.	Component	Points to check
①	Piston	• Wear and damage • Check outer diameter of piston • Connecting rod : Confirm smooth operation • Big end bearing : Confirm smooth operation
②	Piston ring	• Measure piston ring end gap
⑤	Bearing	• Rotate by hand and check for excessive play and catching • Replace with new one if defects are found • Be careful not to scratch housing when removing bearing • Apply force to outer race when press fitting bearing
⑥	Oil seal	• Wear and damage • Replace with new one if defects are found
⑩	O-ring	• Scratches and wear
⑪	Collar	• Wear and damage
⑫	Crankshaft	• Wear and damage
⑬	Cylinder	• Sliding surface of piston for scratches • Correct or replace if problems are detected
㉑	Reed valve	• Wear and damage • Reed valve clearance: 0.2 mm (0.008 in) or less • Correct or replace if problems are detected • Reed valve stopper • Wear and damage • Valve stopper height: 2 mm (0.08 in) • Correct or replace if problems are detected
㉕	Air filter	• Confirm whether dirty or clogged • Replace with new one if dirty

Assembling Compressor

● Assembling Piston

Assemble following components.

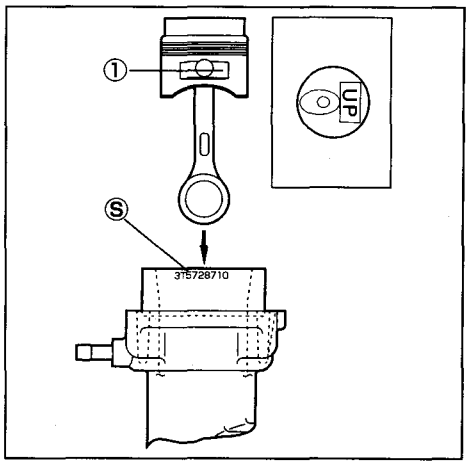
● Piston rings



①Position the "UP" mark on the piston so that it faces the pulley and insert the piston (with connecting rod attached) into the cylinder.

Special tool	Ⓢ Piston slider 3T5-72871-0

Grease Application Points*	● Outer circumference of piston ● Inner surface of compressor cylinder ● Inner surface of piston slider



* Mix heat-resistant LOR#101 and genuine engine oil at a 1:3 ratio.

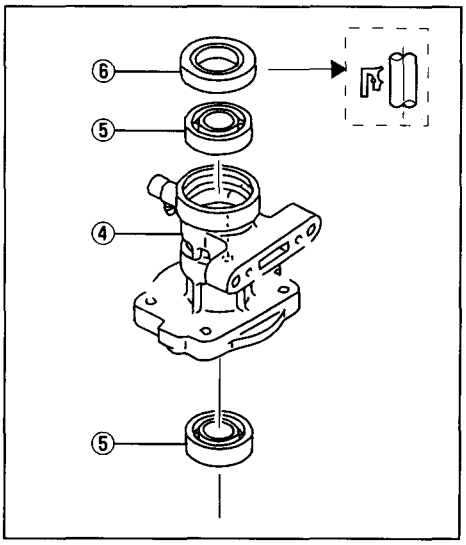
Assembling Housing

Applying pressure, press fit following components into the housing ④.

⑤Bearing

⑥Oil seal

- When press fitting the bearing ⑤ push around the circumference of the outer rail.
- Take care that the oil seal ⑥ is installed in right direction. Assemble following components.



Assemble following components.

⑦Nut

⑧Washer 10.5 – 20 – 3.2

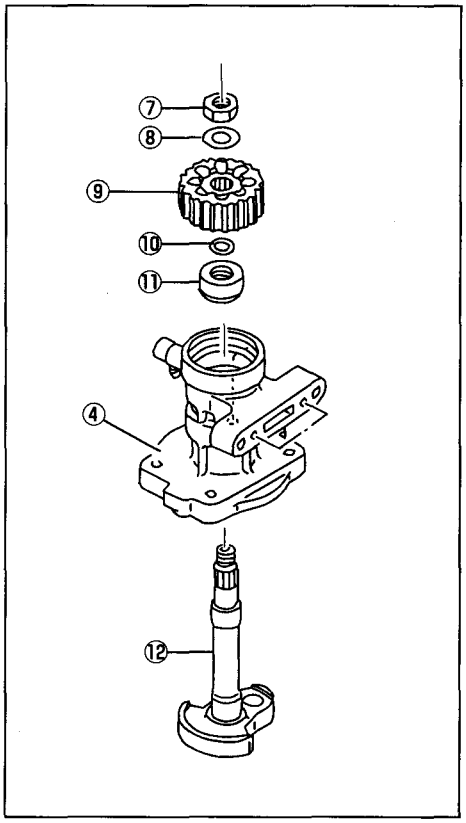
⑨Pulley

⑩O-ring

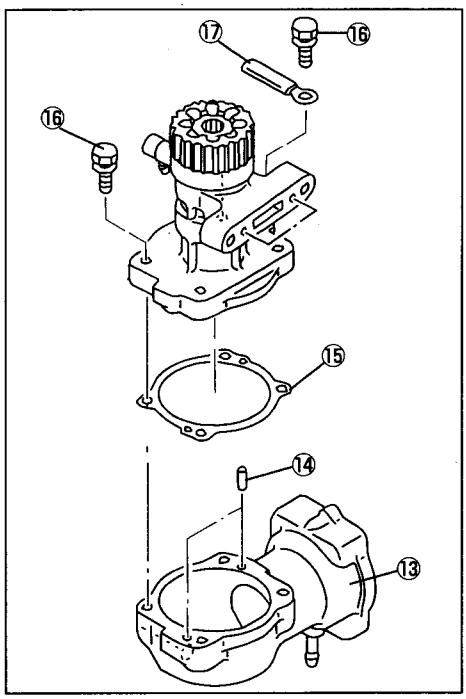
⑪Collar

⑫Crankshaft

- To tighten the nut ⑦, secure the crankshaft ⑫ in place.
  Torque: 44 – 49 N-m (4.5 – 5.0 kg-m) [32 – 36 ft-lb]



Grease Application Points	Apply genuine engine oil to the bearing ⑤and the inner surface of the O-ring⑩.
	Apply LOR#101 to the oil seal ⑥.



Assemble following components into the ⑬ cylinder.

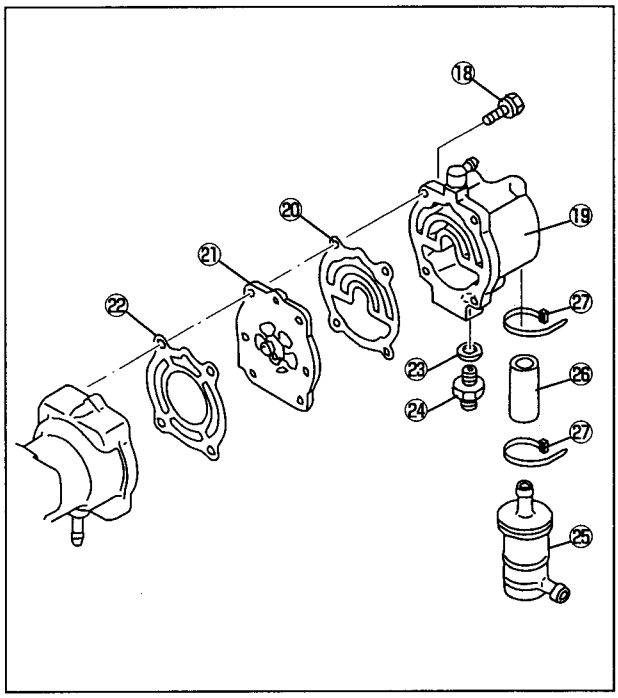
⑭ Knock pins at 2 locations

⑮ Gasket ⇨ Replace with new one.

⑯ Bolt: type H625 at 4 locations

⑰ Cramp at 1 location

- Apply genuine engine oil to the big end of the connecting rod.
- Insert the crank pin in the big end of the connecting rod and install by gently moving the crankshaft.



Assembling cylinder head.

Assemble following components.

⑱ Bolt: type H630 at 4 locations

⑲ Cylinder head

⑳ Compreeor head gasket ⇨ Replace with new one.

㉑ Reed valve assembly

㉒ Valve seat gasket ⇨ Replace with new one.

- Take care not to confuse the top and bottom or front and rear of the reed valve assembly.
- Take care not to confuse the compressor head gasket and valve seat gasket.
- Be sure to completely degrease the mating surfaces of the reed valve sheet and gasket.

⑱ Torque	7.8 – 9.8 N-m (0.8 – 1.0 kg-m) [5.8 – 7.2 ft-lb]

Attach following components to the head ⑲.

㉓ Metal washer

㉔ Hose joint adaptor

㉕ Air filter

㉖ Hose

㉗ Lead wire band: 2 locations

- ㉕ Align the air filter intake in the direction so that the intake towards to engine side as shown in the figure.
- ㉔ Apply Thread Lock to the hose joint adaptor screw area.

㉔ Torque	14 – 16 N-m (1.4 – 1.6 kg-m) [10 – 12 ft-lb]

Disassembling Air Rail

Remove following components.

① Fuel hose assembly and nipples

Disassemble and pull out the stopper plate.

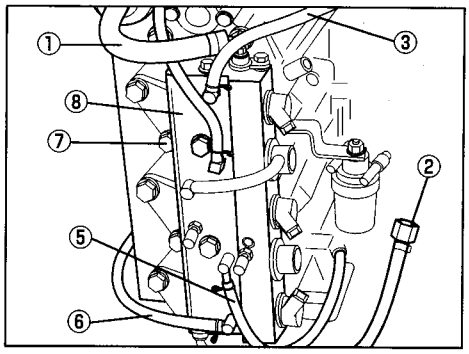
② Air hose assembly
Disconnect the hose joint on the compressor side.

③ Cooling water outlet hose

④ Fuel return hose

⑤ Air discharge hose

⑥ Cooling water inlet hose



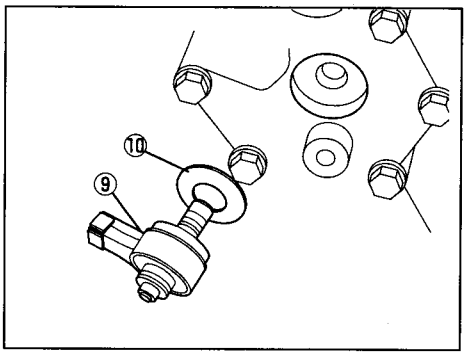
Remove following components.

⑦ Bolt: type H865 at 2 locations

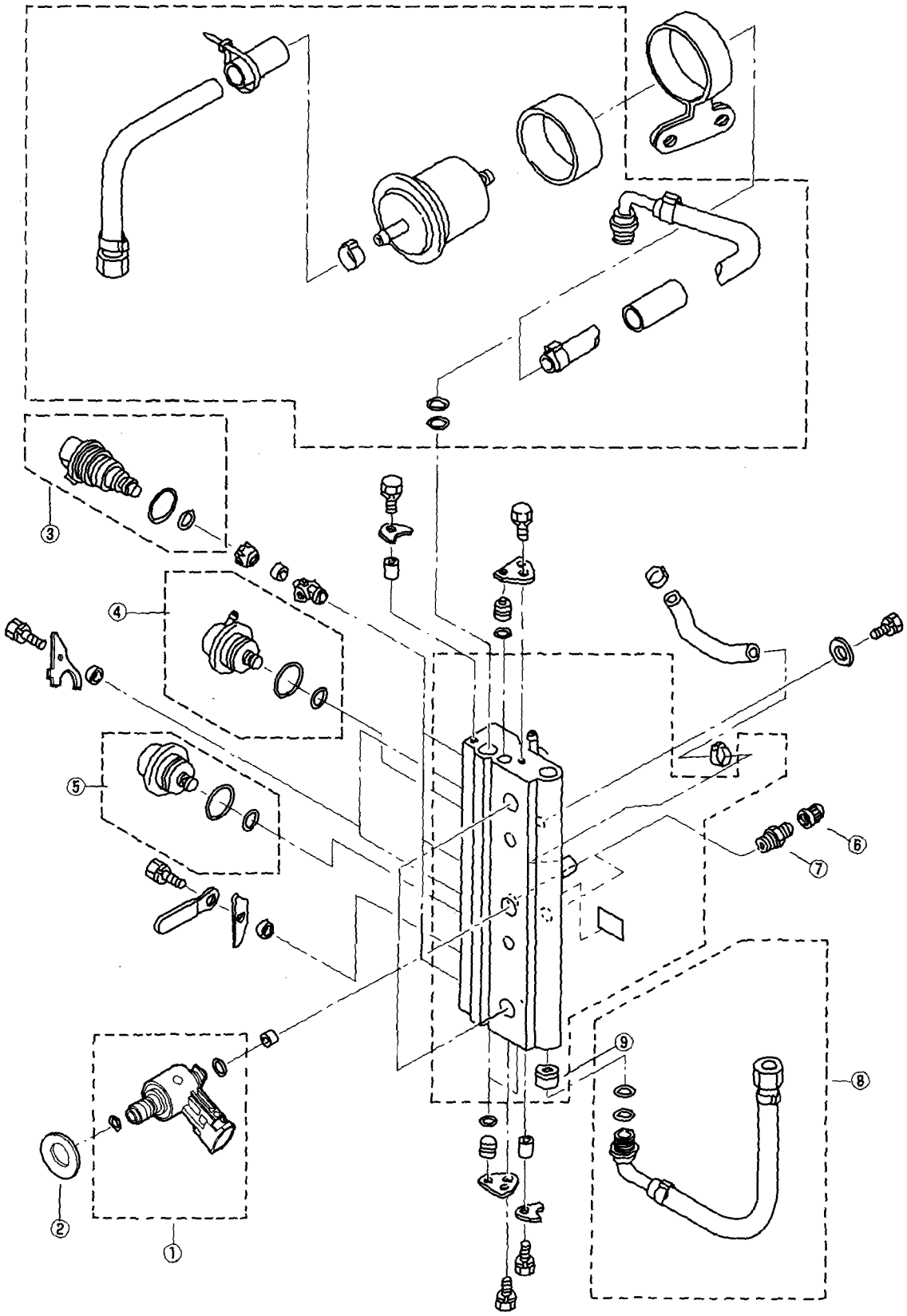
⑧ Air rail assembly

⑨ Air injector: at 3 locations

⑩ Air injector set piece: at 3 locations



Air Rail Assembly Configuration



Inspecting Air Rail

No.	Components	Points to check
1	Air injector	• Wear, deterioration and damage on O-rings and seal rings. Replace with new ones if problems are detected. • Remove any carbon build-up on tip using wire brush. • Refer to chapter 2 for electrical system inspection.
2	Set piece for air injector	• Wear, deformation and damage.
3	Fuel injector	• Wear, deterioration and damage on O-rings. Replace with new ones if problems are detected. • Refer to chapter 2 for electrical system inspection.
4	Fuel regulator	• Wear, deterioration and damage on O-rings. Replace with new ones if problems are detected. • Clogged regulator strainer. Clean if foreign matter is present. • Wear, deterioration and damage on pressure hose. Replace with new one if problems are detected.
5	Air regulator	• Wear, deterioration and damage on O-rings. Replace with new ones if problems are detected. • Clogged regulator strainer. Clean if foreign matter is present.
6	Valve core (part of valve assembly)	• Wear, deterioration and damage on rubber seal. Replace with new ones if problems are detected.
7	Plug	• Wear, deterioration and damage on O-rings. Replace with new ones if problems are detected.
8	Air hose assembly	• Wear and deterioration on hoses and O-rings. Replace with new ones if problems are detected.
9	Orifice (press fit to air rail)	• Foreign matter and clogging. Clean if foreign matter is present.

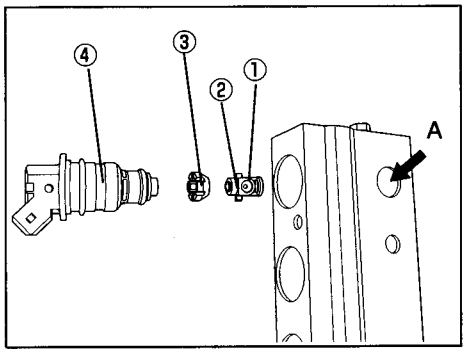
Assembling Air Rail

• Apply genunie engine oil to the O-rings.

Assemble following components.

① Insert

② Seal ring



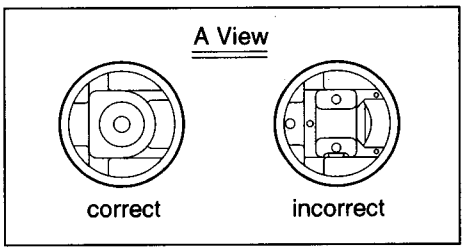
> • Take care to install with insert ① facing in the proper direction as shown in View A to the right.

③ Adapter

④ Fuel injector

> • Be sure to use the special tool when installing the O rings in the fuel injector.

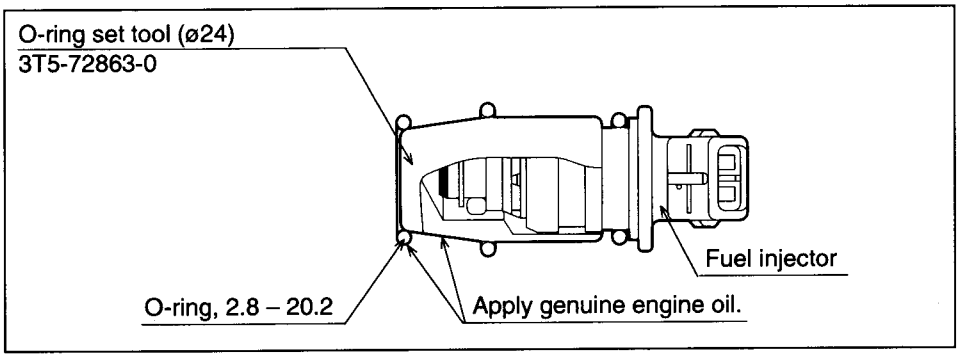
Special tool	O-ring Setting Tool*
	3T5-72870-0



Installing O-ring, 2.8 – 20.2 (3T5-10304-0) on the fuel injector.

Apply genuine engine oil to the O-ring set tool and the O-ring.

Position the O-ring set tool and slide the O-ring into position from above.

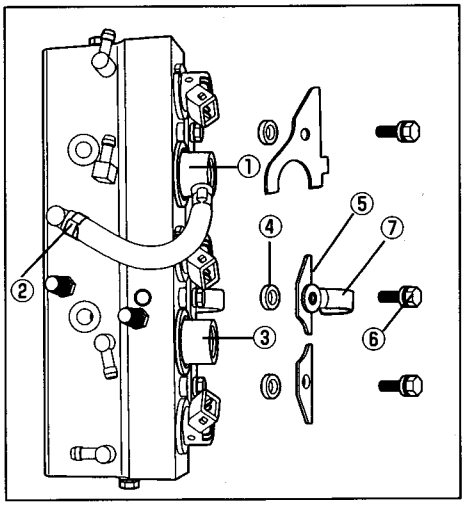


Assemble following components.

① Fuel regulator

② Hose clamp ⇨ Replace with new one.

Special tool	Crimping pliers*
	3T5-72864-0



*: Refer to Chapter 2-5 in chapter.

③ Air regulator

④ Collar

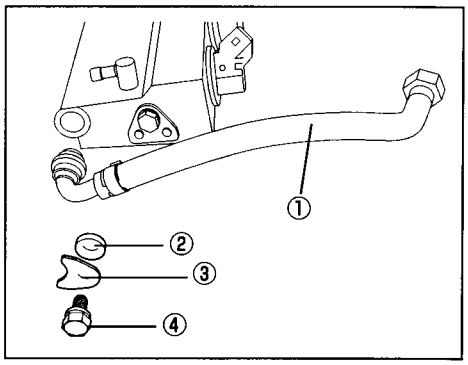
⑤ Plate

⑥ Bolt

⑦ Clamp

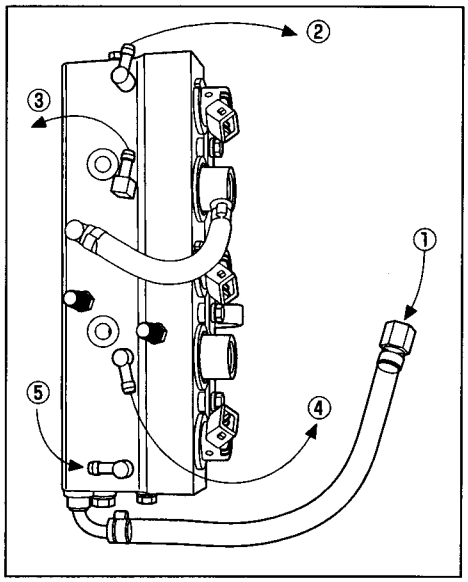
Assemble~components

① Air hose assembly
② Collar
③ Nipple plate
④ Bolt



Installing Hoses (See figure)

① From air compressor (air)
② To air compressor (cooling water)
③ To FFP (fuel)
④ To cylinder (air)
⑤ From exhaust cover (cooling water)

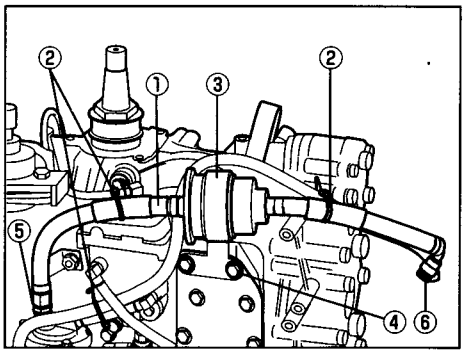


3) Fuel System

Disassembling Fuel Hose Assembly

Remove following components.

① Fuel hose assembly
② Lead wire band: at 2 locations
③ High-pressure fuel filter
④ Bolts: at 2 locations
⑤ Connections to FFP
⑥ Connections to air rail



Hold a cloth in place to absorb spilling fuel when removing components ⑤ and ⑥.

Assembling Fuel and Air Assembly

Assemble in the reverse order of disassembly.

- Bolt: type H630 at 2 locations

Torque
7.8 – 9.8 N-m (0.8 – 1.0 kg-m) [5.8 – 7.2 ft-lb]

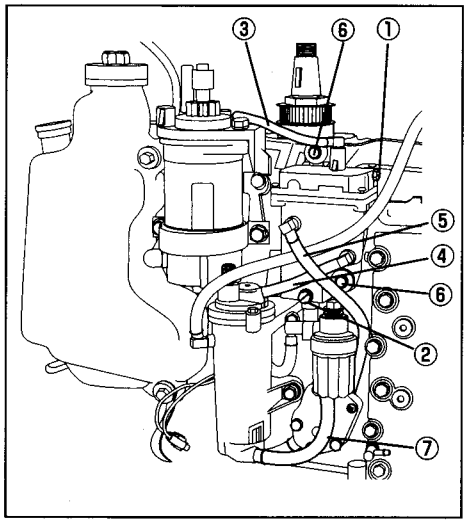
Disassembling Vapor Separator

Drain fuel from vapor separator using following procedures.

① Loosen the air vent screw.

② Loosen the drain screw.

Hold a cloth in place to absorb spilling fuel when loosening ②.



Detach following hoses.

③ Vapor discharge hose: vapor separator ⇨ throttle body

④ Vapor return hose: FFP ⇨ vapor separator

⑤ Fuel inlet hose: fuel pump ⇨ vapor separator

Hold a cloth in place to absorb spilling fuel when detaching hose ④.

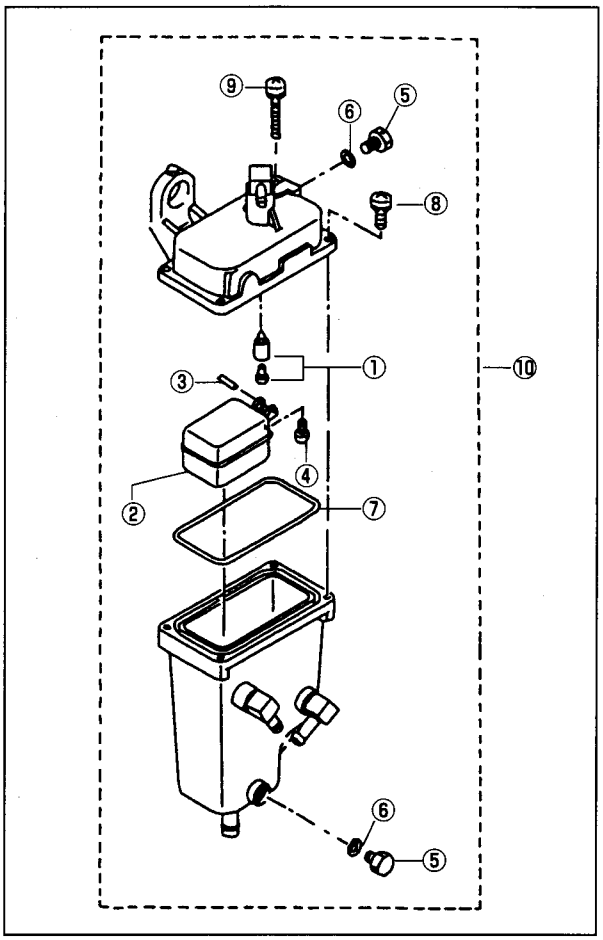
Remove following components.

⑥ Bolt: type H630 at 2 locations

⑦ Fuel outlet hose ⇨ vapor separator ⇨ FFP

Hold a container in place to catch spilling fuel when removing hose ⑦.

Vapor Separator Configuration



Inspecting Vapor Separator

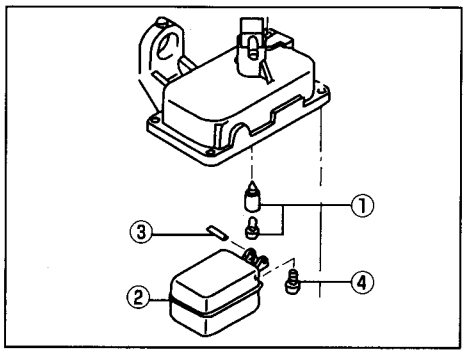
No.	Components	Points to check
①	Float valve	• Wear, deterioration and damage.
②	Float	• Presence of cracks. • Contamination by fuel.
⑥, ⑦	O-rings	• Wear, deterioration and damage.
⑩	Vapor separator assembly	• Contaminants attached to nipple openings. • Damage or cracks on the body.

Assembling Vapor Separator

Assemble following components.

① Float valve
② Float
③ Float arm pin
④ Screw: Pan 408

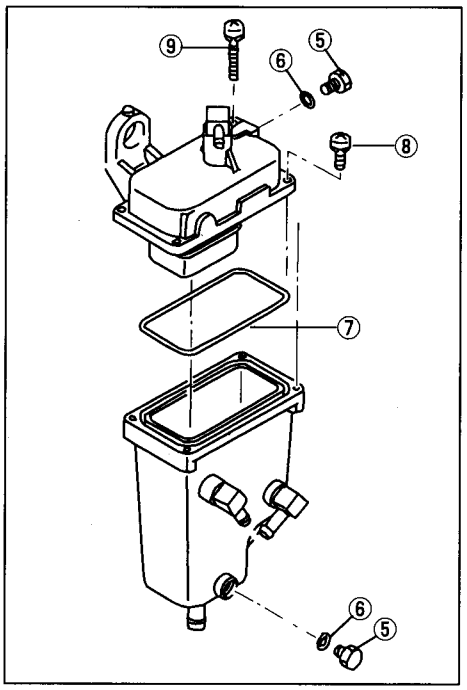
Torque	1.3 – 1.8 N-m (0.13 – 0.18 kg-m) [0.9 –1.3 ft-lb]



⑤ Drain screw: at 2 locations
⑥ O-ring: at 2 locations

Torque
1.3 – 1.8 N-m (0.13 – 0.18 kg-m) [0.9 – 1.3 ft-lb]

Application	Apply genuine engine oil to the O-ring ⑥.



⑦ O-ring
⑧ Screw: Pan 414
⑨ Screw: Pan 430

Torque
1.3 – 1.8 N-m (0.13 – 0.18 kg-m) [0.9 – 1.3 ft-lb]

Application	Apply genuine engine oil to the O-ring ⑦

Assembling Vapor Separator assembly

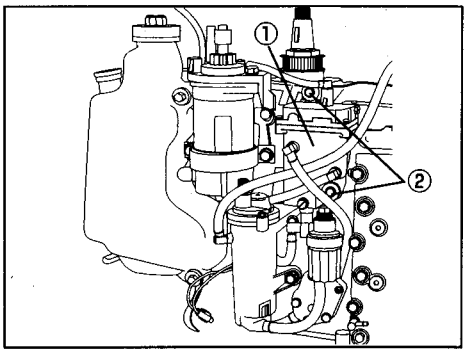
Assemble in the reverse order of disassembly.

① Vapor separator assembly

② Bolt: type H630 at 2 locations

- Washers: at 4 locations
- Collars: at 2 locations
- Rubber mounts: at 2 locations

②Torque
4.6 – 6.3 N-m (0.47 – 0.64 kg-m) [3.4 – 4.6 ft-lb]



Disassembling FFP Assembly *

*** FFP:** abbreviation for fuel-feed pump.

Remove following components.

① FFP connector

② Hose joint: Fuel hose assembly

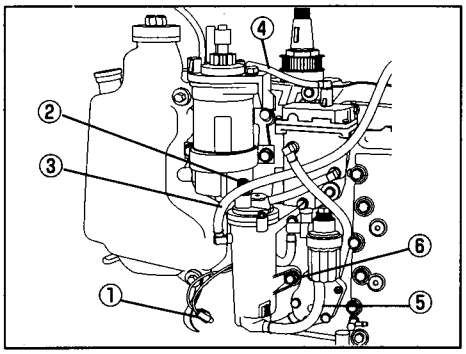
③ Fuel return hose: Air rail ⇨ FFP

④ Vapor return hose: FFP ⇨ Vapor Separator

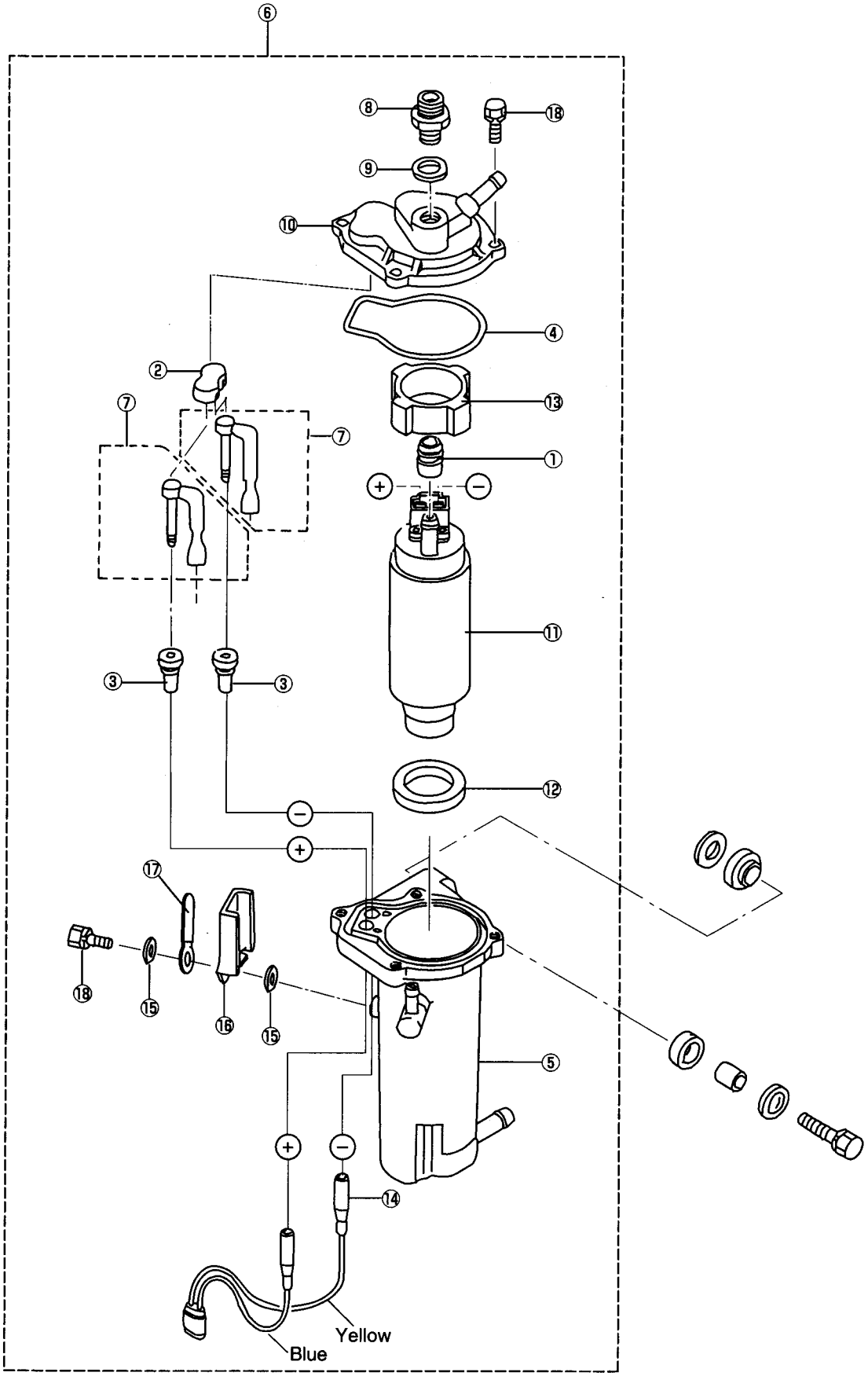
⑤ Fuel hose: Vapor Separator ⇨ FFP

⑥ Bolt: type H630 at 2 locations

Hold a cloth in place to absorb spilling fuel when detaching the hoses.



FFP Configuration



Inspecting FFP (Fuel Feed Pump)

No.	Components	Points to check
①	Pipe grommet	• Wear, deterioration and damage. Replace if defects are detected.
②	Upper cable terminal grommet	
③	Cable terminal grommet	
④	O-rings	
⑤	FFP Case	• Clogging by foreign matter and water.
⑥	FFP assembly	• Dirt and foreign matter on lower intake port. • Cracks and damage on upper and lower plastic sections.
⑦	Cable terminal assembly ⊕ ⊖	• Damage on flat terminal and plug terminal. • Damage on wiring. • Scratches or bending on terminals. • Replace if defects are detected.

Assembling FFP

Assemble following components.

⑧ Hose joint adapter

Torque	14 – 16 N-m (1.4 – 1.6 kg-m) [10 – 12 ft-lb]
Adhesive to apply after degreasing thread area: Three Bond 1342	

⑨ Metal washers

Always replace after disassembly.

⑩ Upper case

Assemble following components.

① Pipe grommet

⑪ FFP

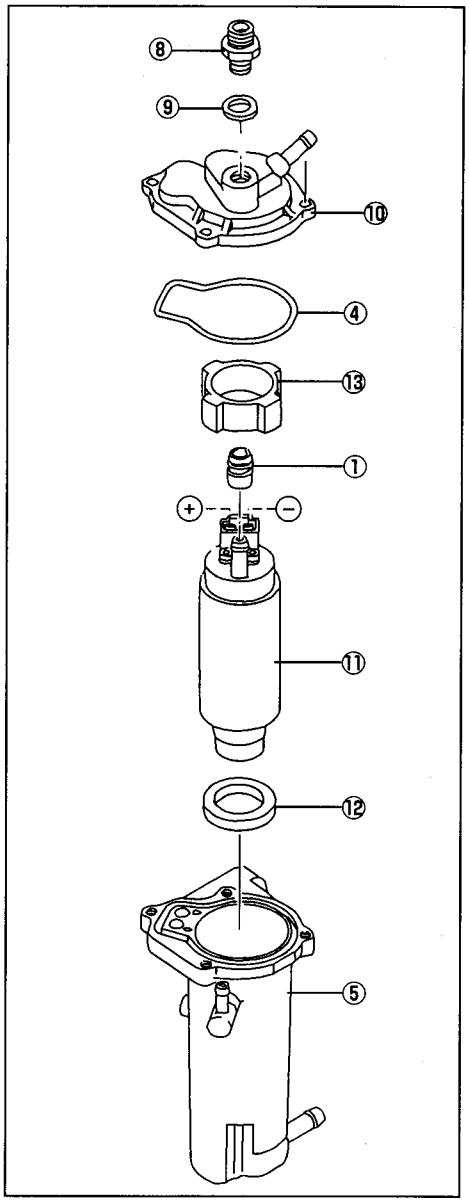
⑫ Lower grommet

Grease to apply	① and ⑫ Genuine engine oil

⑤ FFP case

⑩ Upper case

The position for ⑤ in relation to ⑪ is shown in the figure to the right. Place ⑩ on top and check position.



Assemble following components.

⑬ Upper grommet

③ Cable terminal grommet

Grease to apply	③ and ⑬ Genuine engine oil

⑦ Cable terminal ⊖ black cable

⑦ Cable terminal ⊕ Red cable

Grease to apply	terminals ⑦ Genuine engineoil

Connect to the flat connector cable terminal by lining up with the mark(⊕ or ⊖)on the FFP.

Assemble following components.

⑭ FFP cable

Attach cable to terminal by pressing firmly down from above.

⑮ Spacer (washer) : W5

⑯ Cable covering

⑰ Cramp

Take care not to pinch cable when closing cover.

⑱ Bolt: type H512

Torque
2.6 – 3.5 N-m (0.27 – 0.36 kg-m) [2.0 – 2.6 ft-lb]

Assemble following components.

② Cable terminal upper grommet

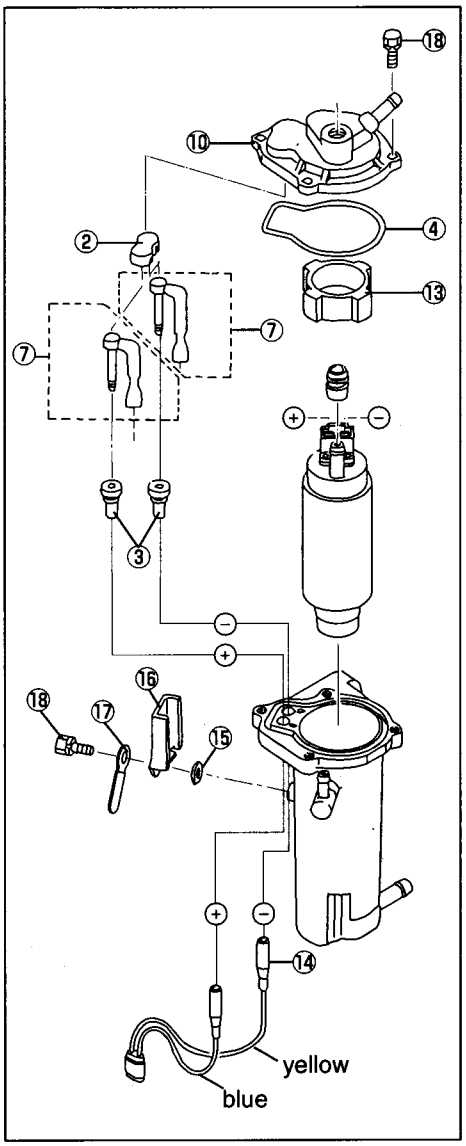
④ Seal ring (O-ring)

Grease to apply:	② and ④ Genuine engine oil

⑩ Upper case

⑱ Bolt: type H518 at 4 locations

Torque
2.6 – 3.5 N-m (0.27 – 0.36 kg-m) [2.0 – 2.6 ft-lb]



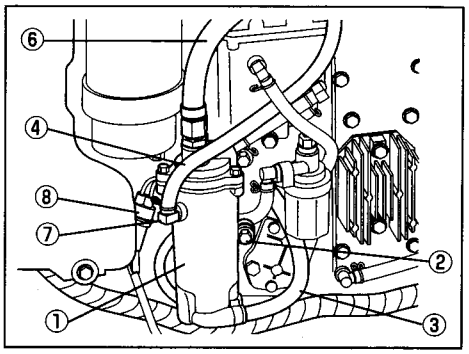
Installing FFP Assembly on Cylinder

Install following components.

① FFP assembly

② Bolt: type H630 at 2 locations

- Washer
- Rubber mounts
- Collars



Torque
4.6 – 6.3 N-m (0.47 – 0.64 kg-m) [3.4 – 4.6 ft-lb]

③ Fuel hose

④ Fuel return hose

⑤ Vapor return hose

Install hose and apply clip.

