SUZUKI OUTBOARD MOTOR

DF 60
DF 70

FOUR STROKE

SERVICE MANUAL

For '03 model –

99500-99E10-01E

FOREWORD

This manual contains an introductory description on SUZUKI Outboard motor DF60/70 and procedures for the inspection, service and overhaul of its main components.
General knowledge information is not included.

Please read the GENERAL INFORMATION section to familiarize yourself with basic information concerning this motor. Read and refer to the other sections in this manual for information regarding proper inspection and service procedures.

This manual will help you better understand this outboard motor so that you may provide your customers with optimum and quick service.

- *This manual has been prepared using the latest information available at the time of publication.*
  If a modification has been made since then, differences may exist between the content of this manual and the actual outboard motor.
- *Illustrations in this manual are used to show the basic principles of operation and work procedures and may not represent the actual outboard motor in exact detail.*
- *This manual is intended for use by technicians who already possess the basic knowledge and skills to service SUZUKI outboard motors.*
  Persons without such knowledge and skills should not attempt to service an outboard engine by relying on this manual only.
  Instead, please contact your nearby authorized SUZUKI outboard motor dealer.

⚠ WARNING

Apprentice mechanics or do-it-yourself mechanics that don't have the proper tools and equipment may not be able to properly perform the services described in this manual. Improper repair may result in injury to the mechanic and may render the engine unsafe for the boat operator and passengers.

NOTE:
This manual is compiled based on 2003 (K3) model.

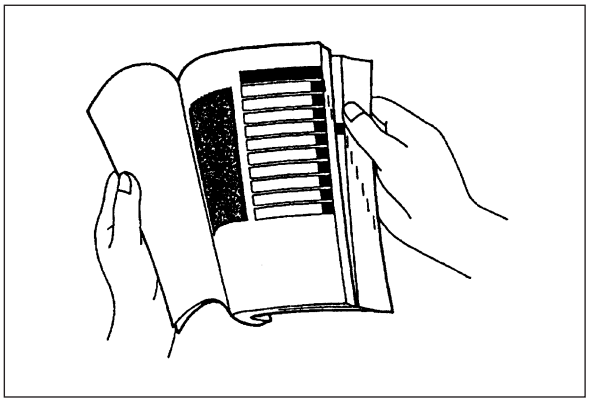
Marine & Power Products Division

GROUP INDEX

HOW TO USE THIS MANUAL

TO LOCATE WHAT YOU ARE LOOKING FOR:

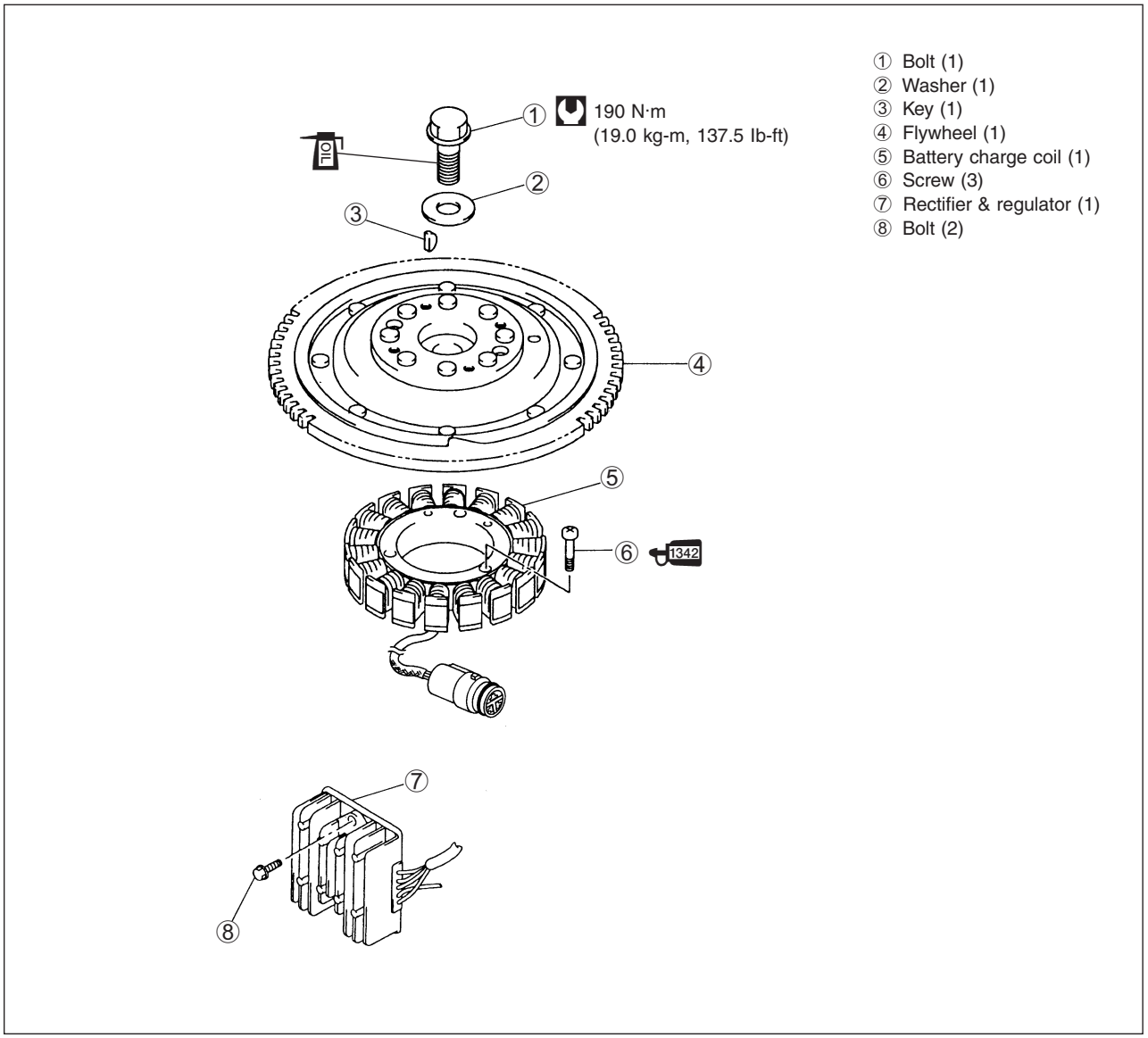
1. The text of this manual is divided into sections.
2. The section titles are listed on the previous page in a GROUP INDEX. Select the section needed for reference.
3. Holding the manual as shown at the right will allow you to find the first page of the section easily.
4. The first page of each section lists a table of contents to easily locate the item and page you need.



COMPONENT PARTS AND IMPORTANT ITEM ILLUSTRATIONS

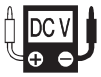
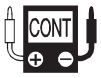
Under the name of each system or unit, an exploded view is provided with work instructions and other service information such as the tightening torque, lubrication and locking agent points.

Example :



SYMBOL

Listed in the table below are the symbols indicating instructions and other important information necessary for proper servicing. Please note the definition for each symbol. You will find these symbols used throughout this manual. Refer back to this table if you are not sure of any symbol(s) meanings.

SYMBOL	DEFINITION	SYMBOL	DEFINITION
	Torque control required. Data beside it indicates specified torque.		Apply THREAD LOCK “1342”.
	Apply oil. Use engine oil unless otherwise specified.		Apply THREAD LOCK SUPER “1333B”.
	Apply SUZUKI OUTBOARD MOTOR GEAR OIL.		Measure in DC voltage range.
	Apply SUZUKI SUPER GREASE “A”.		Measure in resistance range.
	Apply SUZUKI WATER RESISTANT GREASE.		Measure in continuity test range.
	Apply SUZUKI BOND “1104”.		Use peak voltmeter “Stevens CD-77”.
	Apply SUZUKI BOND “1207B”.		Use special tool.
	Apply SUZUKI SILICONE SEAL.		

GENERAL INFORMATION

1

CONTENTS

WARNING / CAUTION / NOTE

Please read this manual and follow its instructions carefully. To emphasize special information, the symbol and the words WARNING, CAUTION and NOTE have special meanings. Pay special attention to the messages highlighted by these signal words.

⚠ WARNING

Indicates a potential hazard that could result in death or injury.

CAUTION

Indicates a potential hazard that could result in motor damage.

NOTE:
Indicates special information to make maintenance easier or instructions clearer.

Please note, however, that the warnings and cautions contained in this manual cannot possibly cover all potential hazards relating to the servicing, or lack of servicing, of the outboard motor. In addition to the WARNING and CAUTION stated, you must also use good judgement and observe basic mechanical safety principles.

GENERAL PRECAUTIONS

⚠ WARNING

- **Proper service and repair procedures are important for the safety of the service mechanic and the safety and reliability of the outboard motor.**
- **To avoid eye injury, always wear protective goggles when filing metals, working on a grinder, or doing other work, which could cause flying material particles.**
- **When 2 or more persons work together, pay attention to the safety of each other.**
- **When it is necessary to run the outboard motor indoors, make sure that exhaust gas is vented outdoors.**
- **When testing an outboard motor in the water and on a boat, ensure that the necessary safety equipment is on board. Such equipment includes : flotation aids for each person, fire extinguisher, distress signals, anchor, paddles, bilge pump, first-aid kit, emergency starter rope, etc.**
- **When working with toxic or flammable materials, make sure that the area you work in is well-ventilated and that you follow all of the material manufacturer's instructions.**
- **Never use gasoline as a cleaning solvent.**
- **To avoid getting burned, do not touch the engine, engine oil or exhaust system during or shortly after engine operation.**
- **Oil can be hazardous. Children and pets may be harmed from contact with oil. Keep new and used oil away from children and pets. To minimize your exposure to oil, wear a long sleeve shirt and moisture-proof gloves (such as dishwashing gloves) when changing oil. If oil contacts your skin, wash thoroughly with soap and water. Launder any clothing or rags if wet with oil. Recycle or properly dispose of used oil.**
- **After servicing fuel, oil/engine cooling system and exhaust system, check all lines and fittings related to the system for leaks.**
- **Carefully adhere to the battery handling instructions laid out by the battery supplier.**

CAUTION

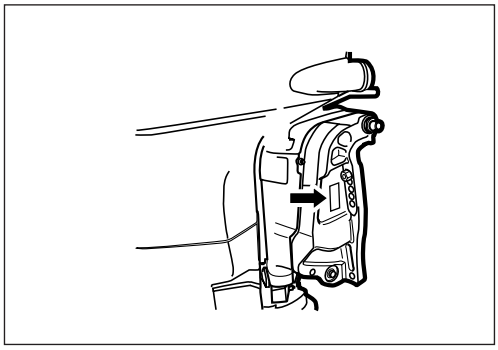
- **If parts replacement is necessary, replace the parts with Suzuki Genuine Parts or their equivalent.**
- **When removing parts that are to be reused, keep them arranged in an orderly manner so that they may be reinstalled in the proper order and orientation.**
- **Be sure to use special tools when instructed.**
- **Make sure that all parts used in assembly are clean and also lubricated when specified.**
- **When use of a certain type of lubricant, bond, or sealant is specified, be sure to use the specified type.**
- **When removing the battery, disconnect the negative cable first and then the positive cable. When reconnecting the battery, connect the positive cable first and then the negative cable.**
- **When performing service to electrical parts, if the service procedures do not require using battery power, disconnect the negative cable at the battery.**
- **Tighten cylinder head and case bolts and nuts, beginning with larger diameter and ending with smaller diameter. Always tighten from inside to outside diagonally to the specified tightening torque.**
- **Whenever you remove oil seals, gaskets, packing, O-rings, locking washers, locking nuts, cotter pins, circlips, and certain other parts as specified, always replace them with new. Also, before installing these new parts, be sure to remove any left over material from the mating surfaces.**
- **Never reuse a circlip. When installing a new circlip, take care not to expand the end gap larger than required to slip the circlip over the shaft. After installing a circlip, always ensure that it is completely seated in its groove and securely fitted.**
- **Use a torque wrench to tighten fasteners to the torque values when specified.**
  Remove grease or oil from screw / bolt threads unless a lubricant is specified.
- **After assembly, check parts for tightness and operation.**

- **To protect the environment, do not unlawfully dispose of used motor oil, other fluids, and batteries.**
- **To protect the Earth's natural resources, properly dispose of used motor parts.**

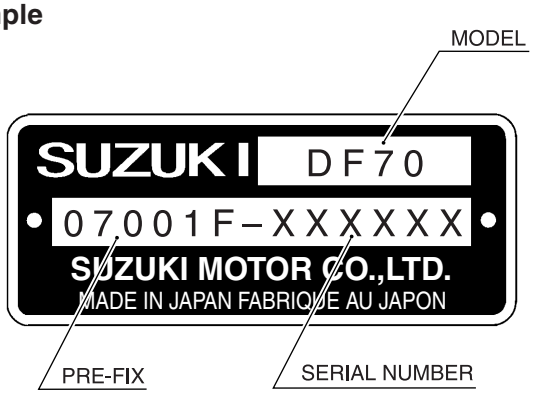
IDENTIFICATION NUMBER LOCATION

MODEL, PRE-FIX, SERIAL NUMBER

The MODEL, PRE-FIX and SERIAL NUMBER of the motor are stamped on a plate attached to the clamp bracket.

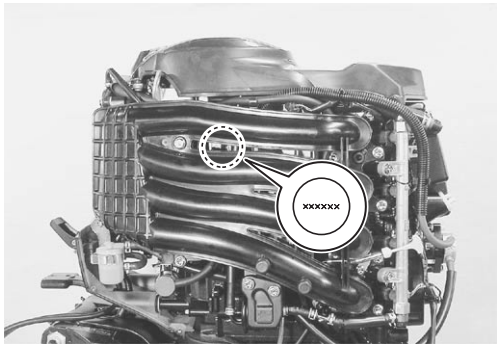


Example



ENGINE SERIAL NUMBER

A second engine serial number plate is pressed into a boss on the cylinder block.



FUEL AND OIL

GASOLINE RECOMMENDATION

Suzuki highly recommends that you use alcohol - free unleaded gasoline with a minimum pump octane rating of 87 (R+M / 2 method) or 91 (Research method). However, blends of unleaded gasoline and alcohol with equivalent octane content may be used.

Allowable maximum blend of a single additive (not combination) :

5% Methanol, 10% Ethanol, 15% MTBE

CAUTION

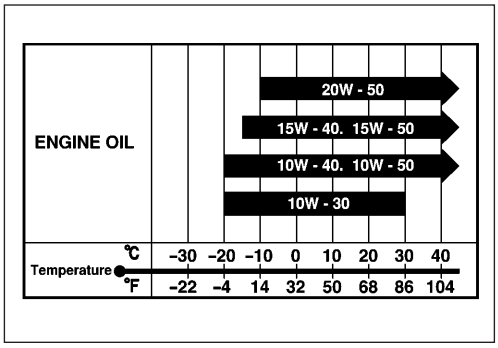
If leaded gasoline is used, engine damage may result. Use only unleaded gasoline.

ENGINE OIL

Use only oils that are rated SE, SF, SG, SH, or SJ under the API (American Petroleum Institute) classification system.

The viscosity rating should be SAE 10W-40.

If an SAE 10W-40 motor oil is not available, select an alternative according to the chart at right.



ENGINE BREAK-IN

The first 10 hours are critically important to ensure correct running of either a brand new motor or a motor that has been reconditioned or rebuilt. How the motor is operated during this time will have direct bearing on its life span and long-term durability.

Break-in period : 10 hours

WARM-UP RECOMMENDATION

Allow sufficient idling time (more than 5 minutes) for the engine to warm up after cold engine starting.

THROTTLE RECOMMENDATION

NOTE:
Avoid maintaining a constant engine speed for an extended period at any time during the engine break-in by varying the throttle position occasionally.

1. FIRST 2 HOURS
   For first 15 minutes, operate the engine in-gear at idling speed.
   During the remaining 1 hour and 45 minutes, operate the engine in-gear at less than 1/2 (half) throttle (3000 r/min).

NOTE:
The throttle may be briefly opened beyond the recommended setting to plane the boat, but must be reduced to the recommended setting immediately after planing.

2. NEXT 1 HOUR
   Operate the engine in-gear at less than 3/4 (three-quarter) throttle (4000 r/min).

3. LAST 7 HOURS
   Operate the engine in-gear at desired engine speed.
   However, do not operate continuously at full throttle for more than 5 minutes.

PROPELLERS

An outboard motor is designed to develop its rated power within a specified engine speed range. The maximum rated power delivered by the DF60/70 models are shown below.

Recommended full throttle speed range	**DF60**	**4700 – 5300 r/min**
	DF70	**5200 – 5800 r/min**

If the standard propeller fails to meet the above requirement, use another pitch propeller to hold the engine speed within the range specified above.

Propeller selection chart

Blade	×	Diam. (in)	×	Pitch (in)
3	×	13 - ¼	×	17 (U1700)
3	×	13	×	18 (U1800)
3	×	13	×	19 (U1900)
3	×	14	×	11 (V1100)
3	×	13 - ¾	×	13 (V1300)
3	×	13 - ½	×	15 (V1500, VS1500)
3	×	13 - ¼	×	17 (V1700, VS1700)
3	×	13	×	19 (V1900, VS1900)
3	×	13	×	21 (V2100, VS2100)

CAUTION

Installing a propeller with pitch either too high or too low will cause incorrect maximum engine speed, which may result in severe damage to the motor.

*SPECIFICATIONS

* These specifications are subject to change without notice.

Item	Unit	Data		
		DF60T	DF70(W)T	DF70WTH
PRE-FIX		06001F	07001F	

DIMENSIONS & WEIGHT

Overall length (front to back)		mm (in)	795 (31.3)	795 (31.3)	892 (35.1)
Overall width (side to side)		mm (in)	435 (17.1)		
Overall height	L	mm (in)	1493 (58.8)		
	UL	mm (in)	1620 (63.8)		
Weight (without engine oil)	L	kg (lbs)	162 (357.1)	162 (357.1)	165 (363.8)
	UL	kg (lbs)	167 (368.2)	167 (368.2)	170 (374.8)
Transom height	L	mm (inch type)	520 (20)		
	UL	mm (inch type)	647 (25)		

PERFORMANCE

Maximum output	kW (PS)	44.1 (60)	51.5 (70)
Recommended operating range	r/min	4700 – 5300	5200 – 5800
Idle speed	r/min	700 ± 50 (in-gear: approx. 700)	

POWERHEAD

Engine type		4-stroke SOHC		
Number of cylinders		4		
Bore	mm (in)	74.0 (2.91)		
Stroke	mm (in)	75.5 (2.97)		
Total displacement	cm^3 (cu in)	1298 (79.2)		
Compression ratio	: 1	9.5		
Spark plug	NGK	BPR6ES		
Ignition system		Full-transistorized ignition		
Fuel supply system		Multi-point sequential electronic fuel injection		
Exhaust system		Through prop exhaust		
Cooling system		Water cooled		
Lubrication system		Wet sump by trochoid pump		
Starting system		Electric		
Throttle control		Remote control	Remote control	Twist grip

Item	Unit	Data		
		DF60T	DF70(W)T	DF70WTH

FUEL & OIL

Fuel		Suzuki highly recommends that you use alcohol-free unleaded gasoline with a minimum pump octane rating of 87 ($\frac{R+M}{2}$ method) or 91 (Research method). However, blends of unleaded gasoline and alcohol with equivalent octane content may be used.
Engine oil		API classification SE, SF, SG, SH, SJ Viscosity rating SAE 10W-40
Engine oil amounts	L (US/Imp. qt)	4.5 (4.8/4.0) : Oil change only 4.8 (5.1/4.2) : Oil filter change
Gear oil		SUZUKI Outboard Motor Gear Oil (SAE #90 hypoid gear oil)
Gearcase oil amounts	ml (US/Imp. oz)	1050 (35.5/37.0)

BRACKET

Trim angle	PTT system
Number of trim position	PTT system
Maximum tilt angle	75°

LOWER UNIT

Reversing system	Gear				
Transmission	Forward-Neutral-Reverse				
Reduction system	Bevel gear				
Gear ratio	12 : 29 (2.417)				
Drive line impact protection	Spline drive rubber hub				
Propeller	Blade × Diam. (in) × Pitch (in)				
	3	×	13 - ¼	×	17 (U1700)
	3	×	13	×	18 (U1800)
	3	×	13	×	19 (U1900)
	3	×	14	×	11 (V1100)
	3	×	13 - ¾	×	13 (V1300)
	3	×	13 - ½	×	15 (V1500, VS1500)
	3	×	13 - ¼	×	17 (V1700, VS1700)
	3	×	13	×	19 (V1900, VS1900)
	3	×	13	×	21 (V2100, VS2100)

*SERVICE DATA

*These service data are subject to change without notice.

Item	Unit	Data	
		DF60T	DF70(W)T/70WTH

POWERHEAD

Recommended operating range	r/min	4700 – 5300	5200 – 5800
Idle speed	r/min	700 ± 50 (in-gear: approx.700)	
*Cylinder compression	kPa (kg/cm². psi)	1300 – 1600 (13 – 16, 185 – 228)	
*Cylinder compression max. difference between any other cylinders	kPa (kg/cm². psi)	200 (2.0, 28)	
*Engine oil pressure {Oil temp. at 60°C (140°F)}	kPa (kg/cm². psi)	420 – 490 (4.2 – 4.9, 60 – 70) at 3000 r/min	
Engine oil		API classification SE, SF, SG, SH, SJ Viscosity rating SAE 10W-40	
Engine oil amounts	L (US/Imp. qt)	4.5 (4.8/4.0) : Oil change only 4.8 (5.1/4.2) : Oil filter change	
Thermostat operating temperature	°C (°F)	58 – 62 (136 – 144)	

* Figures shown are guidelines only, not absolute service limits.

CYLINDER HEAD / CAMSHAFT

Cylinder head distortion		Limit	mm (in)	0.05 (0.002)	
Intake manifold seating faces distortion		Limit	mm (in)	0.10 (0.004)	
Cam height	IN	STD	mm (in)	38.061–38.221 (1.4985–1.5048)	37.631–37.791 (1.4815–1.4878)
		Limit	mm (in)	37.961 (1.4945)	37.531 (1.4776)
	EX	STD	mm (in)	38.059–38.219 (1.4984–1.5047)	37.629–37.789 (1.4815–1.4878)
		Limit	mm (in)	37.959 (1.4944)	37.529 (1.4775)
Camshaft journal oil clearance		STD	mm (in)	0.050 – 0.091 (0.0020 – 0.0036)	
		Limit	mm (in)	0.150 (0.0059)	
Camshaft holder inside diameter	Top	STD	mm (in)	45.000 – 45.016 (1.7717 – 1.7723)	
	2nd	STD	mm (in)	44.800 – 44.816 (1.7638 – 1.7644)	
	3rd	STD	mm (in)	44.600 – 44.616 (1.7559 – 1.7565)	
	4th	STD	mm (in)	44.400 – 44.416 (1.7480 – 1.7487)	
	Bottom	STD	mm (in)	44.200 – 44.216 (1.7402 – 1.7408)	
Camshaft journal outside diameter	Top	STD	mm (in)	44.925 – 44.950 (1.7687 – 1.7697)	
	2nd	STD	mm (in)	44.725 – 44.750 (1.7608 – 1.7618)	
	3rd	STD	mm (in)	44.525 – 44.550 (1.7530 – 1.7539)	
	4th	STD	mm (in)	44.325 – 44.350 (1.7451 – 1.7461)	
	Bottom	STD	mm (in)	44.125 – 44.150 (1.7372 – 1.7382)	
Camshaft runout		Limit	mm (in)	0.10 (0.004)	
Rocker arm shaft to rocker arm clearance		STD	mm (in)	0.012 – 0.045 (0.0005 – 0.0018)	
		Limit	mm (in)	0.090 (0.0035)	
Rocker arm inside diameter		STD	mm (in)	16.000 – 16.018 (0.6299 – 0.6306)	
Rocker arm shaft outside diameter		STD	mm (in)	15.973 – 15.988 (0.6289 – 0.6294)	
Rocker arm shaft runout		Limit	mm (in)	0.12 (0.005)	

Item			Unit	Data	
				DF60T	DF70(W)T/70WTH
VALVE / VALVE GUIDE					
Valve diameter		IN	mm (in)	36 (1.4)	
		EX	mm (in)	30 (1.2)	
Valve clearance (when cold)	IN	STD	mm (in)	0.11 – 0.15 (0.004 – 0.006)	
	EX	STD	mm (in)	0.13 – 0.17 (0.005 – 0.007)	
Valve guide to valve stem clearance	IN	STD	mm (in)	0.020 – 0.050 (0.0008 – 0.0020)	
		Limit	mm (in)	0.070 (0.0028)	
	EX	STD	mm (in)	0.045 – 0.075 (0.0018 – 0.0030)	
		Limit	mm (in)	0.090 (0.0035)	
Valve guide inside diameter	IN,EX	STD	mm (in)	7.000 – 7.015 (0.2756 – 0.2762)	
Valve guide protrusion	IN,EX	STD	mm (in)	14.0 (0.55)	
Valve stem outside diameter	IN	STD	mm (in)	6.965 – 6.980 (0.2742 – 0.2748)	
	EX	STD	mm (in)	6.940 – 6.955 (0.2732 – 0.2738)	
Valve stem end length	IN,EX	Limit	mm (in)	6.05 (0.238)	
Valve stem end deflection	IN	Limit	mm (in)	0.14 (0.006)	
	EX	Limit	mm (in)	0.18 (0.007)	
Valve stem runout	IN,EX	Limit	mm (in)	0.05 (0.002)	
Valve head radial runout	IN,EX	Limit	mm (in)	0.08 (0.003)	
Valve head thickness	IN,EX	STD	mm (in)	1.0 (0.04)	
	IN	Limit	mm (in)	0.6 (0.02)	
	EX	Limit	mm (in)	0.7 (0.03)	
Valve seating contact width	IN,EX	STD	mm (in)	1.3 – 1.5 (0.05 – 0.06)	
Valve spring free length		STD	mm (in)	49.3 (1.94)	
		Limit	mm (in)	48.1 (1.89)	
Valve spring tension		STD	kg (lbs)	24.8 – 29.2 (54.7 – 64.3) for 41.5 mm (1.63 in)	
		Limit	kg (lbs)	22.8 (50.2) for 41.5 mm (1.63 in)	
Valve spring sequareness		Limit	mm (in)	2.0 (0.08)	

Item	Unit	Data	
		DF60T	DF70(W)T/70WTH

CYLINDER / PISTON / PISTON RING

Cylinder distortion		Limit	mm (in)	0.060 (0.0024)
Piston to cylinder clearance		STD	mm (in)	0.020 – 0.040 (0.0008 – 0.0016)
		Limit	mm (in)	0.100 (0.0039)
Cylinder bore		STD	mm (in)	74.000 – 74.020 (2.9134 – 2.9142)
Cylinder measuring position			mm (in)	50 (2.0) from cylinder top surface
Piston skirt diameter		STD	mm (in)	73.970 – 73.990 (2.9122 – 2.9130)
Piston measuring position			mm (in)	15 (0.6) from piston skirt end.
Cylinder bore wear		Limit	mm (in)	0.100 (0.0039)
Piston ring end gap	1st	STD	mm (in)	0.15 – 0.30 (0.006 – 0.012)
		Limit	mm (in)	0.70 (0.028)
	2nd	STD	mm (in)	0.20 – 0.35 (0.008 – 0.014)
		Limit	mm (in)	0.70 (0.028)
Piston ring free end gap	1st	STD	mm (in)	Approx. 7.7 (0.30)
		Limit	mm (in)	6.1 (0.24)
	2nd	STD	mm (in)	Approx. 10.4 (0.41)
		Limit	mm (in)	8.3 (0.33)
Piston ring to groove clearance	1st	STD	mm (in)	0.03 – 0.07 (0.001 – 0.003)
		Limit	mm (in)	0.12 (0.005)
	2nd	STD	mm (in)	0.02 – 0.06 (0.001 – 0.002)
		Limit	mm (in)	0.10 (0.004)
Piston ring groove width	1st		mm (in)	1.22 – 1.24 (0.048 – 0.049)
	2nd		mm (in)	1.51 – 1.53 (0.059 – 0.060)
	Oil		mm (in)	2.81 – 2.83 (0.111 – 0.112)
Piston ring thickness	1st	STD	mm (in)	1.17 – 1.19 (0.046 – 0.047)
	2nd	STD	mm (in)	1.47 – 1.49 (0.058 – 0.059)
Piston pin oil clearance		STD	mm (in)	0.003 – 0.016 (0.0001 – 0.0006)
		Limit	mm (in)	0.040 (0.0016)
Piston pin outside diameter		STD	mm (in)	16.995 – 17.000 (0.6691 – 0.6693)
Piston pin hole diameter		STD	mm (in)	17.003 – 17.011 (0.6694 – 0.6697)

Item		Unit	Data	
			DF60T	DF70(W)T/70WTH

CRANKSHAFT / CONROD

Conrod small end inside diameter	STD	mm (in)	16.968 – 16.979 (0.6680 – 0.6685)
Conrod big end oil clearance	STD	mm (in)	0.020 – 0.050 (0.0008 – 0.0020)
	Limit	mm (in)	0.080 (0.0031)
Conrod big end inside diameter	STD	mm (in)	45.000 – 45.018 (1.7717 – 1.7724)
Crank pin outside diameter	STD	mm (in)	41.982 – 42.000 (1.6528 – 1.6535)
Crank pin outside diameter difference	Limit	mm (in)	0.010 (0.0004)
Conrod bearing thickness	STD	mm (in)	1.484 – 1.502 (0.0584 – 0.0591)
Conrod big end side clearance	STD	mm (in)	0.10 – 0.25 (0.004 – 0.010)
	Limit	mm (in)	0.35 (0.014)
Conrod big end width	STD	mm (in)	21.95 – 22.00 (0.864 – 0.866)
Crank pin width	STD	mm (in)	22.10 – 22.20 (0.870 – 0.874)
Crankshaft center journal runout	Limit	mm (in)	0.06 (0.002)
Crankshaft journal oil clearance	STD	mm (in)	0.016 – 0.036 (0.0006 – 0.0014)
	Limit	mm (in)	0.060 (0.0024)
Crankcase bearing holder inside diameter	STD	mm (in)	56.000 – 56.018 (2.2047 – 2.2054)
Crankshaft journal outside diameter	STD	mm (in)	51.982 – 52.000 (2.0465 – 2.0472)
Crankshaft journal outside diameter difference	Limit	mm (in)	0.010 (0.0004)
Crankshaft bearing thickness	STD	mm (in)	1.998 – 2.014 (0.0787 – 0.0793)
Crankshaft thrust clearance	STD	mm (in)	0.11 – 0.31 (0.004 – 0.012)
	Limit	mm (in)	0.38 (0.015)
Crankshaft thrust bearing thickness	STD	mm (in)	2.47 – 2.52 (0.097 – 0.099)

LOWER UNIT

Design specification thickness for shim & washer.

Pinion gear back-up shim	mm (in)	1.00 (0.039)
Forward gear back-up shim	mm (in)	1.00 (0.039)
Forward gear thrust washer	mm (in)	3.0 (0.12)
Reverse gear thrust washer	mm (in)	2.2 (0.09)
Reverse gear back-up shim	mm (in)	1.5 (0.06)

Item		Unit	Data	
			DF60T	DF70(W)T/70WTH
ELECTRICAL				
Ignition timing			BTDC 4° – BTDC 33°	BTDC 4° – BTDC 29°
Over revolution limiter		r/min	Approx. 6500	
CKP sensor resistance		Ω at 20°C	——	
CMP sensor resistance		Ω at 20°C	168 – 252	
Ignition coil resistance	Primary	Ω at 20°C	1.9 – 2.5	
	Secondary	k Ω at 20°C	No.2 – No.3: 15 – 26 (including H.T. cord and spark plug cap) No.1 – No.4: 16 – 28 (including H.T. cord and spark plug cap)	
High tension cord resistance		k Ω/m at 20°C	Approx. 16	
Battery charge coil resistance		Ω at 20°C	0.3 – 0.5	
Battery charge coil output (12V)		Watt	300	
Standard spark plug	Type	NGK	BPR6ES	
	Gap	mm (in)	0.7 – 0.8 (0.028 – 0.031)	
Fuse amp. rating		A	Main fuse : 30	
Recommended battery capacity (12V)		Ah (kC)	100 (360) or over	
Fuel injector resistance		Ω at 20°C	11.0 – 16.6	
IAC valve resistance		Ω at 20°C	4.8 – 7.2	
IAT sensor/Cylinder temp. sensor /Exhaust manifold temp. sensor (Thermistor characteristic)		k Ω at 25°C	1.8 – 2.3	
ECM main relay resistance		Ω at 20°C	80 – 120	
Starter motor relay resistance		Ω at 20°C	3.5 – 5.1	
PTT motor relay resistance		Ω at 20°C	3.0 – 4.5	
STARTER MOTOR				
Max. continuous time of use		Sec	30	
Motor output		kW	0.9	
Brush length	STD	mm (in)	17.0 (0.67)	
	Limit	mm (in)	10.0 (0.39)	
Commutator undercut	STD	mm (in)	0.5 – 0.8 (0.02 – 0.03)	
	Limit	mm (in)	0.2 (0.01)	
Commutator outside diameter	STD	mm (in)	33.0 (1.30)	
	Limit	mm (in)	32.0 (1.26)	
Commutator outside diameter difference	STD	mm (in)	0.05 (0.002)	
	Limit	mm (in)	0.40 (0.016)	
Pinion to ring gear gap	STD	mm (in)	3.0 – 5.0 (0.12 – 0.20)	
PTT MOTOR				
Brush length	STD	mm (in)	9.8 (0.39)	
	Limit	mm (in)	5.5 (0.22)	
Commutactor outside diameter	STD	mm (in)	22.0 (0.87)	
	Limit	mm (in)	21.0 (0.83)	

SELF-DIAGNOSTIC SYSTEM INDICATION

When the abnormality occurs in a signal from sensor, switch etc., the “CHECK ENGINE” lamp on the monitor-tachometer flashes (lights intermittently) according to the each code pattern with buzzer sounding.

PRIORITY	FAILED ITEM	CODE	LAMP FLASHING PATTERN	FAIL-SAFE SYSTEM ACTIVATING
1	MAP sensor 1	3-4		YES
2	CKP sensor	4-2		YES
3	IAC valve/By-pass air screw adjustment	3-1		NO
4	CMP sensor	2-4		YES
5	CTP switch	2-2		NO
6	Cylinder temp. sensor	1-4		YES
7	IAT sensor	2-3		YES
8	MAP sensor 2 (Sensor hose)	3-2		NO
9	Rectifier & regulator (Over-charging)	1-1		NO
10	Exhaust manifold temp. sensor	1-5		YES
11	Fuel injector (Open circuit)	4-3		NO

NOTE:

- *If more than two items fail at once, the self-diagnostic indication appears according to priority order. The indication repeats three times.*
- *On the tiller handle (TH) model, alerts is signaled by a sound from the caution buzzer contained in the tiller handle.*

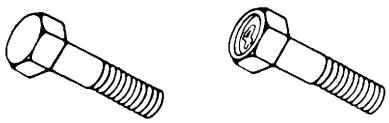
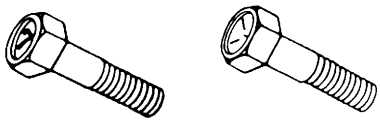
TIGHTENING TORQUE

Tightening Torque – Important Fasteners

ITEM		THREAD DIAMETER	TIGHTENING TORQUE		
			N · m	kg-m	lb-ft.
Cylinder head cover bolt		6 mm	10	1.0	7.0
Cylinder head bolt		10 mm	73	7.3	53.0
Crankcase bolt		8 mm	25	2.5	18.0
		10 mm	50	5.0	36.0
Conrod cap nut		8 mm	35	3.5	25.5
Oil pump stopper		——	50	5.0	36.0
Intake manifold bolt/nut		8 mm	23	2.3	16.5
Exhaust manifold bolt/nut		8 mm	23	2.3	16.5
Valve adjusting lock nut		7 mm	17	1.7	12.5
Rocker arm shaft screw		6 mm	11	1.1	8.0
Timing pulley nut		38 mm	70	7.0	50.5
Camshaft pulley bolt		12 mm	60	6.0	43.5
Oil pressure switch		——	13	1.3	9.5
Oil regulator valve		14 mm	27	2.7	19.5
Delivery pipe bolt		8 mm	23	2.3	16.5
Delivery pipe plug/union bolt	Upper plug	12 mm	40	4.0	29.0
	Lower union	12 mm	40	4.0	29.0
Low pressure fuel pump bolt		6 mm	10	1.0	7.0
Thermostat cover bolt		6 mm	10	1.0	7.0
Water pressure valve cover bolt		6 mm	10	1.0	7.0
Flywheel bolt		16 mm	190	19.0	137.5
Starter motor mounting bolt		8 mm	23	2.3	16.5
Engine oil filter		——	14	1.4	10.0
Engine oil drain plug		12 mm	13	1.3	9.5
Power unit mounting bolt/nut		8 mm	23	2.3	16.5
		10 mm	50	5.0	36.0
Driveshaft housing bolt		10 mm	50	5.0	36.0
Upper mount nut		12 mm	70	7.0	50.5
Upper mount cover bolt		8 mm	23	2.3	16.5
Lower mount nut	Front	12 mm	60	6.0	43.5
	Rear	12 mm	40	4.0	29.0
Clamp bracket shaft nut		22 mm	43	4.3	31.0
Water pump case bolt		8 mm	20	2.0	14.5
Gearcase bolt		10 mm	55	5.5	40.0
Propeller shaft bearing housing bolt		6 mm	10	1.0	7.0
Pinion nut		12 mm	100	10.0	72.5
Propeller nut		18 mm	55	5.5	40.0
Tiller handle pivot bolt/nut		10 mm	45	4.5	32.5

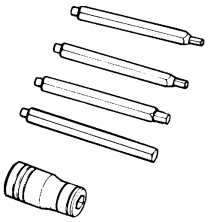
Tightening torque – general bolt

NOTE:
These values are only applicable when torque for a general bolt is not listed in the "Important Fasteners" table.

TYPE OF BOLT	THREAD DIAMETER	TIGHTENING TORQUE		
		N · m	kg-m	lb-ft
 (Conventional or "4" marked bolt)	5 mm	2 – 4	0.2 – 0.4	1.5 – 3.0
	6 mm	4 – 7	0.4 – 0.7	3.0 – 5.0
	8 mm	10 – 16	1.0 – 1.6	7.0 – 11.5
	10 mm	22 – 35	2.3 – 3.5	16.0 – 25.5
 (Stainless steel bolt)	5 mm	2 – 4	0.2 – 0.4	1.5 – 3.0
	6 mm	6 – 10	0.6 – 1.0	4.5 – 7.0
	8 mm	15 – 20	1.5 – 2.0	11.0 – 14.5
	10 mm	34 – 41	3.4 – 4.1	24.5 – 29.5
 (7 marked or  marked bolt)	5 mm	3 – 6	0.3 – 0.6	2.0 – 4.5
	6 mm	8 – 12	0.8 – 1.2	6.0 – 8.5
	8 mm	18 – 28	1.8 – 2.8	13.0 – 20.0
	10 mm	40 – 60	4.0 – 6.0	29.0 – 43.5

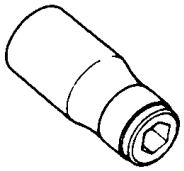
SPECIAL TOOLS

1.



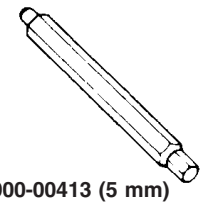
09900-00410
Hexagon wrench set

2.



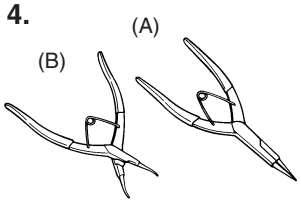
09900-00411
Hexagon socket
(included in 09900-00410)

3.



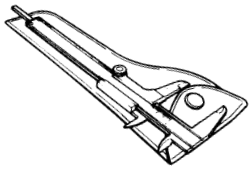
09900-00413 (5 mm)
09900-00414 (6 mm)
Hexagon bit
(included in 09900-00410)

4.



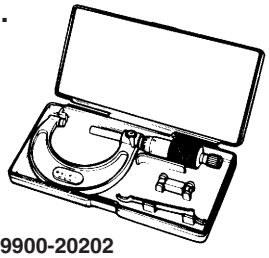
(A) 09900-06107
(B) 09900-06108
Snap ring pliers

5.



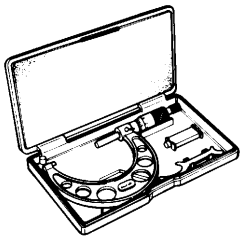
09900-20101 (150 mm)
09900-20102 (200 mm)
Vernier calipers

6.



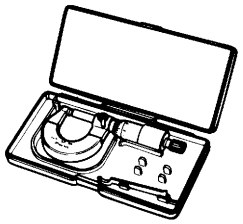
09900-20202
Micrometer (25 – 50 mm)

7.



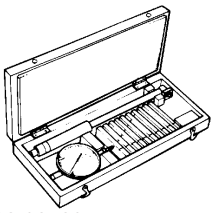
09900-20203
Micrometer (50 – 75 mm)

8.



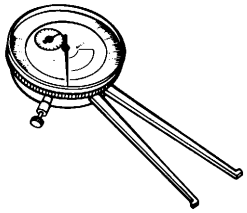
09900-20205
Micrometer (0 – 25 mm)

9.



09900-20508
Cylinder gauge set
(40 – 80 mm)

10.

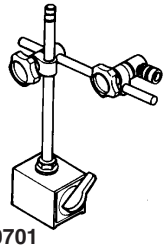


09900-20605
Dial calipers (10 – 34 mm)

11.

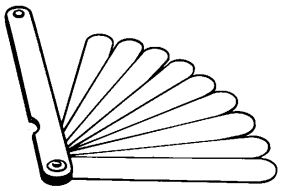
09900-20602
Dial gauge

12.



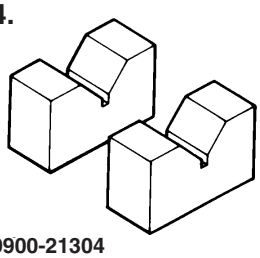
09900-20701
Magnetic stand

13.



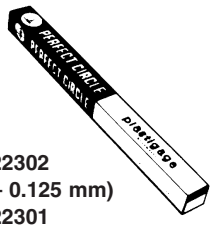
09900-20803
Thickness gauge

14.



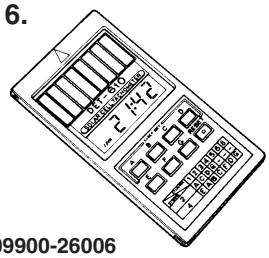
09900-21304
Steel "V" block set

15.



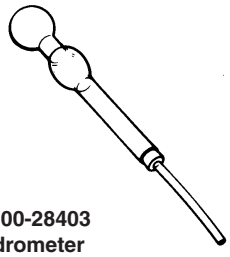
09900-22302
(0.051 – 0.125 mm)
09900-22301
(0.025 – 0.076 mm)
Plastigauge

16.



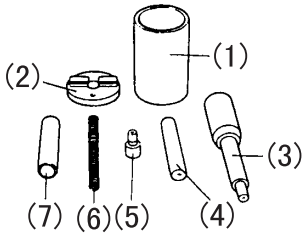
09900-26006
Engine tachometer

17.



09900-28403
Hydrometer

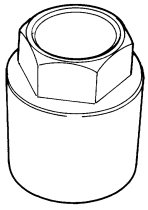
18.



(1) Base
(2) Base cap
(3) Driver handle
(4) Piston pin guide
(5) Piston pin guide
(6) Spring
(7) Spring guide

09910-38211
Piston pin remover & installer

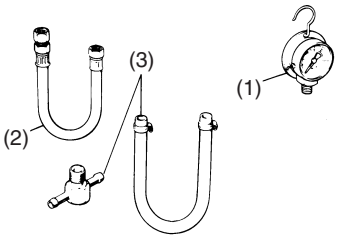
19.



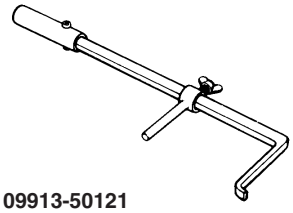
09911-49910
Crankshaft holder

20.

09912-58413
Fuel pressure gauge set
(1) 09912-58442
Fuel pressure gauge
(2) 09912-58432
Fuel pressure hose
(3) 09912-58490
3-way joint & hose

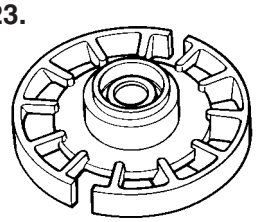


22.

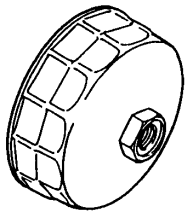
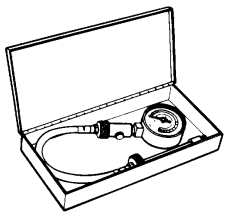
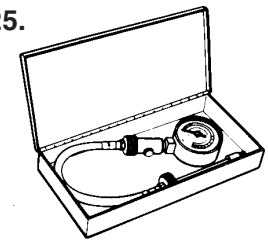
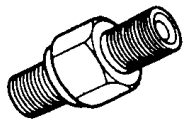
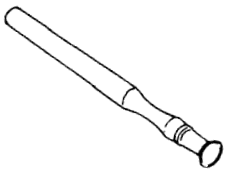
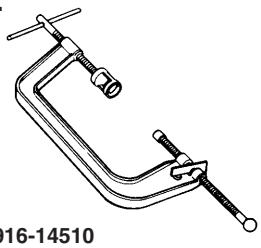
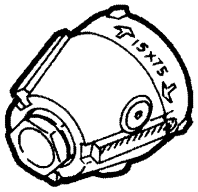
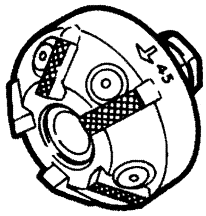
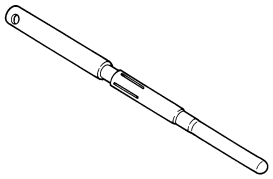
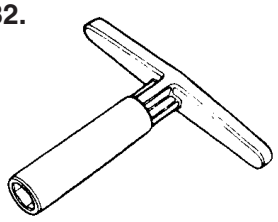
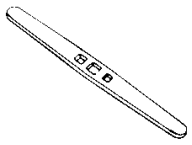
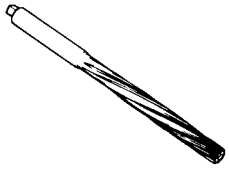
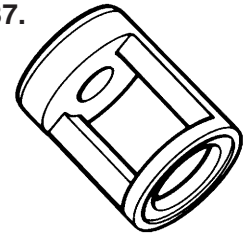
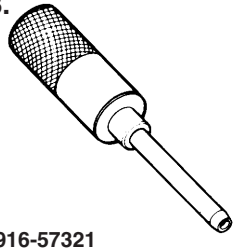
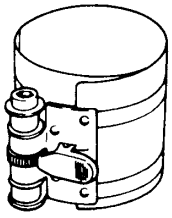
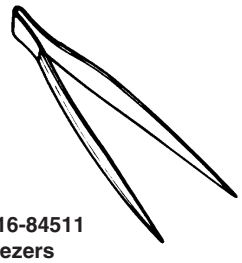
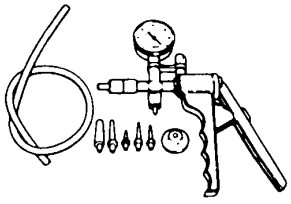
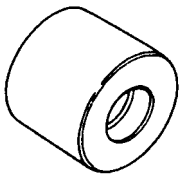
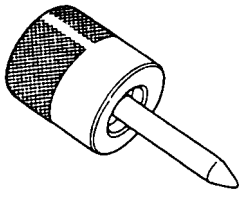
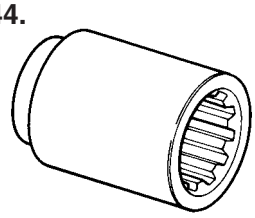
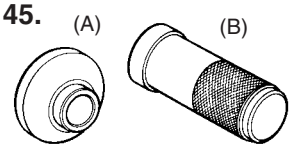
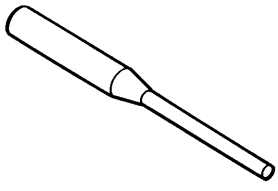


09913-50121
Oil seal remover

23.



09914-79511
Test wheel

23.  **09915-47341** **Oil filter wrench**	**24.**  **09915-64512** **Compression gauge**	**25.**  **09915-77311** **Oil pressure gauge**	**26.**  **09915-78211** **Oil pressure gauge adapter**
27.  **09916-10911** **Valve lapper**	**28.**  **09916-14510** **Valve lifter**	**29.**  **09916-24910** **Valve seat cutter (N-212)**	**30.**  **09916-24935** **Valve seat cutter (N-608)**
31.  **09916-24940** **Solid pilot (N-150-7)**	**32.**  **09916-54910** **Handle (N-505)**	**33.**  **09916-34520** **Valve guide reamer** **(ø7 mm)**	**34.**  **09916-34542** **Valve guide reamer handle**
35.  **09916-37310** **Valve guide reamer** **(ø12 mm)**	**36.**  **09916-44511** **Valve guide** **remover/installer**	**37.**  **09916-48210** **Valve lifter attachment**	**38.**  **09916-57321** **Valve guide installer**
39.  **09916-77310** **Piston ring compressor**	**40.**  **09916-84511** **Tweezers**	**41.**  **09917-47011** **Vacuum pump gauge**	**42.**  **09917-88210** **Valve guide installer** **attachment**
43.  **09917-98210** **Valve stem seal installer**	**44.**  **09921-28710** **Driveshaft holder**	**45.** (A) (B)  **(A) 09922-59410** **Propeller shaft housing installer** **(B) 09922-59420** **Housing installer handle**	**46.**  **09922-89810** **Shift lock pin remover**

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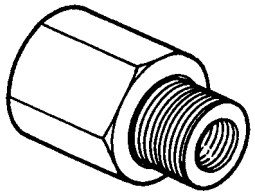

09930-30161
Propeller shaft remover

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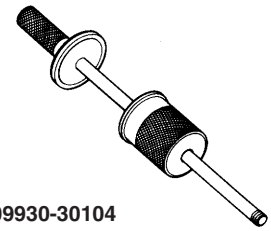
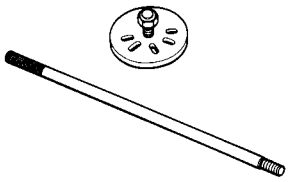


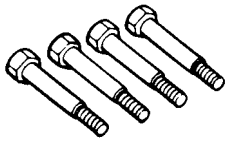
09930-30104
Sliding hammer

49.



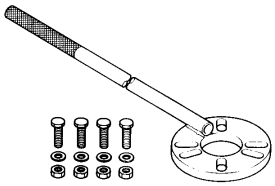
09930-39411
Flywheel rotor remover

50.



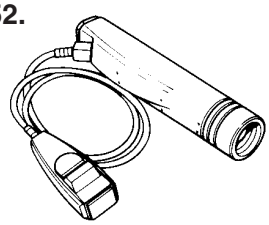
09930-39420
Rotor remover bolt

51.



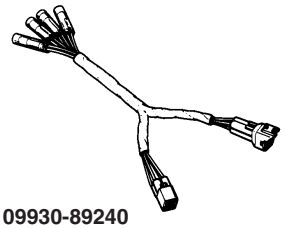
09930-48720
Flywheel holder

52.



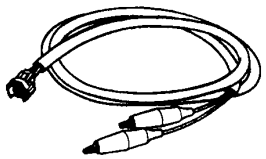
09930-76420
Timing light

53.



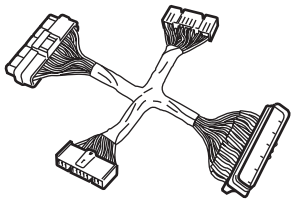
09930-89240
4-pin connector test cord

54.



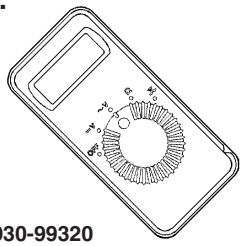
09930-89260
Injector test cord A

55.



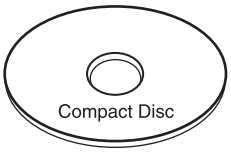
09930-89950
44-pin connector test cord

56.



09930-99320
Digital tester

57.



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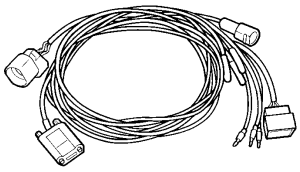
- SDS database ver. 4.10

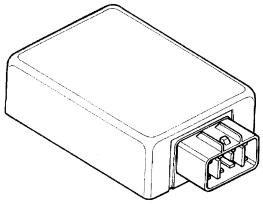
(No parts number)

58.



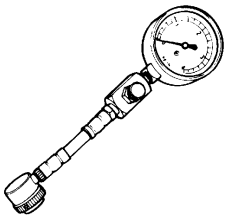
09932-79910
Diagnostic harness

59.



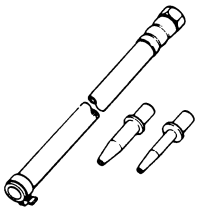
09932-89910
Adapter

60.



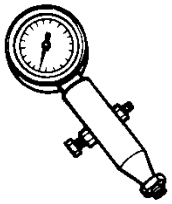
09940-44121
Air pressure gauge

61.



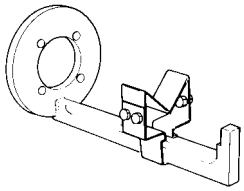
09940-44130
Attachment

62.



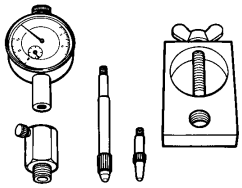
09950-69512
Gearcase oil leakage tester

63.



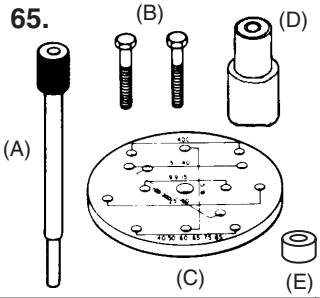
09951-09010
Shimming gauge

64.



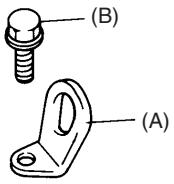
09951-09511
Gear adjusting gauge

65.



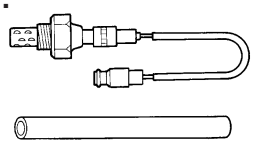
(A) 09951-59910
Pinion bearing installer & remover shaft
(B) 01500-08408
Bolt
(C) 09951-39914
Pinion bearing plate
(D) 09951-19421
Attachment
(E) 09917-98221
Spacer

66.



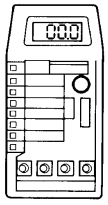
(A) 11291-91B50
Engine hook
(B) 01550-08207
Bolt

67.



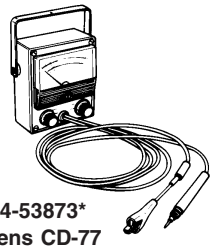
(A) 18213-74F00
O_2 sensor
(B) 18498-99E70
Protector sleeve

68.



99954-53008-820*
Digital voltmeter

69.



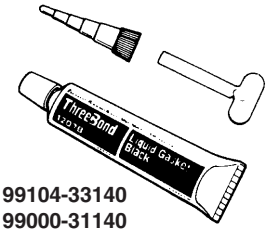
99954-53873*
Stevens CD-77
Peak reading voltmeter

70.

99954-53883*
Gear oil filler

NOTE:
** Marked part No. is in U.S. market only.*

MATERIALS REQUIRED

SUZUKI OUTBOARD MOTOR GEAR OIL  **99000-22540** **(400 ml × 24 pcs.)**	**SUZUKI SUPER GREASE "A"**  ***99000-25030** **99000-25010** **(500 g)**	**WATER RESISTANT GREASE**  **99000-25160** **(250 g)**	**SUZUKI SILICONE SEAL**  **99000-31120** **(50 g)**
SUZUKI BOND "1207B"  *** 99104-33140** **99000-31140** **(100 g)**	**THREAD LOCK "1342"**  **99000-32050** **(50 g)**	**THREAD LOCK SUPER "1333B"**  **99000-32020** **(50 g)**	**4-Stroke Motor Oil** **API : SE, SF, SG, SH, SJ** **SAE : 10W-40**

NOTE:
** Marked part No. is in U.S. market only.*

PERIODIC MAINTENANCE

2

CONTENTS

PERIODIC MAINTENANCE SCHEDULE

The chart below lists the recommended intervals for all the required periodic service work necessary to keep the motor operating at peak performance and economy.
Maintenance intervals should be judged by number of hours or months, whichever comes first.

NOTE:
More frequent servicing should be performed on outboard motors that are used under severe conditions.

PERIODIC MAINTENANCE CHART

Interval / Item to be serviced	Initial 20 hrs. or 1 month	Every 50 hrs. or 3 months	Every 100 hrs. or 6 months	Every 200 hrs. or 12 months
Spark plug	—	—	I	R
Breather hose & Fuel line	I	I	I	I
	Replace every 2 years.			
Engine oil [NOTE]	R	—	R	R
Gear oil	R	—	R	R
Lubrication	—	I	I	I
Anodes & Bonding wires	—	I	I	I
Battery	—	I	I	I
Fuel mixture check (O_2 feedback)	Perform every 2 years.			
Engine oil filter	R	—	—	R
Low pressure fuel filter	—	I	I	I
	Replace every 400 hours or 2 years.			
High pressure fuel filter	Replace every 1000 hours.			
Ignition timing	—	—	—	I
Timing belt	—	—	—	I
	Replace every 800 hours or 4 years.			
Idle Speed	I	—	—	I
Valve clearance	I	—	—	I
Water pump	—	—	—	I
Water pump impeller	—	—	—	R
Propeller nut & pin	I	—	I	I
Bolts & Nuts	T	—	T	T

I : Inspect and clean, adjust, lubricate, or replace, if necessary **T :** Tighten **R :** Replace

NOTE:
OIL CHANGE REMINDER SYSTEM
- *See the page 3-32 for function and operaton.*
- *See the page 2-5 for reset information.*

MAINTENANCE AND TUNE-UP PROCEDURES

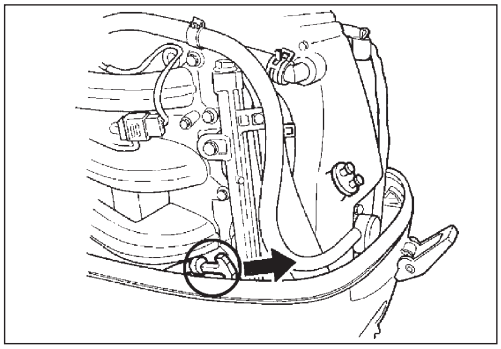
This section describes the servicing procedures for each of the periodic maintenance requirements.

ENGINE OIL/ENGINE OIL FILTER

ENGINE OIL LEVEL CHECK

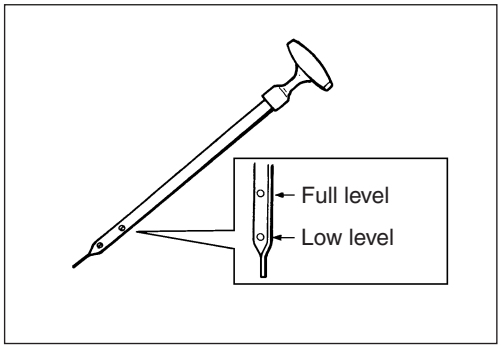
Inspect the oil level before every use.

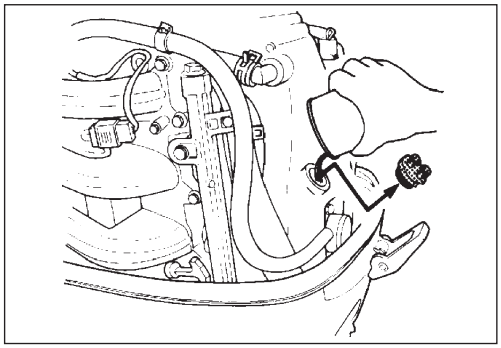
1. Place the outboard motor upright on a level surface.
2. Remove the motor cover.
3. Remove the oil level dipstick and wipe it clean.
4. Insert the dipstick fully into the dipstick hole, then pull it out.
5. Oil level should be between the full level hole (Max.) and the low level hole (Min.).



If the level is low, add the recommended oil to the full level hole.

Recommended oil:
- **4 stroke motor oil**
- **API classification SE, SF, SG, SH, SJ**
- **Viscosity rating SAE 10W-40.**





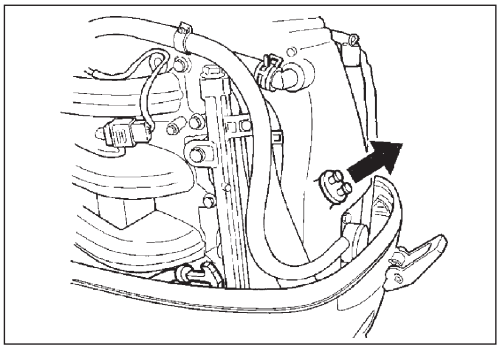
ENGINE OIL CHANGE / ENGINE OIL FILTER REPLACEMENT

ENGINE OIL
Change initially after 20 hours (1 month) and every 100 hours (6 months) thereafter.

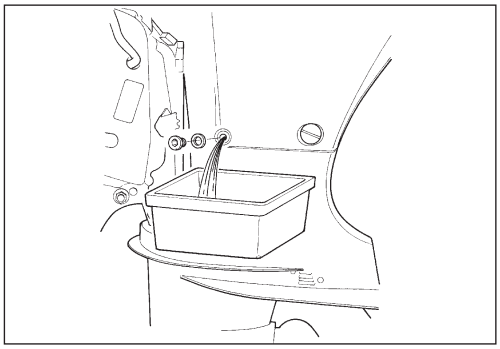
ENGINE OIL FILTER
Replace initially after 20 hours (1 month) and every 200 hours (12 months) thereafter.

NOTE:
- *Engine oil should be changed while the engine is warm.*
- *When replacing the engine oil filter, change the engine oil at the same time.*

1. Place the outboard motor upright on a level surface.
2. Remove the oil filler cap.



3. Place an oil pan as shown, then drain oil by removing the oil drain plug and the gasket.

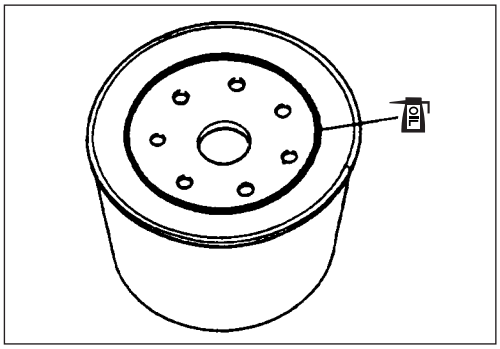


NOTE:
For engine oil change only, go to the STEP 7.

4. Remove the port side cover. (See page 7-2.)
5. Remove the engine oil filter.

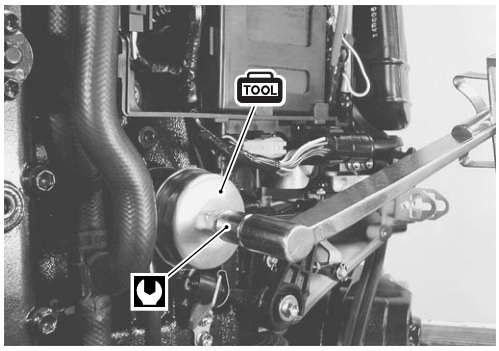
TOOL 09915-47340: Oil filter wrench

6. Install a new engine oil filter.



Engine oil filter: 14 N·m (1.4 kg-m, 10.0 lb-ft)

NOTE:
Apply the engine oil to the o-ring on the filter.



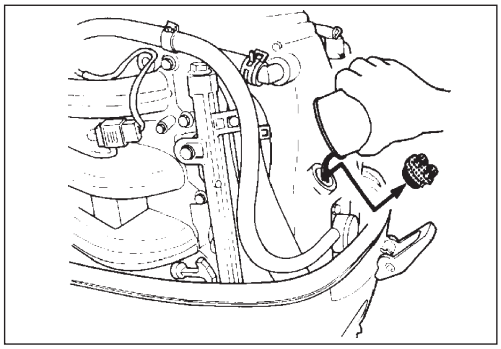
7. Install the gasket and the oil drain plug.
   Tighten the engine oil drain plug.

Engine oil drain plug: 13 N·m (1.3 kg-m, 9.5 lb-ft)

CAUTION

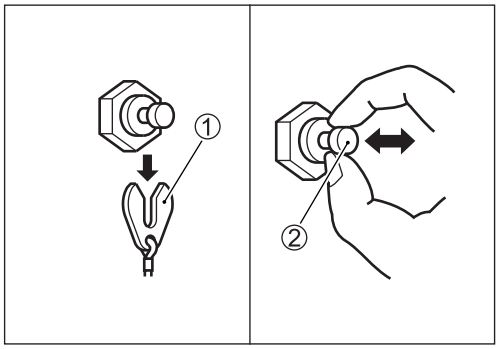
Do not re-use the gasket once removed. Always use a new gasket.

8. Pour the recommended engine oil into the oil filler opening, then install the oil filler cap.



Necessary amont of engine oil:
Oil change only : 4.5 L (4.8/4.0 US/Imp. qt)
Oil filter change : 4.8 L (5.1/4.2 US/Imp. qt)

9. To reset the oil change reminder system's operation time to zero (cancellation);
   (1) Turn the ignition key to the "ON" position.
   (2) Pull out the emergency stop switch plate ①.
   (3) Pull up the emergency stop switch knob ② three times in 10 seconds. A short beep will be heard if cancellation is successfully finished.
   (4) Turn the ignition key to the "OFF" position.
   (5) Set the emergency stop switch plate ① in the orginal position.



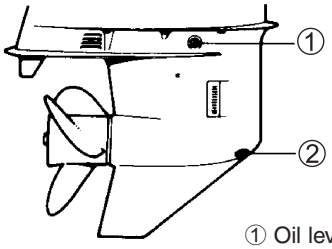
NOTE:
See the OIL CHANGE REMINDER SYSTEM section on the page 3-32.

10. Start the engine and allow it to run for several minutes at the idle speed.
    Turn off the engine and wait for approx. two minutes, then recheck the engine oil level.

GEAR OIL

Change initially after 20 hours (1 month) and every 100 hours (6 months) thereafter.

1. Place the outboard motor upright on a level surface.
2. Place a container under the lower unit.
3. Remove the gear oil drain plug ② before the gear oil level plug ① and drain the gear oil.

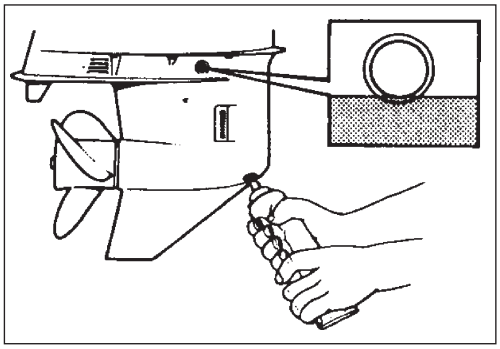


① Oil level plug
② Oil drain plug

4. Fill with the recommended gear oil through the oil drain hole until the oil just starts to flow out from the oil level hole.

Gear oil amount: 1050 ml (35.5/37.0 US/Imp. oz)

Recommended oil:
Suzuki Outboard Motor Gear Oil or
SAE #90 Hypoid gear oil



5. Install the oil level plug before removing the oil filler tube from the drain hole.
6. Install the oil drain plug.

CAUTION

Do not re-use the gasket once removed. Always use a new gasket.

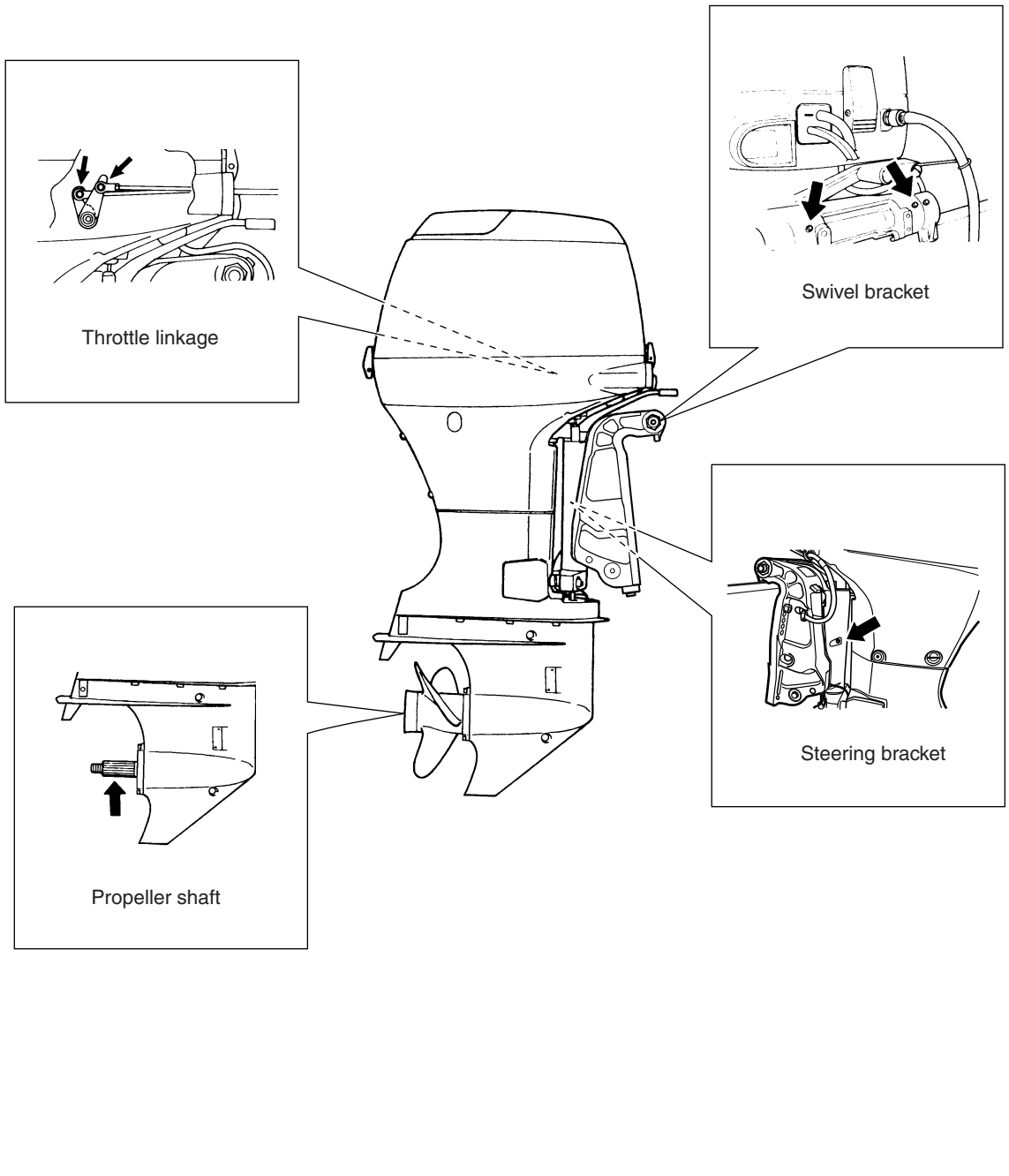
NOTE:
To avoid insufficient injection of the gear oil, check the gear oil level 10 minutes after doing the procedure in the step 6. If the oil level is low, slowly inject the gear oil up to the correct level.

LUBRICATION

Inspect every 50 hours (3 months).

Apply the Water Resistant Grease to the following points.

W/R G's **99000-25160: Suzuki Water Resistant Grease**



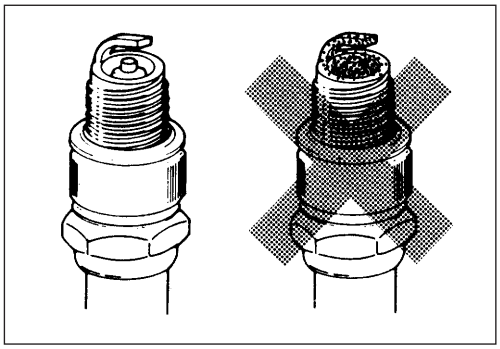
SPARK PLUG

- **Inspect every 100 hours (6 months).**
- **Replace every 200 hours (12 months).**

Standard spark plug : NGK BPR6ES

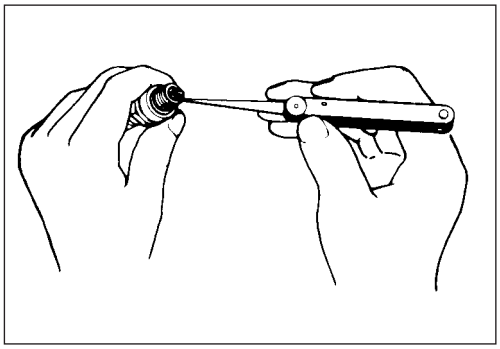
CAUTION

Only resistor (R) type spark plugs must be used with this engine. Using a non-resistor spark plug will cause ignition system malfunctions.



CARBON DEPOSIT

Inspect for a carbon deposit on the spark plug bases.
If carbon is present, remove carbon with a spark plug cleaning machine or by carefully using a pointed tool.

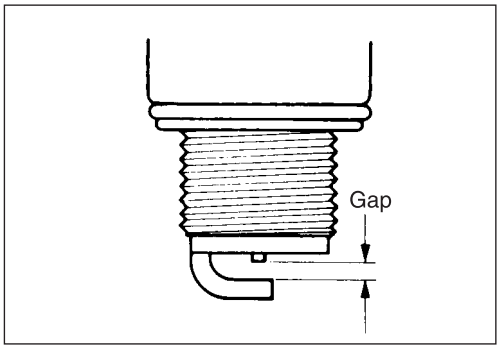


SPARK PLUG GAP

Measure for the spark plug gap using the thickness gauge.
Adjust to within the specified range if the gap is out of the specification.

Spark plug gap: 0.7 – 0.8 mm (0.028 – 0.031 in)

09900-20803: Thickness gauge



CONDITION OF ELECTRODE / INSULATOR

Check the electrode and insulator condition.
If the electrode is extremely worn or burnt, replace the spark plug.
If the spark plug has a broken insulator, damaged threads, etc., replace the spark plug.

CAUTION

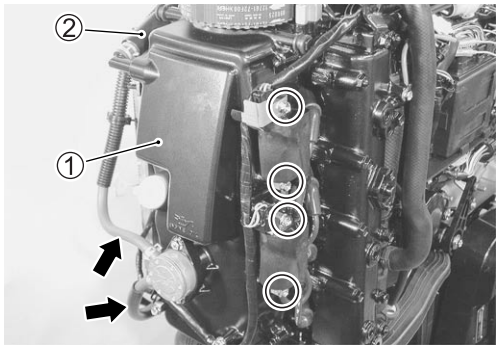
Confirm the thread size and reach when replacing the plug. If the reach is too short, carbon will be deposited on the threaded portion of the plug hole resulting in possible engine damage.

Spark plug: 28 N·m (2.8 kg-m, 20.0 lb-ft)

VALVE CLEARANCE

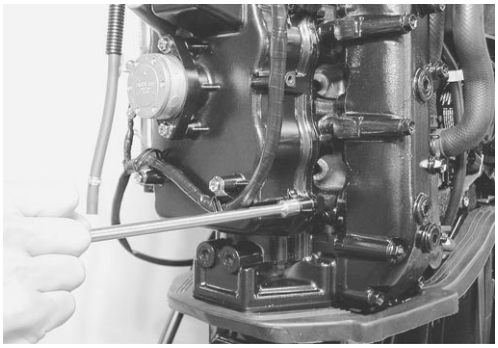
Inspect initially after 20 hours (1 month) and every 200 hours (12 months) thereafter.

1. Remove the following parts:
   - Side covers (See page 7-2.)
   - Flywheel cover
   - Spark plugs
   - Ignition coils



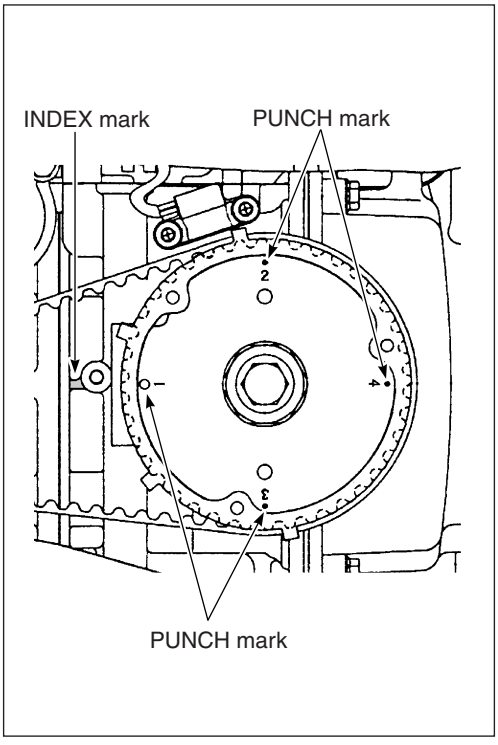
2. Remove the breather hose ② from the cylinder head cover ①.
3. Disconnect the fuel hoses from the low pressure fuel pump.

4. Remove the six bolts and the cylinder head cover ①.



5. Rotate the flywheel clockwise to bring each piston to the Top Dead Center (TDC) on a compression stroke. Align each PUNCH mark on the cam pulley with the INDEX mark on the cylinder head block.

PUNCH mark	TDC cylinder number
1	No.1 cylinder
2	No.2 cylinder
3	No.3 cylinder
4	No.4 cylinder



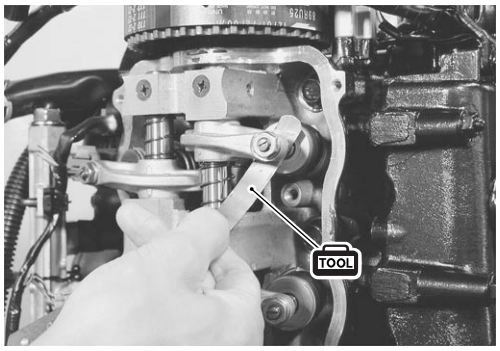
CAUTION

Rotate the crankshaft in the normal running direction only (clockwise) to prevent water pump impeller damage.

NOTE:

- *The piston must be at its TDC position on a compression stroke to check or adjust the valve clearance.*
- *The valve clearance specificaion is for COLD engine condition.*
- *The valve clearance specificaion is different for the intake (IN) valves and the exhaust (EX) valves.*

6. Insert the thickness gauge between the valve stem end and the valve adjusting screw on the rocker arm.



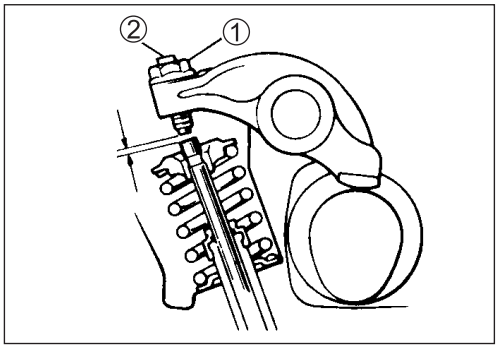
TOOL 09900-20803: Thickness gauge

Valve clearance (when cold):
IN. 0.11 – 0.15 mm (0.004 – 0.006 in)
EX. 0.13 – 0.17 mm (0.005 – 0.007 in)

If the measurement is out of the specification, adjust the valve clearance.

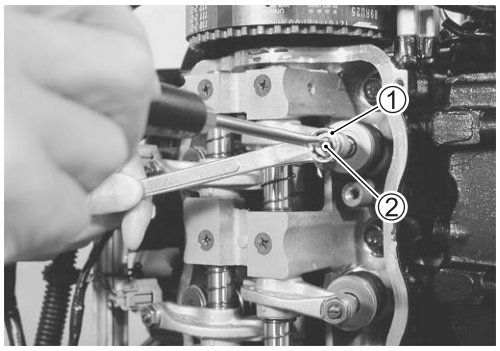
ADJUSTMENT

7. Loosen the valve adjusting lock nut ①.
8. Turn the valve adjusting screw ② to bring the valve clearance to within the specification.



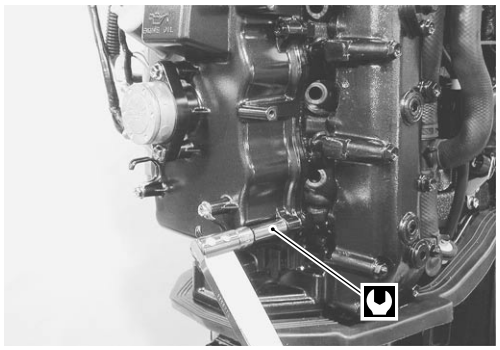
TOOL 09900-20803: Thickness gauge

9. Tighten the valve adjusting lock nut ① while holding the valve adjusting screw ②.



Valve adjusting lock nut: 17 N·m (1.7 kg-m, 12.5 lb-ft)

10. Recheck the valve clearance.
11. Assembly in reverse order of disassembly with the special attention to the following steps.



Cylinder head cover bolt: 10 N·m (1.0 kg-m, 7.0 lb-ft)

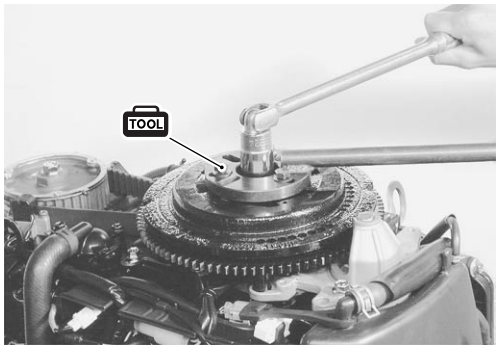
CAUTION

Do not re-use the gasket once removed. Always use a new gasket.

TIMING BELT

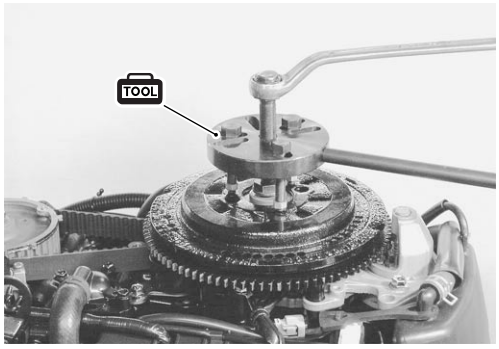
- **Inspect every 200 hours (12 months).**
- **Replace every 800 hours or 4 years.**

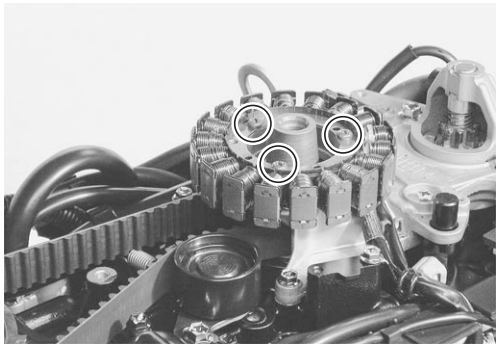
If wear, crack or other damage is found, replace the timing belt.



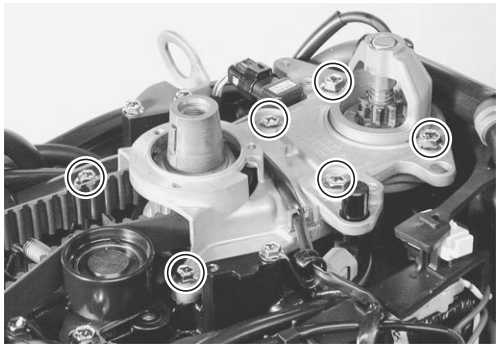
1. Replace the following parts.
   - Flywheel cover
   - Spark plugs
   - Flywheel (See the page 3-52)
   - Battery charge coil (See the page 4-4)

TOOL **09930-48720: Flywheel holder**
09930-39411: Flywheel remover
09930-39420: Flywheel remover bolt

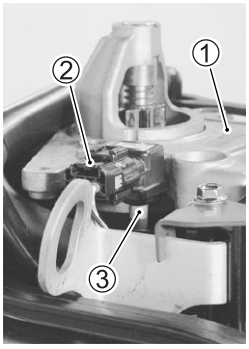


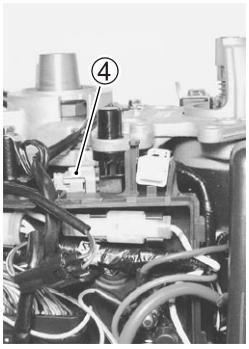


2. Remove the six bolts.

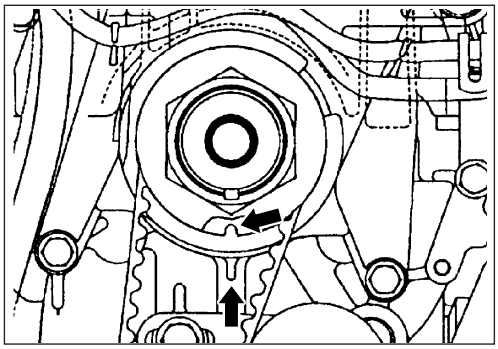


3. Disconnect the wire ② and the hose ③ from the MAP sensor.
4. Disconnect the wire ④ from the CKP sensor.
5. Remove the bracket ①.





6. Rotate the crankshaft to align the HOLLOW mark on the timing pulley with the INDEX mark on the cylinder block.



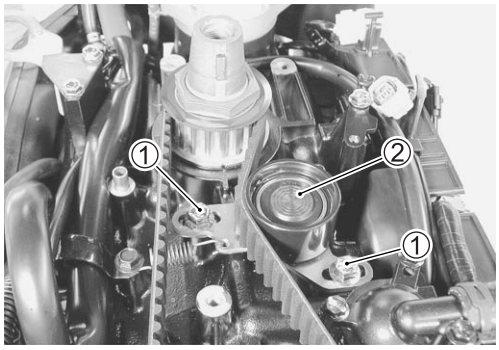
TOOL 09911-49910: Crankshaft holder

CAUTION

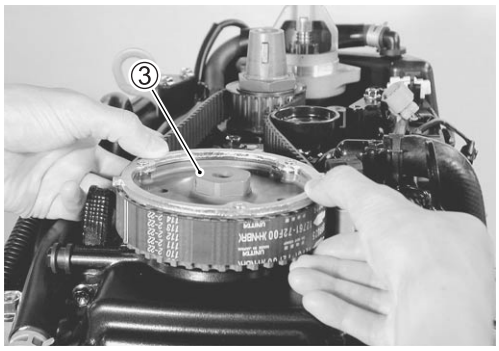
Rotate the crankshaft in the normal running direction only (clockwise) to prevent water pump impeller damage.

CAUTION

Do not rotate the cam pully with the timing belt installed. Rotate the timing pulley (crankshaft).



7. Loosen the two bolts ① securing the tensioner ② to release belt tension.
8. Remove the cam pulley bolt.
9. Remove the timing belt with the cam pulley ③ from the camshaft first, then remove the belt from the timing pulley.



CAUTION

Do not rotate the crankshaft or the cam pulley before installing the timing belt. The following must be checked:
- **The PUNCH mark on the timing pulley aligns with the INDEX mark on the cylinder block.**
- **The PUNCH mark "1" on the cam pulley aligns with the INDEX mark on the cylinder head block.**

If the timing pulley or the cam pulley is rotated with the timing belt removed or installed but misaligned, this may cause the valves to become bent.
If the alignment marks are not correctly matched, loosen the valve adjusting lock nuts and the valve adjusting screws fully, to prevent valve damage. Then align the marks correctly by rotating the cam pulley clockwise.

10. Install the timing belt on the timing pulley first, then install the belt with the cam pulley on the camshaft.

CAUTION

Always keep timing belt away from any grease and oil.

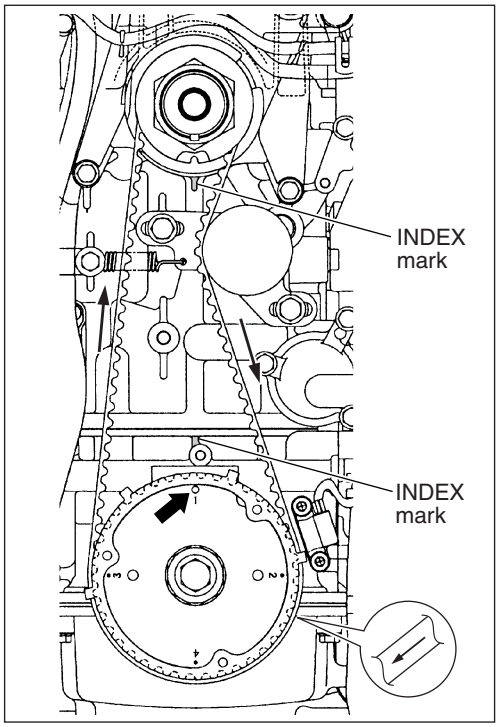
CAUTION

The timing belt must be installed with the arrow mark on the timing belt toward the direction of rotation.

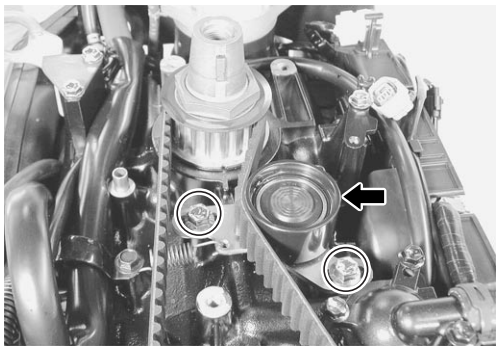
11. Tighten the cam pulley bolt.

Cam pulley bolt: 60 N·m (6.0 kg-m, 43.5 lb-ft)

12. Rotate the crankshaft 2 or 4 rotations to remove looseness.
13. Make sure that the PUNCH mark "1" on the cam pulley aligns with the INDEX mark on the cylinder head block when the PUNCH mark on the timing pulley aligns with the INDEX mark on the cylinder block.



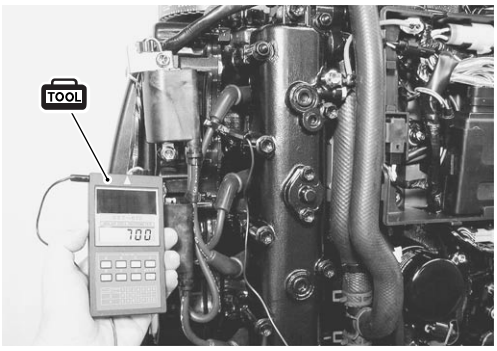
14. Lightly push the tensioner toward the belt, then tighten the two bolts.
15. Install the following parts.
    - Starter motor bracket
    - Battery charge coil (See page 4-5.)
    - Flywheel (See page 3-52.)
    - Spark plugs
    - Flywheel cover



IDLE SPEED

Inspect initially after 20 hours (1 month) and every 200 hours (12 months).

NOTE:
- *Before checking the idle speed, the engine should be allowed to warm up.*
- *Check and/or adjust the idle speed after the engine speed has stabilized.*
- *Before checking the idle speed, check the throttle link mechanism and the throttle valve for smooth operation.*



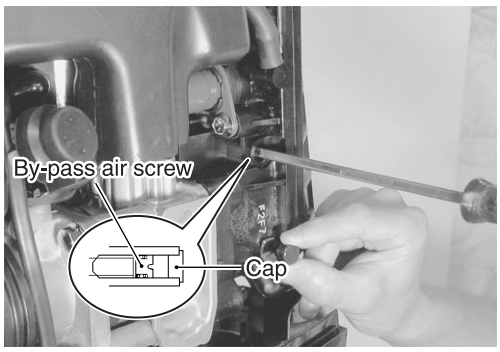
1. Start the engine and allow to warm up.
2. Attach the engine tachometer to the ignition high-tension cord.

TOOL 09900-26006: Engine tachometer

3. Check the engine speed.

Idle speed (in neutral gear): 650 – 750 r/min

ADJUSTMENT :
If the idle speed is out of the specification, perform the following adjustment procedure.



4. Check that the CTP switch is in the ON position.
5. To set the IAC valve duty to constant 22.5%, raise the engine speed to 1000 r/min or higher by turning the by-pass air screw and hold that speed for 10 seconds.
   At this time, the buzzer will sound to notify that the IAC duty is in the fixed mode.

Turning air screw counterclockwise :
Engine speed will increase.
Turning air screw clockwise :
Engine speed will decrease.

NOTE:
- *While the IAC valve duty is at fixed 22.5%, the buzzer will sound for repeated 0.5 second with an interval of 3 seconds.*
- *The 22.5% fixed mode of the IAC valve duty will continue for 5 minutes and then it will be automatically cancelled.*

6. During the fixed mode of the the IAC valve duty, adjust the engine speed to 700 ± 50 r/min by turning the by-pass air screw.

7. Open the throttle valve to turn the CTP switch off.

NOTE:
The fixed mode of the IAC valve duty can be manually cancelled by turning the CTP switch off.

8. Close the throttle valve and then recheck the engine speed. It should now be stable at 650 – 750 r/min.

NOTE:
The idling/trolling speed of 650 – 750 r/min is controlled by the IAC (idle air control) system.
If the engine speed does not return to the specification, the IAC passage (including the IAC hose) may be clogged or the IAC system may not be operating correctly.
See the "IDLE AIR CONTROL SYSTEM" section on the page 3-21.

NOTE:
The trolling speed (in-gear idle speed) is the same as the idel speed.

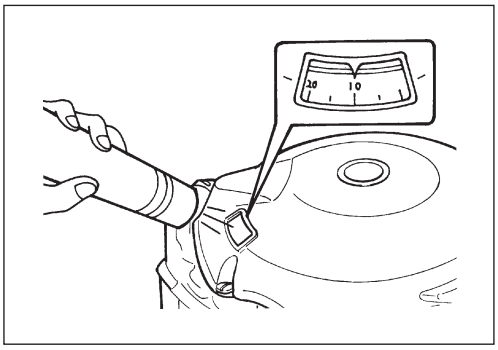
IGNITION TIMING

Inspect every 200 hours (12 months).

NOTE:
Before checking the ignition timing, make sure that the idle speed is adjusted within the specification.

1. Start and warm up the engine.
2. Attach the timing light to the No.1 spark plug high-tension cord.

TOOL 09930-76420: Timing light
09900-26006: Engine tachometer



3. Check the ignition timing while operating the engine at 1000 r/min.

Ignition timing: Approx. BTDC 10° at 1000 r/min

BREATHER HOSE AND FUEL LINE

- **Inspect initially after 20 hours (1 month) and every 50 hours (3 months) thereafter.**
- **Replace every 2 years.**

If leakage, cracks, swelling or other damage is found, replace the breather line and/or the fuel line.

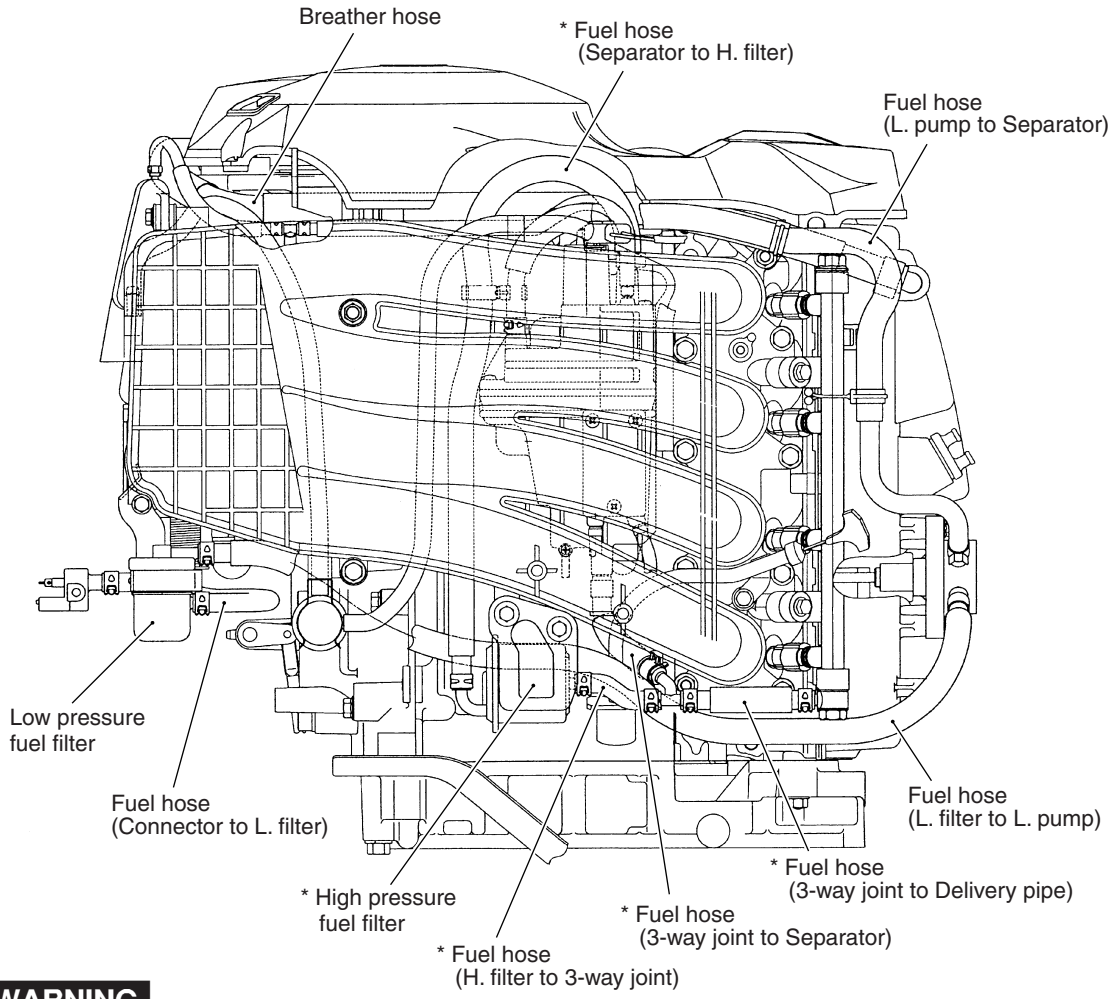
LOW PRESSURE FUEL FILTER

- **Inspect every 50 hours (3 months).**
- **Replace every 400 hours or 2 years.**

If water accumulation, sediment, leakage, crack or other damage is found, replace the fuel filter.

HIGH PRESSURE FUEL FILTER

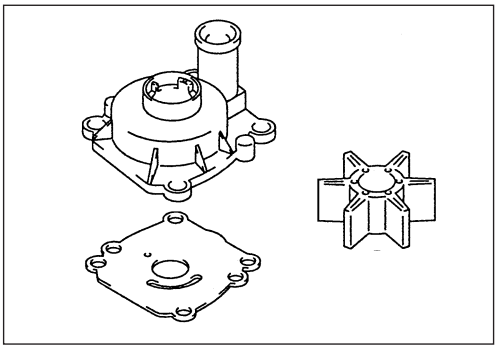
Replace every 1000 hours.



⚠ WARNING

The * marked items remain pressurized at all times. To protect against fuel spray, relieve fuel line pressure before disconnecting or removing these items. See page 5-2.

WATER PUMP IMPELLER / WATER PUMP



WATER PUMP IMPELLER
Replace every 200 hours (12 months).

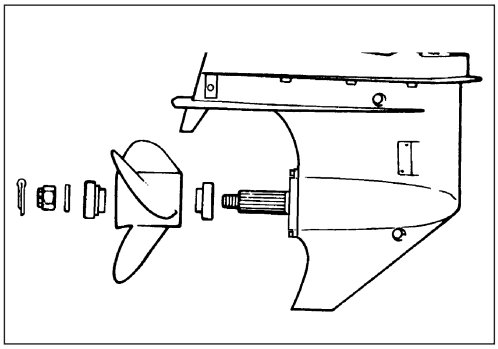
WATER PUMP
Inspect every 200 hours (12 months).

If excessive wear, crack distortion or corrosion is found on the pump case or the under panel, replace.

CAUTION

Do not re-use the gasket once removed. Always use a new gasket.

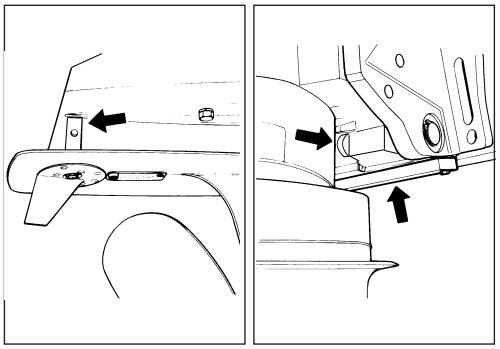
PROPELLER NUT AND PIN / PROPELLER



Inspect initially after 20 hours (1 month) and every 100 hours (6 months) thereafter.

Make sure that the propeller nut and the pin are installed securely.
If excessive wear, breakage or other damage is found on the propeller, the propeller bush or the propeller shaft, replace.

ANODES AND BONDING WIRES



Inspect every 50 hours (3 months).

ANODES

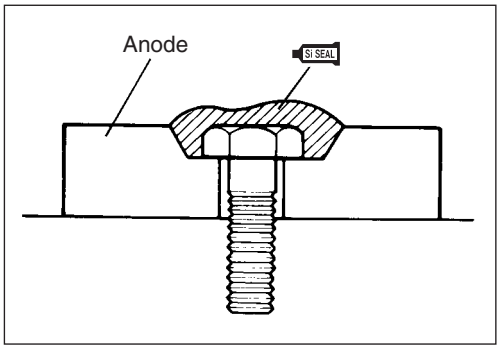
If 2/3 of the anode has corroded away, replace the anode.

CAUTION

Never paint the anode.

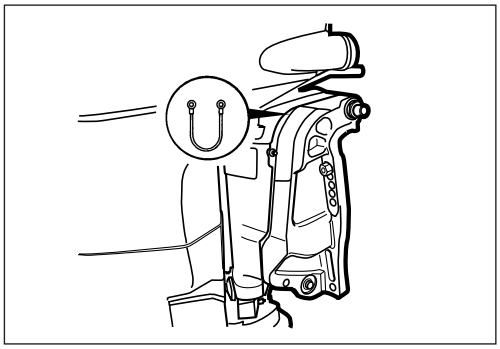
NOTE:
The anode securing bolt should be covered with the Suzuki Silicone Seal.

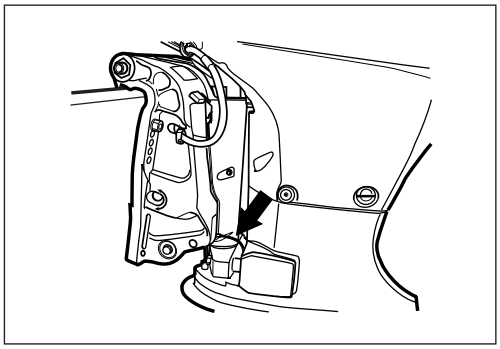
SI SEAL 99000-31120: Suzuki Silicone Seal



BONDING WIRES

If breakage or other damage is found, replace the wire.
If rust or corrosion is found on the wire terminal, clean it with solvent.



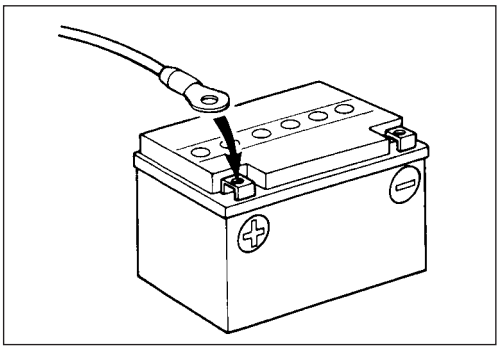


BATTERY

Inspect every 50 hours (3 months).

⚠ WARNING

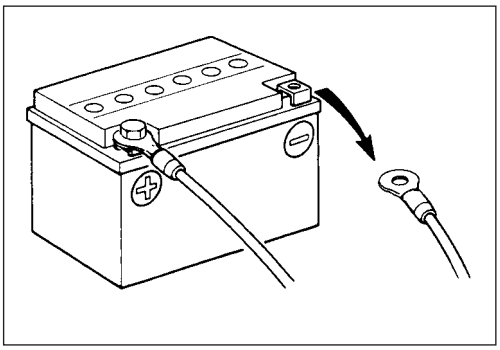
- **Never expose battery to open flame or electric spark as batteries generate gas which is flammable and explosive.**
- **Battery acid is poisonous and corrosive. Avoid contact with eyes, skin, clothing and painted surfaces. If battery acid comes in contact with any of these, flush immediately with large amounts of water. If acid contacts the eyes or skin, get immediate medical attention.**
- **Batteries should always be kept out of reach of children.**
- **When checking or servicing battery, disconnect the negative (black) cable. Be careful not to cause a short circuit by allowing metal objects to contact battery posts and motor at the same time.**
- **Wear approved eye protection.**



Recommended battery:
12 V 100 AH (360 kC) or larger battery

CONNECTING BATTERY

Upon completion of the connection, lightly apply grease to the battery terminals.



