PRE - PRODUCTION ISSUE

SUZUKI OUTBOARD MOTOR

V6 DF200 DF225 DF250 FOUR STROKE

SERVICE MANUAL

FOREWORD

This manual contains an introductory description of the SUZUKI DF200/225/250 Outboard motors and procedures for inspection, service and overhaul of their 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 these outboard motors, assisting you in providing your customers with optimum and quick service.

- *This manual has been prepared using the latest information available at the time of publication.*
  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 SUZUKI outboard engines by relying on this manual only and should contact an 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 2004 (K4) model.

GROUP INDEX

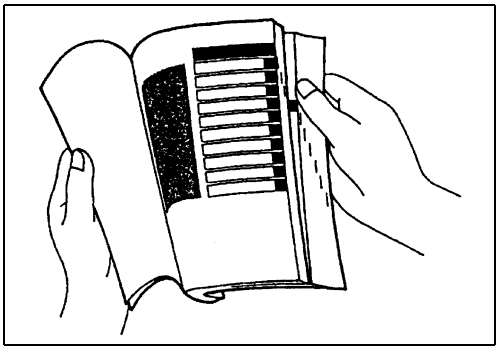
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HOW TO USE THIS MANUAL

TO LOCATE WHAT YOU ARE LOOKING FOR:

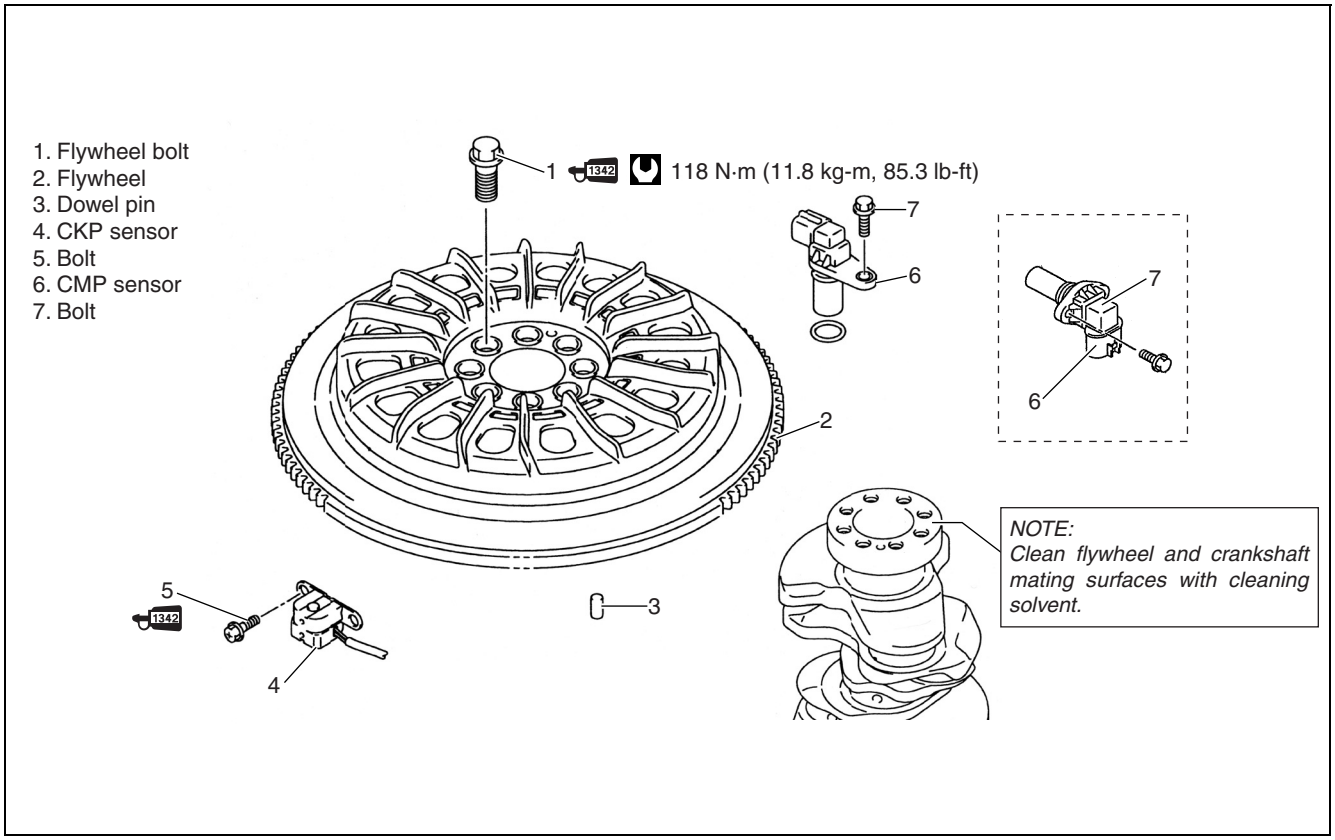
1. The text of this manual is divided into sections.
2. The section titles are listed on the previous page in a GROUP INDEX. Select the section needed for reference.
3. Holding the manual as shown at the right will allow you to find the first page of the section easily.
4. The first page of each section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



COMPONENT PARTS AND IMPORTANT ITEM ILLUSTRATIONS

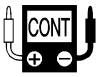
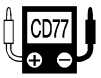
Under the name of each system or unit, an exploded view is provided with work instructions and other service information such as the tightening torque, lubrication and locking agent points.

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 the 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.		

ABBREVIATIONS

Abbreviations used in this service manual are as follows:

BTDC : Before Top Dead Center

CKP : Crankshaft position
CMP : Camshaft position
CTP : Close Throttle position

DC : Direct Current
DOHC : Double Over Head Camshaft

ECM : Engine Control Module
EX (Ex.) : Exhaust

IAC : Idle Air Control
IAT : Intake Air Temperature
IN (In.) : Intake

MAP : Manifold absolute pressure

OCV : Oil control valve

PCV : Positive Crankcase Ventilation
PORT : Port
PTT : Power Trim & Tilt

SPS : Shift Position Sensor
STBD : Starboard

TPS : Throttle Position Sensor

VSV : Vacuum switching valve
VVT : Variable Valve Timing

GENERAL INFORMATION

1

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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 two 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

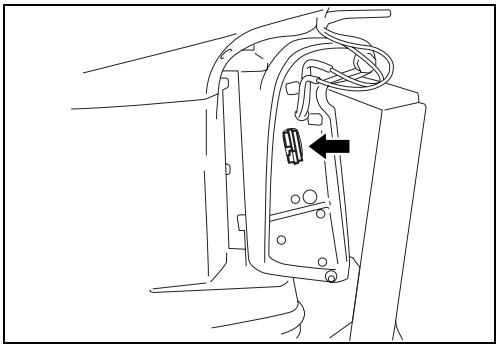
- **If parts replacement is necessary, replace the parts with Suzuki Genuine Parts or their equivalent.**
- **When removing parts that are to be reused, keep them arranged in an orderly manner so that they may be reinstalled in the proper order and orientation.**
- **Be sure to use special tools when 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.**

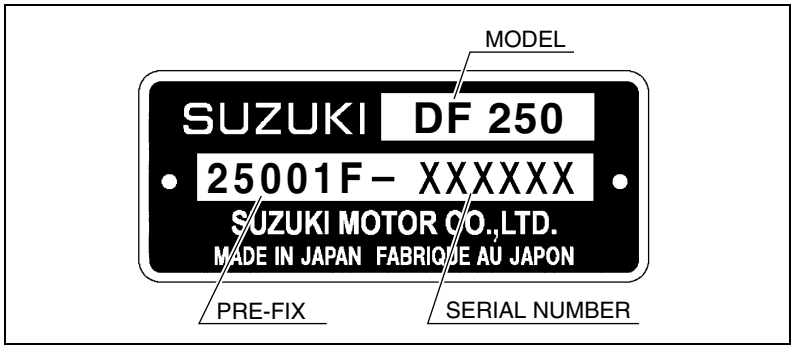
IDENTIFICATION NUMBER LOCATION

MODEL, PRE-FIX, SERIAL NUMBER

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

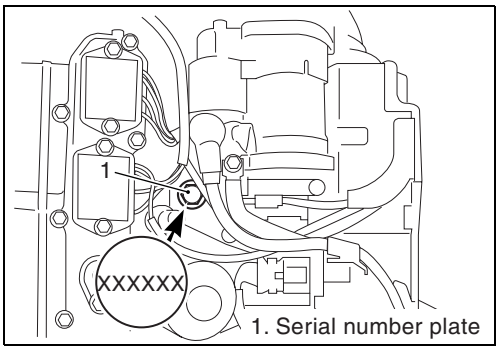


Example



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/2+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

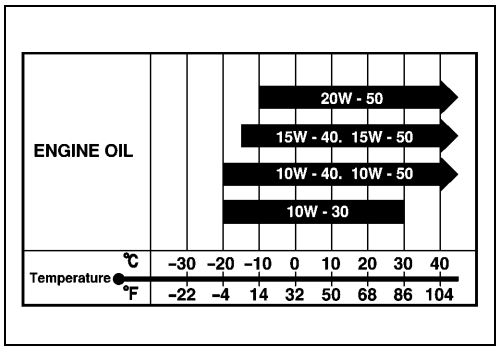
If leaded gasoline is used, engine damage may result. Use only unleaded gasoline.

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 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 (3 000 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 (4 000 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 DF200/225/250 models are shown below.

Recommended full throttle speed range	**DF200**	**5 000 – 6 000 r/min**
	DF225	**5 000 – 6 000 r/min**
	DF250	**5 500 – 6 100 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

Right-hand rotation models				
Blade × Diam. (in.) × Pitch (in.)				
3	×	16	×	17
3	×	16	×	18 and 1/2
3	×	16	×	20
3	×	16	×	21 and 1/2
3	×	16	×	23
3	×	16	×	24 and 1/2

Counter rotation models				
Blade × Diam. (in.) × Pitch (in.)				
3	×	16	×	17
3	×	16	×	18 and 1/2
3	×	16	×	20
3	×	16	×	21 and 1/2
3	×	16	×	23
3	×	16	×	24 and 1/2

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.

NOTE:
In case of twin installation, always use on both engines, the same size right-hand rotation and counter-rotation propellers.

POWERHEAD DIRECTION OF ROTATION

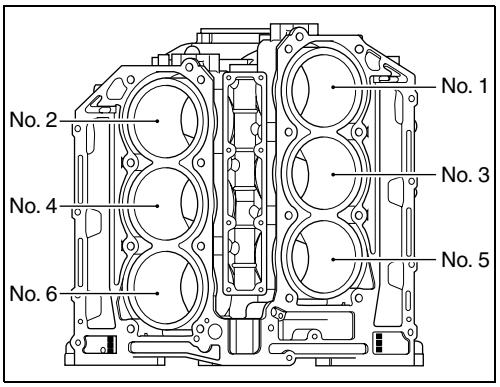
This outboard motor is designed with a L.H. (left hand) rotation powerhead utilizing an offset crankshaft.
This design has the advantage of reducing the size of the motor and keeping the overall motor's weight closer to the boat transom and therefore closer to the boat C/G (center of gravity).

Rotation of the driveshaft is accomplished through a crankshaft drive gear and a driveshaft driven gear.
These gears are located beneath the powerhead in the same oil bath location as the camshaft chain.

As the rotational direction of the driven gear will be opposite of the drive gear, a left-hand rotation powerhead design was adopted to retain a conventional, standard rotation (right-hand) propeller shaft output.

CYLINDER NUMBER

Cylinder number is as mentioned in the right figure.



* SPECIFICATIONS

* These specifications are subject to change without notice.
For DF200Z/225Z/250Z specification, see page 1-11.

Item	Unit	Data		
		DF200T	DF225T	DF250T
PRE-FIX		20001F	22501F	25001F

DIMENSIONS & WEIGHT

Overall length (front to back)		mm (in.)	897 (35.3)		
Overall width (side to side)		mm (in.)	572 (22.5)		
Overall height	UL	mm (in.)	1 834 (72.2)		
	XX	mm (in.)	1 961 (77.2)		
Weight (without engine oil)	UL	kg (lbs)	263 (580)		
	XX	kg (lbs)	268 (591)		
Transom height	UL	mm (in. type)	632 (25)		
	XX	mm (in. type)	759 (30)		

PERFORMANCE

Maximum output	kW (PS)	147 (200)	165 (225)	184 (250)
Recommended operating range	r/min	5 000 – 6 000	5 000 – 6 000	5 500 – 6 100
Idle speed	r/min	650 ± 50 (in-gear: Approx. 650)		

POWER HEAD

Engine type		4-stroke DOHC
Number of cylinders		V-6
Bore	mm (in.)	95 (3.74)
Stroke	mm (in.)	85 (3.35)
Total displacement	cm^3 (cu. in)	3 614 (220.5)
Compression ratio	: 1	9.5
Spark plug	NGK	BKR6E
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

Item	Unit	Data		
		DF200T	DF225T	DF250T

FUEL & OIL

Fuel		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.
Engine oil		API classification SE, SF, SG, SH, SJ Viscosity rating SAE 10W-40
Engine oil amounts	L (US/Imp. qt)	8.0 (8.5/7.0) : Oil change only 8.2 (8.7/7.2) : Oil filter change
Gear oil		SUZUKI Outboard Motor Gear Oil (SAE #90 hypoid gear oil)
Gearcase oil capacity	ml (US/Imp. oz)	1 100 (37.2/38.7)

BRACKET

Trim angle	degree	0 – 19 (PTT system)
Number of trim position		PTT system
Maximum tilt angle	degree	70

LOWER UNIT

Reversing system	Gear
Transmission	Forward-Neutral-Reverse
Reduction system	Bevel gear
Gear ratio	12 : 22 (1.83)
Drive line impact protection	Spline drive rubber hub
Propeller shaft rotation (when shift into forward)	Clockwise
Propeller	Blade × Diam. (in.) × Pitch (in.)
	3 × 16 × 17 3 × 16 × 18 and 1/2 3 × 16 × 20 3 × 16 × 21 and 1/2 3 × 16 × 23 3 × 16 × 24 and 1/2

REDUCTION SYSTEM

1st reduction gear ratio (Crankshaft drive gear: Driven gear)	32 : 40 (1.25)
2nd reduction gear ratio (Lower unit gear)	12 : 22 (1.83)
Total reduction gear ratio	2.29 (40/32 × 22/12)

* These specifications are subject to change without notice.
For DF200T/225T/250T specification, see page 1-9.

Item	Unit	Data		
		DF200Z	DF225Z	DF250Z
PRE-FIX		20001Z	22501Z	25001Z

DIMENSIONS & WEIGHT

Overall length (front to back)		mm (in.)	897 (35.3)
Overall width (side to side)		mm (in.)	572 (22.5)
Overall height	UL	mm (in.)	1 834 (72.2)
	XX	mm (in.)	1 961 (77.2)
Weight (without engine oil)	UL	kg (lbs)	263 (580)
	XX	kg (lbs)	268 (591)
Transom height	UL	mm (in. type)	632 (25)
	XX	mm (in. type)	759 (30)

PERFORMANCE

Maximum output	kW (PS)	147 (200)	165 (225)	184 (250)
Recommended operating range	r/min	5 000 – 6 000	5 000 – 6 000	5 500 – 6 100
Idle speed	r/min	650 ± 50 (in-gear: Approx. 650)		

POWER HEAD

Engine type		4-stroke DOHC
Number of cylinders		V-6
Bore	mm (in.)	95 (3.74)
Stroke	mm (in.)	85 (3.35)
Total displacement	cm^3 (cu. in)	3 614 (220.5)
Compression ratio	: 1	9.5
Spark plug	NGK	BKR6E
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

Item	Unit	Data		
		DF200Z	DF225Z	DF250Z

FUEL & OIL

Fuel		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.
Engine oil		API classification SE, SF, SG, SH, SJ Viscosity rating SAE 10W-40
Engine oil amounts	L (US/Imp. qt)	8.0 (8.5/7.0) : Oil change only 8.2 (8.7/7.2) : Oil filter change
Gear oil		SUZUKI Outboard Motor Gear Oil (SAE #90 hypoid gear oil)
Gearcase oil capacity	ml (US/Imp. oz)	1 100 (37.2/38.7)

BRACKET

Trim angle	degree	0 – 19 (PTT system)
Number of trim position		PTT system
Maximum tilt angle	degree	70

LOWER UNIT

Reversing system	Gear
Transmission	Forward-Neutral-Reverse
Reduction system	Bevel gear
Gear ratio	12 : 22 (1.83)
Drive line impact protection	Spline drive rubber hub
Propeller shaft rotation (when shift into forward)	Counterclockwise
Propeller	Blade × Diam. (in.) × Pitch (in.)
	3 × 16 × 17 3 × 16 × 18 and 1/2 3 × 16 × 20 3 × 16 × 21 and 1/2 3 × 16 × 23 3 × 16 × 24 and 1/2

REDUCTION SYSTEM

1st reduction gear ratio (Crankshaft drive gear: Driven gear)	32 : 40 (1.25)
2nd reduction gear ratio (Lower unit gear)	12 : 22 (1.83)
Total reduction gear ratio	2.29 (40/32 × 22/12)

* SERVICE DATA

* These service data are subject to change without notice.

Item	Unit	Data		
		DF200T/Z	DF225T/Z	DF250T/Z
POWERHEAD				
Recommended operating range	r/min	5 000 – 6 000	5 000 – 6 000	5 500 – 6 100
Idle speed	r/min	650 ± 50 (in-gear: Approx. 650)		
**Cylinder compression	kPa (kg/cm^2, psi)	1 100 – 1 700 (11 – 17, 156 – 242)		
**Cylinder compression max. difference between any other cylinders	kPa (kg/cm^2, psi)	100 (1.0, 14)		
**Engine oil pressure	kPa (kg/cm^2, psi)	400 – 600 (4.0 – 6.0, 57 – 85) at 3 000 r/min (at normal operating temp.)		
Engine oil		API classification SE, SF, SG, SH, SJ Viscosity rating SAE 10W-40		
Engine oil amounts	L (US/lpm. qt))	8.0 (8.5/7.0) : Oil change only 8.2 (8.7/7.2) : Oil filter change		
Thermostat operating temperature	°C (°F)	58 – 62 (136 – 144)		

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

Item			Unit	Data		
				DF200T/Z	DF225T/Z	DF250T/Z

CYLINDER HEAD/CAMSHAFT

Cylinder head distortion		Limit	mm (in.)	0.03 (0.001)		
Manifold seating faces distortion		Limit	mm (in.)	0.10 (0.004)		
Cam height	IN	STD	mm (in.)	43.020 – 43.180 (1.6937 – 1.7000)	42.420 – 42.580 (1.6701 – 1.6764)	44.920 – 45.080 (1.7685 – 1.7748)
		Limit	mm (in.)	42.920 (1.6898)	42.320 (1.6661)	44.820 (1.7646)
	EX	STD	mm (in.)	43.620 – 43.780 (1.7173 – 1.7236)	43.620 – 43.780 (1.7173 – 1.7236)	44.420 – 44.580 (1.7488 – 1.7551)
		Limit	mm (in.)	43.520 (1.7134)	43.520 (1.7134)	44.320 (1.7449)
Camshaft journal oil clearance	Top, 2nd, 3rd, 4th	STD	mm (in.)	0.043 – 0.085 (0.0017 – 0.0033)		
		Limit	mm (in.)	0.120 (0.0047)		
Camshaft journal (housing) inside diameter	Top, 2nd, 3rd, 4th	STD	mm (in.)	26.000 – 26.021 (1.0236 – 1.0244)		
		Limit	mm (in.)	—		
Camshaft journal outside diameter	Top, 2nd, 3rd, 4th	STD	mm (in.)	25.936 – 25.957 (1.0211 – 1.0219)		
		Limit	mm (in.)	—		
Camshaft runout		Limit	mm (in.)	0.10 (0.004)		
Cylinder head bore to tappet clearance		STD	mm (in.)	0.025 – 0.066 (0.0010 – 0.0026)		
		Limit	mm (in.)	0.150 (0.0059)		
Tappet outer diameter		STD	mm (in.)	33.959 – 33.975 (1.3370 – 1.3376)		
Cylinder head bore		STD	mm (in.)	34.000 – 34.025 (1.3386 – 1.3396)		

Item			Unit	Data		
				DF200T/Z	DF225T/Z	DF250T/Z

VALVE/VALVE GUIDE

Valve diameter		IN	mm (in.)	35.9 (1.4)
		EX	mm (in.)	31.4 (1.2)
Tappet clearance (Cold engine condition)	IN	STD	mm (in.)	0.23 – 0.27 (0.009 – 0.011)
	EX	STD	mm (in.)	0.33 – 0.37 (0.013 – 0.015)
Valve seat angle	IN		—	15°, 45°, 60°
	EX		—	15°, 45°, 60°
Valve guide to valve stem clearance	IN	STD	mm (in.)	0.020 – 0.047 (0.0008 – 0.0019)
		Limit	mm (in.)	0.070 (0.0028)
	EX	STD	mm (in.)	0.045 – 0.072 (0.0018 – 0.0028)
		Limit	mm (in.)	0.090 (0.0035)
Valve guide inside diameter	IN, EX	STD	mm (in.)	5.500 – 5.512 (0.2165 – 0.2170)
Valve guide protrusion	IN, EX	STD	mm (in.)	11.4 – 11.8 (0.45 – 0.46)
Valve stem outside diameter	IN	STD	mm (in.)	5.465 – 5.480 (0.2152 – 0.2157)
	EX	STD	mm (in.)	5.440 – 5.455 (0.2142 – 0.2148)
Valve stem 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	STD	mm (in.)	1.1 (0.04)
		Limit	mm (in.)	0.7 (0.03)
	EX	STD	mm (in.)	1.05 (0.04)
		Limit	mm (in.)	0.7 (0.03)
Valve seat contact width	IN	STD	mm (in.)	1.1 – 1.3 (0.04 – 0.05)
	EX	STD	mm (in.)	1.1 – 1.3 (0.04 – 0.05)
Valve spring free length		STD	mm (in.)	40.2 (1.58)
		Limit	mm (in.)	38.6 (1.52)
Valve spring tension		STD	N (kg, lbs)	147 – 173 (15.0 – 17.7, 33.1 – 39.0) for 31.1 mm (1.22 in)
		Limit	N (kg, lbs)	136 (13.9, 30.6) for 31.1 mm (1.22 in)
Valve spring squareness		Limit	mm (in.)	2.0 (0.08)

Item			Unit	Data		
				DF200T/Z	DF225T/Z	DF250T/Z
CYLINDER/PISTON/PISTON RING						
Cylinder distortion		Limit	mm (in.)	0.03 (0.001)		
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.)	95.000 – 95.020 (3.0472 – 3.7409)		
Cylinder measuring position			mm (in.)	50 (1.969) from cylinder top surface		
Piston skirt diameter		STD	mm (in.)	94.970 – 94.990 (3.7390 – 3.7398)		
Piston measuring position			mm (in.)	8 (0.31) from piston skirt end		
Cylinder bore wear		Limit	mm (in.)	0.10 (0.039)		
Piston ring end gap	1st	STD	mm (in.)	0.20 – 0.33 (0.008 – 0.013)		
		Limit	mm (in.)	0.70 (0.028)		
	2nd	STD	mm (in.)	0.33 – 0.48 (0.013 – 0.019)		
		Limit	mm (in.)	1.00 (0.039)		
Piston ring free end gap	1st	STD	mm (in.)	Approx. 11.7 (0.46)		
		Limit	mm (in.)	9.3 (0.366)		
	2nd	STD	mm (in.)	Approx. 13.2 (0.52)		
		Limit	mm (in.)	10.5 (0.413)		
Piston ring to groove clearance	1st	STD	mm (in.)	0.030 – 0.070 (0.0012 – 0.0028)		
		Limit	mm (in.)	0.12 (0.005)		
	2nd	STD	mm (in.)	0.020 – 0.060 (0.0008 – 0.0024)		
		Limit	mm (in.)	0.10 (0.004)		
Piston ring groove width	1st	STD	mm (in.)	1.22 – 1.24 (0.048 – 0.049)		
	2nd	STD	mm (in.)	1.21 – 1.23 (0.048 – 0.048)		
	Oil	STD	mm (in.)	2.51 – 2.53 (0.099 – 0.100)		
Piston ring thickness	1st	STD	mm (in.)	1.17 – 1.19 (0.046 – 0.047)		
	2nd	STD	mm (in.)	1.17 – 1.19 (0.046 – 0.047)		
Pin clearance in piston pin hole		STD	mm (in.)	0.006 – 0.017 (0.0002 – 0.0007)		
		Limit	mm (in.)	0.040 (0.0016)		
Piston pin outside diameter		STD	mm (in.)	21.996 – 22.000 (0.8660 – 0.8661)		
		Limit	mm (in.)	21.980 (0.8654)		
Piston pin hole diameter		STD	mm (in.)	22.006 – 22.014 (0.8664 – 0.8667)		
		Limit	mm (in.)	22.030 (0.8673)		
Pin clearance in conrod small end		STD	mm (in.)	0.003 – 0.014 (0.0001 – 0.0006)		
		Limit	mm (in.)	0.050 (0.0020)		
Conrod small end bore		STD	mm (in.)	22.003 – 22.011 (0.8663 – 0.8666)		

Item		Unit	Data		
			DF200T/Z	DF225T/Z	DF250T/Z

CRANKSHAFT/CONROD

Conrod small end inside diameter	STD	mm (in.)	22.003 – 22.011 (0.8663 – 0.8666)
Conrod big end oil clearance	STD	mm (in.)	0.045 – 0.063 (0.0018 – 0.0025)
	Limit	mm (in.)	0.080 (0.0031)
Conrod big end inside diameter	STD	mm (in.)	57.000 – 57.018 (2.2441 – 2.2448)
Crank pin outside diameter	STD	mm (in.)	53.982 – 54.000 (2.1253 – 2.1260)
Crank pin outside diameter difference (out of round and taper)	Limit	mm (in.)	0.010 (0.0004)
Conrod bearing thickness	STD	mm (in.)	1.482 – 1.497 (0.0583 – 0.0589)
Conrod big end side clearance	STD	mm (in.)	0.300 – 0.450 (0.0118 – 0.0177)
	Limit	mm (in.)	0.550 (0.0217)
Conrod big end width	STD	mm (in.)	20.750 – 20.800 (0.8169 – 0.8189)
Crank pin width	STD	mm (in.)	21.100 – 21.200 (0.8307 – 0.8346)
Crankshaft center journal runout	Limit	mm (in.)	0.04 (0.002)
Crankshaft journal oil clearance	STD	mm (in.)	0.024 – 0.044 (0.0009 – 0.0017)
	Limit	mm (in.)	0.065 (0.0026)
Crankcase bearing holder inside diameter	STD	mm (in.)	70.000 – 70.018 (2.7559 – 2.7566)
Crankshaft journal outside diameter	STD	mm (in.)	64.988 – 65.006 (2.5586 – 2.5593)
Crankshaft journal outside diameter difference (out of round and taper)	Limit	mm (in.)	0.010 (0.0004)
Crankshaft bearing thickness	STD	mm (in.)	2.496 – 2.512 (0.0983 – 0.0989)
Crankshaft thrust play	STD	mm (in.)	0.11 – 0.31 (0.004 – 0.012)
	Limit	mm (in.)	0.35 (0.014)
Crankshaft thrust bearing thickness	STD	mm (in.)	2.425 – 2.475 (0.0955 – 0.0974)