⑥ High-pressure fuel hose

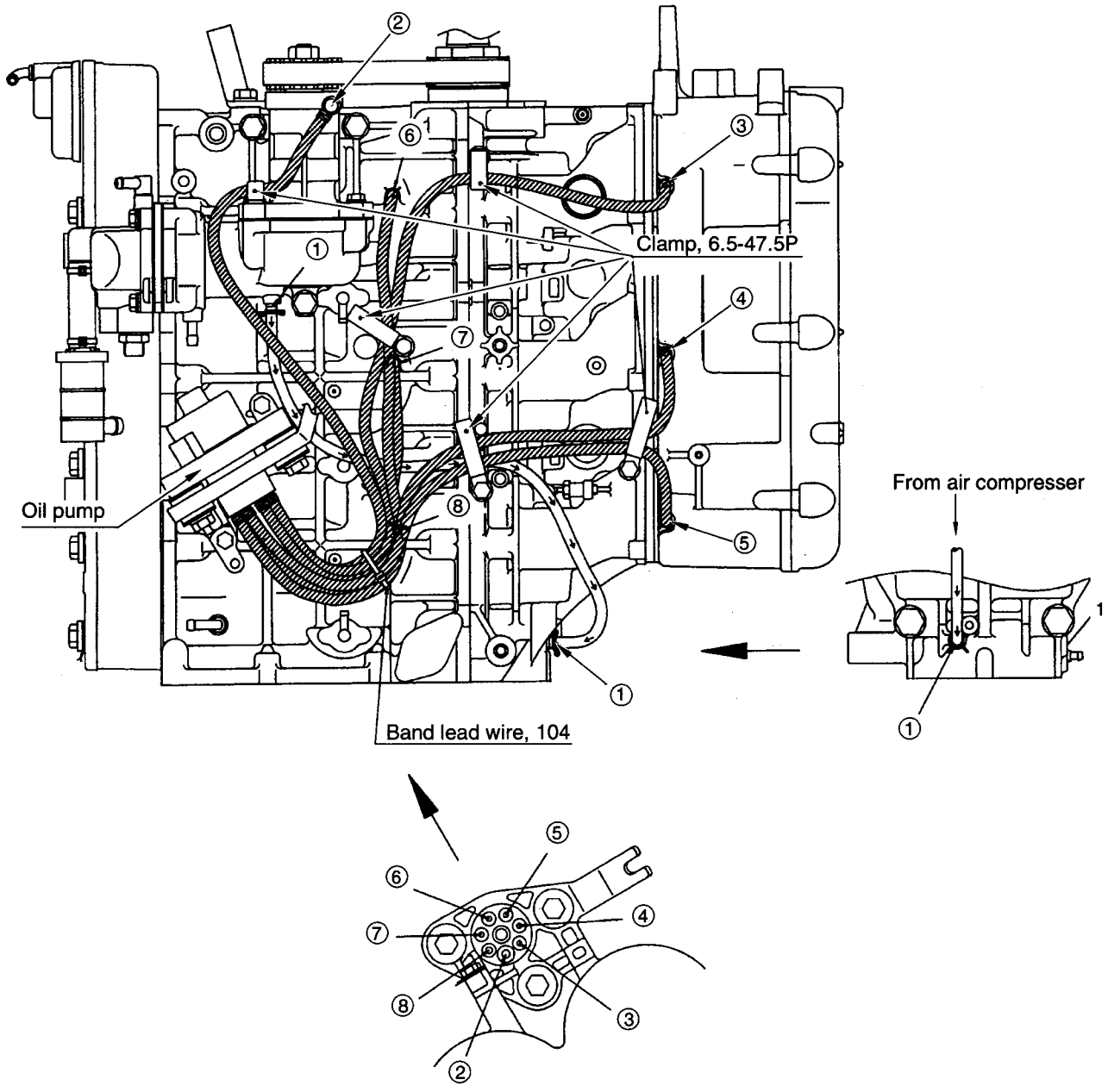
Torque
14 – 16 N-m (1.4 – 1.6 kg-m) [10 – 12 ft-lb]

⑦ FFP cable connector (cable assembly)

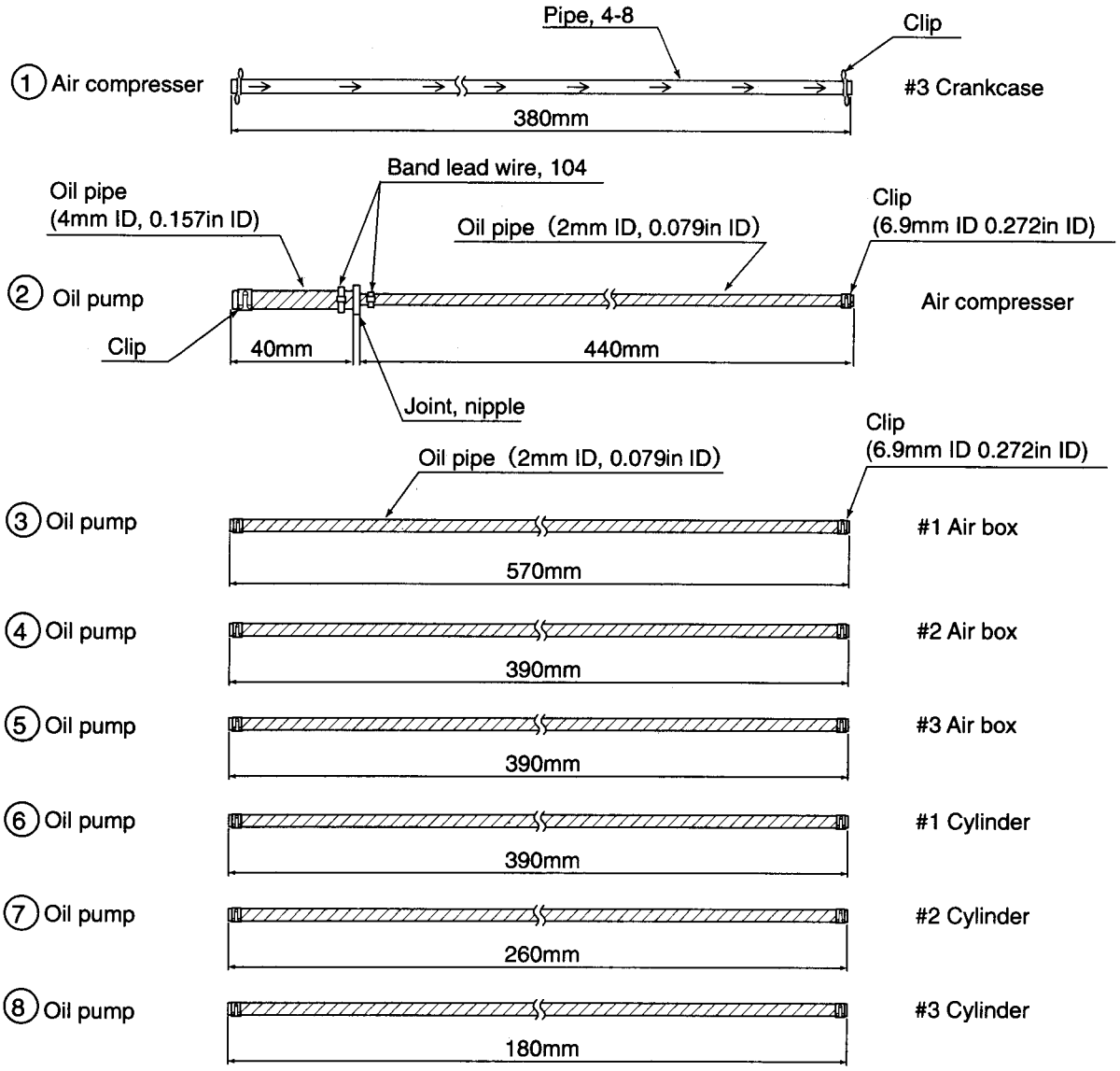
Secure the FFP cable connector using the FFP assembly clamp.

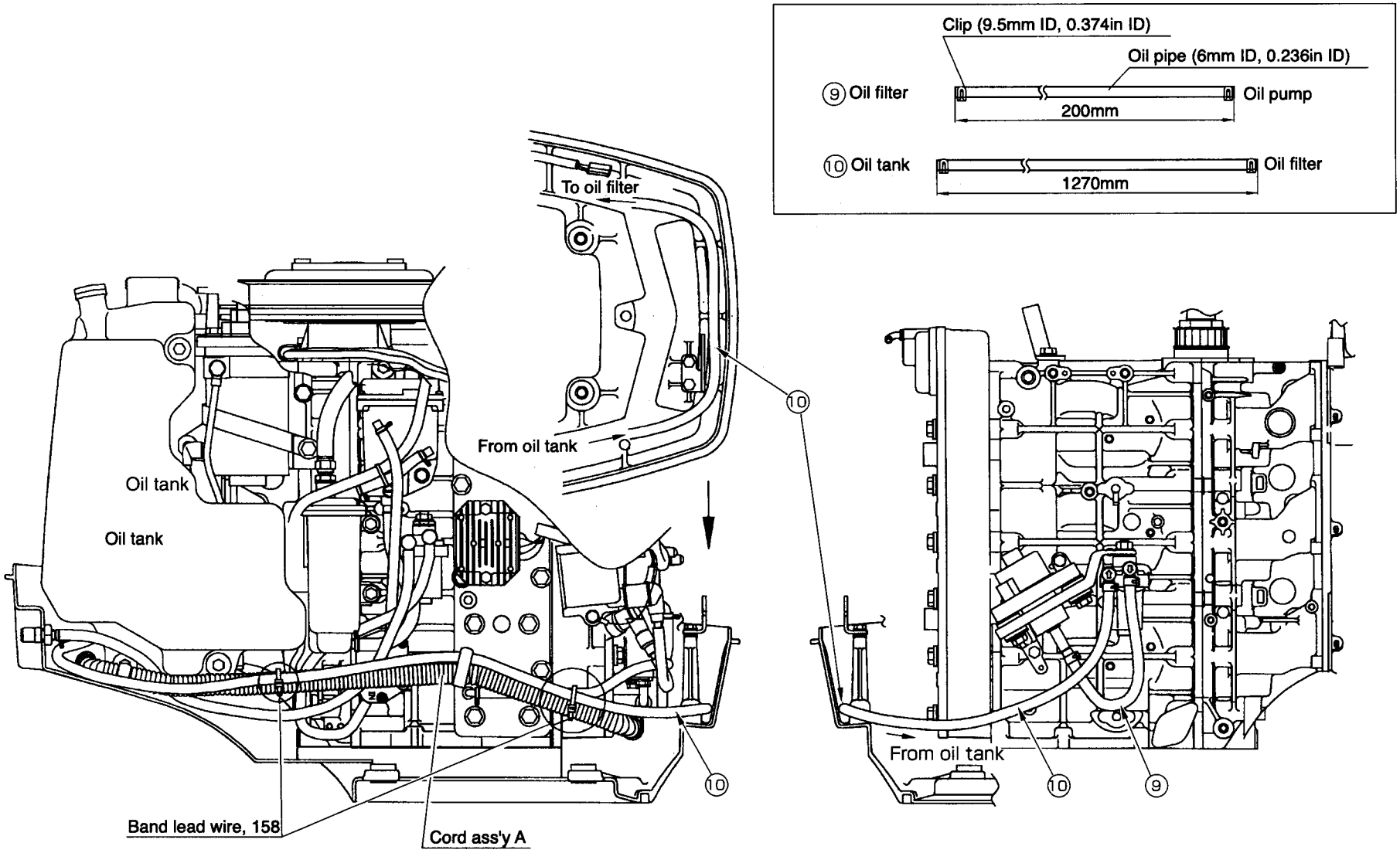
4) Oil pump / Oil line

Oil pipe removal

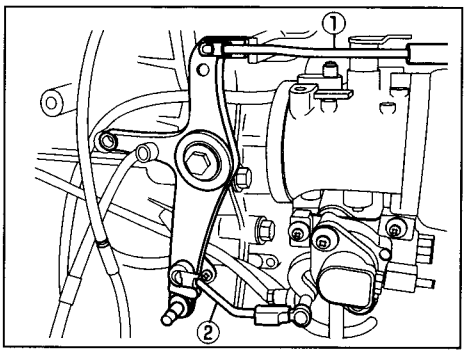


Oil pipe


Pipe, 4-8
Clip
① Air compresser
#3 Crankcase
380mm
Band lead wire, 104
Oil pipe
(4mm ID, 0.157in ID)
Oil pipe (2mm ID, 0.079in ID)
Clip
(6.9mm ID 0.272in ID)
② Oil pump
Air compresser
Clip
40mm
440mm
Joint, nipple
Clip
(6.9mm ID 0.272in ID)
Oil pipe (2mm ID, 0.079in ID)
③ Oil pump
#1 Air box
570mm
④ Oil pump
#2 Air box
390mm
⑤ Oil pump
#3 Air box
390mm
⑥ Oil pump
#1 Cylinder
390mm
⑦ Oil pump
#2 Cylinder
260mm
⑧ Oil pump
#3 Cylinder
180mm


Clip (9.5mm ID, 0.374in ID)
Oil pipe (6mm ID, 0.236in ID)
⑨ Oil filter
Oil pump
200mm
⑩ Oil tank
Oil filter
1270mm
To oil filter
From oil tank
Oil tank
Oil tank
⑩
Band lead wire, 158
Cord ass'y A
From oil tank
⑩
⑨

5) Throttle Machanism



Disassembling Advancer Arm

Disassemble following components.

① Throttle link rod

② TPS* link rod

* TPS: abbreviation for throttle position sensor

> Prior to removing ①, ② and ③ it will be necessary to disconnect the rod snaps from the advancer arm.

> Take care not to apply any force to the corresponding arm when disconnecting the ball joint.

③Bolt: type H635, including washers and collar

④ Advancer arm

⑤ Washer (stainless steel)

⑥ Washer (plastics)

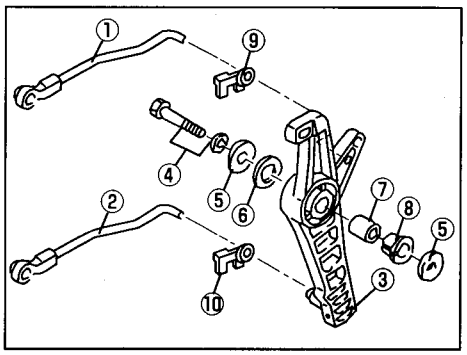
⑦ Collar

⑧ Bushing

Inspect following components.

① Throttle link rod

② TPS link rod



> • Check ball joint cap for wear and damage.
> • Check for bent link rods.

Inspect following components.

⑨ Throttle link rod snap

⑩ TPS link rod snap

> Check for wear and damage.

Assembling Advancer Arm

Assemble following components.

- Advancer arm
- Throttle link rod
- TPS link rod
- Bolt: type H835
- Washers
- Collar
- Bushing

Install following components.

- Throttle link ball joint cap
- TPS link ball joint cap

Install ball joint and cap by hand using a pinching motion.

Take care not to apply force to the TPS lever.

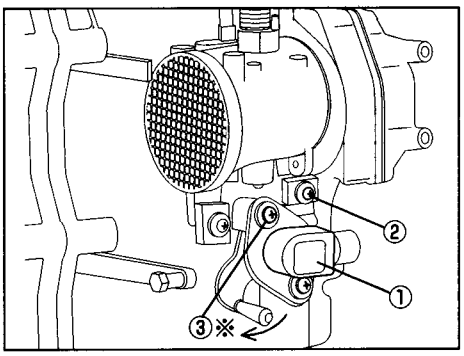
Disassembling TPS

Disassemble following components.

① TPS assembly

② Screw: type 420 panhead at 3 locations

- Washers (3)
- Collars (3)
- Mount rubber (3)



Remove following component.

① TPS assembly

• Confirm whether the arm springs back in the ※ direction • Confirm that arm moves smoothly. • Check the connectors for damage.

• Never loosen small screw ③ that s locked in place using paint. • Doing so will change the 0 point setting, making it unusable.

Refer to chapter 5 when conducting electrical inspections.

Assembling TPS

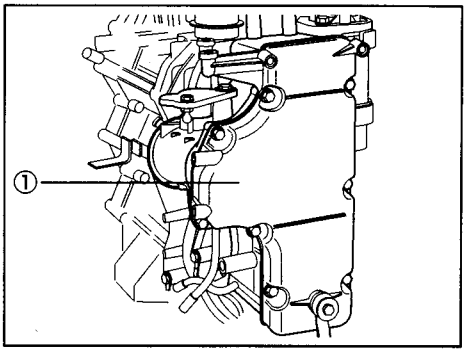
Assemble in the reverse order of disassembly.

Disassembling Air Box, Reed valve assembly, and Throttle Body

Disassemble following components.

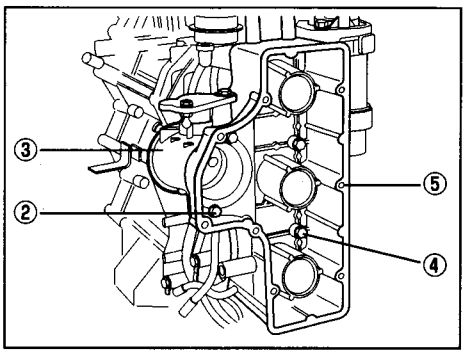
- Bolt: type H625 at 8 locations
- Clamp

① Air box cover



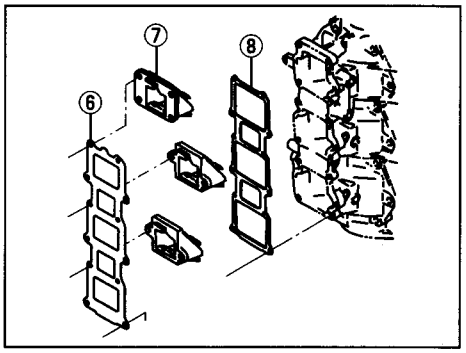
Remove following components.

② Bolt: type H625 at 2 locations
③ Throttle body assembly
④ Bolt: type H625 at 12 locations
⑤ Air box



Remove following components.

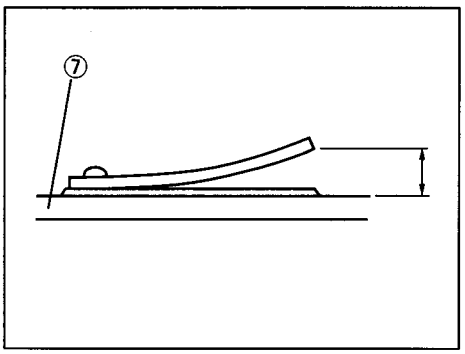
⑥ Gasket
⑦ Reed valve assembly
⑧ Gasket



Inspect following component.

⑦ Reed valve assembly

Valve stopper height: 9.2 – 9.8 mm (0.362 – 0.386 in)
Check whether valve closes properly, is worn or damaged.

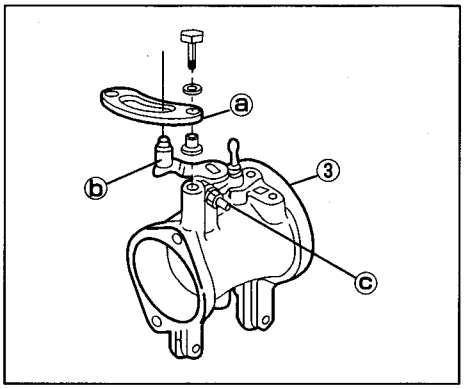


Inspect following component.

③ Throttle body

- Check throttle cam ⓐ for wear.
- Check cam roller ⓑ for wear.
- Confirm that ⓐ and ⓑ operate smoothly.

Do not touch adjuster screw ⓒ.



Assembling Air Box

Assemble following components.

③ Throttle body assembly

① Gasket ⇨ Replace with new one.

② Bolt with screw lock: type H625 at 2 locations

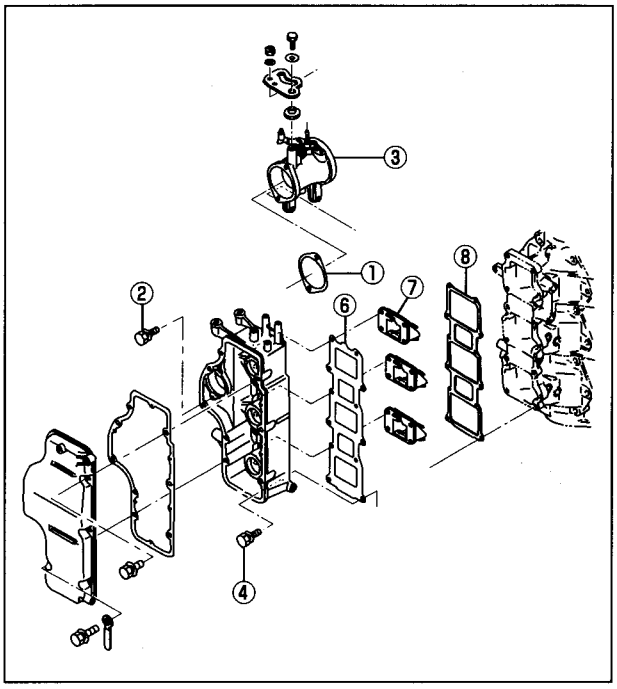
⇨ Replace with new one or apply ThreeBond #1342 when reluse.

Grease to apply:	Interacting surfaces of the throttle cam and roller
	OBM grease

⑧ Gasket ⇨ Replace with new one.

⑦ Reed valve assembly

⑥ Gasket ⇨ Replace with new one.



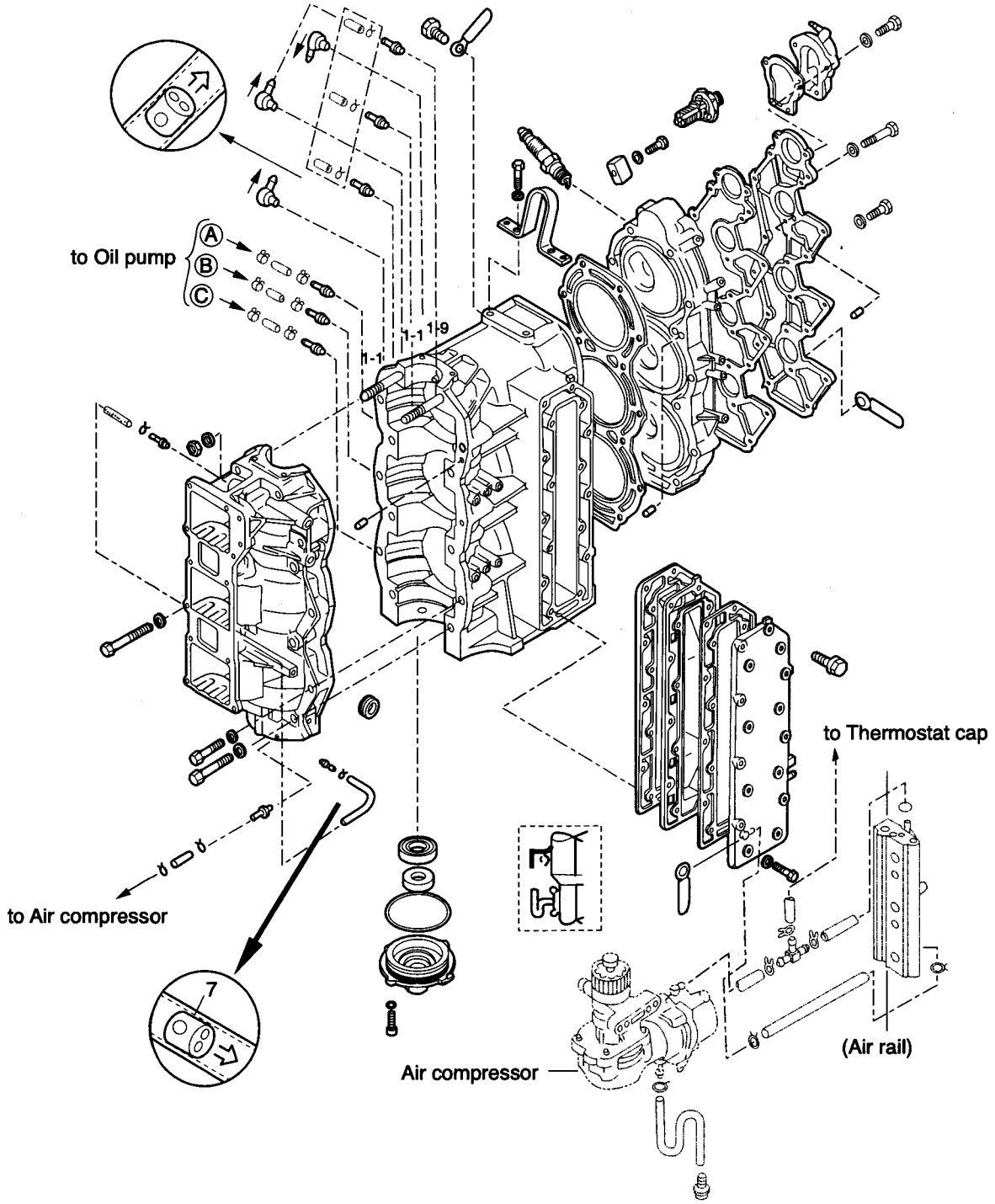
Assembling Air Box

④ Bolt with screw lock: type H625 at 12 locations

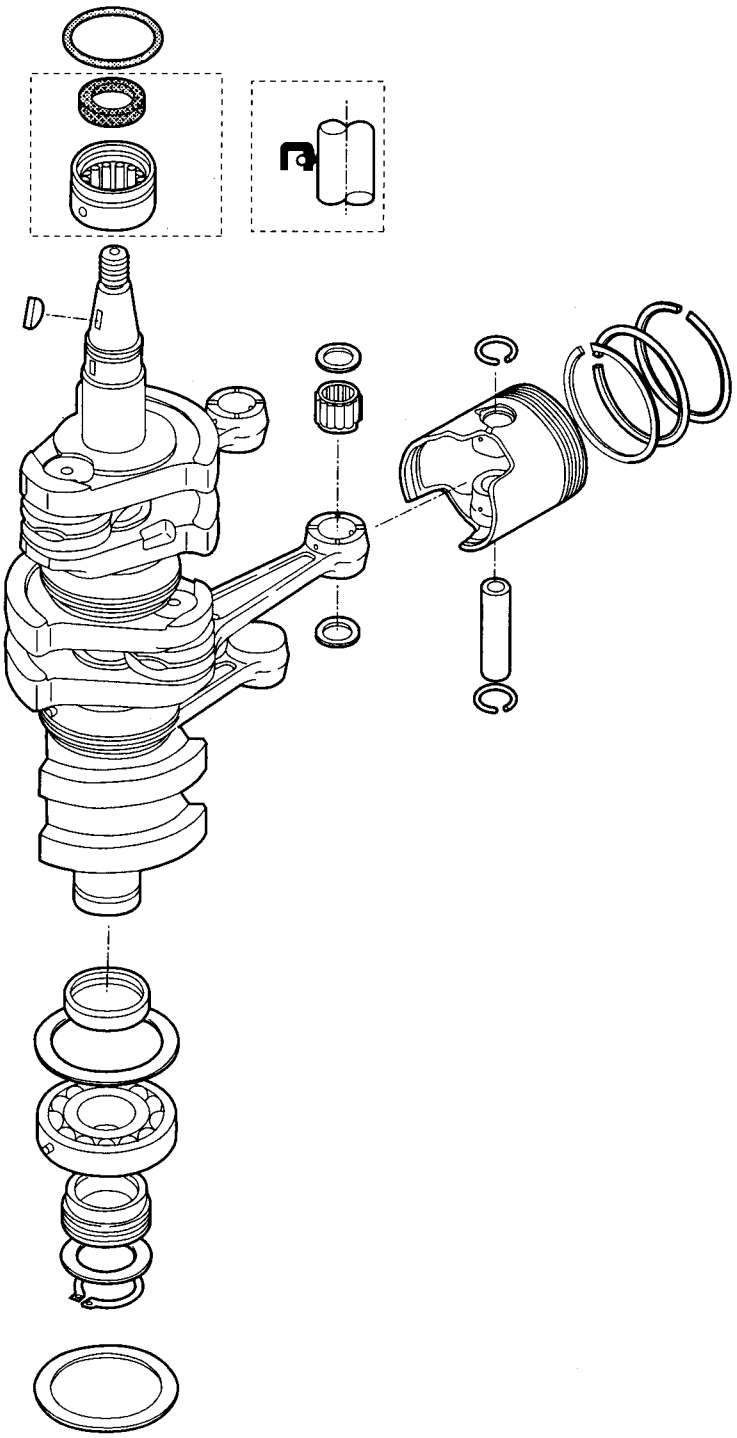
⇨ Replace with new one or apply ThreeBond #1342 when reluse.

3. Engine Short Block

Cylinder and Crankcase Assembly



Piston and Crankshaft



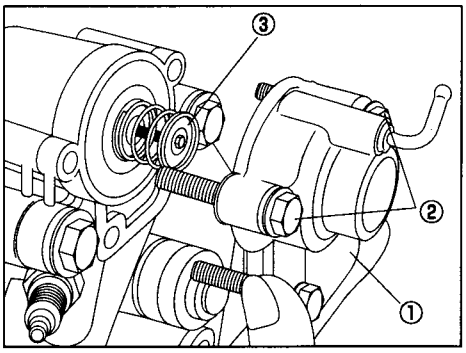
Removing Thermostat

Remove following components.

① Bolt: type H635 at 3 locations

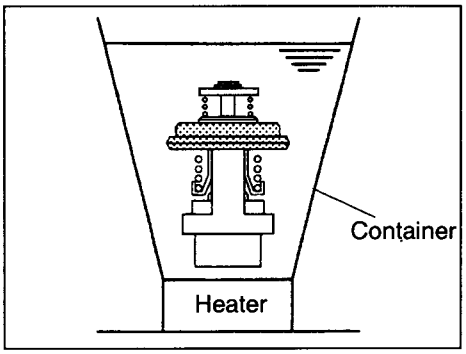
② Thermostat cap

③ Thermostat



Inspect following components.

- Check to see whether foreign matter has entered valve.
- Confirm valve operates within designated temperature range.
- Valve opening temperature: 60°C ± 1.5°C
  : 140°F ± 3°F
- Valve full open temperature : 75°C ± 1.5°C
  : 167°F ± 3°F



Disassembling Cylinder Head and Head Cover

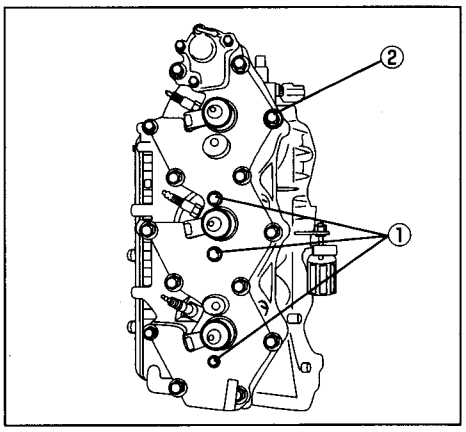
Remove following components.

① Bolt: type H625 at 3 locations

Remove the 6 mm (0.24 in) bolt first.

② Bolt: type H875 at 14 locations

When removing the 8 mm (0.32 in) bolts, loosen in sequence starting from the highest embossed number.

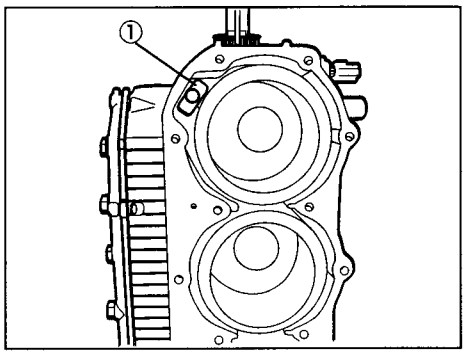


Inspecting Engine Anode

Inspect following component.

① Engine anode

Replace when excessively worn.



Inspecting Cylinder Head

Inspect following components.

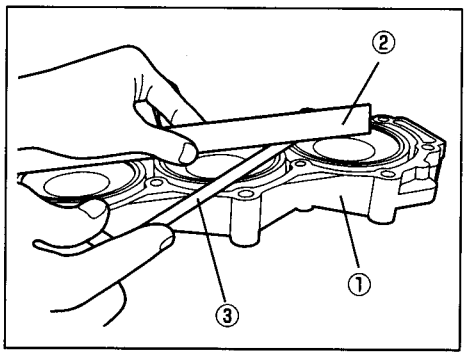
① Cylinder head

Inspecting:

- Check for carbon deposit in combustion chamber.
- Check for sediment in water jacket.

Inspecting:

- Use components ② and ③ to measure distortion.
- ② Straight gauge
- ③ Thickness gauge
- Maximum limit: 0.03 mm (0.0012 in)



Cleaning:

- Clean using a scraper or brush.
- Take care not to scratch any surfaces that are being cleaned.

Adjustment:

- If distortion exceeds limits, repair by polishing the surface plate using #240 to #400 sandpaper in a figure eight pattern.
- Once surface is repaired finish using #600 sandpaper.

Disassembling Exhaust Cover

Remove following components.

① Bolt: type H840 at 2 locations

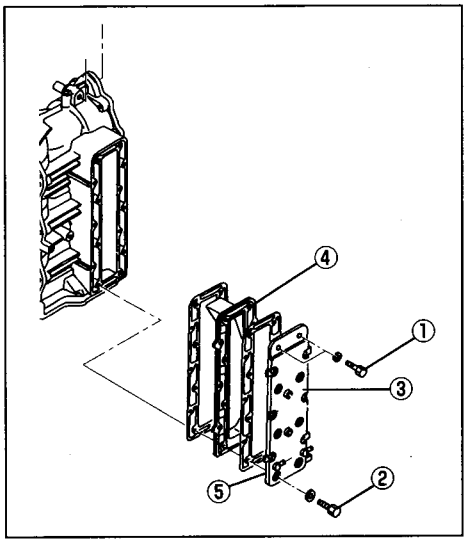
② Bolt: type H835 at 14 locations

> Remove in order starting from the highest embossed number.

③ Outer exhaust cover

④ Inner exhaust cover

> Remove by prying gently with a flathead screwdriver alternately along the 4 grooves on the sides of the cover. Prying too forcefully at only one groove may bend the cover.



Inspecting Exhaust Cover

Inspect following components.

③ Outer exhaust cover

④ Inner exhaust cover

⑤ Cooling water nipple

Inspecting:

> • Check for scratches and distortion on mating surfaces.
> • Check cooling water nipple and other passageways for clogging.

Disassembling Crankcase

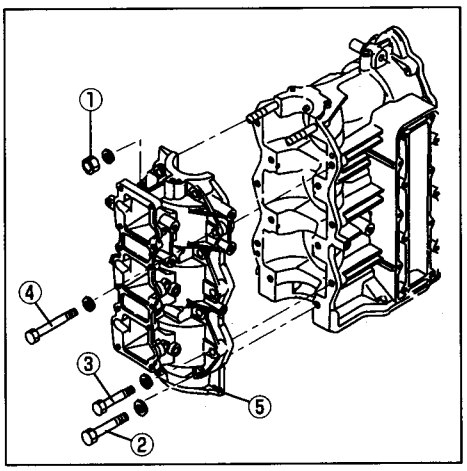
Remove following component.

① Nut: normal type 10 at 2 locations

② Bolt: type H1065 at 6 locations

③ Bolt: type H850 at 5 locations

④ Bolt: type H865 at 1 locations



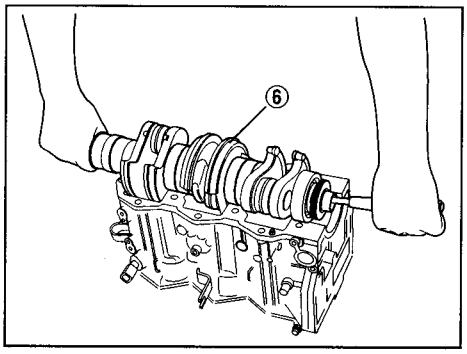
Remove following components.

⑤ Crankcase

> • Remove by prying gently along the grooves with a flathead screwdriver.
> • If the crankshaft is stuck to the crankcase, disengage by tapping lightly using a plastic hammer.

Remove following component.

⑥ Crankshaft assembly

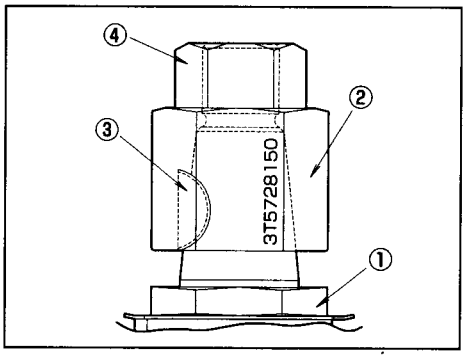


Disassembling Drive Pulley

Remove following components.

① Pulley nut (36 mm, 1.42 in)

Special tool	②Crankshaft holder (36mm) 3T5-72815-0



③ Magneto key

④ Magneto nut

- Install the magneto key ③ on the crankshaft holder ② and secure using the magneto nut ④.
- Using two 36 mm wrenches, use one to secure the crankshaft holder ② and the other to loosen the pulley nut ①.
- After sufficiently loosening the pulley nut ① remove ② ③ and ④; then remove the pulley nut ①.

Assembling Pulley Nut

1. Apply thread lock (Three Bond 1342N) to the screw area.
2. Screw the pulley nut ① into the crankshaft by hand.
3. Position the magneto key ③, then position the crankshaft holder ②.
4. Using the magneto ④, secure the crankshaft holder ②.
5. Take two 36 mm wrenches, use wrench one to secure the crankshaft holder ②, and the other to turn and tighten the pulley nut ① to the following torque.

Torque
90 – 110 N-m (9 – 11 kg-m) [65 – 80 ft-lb]

Disassemble following components.

①Drive pulley

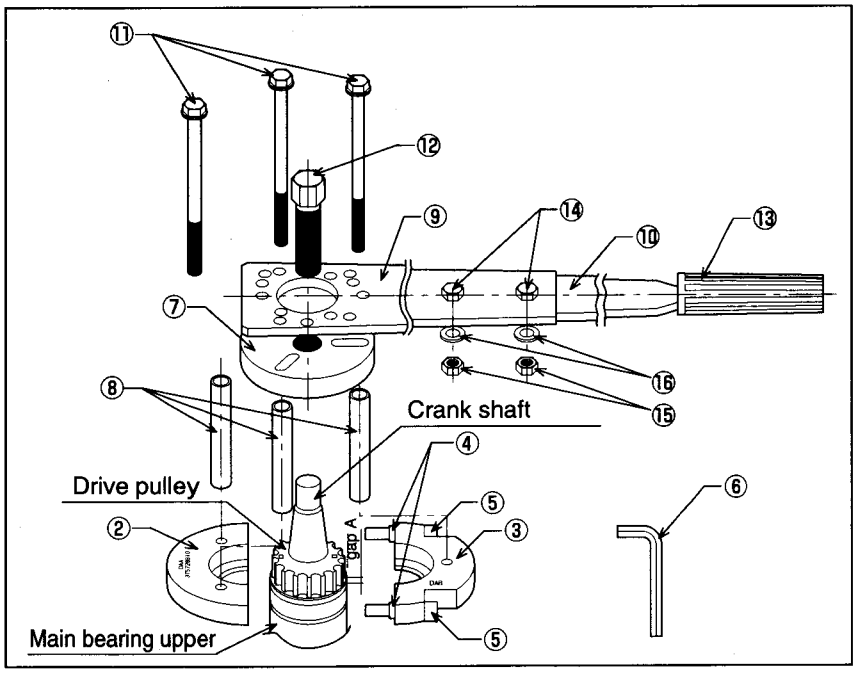
Special tool	Drive pulley puller assembly 3T5-72890-0

Number	Special tool	Part number	Quantity	Stamp Mark
② to ⑯	Drive pulley puller assembly	3T5-72890-0	1 set	
②	Plate A	3T5-72891-0	1	DAA
③	Plate B	3T5-72892-0	1	DAB
④	Knock-out pin, 8.65–11.5–12.7	3T5-72897-0	2	
⑤	Bolt, 8-40	3B7-72785-0	2	
⑥	Hexagonal wrench	3B7-72787-0	1	
⑦	Plate C	3T5-72893-0	1	DAC
⑧	Collar	3T5-72895-0	3	DAE
⑨	Plate D	3T5-72898-0	1	DAF
⑩	Plate E	3T5-72899-0	1	DAG
⑪	Bolt, 8-125	3T5-72896-0	3	
⑪	Washer	940191-0800	3	
⑫	Bolt	3T5-72894-0	1	DAD
⑬	Grip	309-63012-0	1	
⑭	Bolt	910194-1025	2	
⑮	Nut	930191-1000	2	
⑯	Washer	940191-1000	2	

Move the upper main bearing toward the crankweb, widening the gap between the bearing and the drive pulley ①. Into the widened gap insert plate A ② and plate B ③, join them using the knock-out pins ④, and evenly tighten the 8-40 bolts ⑤ on both sides of the joined plates using the hexagonal wrench ⑥.

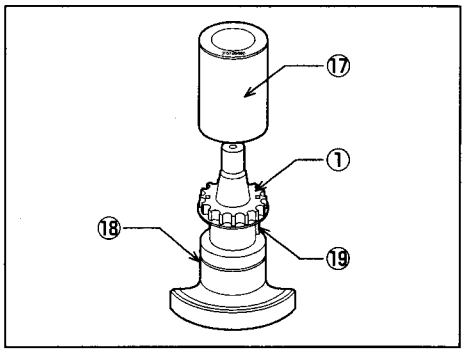
Insert the collars ⑧ between the joined plates A ② and plate B ③ and plate C ⑦, place plate D ⑨ and plate E ⑩ on top of plate C ⑦, and tighten the 8-125 bolts ⑪.

Apply grease to the tip of the screw area of the bolt ⑫ and tighten the bolt using a 19 mm socket wrench until the drive pulley ① is extracted.



Assembling Drive Pulley

Special tool	Drive pulley press
	3T5-72868-0

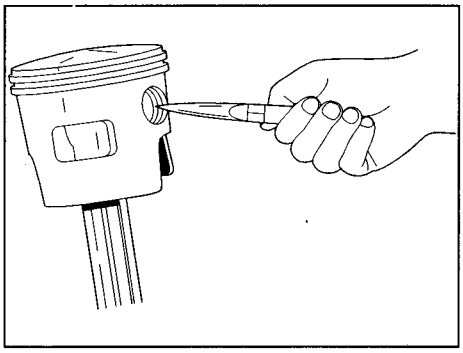


1. After cleaning and degreasing the mating surface of the crankshaft ⑱ and drive pulley ① shaft, apply Locitite 7471 primer. After the primer has dried, apply Locitite 648 to the crankshaft hole.
2. Position the woodruff key ⑲ on the crankshaft ⑱ and position the drive pulley ①.
3. Place the drive pulley press ⑰ on top of the drive pulley ①, aligning the recession of the drive pulley press with the outside of the drive pulley.
4. Lightly tap the center of the upper portion of the drive pulley press with a hammer to press fit the drive pulley. (Half the area to be press fit slips on easily, and the other half has a press fit pin.)