How to connect:
(1) Connect the positive (+) terminal first.
(2) Connect the negative (–) terminal second.

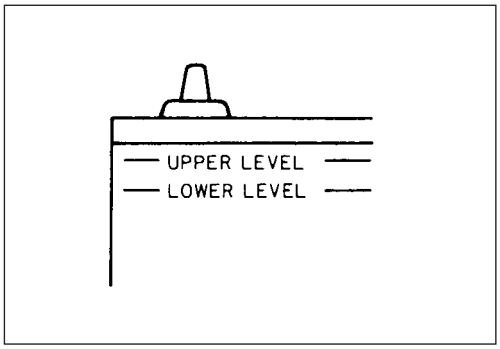
How to disconnect:
(1) Disconnect the negative (–) terminal first.
(2) Disconnect the positive (+) terminal second.

CAUTION

If the battery leads are incorrectly connected, the electrical system could be damage.

BATTERY SOLUTION LEVEL CHECK

The battery solution level should be between the UPPER level and the LOWER level.
If the level is low, add distilled water only.



CAUTION

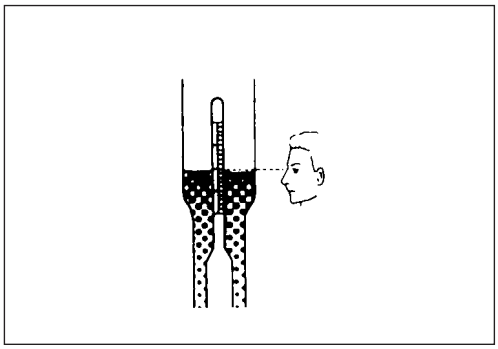
Once the battery has been initially serviced, NEVER add diluted sulphuric acid, or you will damage the battery. Follow the battery manufacture's instructions for specific maintenance procedures.

BATTERY SOLUTION SPECIFIC GRAVITY CHECK

Measure the gravity of the battery solution by using the hydrometer.

TOOL 09900-28403: Hydrometer

Battery solution specific gravity: 1.28 at 20 °C



BOLTS AND NUTS

Inspect initially after 20 hours (1 month) and every 100 hours (6 months) thereafter.

Check that all bolts and nuts listed below are tightened to their specified torque.

ITEM	THREAD DIAMETER	TIGHTENING TORQUE		
		N·m	kg-m	lb-ft
Cylinder head cover bolt	6 mm	10	1.0	7.0
Cylinder head bolt	10 mm	73	7.3	53.0
Intake manifold bolt / nut	8 mm	23	2.3	16.5
Exhaust manifold bolt / nut	8 mm	23	2.3	16.5
Flywheel bolt	16 mm	190	19.0	137.5
Power unit mounting bolt / nut	8 mm	23	2.3	16.5
	10 mm	50	5.0	36.0
Clamp bracket shaft nut	22 mm	43	4.3	31.0
Gearcase bolt	10 mm	55	5.5	40.0
Propeller nut	18 mm	55	5.5	40.0

FUEL MIXTURE CHECK (O_2 FEEDBACK)

Perform every 2 years.

CAUTION

Before performing a fuel mixture check (O_2 feedback), the outboard motor must be checked to be sure that it is free of any trouble codes or operational problems.

To perform the O_2 feedback on 2003 year models, use the Suzuki Diagnostic System (SDS) updated by the database version 4.10 (program version 4.00).
This section contains a set-up procedure on the outboard motor side only. For the fuel mixture check (O_2 feedback) operation using the SDS, refer to the "SDS Operation Manual (program version 4.00)".

NOTE:
See the O_2 FEEDBACK SYSTEM section on the page 3-35 before starting the O_2 feedback operation.

Procedure

⚠ WARNING

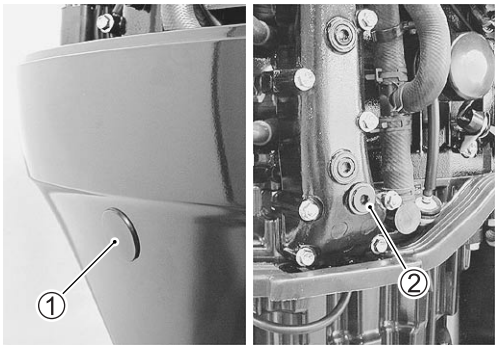
To prevent any sudden boat movement, the boat must be securely moored to the dock while the test wheel equipped engine is running in gear during the feedback test procedure.

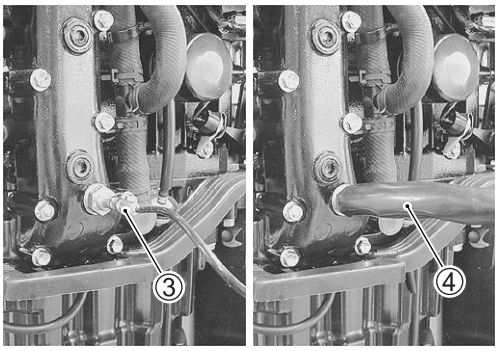
1. Remove the propeller and install the test wheel.

TOOL 09914-79511: Test wheel

2. Remove the grommet ① and the starboard side cover.
3. Remove the plug ② from the oil pump case and install the O_2 sensor ③ and the protector sleeve ④.

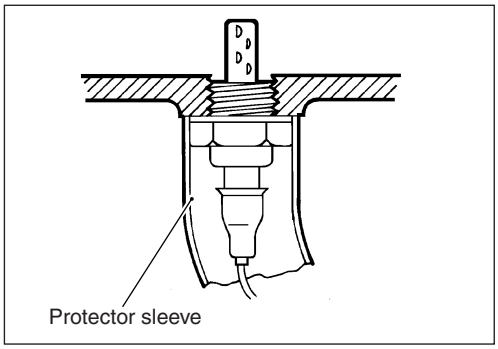
TOOL 18213-74F00: O_2 sensor
18498-99E70: Protector sleeve





CAUTION

The O_2 sensor used for the feedback test procedure must be in proper working order and installed securely.
If either sensor or installation is improper, the O_2 feedback operation will be performed incorrectly and could possibly result in engine operating problems.



NOTE:

- *The O_2 sensor is NOT WATERPROOF.*
  Cover the O_2 sensor with the protector sleeve to protect from water spray.
- *Cut off the protector sleeve (P/N 18498-99E70) to a length of 20 – 30 cm (7.8 – 11.8 in). The O_2 sensor must be completely covered as shown.*

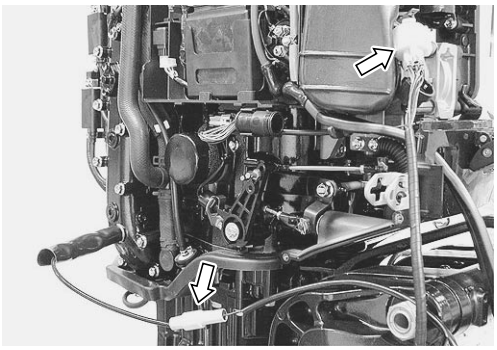
4. Connect the diagnostic harness to both the O_2 sensor connector and the engine harness connector.

TOOL 09932-79910: Diagnostic harness

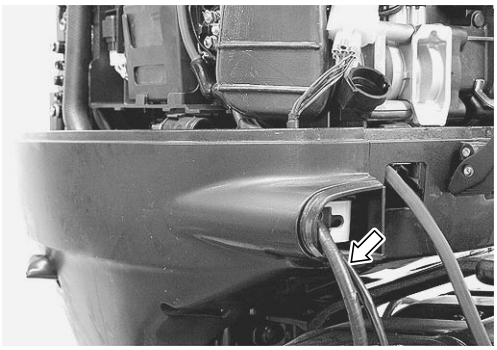
5. Connect the adapter to the diagnostic harness.

TOOL 09932-89910: Adapter

6. Install the starboard side cover.



NOTE:
Route the diagnostic harness through the clearance between the remote control cable holder plate and the side cover.



7. Install the motor cover.
8. Connect the diagnostic harness (with the adapter) to the personal computer.
9. Start and warm up the engine for at least 5 minutes at around 2000 r/min.

NOTE:

Before starting the SDS program, read and follow the "SDS Operation Manual (program version 4.00)".

OIL PRESSURE

Oil pressure (at normal operating temp.):
420 – 490 kPa (4.2 – 4.9 kg/cm², 60 – 70 psi.)
at 3000 r/min.

NOTE:
The figure shown above is guideline only, not absolute service limit.

If the oil pressure is lower or higher than the specification, the following causes may be considered:

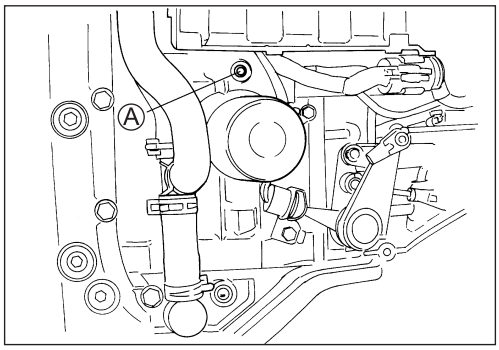
Low oil pressure
- Clogged oil filter
- Leakage from oil passages
- Defective oil pump
- Defective oil pressure regulator
- Damage O-ring
- Combination of above items

High oil pressure
- Using an engine oil of too high viscosity
- Clogged oil passage
- Clogged oil pressure regulator
- Combination of above items

TEST PROCEDURE
1. Check the engine oil level.
2. Remove the starboard side cover.
3. Remove the plug for oil pressure service port Ⓐ.
4. Install the pressure gauge and the adapter into the port Ⓐ.

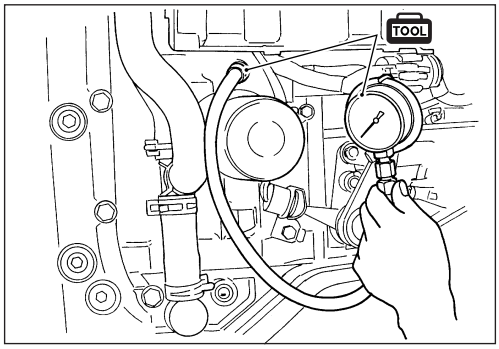
TOOL 09915-77310 : Oil pressure gauge
09915-78211 : Oil pressure gauge adapter

NOTE:
Prior to installation of the plug or adapter, wrap their threads with sealing tape. If the sealing tape edge is bulged out from threads, cut off the excess.



5. Attach the engine tachometer to the spark plug high-tension cord.

TOOL 09900-26006: Engine tachometer



6. Warm up the engine as follows:
   Summer : 5 min. at 2000 r/min
   Winter : 10 min. at 2000 r/min

7. After warming up, shift into the forward gear and increase the engine speed to 3000 r/min, then compare the pressure indicated on the gauge to the specifications.
8. Reinstall parts removed earlier.

CYLINDER COMPRESSION

Cylinder compression:
1300 – 1600 kPa (13 – 16 kg/cm², 185 – 228 psi)

Max. difference between any other cylinders:
200 kPa (2.0 kg/cm², 28 psi) or less

NOTE:

The figures shown above are guidelines only, not absolute service limits.

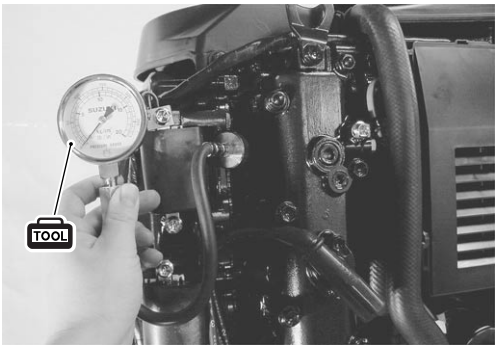
Low compression pressure can indicate one or more of the following:

- Excessively worn cylinder wall
- Worn piston or piston rings
- Stuck piston rings
- Poor seating of valves
- Ruptured or otherwise damaged cylinder head gasket

TEST PROCEDURE

1. Start and warm up the engine, then shut the engine off.
2. Remove the starboard side cover.
3. Remove all spark plugs.
4. Install the compression gauge into the plug hole.

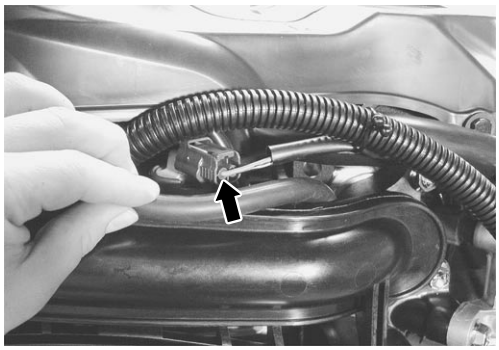
TOOL 09915-64512: Compression gauge



5. Disconnect the safety lanyard from the emergency stop switch.

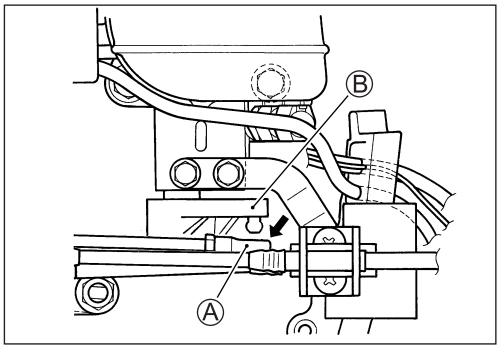
⚠ WARNING

Disconnect the safety lanyard from the emergency stop switch prior to cranking the engine.
This will prevent any residual fuel discharged from the cylinders being ignited by a spark discharge from the spark plug caps.



6. Disconnect the high pressure fuel pump lead wire.
7. Relieve the fuel line pressure. See the FUEL PRESSURE RELIEF PROCEDURE section on the page 5-2.

8. Disconnect the throttle rod Ⓐ from the throttle control lever Ⓑ.
9. Move the throttle control lever Ⓑ to full-open position and hold it.
10. While cranking the engine with the starter motor, note the maximum compression pressure reading on the gauge for each cylinder.
11. Reinstall parts removed earlier.



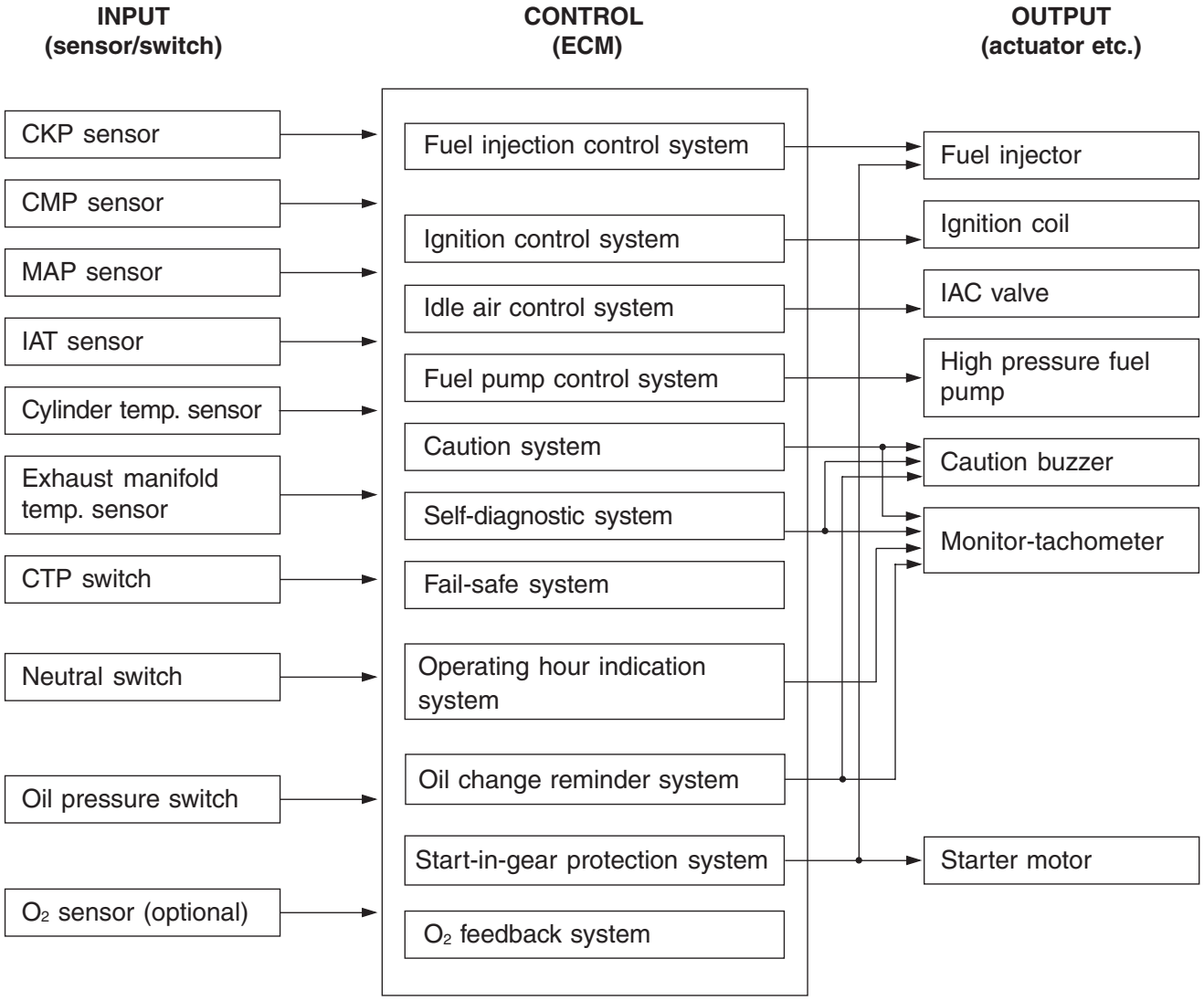
ENGINE CONTROL SYSTEM

CONTENTS

ENGINE CONTROL SYSTEM STRUCTURE

The DF60/DF70 models employ an integrated control system which performs the control functions for fuel injection, ignition, idle/trolling speed (idle air), etc. through the ECM (Engine Control Module).

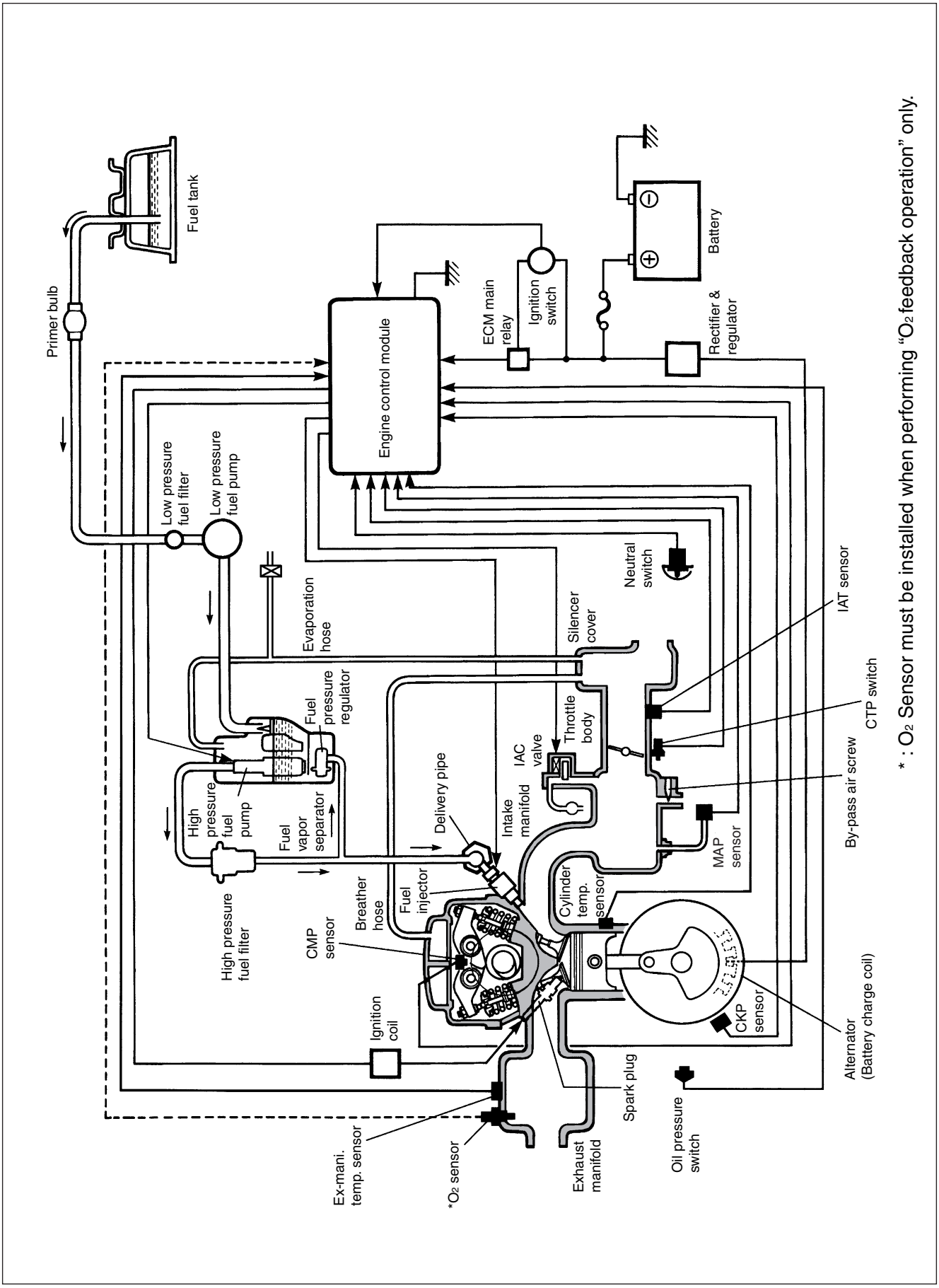
SYSTEM STRUCTURE 1



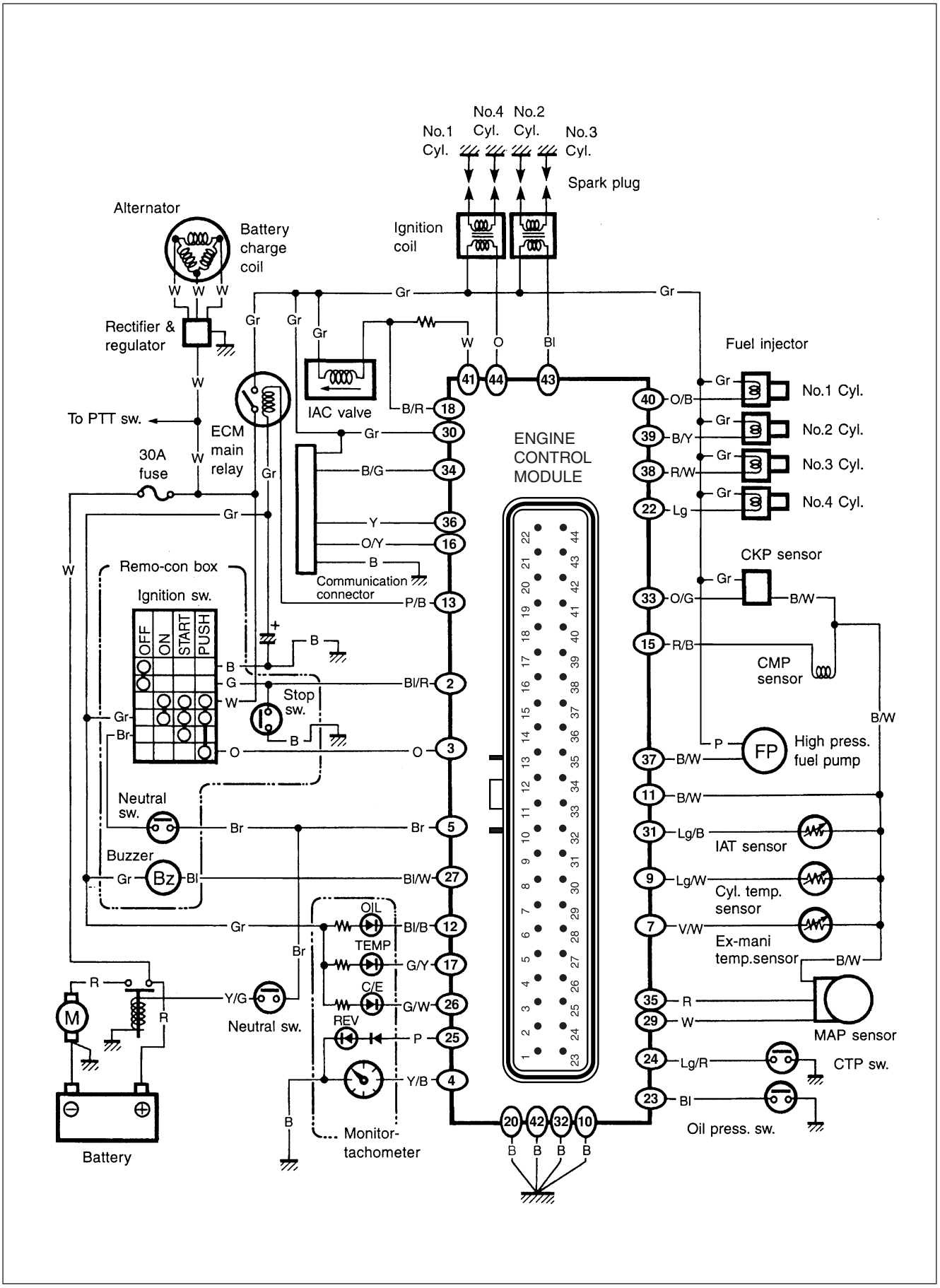
[Abbreviations used in this section]

ECM (Engine control module)
CKP (Crankshaft position)
CMP (Camshaft position)
MAP (Manifold absolute pressure)
IAT (Intake air temperature)
CTP (Closed throttle position)
IAC (Idle air control)

SYSTEM STRUCTURE 2



WIRING DIAGRAM FOR ENGINE CONTROL



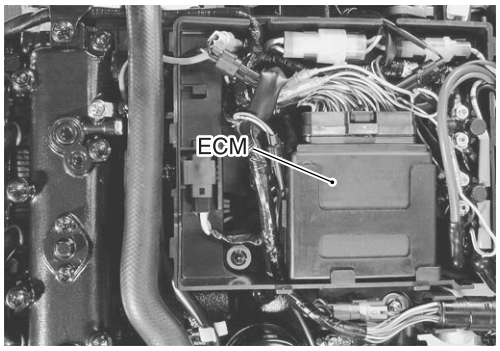
COMPONENTS FOR SYSTEM CONTROL

ENGINE CONTROL MODULE (ECM)

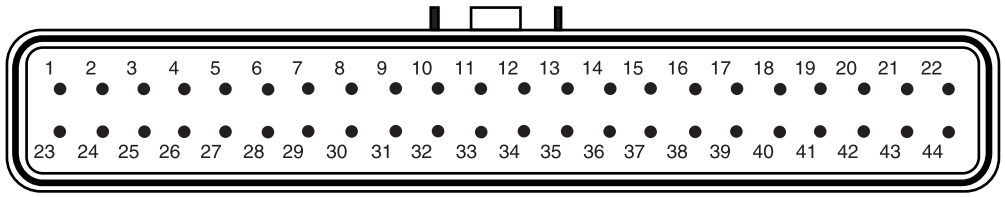
The ECM sends signals to control the actuators based on the information inputs from each sensor/switch. Major controls are as follows:

NAME OF CONTROL	DESCRIPTION
Fuel injection control	Controls fuel injection amount and timing.
Ignition control	Controls ignition timing.
Idle air control	Controls idling/trolling speed by adjusting intake air amount through IAC valve.
Fuel pump control	Controls high pressure fuel pump drive.
Caution system control	Informs operator of abnormal engine condition. Controls engine speed.
Self-diagnostic system control	Informs operator of sensor/switch malfunction.
Fail-safe system control	Allows operation during sensor/switch malfunction.
Operating hour indication system control	Informs operator of total operating time.
Oil change reminder system control	Informs operator of required engine oil replacement interval based on maintenance schedule.
Start-in-gear protection system control	Prevents engine start when shift is positioned in forward or reverse.
O_2 feedback system control	Controls and performs O_2 feedback operation using optional O_2 sensor.

NOTE:
The information related to the Caution system, Self-Diagnostic system, Operating hour indication system, Oil change reminder system and O_2 feedback system are retained in the ECM memory.



ECM CONNECTOR/TERMINALS LAYOUT



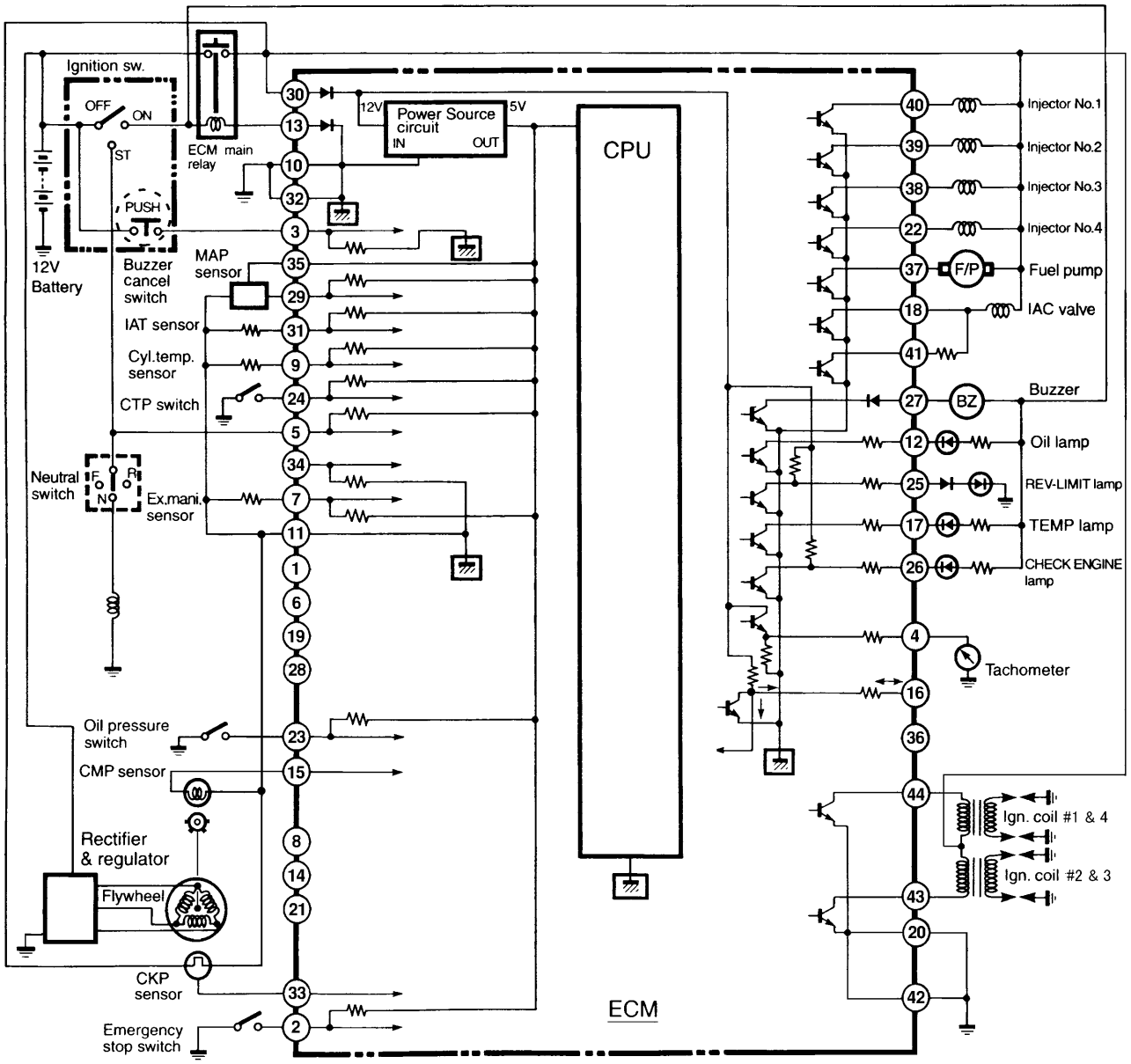
ECM CIRCUITS

TERMINAL	WIRE COLOR	CIRCUIT
1	—	—
2	Bl/R	Emergency stop switch
3	O	Buzzer cancel
4	Y/B	Tachometer
5	Br	Neutral switch, Engine start signal
6	—	—
7	V/W	Ex-manifold temperature sensor
8	—	—
9	Lg/W	Cylinder temperature sensor
10	B	Ground for ECM
11	B/W	Ground for sensor
12	Bl/B	OIL lamp
13	P/B	Ground for ECM main relay
14	—	—
15	R/B	CMP sensor
16	O/Y	PC communication
17	G/Y	TEMP lamp
18	B/R	IAC valve solenoid (–)
19	—	—
20	B	Ground for power souce
21	—	—
22	Lg	No.4 Fuel injector (–)

TERMINAL	WIRE COLOR	CIRCUIT
23	Bl	Oil pressure switch
24	Lg/R	CTP switch
25	P	REV-LIMIT lamp
26	G/W	CHECK ENGINE lamp
27	Bl/W	Buzzer
28	—	—
29	W	MAP sensor
30	Gr	ECM power source
31	Lg/B	IAT sensor
32	B	Ground for ECM
33	O/G	CKP sensor
34	B/G	O_2 feedback
35	R	Power source for MAP sensor
36	Y	PC communication
37	B/W	Fuel pump (–)
38	R/W	No.3 Fuel injector (–)
39	B/Y	No.2 Fuel injector (–)
40	O/B	No.1 Fuel injector (–)
41	W	Resistor
42	B	Ground for power source
43	Bl	No.2 & 3 Ignition (–)
44	O	No.1 & 4 Ignition (–)

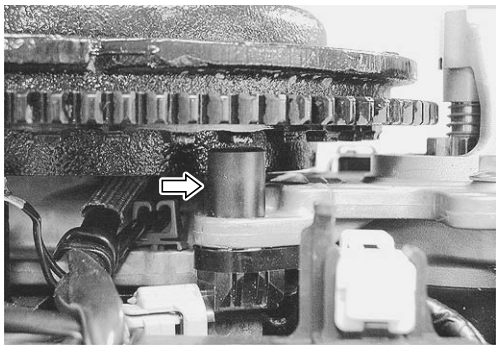
NOTE:
"WIRE COLOR" shows the wire color of the engine wire harness side.

ECM INTERNAL STRUCTURE



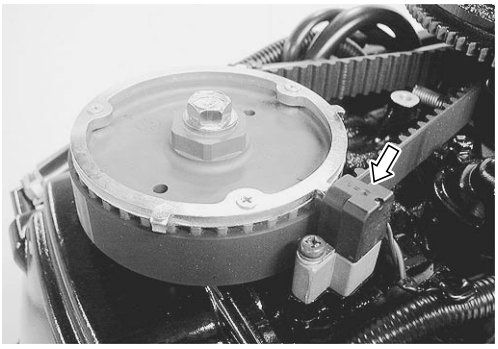
SENSOR AND SWITCH

CKP (Crankshaft Position) SENSOR



The CKP sensor which is a “Hall effect sensor” type is installed below the flywheel rotor. When the reluctor bars on the flywheel passes the sensor, signals are generated and rectified to create “ON” (high voltage) and “OFF” (low voltage) signals in the sensor. These signals are sent to the ECM and are the fundamental signals used to judge the engine speed and crankshaft angle.
There are 34 reluctor bars, spaced 10 degrees apart, followed by a larger index space. During one crankshaft rotation, 34 signals are supplied from the CKP sensor to the ECM.

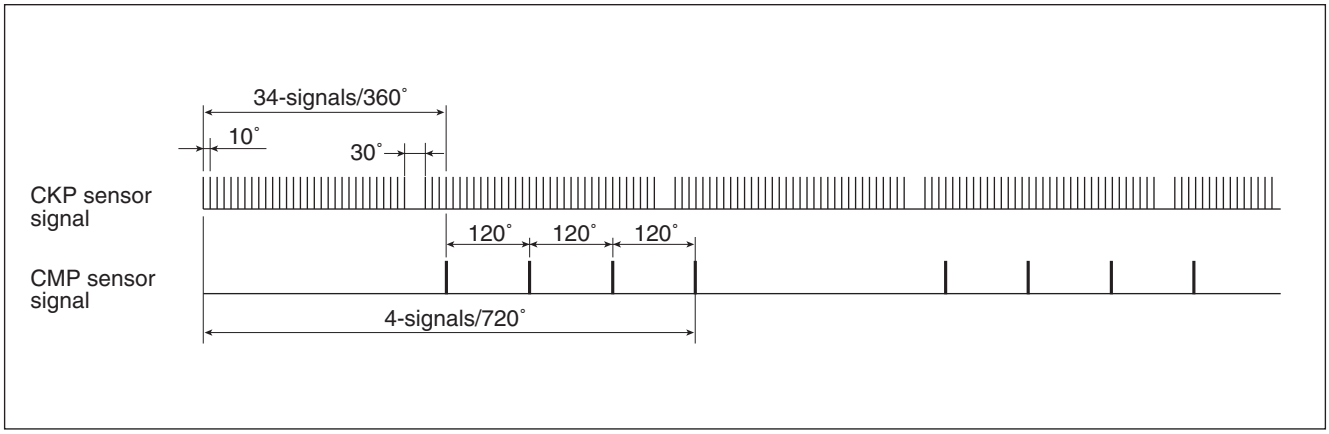
CMP (Camshaft Position) SENSOR



The CMP sensor is installed on the side of the camshaft pulley. When the reluctor bars (trigger vanes) on the camshaft pulley passes the sensor, signals (voltage pulses) are generated and sent to the ECM.
There are four trigger vanes on the camshaft pulley. During one rotation of the camshaft (two rotations of the crankshaft), four signals are supplied from the CMP sensor to the ECM.

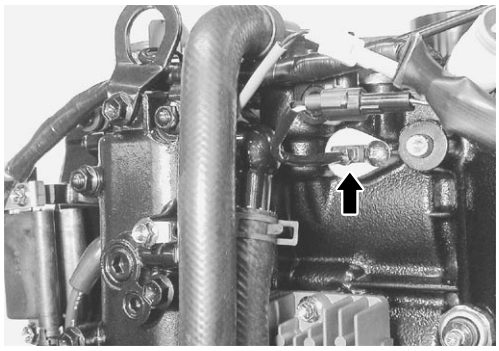
ECM cylinder identification:

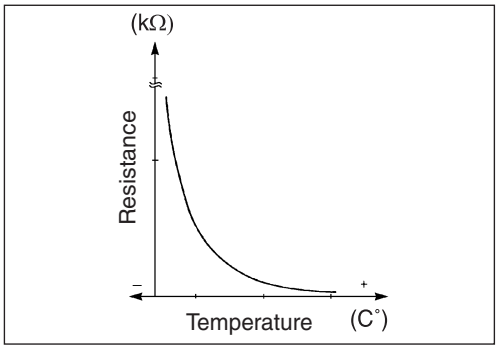
The cylinder is identified by a calculation combined from two signals; one from the CKP sensor and one from the CMP sensor.



CYLINDER TEMPERATURE SENSOR

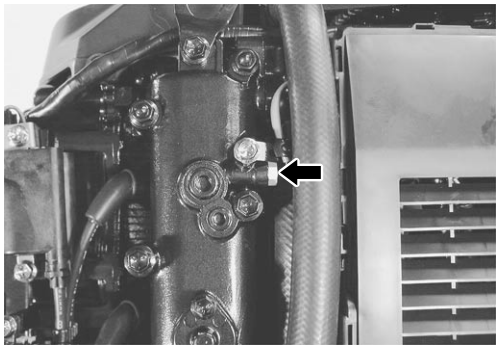
The cylinder temperature sensor is installed on the cylinder (behind the electric part holder) and used to detect the cylinder temperature.
This is a thermistor type sensor (resistance of which changes depending on the temperature) and inputs a signal to the ECM as a voltage value. This input signal is used to compensate the fuel injection time duration, ignition timing, etc.
This sensor is also used to detect engine over-heat as the ECM detects both the temperature and temperature change gradient (temperature rise vs time).





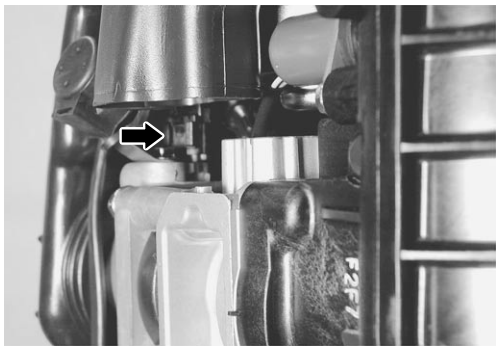
EXHAUST MANIFOLD TEMPERATURE SENSOR

The exhaust manifold temperature sensor is installed on the exhaust manifold and used to detect the exhaust manifold temperature. This sensor is the same type as the cylinder temperature sensor, and inputs a signal to the ECM as a voltage value. This input signal is also used to detect engine over-heat.



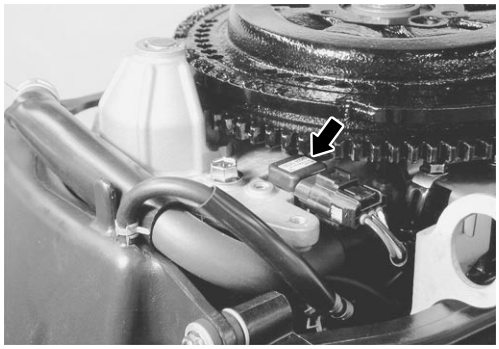
IAT (Intake Air Temperature) SENSOR

The IAT sensor is installed on the surge tank and used to detect the intake air temperature.
This sensor is the same type as the cylinder temperature sensor, and inputs a signal to the ECM as a voltage value.
This input signal is used to compensate the fuel injection time duration.



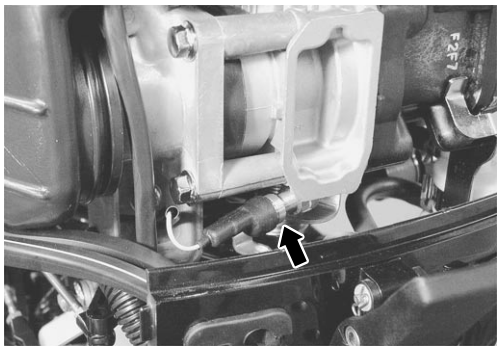
MAP (Manifold Absolute Pressure) SENSOR

The MAP sensor is installed on the intake manifold and used to detect the intake manifold pressure. It also detects the barometric pressure before starting the engine. This sensor inputs the intake manifold pressure to the ECM as a voltage value. This input signal is used as the fundamental signal to determine the fuel injection time duration, ignition timing, etc.



CTP (Closed Throttle Position) SWITCH

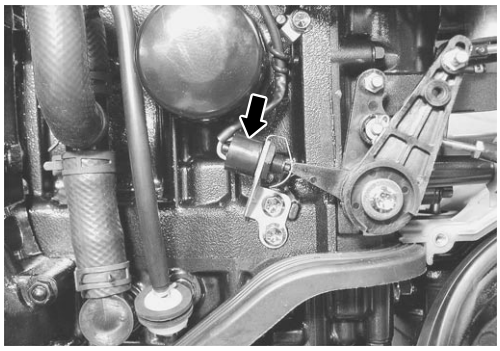
The CTP switch is installed on the bottom of throttle body and used to detect whether the throttle is fully closed or not.
This switch is "ON" at closed throttle and "OFF" at any open throttle position. Based on the switch's throttle position signal input, the ECM determines the control modes for various control system (idle aire contrl, ignition timing control, etc.)



NEUTRAL SWITCH

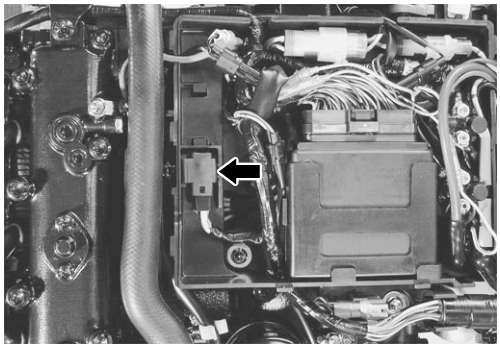
The neutral switch is installed on the cylinder block (starboard side) and used to detect the shift position.
This switch is "ON" in neutral and "OFF" in forward or reverse. Based on the switch's shift position signal input, the ECM performs the following controls:

- When the shift is in forward or reverse at the time of engine start, the fuel injection function is cancelled.
  (Start-in-gear protection. See the page 3-34.)
- When the shift is in neutral, fuel injection is controlled so that the engine speed does not exceed 3000 r/min.
- When the shift is in neutral, if the engine speed exceeds 1000 r/min, ignition timing is fixed at BTDC 5°.
- After shifting into forward or reverse from neutral, the IAC valve is controlled to increase intake air for two seconds to prevent unstable engine idle or stalling.

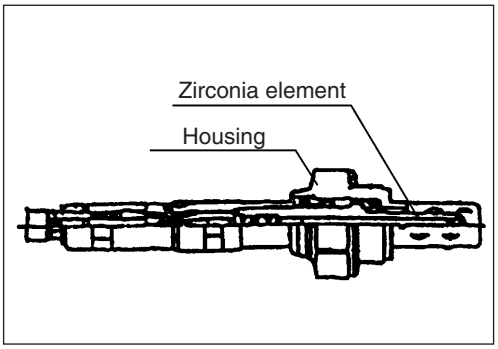


ECM MAIN RELAY

The ECM main relay is installed in the electric parts holder.
When energized by the turning ignition switch ON, it forms the circuit which supplies battery voltage to the ECM, injector, ignition coil, IAC valve, CKP sensor and high pressure fuel pump.



O_2 SENSOR (Optional item)



The O_2 sensor is installed in the exhaust manifold only when the O_2 feedback operation is performed.
This sensor is a zirconia element (platinum plated) which changes output voltage depending on the oxygen concentration difference between its internal and external surface. The voltage change reflects the concentration of the oxygen in the exhaust gas and is used to perform the O_2 feedback operation.

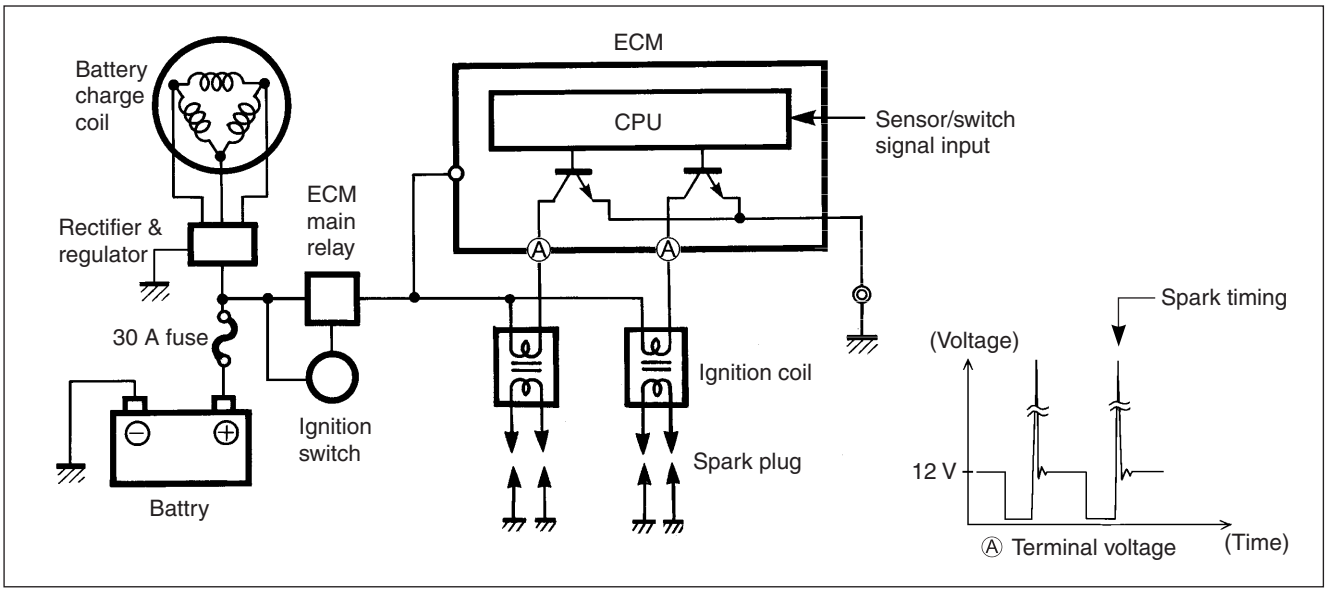
The terminal voltage change (0 – 1 V) is dependent on the concentration of oxygen in the exhaust gas.
This detected voltage value therefore represents the oxygen concentration. The terminal voltage decreases when the oxygen concentration is high, and increases when it is low.

NOTE:
As the zirconia element is not conductive below 250°C, the O_2 sensor will not function properly until the engine is at normal operating temperature.

NOTE:
Zirconia element
The zirconia element produces a potential difference (voltage) when there is a difference in the oxygen concentration of the gases which contact the two sides of the element.
Since the inner surface of the zirconia element (inside the sensor) is exposed to atmospheric air and the outer surface exposed to the exhaust gas, there is a difference in oxygen concentration on each side and thus a difference in the potential generated.

IGNITION SYSTEM

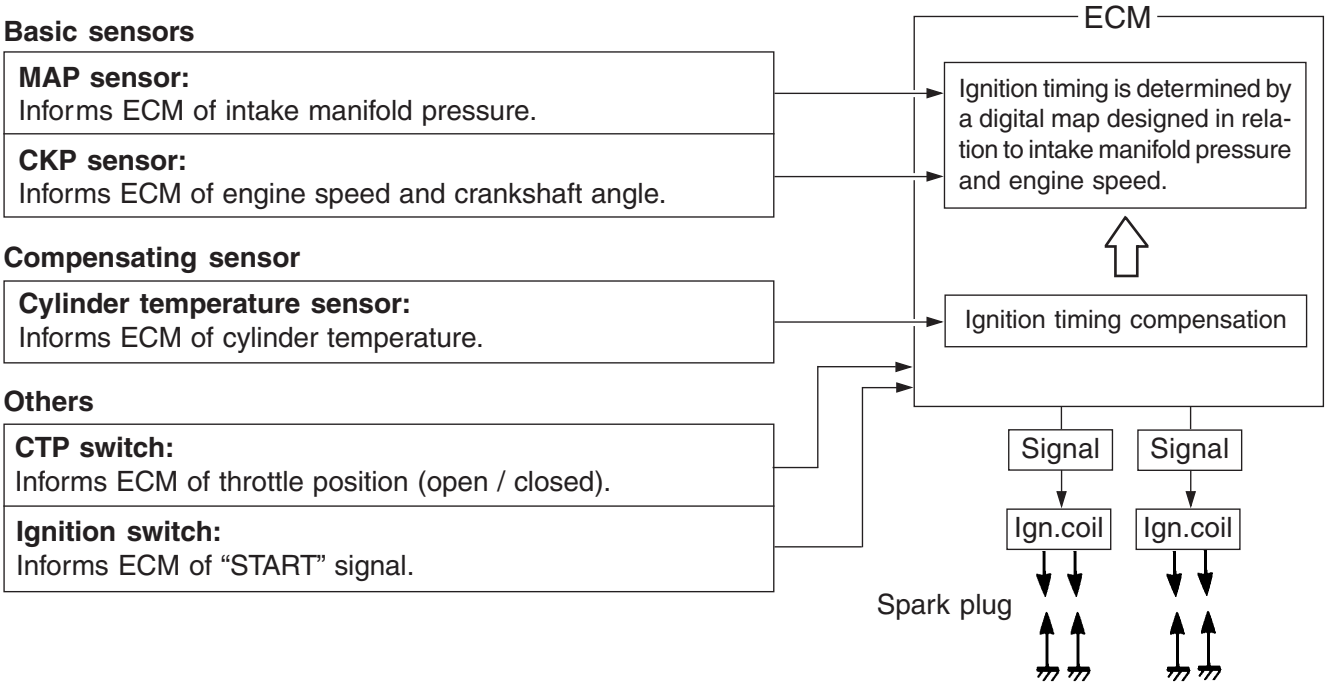
The ignition system used by the DF60/DF70 is a fully transistorized, electronic microcomputer timing advanced type.
This system is totally battery powered, with the ECM controlling all ignition timing functions.
The ignition system is composed of the ignition coil, spark plug and components for system control (ECM, sensor, switch, etc.).
When the ignition switch is “ON”, battery voltage (12V) is applied to the circuit as shown in the illustration. At the calculated time of ignition, the transistor in the ECM turns “OFF”, breaking the grounded circuit. In this way, a mutual induction high voltage occurs in the ignition coil secondary side and spark is generated.



IGNITION CONTROL SYSTEM

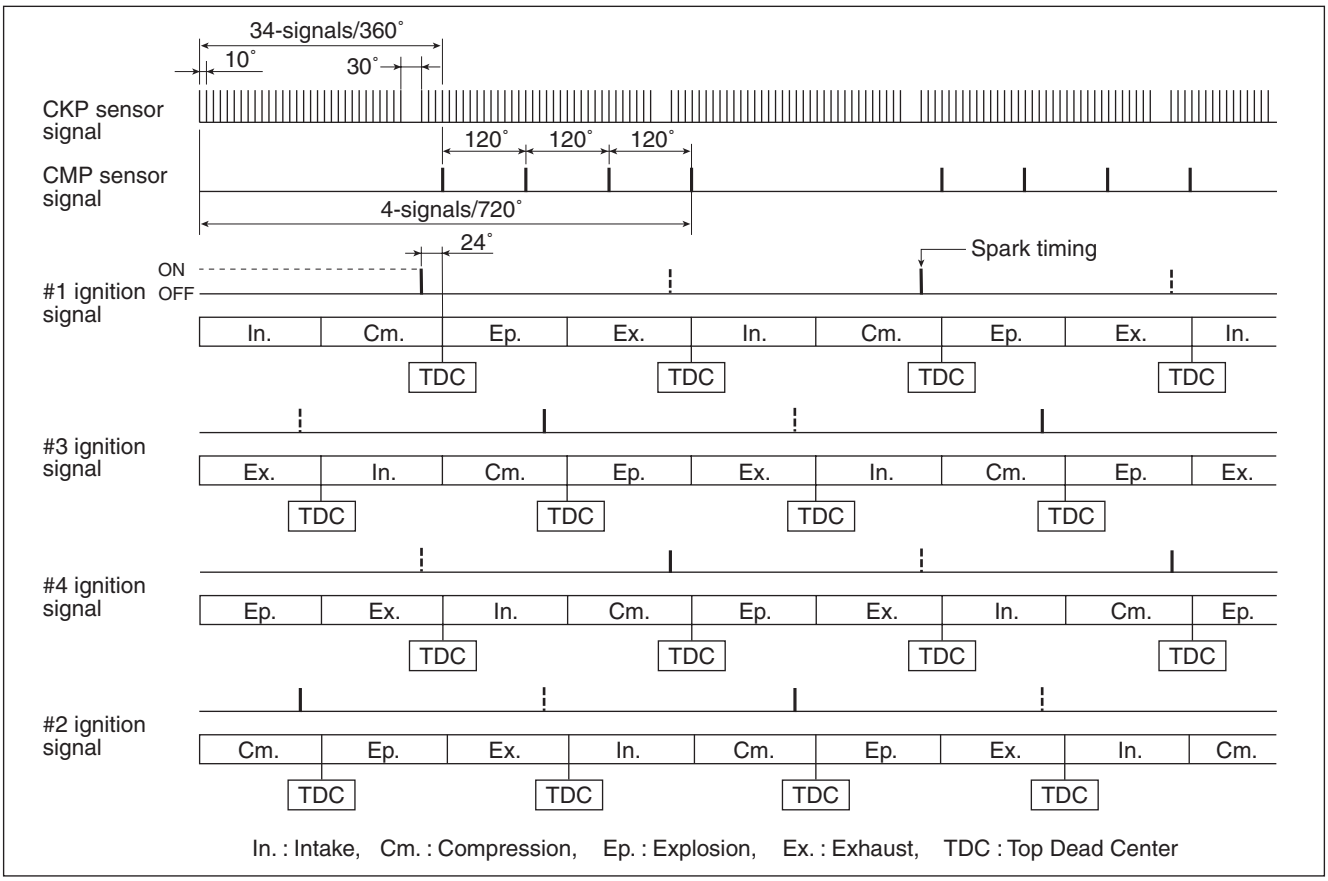
OUTLINE

The sensors at specific points on the engine monitor current engine conditions and send signals to the ECM. Based on these signals, the ECM determines the optimum ignition timing and releases voltage to the ignition coils.



IGNITION TIMING CHART

- The following chart shows the example for the ignition at BTDC 24°.
- The ignition timing is varied by the condition of the engine running.
- Angles indicated in the following chart show the CRANKSHAFT angle.



CONTROL MODE

WHEN CRANKING:

The ignition timing is fixed at BTDC 5° until the engine starts.

WHEN IDLING/TROLLING:

The ignition timing is controlled within the range of BTDC 4° to BTDC 16° to provide stable engine operation at the specified idling/trolling speed.

When the shift lever is in neutral, if engine speed exceeds 1000 r/min, ignition timing remains fixed at BTDC 5°.

WHEN RUNNING (NORMAL OPERATION):

The ignition timing ranges between BTDC 10° – 33° (DF60) or 29° (DF70), depending on current engine operating conditions.

WHEN DECELERATING:

When the throttle valve is closed suddenly, turning the CTP switch “ON”, ignition timing is delayed for a programmed duration to prevent engine stalling or unstable running.

SPECIFICATION

Ignition system	Full-transistorized ignition
Advance	Electronic microcomputer control
Ignition timing	DF60: BTDC 4° – BTDC 33°, DF70: BTDC 4° – BTDC 29°
Firing order	1 – 3 – 4 – 2

ELECTRONIC FUEL INJECTION SYSTEM

The fuel injection system used by the DF60/DF70 is a speed-density, multi-point, sequential, electronic fuel injection type.

The fuel injection system is composed of the fuel line components, air intake components, and components for system control (ECM, sensors, switches, etc.).

FUEL INJECTION CONTROL SYSTEM

OUTLINE

The sensors are mounted at precise locations on the motor to monitor the current conditions of engine operation and send signals to the ECM. Based on these signals, the ECM determines the optimum fuel injection time duration (fuel amount), fuel injection timing (multi-point sequential timing) and controls the injector operating signals accordingly. Fuel injection start timing is set at BTDC 484° on exhaust stroke constant.

Basic sensors

MAP sensor:
Informs ECM of intake manifold pressure.

CKP sensor:
Informs ECM of engine speed and crankshaft angle.

Compensating sensors

Cylinder temperature sensor:
Informs ECM of cylinder temperature.

IAT sensor:
Informs ECM of intake air temperature.

MAP sensor:
Informs ECM of barometric pressure at time of engine starting.

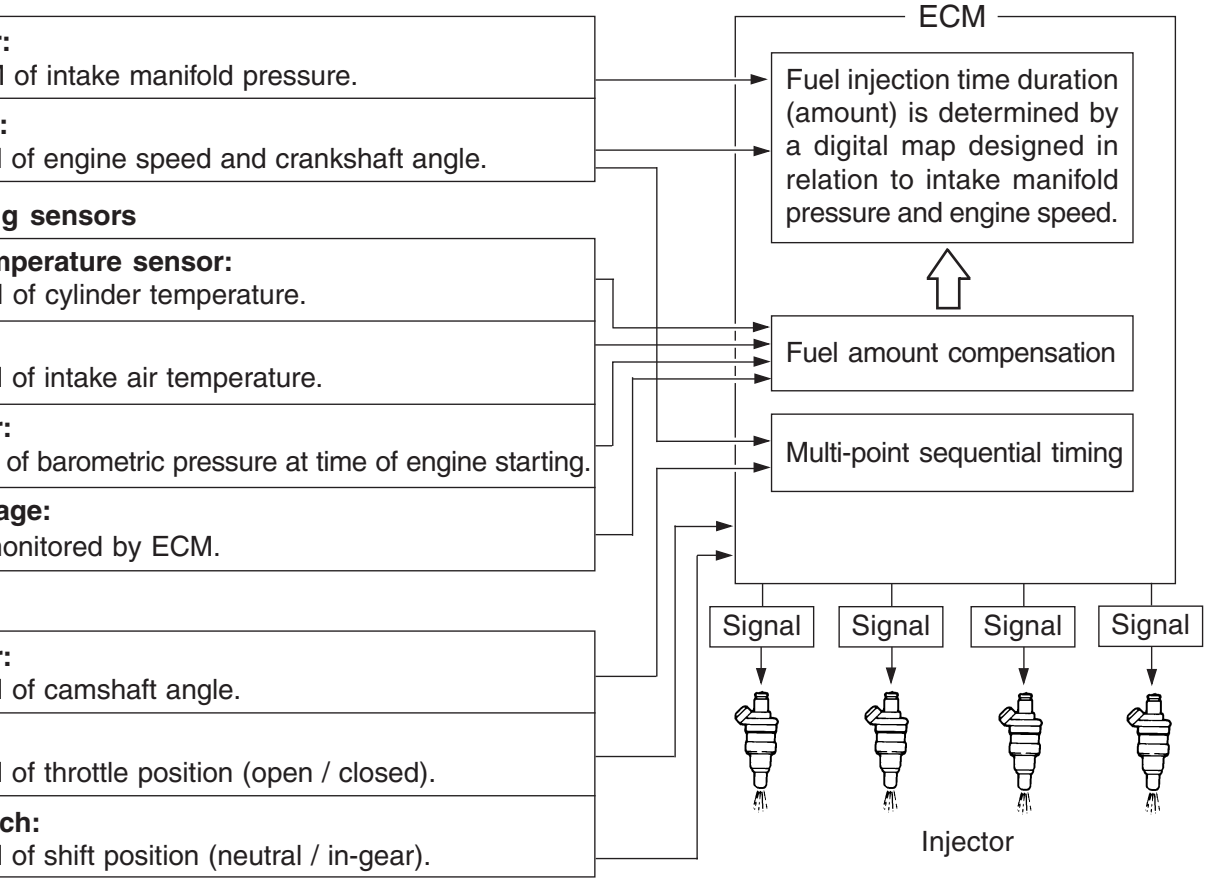
Battery voltage:
Constantly monitored by ECM.

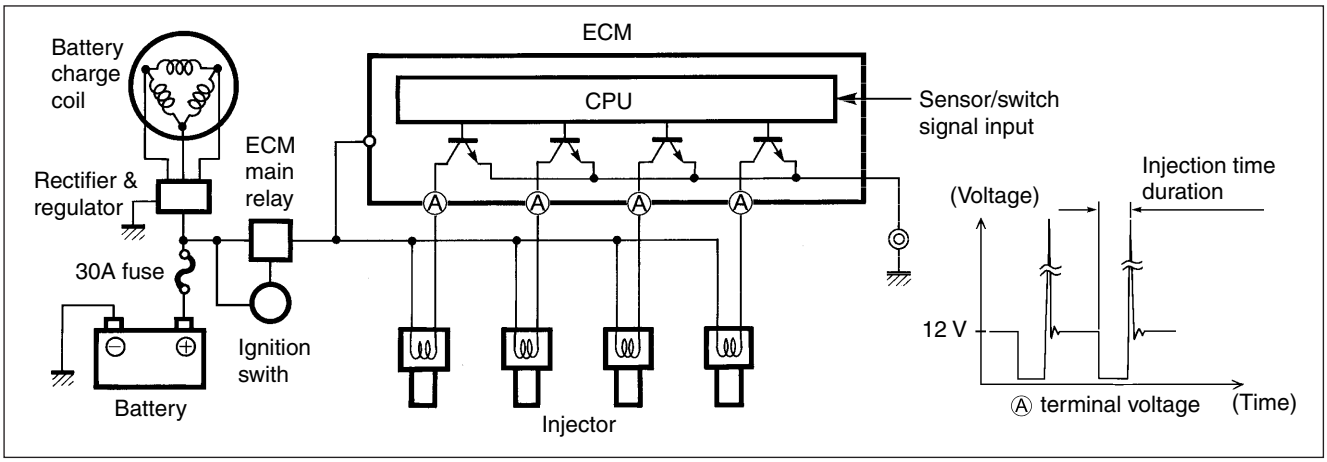
Others

CMP sensor:
Informs ECM of camshaft angle.

CTP switch:
Informs ECM of throttle position (open / closed).

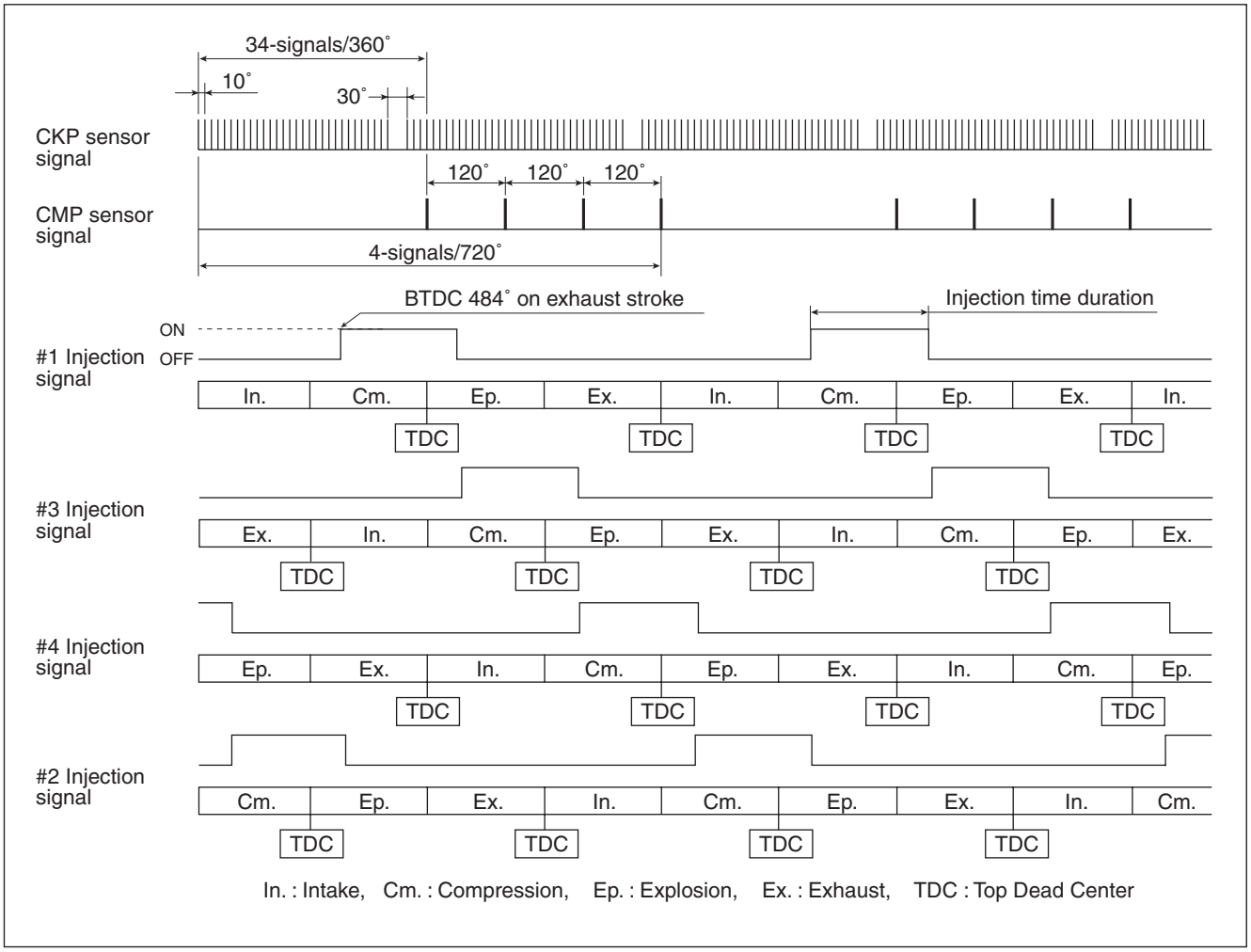
Neutral switch:
Informs ECM of shift position (neutral / in-gear).





FUEL INJECTION TIMING CHART

- The fuel injection timing is always fixed at BTDC 484° on exhaust stroke.
- The fuel ignition time duration (amount) is varied by the condition of the engine running.
- Angles indicated in the following chart show the CRANKSHAFT angle.



CONTROL MODE

BEFORE START:

When the ignition switch is turned “ON”, the ECM receives a MAP sensor signal, indicating the static barometric pressure of the intake manifold, which is used to compensate the fuel injection map for altitude.

WHEN CRANKING:

Fuel is simultaneously injected to all cylinders every time any piston is positioned at compression stroke.

AFTER START (FAST-IDLE FUNCTION):

The fuel injection amount is controlled to increase until the timer, set according to cylinder temperature at the time of engine start, expires.

WHEN IDLING/TROLLING:

The fuel injection amount is controlled to maintain a stable engine speed at the specified idle/trolling rpm.

WHEN ACCELERATING:

The fuel injection amount is controlled to increase.

WHEN DECELERATING:

The fuel injection amount is controlled to decrease.

The fuel injection is also cut off on very rapid engine deceleration.

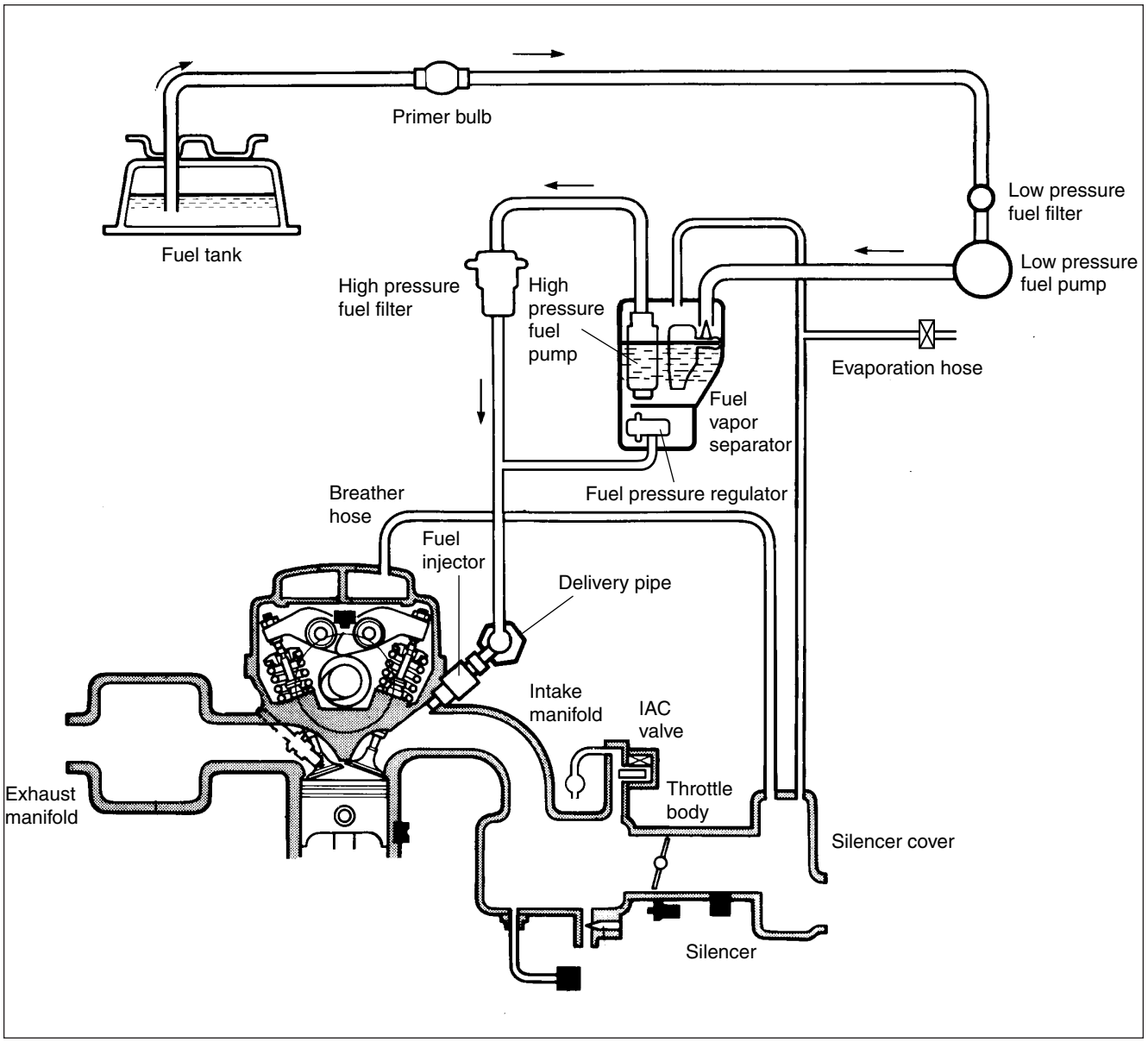
FUEL DELIVERY SYSTEM COMPONENTS

The fuel delivery system is composed of the low pressure line components (fuel tank, filter, pump etc.), fuel vapor separator, high pressure fuel pump, high pressure fuel filter, fuel pressure regulator (located in the fuel vapor separator), delivery pipe, fuel injector and hoses.

Fuel is supplied through the primer bulb, low pressure fuel filter, and low pressure pump to the fuel vapor separator.
Fuel flow from the fuel vapor separator is pressurized by the high pressure fuel pump and supplied through the high pressure fuel filter and fuel delivery pipe to the fuel injectors.
The pressure regulator maintains fuel pressure in the feed line between the high pressure fuel pump and fuel injector.
This pressure, maintained at a constant level, is higher than the pressure in the vapor separator chamber.

When the fuel feed line pressure exceeds the vapor separator chamber pressure by more than approx. 255 kPa (2.55 kg/cm^2, 36.3 psi), the valve in the fuel pressure regulator will open and return the excess fuel to the vapor separator chamber.

Pressurized fuel enters into the intake ports through the fuel injector based on the sequential signals supplied from the ECM.



FUEL VAPOR SEPARATOR

The fuel vapor separator incorporates a float system that maintains a constant fuel level inside the separator chamber.

As the fuel level decreases, fuel flows into the vapor separator from the low pressure fuel pump.

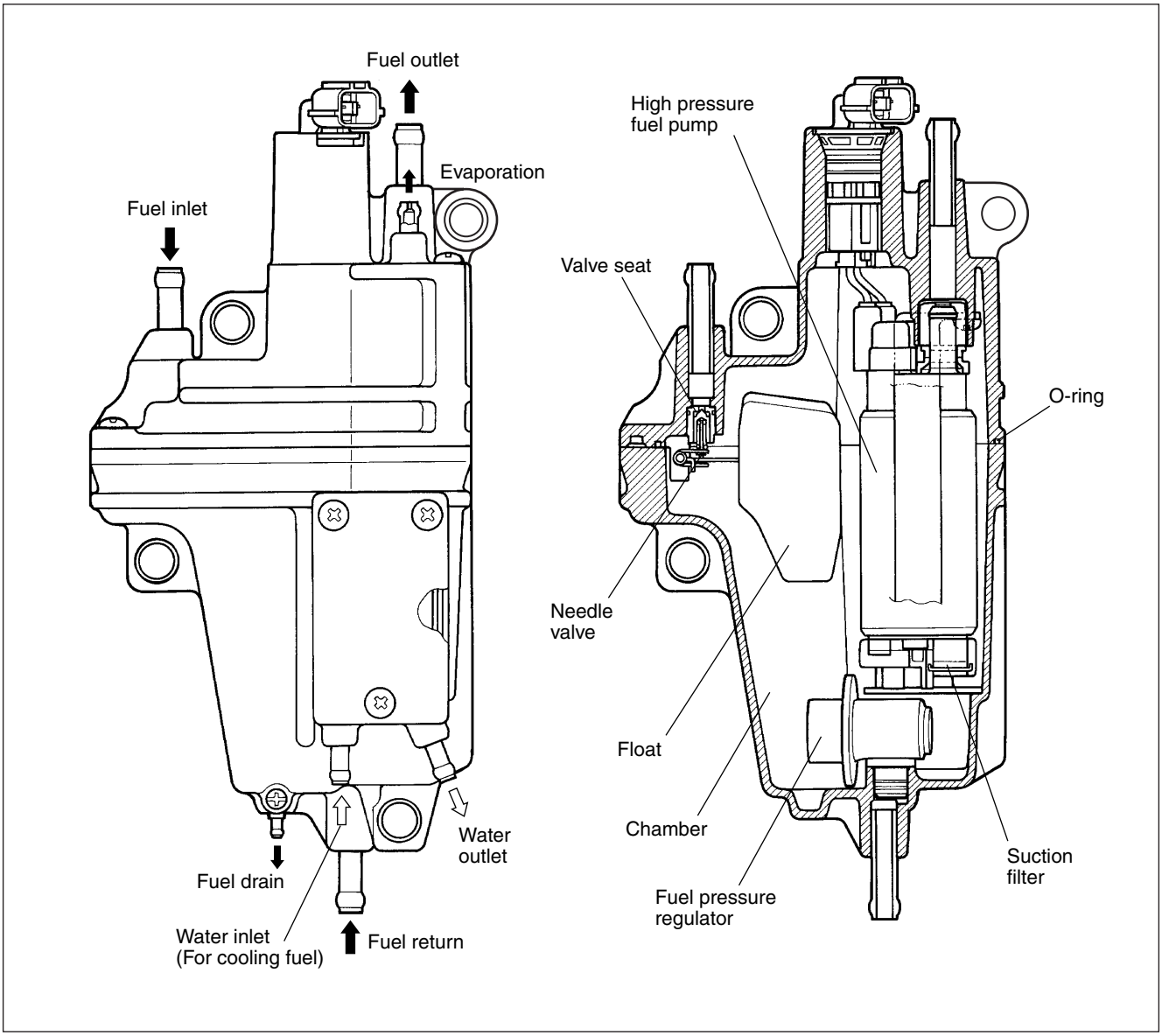
The function of this unit is to separate vapors from fuel delivered by the low pressure fuel pump or fuel returned from the fuel pressure regulator.

This vapor is routed through the evaporation hose connecting the vapor separator cover to the silencer cover.

HIGH PRESSURE FUEL PUMP

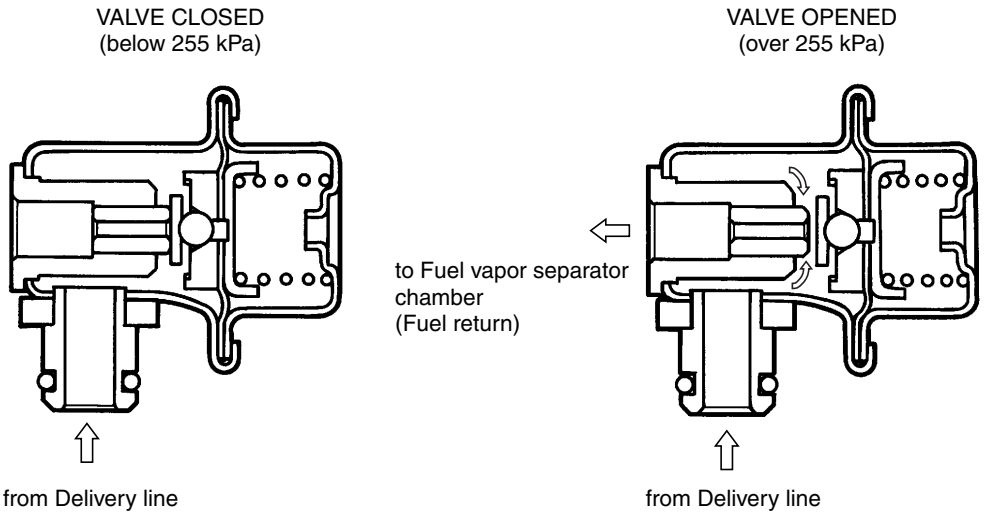
The high pressure fuel pump is an “integral” type in which the pump mechanism is located within the fuel vapor separator.

To supply the optimum fuel amount, the pump is driven by the duty cycle signal from the ECM.



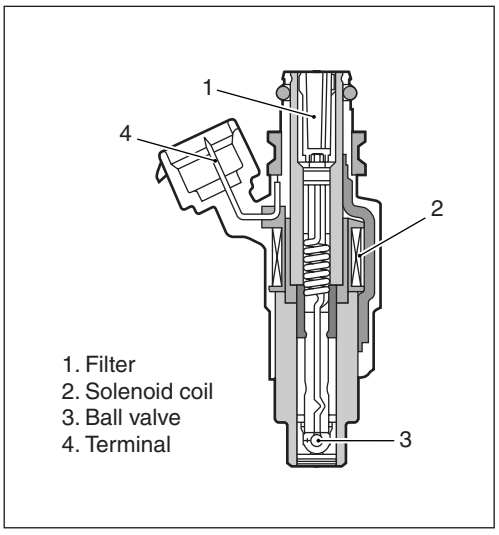
FUEL PRESSURE REGULATOR

The fuel pressure regulator is located in the fuel vapor separator.
The regulator's function in the system is to maintain a constant fuel pressure relative to the injector while the engine is operating.
The regulator diaphragm chamber is open to the vapor separator chamber to keep the pressure balanced.
Fuel pressure, adjusted by the regulator, is constantly maintained higher than the pressure in the fuel vapor separator chamber by approx. 255 kPa (2.55 kg/cm^2, 36.3 psi).
By-pass fuel is returned back to the fuel vapor separator chamber.



FUEL INJECTOR

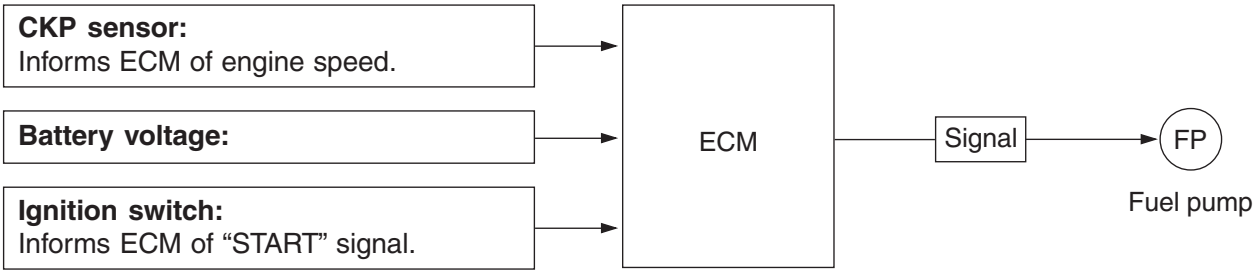
The fuel injector is an electromagnetic valve operated by a signal from the ECM.
When the injection signal is supplied to the fuel injector, the solenoid coil is energized pulling up the plunger.
This opens the injector valve and injects fuel.
Because the fuel pressure is kept constant, the amount of fuel injected is determined by the amount of time (duration) the valve is open.

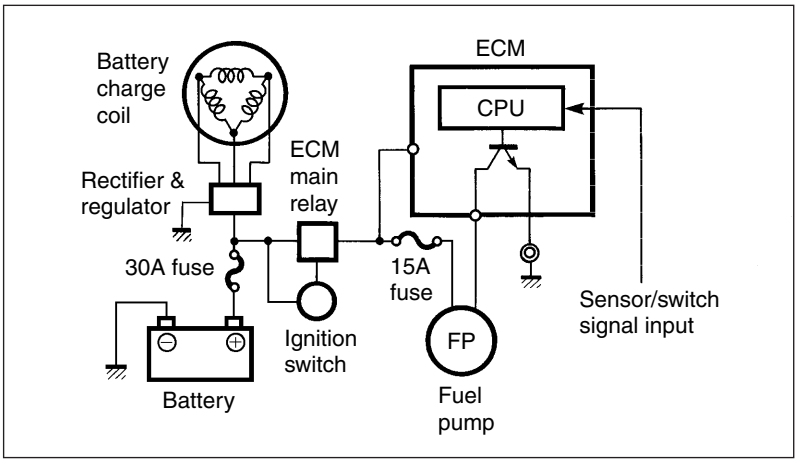


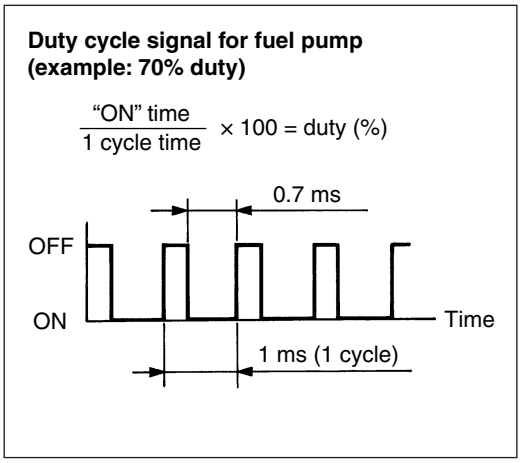
FUEL PUMP CONTROL SYSTEM

OUTLINE

To supply the optimum fuel amount, the ECM controls the fuel pump drive duty cycle, a repeated ON / OFF signal, at a specified rate (1000 times a second).
Based on engine speed and battery voltage, the ECM determines the optimum duty (repeating “ON” time rate within a cycle) and sends this signal to the fuel pump.







CONTROL MODE

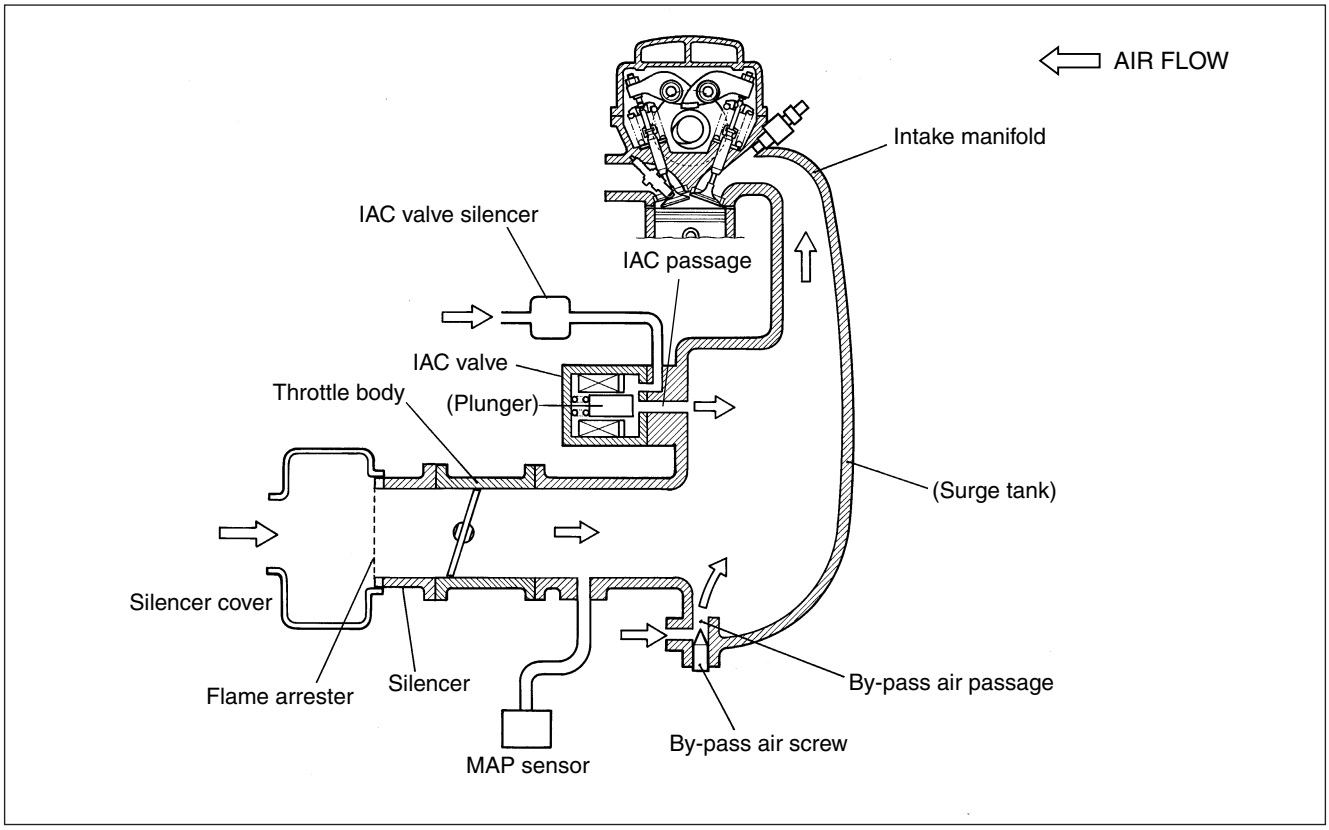
BEFORE START:
For 3 seconds after ignition switch is turned “ON”, the pump is controlled to operate at 100% duty in order to initially pressurize the high pressure line.

WHEN CRANKING:
The pump is controlled to operate at 100% duty.

WHEN RUNNING (NORMAL OPERATION):
The pump is controlled to operate at 60 – 100% duty based on the current engine speed and battery voltage.

AIR INTAKE COMPONENTS

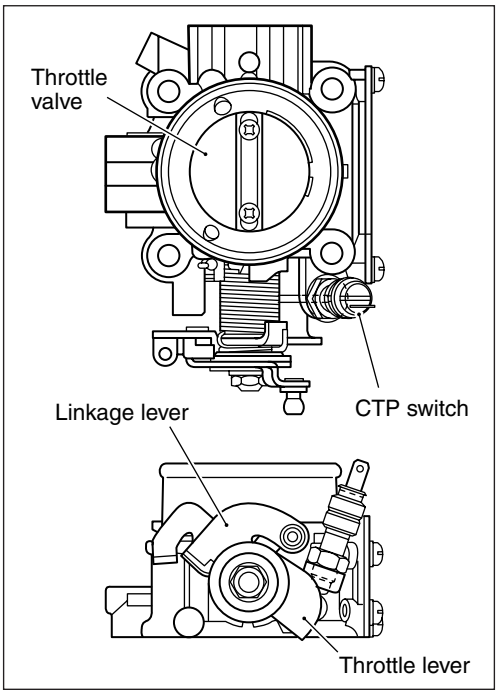
Air, after entering through the silencer, passes through the throttle body and flows into the surge tank where it is then distributed to the cylinder intake manifold.
Intake manifold pressure, monitored by the MAP sensor, is an indirect measure of the intake air amount.
When the throttle is fully closed, the main supply of intake manifold air necessary to sustain the engine idle passes through the by-pass air passage.
To maintain the engine idle speed at the specification, the ECM controlled the IAC valve supplies a regulated amount of additional air through the IAC (idle air control) passage.



THROTTLE BODY

The throttle body adjusts the intake air amount with the throttle valve which is connected to the throttle / linkage lever. The CTP (closed throttle position) switch is installed on the bottom of the throttle body. The CTP switch informs of a throttle valve position.

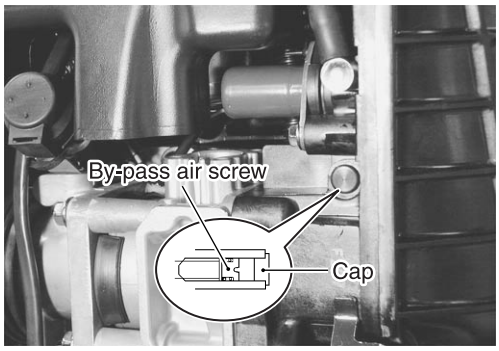
NOTE:
Do not try to adjust or remove any of the throttle body component parts (CTP switch, throttle valve, throttle / linkage lever, etc.). These components have been factory adjusted to precise specifications.



BY-PASS AIR SCREW / PASSAGE

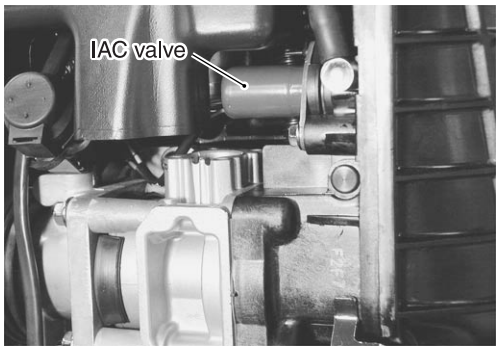
Since the throttle valve is almost fully closed when idling / trolling, the main flow of air necessary to maintain idling / trolling speed passes through the by-pass air passage.
The by-pass air screw controls the flow of air through the passage and provides a means of partially adjusting the total amount of air necessary for idling / trolling.

NOTE:
See the page 2-14 for the by-pass air screw adjustment procedure.



IAC VALVE / PASSAGE

The IAC valve is a linear solenoid plunger type mounted on the intake manifold (surge tank).
Its purpose is to control the amount of intake air flowing from the IAC passage.
The IAC valve is driven by the duty cycle signal from the ECM.



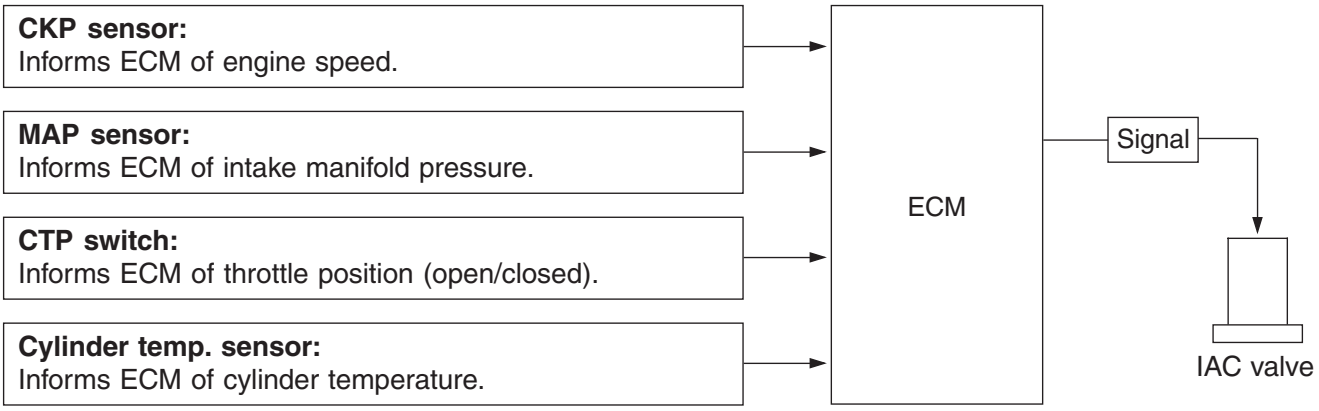
IDLE AIR CONTROL SYSTEM

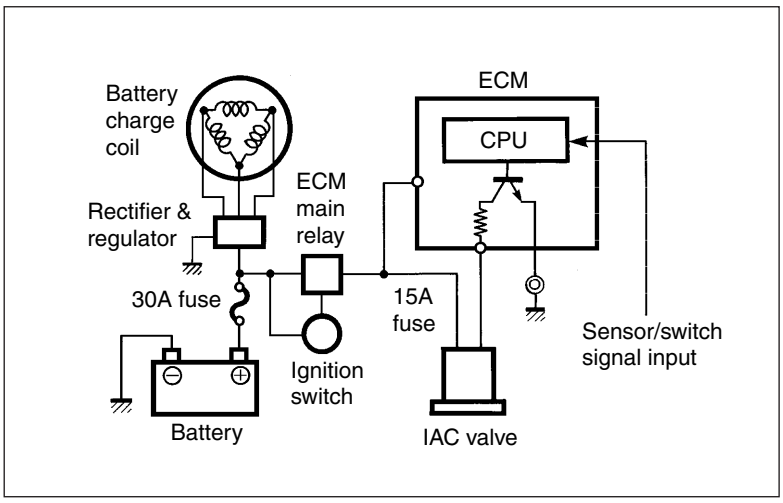
OUTLINE

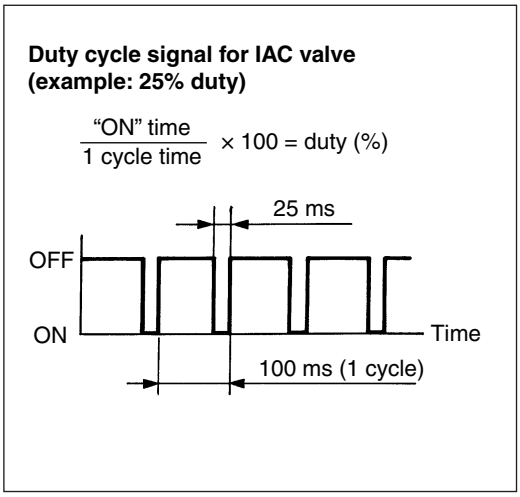
The ECM controls the duty cycle signal of the IAC valve to regulate a portion of the intake air flow to the intake manifold.
This system is used for the following purposes:

- To keep idling / trolling at the specified speed.
- To improve driveability when decelerating (Dash-pot effect).
- To improve engine starting and warm-up performance (Fast-idle function).

The sensors / switch shown below monitor current engine condition and send signals to the ECM. Based on these signals, the ECM determines the optimum duty cycle (repeating “ON” time rate within a cycle).
A repeating ON / OFF signal at a specified rate (10 times a second) is then sent to the IAC valve.







CONTROL MODE

BEFORE START:
The IAC valve is closed (0% duty) when engine is not running.

WHEN CRANKING:
The IAC valve is controlled to operate at 100% duty.

AFTER START (FAST-IDLE FUNCTION):
The IAC valve is controlled to operate at approx. 25 – 100% duty until the timer, which was set according to cylinder temperature at cranking, expires.

WHEN IDLING / TROLLING:
The IAC valve is controlled so that the engine speed is stable at the idling / trolling speed specified.
During this period, the IAC valve has a duty cycle of approx. 22.5% but will vary slightly as idling / trolling conditions change.

WHEN RUNNING (NORMAL OPERATION):
The IAC valve is controlled to operate at 20 – 100% duty, which depends on the current engine conditions.

WHEN DECELERATING (DASH-POT EFFECT):
When the throttle valve is suddenly returned to full close and the CTP switch signal changes to "ON", the IAC valve operates at a controlled gradual return to idle / troll operating duty to prevent engine stalling or unstable running.

NOTE:
Due to the limited intake air flow from the IAC passage and in order to effectively use both the "Dash-pot effect" and "Fast-idle function", the by-pass air screw must be adjusted to provide IAC valve operation at approx. 22.5% duty at the engine idling / trolling specification.
See the page 2-14 for the by-pass air screw adjustment procedure.

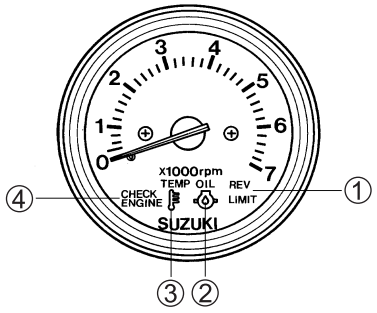
CAUTION SYSTEM

The following four caution systems alert the operator when an abnormality occurs on the engine.

- **OVER-REVOLUTION CAUTION**
- **LOW OIL PRESSURE CAUTION**
- **OVERHEAT CAUTION**
- **LOW BATTERY VOLTAGE CAUTION**

CAUTION TYPE	CAUTION LAMP	CAUTION BUZZER	OVER-REV LIMITER (3000 r/min)
Over-revolution	Yes ①	No	Yes
Low oil pressure	Yes ② (①)	Yes	Yes
Overheat	Yes ③ (①)	Yes	Yes
Low battery voltage	Yes ④	Yes	No

MONITOR-TACHOMETER



① "REV LIMIT" lamp
② "OIL" lamp
③ "TEMP" lamp
④ "CHECK ENGINE" lamp

NOTE:
On the tiller handle model, alerts will be signaled by a sound sequence only from the buzzer contained in the tiller handle.

OVER-REVOLUTION CAUTION SYSTEM

CONDITION:

When the engine speed exceeds 6500 r/min, the ECM initiates intermittent fuel injection and ignition signals to provide a maximum engine speed of 6500 r/min (Over-revolution limiter).

ACTION:

Engine speed	Automatically reduced to approx. 3000 r/min by intermittent fuel injection and ignition signals.
Caution lamp	"REV-LIMIT" lamp lights continuously.
Caution buzzer	No buzzer sounds.

RESET:

Close the throttle to reduce the engine speed below approx. 3000 r/min for 4 seconds.

LOW OIL PRESSURE CAUTION SYSTEM

CONDITION:

Immediate activation of the system when the oil pressure switch turns “ON” due to an engine oil pressure drop below 1.0 kg/cm^2 (100 kPa, 14 psi).

ACTION:

Engine speed	Automatically reduced to approx. 3000 r/min by intermittent fuel injection and ignition signals if the system is activated at 3000 r/min or higher.
Caution lamp	“OIL” lamp lights continuously. “REV-LIMIT” lamp lights continuously during engine speed rev-limiter activation.
Caution buzzer	Sounds in a series of long (1.5 sec) beeps.

RESET:

Stop the engine and check the engine oil level. Refill the engine oil to the correct level if below the low oil mark.

If the engine oil level is correct, the following causes may be considered:

- Improper oil viscosity.
- Malfunctioning oil pressure switch.
- Clogged oil strainer or oil filter.
- Worn oil pump relief valve.
- Oil leakage from oil passage.
- Excessive wear / damage of oil pump.

NOTE:

The low oil pressure caution system is reset when the oil pressure is restored to over 1.0 kg/cm^2 with approx. 3000 r/min or less engine speed operation.

However, the engine must be stopped and checked immediately once the system is activated.

OVERHEAT CAUTION SYSTEM

CONDITION 1 (Maximum temperature)

Immediate activation of the system when:

- Cylinder temperature reaches 111°C.
- Exhaust manifold temperature reaches 101°C.

CONDITION 2 (Temperature rise vs Time)

Immediate activation of the system when:

- The average temperature difference during three consecutive 10 seconds measurement periods of the cylinder temperature sensor at engine speeds of 500 r/min or higher exceeds the limits as shown below.

Temperature range	Temperature difference
86 °C – 99 °C	Approx. 2.2 °C
99 °C –	Approx. 0.6 °C

- The average temperature difference during three consecutive 10 seconds measurement periods of the exhaust manifold temperature sensor at engine speeds of 500 r/min or higher exceeds the limits as shown below.

Temperature range	Temperature difference
80 °C – 95 °C	Approx. 9.6 °C
95 °C –	Approx. 1.4 °C

ACTION:

Engine speed	Automatically reduced to approx. 3000 r/min by intermittent fuel injection and ignition signals if the system is activated at 3000 r/min or higher.
Caution lamp	“TEMP” lamp lights continuously. “REV- LIMIT” lamp lights continuously during engine speed rev-limiter activation.
Caution buzzer	Sounds in a series of long (1.5 sec) beeps.

RESET:

Close the throttle to reduce the engine speed below approx. 3000 r/min.

When the cylinder temperature drops below the limits as shown below, the system resets. However, the system may be activated again unless the cause for overheat (such as insufficient water) is removed.

Caution cause	Reset temperature
Condition 1 (Maximum temperature)	Approx. 73 °C
Condition 2 (Temperature rise vs Time)	Approx. 65 °C

LOW BATTERY VOLTAGE CAUTION SYSTEM

CONDITION:

The system is activated when the battery voltage decreases to less than 9 volts for 30 seconds.

ACTION:

Engine speed	No engine speed limiter is activated.
Caution lamp	“CHECK ENGINE” lamp lights continuously.
Caution buzzer	Sounds in a series of long (1.5 sec) beeps.

RESET:

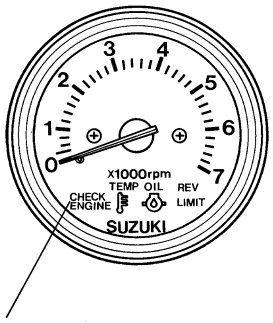
This caution system is automatically reset when the battery voltage increases to more than 9 volts. Refrain from using electrical equipments requiring high amperage such as hydraulic trim tabs, hydraulic jack plate, etc. after this caution is activated.

SELF-DIAGNOSTIC SYSTEM

The self-diagnostic system alerts the operator when an abnormality occurs in a signal from the sensor, switch, etc.
When the system is activated, the "CHECK ENGINE" lamp flashes (lights intermittently) according to each code pattern along with a buzzer sound.
When the engine is running, the buzzer sounds a series of short (0.2 sec.) beeps.
When the engine is not running, the buzzer sounds according to each code pattern, but not simultaneous with the lamp flash. The buzzer sound, activated by the self-diagnostic system, can be temporally canceled by pushing the ignition key in. (Remote control model only)

NOTE:
On the tiller handle model, alerts is signaled by a sound sequence only from the buzzer contained in the tiller handle.