Item		Unit	Data		
			DF200T/Z	DF225T/Z	DF250T/Z

ELECTRICAL

Ignition timing		Degrees at r/min	BTDC 0 – 26 ± 3	BTDC 0 – 25 ± 3	BTDC 0 – 26 ± 3
Over revolution limiter		r/min	6 200		6 300
CKP sensor resistance		Ω at 20°	168 – 252		
CMP sensor resistance		Ω at 20°	—		
Ignition coil resistance	Primary	Ω at 20°	—		
	Secondary	kΩ at 20°	—		
Battery charge coil resistance		Ω at 20°	0.32 – 0.48		
Battery charge coil output (12V)		Watt	648		
Standard spark plug	Type	NGK	BKR6E		
	Gap	mm (in.)	0.7 – 0.8 (0.028 – 0.031)		
Fuse amp. rating		A	Main fuse: 60 Sub fuse: 30		
Recommended battery capacity (12V)		Ah (kC)	100 (360) or larger		
Fuel injector resistance		Ω at 20 °C	10 – 14		
IAC valve resistance		Ω at 20 °C	25 – 34		
IAT sensor/Cylinder temp. sensor/ Ex. mani. temp. sensor (Thermistor characteristic)		kΩ at 25 °C	1.8 – 2.3		
ECM main relay resistance		Ω at 20 °C	145 – 190		
Starter relay coil resistance		Ω at 20 °C	145 – 190		
PTT motor relay coil resistance		Ω at 20 °C	25 – 37		

STARTER MOTOR

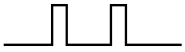
Max. continuous time of use		Sec.	30
Motor output		kW	1.4
Brush length	STD	mm (in.)	16.0 (0.63)
	Limit	mm (in.)	12.0 (0.47)
Commutator undercut	STD	mm (in.)	0.5 – 0.8 (0.02 – 0.03)
	Limit	mm (in.)	0.2 (0.01)
Commutator outside diameter	STD	mm (in.)	29.0 (1.14)
	Limit	mm (in.)	28.0 (1.10)
Commutator outside diameter difference	STD	mm (in.)	0.05 (0.002)
	Limit	mm (in.)	0.40 (0.016)

PTT MOTOR

Brush length	STD	mm (in.)	9.8 (0.39)
	Limit	mm (in.)	5.5 (0.22)
Commutator 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	on off 	YES
2	IAC valve/By-pass air screw adjustment	3 – 1	on off 	NO
3	Cylinder temp. sensor	1 – 4	on off 	YES
4	IAT sensor	2 – 3	on off 	YES
5	CKP sensor	4 – 2	on off 	YES
6	CMP sensor	2 – 4	on off 	YES
7	Air intake system	2 – 2	on off 	YES
8	MAP sensor 2 (Pressure detect passage)	3 – 2	on off 	NO
9	Rectifier & regulator (Over-charging)	1 – 1	on off 	NO
10	Exhaust manifold temp. sensor (STBD)	1 – 5	on off 	YES
11	Exhaust manifold temp. sensor (PORT)	1 – 6	on off 	YES
12	Fuel injector	4 – 3	on off 	NO
13	Throttle position sensor	2 – 1	on off 	YES
14	Shift position sensor	1 – 2	on off 	YES

PRIORITY *	FAILED ITEM	CODE	LAMP FLASHING PATTERN	FAIL-SAFE SYSTEM ACTIVATING
15	CMP sensor (VVT·STBD)	2 – 5		YES
16	CMP sensor (VVT·PORT)	2 – 6		YES
17	VVT advance (STBD)	5 – 1		YES
18	VVT advance (PORT)	5 – 2		YES
19	Neutral switch	3 – 3		NO
20	Model discrimination	4 – 1		YES
21	Oil control valve (STBD)	6 – 1		NO
22	Oil control valve (PORT)	6 – 2		NO

** If more than two items fail at once, the self-diagnostic indication appears according to priority order. The indication repeats three times.*

TIGHTENING TORQUE

Tightening torque – Important fasteners

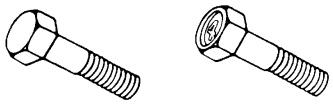
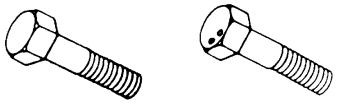
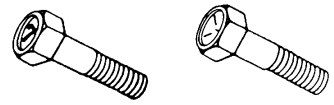
ITEM		THREAD DIAMETER	TIGHTENING TORQUE		
			N·m	kg-m	lb-ft
Cylinder head cover bolt		6 mm	11	1.1	8.0
Cylinder head bolt		8 mm	23	2.3	16.6
		11 mm	86	8.6	62.0
Crankcase bolt		8 mm	27	2.7	19.5
		10 mm	52	5.2	37.6
Crankshaft drive gear bolt		10 mm	48	4.8	34.7
Conrod cap bolt		9 mm	63	6.3	45.6
Camshaft housing bolt		6 mm	12	1.2	8.7
Piston cooling jet		—	20	2.0	14.5
Oil pump bolt		8 mm	23	2.3	16.6
IN. camshaft timing sprocket	VVT model	—	60	6.0	43.4
	Non VVT model	—	78	7.8	56.0
EX. camshaft timing sprocket		—	78	7.8	56.0
OCV		6 mm	12	1.2	8.7
Chain tensioner adjuster bolt		6 mm	11	1.1	8.0
Timing chain guide bolt		6 mm	10	1.0	7.0
Collector cover		8 mm	23	2.3	16.6
Funnel bracket		8 mm	23	2.3	16.6
Engine holder cover bolt		8 mm	23	2.3	16.6
Intake manifold bolt/nut		8 mm	23	2.3	16.5
Oil pressure switch		—	13	1.3	9.5
Fuel delivery pipe bolt		8 mm	23	2.3	16.5
Fuel delivery pipe plug/ union bolt	Upper	12 mm	35	3.5	25.5
	Lower	12 mm	35	3.5	25.5
Low pressure fuel pump bolt		6 mm	10	1.0	7.0
Thermostat cover bolt		6 mm	10	1.0	7.0
Flywheel bolt		12 mm	118	11.8	85.3
Starter motor mounting bolt		8 mm	23	2.3	16.6
Engine oil filter		—	14	1.4	10.0
Engine oil drain plug		12 mm	13	1.3	9.5
Power unit mounting bolt		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 bolt/nut		14 mm	100	10.0	72.3
Upper mount cover bolt		10 mm	50	5.0	36.0
Lower mount bolt/nut		14 mm	100	10.0	72.3
Clamp bracket shaft nut		22 mm	43	4.3	31.0
Water pump case bolt		8 mm	17	1.7	12.3
Driveshaft oil seal housing		—	98	10.0	72.3

ITEM	THREAD DIAMETER	TIGHTENING TORQUE		
		N·m	kg-m	lb-ft
Gearcase bolt	10 mm	54	5.5	40.0
	12 mm	83	8.3	60.0
Propeller shaft bearing housing bolt	8 mm	23	2.3	16.6
Pinion gear nut	14 mm	144	14.5	105.0
Propeller nut	18 mm	55	5.5	40.0

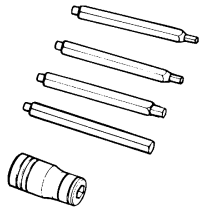
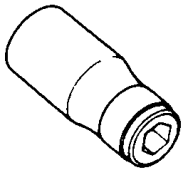
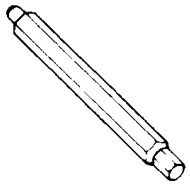
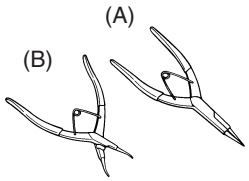
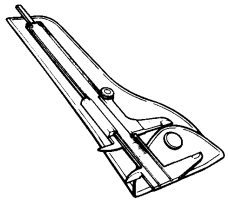
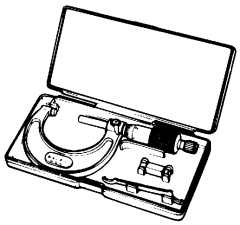
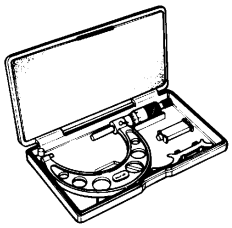
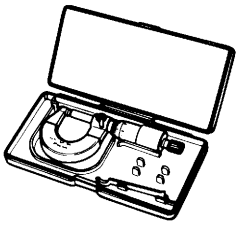
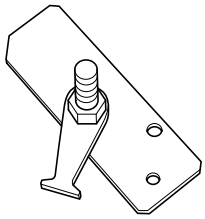
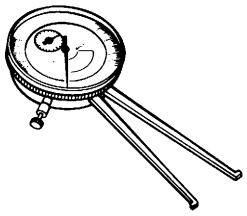
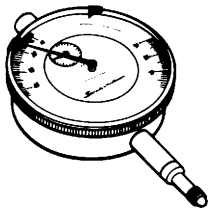
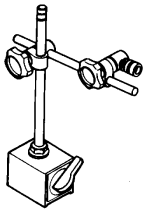
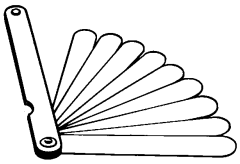
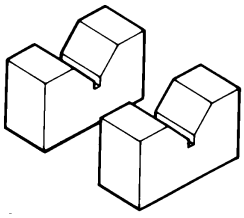
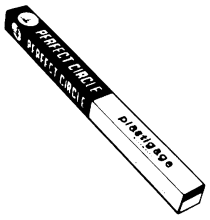
Tightening torque – General bolt

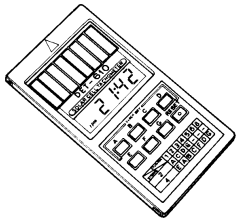
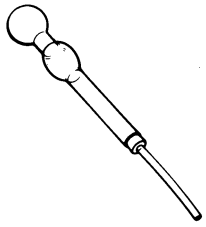
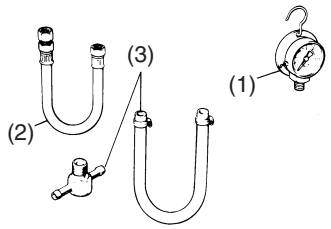
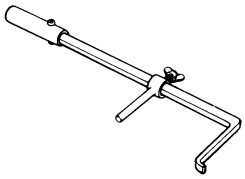
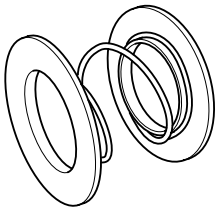
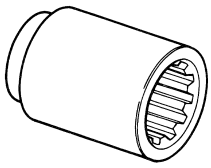
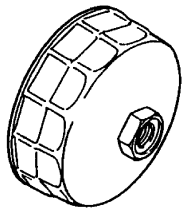
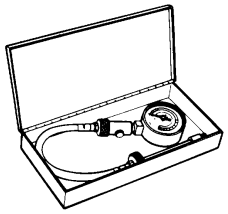
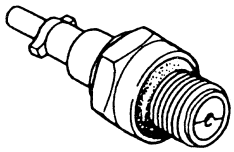
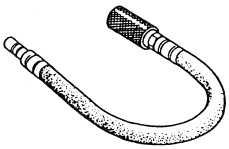
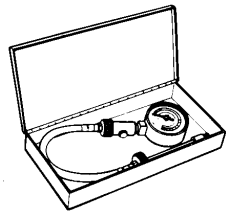
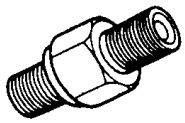
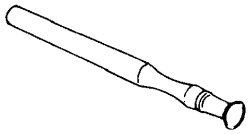
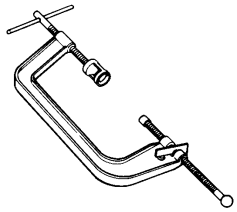
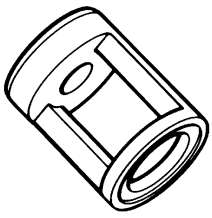
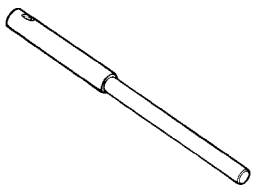
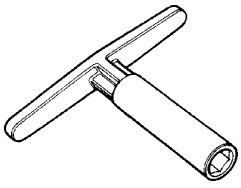
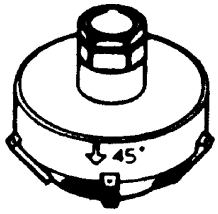
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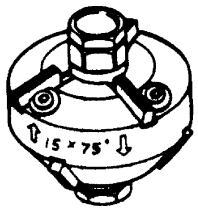
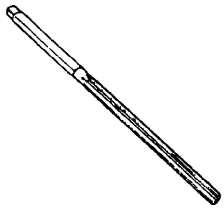
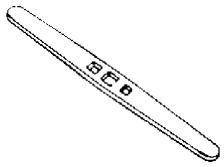
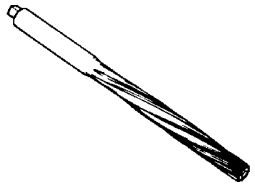
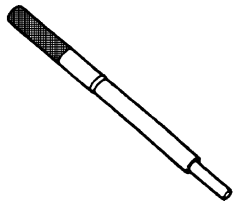
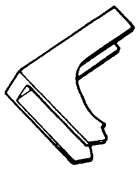
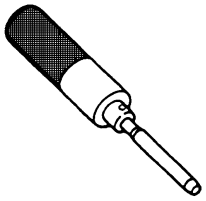
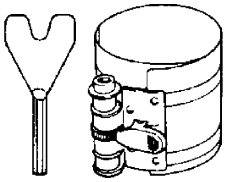
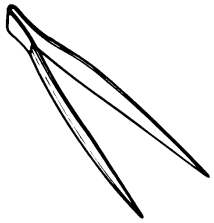
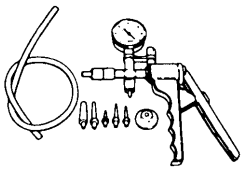
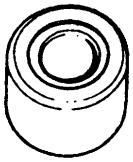
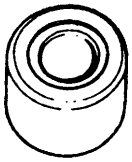
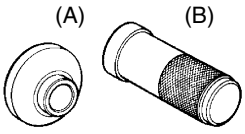
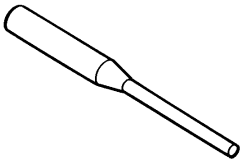
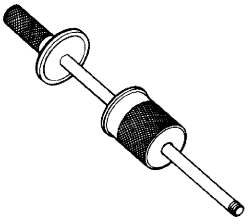
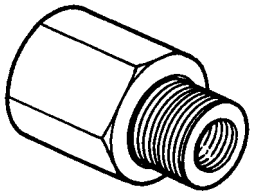
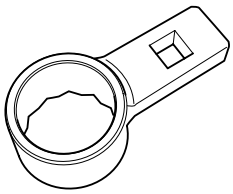
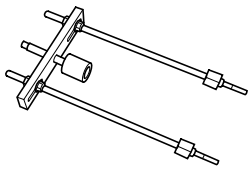
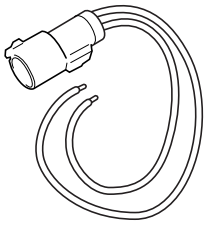
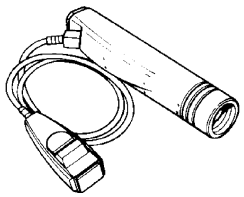
These value are only applicable when torque for a general bolt is not listed in the "Important Fasteners" table.

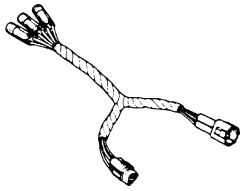
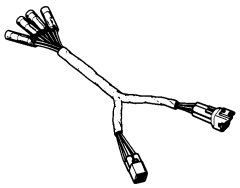
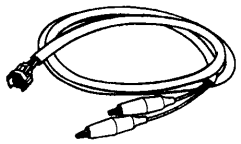
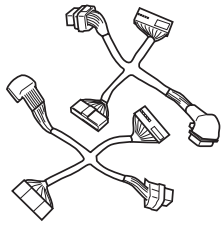
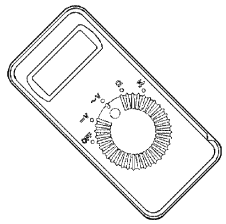
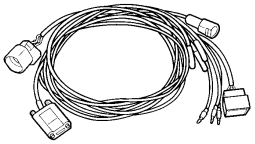
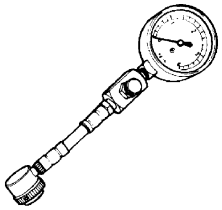
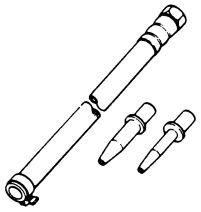
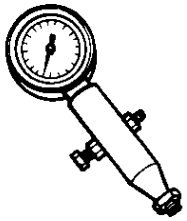
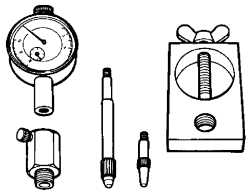
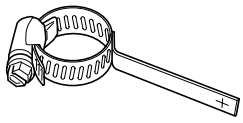
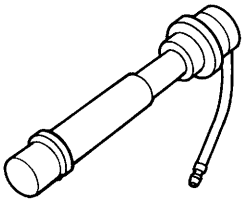
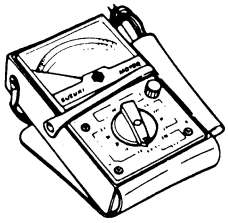
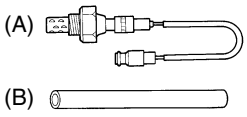
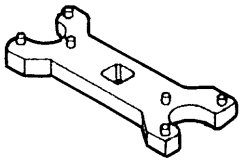
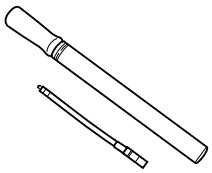
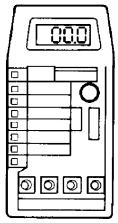
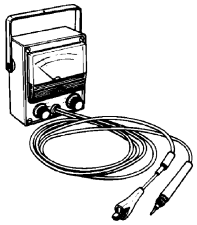
TYPE OF BOLT	THREAD DIAMETER	TIGHTENING TORQUE		
		N·m	kg-m	lb-ft
 (Conventional or "4" marked bolt)	5 mm	2 – 4	0.2 – 0.4	1.5 – 3.0
	6 mm	4 – 7	0.4 – 0.7	3.0 – 5.0
	8 mm	10 – 16	1.0 – 1.6	7.0 – 11.5
	10 mm	22 – 35	2.3 – 3.5	16.0 – 25.5
 (Stainless steel bolt)	5 mm	2 – 4	0.2 – 0.4	1.5 – 3.0
	6 mm	6 – 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) 09900-00415 (8 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 (50 – 75 mm) 09900-20204 (75 – 100 mm) Micrometer	8.  09900-20205 Micrometer (0 – 25 mm)	9.  09916-99310 Flywheel holder	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.**  **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**		**19.**  **09913-50121** **Oil seal remover**
20.  **09951-09310** **Gear adjust spring set**	**21.**  **09921-29410** **Driveshaft holder**	**22.**  **09915-47341** **Oil filter wrench**	**23.**  **09915-64512** **Compression gauge**	**24.**  **09915-67010** **Compression gauge hose attachment**
25.  **09915-64530** **Compression gauge hose**	**26.**  **09915-77311** **Oil pressure gauge**	**27.**  **09915-78211** **Oil pressure gauge adapter**	**28.**  **09916-10911** **Valve lapper**	**29.**  **09916-14510** **Valve lifter**
30.  **09916-14521** **Valve lifter attachment**	**31.**  **09916-24450** **Solid pilot (N-100-5.52)**	**32.**  **09916-54910** **Handle (N-505)**	**33.**  **09916-22420** **Valve seat cutter (60°) (N-114)**	**34.**  **Valve seat cutter (45°) (Neway 634)**

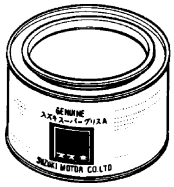
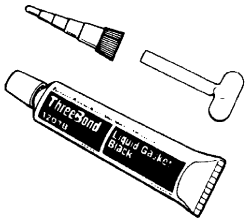
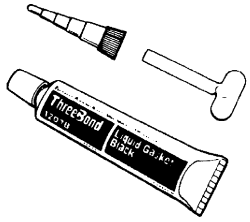
35.  **Valve seat cutter (15°) (Neway 217)**	**36.**  **09916-34550** **Valve guide reamer (ϕ 5.5 mm)**	**37.**  **09916-34542** **Valve guide reamer handle**	**38.**  **09916-37320** **Valve guide reamer (ϕ 10.5 mm)**	**39.**  **09916-44310** **Valve guide remover**
40.  **09916-69310** **Tappet holder**	**41.**  **09916-57330** **Valve guide installer**	**42.**  **09916-77310** **Piston ring compressor**	**43.**  **09916-84511** **Tweezers**	**44.**  **09917-47011** **Vacuum pump gauge**
45.  **09916-56011** **Valve guide installer attachment**	**46.**  **09917-98221** **Valve guide stem seal installer attachment**	**47.**  (A) (B) **(A) 09922-59410** **Propeller shaft housing installer** **(B) 09922-59420** **Housing installer handle**	**48.**  **09922-89810** **Shift lock pin remover**	**49.**  **09930-30104** **Sliding hammer**
50.  **09930-30161** **Propeller shaft remover**	**51.**  **09926-29310** **Driveshaft housing remover**	**52.**  **09951-99310** **Gear holder**	**53.**  **09945-79310** **PTT cable extension**	**54.**  **09930-76420** **Timing light**

55.  **09930-89220** **3-pin connector test cord**	**56.**  **09930-89240** **4-pin connector test cord**	**57.**  **09930-89260** **Injector test cord A**	**58.**  **09930-89340** **26-pin & 34-pin test cord**	**59.**  **09930-99320** **Digital tester**
60.  **09932-79910** **Diagnostic harness** **09932-89910** **SDS adapter**	**61.**  **09940-44121** **Air pressure gauge**	**62.**  **09940-44130** **Attachment**	**63.**  **09950-69512** **Gearcase oil leakage tester**	**64.**  **09951-09511** **Gear adjusting gauge**
65.  **09952-09310** **Back lash indicator tool**	**66.**  **09930-89350** **H·T cord adapter**	**67.**  **09900-25002** **Pocket tester**	**68.**  **(A) 18213-74F00** **O2 sensor** **(B) 18498-99E70** **Protector**	**69.**  **09944-09420** **PTT cylinder cap tool**
70.  **09952-99310** **hand air pump**	**71.**  **99954-53008-820*** **Digital voltmeter**	**72.**  **99954-53873*** **Stevens CD-77** **Peak reading volt-meter**	**73.**  **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 "1104"**  **99000-31030** **(100 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

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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
Fuel line	I	I	I	I
	Replace every 2 years.			
PCV system	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 (O2 feedback)	Perform every 2 years.			
Engine oil filter	R	—	—	R
Low pressure fuel filter	—	I	I	I
	Replace every 400 hours or 2 years.			
Low pressure fuel pump filter	Replace every 1 000 hours.			
High pressure fuel filter	Replace every 1 000 hours.			
Ignition timing	—	—	—	I
Idle speed	I	—	—	I
Tappet clearance	I	—	—	I
Water pump	—	—	—	I
Water pump impeller	—	—	—	R
Propeller nut & pin	I	—	I	I
Bolt & Nuts	T	—	T	T

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

NOTE:
OIL CHANGE REMINDER SYSTEM
- *Refer to page 3-45 for function and operation.*
- *See page 2-5 for reset information.*

MAINTENANCE AND TUNE-UP PROCEDURES

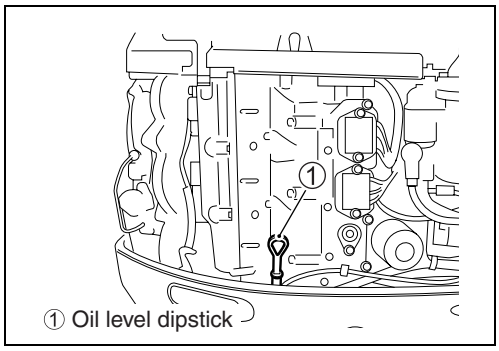
This section describes servicing procedures for each periodic maintenance requirement.

ENGINE OIL/ENGINE OIL FILTER

ENGINE OIL LEVEL CHECK

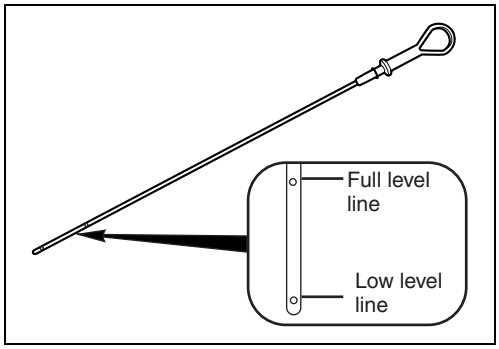
Inspect oil level before every use.

1. Place outboard motor upright on a level surface.
2. Remove motor cover.
3. Remove oil level dipstick and wipe it clean.
4. Reinsert dipstick fully into dipstick tube, then remove to check oil level.



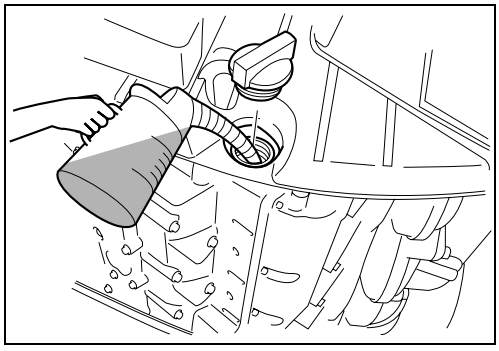
5. Oil level should be between full level Max. mark (hole) and low level Min. mark (hole).

   If level is low, add recommended oil to full level hole (Max.).



Recommended oil:

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



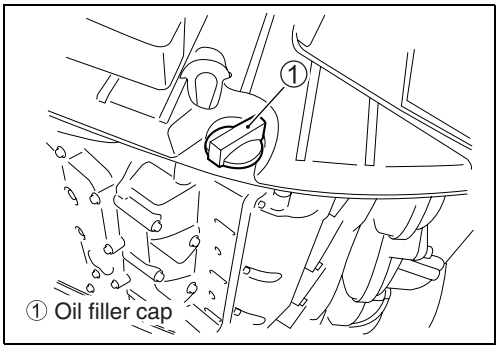
ENGINE OIL CHANGE/ENGINE OIL FILTER REPLACEMENT

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

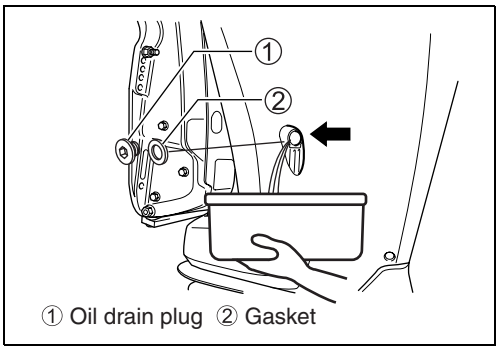
ENGINE OIL FILTER
Replace initially after 20 hours (1 month) and every 200 hours (12 months).