Removing Piston

Remove following components

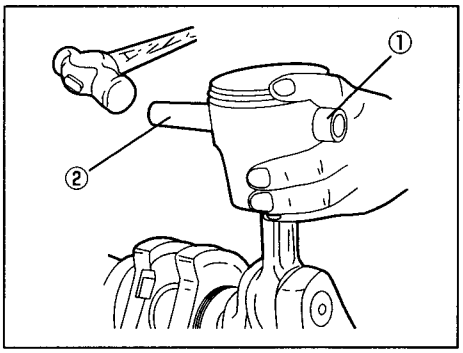
- Piston pin clip: 2 locations



- Remove both clips.
- Take care not to damage the pin hole.

Remove following components

①Piston pin

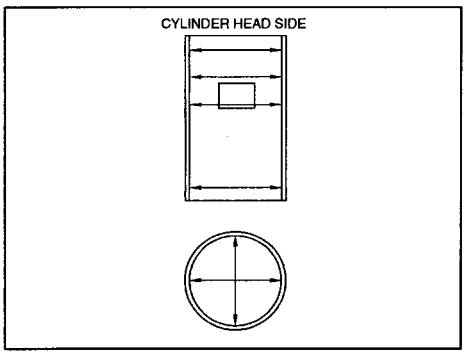


Special tool	②Piston pin tool
	353-72215-0

- Position the piston pin tool ②. Then, supporting the opposite side of the piston with your hand tap lightly on the tool with a hammer to remove the piston pin.
- Take care not to apply force to the connecting rod when using the hammer.
- Take care not to strike the small-end washer.

Inspecting Engine Components

Inspecting Cylinders

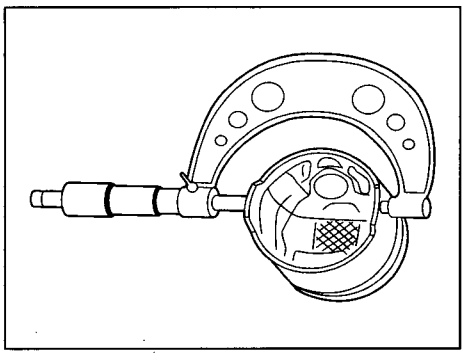


• Cylinder bore (using cylinder gauge)

Standard value	Service limit
86.07 mm (3.3866 in)	Replace when 86.13 mm (3.3909 in) or more

• Measure the area showing the greatest wear.
• Replace the cylinder when the difference between minimum and maximum cylinder bore is 0.06 mm (0.0023 in) or greater.

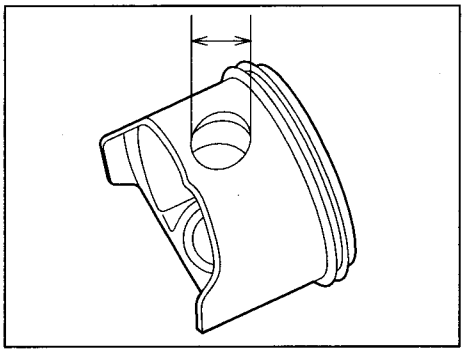
Inspecting Piston



• Outer diameter of piston skirt (using micrometer)

Standard value	Service limit
85.85 mm (3.3799 in)	Replace when 85.79 mm (3.3776 in)

Measure at point 11.5 mm (0.45 in) from the bottom of the piston skirt.



• Piston clearance (between cylinder and piston)

Standard value	Service limit
0.19 – 0.25 mm (0.0075 – 0.0098 in)	Replace when 0.34 mm (0.0134 in) or more

• Inner diameter of piston pin hole (using cylinder gauge)

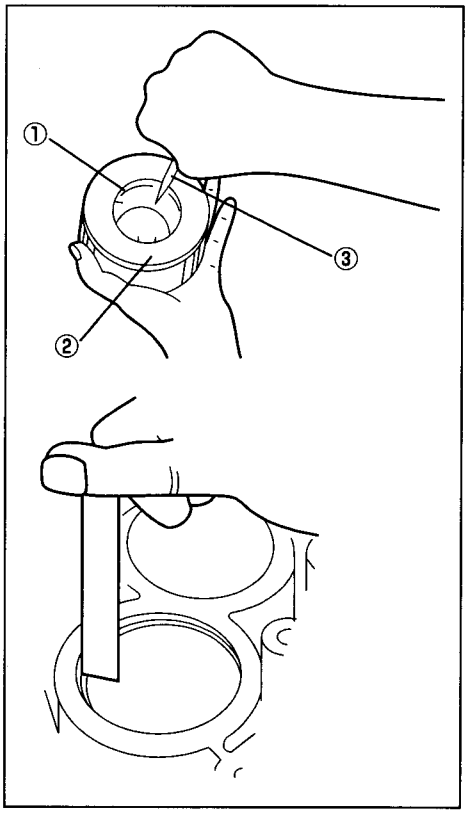
Standard value	Service limit
20.00 mm (0.7874 in)	Depends on clearance with pin

• Clearance between piston pin and pin hole

Standard value	Service limit
Tight: 0.007 mm (0.00028 in)	Replace when 0.02 mm (0.0008 in) or more
Loose: 0.003 mm (0.00012 in)	

Inspecting Piston Rings

① Piston ring
② Ring gauge
③ Thickness gauge



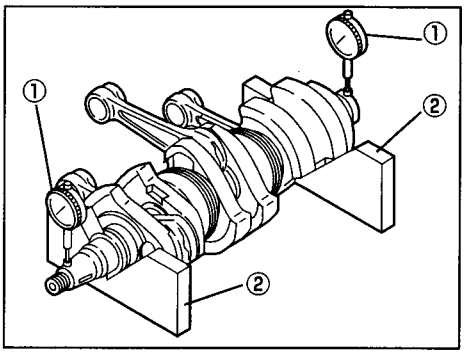
• Piston ring end gap

Ring	Standard value	Service limit
Top	0.25 – 0.40 mm (0.0098 – 0.0157 in)	Replace when 0.8 mm (0.0315 in) or more
2nd, 3rd	0.25 – 0.40 mm (0.0098 – 0.0157 in)	Replace when 0.8 mm (0.0315 in) or more

- Pressing the ring on the piston crown, place in ring gauge.
- Use cylinder when ring gauge is not available.

Inspecting Crankshaft

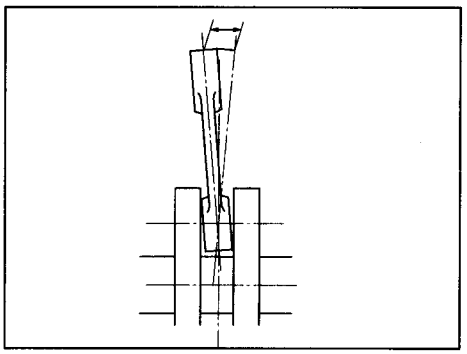
① Dial gauge
② V block



• Crankshaft run-out

Standard value	Service limit
Within 0.05 mm (0.002 in)	Replace when 0.05 mm (0.002 in) or more

• Connecting rod deflection



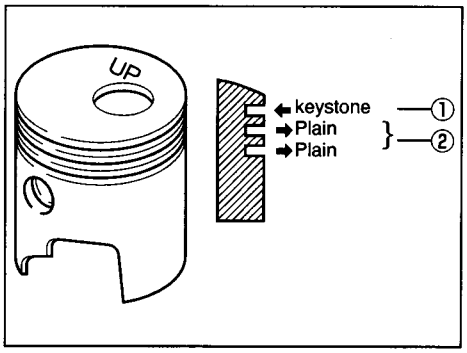
Standard value	Service limit
Within 2 mm (0.0787 in)	Replace when 2 mm (0.0787 in) or more

0Assembling Piston

Assemble following components.

① Top ring (Keystone ring)

② 2nd and 3rd rings (plain rings)



Special tool	Piston ring tool
	353-72249-0

- Install starting from the 3rd ring.
- Install with the stamped mark facing upwards.
- much up piston ring end gap with knock pin.

Assemble following component.

③ Piston pin clip

- Install only on one side first prior to installing piston pin.
- Always use a new piston pin clip.
- The piston pin clip gap should face in the opposite direction of groove Ⓔ.

Assemble following components.

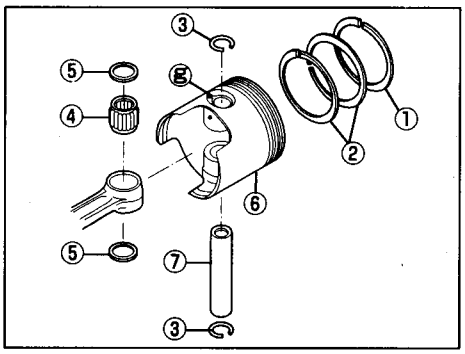
④ Small end bearing

⑤ Washer

⑥ Piston

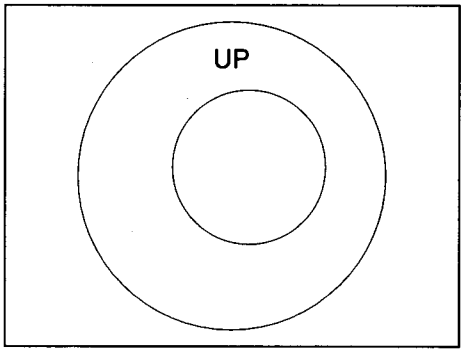
⑦ Piston pin

⑧ Piston pin clip



Special tool	Piston pin tool
	353-72215-0

- Apply engine oil to the pin hole and small-end bearing.
- After positioning the piston on the connector rod, place the piston pin tool against the pin and tap lightly with a hammer to install the pin.
- After installing the pin, install the other piston pin clip.
- Install each piston so the "UP" mark faces the flywheel.



Assembling Short Block

Assemble in reverse order of disassembly.

Apply genuine engine oil to following parts.

- Big end of connecting rod
- Small end of connecting rod and pin boss oil hole
- Main bearing
- Piston ring and entire circumference of piston
- Entire surface of cylinder bore
- Upper bearing O-ring

Assembling Crankshaft

Degrease the surface of the crankcase

Assemble the crankshaft and the cylinder using following procedures.

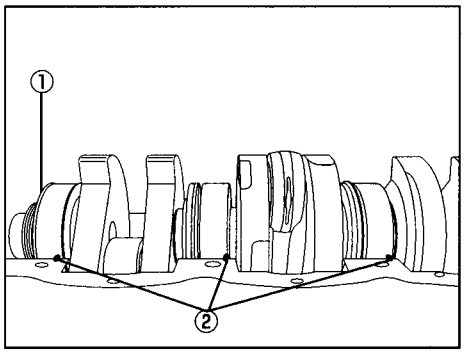
Points to Note:

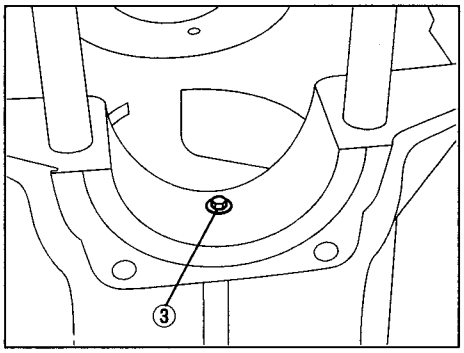
Make sure that all pistons are positioned perpendicularly; then insert piston in perpendicular direction using gentle jiggling motion.
Make sure pistons are not twisted in horizontal direction.

Do the following before completely installing the crankshaft.

- Install the washer 66-85-2 ① on the crankshaft.
- Position the main bearing knock-out pins ② to correspond to the crankcase notches.

Insert into the grooves of the mating surface.





- Lining up position of upper bearing

Line up of the knock holes ③ on the upper bearing with the knock pins on the journal of the cylinder.

Gently move the upper bearing to confirm it is correctly positioned on the knock pins.

Assembling Crankcase

Degrease the mating surface of the crankcase and cylinder.

Caution:

Insufficient degreasing will render sealant less effective, resulting in oil leakage.

Apply sealant evenly over the mating surface on the cylinder.
Sealant: Loctite #518

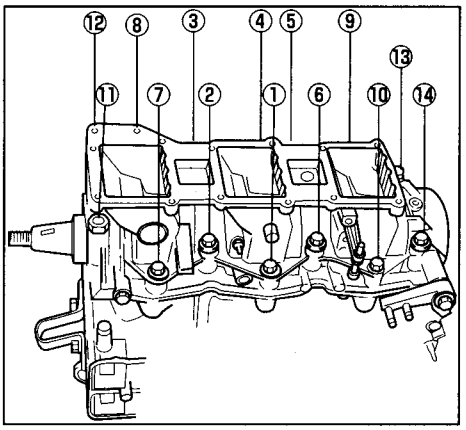
Apply evenly inside the bolt holes so that there are no bare patches. Be careful not to apply too much.

Tap in knock pins at 2 locations on the cylinder; then install crankcase.

Install by tapping with a plastic hammer to ensure that there is an even clearance across the mating face.

Install the crankcase bolts and nut.

Tighten in the sequence shown in the figure to the right.



M8 partial torque	12 – 15 N-m (1.2 – 1.5 kg-m) [8.7 – 11 ft-lb]
M8 full torque	24 – 26 N-m (2.4 – 2.6 kg-m) [17 – 19 ft-lb]
M10 partial torque	17 – 23 N-m (1.7 – 2.3 kg-m) [12 – 17 ft-lb]
M10 full torque	37 – 41 N-m (3.8 – 4.2 kg-m) [28 – 30 ft-lb]

Assembling Cylinder Head

Degrease all mating surfaces on cylinder, cylinder head and head cover.

Install following components.

- Anode
- Knock pins at 2 locations
- Head gasket ⇨ Replace with new one.
- Cylinder head
- Knock pins at 2 locations
- Head cover gasket ⇨ Replace with new one.
- Head cover
- Washer
- Bolt

Tighten in two stages in the order of the embossed numbers.
M6 partial torque 2.0 – 2.9 N-m (0.2 – 0.3 kg-m) [1.4 – 2.2 ft-lb] M6 full torque 4.6 – 6.3 N-m (0.5 – 0.6 kg-m) [3.6 – 4.3 ft-lb]
M8 partial torque 12 – 15 N-m (1.2 – 1.5 kg-m) [8.7 – 11 ft-lb] M8 full torque 29 – 34 N-m (3.0 – 3.5 kg-m) [22 – 25 ft-lb]

Install following components.

- Thermostat
- Thermostat cap gasket ⇨ Replace with new one.
- Thermostat cap
- Bolt:type H635 at 3 locations

Torque
4.6 – 6.3 N-m (0.47 – 0.64 kg-m) [3.4 – 4.6 ft-lb]

Caution:

Be sure to tighten M6 bolts only after tightening the M8 bolts on the head cover. Never tighten the M6 bolts first.

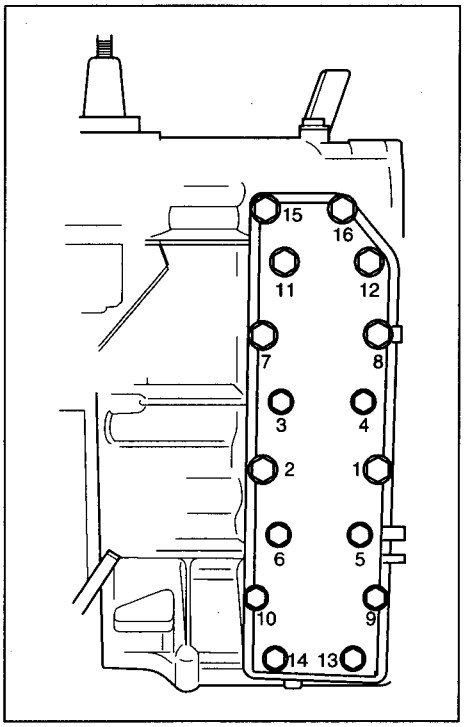
Assembling Exhaust Cover

Clean away any dirt or foreign matter on the mating surfaces of the cylinder and inner and outer exhaust covers; then degrease.

Assemble following components.

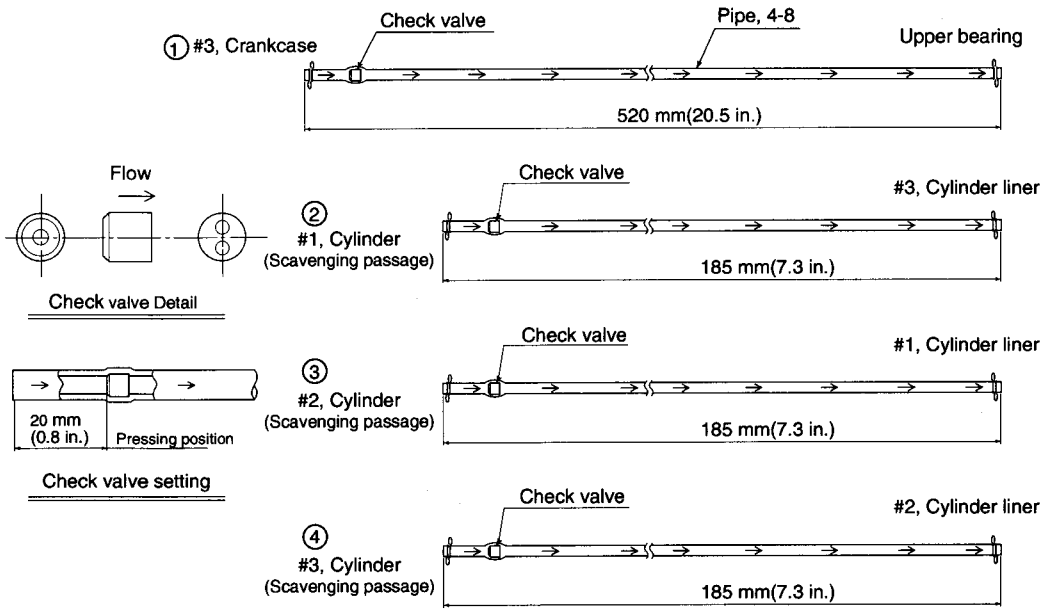
- Exhaust cover gasket ⇨ Replace with new one.
- Inner exhaust cover
- Exhaust cover gasket ⇨ Replace with new one.
- Outer exhaust cover
- Fuel filter band
- Bolt: type H840 at 2 locations
- Bolt: type H835 at 14 locations

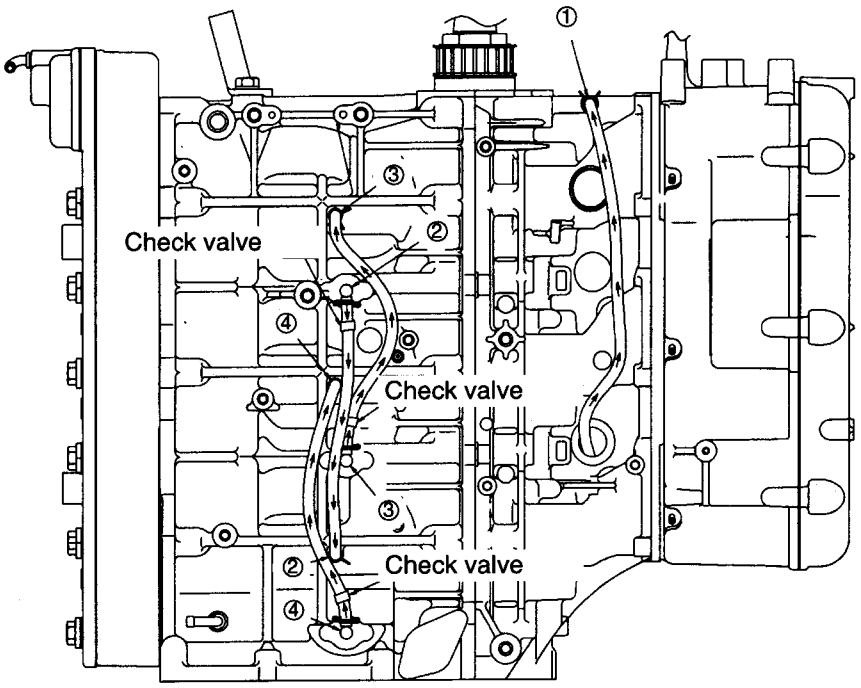
Tighten in the order of the embossed numbers.
Partial torque 5.9 – 7.8 N-m (0.6 – 0.8 kg-m) [4.3 – 5.8 ft-lb] Full torque 13 – 15 N-m (1.3 – 1.5 kg-m) [9.4 – 11 ft-lb]

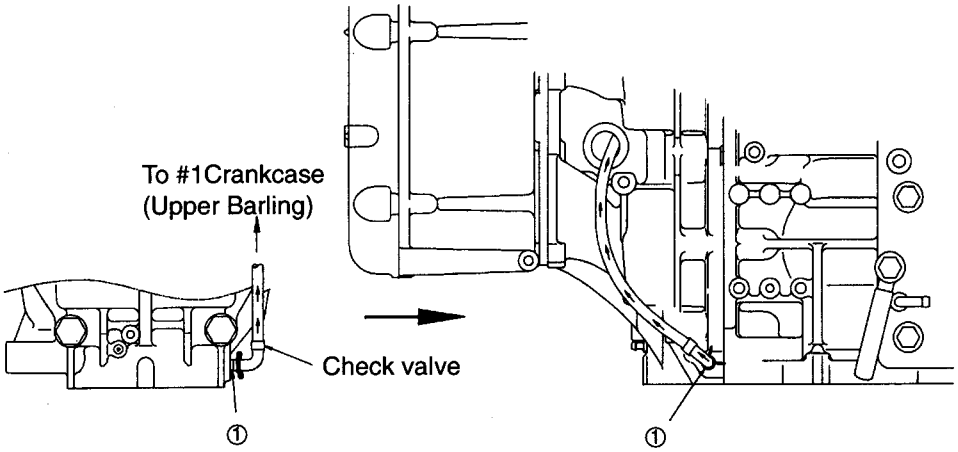


Attaching Recirculation Hoses

Assemble following components.

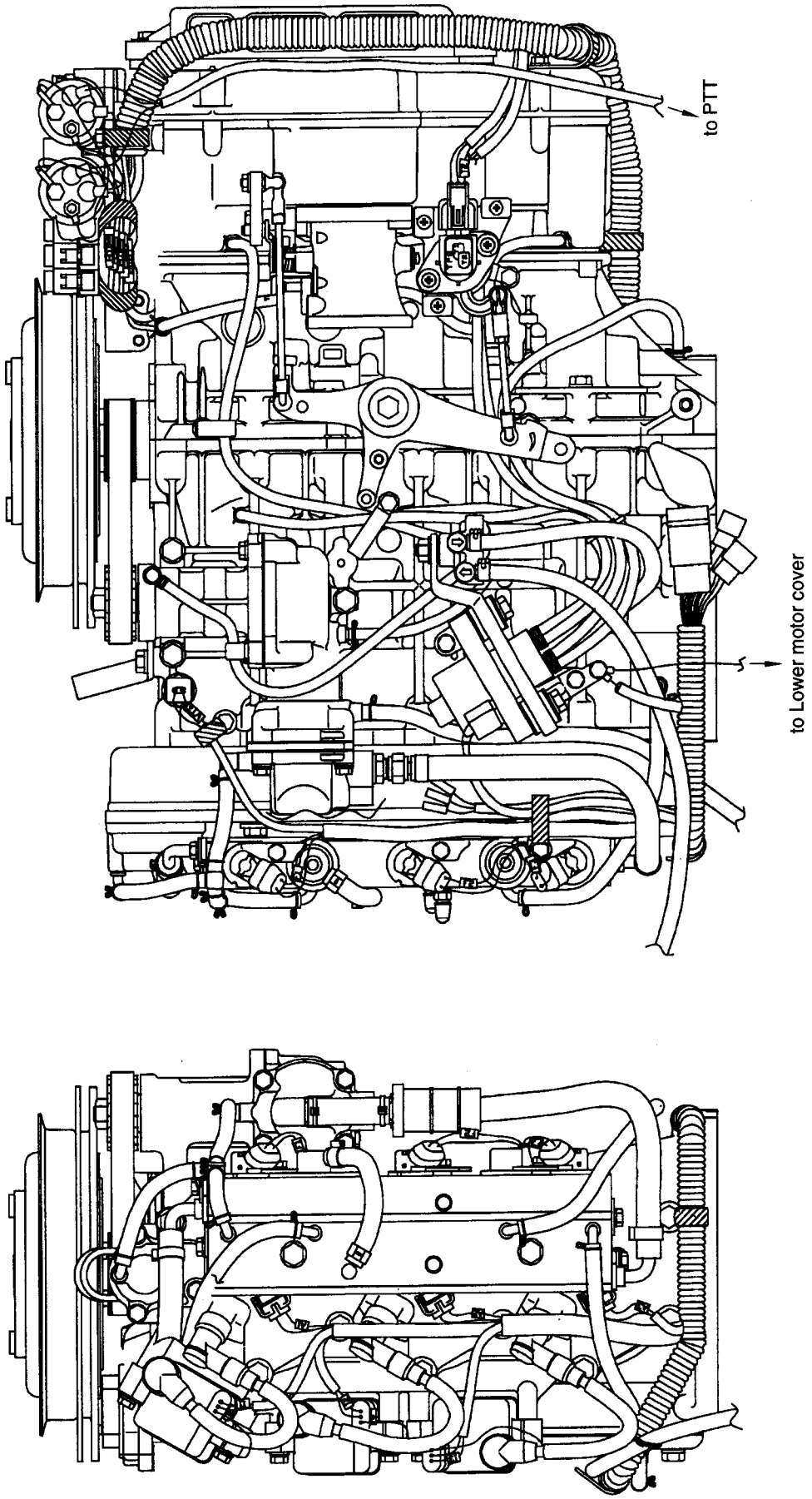


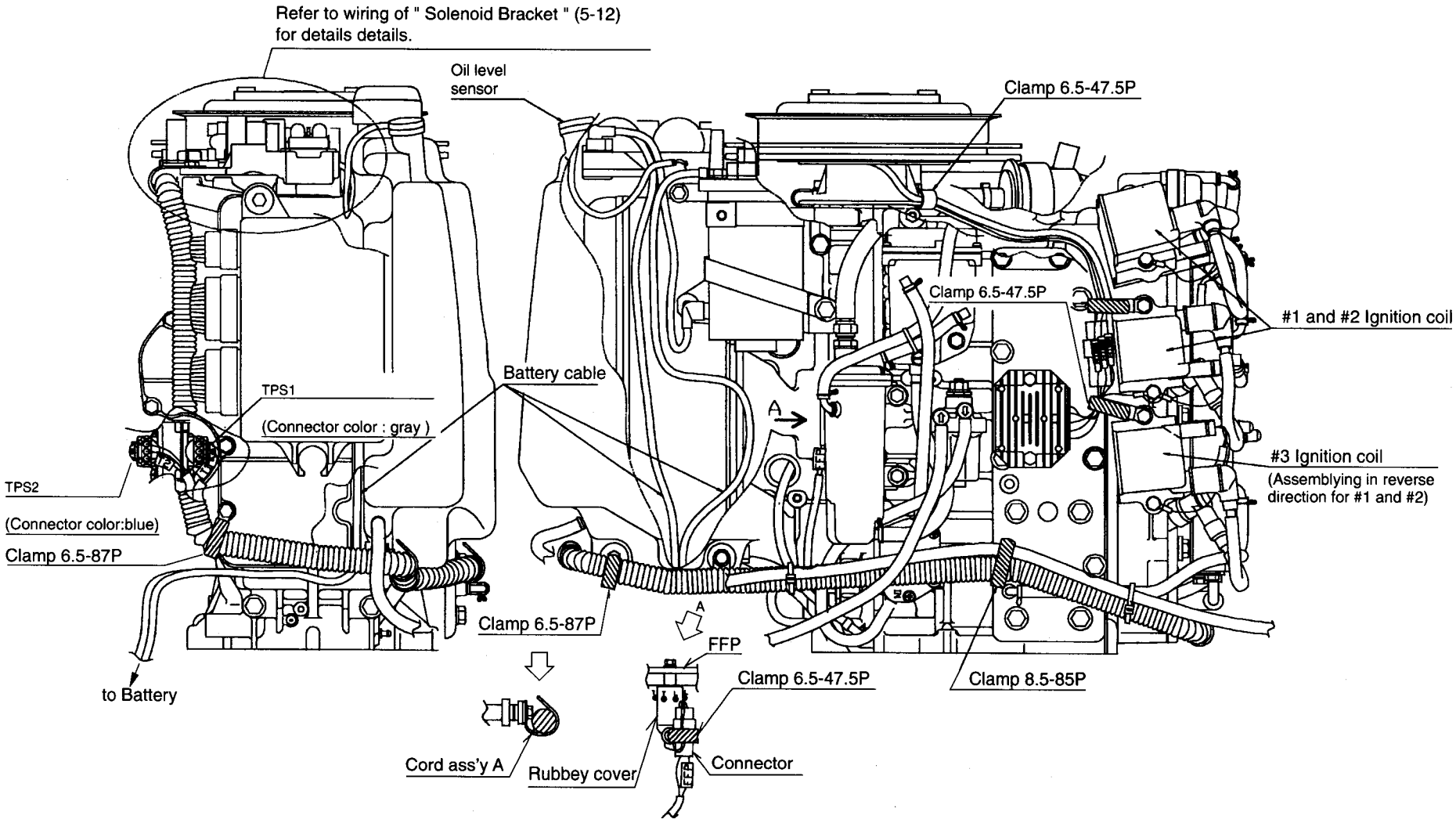


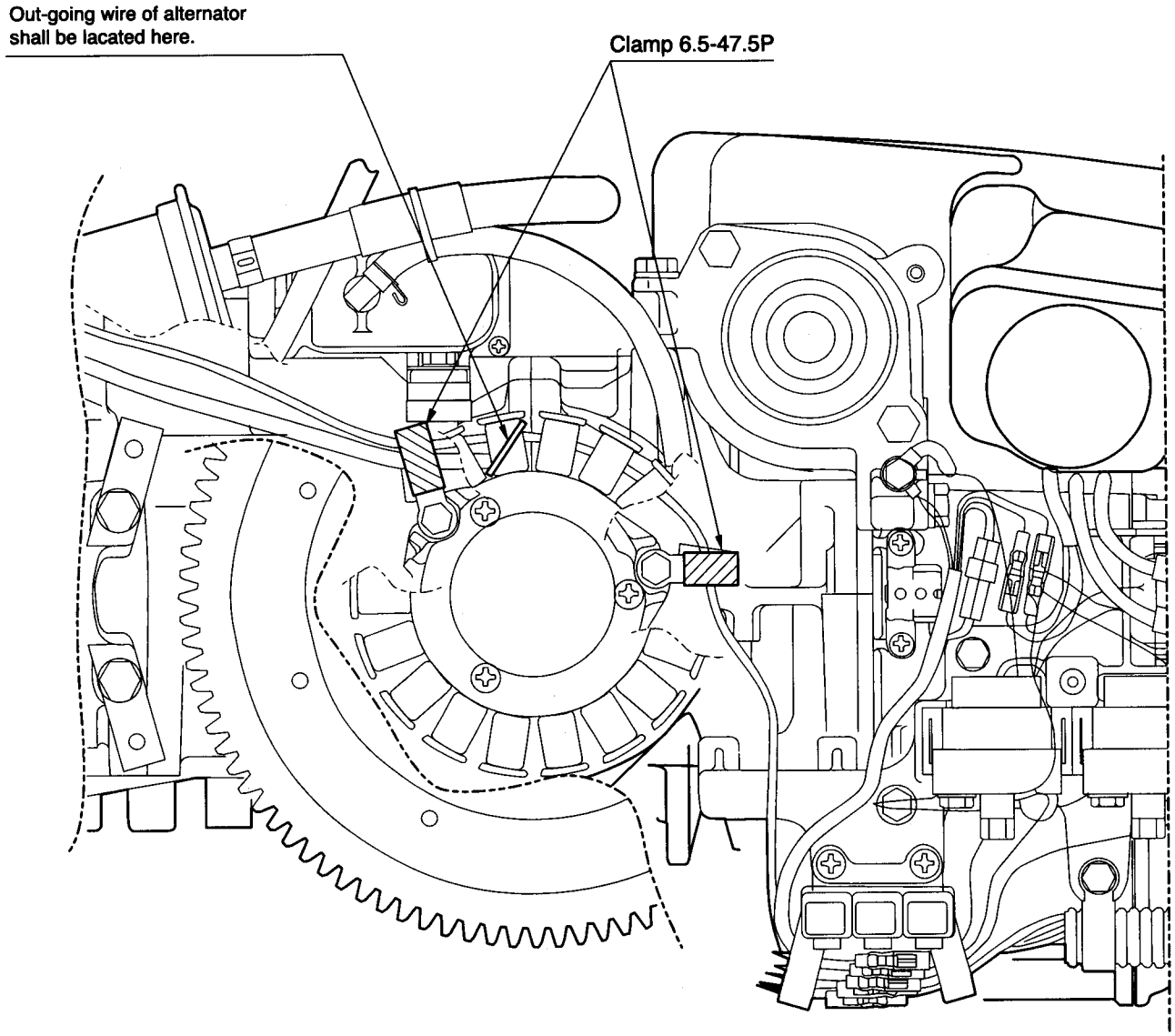


Chapter 5 Electrical Components

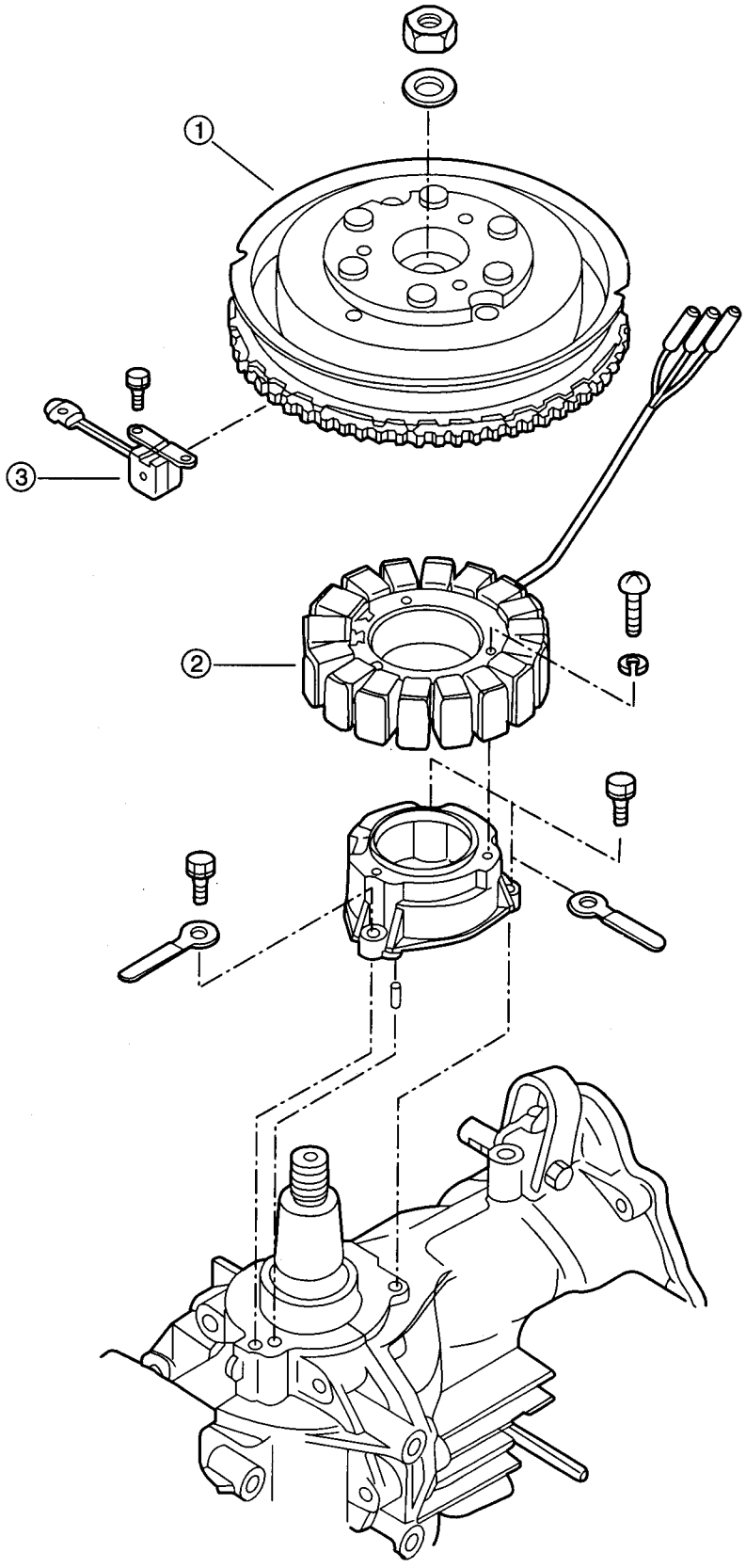
1. Wire Routing



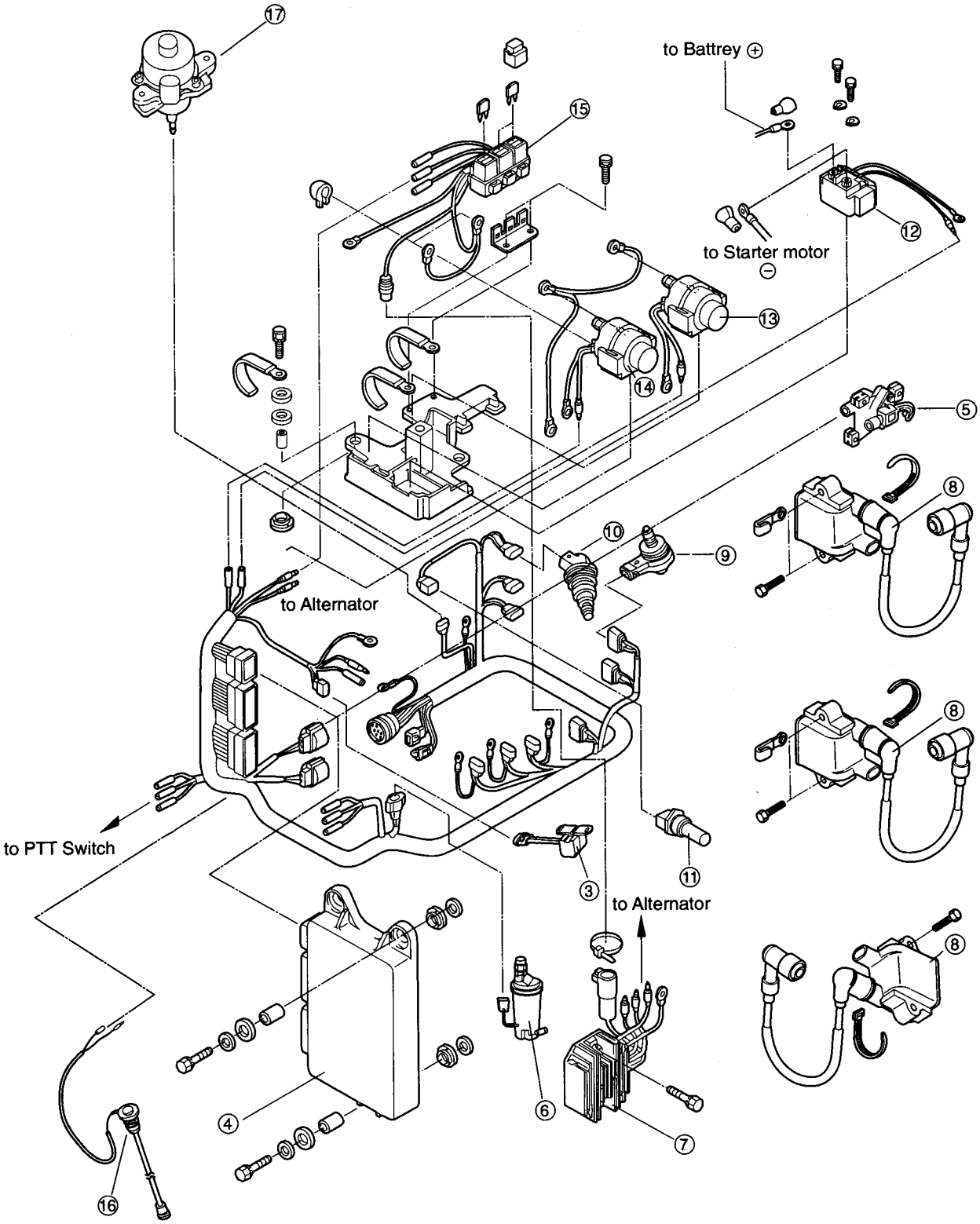

Refer to wiring of " Solenoid Bracket " (5-12)
for details details.
Oil level
sensor
Clamp 6.5-47.5P
Clamp 6.5-47.5P
#1 and #2 Ignition coil
Battery cable
TPS1
(Connector color : gray)
A
#3 Ignition coil
(Assemblying in reverse
direction for #1 and #2)
TPS2
(Connector color:blue)
Clamp 6.5-87P
A
Clamp 6.5-87P
FFP
Clamp 6.5-47.5P
Clamp 8.5-85P
to Battery
Cord ass'y A
Rubbey cover
Connector


Out-going wire of alternator
shall be lacated here.
Clamp 6.5-47.5P

MAGNETO



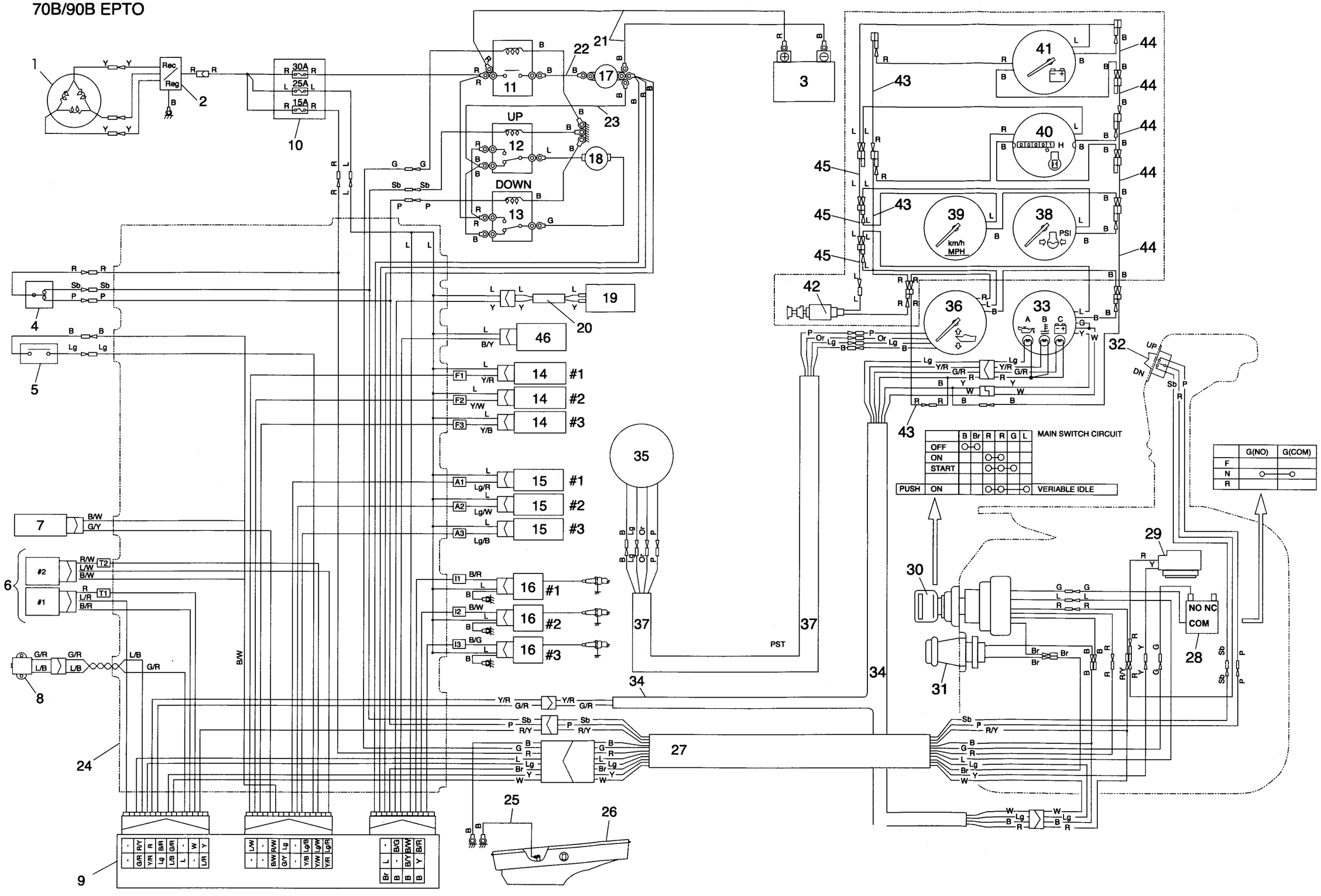
ELECTRIC PARTS



① Flywheel
② Alternator
③ Crank position center
④ ECU (Electronic Control Unit)
⑤ TPS
(Throttle position sensor)
⑥ FFP (Fuel feed pump)
⑦ Rectifier
⑧ Ignition coil
⑨ Air injector
⑩ Fuel injector
⑪ Water temperature sensor
⑫ Starter solenoid
⑬ PTT solenoid, upper
⑭ PTT solenoid, lower
⑮ Fuse holder assembly
⑯ Oil level sensor
⑰ Oil pump

2. Wiring Diagram

70B/90B EPTO



70B / 90B EPTO

NO.	Component	NO.	Component
1	Alternator assembly	24	Cable assembly A
2	Rectifier complete	25	Ground cable
3	Battery (obtain locally)	26	Lower motor cover
4	PTT switch B	27	Cable assembly B
5	Oil level sensor	28	Neutral switch
6	Throttle position sensor (TPS)	29	Buzzer
7	Water temperature sensor	30	Main switch
8	Crank position sensor (CPS)	31	Lanyard stop switch
9	ECU	32	PTT switch
10	Fuse holder assembly	33	Tachometer
11	Starter solenoid	34	Meter lead wire
12	PTT solenoid switch A	35	Trim sender
13	PTT solenoid switch B	36	Trim meter
14	Fuel injector	37	Extention cable of trim sensor
15	Air injector	38	Water pressure meter
16	Ignition coil	39	Speedometer
17	Starter motor	40	Hour meter
18	PTT	41	Voltmeter
19	FFP	42	Meter light switch
20	FFP cable	43	Assist cable, red
21	Battery cable	44	Assist cable, black
22	Starter cable	45	Assist cable, blue
23	Ground cable	46	Oil pump assembly

* PTT : abbreviation for power trim and tilt.