MONITOR-TACHOMETER



"CHECK ENGINE" lamp

PRIORITY/CODE/PATTERN FOR SELF-DIAGNOSTIC SYSTEM OPERATION

PRIORITY	FAILED ITEM	CODE	LAMP FLASHING PATTERN	FAIL-SAFE SYSTEM ACTIVE
1	MAP sensor 1	3 – 4	on / off	YES
2	CKP sensor	4 – 2	on / off	YES
3	IAC valve / By-pass air screw adjustment	3 – 1	on / off	NO
4	CMP sensor	2 – 4	on / off	YES
5	CTP switch	2 – 2	on / off	NO
6	Cylinder temp. sensor	1 – 4	on / off	YES
7	IAT sensor	2 – 3	on / off	YES
8	MAP sensor 2 (Sensor hose etc.)	3 – 2	on / off	NO
9	Rectifier & regulator (Over-charging) **[**NOTE1**]**	1 – 1	on / off	NO
10	Exhaust manifold temp. sensor	1 – 5	on / off	YES
11	Fuel injector	4 – 3	on / off	NO

NOTE:

- *If more than two items fail at once, the self-diagnostic indication appears according to priority order. The indication repeats three times.*
- *If the failed item remains, the self-diagnostic indication appears again after turning the ignition switch "ON".*
- *After correcting failed item, the self-diagnostic indication appears until the ECM receives the proper signal with the engine running.*
- *For the cylinder temp. sensor, the exhaust manifold temp. sensor or the IAT sensor, the self-diagnostic indication will be canceled after corrective action by turning the ignition switch "ON".*
  (The ECM will require 10 – 20 seconds after turning the ignition switch "ON" to cancel the self-diagnostic indication.)

NOTE 1:

The self-diagnostic indication may be canceled by turning ignition switch "ON" because the ECM detects only battery voltage, not charging output. Under this condition the buzzer will not sound a 1-1 code.
However, if the rectifier & regulator have failed, the self-diagnostic indication will again appear after starting the engine.

CONDITION FOR SELF-DIAGNOSTIC SYSTEM OPERATION

FAILED ITEM	CONDITION
MAP sensor 1	• No signal (With engine running) • Receiving an out of range "37 – 860 mmHg (0.20 – 4.53 V)" signal (With engine running)
CKP sensor	• No signal from CKP sensor while receiving 3 signals from CMP sensor
IAC valve/By-pass air screw adjustment	• IAC valve operates at 90% duty or higher when CTP switch is "ON" [NOTE 1]
CMP sensor	• No signal from CMP sensor while receiving 544 signals from CKP sensor (Corresponded to 16 turns of crankshaft)
CTP switch	• Receiving "ON" signal when engine speed is 2500 r/min or higher and intake manifold pressure is 300 mmHg or higher
Cylinder temp. sensor	• No signal • Receiving an out of range "– 46 to +170 °C (0.10 – 4.63 V)" signal
IAT sensor	• No signal • Receiving an out of range "– 46 to +169 °C (0.04 – 4.46 V)" signal
MAP sensor 2 (Sensor hose etc.)	• Receiving unchanging signal regardless engine speed change [NOTE 2]
Rectifier & regulator (Over-charging)	• Receiving 16 volts or higher signal
Exhaust manifold temp. sensor	• No signal • Receiving an out of range "– 46 to +170 °C (0.10 – 4.63 V)" signal
Fuel injector	• No signal

NOTE 1:
This condition will be caused by IAC valve failure or incorrect by-pass air screw adjustment. If IAC valve is always closed or by-pass air is too low, the ECM controls the IAC valve duty to increase to maintain the idling/trolling speed specified.

NOTE 2:
This condition will be caused by disconnected, kinked or clogged MAP sensor hose or clogged inlet manifold.

FAIL-SAFE SYSTEM

The fail-safe system is closely related to the self-diagnostic system.
When an abnormality occurs in a sensor signal, the ECM ignores the out-of-range signal and assumes a pre-programmed value for the failed sensors.
This allows the engine to continue running under the fail-safe condition.

PRE-PROGRAMMED VALUE FOR FAIL-SAFE SYSTEM

FAILED ITEM	PRE-PROGRAMMED VALUE
MAP sensor 1	• 319 – 475 mmHg (Correspond to approx. 750 – 4000 r/min) **[**NOTE1**]**
CKP sensor	Based on signals from CMP sensor: • Ignition timing fixed at BTDC 5° • Normal sequential fuel injection
CMP sensor	Based on signals from CKP sensor: (a) Failed while engine running • Ignition timing fixed at BTDC 5° • Normal sequential fuel injection (b) Failed prior to engine start • Ignition timing fixed at BTDC 5° • 1 simultaneous injection for all cylinders per 2 crankshaft rotations
Cylinder temp. sensor	60 °C (140 °F)
IAT sensor	45 °C (113 °F)
Exhaust manifold temp. sensor	60 °C (140 °F)

NOTE:
There is no back-up system for the ECM itself. The engine will stop if it has failed.

NOTE 1:
This value will change according to the current engine speed.

OPERATING HOUR INDICATION SYSTEM (For remote control model)

When the ignition switch is initially turned “ON” (from “OFF”), the ECM tests the caution system by turning on all four lamps in the monitor-tachometer and sounding the caution buzzer for an initial two seconds.
For the next three seconds, the ECM indicates the total operating hours, using a combination of the tachometer needle and “REV-LIMIT” lamp flashing.

NOTE:
The total operating hours displayed are those of actual engine operation, not ignition switch “ON” time.

MONITOR-TACHOMETER

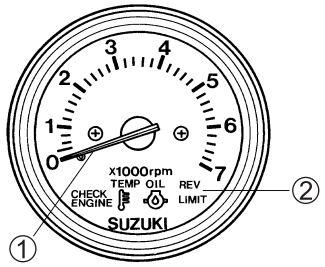


CHART OF TOTAL OPERATING HOURS INDICATION

Total operating hours	MONITOR-TACHOMETER	
	Needle ① indication	REV-LIMIT lamp ② flashing *
0 h – (49 h)	No	No
50 h	500 rpm	
60 h	600 rpm	
⋮	⋮	
540 h	5400 rpm	
550 h	500 rpm	1 time
560 h	600 rpm	
⋮	⋮	
1040 h	5400 rpm	
1050 h	500 rpm	2 times
⋮	⋮	
1540 h	5400 rpm	
1550 h	500 rpm	3 times
⋮	⋮	
2030 h	5300 rpm	
2040 h or over	5400 rpm	3 times

* : One flashing is corresponded to 500 hours.

OIL CHANGE REMINDER SYSTEM

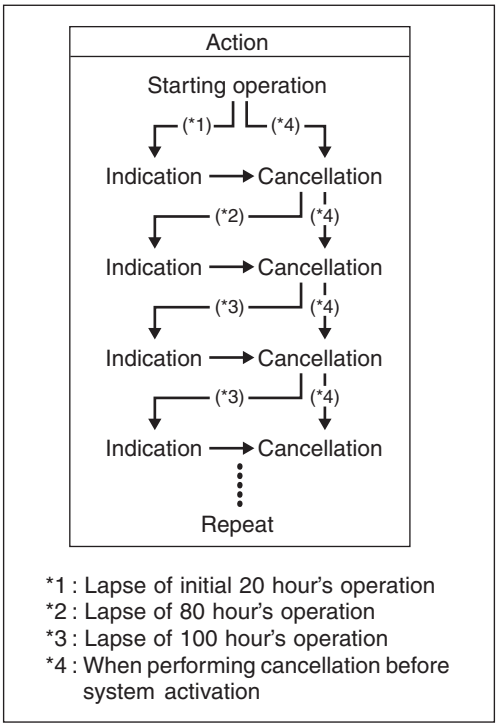
This system informs the operator of the time for replacing ENGINE OIL on the basis of the recommended maintenance schedule. When the total motor operating hours have reached the preprogrammed hours;

- On the tiller handle model, the buzzer will begin a series of double beeps (3 or 4 times).
- On the remote control model, the "OIL" lamp will flash, and the buzzer will begin a series of double beeps if the engine is not running (but ignition swith is ON).

The above mentioned indication will repeat until canceling system activation.

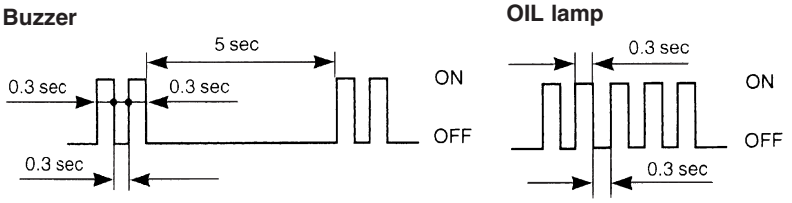
NOTE:

This system will activate up to 2100 hour's operation.

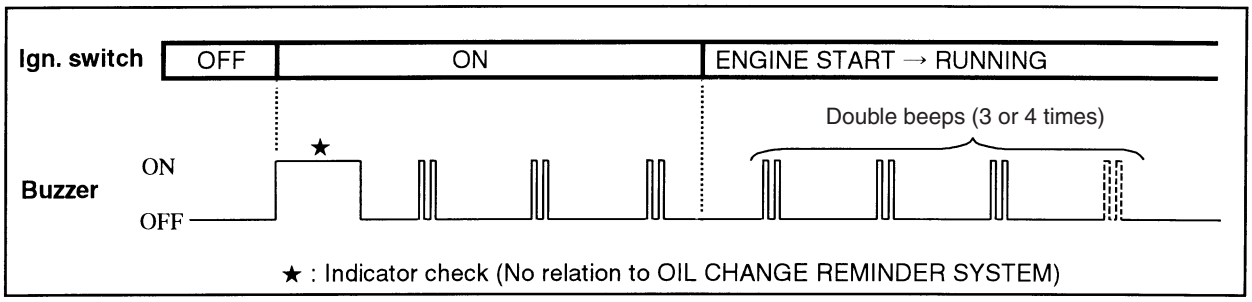


*1 : Lapse of initial 20 hour's operation
*2 : Lapse of 80 hour's operation
*3 : Lapse of 100 hour's operation
*4 : When performing cancellation before system activation

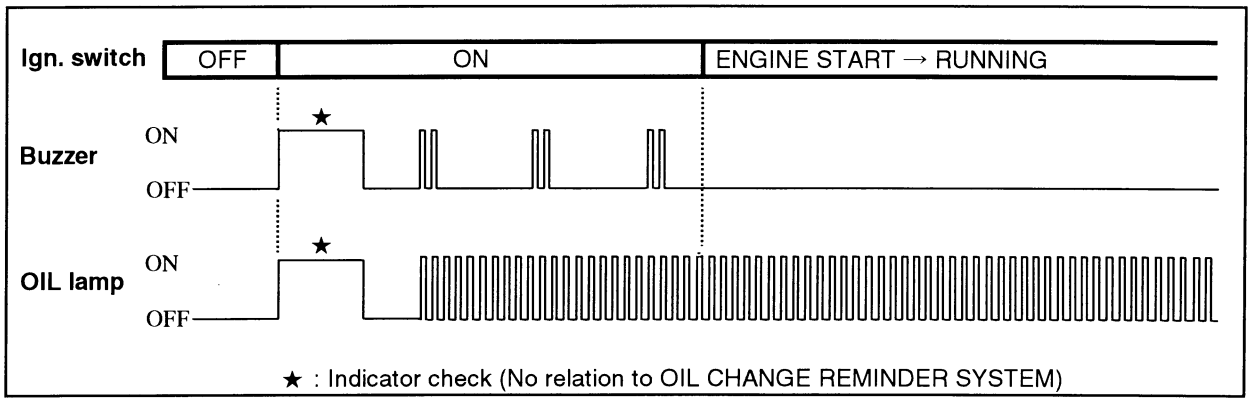
INDICATION OF SYSTEM ACTIVATION



Tiller Handle Model



Remote Control Model



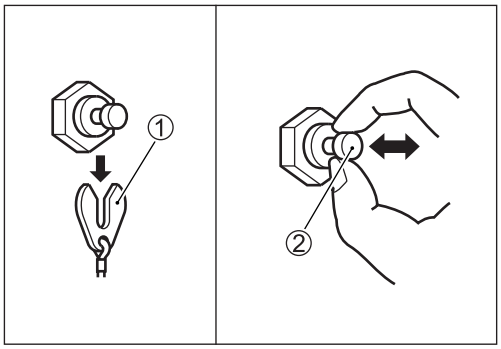
NOTE:

On the tiller handle model, the buzzer for system activation will first begin to sound when the engine is stopped (but ignition switch is ON) after reaching the preprogrammed hours.

CANCELLATION

Procedure

1. Turn the ignition key to the “ON” position.
2. Pull out the emergency stop switch plate ①.
3. Pull up the emergency stop switch knob ② three times in 10 seconds. A short beep will be heard if the cancellation is successfully finished.
4. Turn the ignition key to the “OFF” position.
5. Set the switch plate ① in the original position.



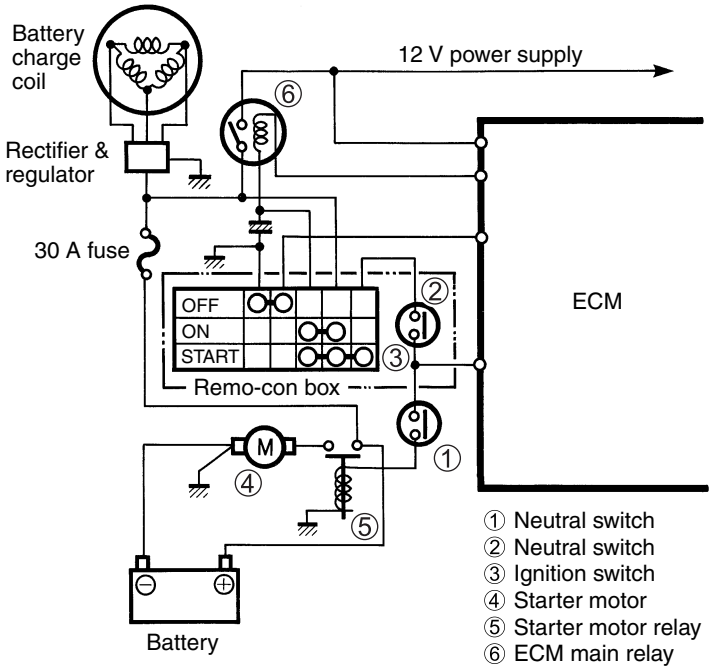
NOTE:

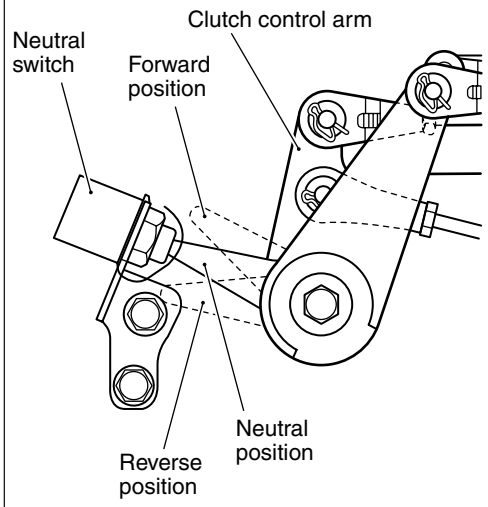
- *Canceling of the system activation is possible regardless of whether or not the engine oil has been replaced. Once the system has operated, however, Suzuki strongly recommends that the engine oil be replaced before canceling the system activation.*
- *Even if the engine oil has been replaced with the system not operating, it is still necessary to perform the cancellation.*

START-IN-GEAR PROTECTION SYSTEM

A switch to detect neutral gear position is located on the cylinder block (starboard side) and operated by the clutch control arm.
This ON/OFF type switch is “ON” in neutral and “OFF” in forward or reverse.
On starting the engine, the ECM detects the shift position using the neutral switch. When the neutral switch is “OFF”, the ECM does not provide injector operating signal.
This neutral switch is also used to regulate the starter motor circuit. The engine will not start, even by emergency rope, with the shift in the forward or reverse position.

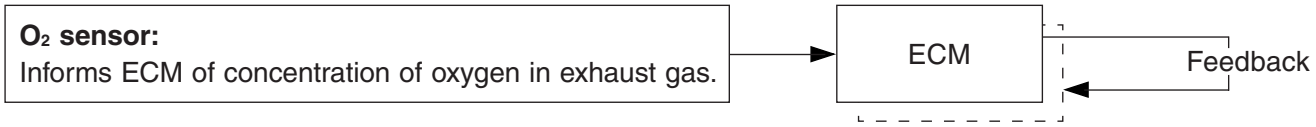
SHIFT POSITION	NEUTRAL SWITCH	OPERATION			
		Fuel injector	Ignition	Fuel pump	Starter motor
Neutral	ON	Yes	Yes	Yes	Yes
Forward / Reverse	OFF	No	Yes	Yes	No





O_2 FEEDBACK SYSTEM

After extended usage, the engine components may become deteriorated or worn out.
This might make the A/F (air / fuel mixture ratio) incorrect which could affect exhaust emissions. To correct the A/F, an O_2 sensor must be temporally installed in the exhaust manifold. This sensor is used to measure the concentration of oxygen in the exhaust gas at engine speed of 2000, 3000 and 4000 r/min.
The ECM uses the input data from the O_2 sensor to correct the compensation coefficient of the fuel injection duration map within the ECM itself.



NOTE:
See the "FUEL MIXTURE CHECK (O_2 FEEDBACK)" section on the page 2-21 for the procedure of the O_2 feedback operation.

INSPECTION
PRECAUTION ON SYSTEM INSPECTION

⚠ WARNING

To prevent any unexpected engine start, perform the following before proceeding with any CRANKING tests.
- **When performing tests not related to the fuel injector operation:**
  - **Disconnect all fuel injector wire connectors.**
- **When performing tests related to the fuel injector operation:**
  - **Relieve fuel pressure in line. (See the page 5-2.)**
  - **Disconnect the high pressure fuel pump wire connector located on the fuel vapor separator.**

CAUTION

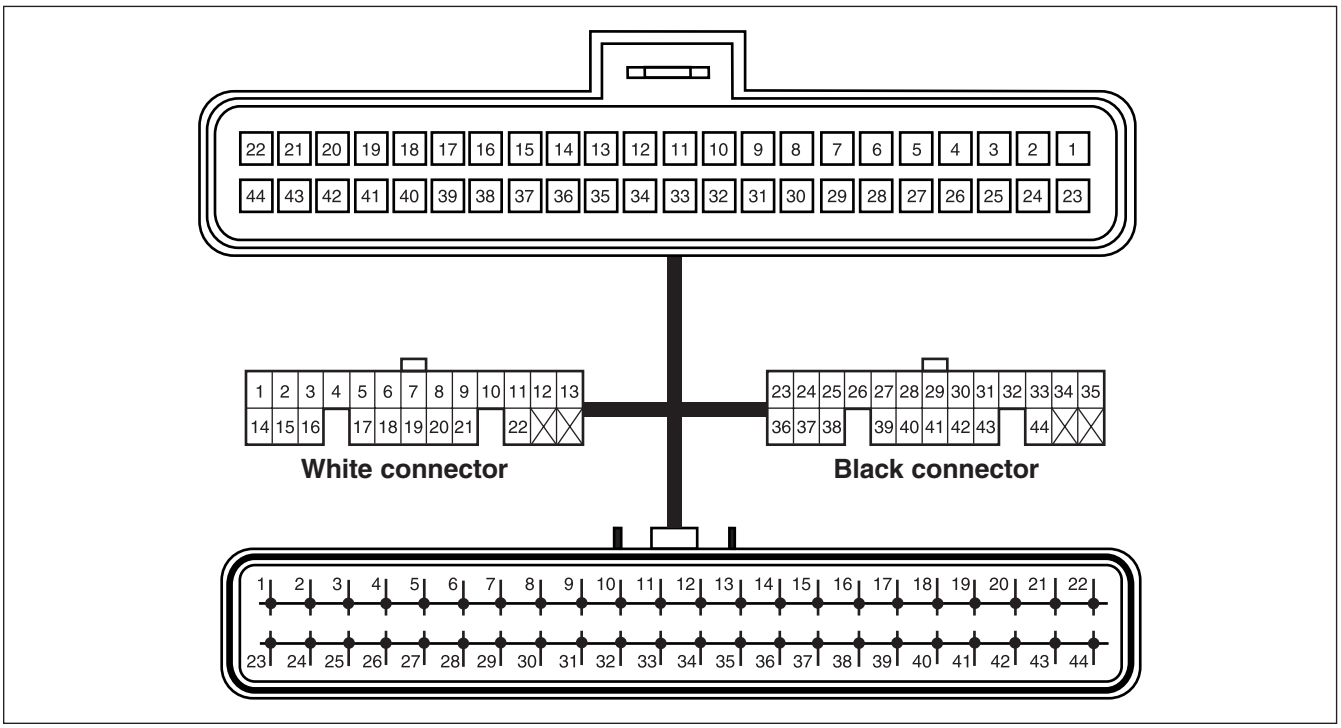
- **Always turn the ignition switch "OFF" and disconnect the battery cables when the wires are being disconnected or connected.**
- **Hold and pull the connector pieces when disconnecting. Do not pull the wires.**

NOTE:
- *Self-diagnostic codes will remain in the ECM memory even if the battery is disconnected.*
- *As each terminal voltage is affected by the battery voltage, use a full-charged battery.*
- *Make sure all ground points have good electrical contact.*
- *Make sure all wires / cables are securely connected.*

44-PIN TEST CORD

This test cord is used when checking the circuit for voltage, etc. and connected between the ECM and the wiring harness.
To measure, connect the tester probes to the relevant terminal of the test cord.

TOOL 09930-89950: 44-pin test cord



INSPECTION FOR ECM CIRCUIT VOLTAGE

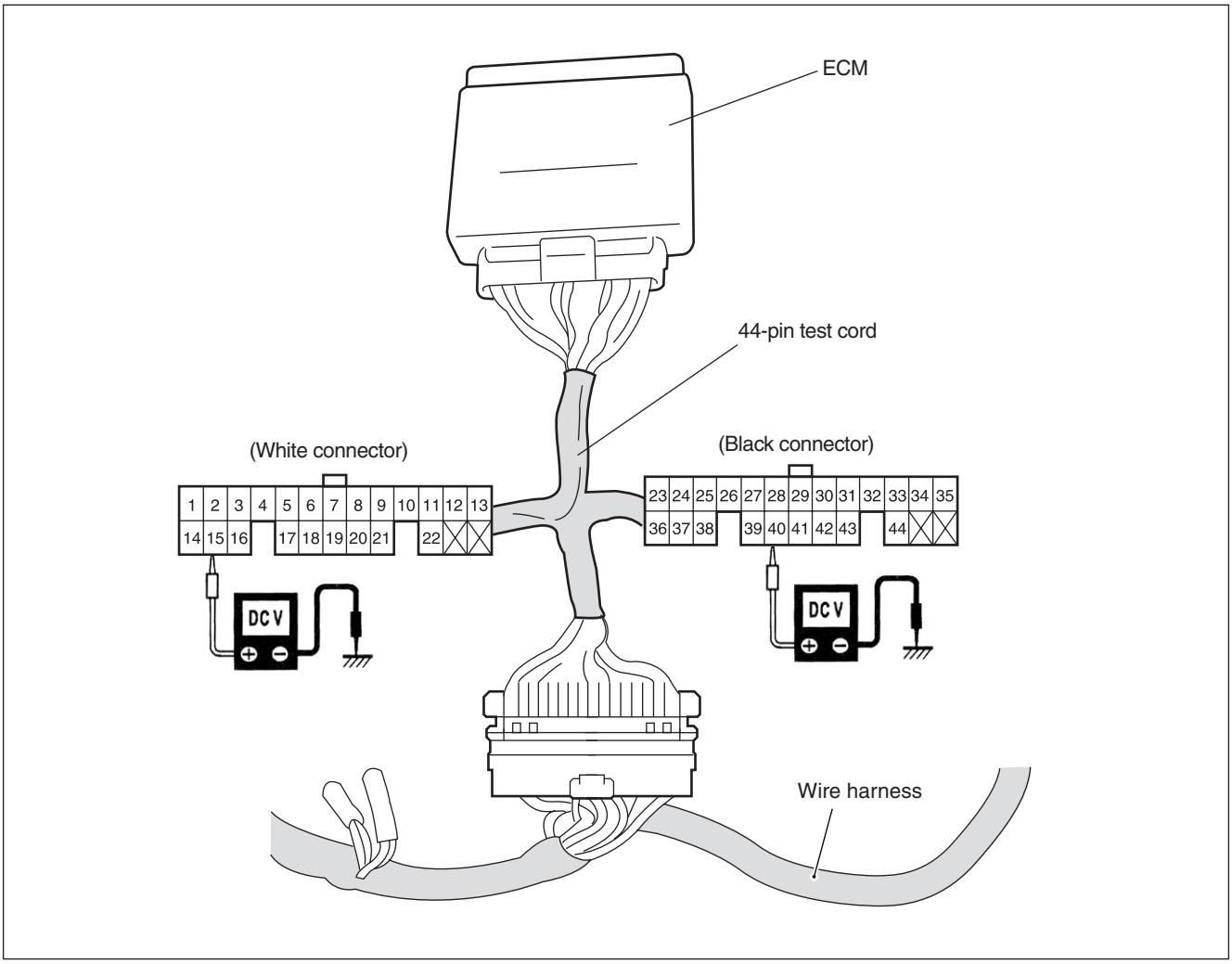
CAUTION

ECM cannot be bench checked. It is strictly prohibited to connect any tester (voltmeter or ohmmeter) to an ECM separated from the engine wiring harness.

TOOL 09930-89950: 44-pin test cord
09930-99320: Digital tester

Tester range: ⎓ V (DC voltage)

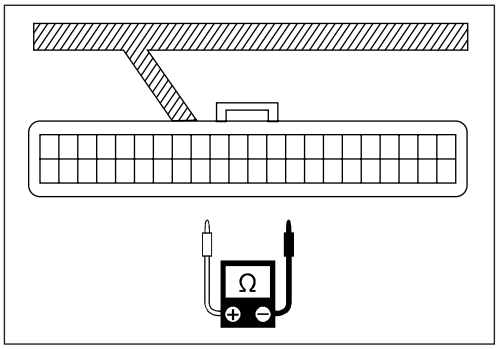
1. Connect the 44-pin test cord between the ECM and the wire harness as shown in the figure.
2. Turn the ignition switch ON.
3. Connect the tester probe ⊖ (Black) to the body ground, and measure the voltage according to the "CIRCUIT VOLTAGE TABLE".



CIRCUIT VOLTAGE TABLE

TERMINAL NUMBER	CIRCUIT	STANDARD VOLTAGE	CONDITION / REMARKS
1	–	–	–
2	Emergency stop switch	Approx. 5V	Ignition switch ON, plate IN
		Approx. 0V	Ignition switch ON, plate OUT
3	Buzzer cancel	Approx. 12V	Ignition switch ON, key pushed
		Approx. 0V	Ignition switch ON, key not pushed
4	Tachometer	–	–
5	Neutral switch / Engine start signal	Approx. 0V	Ignition switch ON, shift into NEUTRAL
		Approx. 2.5V	Ignition swich ON, shift into FORWARD or REVERSE
		6 – 12V	While engine cranking
6	–	–	–
7	Exhaust manifold temperature sensor	0.10 – 4.63V	Ignition switch ON
8	–	–	–
9	Cylinder temperature sensor	0.10 – 4.63V	Ignition switch ON
10	Ground for ECM	–	–
11	Ground for sensors	–	–
12	OIL lamp	–	–
13	Ground for ECM main relay	–	–
14	–	–	–
15	CMP sensor	–	–
16	PC communication	–	–
17	TEMP lamp	–	–
18	IAC valve solenoid (–)	Approx. 12V	Ignition switch ON
19	–	–	–
20	Ground for power source	–	–
21	–	–	–
22	No. 4 Fuel injector (–)	Approx. 12V	Ignition switch ON
23	Oil pressure switch	Approx. 5V	While engine running
		Approx. 0V	Other than above (Ignition switch ON)
24	CTP switch	Approx. 5V	Ignition switch ON, throttle not fully closed
		Approx. 0V	Ignition switch ON, throttle fully closed
25	REV-LIMIT lamp	–	–
26	CHECK ENGINE lamp	–	–
27	Buzzer	–	–
28	–	–	–
29	MAP sensor	0.20 – 4.53V	Ignition switch ON
30	ECM power source	Approx. 12V	Ignition switch ON
31	IAT sensor	0.04 – 4.46V	Ignition switch ON
32	Ground for ECM	–	–
33	CKP sensor	Approx. 0.3V or 5V	Ignition switch ON
34	O_2 feedback / PC communication	–	–
35	Power source for MAP sensor	Approx. 5V	Ignition switch ON
36	PC communication	–	–
37	Fuel pump (–)	Approx. 0V	For 3 sec. after ignition switch ON
			While engine running
		Approx. 12V	Other than above (Ignition switch ON)
38	No. 3 Fuel injector (–)	Approx. 12V	Ignition switch ON
39	No. 2 Fuel injector (–)	Approx. 12V	Ignition switch ON
40	No. 1 Fuel injector (–)	Approx. 12V	Ignition switch ON
41	Resistor	–	–
42	Ground for power source	–	–
43	No. 2 & 3 Ignition (–)	Approx. 12V	Ignition switch ON
44	No. 1 & 4 Ignition (–)	Approx. 12V	Ignition switch ON

INSPECTION FOR RESISTANCE



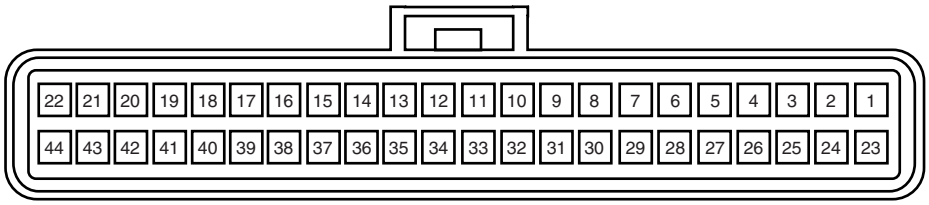
09930-99320: Digital tester

Tester range: Ω (Resistance)

NOTE:
Make sure that the ignition switch is always OFF when measuring resistance.

1. Disconnect the battery cables from the battery.
2. Disconnect the wire harness from the ECM.
3. Connect the tester probes to the terminal of the wire harness side, and measure resistance according to the "RESISTANCE TABLE".

TERMINAL LAYOUT OF WIRE HARNESS CONNECTOR

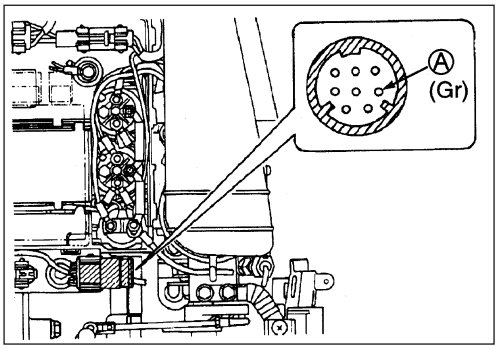


RESISTANCE TABLE

ITEM	TERMINAL NO. FOR TESTER PROBE CONNECTION	STANDARD RESISTANCE (at 20°C)
CMP sensor	15 to 11	168 – 252 Ω
Ignition coil No.1 & 4 (Primary)	44 to 30	1.9 – 2.5 Ω
Ignition coil No.2 & 3 (Primary)	43 to 30	
Fuel injector No.1	40 to 30	11.0 – 16.5 Ω
Fuel injector No.2	39 to 30	
Fuel injector No.3	38 to 30	
Fuel injector No.4	22 to 30	
IAC valve	18 to 30	4.8 – 7.2 Ω
IAT sensor	31 to 11	0°C (32°F) : 5.3 – 6.6 kΩ 25°C (77°F) : 1.8 – 2.3 kΩ 50°C (122°F) : 0.73 – 0.96 kΩ 75°C (135°F) : 0.33 – 0.45 kΩ (Thermistor characteristic)
Cylinder temperature sensor	9 to 11	
Exhaust manifold temp. sensor	7 to 11	
ECM main relay	13 to Terminal Ⓐ [NOTE 1]	145 – 190 Ω
Starter motor relay	5 to GND [NOTE 2]	3.5 – 5.1 Ω

NOTE 1:
Disconnect the remote control wire harness, and connect the tester probe to the terminal Ⓐ (Gray wire).

NOTE 2:
Measure resistance with the shift in the NEUTRAL position.

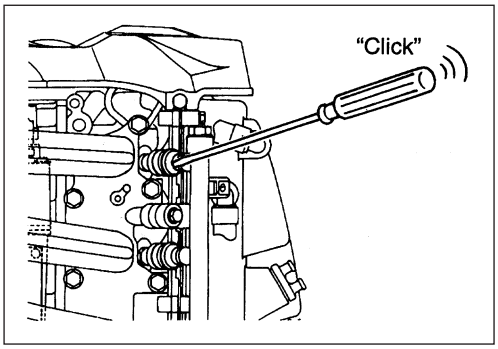


COMPONENT INSPECTIONS

FUEL INJECTOR OPERATING SOUND (CRANKING)

1. Touch a sound scope or long blade screw driver to the fuel injector body as shown.
2. Crank the engine and check for injector operating sound.

Injector operating sound: "Click"



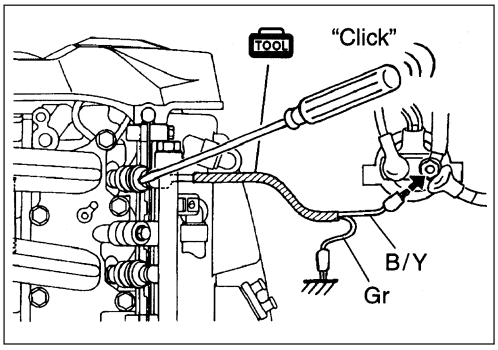
FUEL INJECTOR OPERATING SOUND (INDIVIDUAL)

1. Disconnect the fuel injector wire, and connect the test cord.

TOOL 09930-89260: Injector test cord Ⓐ

2. Connect the Gray wire to the body ground.
3. Momentarily touch the Black/Yellow wire to the starter motor relay right terminal (connected to the battery positive ⊕ terminal), and check for injector operating sound.

Injector operating sound: "Click"



CAUTION

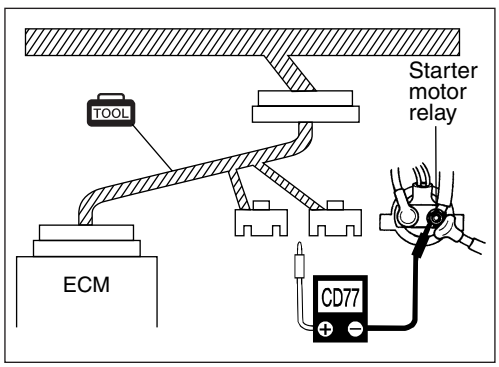
Connecting the fuel injector to the battery positive for more than a few seconds may cause injector overheating and possible injector solenoid failure.

FUEL INJECTOR OPERATING SIGNAL

TOOL 09930-89950: 44-pin test cord

CD77 Peak voltmeter Stevens CD-77
Tester range: NEG50

1. Connect the test cord as shown, then turn the ignition switch ON.
2. Connect the tester probe ⊖ (Black) to the starter motor relay right terminal (connected to the battery positive ⊕ terminal) as shown.

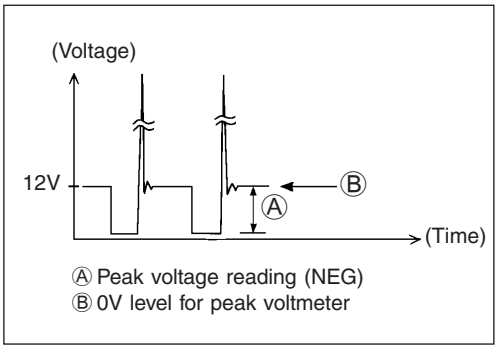


3. Connect the tester probe ⊕ (Red) to each terminal.

Injector	Terminal No.
No.1	40
No.2	39
No.3	38
No.4	22

4. Crank the engine and measure voltage.

Fuel injector operating signal: 6 – 10 V

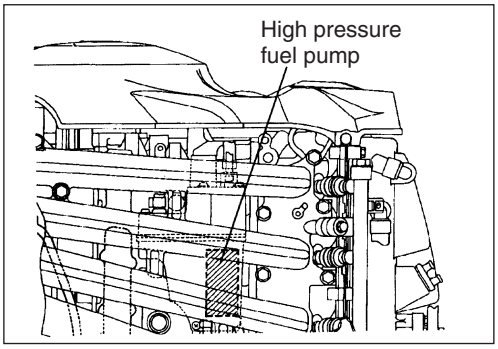


FUEL PUMP 3 SEC. OPERATING SOUND

Turn the ignition switch ON and check for fuel pump operating sound.

Fuel pump operating sound:
Sounds for approx. 3 seconds only

NOTE:
Fuel pump operating sound is low because the pump is in the fuel vapor separator. If you cannot hear clearly, use a sound scope or long blade screw driver.



IGNITION COIL OPERATING SIGNAL

09930-89950: 44-pin test cord

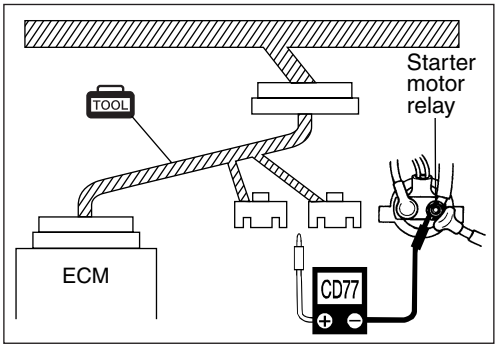
Peak voltmeter Stevens CD-77
Tester range: NEG50

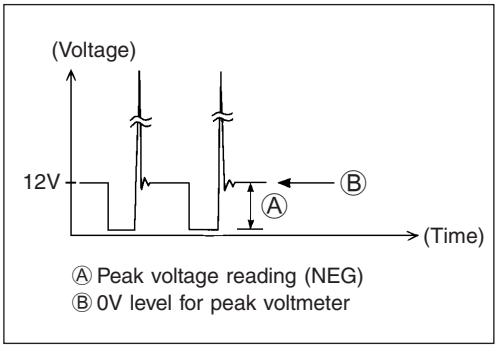
1. Connect the test cords as shown, then turn the ignition switch ON.
2. Connect the tester probe ⊖ (Black) to the starter motor relay right terminal (connected to the battery positive ⊕ terminal) as shown.
3. Connect the tester probe ⊕ (Red) to each terminal.

Ignition coil	Terminal No.
No.1 & 4	44
No.2 & 3	43

4. Crank the engine and measure voltage.

Ignition coil operating signal: 6 – 10 V





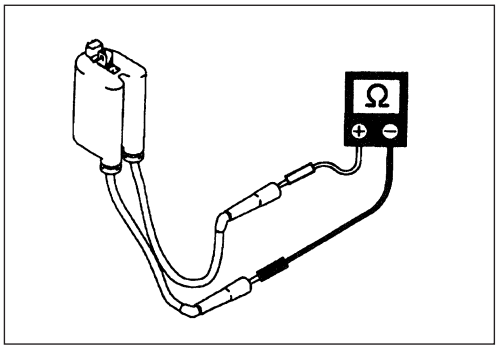
IGNITION SECONDARY COIL RESISTANCE

TOOL 09930-99320: Digital tester

Tester range: Ω (Resistance)

1. Disconnect the spark plug cap from the spark plug.
2. Measure resistance between both spark plug caps as shown.

Ignition secondary coil resistance:
NO. 2&3 15 – 26 kΩ
NO. 1&4 16 – 28 kΩ



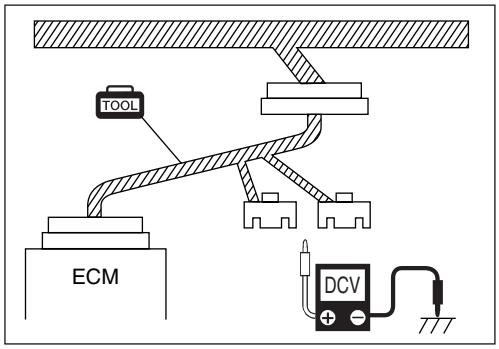
CKP SENSOR SIGNAL

TOOL 09930-89950: 44-pin test cord
09930-99320: Digital tester

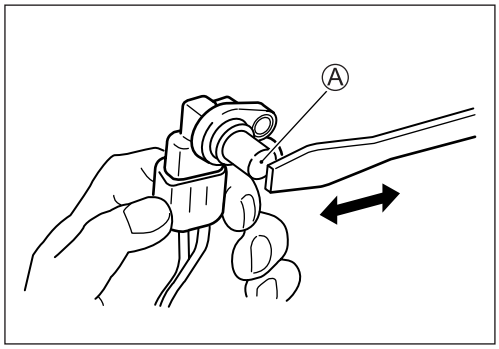
Taster range: ⎓ V (DC voltage)

1. Remove the CMP sensor from the engine.
2. Connect the test cord as shown, then turn the ignition switch ON.
3. Connect the tester probe ⊕ (Red) to the terminal "33".
4. Connect the tester probe ⊖ (Black) to the terminal "11" (or body ground).
5. Measure voltage when steel tip of a screwdriver is brought near and then pulled away from the sensor tip Ⓐ.

CKP sensor signal: Approx. 0.3 V or 5 V



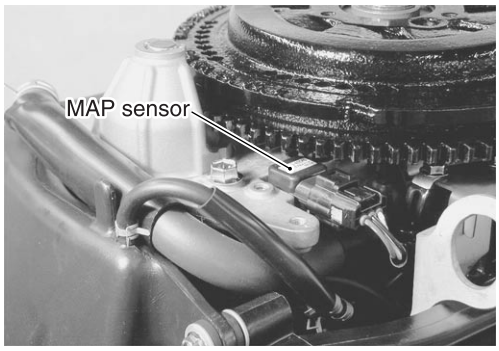
NOTE:
Two signal voltages mentioned above (0.3 V or 5 V) will change by repeating movement of the screwdriver.



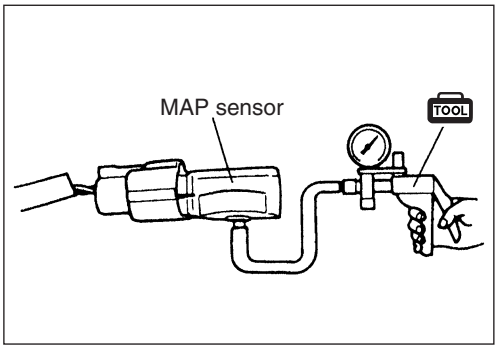
MAP SENSOR OUTPUT VOLTAGE CHANGE

09917-47011: Vaccum pump gauge
09930-89950: 44-pin test cord
09930-99320: Digital tester

Tester range: ⎓ V (DC voltage)



1. Disconnect the MAP sensor hose from the intake manifold (surge tank) side.
2. Connect the gauge to the MAP sensor hose end as shown.
3. While applying negative pressure to the MAP sensor, measure the "29" terminal voltage. (See the page 3-36 and 3-37.)



MAP sensor output voltage change:

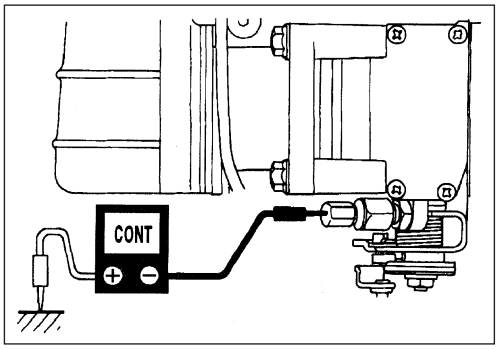
Negative pressure kPa (kg/cm², mmHg)	0 (0, 0)	40 (0.4, 300)	80 (0.8, 600)
"29" terminal voltage (V)	4.00	2.42	0.84

(at 1013 hPa barometric pressure)

CTP SWITCH

09930-99320: Digital tester

Tester range: (Continuity)

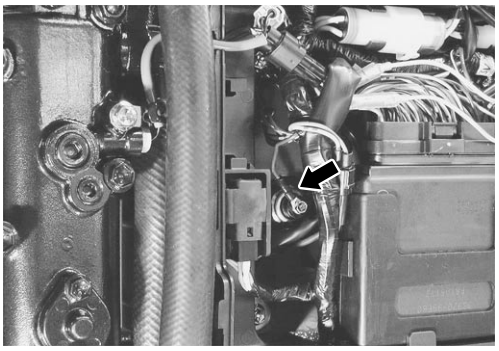


1. Disconnect the CTP switch wire.
2. Inspect continuity between the CTP switch terminal and the body ground.

CTP switch function:

Throttle position	Continuity
Fully closed (switch contact in)	Yes
Not fully closed (switch contact out)	No

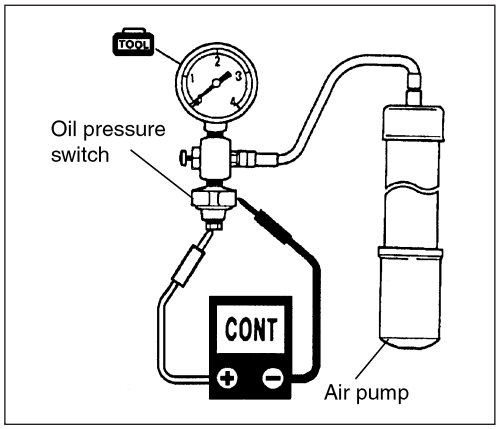
OIL PRESSURE SWITCH



09940-44121 : Air pressure gauge
09930-99320 : Digital tester
: Air pump

Tester range: (Continuity)

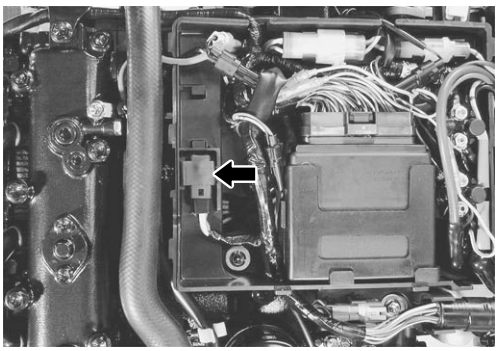
1. Remove the oil pressure switch (See the page 3-53).
2. Connect the gauge and an air pump as shown.
3. While applying pressure to the oil pressure switch, inspect continuity.



Oil pressure switch function:

Pressure kPa (kg/cm²)	Continuity
Less than 70 – 130 (0.7 – 1.3)	Yes
70 – 130 (0.7 – 1.3) or over	No

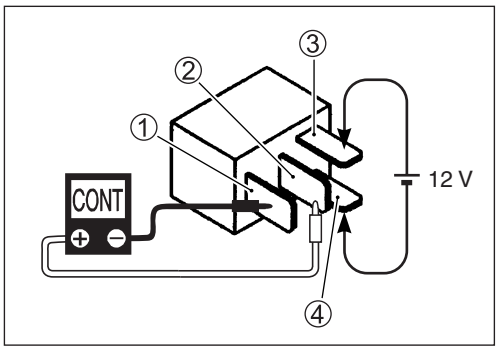
ECM MAIN RELAY



09930-99320: Digital tester

Tester range: (Continuity)

1. Disconnect the ECM main relay from the wire.
2. Inspect continuity between the terminal ① and ② each time 12 V is applied. Connect the positive ⊕ side to the terminal ④, and the negative ⊖ side to the terminal ③.



ECM main relay function:

12 V power	Continuity
Applied	Yes
Not applied	No

CAUTION

Be careful not to touch 12 V power supply wires to each other or with the other terminals.

TROUBLESHOOTING

⚠ WARNING

Before starting troubleshooting, read and follow the "PRECAUTION ON SYSTEM INSPECTION" section on the page 3-36.

In this section, troubleshooting procedures are based on the assumption that "low pressure fuel system" and "mechanical components (power unit, lower unit, etc.)" are normal.

NOTE:
For troubleshooting of "Starter motor will not run", see the page 4-6.

CHART1: SELF-DIAGNOSTIC CODE "3-4"

START

< Ignition switch "ON" >
Check "35" terminal voltage.
Is result OK? (See page 3-38.)

NO → ECM failure

YES ↓

< Ignition switch "ON" >
Check "29" terminal voltage.
Is result OK? (See page 3-38.)

NO → MAP sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

CHART2: SELF-DIAGNOSTIC CODE "4-2"

START

< Ignition switch "OFF" >
Check CKP sensor signal.
Is result OK? (See page 3-42.)

NO → CKP sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

NOTE:
- *It will be possible to start the engine if the CKP sensor has failed.*

CHART3: SELF-DIAGNOSTIC CODE “3-1”

START

< Ignition switch “OFF” >
Check IAC valve resistance.
Is result OK? (See page 3-39.)

NO → IAC valve failure

YES ↓

< Ignition switch “ON” >
Check “18” terminal voltage.
Is result OK? (See page 3-38.)

NO → ECM failure

YES ↓

Possible cause:
- Incorrect by-pass air screw adjustment
- IAC valve failure (mechanical)
- IAC passage failure (clogged hose, etc.)
- ECM failure
- Wire continuity/connection failure

CHART4: SELF-DIAGNOSTIC CODE “2-4”

START

< Ignition switch “ON”/Cranking >
Check CMP sensor resistance.
Is result OK? (See page 3-39.)

NO → CMP sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

NOTE:
It will be possible to start the engine if the CMP sensor has failed.

CHART5: SELF-DIAGNOSTIC CODE “2-2”

START

< Ignition switch “ON” >
Check “24” terminal voltage.
Is result OK? (See page 3-38.)

NO → CTP switch failure

[NOTE1]

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

NOTE1:
In this case, the CTP switch will be in “always ON” condition. (“24” terminal voltage will be 0 V always regardless throttle position.)

CHART6: SELF-DIAGNOSTIC CODE “1-4”

START

< Ignition switch “OFF” >
Check cylinder temp. sensor resistance.
Is result OK? (See page 3-39.)

NO → Cylinder temp. sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

CHART 7: SELF-DIAGNOSTIC CODE “2-3”

START

< Ignition switch “OFF” >
Check IAT sensor resistance.
Is result OK? (See page 3-39.)

NO → IAT sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

CHART8: SELF-DIAGNOSTIC CODE “3-2”

START

< Individual check >
Check MAP sensor hose is in good condition/connection.
Is result OK?

NO → MAP sensor hose failure

YES ↓

< Ignition switch “ON” >
Check MAP sensor output voltage change.
Is result OK? (See page 3-43.)

NO → MAP sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

CHART9: SELF-DIAGNOSTIC CODE “1-1”

START

< Individual check >
Check rectifier & regulator resistance.
[NOTE1**]**
Is result OK?

NO → Rectifier & regulator failure

YES ↓

< Engine running >
Check “30” terminal voltage at idle speed. (See page 3-38.)
Is result 16 V or over?

YES → Rectifier & regulator failure

NO ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

NOTE:
This self-diagnostic code indication may be canceled by turning the ignition switch ON because the ECM detects battery voltage.

NOTE1:
It is difficult to check the rectifier & regulator completely. Before replacing with new one, check if its ground point has good electrical contact.

CHART10: SELF-DIAGNOSTIC CODE “1-5”

START

< Ignition switch “OFF” >
Check exhaust manifold temp. sensor resistance.
Is result OK? (See page 3-39.)

NO → Exhaust manifold temp. sensor failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

CHART11: SELF-DIAGNOSTIC CODE “4-3”

START

< Ignition switch “OFF” >
Check fuel injector resistance.
Is result OK? (See page 3-39.)

NO → Fuel injector failure

YES ↓

Possible cause:
- ECM failure
- Wire continuity/connection failure

CHART12: ENGINE CRANKED, BUT NOT START (OR STOPS SHORTLY AFTER STARTING)

Before starting this troubleshooting, make sure that:
- **There is no self-diagnostic code indication.**
- **Emergency stop switch plate is set in place.**

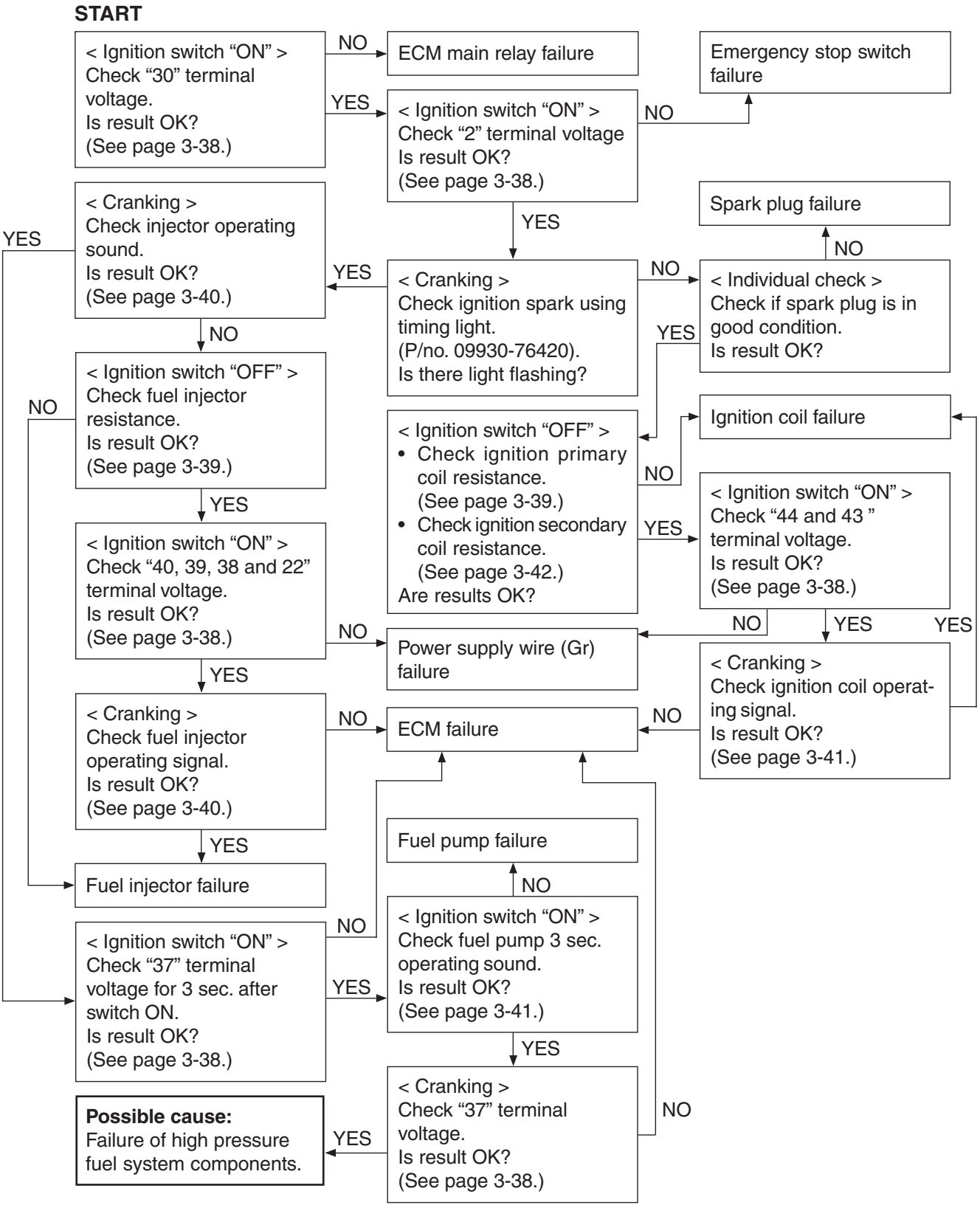
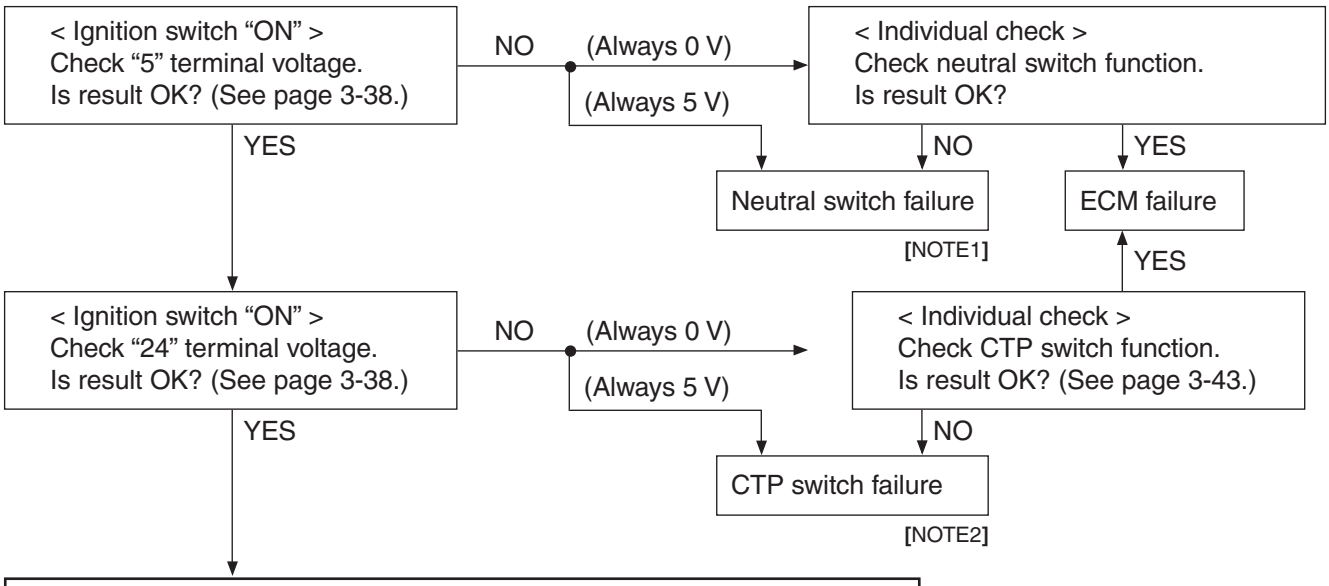


CHART13: UNSTABLE IDLING/TROLLING (OR ENGINE TENDS TO STALL)

Before starting this troubleshooting, make sure that:
- **There is no self-diagnostic code indication.**

START



Possible cause:
- Incorrect by-pass air screw adjustment **[**NOTE3**]**
- IAC valve failure **[**NOTE3**]**
- IAC passage failure (clogged hose, etc.) **[**NOTE3**]**
- Spark plug failure
- Ignition coil failure
- ECM failure
- Wire continuity/connection failure
- Failure of high pressure fuel system components:
  - Fuel injector (clog, stuck valve, etc.)
  - Fuel pressure regulator (incorrect regulated pressure, etc.)
  - Fuel pump (clogged suction filter, leakage in tank, etc.)
  - Fuel filter (clog, etc.)
  - Hose (clog, kink, leakage, etc.)

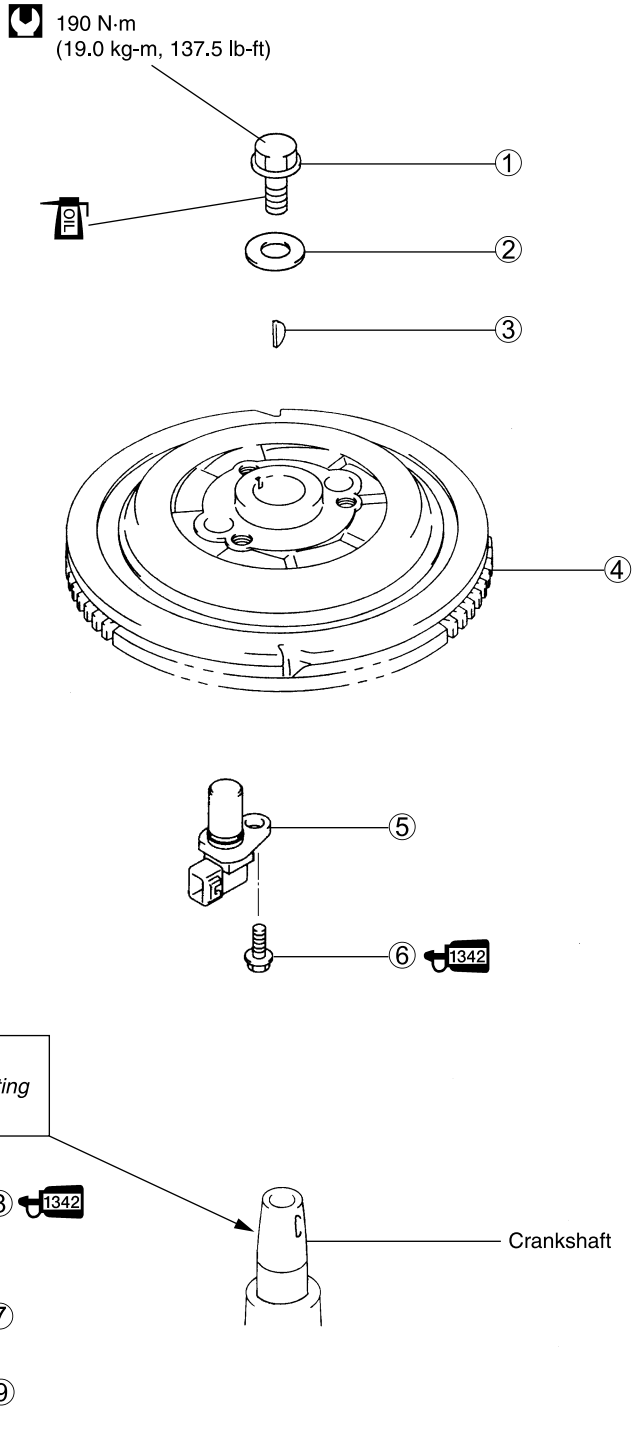
NOTE1:
If the neutral switch has failed (while engine running), the engine will tend to stall when shifting into gear.
If the neutral switch has failed as "always ON", the engine speed is limited to 3000 r/min by intermittent fuel injection and ignition timing is fixed at BTDC 9°.
If the neutral switch has failed as "always OFF", the engine can not cranked.

NOTE2:
If the CTP switch has failed, the engine will tend to stall when decelerating.

NOTE3:
- *The self-diagnostic code "3-1" may not be indicated because the IAC valve condition depends on the ECM control. (See the page 3-29.)*
- *If the IAC valve has failed, "Fast-idle function (warm-up mode)" won't operate.*

REMOVAL/INSTALLATION
FLYWHEEL/CKP SENSOR/CMP SENSOR

① **Flywheel bolt (1)**
② **Washer (1)**
③ **Key (1)**
④ **Flywheel magneto (1)**
⑤ **CKP sensor (1)**
⑥ **Bolt (1)**
⑦ **CMP sensor (1)**
⑧ **Screw (2)**
⑨ **Spacer (1)**



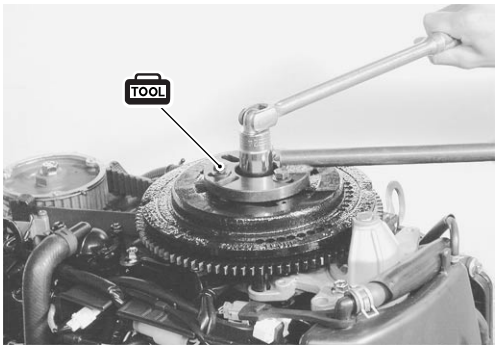
NOTE:
Clean flywheel and crankshaft mating surfaces with cleaning solvent.

TOOL **09930-48720: Flywheel holder**
09930-39411: Flywheel remover
09930-39420: Flywheel remover bolt

REMOVAL

1. Remove the flywheel cover.
2. Loosen the flywheel bolt by 2 – 3 turns.

TOOL 09930-48720: Flywheel holder

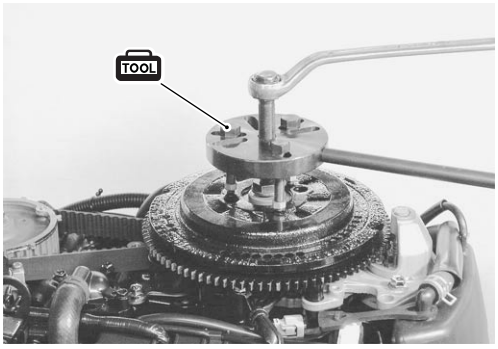


NOTE:

Do not remove the flywheel bolt from the crankcase before unfastening flywheel using the bolts.

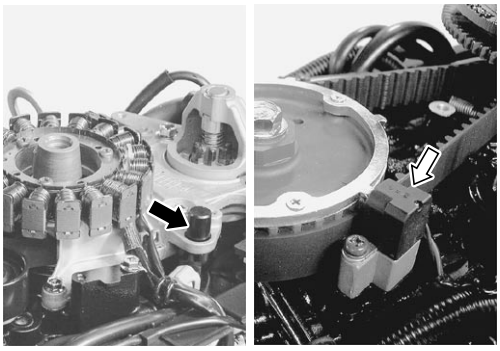
3. Unfasten the flywheel from the crankshaft.

TOOL 09930-39411: Flywheel remover
09930-39420: Flywheel remover bolt



4. Remove the flywheel bolt and the flywheel.

5. Disconnect the CKP sensor wire and the CMP sensor wire.
6. Remove the bolt and the CKP sensor.
7. Remove the two screws and the CMP sensor.



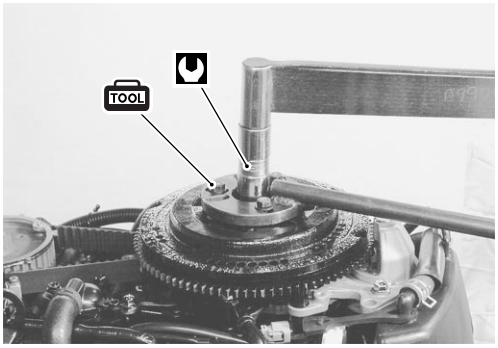
INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

Flywheel

- Clean the flywheel and crankshaft mating surfaces with cleaning solvent.
- Apply engine oil lightly to the flywheel bolt before installing.

TOOL 09930-48720: Flywheel holder



Flywheel bolt: 190 N·m (19.0 kg-m, 137.5 lb-ft)

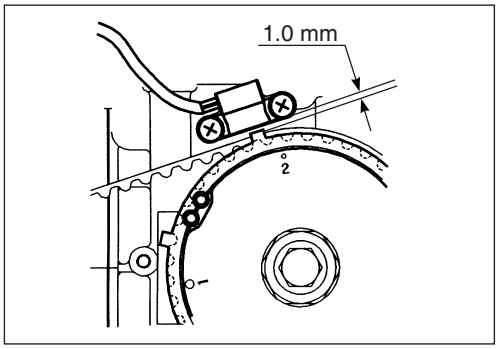
CKP sensor / CMP sensor

- Apply the thread lock to the sensor securing screws / bolt.

1342 99000-32050: Thread Lock 1342

- Install CMP sensor with a gap of 1.0 mm between the sensor and the reluctor bar (trigger vane) on the cam pulley.

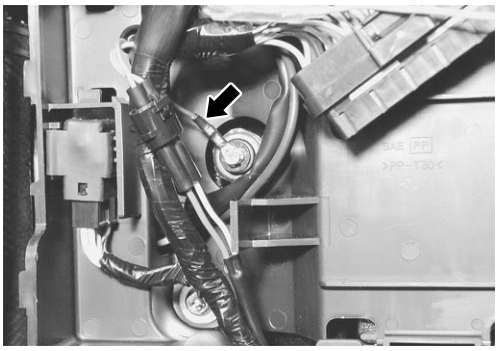
TOOL 09900-20803: Thickness gauge



OIL PRESSURE SWITCH

REMOVAL

1. Remove the ECM from the electric parts holder.
2. Loosen the bolt and disconnect the switch wire (Blue).
3. Remove the oil pressure switch from the cylinder block.

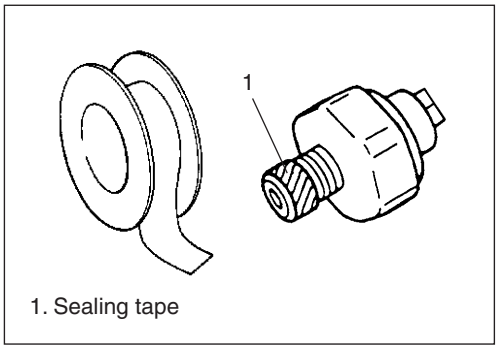


INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

Oil pressure switch: 13 N·m (1.3 kg-m, 9.5 lb-ft)

NOTE:
Prior to installation, wrap the oil pressure switch thread with sealing tape. If the sealing tape edge is bulged out from the thread, cut off the excess.



1. Sealing tape

ELECTRICAL

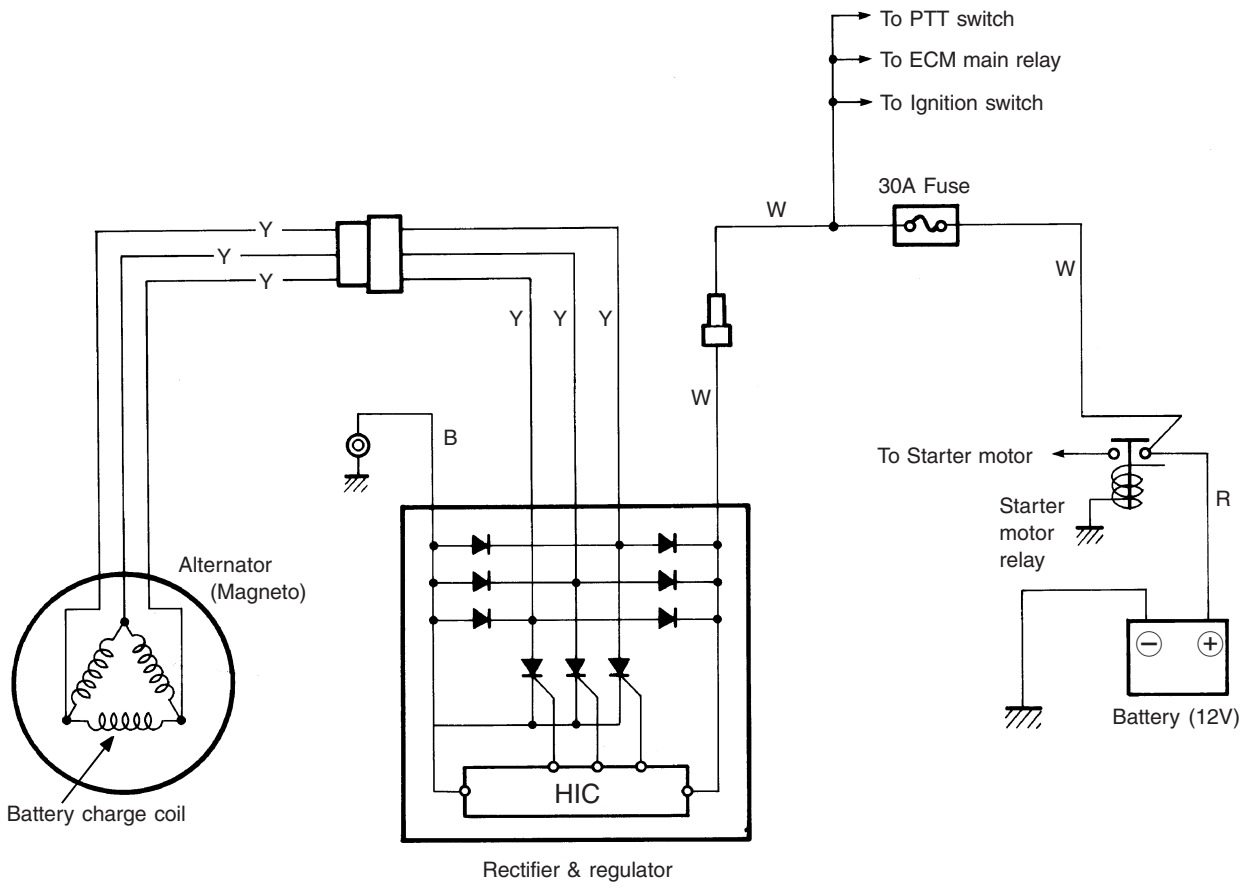
CONTENTS

BATTERY CHARGING SYSTEM

OUTLINE

The battery charging system circuit is illustrated below.
It is composed of the battery charge coil, the rectifier & regulator and the battery.
The three phase AC current generated from the battery charge coil is converted by the rectifier & regulator into regulated DC current which is used to charge the battery.

OUTPUT	300 W
REGULATED VOLTAGE	14.5 – 15.5 V

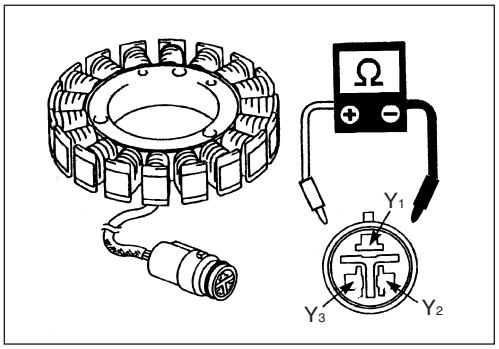


INSPECTION

BATTERY CHARGE COIL

09930-99320: Digital tester

Tester range: Ω (Resistance)



1. Disconnect the battery charge coil wire from the rectifier & regulator.
2. Measure resistance between the terminals for all combinations.

Battery charge coil resistance:

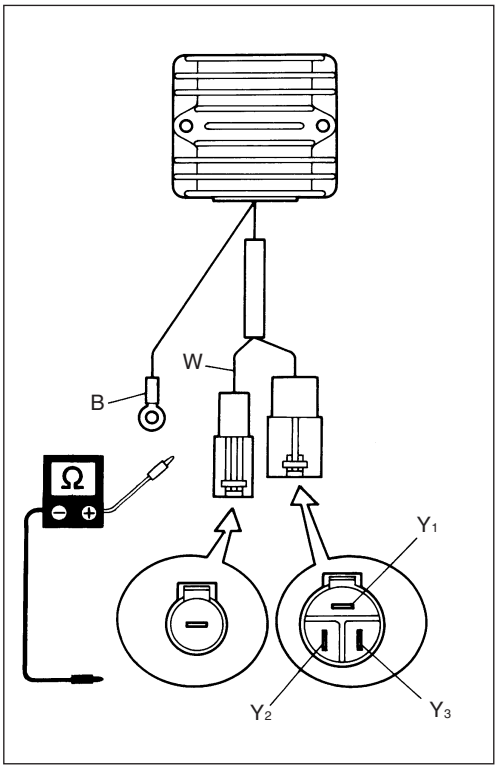
Terminal for tester probe connection	Resistance
Yellow1 to Yellow2	0.3 – 0.5 Ω
Yellow1 to Yellow3	0.3 – 0.5 Ω
Yellow2 to Yellow3	0.3 – 0.5 Ω

If the measurement is out of the specification, replace the battery charge coil.

RECTIFIER & REGULATOR

09930-99320: Digital tester

Tester range: Ω (Resistance)



1. Disconnect all wires of the rectifier & regulator.
2. Measure resistance between the terminals for all combinations.

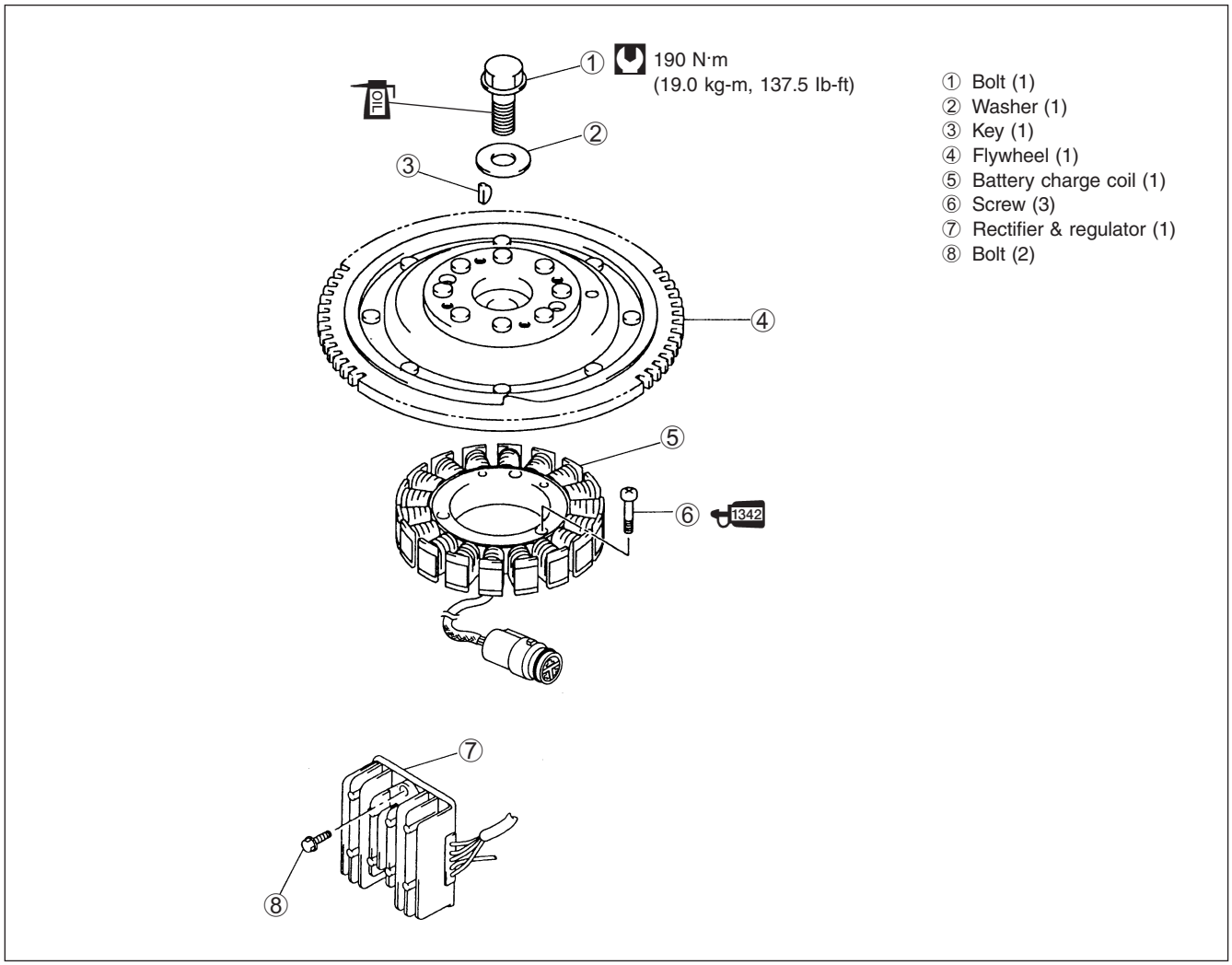
NOTE:
The values given below are for the SUZUKI digital tester.
As thyristors, diodes, etc. are used inside this rectifier & regulator, the resistance values will differ when an ohmmeter other than the SUZUKI digital tester is used.

Rectifier & regulator resistance:

		Tester probe ⊕ (Red)				
		Black	White	Yellow1	Yellow2	Yellow3
Tester probe ⊖ (Black)	Black		20 – 50 MΩ	20 – 50 MΩ	20 – 50 MΩ	20 – 50 MΩ
	White	Approx. 5 MΩ		Approx. 0.8 MΩ	Approx. 0.8 MΩ	Approx. 0.8 MΩ
	Yellow1	Approx. 0.8 MΩ	20 – 50 MΩ		20 – 50 MΩ	20 – 50 MΩ
	Yellow2	Approx. 0.8 MΩ	20 – 50 MΩ	20 – 50 MΩ		20 – 50 MΩ
	Yellow3	Approx. 0.8 MΩ	20 – 50 MΩ	20 – 50 MΩ	20 – 50 MΩ	

If the mesurement is out of the specification, replace the rectifier & regulator.

REMOVAL/INSTALLATION



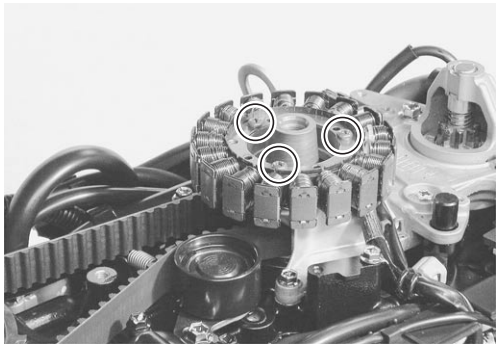
① Bolt (1)
② Washer (1)
③ Key (1)
④ Flywheel (1)
⑤ Battery charge coil (1)
⑥ Screw (3)
⑦ Rectifier & regulator (1)
⑧ Bolt (2)

REMOVAL

Before removing electrical parts:
- **Disconnect battery cables from battery.**

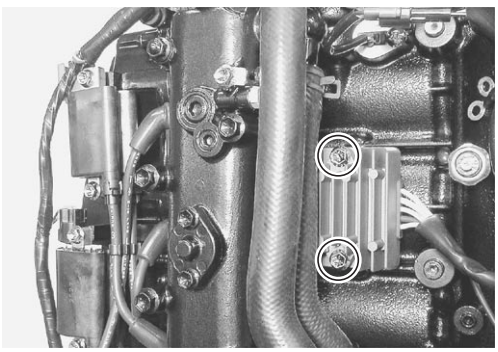
Battery charge coil

1. Remove the flywheel. (See page 3-52.)
2. Remove the three screws.
3. Disconnect the battery charge coil lead wire.



Rectifier & regulator

1. Remove the electric parts holder. (See page 4-17.)
2. Remove the two bolts.



INSTALLATION

Installation is reverse order of removal with the special attention to the following step.

Battery charge coil

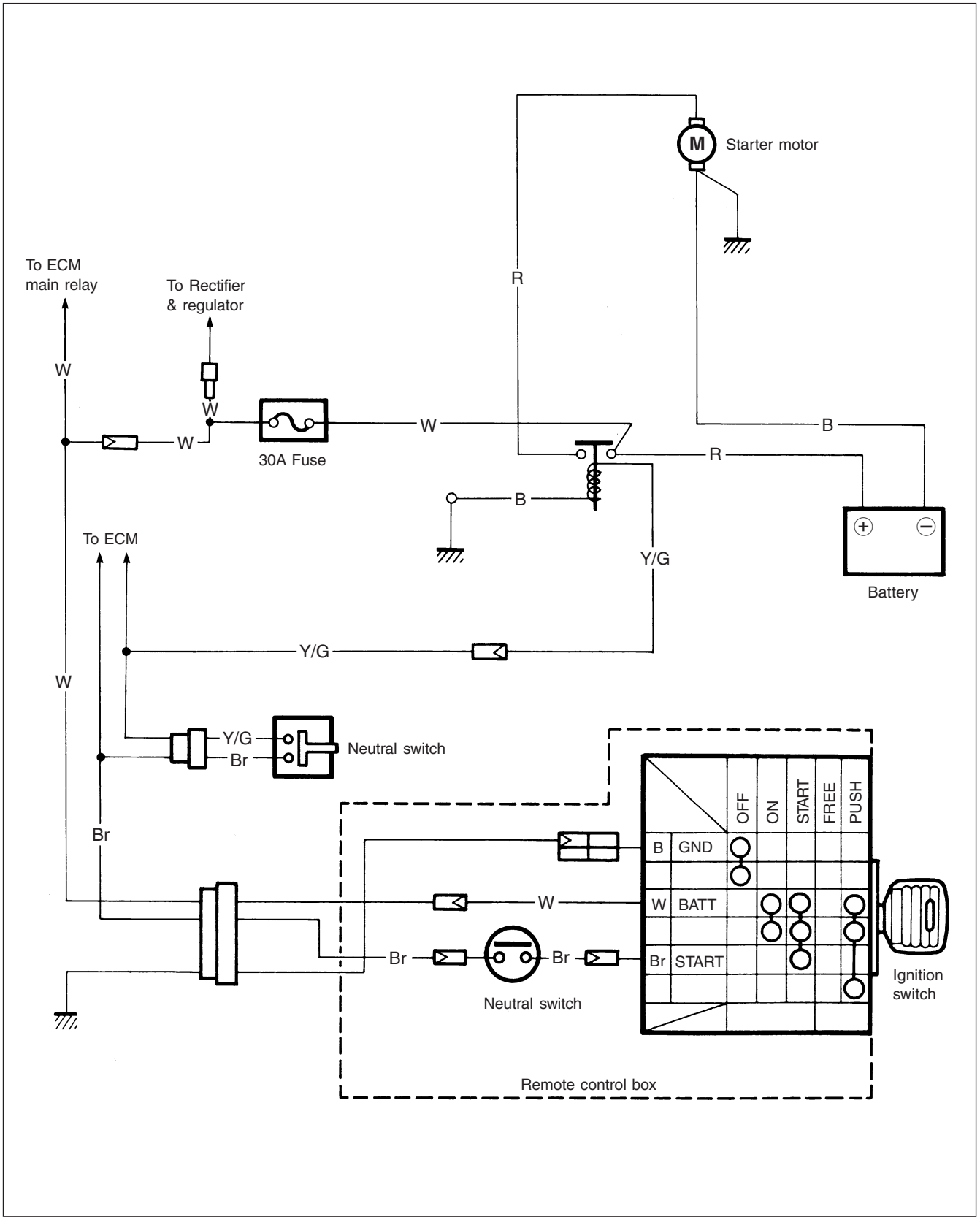
Apply the thread lock to the coil securing screws.

1342 99000-32050: Thread Lock 1342

ELECTRIC STARTER SYSTEM

OUTLINE

The electric starter system circuit is illustrated below. It is mainly composed of the battery, the starter motor, the relay, the neutral switches and the ignition switch.



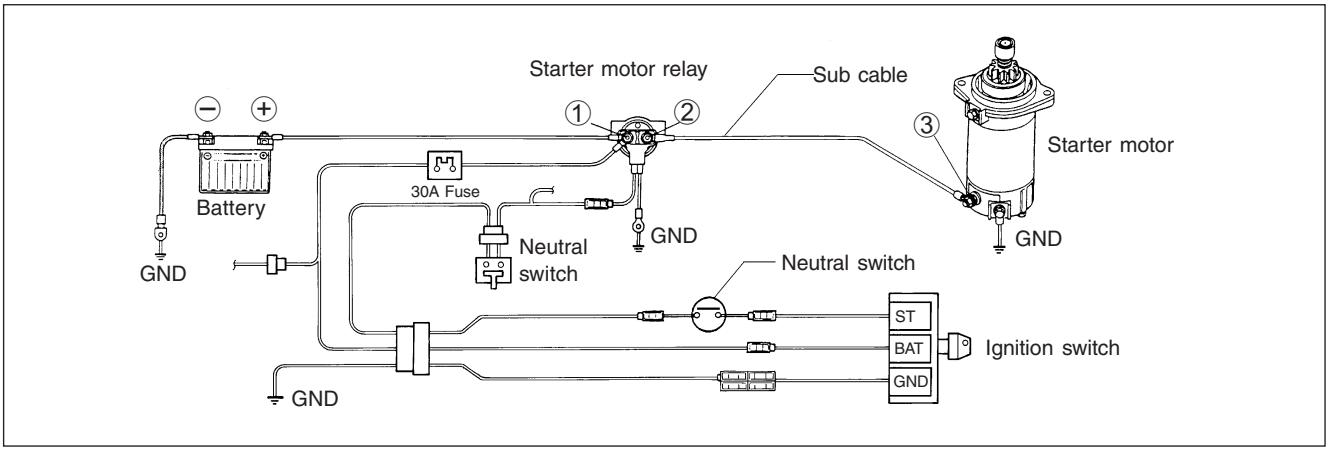
TROUBLESHOOTING

NOTE:

Before troubleshooting the electric starter system, make sure the followings:

- *Battery is fully charged.*
- *All cables / wires are securely connected.*
- *Shift is in "NEUTRAL" position.*

Circuit check schematic



Starter motor will not run.

Check if there is "click" sound of relay when turning ignition switch "START".
Is there "click" sound?

NO → Measure voltage at terminal ①. It must be above 12V. Is result OK?

NO → Battery cable failure

YES → Check if 30A fuse is in good condition. Is result OK?

NO → 30A fuse failure

YES → Check ignition switch function. (See page 4-8.) Is result OK?

NO → Ignition switch failure

YES → Check function of both neutral switches. (See page 4-8 and 4-9.) Is result OK?

NO → Neutral switch failure

YES → Starter motor relay failure

Check starter motor relay. (See page 4-9.)

YES → Measure voltage at terminal ② while turning ignition switch at "START". It must be above 12 V. Is result OK?

NO → Starter motor relay failure

YES → Measure voltage at terminal ③ while turning ignition switch "START". It must be above 12 V. Is result OK?

YES → Starter motor failure

Check starter motor. (See page 4-14.)

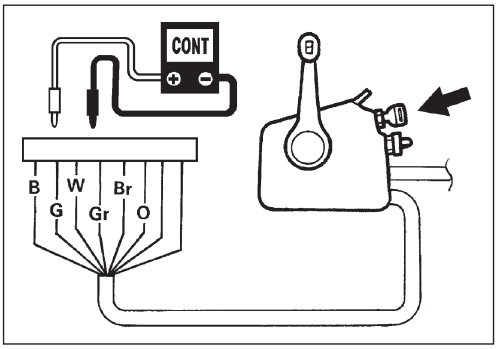
NO → Sub cable failure

INSPECTION

IGNITION SWITCH

09930-99320: Digital tester

Tester range: (Continuity)



1. Shift into NEUTRAL.
2. Disconnect the remo-con box wire harness connector from the engine side.
3. Inspect continuity between the wires while operating the switch key.

Ignition switch function: ○——○: Continuity

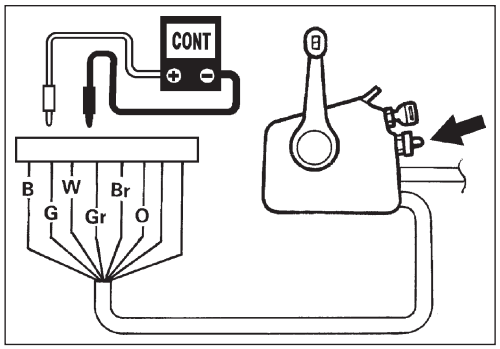
Key Position	Black	Green	White	Gray	Brown	Orange
OFF	○	○				
ON			○	○		
START			○	○	○	
PUSH IN			○			○

If the result is out of the specification, replace the ignition switch.

EMERGENCY STOP SWITCH

NOTE:
The steps for this inspection are the same as "IGNITION SWITCH" section except for tester probe connection.

Inspect continuity between the Green wire and the Black wire.



Emergency stop switch function:

Switch plate position	Continuity
Plate IN	No
Plate OUT	Yes

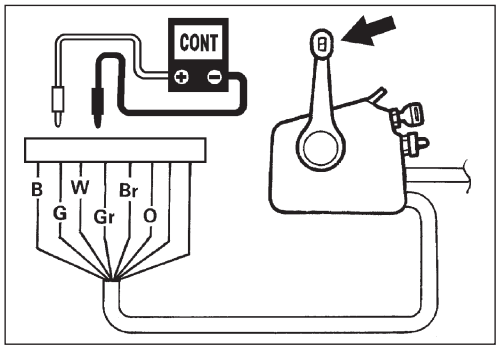
If the result is out of the specification, replace the emergency stop switch.

NEUTRAL SWITCH

Neutral switch in remo-con box

NOTE:
The steps for this inspection are the same as "IGNITION SWITCH" section except for tester probe connection.

Inspect continuity between the Brown wire and the White wire while operating the remo-con handle.



Neutral switch function:

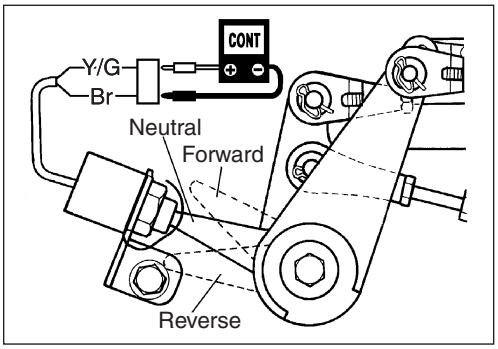
Shift position	Continuity
Neutral	Yes
Forward	No
Reverse	No

If the result is out of the specification, replace the neutral switch.

Neutral switch on cylinder block

09930-99320: Digital tester

Tester range: (Continuity)



1. Disconnect the neutral switch wire located in the electric parts holder.
2. Inspect continuity between the Yellow/Green wire and the Brown wire while operating the remo-con handle.

Neutral switch function:

Shift position	Continuity
Neutral	Yes
Forward	No
Reverse	No

If the result is out of the specification, replace the neutral switch.

STARTER MOTOR RELAY

09930-99320: Digital tester

Disconnect all cables / wires from the starter motor relay.

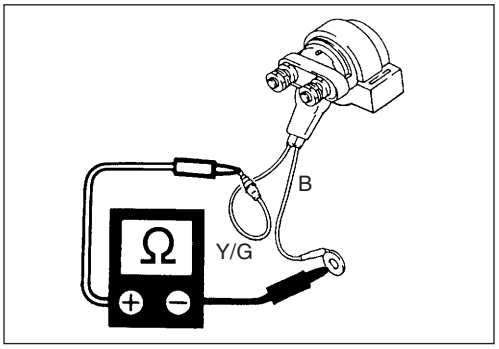
Resistance check

Tester range: Ω (Resistance)

Measure resistance between the Yellow/Green wire and the Black wire.

Starter motor relay resistance: 3.5 – 5.1 Ω

If the resistance is out of the specification, replace the starter motor relay.



Function check

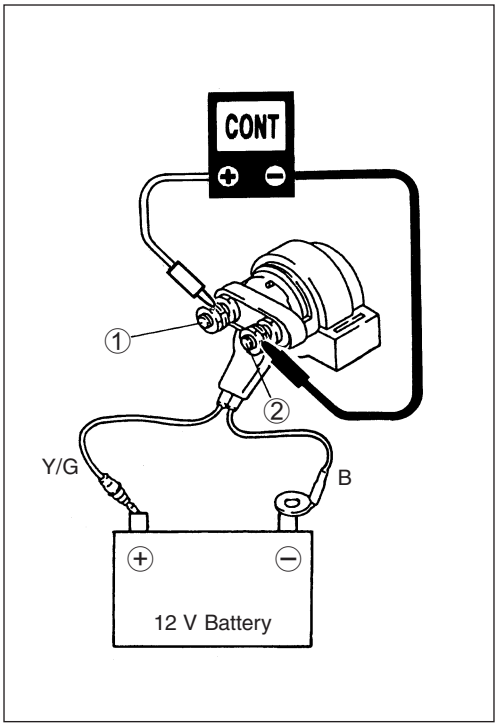
Tester range: (Continuity)

Inspect continuity between the terminal ① and ② with momently applying 12 V power. Connect the Yellow/Green wire to the positive ⊕ terminal, and the Black wire to the negative ⊖ terminal of the battery.

Starter motor relay function:

12 V power	Continuity
Applied	Yes
Not applied	No

If the result is out of the specification, replace the starter motor relay.



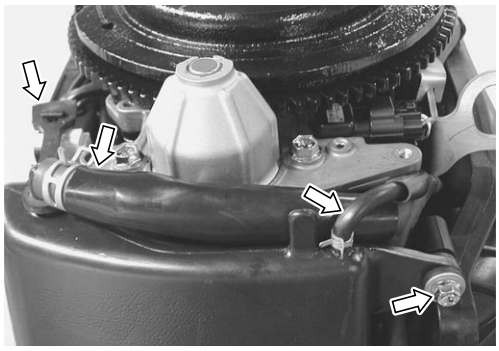
STARTER MOTOR

REMOVAL

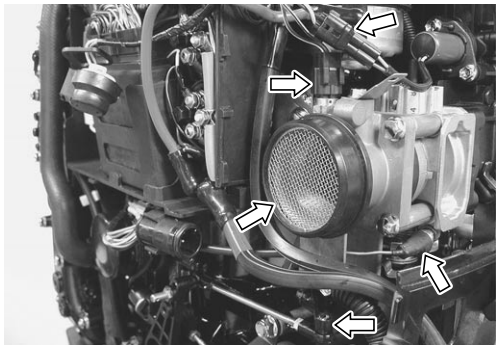
Before removing starter motor:
- **Disconnect battery cables from battery.**

1. Remove the screw and the flywheel cover.

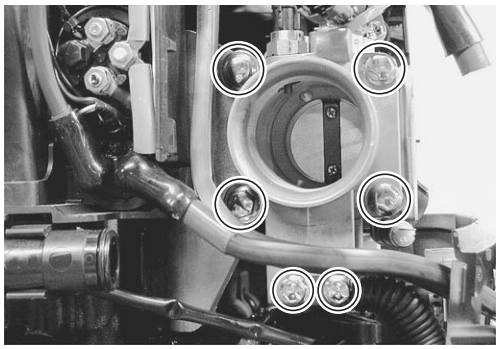
2. Remove the breather hose and the evaporation hose.
3. Remove the bolt, the fastening band and the silencer cover.



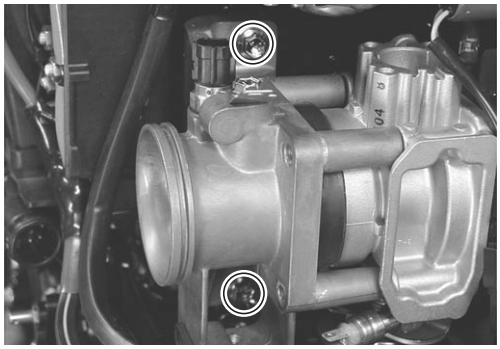
4. Disconnect the lead wire connectors from the IAT sensor, the IAC valve and the CTP switch.
5. Disconnect the throttle linkage rod.
6. Remove the flame arrester and the seal rubber.



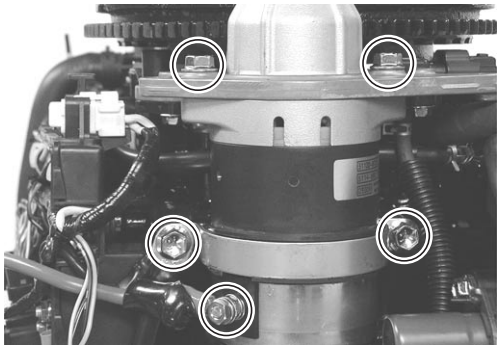
7. Remove the six silencer / throttle body securing bolts.



8. Loosen the two silencer bracket bolts.
9. Remove the silencer and the throttle body.



10. Remove the starter motor sub cable.
11. Remove the four bolts, the motor band and the starter motor assy.



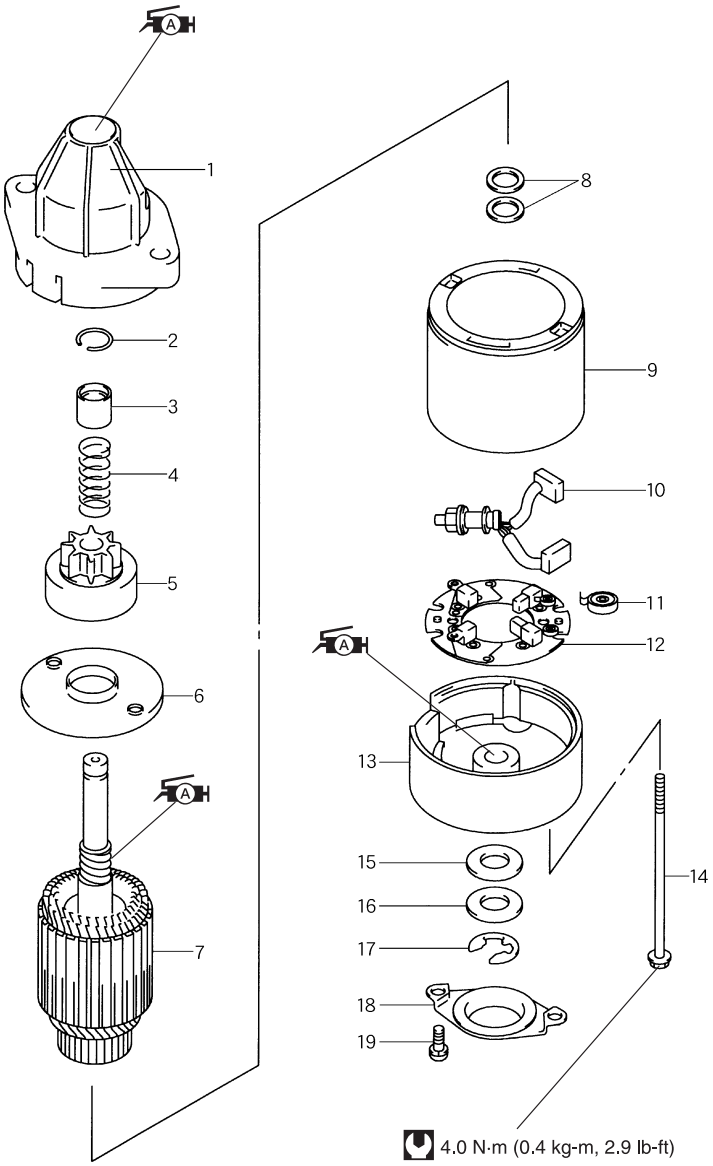
INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

- Install the starter motor and tighten the four starter motor mounting bolts securely.

Starter motor mounting bolt:
23 N·m (2.3 kg-m, 16.5 lb-ft)

- Install the silencer and the throttle body to the intake manifold with the six bolts first, then tighten the two silencer bracket bolts.

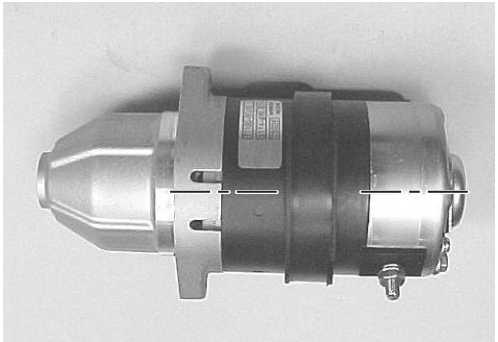


1. Front cover (1)
2. Stopper ring (1)
3. Pinion stopper (1)
4. Spring (1)
5. Pinion (1)
6. Cover (1)
7. Armature (1)
8. Washer (2)
9. Stator (1)
10. Brush (1)
11. Brush spring (2)
12. Brush holder (1)
13. Rear cover (1)
14. Bolt (2)
15. Washer (1)
16. Washer (1)
17. Circrip (1)
18. Sub rear cover (1)
19. Screw (2)

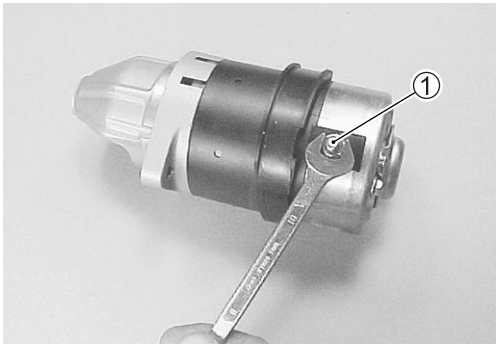
DISASSEMBLY

NOTE:

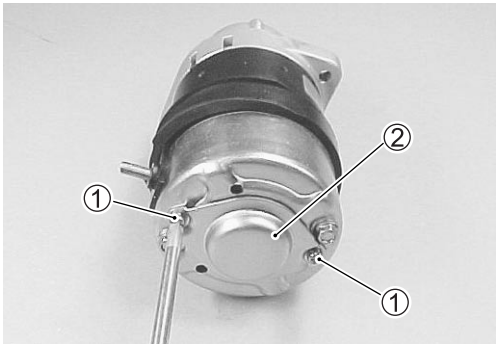
For correct assembly, scribe an alignment mark on the front cover, the stator and the rear cover.



1. Remove the nut ① on the ⊕ terminal.

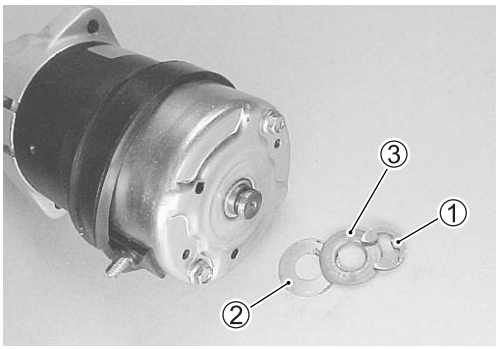


2. Remove the two screws ① and the sub rear cover ②.

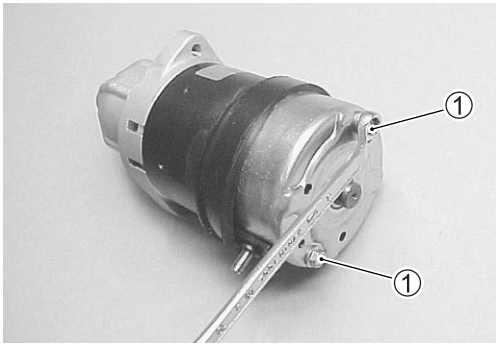


3. Remove the circlip ①, the washer ② and ③.

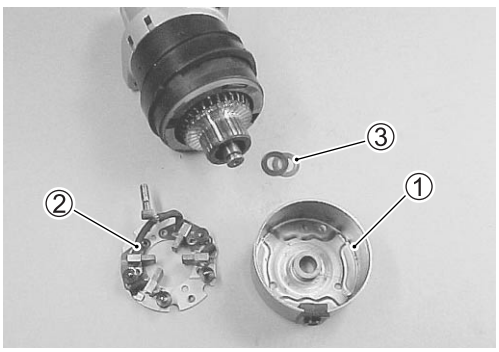
NOTE:
When installing, set the thicker washer ③ to the circlip side.