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

1. Place outboard motor upright on a level surface.
2. Remove oil filler cap.
3. Place a container under engine oil drain plug.
4. Remove engine oil drain plug and gasket to drain engine oil.



① Oil filler cap

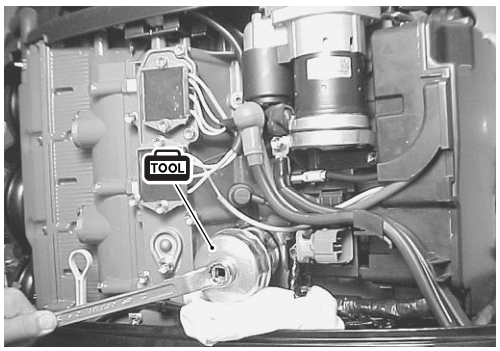


① Oil drain plug ② Gasket

5. ENGINE OIL FILTER REPLACEMENT

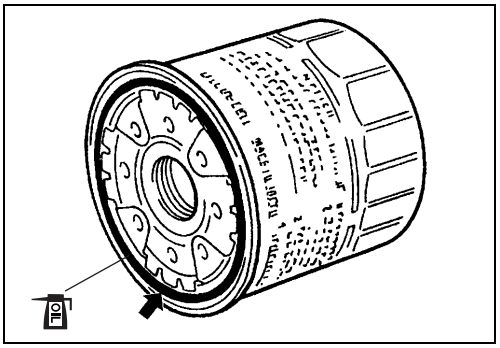
NOTE:
For engine oil change only, go to step 6.

To replace engine oil filter:
(1) Place a shop cloth under oil filter before removal to absorb any oil released.
(2) Using oil filter wrench to loosen the oil filter, then remove filter and O-ring.

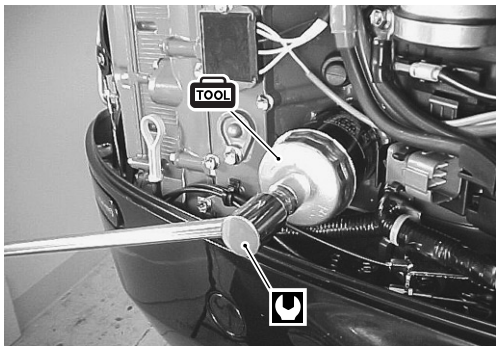


TOOL 09915-47341: Oil filter wrench

NOTE:
Before fitting new oil filter, be sure to oil O-ring.

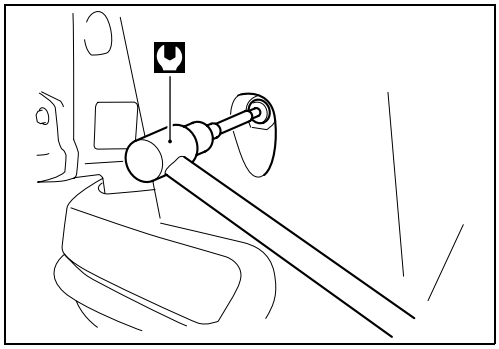


(3) Screw new filter on by hand until filter O-ring contacts the mounting surface.
(4) Tighten filter 3/4 turn from point of contact with mounting surface using an oil filter wrench.



Engine oil filter: 14 N·m (1.4 kg-m, 10.0 lb-ft), 3/4 turn

6. Install new gasket and oil drain plug.
Tighten engine oil drain plug to specified torque.

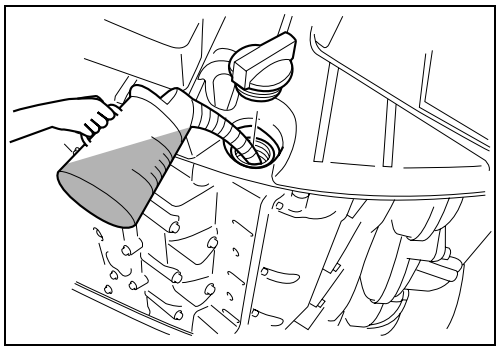


Engine oil drain plug: 13 N·m (1.3 kg-m, 9.5 lb-ft)

CAUTION

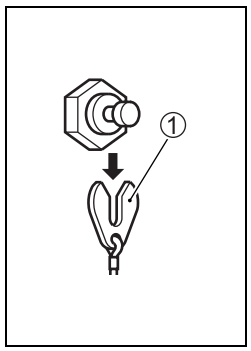
Do not re-use gasket once removed. Always use a new gasket.

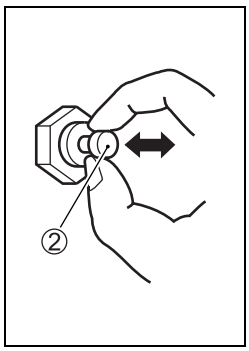
7. Pour recommended engine oil into oil filler opening, then install oil filler cap.



Engine oil amounts
Oil change only: 8.0 L (8.5/7.0 US/Imp. qt)
Oil filter change: 8.2 L (8.7/7.2 US/Imp. qt)

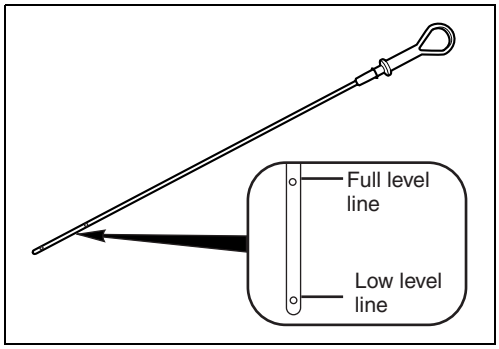
8. To reset oil change reminder system's operation time to zero (cancellation);
(1) Turn ignition key to "ON" position.
(2) Pull out emergency stop switch plate ①.
(3) Pull up emergency stop switch knob ② three times in ten seconds. A short beep will be heard if cancellation is successfully finished.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





NOTE:
See "OIL CHANGE REMINDER SYSTEM" section on page 3-45.

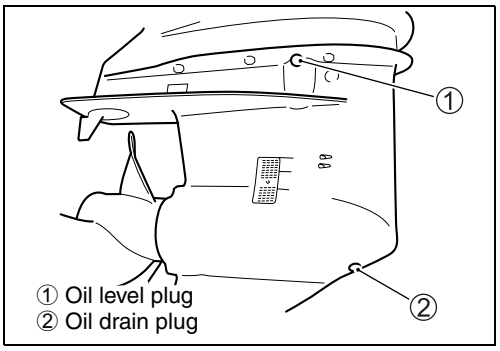
9. Start engine and allow it to run for several minutes at idle speed.
Check oil filter for oil leakage.
Turn off engine and wait for approx. two minutes, then recheck engine oil level.



GEAR OIL

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

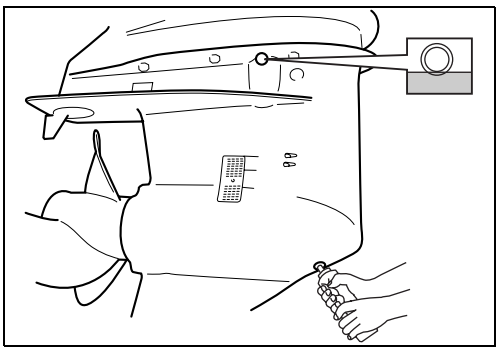
1. Place outboard motor upright on a level surface.
2. Place a container under the lower unit.
3. Remove lower gear oil drain plug first, then remove gear oil level plug and drain gear oil.



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

   Gear oil amount: 1 100 ml (37.2/38.7 US/Imp. oz)

   Recommended oil:
   SUZUKI OUTBOARD MOTOR GEAR OIL or
   SAE #90 HYPOID GEAR OIL



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

CAUTION

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

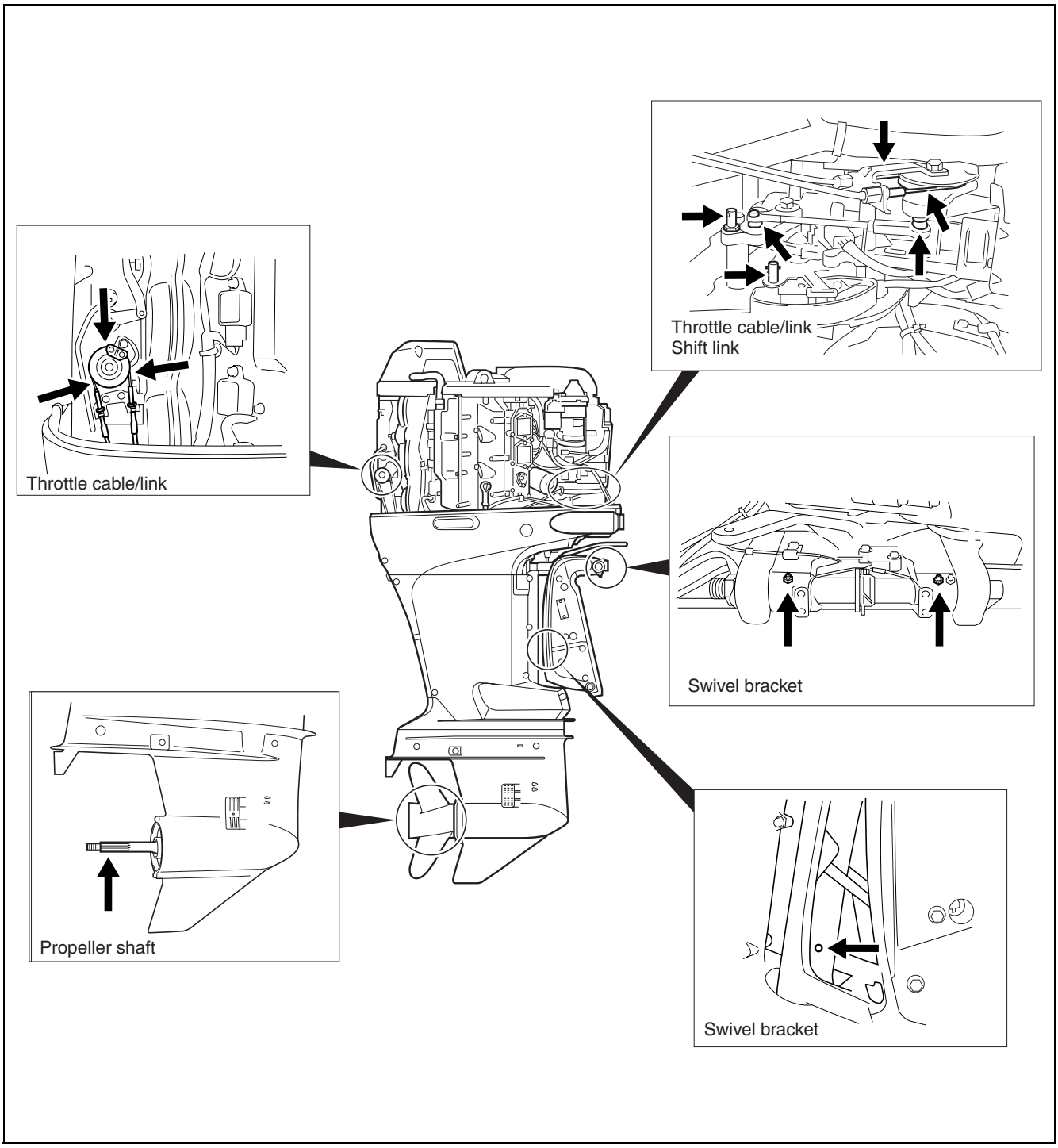
NOTE:
To avoid a possible low gear oil level, recheck gear oil level 10 minutes after doing procedure in step 6. If oil level is low, add additional gear oil until level is correct.

LUBRICATION

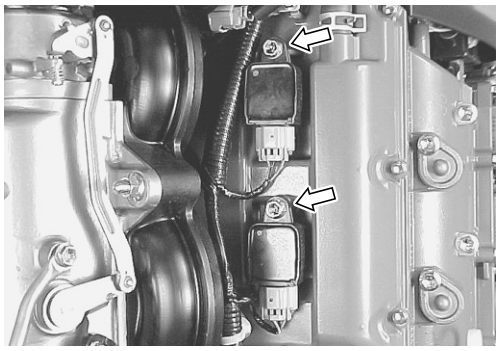
Inspect every 50 hours (3 months).

Apply SUZUKI 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 BKR6E

CAUTION

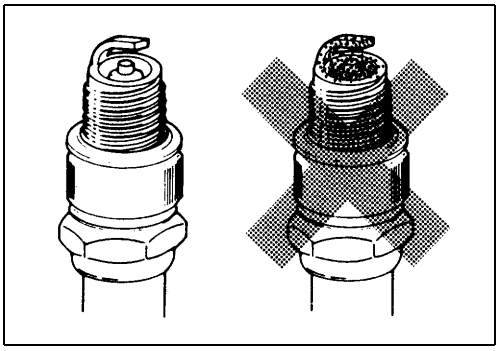
Only resistor (R) type spark plugs must be used with this engine. Using a non-resistor spark plug will cause ignition and fuel injection system malfunctions.

REMOVAL

- Disconnect ignition coil connector, then remove the bolt securing the ignition coil.
- Remove the ignition coil and spark plug.

CARBON DEPOSIT

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

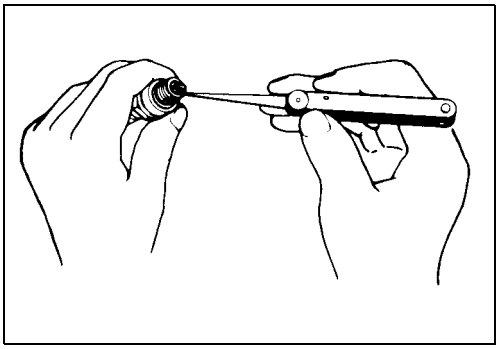


SPARK PLUG GAP

Measure spark plug gap with a thickness gauge.
Adjust to within specified range if gap is out of specification.

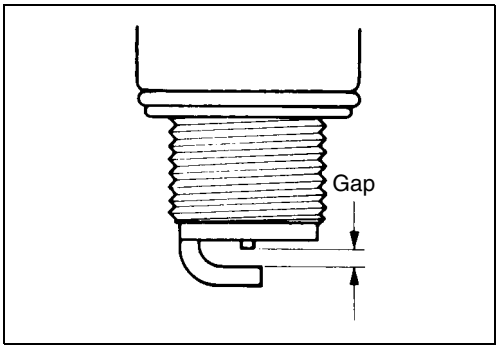
Spark plug gap: 0.7 – 0.8 mm (0.028 – 0.031 in)

09900-20803: Thickness gauge



CONDITION OF ELECTRODE

Inspect electrode for a worn or burnt condition.
If it is extremely worn or burnt, replace spark plug.
Also, be sure to replace spark plug if it has a broken insulator, damaged thread, etc.

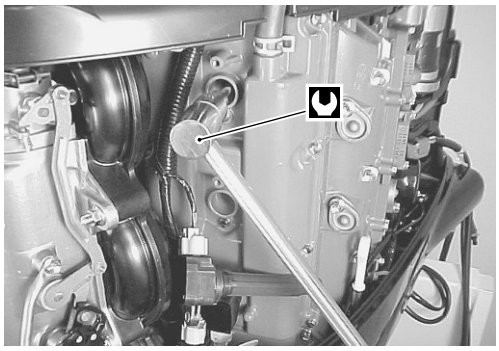


CAUTION

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.

INSTALLATION
Installation is reverse order of removal.

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

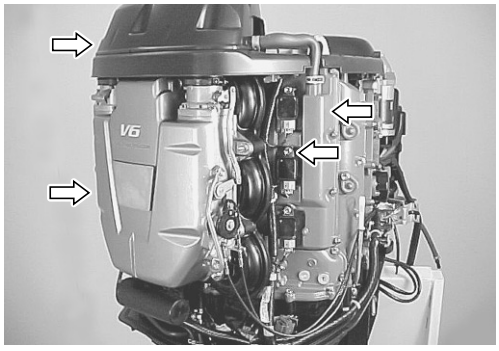


TAPPET CLEARANCE

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

The tappet clearance specification is different for intake and exhaust valves.
Too small a tappet clearance may reduce engine power, too large a tappet clearance increases valve noise and hastens valve and seat wear.
When the tappets are set to the specified clearance, the engine will run without excessive noise from the valve mechanism and will deliver full power. In this engine, the tappet clearance is increased or decreased by replacing the shim disc, made of a special wear resistant material, fitted to the top of the tappet.
Using the proper tools provides for easy removal and installation of the shim disc.
Tappet clearance adjustment should be checked and adjusted:
- during scheduled periodic inspection.
- when valve mechanism is serviced.
- when camshafts are disturbed by removing them for inspection.

CHECKING AND ADJUSTING TAPPET CLEARANCE

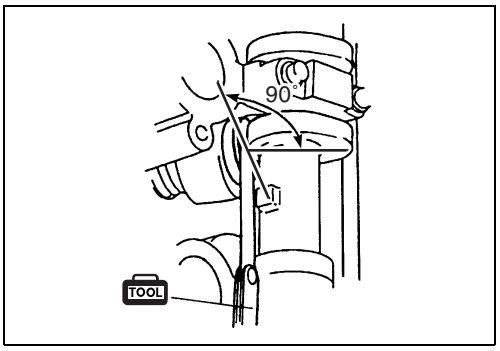


1. Remove following parts:
   - Engine side lower cover (See page 7-2.)
   - Ring gear cover and air intake silencer case
   - Ignition coils
   - Spark plugs
   - Collector assembly (See page 6-3, 6-5.)

2. Remove PORT and STBD cylinder head covers. (See page 6-8.)

3. Rotate crankshaft counterclockwise to bring cam nose vertical to shim surface.
4. Measure tappet clearances by inserting thickness gauge between cam and shim surface.

   Tappet clearance (cold engine condition):
   IN.: 0.23 – 0.27 mm (0.009 – 0.011 in)
   EX.: 0.30 – 0.34 mm (0.012 – 0.013 in)



TOOL 09900-20803: Thickness gauge

CAUTION

This is left hand (LH) rotation powerhead.
Rotate crankshaft counterclockwise to prevent water pump impeller damage.

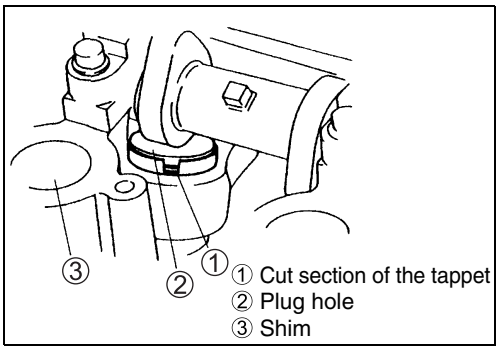
NOTE:
- *Rotate crankshaft and measure clearance for each tappet respectively by bringing cam nose vertical to shim surface.*
- *All tappet clearances can be measured during two crankshaft rotations.*

5. If out of specification, adjust tappet clearance by changing shim.

ADJUSTMENT

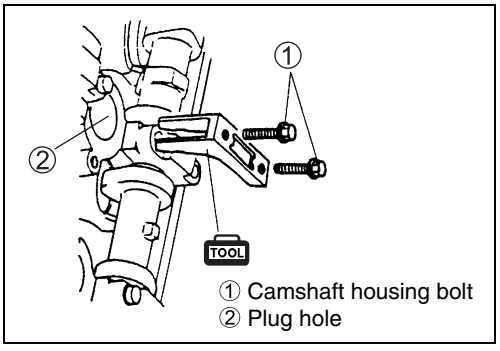
Tappet clearances are adjusted by replacing tappet shim.

1. With cam nose vertical to valve, turn tappet cut-away towards center of cylinder head as shown in figure.

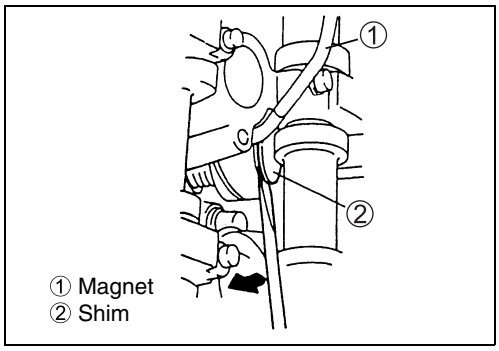


2. Rotate crankshaft to open (lift up) valve and then remove camshaft housing bolts where shim is to be replaced.
3. Install special tool with camshaft housing bolts as shown in figure.

TOOL 09916-69310: Tappet holder



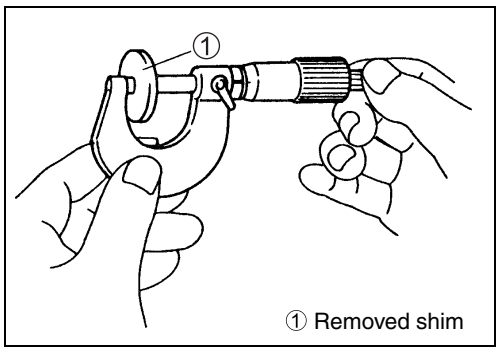
4. Rotate top of cam 90 degree counterclockwise and remove shim from cut-away at tappet.
   (Two tappets can be adjusted at the same time.)



CAUTION

- **Do not put your finger between camshaft and tappet while the tappet is being held with the tappet holder.**
- **Use a magnet to remove and install shim.**
- **When installing shim, identification mark on the shim should face down (towards tappet).**

5. After removing shim, measure thickness of original shim and determine correct thickness of shim for proper tappet clearance as calculated by following formula.

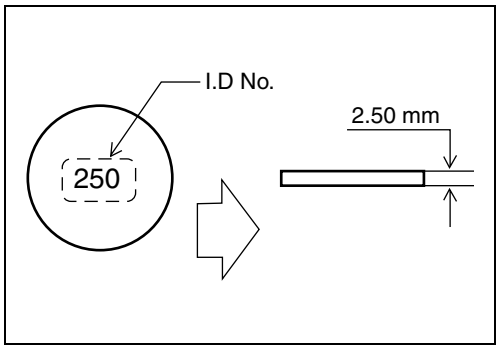


TOOL 09900-20205: Micrometer

IN. side:
A = B + (C – 0.25 mm)
EX. side:
A = B + (C – 0.32 mm)

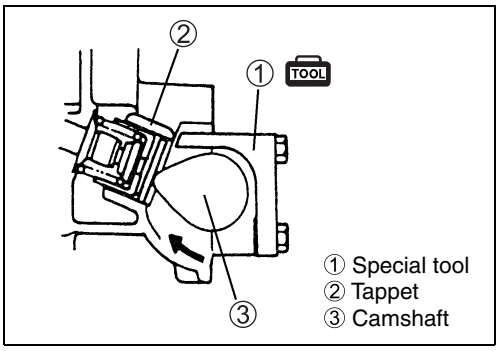
A: Correct thickness of shim for proper tappet clearance (mm)
B: Thickness of original shim (mm)
C: Original tappet clearance (mm)

I.D No.	Thickness (mm)	I.D No.	Thickness (mm)	I.D No.	Thickness (mm)
218	2.18	248	2.48	278	2.78
220	2.20	250	2.50	280	2.80
223	2.23	253	2.53	283	2.83
225	2.25	255	2.55	285	2.85
228	2.28	258	2.58	288	2.88
230	2.30	260	2.60	290	2.90
233	2.33	263	2.63	293	2.93
235	2.35	265	2.65	295	2.95
238	2.38	268	2.68	298	2.98
240	2.40	270	2.70	300	3.00
243	2.43	273	2.73		
245	2.45	275	2.75		



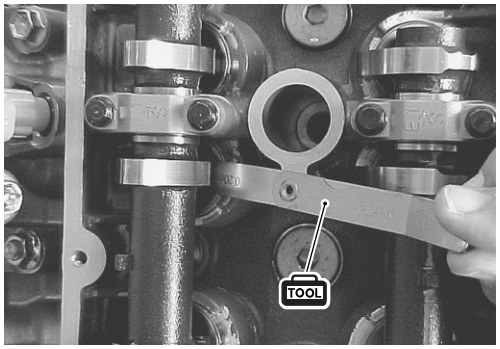
6. Install shim. Identification number should face down (towards tappet).
7. Rotate crankshaft to be open (lift up) valve.
8. Remove tappet holder ① and tighten camshaft housing bolts to specified torque.

Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.7 lb-ft)

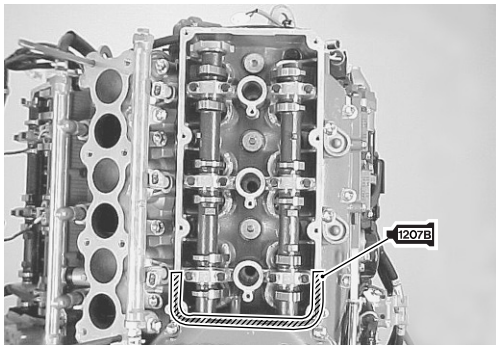


9. Recheck tappet clearance.

NOTE:
After completing tappet clearance adjustment and securing camshaft housing bolts, inspect tappet clearance again.



REASSEMBLY
After checking and adjusting all valves, reinstall parts removed earlier.
Installation is reverse order of removal.

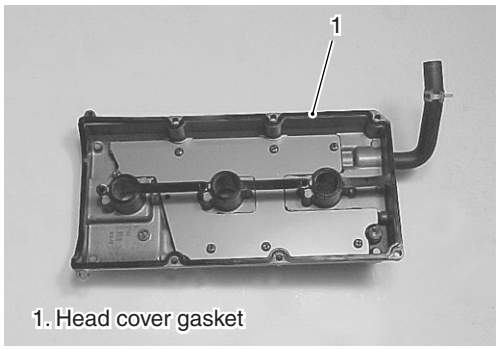


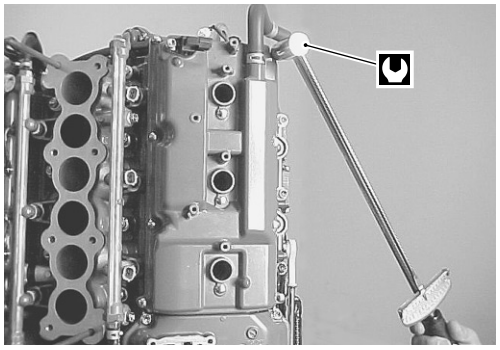
Cylinder head cover
Install the cylinder head cover. (See page 6-10.)

NOTE:
Examine cylinder head cover gasket for damage.
Always replace gasket if sealing performance is suspect.

- Tighten cylinder head cover bolts to specification.