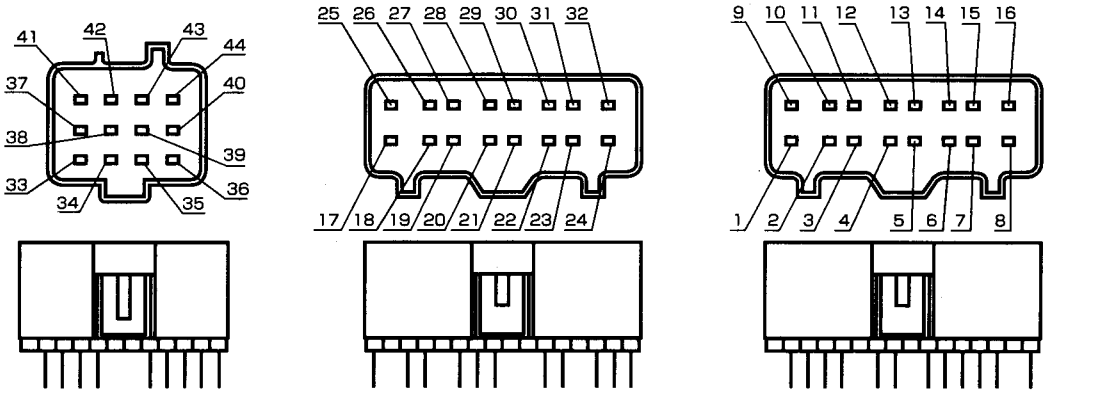
* FFP : abbreviation for fuel feed pump.

Cable color abbreviations

B	black
Br	brown
G	green
L	blue
Lg	light green
Or	orange
P	pink
R	red
Sb	sky blue
W	white
Y	yellow
Gr	gray

(Note) Slash (/) shows stripe color of cable

Wire Connection



NO	Component	Cable color addreviations	
1	TPS 1	L/R	Blue/Red
2			
3	Key switch (PUSH)	L	Blue
4	CPS(Crank position sensor)	L/B	Blue/Black
5	Warning lamp(Oil)	L/g	light green
6	Warning lamp(Temp.)	Y/R	Yellow/Red
7	Warning lamp(Battery)	G/R	Green/Red
8			
9	Buzzer	Y	Yellow
10	Tachometer	W	White
11			
12	CPS(crank position sensor)	G/R	Green/Red
13	TPS 1	B/R	Black/Red
14	TPS 1	R	Red
15	key switch(Power source)	R/Y	Red/Yellow
16			
17	#1 Fuel injector	Y/R	Yellow/Red
18	#2 Fuel injector	Y/W	Yellow/White
19	#3 Fuel injector	Y/B	Yellow/Black
20			
21	WTS(Water temp. sensor)	G/Y	Green/Yellow
22	WTS(Water temp. sensor, TPS 2 and Oil level sensor Ground)	B/W	Black/White
23			
24			
25	#1 Air injector	Lg/R	Light green/Red
26	#2 Air injector	Lg/W	Light green/White
27	#3 Air injector	Lg/B	Light green/Black
28			
29	Oil level sensor	Lg	Light green
30	TPS 2	R/W	Red/White
31			
32	TPS 2	L/W	Blue/White
33	Ground	B	Black
34	Ground	B	Black
35	Ground	B	Black
36	Stop switch	Br	Brown
37	FFP(Fuel feed pump)	Y	Yellow
38	Electric oil pump [for MD70/90B only]	B/Y	Black/Yellow
39			
40	Power source(25A Fuse, #1,2,3 Air injector, #1,2,3 Fuel injector)	L	Blue
41	#1 Ignition coil	B/R	Black/Red
42	#1 Ignition coil	B/W	Black/White
43	#1 Ignition coil	B/G	Black/Green
44			

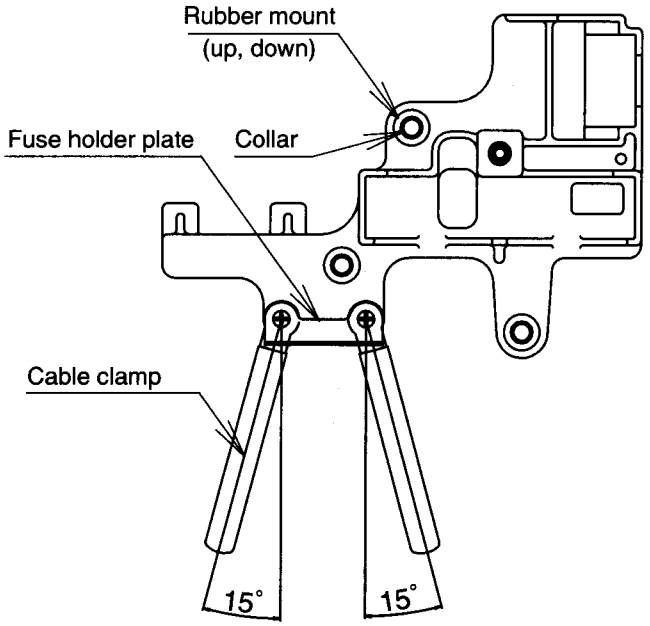
Note: Slash (/) shows shripe color of cable.

3. Assembly

Solenoid Bracket

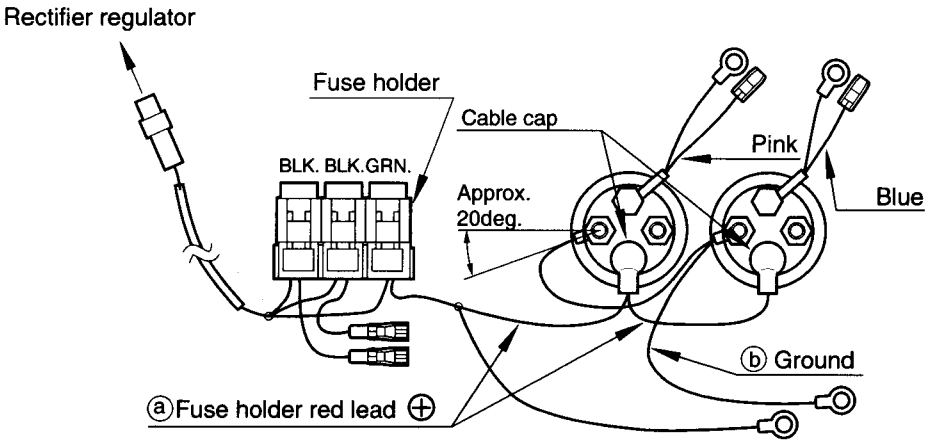
Pre-Assembly step 1

Attach the cable clamp, fuse holder plate and rubber mount to the bracket.



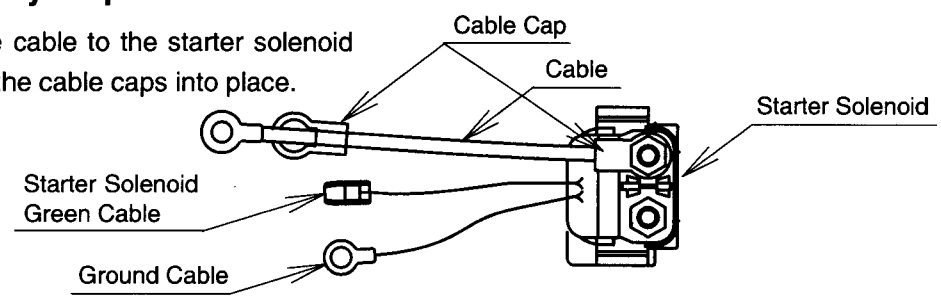
Pre-assembly Step 2

ⓐ Attach the fuse holder red lead ⊕ to the PTT solenoids and cover with the cable caps.
ⓑ Attach the ground cable ⊖ to the PTT solenoids.



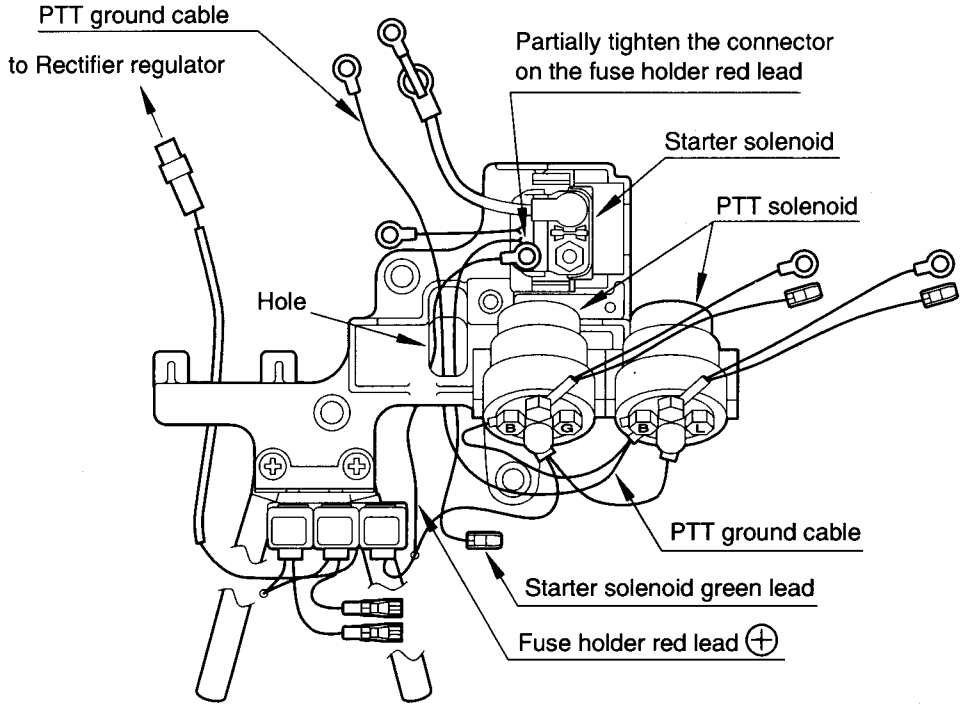
Pre-Assembly Step 3

Attach the cable to the starter solenoid and slide the cable caps into place.

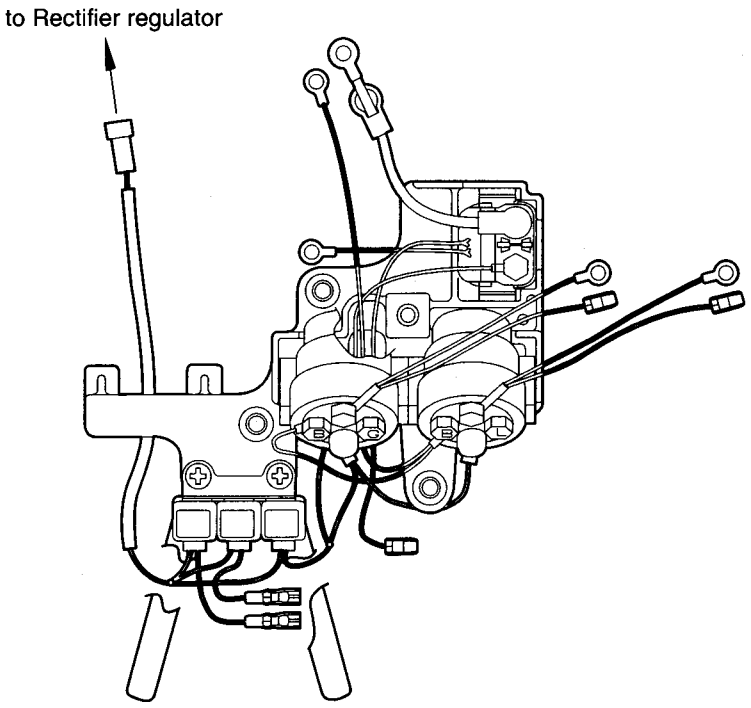


Pre-Assembly Step 4

Pass the fuse holder red lead⊕, PTT solenoid goround cable and starter solenoid green lead through the hole in the center of the solenoid bracket; Then attach the starter solenoid, PTT solenoid, and fuse holder to the bracket.

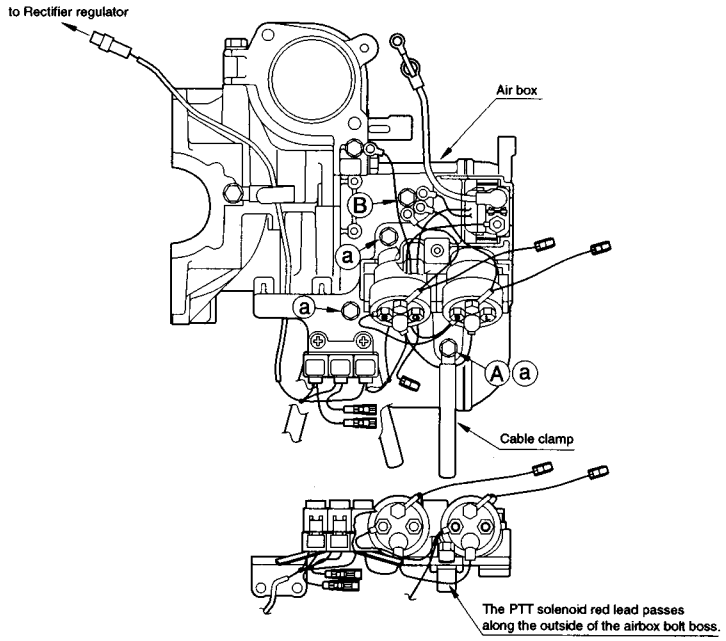


Completed Pre-Assembly



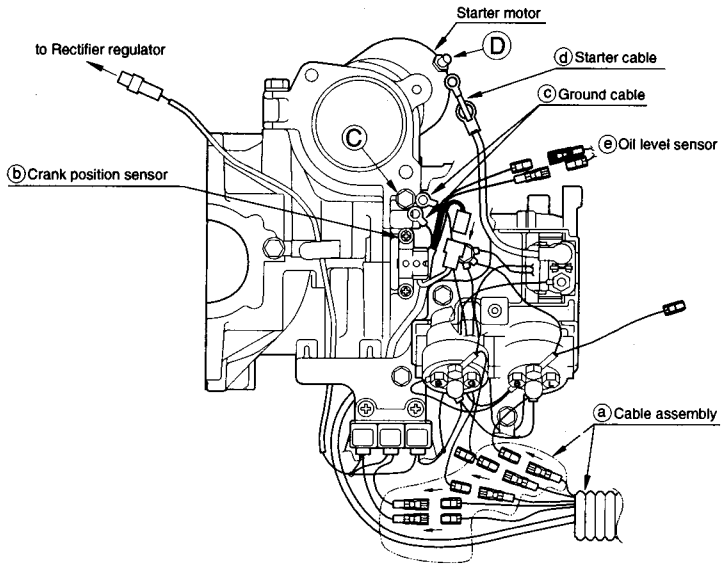
Assembly Step 1

- Install bracket on air box. (Bolt ⓐ at 3 locations)
- I Install the starter solenoid and the PTT solenoid ground cables on the air box bolt Ⓑ boss. The PTT solenoid red lead passes along the outside of the air box bolt boss.



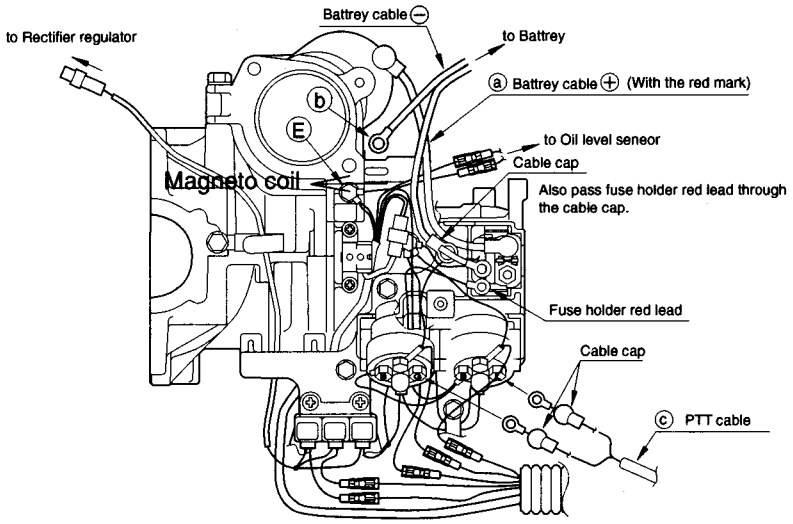
Assembly Step 2

ⓐ Connect the cable assembly light blue lead, pink lead, green lead, green lead, red lead, red / white lead, and blue lead.
ⓑ Install and connect the crank position sensor and cable assembly.
ⓒ Connect cable assembly A ground cable and PTT ground cable to the starter motor bracket Ⓕ.
ⓓ Install the starter cable between the starter solenoid and starter motor Ⓓ. Cover with the cap.
ⓔ Connect the oil level sensor connectors.

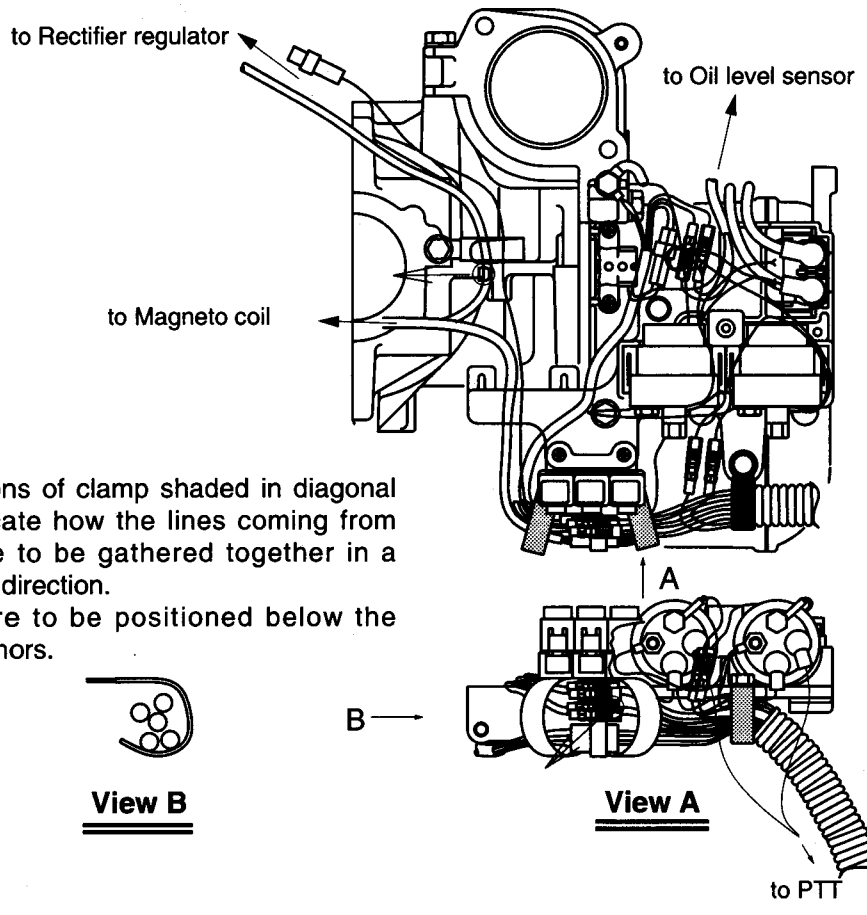


Assembly Step 3

- Attach the battery cable ⓐ lead (with the red mark) to the starter solenoid. At that time, also pass the fuse holder red lead through the cable cap.
- Attach the battery cable⊕ⓑ lead to section Ⓔ of the starter motor bracket.
- Attach the PTT cable ⓒ lead wire (blue) and ground wire (green) to the PTT solenoid and cover with the cap.



Assembly Completed



Note:
The sections of clamp shaded in diagonal lines indicate how the lines coming from above are to be gathered together in a downward direction.
Cables are to be positioned below the clamp anchors.

View B

View A

4. Inspection

Flywheel Magneto

The flywheel magneto itself does not require inspection, however, the following precautions are necessary when operating in the flywheel area during servicing operations. The magnets is attached to the flywheel using adhesive glue, so it will be necessary to observe the following precautions.

Precautions:

- Avoid applying shock or impact to the flywheel, such as that from the tapping of a hammer.
- Be sure to use the recommended tool rather than selecting from any standard tools that happen to be available.
- Always replace the flywheel if it has been dropped on the floor or any other hard surface.

Resistance Values for Coils

- These include values for the ignition coil, alternator coil, and crank position sensor.

Refer to the section "Specifications and Standards Used in Servicing" in Chapter 2.

Rectifier Regulator

Inspect:

- For faulty connections or severed lines in the wire harness.
- Measure conductivity and resistance values by referring to the check sheet table below. (Values listed are standard values.)
- Disconnect wiring and measure with regulator isolated from electrical system.

Rectifier Checkpoint Table

		Tester + lead (red)				
		Red	Yellow	Black	Yellow	Yellow
Tester - lead (black)	Red		OFF	OFF	OFF	OFF
	Yellow	ON (4kΩ)		OFF	OFF	OFF
	Black	ON (5kΩ)	ON (4kΩ)		ON (4kΩ)	ON (4kΩ)
	Yellow	ON (4kΩ)	OFF	OFF		OFF
	Yellow	ON (4kΩ)	OFF	OFF	OFF	

Note:

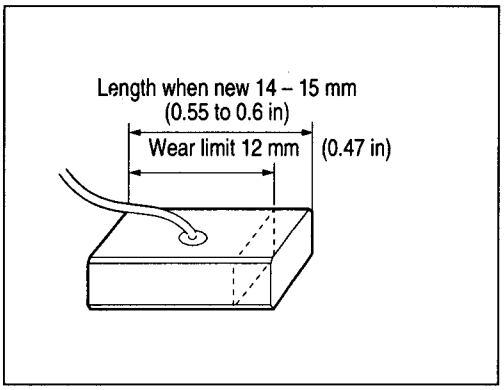
- Measure using the Hioki HiTester model 3030 or equivalent product. Do not use an insulation resistance tester. (megohm – meter)
- The tester needle moving represents an ON reading and not moving represents an OFF reading. The ( ) contain approximate values for the 1 kΩ range. Note that values will vary depending on tester condition (internal power supply), testing range and the individual model.
- Be sure to disconnect any wiring connections in order to isolate each component before measuring.
- The readings obtained using this testing procedure are not absolute values and are intended for use only as reference.

Starter Motor

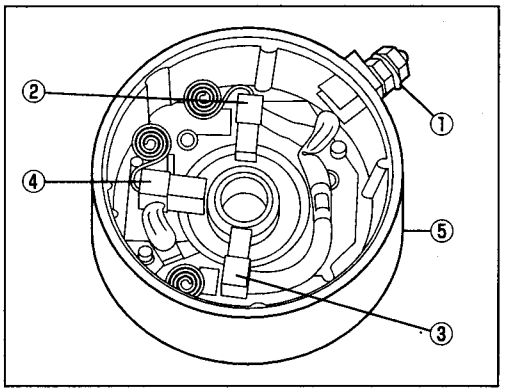
Brushes and Springs

1. Check the brushes for wear.

When brush length is 12 mm (0.47 in) or less ⇨ Replace with new one.

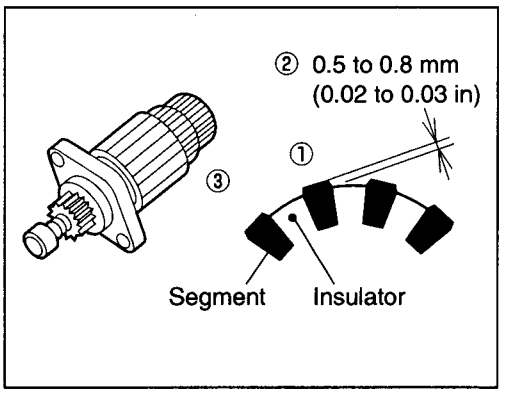


2. Inspecting the green cable between the brush holders.
   Using an analog multimeter, inspect conduction between the following components.
   - When the meter detects conductivity between brush ② and brush ④ and between brush ③ and brush ④ replace the brush assembly.
   - When the meter detects conductivity between brush ② and motor base ⑤ and between brush ③ and motor base ⑤ replace the brush assembly.
   - When the meter detects conductivity between brush ② and starter motor connector ① and between brush ③ and starter motor connector ① replace the brush assembly.
   - When the meter detects conductivity between brush ④ and motor base ⑤ replace the brush assembly.



③ Brush spring tension

When there is a loss of tension ⇨ replace spring.



Armature

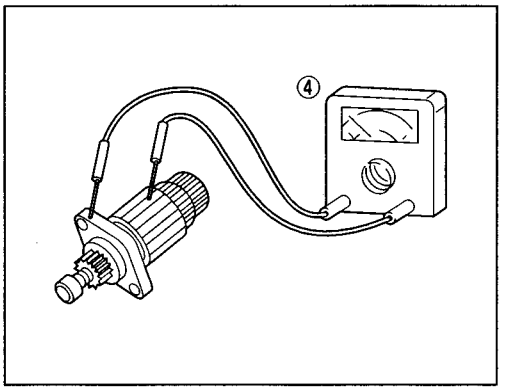
① Measure the depth of the insulator on the commutator.

② When the distance at location ② does not fall within the 0.5 to 0.8 mm (0.02 to 0.03 in) range or when deformed from excessive wear, repair the teeth attached to the plate so that they conform to the designated range.

③ To remove excessive carbon buildup on the commutator, select a sandpaper in the #500 to #600 range.

④ Inspect the armature insulation.

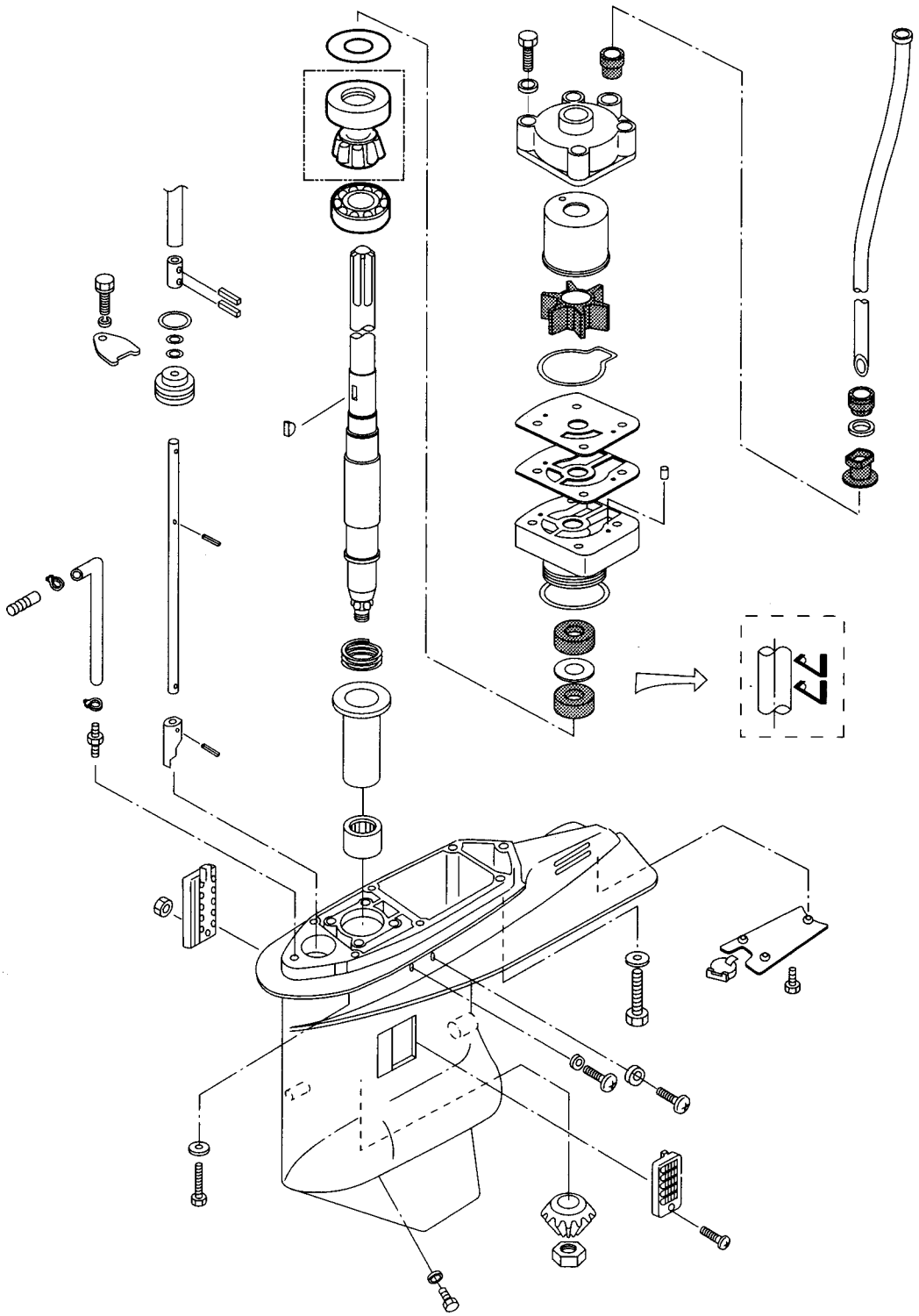
When conductive ⇨ Replace starter motor assembly.



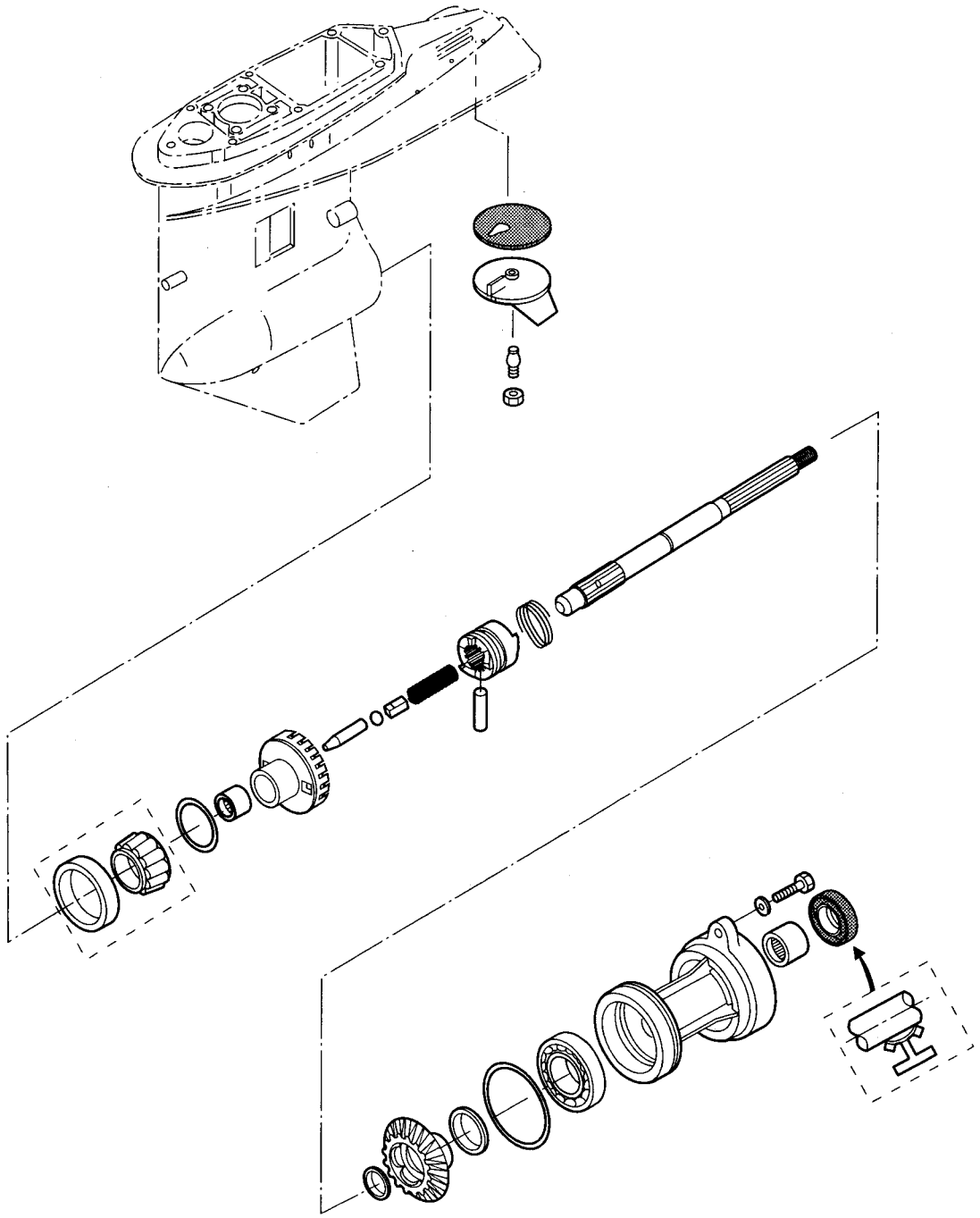
Chapter 6 Lower Unit

1. Configuration

GEAR CASE (DRIVE SHAFT)



GEAR CASE (PROPELLER SHAFT)



2. Disassembly

Caution:

- Begin the procedure by first removing the spark plug caps and then removing the spark plugs.
- When working with the outboard engine tilted full up, make sure to secure the engine firmly in place using a tilt up stopper.

Disassembling Gear Case

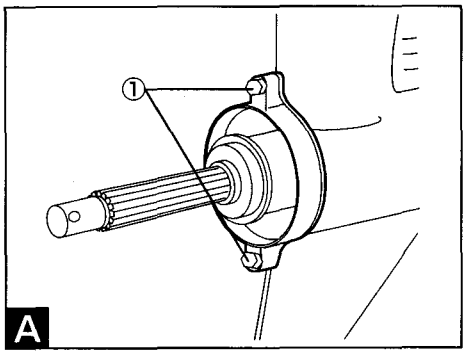
The gear case can be disassembled from this outboard engine without having to remove the power unit.

Refer to Section 5 and Section 7 of Chapter 3 for information about propeller disassembly, gear case disassembly and oil drain and water pump impeller disassembly.

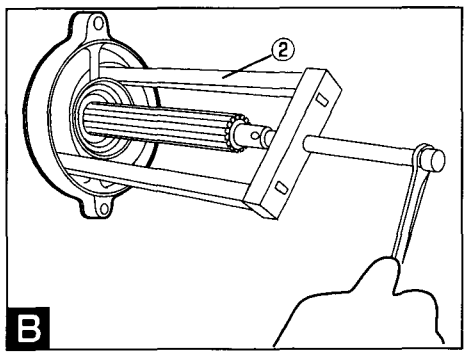
Caution:

- During disassembly be sure to securely mount the gear case using a holding tool (for instance, a vise). Drain all gear case oil into a receptacle and inspect to determine whether metal pieces are mixed in with the oil.
- Small metal pieces mixed in with the oil may be the result of natural wear to the gear, bearing, or shaft. The presence of large metal pieces usually suggests severe internal damage. When inspecting internal components be sure to make a note of any observations for future reference.

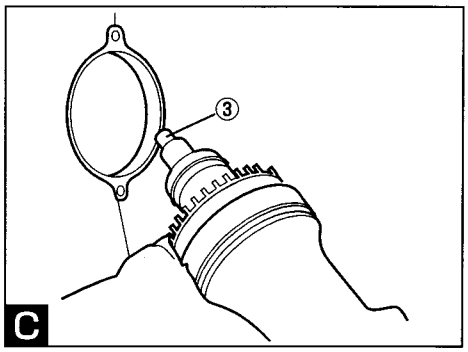
	Special tool	Part number
2	Propeller shaft housing puller	353-72252-0
4	Drive shaft socket	3B7-72232-0
5	Bevel gear B nut wrench	3B7-72231-0



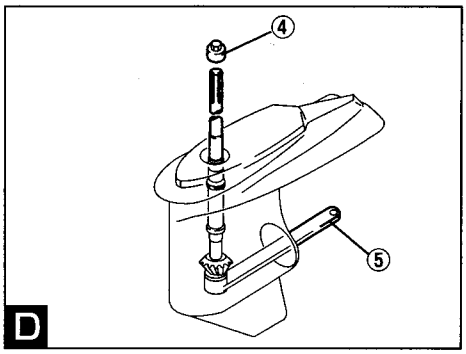
A : 1. Remove propeller shaft housing bolts ①.
B : 2. Attach the propeller shaft housing puller ② and tighten the bolt until the propeller shaft housing separates from the gear case.

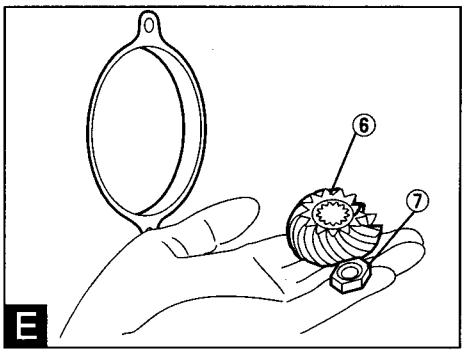


C: 3. Remove the propeller shaft and housing from the gear case. Make sure that the clutch push lock ③ has also come free.