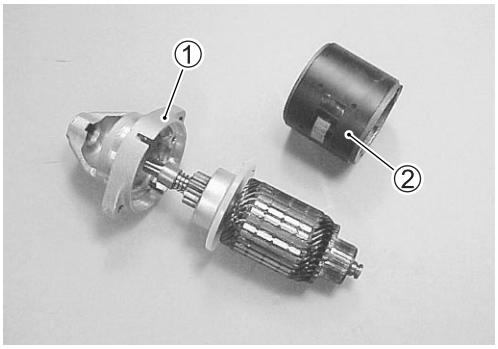
4. Remove the two bolts ①.



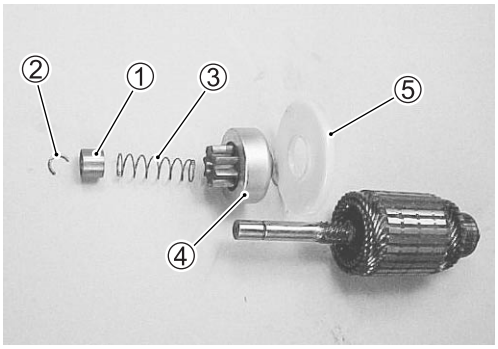
5. Remove the rear cover ① and the brush holder ②.
6. Remove the two washers ③ from the armature shaft.



7. Remove the front cover ① and the stator ②.



8. Push down the pinion stopper ①, remove the stopper ring ②.
9. Remove the pinion stopper ①, the spring ③, the pinion ④ and the cover ⑤.



⚠ WARNING

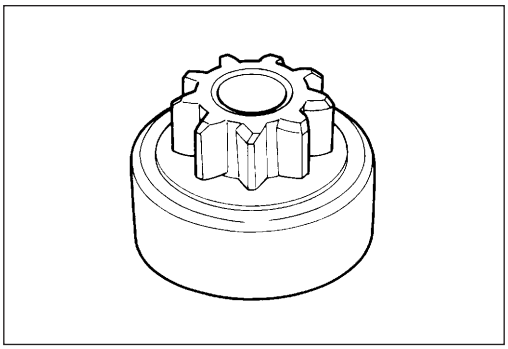
Wear safety grasses when disassembling and assembling stopper ring.

NOTE:
Using a screw-driver, pry off the stopper ring.

INSPECTION & SERVICING

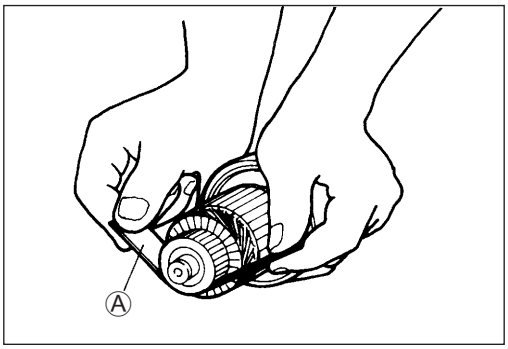
Pinion

Inspect the pinion.
If excessive wear or other damage is found, replace the pinion.



Armature and Commutator

1. Inspect the commutator surface.
   If the surface is gummy or dirty, clean with 400 grade emery paper Ⓐ.

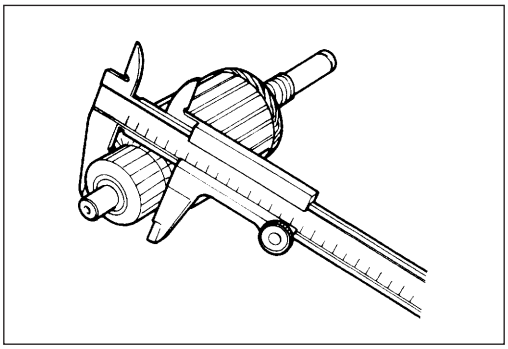


2. Measure the commutator outside diameter.

TOOL 09900-20101: Vernier calipers

Commutator outside diameter:
Standard : 33.0 mm (1.30 in)
Service limit: 32.0 mm (1.26 in)

If the measurement exceeds the service limit, replace the armature.

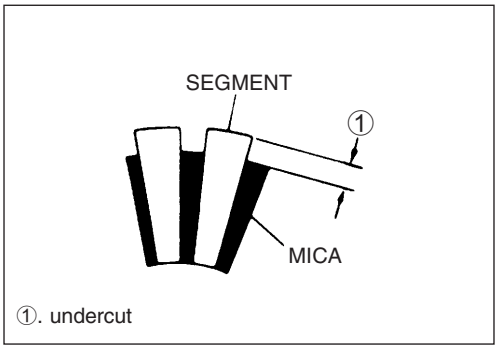


3. Check that the mica (insulator) between the segments is un dercut to the specified depth.

Commutator undercut:
Standard : 0.5 – 0.8 mm (0.02 – 0.03 in)
Service limit: 0.2 mm (0.01 in)

If the measurement exceeds the service limit, cut to the specified depth.

NOTE:
Remove all particles of mica and metal using compressed air.



①. undercut

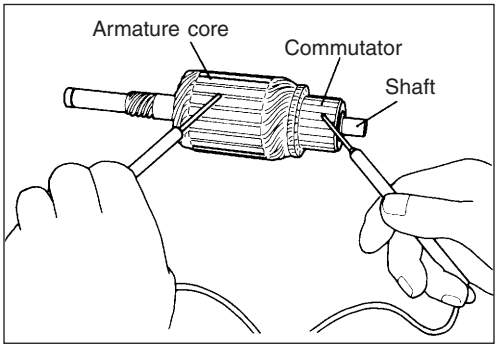
⚠ WARNING

Wear safety grasses when using compressed air.

4. Inspect continuity of the armature coil.

09930-99320: Digital tester

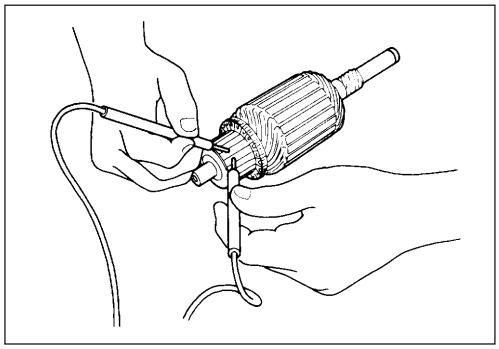
Tester range: (Continuity)



Armature coil continuity

Tester probe connection	Continuity
Between commutator segments	Yes
Commutator to Armature core	No
Commutator to Shaft	No

If the result is out of the specification, replace the armature.



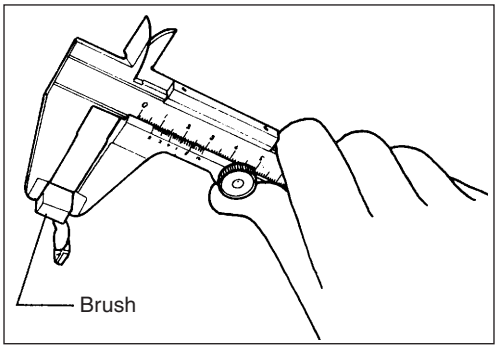
Brushes

Measure length of each brush.

09900-20101: Vernier calipers

Brush length:
Standard : 17.0 mm (0.67 in)
Service limit: 10.0 mm (0.39 in)

If the mesurement exceeds the service limit, replace the brush.



Brush Holder

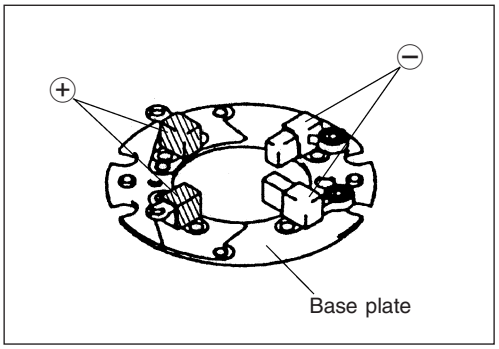
Inspect continuity of the brush holder.

09930-99320: Digital tester

Tester range: (Continuity)

Brush holder continuity:

Tester probe connection	Continuity
Brush holder positive ⊕ to Brush holder negative ⊖	No
Brush holder positive ⊕ to Base plate (ground)	No



If the result is out of the specification, replace the brush holder.

ASSEMBLY

Assembly is reverse of disassembly with the special attention to the following steps.

CAUTION

When installing armature, exercise care to avoid breaking brushes.

- Apply the grease to the armature shaft and the shaft holes.

99000-25010: Suzuki Super Grease "A"

- Align the front cover, the stator and the rear cover with the alignment lines scribed earlier and assemble the starter motor.

Through bolt: 4.0 N·m (0.4 kg-m, 2.9 lb-ft)

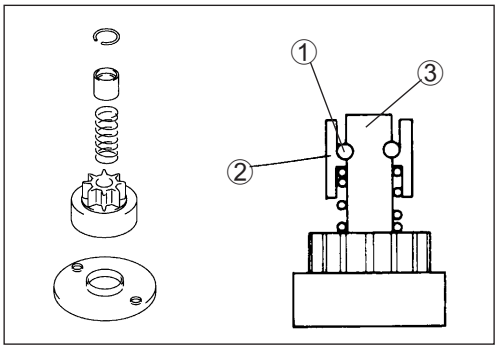
⚠ WARNING

Wear safety grasses when disassembling and reassembling stopper ring.

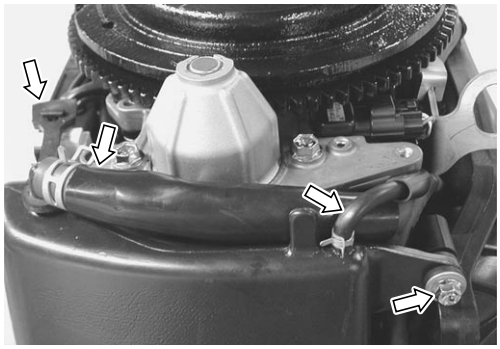
- Install the pinion, the spring, the pinion stopper and the stopper rings.

NOTE:

Make sure that the stopper rings ① tightly fit in the pinion stopper ② and the armature shaft ③.

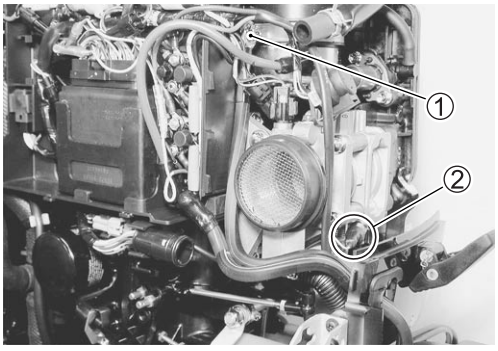


ELECTRIC PARTS HOLDER
REMOVAL

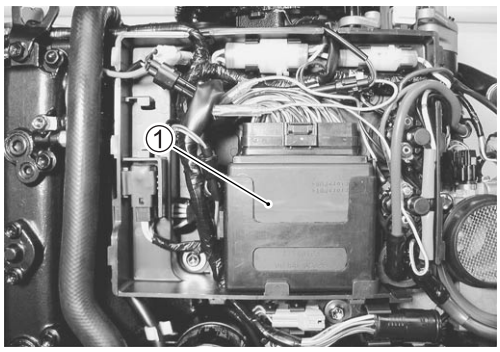


Before removing electric parts holder:
- **Disconnect battery cables from battery.**

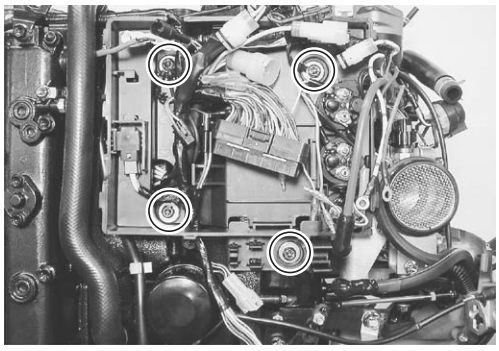
1. Remove the electric parts holder cover with pushing it upward.
2. Remove the breather hose and evaporation hose.
3. Remove the bolt, the fastening band and the silencer cover.
4. Remove the bolt ① and disconnect the wires.
5. Disconnect the CTP switch wire ②.



6. Remove the ECM ①.
7. Disconnect the following wires in the electric parts holder.
   - Connector of cylinder temp. sensor (Lg/W, B/W)
   - Connector of ex. manifold temp. sensor (V/W, B/W)
   - Blue wire on oil pressure switch
   - Connector of PTT motor relay (P)
   - Connector of PTT motor relay (Lbl)
   - Connector of battery charge coil (Y, Y, Y)
   - Connector of rectifier & regulator (W)
   - All cables / wires on starter motor relay terminals
   - Connector of starter motor relay (Y/G)
   - Blue wire on PTT motor relay terminal
   - Green wire on PTT motor relay terminal
   - Connector of neutral switch (Y/G, Br)



8. Remove the four bolts and the electric parts holder.



INSTALLATION
Installation is reverse order of removal.
See the page 10-2 to 10-5 for check of wire routing.

MONITOR-TACHOMETER

INSPECTION

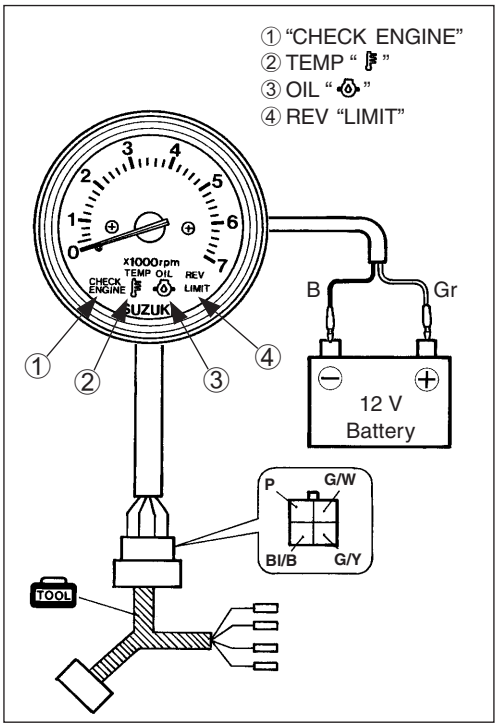
MONITOR LAMP CHECK

1. Connect the test cord as shown.

TOOL 09930-89240: 4-pin test cord

NOTE:
This check can be performed without the test cord (P/no. 09930-89240). If it is not available, directly connect the battery to the terminal of the meter.

2. Apply 12 V power to the meter. Connect the Gray wire to the positive ⊕ terminal, and the Black wire to the negative ⊖ terminal of the battery.

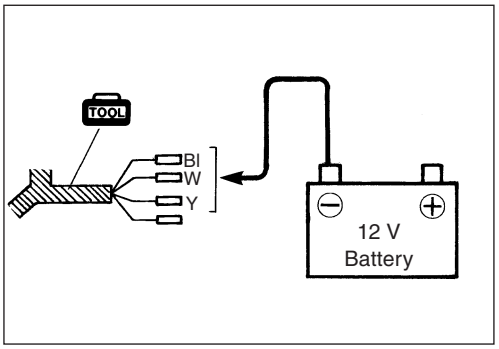


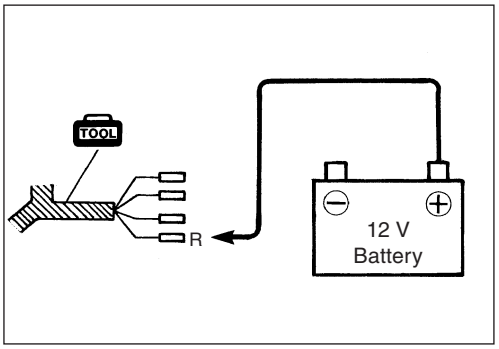
3. Check if the lamp lights when connecting the battery to the test cord terminal as shown.

Monitor lamp check:

Battery terminal	Terminal for battery connection		Lighting lamp
	Test cord	Meter	
Negative (–)	Bl	G/W	Lamp ①
Negative (–)	W	G/Y	Lamp ②
Negative (–)	Y	Bl/B	Lamp ③
Positive (+)	R	P	Lamp ④

If the result is out of the specification, replace the monitor-tachometer.





FUEL SYSTEM

CONTENTS

PRECAUTION ON FUEL SYSTEM SERVICE

GENERAL PRECAUTION

⚠ WARNING

Gasoline is extremely flammable and toxic. Always observe the following precautions when working around gasoline or servicing the fuel system.

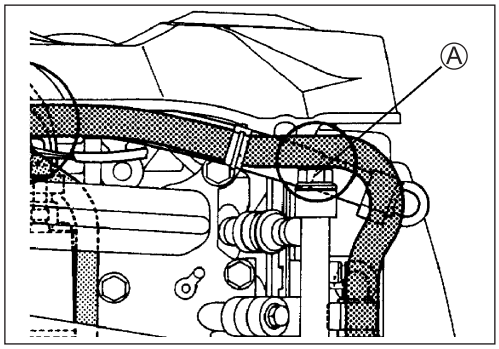
- **Disconnect battery cables except using battery power for servicing / inspection.**
- **Keep the working area well ventilated, away from open flame (such as gas heater) or sparks.**
- **Do not smoke or allow anyone else to smoke near the working areas. Post a "NO SMOKING" sign.**
- **Have a CO_2 fire extinguisher to be ready for use.**
- **Always use appropriate safety equipment and wear safety glasses when working around pressurized fuel systems.**
- **To avoid potential fire hazards, do not allow fuel to spill on hot engine parts or on operating electrical components.**
- **Wipe up fuel spills immediately.**

⚠ WARNING

The components after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing components.

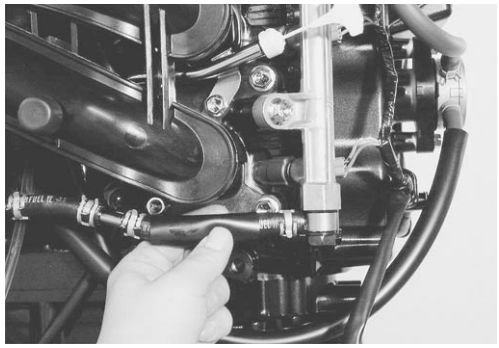
FUEL PRESSURE RELIEF PROCEDURE

1. Turn the ignition switch OFF, then disconnect the battery cables from the battery.
2. Shield the delivery pipe plug Ⓐ area using a cloth.
3. Slowly loosen the plug Ⓐ by 2 – 3 turns to gradually release fuel pressure in line.
4. Wipe up fuel spills immediately.



5. Make sure that the fuel pressure has been removed by pinching the fuel hose with finger tips.
6. Tighten the delivery pipe plug Ⓐ.

Delivery pipe plug: 40 N·m (4.0 kg-m, 29.0 lb-ft)



FUEL LINE

REMOVAL/INSTALLATION

Remove or install the fuel hoses with the special attention to the following steps.

⚠ WARNING

The components after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing components. (See the page 5-2.)

CAUTION

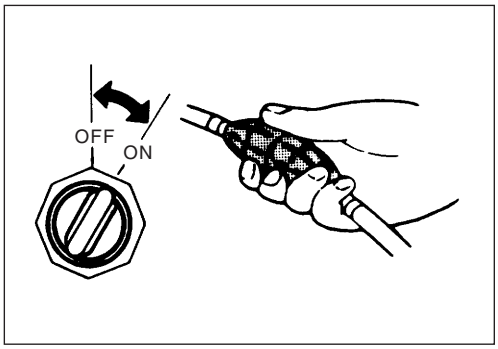
- **Do not over-bend (kink) or twist hoses when installing.**
- **When installing hose clips, position tabs to avoid contact with other parts.**
- **Be sure that hoses do not contact rods, levers or other components with engine either operating or at rest.**
- **Extreme care should be taken not to cut, abrade or cause any other damage to hoses.**
- **Use care not to excessively compress hoses when tightening clamps.**

NOTE:

- *Check the fuel hose routing. (See the page 10-8 and 10-9.)*
- *Check for fuel leakage.*

FUEL LEAKAGE CHECK PROCEDURE

After performing any fuel system service, always be sure that there is not fuel leakage by checking as follows.

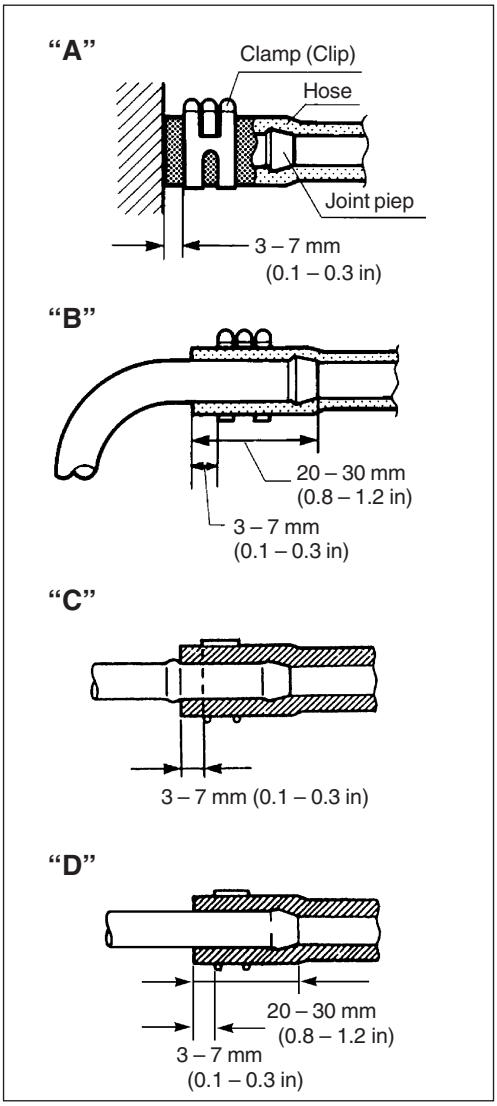


1. Squeeze the fuel primer bulb until you feel resistance.
2. Turn the ignition switch “ON” for 3 seconds (to operate the fuel pump), then turn it “OFF”.
   Repeat this (ON and OFF) procedure 3 or 4 times to pressurize the fuel system.
3. Once pressurized, check all connections and components for any signs of leakage.

FUEL HOSE CONNECTION

Note that the fuel hose connection varies with each type of the pipe. Be sure to connect and clamp each hose correctly by referring to the following figure.

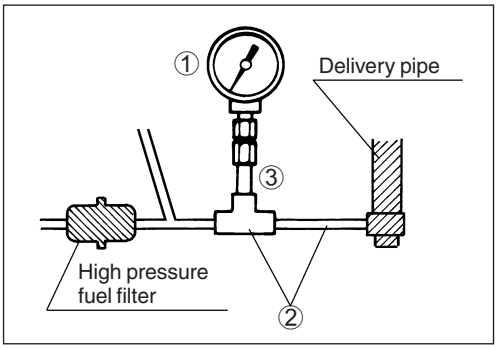
- For the type “A” (short barbed end) pipe, hose should completely cover the pipe.
- For the type “B” (bent end) pipe, hose should cover straight part of the pipe by 20 – 30mm (0.8 – 1.2 in).
- For the type “C” pipe, hose should fit up against flanged part of the pipe.
- For the type “D” pipe, hose should cover the pipe by 20 – 30mm (0.8 – 1.2 in).



FUEL PRESSURE INSPECTION

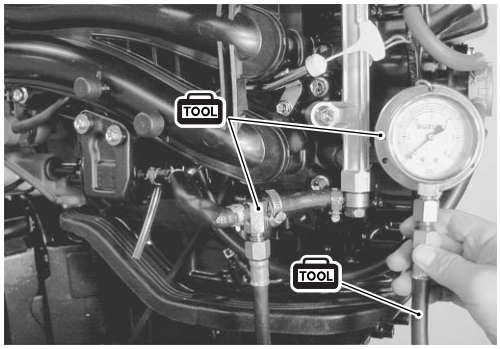
1. Relieve the fuel pressure in line. (See the page 5-2.)
2. Remove the port side cover. (See the page 7-2.)
3. Remove the high pressure fuel filter from the intake manifold.
4. Connect the special tools between the fuel feed hose and the delivery pipe as shown in the figure.
5. Clamp the hoses securely to ensure no leaks occur during checking.

TOOL **09912-58442: Pressure gauge – ①**
09912-58490: 3-way joint & hose – ②
09912-58432: Fuel pressure hose – ③



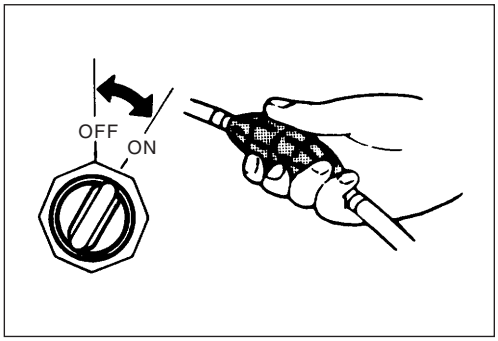
CAUTION

A small amount of fuel may be released when the fuel feed hose is disconnected.
Place container under the fuel feed hose with a shop cloth so that released fuel is caught in container or absorbed in cloth. Place fuel soaked cloth in an approved container.



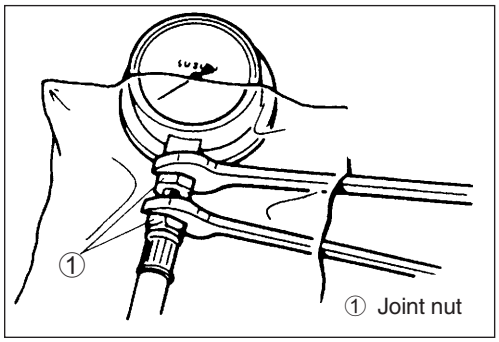
6. Squeeze the fuel primer bulb until you feel resistance.
   Turn the ignition switch "ON" for 3 seconds (to operate the fuel pump), then turn it "OFF".
   Repeat this ("ON" and "OFF") procedure 3 or 4 times to pressurize the fuel system and then check the fuel pressure.
7. Measure the fuel pressure in line at cranking or idle speed operation.

Fuel pressure: Approx. 255 kPa (2.55 kg/cm², 36.3 psi)



8. Stop the engine and wait 5 minutes.
9. Read residual fuel pressure in line.

Residual fuel pressure:
200 kPa (2.0 kg/cm², 28.4 psi) or higher



CAUTION

As the fuel feed line is still under high fuel pressure, make sure to release fuel pressure according to the following procedures.
- **Place container under the joint to catch fuel.**
- **Cover the joint with rag and loosen the joint nut slowly to gradually release fuel pressure.**

10. After measuring the fuel pressure, remove the fuel pressure gauge.
11. Reconnect the fuel line.
12. With the engine not running and the ignition switch "ON", check the fuel system for leaks.

FUEL VAPOR SEPARATOR / HIGH PRESSURE FUEL PUMP

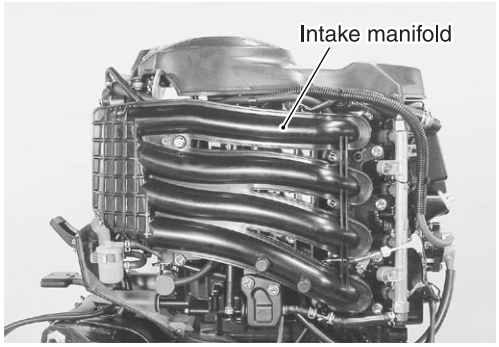
REMOVAL / INSTALLATION

⚠ WARNING

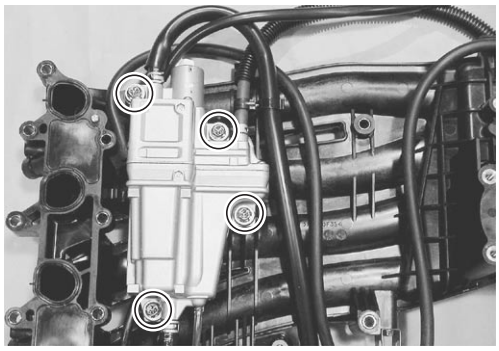
The components after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing the components. (See the page 5-2.)

REMOVAL

1. Remove the intake manifold assembly. (See the page 6-2.)



2. Remove the four bolts and the fuel vapor separator assembly from the intake manifold.
3. Disconnect all hoses from the fuel vapor separator.

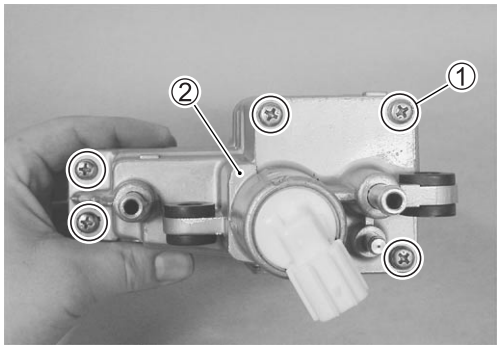


INSTALLATION

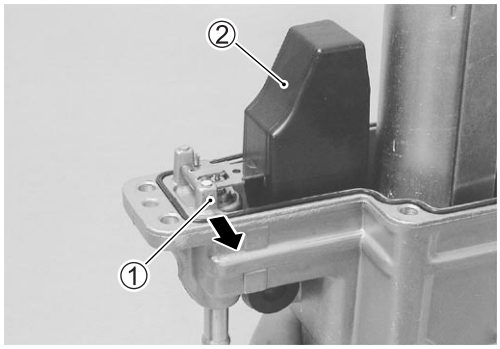
Installation is reverse order of removal.
See the page 6-5 for installation of the intake manifold assembly.

DISASSEMBLY

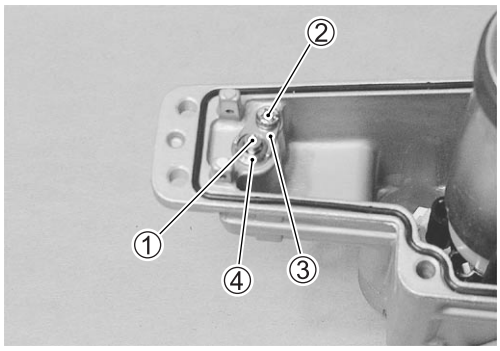
1. Remove the five screws ①.
2. Remove the separator cover ② with the high pressure fuel pump from the separator case.



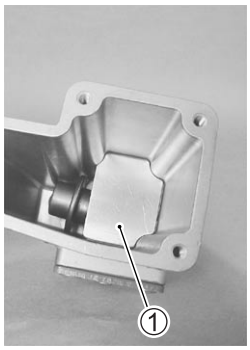
3. Remove the float pin ① and the float ②.

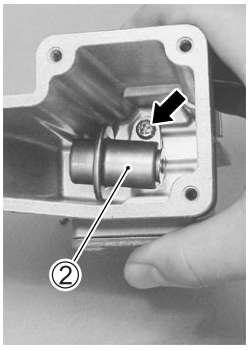


4. Remove the needle valve ①, the screw ②, the plate ③ and the valve seat ④.

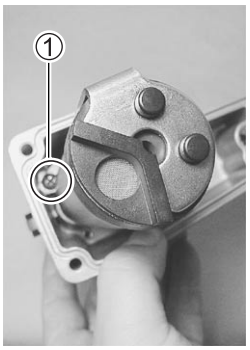


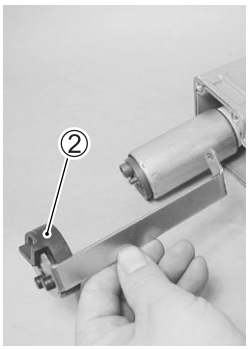
5. Remove the plate ①.
6. Remove the screw and the fuel pressure regulator ② from the separator case.



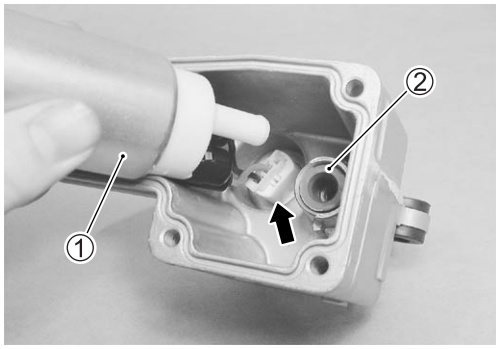


7. Remove the screw ①.
8. Remove the suction filter ② with the bracket.





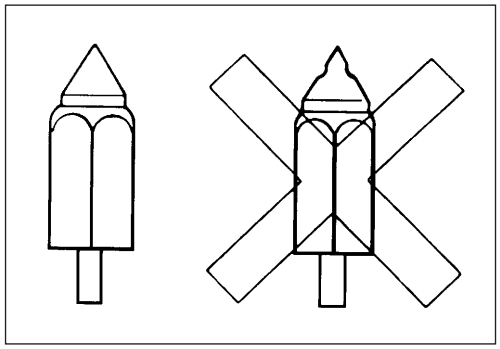
9. Remove the high pressure fuel pump ① and the grommet ② from the separator cover and then disconnect the pump lead wire connector.



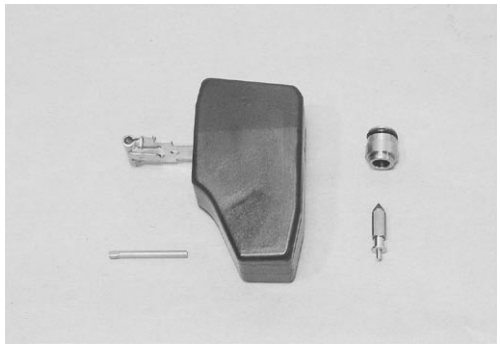
INSPECTION

NOTE:
If cracks, excessive wear or other damage is found on any component, replace component.

Needle valve/Valve seat
Inspect the needle valve and the valve seat for groove, other damage or dirt.
Replace or clean if necessary.

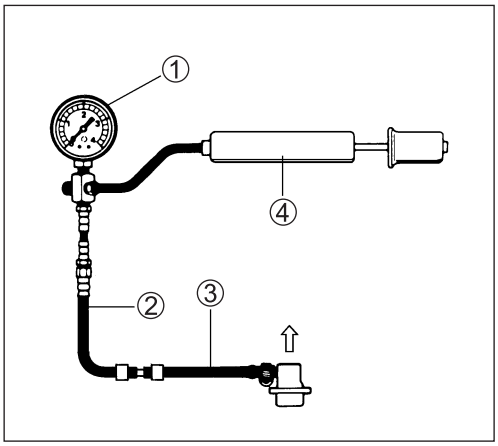


Float
Inspect the float for crack or other damage.
Replace if necessary.



Filter
Inspect the pump suction filter for clog or other damage.
Replace or clean if necessary.

Fuel pressure regulator
Check the fuel pressure regulator operation.



TOOL **09940-44121: Air pressure gauge – ①**
09940-44130: Attachment – ②
09912-58490: Hose – ③
: Hand air pump – ④

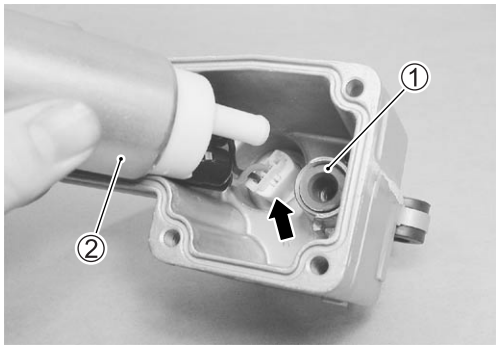
1. Connect the special tools to the inlet side of the regulator as shown in the figure.
2. Pump air into the regulator using a hand air pump ④ until air is released through the outlet side.
3. Read pressure on the gauge ① when air is released.

Regulator operating pressure:
240 – 270 kPa (2.4 – 2.7 kg/cm², 34.1 – 38.4 psi)

If the result is out of the specification, replace the regulator.

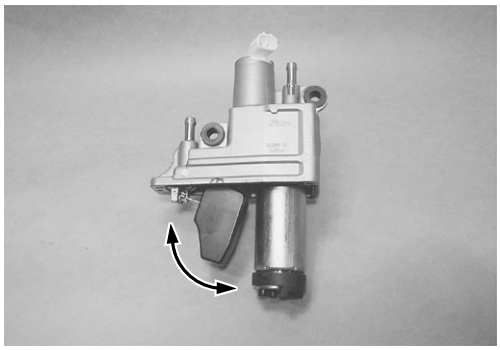
REASSEMBLY

Assembly is reverse order of disassembly with the special attention to the following steps.



High pressure fuel pump
Connect the pump lead wire connector, then install the grommet ① and fuel pump ②.

NOTE:
Apply fuel to the grommet before installing.

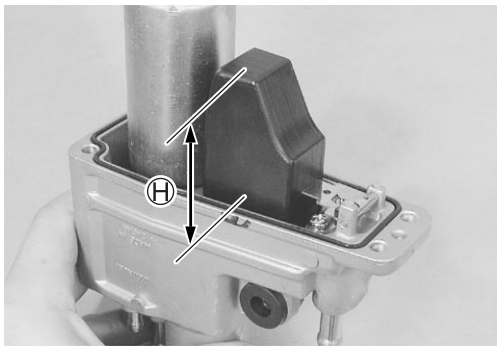


Float / Float pin
Install the float and the float pin.

NOTE:
After assembling, check for smooth and free float movement.

Checking float height
Measure the float height.

TOOL **09900-20101: Vernier calipers**

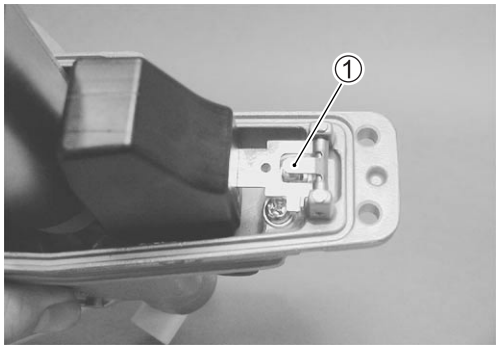


Float height Ⓗ: 43 ± 1 mm

NOTE:
Make sure that the float weight is not applied to the needle valve.

Setting float height

To correct specification, bend only the adjustment tab ①.



CAUTION

When adjusting tab, do not bend to the point that it applies pressure to the needle and seat.

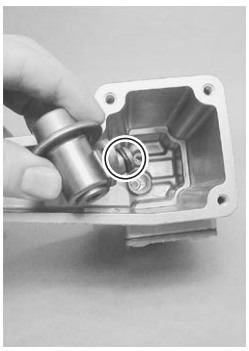
Fuel pressure regulator

1. Install the fuel pressure regulator and tighten the screw securely.

NOTE:

Apply fuel to the O-ring before installing the regulator.

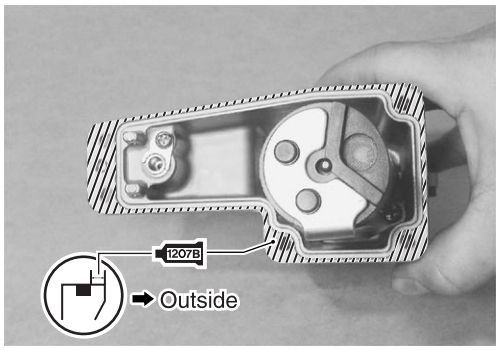
2. Install the plate.



Separator cover / Separator case

1. Install the seal ring, then apply the Suzuki Bond evenly to only the outside mating surface of the separator case as shown in the figure.

1207B 99000-31140 : Suzuki Bond 1207B



NOTE:

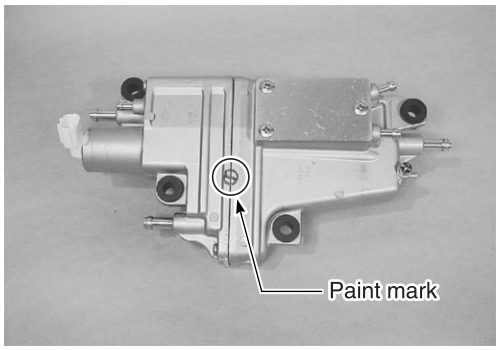
- *Clean the mating surfaces before applying the bond.*
- *Do not apply the bond to the seal ring, the groove and the inside mating surface.*

2. Install the separator case, then tighten the screws securely.

NOTE:

The separator cover and the case are a set.

Make sure the paint marks on both items are matched when assembling.



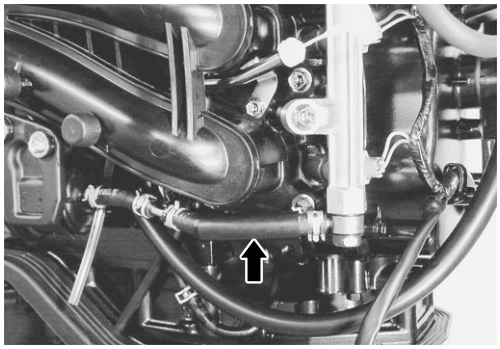
FUEL INJECTOR / DELIVERY PIPE

REMOVAL

⚠ WARNING

The components after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing components.
(See the page 5-2.)

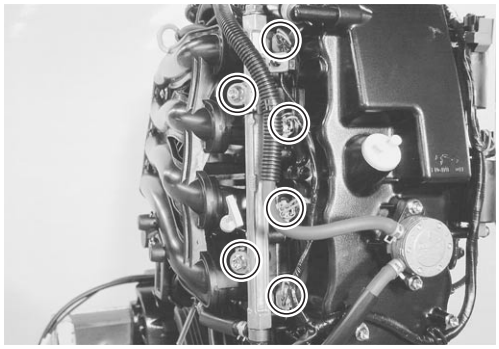
1. Remove the port side cover. (See the page 7-2.)
2. Loosen the clamp and place a large cloth over the end of the fuel feed hose.
   Slowly pull the fuel feed hose from the fuel delivery pipe.
   Drain any excess fuel in the hose into a small container.



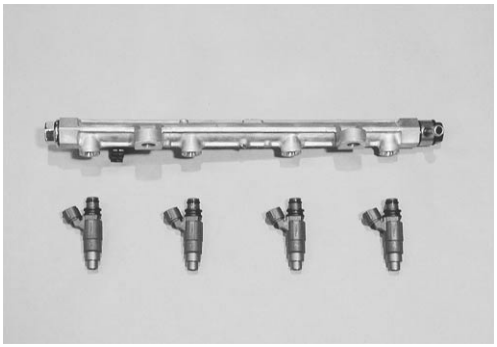
3. Disconnect the four fuel injector connectors.
4. Remove the two bolts and the fuel delivery pipe (with the fuel injectors).

CAUTION

A small amount of fuel may be released when the fuel injector is removed from delivery pipe.
Place a shop cloth under fuel injector before removal to absorb any fuel released.
Dispose of fuel soaked cloth in appropriate container.



5. Remove each injector from the delivery pipe.



INSPECTION

See the page 3-39 to 3-41 for inspection of the fuel injector operation.

INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

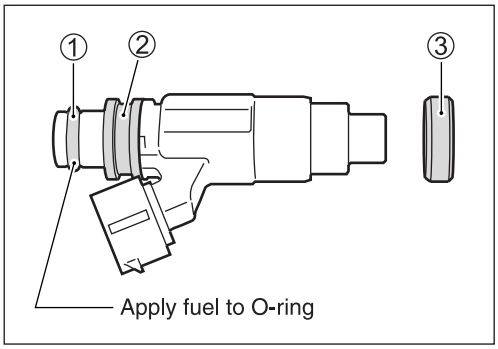
CAUTION

Do not re-use the O-ring and the cushion once removed.

Always use new parts.

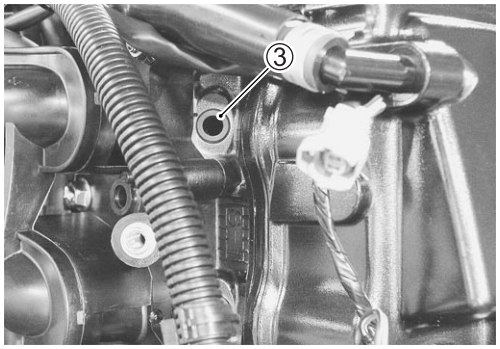
1. Replace the injector O-ring ① with new one using care not to damage it. Install the grommet ② to injector.

2. Apply thin coat of fuel to the injector O-ring, then install the injectors into the delivery pipe.



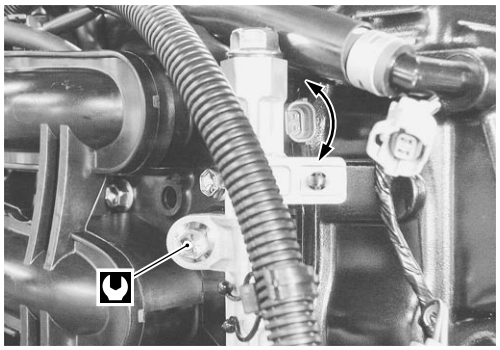
3. Replace the injector cushion ③ with new one and install it to the cylinder head.

4. Install the delivery pipe (with the injectors) into the cylinder head.



5. Tighten the two delivery pipe bolts and make sure that the injectors rotate smoothly.

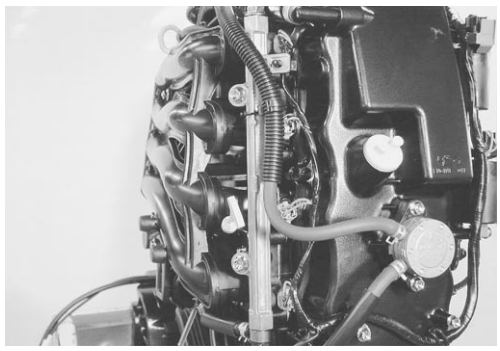
Fuel delivery pipe bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)



6. Reconnect the fuel feed hose to the fuel delirery pipe.

7. Connect the lead wires to each injector connectors.

8. Turn the ignition switch “ON” for 3 seconds (to operate the fuel pump), then turn it “OFF”.
   Repeat this (ON and OFF) procedure 3 or 4 times to pressurize the fuel system.
   Check for fuel leaks around the fuel injector.

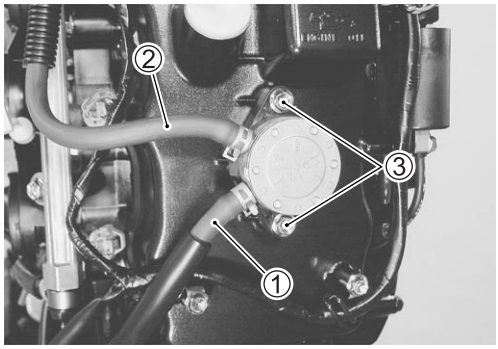


LOW PRESSURE FUEL PUMP

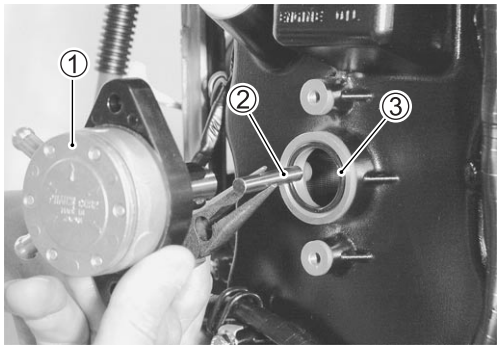
REMOVAL / INSTALLATION

REMOVAL

1. Remove both side covers. (See the page 7-2.)
2. Disconnect the hose ① (inlet) and the hose ② (outlet) from the fuel pump.
3. Remove the two bolts ③.



4. Remove the fuel pump ①, the pump rod ② and the O-ring ③.

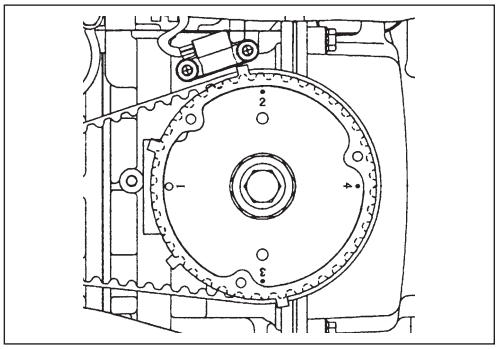


INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

CAUTION

- **Before installing the fuel pump, rotate the crankshaft to bring the No.1 (top cylinder) piston to the Top Dead Center on a compression stroke.**
- **Do not re-use the O-ring once removed. Always use a new O-ring.**

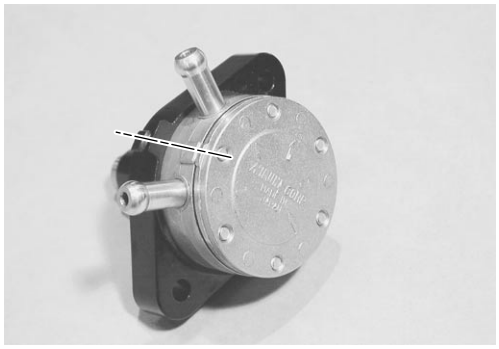


Low pressure fuel pump bolt:
10 N·m (1.0 kg-m, 7.0 lb-ft)

DISASSEMBLY / REASSEMBLY

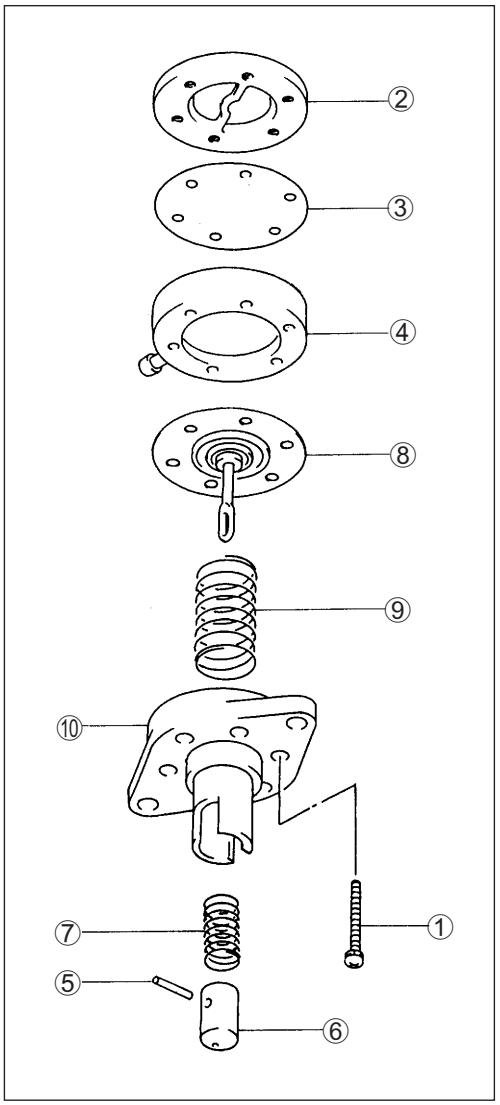
DISASSEMBLY

NOTE:
For correct assembly, scribe an alignment mark on each part of the fuel pump.



1. Remove the six screws ①.
2. Remove the following parts:
   - Outer plate ②
   - Diaphragm ③
   - Valve body ④

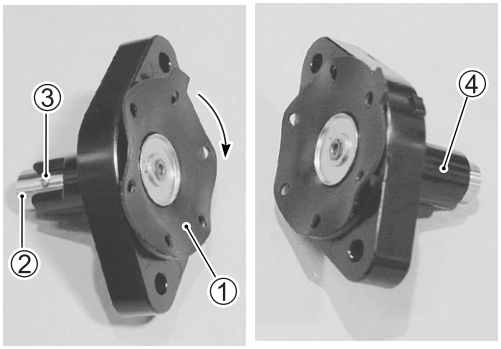
3. Turn the piston ⑥ until the pin ⑤ comes out through the cutaway of the pump body ⑩.
   Remove the following parts:
   - Piston ⑥
   - Spring ⑦
   - Diaphragm ⑧
   - Spring ⑨
   - Pump body ⑩



REASSEMBLY

Reassembly is reverse order of disassembly with the special attention to the following step.

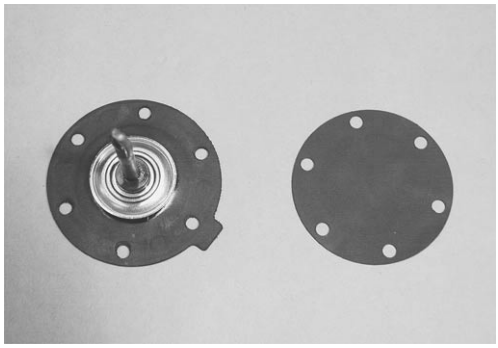
NOTE:
After connecting the diaphragm ① to the piston ② with the pin ③, align the six diaphragm holes to the pump body holes by turning the piston ② and the diaphragm ① together so that the pin ③ will not come out through the cutaway of the pump body ④.



INSPECTION

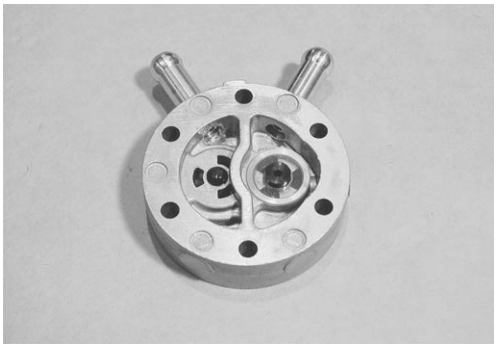
Diaphragm

Inspect all diaphragms. If distortion, tear or other damage is found, replace the fuel pump assembly.



Check-valves

Inspect the check valves in the valve body. If tear, distortion or other damage is found, replace the fuel pump assembly.



Pump body

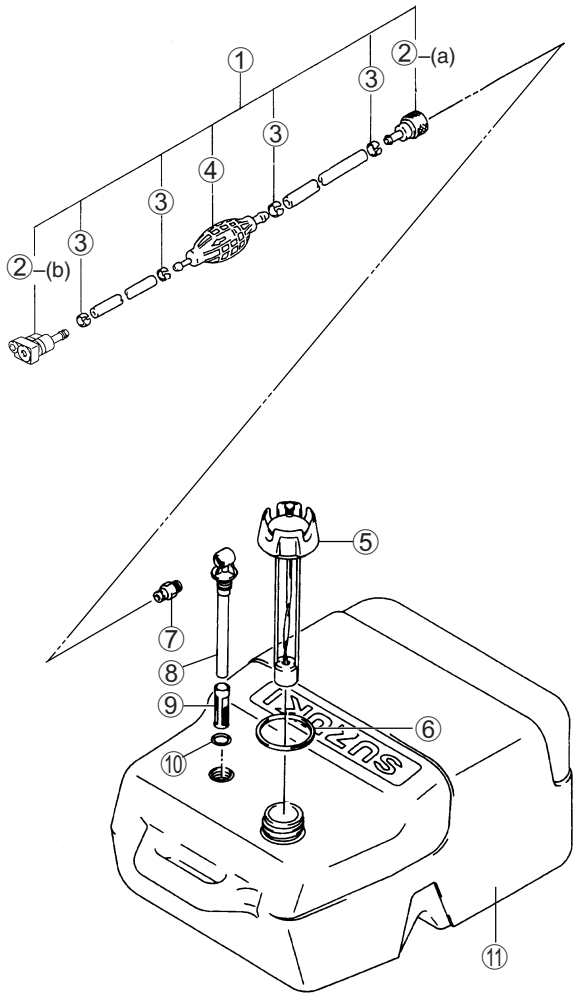
Inspect the pump body. If crack, nick, distortion or other damage is found, replace the fuel pump assembly.

FUEL TANK

DISASSEMBLY / REASSEMBLY

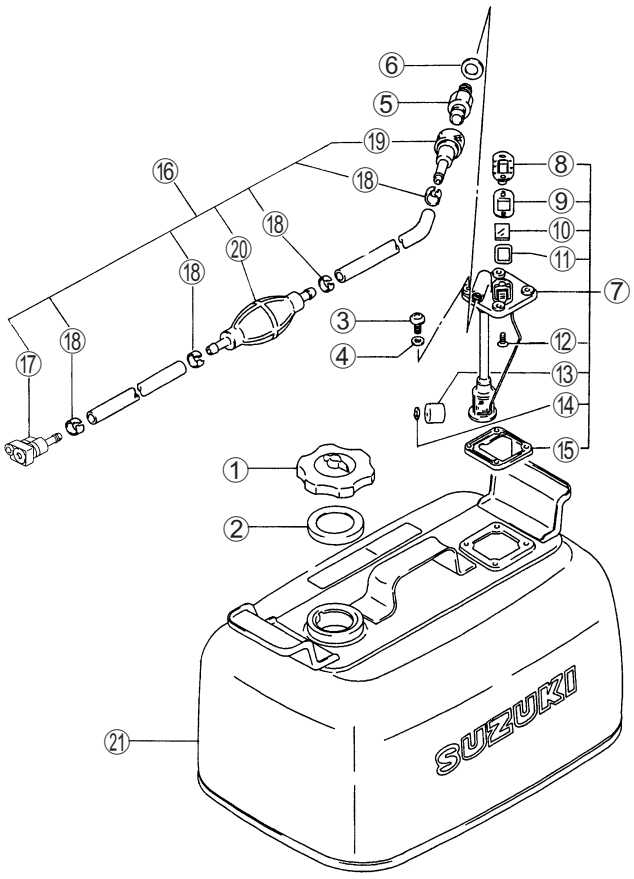
When disassembling or reassembling the fuel tank, refer to the construction diagram below.

Plastic tank



① Fuel hose assy (1)
[②–(a) Connector (1)]
[②–(b) Connector (1)]
[③ Clip (4)]
[④ Primer bulb (1)]
⑤ Tank cap (1)
⑥ Gasket (1)
⑦ Connector plug (1)
⑧ Outlet (1)
⑨ Filter (1)
⑩ O-ring (1)
⑪ Fuel tank (1)

Steel tank

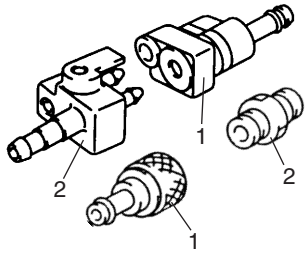


① Tank cap (1)
② Gasket (1)
③ Screw (4)
④ Gasket (4)
⑤ Connector plug (1)
⑥ Gasket (1)
⑦ Fuel gauge assy (1)
[⑧ Cover (1)]
[⑨ Gasket (1)]
[⑩ Lens (1)]
[⑪ Gasket (1)]
[⑫ Screw (2)]
[⑬ Float (1)]
[⑭ Push nut (1)]
[⑮ Gasket (1)]
⑯ Fuel hose assy (1)
[⑰ Connector (1)]
[⑱ Clip (4)]
[⑲ Connector (1)]
[⑳ Primer bulb (1)]
㉑ Fuel tank (1)

INSPECTION

Fuel connector

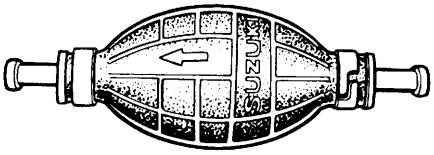
Inspect the fuel connector and the connector plug. If leakage, deterioration or other damage is found, replace the connector and/or the plug.



1. Connector 2. Connector plug

Fuel primer bulb

Inspect the fuel primer bulb. If crack, leakage or deterioration is found, replace the bulb.
If the check valve function is defective, replace the bulb.

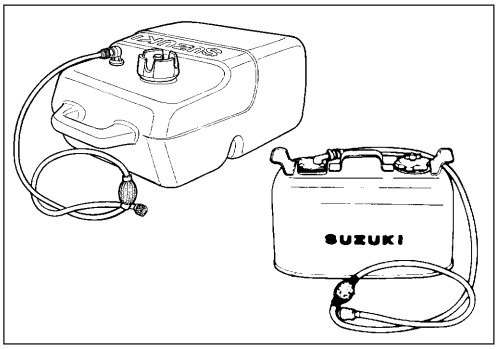


Fuel hose

Inspect the fuel hoses. If cut, crack, leakage, abrasion, tear or deterioration is found, replace the hoses.

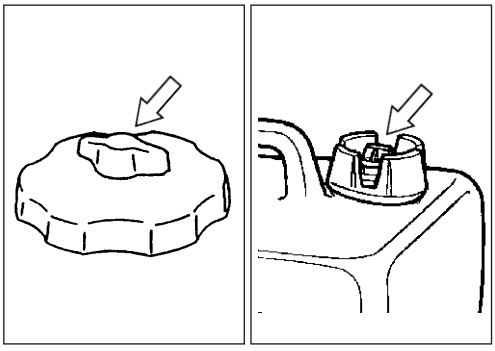
Fuel tank

Inspect the fuel tank. If crack, leakage or deterioration is found, replace the tank.
If water or other contamination is found, drain and clean the tank.



Tank cap

Check that the fuel tank vent opens and relieves internal tank pressure properly.
If vent is suspect, replace the tank cap.



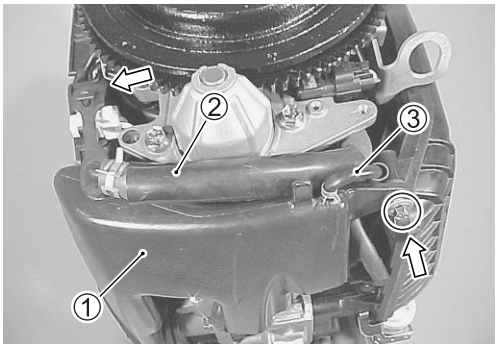
POWER UNIT

CONTENTS

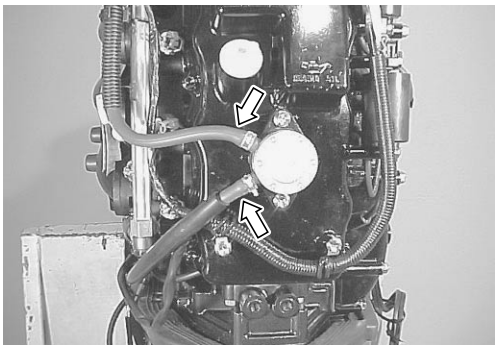
INTAKE MANIFOLD ASSY
REMOVAL

Before removing the intake manifold assy:
- **Remove the fuel pressure in line. (See the page 5-2.)**
- **Disconnect the battery cables from the battery.**
- **Remove the flywheel cover.**
- **Remove both side covers. (See the page 7-2.)**

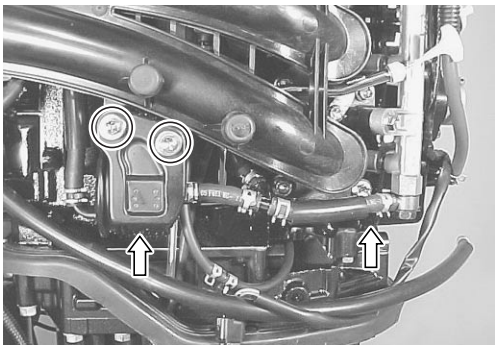
1. Remove the breather hose ② and the evaporation hose ③ from the silencer cover ①.
2. Remove the bolt, the cover band and the silencer cover.



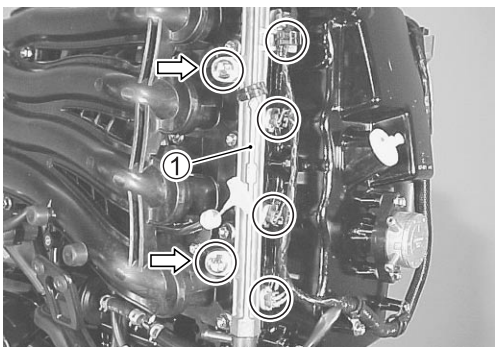
3. Disconnect the fuel hoses from the low pressure fuel pump.



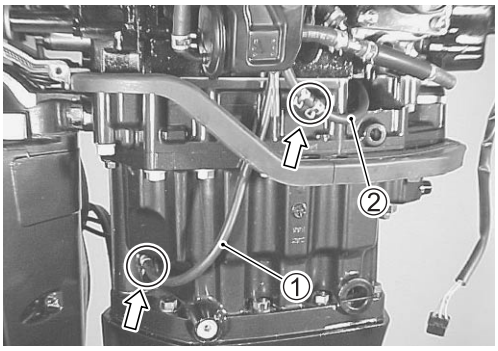
4. Remove the two bolts and the high pressure fuel filter.
5. Disconnect the fuel hose from the delivery pipe.



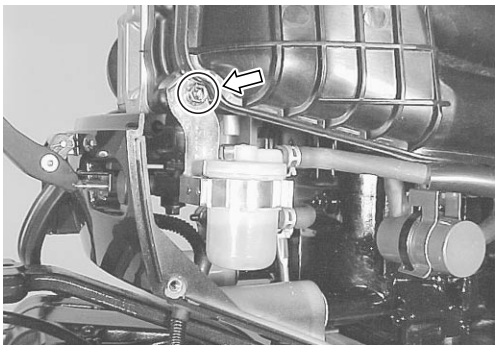
6. Disconnect the wire from the fuel injectors.
7. Remove the two bolts.
8. Remove the delivery pipe ① with the fuel injectors.



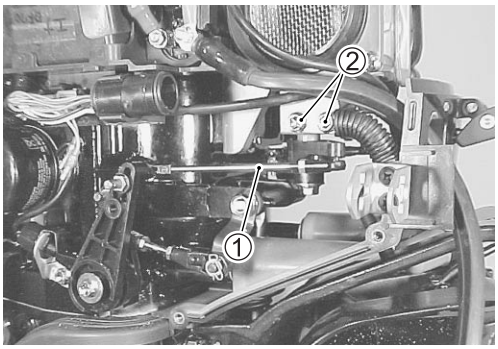
9. Disconnect the water hose ① from the oil pan.
10. Disconnect the water hose ② from the joint.



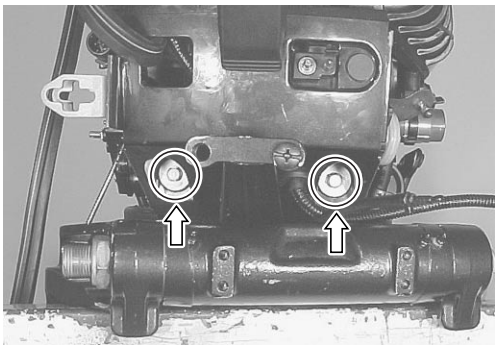
11. Remove the bolt and the low pressure fuel filter with the bracket.



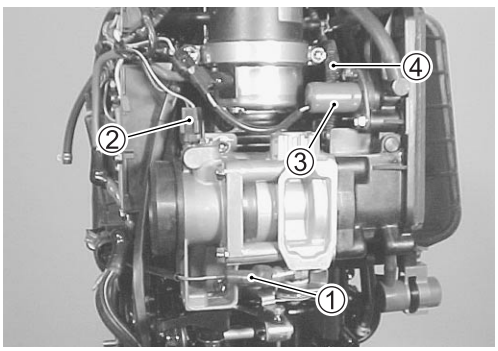
12. Disconnect the throttle rod ①.
13. Remove the two bolts ②.



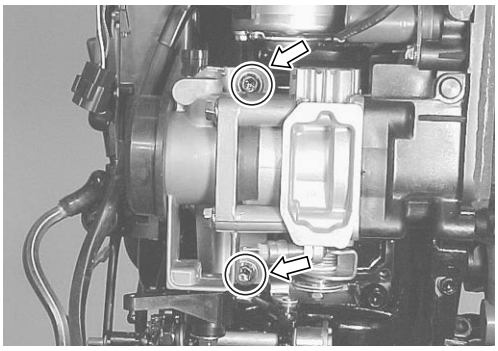
14. Remove the two bolts securing front panel.



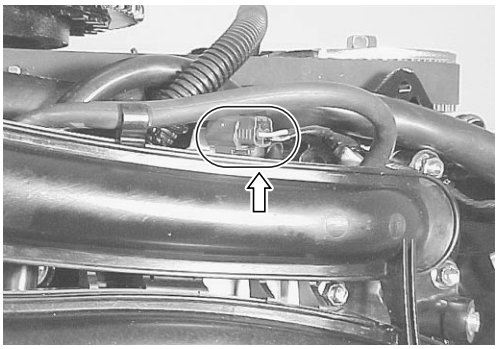
15. Disconnect the wires from the CTP switch ①, the IAT sensor ② and the IAC valve ③.
16. Disconnect the MAP sensor hose ④ from the intake manifold.



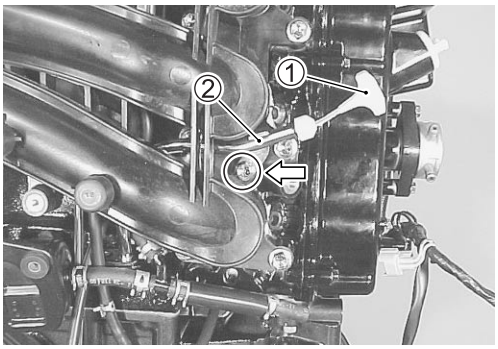
17. Remove the two bolts.



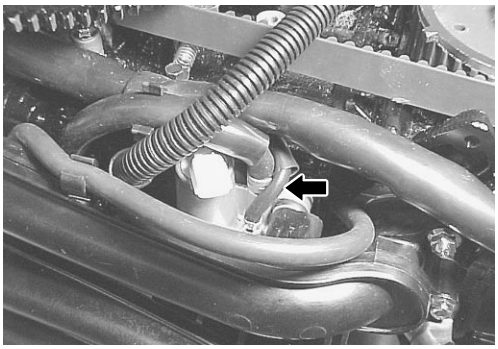
18. Disconnect the wire from the high pressure fuel pump.



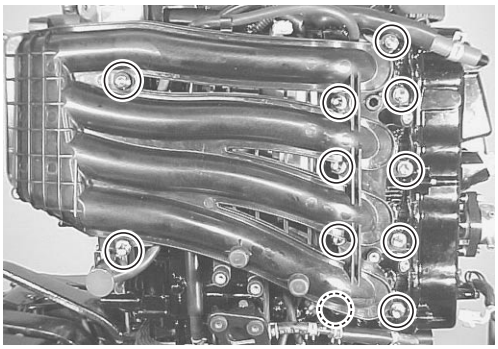
19. Pull out the oil level gauge ①.
20. Remove the bolt and the gauge guide ②.



21. Disconnect the evaporation hose from the fuel vapor separator.



22. Remove the eight bolts and the three nuts.
23. Remove the intake manifold assy.

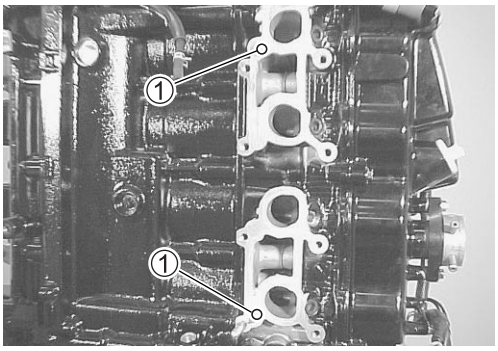


INSTALLATION

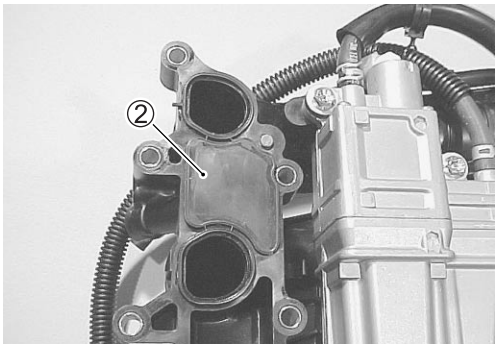
Installation is reverse order of removal with the special attention to the following steps.

CAUTION

Do not re-use the gaskets once removed. Always use new gaskets.

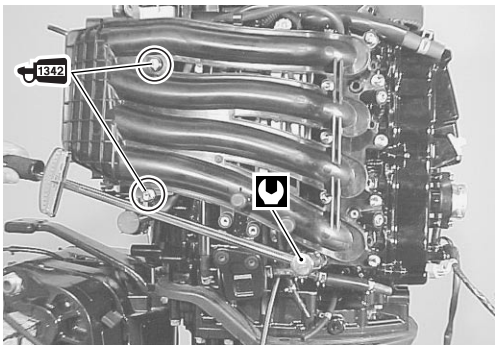


- Install the two dowel pins ① and the gaskets ②.



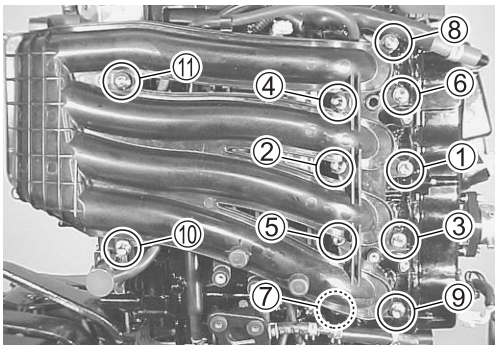
- Apply the thread lock to the two bolts as shown.

1342 99000-32050: THREAD LOCK "1342"



- Tighten the eight bolts and the three nuts according to the numerical order as shown.

Intake manifold bolt/nut: 25 N·m (2.5 kg-m, 18.0 lb-ft)



- Install the fuel injector and the delivery pipe.

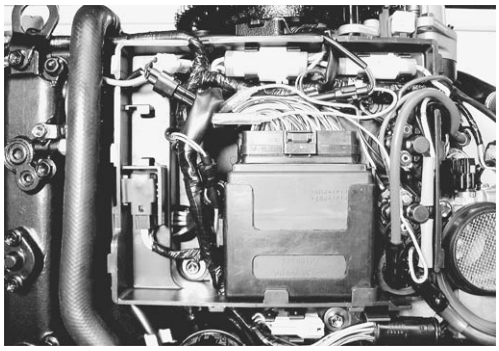
CHECKING

Check hose routing. (See the page 10-8 to 10-12.)
Check wire routing. (See the page 10-2 to 10-7.)
Check for fuel leakage and water leakage.

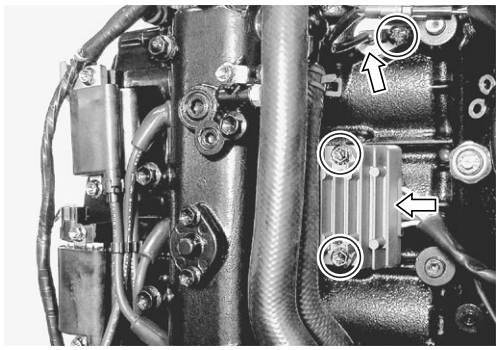
POWER UNIT
REMOVAL

Before removing the power unit:
- **Drain the engine oil.**
- **Remove the intake manifold assy. (See the page 6-2.)**

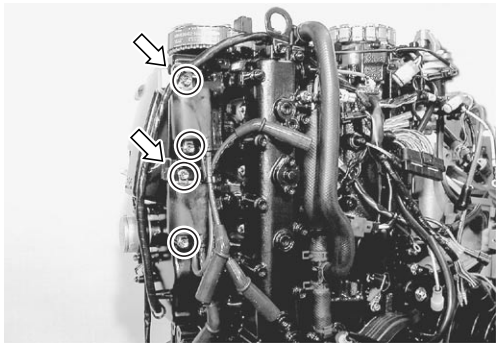
1. Remove the electric parts holder. (See the page 4-17.)



2. Remove the two bolts and the rectifier & regulator.
3. Remove the screw and the cylinder temperature sensor.

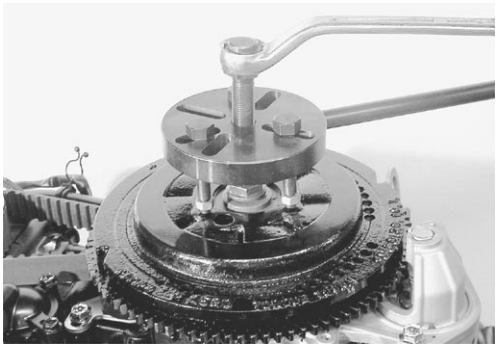


4. Disconnect the spark plug caps from the spark plug.
5. Disconnect the wires from the ignition coils.
6. Remove the four bolts and the ignition coils.

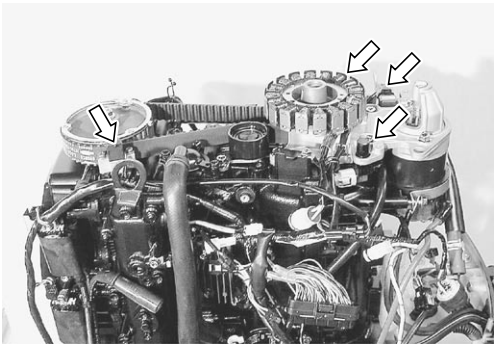


7. Remove the flywheel. (See the page 3-52.)

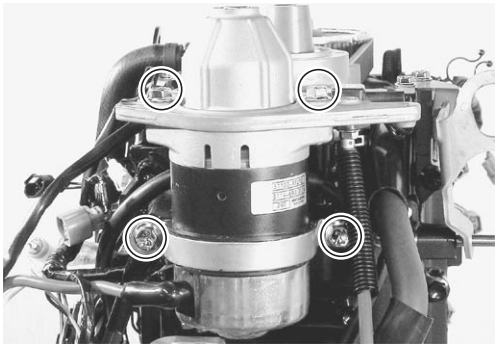
TOOL **09930-48720: Flywheel holder**
09930-39411: Flywheel remover
09930-39420: Flywheel remover bolt



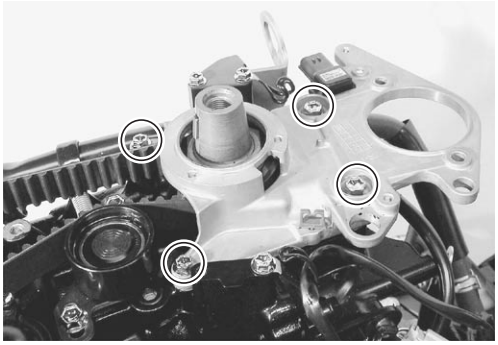
8. Remove the battery charge coil. (See the page 4-4.)
9. Remove the CKP sensor and the CMP sensor. (See the page 3-52.)
10. Disconnect the MAP sensor wire.



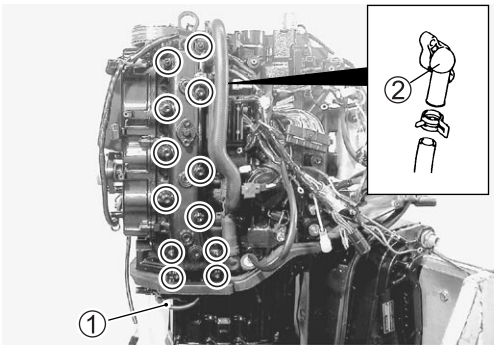
11. Remove the starter motor. (See the page 4-10.)



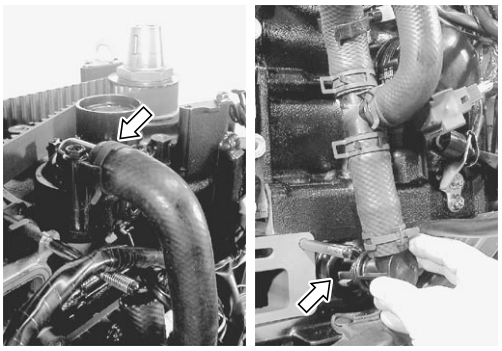
12. Remove the four bolts and the starter motor bracket.



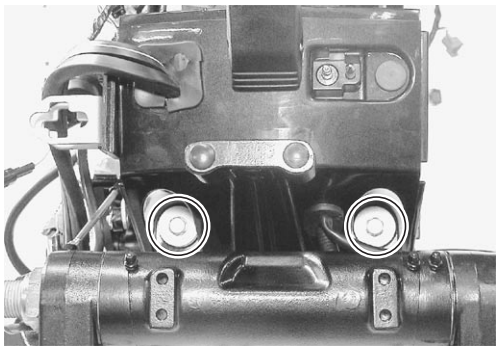
13. Remove the eight bolts, the four nuts and the exhaust manifold.
14. Disconnect the water inspection hose ①.
15. Disconnect the water hose from the water pressure valve cover ②.



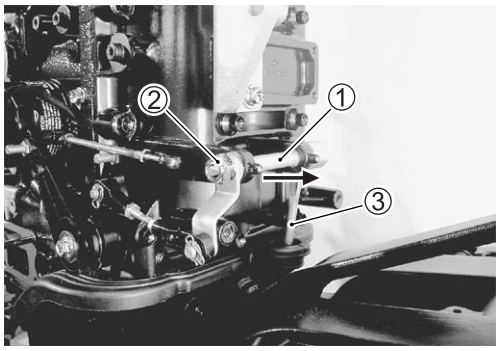
16. Disconnect the water hose from the thermostat cover.
17. Disconnect the elbow joint from the engine holder.



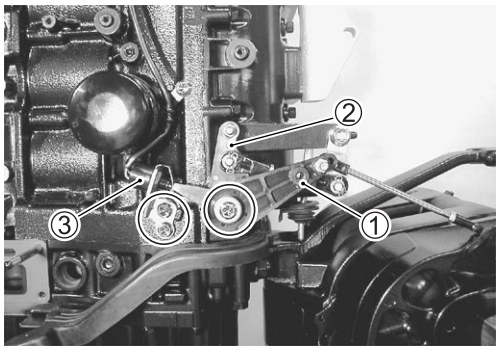
18. Remove the two bolts and the front panel.



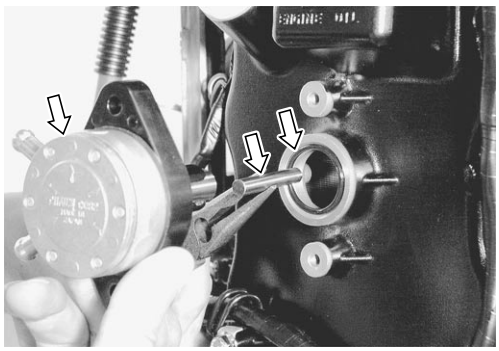
19. Loosen the nut ② and push the clutch shaft ① toward the port side.
20. Disconnect the shift rod ③ from the clutch shaft.



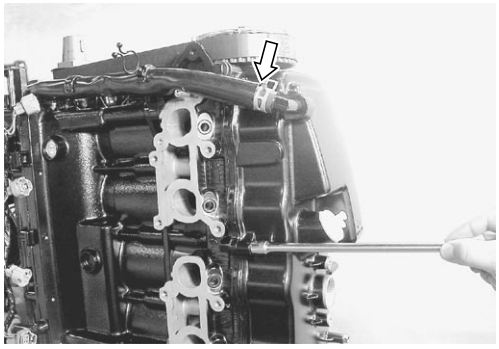
21. Remove the bolt, the throttle control lever ① and the clutch control lever ②.
22. Remove the two bolts and the neutral switch ③ with the bracket.



23. Remove the low pressure fuel pump, the O-ring and the pump rod. (See the page 5-13.)



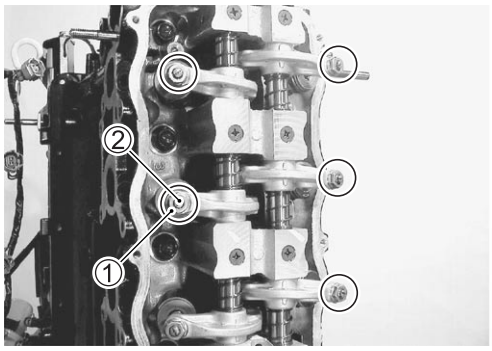
24. Remove the six bolts and cylinder head cover.
25. Disconnect the breather hose from cylinder head cover.



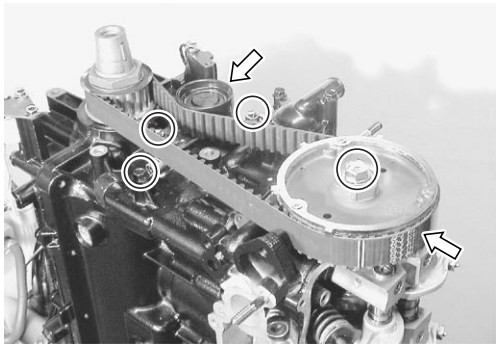
26. Loosen all valve adjusting lock nuts ①.
27. Loosen all valve adjusting screws ② fully.

CAUTION

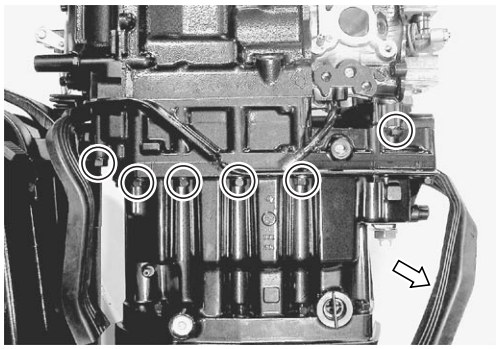
To prevent valve damage, loosen the valve adjusting lock nuts and the valve adjusting screws fully before removing the timing belt.



28. Remove the three bolts and timing belt tensioner ①.
29. Remove the cam pulley bolt, then remove the timing belt with the cam pulley. (See the page 2-12.)

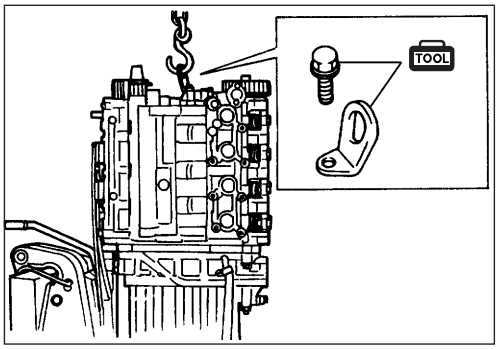


30. Remove the side cover seal from the engine holder.
31. Remove the ten bolts and the two nuts.



32. Install the engine hook as shown position.
33. Lift up and remove the power unit from the engine holder.

TOOL 11291-91850: Engine hook
01150-08207: Bolt



⚠ WARNING

Never use the engine hook (part no. 11291-91850) when lifting whole outboard motor. This hook must be used only when removing or installing power unit.

INSTALLATION

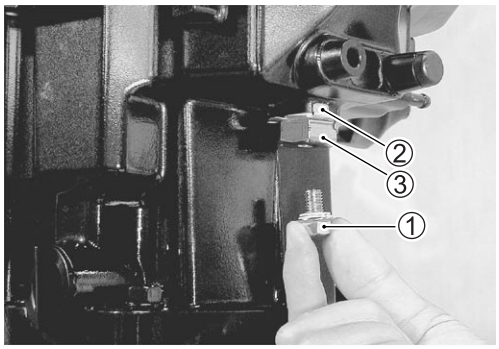
Installation is reverse order of removal with the special attention to the following steps.

CAUTION

Do not re-use the gasket once removed. Always use a new gasket.

BEFORE INSTALLATION

1. Remove the plug ① with the gasket.
2. Drive the locking edges of the lock washer ②.
3. Remove the oil pump stopper ③ from the oil pan.



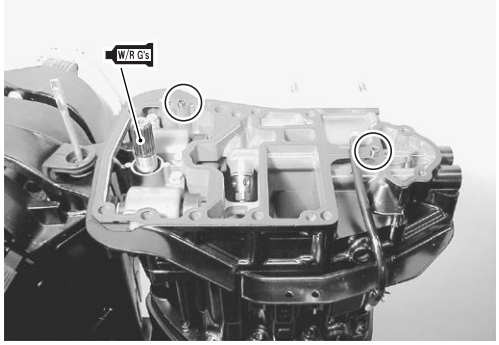
POWER UNIT INSTALLATION

1. Set the two dowel pins and the gasket.
2. Apply the grease to the drive shaft splines.

W/R G's 99000-25160: Suzuki Water Resistant Grease

3. Install the power unit to the engine holder.

NOTE:
Rotate the crankshaft to aid alignment of the drive shaft and the crankshaft splines.

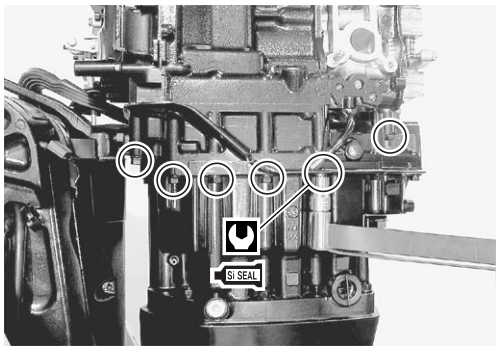


4. Apply the seal to the bolts and the nuts.

SI SEAL 99000-31120: Suzuki Silicone Seal

5. Tighten the ten bolts and the two nuts.

Power unit mounting bolt / nut:
8 mm 23 N·m (2.3 kg-m, 16.5 lb-ft)
10 mm 50 N·m (5.0 kg-m, 36.0 lb-ft)



OIL PUMP SHAFT ENGAGEMENT

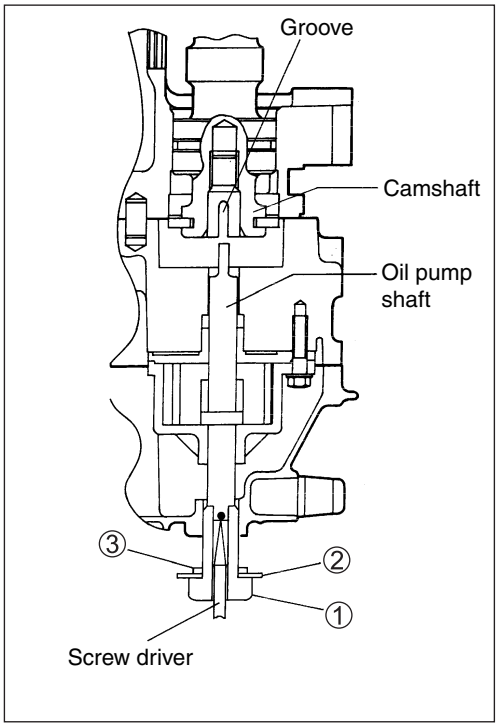
1. Screw (2 – 3 turns) the oil pump stopper ① with the lock washer ② and the gasket ③ onto the oil pan.

CAUTION

Do not screw the oil pump shaft stopper fully before engaging the oil pump shaft with the groove in the camshaft.

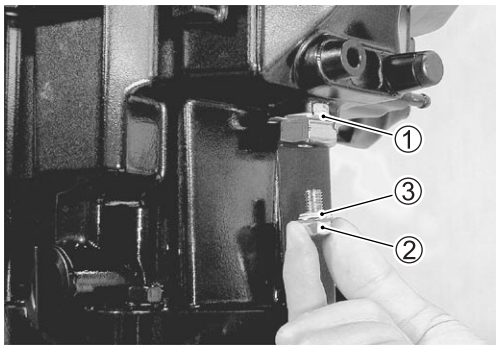
2. Engage the oil pump shaft with the groove in the camshaft by using a screw driver as shown.
   While holding the screw driver, tighten the oil pump stopper ①.

Oil pump stopper: 50 N·m (5.0 kg-m, 36.0 lb-ft)



3. Bent two locking edges of the lock washer ① toward the opposite direction each other. (upward and downward)
4. Tighten the plug ② with the gasket ③.

Oil pump stopper plug: 23 N·m (2.3 kg-m, 16.5 lb-ft)



EXHAUST MANIFOLD

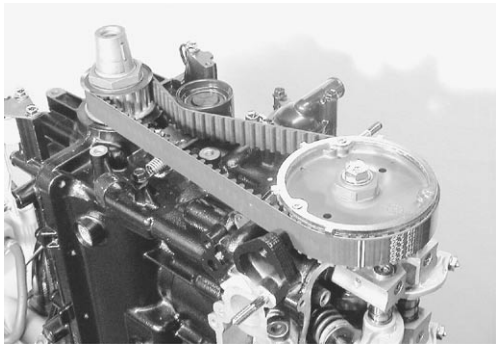
Install the exhaust manifold.

Exhaust manifold bolt / nut: 23 N·m (2.3 kg-m, 16.5 lb-ft)

TIMING BELT

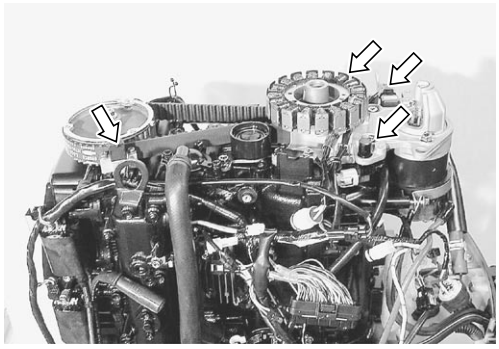
Install the timing belt, the cam pulley and the belt tensioner. (See the page 2-12.)

Cam pulley bolt: 60 N·m (6.0 kg-m, 43.5 lb-ft)



FLYWHEEL

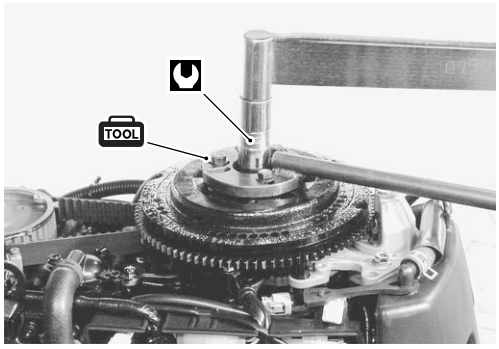
1. Install the battery charge coil. (See the page 4-5.)
2. Install the CKP sensors and the CMP sensor. (See the page 3-52.)
3. Connect the MAP sensor wire.



4. Install the flywheel. (See the page 3-52.)

Flywheel bolt: 190 N·m (19.0 kg-m, 137.5 lb-ft)

09930-48720: Flywheel holder

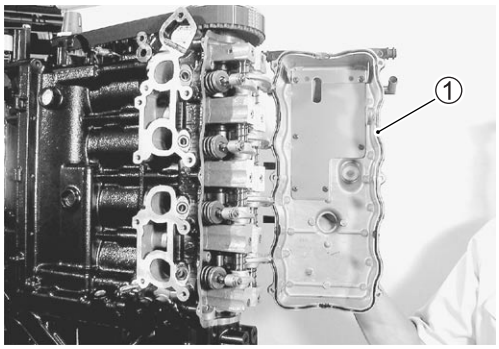


CYLINDER HEAD COVER

1. Install the gasket ① on the cylinder head cover.
2. Tighten the six bolts.

Cylinder head cover bolt: 10 N·m (1.0 kg-m, 7.0 lb-ft)

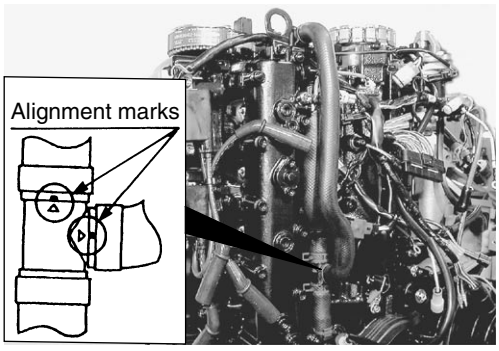
NOTE:
Before installing the cylinder head cover, adjust the valve clearance. (See the page 2-9.)



WATER HOSE

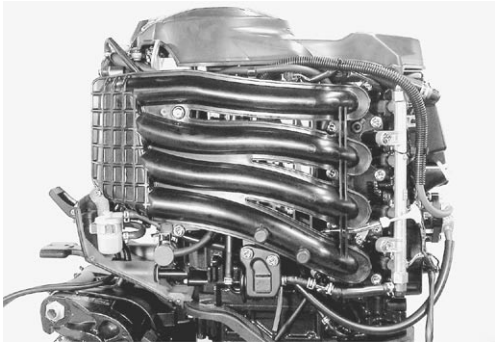
Install the water hoses.

NOTE:
Align the mark on the each hose with the marks on the 3-way joint as shown.



INTAKE MANIFOLD / FUEL INJECTOR / DELIVERY PIPE

1. Install the intake manifold assy. (See the page 6-5.)
2. Install the fuel injector and the delivery pipe. (See the page 5-12.)



FINAL ASSEMBLY CHECK

Perform the following checks in order to ensure proper and safe operation of the repaired unit.

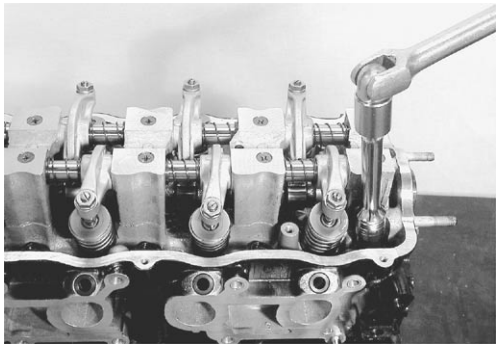
- All parts removed have been returned to the original positions.
- Lower unit gear engagement is properly adjusted.
- Fuel hose routing matches the service manual illustration. (See the page 10-8 to 10-10.)
- Wire routing matches the service manual illustration. (See the page 10-2 to 10-7.)
- No fuel leakage is evident.
- No water leakage is evident during final test running.

CYLINDER HEAD ASSY

REMOVAL

Before removing the cylinder head assy:
- **Remove the power unit. (See page 6-6.)**

1. Remove the ten bolts.
2. Remove the cylinder head assy and the gasket.

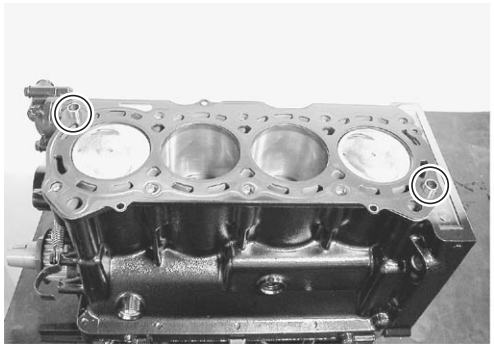


INSTALLATION

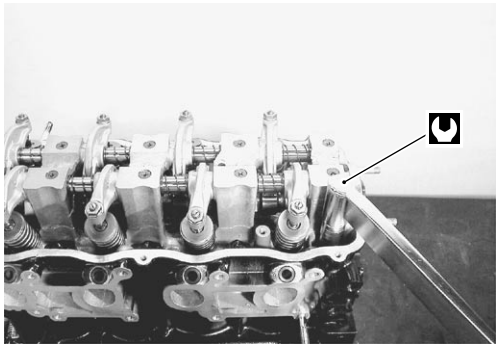
Installation is reverse order of removal with the special attention to the following steps.

CAUTION

Do not re-use the gasket once removed. Always use a new gasket.



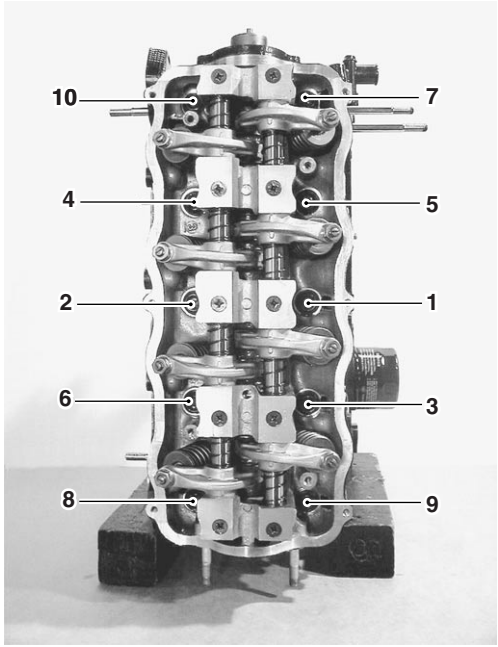
1. Install the gasket and the two dowel pins.
2. Install the cylinder head to the cylinder block.
3. Apply engine oil lightly to the cylinder head bolts.
4. Tighten the bolts to 50 percent (%) of the specified torque according to the numerical order in the figure.



Cylinder head bolt (50% torque):
1st step 37 N·m (3.7 kg-m, 27.0 lb-ft)

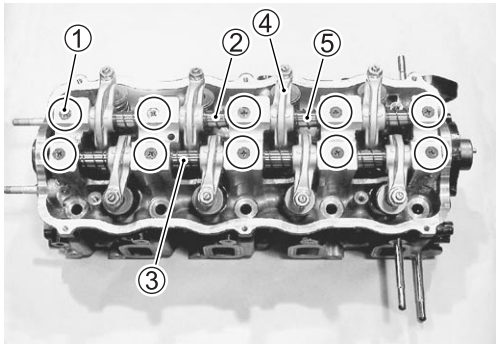
5. Loosen all bolt to 0 N·m (0 kg-m, 0 lb-ft) according to the reverse order. (2nd step)
6. Finally tighten the bolts to the specified torque in two steps according to the numerical order in the figure.

Cylinder head bolt:
3rd step 37 N·m (3.7 kg-m, 27.0 lb-ft)
Final step 73 N·m (7.3 kg-m, 53.0 lb-ft)

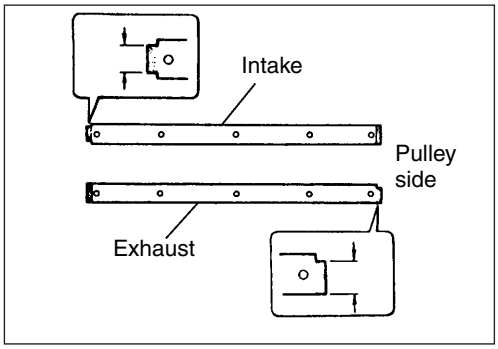


DISASSEMBLY

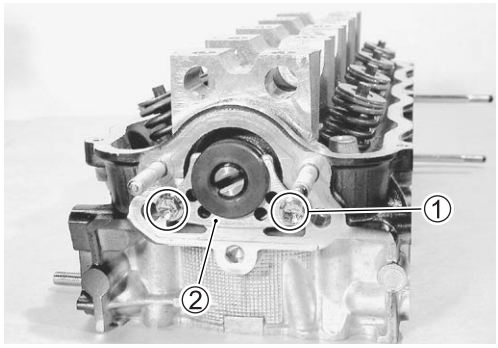
1. Remove the ten screws ①.
2. Remove the intake rocker arm shaft ② and the exhaust rocker arm shaft ③.
3. Remove all rocker arms ④ and all springs ⑤.



NOTE:
The intake rocker arm shaft differs from the exhaust one in shape as shown.



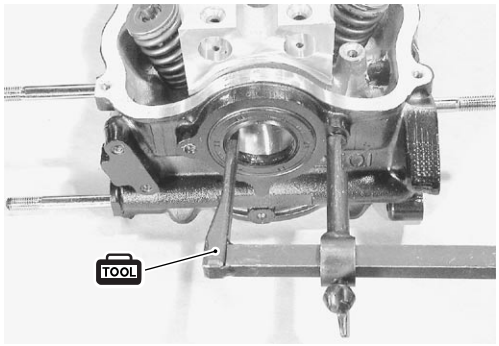
4. Remove the two bolts ① and the camshaft thrust plate ②.



5. Remove the oil seal using the special tool.

TOOL 09913-50121: Oil seal remover

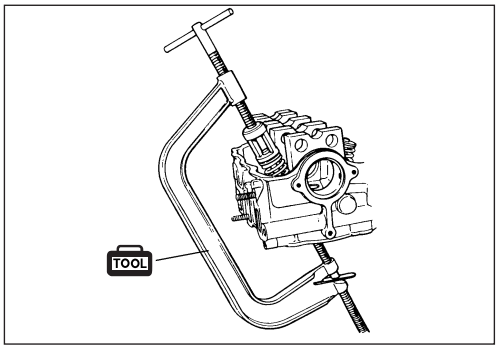
6. Remove the camshaft pulling toward the pulley side.

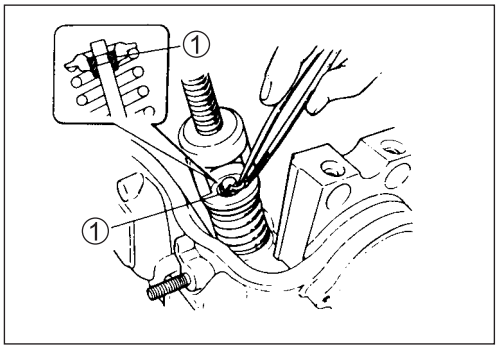


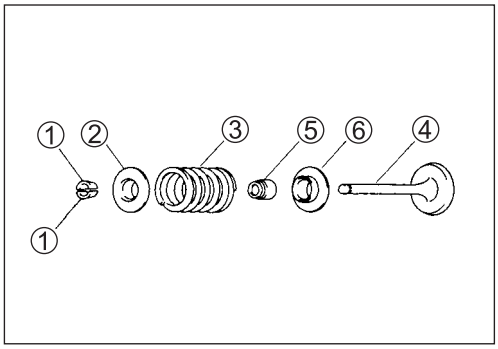
7. Remove the valve cotters ① while compressing the valve spring.
8. Remove the valve spring retainer ②, the valve spring ③ and the valve ④.