Cylinder head cover bolts: 11 N·m (1.1 kg-m, 8.0 lb-ft)





OCV (Oil control valve)

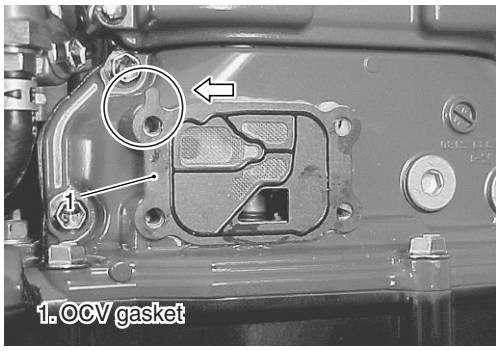
- On the DF250 model, install gasket and OCV, and then tighten bolts securely.

NOTE:

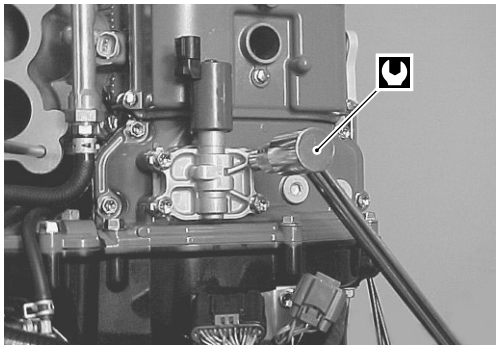
Position the projection of OCV gasket as shown the right.

CAUTION

Do not re-use OCV gasket. Always replace with new one.

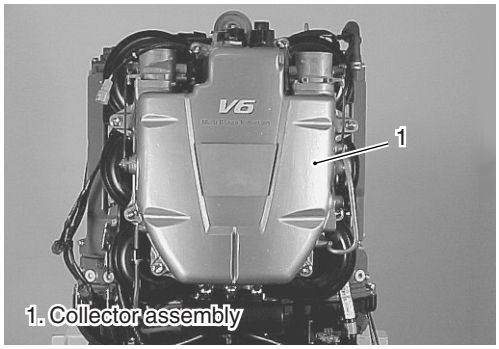


OCV bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



Collector assembly

- Install the collector assembly. (See page 6-5, 6-7.)



Checking

- All parts removed have been returned to their original positions.
- Check hose and wire routing. (See page - .)
- Check oil leakage.

TAPPET SHIM SELECTION CHART [IN. side]

Shim I.D. No. / Present shim size (mm) / Tappet clearance (mm)	218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300
	2.18	2.20	2.23	2.25	2.28	2.30	2.33	2.35	2.38	2.40	2.43	2.45	2.48	2.50	2.53	2.55	2.58	2.60	2.63	2.65	2.68	2.70	2.73	2.75	2.78	2.80	2.83	2.85	2.88	2.90	2.93	2.95	2.98	3.00
0.00 – 0.04											220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278
0.05 – 0.09									220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283
0.10 – 0.14							220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288
0.15 – 0.19					220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293
0.20 – 0.22			220	223	225	225	228	230	233	235	240	240	245	245	250	250	255	255	260	260	263	265	270	270	273	278	280	280	283	285	290	290	293	295
0.23 – 0.27	SPECIFIED CLEARANCE/NO. ADJUSTMENT REQUIRED																																	
0.28 – 0.32	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300		
0.33 – 0.37	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300				
0.38 – 0.42	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300						
0.43 – 0.47	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300								
0.48 – 0.52	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300										
0.53 – 0.57	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300												
0.58 – 0.62	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300														
0.63 – 0.67	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300																
0.68 – 0.72	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300																		
0.73 – 0.77	268	270	273	275	278	280	283	285	288	290	293	295	298	300																				
0.78 – 0.82	273	275	278	280	283	285	288	290	293	295	298	300																						
0.83 – 0.87	278	280	283	285	288	290	293	295	298	300																								
0.88 – 0.92	283	285	288	290	293	295	298	300																										

1. Measure tappet clearance “Engine cold”.
2. Measure present shim size.
3. Match clearance in vertical column with present shim size in horizontal column.

[EXAMPLE]
Tappet clearance is — 0.35 mm
Present shim size — 2.40 mm
Shim size to be used — 2.50 mm

TAPPET SHIM SELECTION CHART [EX. side]

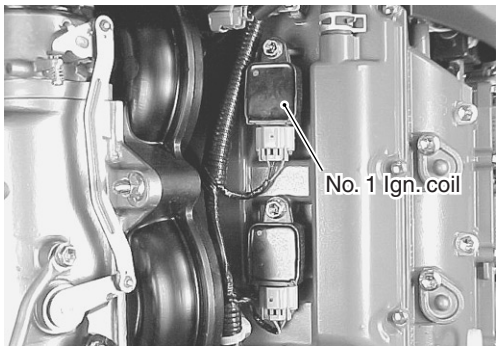
Shim ID No. / Present shim size (mm) / Tappet clearance (mm)	218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300
	2.18	2.20	2.23	2.25	2.28	2.30	2.33	2.35	2.38	2.40	2.43	2.45	2.48	2.50	2.53	2.55	2.58	2.60	2.63	2.65	2.68	2.70	2.73	2.75	2.78	2.80	2.83	2.85	2.88	2.90	2.93	2.95	2.98	3.00
0.00 – 0.04															220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268
0.05 – 0.09												218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273
0.10 – 0.14											220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278
0.15 – 0.19									220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283
0.20 – 0.24						218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288
0.25 – 0.29				218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293
0.30 – 0.32			218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295
0.33 – 0.37	SPECIFIED CLEARANCE/NO. ADJUSTMENT REQUIRED																																	
0.38 – 0.39	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300		
0.40 – 0.44	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300			
0.45 – 0.49	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300					
0.50 – 0.54	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300							
0.55 – 0.59	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300									
0.60 – 0.64	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300											
0.65 – 0.69	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300													
0.70 – 0.74	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300															
0.75 – 0.79	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300																	
0.80 – 0.84	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300																			
0.85 – 0.89	270	273	275	278	280	283	285	288	290	293	295	298	300																					
0.90 – 0.94	275	278	280	283	285	288	290	293	295	298	300																							

1. Measure tappet clearance “Engine cold”.
2. Measure present shim size.
3. Match clearance in vertical column with present shim size in horizontal column.

[EXAMPLE]
Tappet clearance is — 0.40 mm
Present shim size — 2.40 mm
Shim size to be used — 2.48 mm

IDLE SPEED

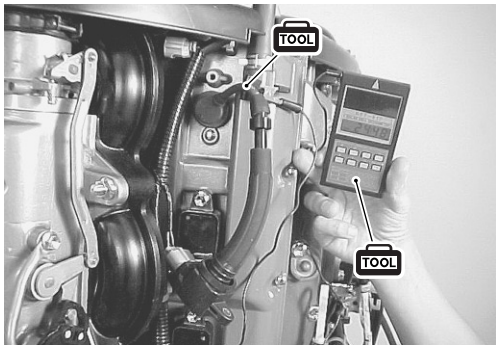
Inspect initially after 20 hours (1 month) and every 200 hours (12 months).



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

1. Remove bolt and No. 1 ignition coil.
2. Connect special tool (H·T cord with plug cap adapter) between No. 1 ignition coil and spark plug.

TOOL 09930-89350: H·T cord with plug cap adapter



3. Start engine and allow to warm up.
4. Attach engine tachometer to the special tool.

TOOL 09900-26006: Engine tachometer

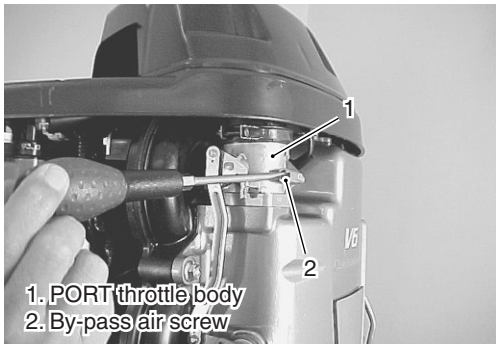
5. Check engine speed.

   Idle speed (in neutral gear): 600 – 700 r/min.

ADJUSTMENT:

If engine idle speed is out of specification, the following adjustment procedure must be performed.

6. Shift into Neutral and close the throttle fully (this will cause the fully close throttle signal to be input to the ECM).
7. To set the IAC valve duty to constant 30%, turn the ignition key from ON to START five times within ten seconds.
   At this time, caution buzzer will sound to notify that IAC duty is in fixed mode.



NOTE:
- *The ignition key operation to set the IAC valve into the fixed mode should be performed with the engine running at idle.*
- *While IAC valve duty is at a fixed 30% duty, the caution buzzer will sound in a repeating pattern of 0.5 second on with an interval of 3 seconds off.*
- *The 30% fixed mode of IAC valve duty will continue for 5 minutes after which it will automatically cancel.*

8. During this fixed mode of IAC valve duty, adjust engine speed to 650 ± 50 r/min. by turning by-pass air screw.

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

9. When finished adjusting the idle speed, opening the throttle will automatically cancel the IAC fixed mode.

NOTE:
The fixed mode of IAC can also be canceled manually by shifting to Forward or Reverse or raising the engine speed (causes the fully close throttle signal of TPS to be OFF).

10. Return the throttle to full close and check engine speed. It should now be stable at 600 – 700 r/min.

NOTE:
Idling/trolling speed of 600 – 700 r/min. is controlled by IAC (idle air control) system.
If engine speed does not return to specification, IAC passage may be clogged or IAC system may not be operating correctly.
See "IDLE AIR CONTROL SYSTEM" section on page 3-28.

NOTE:
Trolling speed (in-gear idle speed) is same as idle speed.

IGNITION TIMING

Inspect every 200 hours (12 months).

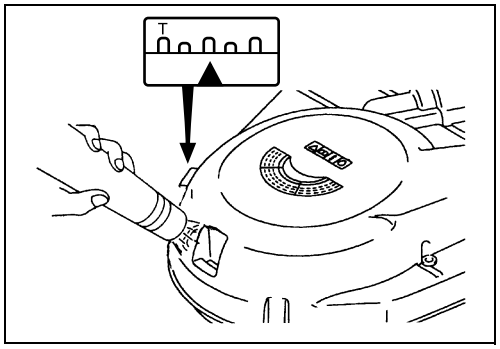
NOTE:
Before checking the ignition timing, make sure idle speed is adjusted within the specification.

1. Start the engine and allow to warm up.
2. Attach the timing light cord to the No. 1 ignition coil primary wire.

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

3. Check the ignition timing while operating the engine in neutral gear at 1 000 r/min.

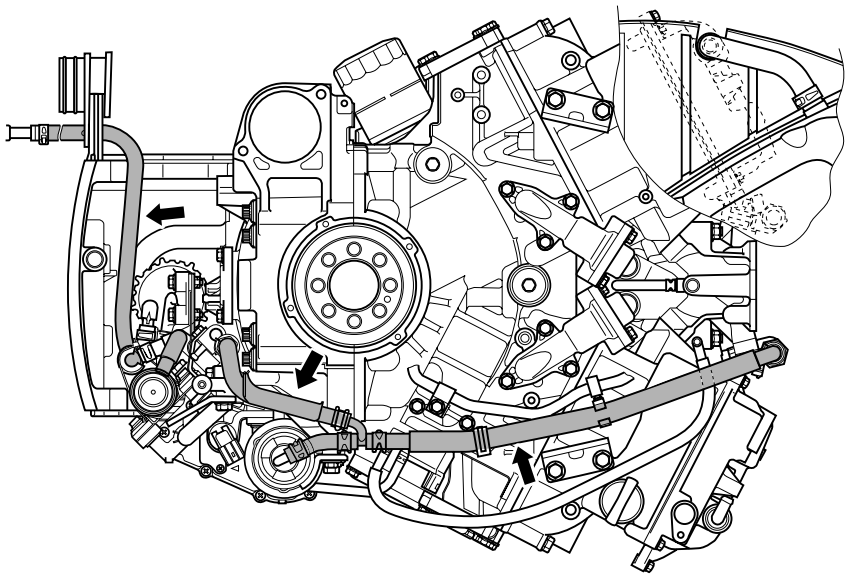
   Ignition timing: Approx. BTDC 0° ± 5° at 1 000 r/min.

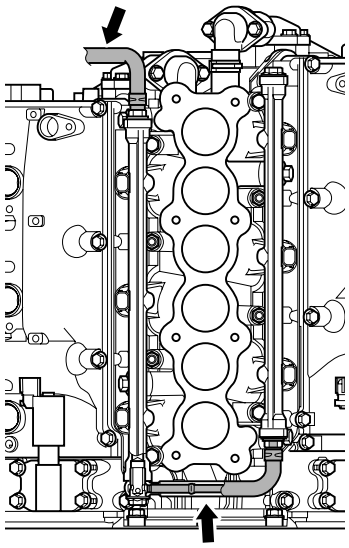


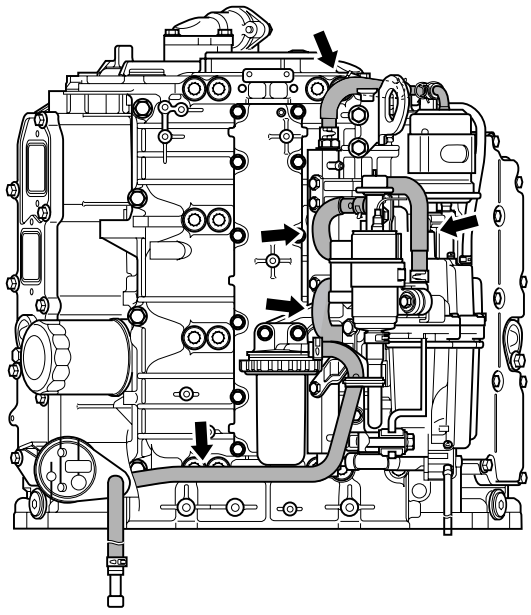
FUEL LINE

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

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

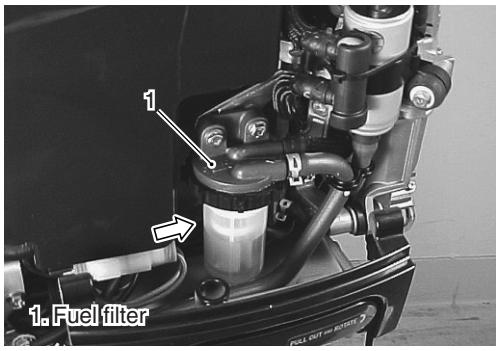






LOW PRESSURE FUEL FILTER

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



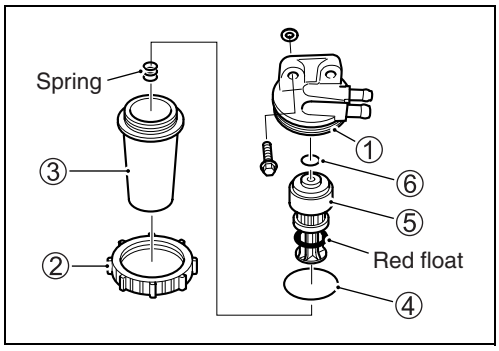
If leakage, cracks or other damage is found, replace the fuel filter.

NOTE:
When water is present in the fuel supply, the red indicator float surrounding the filter element rises.
Whenever the red float is up, remove filter cap and drain the water.

Inspect and Cleaning

⚠ WARNING

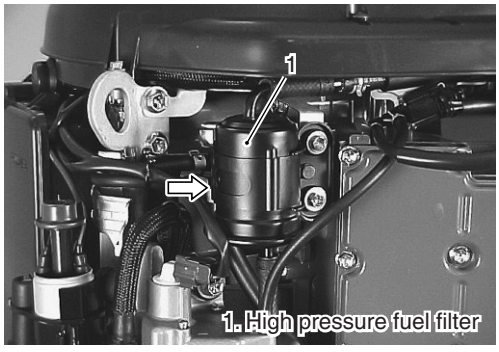
- **Stop the motor before cleaning the fuel filter.**
- **Do not smoke and keep open flames and sparks away while working near any part of the fuel system.**



1. Turn the engine “off”.
2. Remove the two (2) bolts securing low pressure fuel filter to filter bracket and remove fuel filter.
3. Remove the ring nut ②.
4. Separate the filter cap ③ from filter body ①, then remove large O-ring ④, filter element ⑤ and small O-ring ⑥.
5. Inspect filter element and O-rings for damage.
   Replace if damaged.
6. Wash the filter element with cleaning solvent.
7. Assemble the small O-ring ⑥ and filter element ⑤ to filter body ①.
8. Install large O-ring ④ and filter cap ③, then thread the ring nut ② into position.
9. Install low pressure fuel filter and tighten bolts securely.
10. Restart the engine and check that there are no leaks around the fuel filter.

HIGH PRESSURE FUEL FILTER

- **Replace every 1 000 hours.**

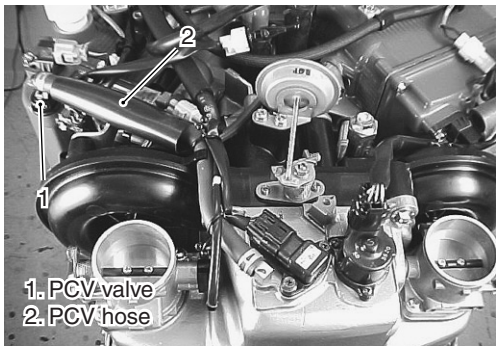


SUZUKI recommends that replacing the high pressure fuel filter every 1 000 operating hours.

PCV SYSTEM

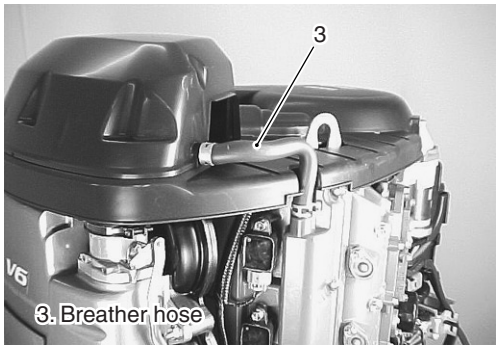
- **Inspect initially after 20 hours (1 month) and every 50 hours (3 months).**
- **Replace every 2 years.**

NOTE:
Be sure to check for any obstruction in the PCV valve or its hose before checking engine idle speed/IAC duty.
An obstructed PCV valve or hose prevents proper operation of these items.



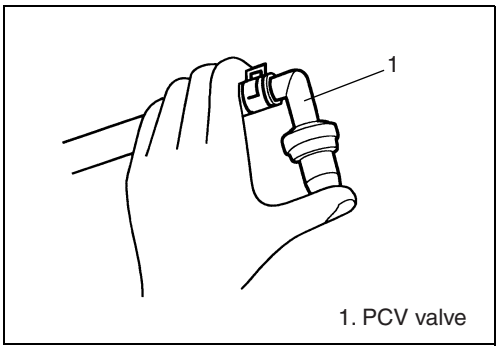
PCV HOSE

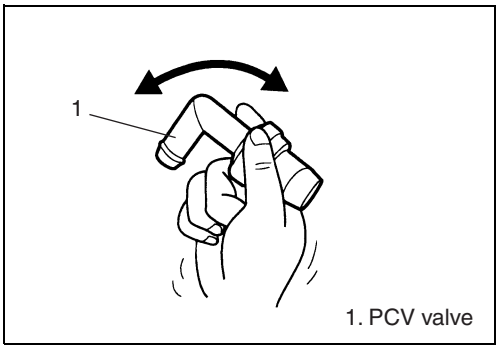
Check crank case ventilation hoses (breather hose) and PCV hoses for connection, leakage, cracks, clog or deterioration.
Check for sticking or clogged PCV valve. Replace as necessary.



PCV valve inspection

1. Disconnect PCV valve from cylinder head cover.
2. Run engine at idle.
3. Place your finger over end of PCV valve to check for vacuum.
   If there is no vacuum, check for clogged valve. Replace as necessary.
4. After checking vacuum, stop engine and remove PCV valve from hose.
   Shake valve and listen for the rattle of check needle inside the valve.
   If valve does not rattle, replace valve.
5. After checking, connect PCV valve, PCV hose and tighten clamps securely.

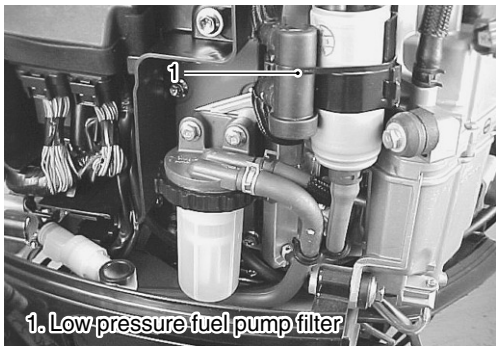




LOW PRESSURE FUEL PUMP FILTER

Replace every 1 000 hours.

SUZUKI recommends that replacing the low pressure fuel pump filter every 1 000 operating hours.



1. Low pressure fuel pump filter

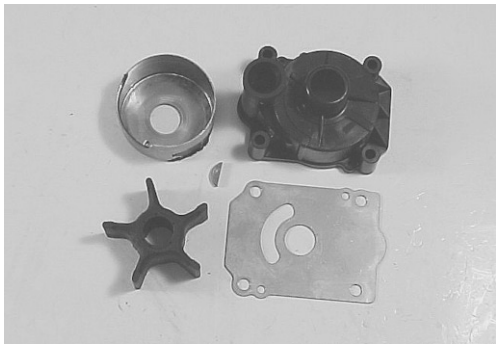
WATER PUMP/WATER PUMP IMPELLER

WATER PUMP
Inspect every 200 hours (12 months).

Inspect water pump case, inner sleeve and under panel.
Replace if wear, cracks, distortion or corrosion is found.

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

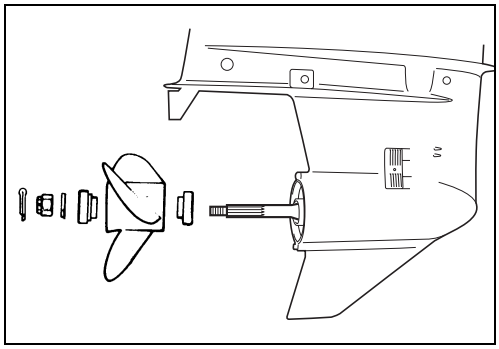
Inspect water pump impeller.
Replace if vanes are cut, torn or worn.



PROPELLER/NUT/COTTER PIN

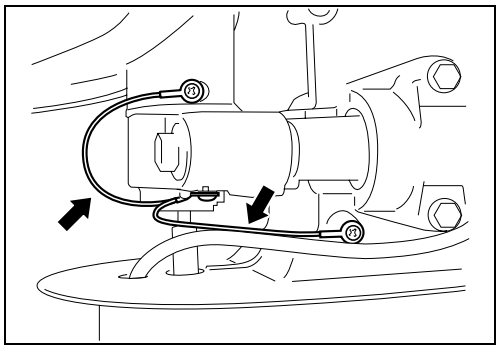
Inspect initially after 20 hours (1 month) and every 100 hours (6 months).

- Inspect propeller for bent, chipped or broken blades. Replace propeller if damage noticeably affects operation.
- Inspect propeller splines. Replace propeller if splines are worn, damaged or twisted.
- Inspect propeller bush for slippage. Replace if necessary.
- Make sure that propeller nut is torqued to specification and cotter pin is installed securely.



BONDING WIRES

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



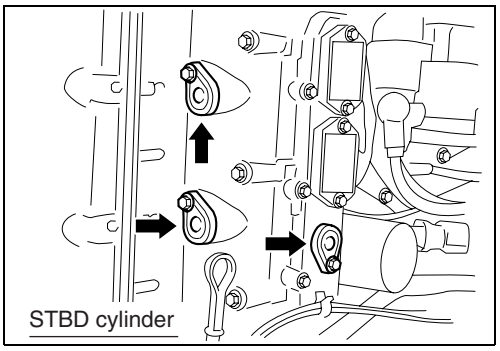
ANODES

Inspect every 50 hours (3 months).

ANODES

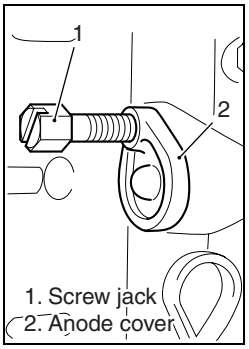
If 2/3 of zinc anode has corroded away, replace anode.

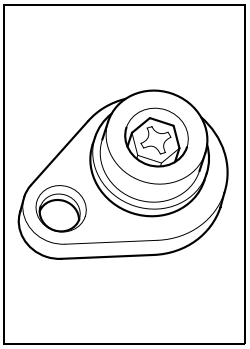
The anode should be periodically cleaned with a wire brush to ensure maximum effectiveness.



NOTE:

The anode cover may be separated from the power unit body by inserting and turning a 10 mm bolt it to function as a screw jack.





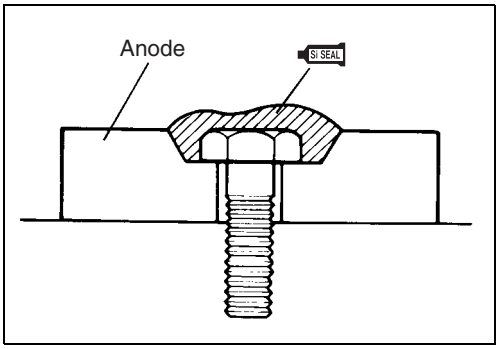
CAUTION

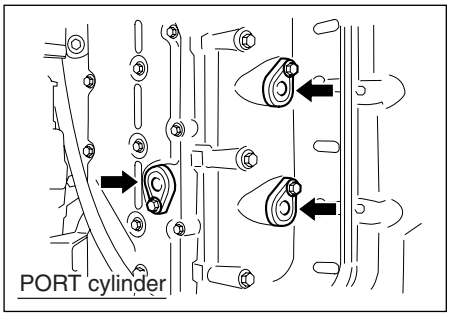
Never paint the anode.

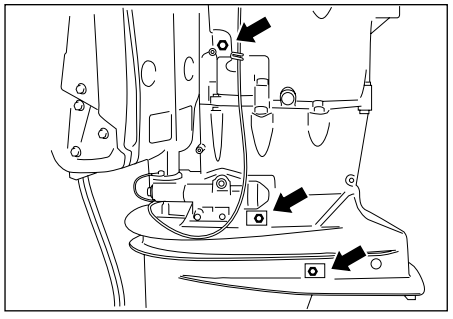
NOTE:

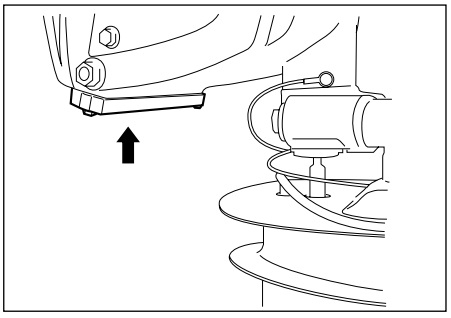
The anode securing bolt should be covered with SUZUKI SILICONE SEAL.