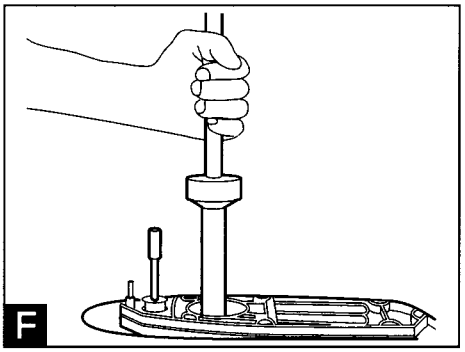


D: 4. Completely degrease the drive shaft spline.
E and bevel gear B nut ⑦. Hold down the bevel B gear nut with the bevel B gear nut wrench ⑤, with the drive shaft socket ④ rotate the drive shaft counter-clockwise and loosen the nut. Disassemble the bevel gear B ⑥ and nut ⑦ from the gear case.

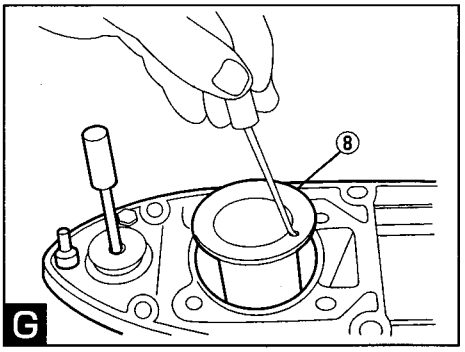




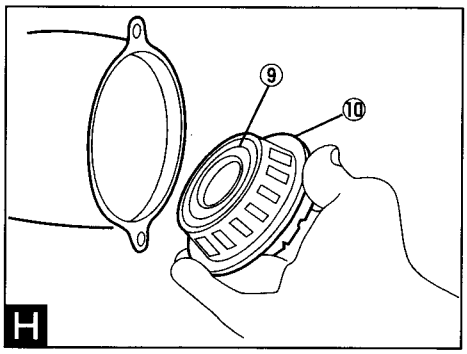
F: 5. Lift the drive shaft away from the gear case.



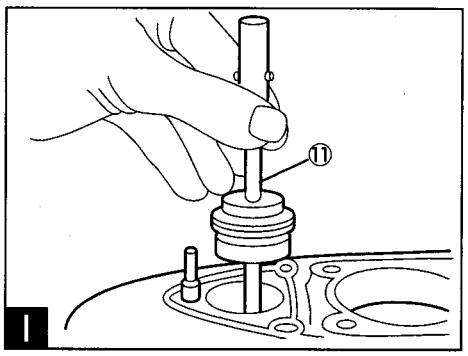
G: 6. Use a wire or another type of hooking device to remove the drive shaft spring guide ⑧.



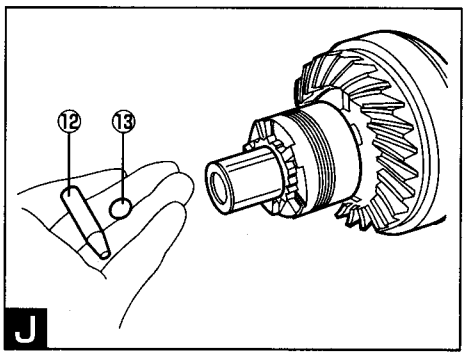
H: 7. Insert you hand inside the gear case and remove the bearing ⑨ and bevel gear A ⑩.



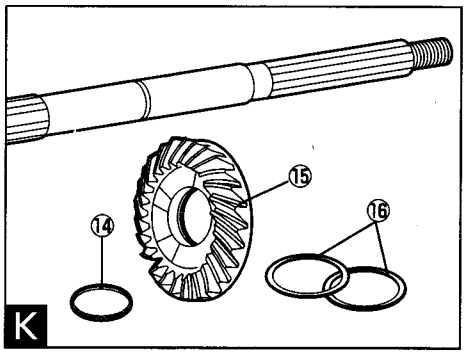
I: 8. Remove the stopper and cam rod ⑪ from the gear case. Completely disassemble cam rod components including the cam rod bushing and internal and external O-rings.



J: 9. Remove the clutch push rod ⑫ and ball ⑬ from the propeller shaft and pull on the propeller shaft to remove it from its housing.



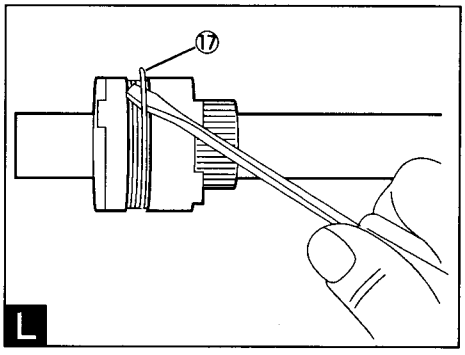
K: 10. Disassemble the washer ⑭, bevel gear ⑯, and all shims.



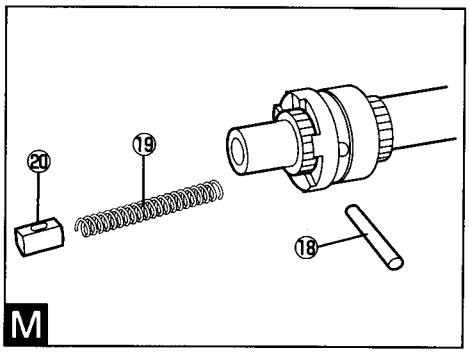
L: 11. Insert a flathead screw driver under one end of the clutch pin snap ⑰ and wind the snap away from the clutch to remove it from its groove.

Caution:

Be sure to replace the clutch pin snap ⑰ with a new snap. Reusing the snap may cause it to expand while the engine is running and cause severe damage to other components.



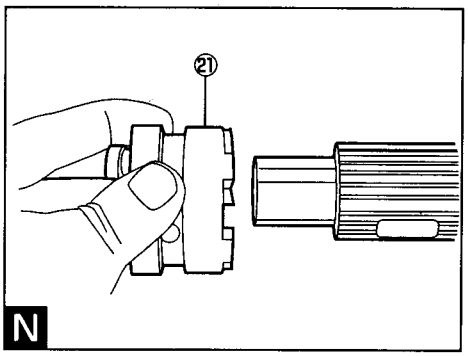
M: 12. Place the area of the propeller shaft opening (the side with bevel gear A) on a workbench and push out the clutch pin ⑱. Replace the clutch spring ⑲ and spring holder ⑳ if necessary.



Warning:

The clutch pin and spring holder release from the propeller shaft with great force. Be sure to wear protective eyeglasses when removing the clutch pin. Do not hold the propeller shaft with the opening pointing in the direction of your face or body.

N: 13. Remove the clutch ㉑ from the propeller shaft.



3. Inspection

Inspect following components.

Component	Inspection points	Remarks
Bevel gears A,B,C and clutch	• Wear and damage on pawls of bevel gears A and C • Wear and damage on clutch pawl • Meshing of bevel gears A,B and C and backlash* • Wear on bearings for bevel gears A and C	Replace Replace Replace as necessary Replace
Propeller shaft	• Play between clutch and spline • Misalignment	Replace as necessary Replace
Drive shaft	• Drive shaft misalignment • Wear on spline area • Contact with needle roller bearing • Wear on impeller key grooves	Replace★ Replace as necessary Replace as necessary Replace
Water pump	• Wear or cuts on impeller blade • Wear or cracking on impeller key grooves • Wear on impeller key • Wear or deformation of pump case liner • Wear on pump guide plate • Wear or cuts on pump case lower oil seal lip	Replace Replace Replace Replace Replace as necessary Replace as necessary
Propeller shaft housing	• Wear or cuts on oil seal lip • Knocking against bearing housing • Cracks on tightening bolt boss	Replace as necessary Replace Replace
Gear case	• Cracks or damage • Bending or damage to skag	Replace Repair or replace
Clutch cam	• Wear due to contact with push rod	Replace as necessary
Push rod	• Wear due to contact	Replace as necessary
Steel ball	• Wear due to contact	Replace as necessary
Spring holder	• Wear due to contact	Replace as necessary
Clutch pin	• Bending	Replace
Drive shaft bearing	• Damage or wear	Replace

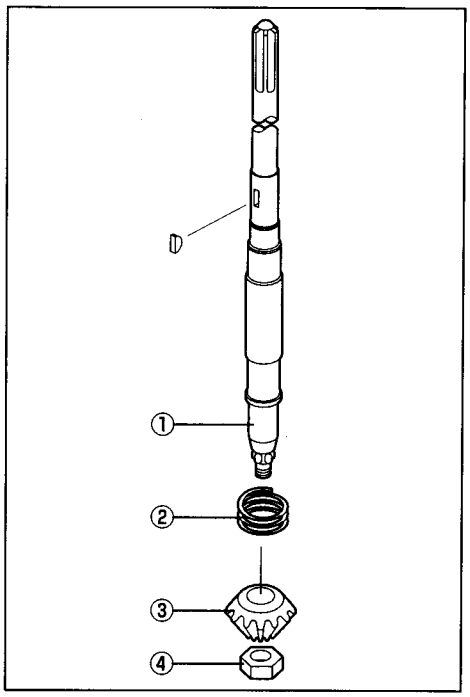
* Refer to the information on the values read by the backlash gauge and adjusting shims in Section 5 of this chapter.

★Refer to Section 8 of Chapter 2.

4. Reassembly

Assembling Gear Case

Observe the precautionary notes provided at various steps while assembling in the reverse order of disassembly.



Installing Bevel Gear on Drive Shaft

Install following components.

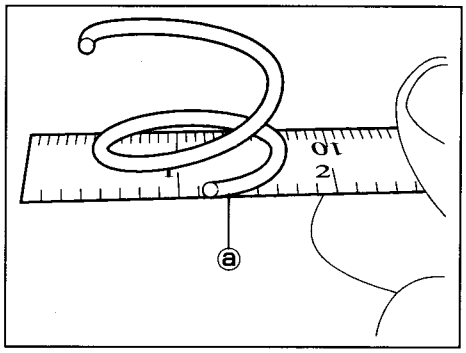
- Bevel gear A bearing

Use the outer race to press fit the bearing in place.

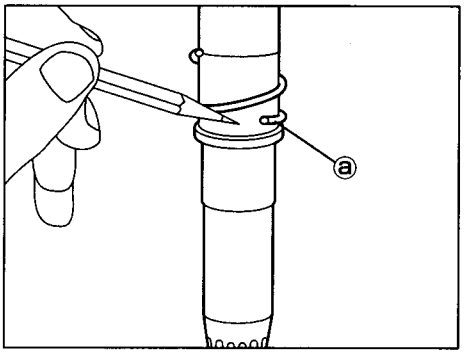
① Drive shaft
② Drive shaft Spring
③ Bevel gear B
④ Bevel gear B nut

Drive shaft spring alignment:

Position the end-turn side ⓐ of the drive shaft spring facing the bevel-gear side of the drive shaft and slide the spring upward from the bottom of the shaft. Install the spring so that the end-turn side ⓐ is seated against the drive shaft stopper.



Bevel B nut tightening torque
98 – 120 N-m (10 – 12 kg-m) [72 – 78 ft-lb]



Special tool	Bevel gear B nut wrench: 3B7-72231-0 Drive shaft socket: 3B7-72232-0

Applying Adhesive

Drive shaft*	Completely degrease	Three Bond
Bevel gear B nut	the screw area and tapered area	1373B

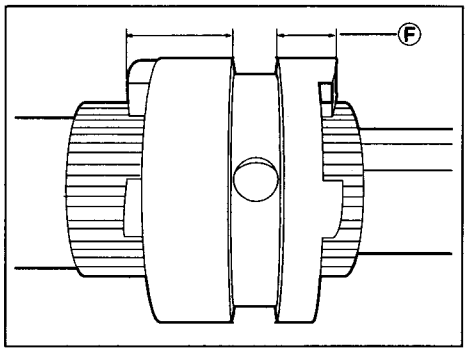
* Take care not to apply adhesive to the tapered surface area or spline area.

Assembling Propeller Shaft and Clutch

Assemble following the reverse sequence of the disassembly procedure.

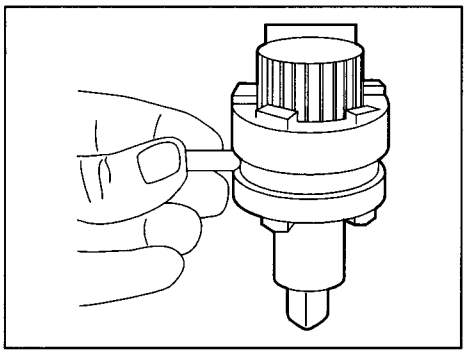
Clutch Direction

Install the clutch with the narrow part of the clutch pawl facing bevel gear A (direction F).

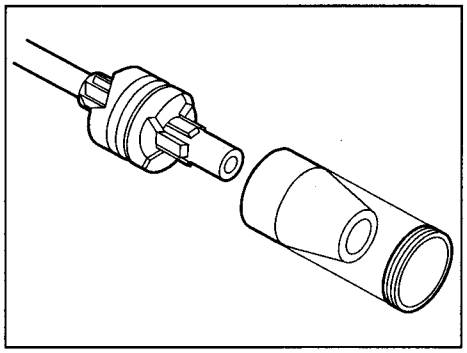


Assembling Clutch Pin Snap

- Slide the clutch spring, spring holder, steel ball, and push rod onto the propeller shaft.

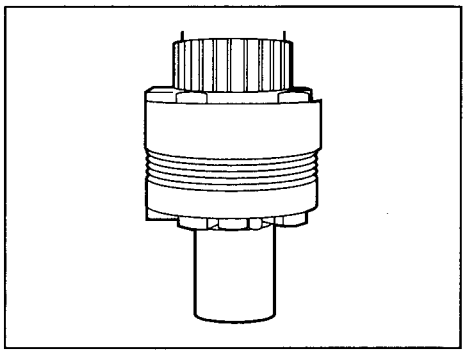


- Push on the push rod and insert the clutch pin into the holes in the clutch and spring holder.
- Remove the push rod and steel ball.
- Slidethe clutch pin snap tool on the propeller shaft.
- Slide the clutch pin snap onto the tool and attach it to the clutch grooves.



Clutch pin snaps ⇨ Replace with new snaps.

Special tool	Clutch pin snap tool 345-72229-0



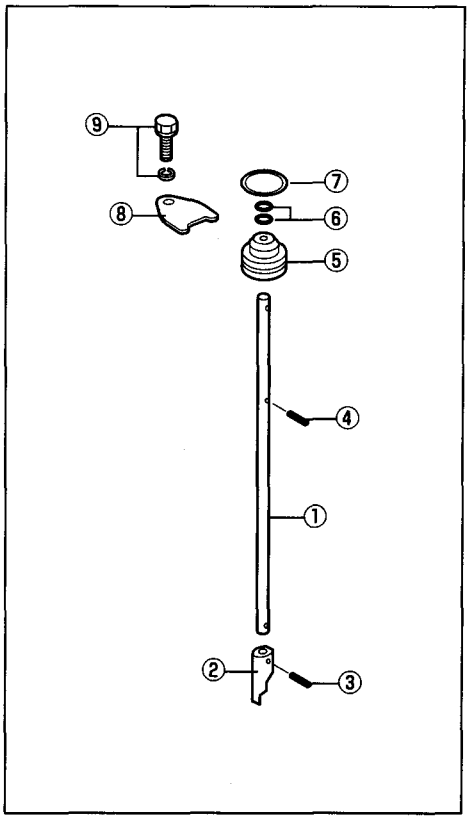
Assembling Clutch Cam, Cam Rod and Clutch Cam Rod Bushing

Install following components on the cam rod ①

- Clutch cam ②
- Clutch cam spring pin: 3.5 – 16 ③
- Clutch cam spring pin: 3.5 – 10 ④
- Install the following components on the cam rod
- bushing ⑤
- O-ring: 1.9 – 6.8
- O-ring: 3.5 – 21.7

Special tool	Spring pin tool B
	345-72228-0

Spring pins must never be reused.
Apply gear oil to the O-rings.
Install so that the spring pin ③ does not protrude out from the clutch cam.



Install following components on the gear case.

- Cam rod assembly
- Cam rod bushing stopper

Tighten the stopper ⑧ using the bolt H612 ⑨ and secure the cam rod bushing

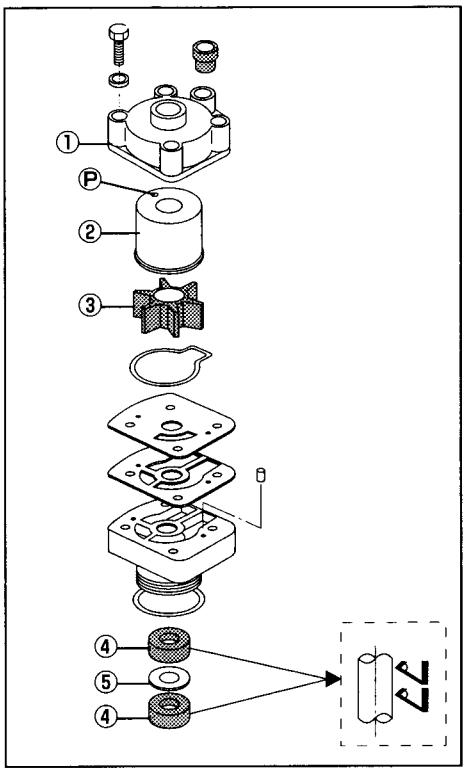
Once installation is completed, operate the cam rod to confirm that it moves freely up and down.

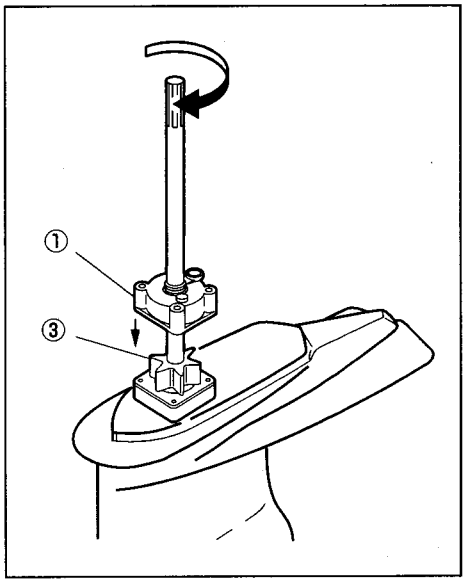
Assembling Water Pump

Install following components.

Refer to Section 7 Inspecting Cooling System of Chapter 3 Inspection and Maintenance for detailed descriptions of components.

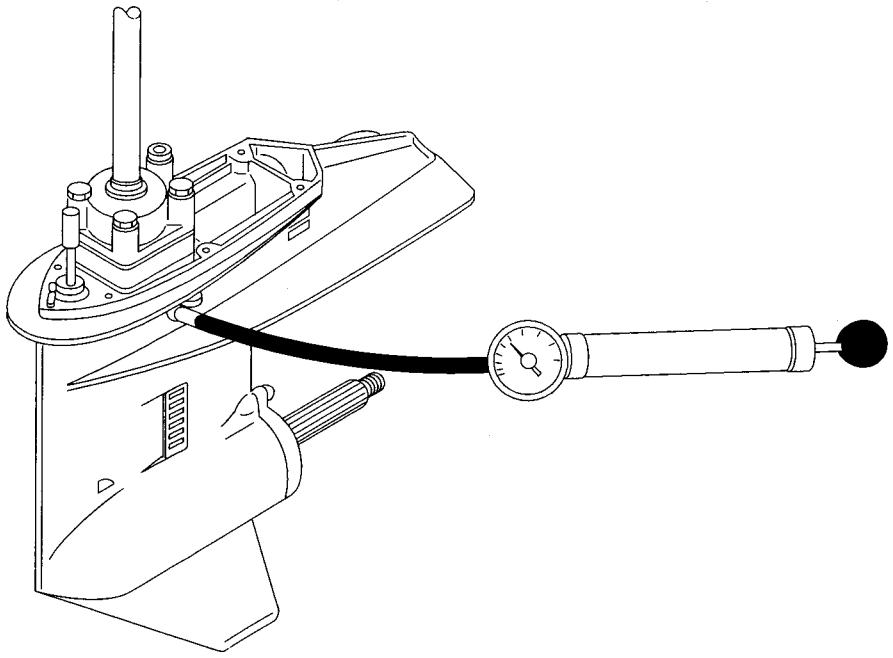
- Confirm the alignment of the oil seals ④.
- Apply gear oil to the lip area of the oil seals ④.
- Insert the shim ⑤ between the oil seals ④.
- Insert the drive shaft into the pump case, taking care not to scratch the lip area of the oil seals ④.
- Carefully fit the protruding side Ⓟ of the pump case liner ② into the recession in the upper pump case ①.
- Insert the pump impeller key firmly into the drive shaft.
- Apply OBM grease in the pump case liner ②.
- When installing the pump impeller ③ in the upper pump case ①, rotate the drive shaft as shown in the figure to the bottom right an push. (Make sure that the pump impeller ③ blades are correctly aligned.)





Testing Gear Case Pressure Resistance

• Before adding gear oil conduct a gear case pressure resistance test and vacuum test following the procedures described below.



Positive Pressure Test

•Remove the upper oil plug and attach the gear case pressure tester.

• Increase pressure until the pressure tester gauge registers a reading of 21 – 42 kPa (0.2 – 0.4 kg/cm², 2.8 –5.7 psi). If a pressure leak occurs immerse the gear case in water and identify the area of the leak. After making the necessary repairs conduct the test again.

• Remove the pressure tester.

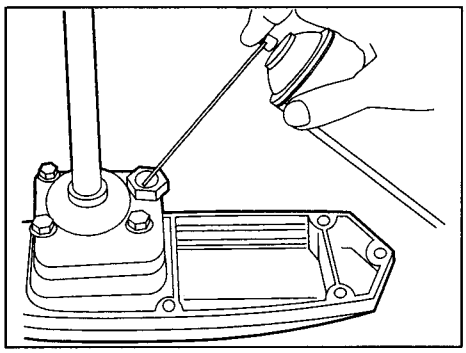
Negative Pressure Test

• Attach the gear case vacuum tester to the upper oil plug screw area.

• Increase the degree of vacuum until the vacuum tester gauge registers a reading of 10.1 – 16.9 kPa (76 – 127 mm, 3 – 5 in on the mercury). If a vacuum leak occurs apply oil to the seal suspected to be leaking. If the leak stops and oil is sucked into the gear case, the seal is defective and should be replaced. After making the necessary repairs and correcting the problem conduct the test again.

Adding Gear Oil

Refer to Section 5 Inspecting Gear Case Area of Chapter 3 Inspection and Maintenance for a detailed description of the gear oil replacement procedure.



Assembling Gear Case Assembly

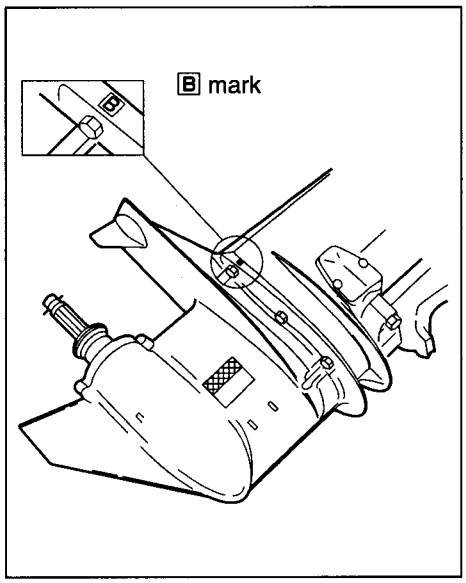
Precautions to follow before assembling.

• Apply a thin coating of the specified grease to the spline area on the engine side of the drive shaft.
Grease Type: Nippeko LT-2

Apply oil to the water pipe rubber seal.

Installing the Gear Case Assembly on the Drive Shaft Housing

Assemble by first installing bolts at the 2 locations on the gear case marked with the [B], then install the remaining bolts.



Tightening torque
M8 bolts : 24 – 26 N-m (2.4 – 2.6 kg-m)
: [17 – 19 ft-lb]
M10 bolts : 37 – 41 N-m (3.8 – 4.2 kg-m)
: [28 – 30 ft-lb]

Spring pin ⇨ Replace with new pin

Special tool	Spring pin tool B
	369-72218-0

5. Gear Backlash

1. Positioning Bevel Gear B: Shimming Gauge

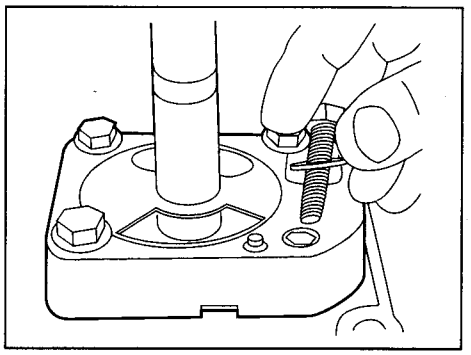
Positioning of bevel gear B must be performed prior to the backlash measurement.

Special tool	Shimming gauge	3B7-72250-0
	Thickness gauge	353-72251-0

Checking

1. Install lower pump case to fix driveshaft.
   Note: use bolt and plain washers.

Tightening torque
11 – 15 N-m (1.1 – 1.5 kg-m) [8 – 11 lb-ft]



2. Install bevel gear B ③.

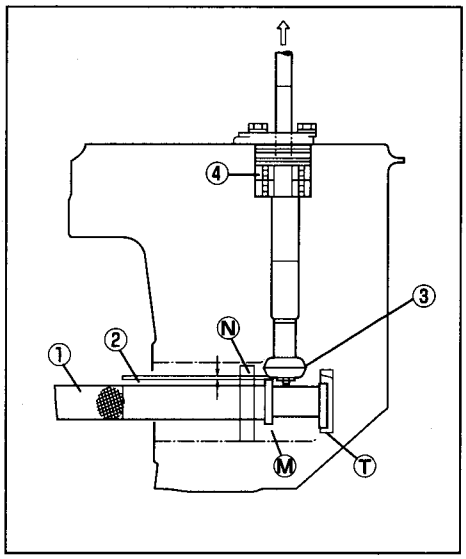
Tightening torque
40 – 58 N-m (4 – 6 kg-m) [29 – 44 lb-ft]

3. Insert shimming gauge ①.

Note: * Taper Ⓣ must be contacted to bearing outer surface firnaly.
* Opening slit of shimming gauge at Ⓝ must be at the position 12 o`clock.

4. Measure the gap between Ⓜ position of gauge and bevel gesr B with thickness gauge ②.
   Note: When measuring, driveshaft must be pulled up as shown as an arrow mark completely so as not have any play.

Gap	0.6 – 0.64 mm (0.0236 – 0.0252 in)



5. If the gap is not in the specified range, adjust the gap with the shim.

Shim	Location
①0.1mm(0,00394in) ②0.15mm(0.00591in) ③0.3mm(0.01181in)	Between Lower pump case and bearing.

2. Gear Backlash

Bevel Gear Backlash Measurement Tool Specifications:

Special tools for measuring the gap between bevel gear A and bevel gear B

Number	Tool	Part number	Quantity	Stamped Mark	Symbol in text
1	Backlash measuring tool kit A	3B7-72234-0	1 kit		
1-1	Set piece A	3B7-72245-0	1	BCD	③
1-2	O-ring, 2-9	332-60002-0	1		④
1-3	Cone disk spring	3B7-72734-0	6		②
1-4	Shaft	3B7-72723-0	1	BCB	①
1-5	Plate	3B7-72724-0	1	BCA	⑤
1-6	Nut, 12P1.5	3B7-72735-0	2		⑥
2	Clamp assembly	3B7-72720-0	1		⑦
3	Dial gauge plate	3B7-72729-0	1		⑧
4	Bolt (for lower pump case)	910191-0835	4		

Special tools for measuring the gap between bevel gear B and bevel gear C

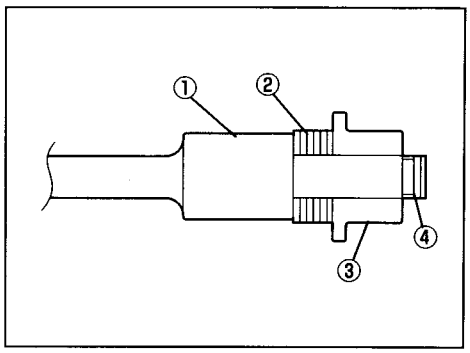
Number	Tool	Part number	Quantity	Stamped Mark	Symbol in text
5	Backlash measuring tool kit B	3B7-72255-0	1		
5-1	Retainer	3B7-72703-0	1	BEC	⑬
5-2	Set piece B	3B7-72727-0	1	BED	⑫
5-3	Shaft B	3B7-72726-0	1	BEB	⑪
5-4	Plate B	3B7-72725-0	1	BEA	⑭
5-5	Washer, 13-21-2.5	346-72707-0	1		⑮
5-6	Nut, 12P1.5	3B7-72735-0	1		⑯
2, 3, 4	Identical to the tools for the gap between bevel gears A and B				

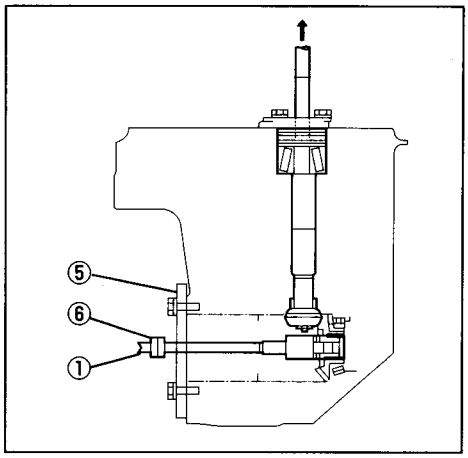
- Be sure to position bevel gear B prior to measuring bevel gear backlash.

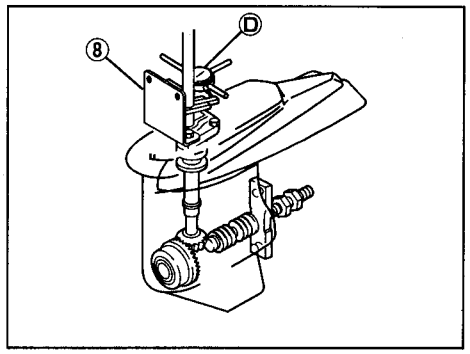
Be sure to position bevel gear B prior to measuring bevel gear backlash.

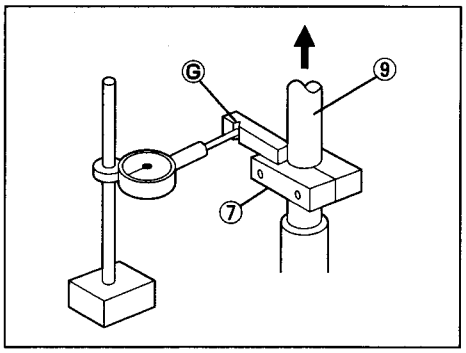
2-1) Measuring Backlash Between Bevel Gear A and Bevel Gear B

1. Assemble backlash measuring tool kit A. Place 6 cone springs ② (two sets of three arranged back-to-back) on the shaft ①. After inserting the O-ring ④ in the grooves of the shaft, slide the set piece ③ onto the shaft. Screw the plate ⑤ onto the other side of the shaft.
2. Attach the assembled shaft unit to the gear case. Tighten down the plate ⑤ with the bolts.
3. Tighten the shaft ① until the drive shaft begins to rotate.
4. After the drive shaft begins to rotate screw in the shaft another one-half turn (180°).
5. Using the nut ⑥, secure the shaft so that it doesn't move even if the drive shaft is rotated .
6. Secure the clamp assembly ⑦ in a location near the drive shaft lower pump case.
7. Secure the dial gauge plate ⑧ to the gear case.
8. Install the dial gauge (D) on the plate and position the tip of the dial gauge at a right angle to the clamp assembly ⑦ v-groove (G).
9. Pull up on the drive shaft ⑨ while rotating it and take a dial gauge reading.









Backlash Gauge Reading and Corresponding Adjusting Shim Sizes

Remark: This information applies to backlash between bevel gear A and bevel gear B and between bevel gear B and bevel gear C.

	Gauge reading
Appropriate backlash	0.24 – 0.48 mm : 0.0094 – 0.0189 in

Notes:

1. The values listed in the table represent the range of dial gauge readings taken using the various special tools.
2. Replace shims as necessary in order to adjust to the required thickness. A + sign indicates that shim thickness should be increased, while a - sign indicates it should be decreased.
3. It is important to repeat the measuring procedure several times.

Example:

- Shim replacement is unnecessary in cases where backlash values fall within the designated range.
- If the gauge reading is 0.70 mm, a 0.10 mm shim should be added.

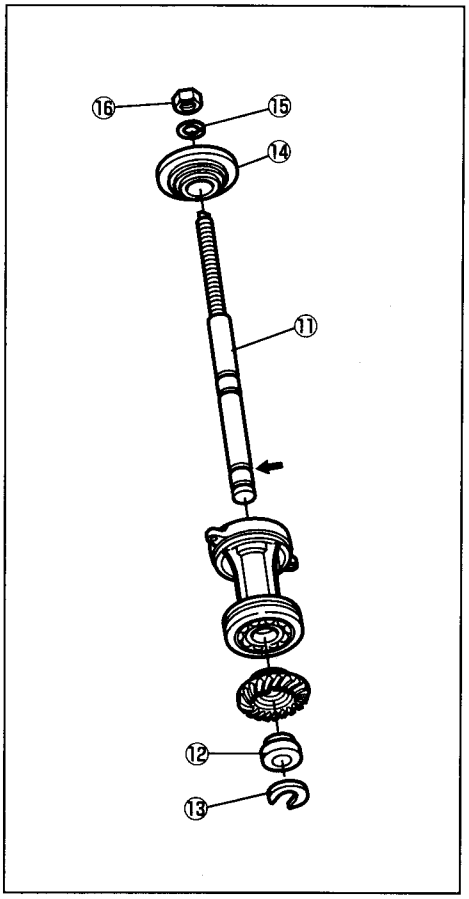
Shim size in mm	Location	Shim size
0.1, 0.15 (0.0039, 0.0059 in)	between bevel gear A and bearing	47 × 57 (1.85 × 2.24 in)
0.1, 0.15 (0.0039, 0.0059 in)	between bevel gear C and bearing	42 × 50 (1.63 × 1.97 in)

MD 90A & B	
Shim size in mm(inch)	Shim thickness in mm(inch) + increase / - decrease
0.00 – 0.11 (0.0000 – 0.0043)	– 0.10 (– 0.0039)
0.12 – 0.23 (0.0047 – 0.0090)	– 0.05 (– 0.0019)
0.24 – 0.48 (0.0094 – 0.0188)	0.00 (0.0000)
0.49 – 0.59 (0.0192 – 0.0232)	+ 0.05 (+ 0.0019)
0.60 – 0.74 (0.0236 – 0.0291)	+ 0.10 (+ 0.0039)
0.75 – 0.89 (0.0290 – 0.0350)	+ 0.15 (+ 0.0059)
0.90 – 1.04 (0.0354 – 0.0409)	+ 0.20 (+ 0.0078)
1.05 – 1.20 (0.0413 – 0.0472)	+ 0.25 (+ 0.0098)
1.21 – 1.35 (0.0476 – 0.0531)	+ 0.30 (+ 0.0118)
1.36 – 1.50 (0.0535 – 0.0590)	+ 0.35 (+ 0.0137)
1.51 – 1.65 (0.0594 – 0.0649)	+ 0.40 (+ 0.0157)
1.66 – 1.81 (0.0653 – 0.0712)	+ 0.45 (+ 0.0177)
1.82 – 1.96 (0.0716 – 0.0771)	+ 0.50 (+ 0.0196)
1.97 – 2.11 (0.0775 – 0.0830)	+ 0.55 (+ 0.0216)
2.12 – 2.26 (0.0834 – 0.0889)	+ 0.60 (+ 0.0236)

MD 70A & B	
Shim size in mm(inch)	Shim thickness in mm(inch) + increase / - decrease
0.00 – 0.14 (0.0000 – 0.0055)	– 0.10 (– 0.0039)
0.15 – 0.26 (0.0059 – 0.0102)	– 0.05 (– 0.0019)
0.27 – 0.54 (0.0106 – 0.0212)	0.00 (0.0000)
0.55 – 0.66 (0.0216 – 0.0260)	+ 0.05 (+ 0.0019)
0.67 – 0.84 (0.0263 – 0.0330)	+ 0.10 (+ 0.0039)
0.85 – 1.01 (0.0334 – 0.0397)	+ 0.15 (+ 0.0059)
1.02 – 1.19 (0.0401 – 0.0468)	+ 0.20 (+ 0.0078)
1.20 – 1.37 (0.0472 – 0.0539)	+ 0.25 (+ 0.0098)
1.38 – 1.54 (0.0543 – 0.0606)	+ 0.30 (+ 0.0118)
1.55 – 1.72 (0.0610 – 0.0677)	+ 0.35 (+ 0.0137)
1.73 – 1.90 (0.0681 – 0.0748)	+ 0.40 (+ 0.0157)
1.91 – 2.07 (0.0751 – 0.0814)	+ 0.45 (+ 0.0177)
2.08 – 2.25 (0.0818 – 0.0885)	+ 0.50 (+ 0.0196)

2-2) Measuring Backlash between Bevel Gear B and Bevel Gear C

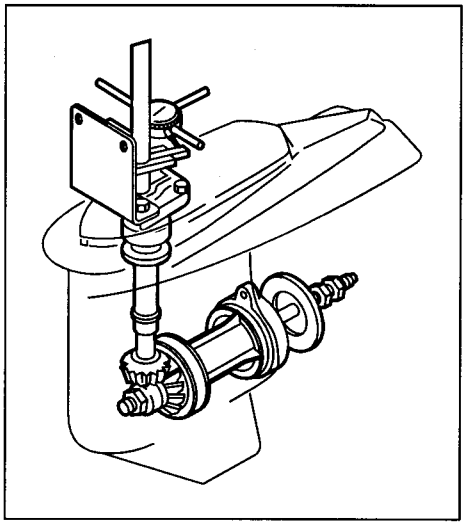
1. Disassemble bevel gear A.
2. Install bevel gear C on the propeller shaft housing.
3. Pass shaft B ⑪ through the propeller shaft housing.
4. Slide set piece B ⑫ over shaft B ⑪ and fit the retainer ⑬ into the groove on the shaft.
   Note: Install the side of the retainer ⑬ without a v-groove on the propeller side.
5. Press fit the parts assembled in Items 2. to 4. above into the gear case and secure the propeller shaft housing with the bolt.
6. Slide plate B ⑭ over shaft B ⑪ and attach it using the washer ⑮ and nut ⑯.
7. Secure the drive shaft with your hand and tighten the nut ⑯ with your fingers. Then, tighten the nut an additional 1/4 turn with a wrench.
8. To measure backlash, carry out Items 6 to 9 of the procedure for measuring backlash between bevel gear A and bevel gear C.



2-3) Confirming Propeller Shaft Front-to-rear Play

After adjusting backlash, confirm front-to-rear play in the propeller shaft once the gear case assembly has been normally assembled.
If play exceeds the reasonable range of 0.2 to 0.4 mm, select a bevel gear C washer for washer replacement.

Bevel gear C washer sizes	Location
2.8, 3.0, 3.2 mm (in) (0.11, 0.118, 0.126 in)	The side of bevel gear with teeth



6. Removing and Replacing Bearings

This section describes procedures to follow when it becomes necessary to replace the following crank case components during maintenance.

- Drive shaft tapered roller bearing
- Gear case needle bearing
- Propeller shaft housing needle bearing
- Bevel gear A tapered roller bearing
- Bevel gear A needle bearing
- Bevel gear C ball bearing

1. Drive Shaft Tapered Roller Bearing

Disassembling inner race:

Drive shaft inner race bearing diameter "D" and inner race diameter "d" are the same. Accordingly, it is not possible to prepare an inner race bearing tool.

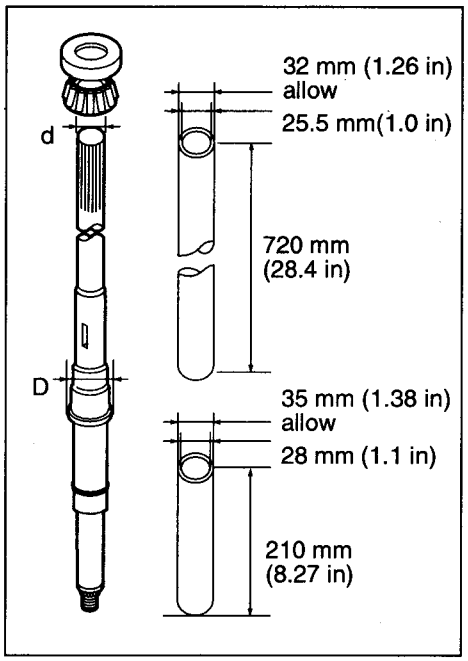
To remove the inner race, position a flathead screwdriver or similar tool in contact with the bearing and tap the screwdriver with a hammer.

Example:

Reuse of removed bearings is prohibited.

Reassembling inner race:

Prepare the metal pipe shown in the figure and apply pressure using a press.