09916-14510: Valve lifter
09916-48210: Attachment
09916-84511: Tweezers

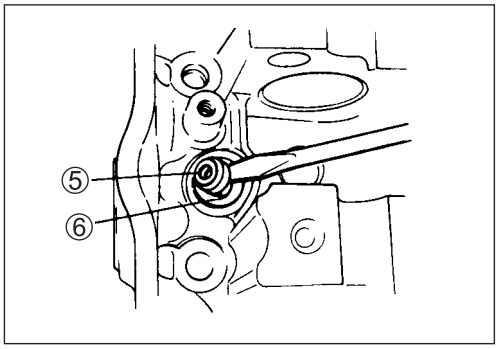
NOTE:
Reassemble each valve and valve spring to their original positions.







9. Remove the valve stem seal ⑤ and the valve spring seat ⑥.



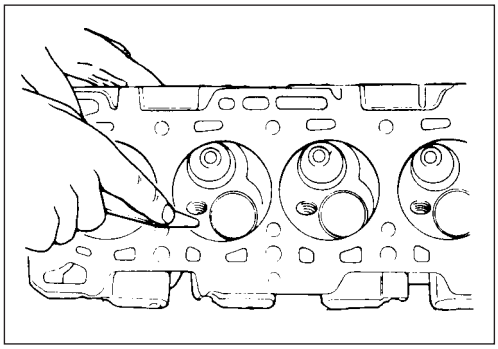
INSPECTION / SERVICING

NOTE:
If crack, excessive wear or other damage is found on any component, replace.

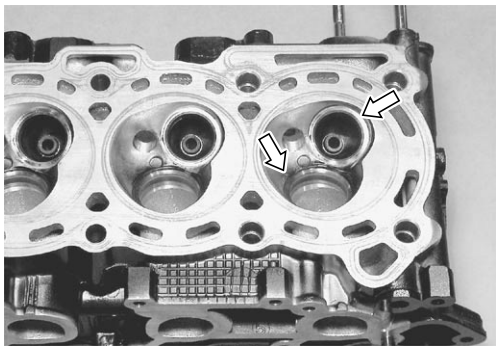
CYLINDER HEAD

1. Remove all carbon from the combustion chamber.

NOTE:
- *Do not use any sharp edged tool to scrape carbon off the cylinder head or the head components.*
- *Be careful not to scuff or nick the metal surfaces when decarboning.*



2. Inspect the intake ports, the exhaust ports, the combustion chambers and the head surface.
   If crack or other damage is found, replace the cylinder head.

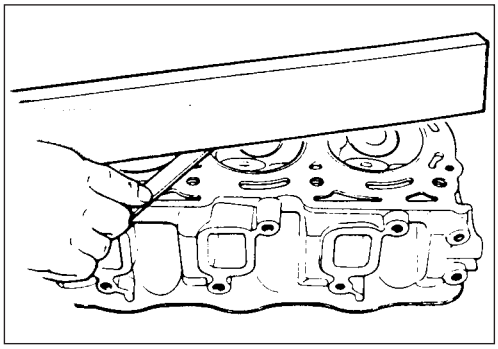


Valve seat
Check the valve seat.
If crack or other damage is found, replace the cylinder head.

Cylinder head distortion
Measure the cylinder head distortion (gasketed surface) at a total of 6 locations as shown.

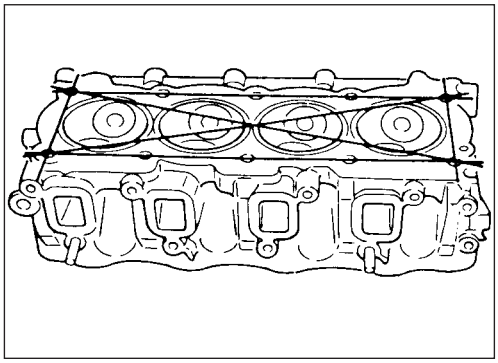
TOOL 09900-20803: Thickness gauge
Straight gauge

Service limit: 0.05 mm (0.002 in)



If the measurement exceeds the service limit, resurface or replace the cylinder head.

NOTE:
The cylinder head can be resurfaced, using a surface plate and #400 grit wet sandpaper. Move the cylinder head in a figure eight pattern when sanding.

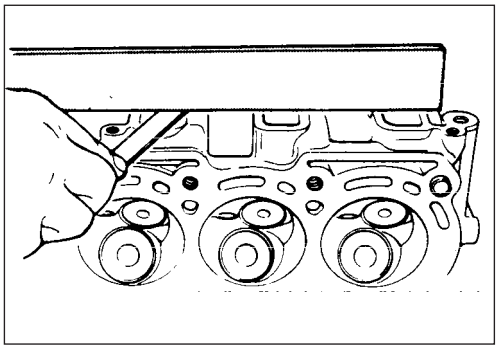


Intake manifold seating faces distortion
Measure the intake manifold seating faces distortion.

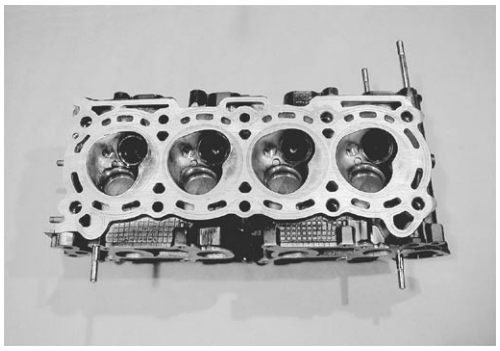
TOOL 09900-20803: Thickness gauge
Straight gauge

Service limit: 0.10 mm (0.004 in)

If the measurement exceeds the service limit, resurface or replace the cylinder head.



Water jackets
Inspect the water jackets.
If clog or obstruction is found, clean the water jacket.



CAMSHAFT

Cam height
Measure the cam height Ⓗ.

TOOL 09900-20202: Micrometer

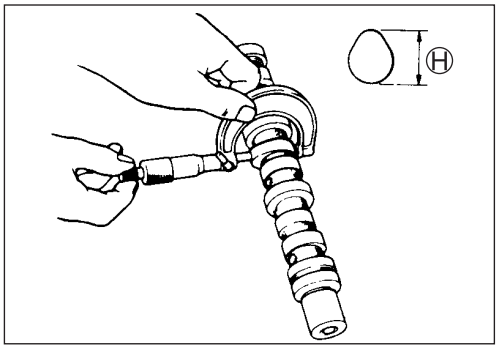
Standard:

DF60	**IN**	**38.061 – 38.221 mm (1.4985 – 1.5048 in)**
	EX	**38.059 – 38.219 mm (1.4984 – 1.5047 in)**
DF70	**IN**	**37.631 – 37.791 mm (1.4815 – 1.4878 in)**
	EX	**37.629 – 37.789 mm (1.4815 – 1.4878 in)**

Service limit:

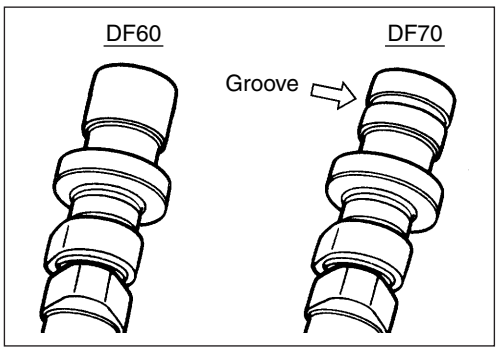
DF60	**IN**	**37.961 mm (1.4945 in)**
	EX	**37.959 mm (1.4944 in)**
DF70	**IN**	**37.531 mm (1.4776 in)**
	EX	**37.529 mm (1.4775 in)**

If the measurement exceeds the service limit, replace the camshaft.



Camshaft identification

DF60	Without groove
DF70	With groove



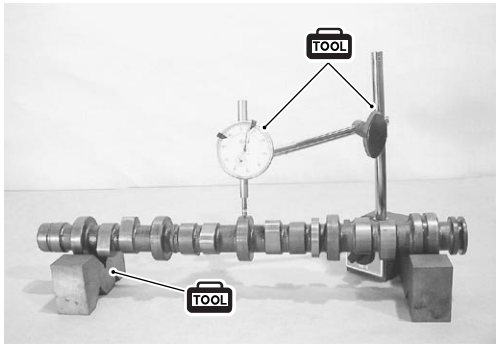
Camshaft runout

Measure the camshaft runout.

TOOL 09900-20602: Dial gauge
09900-20701: Magnetic stand
09900-21304: Steel "V" block set

Service limit: 0.10 mm (0.004 in)

If the measurement exceeds the service limit, replace the camshaft.



Camshaft journal oil clearance

Standard : 0.050 – 0.091 mm (0.0020 – 0.0036 in)
Service limit: 0.150 mm (0.0059 in)

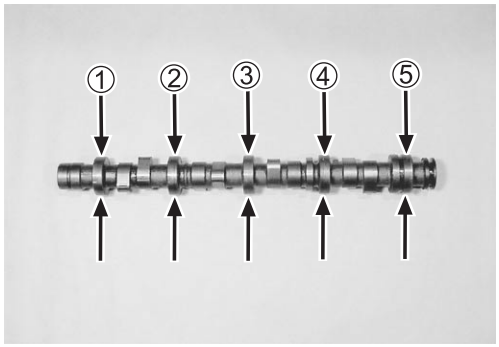
If the measurement exceeds the service limit, replace the camshaft and/or the cylinder head.

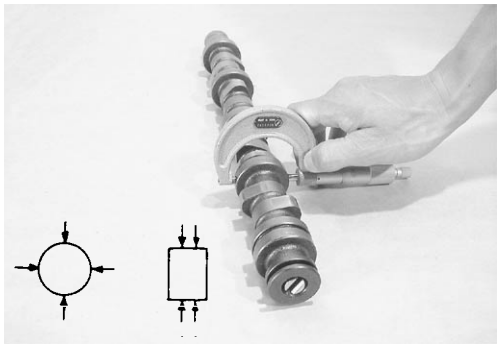
To check the clearance, measure the following items:
- Camshaft journal outside diameter (5 locations)
- Camshaft holder inside diameter (5 locations)

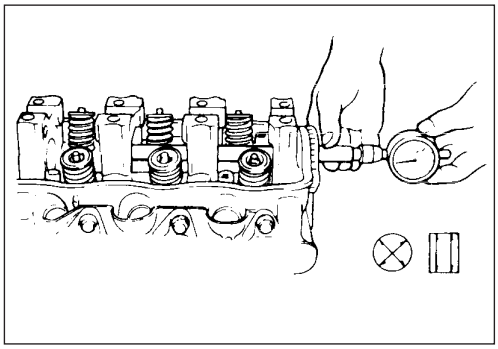
TOOL 09900-20202: Micrometer
Small bore gauge or Dial calipers

Standard:

Position	Camshaft journal outside diameter	Camshaft holder inside diameter
①	44.925 – 44.950 mm (1.7687 – 1.7697 in)	45.000 – 45.016 mm (1.7717 – 1.7723 in)
②	44.725 – 44.750 mm (1.7608 – 1.7618 in)	44.800 – 44.816 mm (1.7638 – 1.7644 in)
③	44.525 – 44.550 mm (1.7530 – 1.7539 in)	44.600 – 44.616 mm (1.7559 – 1.7565 in)
④	44.325 – 44.350 mm (1.7451 – 1.7461 in)	44.400 – 44.416 mm (1.7480 – 1.7487 in)
⑤	44.125 – 44.150 mm (1.7372 – 1.7382 in)	44.200 – 44.216 mm (1.7402 – 1.7408 in)



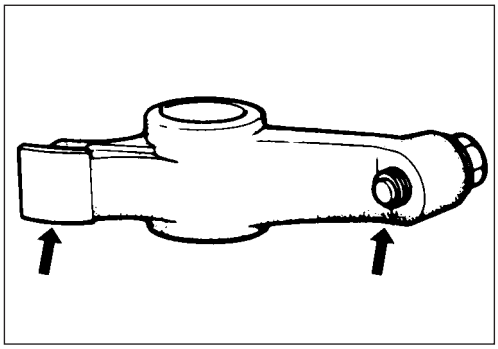




ROCKER ARM / SHAFT

Rocker arm wear

Inspect the arm-riding face and the tip of the adjusting screw.
If excessive wear is found, replace the rocker arm and/or the adjusting screw.

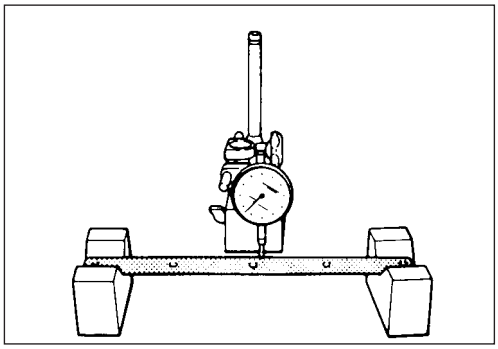


Rocker arm shaft runout

TOOL 09900-20602: Dial gauge
09900-20701: Magnetic stand
09900-21304: Steel "V" block set

Service limit: 0.12 mm (0.005 in)

If the measurement exceeds the service limit, replace the rocker arm shaft.



Rocker arm shaft to rocker arm clearance

Standard : 0.012 – 0.045 mm (0.0005 – 0.0018 in)
Service limit: 0.090 mm (0.0035 in)

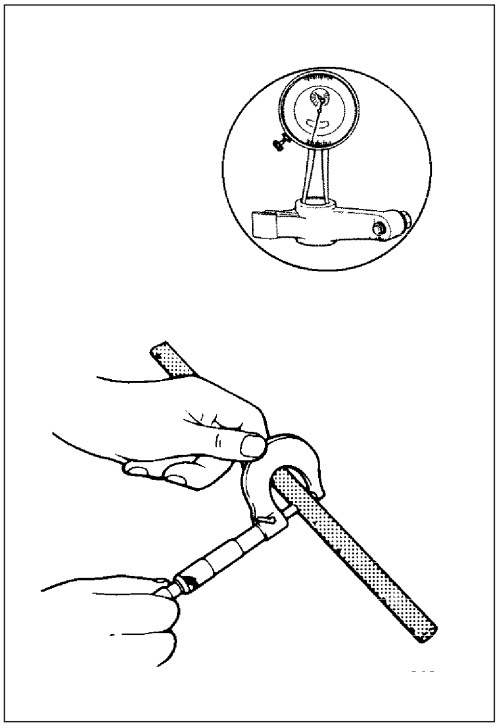
If the measurement exceeds the service limit, replace the rocker arm and/or the rocker arm shaft.

To check the clearance, measure the following items:
- Rocker arm shaft outside diameter
- Rocker arm inside diameter

TOOL 09900–20205: Micrometer
09900–20605: Dial calipers

Standard:

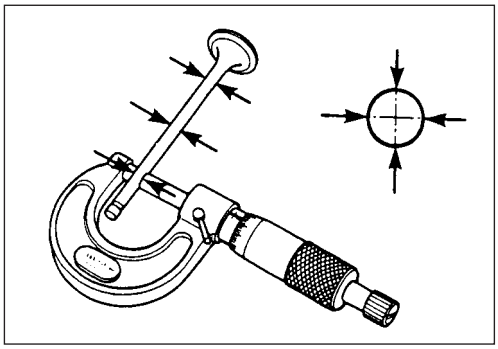
Rocker arm shaft outside diameter	Rocker arm inside diameter
15.973 – 15.988 mm (0.6289 – 0.6294 in)	16.000 – 16.018 mm (0.6299 – 0.6306 in)



VALVE / VALVE GUIDE

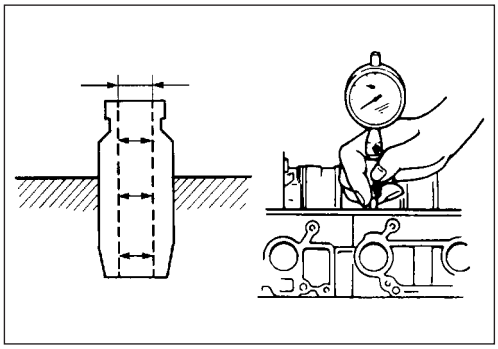
Valve guide to valve stem clearance

Standard : IN 0.020 – 0.050 mm (0.0008 – 0.0020 in)
EX 0.045 – 0.075 mm (0.0018 – 0.0030 in)
Service limit: IN 0.070 mm (0.0028 in)
EX 0.090 mm (0.0035 in)



If the measurement exceeds the service limit, replace the valve and/or the valve guide.

To check the clearance, measure the following items:
- Valve stem outside diameter
- Valve guide inside diameter



TOOL 09900-20205: Micrometer
Small bore gauge or Dial calipers

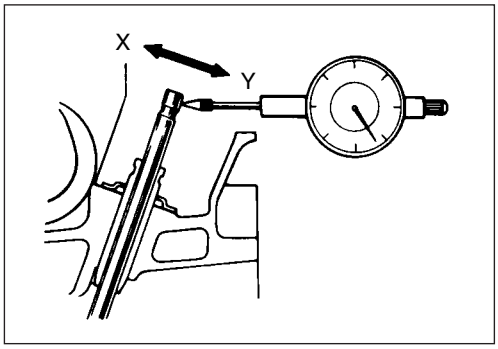
Standard:

	Valve stem outside diameter	Valve guide inside diameter
IN	6.965 – 6.980 mm (0.2742 – 0.2748 in)	7.000 – 7.015 mm (0.2756 – 0.2762 in)
EX	6.940 – 6.955 mm (0.2732 – 0.2738 in)	7.000 – 7.015 mm (0.2756 – 0.2762 in)

If you are unable to measure the valve guide inside diameter, measure the "Valve stem end deflection".

Valve stem end deflection

Measure the valve stem end deflection as follows:
1. Install the valve into the valve guide.
2. Position the valve head at approx. 10 mm away from the valve seat.
3. Move the stem end in the direction "X – Y", and measure the deflection.



TOOL 09900-20602: Dial gauge
09900-20701: Magnetic stand

Service limit: IN 0.14 mm (0.006 in)
EX 0.18 mm (0.007 in)

If the measurement exceeds the service limit, replace the valve. If the measurement still exceeds the service limit with a new valve, replace the valve guide.

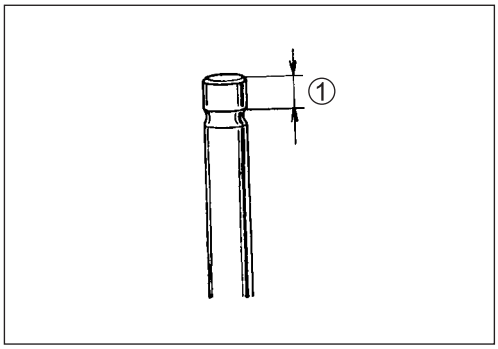
NOTE:
For the valve guide replacement, see the "VALVE GUIDE REPLACEMENT" section on the page 6-23.

Valve stem end length
Measure the valve stem end length ①.

TOOL 09900-20102: Vernier calipers

Service limit: IN & EX 6.05 mm (0.238 in)

If the measurement exceeds the service limit, replace the valve.

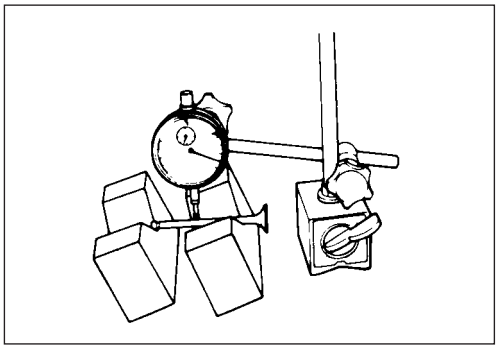


Valve stem runout
Measure the valve stem runout.

TOOL 09900-20602: Dial gauge
09900-20701: Magnetic stand
09900-21304: Steel "V" block set

Service limit: IN & EX 0.05 mm (0.002 in)

If the measurement exceeds the service limit, replace the valve.

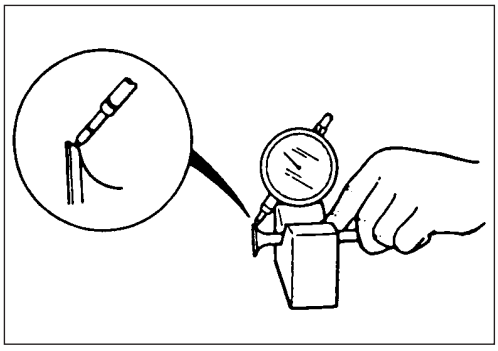


Valve head radial runout
Measure the valve head radial runout.

TOOL 09900-20602: Dial gauge
09900-20701: Magnetic stand
09900-21304: Steel "V" block set

Service limit: IN & EX 0.08 mm (0.003 in)

If the measurement exceeds the service limit, replace the valve.

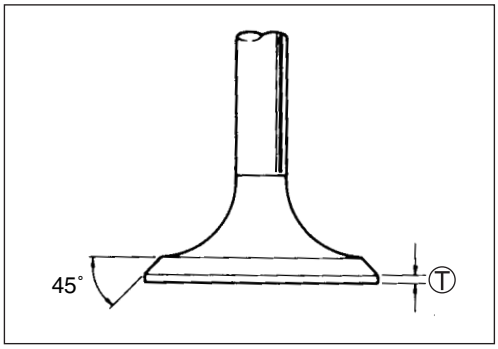


Valve head thickness
Measure the valve head thickness Ⓣ.

TOOL 09900-20102: Vernier Calipers

Standard : IN & EX 1.0 mm (0.04 in)
Service limit: IN 0.6 mm (0.02 in)
EX 0.7 mm (0.03 in)

If the measurement exceeds the service limit, replace the valve.

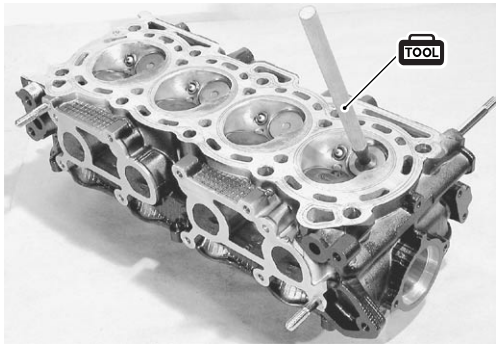


Valve seating contact width

Measure the valve seating contact width Ⓐ as follows:

1. Coat the valve seat evenly with Prussian blue (or equivalent).
2. Install the valve into the valve guide.
3. Put the valve lapper on the valve.

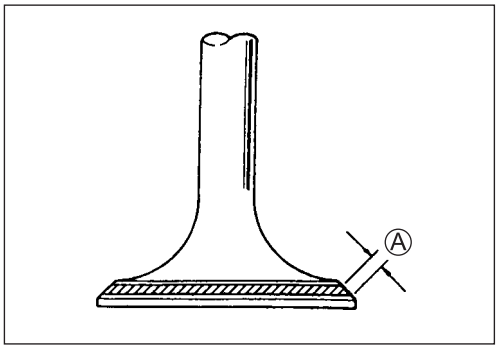
TOOL 09916-10911: Valve lapper



4. Rotate the valve while gently tapping the valve contact area against the seat.
5. Continuously pattern on the valve seating face with Prussian blue.
6. Measure the valve seating contact width Ⓐ.

TOOL 09900-20102: Vernier calipers

Standard: IN & EX 1.3 – 1.5 mm (0.05 – 0.06 in)



If the measurement is out of the specification, service the valve seat.

NOTE:

For the valve seat servicing, see the "VALVE SEAT SERVICING" section on the page 6-24.

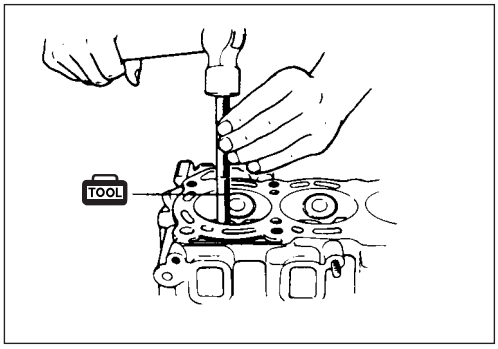
VALVE GUIDE REPLACEMENT

CAUTION

Be careful not to damage the cylinder head when replacing the valve guide.

1. Drive the valve guide out toward the valve spring side.

TOOL 09916-44511: Valve guide remover / installer

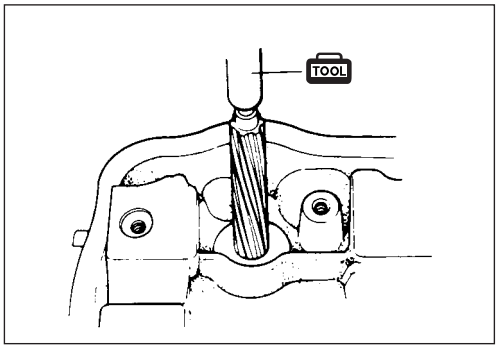


2. Refinish the valve guide hole.

TOOL 09916-37310: Valve guide reamer (ϕ12 mm)
09916-34542: Valve guide reamer handle

NOTE:

Turn the reamer clockwise, never counterclockwise.



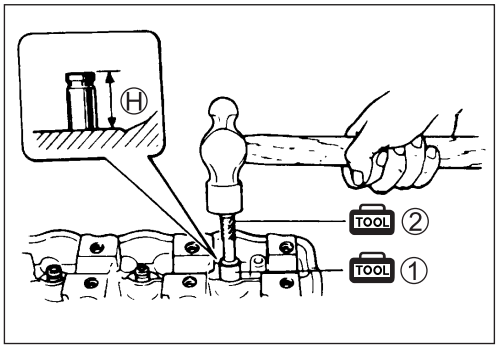
3. Drive in the valve guide until the tool ① contacts the cylinder head.

TOOL 09917-88210: Valve guide installer attachment – ①
09916-57321: Valve guide installer – ②

4. Measure the valve guide protrusion Ⓗ.

TOOL 09900-20102: Vernier calipers

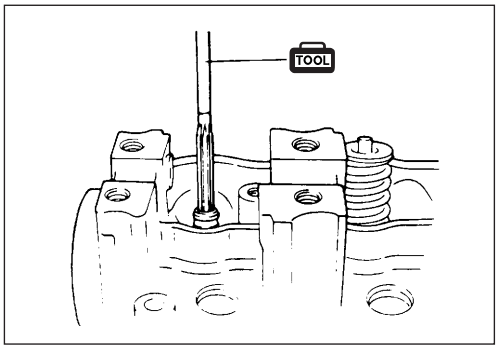
Valve guide protrusion:
Standard: IN & EX 14.0 mm (0.55 in)



5. Refinish the valve guide bore.

TOOL 09916-34520: Valve guide reamer (ϕ7 mm)
09916-34542: Valve guide reamer handle

NOTE:
Clean and oil the valve guide bore when reamed.

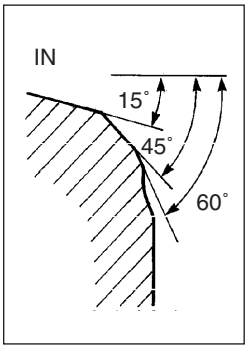


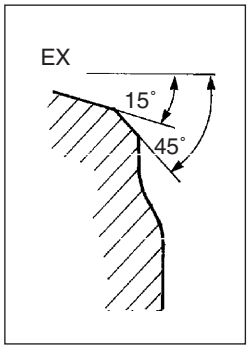
VALVE SEAT SERVICING

If the valve seating contact width is out of the specification, reface the valve seat as follows:

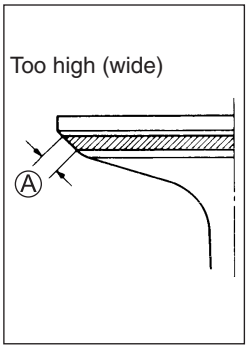
TOOL 09916-24940: Solid pilot (N-150-7)
09916-54910: Handle (N-505)
09916-24935: Valve seat cutter (N-608)
09916-24910: Valve seat cutter (N-212)

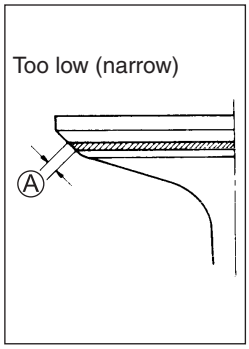
NOTE:
Turn the cutter clockwise, never counterclockwise.





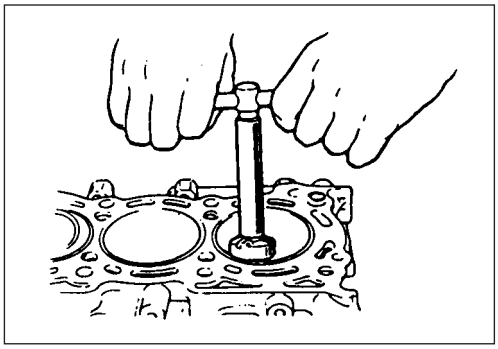
1. Insert the 45° cutter and reface the valve seat.
2. Measure the valve seating contact width Ⓐ. See the "Valve seating contact width" section on the page 6-23.
3. If the width Ⓐ is too high (or wide), reface the valve seat using the 15° cutter.
   If the width Ⓐ is too low (or narrow), reface the valve seat using the 45° cutter.
4. Clean up any burrs using the 45° cutter very lightly.





CAUTION

Grind the seat areas minimally only.
Do not grind more than necessary.

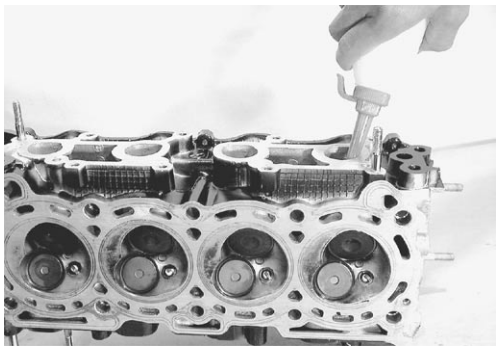


5. Recheck the valve seat contact width Ⓐ.

CAUTION

Do not use lapping compound after the final cut is made. The finished valve seat should have a velvety smooth finish and not a highly polished or shiny finish. This will provide a soft surface for the final seating of the valve which will occur during the first few seconds of engine operation.

NOTE:
Clean and assemble the cylinder head and the valve components. Fill the intake and the exhaust ports with solvent to check for leaks between the valve seat and the valve. If any leaks occur, inspect the valve seat and the face for burrs or other things that could prevent the valve from sealing.



VALVE SPRING

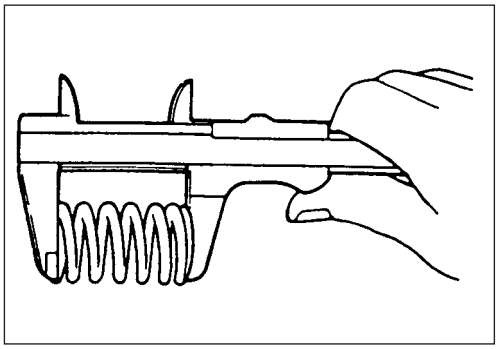
Valve spring free length

Measure the spring free length.

TOOL 09900-20102: Vernier calipers

Standard : 49.3 mm (1.94 in)
Service limit: 48.1 mm (1.89 in)

If the measurement is the lower than the service limit, replace the valve spring.



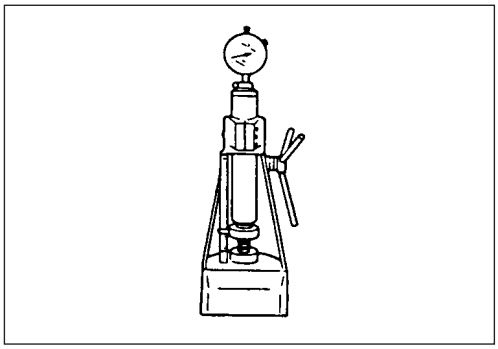
Valve spring tension

Measure the valve spring tension.

TOOL 09900-20102: Vernier caliper

Standard:
24.8 – 29.2 kg (54.7 – 64.3 lbs) for 41.5 mm (1.63 in)
Service limit: 22.8 kg (50.2 lbs) for 41.5 mm (1.63 in)

If the measurement is the lower than the service limit, replace the valve spring.



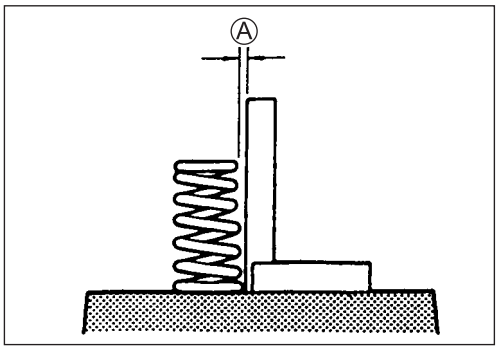
Valve spring sequareness

Measure the valve spring sequareness Ⓐ.

TOOL 09900-20102: Vernier calipers
Sequare plate

Service limit: 2.0 mm (0.08 in)

If the measurement exceeds the service limit, replace the valve spring.



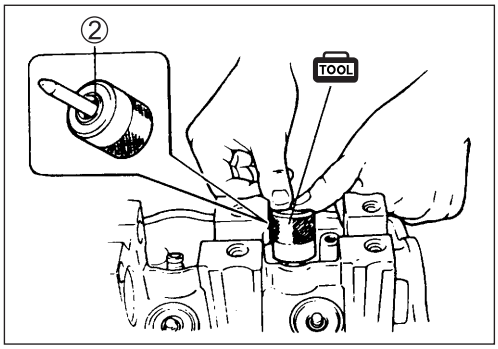
REASSEMBLY

Reassembly is reverse order of disassembly with the special attention to the following steps.

VALVE

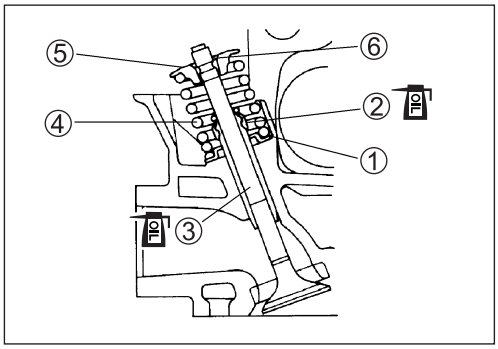
1. Install the valve spring seat ①.
2. Apply the engine oil to the valve stem seal ②.
3. Install the valve stem seal onto the valve guide by pushing the tool with finger tip.

TOOL 09917-98210: Valve stem seal installer



CAUTION

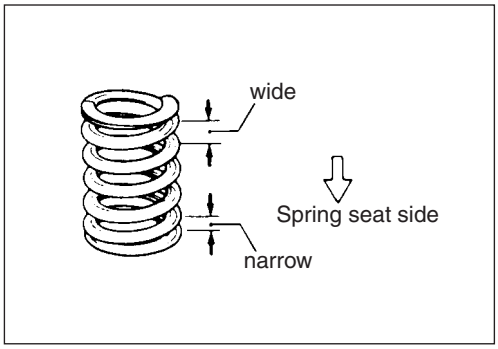
Do not re-use the seal once removed. Always use a new seal.



4. Apply the engine oil to the stem seal, the valve guide bore and the valve stem.
5. Install the valve ③, the valve spring ④, and the valve retainer ⑤.

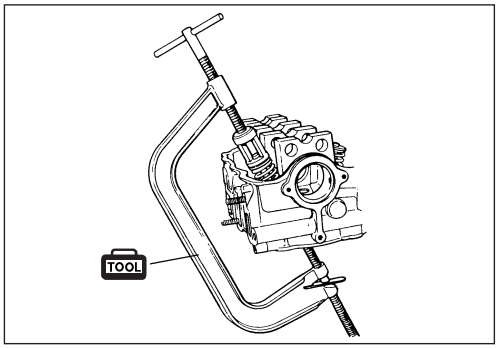
NOTE:

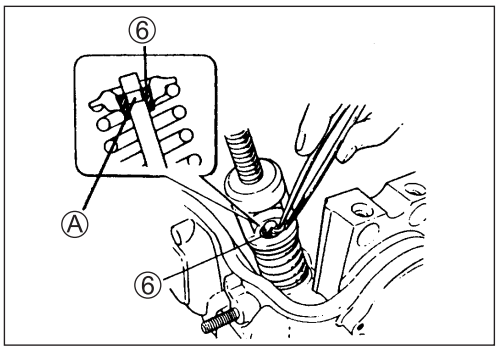
- *Reassemble each valve and valve spring to their original position.*
- *Set the valve spring in place with the narrow spiral area facing the valve spring seat.*



6. Install the valve cotters ⑥ while compressing the valve spring by the tool.
7. Make sure the valve cotters seat in the groove Ⓐ properly.

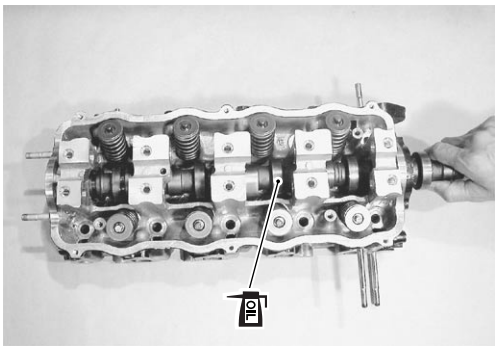
TOOL 09916-14510: Valve lifter
09916-48210: Attachment
09916-84511: Tweezers





CAMSHAFT

1. Apply the engine oil to the camshaft and all holder journals.
2. Install the camshaft from the camshaft pulley side.



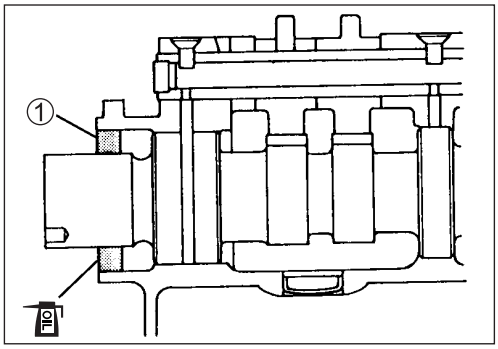
3. Install the camshaft thrust plate by the two bolts.

4. Apply the engine oil to the lip area of the oil seal ①.
5. Press fit the oil seal until its top face is lower than the block face by 0.5 mm.

CAUTION

Do not re-use the seal once removed. Always use a new seal.

6. Make sure the camshaft smoothly rotates by hand.

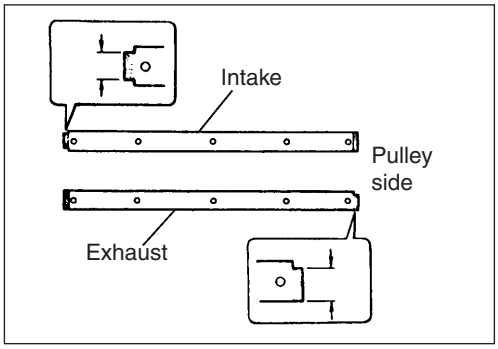


ROCKER ARM / SHAFT

1. Apply the engine oil to the rocker arms and the rocker arm shafts.
2. Install the rocker arms, the rocker arm springs, the intake rocker arm shaft and the exhaust rocker arm shaft.

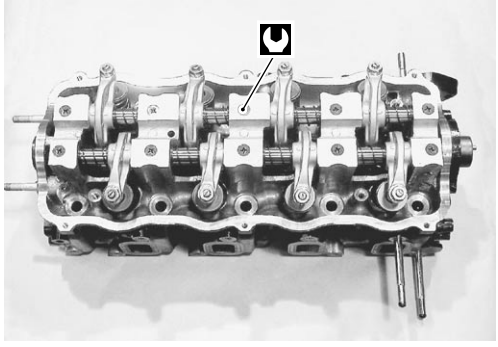
NOTE:

- *Reassemble each rocker arm to its original position.*
- *The intake rocker arm shaft differs from the exhaust one in shape as shown. When assembling, make sure of shaft shape and installing direction.*



3. Tighten the ten screws.

Rocker arm shaft screw: 11 N·m (1.1 kg-m, 8.0 lb-ft)



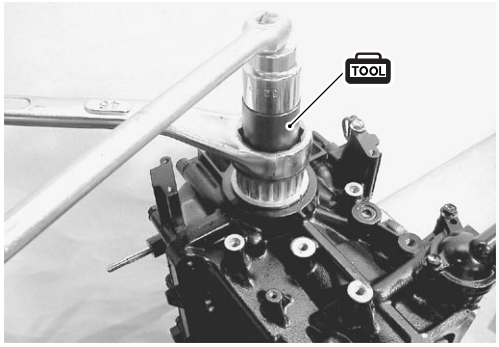
CYLINDER / CRANKSHAFT / PISTON
DISASSEMBLY

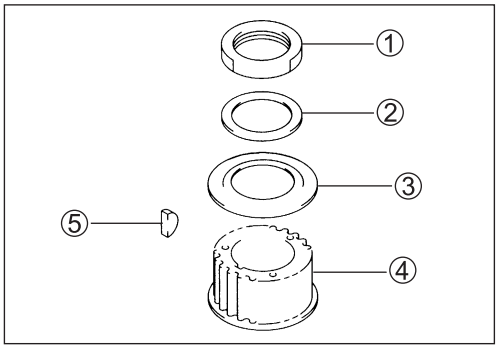
Before disassembling:
- **Remove the power unit. (See the page 6-6.)**
- **Remove the cylinder head assy. (See the page 6-14.)**

1. Remove the timing pulley nut ①.

TOOL 09911-49910: Crankshaft holder

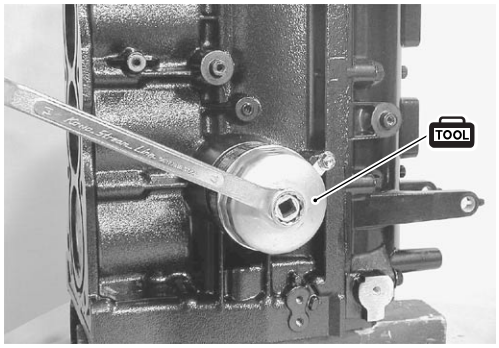
Remove the washer ②, the guide ③, the timing pulley ④ and the key ⑤.



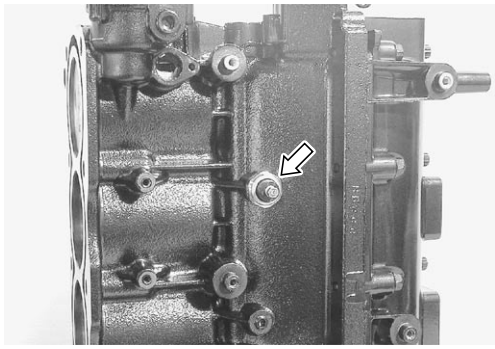


2. Remove the oil filter.

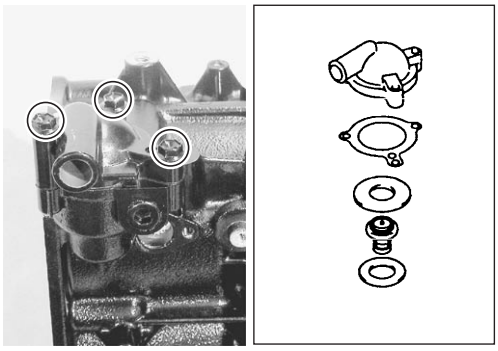
TOOL 09915-47340: Oil filter wrench



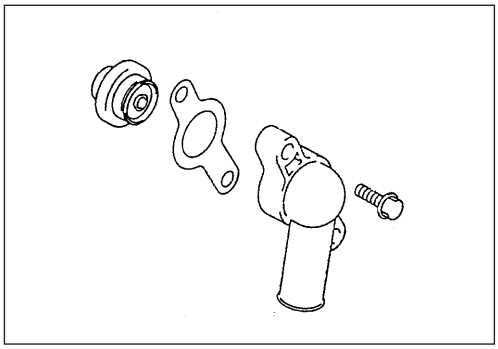
3. Remove the oil pressure switch.



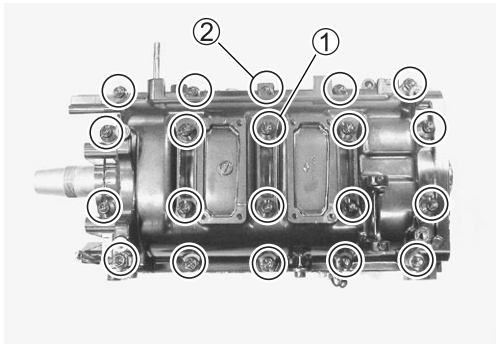
4. Remove the three bolts, the thermostat cover, the gasket, the thermostat and the stopper plates.



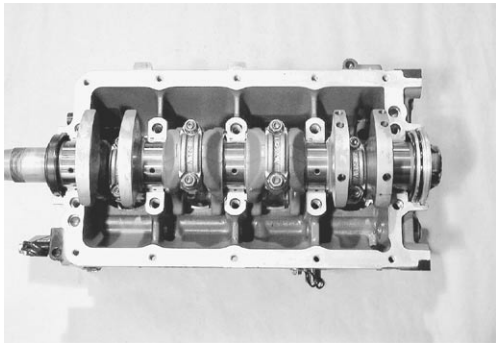
5. Remove the two bolts, the water pressure valve cover, the gasket and the water pressure valve from the exhaust manifold.



6. Remove the ten M10-bolts ①.
7. Remove the ten M8-bolts ②.
8. Remove the crankcase from the cylinder block.

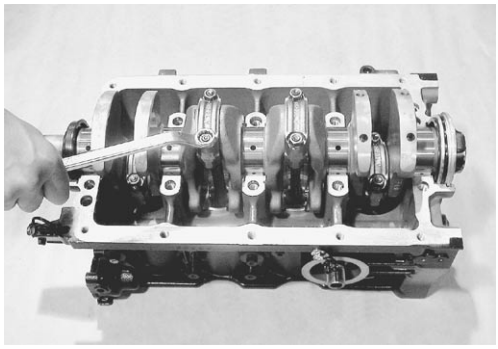


NOTE:
For proper assembly, mark the cylinder number on all conrod caps using quick dry paint.

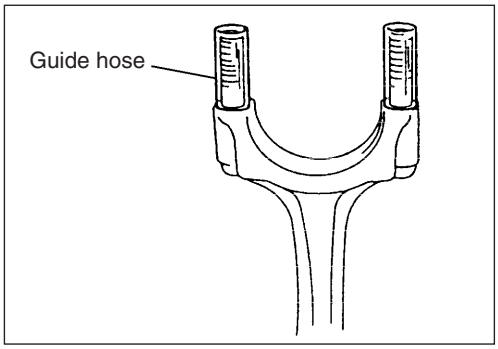


9. Remove all conrod cap nuts and conrod caps.

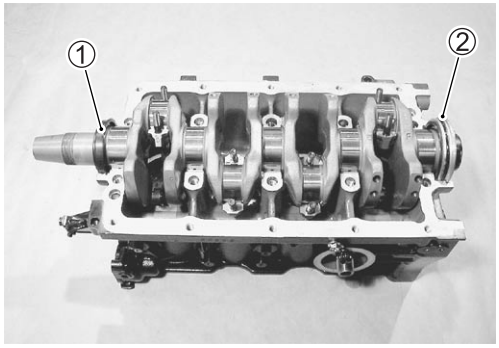
NOTE:
Reassemble each conrod cap to its original position.



NOTE:
To prevent damage to the crank pin and the bolt threads, install a guide hose over the threads of the conrod bolts.



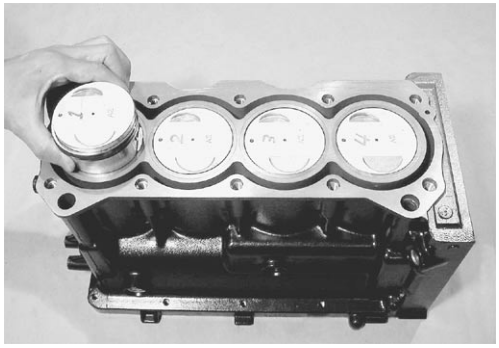
10. Remove the crankshaft.
11. Remove the oil seal ① and the oil seal housing ② from the crankshaft.



12. Remove the pistons with the conrod.

NOTE:

- *For proper assembly, mark cylinder number on all conrods and pistons using quick dry paint.*
- *To prevent damage to the piston rings, decarbon from the cylinder bore wall before removing the piston.*



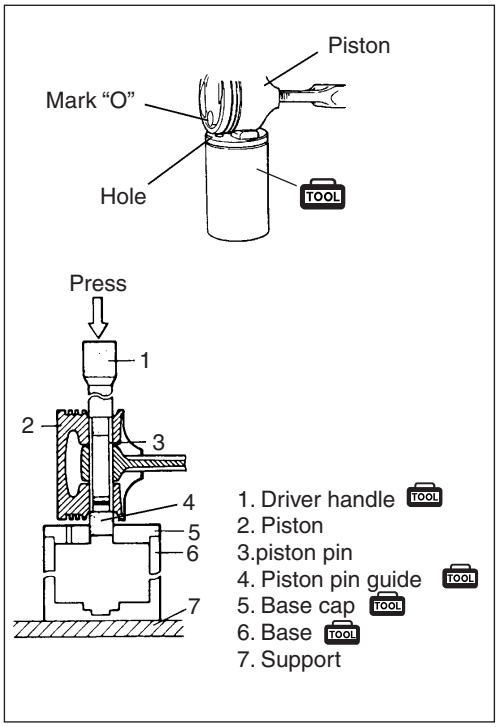
13. Remove all piston rings.

NOTE:
Install the 1st ring to the piston with its original direction.
There is no I.D. mark on the standard size 1st ring.

14. Remove the piston pin from the piston and the conrod using the tool and an arbor press as shown.

TOOL 09910-38211: Piston pin remover & installer

NOTE:
Reassemble each piston, piston pin and conrod with their original combination and position.



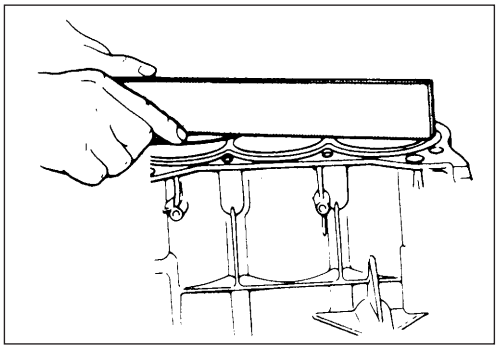
INSPECTION / SERVICING

NOTE:
If excessive wear, cracks, defective or other damage is found on any component, replace component.

CYLINDER / PISTON

Cylinder distortion

Measure the cylinder distortion (gasketed surface) at a total of 6 locations as shown.

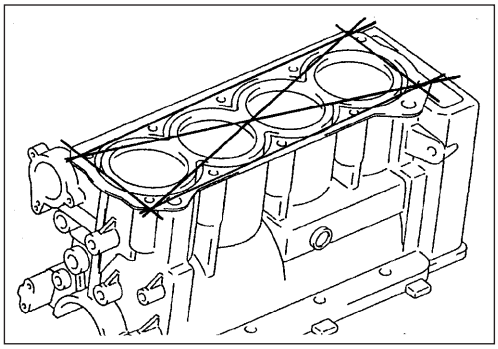


TOOL **09900-20803: Thickness gauge**
Straight gauge

Service limit: 0.060 mm (0.0024 in)

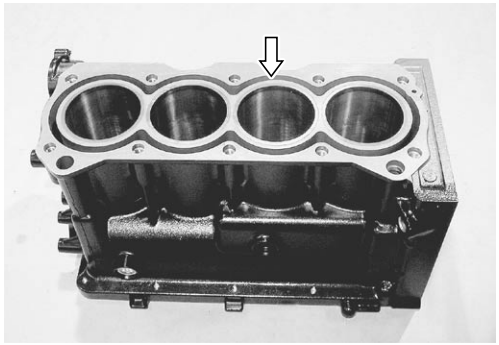
If the measurement exceeds the service limit, resurface or replace the cylinder.

NOTE:
The cylinder can be resurfaced, using a surface plate and #400 grit wet sandpaper. Move the cylinder in a figure eight pattern when sanding.



Water jacket

Check the water jackets.
If clog or obstruction is found, clean the water jacket.



Cylinder bore wear (difference)

Measure the cylinder bore in the thrust and axial directions at the three positions Ⓐ, Ⓑ and Ⓒ as shown.

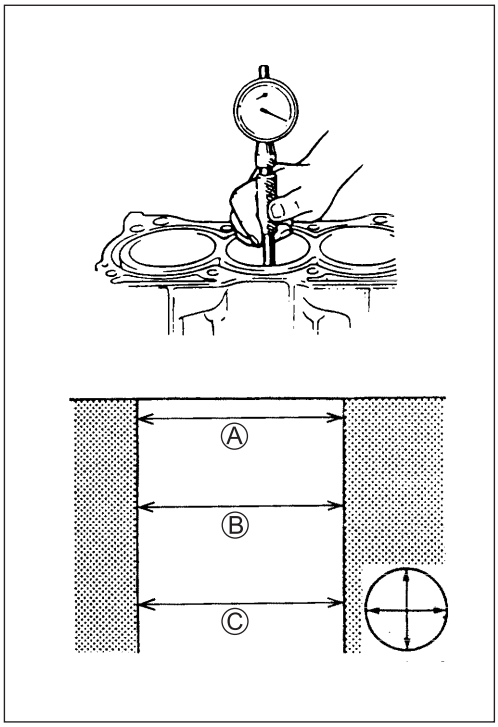
Check for the followings:

- Difference of the measurements at the two positions. (Taper)
- Difference between the thrust and axial measurement. (Out-of-round)

TOOL 09900-20508: Cylinder gauge set

Service limit: 0.100 mm (0.0039 in)

If the measurement exceeds the service limit, rebore or replace the cylinder.



Piston to cylinder clearance

Standard : 0.020 – 0.040 mm (0.0008 – 0.0016 in)
Service limit: 0.100 mm (0.0039 in)

If the measurement exceeds the service limit, replace the piston and/or the cylinder or rebore the cylinder.

To check the clearance, measure the following items:

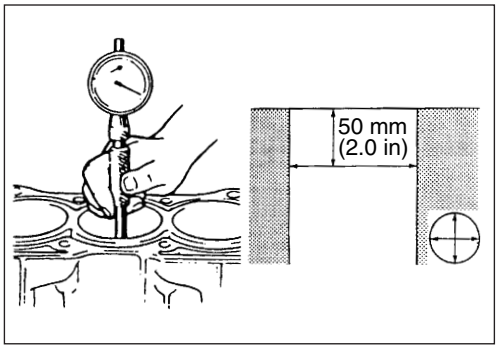
- Cylinder bore at 50 mm elevation from the gasketed surface
- Piston skirt diameter at 15 mm elevation from the skirt end

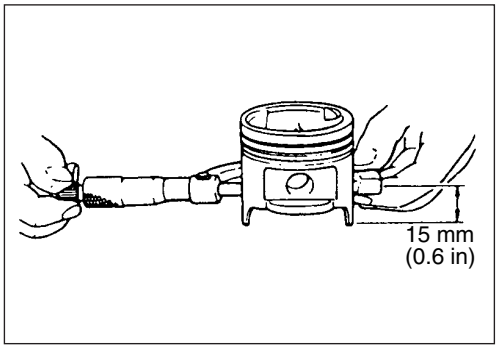
TOOL 09900-20508: Cylinder gauge set
09900-20203: Micrometer

Standard:

Cylinder bore	Piston skirt diameter
74.000 – 74.020 mm (2.9134 – 2.9142 in)	73.970 – 73.990 mm (2.9122 – 2.9130 in)

NOTE:
For this check, measure the cylinder bore and the piston skirt diameter in the direction that makes a right angle with the crankshaft (piston pin).

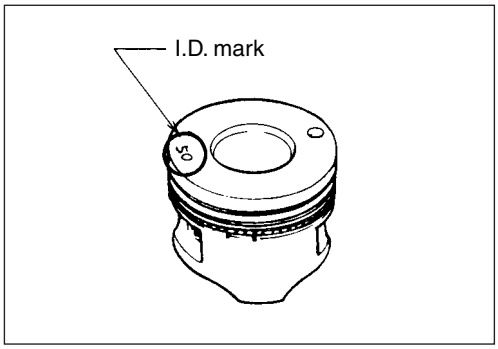




Identification of oversize piston / piston ring

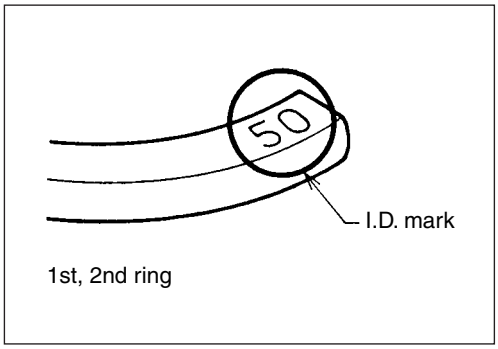
Piston

Oversize	I.D. mark
0.50 mm (0.020 in)	0.50



1st & 2nd ring

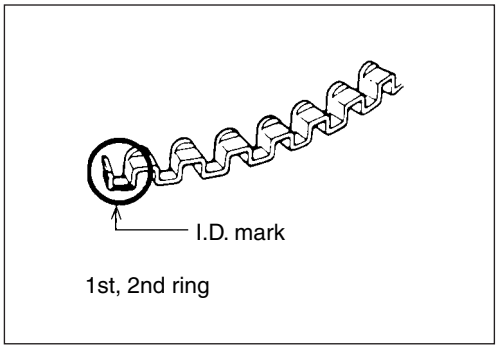
Oversize	I.D. mark
0.50 mm (0.020 in)	50



1st, 2nd ring

Oil ring

Oversize	I.D. mark
0.50 mm (0.020 in)	Red paint



1st, 2nd ring

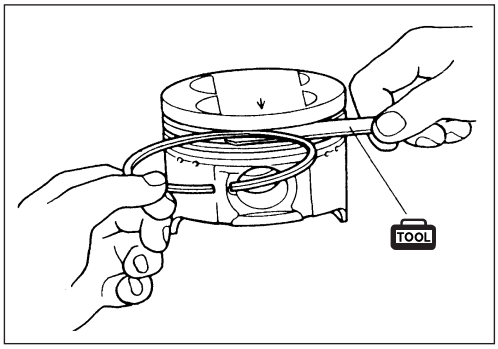
NOTE:
For the oil ring side rail, measure the outer diameter of the rail to distinguish because there is no I.D. mark.

Piston ring to groove clearance

Measure the clearance after decarboning.

TOOL 09900-20803: Thickness gauge

Standard : 1st 0.03 – 0.07 mm (0.001 – 0.003 in)
2nd 0.02 – 0.06 mm (0.001 – 0.002 in)
Service limit: 1st 0.12 mm (0.005 in)
2nd 0.10 mm (0.004 in)



If the measurement exceeds the service limit, replace the piston and/or the piston ring.

Standard:

	Piston ring groove width	Piston ring thickness
1st	**1.22 – 1.24 mm (0.048 – 0.049 in)**	**1.17 – 1.19 mm (0.046 – 0.047 in)**
2nd	**1.51 – 1.53 mm (0.059 – 0.060 in)**	**1.47 – 1.49 mm (0.058 – 0.059 in)**
Oil	**2.81 – 2.83 mm (0.111 – 0.112 in)**	———

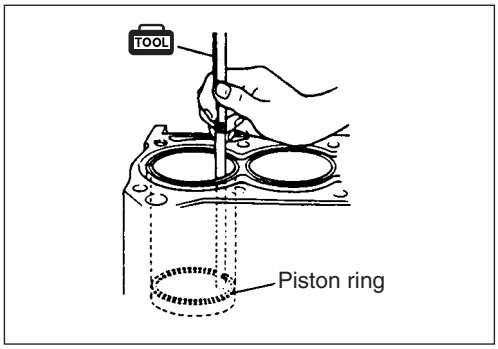
TOOL 09900-20102: Vernier calipers
09900-20205: Micrometer

Piston ring end gap
Measure the piston ring end gap with the piston ring in the lowest position of the cylinder bore.

TOOL 09900-20803: Thickness gauge

Standard : 1st 0.15 – 0.30 mm (0.006 – 0.012 in)
2nd 0.20 – 0.35 mm (0.008 – 0.014 in)
Service limit: 1st & 2nd 0.70 mm (0.028 in)

If the measurement exceeds the service limit, replace the piston ring.

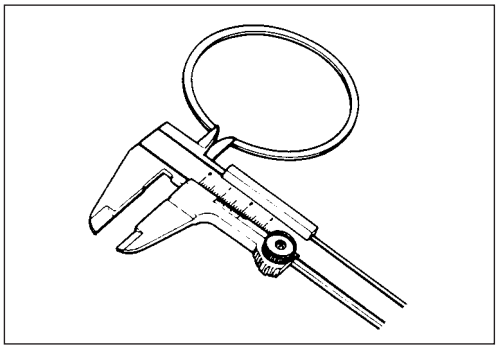


Piston ring free end gap
Measure the piston ring free end gap.

TOOL 09900-20102: Vernier calipers

Standard : 1st Approx. 7.7 mm (0.30 in)
2nd Approx. 10.4 mm (0.41 in)
Service limit: 1st 6.1 mm (0.24 in)
2nd 8.3 mm (0.33 in)

If the measurement is lower than the service limit, replace the piston ring.



Piston pin oil clearance

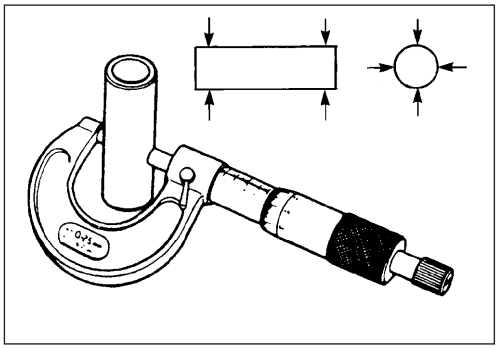
Check for the followings:

- The piston pin and the piston pin hole are free from excessive wear and damage.
- The piston pin can move smoothly in the piston pin hole with oil.

If the result is not the above conditions, replace the piston pin and/or the piston.

Standard : 0.003 – 0.016 mm (0.0001 – 0.0006 in)
Service limit: 0.040 mm (0.0016 in)

If the measurement exceeds the service limit, replace the piston pin and/or the piston.



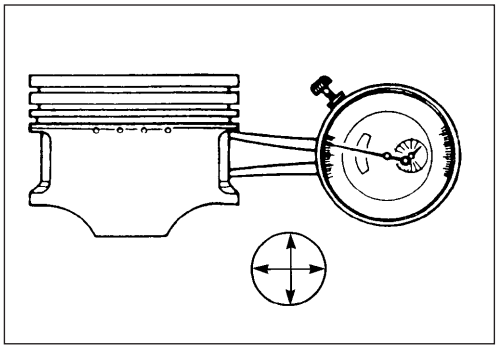
To check the clearance, measure the following items:

- Piston pin outside diameter in the thrust and axial directions.
- Piston pin hole diameter in the thrust and axial directions.

TOOL 09900-20205: Micrometer
09900-20605: Dial calipers

Standard:

Piston pin outside diameter	Piston pin hole diameter
16.995 – 17.000 mm (0.6691 – 0.6693 in)	17.003 – 17.011 mm (0.6694 – 0.6697 in)

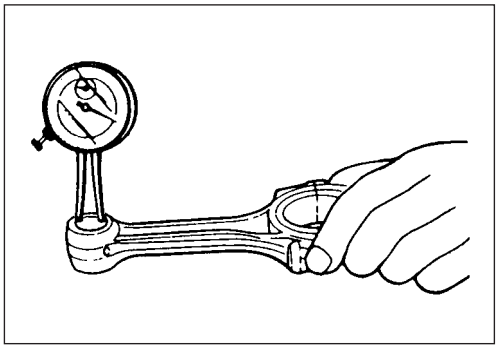


Conrod small end inside diameter

Measure the conrod small end inside diameter.

TOOL 09900-20605: Dial calipers

Standard: 16.968 – 16.979 mm (0.6680 – 0.6685 in)



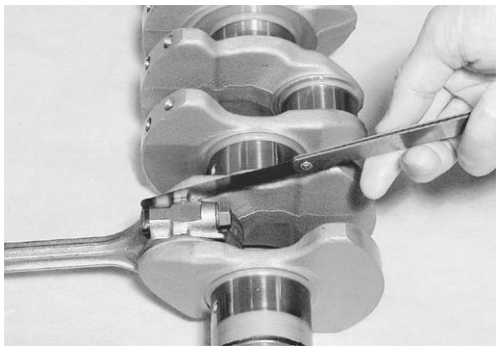
If the measurement is out of the specification, replace the conrod.

NOTE:
The piston pin is press-fitted into the conrod small end hole. There must be a negative clearance between the two items.

CONROD / CRANKSHAFT / CRANKCASE

Conrod big end side clearance

Measure the conrod big end side clearance with the conrod installed on the crank pin as shown.



TOOL 09900-20803: Thickness gauge

Standard : 0.10 – 0.25 mm (0.004 – 0.010 in)
Service limit: 0.35 mm (0.014 in)

If the measurement exceeds the service limit, replace the conrod and/or the crankshaft.

Standard:

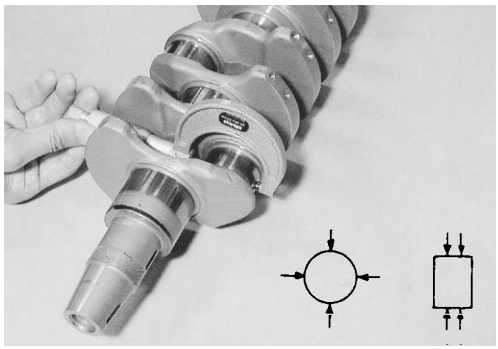
Conrod big end width	Crank pin width
21.95 – 22.00 mm (0.864 – 0.866 in)	22.10 – 22.20 mm (0.870 – 0.874 in)

TOOL 09900-20205: Micrometer
09900-20605: Dial calipers

Crank pin outside diameter / difference

Measure the crank pin outside diameter in the thrust and axial directions at the two positions as shown.
Check for the followings:

- Difference of the measurements at the two positions. (Taper)
- Difference between the thrust and axial measurement. (Out-of-round)



TOOL 09900-20202: Micrometer

Service limit: 0.010 mm (0.0004 in)

If the measurement exceeds the service limit, replace the crankshaft.

Crank pin outside diameter:
Standard: 41.982 – 42.000 mm (1.6528 – 1.6535 in)

Conrod bearing condition

If pitting, flaking, burn or excessive wear is found, replace the conrod bearing.

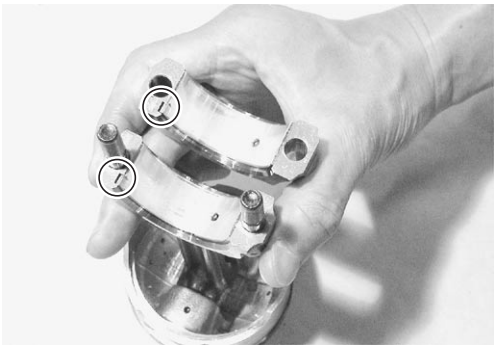
Conrod big end oil clearance

Standard : 0.020 – 0.050 mm (0.0008 – 0.0020 in)
Service limit: 0.080 mm (0.0031 in)

If the measurement exceeds the service limit, replace the conrod bearing.

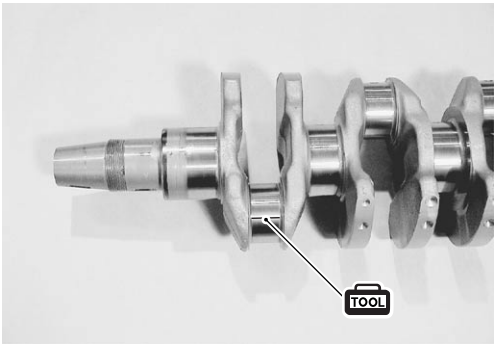
Measure the conrod big end oil clearance as follows:
1. Clean the surface of the conrod, the conrod cap, the conrod bearing, and the crank pin.
2. Install the conrod bearing onto the conrod and the conrod cap.

NOTE:
- *Reassemble each bearing, conrod cap to their original position.*
- *Do not apply oil to the bearing.*



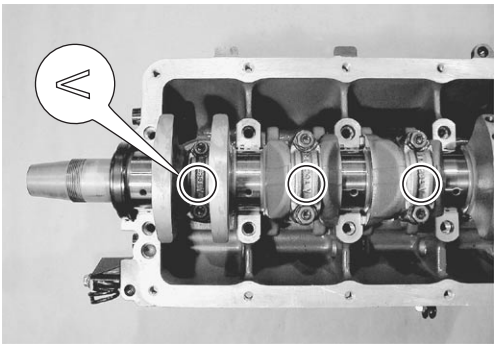
3. Place a piece of the plastigauge on the crank pin with parallel to the crankshaft, avoiding the oil hole.

TOOL 09900-22301: Plastigauge



4. Install the conrod cap (with the bearing) to the conrod with the arrow mark on the cap toward the flywheel side.
5. Apply engine oil to the conrod bolts and tighten the nuts by the two steps.

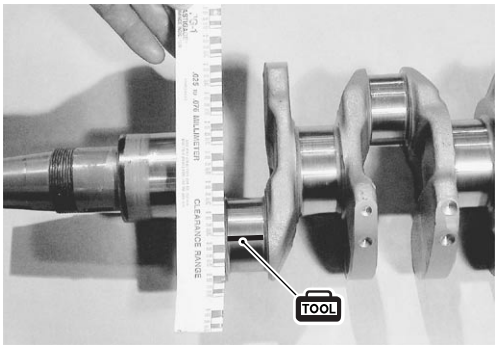
Conrod cap nut:
Primary 18 N·m (1.8 kg-m, 13.0 lb-ft)
Secondary 35 N·m (3.5 kg-m, 25.5 lb-ft)



NOTE:
Do not rotate the conrod with the plastigauge in place.

6. Remove the conrod, the conrod cap and the bearing from the crank pin.

7. Measure the compressed plastigauge width at its widest point.

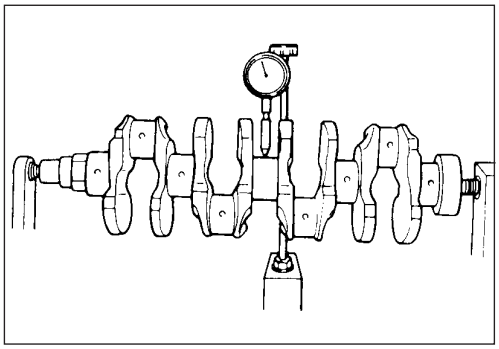


Crankshaft center journal runout
Measure the crankshaft center journal runout.

09900-20602: Dial gauge
09900-20701: Magnetic stand

Service limit: 0.06 mm (0.002 in)

If the measurement exceeds the service limit, replace the crankshaft.

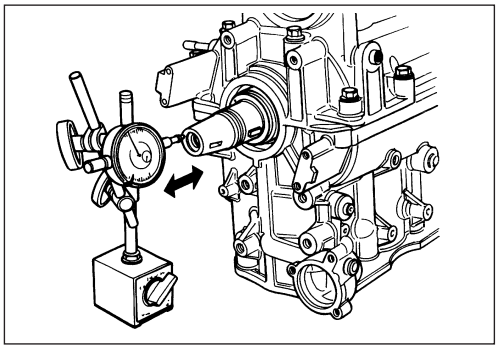


Crankshaft thrust clearance
Measure the crankshaft thrust clearance as shown, after installing the crankshaft bearing, the thrust bearing, the crankshaft and the crankcase to the cylinder in the normal manner.

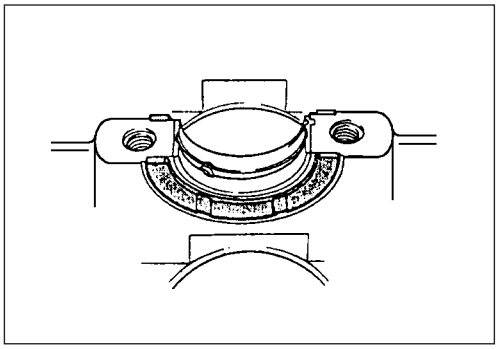
09900-20602: Dial gauge
09900-20701: Magnetic stand

Standard : 0.11 – 0.31 mm (0.004 – 0.012 in)
Service limit: 0.38 mm (0.015 in)

If the measurement exceeds the service limit, replace the crankshaft thrust bearing.



Crankshaft thrust bearing thickness:
Standard: 2.47 – 2.52 mm (0.097 – 0.099 in)

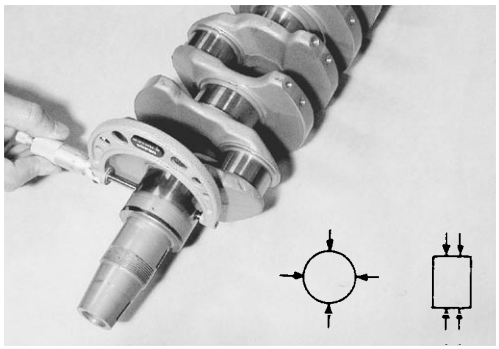


Crankshaft journal outside diameter / difference

Measure the crankshaft journal outside diameter in the thrust and axial directions at the two positions as shown.

Check for the followings:

- Difference of the measurements at the two positions. (Taper)
- Difference between the thrust and axial measurement. (Out-of-round)



TOOL 09900-20203: Micrometer

Service limit: 0.010 mm (0.0004 in)

If the measurement exceeds the service limit, replace the crankshaft.

Crankshaft journal outside diameter:
Standard: 51.982 - 52.000 mm (2.0465 – 2.0472 in)

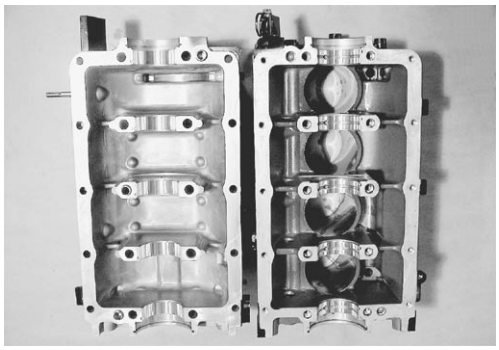
Crankshaft bearing condition

If pitting, flaking, burn or excessive wear is found, replace the bearing.

Crankshaft journal oil clearance

Standard : 0.016 – 0.036 mm (0.0006 – 0.0014 in)
Service limit: 0.060 mm (0.0024 in)

If the measurement exceeds the service limit, replace the crankshaft bearing.

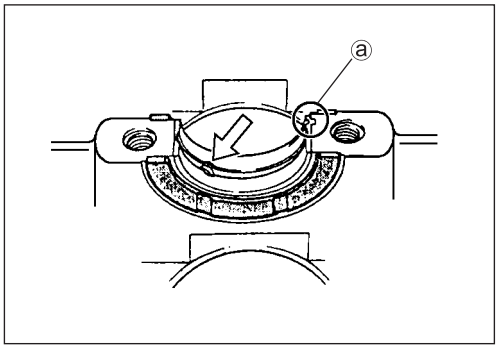


Measure the crankshaft journal oil clearance as follows:

1. Clean the surface of the bearing holder (crankcase and cylinder), the bearing and the bearing journal.
2. Install the crankshaft bearing to the cylinder and the crankcase.

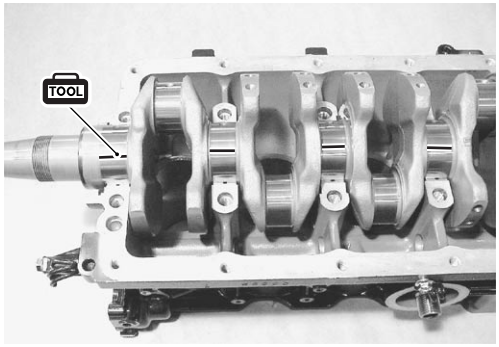
NOTE:

- *Reassemble each bearing to its original position.*
- *Install the half of bearing with the oil hole to the cylinder side.*
- *Align the tab ⓐ of the bearing with the notch in the cylinder and the crankcase.*
- *Do not apply oil to the bearing.*



3. Install the crankshaft to the cylinder.
4. Place a piece of the plastigauge on the journal with parallel to the crankshaft, avoiding the oil hole.

TOOL 09900-22301: Plastiguage



5. Install the crankcase (with the bearing) to the cylinder.
6. Apply the engine oil to the crankcase bolts and tighten the bolts by the three steps.

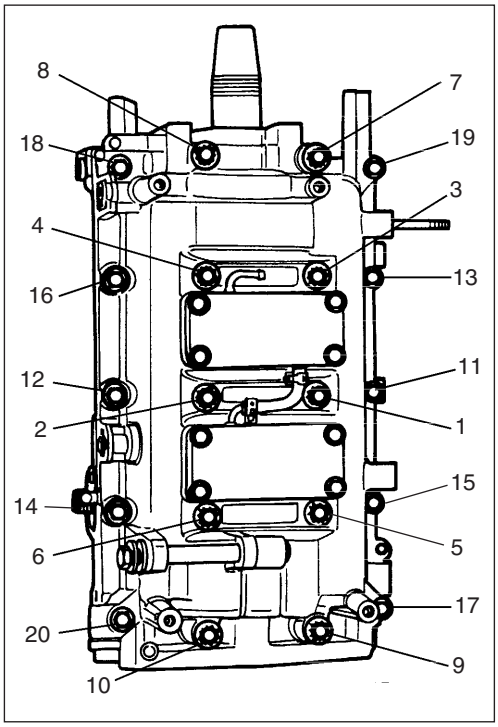
Crankcase bolt:

1st step	**8 mm**	**5 N·m (0.5 kg-m, 3.5 lb-ft)**
	10 mm	**10 N·m (1.0 kg-m, 7.0 lb-ft)**
2nd step	**8 mm**	**20 N·m (2.0 kg-m, 14.5 lb-ft)**
	10 mm	**40 N·m (4.0 kg-m, 29.0 lb-ft)**
Final step	**8 mm**	**25 N·m (2.5 kg-m, 18.0 lb-ft)**
	10 mm	**50 N·m (5.0 kg-m, 36.0 lb-ft)**

NOTE:

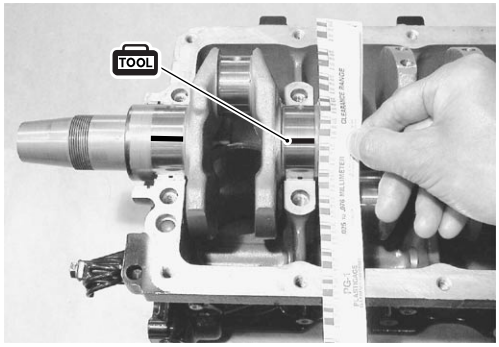
- *The crankcase should be torqued to the specification in order to assure proper compression of the plastigauge and accurate reading of the clearance.*
- *Do not rotate the crankshaft with the plastigauge in place.*

7. Remove the crankcase from the cylinder.



8. Measure the compressed plastigauge width at its widest point.

NOTE:
For bearing replacement, see the "CRANKSHAFT/CRANKCASE COMBINATION" section on the page 6-42.



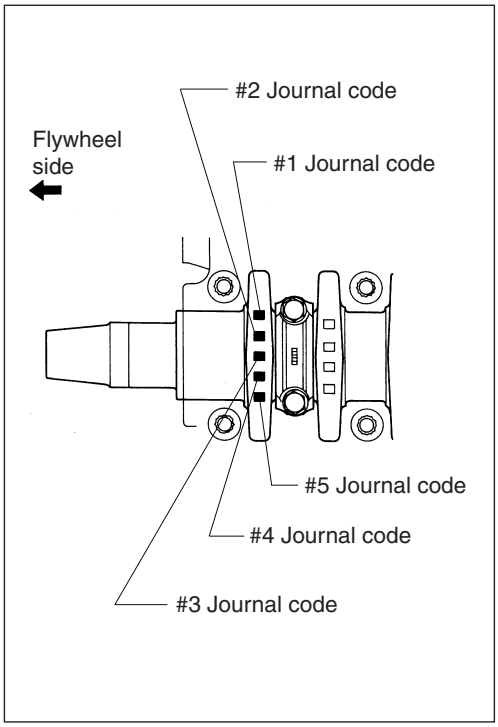
CRANKSHAFT / CRANKCASE COMBINATION

Crankshaft journal outside diameter code

The codes are stamped on the upper (flywheel side) web of the crankshaft as shown.

Standard:

Code	Crankshaft journal outside diameter
1	51.994 – 52.000 mm (2.0470 – 2.0472 in)
2	51.988 – 51.944 mm (2.0467 – 2.0470 in)
3	51.982 – 51.988 mm (2.0465 – 2.0467 in)

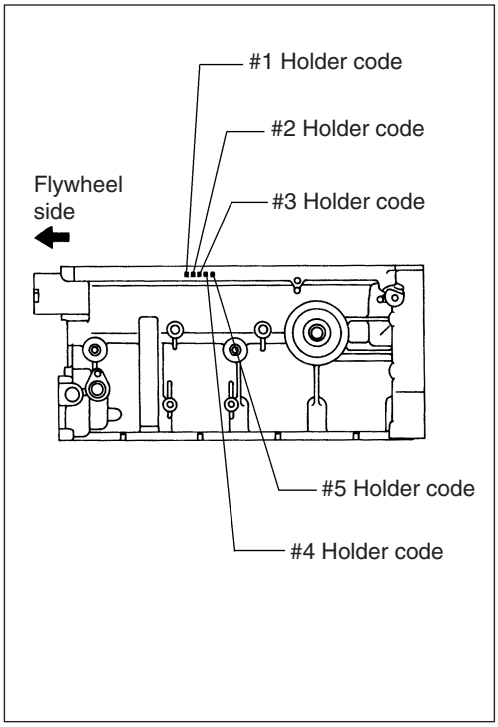


Crankcase bearing holder inside diameter code

The codes are stamped on the starboard side of the cylinder block as shown.

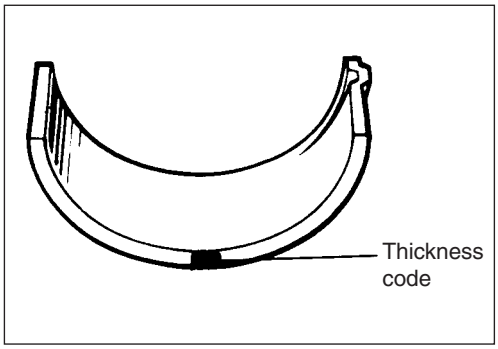
Standard:

Code	Crankcase bearing holder inside diameter
A	56.000 – 56.006 mm (2.2047 – 2.2050 in)
B	56.006 – 56.012 mm (2.2050 – 2.2052 in)
C	56.012 – 56.018 mm (2.2052 – 2.2054 in)



Crankshaft bearing thickness code

The codes are painted on the side of the bearing as shown.



Standard:

Code	Crankshaft bearing thickness
Green	**1.998 – 2.002 mm (0.0787 – 0.0788 in)**
Black	**2.001 – 2.005 mm (0.0788 – 0.0789 in)**
No paint	**2.004 – 2.008 mm (0.0789 – 0.0791 in)**
Yellow	**2.007 – 2.011 mm (0.0790 – 0.0792 in)**
Blue	**2.010 – 2.014 mm (0.0791 – 0.0793 in)**

Crankshaft bearing selection

Select the crankshaft bearing referring the below table.

Bearing selection table

		Crankshaft journal outside diameter		
	Code	1	2	3
Crankcase bearing holder inside diameter	A	Green	Black	No paint
	B	Black	No paint	Yellow
	C	No paint	Yellow	Blue

NOTE:

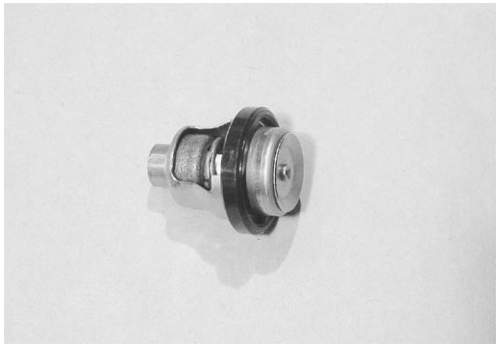
Remeasure the crankshaft journal oil clearance using new bearings selected. (See the page 6-40.)

OIL SEAL

If crack, cut or other damage is found, replace.

THERMOSTAT

If deposited salt, corrosion, wear or other damage is found, clean or replace.

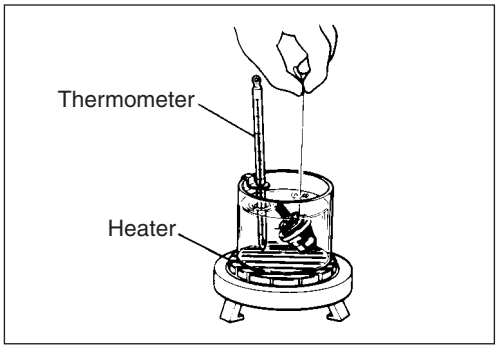


Thermostat operation

Check the thermostat opening temperature as follows.

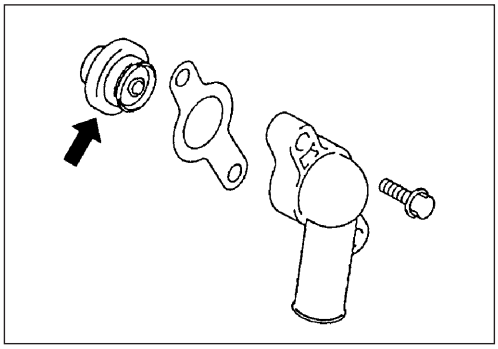
1. Insert a length of thread between the thermostat valve / body and suspend the thermostat in a container filled with water.
2. Place the thermometer in the container and heat water. Observe water temperature when the thermostat valve opens and releases the thread.

Thermostat operating temperature:
Standard: 58 – 62 °C (136 – 144 °F)



WATER PRESSURE VALVE

If deposited salt, corrosion, wear or other damage is found, clean or replace.



REASSEMBLY

Reassembly is reverse order of disassembly with the special attention to the following steps.

PISTON TO CONROD

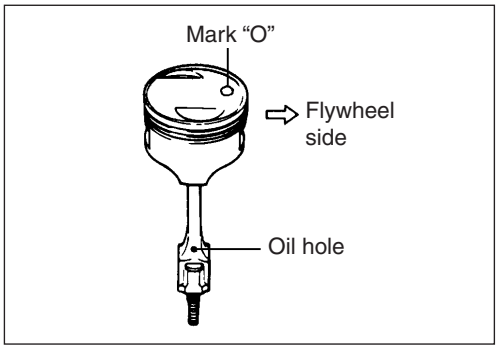
1. Apply the engine oil to the piston pin holes and the conrod. Make sure that the conrod is installed with the direction as shown.

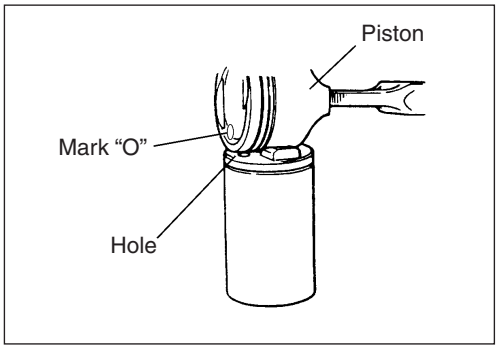
CAUTION

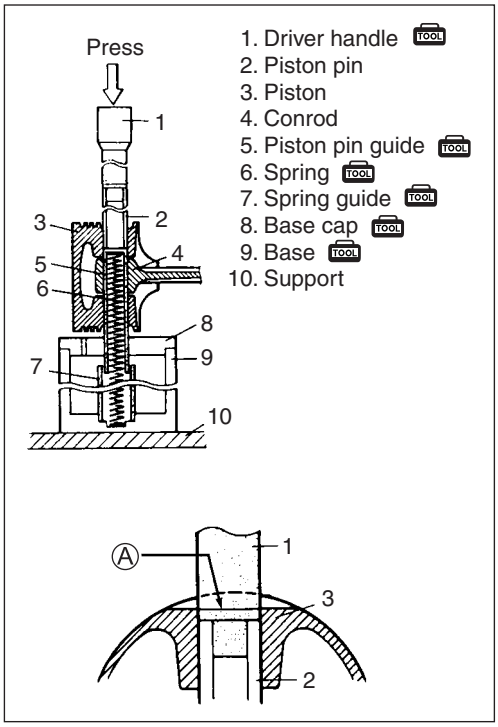
Reassemble each piston, piston pin and conrod with their original combination and position.

2. Press fit the piston pin to the conrod (with the piston) until the line Ⓐ on the driver handle flush with the flat surface of the piston, using the tool and an arbor press as shown.

TOOL 09910-38211: Piston pin remover & installer







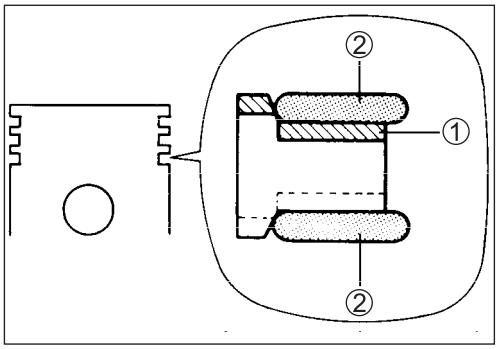
PISTON RING TO PISTON

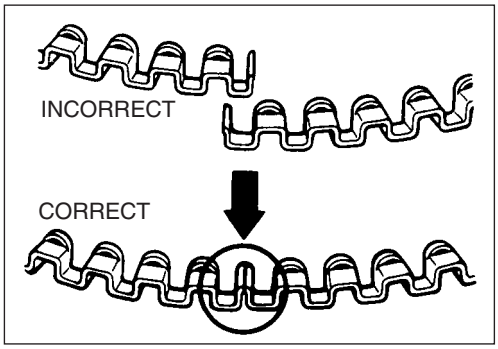
Oil ring

1. Apply the engine oil to the piston rings.
2. Install the spacer ① first, then the side rails ② to the piston.

CAUTION

When installing the spacer, do not allow its two ends to overlap in the groove.



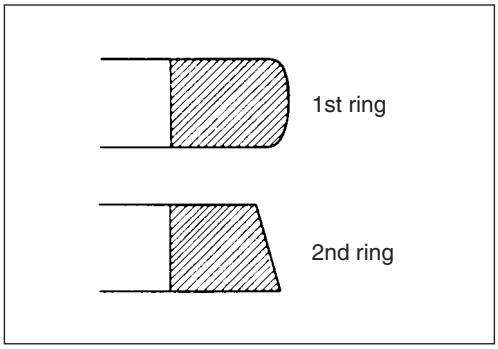


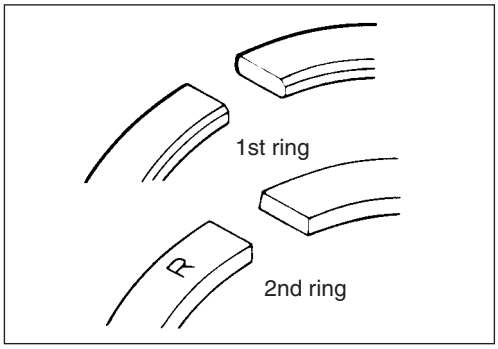
1st ring and 2nd ring

1. Apply the engine oil to the piston rings.
2. Install the 2nd ring and the 1st ring to the piston.

CAUTION

- **Install the 2nd ring to the piston with the "R" mark toward the piston head side.**
- **Install the 1st ring to the piston with its original direction.**
  There is no I.D. mark on the standard size 1st ring.

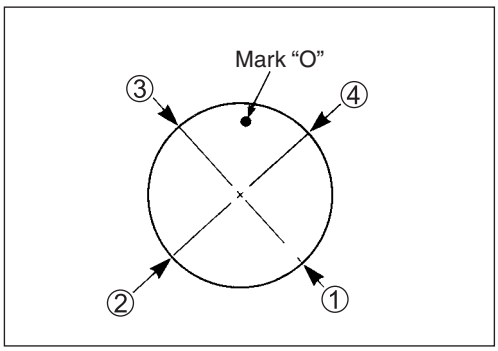




Ring gap direction

Position the rings so that their gaps are stagged at approximately 90 degree angles as shown.

① 1st ring
② Oil ring lower side rail
③ 2nd ring
④ Oil ring upper side rail

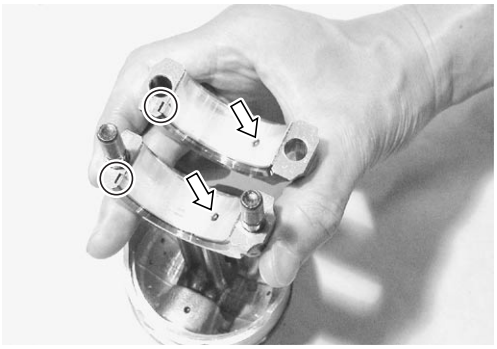


PISTON TO CYLINDER

1. Install the conrod bearing to the conrod and the conrod cap.

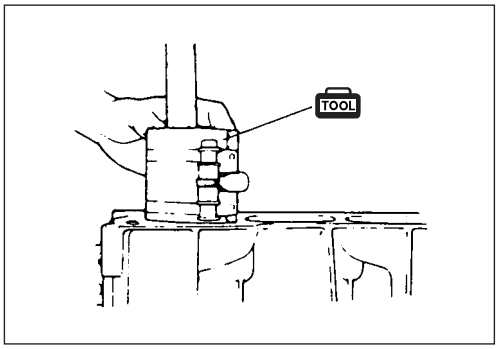
CAUTION

- **Reassemble each conrod bearing to its original position.**
- **Install the half of the bearing with the oil hole to the conrod side.**
- **Do not apply oil to the back of the bearing.**

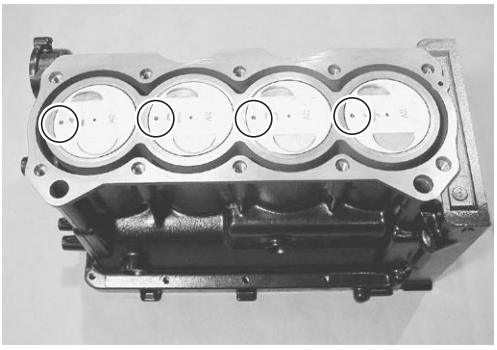


2. Apply the engine oil to the piston and cylinder bore wall.
3. Insert piston (with conrod) to cylinder from head side using the tool.

TOOL 09916-77310: Piston ring compressor

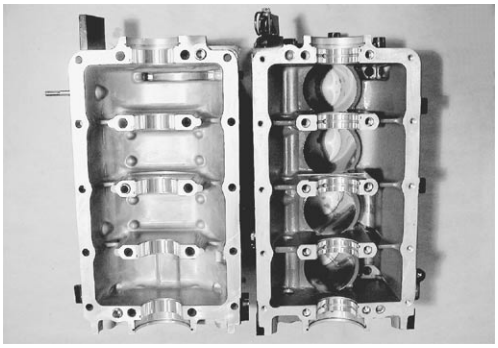


NOTE:
Position the CIRCLE mark on the piston head to the flywheel side.



CRANKSHAFT TO CYLINDER

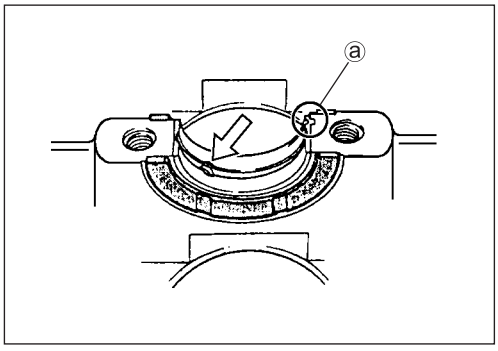
1. Install the crankshaft bearings to the cylinder and the crankcase.
2. Apply the engine oil to the bearings.



CAUTION

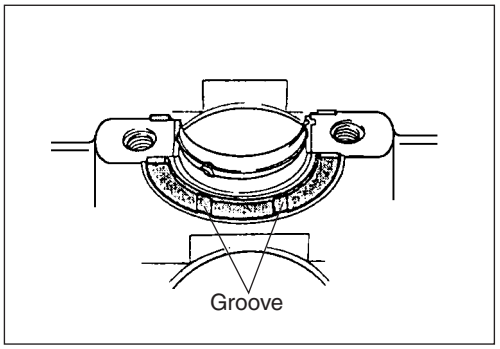
- **Reassemble each bearing to its original position.**
- **Install the half of the bearing with the oil hole to the cylinder side.**
- **Do not apply oil to the back of the bearing.**

NOTE:
Align the tab ⓐ of the bearing with the notch in the cylinder and the crankcase.



3. Install the crankshaft thrust bearings to the cylinder.

NOTE:
Install the thrust bearing with its groove facing outward.

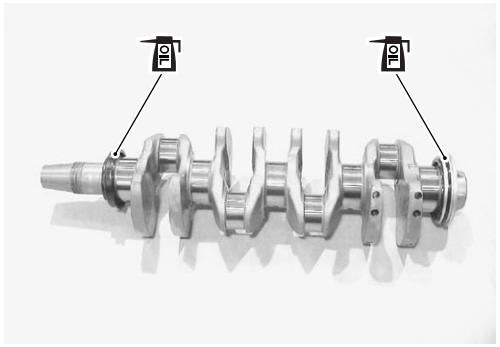


4. Apply the engine oil to the lip area of the upper oil seal.
5. Install the upper oil seal and the lower oil seal housing to the crankshaft.

CAUTION

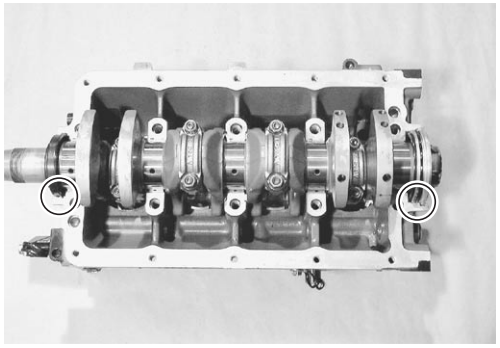
Do not re-use the seal once removed. Always use a new seal.

NOTE:
Install the upper oil seal with its spring/lipped side facing inward.



6. Install the crankshaft to the cylinder.

NOTE:
When installing the crankshaft to the cylinder, be sure to fit the tabs of the seal and the housing in the grooves of the cylinder.



7. Apply the engine oil to the crank pins and the conrod bearings.
8. Install the conrod cap (with the bearing) to the conrod with the arrow mark on the cap toward the flywheel side.

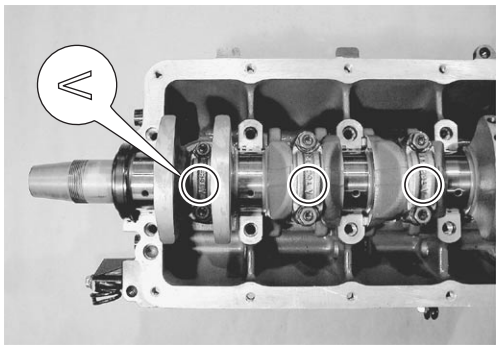
CAUTION

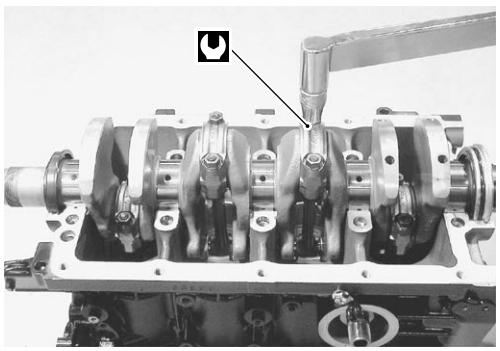
Reassemble each conrod cap to its original position.

9. Apply the engine oil to the conrod bolts.
10. Tighten the nuts by the two steps.

Conrod cap nut:

1st step	**18 N·m (1.8 kg-m, 13.0 lb-ft)**
Final step	**35 N·m (3.5 kg-m, 25.5 lb-ft)**





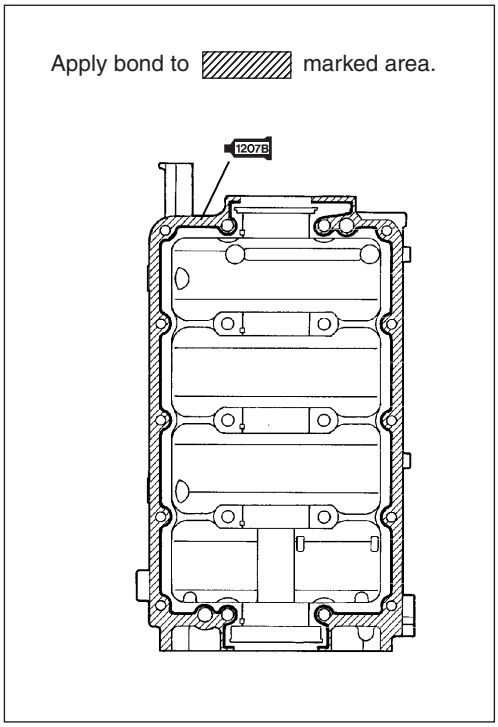
CRANKCASE TO CYLINDER

1. Clean the mating surface of the cylinder and the crankcase.
2. Apply the bond to the mating surface of the crankcase as shown.

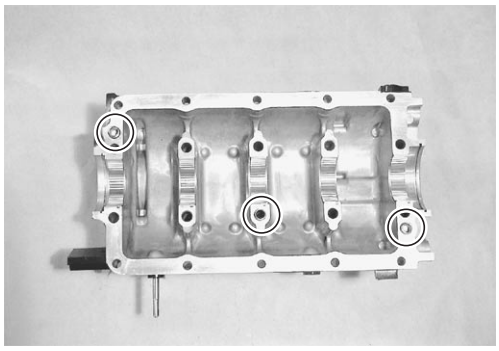
1207B 99000-31140: Suzuki Bond 1207B

CAUTION

Apply the bond to the mating surface avoiding the bearing with the bond.



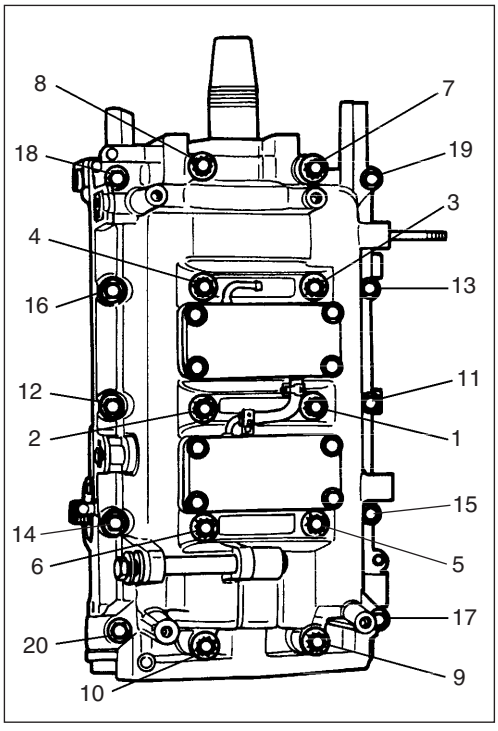
3. Install the three dowel pins.



4. Install the crankcase (with the bearing) to the cylinder.
5. Apply the engine oil lightely to the crankcase bolts.
6. Tighten the twenty bolts by the three steps according to the numerical order as shown.

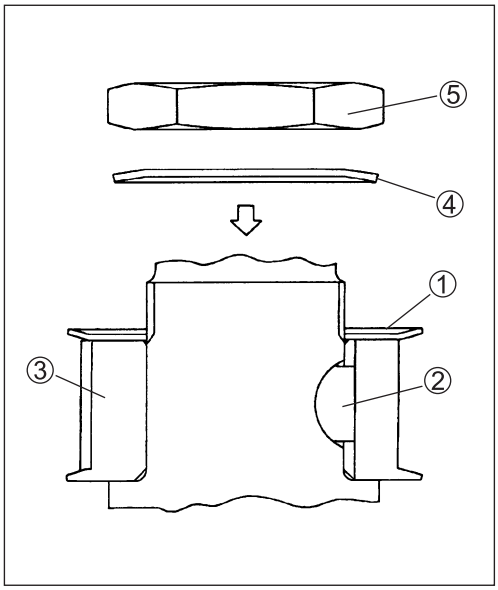
Crankcase bolt:

1st step	**8 mm**	**5 N·m (0.5 kg-m, 3.5 lb-ft)**
	10 mm	**10 N·m (1.0 kg-m, 7.0 lb-ft)**
2nd step	**8 mm**	**20 N·m (2.0 kg-m, 14.5 lb-ft)**
	10 mm	**40 N·m (4.0 kg-m, 29.0 lb-ft)**
Final step	**8 mm**	**25 N·m (2.5 kg-m, 18.0 lb-ft)**
	10 mm	**50 N·m (5.0 kg-m, 36.0 lb-ft)**



TIMING PULLEY

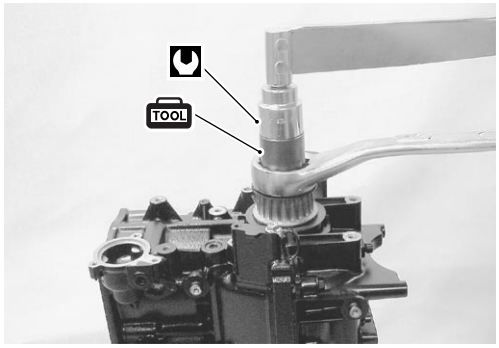
1. Install the key ②, the timing pulley ③, the upper guide ①, and the washer ④ to the crankshaft.
   Make sure that the guide ① and the washer ④ are installed with the direction as shown.