Si SEAL 99000-31120: SUZUKI SILICONE SEAL









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 the battery, disconnect the negative (black) cable. Be careful not to cause a short circuit by allowing metal objects to contact the battery posts and the motor at the same time.**
- **Wear approved eye protection.**

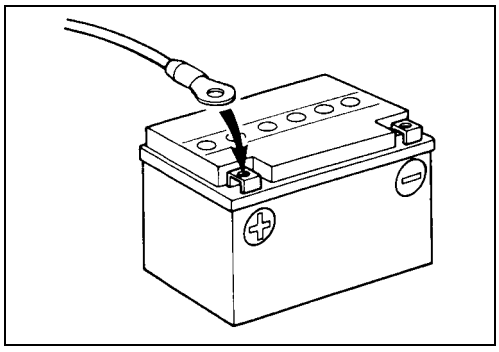
Recommended battery: 12 V 100 AH (360 kC) or larger

CONNECTING BATTERY

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

How to connect:

1. Connect positive (+) terminal first.
2. Connect negative (–) terminal second.

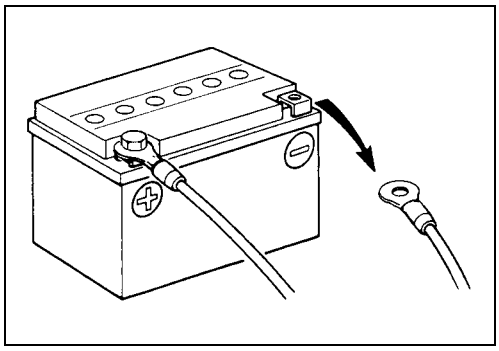


How to disconnect:

1. Disconnect negative (–) terminal first.
2. Disconnect positive (+) terminal second.

CAUTION

If the battery leads are loose, incorrectly connected or reversed, the electrical system could be damaged.



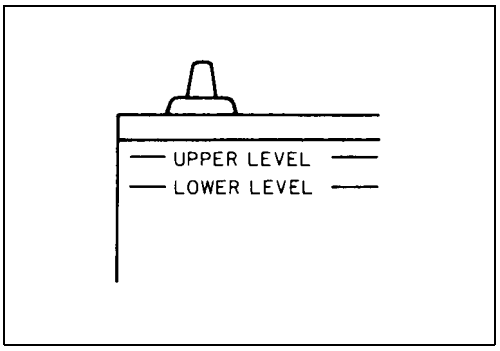
BATTERY SOLUTION LEVEL CHECK

Battery solution level should be between UPPER level and LOWER level.

If level is low, add distilled water only.

CAUTION

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

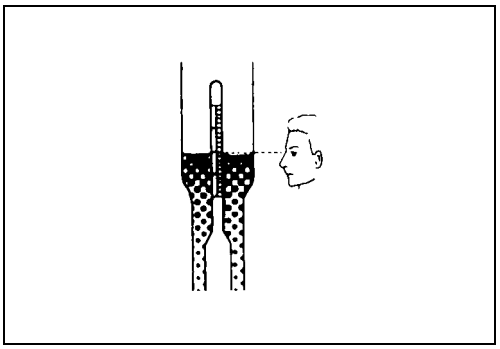


BATTERY SOLUTION GRAVITY CHECK

Measure the gravity of battery solution using a hydrometer.

Battery solution gravity: 1.28 at 20 °C

09900-28403: Hydrometer



BOLTS AND NUTS

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

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	11	1.1	8.0
Collector	8 mm	23	2.3	16.6
Flywheel bolt	12 mm	118	11.8	85.3
Power unit mounting bolt	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
Lower mount bolt/nut	14 mm	100	10.0	72.3
Gearcase bolt	10 mm	54	5.5	40.0
	12 mm	83	8.3	60.0
Propeller nut	18 mm	55	5.5	40.0

FUEL MIXTURE CHECK (O2 FEEDBACK)

Perform every 2 years.

To perform fuel mixture check (O2 feedback) operation, a battery powered personal computer and the Suzuki Diagnostic System software/hardware must be used.
For fuel mixture check (O2 feedback) operation, refer to “Suzuki Diagnostic System Operation Manual”.

NOTE:
See “O2 FEEDBACK SYSTEM” section on page 3-47 before starting O2 feedback operation.

OIL PRESSURE

Oil pressure (at normal operating temp.):
400 – 600 kPa (4.0 – 6.0 kg/cm², 57 – 85 psi)
at 3000 r/min.

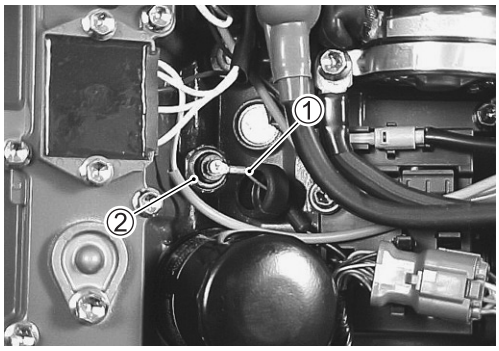
NOTE:
The figure shown above is a guideline only, not an absolute service limit.

If oil pressure is lower or higher than specification, the following causes may be considered.
(See page 6-98 for oil passage locations.)

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

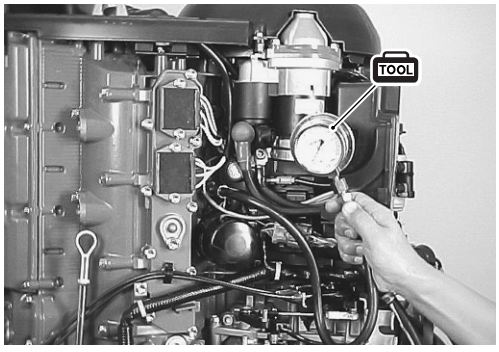
High oil pressure
- Using an engine oil of too high viscosity
- Clogged oil passage
- Clogged oil pressure regulator
- Combination of above items

TEST PROCEDURE
1. Check the engine oil level.
2. Loosen screw and disconnect blue lead wire ① from oil pressure switch ②.
   Remove the oil pressure switch.



3. Install oil pressure gauge adaptor into oil pressure swicth hole in place of oil pressure switch.

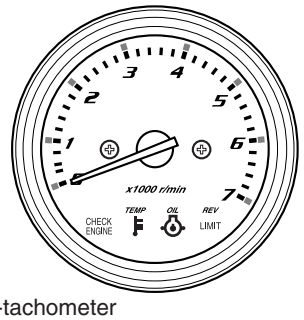
TOOL **09915-77311: Oil pressure gauge**
09915-78211: Oil pressure gauge adapter



4. Start engine and allow to warm up as follows:

   Summer : 5 min. at 2 000 r/min.
   Winter : 10 min. at 2 000 r/min.

5. After warming up, shift into forward gear and increase engine speed to 3 000 r/min., then compare pressure indicated on gauge to specifications.
6. After testing, reinstall oil pressure switch.
   (See page 3-69.)



Monitor-tachometer

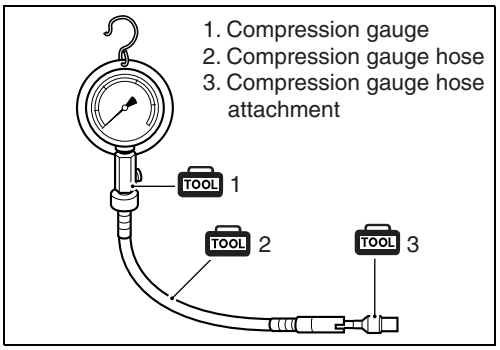
CYLINDER COMPRESSION

Cylinder compression:
Standard: 1 100 – 1 700 kPa
(11 – 17 kg/cm², 156 – 242 psi)
Max. difference between any other cylinders:
100 kPa (1.0 kg/cm², 14 psi)

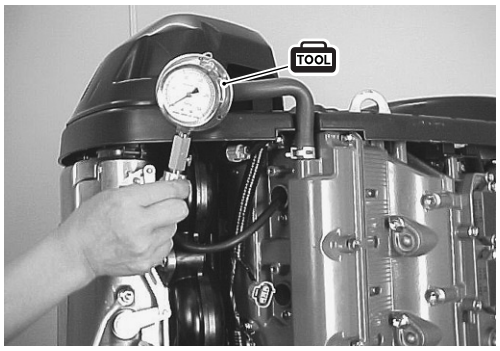
NOTE:
Figures shown are guidelines only, not absolute service limits.

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

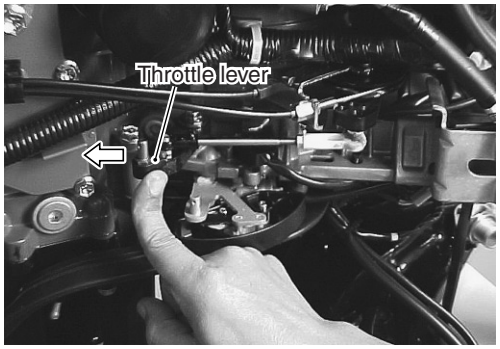
TEST PROCEDURE
1. Start engine and allow to warm up, then shut engine off.
2. Disconnect all ignition coil connectors.
3. Remove the bolts securing the ignition coil, then remove all spark plugs.
4. Install compression gauge hose attachment into spark plug hole, then connect compression gauge hose to gauge hose attachment and compression gauge.



TOOL 09915-64512: Compression gauge
09915-64530: Compression gauge hose
09915-67010: Compression gauge hose attachment



5. Disconnect remote control throttle cable from throttle lever.
6. Move and hold throttle lever in full-open position.
7. While cranking engine with starter motor, note maximum compression pressure reading on gauge for each cylinder.
8. Reinstall parts removed earlier. (spark plugs, ignition coils, etc.)

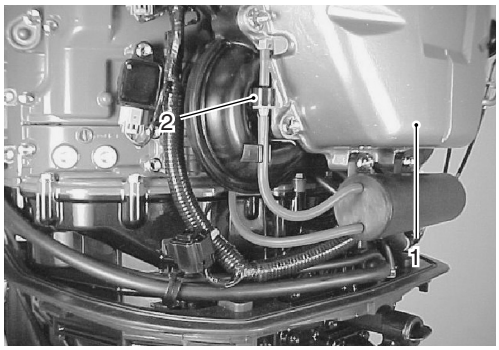


ENGINE VACUUM CHECK

Engine vacuum is required for proper operation of the Multi-Stage Induction system used on the DF225 & DF250. Engine vacuum is also an indicator of general engine condition.

1. Warm up engine to normal operating temperature.
   Make sure engine idle speed is within specification.
2. Stop engine and disconnect vacuum outlet hose from PORT side of intake manifold outer cover (collector cover).
3. Connect special tools (vacuum gauge, hose and 3-way joint) between engine vacuum hose and collector cover hose connection.

TOOL **09915-67311: Vacuum Gauge**
09918-08210: Hose joint
09355-35754-601: Hose
09367-04002: 3-way joint

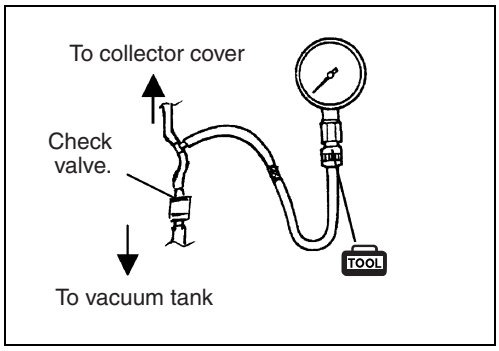


1. Intake manifold outer cover (Collector cover)
2. Check valve

4. Start engine and run at idle speed. Vacuum reading on gauge should be within specification.

   Vacuum specification (idle speed at sea level)
   61 – 71 kPa (457 – 533 mmHg, 18 – 21 inHg)

5. If vacuum is not within specification, further testing (leak-down test, compression test, etc.) and evaluation of engine condition is required.



Possible causes of incorrect engine vacuum

- Piston ring leakage
- Incorrect valve timing
- Poor valve/valve seat/valve guide condition
- Intake leakage
- Cylinder head gasket leakage
- Restricted exhaust

ENGINE CONTROL SYSTEM

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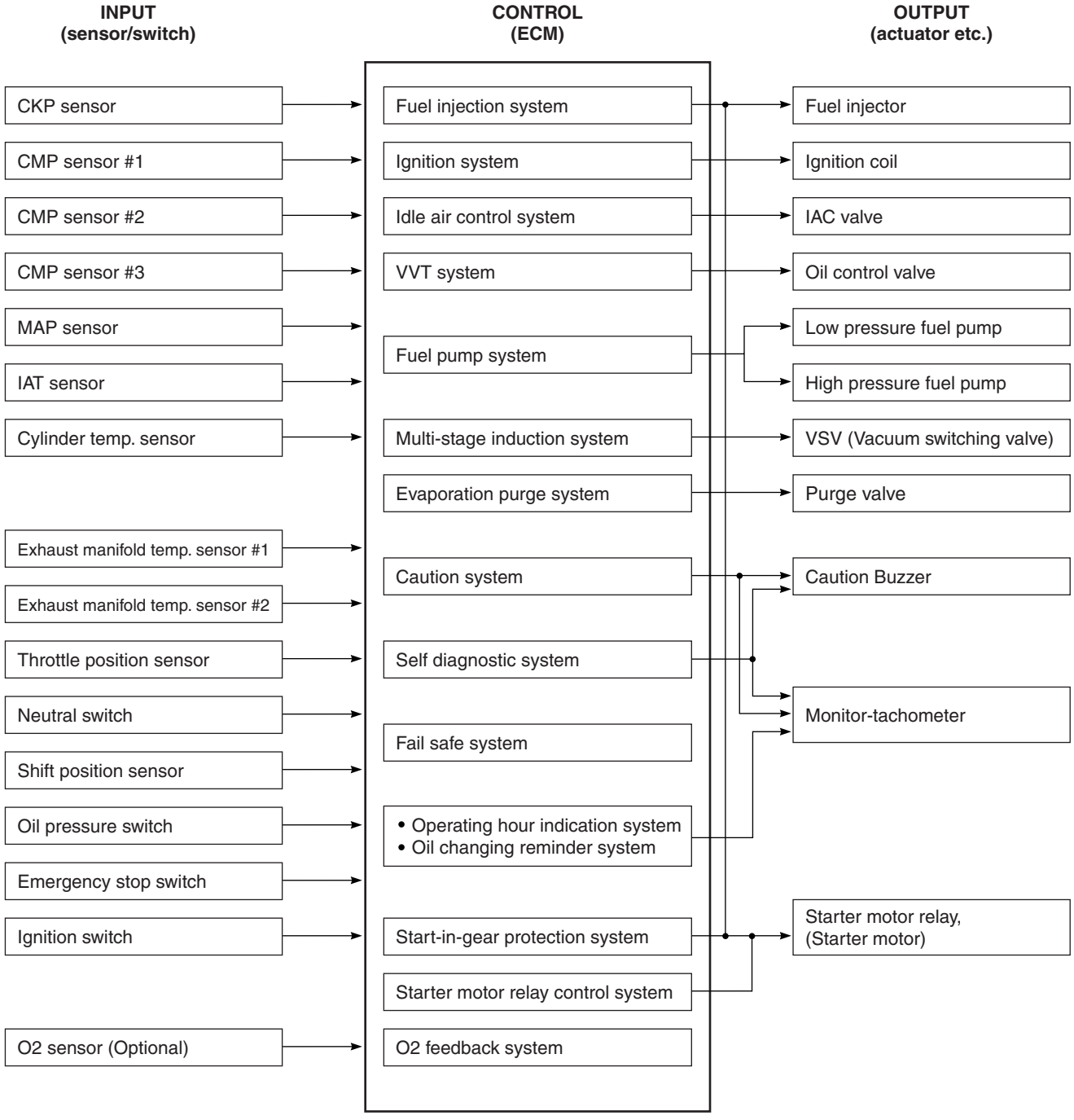
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ENGINE CONTROL SYSTEM STRUCTURE

The DF200/DF225/DF250 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

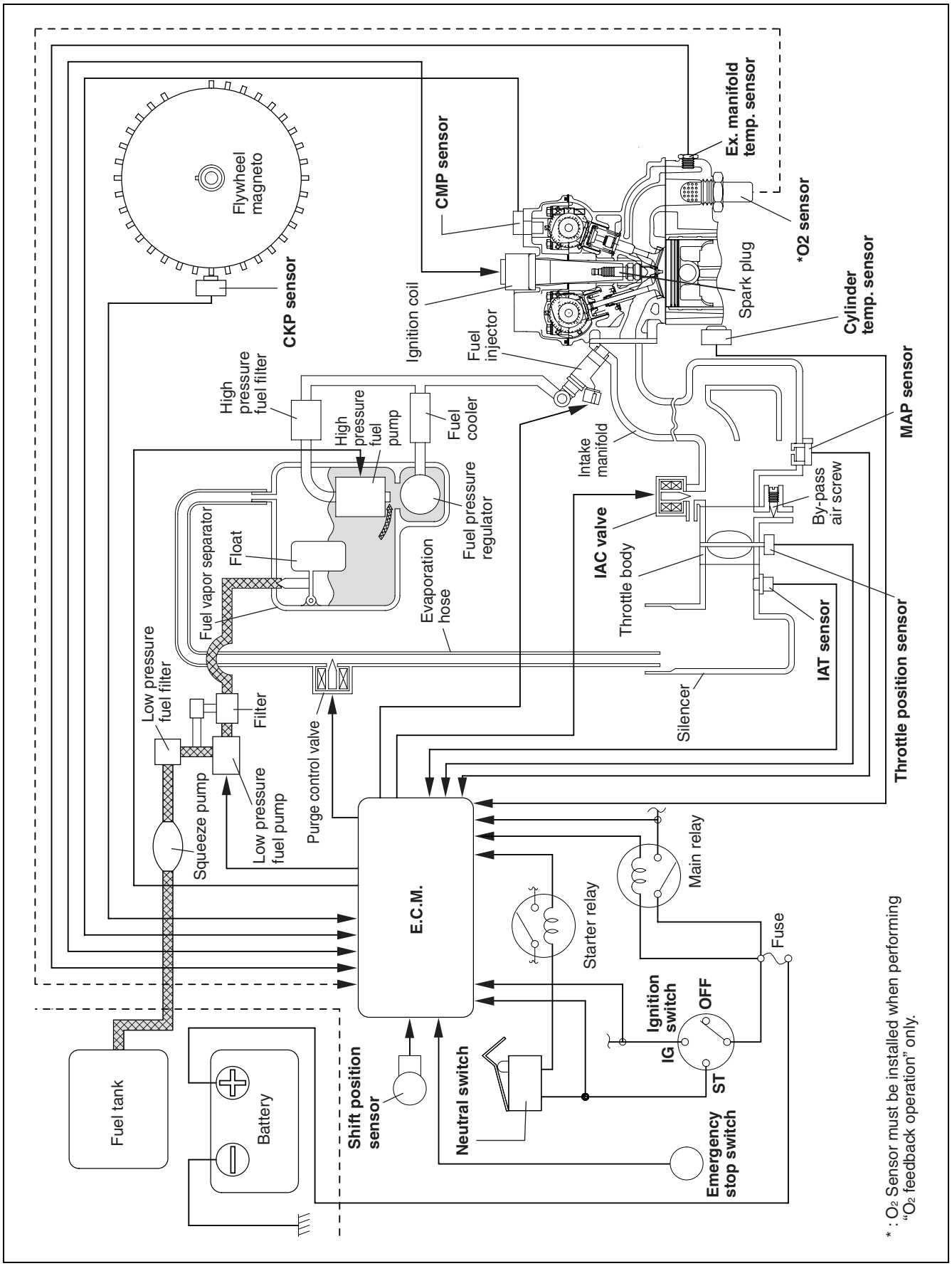


NOTE:

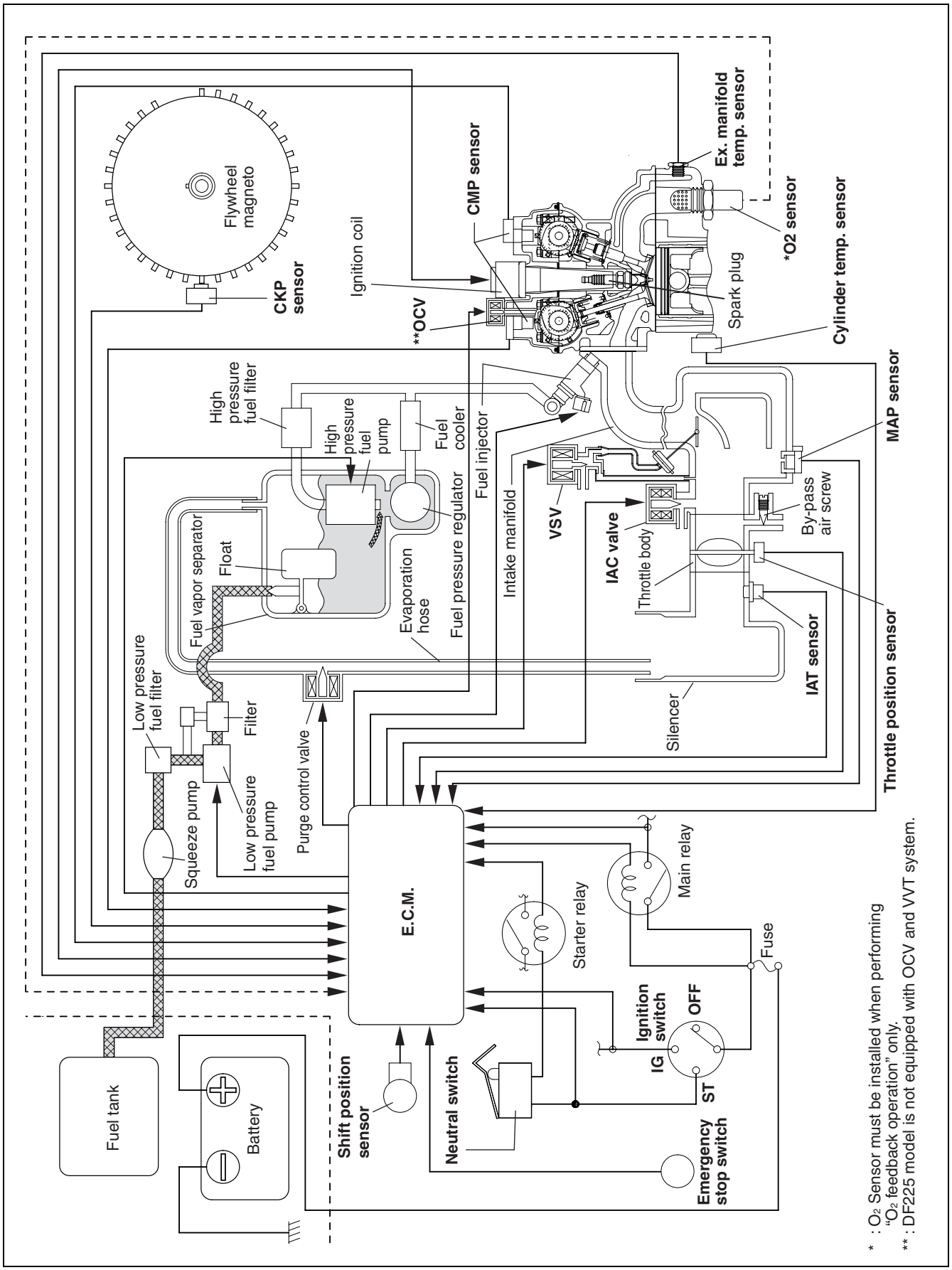
- *DF200/225 models are not equipped with CMP sensor #2·3 and VVT system.*
- *DF200 model is not equipped with Multi-stage induction system.*

SYSTEM STRUCTURE 2

[DF200]



[DF225/DF250]



* : O_2 Sensor must be installed when performing "O_2 feedback operation" only.
** : DF225 model is not equipped with OCV and VVT system.

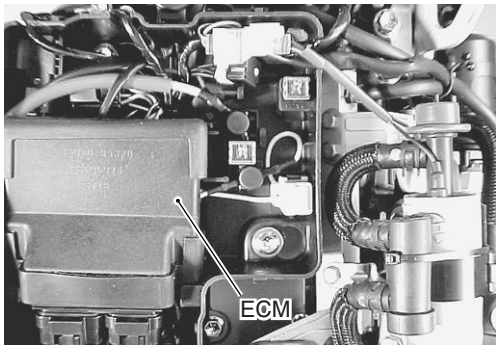
COMPONENTS FOR SYSTEM CONTROL

ENGINE CONTROL MODULE (ECM)

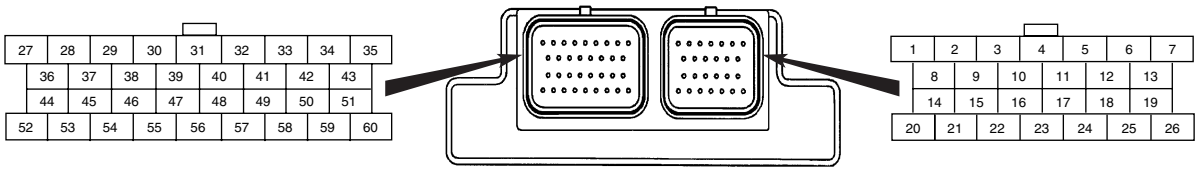
The ECM sends signals to control the actuators based on the information inputs from each sensor/switch. Major controls are as follows:

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.
VVT system	• Controls intake cam valve timing through OCV (Oil control valve).
Fuel pump control	• Controls high pressure fuel pump drive. • Controls Low pressure fuel pump drive.
Multi-stage induction system	• Changing the length of intake manifold pipes according to engine speed.
Evaporation purge system	• Discharges vapor generated within fuel vapor separator to air intake silencer case by controlling purge valve.
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 with back-up system during sensor/switch malfunction.
Total operating hour indication system control	• Informs operator of total operating time.
Oil changing reminder system control	• Informs operator of time for replacing engine oil on the basis of the maintenance schedule.
Start-in-gear protection system control	• Prevents engine start when shift is positioned in forward or reverse.
Starter motor relay control system	• Prevents starter motor operation when engine is already operating.
O2 feedback system control	• Controls and performs O2 feedback operation using optional O2 sensor.

NOTE:
The information related to the Caution system, Self-Diagnostic System, Total operating hour indication system and O2 feedback system are retained in ECM memory.