2. Needle Bearing

Gear Case and Propeller Shaft Housing Needle Bearing

Special tools for removing and replacing the bearing

No.	Tool	Part number	Quantity	Stamped Mark	Application	
					Gear case	Propeller shaft housing
1	Needle bearing puller kit	3B7-72700-0	1			
1-1	Shaft ①	3B7-72702-0	1	NDC	○	○
1-2	Retainer ②	353-72703-0	1	NDF	○	
1-3	Guide A ③	3B7-72705-0	1	NDG	○	
1-4	Stopper ④	353-72704-0	1	NDD	△	△
1-5	Plate ⑤	3B7-72701-0	1	NDB	○	○
1-6	Washer, 13-21-2.5 ⑥	346-72707-0	1		○	○
1-7	Nut, 12P1.5 ⑦	3B7-72735-0	1		○	○
1-8	Retainer B ⑧	3B7-72709-0	1	NDI		○
1-9	Guide B ⑨	3B7-72710-0	1	NDH		○

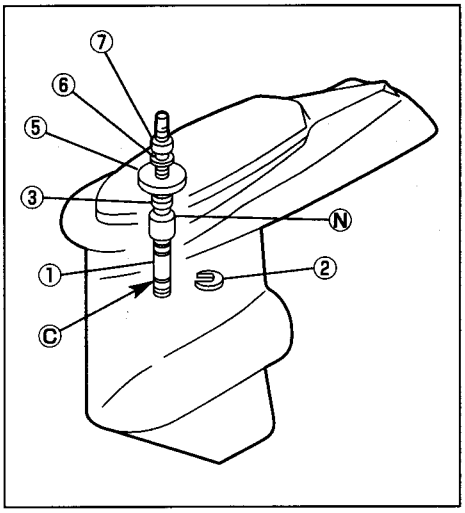
Remarks:

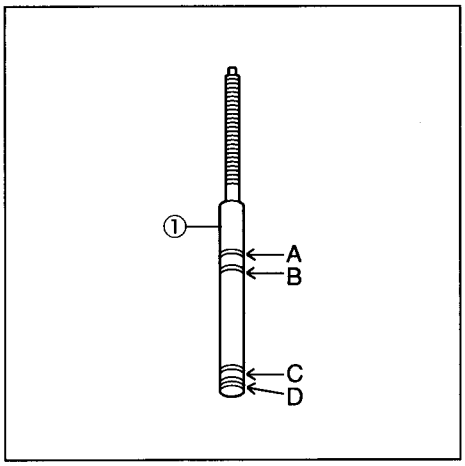
○: Used for removing or replacing bearings.

△: Used for replacing bearings.

Removing Gear Case Needle Bearing

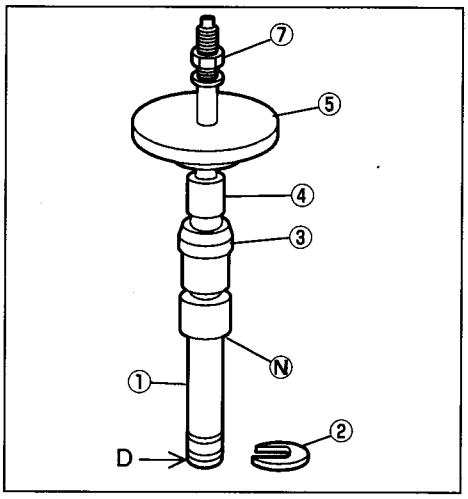
1. Disassemble the drive shaft, lower pump case, propeller case, and all surrounding parts.
2. Insert the shaft ① into the gear case from the water pump side.
3. Attach the retainer ① to groove Ⓒ from the propeller shaft ② side.
4. Attach the guide A and plate ③ to the shaft ⑤ from the water pump side.
5. Secure the screw end of the shaft ① using a wrench, and tighten the nut ⑦ until the needle bearing Ⓝ separates from the housing.





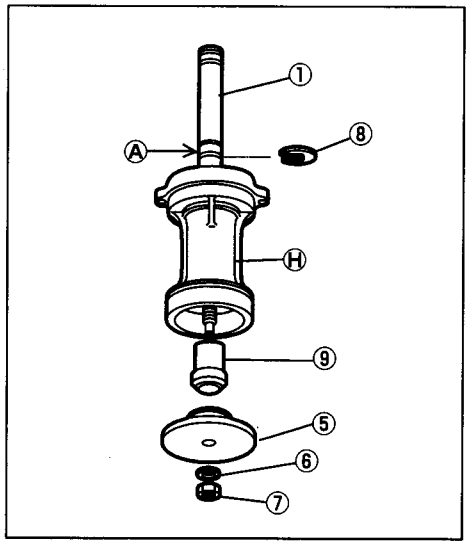
Replacing Gear Case Needle Bearing

1. Insert the shaft ① into the gear case from the water pump side.
2. Attach guide A ③ and the needle bearing Ⓝ to the shaft ① from the propeller shaft side.
   Note: Be sure to align the carved side of the needle bearing toward the propeller shaft side. Also, apply gear oil.
3. Insert the retainer ② into groove D of the shaft ①.
   Note: Be sure to align the v-groove surface of the retainer ② toward the bearing.
4. Attach the stopper ④ and plate ⑤ to the shaft ① from the water pump side.
5. Secure the screw side of the shaft ① with a wrench and tighten the nut ⑦ until the stopper ④ comes



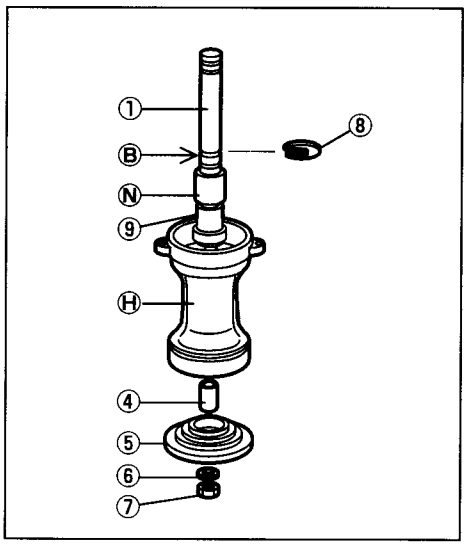
Removing Propeller Shaft Housing Needle Bearing

1. Remove the oil seal from the propeller shaft housing Ⓗ.
2. Heat the propeller shaft housing Ⓗ and remove the ball bearing.
   Remark: The advisable method of heating the propeller shaft housing is to immerse it in a receptacle containing hot water.
3. Place the needle bearing over the shaft ①.
4. Attach retainer B áG to groove Ⓐ of the shaft ①.
   Note: Be sure to align the v-groove surface of retainer B ⑧ toward the bearing.
5. Attach guide B ⑨ and the plate ⑤ to the screw side of the shaft ①.
6. Secure the screw end of the shaft ① with a wrench and tighten the nut ⑦ until the needle bearing separates from the housing.



Replacing Propeller Shaft Housing Needle Bearing

1. Attach retainer Ⓑ ⑧ to the groove of the shaft ①.
   Note: Be sure to align the v-groove surface of retainer Ⓑ ④ toward the bearing.
2. Insert the needle bearing Ⓝ and guide B ⑨ over the shaft ① from the screw side, and insert the shaft ① into the propeller shaft housing Ⓗ from the propeller side. Also, apply gear oil.
3. Attach the stopper ④ and plate ⑤ to the shaft ① from the gear side.
4. Secure the screw side of the shaft ① with a wrench and tighten the nut until the stopper ④ comes into contact with the plate ⑤.



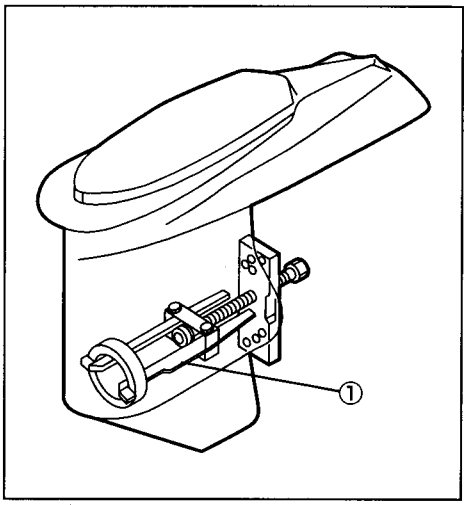
3. Bevel Gear A Tapered Roller Bearing

Special tools for removing and replacing the bearing

No.	Tool	Part number	Quantity	Stamped Mark	Application
1	Bevel gear A bearing puller assembly ①	3B7-72224-0	1		Removing outer race
2	Plate ②	3B7-72732-0	1	GAC	Replacing outer race
	Rod ③	3B7-72731-0	1	GAA	
	Spring washer ④	941392-1000	1		
	Nut, 10P1.5 ⑤	930191-1000	1		
	Guide ⑥	3B7-72733-0	1	GAE	
3	Bevel gear A bearing set tool ⑦	3B7-72719-0	1	3B7727190	Replacing inner race

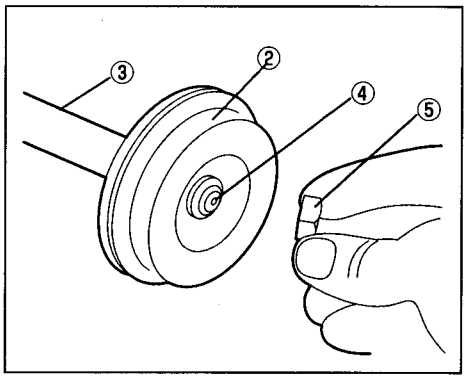
Removing Outer Race

1. Hook the pawl of the puller assembly ① to the outer race and secure the plate to the gear case using the bolt.
2. Tighten the bolt until the outer race separates from the housing.

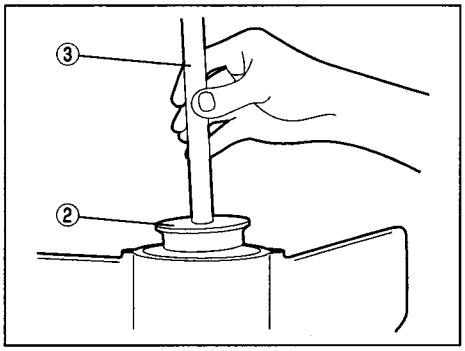


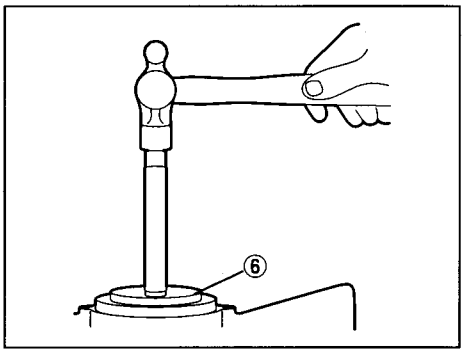
Replacing Outer Race

1. Align the gear case toward the opening of the propeller shaft and secure it in a level position using a padded vice or other holding tool.
2. Confirm that the surface inside the gear case that attaches to the outer race is clean and smooth, then apply oil.
3. Apply oil to the outer surface of the outer race, align the carved surface toward the closed end of the gear case and position it at the center of the housing.
4. Place the plate ② and spring washer ④ over the rod ③ and secure them with the nut ⑤.



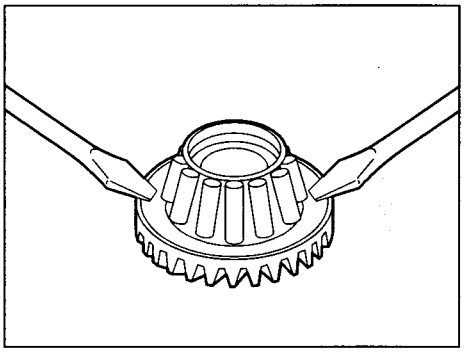
5. Insert the rod assembly inside the gear case so that the plate comes into contact with the inside of the outer race.
6. Insert the guide inside the rod and seat it in the opening of the gear case.
7. Tapping the end of the rod with a hammer, firmly secure the outer race inside the housing.
   Remark: The tapping sound made by the hammer changes when the outer race comes into contact with the tip of the housing.



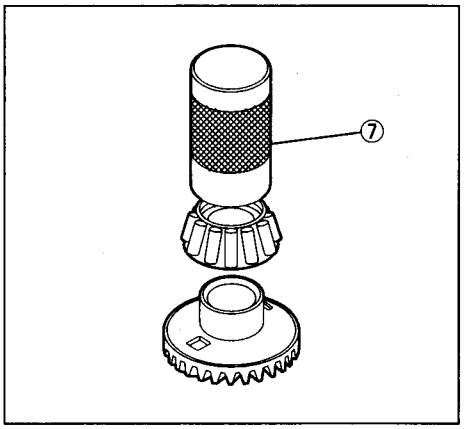


Removing Inner Race

1. Insert flathead screwdrivers in the notch of Bevel gear A and slowly remove the gear and bearing.

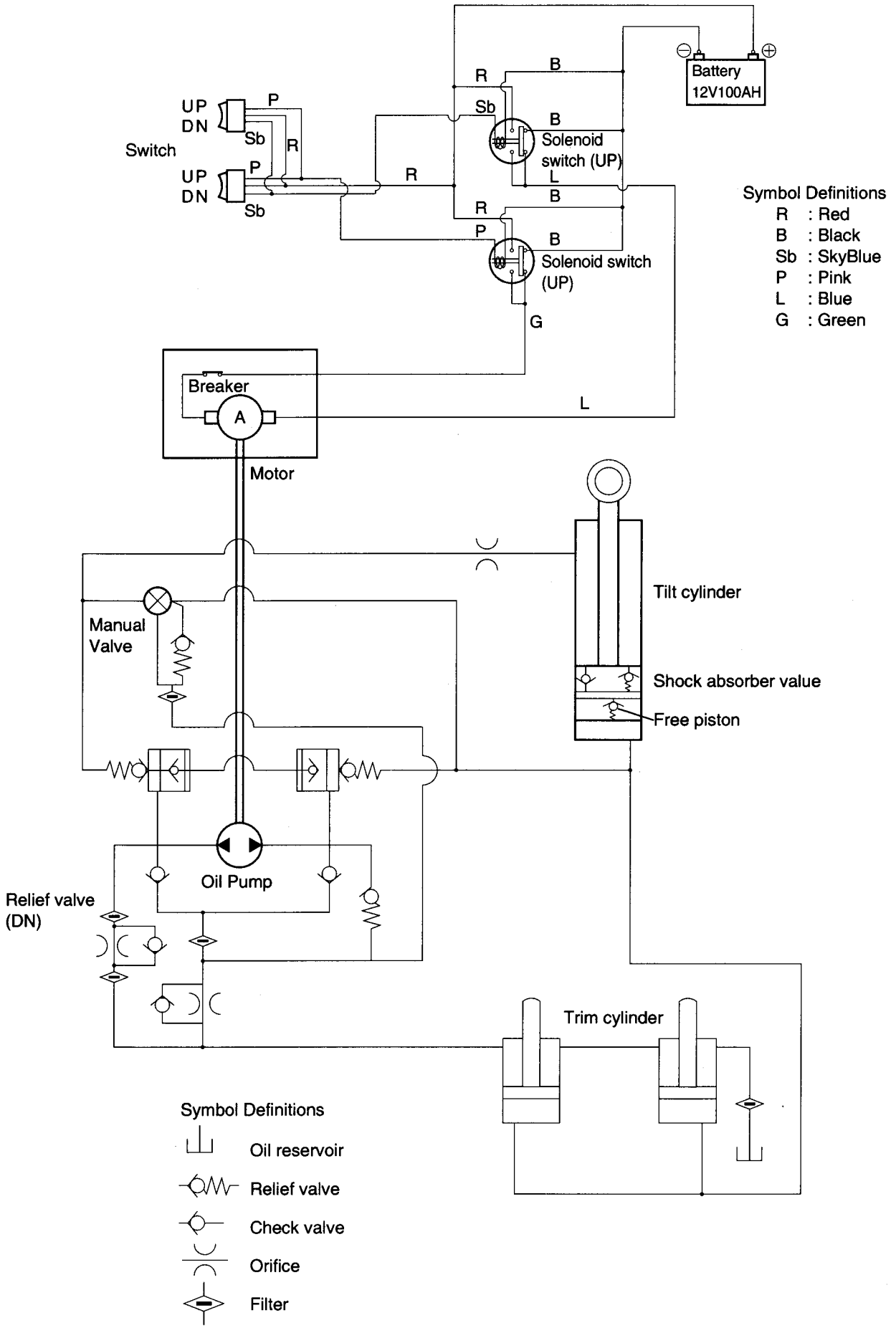


2. Using the set tool ⑦, push fit the bearing onto the gear.

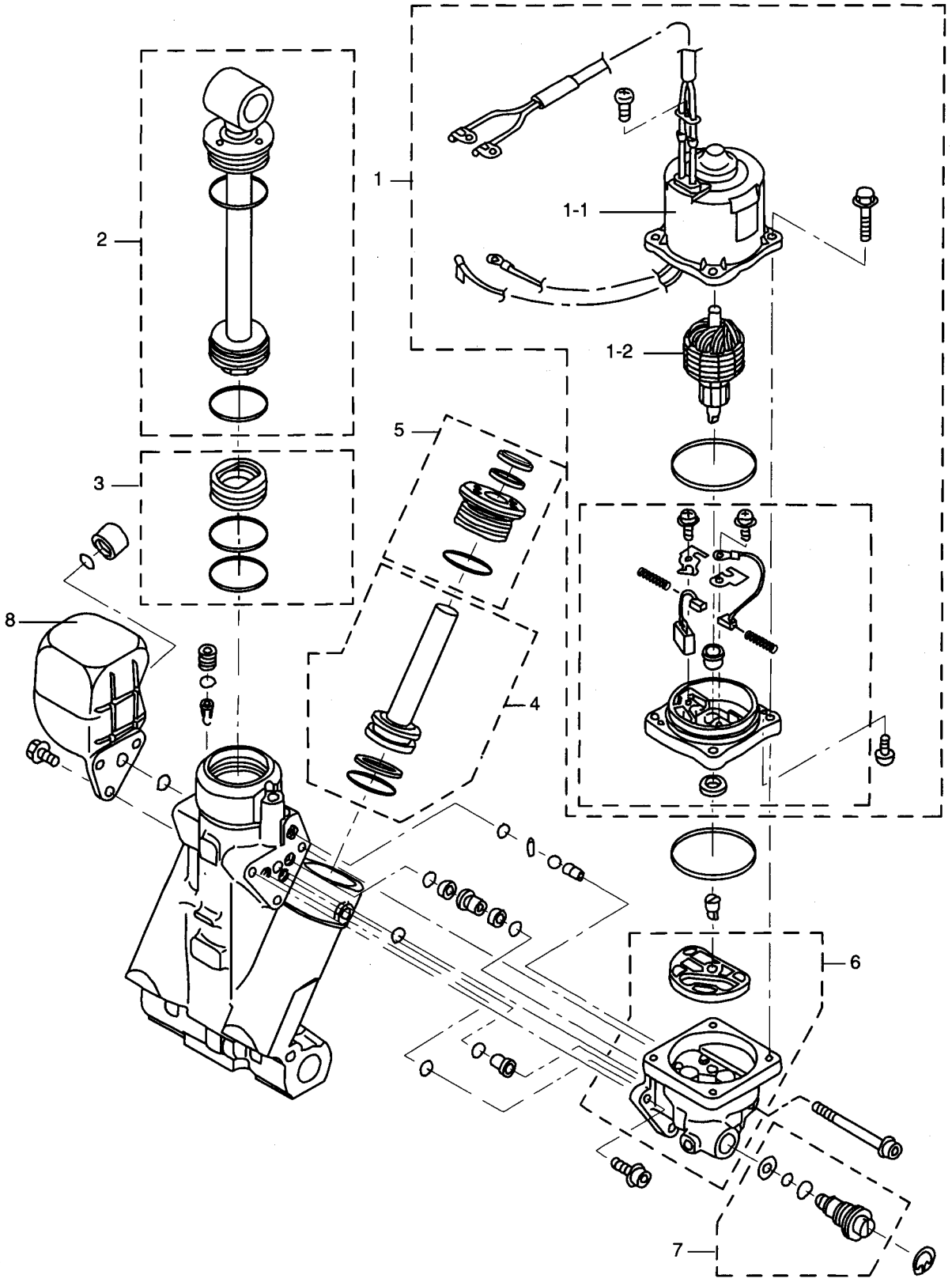


Chapter 7 Power Trim and Tilt

1. Configuration



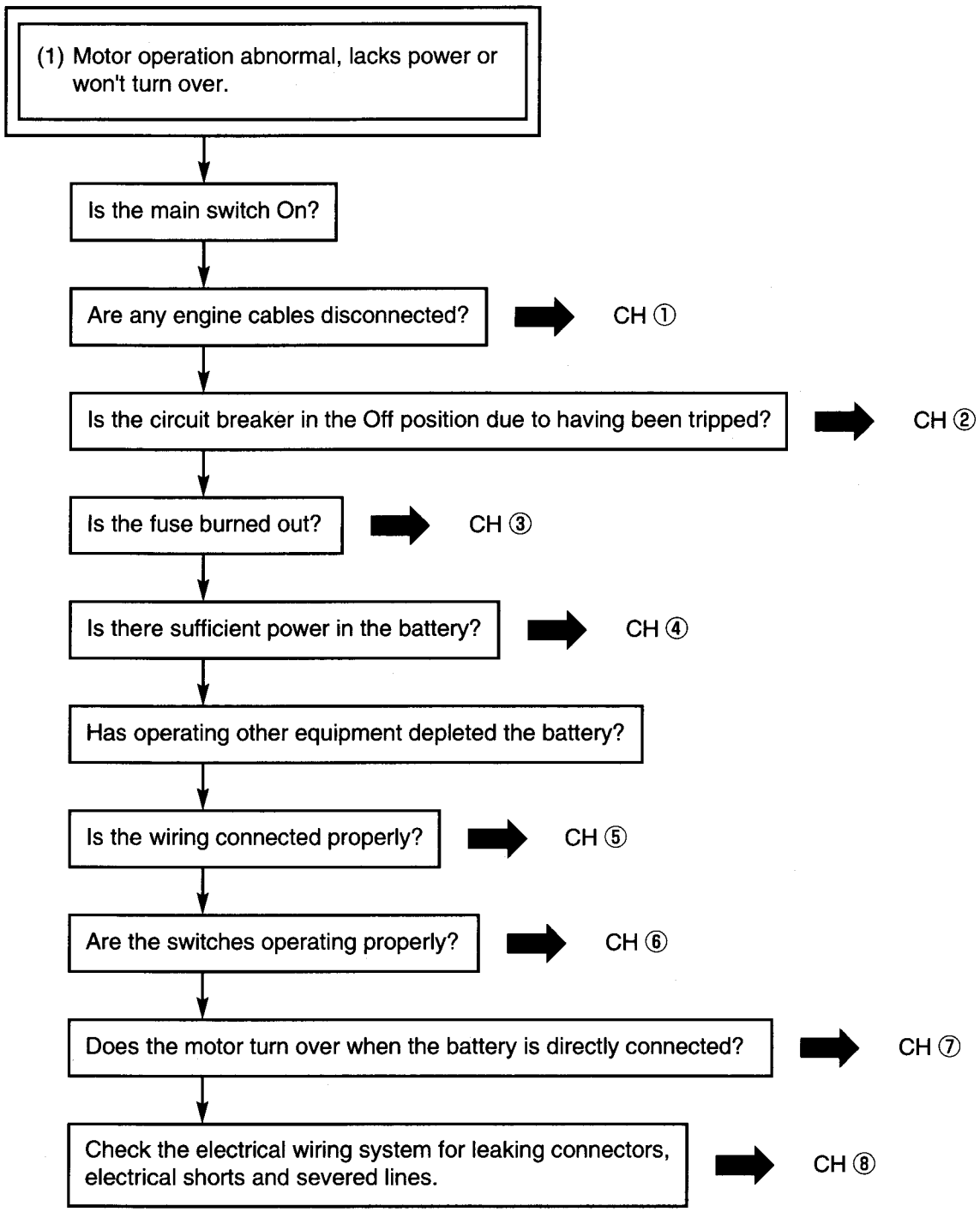
2. Component Parts

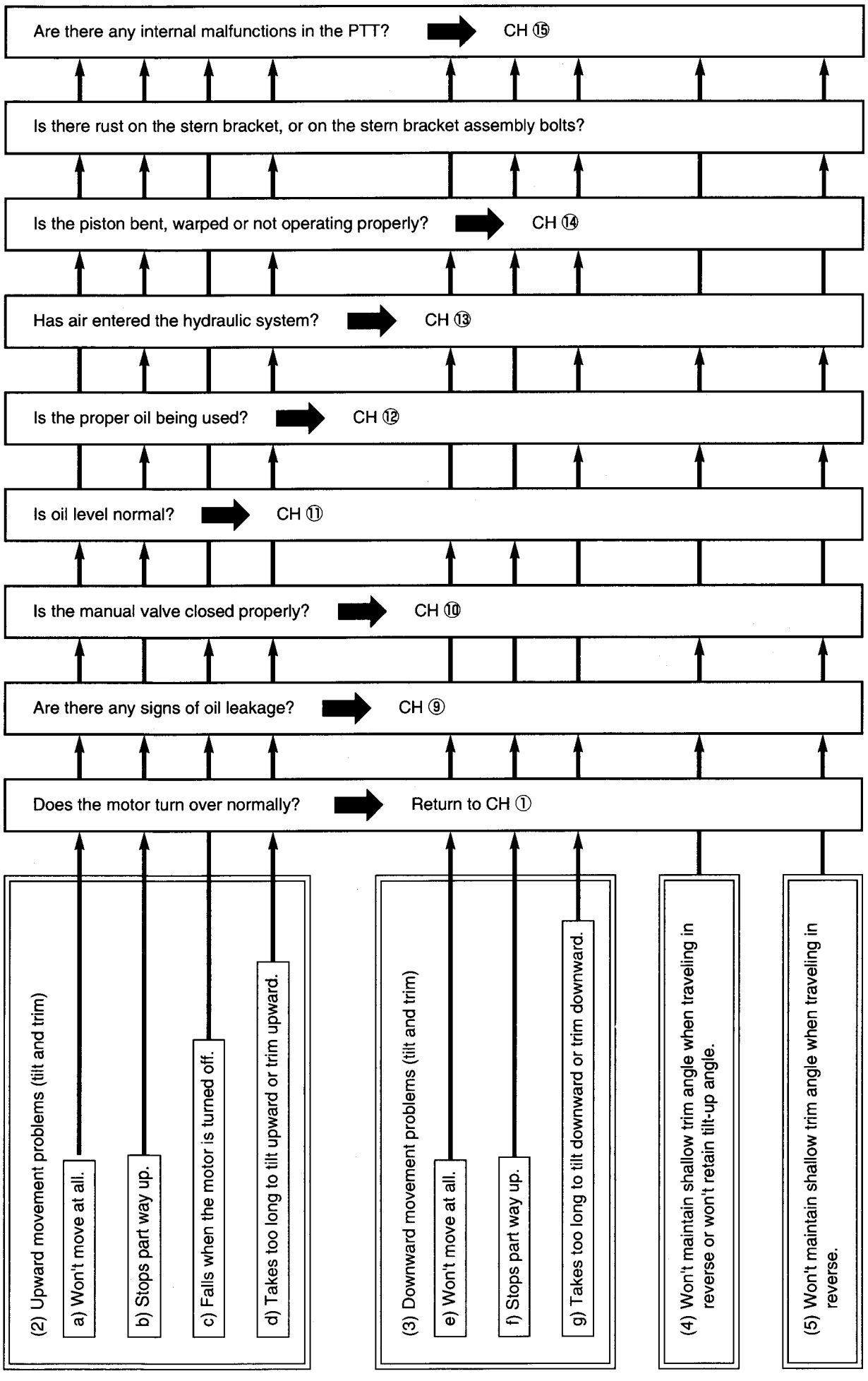


1. Motor assembly
1-1 Yoke assembly
1-2 Armature assembly
2. Tilt piston rod assembly
3. Free piston
4. Trim piston
5. Trim rod guide assembly
6. Pump
7. Manual valve
8. Reserve tank

3. Troubleshooting

(1) Symptoms and Points to Check




Are there any internal malfunctions in the PTT? CH ⑮
Is there rust on the stern bracket, or on the stern bracket assembly bolts?
Is the piston bent, warped or not operating properly? CH ⑭
Has air entered the hydraulic system? CH ⑬
Is the proper oil being used? CH ⑫
Is oil level normal? CH ⑪
Is the manual valve closed properly? CH ⑩
Are there any signs of oil leakage? CH ⑨
Does the motor turn over normally? Return to CH ①
(2) Upward movement problems (tilt and trim)
a) Won't move at all.
b) Stops part way up.
c) Falls when the motor is turned off.
d) Takes too long to tilt upward or trim upward.
(3) Downward movement problems (tilt and trim)
e) Won't move at all.
f) Stops part way up.
g) Takes too long to tilt downward or trim downward.
(4) Won't maintain shallow trim angle when traveling in reverse or won't retain tilt-up angle.
(5) Won't maintain shallow trim angle when traveling in reverse.

(2) Checking Procedure

CH① Are any engine cables disconnected?

- Confirm that the battery cables are connected to the battery.
- Confirm that cable connectors are firmly secured in place.

CH② Is the circuit breaker in the "OFF" position?

- Run a hand over the motor to check for overheating as this may indicated a tripped breaker. Allow the motor to cool for 3 minutes.

CH③ Is the fuse burned out?

- Open the engine cover and inspect the fuses installed on the electric bracket.

CH④ Is there sufficient power in the battery?

- Make sure that the battery outputs 12V and 100AH or more.
- Check specific gravity of battery fluid. Recharge if specific gravity is 1.22 or less at a temperature of 20°C (68°F).
- Try turning over the starter motor. If it turns over, the battery is OK.

CH⑤ Is the wiring connected properly?

- Check for improperly connected wiring using the wiring diagram.

CH⑥ Are the switches operating properly?

- Main switch
  If other equipment (the starter motor or buzzer) function the main switch is OK. Use a tester to confirm that current is passing between the red line leads. If there is conduction when the switch is in the ON position the switch is OK.
- PTT switch
  Disconnect either the sky blue or pink lead on the solenoid switch installed on the engine's electric bracket and touch the plug against the connector on the red cable. Operation of the PTT indicates a faulty PTT switch. (UP: sky blue, DN=Down: pink)
  The alternative is to use an electrical tester to check conductivity of the switch. If there is conductivity between the red and sky blue leads when the switch is in the UP position the switch is OK.
- Solenoid switch
  Disconnect either the sky blue or pink solenoid lead mentioned above and touch it against the red cable terminal. If this causes a clicking noise the solenoid switch is OK. Next, check for conductivity between the switch connectors when the solenoid switch is switched on and off. (Note: The red, blue, and green cables must be disconnected.) If it is known that one of the connectors is OK, simply move the switch between the UP and DN position.

Conductivity		Solenoid switch	
		ON	OFF
DN Solenoid Switch	Blue to black	no	yes
	Blue to red	yes	no
UP solenoid switch	Green to black	no	yes
	Green to red	yes	no

CH⑦ **Does the motor turn over when the battery is directly connected?**

- Disconnect the blue lead and green lead of the PTT and touch the plugs against the red and black lead terminals, respectively. Operation is normal if the blue-to-red and green-to-black contacts move the motor up and the blue-to-black and green-to-red contacts move the motor down.
- Disconnect the PTT cable from the engine cover and touch the end against the battery terminal. If this does not activate the motor is defective.

CH⑧ **Check the electrical wiring system for leaking connectors, electrical shorts and severed lines.**

- With the focus on the various cables, check for electrical shorts.
- Also check the various switches for damaged cables.

CH⑨ **Are there any signs of oil leakage?**

- Conduct an external visual check for oil leakage.
  To check for minor leaks, operate the PTT unit and look for signs of oil leakage on the surrounding water's surface.
- In cases where oil leaks are discovered in the PTT unit or the cylinder, it will be necessary to conduct a disassembly test to check for damage. Repair as necessary.

CH⑩ **Is the manual valve closed properly?**

- Firmly close the manual valve.
  Direction: clockwise,

Torque	2.9 – 3.9 N-m (0.3 – 0.4 kg-m, 2.2 – 2.9 ft-lb)

CH⑪ **Is the oil level normal?**

- Check the reserve tank oil level..
  The oil level should be even with the bottom of the oil plug hole when the engine is in the tilt-up position (the piston rods are fully extended). (Refer to CH⑬ for a description of the air bleeding procedure.)
- When unable to tilt up due to lack of oil:
  (1) Turn the manual valve two or three turns to the open position.
  (2) Tilt the engine up manually. Carefully engage the tilt stopper so the outboard does no move back down.
  (3) Check for areas from which oil leaks areas and repair them.
  (4) Close the manual valve.

(5) Taking care not to include air, fill the tank until oil is even with the bottom of the oil plug hole. After filling, rotate the PTT to the tilt-up position in stages, adding oil at each stage..

(6) Once the tilt up procedure has been completed, disengage the tilt stopper, bleed out the air, confirm oil level, and confirm PTT operation.

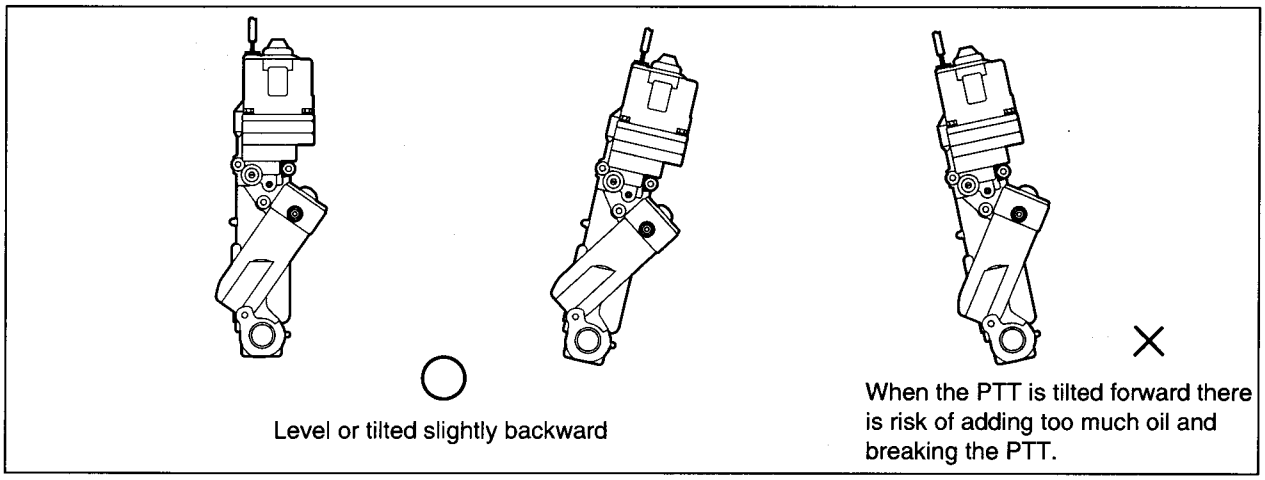
(7) Repeat the air bleeding procedure as necessary and check the oil level again. (Refer to CH⑬ for a description of the air bleeding procedure.)

Caution

The reserve tank is made of plastic. Be sure to stay within the tightening torque range when tightening the cap.	
Tightening torque	4.9 – 9.8 N-m (0.5 – 1.0 kg-m) [3.6 – 7.2 ft-lb]

- Oil volume: 682 ml. (23.0 fl.oz)

  Position the PTT as depicted in the figures below when adding oil.



○ Level or tilted slightly backward

× When the PTT is tilted forward there is risk of adding too much oil and breaking the PTT.

CH⑫ Is the proper oil being used?

- Use only the specified type of oil.

  (The oil specified for this engine is Power Torque Fluid made by Nisseki Mitsubishi Oil.)

  Recommended oil types: DEXTRON III or equivalent automatic transmission fluid (ATF)

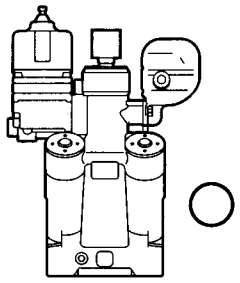
Caution

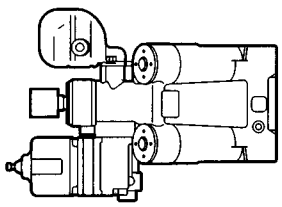
To ensure reliable PTT operation, do not mix different types of oil.

CH⑬ Has air entered the hydraulic system?

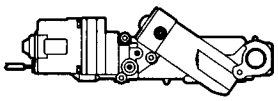
- Follow this sequence when bleeding air.
  (1) Turn the manual valve two or three turns to the open position.
  (2) Tilt the motor up to the maximum tilt-up position and carefully engage the tilt stopper.
  (3) Check the oil level and add oil as necessary. Completely close the manual valve and wait five minutes.
  (4) Disengage the tilt stopper, operate the PTT motor and trim down the outboard to the lowest position. Wait five minutes.
  (5) Operate the PTT motor, tilt up the outboard to the maximum position, confirm reserve tank oil level, and add oil as necessary. Wait five minutes.
  (6) Repeat the procedure in Items (4) and (5) five or six times.

The drawings below depict storage positions that will prevent air contamination.
(Positioning the motor in the opposite positions will result in air contamination.)





Reserve tank side faces up

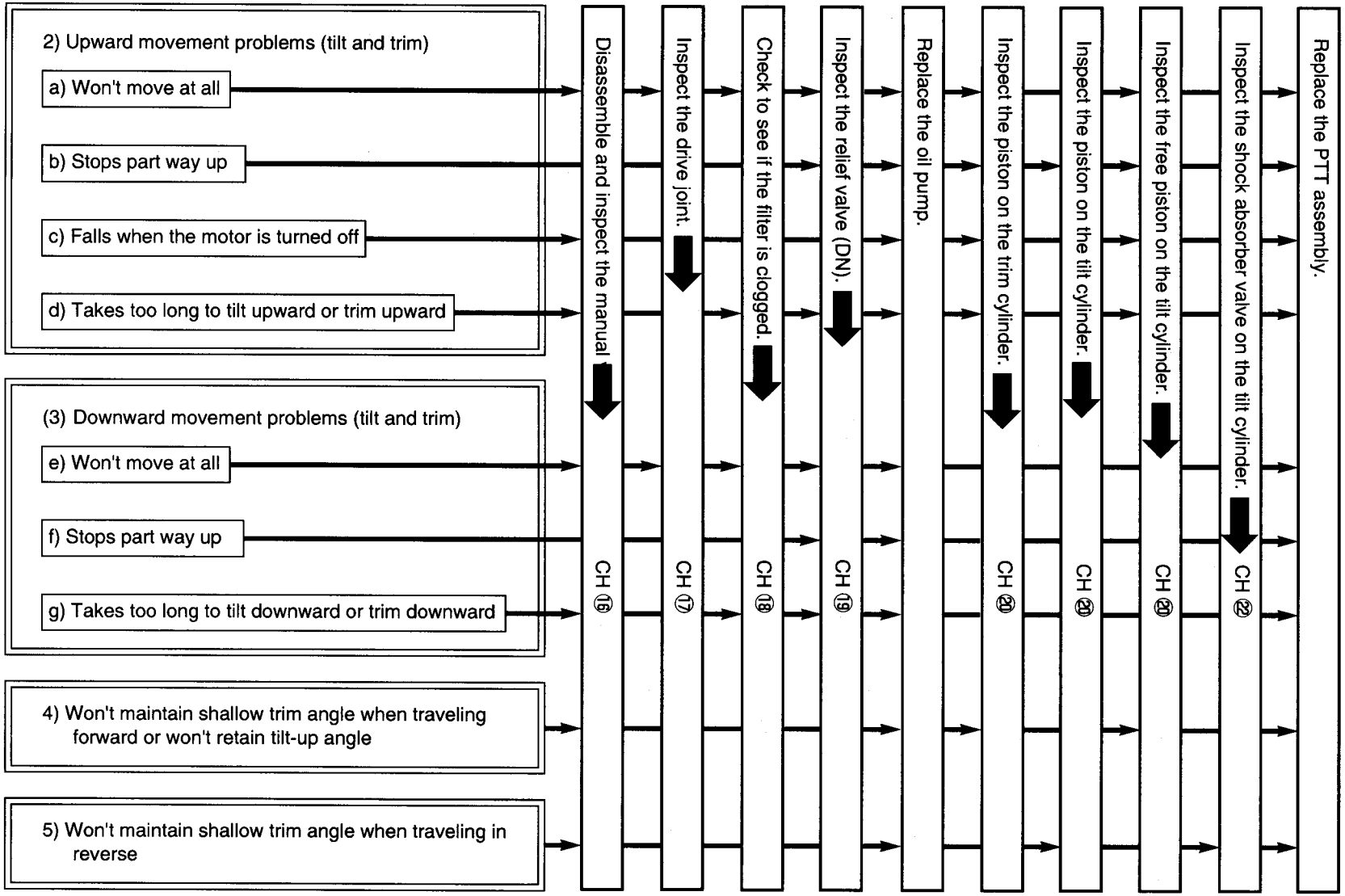


Flat surface faces down

CH⑭ Is the piston rod, bent, warped, or not operating properly?

- With the manual valve opened, perform a manual tilt up and down procedure to confirm that the piston moves freely.
- Conduct a visual inspection.

CH ⑮ Are there any internal malfunctions in the PTT? The cause of the problem varies according to the type of symptom. Be sure to refer to the table below when inspecting.



Note:
1. Use the special tools when disassembling the PTT.
2. When disassembling the PTT, place the outboard in the maximum tilt up position (with the piston rods fully extended), open the manual valve, and after waiting a while adjust internal pressure to 0. Then, begin to work.
3. When removing components take care that oil doesn't spurt out into your eyes, over your body, or on your clothing.
4. Remove the motor and reserve tank after removing the reserve tank cap and draining out the oil.

CH⑯ Disassemble and inspect the manual valve.

- Check the tip of the manual valve for damage.
- Check the O-rings for damage.
- Check for damage deep within the valve mounting holes.

CH⑰ Inspect the drive joint and pump.

Remove the motor and inspect the drive joint.

- Check whether the drive joint is completely attached to the gear pump.
- Check for damage.

CH⑱ Inspect and clean the filters.

- Remove the motor pump sub-assembly and remove and clean the relief valve (DN) filter.
- Remove the motor assembly and remove and clean the filter.
- Remove the plug from the right side of the manifold tilt cylinder and remove and clean the filter.