2. Tighten the timing pulley nut ⑤ to the specified torque.

TOOL 09911-49910: Crankshaft holder

Timing pulley nut: 70 N·m (7.0 kg-m, 50.5 lb-ft)



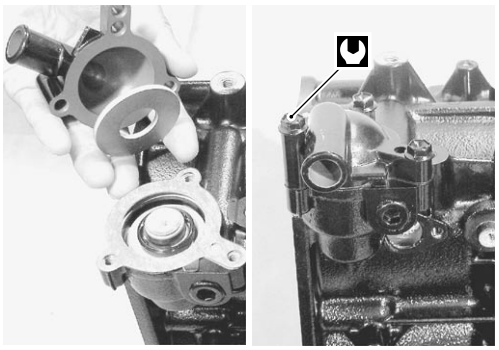
THERMOSTAT

Install the thermostat, the gasket and the cover by the three bolts.

CAUTION

Do not re-use the gasket once removed. Always use a new gasket.

Thermostat cover bolt: 10 N·m (1.0 kg-m, 7.0 lb-ft)



WATER PRESSURE VALVE

1. Apply the bond to both surfaces of the gasket in its mating area.

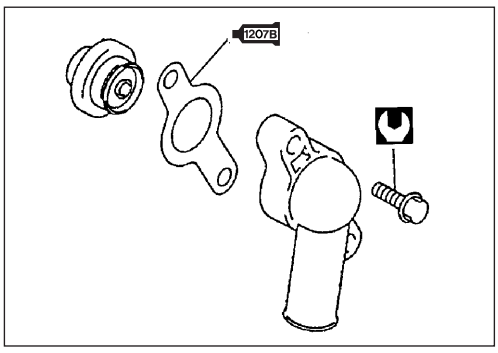
1207B 99000-31140: Suzuki Bond 1207B

2. Install the water pressure valve, the gasket and the cover by the two bolts.

CAUTION

Do not re-use the gasket once removed. Always use a new gasket.

Water pressure valve cover bolt: 10 N·m (1.0 kg-m, 7.0 lb-ft)



OPERATION

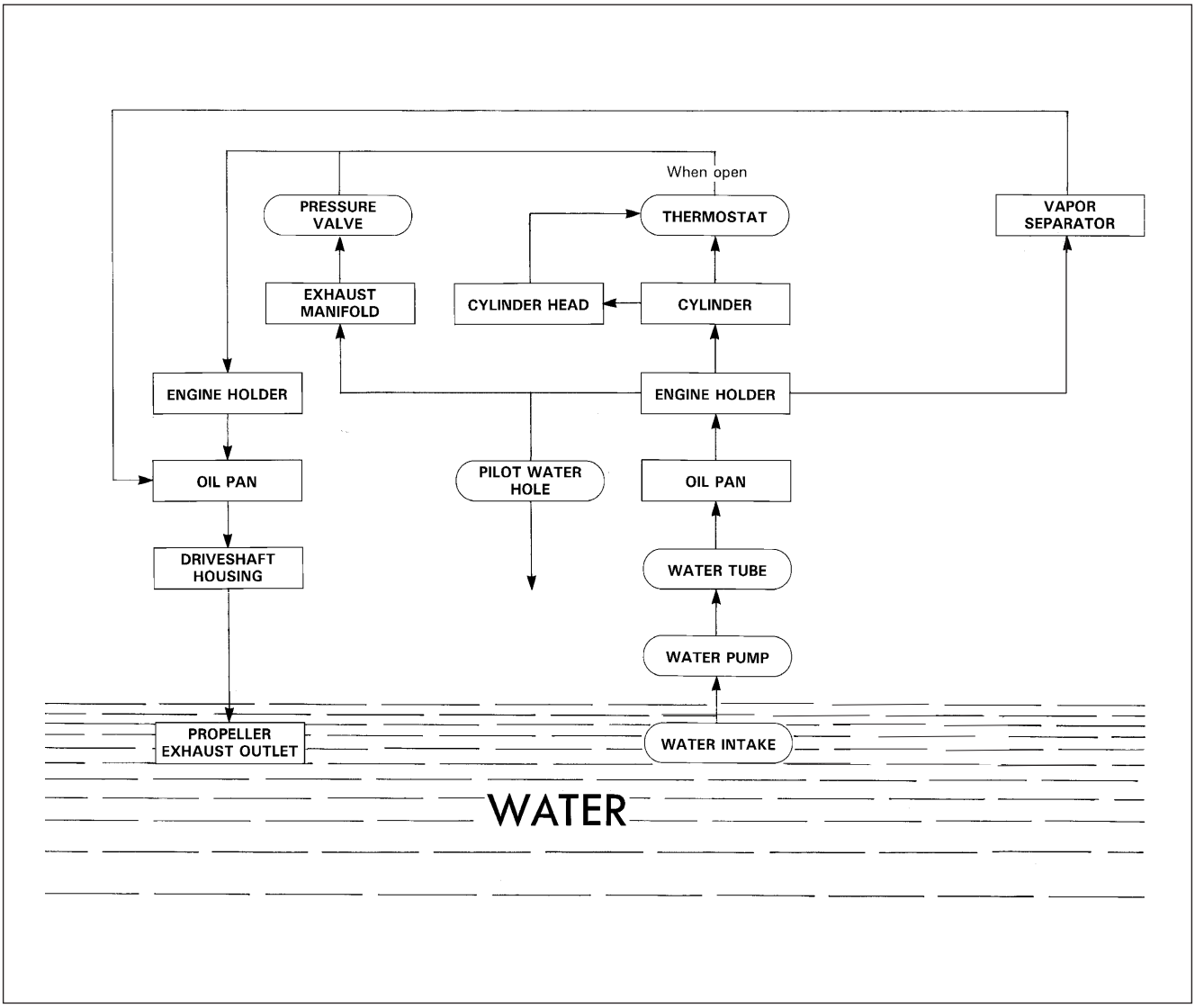
WATER COOLING SYSTEM

The water cooling system consists of the water pump (in the lower unit), the water tube (between the lower unit and the power unit), the thermostat and the water pressure valve (in the cylinder). This system cools both the power unit and the exhaust and is shown in the schematic form below.

If overheating occurs, the components of the cooling system must be inspected for blockage, corrosion build-up or damage.

Component inspection	Refer to page
Water pump / Impeller	9-11
Water Tube	7-15
Thermostat	6-44
Water pressure valve	6-44
Cylinder Head	6-18
Cylinder Block	6-32

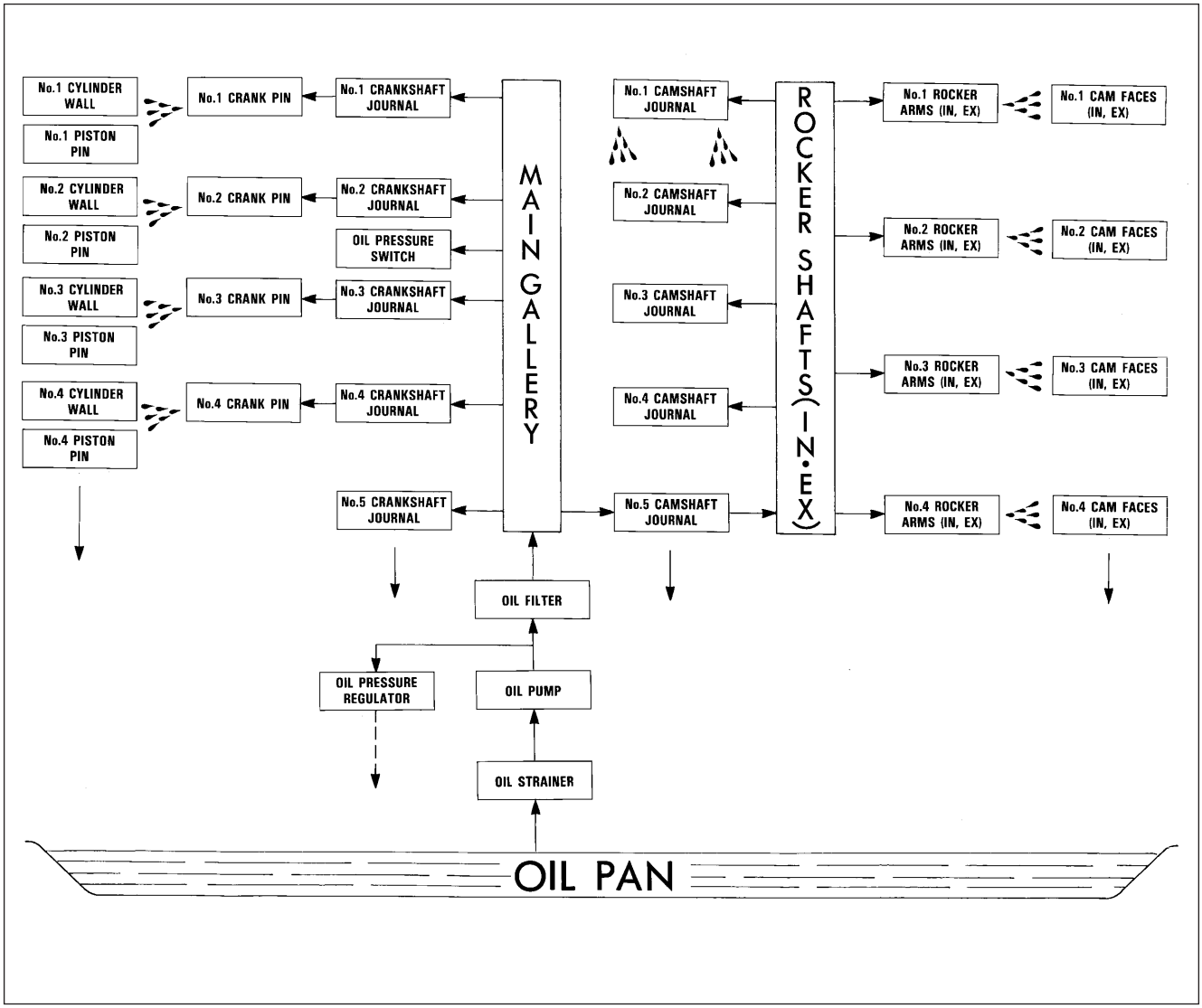
COOLING SYSTEM SCHEMATIC



ENGINE LUBRICATION SYSTEM

The engine oil stored in the oil pan is pumped up by the trochoid type pump.

ENGINE OIL LUBRICATION CHART



MID UNIT

CONTENTS

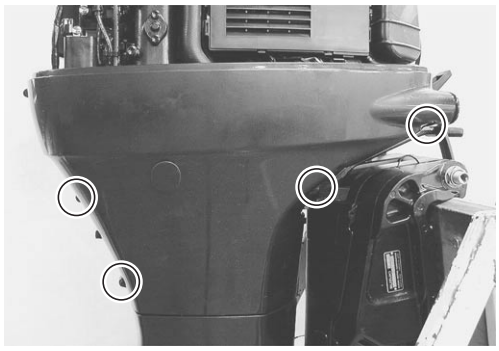
ENGINE SIDE COVER

REMOVAL

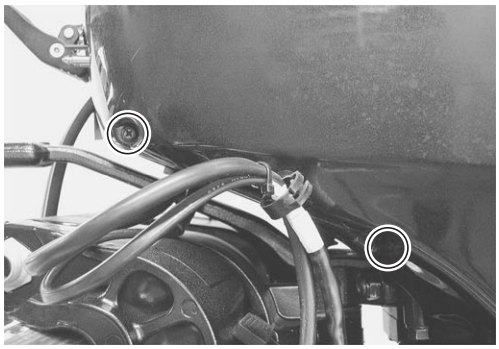
1. Remove the snap pin, the washer, the pin and the fastener.

2. Remove the side cover seal.

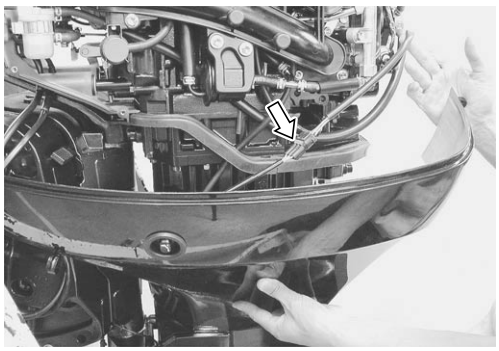
3. Remove the four bolts and the side cover (starboard).



4. Remove the two bolts.

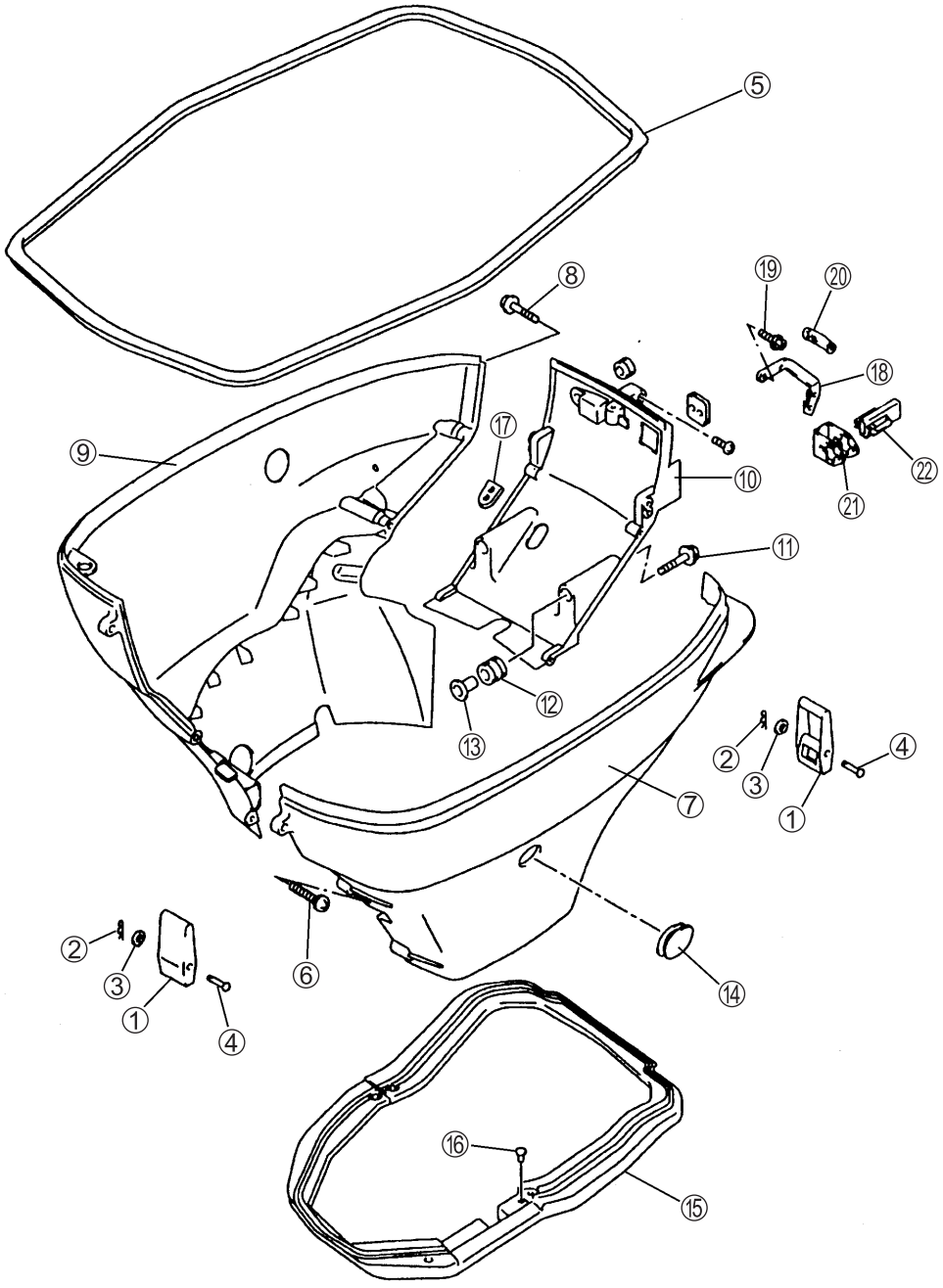


5. Remove the side cover (port) and disconnect the PTT switch connector.



INSTALLATION

Installation is reverse order of removal.



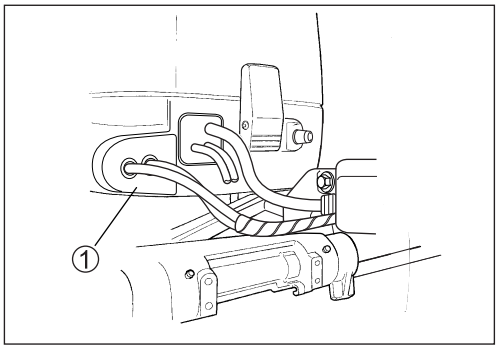
① Fastener
② Snap pin
③ Washer
④ Pin
⑤ Side cover seal
⑥ Screw
⑦ Side cover (starboard)
⑧ Screw
⑨ Side cover (port)
⑩ Front panel
⑪ Bolt
⑫ Cushion
⑬ Washer
⑭ Side cover plug
⑮ Side cover seal
⑯ Pin
⑰ Grommet
⑱ Front panel bracket
⑲ Bolt
⑳ Tube
㉑ Remocon cable holder
㉒ Stopper

TILLER HANDLE

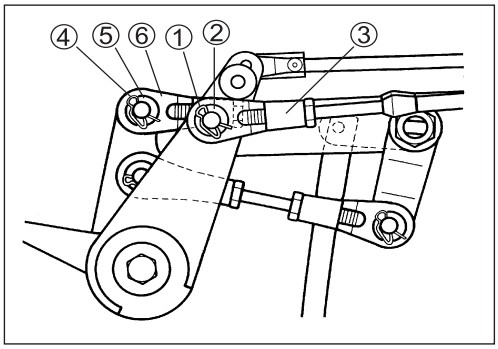
REMOVAL / DISASSEMBLY

REMOVAL

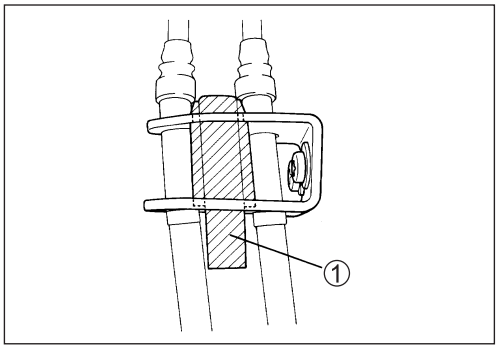
1. Remove the rigging port grommet ① from the front panel.
2. Remove both side covers. (See the page 7-2.)



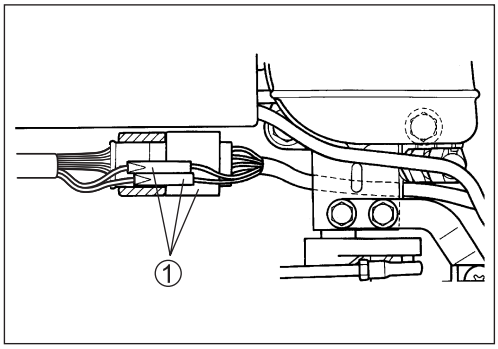
3. Remove the snap pin ①, the washer ② and the throttle cable connector ③ from the throttle control arm.
4. Unthread the connector from the throttle cable.
5. Remove the snap pin ④, the washer ⑤ and the shift cable connector ⑥ from the clutch control arm.
6. Unthread the connector from the shift cable.



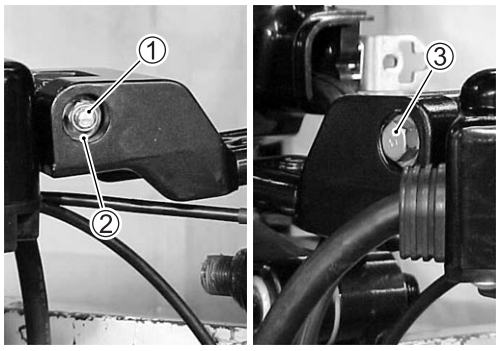
7. Remove the cable stopper ① from between the cables.



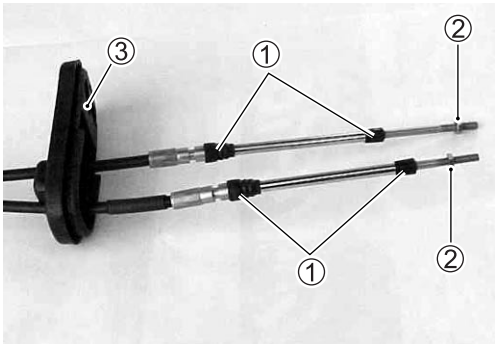
8. Disconnect the handle wire harness connectors ① from the engine wiring harness.



9. Remove the nut ① and the washer ②.
10. Loosen and remove the handle pivot bolt ③.
11. Remove the tiller handle assembly.
12. Account for the three washers and the spring.

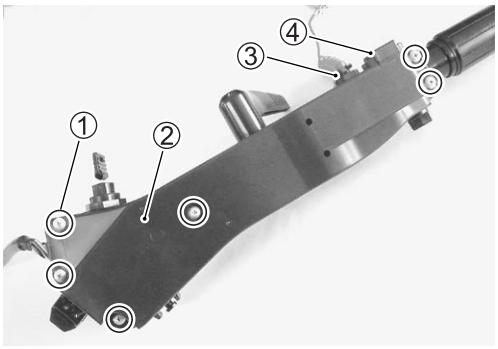


13. Remove the seals ① and the connector lock nuts ② from the throttle / shift cables.
14. Slide the rigging port grommet ③ off.

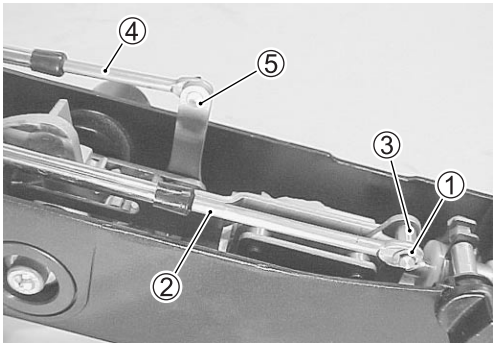


DISASSEMBLY

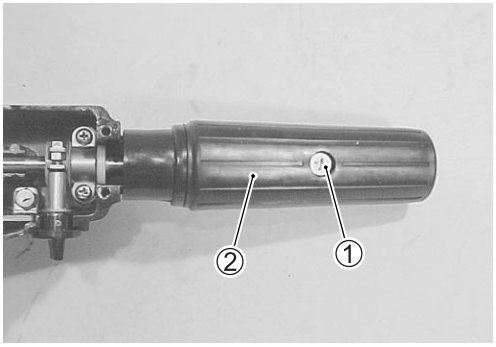
1. Remove the six screws ① and take off the tiller handle lower cover ②.
2. Disconnect the lead connectors of the emergency stop switch ③ and the PTT switch ④.



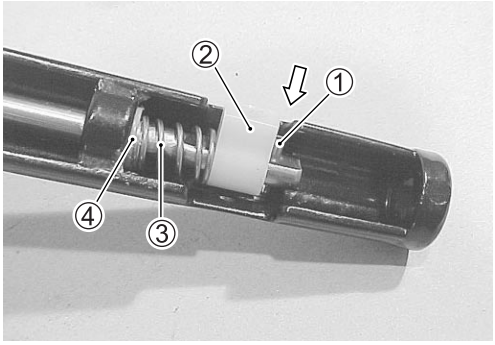
3. Remove the E-ring ① and the throttle cable ② from the throttle link ③.
4. Remove the shift cable ④ from the clutch link ⑤ in the same manner.



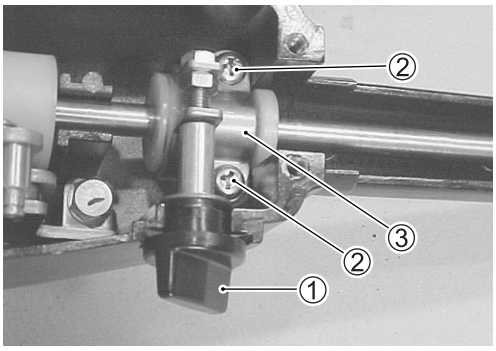
5. Remove the screw ① and the handle grip ②.



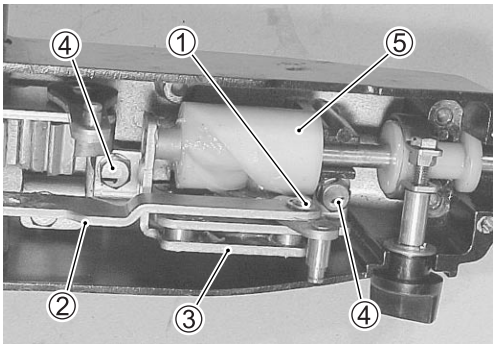
6. Drive out the handle rod stopper pin ①, then pull out the rod stopper ②, the spring ③ and the handle rod bush ④.



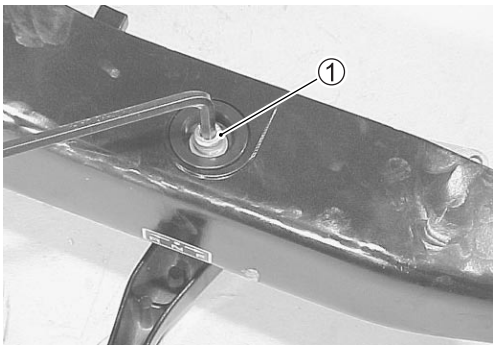
7. Loosen the throttle tension adjuster ①.
8. Remove the two screws ② and the handle rod plate ③.



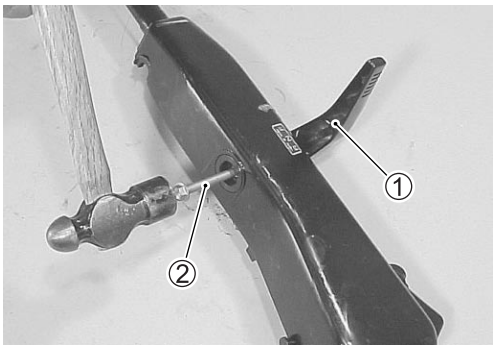
9. Remove the E-ring ① and the lock plate ② from the throttle link ③.
10. Remove the two screws ④ securing the throttle link ③ to the tiller handle housing, then remove the throttle link ③ and the handle rod assembly ⑤.



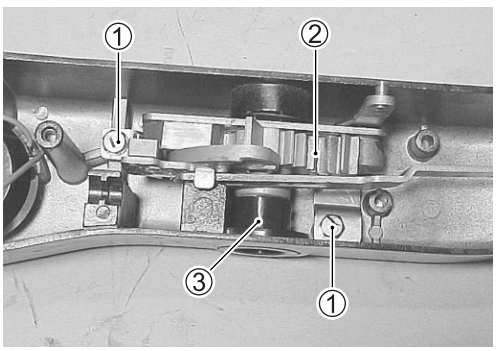
11. Remove the bolt ① securing the shift lever.



12. Separate the shift lever ① by installing a 8mm bolt ② in the shift lever as shown.
13. Using a hammer, tap on the bolt head until the shift lever separates, then remove the bolt.



14. Remove the two bolts ① securing the clutch link ② to the tiller handle housing, then remove the clutch link and the spacer ③.

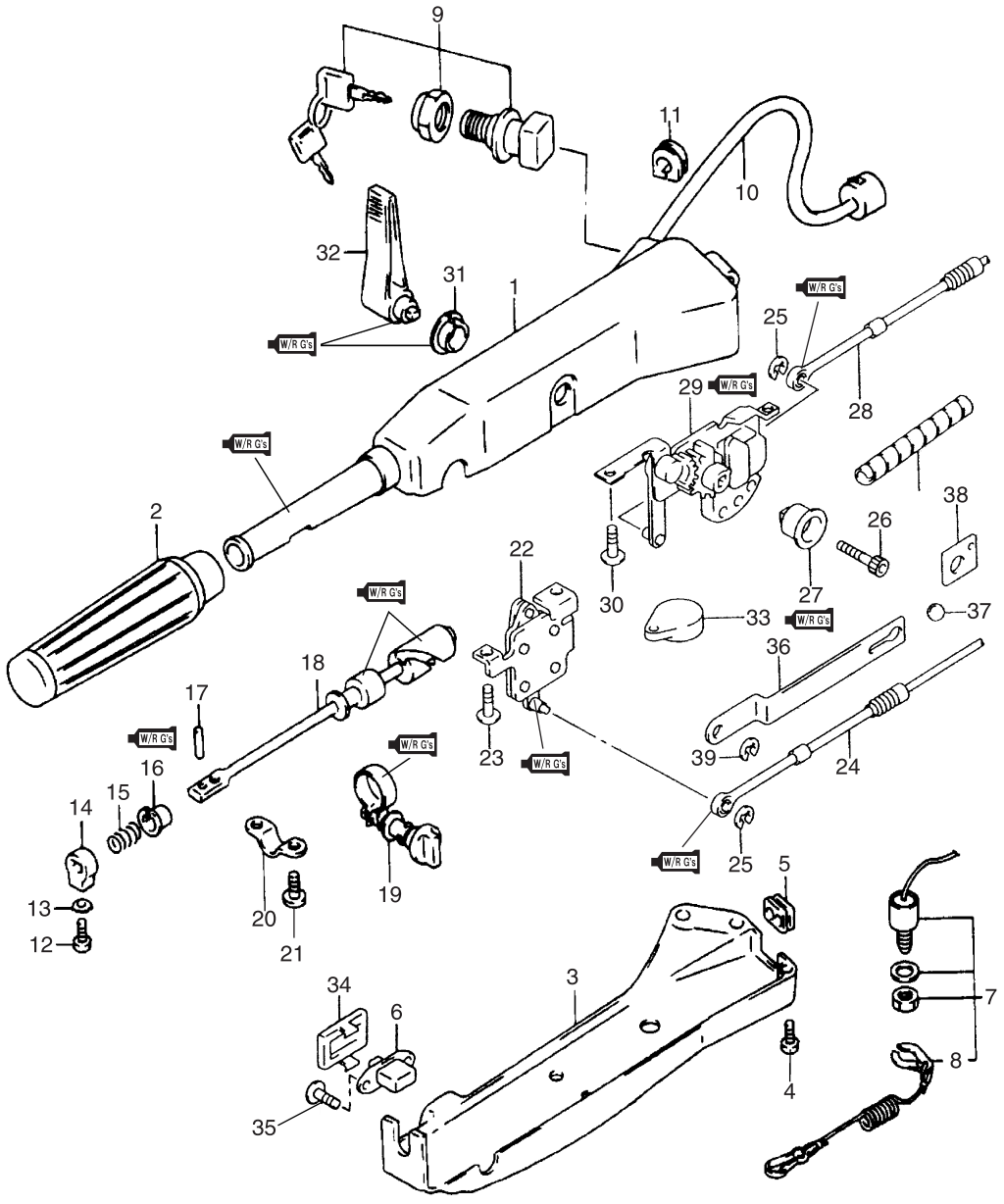


REASSEMBLY / INSTALLATION

REASSEMBLY

Assembly is reverse order of disassembly.

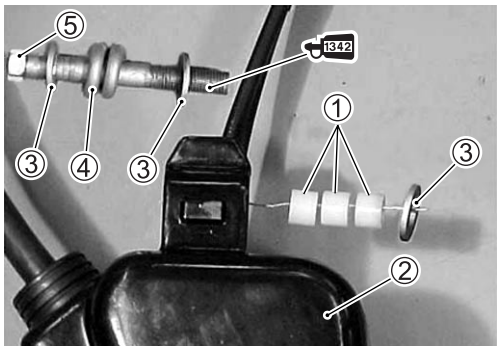
When reassembling the tiller handle, refer to the construction diagram below .



1. Tiller handle housing (1)
2. Handle grip (1)
3. Lower cover (1)
4. Screw (6)
5. Cable grommet (1)
6. PTT switch (1)
7. Emergency switch (1)
8. Lock plate (1)
9. Ignition switch (1)
10. Handle wire harness (1)
11. Handle wire grommet (1)
12. Screw (1)
13. Washer (1)
14. Handle rod stopper (1)
15. Spring (1)
16. Bush (1)
17. Pin (1)
18. Handle rod (1)
19. Handle grip adjuster (1)
20. Plate (1)
21. Screw (2)
22. Throttle link (1)
23. Screw (2)
24. Throttle cable (1)
25. E-ring (2)
26. Bolt (1)
27. Bush (1)
28. Shift cable (1)
29. Clutch link (1)
30. Bolt (2)
31. Bush (1)
32. Shift lever (1)
33. Buzzer (1)
34. Switch cover (1)
35. Screw (2)
36. Lock plate (1)
37. Ball (1)
38. Guide plate (1)
39. E-ring (1)

INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

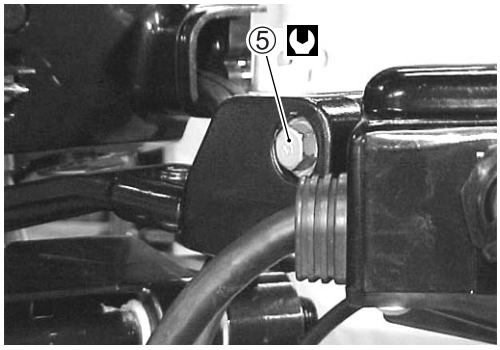


Tiller handle assembly

1. Install the three nylon bushes ① into the tiller handle mounting hole and set the tiller handle ② on the handle bracket.
2. Place the three washers ③ and the spring ④ in position. Insert the handle pivot bolt ⑤.
3. Apply the thread lock to the pivot bolt and tighten the bolt to the specified torque.

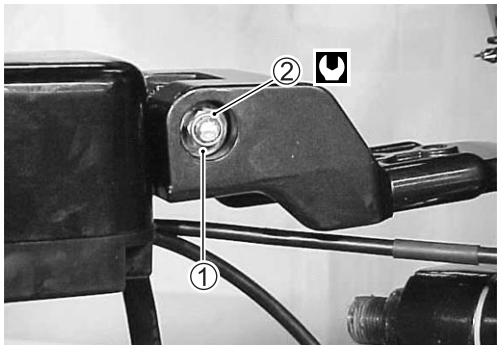
Handle pivot bolt: 20 N·m (2.0 kg-m, 14.5 lb-ft)

1342 99000-32050: Thread Lock 1342



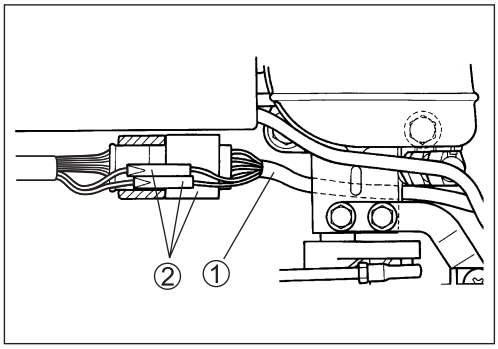
4. Install the washer ① and the nut ②, then tighten the nut to the specified torque.

Handle pivot nut: 45 N·m (4.5 kg-m, 32.5 lb-ft)



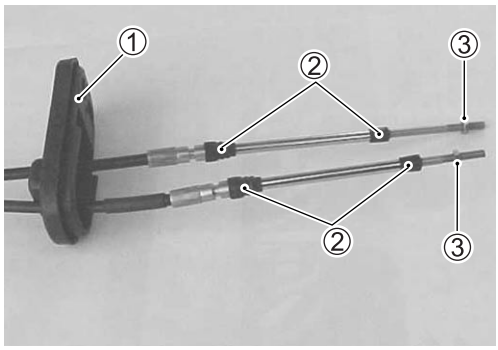
Handle wire harness

1. Route the handle wire harness ① as shown.
2. Connect the handle wire harness connectors ② to the engine side.

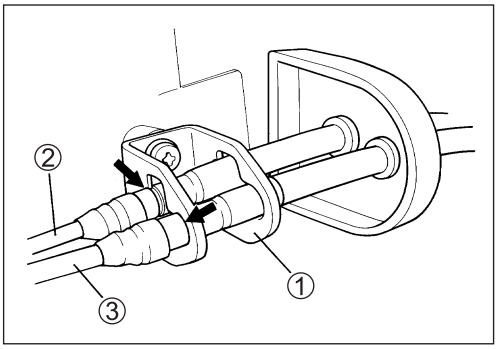


Throttle/Shift cable installation

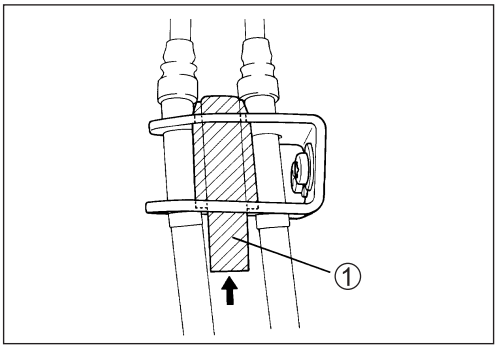
1. Insert the shift cable and the throttle cable through the rigging port grommet ① as shown.
2. Install the seals ② and the connector lock nuts ③ on the throttle / shift cables.



3. Secure the shift cable ② and the throttle cable ③ in the cable holder ① by the fitting groove on the cable into the slots of the holder.



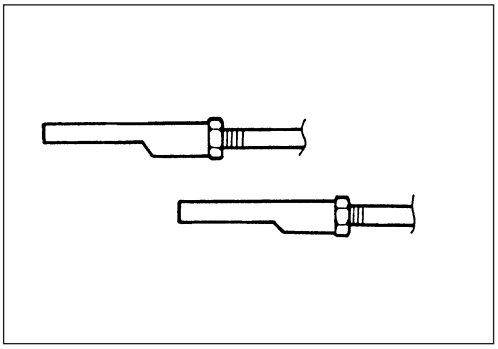
4. Push the cable stopper ① into the clearance between both cables until the stopper is fixed on the cable holder.



5. Screw the cable connector onto both cables.

CAUTION

The cable connector and the turnbackles must be threaded at least 13 mm (0.5 in) onto the cable.



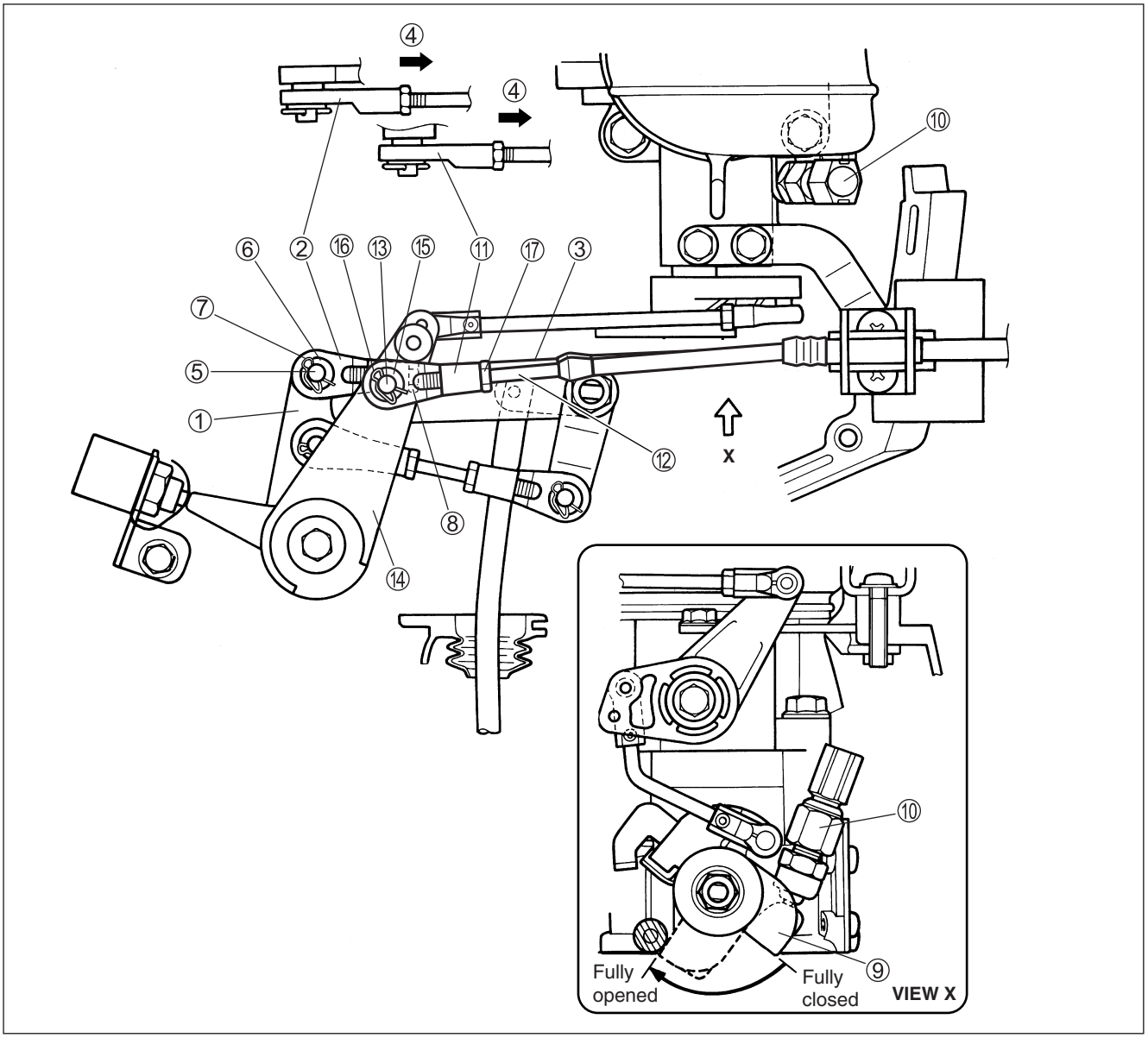
Shift cable to clutch control lever adjustment

1. Place the shift lever and the clutch control lever ① in the “NEUTRAL” position.
2. Push the cable connector ② and the shift cable ③ in the direction shown by the arrow ④ to remove all play in the cable.
3. While pressing against the cable and the connector, adjust the connector ② to align with the pivot pin ⑤ on the clutch control lever.
4. When aligned, press the connector ② (flat side of the connector toward the clutch control lever) over the pivot pin ⑤.

5. Install the washer ⑥ and the snap pin ⑦, then tighten the cable lock nut ⑧ against the connector to maintain adjustment.
6. Make sure that both forward and reverse gears can be engaged with the same angle of the shift lever travel from the “NEUTRAL” position.

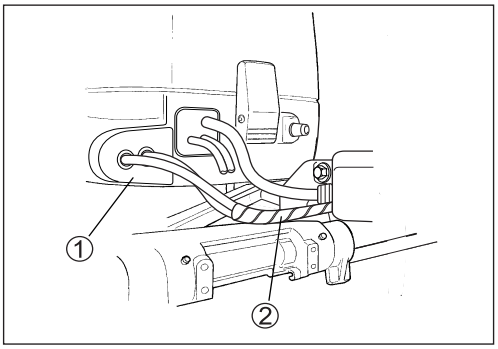
Throttle cable to throttle control arm adjustment

1. Set the throttle grip to the fully closed position.
2. Make sure that the throttle lever ⑨ is fully closed.
   (The CTP switch ⑩ must be in “ON”, pushed-in, position.)
3. Push the cable connector ⑪ and the throttle cable ⑫ in the direction shown by the arrow ④ to remove all play in the cable.
4. While pressing against the cable and the connector, adjust the connector ⑪ to align with the pivot pin ⑬ on the throttle control arm ⑭.
5. When aligned, press the connector ⑪ (flat side of the connector toward the throttle control arm) over the pivot pin ⑬.
6. Install the washer ⑮ and the snap pin ⑯, then tighten the cable lock nut ⑰ against the connector to maintain adjustment.



Rigging port grommet
Install both side covers and the rigging port grommet ①.

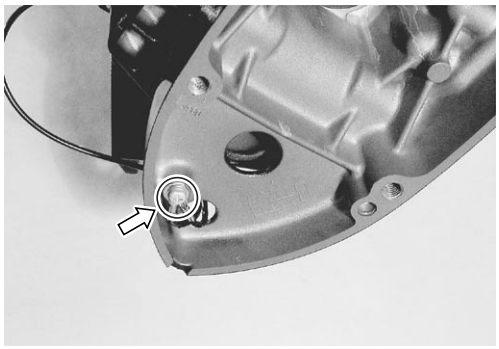
Cable routing
Bind the shift cable and the throttle cable with the spiral tube ② as shown.



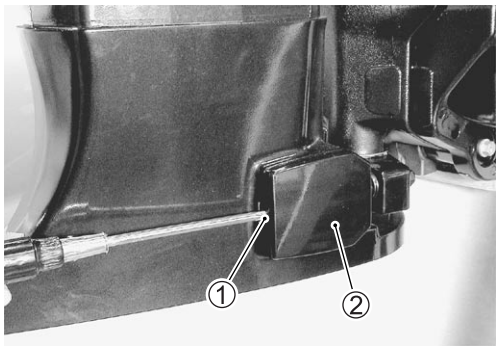
DRIVESHAFT HOUSING AND OIL PAN

REMOVAL

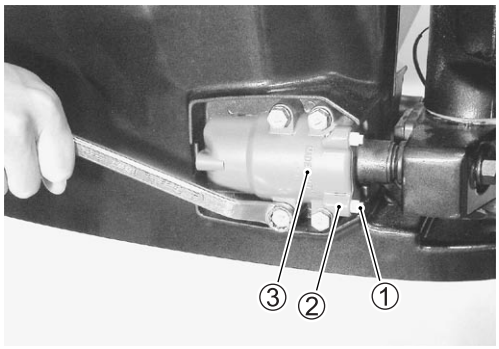
1. Remove the power unit. (See the page 6-6 to 6-10.)
2. Remove the lower unit. (See the page 9-2.)
3. Remove the screw and the bonding wires from the driveshaft housing.



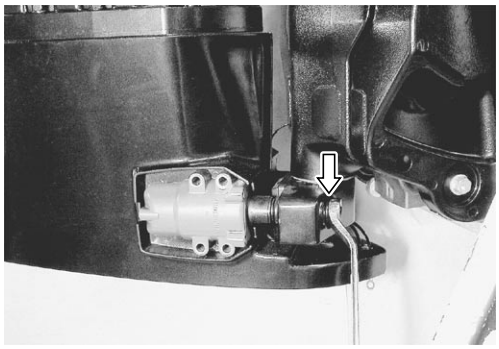
4. Remove the screw ① and the lower mount cover cap ②. (Both sides)



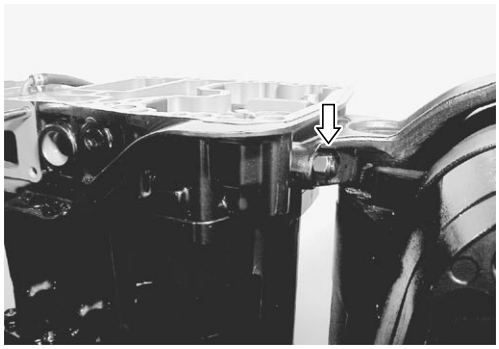
5. Make sure that the pins ① and springs ② are installed on lower mount cover ③. (Both sides)
6. Remove the four bolts and the lower mount cover ③. (Both sides)



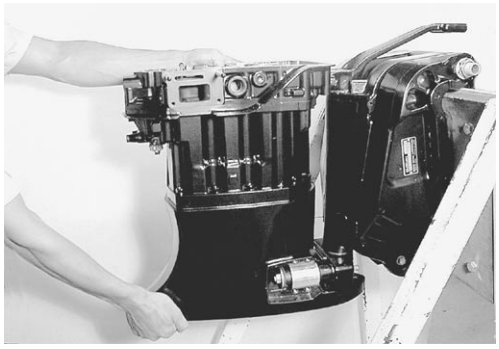
7. Remove the two lower mount nuts and the washers.



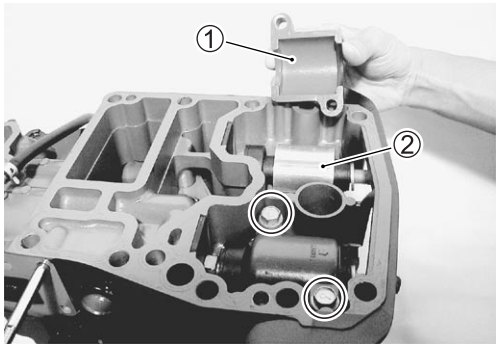
8. Remove the two upper mount nuts and the washers.



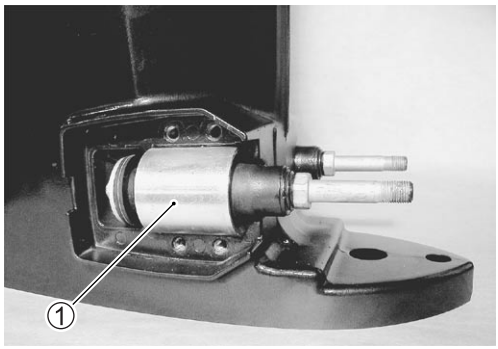
9. Remove the driveshaft housing with the oil pan from the steering bracket.



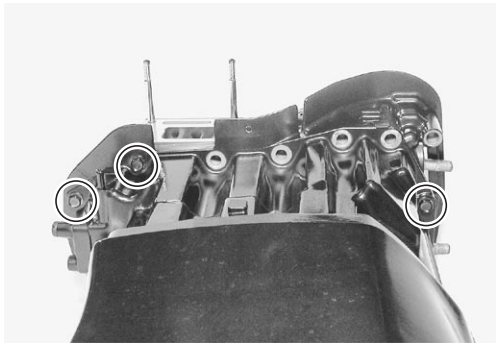
10. Remove the bolts and the upper mount cover ①.
11. Remove the upper mount assy ②.



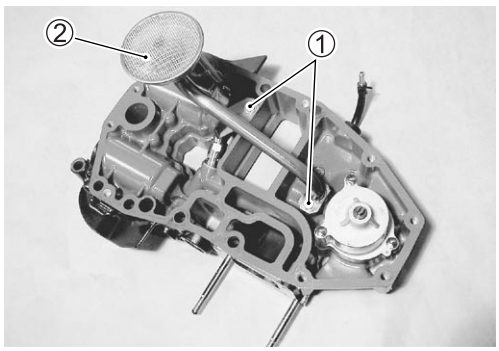
12. Remove the lower mount assy ①.



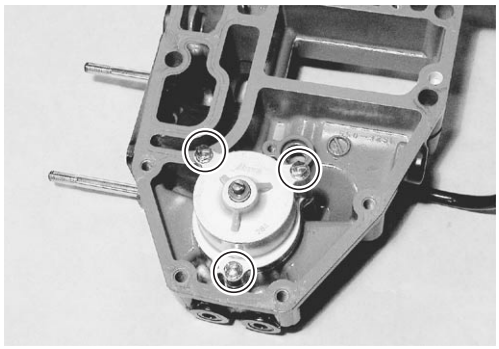
13. Remove the six bolts and the engine holder.



14. Remove the two bolts ① and the oil strainer ②.

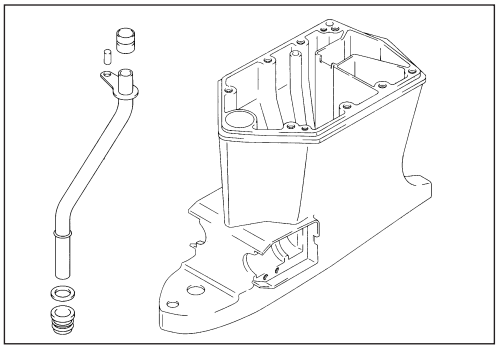


15. Remove the three bolts and the oil pump assy.



16. Remove the eight bolts and the oil pan.

17. Remove the water tube and the grommets.

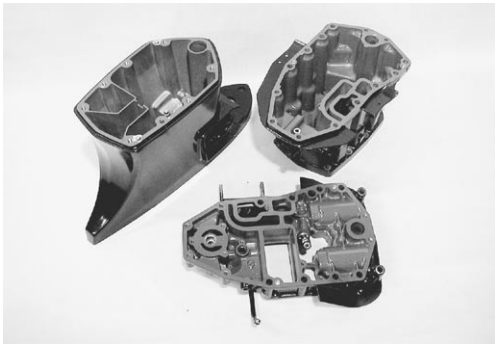


INSPECTION

NOTE:
If excessive wear, cracks, defective or other damage is found on any component, replace component.

MID UNIT COMPONENT

Inspect the oil pan, the driveshaft housing, the engine holder and the mount covers.
If crack, defective or other damage is found, replace.



MOUNT

Inspect the upper mount and the lower mount.
If excessively wear, corrosion or other damage is found, replace.

OIL PUMP

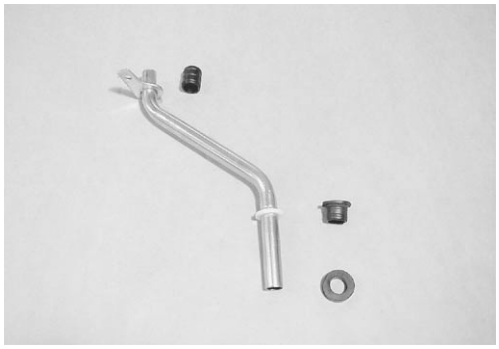
Inspect the oil pump.
If excessively wear or other damage is found, replace.

OIL STRAINER

Inspect the oil strainer.
If clog is found, clean.
If crack or other damage is found, replace.

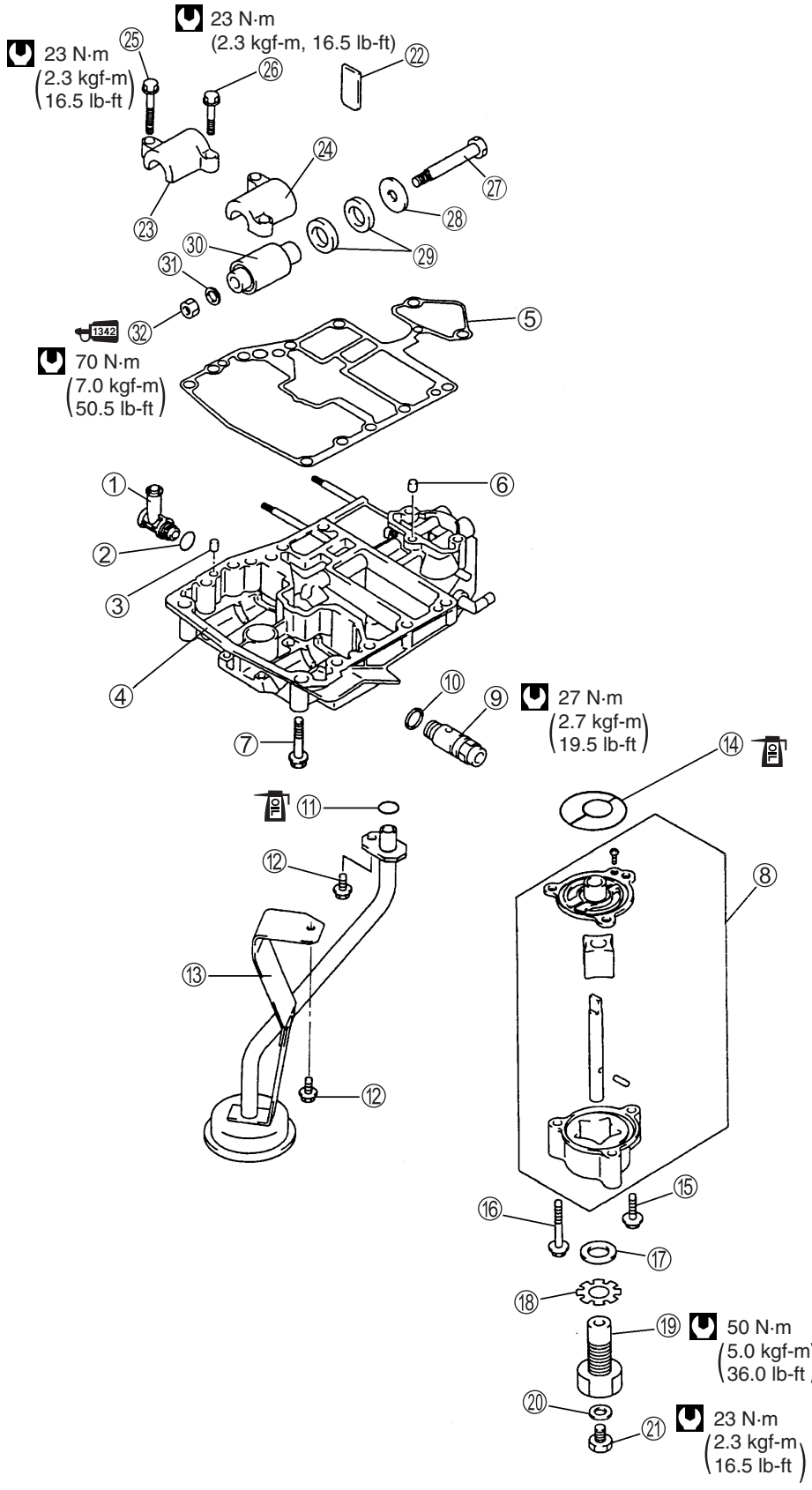
WATER TUBE

Inspect the water tube.
If clog is found, clean.
If crack, corrosion or other damage is found, replace.

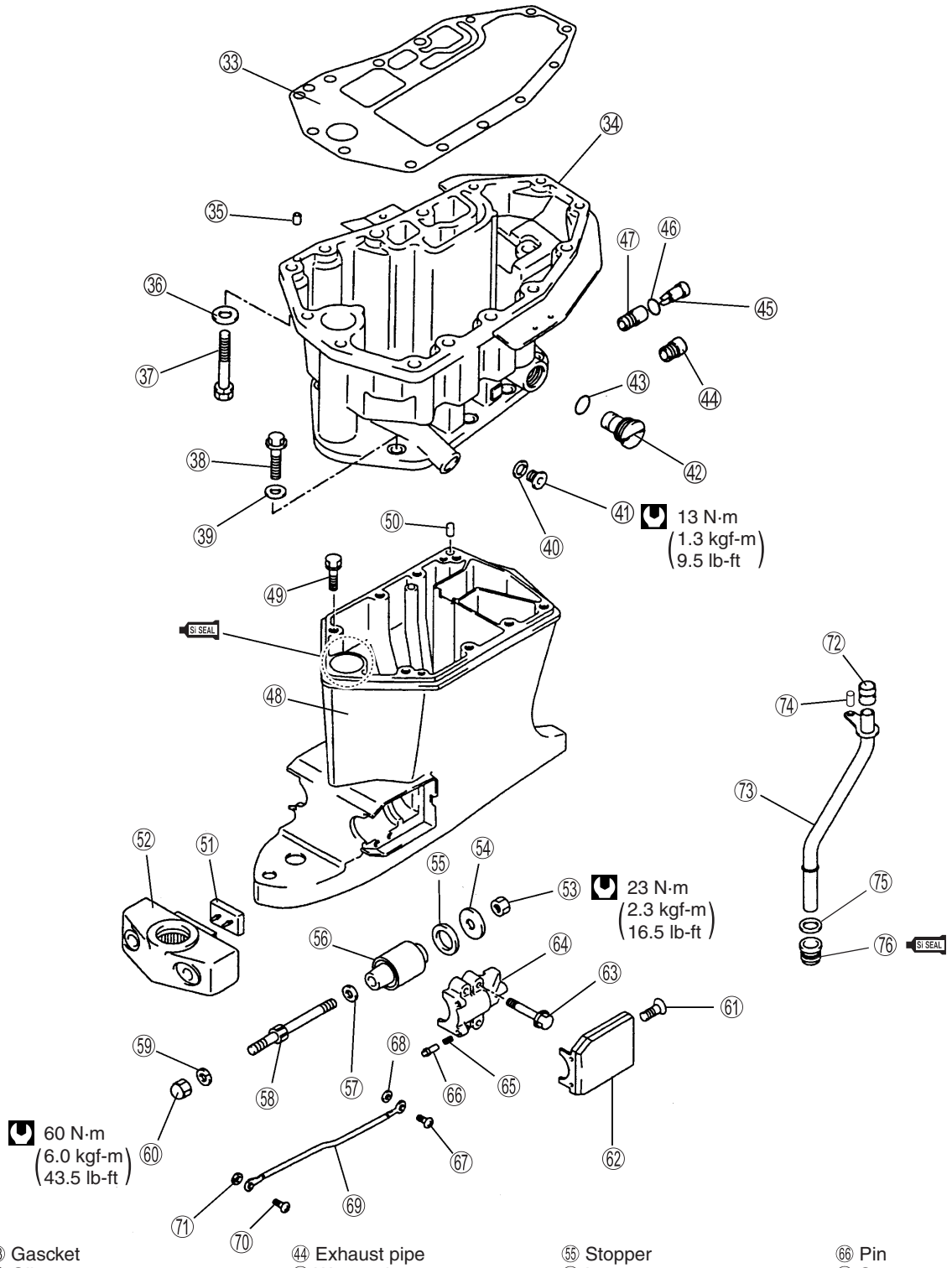


REASSEMBLY

Reassembly is reverse order of removal with the special attention to the following steps.



① Water pipe
② O-ring
③ Dowel pin
④ Engine holder
⑤ Gasket
⑥ Dowel pin
⑦ Bolt
⑧ Oil pump assy
⑨ Oil pressure regulator
⑩ Gascket
⑪ O-ring
⑫ Bolt
⑬ Oil strainer
⑭ O-ring
⑮ Bolt
⑯ Bolt
⑰ Gascket
⑱ Lock washer
⑲ Oil pump stopper
⑳ Gascket
㉑ Bolt
㉒ Upper thrust mount
㉓ Upper mount cover (starboard)
㉔ Upper mount cover (port)
㉕ Bolt
㉖ Bolt
㉗ Bolt
㉘ Washer
㉙ Stopper
㉚ Upper mount
㉛ Washer
㉜ Upper mount nut



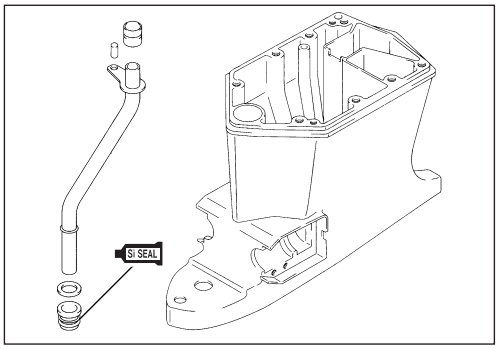
㉝ Gascket
㉞ Oil pan
㉟ Dowel pin
㊱ Washer
㊲ Bolt
㊳ Bolt
㊴ Washer
㊵ Gascket
㊶ Drain plug
㊷ Water plug
㊸ O-ring
㊹ Exhaust pipe
㊺ Water tube cover
㊻ O-ring
㊼ Water indicator tube
㊽ Driveshaft housing
㊾ Bolt
㊿ Dowel pin
(51) Lower thrust mount
(52) Lower mount bracket
(53) Lower mount nut (rear)
(54) Washer
(55) Stopper
(56) Lower mount
(57) Washer
(58) Lower mount bolt
(59) Washer
(60) Lower mount nut (front)
(61) Screw
(62) Lower mount cover cap
(63) Bolt
(64) Lower mount cover
(65) Spring
(66) Pin
(67) Screw
(68) Insulation washer
(69) Bonding wire
(70) Screw
(71) Insulation washer
(72) Bushing
(73) Water tube
(74) Pin
(75) Washer
(76) Bushing

DRIVESHAFT HOUSING AND OIL PAN

1. Apply the seal to the outer surface of the lower bushing.

Si SEAL 99000-31120: Suzuki Silicone Seal

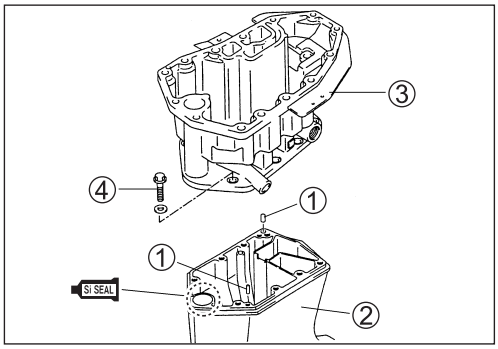
2. Install the water tube with the bushings, the washer and the pin to the driveshaft housing.



3. Install the two dowel pins ① to driveshaft housing ②.
4. Apply the seal to mating face around the driveshaft hole.

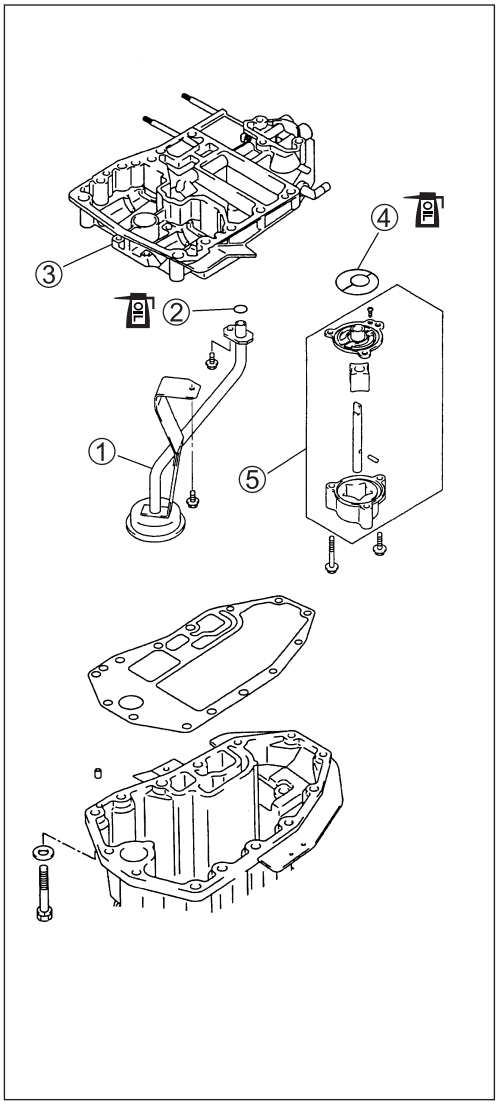
Si SEAL 99000-31120: Suzuki Silicone Seal

5. Install the oil pan ③ to the driveshaft housing ②, then tighten the eight bolts ④.



ENGINE HOLDER AND OIL PUMP ASSY

1. Install the O-ring ② to the oil strainer ① and apply the engine oil to the O-ring ②.
2. Install the oil strainer ① to the engine holder ③, then tighten the bolts.
3. Apply the engine oil to the O-ring ④.
4. Install the O-ring ④ and the oil pump ⑤ to the engine holder ③, then tighten the three bolts.

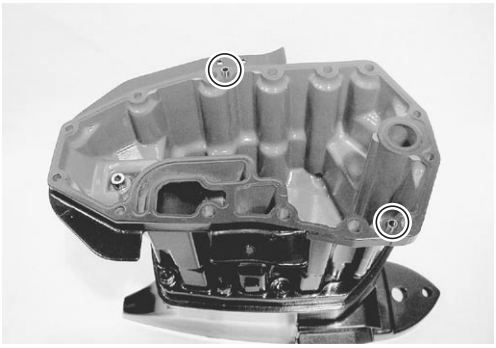


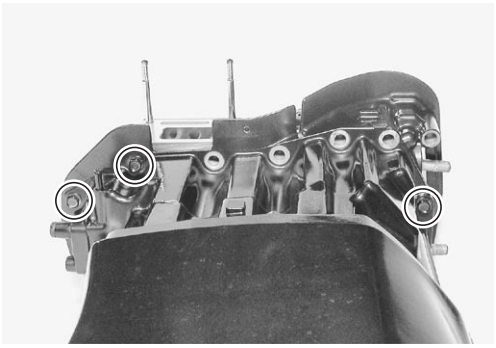
5. Install the two dowel pins and the gasket to the oil pan.
6. Install the engine holder to the oil pan, then gently tighten it temporarily with the six bolts.

NOTE:
When installing the power unit, tighten the engine holder mounting bolts to the specified torque. (See page 6-11.)

CAUTION

Do not re-use the gasket once removed. Always a use new gasket.



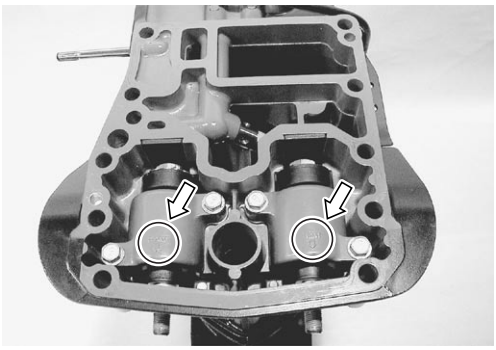


UPPER AND LOWER MOUNT

Upper mount and mount cover

1. Install the upper mount assy.
2. Install the upper mount cover with the lettered mark "FRONT" facing forward, then tighten the bolts.

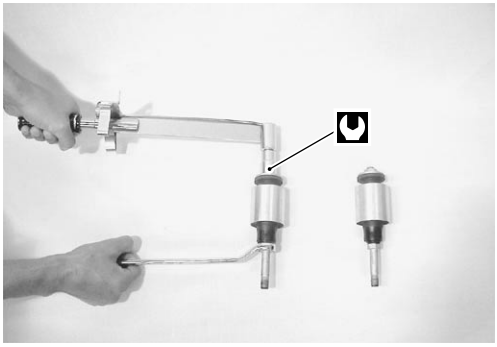
Upper mount cover bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)



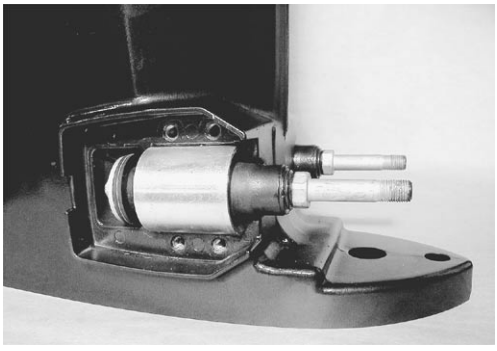
Lower mount

1. Install the lower mount assy to the driveshaft housing, then tighten the nut to the specified torque.

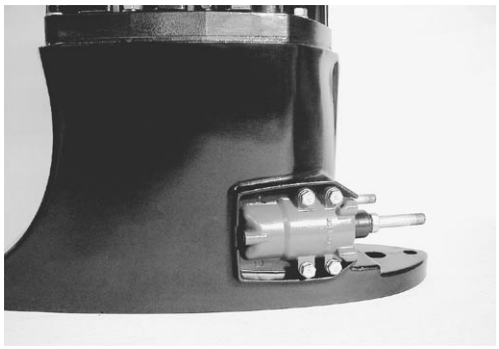
Lower mount nut (rear): 40 N·m (4.0 kg-m, 29.0 lb-ft)



2. Install the lower mount assy to the driveshaft housing.

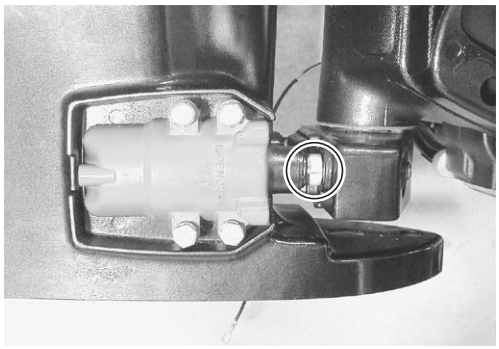


3. Install the lower mount cover to the driveshaft housing, then gently tighten it temporarily with the bolts.



DRIVESHAFT HOUSING / OIL PAN

1. Install the driveshaft housing / oil pan to the steering bracket. Insert the bolt hexagon head properly into the lower mount bracket hollow.

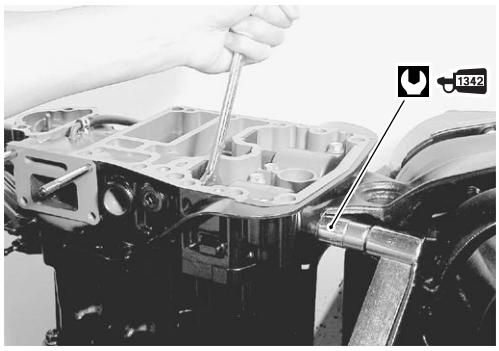


2. Apply the thread lock to the upper mount nuts.

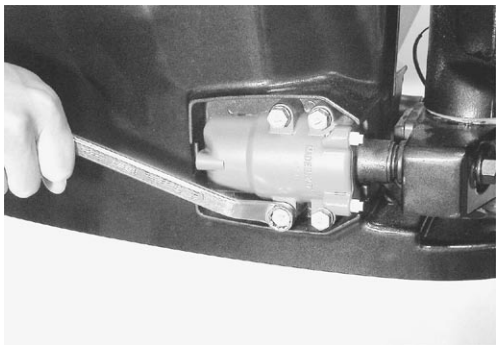
1342 99000-32050: Thread Lock 1342

3. Tighten the upper mount nuts to the specified torque.

Upper mount nut: 70 N·m (7.0 kg-m, 50.5 lb-ft)

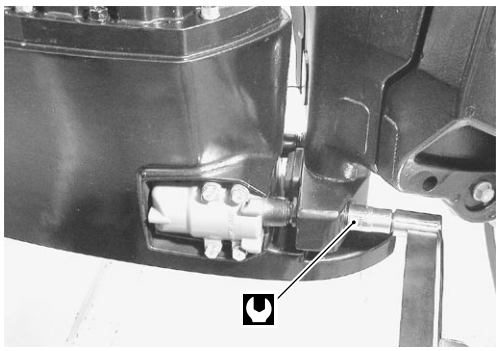


4. Tighten the lower mount cover bolts.

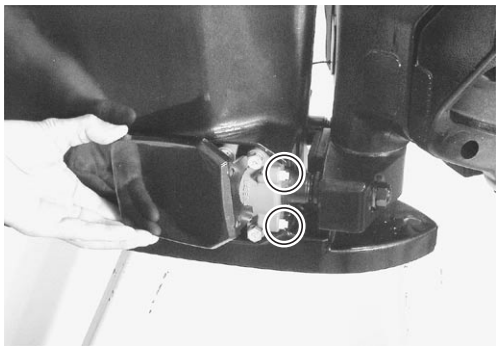


5. Tighten the lower mount nuts to the specified torque.

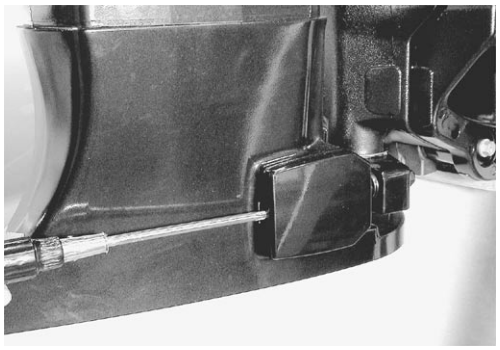
Lower mount nut (front): 60 N·m (6.0 kg-m, 43.5 lb-ft)



6. Install the springs and the pins to the lower mount cover.

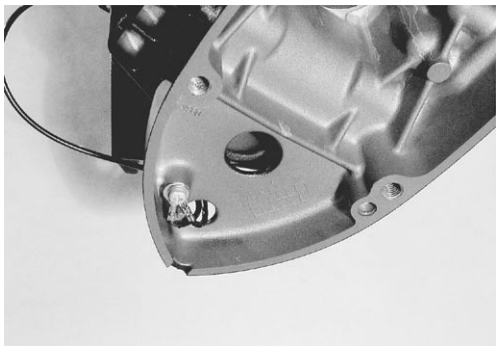


7. Install the lower mount cap to the lower mount cover, then tighten the screw.



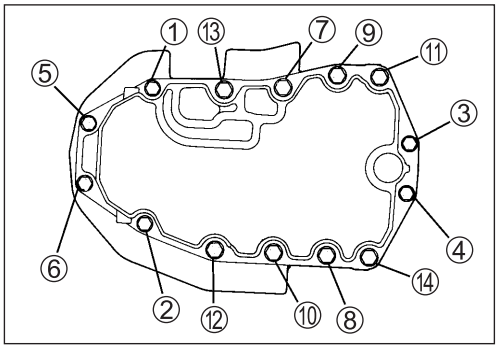
BONDING WIRE

Install the bonding wires to the driveshaft housing, then tighten the screw.



POWER UNIT

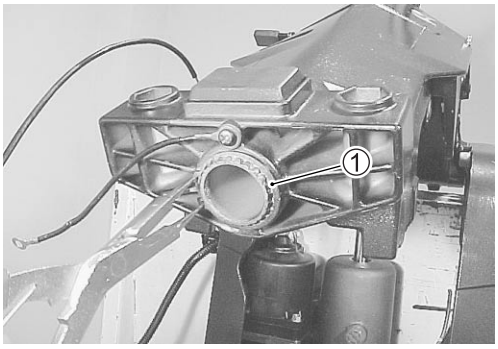
Install the power unit. (See the page 6-11.)



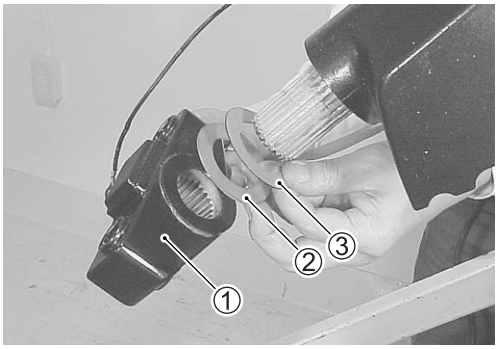
SWIVEL BRACKET, STEERING BRACKET AND CLAMP BRACKET

REMOVAL / DISASSEMBLY

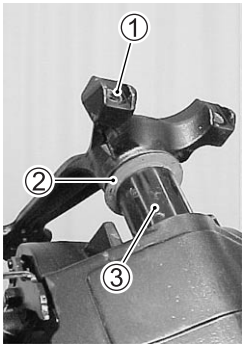
1. Remove the driveshaft housing / oil pan.
   (See the page 7-12 to 7-13.)
2. Remove the circlip ①.

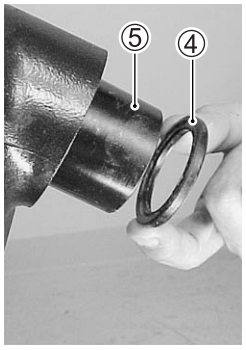


3. Remove the lower mount bracket ①, the shim ② and the washer ③ from the steering shaft.

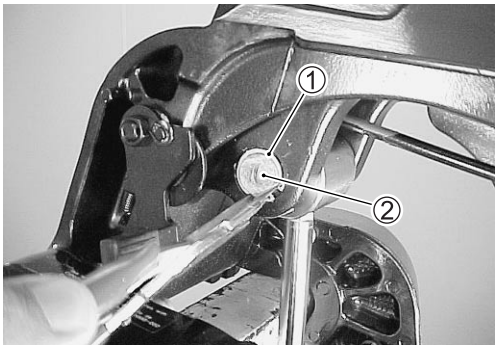


4. Lift the steering bracket ① upward to remove from the swivel bracket.
5. Remove the washer ② and the upper bushing ③.
6. Remove the swivel bracket seal ④ and the lower bushing ⑤.

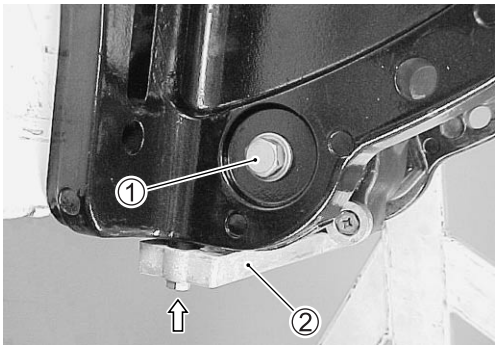


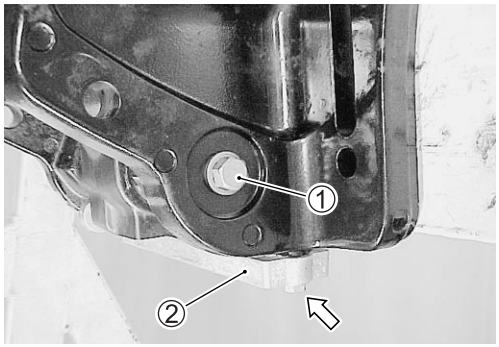


7. Remove the circlip ① and push out the tilt cylinder upper rod ②.

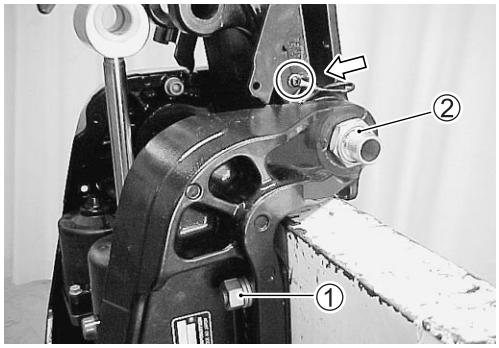


8. Remove the tilt cylinder lower shaft bolts ①.
9. Remove the bolts and anode ②.

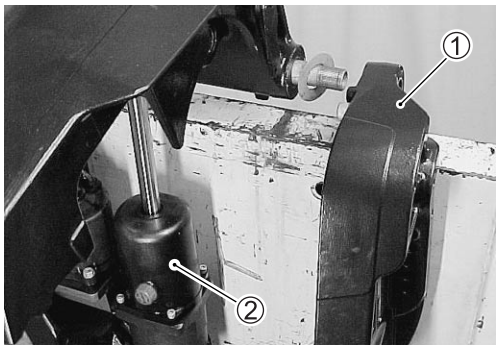




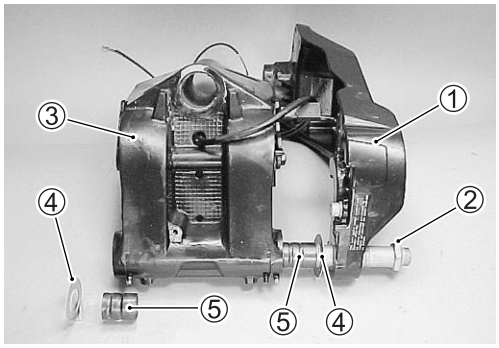
10. Remove the starboard motor mounting bolts ①.
11. Remove the clamp bracket shaft nut ②.
12. Remove the screw and bonding wire from the swivel bracket.



13. Slide the starboard clamp bracket ① off the clamp bracket shaft.
14. Remove the PTT unit ② with the lower rod.



15. Pull the port clamp bracket ① outward to remove the clamp bracket and the bracket shaft ② from the swivel bracket ③.
16. Remove the washer ④ and bushing ⑤ from each side of the swivel bracket.

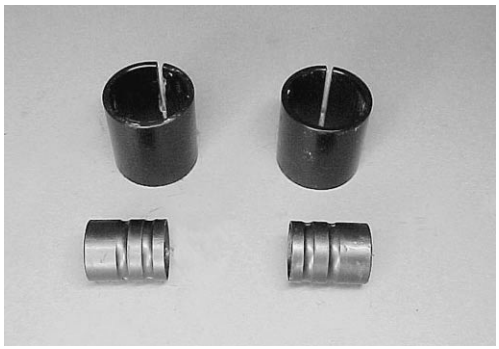


INSPECTION

NOTE:
If excessive wear, cracks, defective or damage is found on any component, replace component.

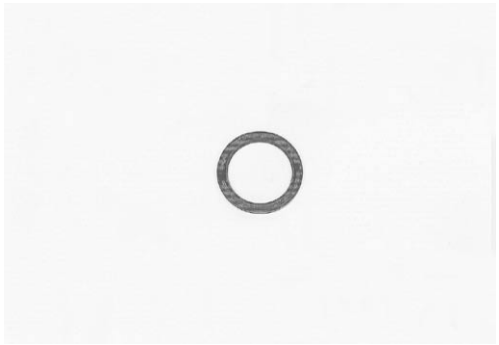
BUSHINGS

Inspect all bushings for excessive wear or other damage.
Replace if necessary.
If bushing fit is loose when installing, replace the bushing.



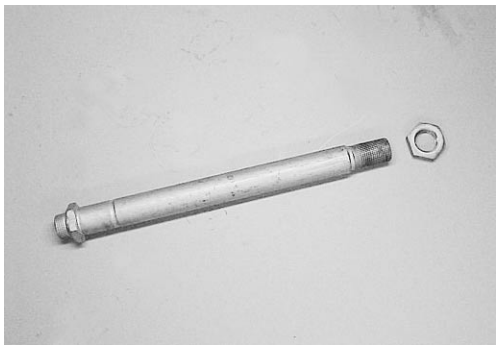
OIL SEAL

Inspect swivel bracket seal for cuts, nicks, excessive wear or other damage.



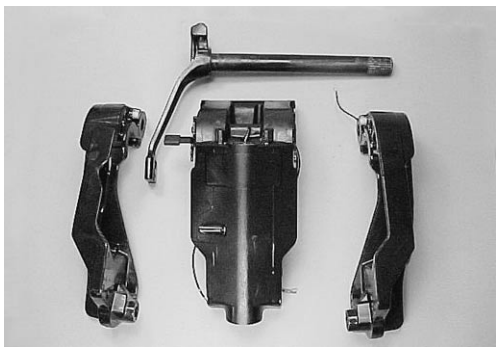
CLAMP BRACKET SHAFT

Inspect the clamp bracket shaft for bend, twist or other damage.
Replace if necessary.



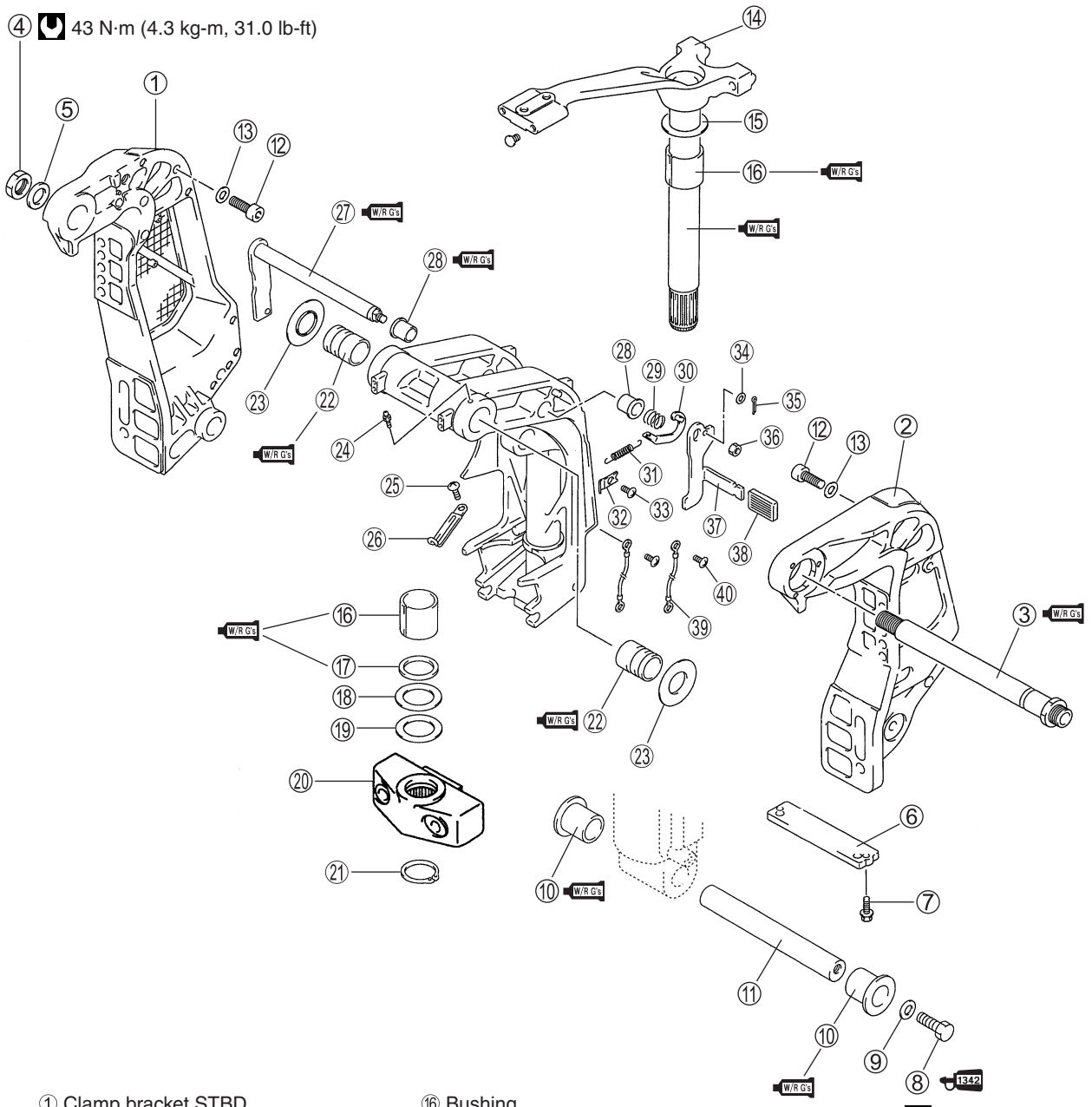
BRACKET

Inspect the clamp brackets, the steering bracket and the swivel bracket for excessive wear, cracks or other damage.
Replace if necessary.



REASSEMBLY

Reassembly is reverse order of removal with the special attention to the following steps.



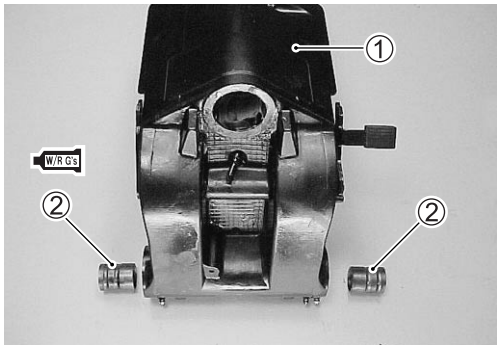
① Clamp bracket STBD
② Clamp bracket PORT
③ Clamp bracket shaft
④ Nut
⑤ Washer
⑥ Anobe
⑦ Bolt
⑧ Bolt
⑨ Washer
⑩ Bushing
⑪ Lower shaft
⑫ Bolt
⑬ Washer
⑭ Steering bracket
⑮ Washer
⑯ Bushing
⑰ Oil seal
⑱ Washer
⑲ Shim
⑳ Lower mount bracket
㉑ Circlip
㉒ Bushing
㉓ Washer
㉔ Grease nipple
㉕ Screw
㉖ Clapm
㉗ Tilt lock lever
㉘ Bushing
㉙ Spring
㉚ Link
㉛ Spring
㉜ Bracket
㉝ Screw
㉞ Washer
㉟ Pin
㊱ Nut
㊲ Tilt lock lever PORT
㊳ Rubber
㊴ Bonding wire
㊵ Screw

CLAMP BRACKET AND SWIVEL BRACKET

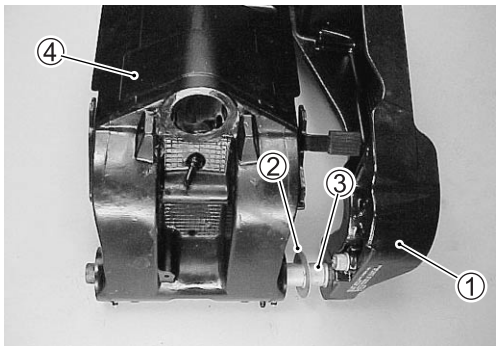
NOTE:
Before installing the clamp bracket to the swivel bracket, apply the grease to the clamp bracket shaft and the bushings.

W/R G's **99000-25160: Suzuki Water Resistant Grease**

1. Insert the port and starboard bushings ② into the swivel bracket ①.

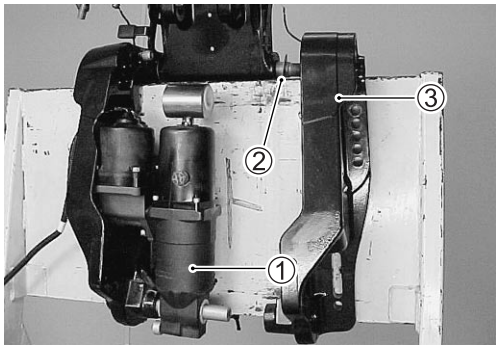


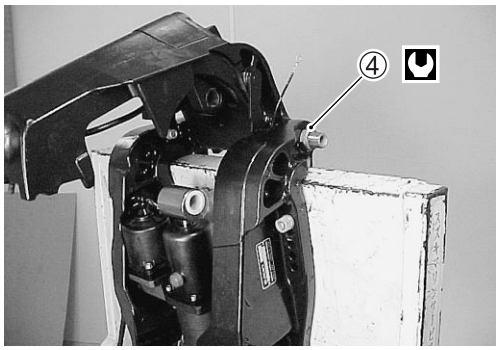
2. Assemble the port clamp bracket ①, the washer ②, the clamp bracket shaft ③ and the swivel bracket ④.



3. Install the PTT unit assembly ①, the lower shaft and the bushings in position.
   (For the PTT unit assembly installation, see the page 8-15.)
4. Install the washer ②, the starboard clamp bracket ③ and the clamp bracket shaft nut ④, then tighten the nut ④ to the specified torque.

Clamp bracket shaft nut: 43 N·m (4.3 kg-m, 31.0 lb-ft)

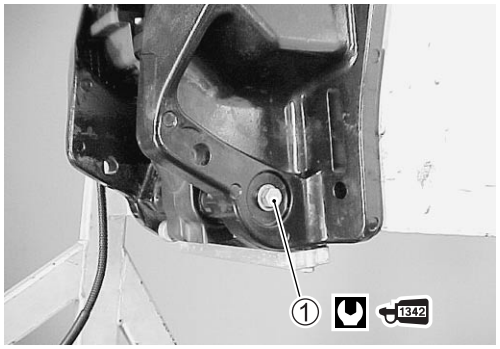




5. Tighten the lower shaft bolts ①, pre-coated with the thread lock, to the specified torque.

1342 **99000-32050: Thread lock 1342**

Cylinder lower shaft bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)



STEERING BRACKET

1. Apply the Water Resistant Grease to the steering bracket shaft.

W/R G's 99000-25160: Suzuki Water Resistant Grease

NOTE:
Apply the grease to the bushings, the oil seal lip and the pilot shaft portion of the steering bracket.

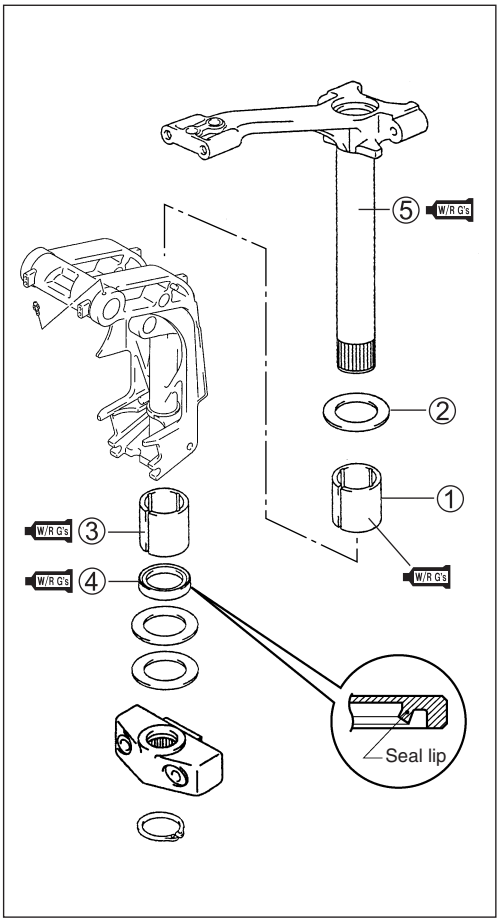
2. Install the upper bushing ① and the washer ② to the swivel bracket.
3. Install the lower bushing ③ and the swivel bracket seal ④ to the swivel bracket.

NOTE:
Install the seal ④ with the lip (spring side) facing downward.

4. Install the steering bracket ⑤ to the swivel bracket.

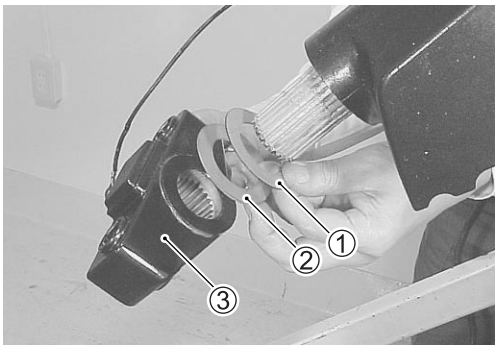
CAUTION

Do not re-use the seal once removed. Always use a new seal.

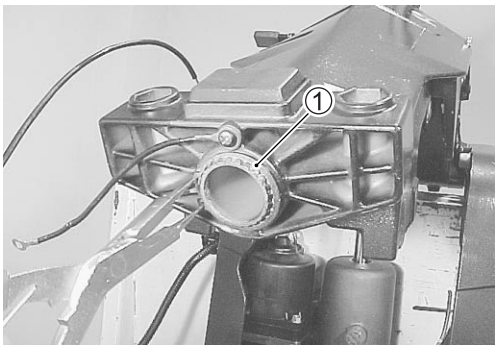


LOWER MOUNT BRACKET

1. Install the washer ① and the shim ②, and then slide the lower mount bracket ③ upward on the splines until it contacts the shim.

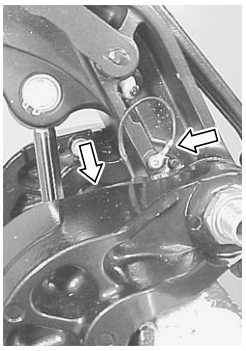


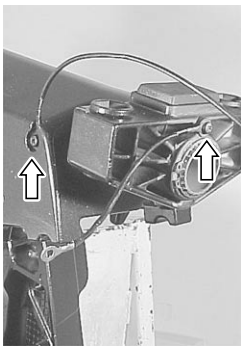
2. Install the circlip ① to retain the bracket.



BONDING WIRE

Reattach the bonding wires, then tighten the screw securely.

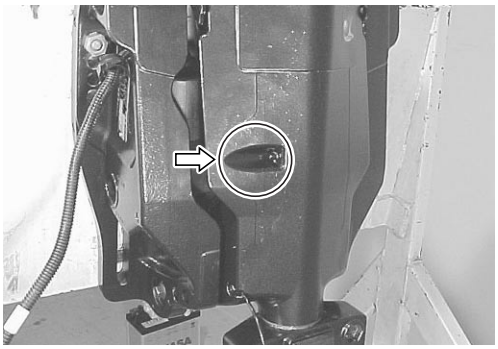


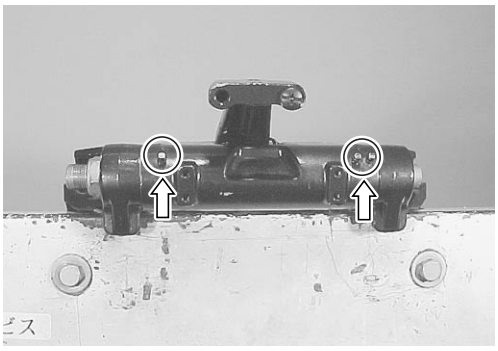


LUBRICATION

After completing reassembly of the mid unit, apply the Watar Resistant Grease through each grease nipple.

W/R G's **99000-25160: Suzuki Water Resistant Grease**

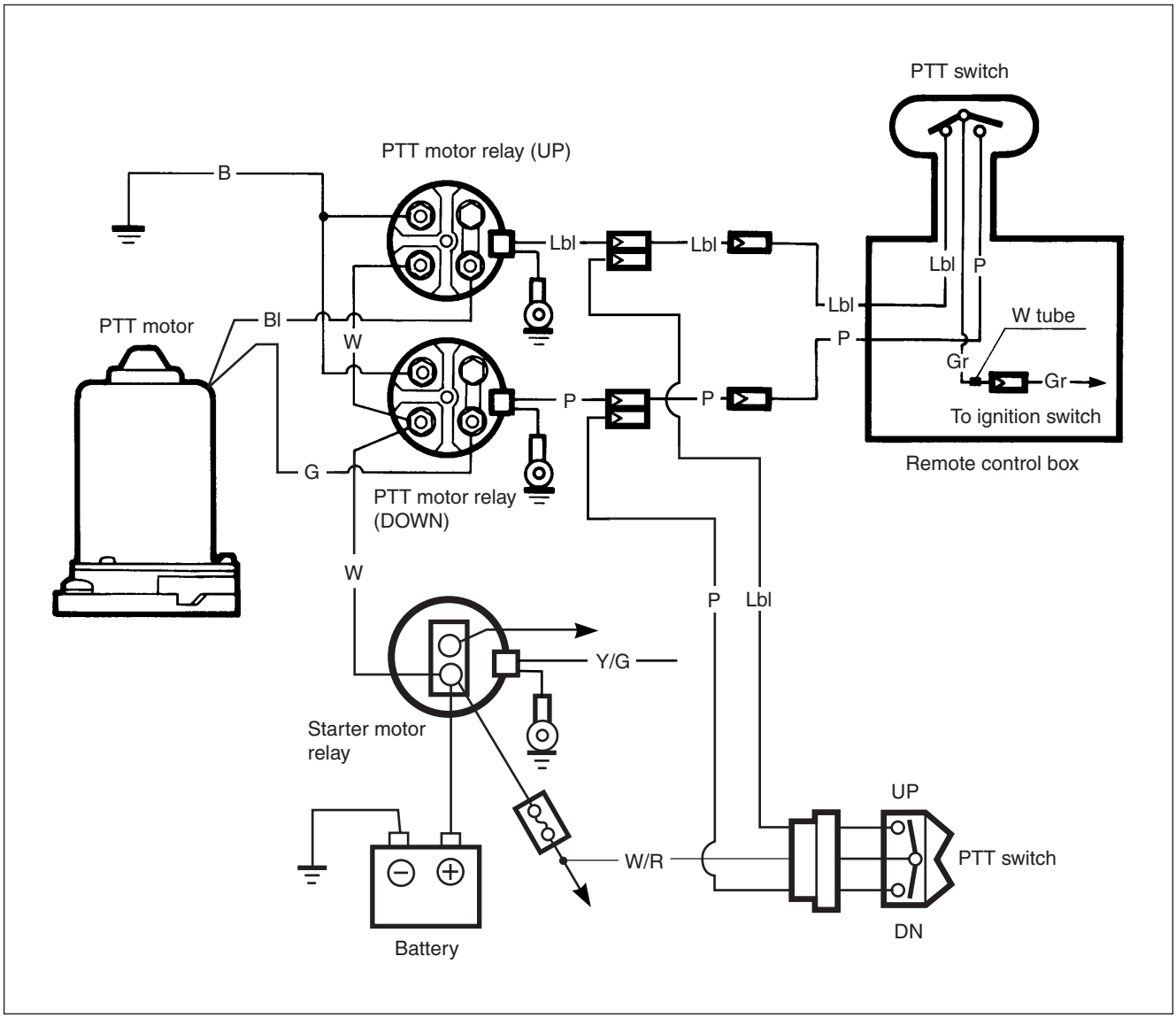




POWER TRIM AND TILT

CONTENTS

SYSTEM WIRING DIAGRAM

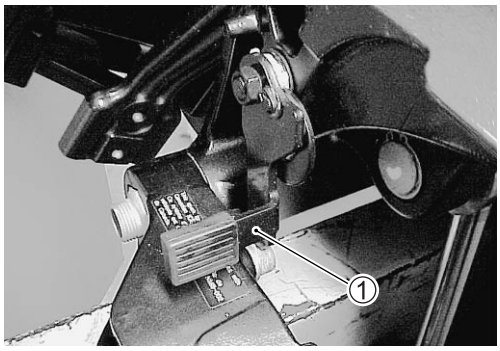


SERVICE PROCEDURE

OIL LEVEL

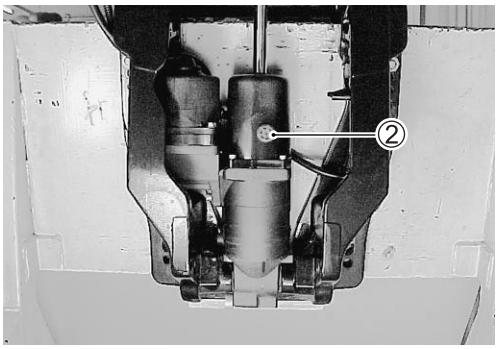
To check the PTT oil level:

1. Raise the engine to a full-tilt position.
2. Lower the manual tilt lock lever ①.
3. Remove the oil filler plug ②.
4. If the oil can be seen at the filler plug level, the unit is full.
5. If the oil level is low, refill with the recommended oil.