ECM CONNECTOR/TERMINALS LAYOUT

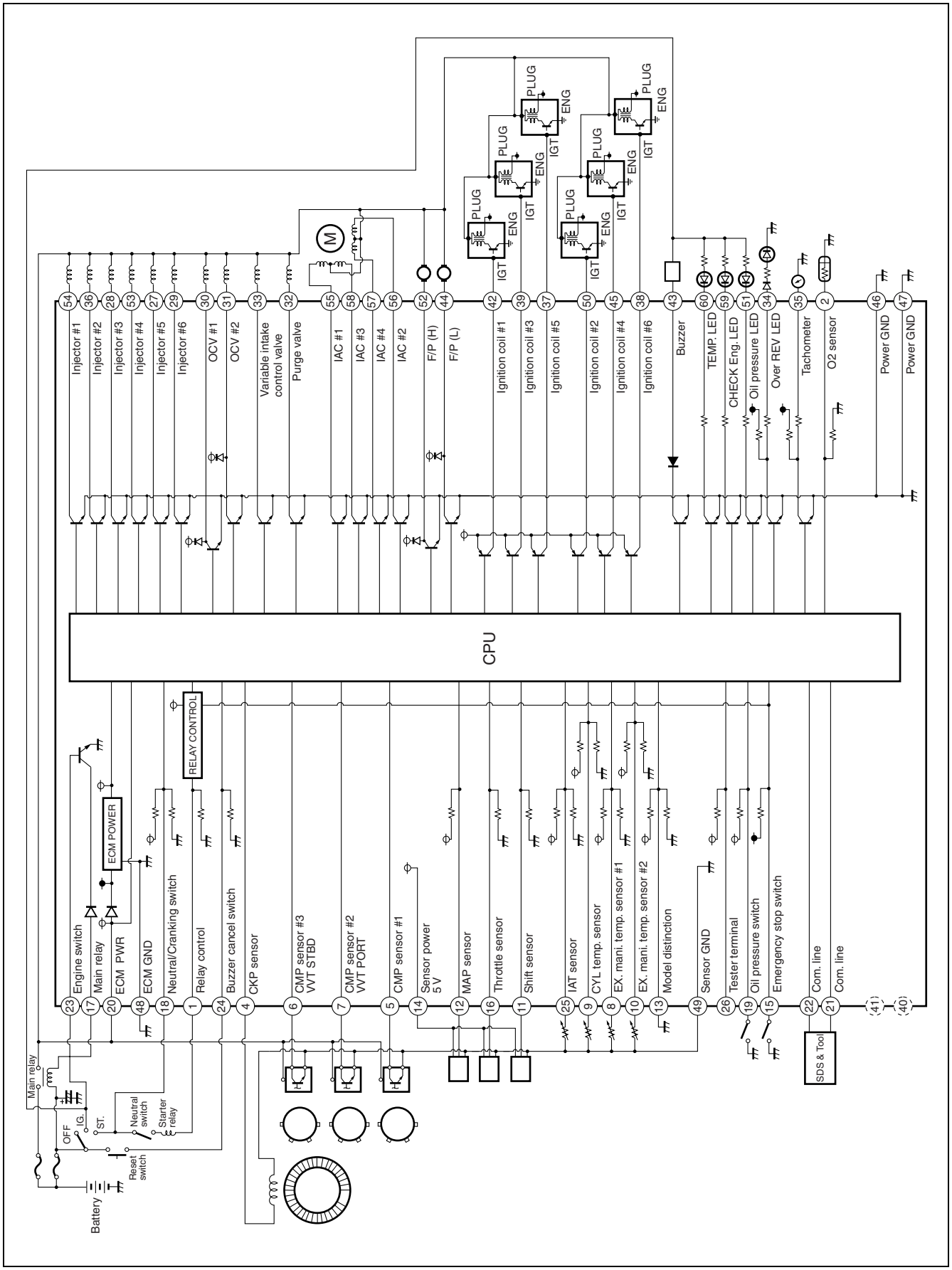


(FRONT VIEW)

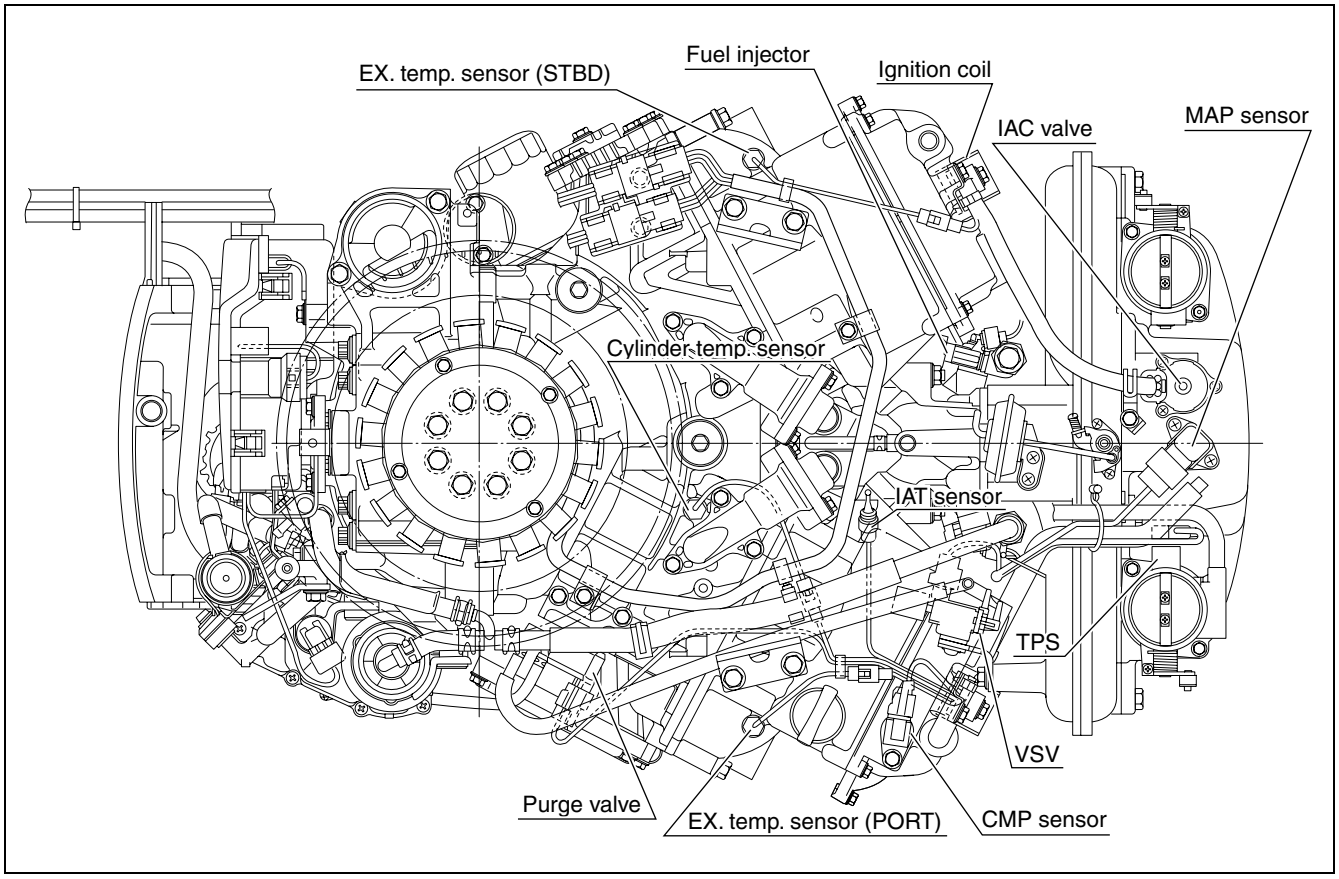
TERMINAL	WIRE COLOR	CIRCUIT
1	Dg	Starter relay control
2	B/G	O2 Feedback
3	—	—
4	R/B	CKP sensor
5	Y/Bl	CMP sensor #1
6	B/O	CMP sensor #3 (VVT_ STBD)
7	O/G	CMP sensor #2 (VVT_ PORT)
8	V/W	Ex-manifold temp. sensor #1
9	Lg/W	Cylinder temp. sensor
10	G/R	Ex-manifold temp. sensor #2
11	P/Bl	Shift position sensor
12	W	MAP sensor
13	B	Model distinction (DF200 only)
14	R	Power source for sensor
15	Bl/R	Emergency stop switch
16	Br/Y	Throttle position sensor
17	P/B	Ground for ECM main relay
18	Br	Neutral/Cranking switch
19	Bl	Oil pressure switch
20	Gr	ECM power source
21	Y	PC communication
22	O/Y	PC communication
23	B/Bl	Engine switch
24	O	Buzzer cancel
25	Lg/B	IAT sensor
26	—	—
27	O/Bl	No. 5 Fuel injector (–)
28	R/W	No. 3 Fuel injector (–)
29	Y/R	No. 6 Fuel injector (–)
30	Br/W	No. 1 OCV (–)

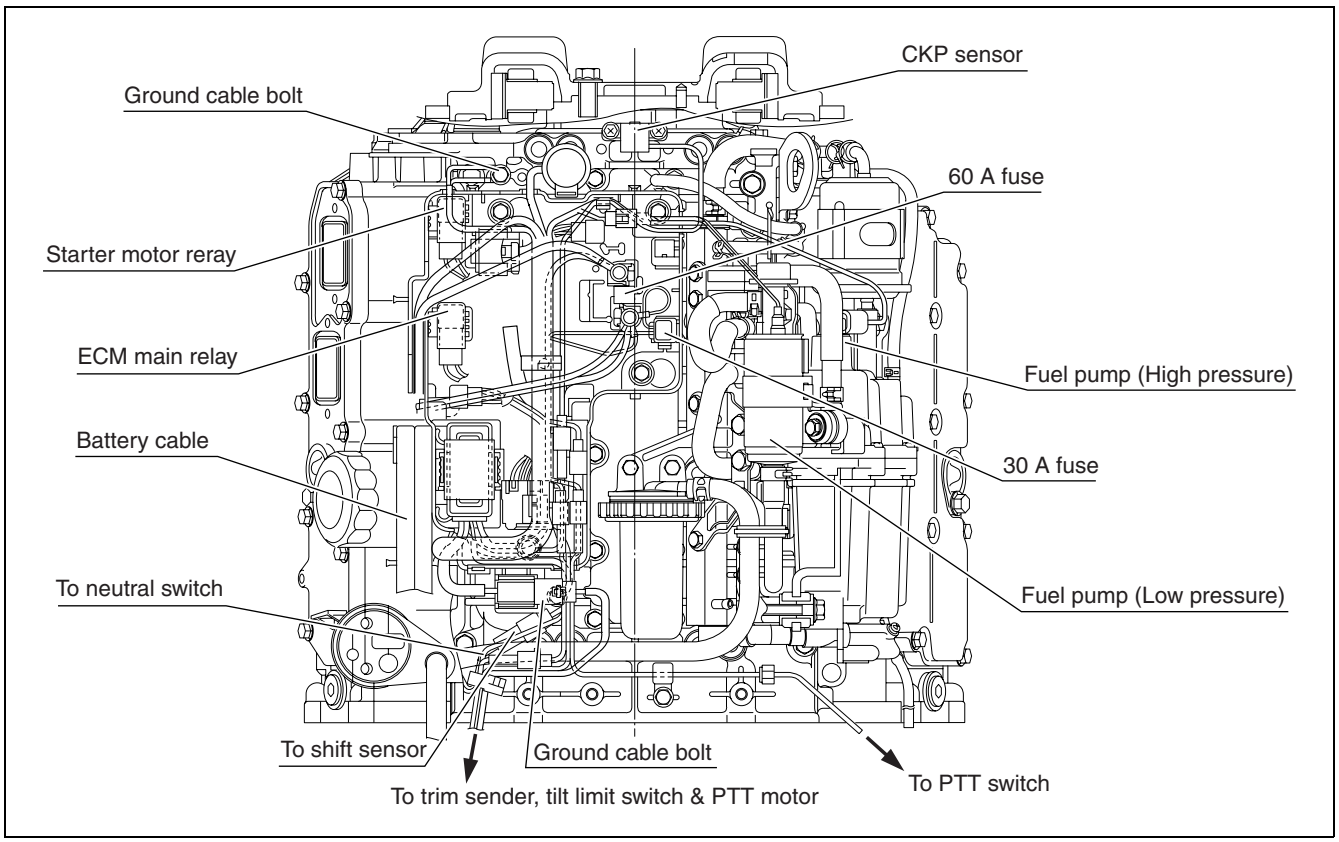
TERMINAL	WIRE COLOR	CIRCUIT
31	Br/R	No. 2 OCV (–)
32	O/W	Purge valve (–)
33	Gr/R	Variable intake control valve (VSV)
34	P	Rev-Limit lamp
35	Y/B	Tachometer
36	B/Br	No. 2 Fuel injector (–)
37	W/G	No. 5 Ignition coil (–)
38	Bl/Y	No. 6 Ignition coil (–)
39	Gr/Y	No. 3 Ignition coil (–)
40	—	—
41	—	—
42	O	No. 1 Ignition coil (–)
43	Bl/W	Buzzer
44	B/Y	Low pressure fuel pump (–)
45	Lg/R	No. 4 Ignition coil (–)
46	B	Ground for power
47	B	Ground for power
48	B	Ground for ECM
49	B/W	Ground for sensor
50	Bl	No. 2 Ignition coil (–)
51	Bl/B	Oil lamp
52	B/R	High pressure fuel pump (–)
53	Lg	No. 4 Fuel injector (–)
54	O/B	No. 1 Fuel injector (–)
55	W/B	IAC valve #1
56	R/Y	IAC valve #2
57	W/Bl	IAC valve #4
58	R/G	IAC valve #3
59	G/W	CHECK ENGINE lamp
60	G/Y	TEMP lamp

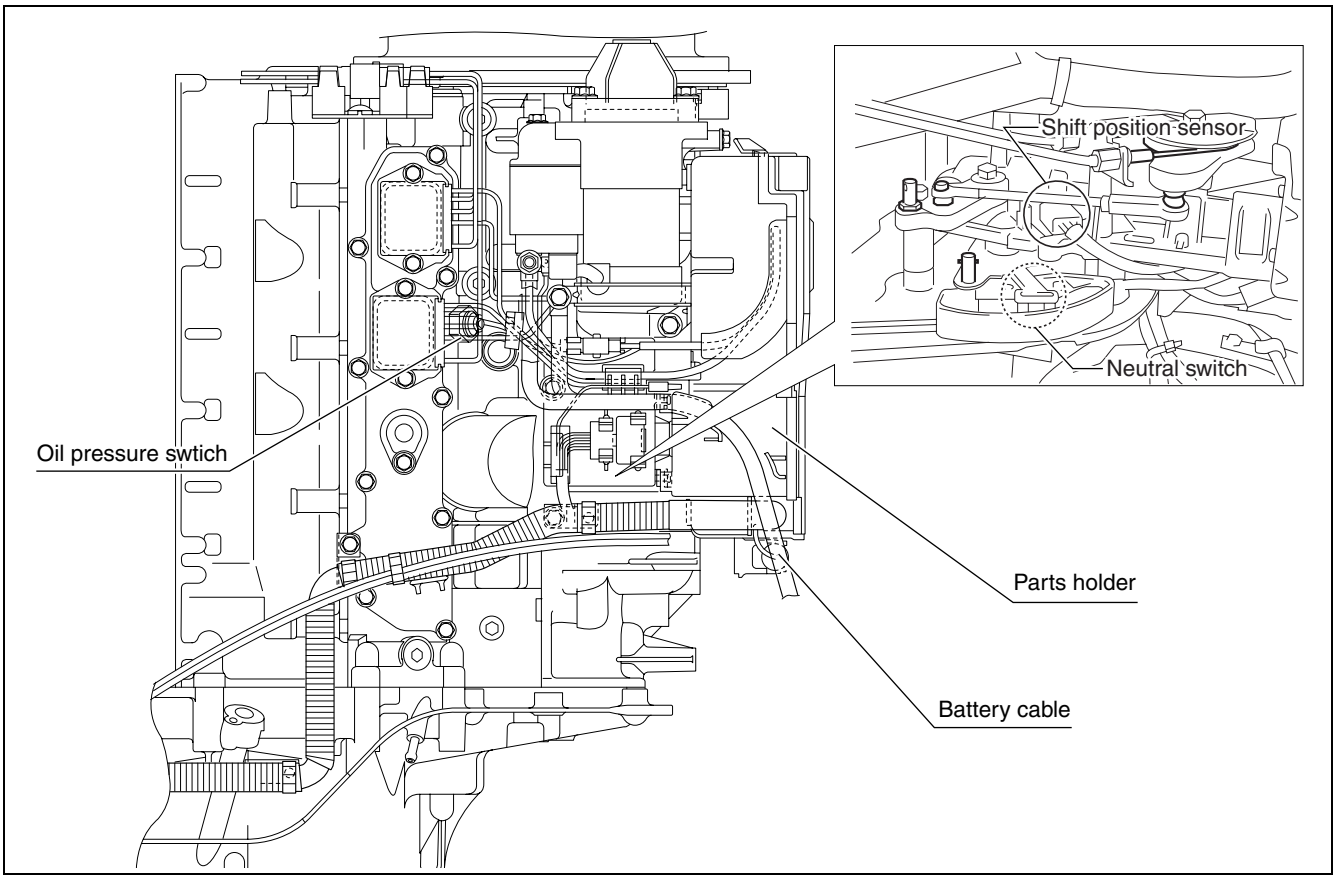
ECM INTERNAL STRUCTURE

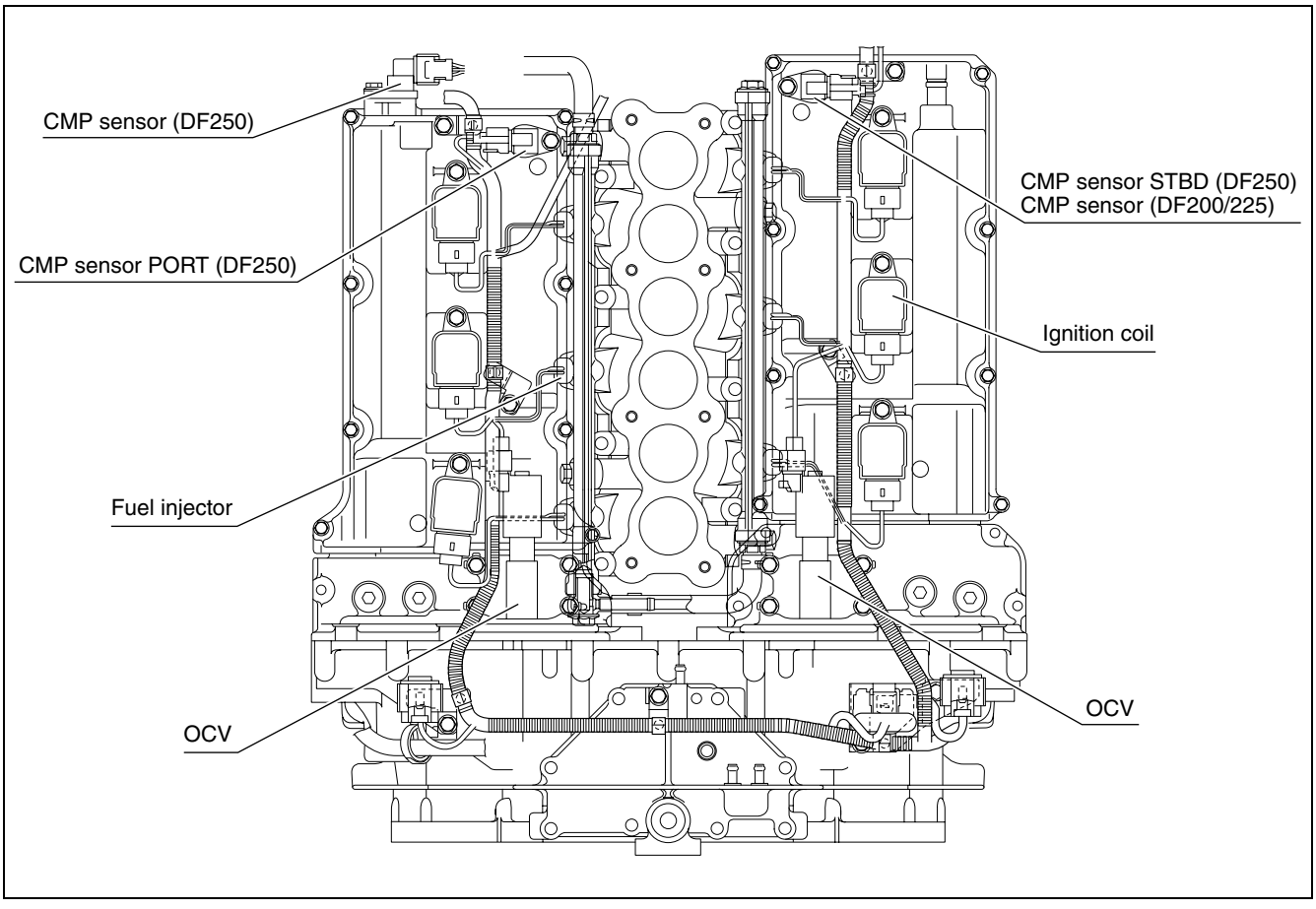


LOCATION OF SENSOR AND SWITCH





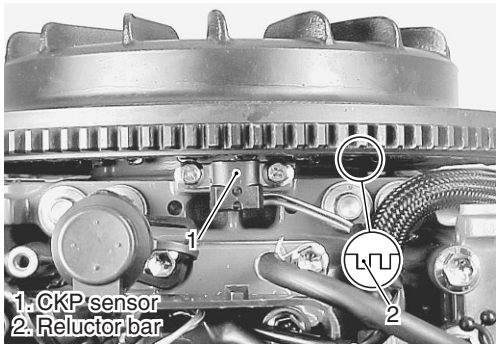

Shift position sensor
Neutral switch
Oil pressure swtich
Parts holder
Battery cable


CMP sensor (DF250)
CMP sensor PORT (DF250)
CMP sensor STBD (DF250)
CMP sensor (DF200/225)
Ignition coil
Fuel injector
OCV
OCV

SENSOR AND SWITCH

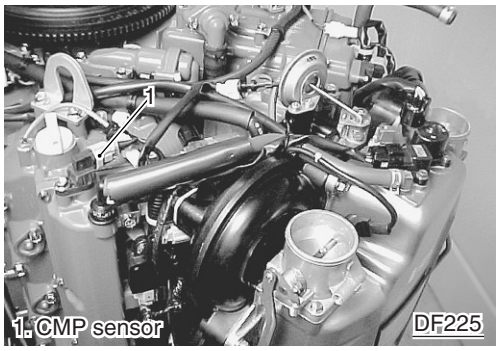
CKP (Crankshaft Position) SENSOR

There is one (1) CKP sensor installed below the flywheel rotor. When the reluctor bars on the flywheel pass the sensor, a signal (voltage pulse) is generated and sent to the ECM.
This is the fundamental signal used to judge engine speed and crankshaft angle.
There are 34 reluctor bars, spaced 10 degrees apart, followed by a 20 degree index space. During one crankshaft rotation, 34 signals are input to the ECM.

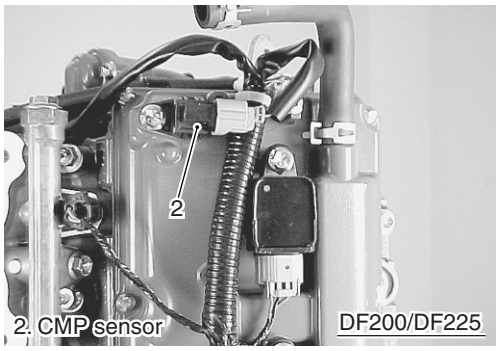


CMP (Camshaft Position) SENSOR #1

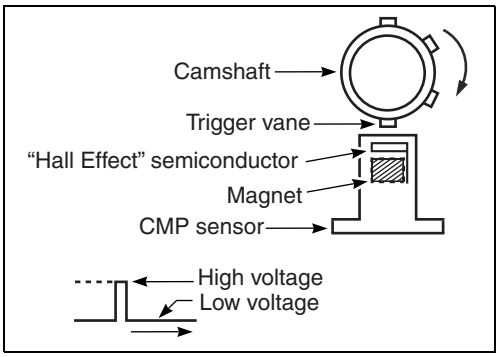
- For DF250 model:
  CMP sensor #1 is mounted on the PORT cylinder head cover with trigger vanes pressed onto the end of the PORT exhaust camshaft. This sensor detects piston position.
- For DF200/225 models:
  CMP sensor #1 is mounted on the STBD cylinder head cover with trigger vanes pressed onto the end of the Intake camshaft. This sensor detects piston position.
- Signals received from this sensor are also used by the ECM to determine sequential fuel injection control.



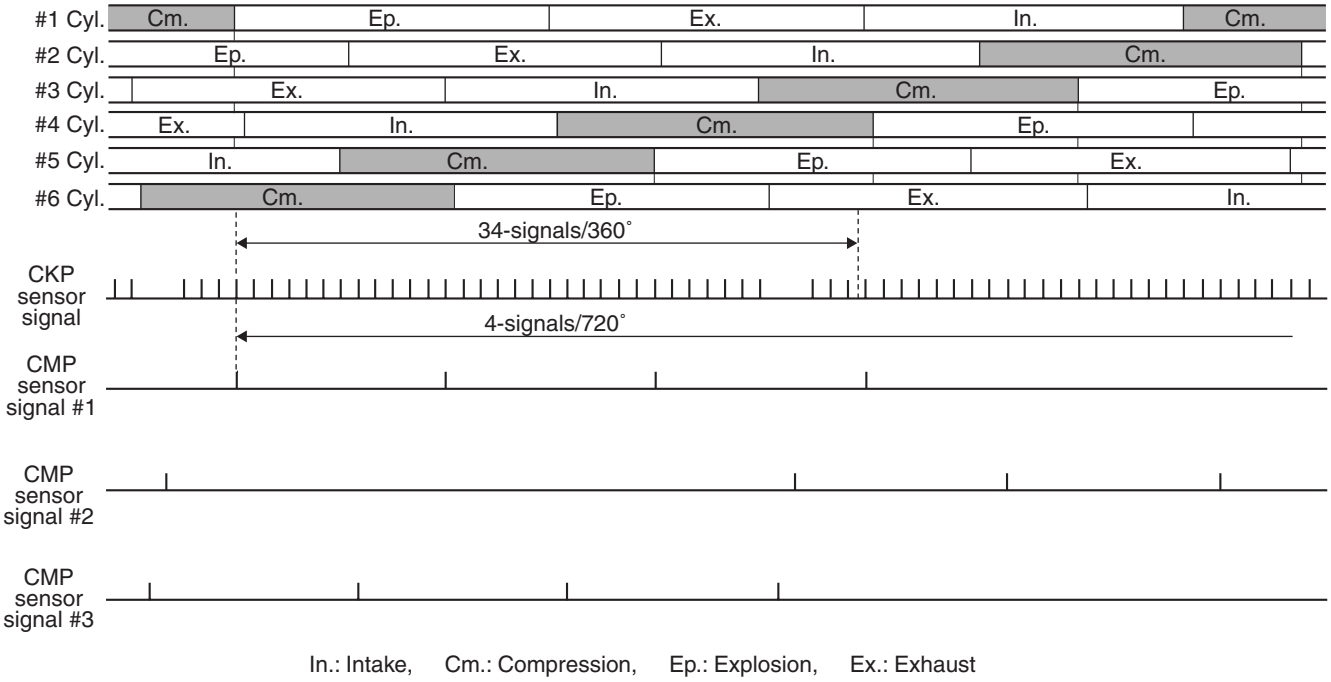
The CMP sensor contains a “Hall Effect” semiconductor and a magnet. The semiconductor generates a voltage in proportion to the line of magnetic force passed through it. When a trigger vane on the camshaft reluctor aligns with the sensor’ internal magnet, a large amount of magnetic force is generated allowing a high voltage to pass through the semiconductor. When the trigger vane moves away from the sensor, no magnetic force is generated and low voltage passes through the semiconductor.
These generated voltages are rectified to create “ON” (high voltage) & “OFF” (low voltage) signals to the ECM.