CH⑲ Inspect the relief valve (DN).

- Check the valve seat for damage.
- Check the valve (ball) for damage or wear.
- Check the O-ring for damage.
- Check whether the valve operates smoothly.
- Check to see if the filter is clogged.

CH⑳ Inspect the cylinder and piston.

- Check the piston for damage.
- Check the O-rings and back-up ring for damage or wear.
- Check the sliding surface of the cylinder piston for damage.

CH㉑ Inspect the shock absorber valve on the tilt cylinder.

Disassemble and inspect the piston.

- Check the spring for fatigue.
- Check the valve (ball) for damage.
- Check the valve seat for damage.
- Confirm that the valve has not been contaminated by foreign matter.

4. Service Data

1. Pump Assembly

Oil pump	Gear pump
Relief valve (UP) opening pressure	8.83 – 11.76 MPa (90 – 120 kg/cm², 1280 – 1700 psi)
Relief valve (DN) opening pressure	3.92 – 7.25 MPa (40 – 75 kg/cm², 570 – 1070 psi)
Oil volume	682 ml (23.0 fl. oz.)
Specified oil	Nisseki Mitsubishi Power Torque Fluid

2. Motor

Rated time	60 sec	
Rated voltage	12V (D.C.)	
Output	0.4kw	
Direction of rotation	Forward / reverse	
Circuit breaker	Current sensitive type	
	Operation 20 sec or more (80A)	
Commutator standard Outer diameter	22.1 mm (0.87 in)	
Maximum value	21.0 mm (0.83 in)	
Brush standard dimensions (ℓ figure to the right)	10.0 mm (0.39 in)	
Maximum value	5.0 mm (0.2 in)	

3. Trim Cylinder

Piston diameter	38.0 mm (1.50 in)
Piston rod diameter	17.84 mm (0.70 in)
Stroke	96.9 mm (3.81 in)

4. Tilt Cylinder

Piston diameter	45.0 mm (1.77 in)
Piston rod diameter	19.0 mm (0.75 in)
Stroke	157.3 mm (6.19 in)
Shock absorber valve opening pressure	14.7 – 18.6 MPa (150 – 190 kgf/cm², 2130 – 2700 psi)

5. Switches

Control box (P-type)	Unipolar, double-throw hand rocker switch (3A)
Lower motor cover (P-type)	Unipolar, double-throw hand rocker switch (3A)
Panel (F-type)	Unipolar, double-throw toggle switch (20A)

6. Solenoid Switch (UP, DN)

Rated voltage	12V (D.C.)
Rated time	60 sec (80A)
Exciting current	4A or less

7. Tightening Bolts

Cap, reserve tank	4.9 – 9.8 N-m	(0.5 – 1.0 kg-m)	(3.6 – 7.2 ft-lb)
Manual valve	2.9 – 3.9 N-m	(0.3 – 0.4 kg-m)	(2.2 – 2.9 ft-lb)
Bolt, motor assembly	2.9 – 3.9 N-m	(0.3 – 0.4 kg-m)	(2.2 – 2.9 ft-lb)
Bolt, reserve tank	3.9 – 5.9 N-m	(0.4 – 0.6 kg-m)	(2.9 – 4.3 ft-lb)
Bolt, pump	6.9 – 9.8 N-m	(0.7 – 1.0 kg-m)	(5.0 – 7.2 ft-lb)
Rod guide, Trim	74.6 – 81.2 N-m	(7.6 – 8.3 kg-m)	(54.7 – 59.8 ft-lb)
Rod guide, tilt	107.8 – 147.0 N-m	(11.0 – 15.0 kg-m)	(79.2 – 108.0 ft-lb)
Nut, tilt pin rod	78.4 – 117.6 N-m	(8.0 – 12.0 kg-m)	(57.6 – 86.4 ft-lb)
Screw, PTT switch (P-type)	0.5 – 0.8 N-m	(0.05 – 0.08 kg-m)	(0.4 – 0.6 ft-lb)
Nut, PTT switch (F-type)	1.5 – 2.9 N-m	(0.15 – 0.3 kg-m)	(1.1 – 2.2 ft-lb)

8. O-ring Standard Measurements Wire diameter - Internal diameter

Cap, reserve tank	1.9 – 11.0 mm	(0.075 – 0.433 in)
Reserve tank	1.78 – 7.65 mm	(0.070 – 0.301 in)
Motor Assembly	1.78 – 69.6 mm	(0.070 – 2.740 in)
Motor	2.0 – 69.5 mm	(0.079 – 2.736 in)
Pump	1.78 – 7.65 mm	(0.070 – 0.301 in)
Manual valve	1.5 – 13.5 mm 1.59 – 7.94 mm	(0.059 – 0.531 in) (0.062 – 0.313 in)
Relief valve (DN)	1.9 – 8.8 mm	(0.075 – 0.346 in)
Rod guide, trim	3.5 – 35.7 mm	(0.138 – 1.406 in)
Trim piston	3.5 – 31.7 mm	(0.138 – 1.248 in)
Rod guide, tilt	3.5 – 41.5 mm	(0.138 – 1.634 in)
Tilt piston	3.5 – 38.7 mm	(0.138 – 1.524 in)
Free piston	3.5 – 38.7 mm	(0.138 – 1.524 in)
Spacer (tilt stroke)	2.0 – 41.5 mm	(0.079 – 1.634 in)

9. Oil Seals Internal diameter - External diameter - Thickness

Motor	8 - 8 - 4.5 mm (0.315 - 0.709 - 0.177 in)
Water seal	17 - 24.6 - 2.6 mm (0.669 - 0.969 - 0.102 in)
Packing	18 - 26 - 5 mm (0.709 - 1.024 - 0.197 in)

5. Disassembly and Assembly

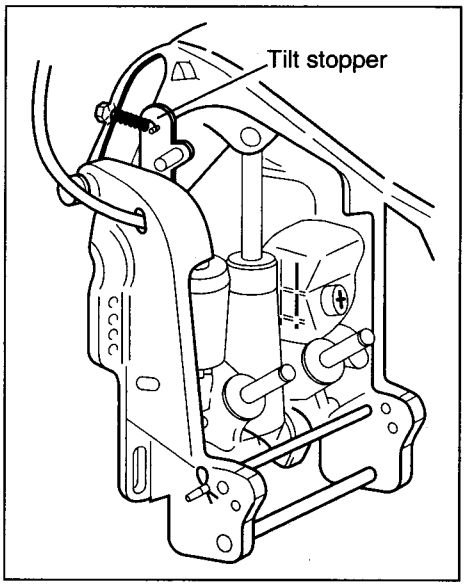
1 Removing PTT

* Precautions for Disassembling and Assembling Power Trim and Tilt (PTT)

• When disassembling and assembling PTT, be sure to firmly secure the outboard and fully support the weight of the engine.

Removal Procedure

1. Tilt the outboard to the maximum tilt-up position and engage the tilt stopper to maintain the position.
2. Remove the bolt (612) and washer (6.5-23-1.5) that secure the cylinder pin and upper motor cover. Pull out the cylinder pin and upper motor cover. Undo the pin and thrust rod and remove the thrust rod.
3. Position the tilt rod and trim rod in their unextended positions. Remove the battery cable from the battery.
4. Remove the cover and electric bracket. Remove the PTT cables (blue, green) from solenoid switch A (UP) and solenoid switch B (DN). Pull the PTT cables out and away from the lower motor cover.
5. Lightly tapping on the cylinder pin and lower motor cover, push out and remove the clip (d=22) and washer (22.6-30-2) from the cylinder pin and lower motor cover. Remove the stern bracket side bushing.
6. Pull out the PTT assembly from between the right bracket and left bracket. Remove the PTT side bushing.

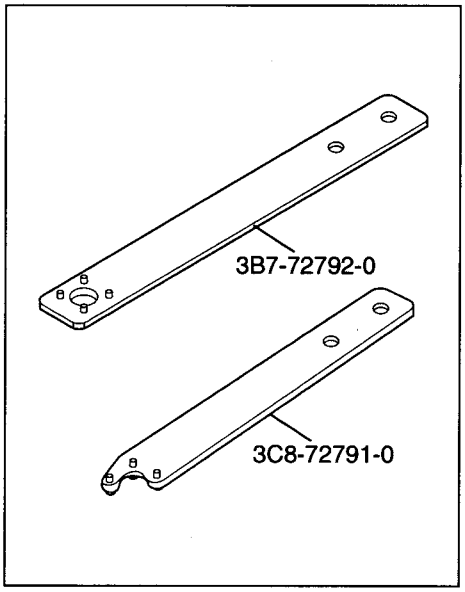


Engage the tilt stopper to secure the outboard in the maximum tilt-up position.

2.Disassembling PTT

* Precautions to follow before disassembling.

• Use the special tools tilt rod guide wrench and (3C8-72791-0) and trim rod guide wrench (3B7-72792-0) when disassembling the PTT.



- During disassembly there is risk that oil will spurt out into your eyes or onto your body or clothes. Be sure to take protective measures.
- Clean the outside of the PTT before disassembly.

1. Attach the PTT cable to a battery (12V), and position the tilt rod in the maximum tilt-up position. Leave the tilt rod in position for a while until the internal pressure is reduced to zero.
2. Open the manual valve, remove the cap and reserve tank, and drain the PTT oil from the sub-tank. Taking care not to damage the grease nipple of the lower section of the PTT, apply cloth or other protective material and secure the PTT with a vise.
3. Remove the 3 bolts that secure the reserve tank to the manifold and remove the reserve tank.
4. Remove the O-ring from the manifold and check the O-ring for damage or wear. Check for damage or wear to the various mating surfaces of the manifold and reserve tank.
5. Remove the motor assembly. Confirm the position of the O-ring.
6. Fully tighten the manual valve and remove the C-ring using clip pliers.
7. Remove the 3 bolts that secure the pump to the manifold and remove the pump.

* **The inside of the pump consists of components that cannot be disassembled. Do not remove components or disassemble.**

8. Remove the 5 O-rings from the manifold and check the O-rings for damage or wear. Remove the relief valve (DN) valve seat, O-ring, filter, and ball. Remove the check valve orifice and ball. Check the valve seat, orifice, and other areas for damage or wear.
9. Use the tilt rod guide wrench to loosen the tilt rod guide and remove it from the manifold.
10. Pull up the piston rod and remove it from the manifold.
11. Remove the nut at the lower side of the piston rod. Remove the 4 shock absorber valves (spring, rod, ball) attached to the piston.
12. Slide the piston and tilt rod guide downward and remove them from the shaft. At that time take care not to damage the O-ring, seal or other components.

Assembling PTT

* Precautions before Assembling

- Clean the parts and check them for damage or wear. Check the rod for bending.
- Arrange the cleaned parts on sheets of paper. The use of cloth results in threads becoming attached to components and can cause faulty PTT operation.
- Reassemble following the reverse sequence of the disassembly procedure.

1. Tilt Cylinder and Trim Cylinder

① Apply PTT oil to the inner surface of the manifold and the various parts.

② When tightening the nut and tilt rod piston onto the rod, apply Three Bond (1342) to the screw area.

Thread Lock	Three Bond 1342

Nut tightening torque	78.4 – 117.6 N-m (8.0 – 12.0 kg/m) (57.6 – 86.4 ft-lb)

③ Attach the tilt rod and trim rod. (Follow the procedure described below.)

A) Apply an appropriate amount of PTT oil to the bottom part of the manifold.

B) Insert the piston and piston rod into the manifold and push down on the piston until it reaches the oil surface.

C) Apply PTT oil to the upper surface of the manifold and tighten the rod guide.

* When tightening the tilt rod and trim rod on the manifold, use the special tool and tighten to the specified torque.

Trim rod guide tightening torque	74.6 – 81.2 N-m (7.6 – 8.3 kg/m) (54.7 – 59.8 ft-lb)
Tilt rod guide tightening torque	107.8 –147.0 N-m (11.0 – 15.0 kg/m) (79.2 – 108.0 ft-lb)

2. Pump

Apply PTT oil to the 5 O-rings and attach them to the correct locations on the manifold.

Attach the relief valve (DN) and check valve.

Attach the pump to the manifold with the 3 bolts.

Pump bolt tightening torque	6.9 – 9.8 N-m (0.7 – 1.0 kg/m) (5.0 – 7.2 ft-lb)

3. Manual Valve

Apply PTT oil to the manual valve and securely attach it to the pump.

Manual valve tightening torque

Manual valve tightening torque	2.9 – 3.9 N-m (0.3 – 0.4 kg/m) (2.2 – 2.9 ft-lb)

Attach the C-ring with clip pliers.

4. Motor assembly

Refer to the section on motor assembly.

5. Reserve Tank

Apply PTT oil to the O-ring and tighten the tank with the 3 bolts.

Reserve tank bolt tightening torque	3.9 – 5.9 N-m (0.4 – 0.6 kg/m) (2.9 – 4.3 ft-lb)

Fill the reserve tank to the specified level with PTT oil and tighten the cap.

PTT oil volume	682 ml (23.0 fl oz)
Cap tightening torque	4.9 – 9.8 N-m (05 – 1.0 kg/m) (3.6 – 7.2 ft-lb)

Bleed air from the PTT. (Refer to the section on PTT air bleeding.)

Motor Assembly

1. Removal

Remove the 4 bolts securing the motor assembly to the pump and remove the pump. Check the drive joint, pump, and O-ring.

2. Disassembly

Remove the 2 screws securing the yoke assembly to the bracket assembly and remove the yoke assembly (with armature) from the bracket. Remove the armature from the yoke assembly.

3. Inspection

① Armature and commutator (with armature) from the bracket. Remove the armature from the yoke assembly.

A) Using an electrical tester, check for conductivity between the commutator and armature. The system is normal if there is no conductivity.

B) Using an electrical tester, check for conductivity between the commutator and each segment. If there is conductivity at even one location replace the motor assembly with a new one.

C) When the commutator surface is rough or scorched polish the surface with sandpaper (#500 or #600 grit). When the problem cannot be repaired using sandpaper or when unevenly worn replace the motor assembly with a new one.

	Standard	Limit
Commutator external diameter	22.2 mm (0.87 in)	21.0 mm (0.83 in)

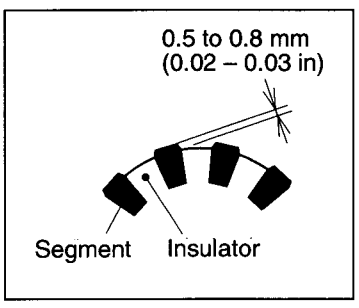
D) Check whether commutator under-cut is of the prescribed depth. When depth is insufficient repair using a metal saw blade.

	Standard	Limit
Commutator under-cut	0.5 to 0.8 mm (0.02 – 0.03 in)	0.2 mm (0.008 in)

② Brushes

Check the length of the brushes. Replace any worn to a length below the limit.

	Standard	Limit
Brush length Standard	10 mm (0.39 in)	5 mm (0.20 in)



4. Assembly

* Precautions for Assembling

- Reassemble following the reverse sequence of the disassembly procedure.
- When attaching the armature to the bracket, check to ensure there is no damage to the brushes.
- To facilitate assembly, first install the armature on the bracket then install the bracket on the yoke.

5. Installation

* Precautions for installing the motor on the pump

- Install following the reverse sequence of the removal procedure.
- Securely install the drive joint and pump on the gear pump.
- Install the O-ring between the motor and the pump after checking to ensure the O-ring isn't damaged.
- Add PTT oil to the pump until it reaches the same surface as the gear pump.
- When attaching the motor to the pump, align the notches at the end of the armature shaft, the drive joint, and the pump and firmly push the armature shaft into the drive joint and joint.
- Attach the motor to the pump using the 4 bolts.
- When attaching the motor to the pump take care that there is no grime or foreign matter on the various mating surfaces

Motor bolt tightening torque	2.9 – 3.9 N-m (0.3 – 0.4 kg/m) (2.2 – 2.9 ft-lb)

Installing PTT

1. Attach the green PTT cable to the battery cable terminal _ and the blue cable to the battery cable terminal _, and tilt the outboard down with the tilt rod and trim rod in their unextended positions.
2. Apply the recommended grease to the upper cylinder pin bushing and lower cylinder pin bushing (for PTT) and attach the bushings to the correct locations on the PTT and swivel bracket.
3. Apply the recommended grease to the lower cylinder pin bushings (for the swivel bracket) and attach them to the right and left sides of the stern bracket.
4. Attach PTT to the correct location between the right and left sides of the stern bracket. Apply the recommended grease to the lower cylinder pin and pass the pin between the left and right sides of the stern bracket and PTT.
5. After attaching the washer (6.5-23-1.5), attach the clip (d = 22).
6. Operate the PTT and while extending the tilt rod upward align the holes in the swivel bracket and tilt rod.
7. Apply the recommended grease to the cylinder hole and pass the pin through the swivel bracket and tilt rod. Attach the bolt (6-12) and washer (6.5-23-1.5).
8. Attach the thrust rod and thrust rod pin.
9. Pass the PTT cable through the lower motor cover, and attach the blue lead to solenoid switch A (UP) and the green lead to solenoid switch B (DN). Attach the cover and electronic bracket.

Chapter 8 Tiller Handle Type (NO Information)

Chapter 9 Troubleshooting

1. Troubleshooting Tables

These troubleshooting tables cover the various malfunctions and failures that can occur in the engine's electrical components. Notification of malfunctions and failures is provided using a system of warning beeps (buzzers) and indicator lights.
The system of beeps and indicators is described in a separate section.

Symptom		Item	Self-diagnosable points	Beeps	Warning indicator A (oil) 	Warning indicator B (water temp) 	Warning indicator C (battery) 
1. Starter motor is dead or turns very slowly. Starter motor works but the flywheel doesn't rotate	1-1. Power head	The flywheel doesn't rotate					
	1-2. Air compressor system						
	1-3. Electrical system	Battery	○				Flashing
		Fuse					
		Wiring					
		Electrical components					
		Self-diagnosis function indicates faulty components	○				
	1-4. Remote control	Control lever					
2. Engine turns over but won't start	2-1. Power head	Low fuel pressure					
	2-2. Fuel system	Fuel tank					
		Fuel filter					
		Low fuel pressure in air rail (standard: 600 - 640kPa, 87 – 93 psi)	○		Flashing	Flashing	Flashing

Cause		Remedy (see chapter on servicing information for specifications)
1-1-1.	Piston seizes up	Inspect and repair or replace as necessary
1-2-1.		
1-3-1.	Battery is low; or batter cables or circuit line connections may be loose or corroded	Inspect and replace as necessary
1-3-2.	Burned out fuse	Check whether any of the 3 fuses are burned out. Check circuits connected to faulty fuse and replace the fuse after repairing circuits as necessary
1-3-3.	Severed wire or loose connection or poor contact	Inspect and replace as necessary
1-3-4.	Faulty main switch, neutral switch, starter solenoid or starter motor	
1-3-5.	Damaged components; or, severed wire, loose connection or poor contact	Inspect and repair or replace as necessary
1-4-1.	Control lever is in the "F" or "R" position	Shift to the neutral position
2-1-1.	Stuck piston ring	Inspect and repair or replace as necessary
2-1-2.	Reed valve fails to close, is worn or damaged	
2-2-1.	Fuel is low or tank is empty	Add fuel and carry out the remedy in 2-2-5
2-2-2.	Fuel tank air vent is closed	Open air vent and carry out the remedy in 2-2-5
2-2-3.	Fuel filter is clogged	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
2-2-4.	Water in fuel filter (indicated by floating of red float inside the filter)	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
2-2-5.	Fuel not reaching fuel lines	Check primer valve for stiffness. Pinch primer valve. When valve stiffens turn main switch on for 2 seconds. Repeat process until primer valve is sufficiently stiff
2-2-6.	Fuel not fed to fuel lines after tank is filled	
2-2-7.	Clogged fuel filter	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
2-2-8.	Clogged fuel lines	Check for twisted, flattened or bent fuel lines
2-2-9.	Fuel pump (lift pump) is broken (leaking)	Inspect and replace as necessary
2-2-10.	FFP (*1) does not function	Confirm that sound of FFP assembly motor continues for about 2 seconds when the main switch is turned from the OFF to the ON position
2-2-11.	Internal leak in FFP (*1) case	Inspect and replace rubber seal or FFP
2-2-12.	Faulty fuel regulator	Replace
2-2-13.	Fuel leaks	Inspect fuel line for damage and inspect connections

(* 1) FFP : Fuel feed pump

Symptom		Item	Self-diagnosable points	Beeps	Warning indicator A (oil) 	Warning indicator B (water temp) 	Warning indicator C (battery) 
2. Engine turns over but does not start	2-2. Fuel system	High fuel pressure in air rail (standard: 600 – 640 kPa, 87 – 93 psi)					
	2-3. Air system	Low air pressure in air rail (standard: 530 – 570 kPa, 77 – 83 psi)					
		High air pressure in air rail (standard: 530 – 570 kPa, 77 – 83 psi)					
	2-4. Electrical system	Fuse					
		Stop switch					
		Air injector					
		Spark plug Gap standerd 0.7-0.8mm (0.0276-0.0315 in)					
		Spark plug cap					
		Crank position sensor Gap with encoder ring standard : 0.5-0.9mm (0.020-0.035 in)					
		ECU					
		Self-diagnosing function indicates low (abnormal) battery voltage	○				Flashing
		Self-diagnosing function indicates faulty components	○				
		Self-diagnosing function indicates TPS idling position error	○		Flashing	Flashing	Flashing
			○		Flashing	Flashing	Flashing

Cause		Remedy (see chapter on servicing information for specifications)
2-2-14.	Return circuit from fuel regulator outlet to vapor separator is clogged	Inspect and repair as necessary
2-2-15.	Faulty fuel regulator	Replace
2-3-1.	Air hose connecting nut is loose	Inspect and repair as necessary
2-3-2.	Air filter is clogged	Inspect and replace
2-3-3.	Orifice is clogged	
2-3-4.	Faulty air hose connection O-ring	Inspect and repair
2-3-5.	Air hose passage is crushed	
2-3-6.	Faulty (leaking) air regulator	Inspect and replace
2-3-7.	Faulty air compressor reed valve	
2-3-8.	Extensive wear on air compressor cylinder or piston ring	
2-3-9.	Faulty drive belt	
2-3-10.	Faulty air regulator	Inspect and replace
2-3-11.	Passage beyond air regulator is blocked	Inspect and repair as necessary
2-4-1.	Fuse is burned out	Check whether one of the 3 fuses has burned out. After checking and repairing areas related to the burned out fuse replace the fuse
2-4-2.	Lock is undone	Inspect and replace as necessary
2-4-3.	Stop switch has shorted out	Inspect and repair
2-4-4.	Carbon buildup on fuel injector	Inspect and clean or replace as necessary
2-4-5.	Faulty spark plug	Adjust gap to specifications. Replace if electrodes are excessively worn, cracked or damaged. Replace in cases of leakage or blackened electrodes due to carbon buildup. Replace if plug is wet with fuel and doesn't fire
2-4-6.	Cap is loose	Inspect and repair as necessary
2-4-7.	Faulty cap	Replace
2-4-8.	Incorrect encoder (flywheel) gap	Inspect and adjust
2-4-9.	ECU does not function	Replace ECU
2-4-10.	Battery is low. Or, battery voltage drops to less than 10V while engine turns over due to faulty starter motor	Replace or recharge battery. Inspect terminal and cables
2-4-11.	Damaged components; or, severed wire, loose connection or poor contact	Inspect and repair or replace as necessary
2-4-12.	TPS initial values are incorrect	Inspect and after repairing reset TPS (*2)
2-4-13.	TPS (*1) and / or ECU has been replaced	Reset TPS (*2)

Symptom		Item	Self-diagnosable points	Beeps	Warning indicator A (oil) 	Warning indicator B (water temp) 	Warning indicator C (battery) 
3. Engine starts but idling falters or is unstable	3-1. Power head	Engine rpm abnormally low (seized up)					
		Faulty compression					
	3-2. Fuel system	Fuel tank					
		Fuel hose					
		Fuel filter					
		Low fuel pressure in air rail (Standard: 600 – 640 kPa, 87 – 93 psi)					
		High fuel pressure in air rail (Standard: 600 – 640 kPa, 87 – 93 psi)					
	3-3. Air system	Low air pressure in air rail (Standard: 530 – 570 kPa, 77 – 83 psi)					
		High air pressure in air rail (Standard: 530 – 570 kPa, 77 – 83 psi)					
	3-4. Electrical system	Spark plug					
		Spark plug Gap standerd 0.7-0.8mm (0.0276-0.0315 in)					
		Spark plug cap					
		Self-diagnosing function indicates faulty components	○				
		Self-diagnosing function indicates TPS idling position error	○		Flashing	Flashing	Flashing
			○		Flashing	Flashing	Flashing
4. Idle speed too high	4-1. Electrical system	Variable idling switch					
		Self-diagnosing function indicates TPS idling position error	○		Flashing	Flashing	Flashing
			○		Flashing	Flashing	Flashing

Cause		Remedy (see chapter on servicing information for specifications)
3-1-1.	Scratches on piston. Or, something is causing resistance	Inspect and repair
3-1-2.	Piston ring buildup	
3-1-3.	Reef valve fails to close, is worn or damaged	
3-1-4.	Faulty cylinder head gasket	
3-1-5.	Loose head bolt or crankcase bolt	
3-2-1.	Fuel is low or tank is empty	Add fuel and carry out the remedy in 2-2-5
3-2-2.	Fuel tank air vent is closed	Open air vent and carry out the remedy in 2-2-5
3-2-3.	Air being sucked in through cracks or faulty connectors	Inspect and repair
3-2-4.	Fuel filter is clogged	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
3-2-5.	Water in fuel filter (indicated by floating of red float inside the filter)	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
3-2-6.	Refer to remedies 2-2-7 to 2-2-13	
3-2-7.	Refer to remedies 2-2-14 to 2-2-15	
3-3-1.	Refer to remedies 2-3-1 to 2-3-9	
3-3-2.	Refer to remedies 2-3-10 to 2-3-11	
3-4-1.	Carbon buildup in fuel injector area	Inspect, clean and replace as necessary
3-4-2.	Faulty spark plug	Adjust gap to specifications. Replace if electrodes are excessively worn, cracked or damaged. Replace in cases of leakage or blackened electrodes due to carbon buildup. Replace if plug is wet with fuel and doesn't fire
3-4-3.	Cap is loose	Inspect and repair
3-4-4.	Faulty cap	Inspect and replace
3-4-5.	Damaged components; or, severed wire, loose connection or poor contact	Inspect and repair or replace as necessary
3-4-6.	TPS initial values are incorrect	Inspect and after repairing reset TPS (*2)
3-4-7.	TPS (*1), ECU has been replaced	Reset TPS (*2)
4-1-1.	Idling setting has been changed	Adjust idling speed using variable idle
4-1-2.	TPS initial values incorrect	Inspect and after repairing reset TPS (*2)
4-1-3.	Reset TPS (*2)	

Symptom		Item	Self-diagnosable points	Beeps	Warning indicator A (oil) 	Warning indicator B (water temp) 	Warning indicator C (battery) 
5. Engine unstable above 3,000 rpm	5-1. Fuel system	Fuel tank					
		Fuel hose					
		Fuel filter					
		Low fuel pressure in air rail (Standard: 600 – 640 kPa)					
		High fuel pressure in air rail (Standard: 600 – 640 kPa)					
	5-2. Air system	Low air pressure in air rail (Standard: 530 – 570 kPa)					
		High air pressure in air rail (Standard: 530 – 570 kPa)					
	5-3. Electrical system	Spark plug Gap standerd 0.7-0.8mm (0.0276-0.0315 in)					
		Engine rpm limited					
		Faulty TPS (*1) function	○		Flashing	Flashing	Flashing
		Self-diagnosing function indicates faulty components	○				
6. No acceleration at full throttle	6-1. Power head	Engine rpm abnormally low (seizing up)					
		Faulty compression					
		Advance arm does not function					
	6-2. Fuel system	Fuel tank					
		Fuel hose					
		Fuel filter					
		Low fuel pressure in air rail (Standard: 600 – 640 kPa)					
		High fuel pressure in air rail (Standard: 600 – 640 kPa)					

Cause		Remedy (see chapter on servicing information for specifications)
5-1-1.	Fuel is low or tank is empty	Add fuel and carry out the remedy in 2-2-5
5-1-2.	Fuel tank air vent is closed	Open air vent and carry out the remedy in 2-2-5
5-1-3.	Air being sucked in through cracks or faulty connectors	Inspect and repair
5-1-4.	Water in fuel filter (indicated by floating of red float inside the filter)	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
5-1-5.	Refer to remedies 2-2-7 to 2-2-13	
5-1-6.	Refer to remedies 2-2-14 to 2-2-15	
5-2-1.	Refer to remedies 2-3-1 to 2-3-9	
5-2-2.	Refer to remedies 2-3-10 to 2-3-11	
5-3-1.	Faulty spark plug	Adjust gap to specifications. Replace if electrodes are excessively worn, cracked or damaged. Replace in cases of leakage or blackened electrodes due to carbon buildup. Replace if plug is wet with fuel and doesn't fire
5-3-2.	Refer to remedies 10-1-1 to 10-1-11	
5-3-3.	Refer to remedies 2-4-1s to 2-4-13	
5-3-4.	Damaged components; or, severed wire, loose connection or poor contact	Inspect and repair as necessary
6-1-1.	Scratches on piston. Or, something is causing resistance	
6-1-2.	Scratches on piston or cylinder liner	
6-1-3.	Carbon buildup in combustion chamber	
6-1-4.	Excessive wear or sticking of piston ring	
6-1-5.	Faulty upper bearing oil seal or crankcase head oil seal	
6-1-6.	Disfiguration or wear of throttle link components	Inspect and adjust
6-1-7.	Remote control cable not properly installed or faulty remote control box	Inspect and replace
6-2-1.	Fuel is low or tank is empty	Add fuel and carry out the remedy in 2-2-5
6-2-2.	Fuel tank air vent is closed	Open air vent and carry out the remedy in 2-2-5
6-2-3.	Air being sucked in through cracks or faulty connectors	Inspect and repair
6-2-4.	Water in fuel filter (indicated by floating of red float inside the filter)	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary
6-2-5.	Refer to remedies 2-2-7 to 2-2-13	
6-2-6.	Refer to remedies 2-2-14 to 2-2-15	

Symptom		Item	Self-diagnosable points	Beeps	Warning indicator A (oil) 	Warning indicator B (water temp) 	Warning indicator C (battery) 
6. No acceleration at full throttle	6-3. Air system	Low air pressure in air rail (Standard: 530 – 570 kPa)					
		High air pressure in air rail (Standard: 530 – 570 kPa)					
	6-4. Electrical system	Spark plug [Gap Standard : 0.7-0.8mm (0.0276-0.0315 in)]					
		Air injector					
		Self-diagnosing function indicates faulty components	○				
7. Engine accelerates, boat speed does not increase	7-1. Outboard engine	Propeller					
		Installation					
		Boat					
8. Unable to turn off engine with main switch	8-1. Electrical system	Main switch					
		Stop switch					
		Ground line					
9. Poor acceleration at full throttle or sudden drop down to idling speed	9-1. Power head	Advancer arm does not function					
	9-2. Electrical control system	Cooling water temperature too high (temp indicator flashes)	○	Continuous		Flashing	
			○	Continuous		Flashing	
			○	Continuous		Flashing	
			○	Continuous		Flashing	
		Battery voltage abnormally high (battery indicator flashes)	○		Flashing	Flashing	Flashing
			○		Flashing	Flashing	Flashing
		TPS not functioning	○		Flashing	Flashing	Flashing
		Eletric oil pump not functioning	○		Flashing	Flashing	Flashing

Cause		Remedy (see chapter on servicing information for specifications)
6-3-1.	Refer to remedies 2-3-1 to 2-3-9	
6-3-2.	Refer to remedies 2-3-10 to 2-3-11	
6-4-1.	Faulty spark plug	Adjust gap to specifications. Replace if electrodes are excessively worn, cracked or damaged. Replace in cases of leakage or blackened electrodes due to carbon buildup. Replace if plug is wet with fuel and doesn't fire
6-4-2.	Carbon deposit on fuel injector	Inspect, clean and replace as necessary
6-4-3.	Severed wire or loose connection or poor contact	Inspect and replace or repair as necessary
7-1-1.	Incorrect propeller pitch	
7-1-2.	Propeller is slipping	
7-1-3.	Propeller is warped or damaged	
7-1-4.	Transom length unsuitable for boat	Inspect and adjust
7-1-5.	Incorrect trim angle	
7-1-6.	Boat bottom is dirty	Inspect and clean
7-1-7.	Incorrect loading position	Inspect and adjust
7-1-8.	Overloading of boat	
7-1-9.	Problem with shape of boat	
8-1-1.	Faulty electrical contact on main switch or severed line in harness	Inspect and replace or repair
8-1-2.	Electrical contact on stop switch or severed line in harness	
8-1-3.	Faulty ground line contact or severed line in harness	
9-1-1.	Disfiguration or wear of throttle link components	
9-1-2.	Remote control cable not properly installed or faulty remote control box	
9-2-1.	Water strainer is clogged	Inspect
9-2-2.	Faulty water pump	Inspect and replace or repair as necessary
9-2-3.	Faulty thermostat	
9-2-4.	Cooling water inlet is clogged	
9-2-5.	Faulty battery or 2 batteries connected in series	Inspect
9-2-6.	Faulty rectifier regulator	Inspect and replace
9-2-7.	Faulty TPS, faulty wiring connections or severed line in harness	Inspect and replace or repair as necessary
9-2-8.	Wiring connections for TPS connectors (TPS1, TPS2) are reversed	Connect at the normal positions
9-2-9.	Faulty Electric oil pump, faulty wiring connections, faulty line in Harness	Inspect and replace or repair as necessary

Symptom		Item	Self-diagnosable points	Beeps	Warning indicator A (oil)	Warning indicator B (water temp)	Warning indicator C (battery)
10. Unable to exceed 3,000 rpm at full throttle or suddenly drops and stays at 3,000 rpm	10-1. Electrical control system	Cooling water temperature too high (temp indicator flashes)	○	Continuous		Flashing	
			○	Continuous		Flashing	
			○	Continuous		Flashing	
			○	Continuous		Flashing	
		Battery voltage abnormally low (battery indicator flashes)	○				Flashing
			○				Flashing
			○				Flashing
			○				Flashing
			○				Flashing
		TPS not functioning	○		Flashing	Flashing	Flashing
		Remote control					

*1. TPS: Throttle position sensor
FFP: Fuel-feed pump (electric pump)
Lift pump: diaphragm fuel pump

*2. TPS reset: reset is required in the following circumstances.
①When cable has been reset because of a TPS error indication due to incorrect remote control cable setup
②When TPS and / or ECU has been replaced
③When the link or rod snap ring has been replaced due to wear or warping in linkage
When one of the above situations occurs it is necessary to reset ECU and TPS. Refer to the section on self-diagnosis functions and reset the TPS to its initial values.

Cause		Remedy (see chapter on servicing information for specifications)
10-1-1.	Water strainer is clogged	Inspect
10-1-2.	Faulty water pump	Inspect and replace or repair as necessary
10-1-3.	Faulty thermostat	
10-1-4.	Cooling inlet is clogged	
10-1-5.	Faulty battery	Replace
10-1-6.	Faulty alternator	Inspect and replace
10-1-7.	Severed alternator system wiring	Inspect and repair as necessary
10-1-8.	Faulty battery cable or electrical connections	
10-1-9.	Faulty rectifier regulator	Inspect and replace
10-1-10.	Faulty TPS, faulty wiring connections or severed line in harness	Inspect and repair or replace as necessary
10-1-11.	Engine was started with neutral warm-up lever raised	Return the lever to normal position and restart

2. TLDI Self-Diagnosing Functions

The TLDI engine self-diagnosing function is used to display detailed information on the locations of faults in the electrical system that have been detected by the engine control unit (ECU). Special devices, such as monitoring equipment and personal computers, are not required for the self-diagnosis function. It utilizes a system of key switch operation, tachometer readings and three types of warning indicator lights to provide the information required for the four operating modes listed below.

That TLDI self-diagnosis function is comprised of the following four modes.

Mode 1: tachometer operation test
Mode 2: engine operating time display
Mode 3: fault location and fault log display
Mode 4: fault log delete

(1) Gossary of Self-Diagnosis Terminology

Key switch:

The key switch is attached to the remote control box. There are four positions: Off, On, Start, and key depressed at the On position. The self-diagnosing function is used with the key in the On position.

Warning indicators:

Warning indicators for indicating cooling water temperature, oil level, and battery problems are installed on the tachometer.

All three indicators simultaneously flash and beeps sound when a fault or failure is detected in an electrical component. (Refer to the Warning Indicator Definition Table.)

The self-diagnosing function uses the three indicators in combination with the tachometer to indicate the type of malfunction or failure that has occurred. (Refer to the Fault Indication Table.)

Warning beeper:

The beeper is located on the remote control box. The beeper emits the following four sound patterns.

Long beep: 2 seconds

Short beep 0.3 seconds

Intermittent short beep: 3 short beeps at 2-minute intervals

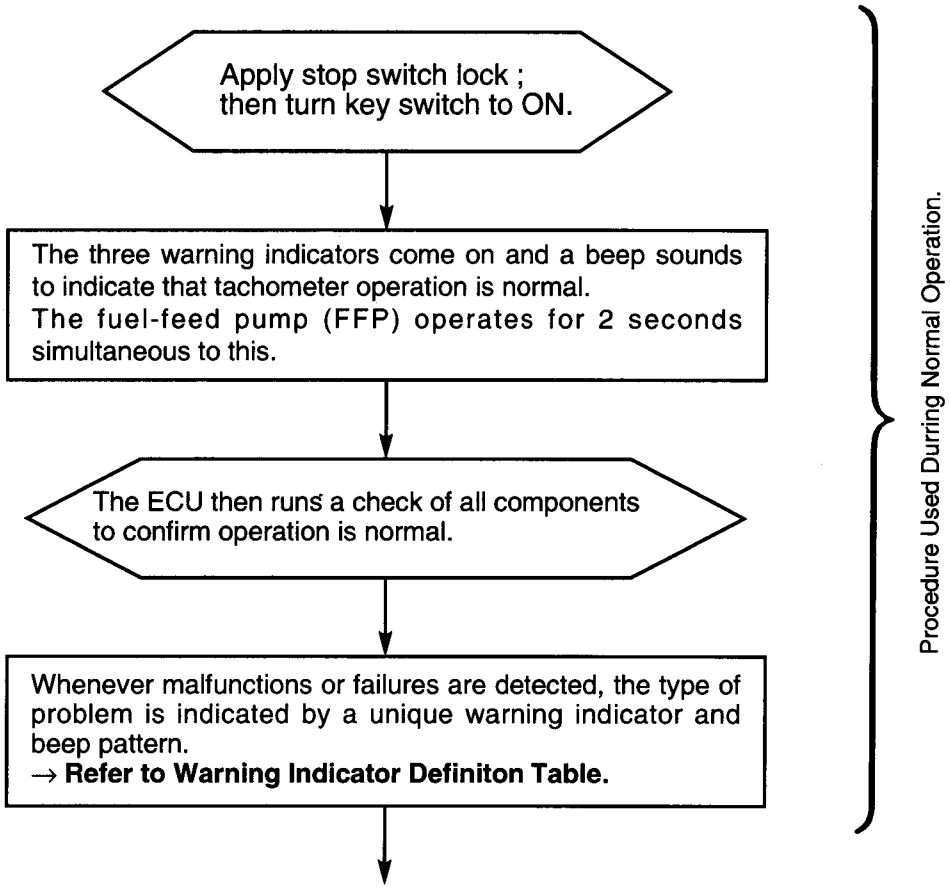
Continuous uninterrupted beep

Fault log:

Any malfunctions or failures that have occurred in the past from which the system has recovered are logged in the ECU memory. The self-diagnosing function is able to access this fault log information.

(2) Self-Diagnosing Function Procedures

- The self-diagnosing function can only be enabled when the engine is not running.
- The self-diagnosing function can be terminated during any of the steps listed below by simply turning the key switch to the Off position.
- Note that the optional tachometer and cable are required when using the self-diagnosing function with the EF models.



Using the Self-Diagnosing Function

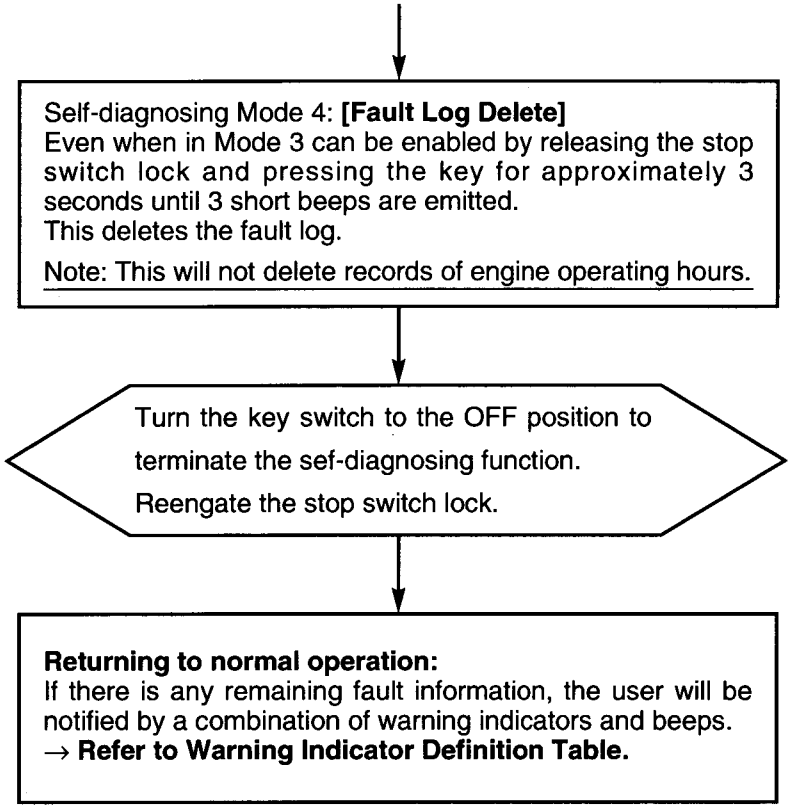
With the switch in the ON position,
Press the key for a period of approximately
5 seconds until a beep sounds

Self-diagnosing Mode 1: **[Tachometer Operation Test]**
Mode 1 starts with two long beeps as the tachometer needle points to 5,000 rpm.
The needle then returns to 0 and operation automatically proceeds to Mode 2.