Recommended oil:

Dexron Ⅲ automatic transmission fluid or equivalent



CAUTION

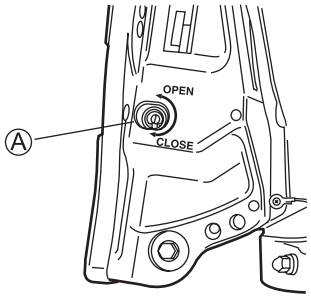
To ensure consistent pump operation, do not mix different types of oil.

6. Reinstall the oil filler plug.

AIR BLEEDING

1. Check that the manual release valve is tightened to the specified torque.

Manual release valve: 3.6 N·m (0.36 kg-m, 2.6 lb-ft)



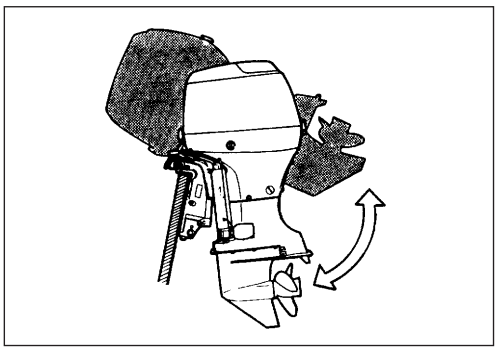
Ⓐ Manual release valve

CAUTION

Do not over-tighten the manual release valve.

Counterclockwise = open
Clockwise = close

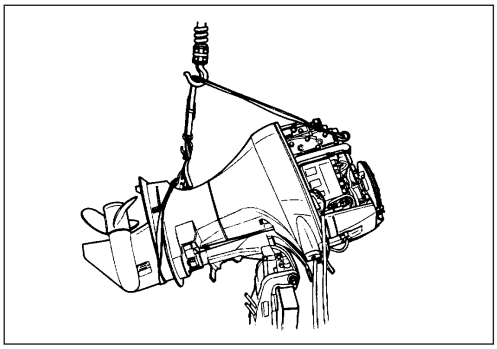
2. Operate the PTT switch, raising and lowering the motor up and down (full tilt position to full trim down position) 4 to 5 times.
3. Check the oil level, topping off if necessary.
4. Reinstall the oil filler plug.



POWER TRIM AND TILT UNIT

REMOVAL

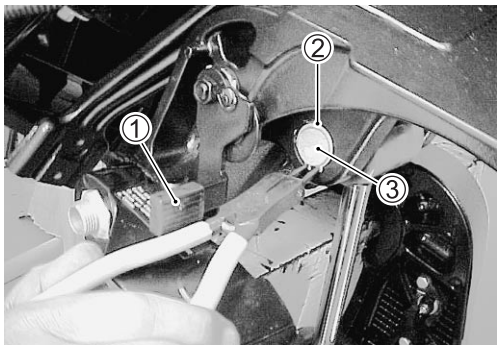
1. Raise the engine to the full tilt position and the lower manual tilt lock levers ①.



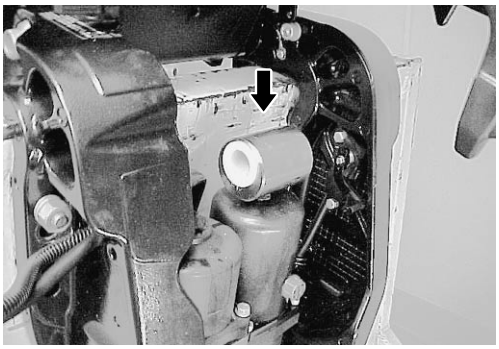
⚠ WARNING

During the following procedures, the engine must be firmly secured and its weight fully supported. (See right)

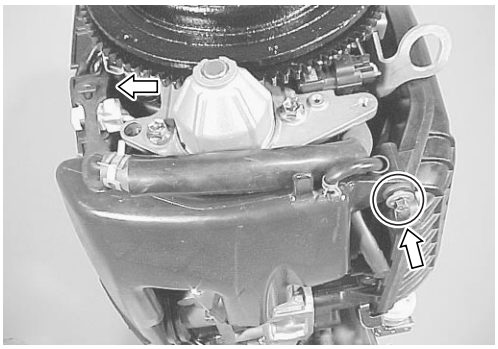
2. Remove the tilt rod snap ring ② and push the tilt cylinder upper shaft pin ③ out.



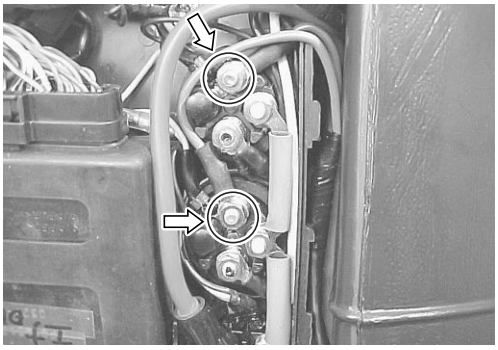
3. Lower the tilt rod to the full down position and disconnect the battery cable.



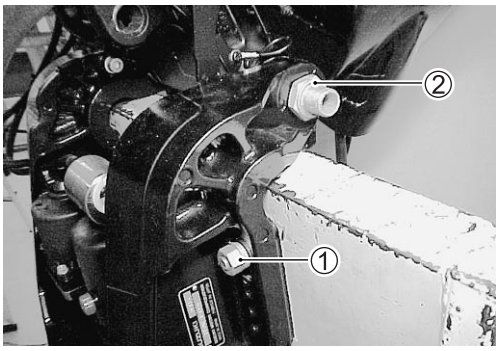
4. Remove the silencer cover bolt and the fastening band.



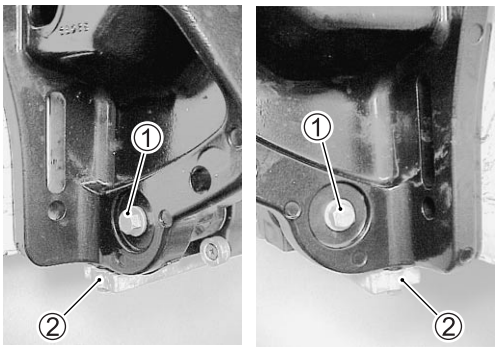
5. Disconnect the PTT motor cable wire leads (Green, Blue) from the PTT motor relays.
6. Remove the PTT motor cable from the engine lower cover.



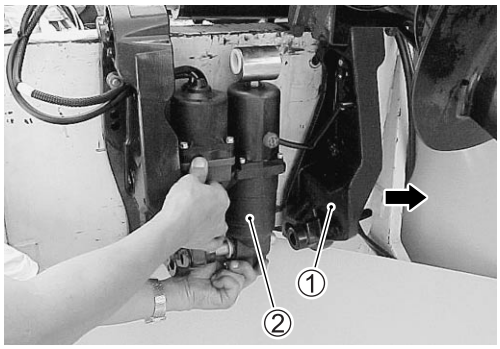
7. Remove the starboard motor mounting bolts ① and the clamp bracket shaft nut ②.



8. Remove the PTT cylinder lower shaft bolts ①.
9. Remove the two bolts and the anode ②.



10. Slide the starboard clamp bracket ① off the clamp bracket shaft, then remove the PTT unit ②.

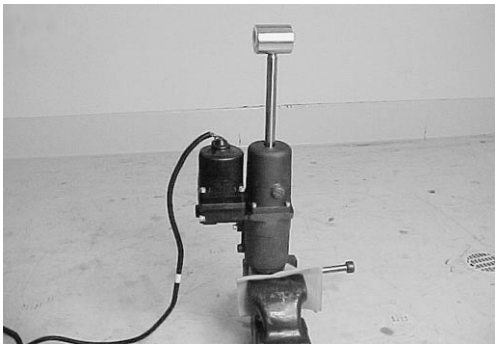


DISASSEMBLY

NOTE:
Before disassembly, wash the PTT body with a stiff bristle brush and hot, soapy water to remove sand or dirt and dry the PTT body with compressed air.

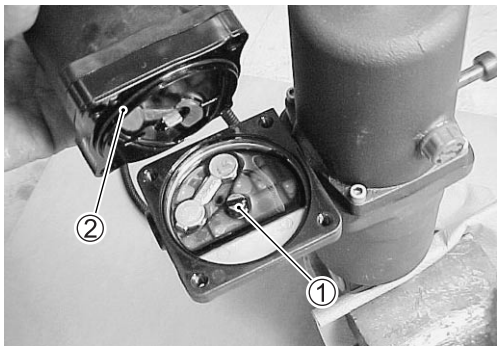
1. Place the lower mounting eye of the PTT cylinder in a vise. Tighten the vise only enough to secure the PTT unit, do not over tighten.

NOTE:
To prevent damage to the PTT cylinder use wood blocks, vise jaw protectors, etc., between the vise jaws and the PTT components before tightening the vise.

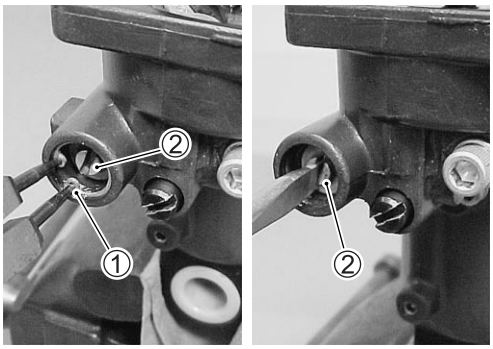


2. Connect the PTT motor cable leads (Green, Blue) to the battery and operate the PTT motor until the tilt piston rod is at a maximum stroke. (full-tilt up position)

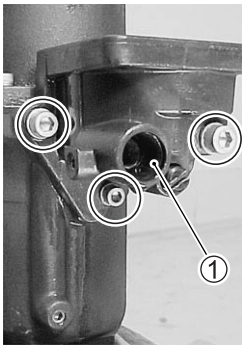
3. Remove the PTT motor. (See the page 8-10)
   Note the position of the drive joint ① and the O-ring ②, before removing them.
4. Remove the fill plug and drain the PTT oil into a suitable container.

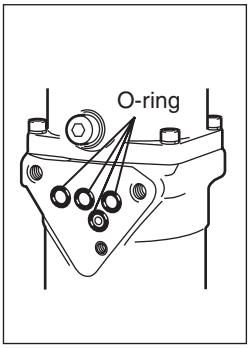


5. Remove the manual release valve snap ring ①, then remove the manual release valve ②.

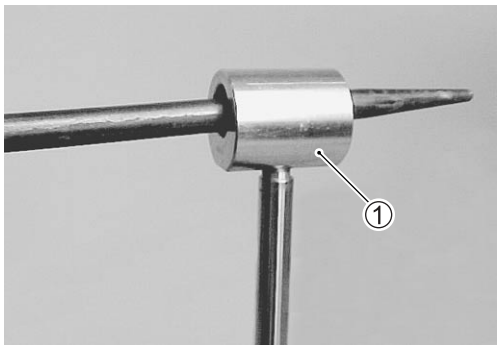


6. Remove the three bolts securing the PTT pump case ①, then detach the PTT pump case from the PTT body.
   Note the position of the O-rings and remove them.

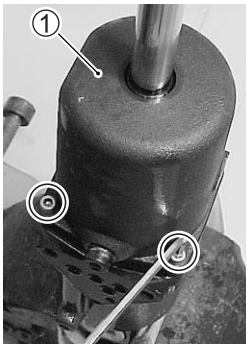




7. Remove the upper eye ①.



8. Remove the four bolts securing the cylinder cover ①, then detach the cover from the PTT body.
9. Remove the O-ring ②.



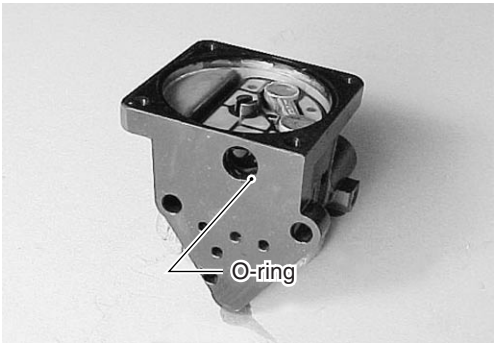
INSPECTION

Arrange all components on a clean sheet of paper.

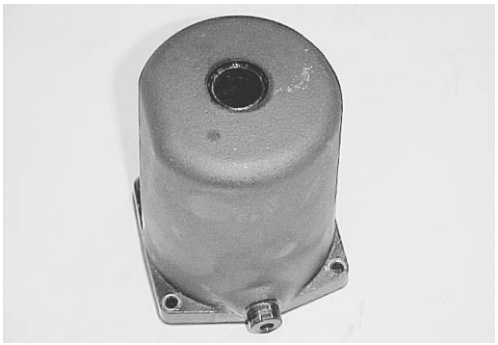
NOTE:
Do not lay the PTT components out on a rag, as dirt or lint may be transferred to these items which may cause possible system operating problems.

NOTE:
If excessive wear, cracks, defective or other damage is found on any component, replace component.

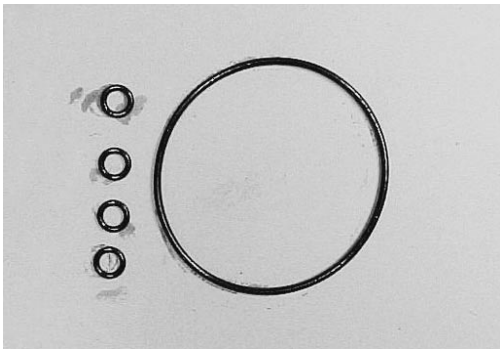
- Inspect the PTT pump case for cracks, nicks, stripped threads and any other imperfections.
  Replace if necessary.



- Inspect the cylinder cover for cracks, nicks or damage.
  Replace if necessary.
- Inspect the cylinder cover seal for cuts, nicks or wear.

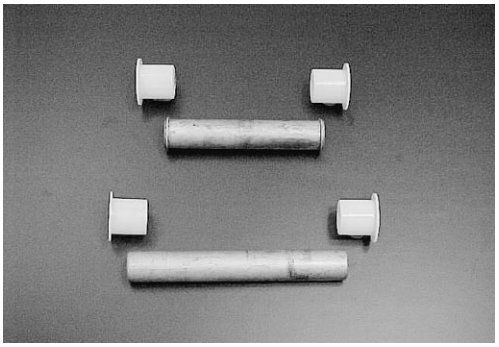


- Inspect the O-rings for cuts, nicks or tears.



- Inspect the manual release valve for damage.
  Replace if necessary.
- Inspect the O-rings for cuts, nicks or tears.

- Inspect the lower shaft and the upper shaft for bent, twist or other damage.
  Replace if necessary.
- Inspect all bushings for excessive wear or other damage.
  Replace if necessary.
  If bushing fit is loose when installing, replace the bushing.



REASSEMBLY

Assembly is reverse order of disassembly with the special attention to the following steps.

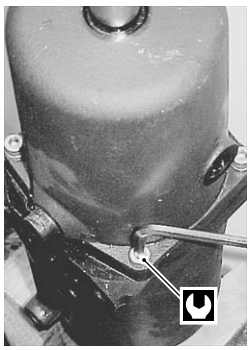
CAUTION

- **Do not re-use the O-ring and seal once removed. Always use new parts.**
- **Lubricate all components and O-rings with the PTT fluid before assembly.**
- **Do not re-use the PTT fluid. Always refill with new fluid.**

TILT CYLINDER COVER

1. Apply the PTT fluid to the cylinder cover seal, then install the cylinder cover.
2. Tighten the four bolts securely.

Cylinder cover bolt: 4.7 N.m (0.47 kg-m, 3.4 lb-ft)

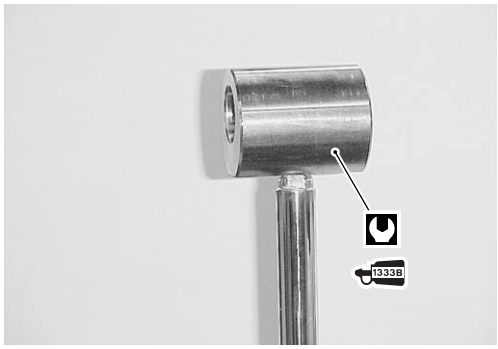


UPPER EYE

1. Apply the Thread Lock to the threads of the upper eye before threading it onto the tilt rod.
2. Tighten the upper eye to the specified torque.

Upper eye: 108 N.m (10.8 kg-m, 78.0 lb-ft)

99000-32020: Thread Lock Super "1333B"



PTT PUMP CASE

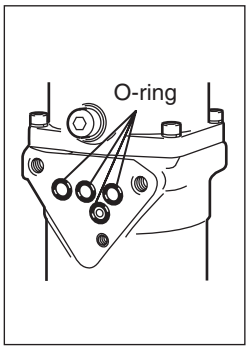
1. Install the four O-rings to the PTT body.

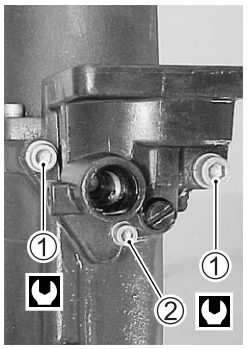
NOTE:
Lubricate the O-ring with the PTT fluid before installing the PTT body.

2. Install the PTT pump case, then tighten the three bolts to the specified torque.

PTT pump case bolt:

① 8 N·m (0.8 kg-m, 5.8 lb-ft)
② 5.5 N·m (0.55 kg-m, 4.0 lb-ft)



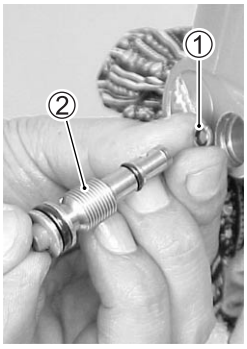


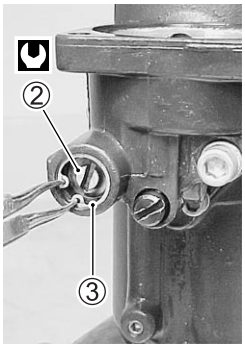
MANUAL RELEASE VALVE

1. Oil and install the seal washer ① and the manual release valve ②.
2. Tighten the valve to the specified torque.

Manual release valve: 3.6 N.m (0.36 kg-m, 2.6 lb-ft)

3. Install the snap ring ③.



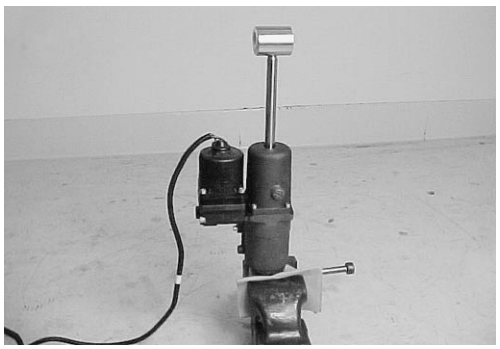


PTT MOTOR
See the PTT MOTOR INSTALLATION section on the page 8-14.

AIR BLEEDING
- Pour the recommended PTT fluid in to the reservoir until the specified level.
- Perform the air bleeding procedure.
  See the AIR BLEEDING section on the page 8-3.

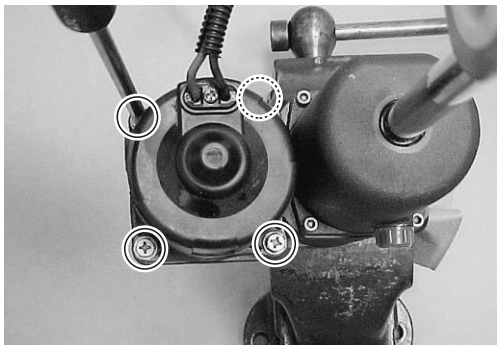
PTT MOTOR
PTT MOTOR REMOVAL
NOTE:
Before removing the PTT motor, wash the PTT body with a stiff bristle brush and hot, soapy water to remove sand or dirt and dry the PTT body with compressed air.

1. Place the lower mounting eye of the PTT cylinder in a vise. Tighten the vise only enough to secure the PTT unit, do not over tighten.

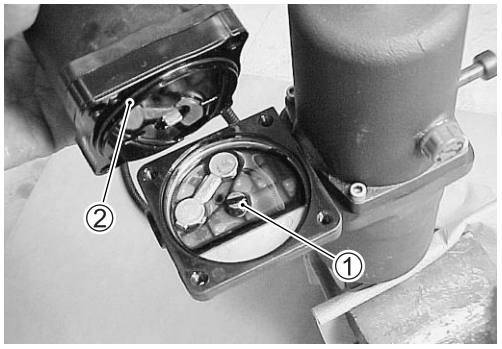


NOTE:
To prevent damage to the PTT cylinder use wood blocks, vise jaw protectors, etc., between the vise jaws and the PTT components before tightening the vise.

2. Remove the four bolts securing the PTT motor to the PTT pump case.

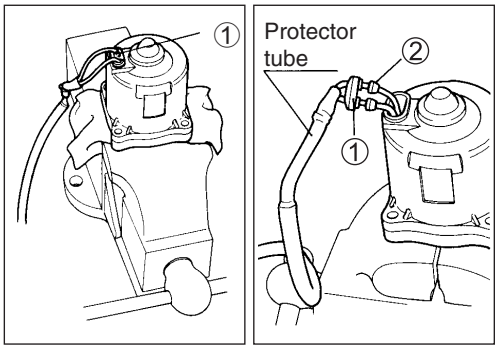


3. Detach the PTT motor from the PTT pump case.
   Note the position of the drive joint ① and the O-ring ② and remove them.

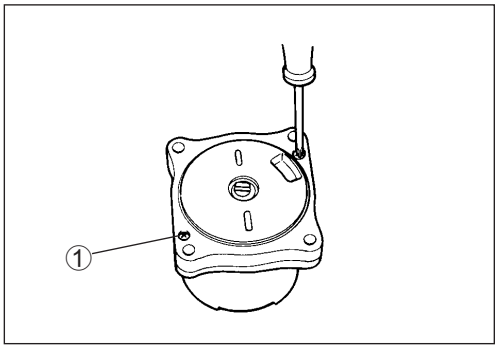


PTT MOTOR DISASSEMBLY

1. For correct assembly, scribe an alignment mark on the field case and the brush holder.
2. Remove the tape from the PTT motor cables and the cable protector tube, then slide the cable protector tube upward.
3. Remove the screw securing the motor cable holder ①, then slide the motor cable holder and the grommets ② out as shown.

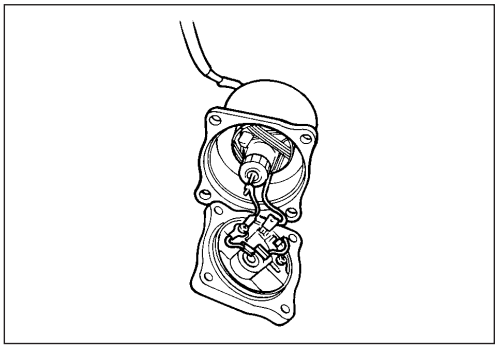


4. Remove the two screws ① securing the field case to the brush holder.

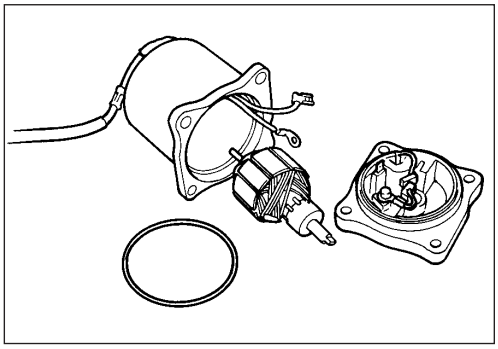


5. Slide the field case upward and away from the brush holder.

NOTE:
When separating the field case from the brush holder, proceed by pushing the PTT motor cables into the brush holder side.



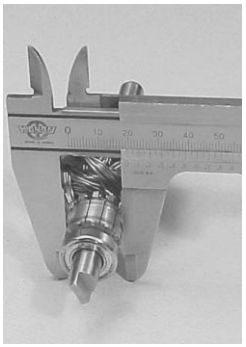
6. Disconnect the PTT motor cables from the brush holder.
7. Remove the armature from the field case.
   Note the position of the O-ring encircling the brush holder.



PTT MOTOR INSPECTION

Armature and Commutator

1. Inspect the commutator surface for gum or dirt.
   Clean with #500 grit emery paper if necessary.



Measure the commutator outside diameter.

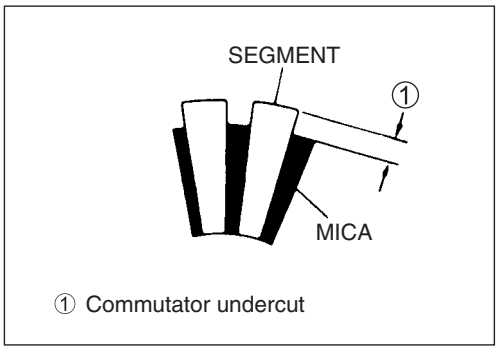
TOOL 09900-20101: Vernier calipers

Commutator outside diameter:
Standard : 22.0 mm (0.87 in)
Service limit: 21.0 mm (0.83 in)

If the measurement exceeds the service limit, replace the armature.

2. Measure the commutator undercut (depth) between the mica (insulator) and the segments.

Commutator undercut ① (depth):
Standard : 1.6 – 1.9 mm (0.06 – 0.07 in)
Service limit: 1.3 mm (0.05 in)



① Commutator undercut

If the measurement exceeds the service limit, cut the mica to the specified depth.

NOTE:
Remove all particles of the mica and the metal using compressed air.

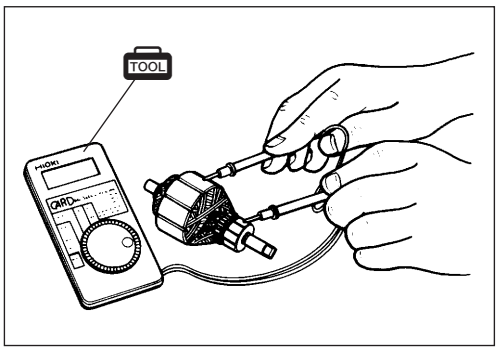
⚠ WARNING

Wear safety grasses when using compressed air.

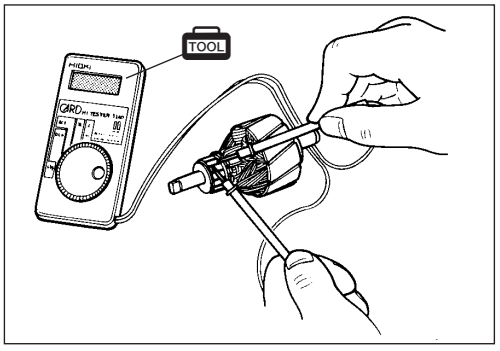
3. Inspect the continuity between the commutator and the armature core/shaft.
   If the continuity exists, replace the armature.

TOOL 09930-99320: Digital tester

Tester range: (Continuity)



4. Inspect the continuity between the adjacent commutator segments.
   If no continuity exists, replace the armature.

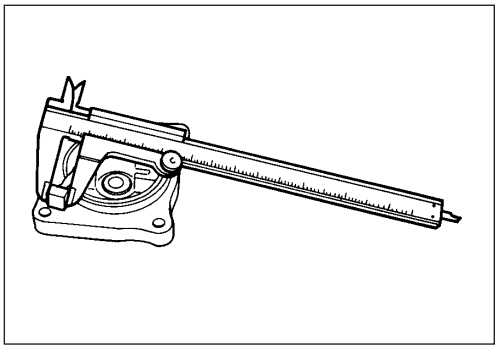


Brushes
Measure the length of each brush.

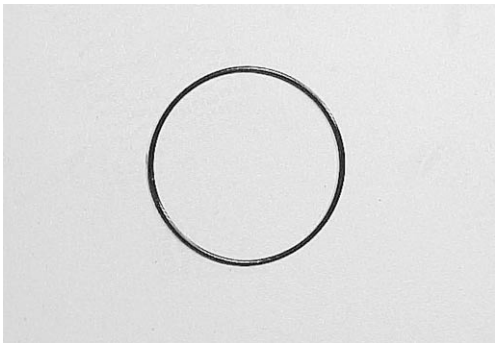
TOOL **09900-20101: Vernier calipers**

Brush length:
Standard: 9.8 mm (0.39 in.)
Service limit: 5.5 mm (0.22 in.)

If the measurement exceeds the service limit, replaced the brush.



O-ring
Inspect the O-ring between the PTT motor and the PTT pump case for cuts, nicks or tears.

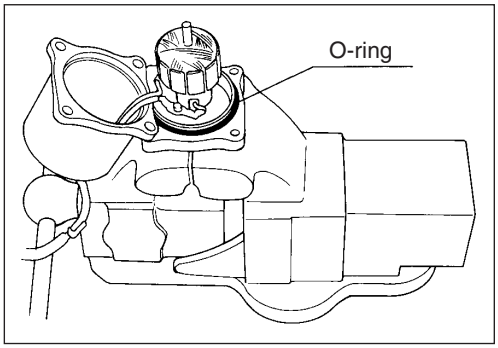


PTT MOTOR REASSEMBLY
Reassembly is reverse order of disassembly with the special attention to the following steps.

1. Install the armature to the brush holder first.

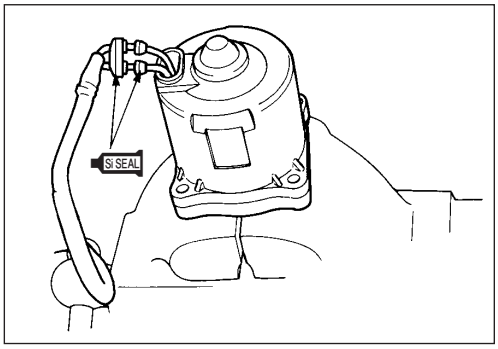
CAUTION

When installing the armature, exercise care to avoid breaking the brushes.

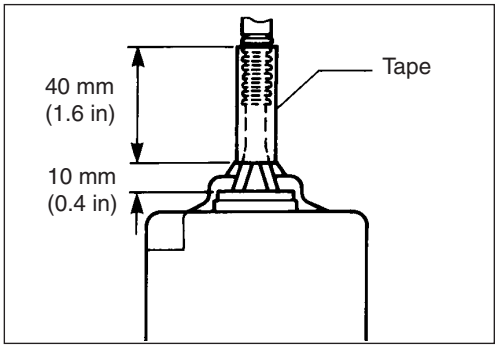


2. Match up previously scribed alignment marks.
3. When assembling the field case to the brush holder, proceed by pulling the PTT motor cables out of the field case.
4. Apply the Silicone Seal to the PTT motor cable holder and the grommets, then install the cable holder screw.

Si SEAL **99000-31120: Suzuki Silicone Seal**

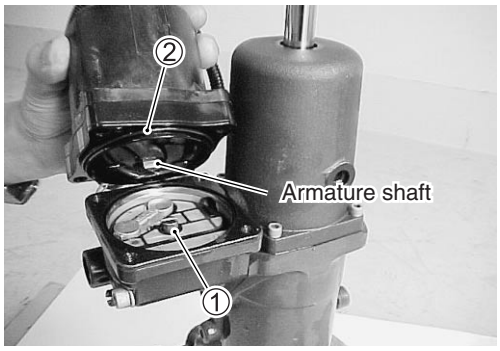


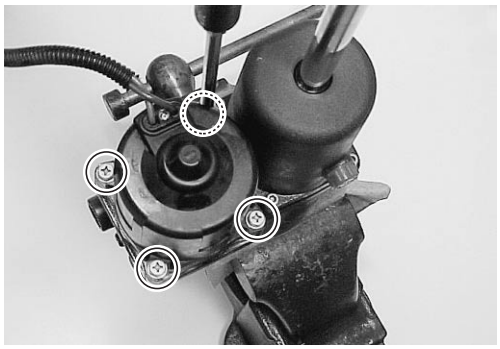
5. Fix the cable protector tube to the PTT motor cables with heat-resisting tape.



PTT MOTOR INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.





1. Ensure that the drive joint ① is aligned and firmly inserted into the gear pump assembly.
2. Fit the O-ring ② to the PTT motor.
3. Check the level of the PTT fluid contained in the PTT pump case. If the level is low, add the recommended PTT fluid until the level with the mating surface of the PTT motor.
4. Ensure that the faces of the PTT motor and the pump unit are free of dirt or debris.
   When attaching the PTT motor to the PTT pump case, ensure that the tip of the armature shaft fits firmly into the drive joint ①.
5. Tighten the four bolts to the specified torque.

PTT motor screw: 5 N·m (0.5 kg-m, 3.6 lb-ft)

6. Pour the recommended PTT fluid into the reservoir until the specified level.
7. Perform the air bleeding procedure.
   See the AIR BLEEDING section on the page 8-3.

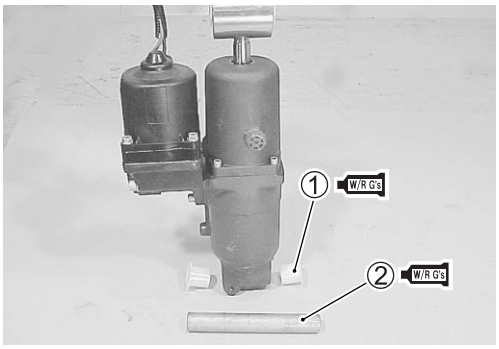
INSTALLATION

Installation is reverse order of removal with the special attention to the following steps.

1. Lower the tilt rod to the full down position.

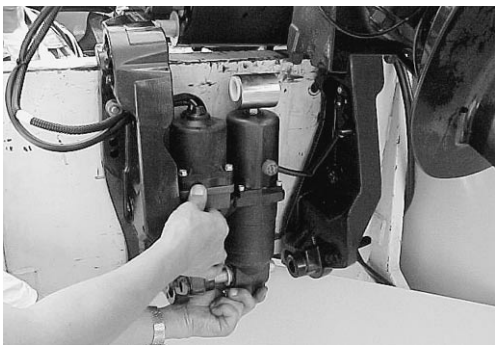
2. Apply the Water Resistant Grease to the tilt cylinder lower shaft and the lower shaft bushing.
3. Install the bushings ① and the cylinder lower shaft ② to the PTT unit.

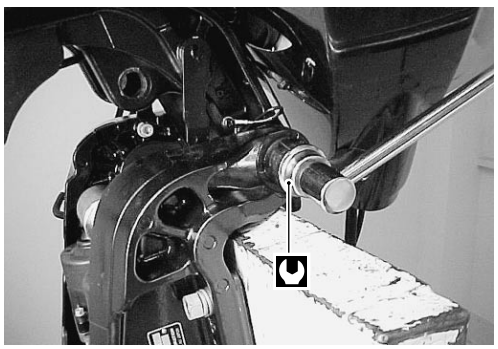
W/R G's 99000-25160: Suzuki Water Resistant Grease



4. Place the PTT unit in position, then install the clamp bracket.
5. Tighten the clamp bracket shaft nut to the specified torque.

Clamp bracket shaft nut: 43 N·m (4.3 kg-m, 31.0 lb-ft)



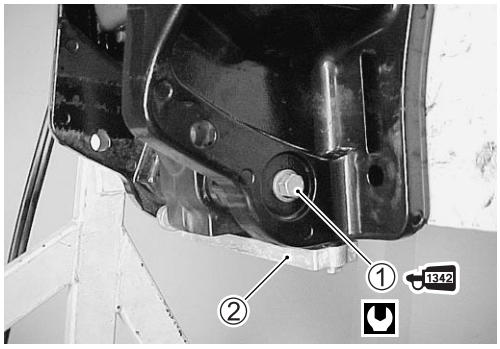


6. Tighten the lower shaft bolts ①, pre-coated with the thread lock, to the specified torque.

1342 99000-32050: Thread Lock "1342"

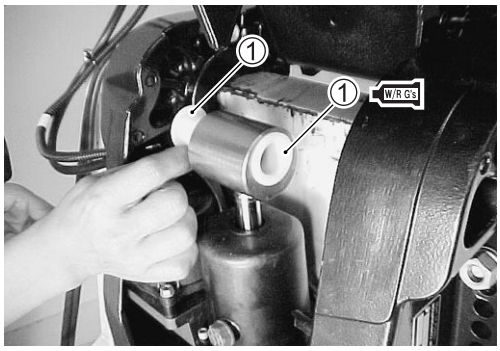
Cylinder lower shaft bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

7. Install the anode ②, then tighten the bolts securely.



8. Apply the Water Resistant Grease to the tilt rod upper bushings ①, then install the bushings in the tilt rod.
9. Operate the PTT motor to extend the PTT rod upward. Align the tilt rod with the hole in the swivel bracket as the tilt rod extends.

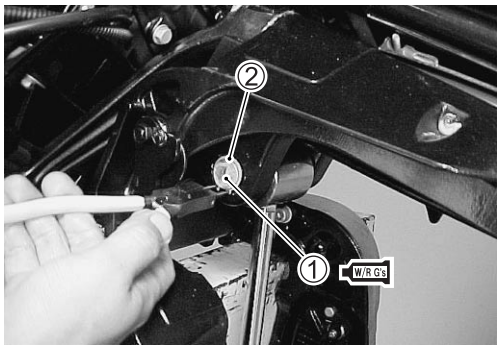
W/R G's **99000-25160: Suzuki Water Resistant Grease**



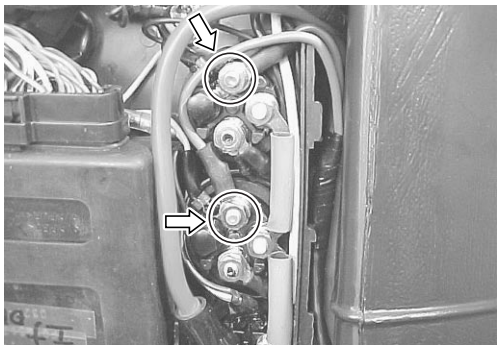
10. Apply the Water Resistant Grease to the PTT rod upper shaft ①, then insert the shaft through the swivel bracket and the tilt rod.

W/R G's **99000-25160: Suzuki Water Resistant Grease**

11. Secure the upper shaft with the snap ring ②.



12. Route the PTT motor cable in through the lower cover and connect the terminals to the PTT motor relays. (Cable routing – See the WIRE/HOSE ROUTING section.)



PTT MOTOR RELAY

Two methods can be used to test the PTT motor relays.

Method 1.

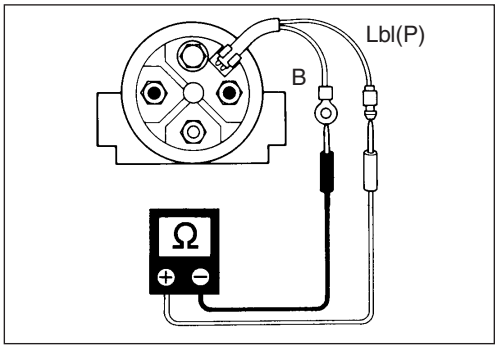
Measure the resistance between the two lead wires of the relay.

09930-99320: Digital tester

Tester range: Ω (Resistance)

	Tester probe connection	
	Red ⊕	**Black ⊖**
UP relay	Light Blue	Black
DOWN relay	Pink	Black

PTT motor relay solenoid coil resistance: 3.0 – 4.5 Ω



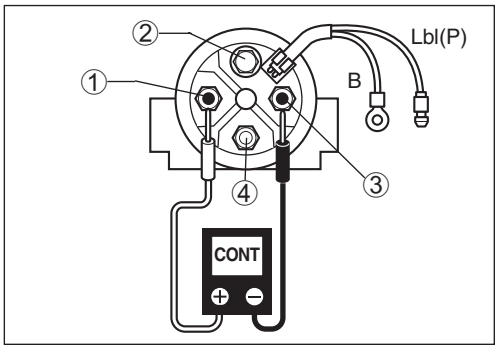
Method 2.

1. Inspect the relay operation using a battery (12V) as follows:

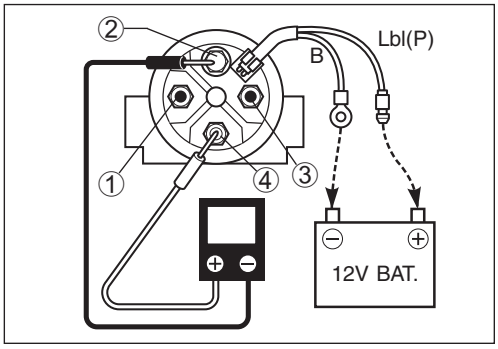
09930-99320: Digital tester

Tester range: (Continuity)

(1) Without the lead wires connected to the battery, there should be continuity between the terminals ①, ② and ③ but should be no continuity between the terminals ③ and ④.



(2) With the Black lead wire connected to the battery negative ⊖ terminal and the Light blue (or Pink) lead wire connected to the battery positive ⊕ terminal, there should be continuity between the terminals ②, ③ and ④.



2. The relay is considered to be without defect if the continuity test results are as stated the above.

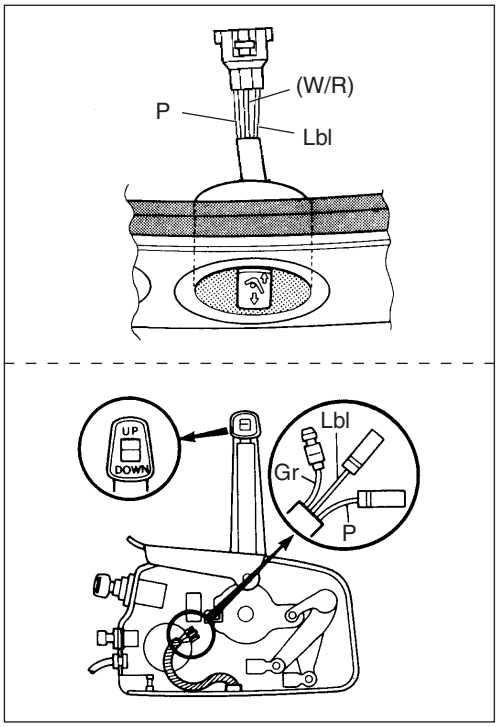
PTT SWITCH

Test the continuity between the switch lead wires at each of the three switch positions.

09930-99320: Digital tester

Tester range: (Continuity)

	Tester probe connection		Continuity
	Red ⊕	**Black ⊖**	
"DN" side depressed	Pink	Gray (White/Red)	**Yes**
"UP" side depressed	Light Blue	Gray (White/Red)	**Yes**
not depressed	Pink	Gray (White/Red)	**No**
	Light Blue		

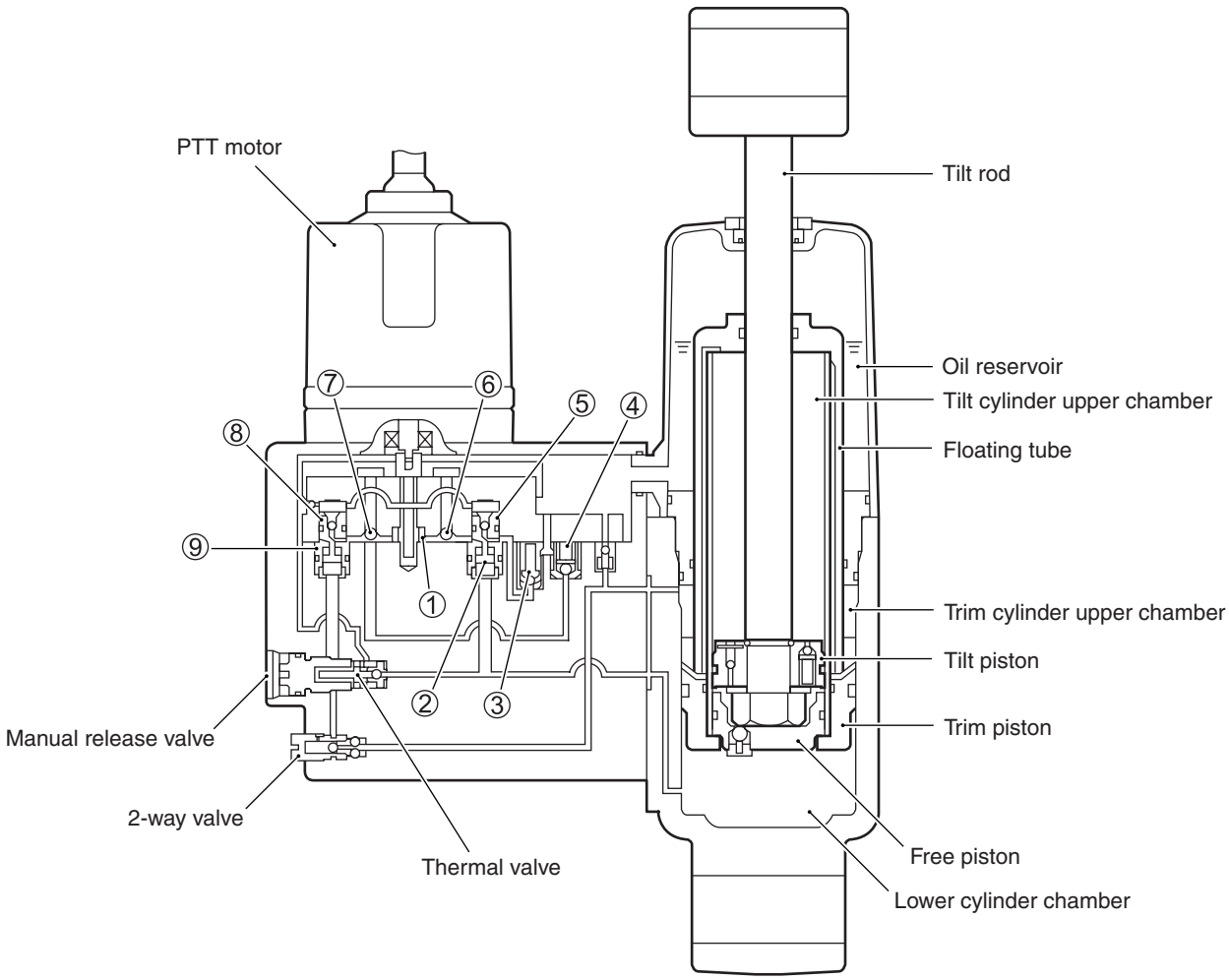


OPERATION

The power trim and tilt system is operated by a “rocker” type switch (protected by a rubber thumb pad) on top of the remote control box handle.

When the switch is depressed, power is delivered to the electric motor via the relevant relay. The relay with the Blue wire connected to the PTT pump is for trim/tilt “UP”, while the relay with the Green wire is for trim/tilt “DOWN”.

COMPONENTS

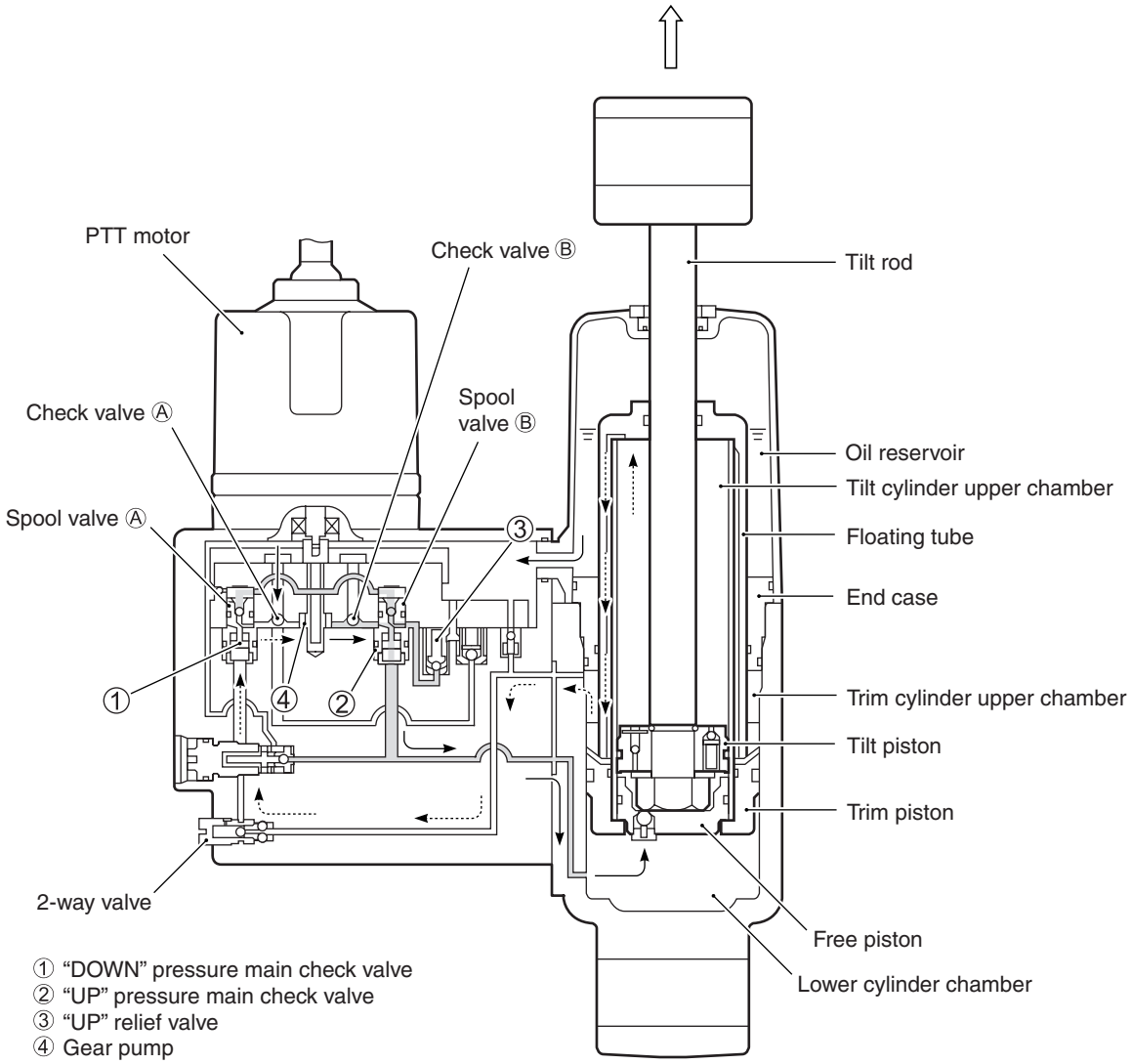


① Gear pump
② “UP” pressure main check valve
③ “UP” relief valve
④ “DOWN” relief valve
⑤ Spool valve Ⓑ
⑥ Check valve Ⓑ
⑦ Check valve Ⓐ
⑧ Spool valve Ⓐ
⑨ “DOWN” pressure main check valve

PRINCIPLES OF OPERATION

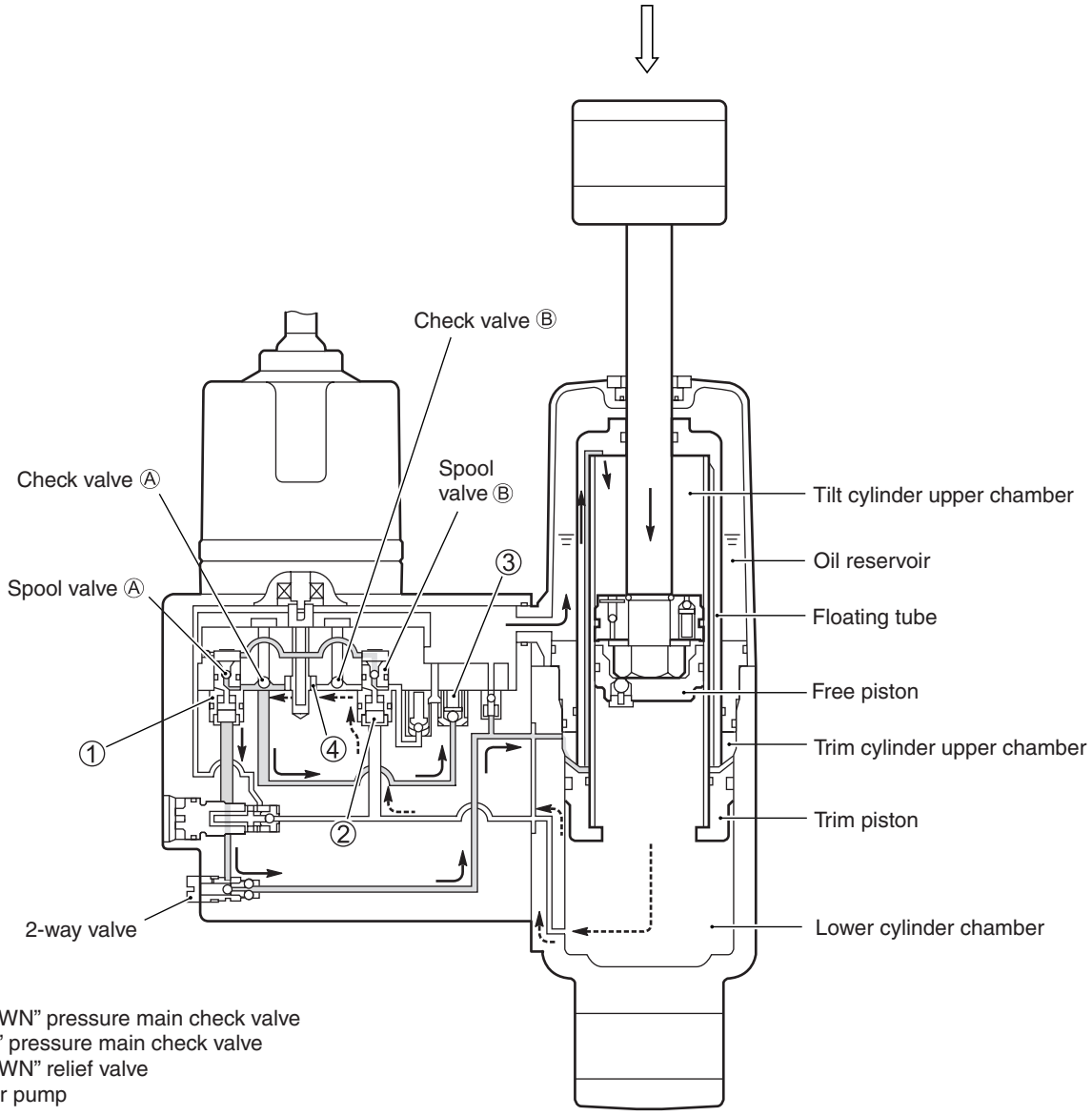
TRIM/TILT "UP" CIRCUIT

When the PTT switch is operated "UP" position, the electric motor and gear pump ④ will operation on clockwise direction.
Pressurized oil will open check valve Ⓐ, oil will flow from reservoir to spool valve Ⓐ via pump and spool valve Ⓑ.
The spool valve Ⓐ will down, then "DOWN" pressure main check valve ① will open.
Oil in the upper chamber will return to pump via 2-way valve, and then oil pressure will rise and open "UP" pressure main check valve ②, then oil will flow to lower cylinder chamber of cylinder.
It makes the piston rod push up and the engine tilt up.
To keep oil level, oil flows from reservoir to pump through the check valve Ⓐ.
Oil through the "DOWN" pressure main check valve ① and returns to pump.
When trim motor stops, both the "DOWN" pressure main check valve ① and the "UP" pressure main check valve ② will close to retain tilt/trim position.
In the trim area, trim piston and floating tube are moving with piston rod.
When full trim/tilt "UP" position is attained, sustained operation of the "UP" relay will have no effect, as pump oil flow will be returned to the reservoir through the "UP" relief valve ③.



TRIM/TILT "DOWN" CIRCUIT

When the PTT switch is operated "DOWN" position, the electric motor and gear pump will operation on counterclockwise direction.
Check valve Ⓑ will open; oil will flow from reservoir to spool valve Ⓐ.
It makes spool valve Ⓑ move to downward, then "UP" pressure main check valve ② open.
Oil in the lower chamber will return to pump, and then oil pressure will rise and open "DOWN" pressure main check valve ①, then oil will flow to upper cylinder chamber of cylinder.
It makes the piston rod push down and the engine will tilt down.
To keep oil level, oil flows from reservoir to pump through the check valve Ⓑ.
Surplus oil in the pump through the "DOWN" relief valve ③ and returns to reservoir.
When trim motor stops, both the "DOWN" pressure main check valve ① and the "UP" pressure main check valve ② will close to retain tilt/trim position.
In the trim area, trim piston and floating tube are moving with piston rod.
When full trim/tilt "DOWN" position is attained, sustained operation of the "DOWN" relay will have no effect, as pump oil flow will be returned to the reservoir through the "DOWN" relief valve ③.

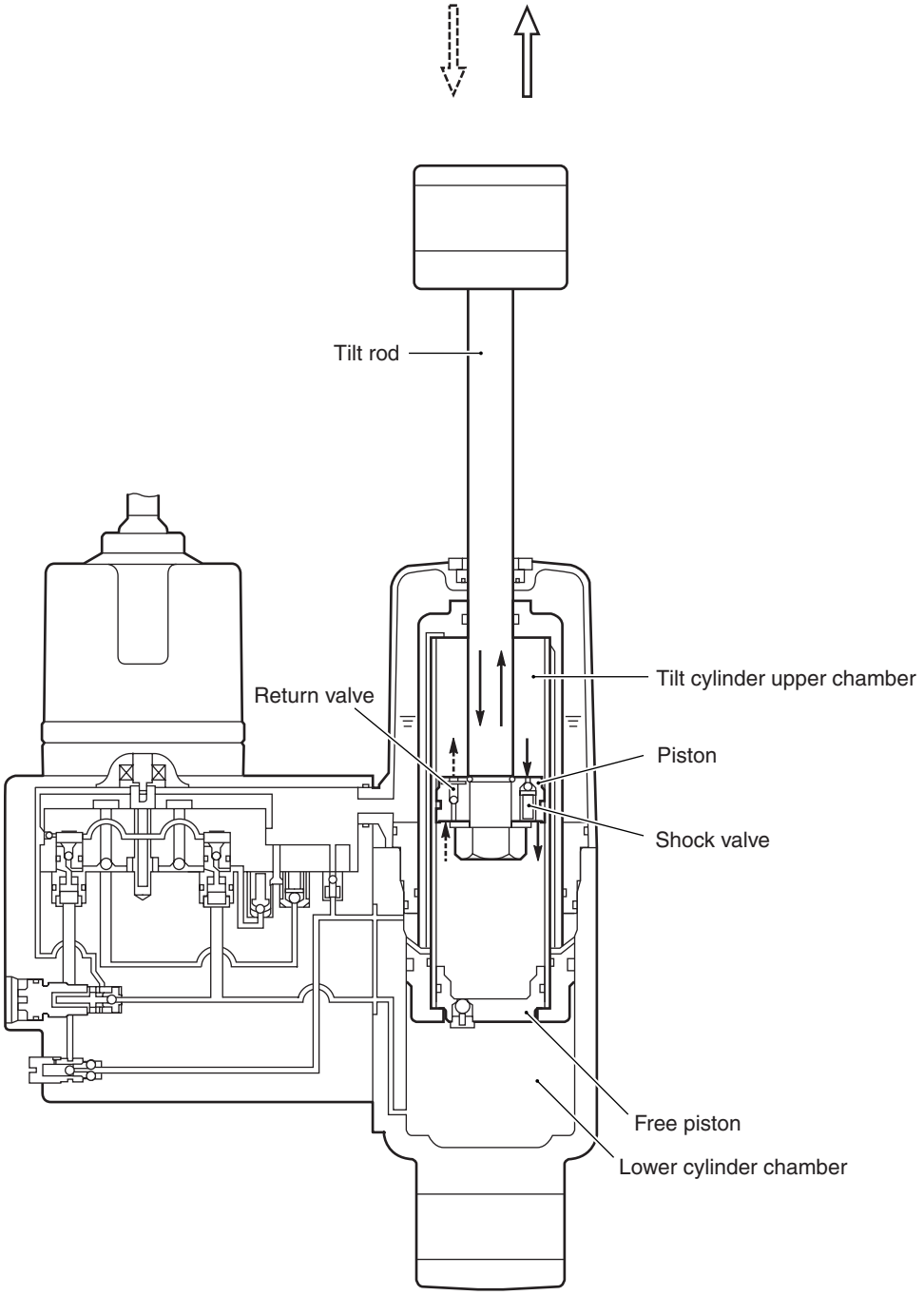


① "DOWN" pressure main check valve
② "UP" pressure main check valve
③ "DOWN" relief valve
④ Gear pump

SHOCK ABSORBER CIRCUIT

(i) Shock valve
Should the lower unit strike an underwater object whilst in motion, the piston will rise abruptly, creating a sudden high impact pressure in the upper cylinder chamber. The shock valve will then open, allowing oil to flow into the area between the tilt ram piston and the free piston, thereby dampening (absorbing) the impact.

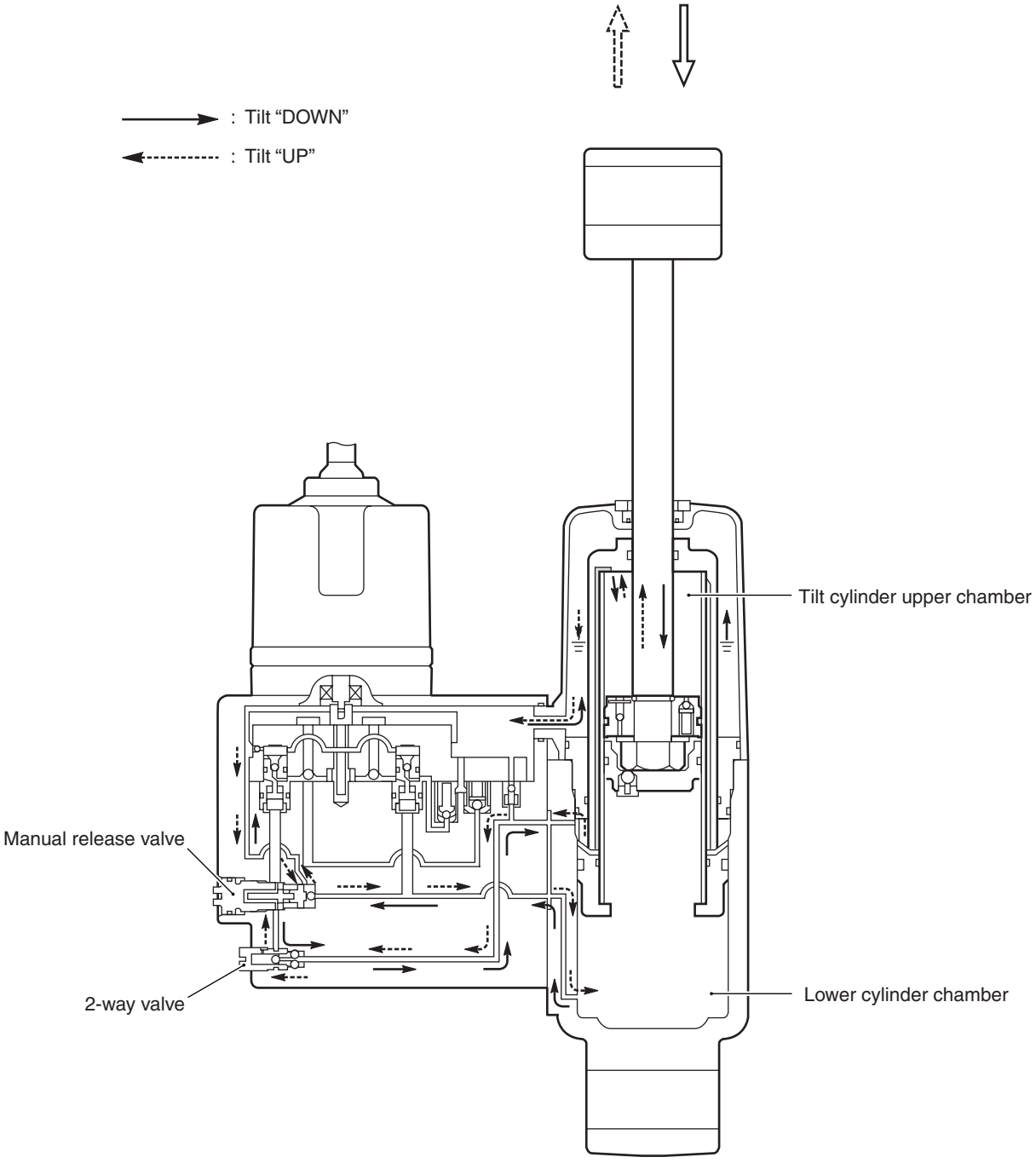
(ii) Return valve
When the point of impact has passed, propeller thrust and motor weight will force the tilt ram piston back downwards. The oil from between the ram piston and the free piston is then expelled through the return valve before flowing into the upper cylinder chamber.



MANUAL RELEASE CIRCUIT (MANUAL VALVE)

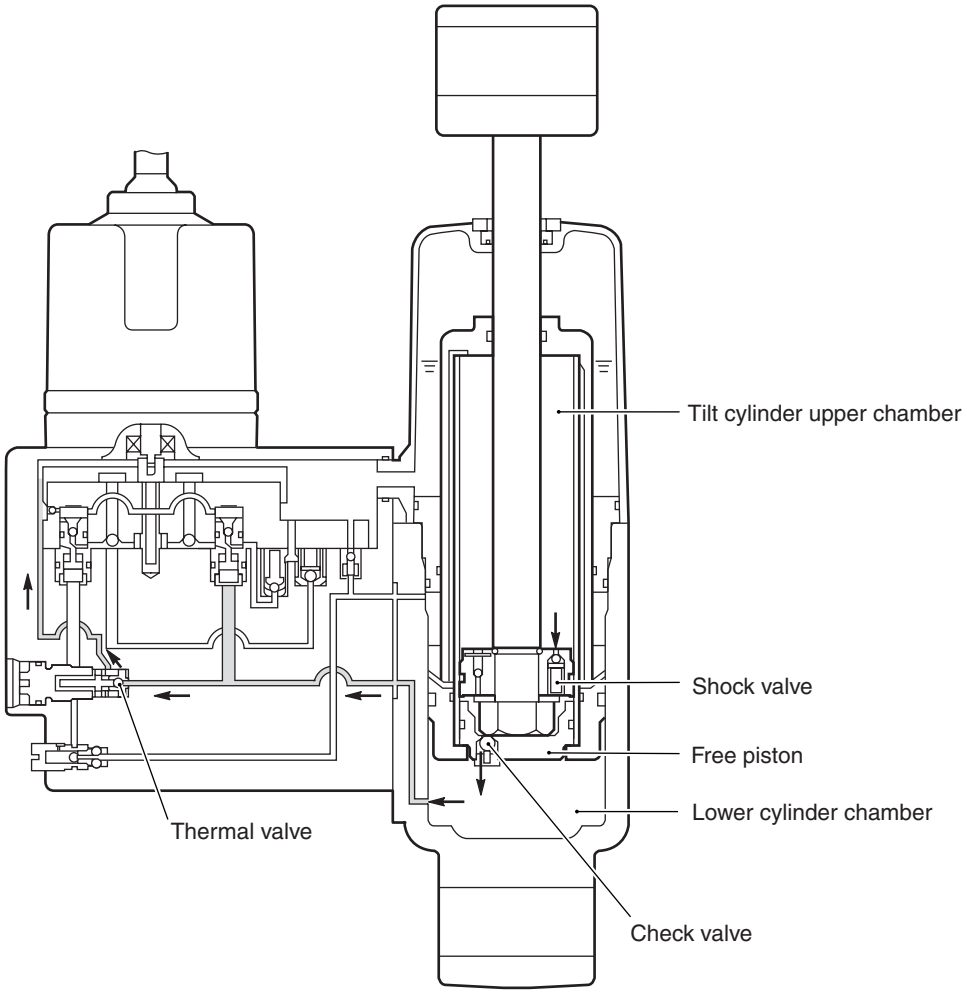
Operation: Turn manual valve maximum three (3) full turns counterclockwise.

When the manual valve is loosened, oil will flow unimpeded (without resistance) through the internal pump tubes, thereby facilitating manual tilting or lowering of the outboard. To hold the engine in a selected position, the manual valve must be closed again.



THERMAL VALVE

As temperature goes up, oil pressure will increase and the oil in PTT unit will expand.
High oil pressure in the upper cylinder chamber caused by rising of outside temperature will release thermal valve and make the oil flow to reservoir to prevent from damaging of PTT unit.



LOWER UNIT

CONTENTS

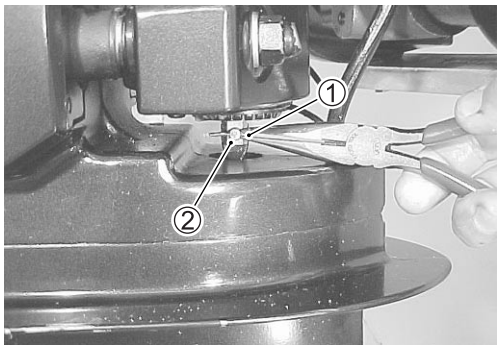
REMOVAL & DISASSEMBLY

⚠ WARNING

Always disconnect the battery cable before removing the lower unit.

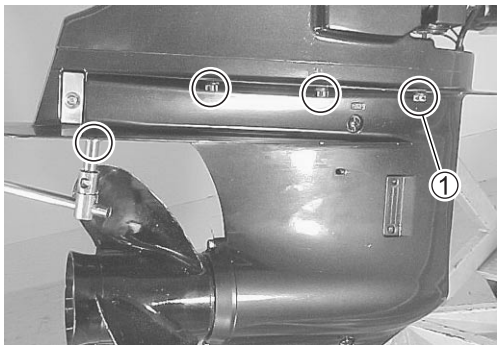
1. Shift to the NEUTARAL position.
2. Remove the bolt and the trim tab.

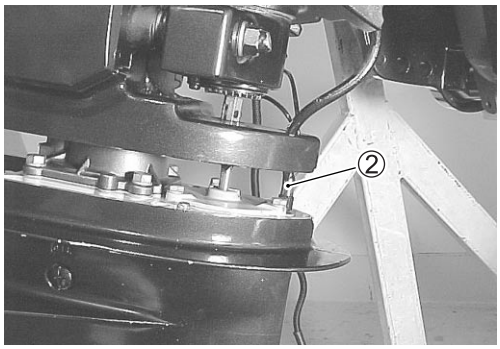
3. Remove the cotter pin ① and the connector pin ②.



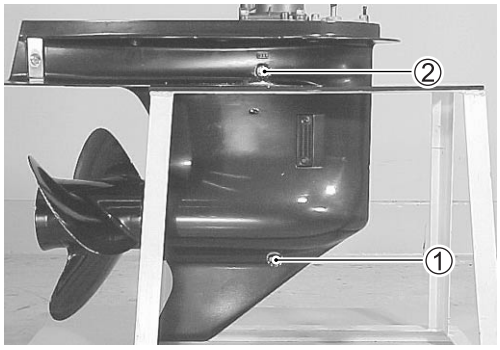
4. Remove the seven bolts ① and separate the gearcase from the driveshaft housing.

NOTE:
Before the gearcase is removed completely, disconnect the speedometer pick up tube ② from the gearcase.

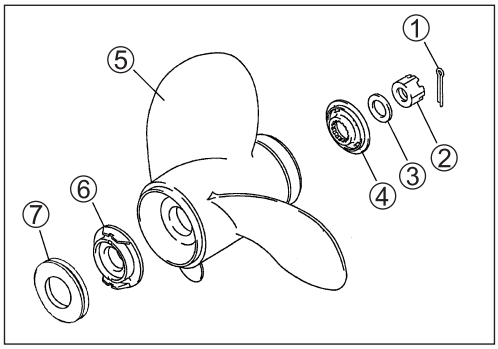




5. Place a drain pan under the oil drain plug.
   Remove the oil drain plug ① first, then the oil level plug ② and allow the gear oil to drain.
   Inspect oil for water, contaminates or metal.

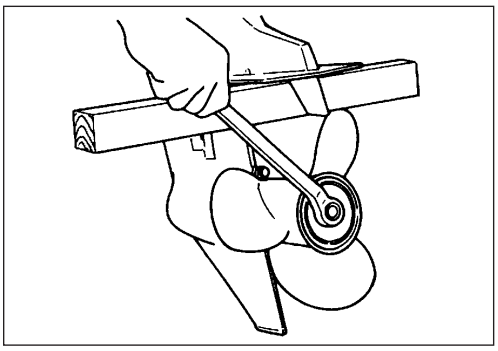


6. Remove the cotter pin ① from the propeller nut and remove the propeller nut ②.
7. Remove the washer ③, the spacer ④, the propeller ⑤, the stopper ⑥ and the spacer ⑦ from the propeller shaft.

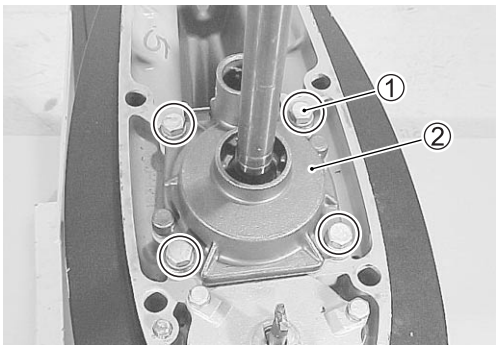


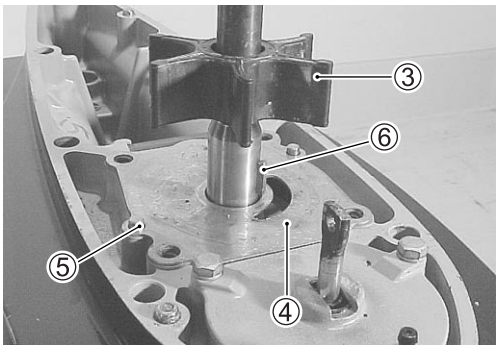
⚠ WARNING

To prevent injury from propeller blades, wear gloves and place a block of wood between the anti-cavitation plate and the propeller blade tips to lock the propeller in place.

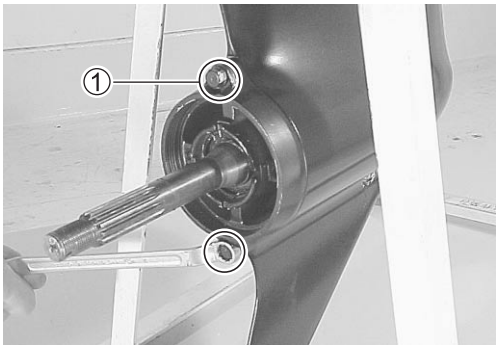


8. Loosen the four bolts ①, then remove the water pump case ②, the impeller ③, the impeller key ⑥, the pump under plate ④ and the dowel pins ⑤.
9. Keep the impeller key for reuse and discard the plate gasket.



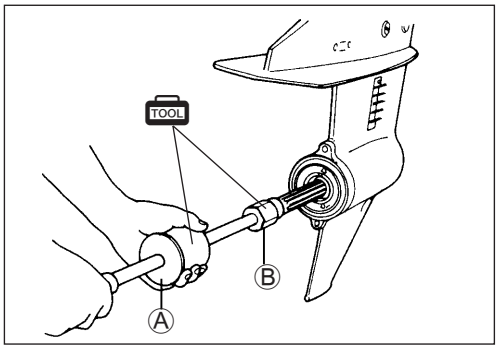


10. Remove the two bolts ① securing the propeller shaft bearing housing to the gearcase.



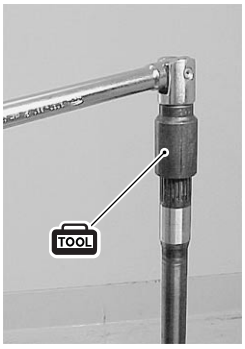
11. Using the special tools, draw out the propeller shaft bearing housing.
    Remove the propeller shaft and the bearing housing assembly.

TOOL 09930-30104: Sliding hammer Ⓐ
09930-30161: Propeller shaft remover Ⓑ

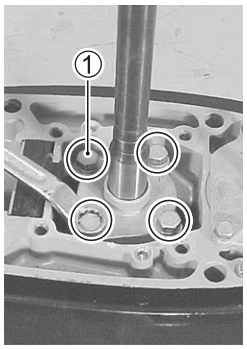


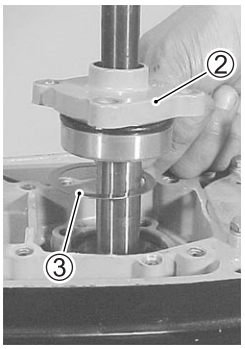
12. Hold the pinion nut securely, then fit the special tool to the driveshaft and loosen the pinion nut.

TOOL 09921-29410: Driveshaft holder

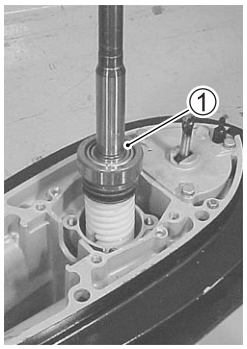


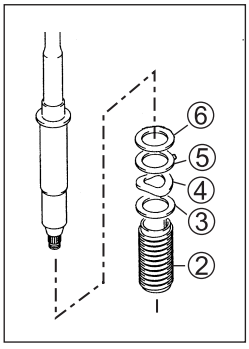
13. Remove the four bolts ①, then remove the driveshaft oil seal housing ② and the pinion shim ③.



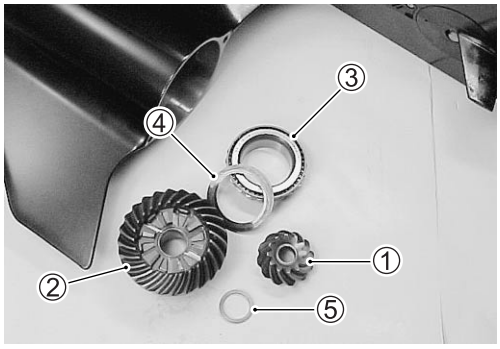


14. Lift out the driveshaft assembly ①.
    Remove the driveshaft collar ②, the washer ③, the wave washer ④, the washer (with tab) ⑤ and the washer ⑥ from the driveshaft.

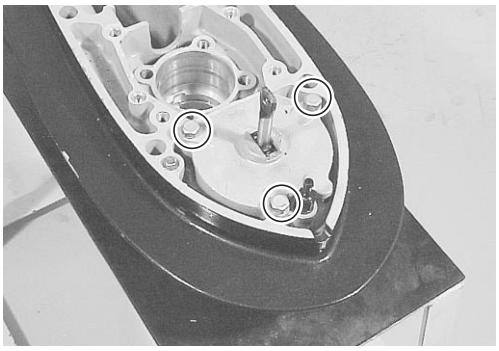




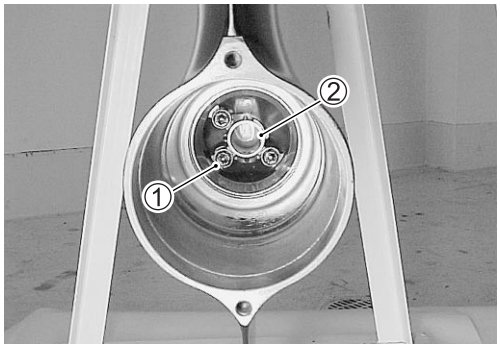
15. Remove the pinion gear ①.
    Remove the forward gear ② (with the thrust washer ⑤, the back-up shim ④ and the bearing ③).



16. Remove the three bolts and the shift rod guide housing assembly.
    Account for the detent ball, the spring and the plate.

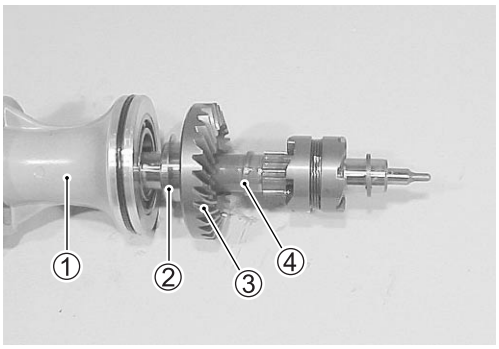


17. Remove the three bolts ①, then remove the shift cam housing ②.
    Account for the dowel pins.

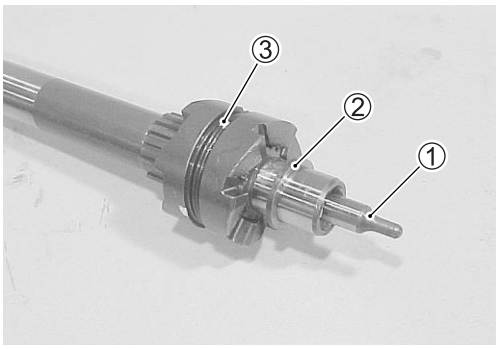


Dissasembly of propeller shaft components

1. Slide the propeller shaft away from the reverse gear ③ and the bearing housing assembly ①.
   Account for the reverse gear back-up shim ② and the reverse gear thrust washer ④.

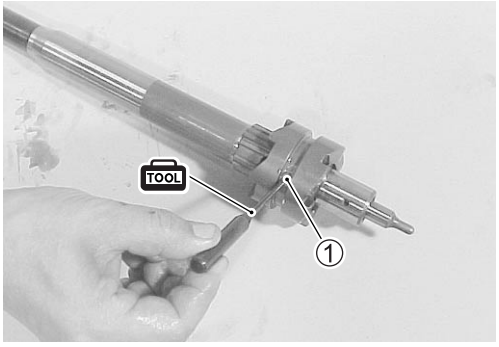


2. Remove the push rod ① and the forward gear thrust washer ②.
3. Remove the spring ③ from the clutch dog shifter.

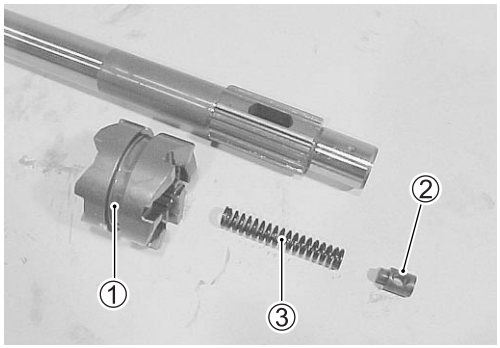


4. Using the special tool, push the dog pin ① out of the clutch dog shifter.

TOOL 09922-89810: Shift pin remover

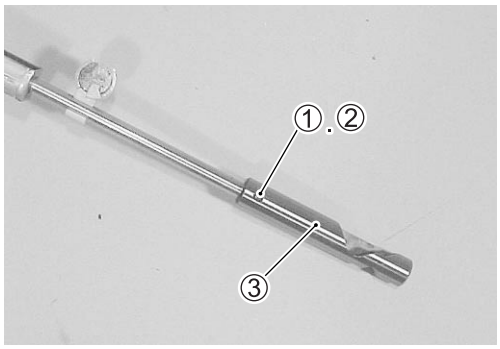


5. Remove the clutch dog shifter ①.
   Remove the push pin ② and the spring ③.

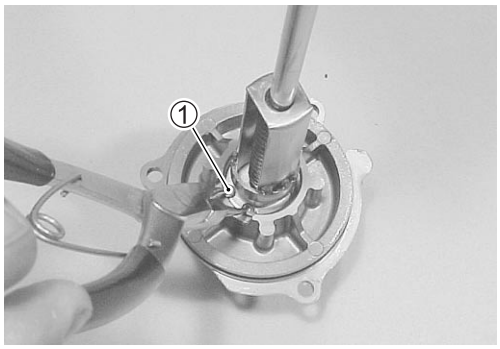


Dissasembly of shift rod components

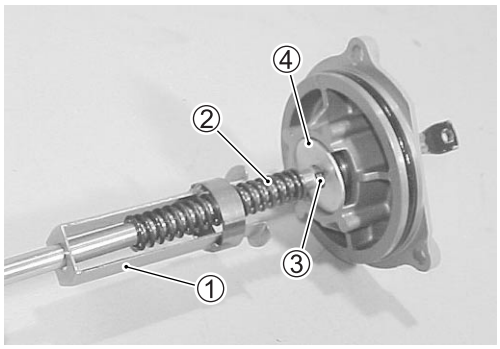
1. Push the pin ① and ② out and remove the clutch cam ③.



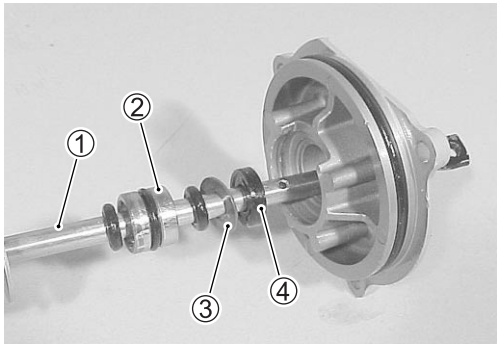
2. Remove the circlip ①.



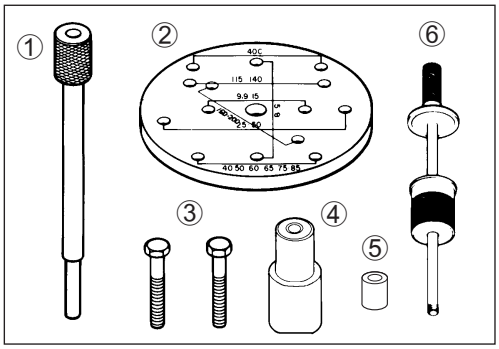
3. Remove the shift rod spring collar ① by turning it.
   Remove the spring ②, the pin ③ and the washer ④.



4. Remove the shift rod ① from the housing.
   Remove the shift rod guide ② (with the O-ring), the washer ③ and the dust seal ④.



PINION BEARING



Removal / installation is in the following procedure.

Removal & Installation Tools

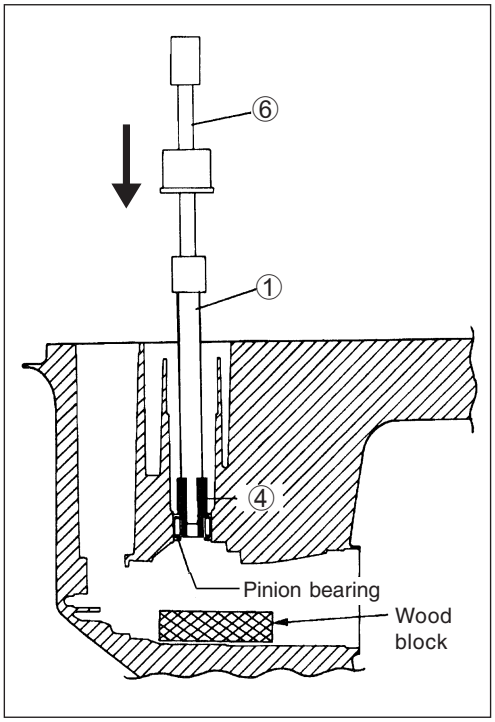
09951-59910: Shaft (removal & installation) ①
09551-39914: plate ②
01500-08403: Bolt ③
09951-19421: Attachment ④
09917-98221: Spacer (Attachment) ⑤
09930-30104: Sliding hammer ⑥

REMOVAL

1. Place the attachment ④ inside the pinion bearing.
2. Insert the shaft ① into the attachment ④.
3. Thread the sliding hammer ⑥ into the top of the shaft ①.
4. Put a wood block under the pinion bearing.
5. Drive the pinion bearing out downward by striking the top of the shaft ① with the sliding hammer ⑥.

CAUTION

- **When removing the pinion bearing, use care to avoid damaging the gearcase.**
- **Do not re-use the pinion bearing once removed. Always use a new pinion bearing.**

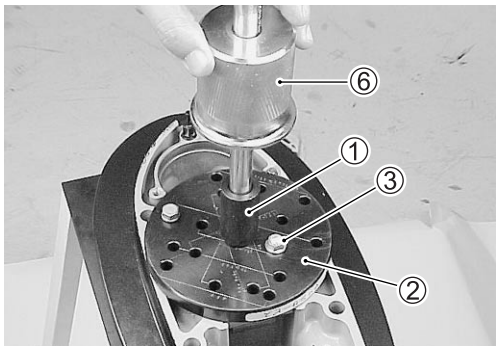


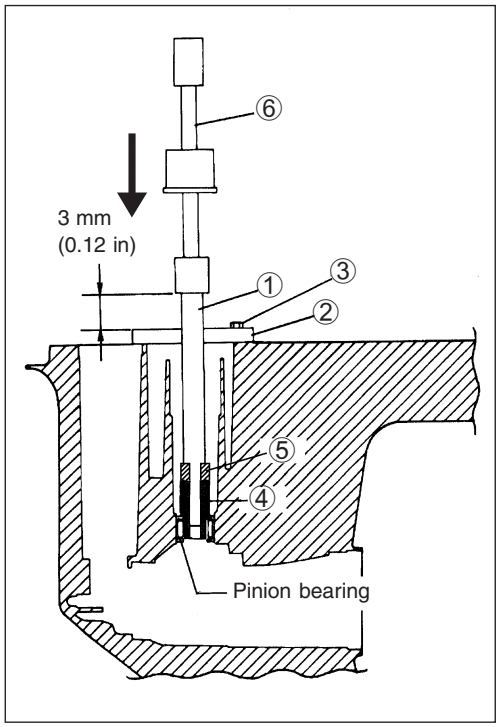
INSTALLATION

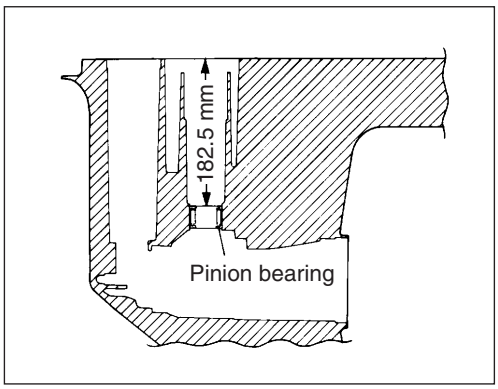
CAUTION

- **Before installing the bearing, ensure that the inside of the gearcase is clean and free of debris.**
- **Ensure that the bearing stamped mark faces upward.**

1. Set the shaft ①, the plate ②, the spacer ⑤, the attachment ④ and the pinion bearing as shown in the figure.
2. Place the shaft ① (with the pinion bearing on the end of the shaft) into the gearcase.
3. Secure the plate ② by tightening the bolts ③.
4. Thread the sliding hammer ⑥ into the top of the shaft ①.
5. Drive the pinion bearing down into position by gently striking the shaft ① until the dimension between the undersurface of the shaft ① shoulder and the top surface of the plate ② become 3 mm.







INSPECTION

NOTE:
If excessive ware, cracks, defective or other damage is found on any component, replace component.

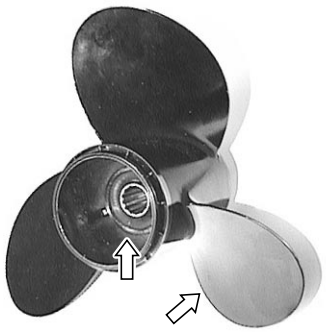
NOTE:
Thoroughly wash all metal components with cleaning solvent and dry with compressed air.

⚠ WARNING

Wear safety grasses when using compressed air.

PROPELLER

- Inspect the propeller for bent, chipped or broken blades. Replace or repair if necessary.
- Inspect the propeller bushing splines for wear or other damage. Replace if necessary.
- Inspect the propeller bushing for deterioration or slipping. Replace if necessary.



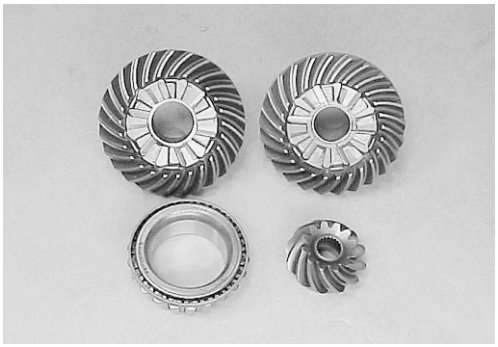
GEARCASE

- Inspect the gearcase for cracks or other damage. Replace if necessary.
- Inspect the pinion bearing for pitting, rough or other damage. Replace if necessary.

NOTE:
If removal and replacement are required, see the "PINION BEARING" section on the page 9-7.

GEARS

- Inspect the forward, reverse and pinion gear teeth and the engaging dogs for excessive wear or other damage. Replace if necessary.
- Inspect the forward gear bearing for pitting, rough or other damage. Replace if necessary.



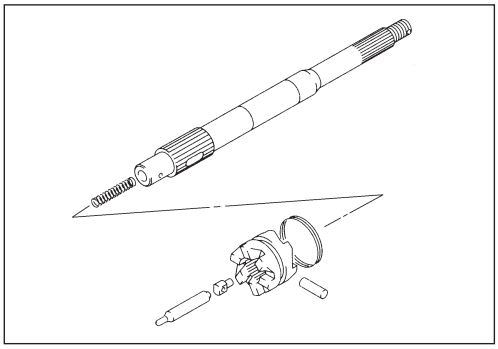
PROPELLER SHAFT COMPONENTS

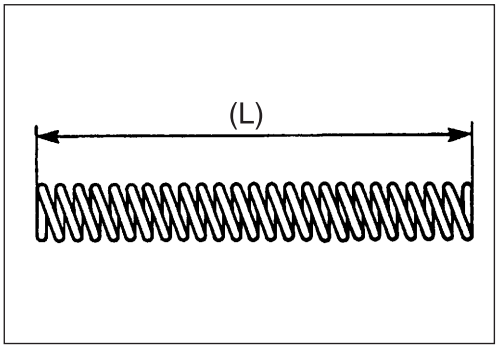
- Inspect the push rod and the push rod pin for excessive wear or other damage. Replace if necessary.
- Inspect the clutch dog shifter for excessive wear, chip or other damage. Replace if necessary.
- Inspect the dog pin for bent or other damage. Replace if necessary.
- Inspect the propeller shaft / splines for wear, twist or other damage. Replace if necessary.
- Measure the clutch return spring free length.

09900-20101: Vernier calipers

Clutch return spring free length (L)
Standard : 67 mm (2.6 in)
Service limit: 64 mm (2.5 in)

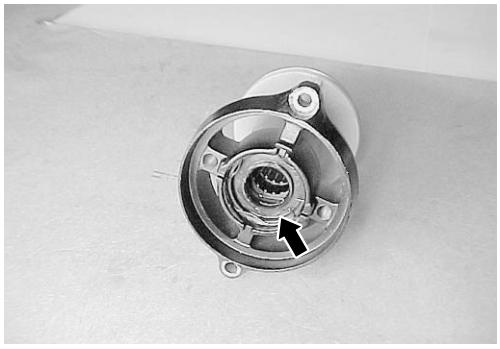
If the measurement exceeds the service limit, replace the clutch return spring.





PROPELLER SHAFT BEARING HOUSING

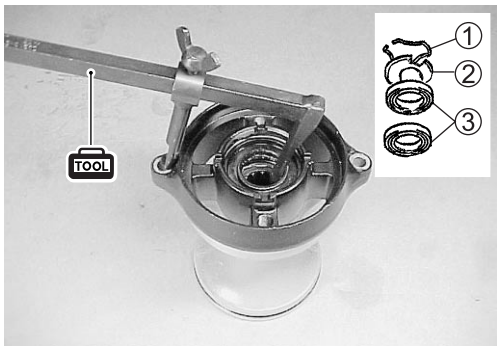
- Inspect the housing for cracks or other damage. Replace if necessary.
- Inspect the propeller shaft bearings and the reverse gear bearing for pitting, rough or other damage. Replace if necessary.
- Inspect the oil seals and the O-ring for cuts, nicks or tears.



Replacing propeller shaft oil seal

1. Remove the retaining ring ① and the washer ②.
2. Extract the oil seals ③ using the oil seal remover.

09913-50121 : Oil seal remover

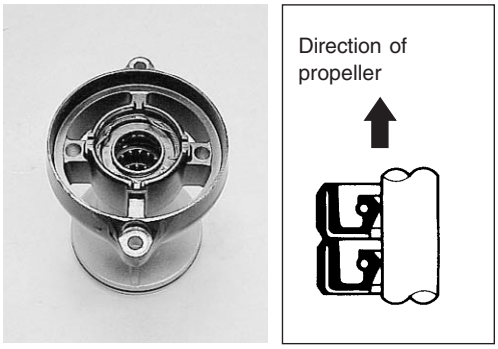


CAUTION

Do not re-use the oil seal once removed.
Always use a new oil seal.

3. Apply the Water Resistant Grease to the inner circumference of the housing.
4. Using an oil seal installer, drive the two oil seals (one at a time) into the housing.
   The lipped portion of the seal should face toward the propeller.
   Apply the Water Resistant Grease to the seal lips.

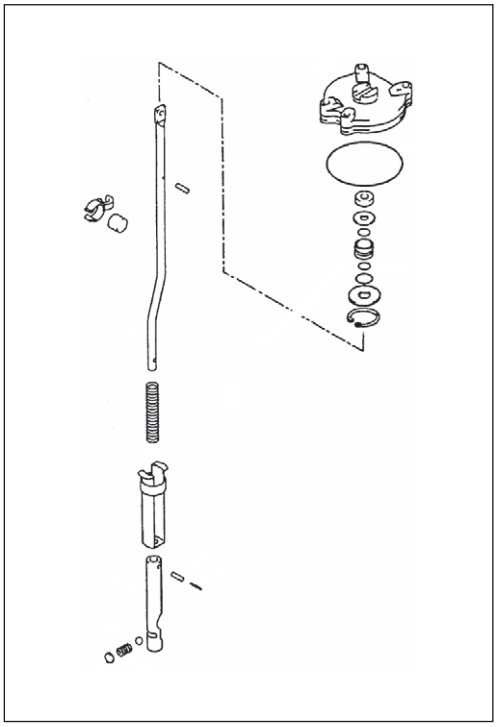
99000-25160: Suzuki Water Resistant Grease



5. Install the washer and the retaining ring.

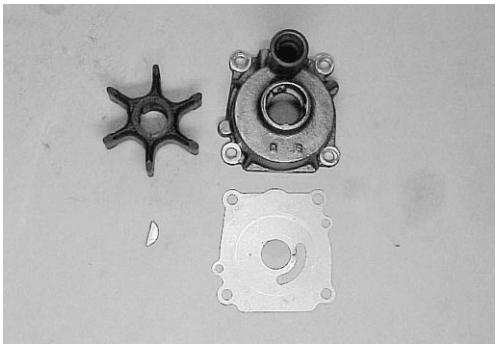
SHIFT ROD GUIDE HOUSING COMPONENTS

- Inspect the “stepped” surfaces of the shift cam for excessive wear, chip or other damage. Replace if necessary.
- Inspect the shift rod guide housing for cracks or other damage. Replace if necessary.
- Inspect the shift rod guide for excessive wear, pit, corrosion or stiff. Replace if necessary.
- Inspect the detent ball for wear, rough or other damage. Replace if necessary.
- Inspect the O-ring for wear, cuts, nicks or tears.



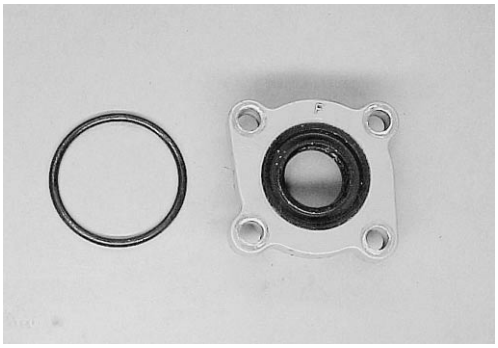
WATER PUMP AND RELATED ITEMS

- Inspect the impeller vanes for cuts, cracks, tears or excessive wear. Replace if necessary.
- Inspect the pump case and the under panel for cracks, distortion or corrosion. Replace if necessary.



DRIVESHAFT OIL SEAL HOUSING

- Inspect the housing for cracks or other damage. Replace if necessary.
- Inspect the oil seals and the O-ring for wear, cuts, nicks or tears.



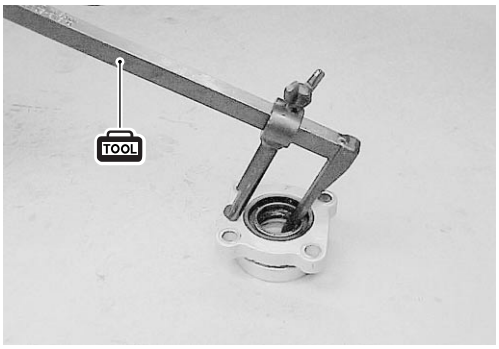
Replacing driveshaft oil seal

1. Extract the oil seals using the oil seal remover.

09913-50121: Oil seal remover

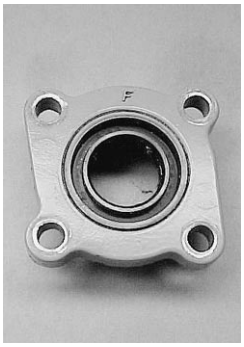
2. Apply the Water Resistant Grease to the inner circumference of the housing.

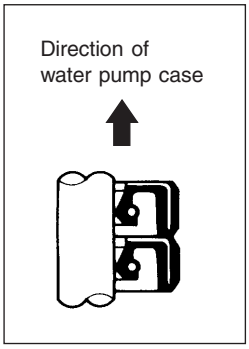
99000-25160: Suzuki Water Resistant Grease



3. Using an oil seal installer, drive the two oil seals (one at a time) into the housing.
   The lipped portion of the seal should face toward the water pump case.
   Apply the Water Resistant Grease to the seal lips.

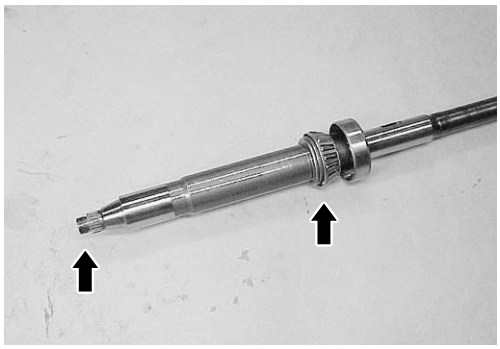
99000-25160: Suzuki Water Resistant Grease





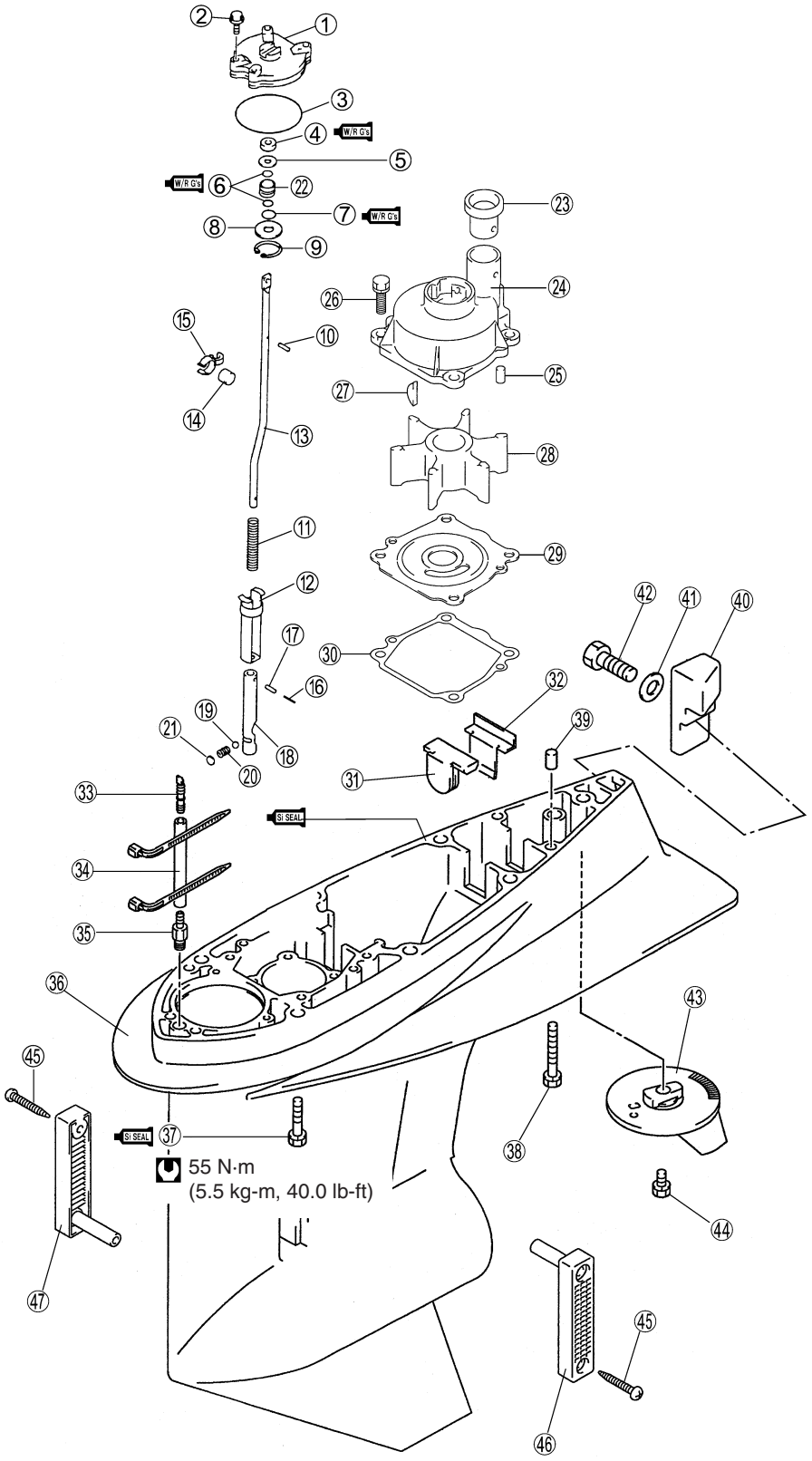
DRIVESHAFT

- Inspect the driveshaft / splines for wear, twist or other damage. Replace if necessary.
- Inspect the driveshaft bearing for pitting, rough or other damage. Replace if necessary.