The four camshaft trigger vanes provid four high voltage signals from CMP sensor to ECM during one rotation of camshaft (two rotations of crankshaft).

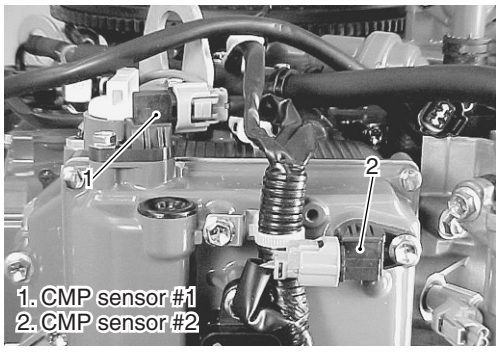


ECM cylinder identification:
Cylinders are identified by a calculation combined from two signals; one from the CKP sensor and one from the CMP sensor.



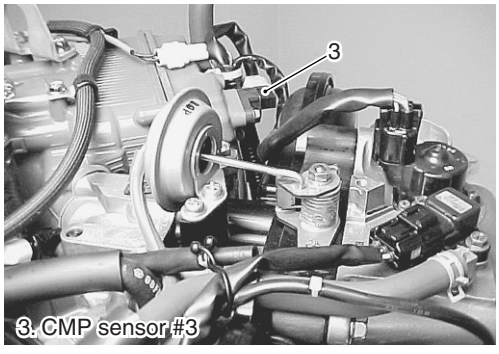
CMP (Camshaft position) SENSOR #2

- For DF250 model:
  CMP sensor #2 is mounted on the PORT cylinder head cover with trigger vanes pressed onto the end of the PORT intake camshaft. This sensor detects camshaft position.
- This sensor is the same type as the CMP sensor #1, and inputs signals to ECM. This signal is used to control PORT intake camshaft valve timing through OCV (Oil control valve).



CMP (Camshaft position) SENSOR #3

- For DF250 model:
  CMP sensor #3 is mounted on the STBD cylinder head cover with trigger vanes pressed onto the end of the STBD intake camshaft. This sensor detects camshaft position.
- This sensor is the same type as the CMP sensor #1, and inputs signals to ECM. This signal is used to control STBD intake camshaft valve timing through OCV (Oil control valve).

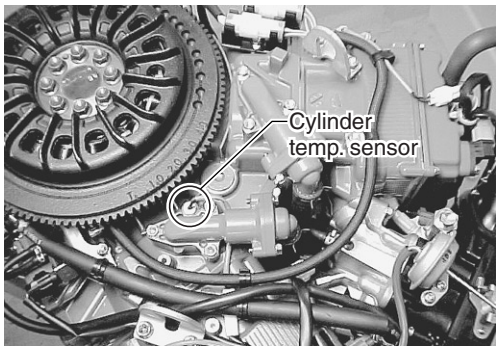


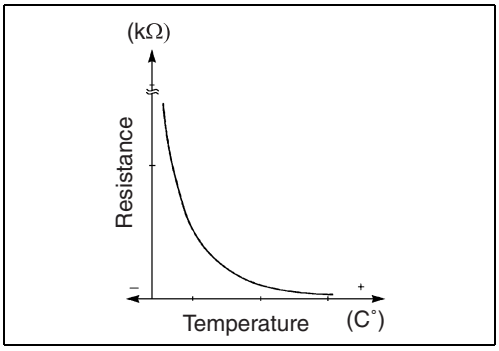
CYLINDER TEMPERATURE SENSOR

The cylinder temperature sensor is installed on the cylinder (top side) and used to detect the cylinder temperature.

This is a thermistor type sensor (resistance of which changes depending on temperature) and inputs a signal to the ECM as a voltage value. This signal is used to compensate the fuel injection time duration, ignition timing, evaporation purge system, 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).



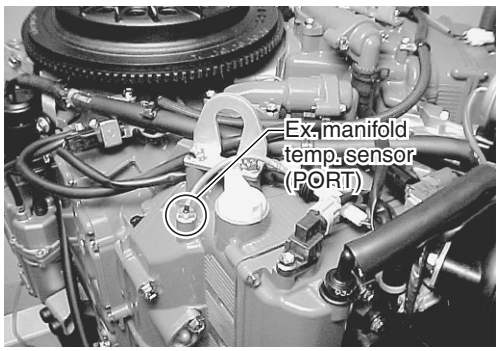


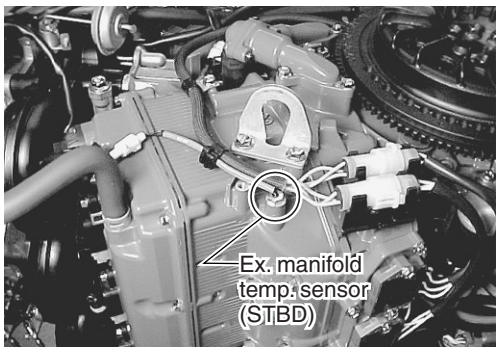
EXHAUST MANIFOLD TEMPERATURE SENSOR

Two exhaust manifold temperature sensor are used, one installed on each exhaust manifold (PORT and STBD) and used to detect 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 signal is also used to detect engine over-heat and control evaporation purge system.



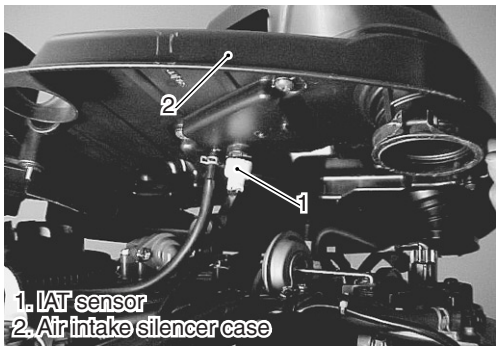


IAT (Intake Air Temperature) SENSOR

The IAT sensor is installed on the bottom of the ring gear cover and air intake silencer case 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 signal is used to compensate the fuel injection time duration.

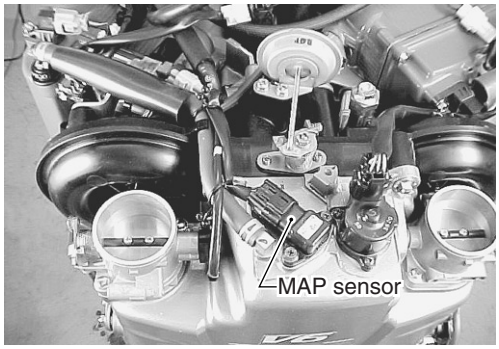


MAP (Manifold Absolute Pressure) SENSOR

The MAP sensor is installed on the collector assembly (top side) and used to detect the intake manifold (surge tank) pressure.

It also detects the barometric pressure before starting the engine. This sensor inputs the intake manifold (surge tank) pressure to the ECM as a voltage value.

This input signal is used as the fundamental signal to determine fuel injection time duration, ignition timing, etc.



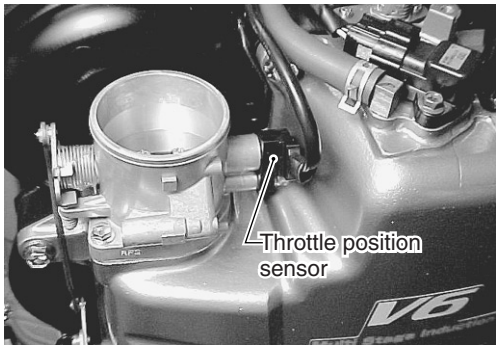
TPS (Throttle Position Sensor)

The TPS is installed on the PORT side throttle body and detects the throttle opening with the throttle shaft interlocked.

This sensor is a variable resistor changing resistance (Ohms) in accordance with the throttle opening.

The varying resistance value is converted to voltage and input to the ECM.

Based on the TPS voltage, the ECM calculates the idle position and throttle opening and determines the control modes of various controls systems (Idle air control, VVT system control, Fuel injection control system, etc.).



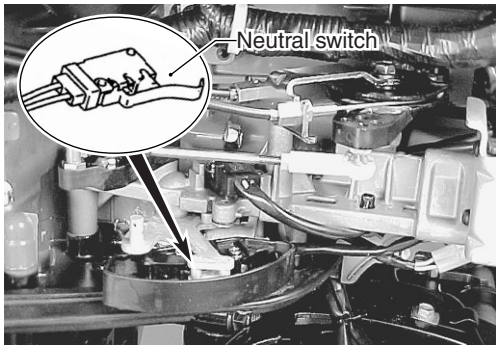
NEUTRAL SWITCH

The neutral switch is installed on the throttle lever holder and used to detect the shift position.

This switch is “ON” in neutral and “OFF” in forward or reverse.

Based on the switch’ shift position signal input, the ECM performs the following controls:

- When the shift is in forward or reverse at the time of engine start, no power is supplied to starter motor relay preventing starter motor engagement.
  (Start-in-gear protection. See page 3-46.)



SPS (Shift Position Sensor)

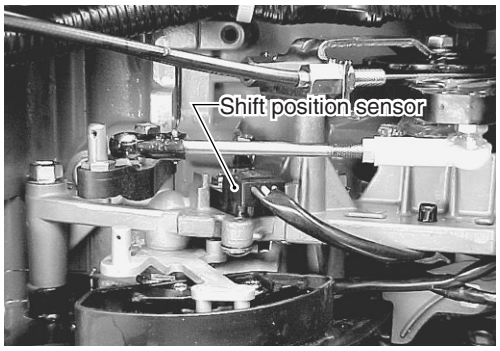
The SPS is installed on the throttle lever holder and detects the shift position with the clutch lever operation interlocked.

This sensor is a variable resistor that changes resistance (ohms) in accordance with the shift position.

The varying resistance value is converted to voltage and input to the ECM.

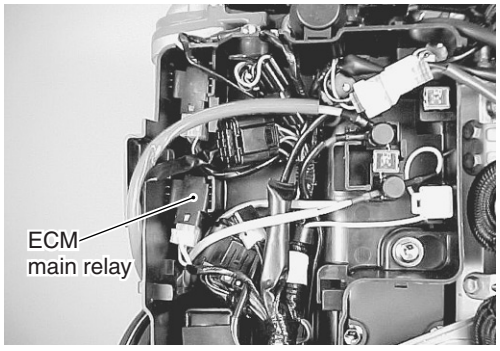
Based on the SPS voltage, the ECM calculates and determines the change of shift position and executes the following controls.

- When the shift is in neutral, fuel injection is controlled to prevent engine speed from exceeding 3 000 r/min.
- After shifting into forward or reverse from neutral, the IAC valve is controlled to increase intake air for 0.1 second to prevent unstable engine idle or stalling.



ECM MAIN RELAY

The ECM main relay is installed in the electric parts holder. When energized by turning the ignition switch ON, a circuit is formed which supplies battery voltage to the ECM, fuel injector, ignition coil, IAC valve, CMP sensor, high/low pressure fuel pump, purge valve, OCV (Oil control valve) and VSV (Vacuum switching valve).

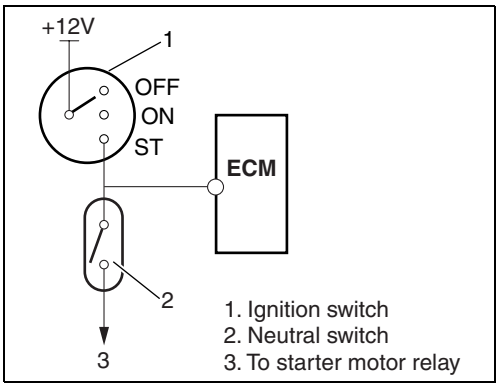


CRANKING SWITCH SIGNAL

The ECM detects the engine being started by the position of ignition switch key. When the ignition key is turned to ST position, a voltage (12 V) signal is input to the ECM.

The ECM in turn controls the actuators for ignition, fuel injection, IAC, etc. to the starting mode.

With the key is turned to IG position after the engine has been started, the input voltage becomes approx. 1.4 V.



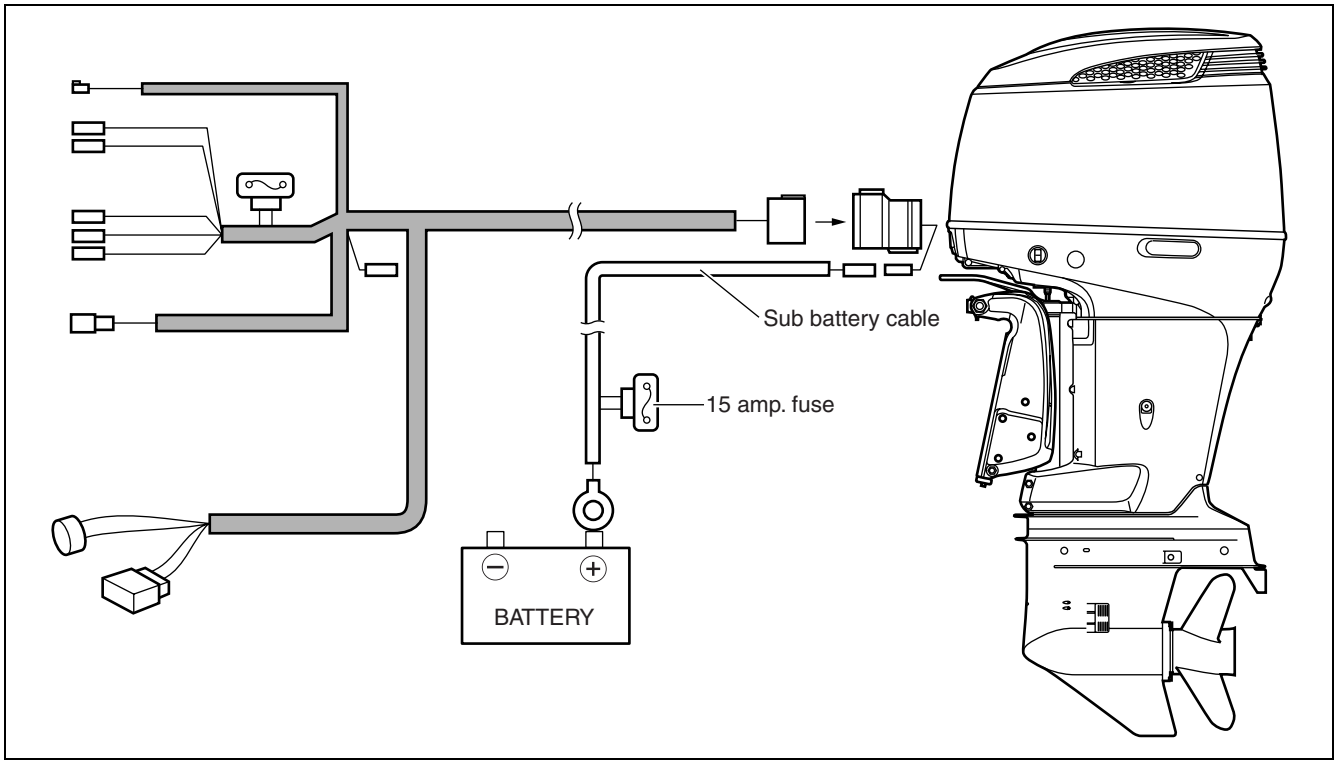
SUB BATTERY CABLE

The ECM power source is through the gray lead wire which supplies power directly from the battery.

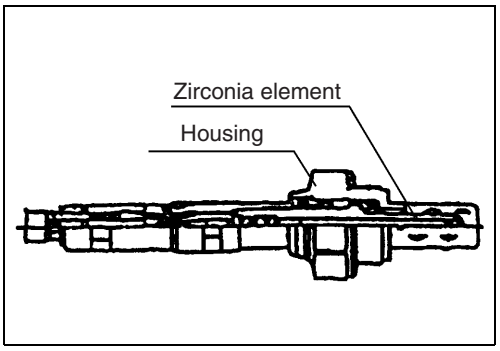
The white lead wire in the remote control extension harness carries battery power to the ignition switch. When the ignition switch is turned ON, battery power passes from the white lead wire, through the ignition switch contacts to the gray output lead wire to the ECM.

NOTE:

Ensure battery cable connections are clean and secure.
Failure at the battery connection will cause incorrect operation of the ECM and starter motor cranking system.



O2 SENSOR (Optional item)



The O2 sensor is installed in the exhaust manifold only when the O2 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 surfaces. The voltage change reflects the concentration of the oxygen in the exhaust gas and is used to perform the O2 feedback operation.

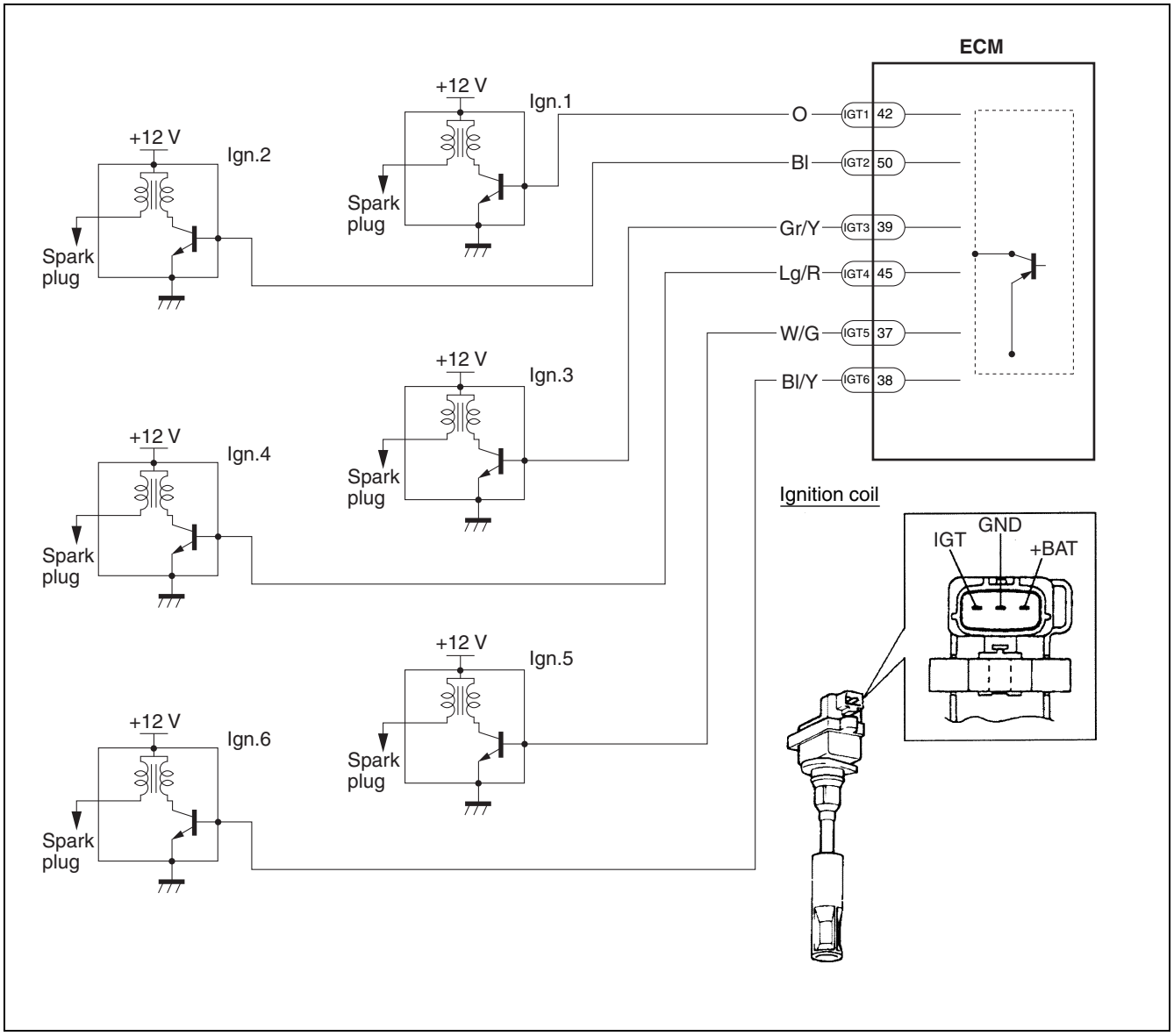
The terminal voltage change (0 – 1 V) is dependent on the concentration of oxygen in the exhaust gas.
This detected voltage value therefore represents the oxygen concentration. The terminal voltage decreases when the oxygen concentration is high, and increases when it is low.

NOTE:
As the Zirconia element is not conductive below 250 °C, the O2 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

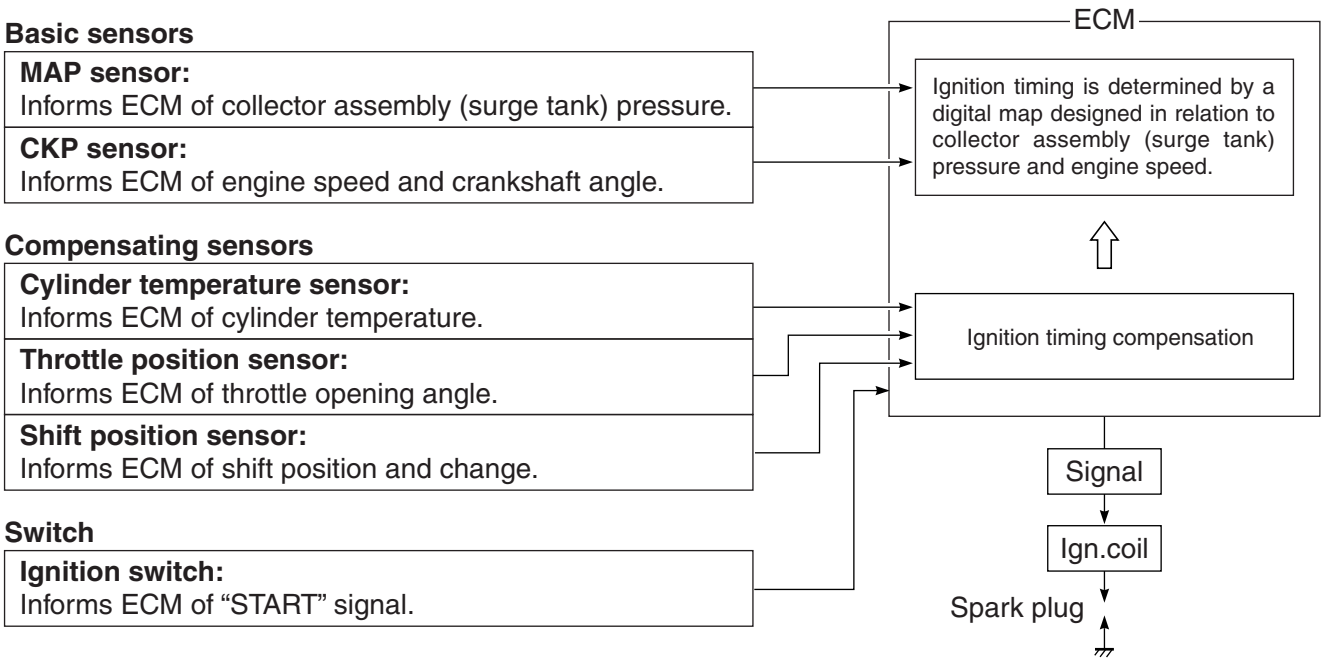
The ignition system used by the DF200/DF225/DF250 is a fully transistorized, electronic microcomputer timing advanced type.
This system is totally battery powered, with the ECM controlling all ignition timing functions.
The ignition system is composed of the ignition coil, spark plug and components for system control (ECM, sensor, switch etc.)
When the ignition switch is “ON”, battery voltage (12 V) is applied to the circuit as shown in the illustration.
The ECM determines the optimum ignition timing and duration of current flowing through the ignition coil primary winding based on the signals received from various sensors. The ECM interrupts the base current of the power transistor inside the ignition coil thereby controling current flow (ignition) to the primary winding of ignition coil.
In this way, a mutual induction high voltage occurs in the ignition coil secondary side and spark is generated.



IGNITION CONTROL SYSTEM

OUTLINE

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.

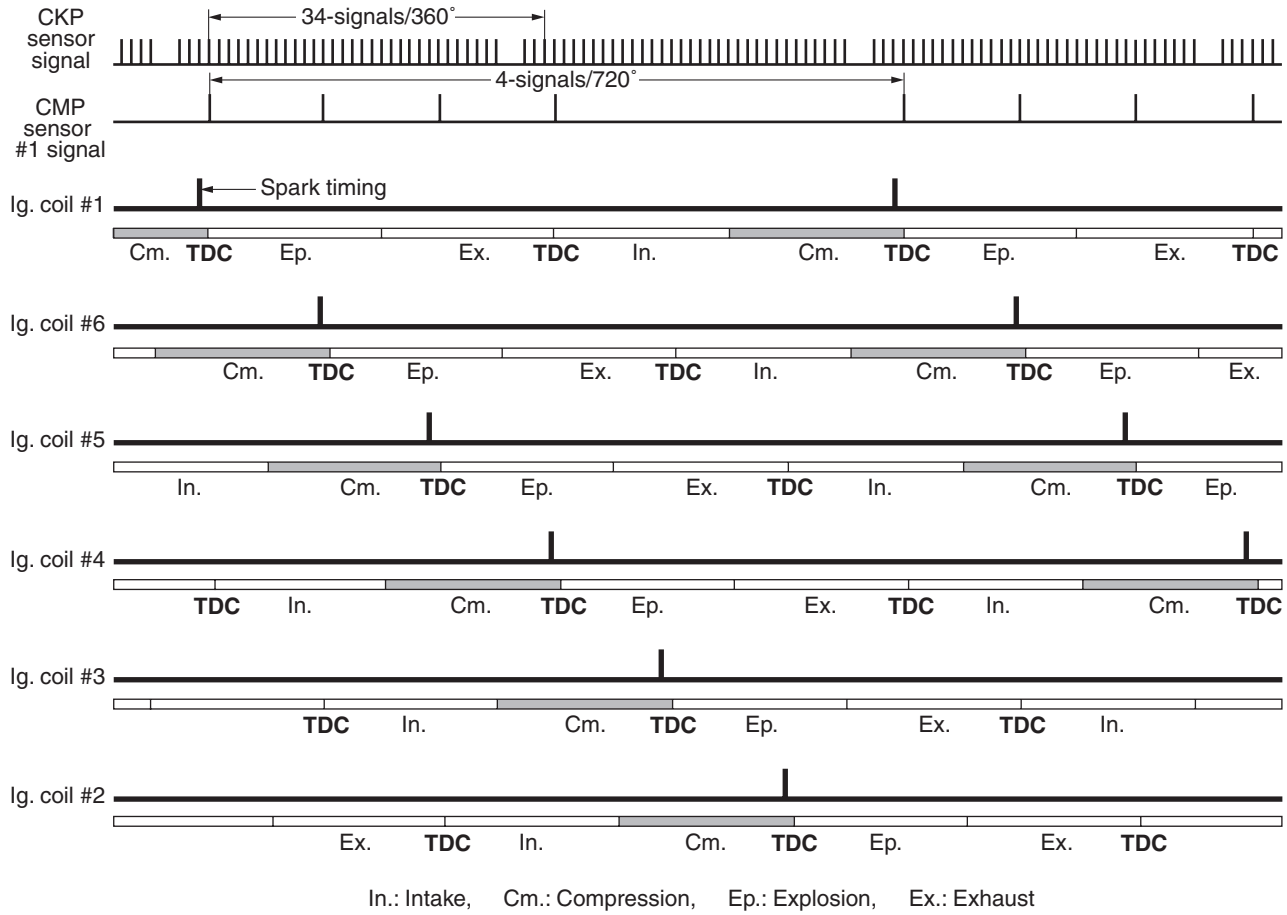


SPECIFICATION

Ignition system	Full-transistorized ignition
Advance	Electronic microcomputer control
Ignition timing	BTDC 0° – BTDC 26° (DF200) BTDC 0° – BTDC 25° (DF225) BTDC 0° – BTDC 26° (DF250)
Firing order	1 – 6 – 5 – 4 – 3 – 2

IGNITION TIMING CHART

The following chart is an example for ignition at BTDC 10°.