Self-diagnosing Mode 2: **[Engine Operating Hours Display]**
This Mode displays the number of engine operating hours on the tachometer in combination with the three warning indicators.
→ **Refer to Engine Operating Hours Table.**

With the key in the On position, press for approximately 1 second until the beep sounds to enable Mode 3.

Self-diagnosing Mode 3: **[Fault Location and Fault Log Display]**
This Mode displays after one short beep sounds, the fault location and fault log for first incident at a time using the tachometer in combination with the three warning indicators.
→ **Refer to the Fault Indication Table.**
The locations and logs for successive faults can be viewed by pressing for approximately 1 second until the beep sounds with the key switch in the ON potision.
Once Mode 3 has been used to display the location and log information for all recorded faults, the display goes blank,
Pressing the key switch at this point will repeat display of location and log information from the first fault.
Note that noting is displayed if there is currently no recorded fault information.
(Tachometer and warning indicators are inacitive.)



Note:The self-diagnosing function can be terminated during any of the steps listed above by simply turning the key switch to the OFF position

Warning Indicator Definition Table ···· while operating engine

Warning indicators				ESG Speed Control(*1)	Fault Description	Reference	Remedy
Beeps	 Left Indicator	 Center Indicator	 Right Indicator				
Continuous	×	×	×	High-speed	Engine overrun	Approx.6,000 rpm	Readjust propeller and outboard engine mounting height and trim.
Intermittent (3 short sound every 2 minutes)	Flashing	×	×	—	Oil level low	Approx.610ml or less (21 US fl oz)	Replenish angine oil
Continuous	×	Flashing	×	Low-speed	Coolng water temp. high		Refer to troubleshooting table.
Continuous	×	Flashing	×	Forced idling	Coolng water temp. abnormally high		
—	×	×	Flashing	Low-speed	Battery voltage abnormally low	Approx.9V or less	
—	×	×	Flashing	—	Battery voltage low	Approx.10V or less	
—	Flashing	Flashing	Flashing	Low-speed	Battery voltage high	Approx.18V or more	Refer to Fault Indication Table used for self-diagnosing function.
—	Flashing	Flashing	Flashing	Engine stop	Battery voltage abnormally high	Approx.20V or more	
—	Flashing	Flashing	Flashing	—	Faulty TPS(*2) idle position		
—	Flashing	Flashing	Flashing	Forced idling	Faulty TPS	TPS1 & TPS2	
—	Flashing	Flashing	Flashing	Low-speed	Faulty TPS	TPS1 & TPS2	
—	Flashing	Flashing	Flashing	Forced idling	Faulty TPS power supply	TPS1 & TPS2	
—	Flashing	Flashing	Flashing	Low-speed	Faulty TPS power supply	TPS1 & TPS2	
—	Flashing	Flashing	Flashing	—	Faulty air injector		
—	Flashing	Flashing	Flashing	—	Faulty fuel injector		
—	Flashing	Flashing	Flashing	—	Faulty sparkplug		
—	Flashing	Flashing	Flashing	—	Faulty ignition coil		
—	Flashing	Flashing	Flashing	—	Faulty FFP(*3)		
—	Flashing	Flashing	Flashing	—	Faulty CPS(*4)		
—	Flashing	Flashing	Flashing	—	Faulty engine temperature sensor		
Intermittent (3 short sound every 2 minutes)	Flashing	Flashing	Flashing	Forced idling	Faulty oil pump		

*1:ESG speed control
High-speed: regulated to approx. 6,000 rpm.
Low-speed: regulated to approx. 3,000 rpm.
Forced idling: regulated to idling speed.
*2:TPS : abbreviation for throttle position sensor.
*3:TPS : abbreviation for fuel-feed pump.

Engine Operating Hours Table (Self-Diagnosing Mode 2)

Engine operating hours (h)	 Tachometer reading (rpm)	Warning indicators		
		 A Indicator	 B Indicator	 C Indicator
0 – 1	1,000	—	—	—
1 – 2	2,000	—	—	—
2 – 3	3,000	—	—	—
3 – 4	4,000	—	—	—
4 – 5	5,000	—	—	—
5 – 6	6,000	—	—	—
6 – 7	7,000	—	—	—
7 – 8	800	—	—	On
8 – 9	900	—	—	On
10 – 14	1,000	—	—	On
15 – 24	2,000	—	—	On
25 – 34	3,000	—	—	On
35 – 44	4,000	—	—	On
45 – 54	5,000	—	—	On
55 – 64	6,000	—	—	On
65 – 74	7,000	—	—	On
75 – 84	800	—	On	On
85 – 94	900	—	On	On
95 – 149	1,000	—	On	On
150 – 249	2,000	—	On	On
250 – 349	3,000	—	On	On
350 – 449	4,000	—	On	On
450 – 549	5,000	—	On	On
550 – 649	6,000	—	On	On
650 – 749	7,000	—	On	On
750 – 849	800	On	On	On
850 – 949	900	On	On	On
950 – 1499	1,000	On	On	On
1500 – 2499	2,000	On	On	On
2500 – or more	3,000	On	On	On

Fault Indication Table (Self-diagnosing Mode 3)

Malfunction & failure indication		Description of problem	Fault log	
			Fault	Fault log (yes)
 Tachometer (rpm)	 Indicator A		 Indicator B	 Indicator C
0	Off	No malfunction or failure	Off	Off
0	On	Battery voltage high	On indicates severed line or component fault	On indicates severed line or component fault
0	Flashing	Battery voltage abnormally high		
1,000	Off	Faulty #1 air injector	Off Stays off even when line is severed or component is faulty. → Refer to *1	→ Refer to *2
1,000	On	Faulty #1 fuel injector		
1,000	Flashing	Faulty #1 spark plug		
		Faulty #1 ignition coil		
2,000	Off	Faulty #2 air injector		
2,000	On	Faulty #2 fuel injector		
2,000	Flashing	Faulty #2 spark plug		
		Faulty #2 ignition coil		
3,000	Off	Faulty #3 air injector		
3,000	On	Faulty #3 fuel injector		
3,000	Flashing	Faulty #3 spark plug		
		Faulty #3 ignition coil		
4,000	Off	Oil level low	On indicates low oil level	On indicates low oil level history
4,000	On	Battery voltage low	On indicates battery voltage low	On indicates low battery voltage history
4,000	Flashing	Battery voltage abnormally low		
5,000	Off	Faulty CPS (*3)	On indicates severed line or component fault	On indicates severed line or component fault history
5,000	On	#1 TPS (*4) idling position error	On indicates incorrect TPS initial settings	On indicates incorrect TPS initial setting history
5,000	Flashing	Faulty #2 TPS idling position error		
5,500	Off	Faulty #1 TPS	On indicates severed line or component fault	On indicates severed line or component fault history
5,500	On	#1 TPS power supply high		
6,000	Flashing	#1 TPS power supply slow		
6,000	Off	Faulty #2 TPS		
6,000	On	#2 TPS power supply high		
6,000	Flashing	#2 TPS power supply low		
6,500	Off	Faulty water temp sensor		
6,500	On	Cooling water temp high	On indicates severed line or component fault history	On indicates rise in cooling water temperature history
6,500	Flashing	Cooling water abnormally temp high		
7,000	Off	Faulty FFP (*5)	On indicates rise in cooling water temperature	On indicates severed line or component fault

*3. CPS: crank position sensor

*4. TPS: throttle position sensor

*5. FFP: fuel-feed pump

Remedial Measures and Added Notes
Refer to troubleshooting tables
Replace components or check wiring and connections for abnormalities and repair as necessary. * 1. In the case of injector and ignition coil faults, indicator B does not illuminate when self-diagnosing modes are enabled while the engine is off. This is to determine whether operation is under the proper ECU control. * 2. Indicator C illuminates to indicate that there is a severed line or fault in a component. → Remedy: Delete current fault log (using Mode 4), operate the engine (or simply turn it over for 5 seconds or longer), and run the self-diagnosing function again to determine the type of fault. In instances when Indicator C again illuminates for the same malfunction or failure take remedial measures. →In case of injector problems ...Replace with new injector. If the fault remains, check the wiring. →In case of ignition coil problems: ...If only one ignition coil is indicated as faulty replace with a new coil. If the fault remains, check the wiring. ...If all three ignition coils are indicated as faulty it means that there could be a short in the wiring or in one of the coils.
Replenish engine oil. * Fault indicator remaining illuminated after engine oil has been replenished indicates a severed or shorted line or faulty component.
Refer to troubleshooting tables
Replace components or check wiring and connections for abnormalities and repair as necessary. * When engine speed fluctuation is great a fault may be indicated even if there is no fault or abnormality with components or wiring.
Refer to the procedure for restoring TPS initial values.
Replace components or check wiring and connections for abnormalities and repair as necessary.
Refer to troubleshooting tables
Replace components or check wiring and connections for abnormalities and repair as necessary.

(3) Resetting TPS Initial Values

Use the following procedures to reset the ECU and TPS in cases where self-diagnosing indicates idling position errors for TPS1 and TPS2.

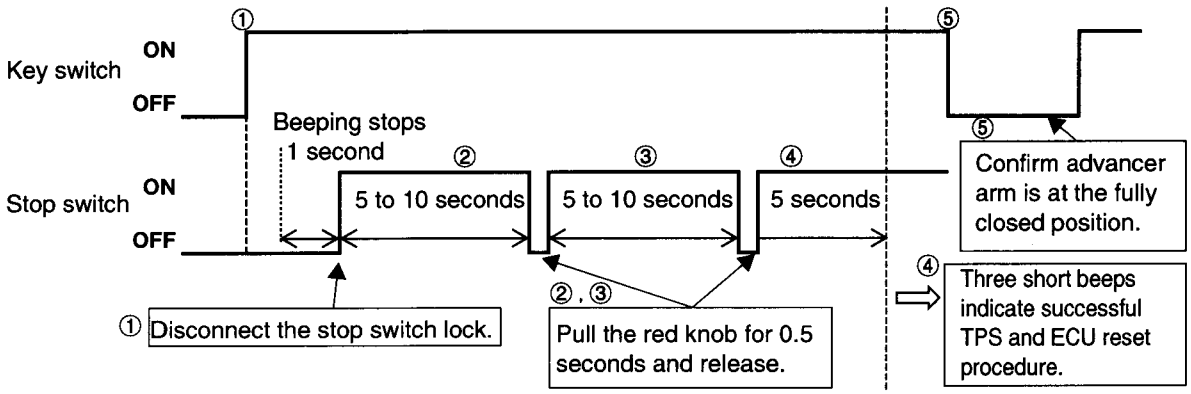
① When either the TPS or ECU is replaced:
② When the self-diagnosing function indicates "TPS Idling Position Error":
③ When links and rod snap rings are replaced due to warping or wear in the linkage:
④ When the TPS Idling Position Error indication appears after performing engine disassembly and assembly operations:
⑤ When a new engine is first put into service:

It is necessary to reset the ECU and TPS if any of the above conditions occurs.

Reset Procedure

(1) With the throttle in the fully closed position adjust the cables or wires in order bring the advancer arm into contact with the fully closed stopper position. Then, move the throttle several times to confirm that the arm is seated snugly against the fully closed stopper.
(2) Perform the following procedures with the throttle in the fully closed position. (Refer to the figure below.)
① Set the key switch to the On position. Disconnect the stop lock switch within one second after the beep stops sounding.
② Wait about 5 to 10 seconds, pull the red knob on the stop switch for about 0.5 seconds, then release the switch.
③ Wait another 5 to 10 seconds, again pull the red knob on the stop switch for about 0.5 seconds, then release the switch.
④ The sounding of 3 short beeps about 5 seconds after the knob is released indicates a successful reset of the TPS and ECU. (If no beeps sound, replace the stop switch lock and restart the reset procedure.)
If no beeps are heard, replace stop switch lock. And start again.
⑤ Next, set the key switch to the Off position, confirm that the throttle (advancer arm) is at the fully closed position, then turn the key switch to the On position.

Reset Procedure Chart

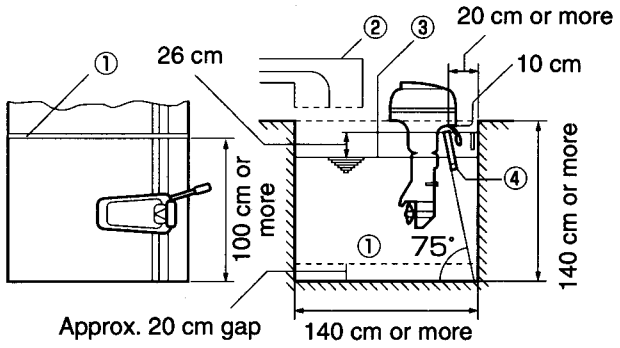


Chapter 10 Test Run and Inspection After Servicing

1. Test Tank and Test Propeller

● Test Run Tank Requirements and Precautions For Use

① Partition (required when testing two engines in one tank)
② Ventilation duct
③ Water level
④ Transom board

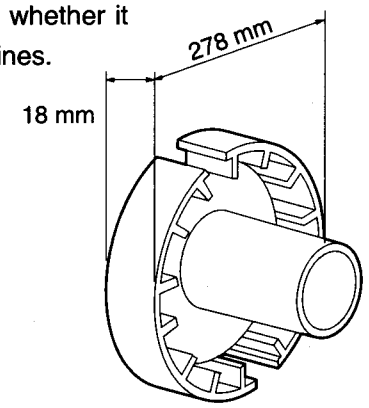


- The figure to the right shows the minimum dimensions required for the test run tank.
- The dimensions shown in the figure are the minimum that must be provided for a single engine, whether it be in a tank partitioned for two engines.

must be provided for a single engine, whether it be in a tank partitioned for two engines.

● Test Propeller

Out to diameter: 278 mm
Out width: 18 mm



Engine speed at full throttle (rpm)
Approx. 5,000

● Precautions for Operation

- Continuous operation will raise the temperature of water in the tank, potentially causing the engine to seize up, so it is important to maintain water temperature in the 25°C (77°F) range. It is also recommended that cooling and overflow systems be installed.
- Over periods of continued use the tank water gradually becomes contaminated by the waste discharged from the engine. This waste, which eventually coats the interior of the engine's cooling system, will reduce the engine's cooling capability, so it is important to change tank water on a regular basis.
- Over periods of continued use, engine exhaust fumes will accumulate in the vicinity of the engine. Engine performance is affected as the engine takes in air with increasing levels of these gases from the the throttle body, so it is important to install mechanical ventilation system to maintain an exhaust gas-free environment around the engine.
- The water in the tank will tend to splash and spray out unless a sufficiently high of water is maintained in the tank.

2. Inspection

● Items to Check Prior to Test Run

- Fuel line condition
- Oil line condition including air bleeding from the oil pump
- Gearshift lever operation
- Electrical wiring, connections and clamps
- Integrity of self-diagnosing function

● Items to Check During the Test Run

Check the following items while the engine is in an idling state.

- Fuel leakage from the various joined seams of the engine.
- Water leakage from the various joined seams of the engine.
- Unusual sounds during operation.
- Idling speed and stability
- Stop switch operation
- Tachometer needle operation
- Clutch operation
- Engine speed during acceleration and deceleration
- Cooling water discharge (with sufficient force from water inspection hole)

● Additional Tightening After Test Run

- Retighten the various bolts to specified torque values.

● Breaking in Engine

- It is important to perform a breaking in of the engine in order to properly seat the sliding surfaces of the various parts in cases where pistons, piston rings, piston pins and cylinders have been replaced.
- Perform the various breaking in steps listed in the table below after pressure feeding engine oil and allowing the engine to idle for 10 minutes.
- Breaking in period: 10 hours.

Time	0 to 10 min. ➡10 min. to 1 hr.➡2 hrs. to 10 hrs.➡ 2 hrs. to 10 hrs. ➡ 10 hours or more				
Breaking in engine	At minimum speed At closed throttle	At half throttle	Full throttle for 1 minute, at 10 minute intervals At 3/4 throttle or less	At full throttle for short intervals At 3/4 throttle	At normal operating speed
Operating range		Approx. 3,000 rpm or less	Approx. 4,000 rpm or less	Approx. 4,000 rpm	8,150 – 4,000 rpm

Caution

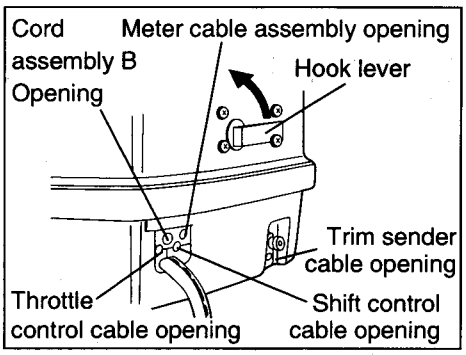
- The use of inferior or non-standard fuels and oils can not only shorten engine life but can also cause starting problems and lead to breakdowns. Be sure to always use the designated fuel and engine oil types.
- Do not use a gasoline/oil mixture in this engine. Alway use pure gasoiine.

Chapter 11 Installation on Boat and Test Run

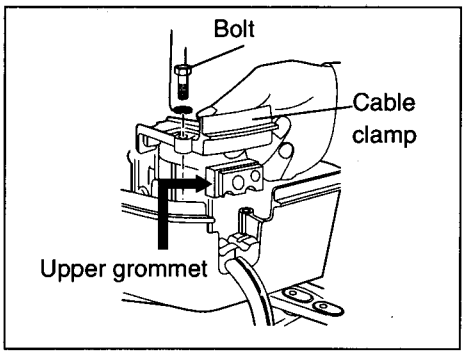
The other chapters of this manual provide general information required for using this outboard engine. This chapter is dedicated only to those points for which special user caution is required.

1. Installing Remote Control System Cable (Engine Side)

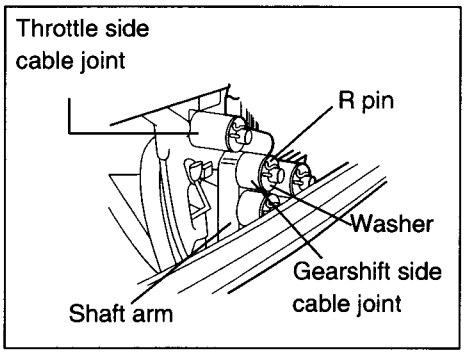
(1) Pull the hook lever on the upper motor cover up to detach the upper motor cover.



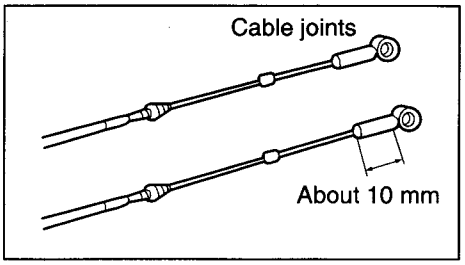
(2) Remove the bolt holding the cable clamp in place and remove the cable clamp and upper grommet.



(3) Remove the R pins holding the throttle side and gearshift side cable joints in place and remove both cable joints.

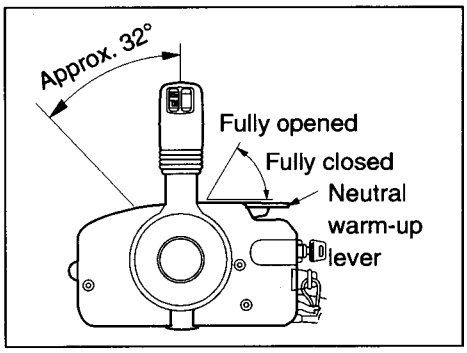


(4) Screw the cable joints onto the tip of the remote control cables up to a length of about 19 mm. Pass the meter cable assembly and cable assembly B attached to the remote control box through the front of the lower motor cover. Next, pass through the 2 remote control cables.

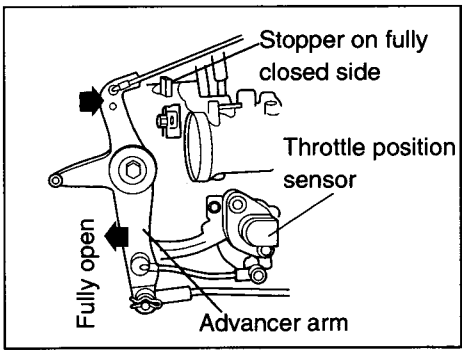


- I Observing the cables, move the remote control box's remote control lever down in the forward direction until it stops (approx. 32°). The cable that moves first is the gearshift cable.
  * A distance of 10 mm is equivalent to about nine threads on the joint.

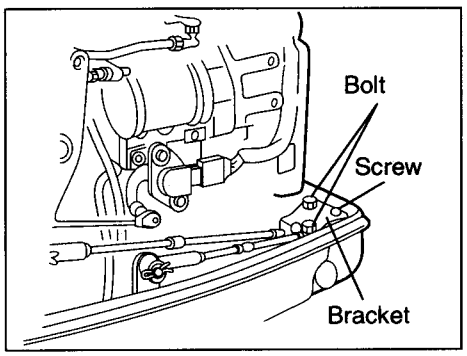
(5) Confirm that the remote control lever on the remote control box is in Neutral and that the neutral warm-up lever is at the fully closed position.



(6) Move the advancer arm to the fully closed position.



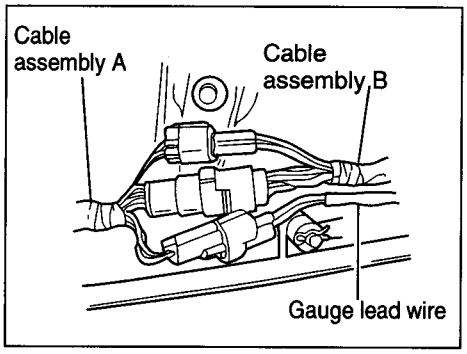
(7) Turn the cable joint on the end of the remote control cable to align the cable joint with the gearshift arm and advancer arm pins and secure it in place using the locknut. Then, insert the arm pin and secure it using the R pin and washers.



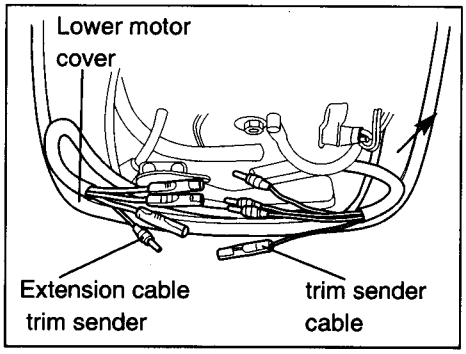
Remarks:

- Confirm that the outboard engine gears engage at a certain point when the remote control lever is fully pushed down in the Forward and Reverse directions (approx. 32°) and that the throttle is at the fully opened position when the remote control lever is pushed completely down.
  Next, return the remote control lever to the Neutral position and confirm that this also moves the advancer arm on the outboard engine to the fully closed position. Note that the throttle position sensor will malfunction unless the advancer arm is seated snugly against the fully closed stopper. If the advancer arm is not seated against the fully closed stopper remove and adjust the cable joint position on the engine side and reinstall.

(8) Connect both cable assembly B and the gauge lead wire to cable assembly A.



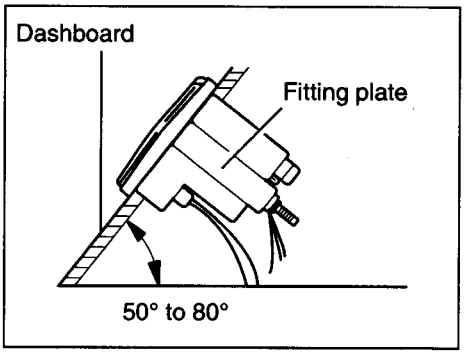
(9) Connect the trim sender and the extension cable trim sensor.



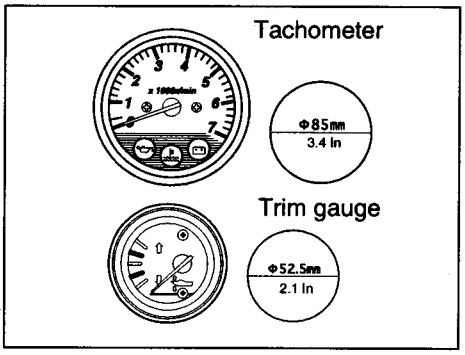
2. Gauges and Battery

1) Installing the Various Gauges

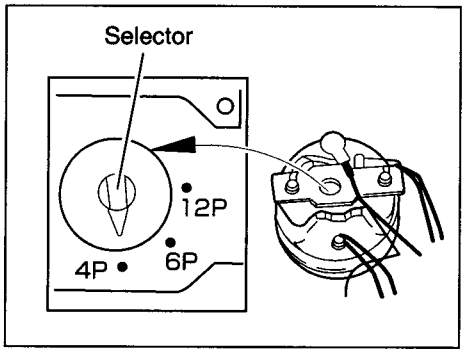
Be sure to install the various gauges on a proper dashboard in a location where they are protected from spray from the water. The dashboard may be anywhere from 2 to 11 mm (0.08 to 0.43 in) in thickness.
It will be necessary to install a separate fitting plate with holes cut to gauge sizes if thickness exceeds 11 mm (0.43 in).



- Mounting angle
  The recommended installation angle for the dashboard is in the 50° to 80° range.



- Tachometer (EP series)
  Turning the tachometer selector knob to the 4P setting.

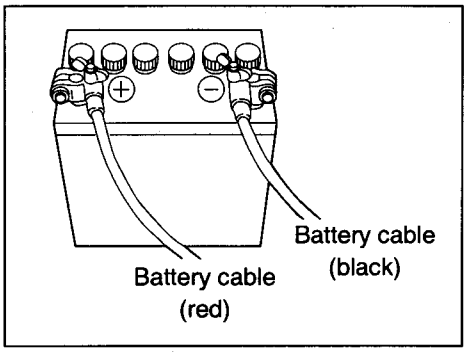


2) Installing Battery

This outboard engine requires battery power in order to operate. Use a 12V 100AH (or 12V 120AH in colder climates) battery.

(1) The battery should be secured in place in its own box to protect it from water spray and prevent it from tipping over with the movement of the boat.

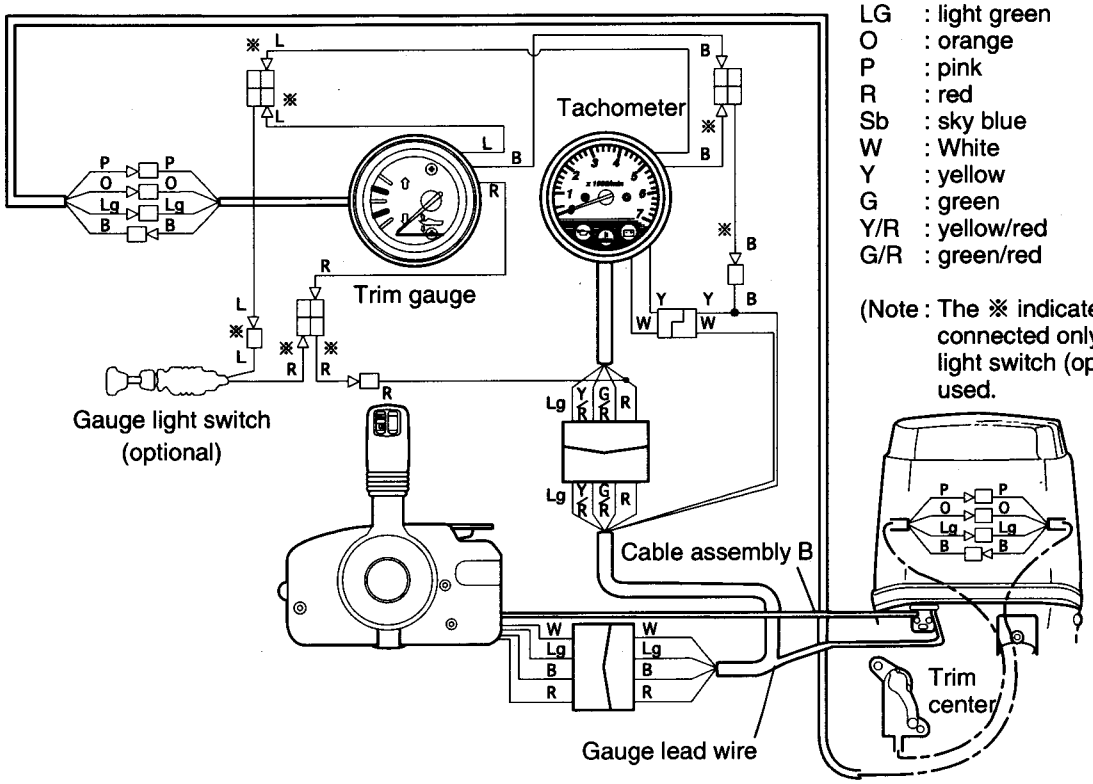
(2) Connect the battery cable with the red connector to the positive terminal and the cable with black connector to the negative terminal. (Be sure to remove the negative (black) connector first when disconnecting the cables.)
The battery cable enclosed in red plastic tubing is the one that connects to the positive terminal.



Caution

- Be sure to carefully read the warning label on the battery prior to use.
- Never disconnect battery cables while the engine is in operation.

3) Wiring Diagram for Remote Control Unit and Gauges



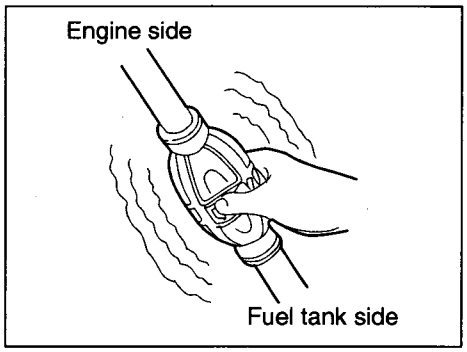
Color abbreviations

B	: black
L	: blue
LG	: light green
O	: orange
P	: pink
R	: red
Sb	: sky blue
W	: White
Y	: yellow
G	: green
Y/R	: yellow/red
G/R	: green/red

(Note : The ※ indicates lines to be connected only when the gauge light switch (optional) is being used.

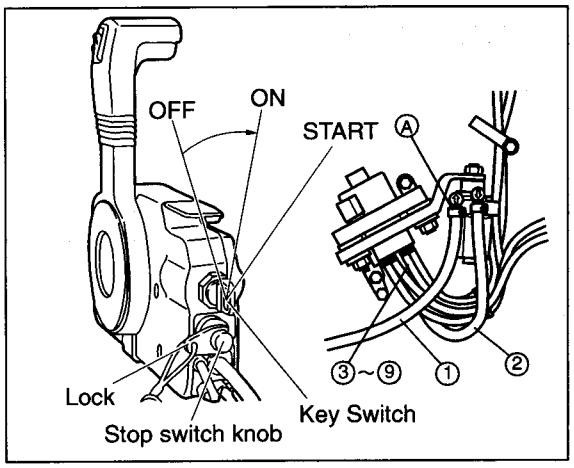
3. Operating the Engine

1. Force-Feeding Fuel
   The following fuel force-feeding procedure must be performed for engines that are new, overhauled, in storage for long periods or that ran out of fuel.
   a. Begin by squeezing the primer bulb until it becomes firm.
   b. Turn the main switch to On and hold for approximately 3 seconds. This actuates the fuel-feed pump (FFP).
   c. Return the main switch to Off and squeeze the primer bulb once again until it becomes hard.
   d. Repeat steps b and c until the primer bulb remains firm.



2. Force-Feeding Engine Oil

Perform the following oil force-feeding procedure for engines that are new, that have been serviced and reassembled, that have run out of oil or that have been stored for long periods.

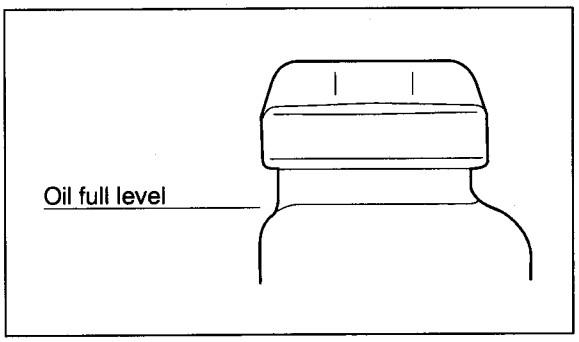


Hose ① (Oil tank – Oil filter)

a. Fill the oil tank with Genuine MD Gold or equivalent.
b. Prpvide an clean drain pan. Remove the hose at Ⓐ.
c. Drain the oil into the drain pan till all the air babbles are comletely bled. Then replace the hose and clip.

Hose ②–⑨ (Oil filter – Oil pump – Cylinder)

a. Turn on the key switch.
b. Remove the lock of safety stop switch wihtin a second after buzzer sounds off.
c. Remove lock of the switch. Pull and release the safety stop switch knob 2 times rapidly within 2sec.
d. Buzzer should sound 3 tomes and oil pump starts to bleed oil for about a minute.
e. Turn off the key switch after bleeding the air from oil.



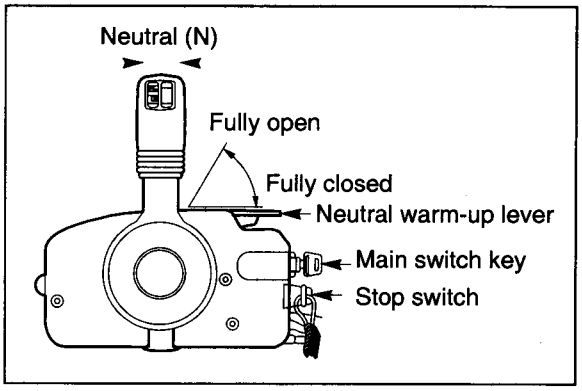
Incleasing engine oil for break-in

Important: When the engine is brand new and when the bleeding air from oil pump / oil line with operating the key switch as above, the engine oil is automatically increased to ptotect engine.

During this period, the additional amount of oil is supplied. The additional oil supply will be finished after total 1 hour engine operation is completed at 4000 rpm or highter.

Oil supply will be normal after then.

3. Insert the key into the switch.



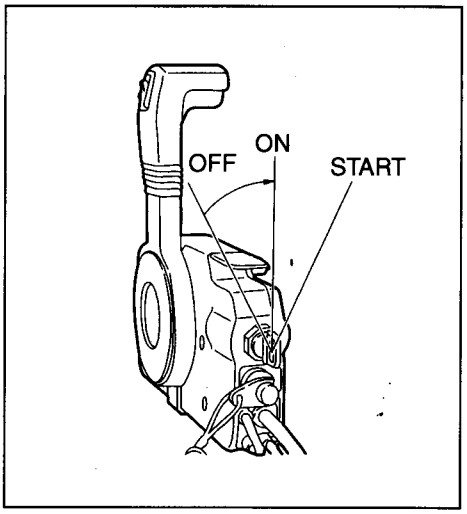
Remarks:

The engine will not start unless the remote control lever is in the Neutral position.

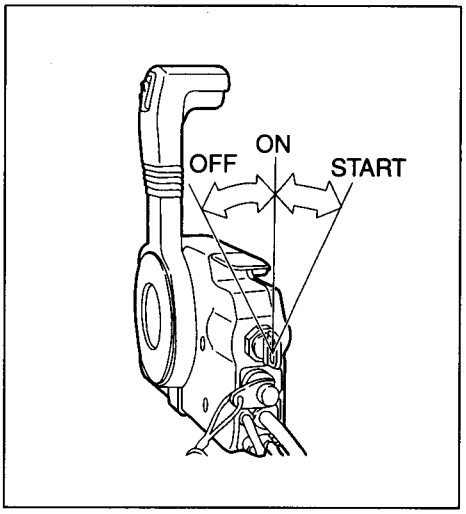
4. Set the remote control lever to the Neutral (N) position. Make sure that the neutral warm-up lever has been set to the fully closed position.

Remarks:

- Prior to turning the main switch key to the On position, make sure that the neutral warm-up lever has been set to the fully closed position.
- Mistakenly turning the key to the ON position with the neutral warm-up lever open will result in an operational error being recorded in the engine control unit (ECU). Repeating this error will result in the 3 warning indicators flashing simultaneously. Should this occur turn the main switch key to the Off position, then move the neutral warm-up lever to the fully closed position and proceed to the next step.



5. Turn the main switch key to the On position. When the beep stops (after 1 or 2 seconds) turn the key to Start and turn over the engine.
6. As soon as the engine starts, release the key. The key will automatically return to its normal position.



Remarks:

Pushing down on the key for a period of 1 second during idling or trolling operation has the effect of increasing engine speed. A beep sounds each time the key is pushed and engine speed changes as follows.

700 rpm ⇨ 800 ⇨ 900 ⇨ 800 ⇨ 700 ⇨ 800 ⇨ 900 rpm

2) Warning Process

Whenever engine trouble occurs, the warning indicators begin flashing and the beeper sounds.
The remedial actions described in the following sections must be taken whenever engine faults occur.

1. Engine Speed Control System (ESG)
   A sudden drop in engine load can cause the engine to race out of control. Whenever this condition occurs, the warning beeper sounds and the ESG mechanism is regulated.

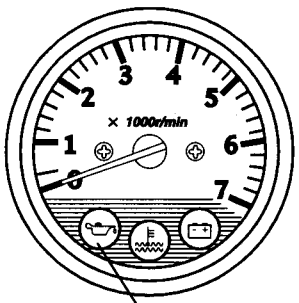
ESG regutated speed: approx. 6,000 rpm

2. Oil Level Indicator
   An oil level warning is displayed whenever the oil falls below the designated level (approx. 610 ml). The warning consists of flashing indicators accompanied by 3 short beeps at 2 minute intervals.
   Note: The warning is displayed whether the gearshift lever is in the Neutral, Forward or Reverse positions.

Remedial Action:

Reduce engine speed, move the boat to a safe harbor and turn the main switch to OFF. Replenish the oil in the oil tank only after the engine has stopped. Restart the engine and confirm that the tachometer (or switchbox) warning indicators are off and the beeper stays silent.

Tachometer on EPTO series



Oil level indicator

3. Cooling Water Indicator

A water temperature warning is displayed and the engine automatically reduces speed whenever the cooling water rises above the designated level.

No.	Sensor setting	Regulated rpm
1	Threshold	2,800 to 3,200 rpm
2	Over threshold	700 to 900 rpm

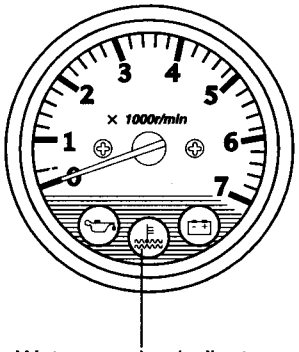
Remedial Action:

Quickly move the boat to a safe harbor, set the throttle grip or remote control lever to the low speed range and set the gearshift or remote control lever to the Neutral (N) position. Confirm whether cooling water is discharged with sufficient force from the water inspection hole; then turn off the engine. Remove any trash or plastic material from the vicinity of the gear case.

Remarks:

- The following procedure is required to cancel the engine regulation mode once it has been activated, regardless of whether temperature has returned to normal.
  Table No. 1: lower to idling speed.
  Table No. 2: turn off engine.
- This warning applies to only to cooling water temperature and is not related to fuel combustion and lubrication oil related warnings.

Tachometer on EPTO series



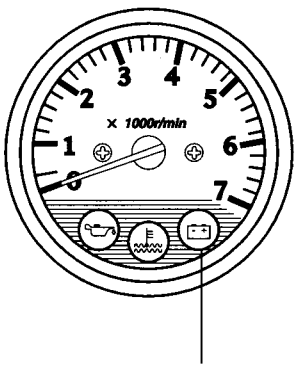
Water warning indicator
Light warning indicator

4. Battery Level Warning

- The battery warning indicator flashes when the battery level falls below 10V. All 3 warning indicators flash when battery voltage rises to abnormally high levels.
- The battery warning indicator flashes and engine speed is automatically reduced to the 2,800 to 3,200 rpm range when a battery fault occurs or there are faulty battery cable connections. Note that the engine will completely shut down in the case of serious faults.

Remedial Action:

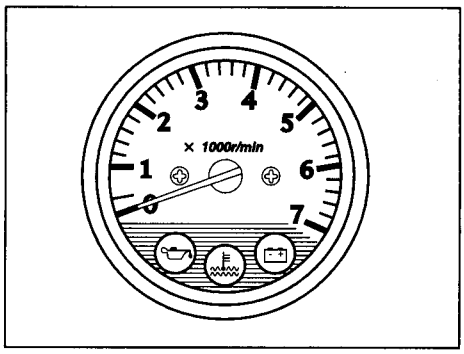
- Inspect and properly install battery connectors.
- Recharge battery.
- Replace battery.



Battey warning indicator

5. Engine Trouble Warning

Whenever faults or engine trouble occur the three warning indicators begin flashing simultaneously.



Remarks:

One of the following three types of warnings is output, depending on the cause (seriousness) of the trouble.

1. Warning indicators only flash.
2. Warning indicators flash and engine speed is regulated to the 2,800 to 3,200 rpm range.
3. Warning indicators flash and engine speed is regulated to the 700 to 900 rpm range.

TOHATSU CORPORATION

Marine seles Dept.
5-4, Azusawa 3-chome,
Itabashi-ku, TOKYO 174-0051,
Japan
Phone: 81-3-3966-3116
Fax: 81-3-3966-2951

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