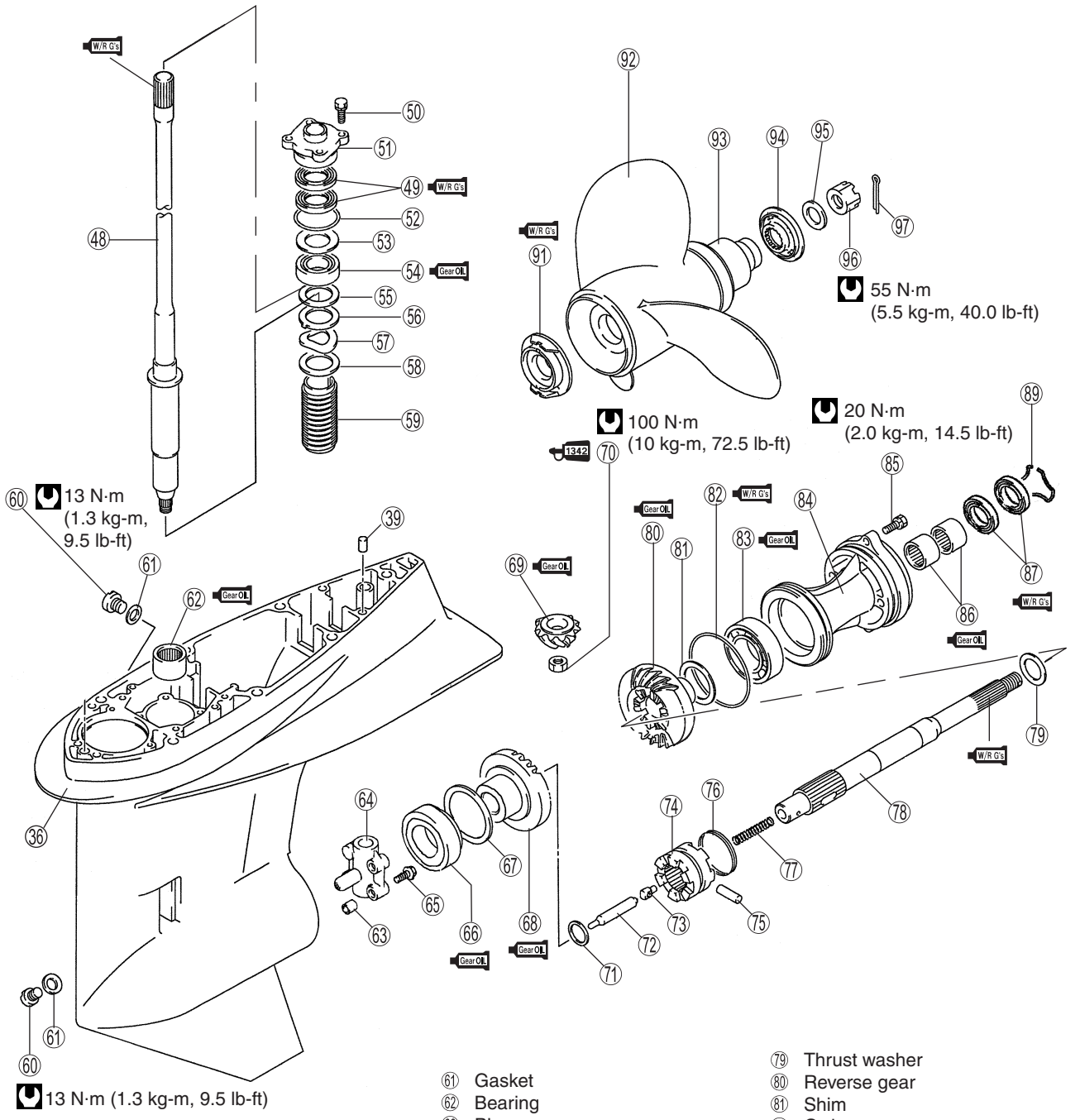


ASSEMBLY & INSTALLATION

Assembly & installation are reverse order of removal & disassembly with the special attention to the following steps.



① Shift rod guide housing
② Bolt
③ O-ring
④ Dust seal
⑤ Washer
⑥ O-ring
⑦ O-ring
⑧ Washer
⑨ Circlip
⑩ Pin
⑪ Spring
⑫ Shift rod spring collar
⑬ Shift rod
⑭ Magneto
⑮ Magneto holder
⑯ Pin
⑰ Pin
⑱ Clutch cam
⑲ Detent ball
⑳ Spring
㉑ Plate
㉒ Shift rod guide
㉓ Grommet
㉔ Water pump case
㉕ Pin
㉖ Bolt
㉗ Key
㉘ Water pump impeller
㉙ Pump case under panel
㉚ Gasket
㉛ Exhaust seal
㉜ Exhaust seal plate
㉝ Union
㉞ Hose
㉟ Nipple
㊱ Gearcase
㊲ Bolt
㊳ Bolt
㊴ Pin
㊵ Anode
㊶ Washer
㊷ Bolt
㊸ Trim tab
㊹ Bolt
㊺ Screw
㊻ Water filter PORT
㊼ Water filter STBD



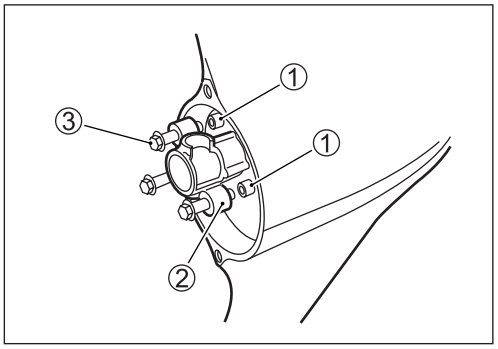
48 Driveshaft
49 Oil seal
50 Bolt
51 Oil seal housing
52 O-ring
53 Shim
54 Bearing
55 Washer
56 Washer
57 Wave washer
58 Washer
59 Driveshaft collar
60 Plug
61 Gasket
62 Bearing
63 Pin
64 Shift cam housing
65 Bolt
66 Bearing
67 Shim
68 Forward gear
69 Pinion gear
70 Pinion nut
71 Thrust washer
72 Push rod
73 Push pin
74 Clutch dog shifter
75 Dog pin
76 Dog spring
77 Spring
78 Propeller shaft
79 Thrust washer
80 Reverse gear
81 Shim
82 O-ring
83 Bearing
84 Propeller shaft bearing housing
85 Bolt
86 Bearing
87 Oil seal
88 Washer
89 Retaining ring
90 Spacer
91 Stopper
92 Propeller
93 Propeller bushing
94 Spacer
95 Washer
96 Nut
97 Pin

CAUTION

- **Make sure that all parts used in assembly are clean and lubricated.**
- **After assembly, check parts for tightness and smoothness of operation.**
- **Before final assembly, be absolutely certain that all gear contact, shim adjustments and tolerances are correct.**
  Failure to correctly adjust these areas will result in lower unit damage.
  (See the "GEARS SHIMMING AND ADJUSTMENT" section on the page 9-23)

SHIFT CAM HOUSING

Install the dowel pins ① and the shift cam housing ②, then tighten the three bolts ③ securely.

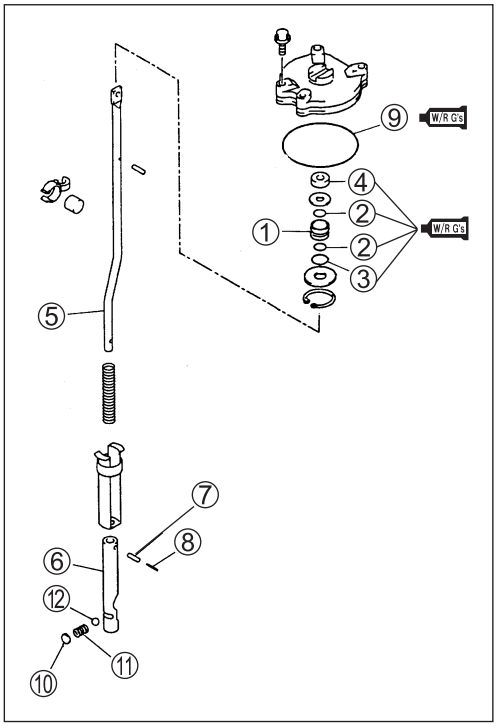


SHIFT ROD GUIDE HOUSING ASSEMBLY

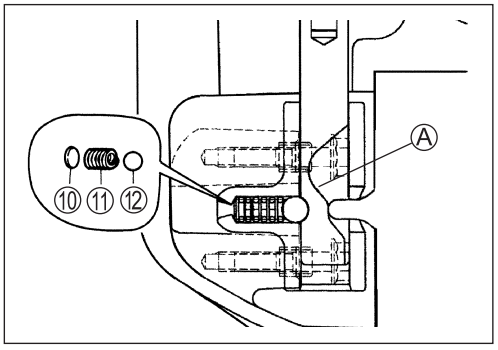
1. Apply the Water Rasistant Grease to the inside of the dust seal ④, the O-ring ②, ③ and ⑨.

W/R G's 09900-25160: Suzuki Water Resistant Grease

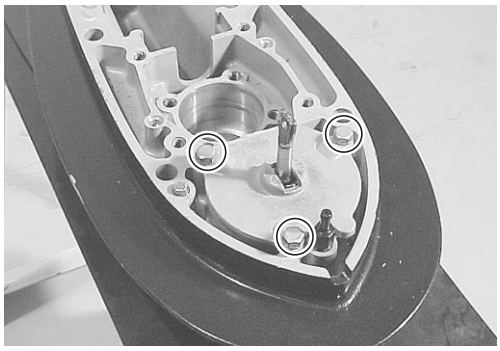
2. Align the pin holes of the shift rod ⑤ and the shift cam ⑥. Insert the pin ⑦ through the pin holes first, then insert the pin ⑧ into the pin ⑦.



3. Install the plate ⑩, the spring ⑪ and the detent ball ⑫ in the gearcase.
4. Install the shift rod / cam with the face Ⓐ of the cam facing toward the propeller side.



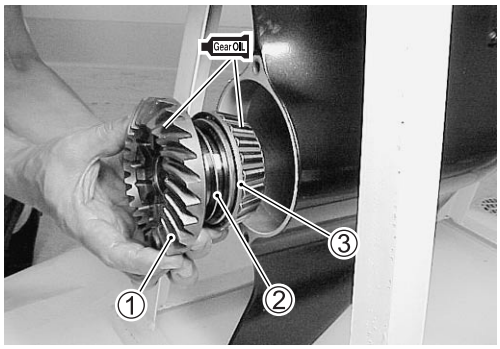
5. Install the shift rod guide housing to the gearcase and tighten the three bolts securely.
6. Make sure that the shift rod guide housing assembly shifts smoothly.



FORWARD GEAR

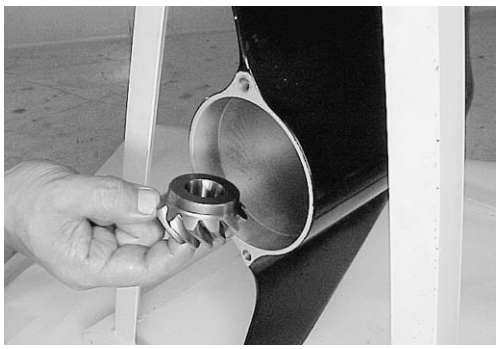
Place the forward gear bearing ③ and the back-up shim ② in position, then install the forward gear ①.

Gear OIL **09900-22540: Suzuki Outboard Motor Gear Oil**



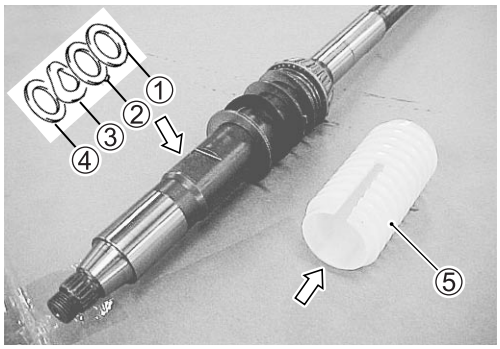
PINION GEAR

Place the pinion gear in the gearcase.



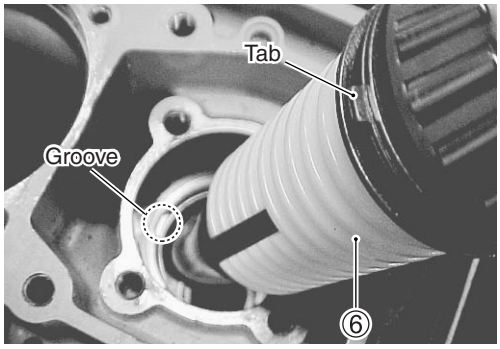
DRIVESHAFT

1. Assemble the washer ①, the washer (with the tab) ②, the wave washer ③, the washer ④ and the driveshaft collar ⑤ to the driveshaft.
2. After installing the driveshaft collar, fit the convex part of the collar in the concave part of the driveshaft by turning the collar.

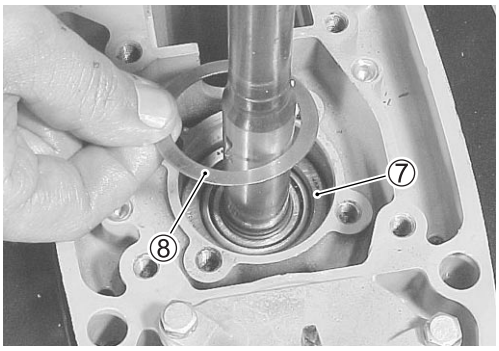


3. Lower the driveshaft assembly ⑥ down into the gearcase until the bottom of the shaft protrudes through the center of the pinion.

NOTE:
The washer tab should be located into the groove on the gearcase.



4. Install the bearing outer race ⑦ and the pinion shim ⑧ to the driveshaft.

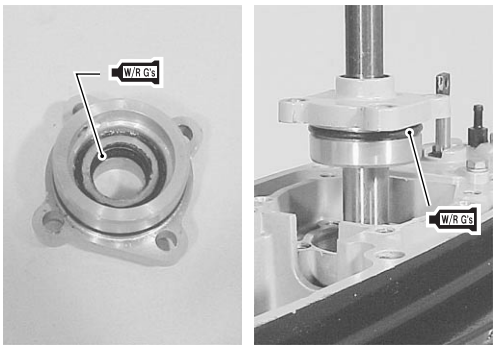


DRIVESHAFT OIL SEAL HOUSING

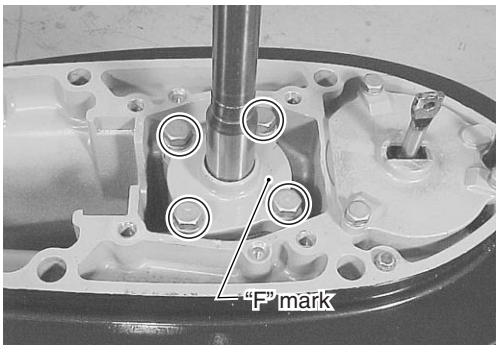
1. Apply the Water Resistant Grease to the driveshaft oil seal.

W/R G's 99000-25160: Suzuki Water Resistant Grease

2. Apply the Water Resistant Grease to the O-ring, then install the O-ring into the groove on the driveshaft oil seal housing.



3. Install the driveshaft oil seal housing on the gearcase, then tighten the four bolts securely.



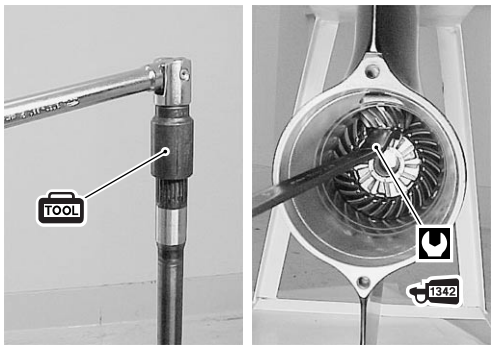
PINION NUT

Apply the Thread Lock to the threads of the pinion nut, then tighten the nut to the specified torque.

Pinion nut: 100 N·m (10.0 kg-m, 72.5 lb-ft)

1342 99000-32050: Thread Lock 1342

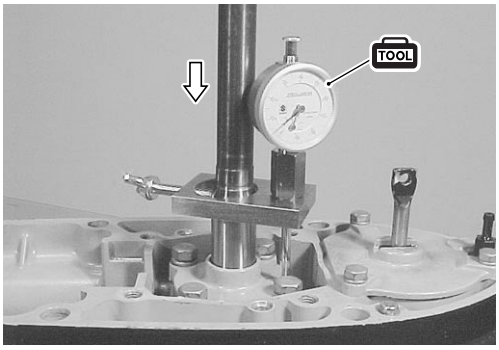
TOOL 09921-28710: Drive shaft holder



CHECKING DRIVESHAFT THRUST PLAY

Before installing the reverse gear, the driveshaft thrust play should be checked.
(See the "Checking driveshaft thrust play" section on the page 9-24.)

TOOL 09951-09511: Gear adjusting gauge

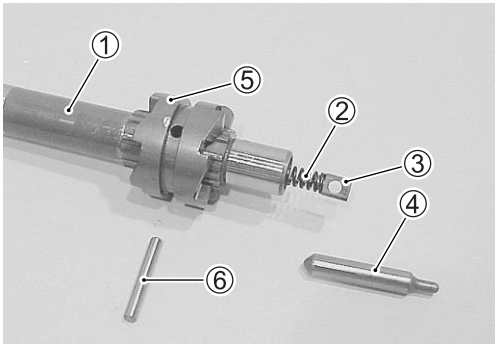


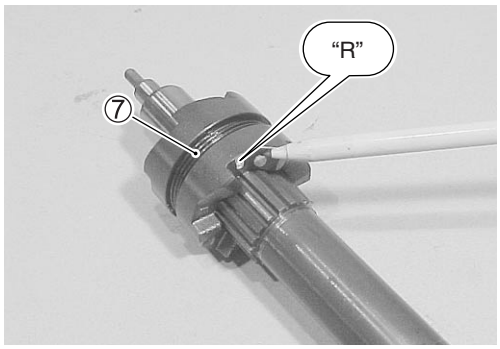
PROPELLER SHAFT

1. Slide the clutch dog shifter ⑤ onto the propeller shaft ①.

NOTE:
For correct installation, the side of the clutch dog shifter which should face toward the reverse gear is marked with the letter "R".

2. Insert the spring ②, the push pin ③ and the push rod ④ into the propeller shaft.
3. Align the holes in the clutch dog shifter ⑤ and the push pin ③, then slide the dog pin ⑥ through them.
4. Install the dog spring ⑦, ensuring that it fits snugly into the groove on the clutch dog shifter.



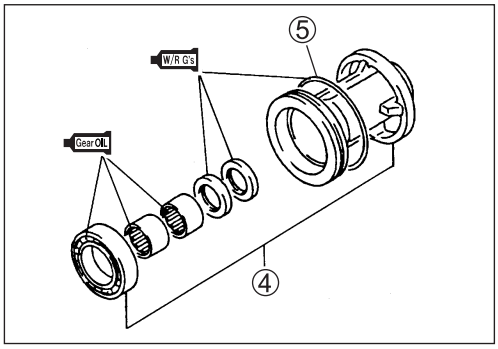


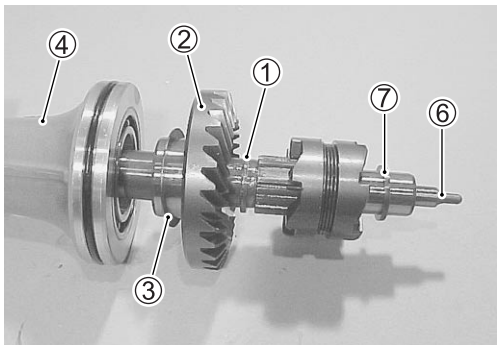
PROPELLER SHAFT / BEARING HOUSING

1. Install the O-ring ⑤ to the propeller shaft bearing housing ④.
2. Assemble the propeller shaft in the following sequence:
   - Forward thrust washer ⑦
   - Reverse thrust washer ①
   - Reverse gear ②
   - Reverse gear back-up shim ③
   - Propeller shaft housing ④

W/R G's 99000-25160: Suzuki Water Resistant Grease

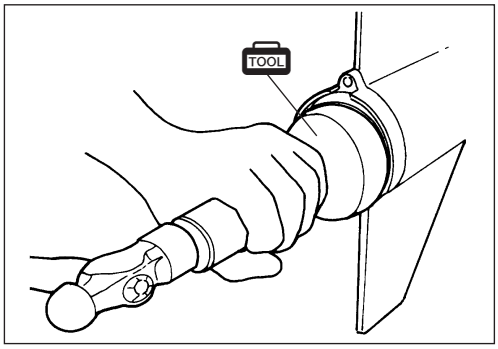
Gear OIL 99000-22540: Suzuki Outboard Motor Gear Oil





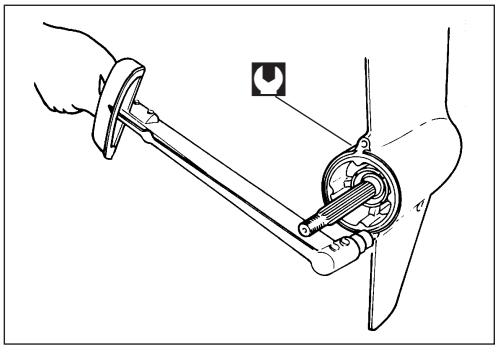
3. Using the special tools, install the propeller shaft and the housing assembly in the gear case.

TOOL 09922-59410: Propeller shaft housing installer
09922-59420: Housing Installer Handle



4. When the housing is fully seated, tighten the two bolts to the specified torque.

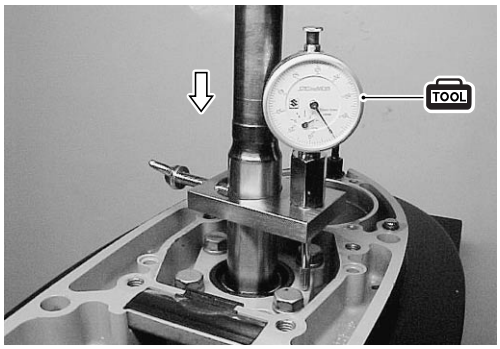
Bearing housing bolt: 20 N·m (2.0 kg-m, 14.5 lb-ft)



RECHECKING DRIVESHAFT THRUST PLAY

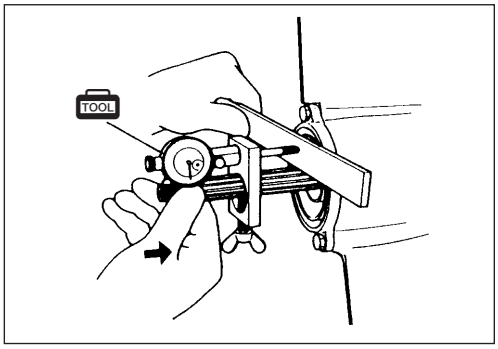
Recheck the driveshaft thrust play.
This should not be less than previously checked on the page 9-17. (See the "RECHECKING DRIVESHAFT THRUST PLAY" section on the page 9-26.)

09951-09511: Gear adjusting gauge



CHECKING PROPELLER SHAFT THRUST PLAY

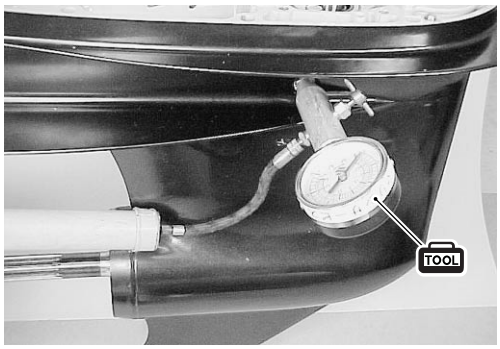
See the page 9-27.



LEAKAGE CHECK

Check for leakage of the oil seal and the O-ring when applying air pressure inside of the gearcase.

09950-69512: Oil leakage tester
: Hand air pump



Procedure

1. Install the oil leakage tester into the oil level hole.
2. Connect a hand air pump to the oil leakage tester.
3. While rotate the driveshaft and the propeller shaft clockwise several times, apply specified pressure for leakage test.

NOTE:
Apply low initial pressure of 20 – 40 kPa, (0.2 – 0.4 kg/cm², 2.8 – 5.7 psi) first, then apply the specified pressure.

Leakage test pressure: 100 kPa (1.0 kg/cm², 14.2 psi)

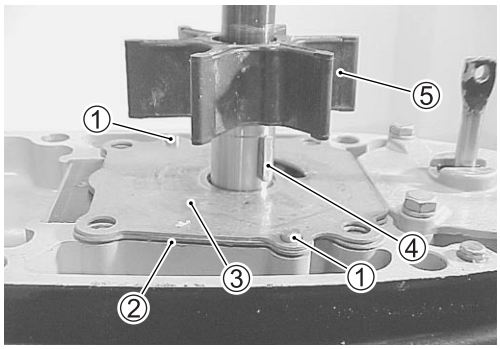
CAUTION

Do not exceed pressure of 110 kPa (1.1 kg/cm², 15.6 psi) or damage to oil seals will result.

4. Once stabilized, the pressure should remain steady for at least 5 min.
   If the pressure does not fall, sealing performance is correct.

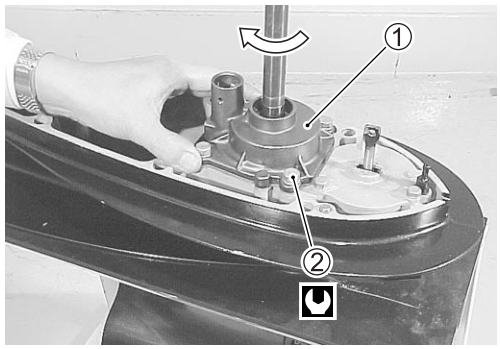
WATER PUMP

1. Place the dowel pins ①, the under panel gasket ② and the under panel ③ into position.
2. Insert the key ④ in the driveshaft and slide the impeller ⑤ onto the driveshaft, ensuring that the key and the keyway are aligned.



3. Install the pump case ① while rotating the driveshaft clockwise to flex the impeller vanes in correct direction.
4. Tighten the four pump case bolts ② to the specified torque.

Pump case bolt: 20 N·m (2.0 kg-m, 14.5 lb-ft)

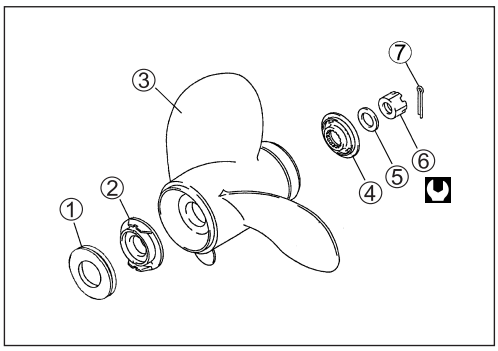


PROPELLER INSTALLATION

1. Install the spacer ① and the propeller stopper ② onto the propeller shaft, then slide on the propeller ③.
2. Fit the spacer ④, the washer ⑤ and the nut ⑥, then tighten the nut to the specified torque.

Propeller nut: 55 N·m (5·5 kg-m, 40.0 lb-ft)

3. Push the cotter pin ⑦ through the nut and the shaft, then bend to secure.

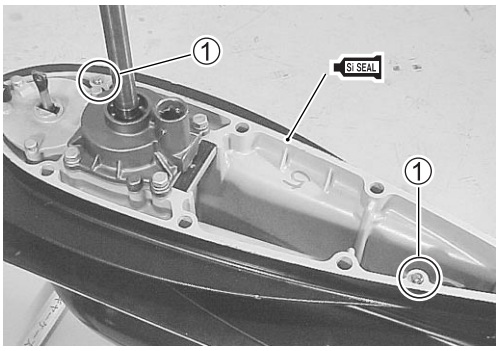


LOWER UNIT INSTALLATION

1. Install the dowel pins ①.
2. Apply the Water Resistant Grease to the driveshaft splines.
3. Apply the Silicone Seal lightly to the mating surfaces of the gearcase and the driveshaft housing.
4. Slide the gearcase into place, making sure that the top of the driveshaft engages properly with the crankshaft and the water tube locates in the water pump case outlet.

W/R G's 99000-25160: Suzuki Water Resistant Grease

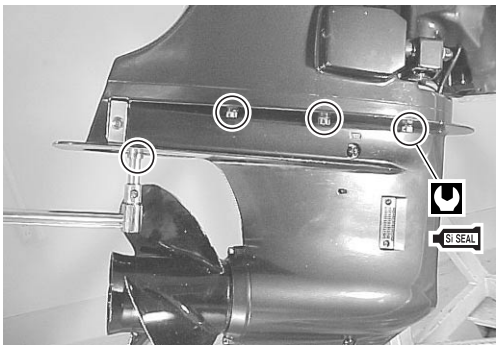
Si SEAL 99000-31120: Suzuki Silicone Seal



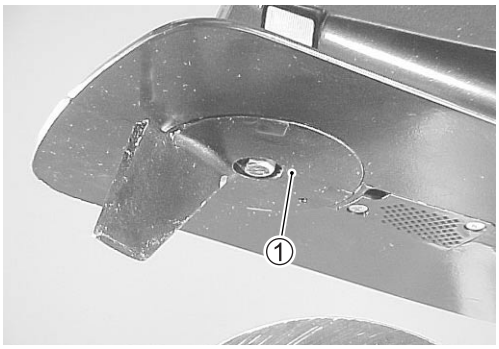
5. Apply the Silicone Seal to the seven gearcase bolts and tighten them to the specified torque.

Si SEAL 99000-31120: Suzuki Silicone Seal

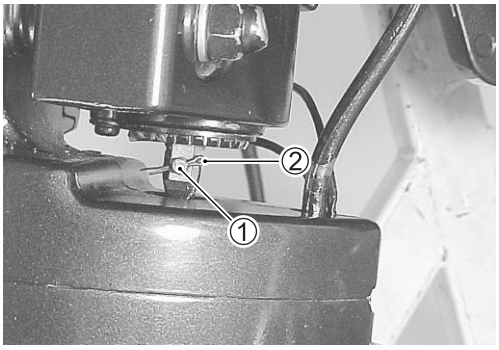
Gearcase bolt: 55 N·m (5.5 kg-m, 40.0 lb-ft)



6. Install the trim tab ①.



7. Connect the shift rod to the clutch rod with the connector pin ① and the cotter pin ②.

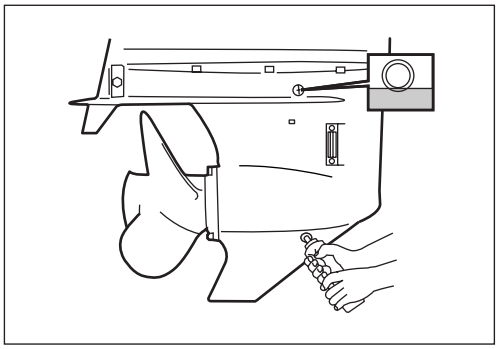


GEAR OIL

Fill the gearcase with the specified gear oil.
See the “PERIODIC MAINTENANCE/GEAR OIL” section on the page 2-5.

Necessary amount of gear oil:
1050 ml (35.5/37.0 US/Imp.oz)

Gear OIL 99000-22540: Suzuki Outboard Motor Gear Oil



TRIM TAB ADJUSTMENT

The trim tab counteracts or minimizes propeller torque “pull” felt through the steering system.
If steering is pulled to starboard or port side, adjust the trim tab with the following procedure:

Adjusting

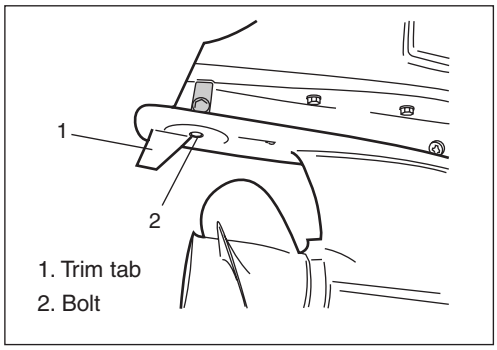
1. Loosen the bolt of the trim tab.

2. Change the direction of the trim tab.
   - To compensate for a veer to starboard, set the trailing edge of the tab to the right (as viewed from behind).
   - To compensate for a veer to port, set the trailing edge of the tab to the left.

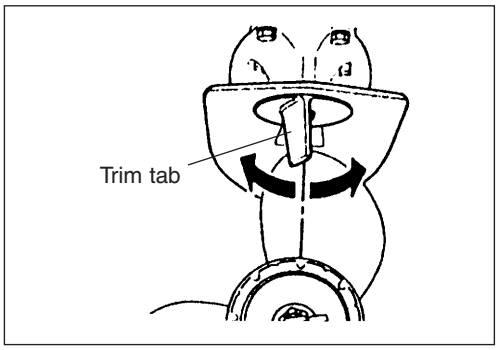
3. Tighten the bolt of the trim tab.

4. Test ride boat and repeat the procedure 1– 3 to set the trim tab in the best position.

With a properly adjusted trim tab, steering should be neutral and there should be no tendency for steering to be pulled to either port or starboard.



1. Trim tab
2. Bolt

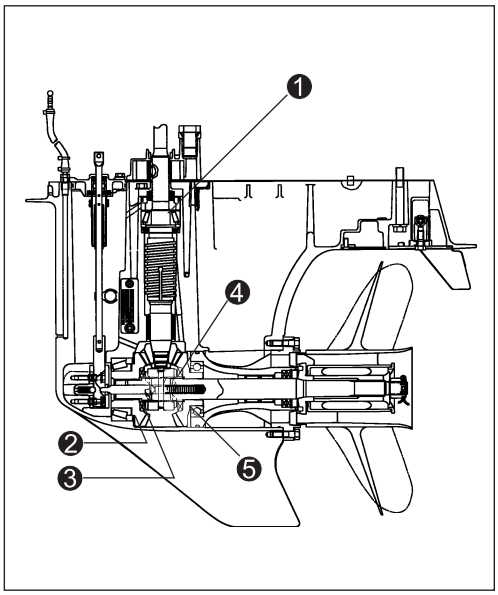


LOWER UNIT GEARS- SHIMMING AND ADJUSTMENT

If the lower unit has been rebuilt or has had components replaced, shimming for correct gear contact and backlash will have to be adjusted to ensure smooth, reliable operation of gears.

Shim/Washer & Mounting position

	Numerical index/item	Available thickness (mm)	Design specification Thickness (mm)
❶	Pinion gear back up shim	0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.05, 1.10, 1.15	1.0
❷	Forward gear back up shim	0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90	1.0
❸	Forward gear thrust washer	3.0	3.0
❹	Reverse gear thrust washer	0.9, 1.0, 1.2, 1.3, 1.4, 1.6	2.2
❺	Reverse gear back up shim	1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6	1.5



PINION GEAR BACK-UP SHIM ADJUSTMENT

1. Position the shimming gauge Ⓐ horizontally in a vise and tighten the vise securely.

TOOL 09951-09010: Shimming gauge

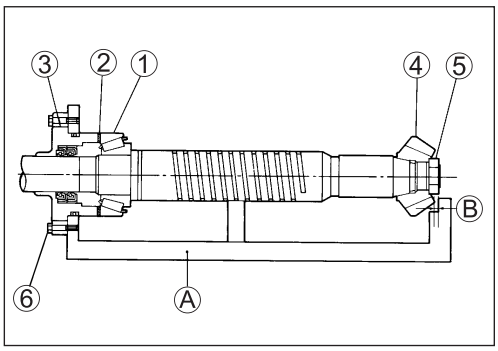
2. Assemble the bearing outer race ①, the back-up shim ② and the driveshaft oil seal housing ③ to the driveshaft.

NOTE:
Use a thinner pinion back-up shim ② than the standard shim so that a clearance Ⓑ exists.

3. Insert the driveshaft through the shimming gauge Ⓐ opening and then install the pinion gear ④ and the nut ⑤ to the driveshaft, tighten the pinion nut.

Pinion nut: 100 N·m (10.0 kg-m, 72.5 lb-ft)

4. Install the oil seal housing ③ to the shimming gauge Ⓐ with the bolts ⑥.



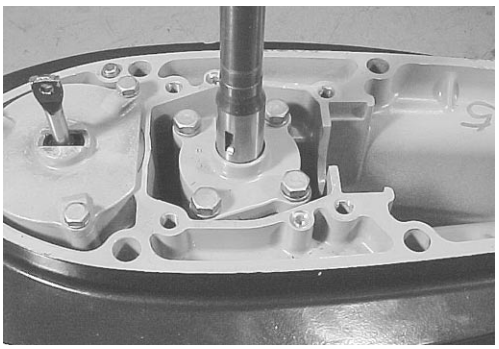
5. Depress and hold the driveshaft so that the driveshaft bearing is firmly seated in the bearing outer race.

6. Hold the driveshaft against the oil seal housing ③ while measuring the clearance Ⓑ between the gauge and the flat edge of the pinion gear ④ with the thickness gauge.

7. Select the pinion gear back-up shim of the thickness at the clearance Ⓑ become 1.5 mm (0.06 in).

FORWARD GEAR BACK-UP SHIM ADJUSTMENT

Follow the procedure below to adjust the forward gear / pinion gear.

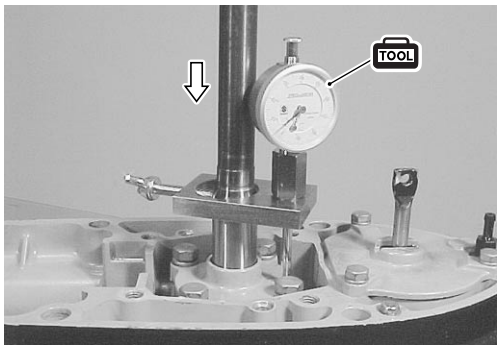


Step to prior to adjustment

1. Correctly assemble the driveshaft oil seal housing, the driveshaft, the forward gear, the pinion gear and the related components. (See the page 9-16 to 9-17.)
   Do not install the reverse gear at this time.

2. Tighten the pinion nut to the specified torque.

Pinion nut: 100 N·m (10.0 kg-m, 72.5 lb-ft)



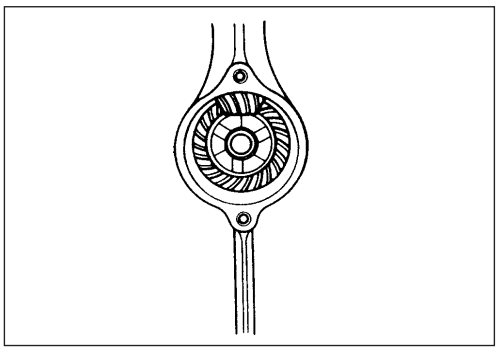
Checking driveshaft thrust play

1. Affix the gear adjusting gauge to the drive shaft.

TOOL 09951-09511: Gear adjusting gauge

2. To check the driveshaft thrust play, push the forward gear inward and fix it by hand.
   Slowly push the driveshaft downward, then read the maximum play.

Driveshaft thrust play:
Approx. 0.4 – 0.6 mm (0.016 – 0.023 in)



If the thrust play is larger than the specified, the thickness of the forward gear back-up shim must be increased.
If the thrust play is smaller, the forward gear back-up shim thickness must be decreased.

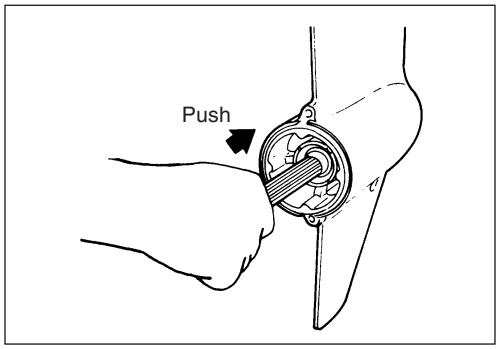
Checking and adjusting tooth contact pattern (Pinion and Forward gear)

Check the tooth contact pattern by using the following procedure:

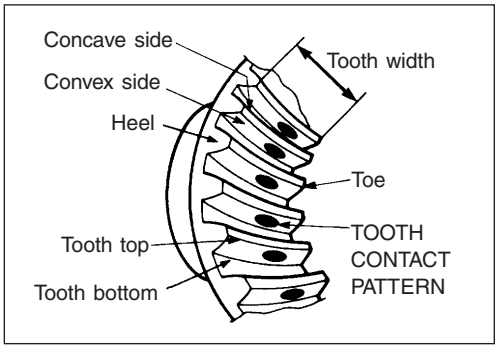
1. To assess the tooth contact, apply a light coat of Prussian Blue on the convex surface of the forward gear.

2. Install the propeller shaft and the housing assembly (minus the reverse gear and the internal components).
3. Push the propeller shaft inward and hold in position.
4. Using the driveshaft holder, rotate the driveshaft 5 – 6 times.

TOOL 09921-28710: Driveshaft holder



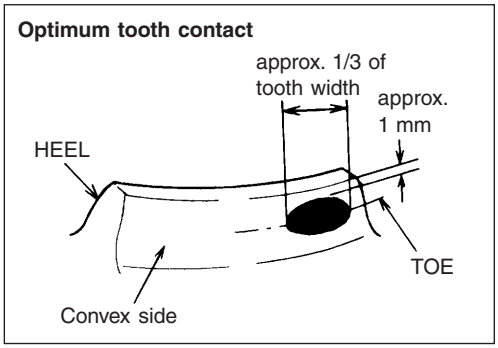
5. Carefully pull out the propeller shaft and the housing to check the tooth contact pattern.



Optimum tooth contact

The optimum tooth contact is shown in the figure.

A shim adjustment may be necessary to obtain the optimum tooth contact pattern.



CAUTION

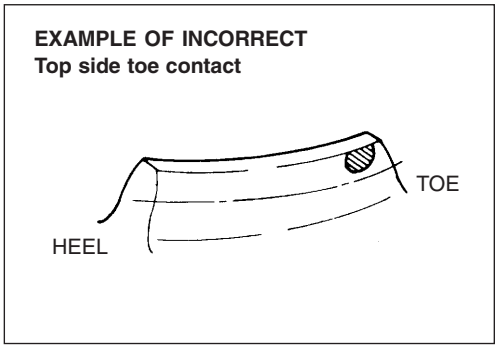
The backlash of the gear should be checked when increasing or decreasing the thickness of the shim to adjust tooth contact.

Example (1)

Incorrect topside toe contact:

Correction measures:

- Decrease the thickness of the forward gear shim.
- Slightly increase the pinion gear shim thickness.



CAUTION

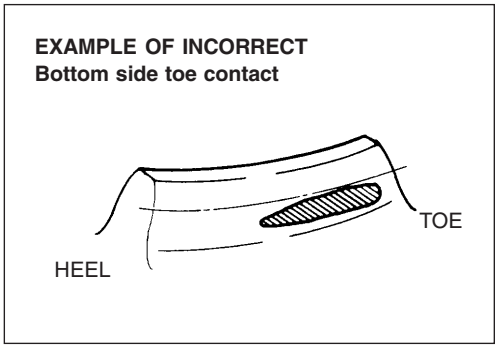
Do not set tooth contact in the top side toe contact position. Damage and chipping of the forward and pinion gear may result.

Example (2)

Incorrect bottom side toe contact:

Correction measures:

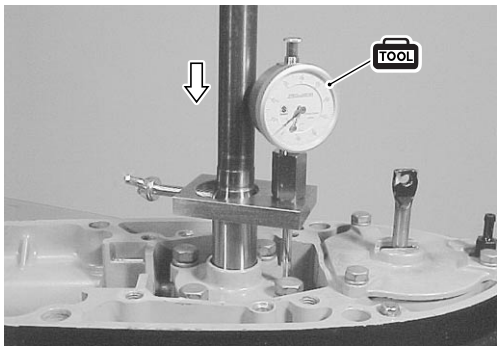
- Increase the thickness of the forward gear shim.
- Slightly decrease the pinion gear shim thickness.



CAUTION

Do not set tooth contact in the bottom side toe contact position. Chipping of the pinion gear may result.

CHECKING DRIVESHAFT THRUST PLAY



After obtaining optimum tooth contact, the driveshaft thrust play should be measured.

1. Affix the gear adjusting gauge to the driveshaft.

TOOL 09951-09511: Gear adjusting gauge

2. Slowly push the driveshaft downward and read the maximum play. Designate this measurement as the play (A).

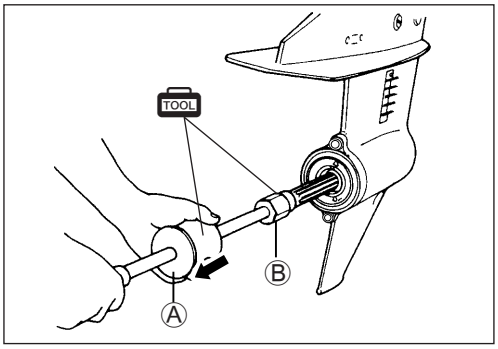
Driveshaft thrust play:
Approx. 0.4 – 0.6 mm (0.016 – 0.023 in)

NOTE:
The driveshaft thrust play (A) should be known to adjust the reverse gear shim.

RECHECKING DRIVESHAFT THRUST PLAY

(Reverse gear back-up shim adjustment)

1. After adjusting the forward gear tooth contact pattern, correctly assemble the propeller shaft, the housing assembly, the reverse gear and the related components (See the page 9-17 to 9-19).
2. Install the sliding hammer Ⓐ and the remover Ⓑ onto the propeller shaft and strike a few gentle outward taps.



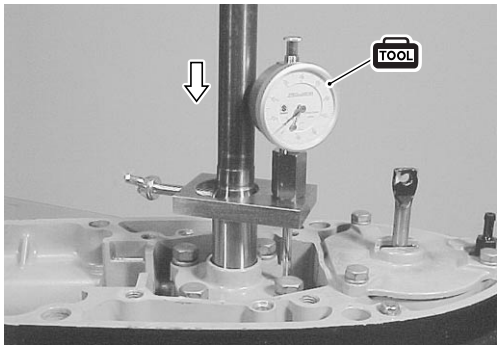
TOOL 09930-30161: Propeller shaft remover – Ⓑ
09930-30104: Sliding hammer – Ⓐ

3. Affix the gear adjusting gauge to the driveshaft.

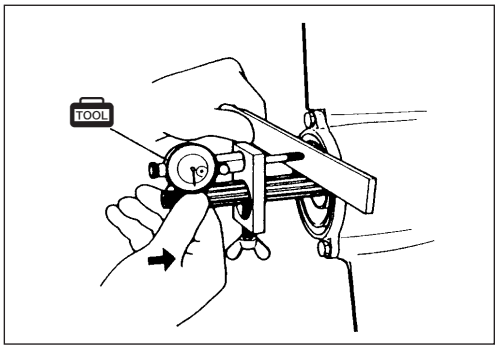
TOOL 09951-09511: Gear adjusting gauge

4. Slowly push the driveshaft downward and read the maximum play. Designate this measurement as the play (B).
5. Compare the play (B) to the play (A).
6. The reverse gear back-up shim adjustment is correct if the play (B) is equal to the play (A).

If the play (B) is less than the play (A), reduce the reverse gear back-up shim thickness.



CHECKING PROPELLER SHAFT THRUST PLAY



After adjusting all gear positions, measure the propeller shaft thrust play. If the measurement is not within the following specification, a shim adjustment is required.

Propeller shaft thrust play: 0.2 – 0.4 mm (0.01 – 0.02 in)

NOTE:
Maintain the forward gear thrust washer at the standard thickness (3.0 mm) and adjust only reverse gear thrust washer with the shim.

Measurement step:

1. Affix the gear adjusting gauge to the propeller shaft.

TOOL 09951-09511: Gear adjusting gauge

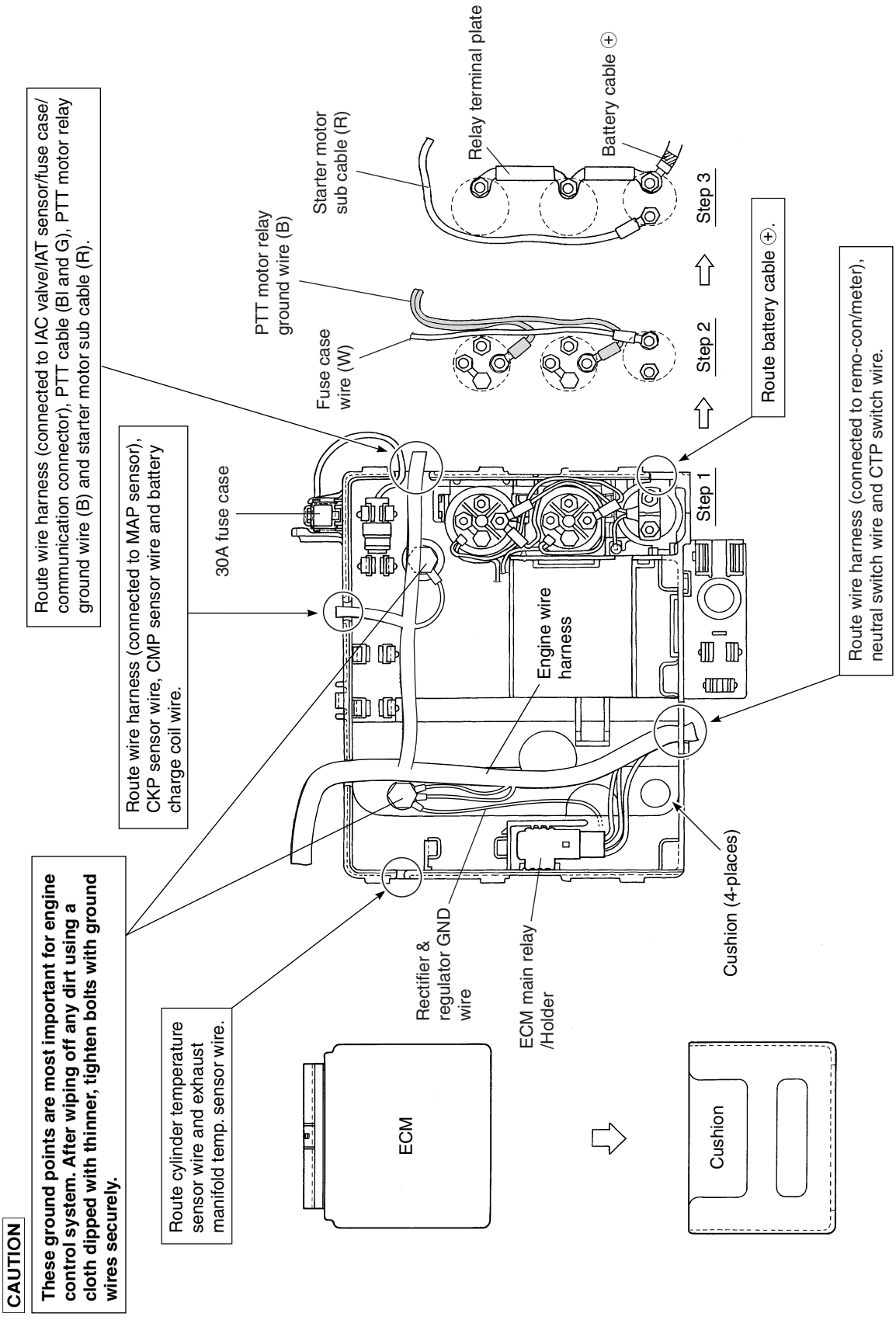
2. Slowly push the propeller shaft inward.
3. Hold the shaft in and set the dial gauge pointer to zero.
4. Slowly pull the propeller shaft outward and read the maximum thrust play.

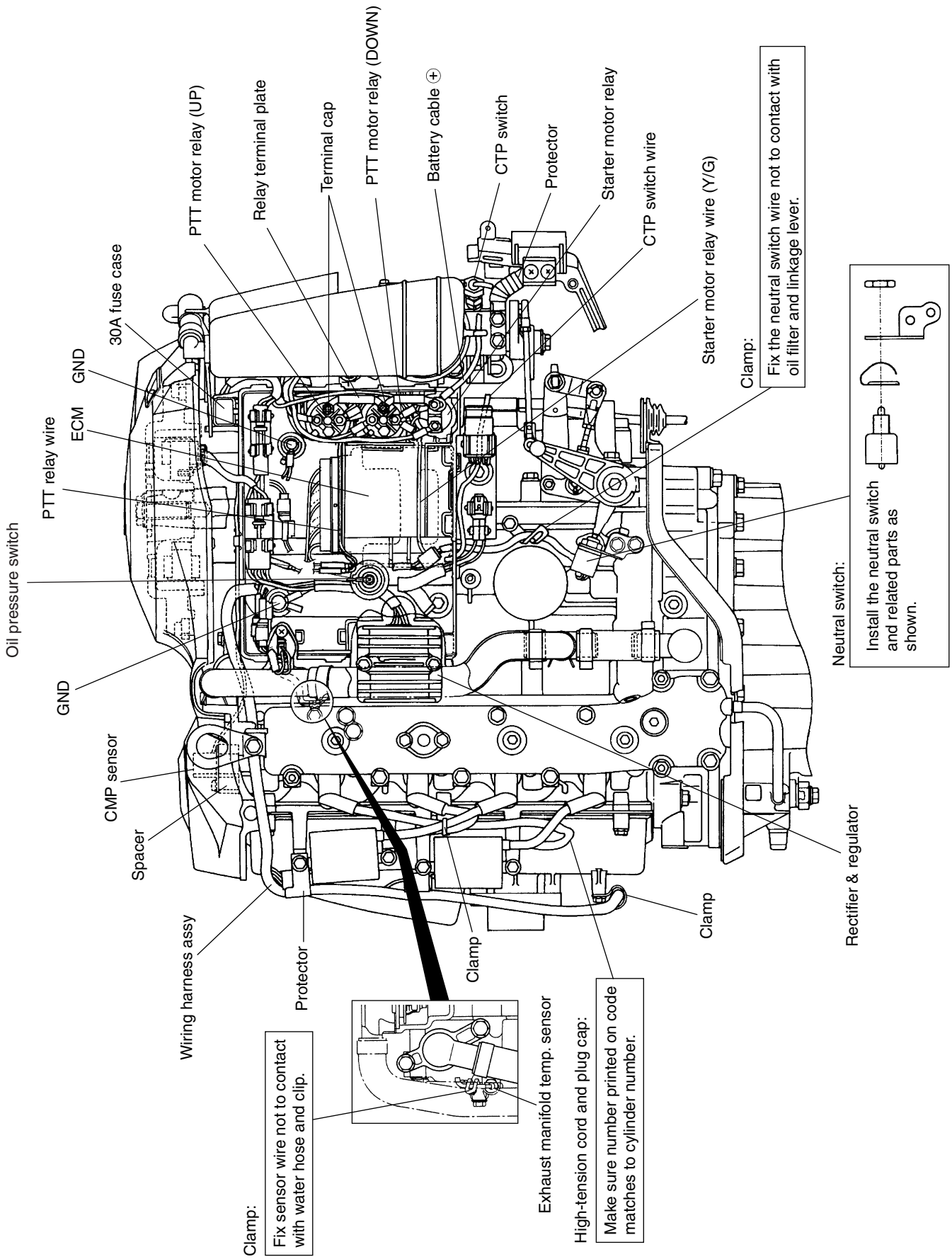
If the measurement is more than the specification, increase the reverse gear thrust washer thickness.
If the measurement is less than the specification, reduce the reverse gear thrust washer thickness.

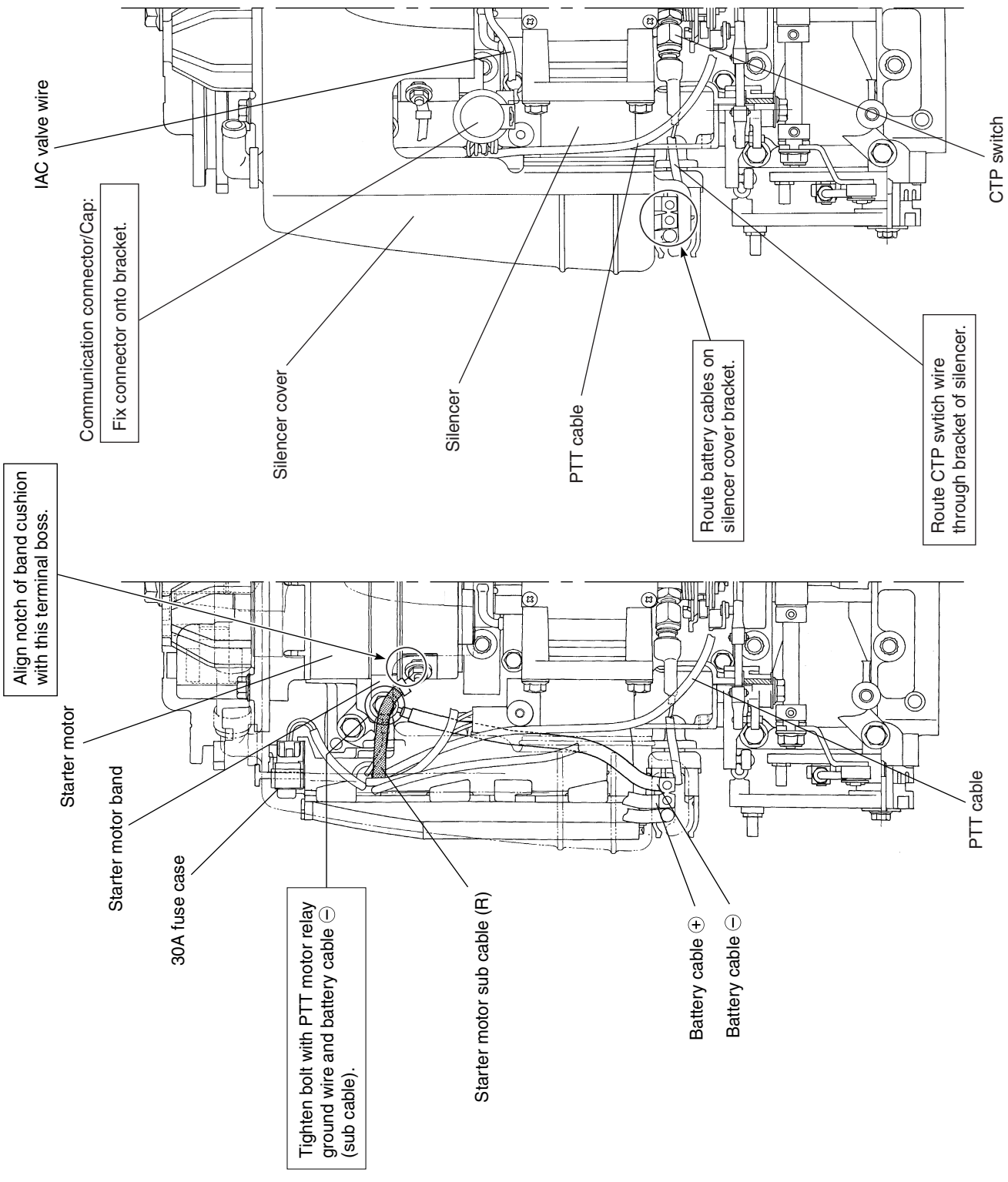
ROUTING AND DIAGRAM

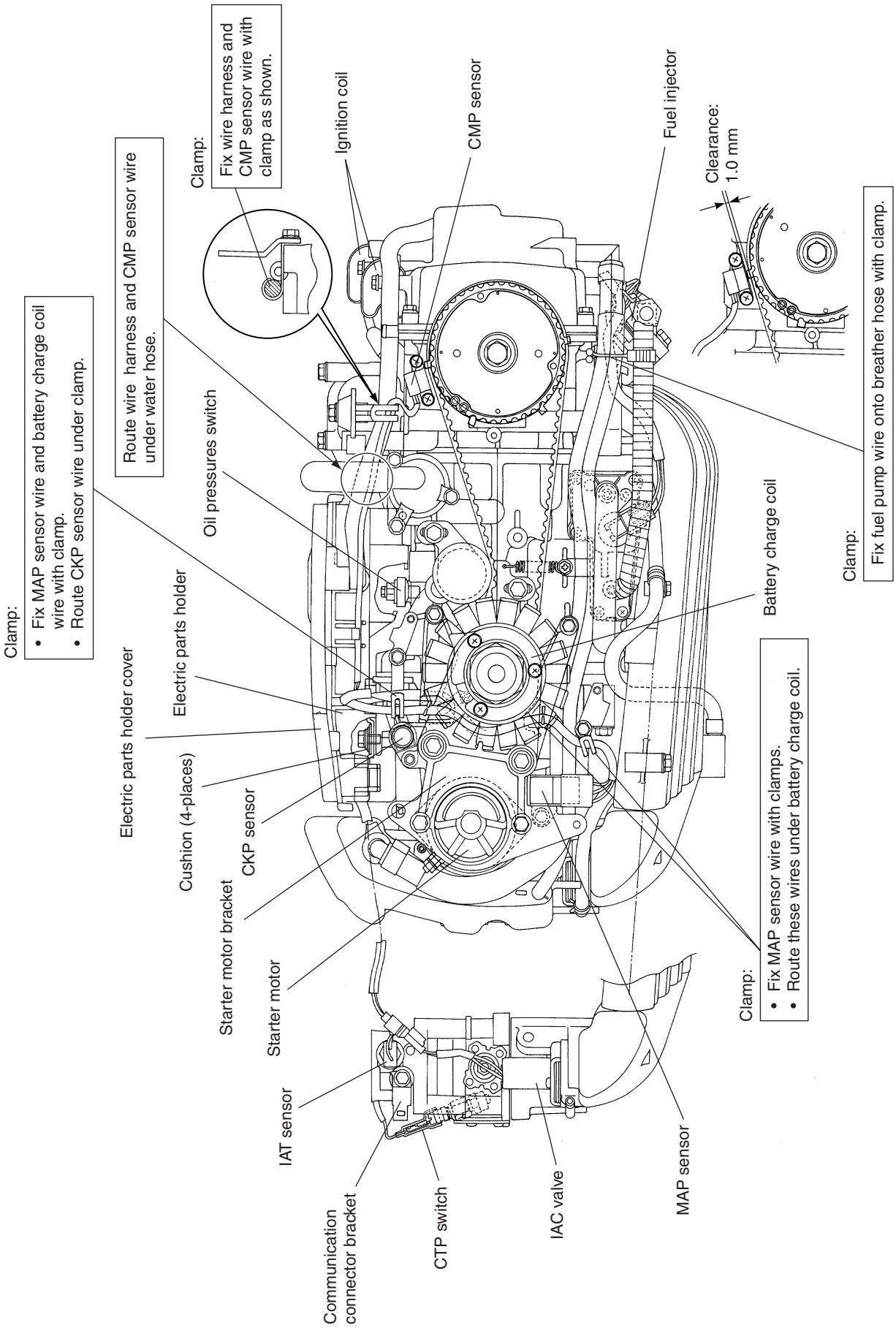
CONTENTS

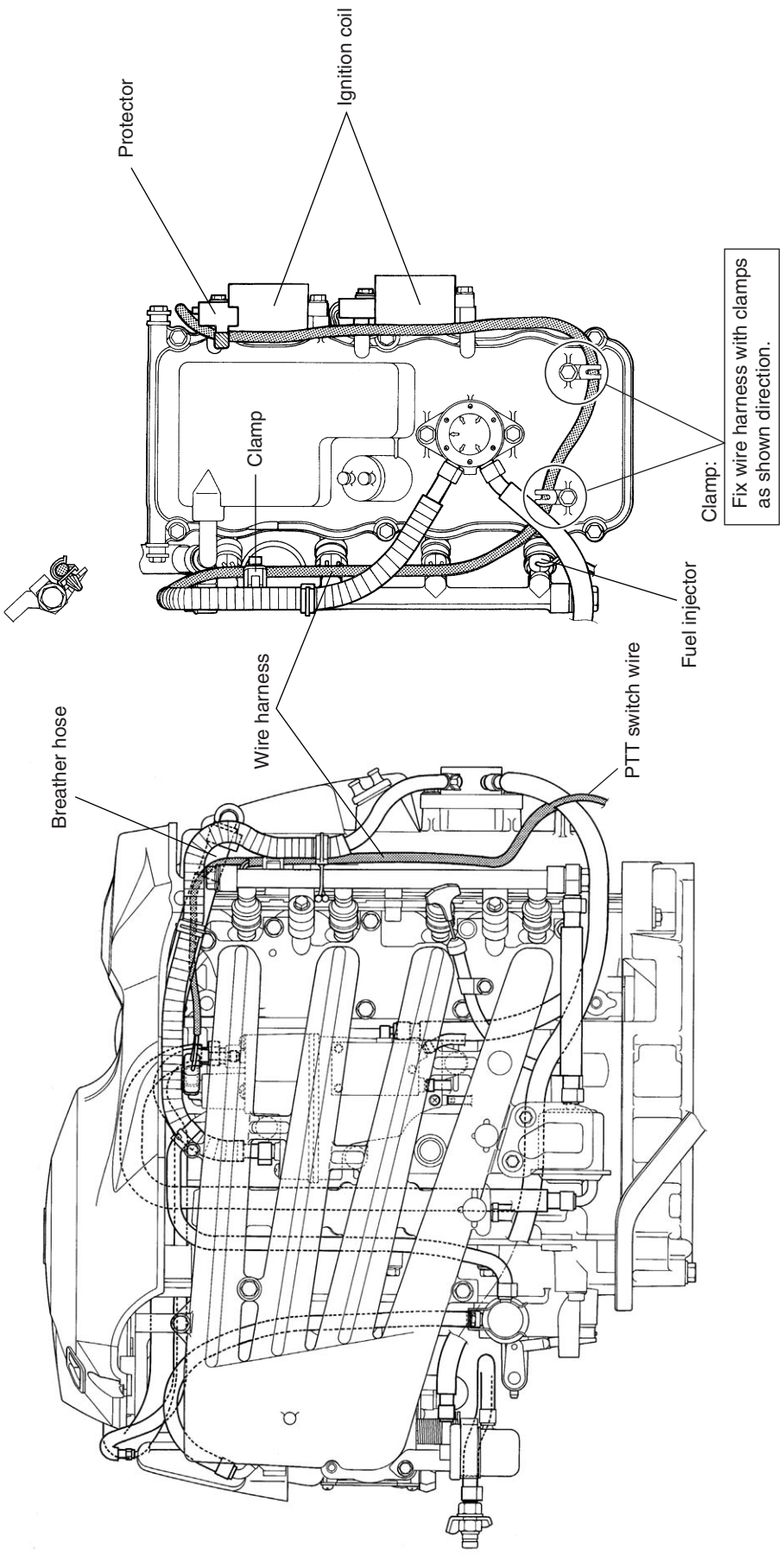
WIRE ROUTING

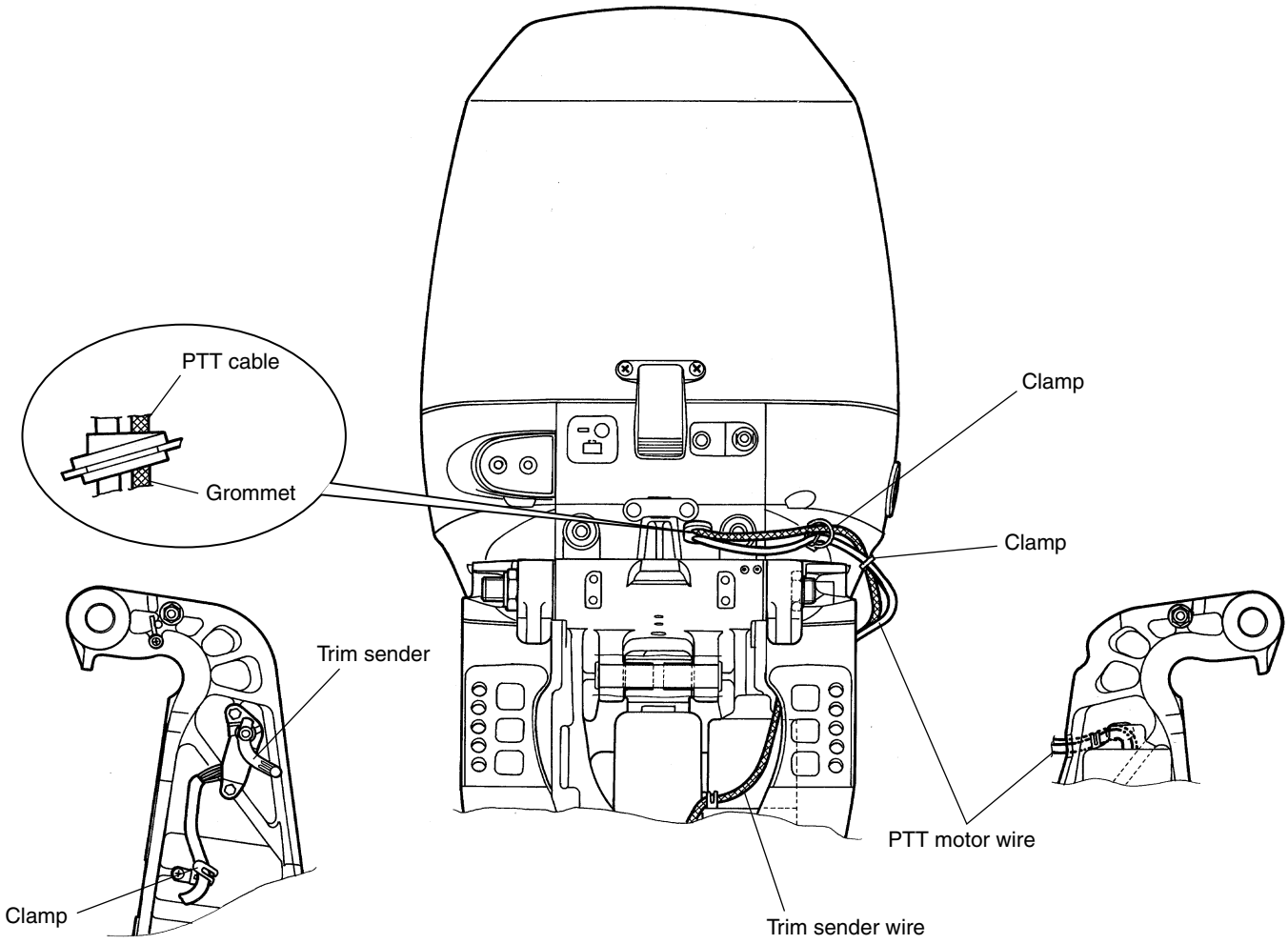



Oil pressure switch
PTT relay wire
ECM
GND
30A fuse case
PTT motor relay (UP)
Relay terminal plate
Terminal cap
PTT motor relay (DOWN)
Battery cable ⊕
CTP switch
Protector
Starter motor relay
CTP switch wire
Starter motor relay wire (Y/G)
Clamp:
Fix the neutral switch wire not to contact with oil filter and linkage lever.
Neutral switch:
Install the neutral switch and related parts as shown.
GND
CMP sensor
Spacer
Wiring harness assy
Protector
Clamp
Clamp
Rectifier & regulator
Clamp:
Fix sensor wire not to contact with water hose and clip.
Exhaust manifold temp. sensor
High-tension cord and plug cap:
Make sure number printed on code matches to cylinder number.


IAC valve wire
Communication connector/Cap:
Fix connector onto bracket.
Silencer cover
Silencer
PTT cable
Route battery cables on silencer cover bracket.
Route CTP swtich wire through bracket of silencer.
CTP switch
Align notch of band cushion with this terminal boss.
Starter motor
Starter motor band
30A fuse case
Tighten bolt with PTT motor relay ground wire and battery cable ⊖ (sub cable).
Starter motor sub cable (R)
Battery cable ⊕
Battery cable ⊖
PTT cable

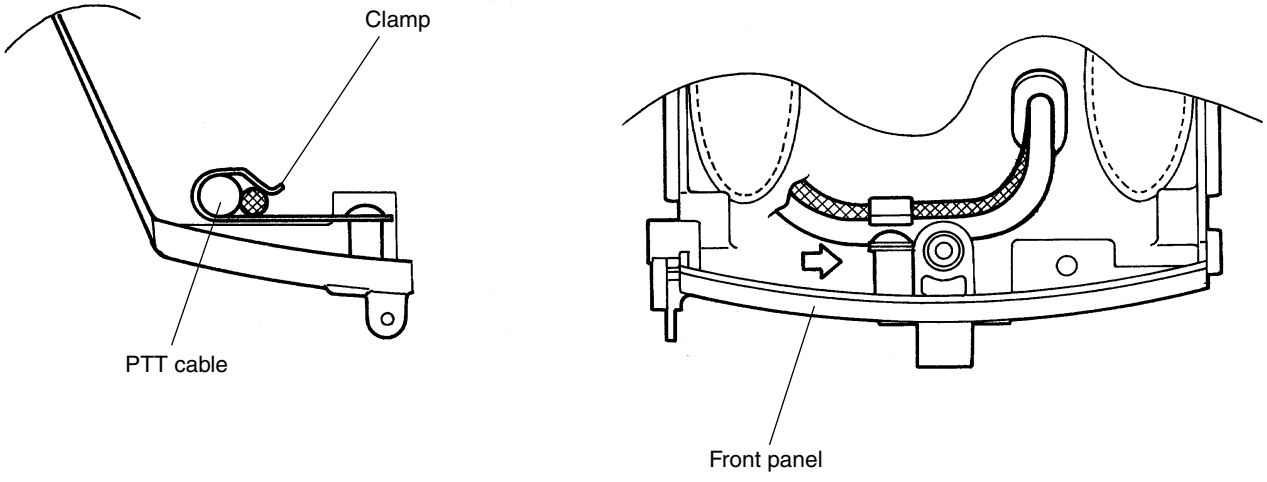

Clamp:
• Fix MAP sensor wire and battery charge coil wire with clamp.
• Route CKP sensor wire under clamp.
Route wire harness and CMP sensor wire under water hose.
Clamp:
Fix wire harness and CMP sensor wire with clamp as shown.
Ignition coil
CMP sensor
Fuel injector
Clearance: 1.0 mm
Oil pressures switch
Electric parts holder cover
Electric parts holder
Cushion (4-places)
CKP sensor
Starter motor bracket
Starter motor
IAT sensor
Communication connector bracket
CTP switch
IAC valve
MAP sensor
Battery charge coil
Clamp:
• Fix MAP sensor wire with clamps.
• Route these wires under battery charge coil.
Clamp:
Fix fuel pump wire onto breather hose with clamp.


Protector
Ignition coil
Clamp
Clamp:
Fix wire harness with clamps as shown direction.
Fuel injector
Wire harness
PTT switch wire
Breather hose



PORT CLAMP BRACKET

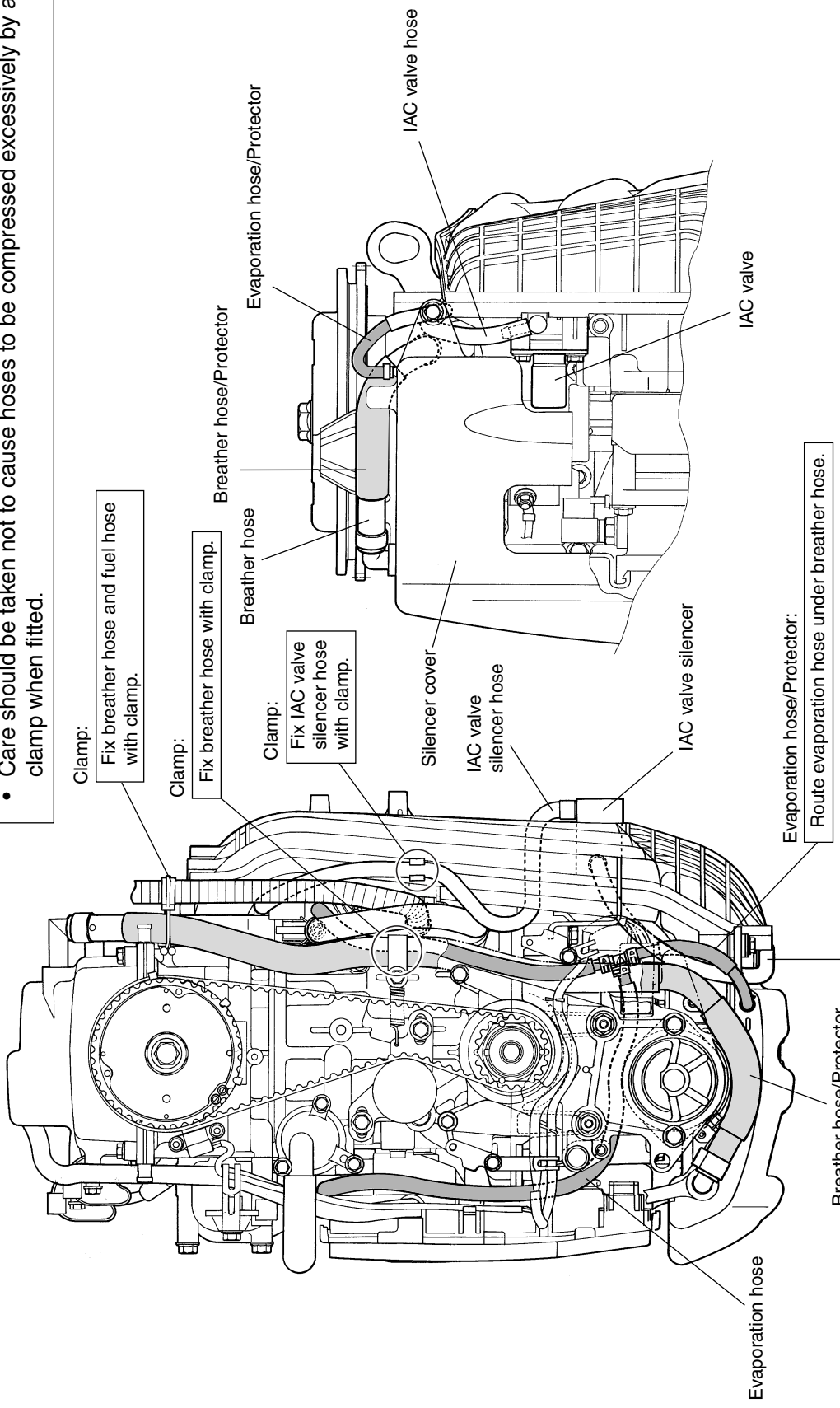
STBD CLAMP BRACKET

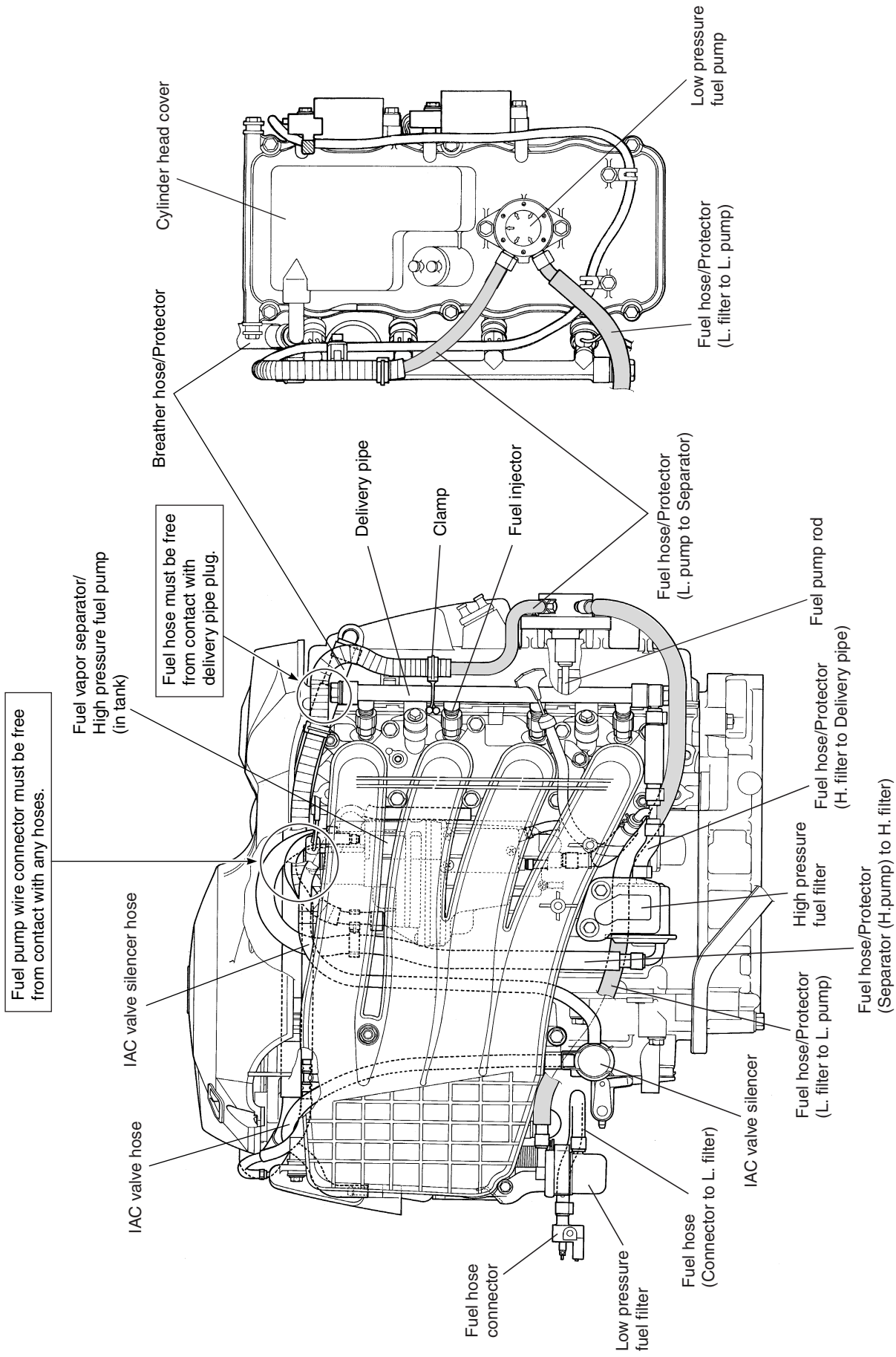


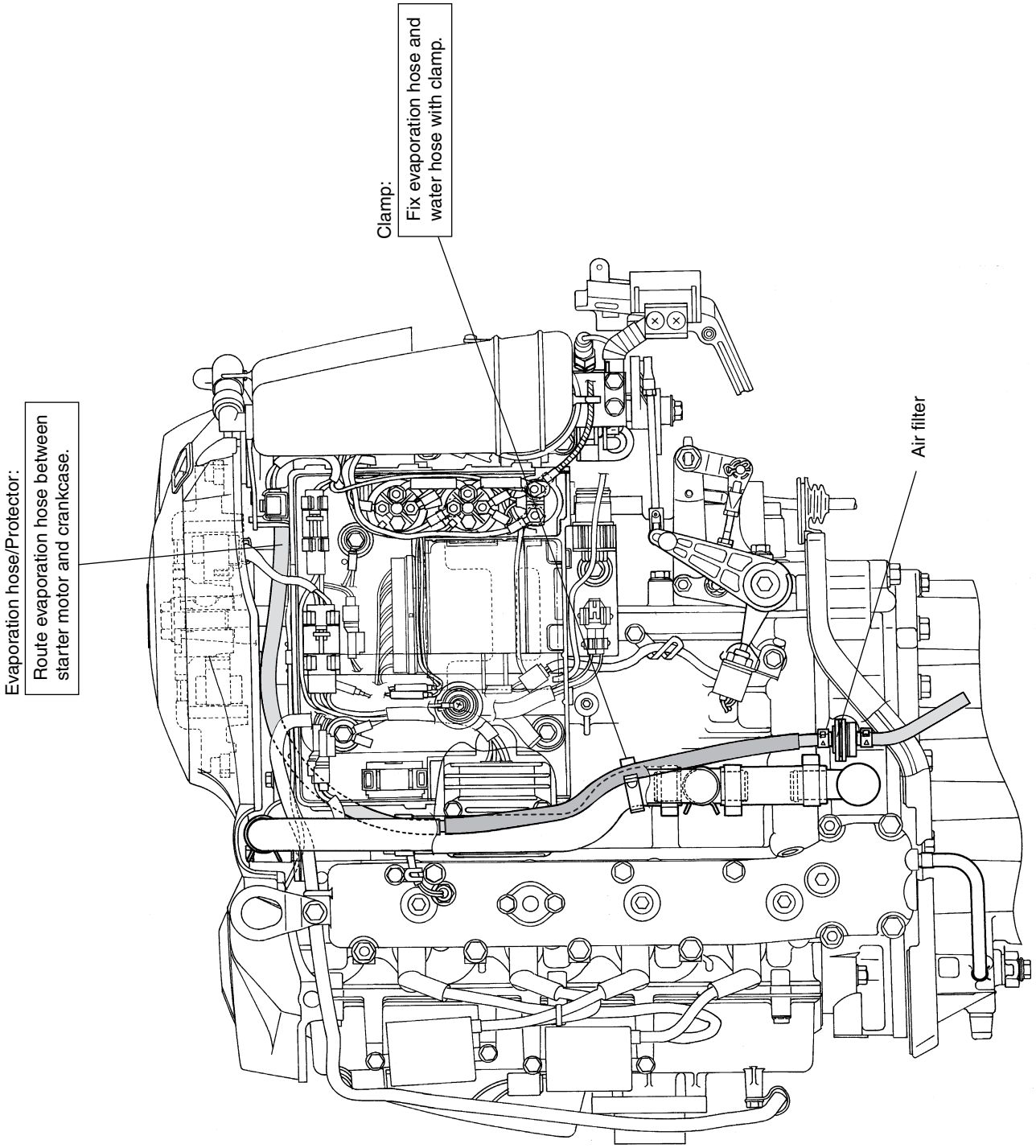
FUEL HOSE ROUTING

CAUTION

- Do not over-bend (kink) or twist hoses when installing.
- When installing hose clips, position tabs to avoid contact with other parts.
- Check that hoses do not contact rods and levers during either engine operation or standstill.
- Extreme care should be taken not to cut, abrade or cause any other damage on hoses.
- Care should be taken not to cause hoses to be compressed excessively by any clamp when fitted.



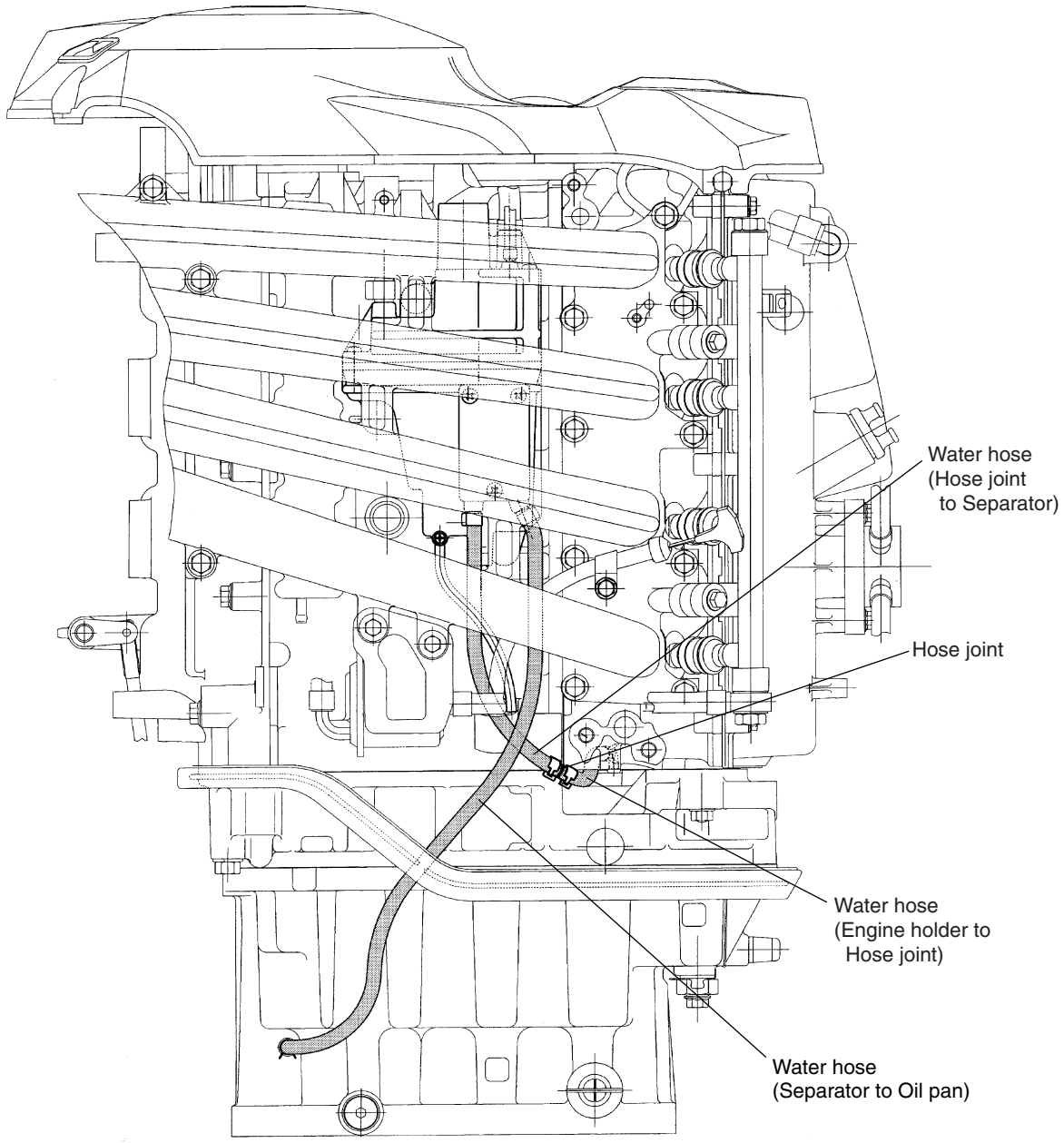

Fuel pump wire connector must be free from contact with any hoses.
Fuel vapor separator/ High pressure fuel pump (in tank)
Fuel hose must be free from contact with delivery pipe plug.
IAC valve silencer hose
IAC valve hose
Fuel hose connector
Low pressure fuel filter
Fuel hose (Connector to L. filter)
IAC valve silencer
Fuel hose/Protector (L. filter to L. pump)
High pressure fuel filter
Fuel hose/Protector (H. filter to Delivery pipe)
Fuel hose/Protector (Separator (H.pump) to H. filter)
Fuel pump rod
Fuel hose/Protector (L. pump to Separator)
Delivery pipe
Clamp
Fuel injector
Breather hose/Protector
Cylinder head cover
Low pressure fuel pump
Fuel hose/Protector (L. filter to L. pump)

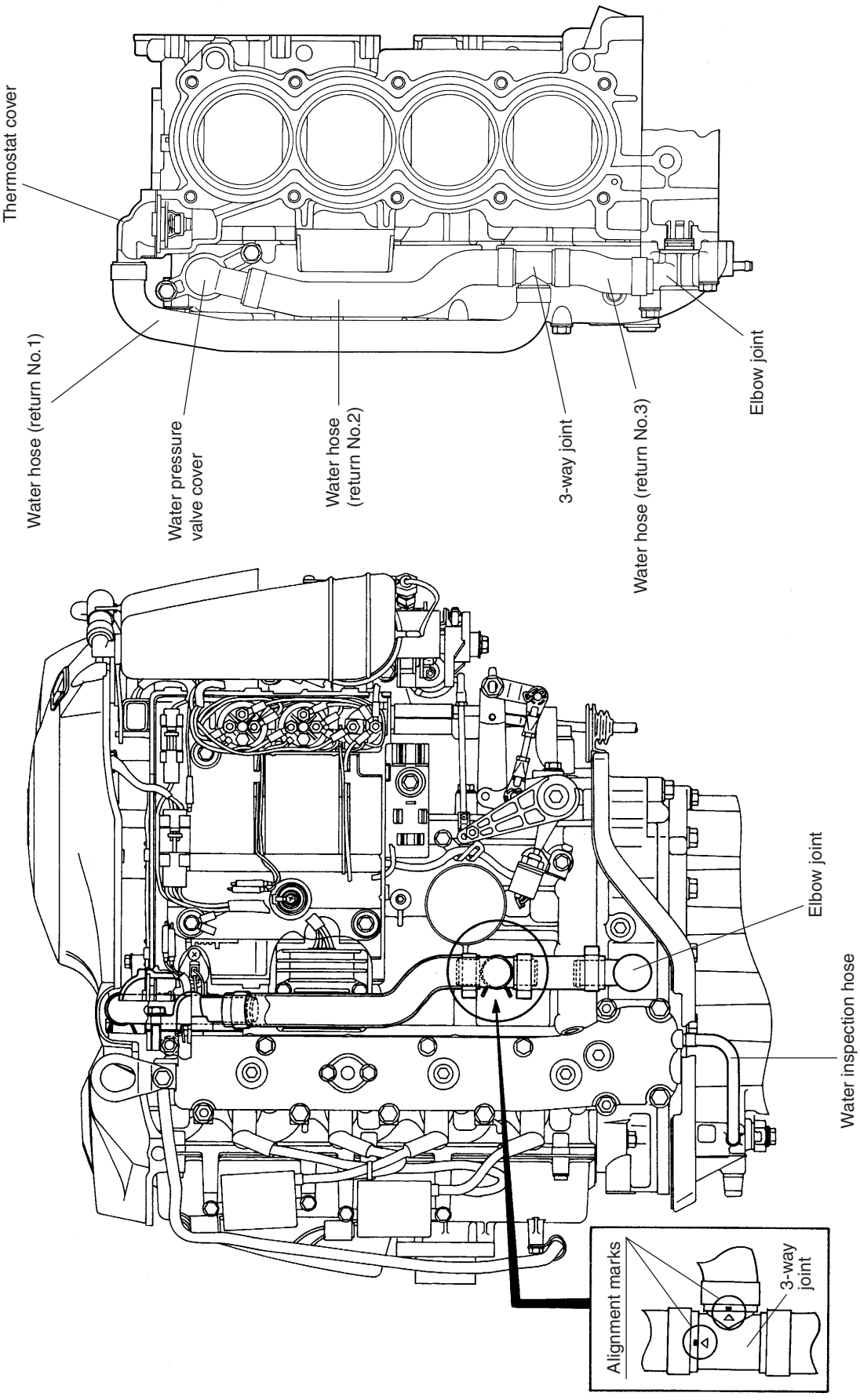

Clamp:
Fix evaporation hose and water hose with clamp.
Evaporation hose/Protector:
Route evaporation hose between starter motor and crankcase.
Air filter

WATER HOSE ROUTING

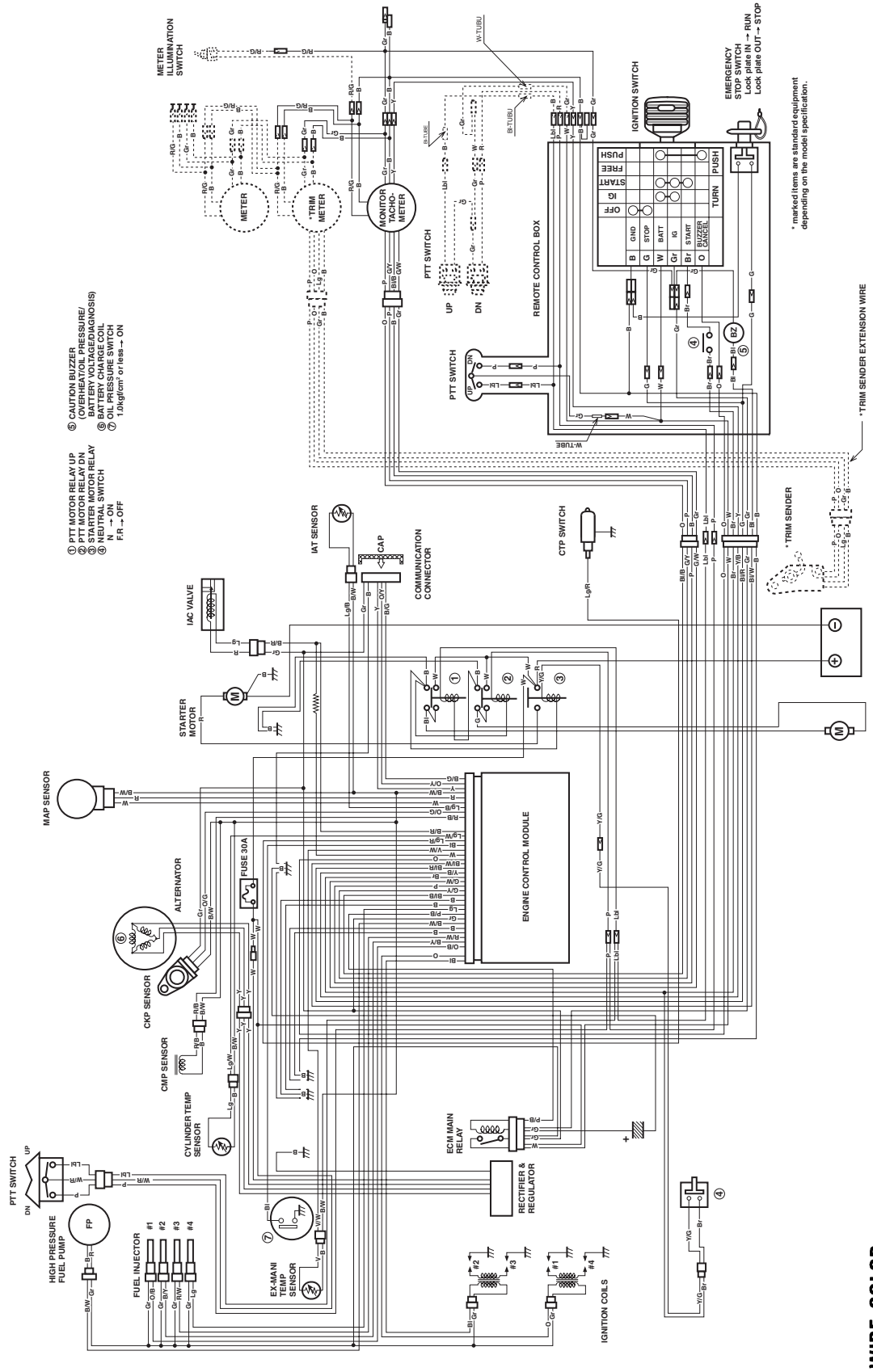
CAUTION

- Do not over-bend (kink) or twist hoses when installing.
- When installing hose clips, position tabs to avoid contact with other parts.
- Check that hoses do not contact rods and levers during either engine operation or standstill.
- Extreme care should be taken not to cut, abrade or cause any other damage on hoses.
- Care should be taken not to cause hoses to be compressed excessively by any clamp when fitted.




Thermostat cover
Water hose (return No.1)
Water pressure valve cover
Water hose (return No.2)
3-way joint
Water hose (return No.3)
Elbow joint
Elbow joint
Water inspection hose
Alignment marks
3-way joint

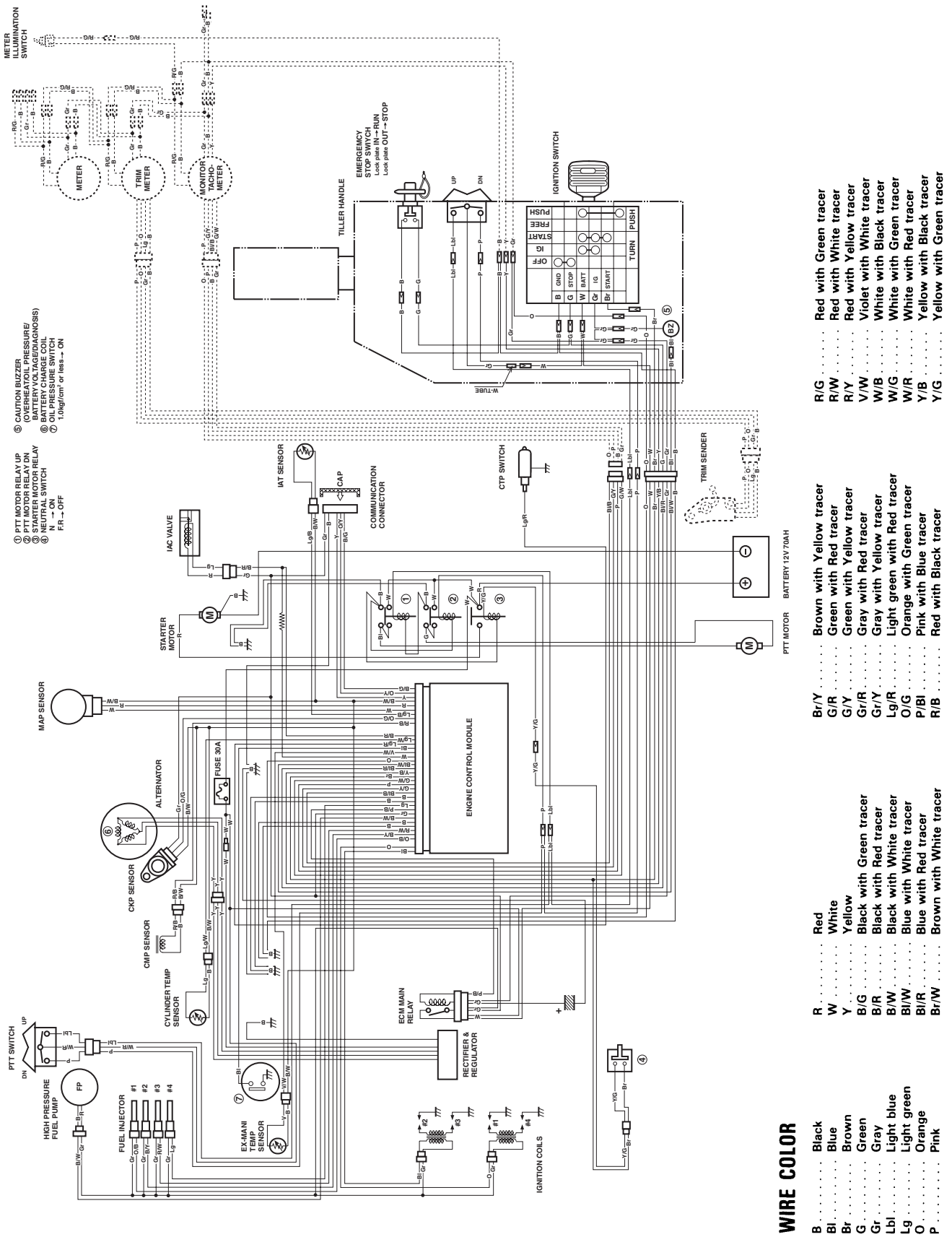
WIRING DIAGRAM
DF60T/DF70T/DF70WT



WIRE COLOR

B	Black	R	Red
Bl	Blue	W	White
Br	Brown	Y	Yellow
G	Green	B/G	Black with Green tracer
Gr	Gray	B/R	Black with Red tracer
Lbl	Light blue	B/W	Black with White tracer
Lg	Light green	Bl/W	Blue with White tracer
O	Orange	Bl/R	Blue with Red tracer
P	Pink	Br/W	Brown with White tracer
Br/Y	Brown with Yellow tracer	R/G	Red with Green tracer
G/R	Green with Red tracer	R/W	Red with White tracer
G/Y	Green with Yellow tracer	R/Y	Red with Yellow tracer
Gr/R	Gray with Red tracer	V/W	Violet with White tracer
Gr/Y	Gray with Yellow tracer	W/B	White with Black tracer
Lg/R	Light green with Red tracer	W/G	White with Green tracer
O/G	Orange with Green tracer	W/R	White with Red tracer
P/Bl	Pink with Blue tracer	Y/B	Yellow with Black tracer
R/B	Red with Black tracer	Y/G	Yellow with Green tracer

DF70WTH



WIRE COLOR

B	Black	R	Red
Bl	Blue	W	White
Br	Brown	Y	Yellow
G	Green	B/G	Black with Green tracer
Gr	Gray	B/R	Black with Red tracer
Lbl	Light blue	B/W	Black with White tracer
Lg	Light green	Bl/W	Blue with White tracer
O	Orange	Bl/R	Blue with Red tracer
P	Pink	Br/W	Brown with White tracer
Br/Y	Brown with Yellow tracer	R/G	Red with Green tracer
G/R	Green with Red tracer	R/W	Red with White tracer
G/Y	Green with Yellow tracer	R/Y	Red with Yellow tracer
Gr/R	Gray with Red tracer	V/W	Violet with White tracer
Gr/Y	Gray with Yellow tracer	W/B	White with Black tracer
Lg/R	Light green with Red tracer	W/G	White with Green tracer
O/G	Orange with Green tracer	W/R	White with Red tracer
P/Bl	Pink with Blue tracer	Y/B	Yellow with Black tracer
R/B	Red with Black tracer	Y/G	Yellow with Green tracer

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