CONTROL MODE

WHEN CRANKING:

The ignition timing is fixed at BTDC 5° (STBD bank) or BTDC 0° (PORT bank) until the engine starts.

WHEN IDLING/TROLLING:

The ignition timing is controlled within the range of BTDC 0° ± 5° to provide stable engine operation at the specified idling/trolling speed.

WHEN RUNNING (NORMAL OPERATION):

The ignition timing ranges between BTDC 0° – 26° (DF200), BTDC 0° – 25° (DF225) or BTDC 0° – 26° (DF250), depending on current engine operating conditions.

ELECTRONIC FUEL INJECTION SYSTEM

The fuel injection system used by the DF200/DF225/DF250 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

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 a constant of ATDC 280° (640° of crankshaft rotation) on the exhaust stroke.

Basic sensors

MAP sensor:
Informs ECM of collector assembly (surge tank) pressure.

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

Compensating sensors

Cylinder temperature sensor:
Informs ECM of cylinder temperature.

Exhaust manifold temperature sensor:
Informs ECM of exhaust manifold temperature.

IAT sensor:
Informs ECM of intake air temperature.

TPS (Throttle position sensor):
Informs ECM of throttle opening angle.

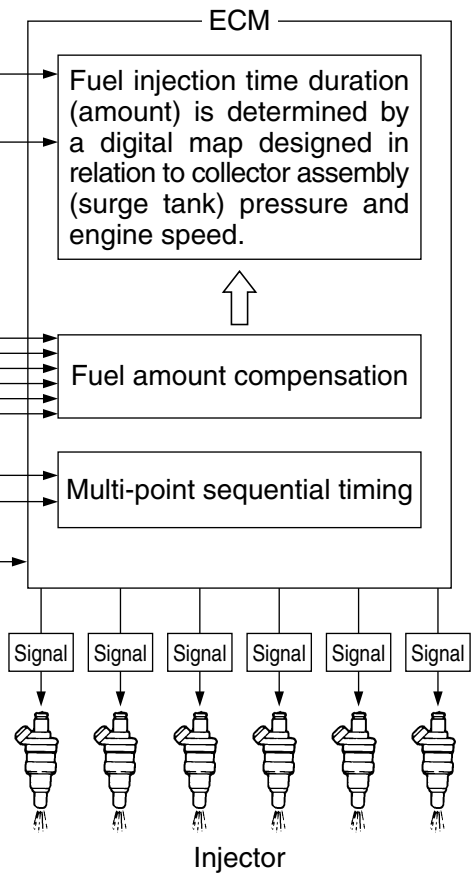
MAP sensor:
Informs ECM of barometric pressure at time of engine start.

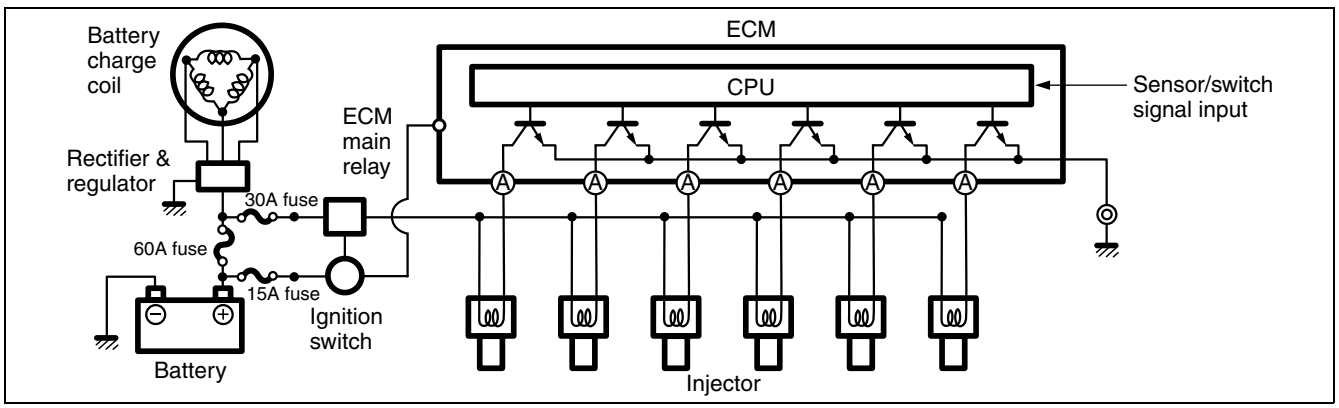
Battery voltage:
Constantly monitored by the ECM.

Others

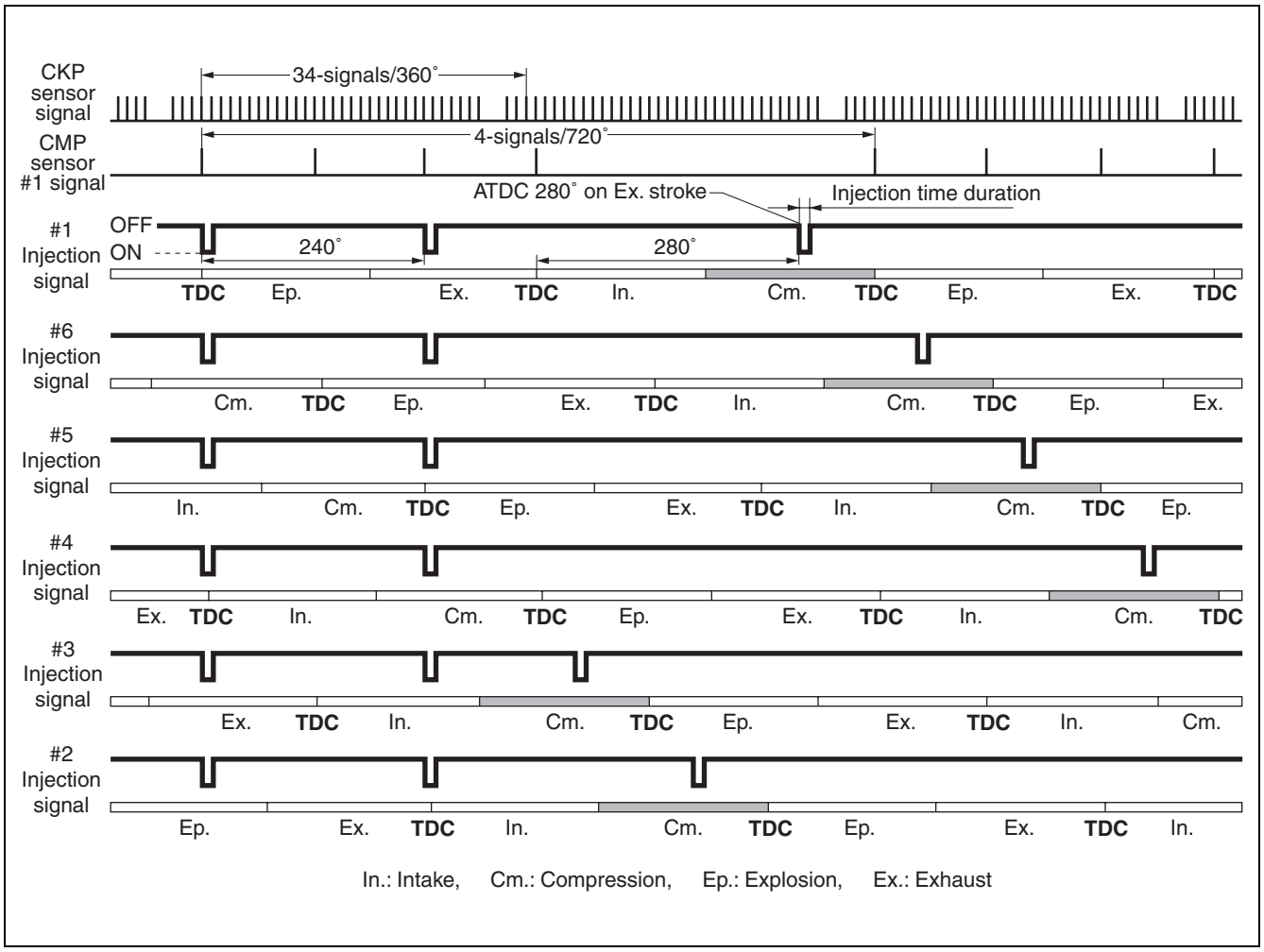
CMP sensor:
Informs ECM of camshaft angle.

Shift position sensor:
Informs ECM of shift position (neutral or in-gear).





FUEL INJECTION TIMING CHART



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 collector assembly (surge tank). This signal is used to compensate the fuel injection map for altitude.

WHEN CRANKING:

Fuel is simultaneously injected to all cylinders according to the “Start up mode” map in relation to crankshaft angle.

AFTER START (FAST-IDLE FUNCTION):

The fuel injection amount is controlled to remain increased 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 fuel 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 fuel pump to the fuel vapor separator.

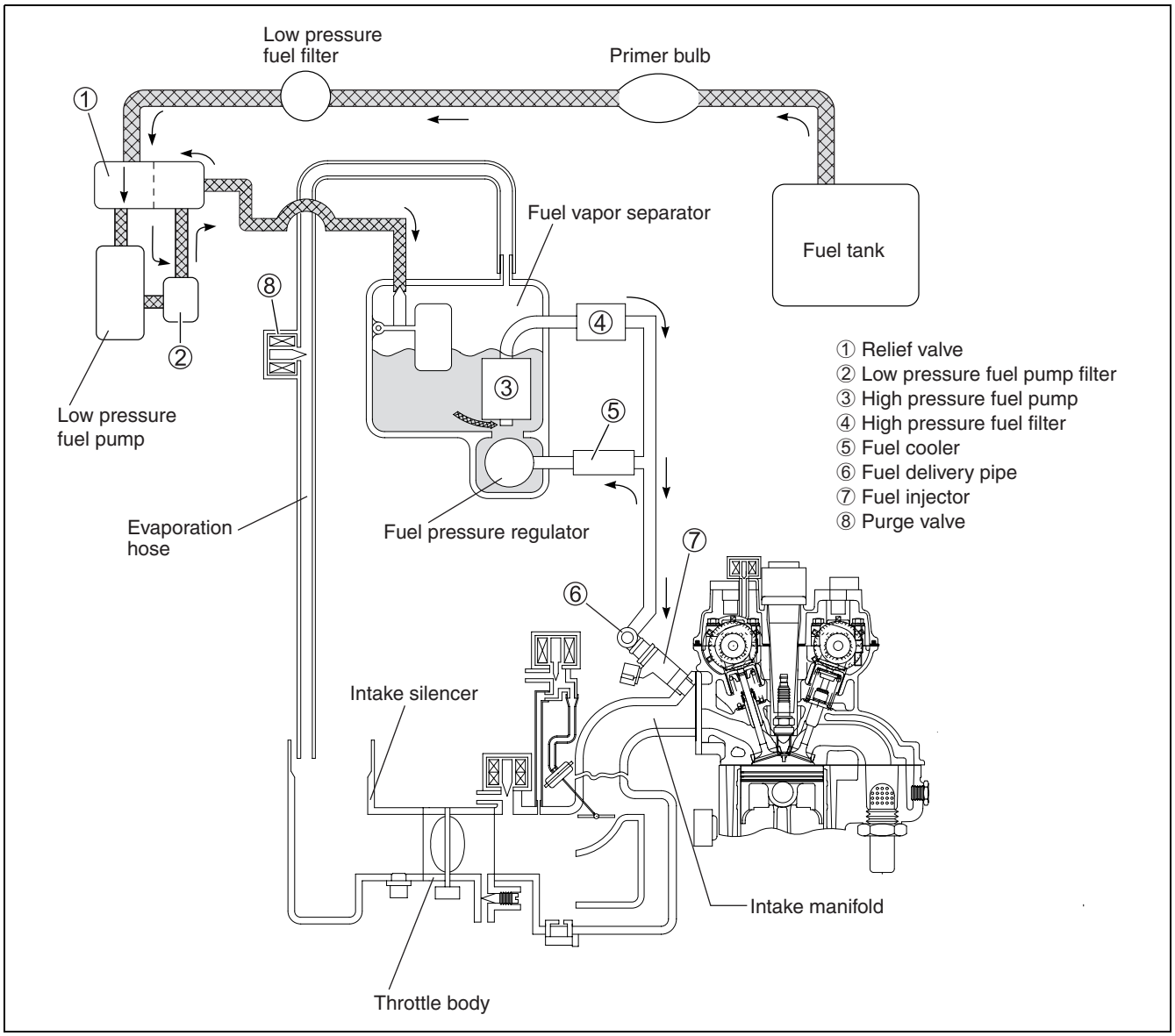
Fuel flow from the fuel vapor separator is pressurized by the high pressure fuel pump and supplied through the high pressure fuel filter and fuel delivery pipe to the fuel injectors.

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 fuel feed line pressure exceeds vapor separator chamber pressure by more than approx. 250 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.

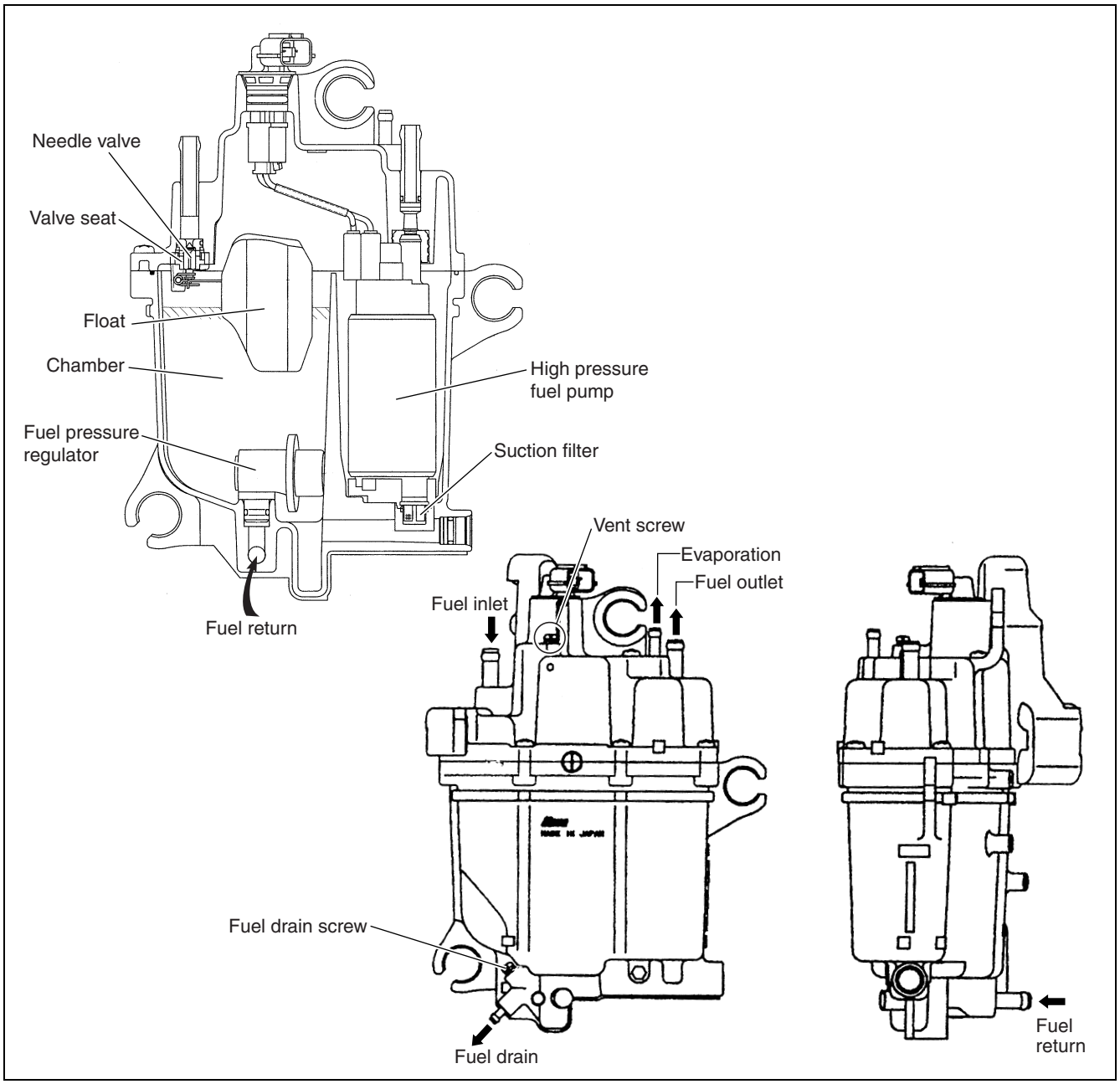
The function of this unit is to separate vapors from fuel delivered by the low pressure fuel pump or fuel returned from the fuel pressure regulator.

This vapor is routed through the evaporation purge system to the air intake silencer case. (See page 3-26 for the Evaporation purge system.)

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 ECM.



FUEL PRESSURE REGULATOR

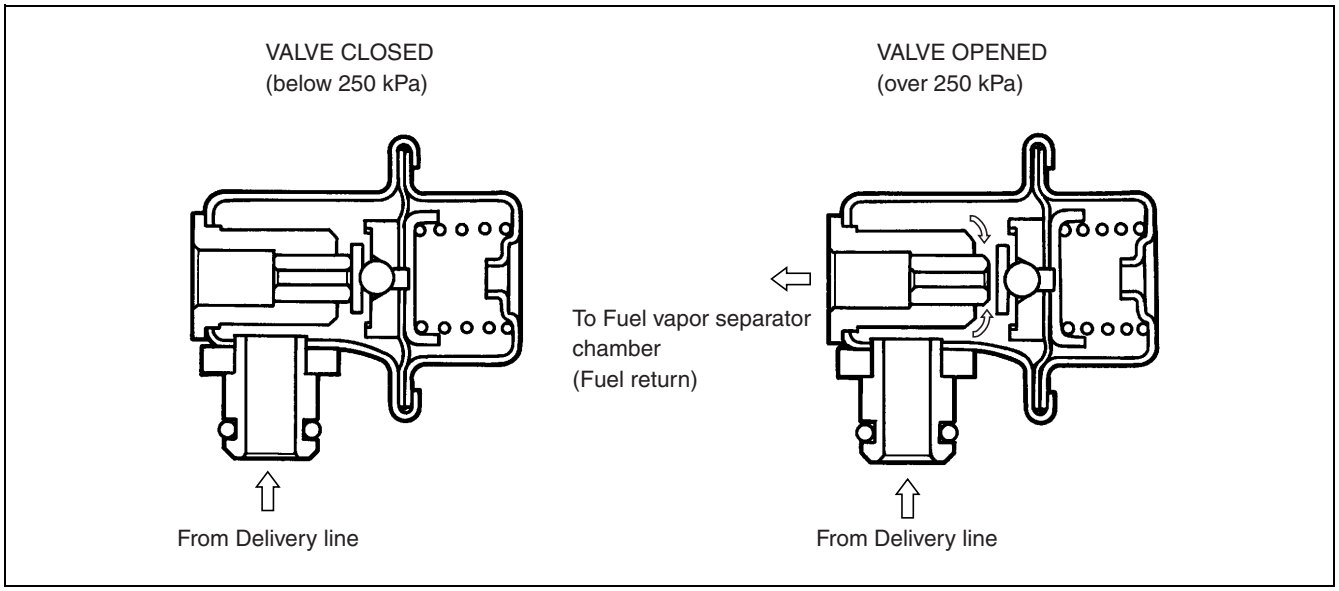
The fuel pressure regulator is located in the fuel vapor separator.

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 fuel 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. 250 kPa (2.55 kg/cm^2, 36.3 psi).

By-pass fuel is returned to the fuel vapor separator chamber.



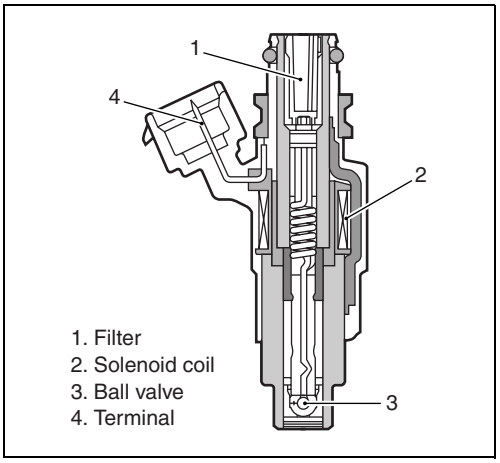
FUEL INJECTOR

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.

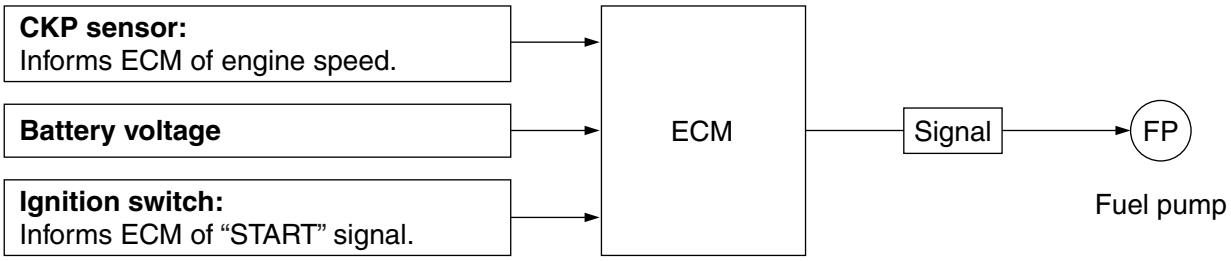


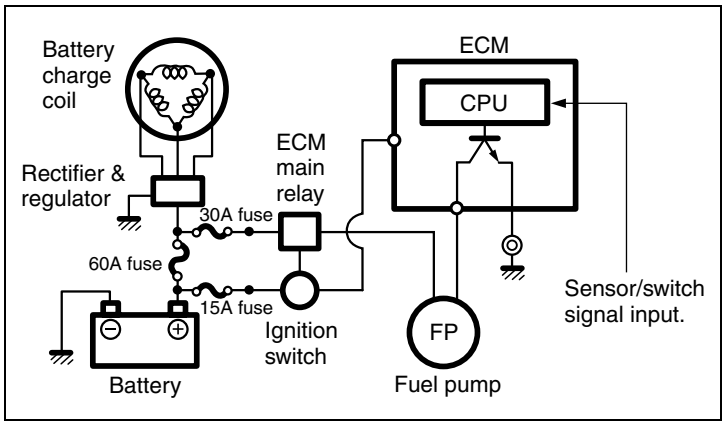
HIGH PRESSURE FUEL PUMP CONTROL SYSTEM

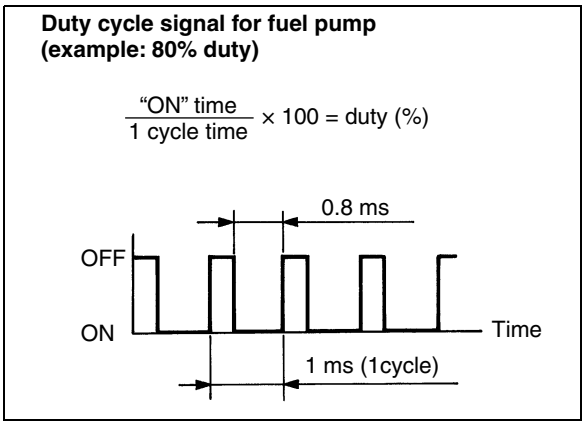
OUTLINE

To supply the optimum fuel amount, the ECM controls the fuel pump drive duty cycle, a repeated ON/OFF signal, at a specified rate (1 000 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 MODES

BEFORE START:

For 6 seconds after the 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.

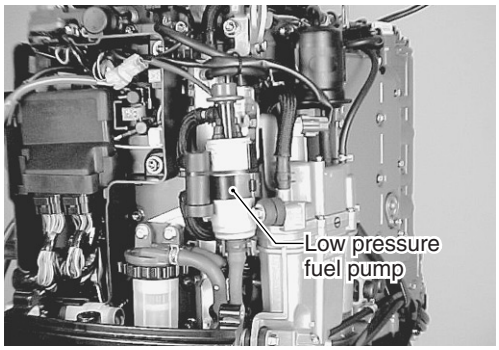
WHEN RUNNING (NORMAL OPERATION):

The pump is controlled to operate at 50 – 100% duty based on the current engine speed and battery voltage.

LOW PRESSURE FUEL PUMP CONTROL SYSTEM

CAUTION

Fuel flowing through the pump is the pump coolant. The fuel pump should never be run dry for long periods or it will become damaged.

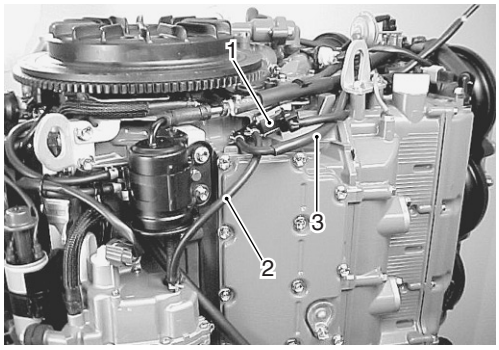


The low pressure fuel pump is an electrically operated type that supplies fuel from the fuel tank to the vapor separator.
The pump is controlled by the ECM and operates with at approx. 100% duty under any of the conditions below.

- Six (6) seconds after the ignition switch has been turned ON.
- Whenever the ECM receives a signal input from the CKP sensor.

EVAPORATION PURGE SYSTEM

The evaporation purge system connects the vapor separator and the air intake silencer case with a hose in which the purge valve is installed. This system' function is to prevent hard starting of the engine during hot soak periods by controlling the discharge of vapors from the vapor separator into the air intake case.
The ECM outputs a signal to the purge valve for opening/closing on the basis of signals from IAT sensor, cylinder temp. sensor, exhaust manifold temp. sensor and CKP sensor. (Normally, the purge valve closes when the engine in shut off and opens after the engine has been started.)



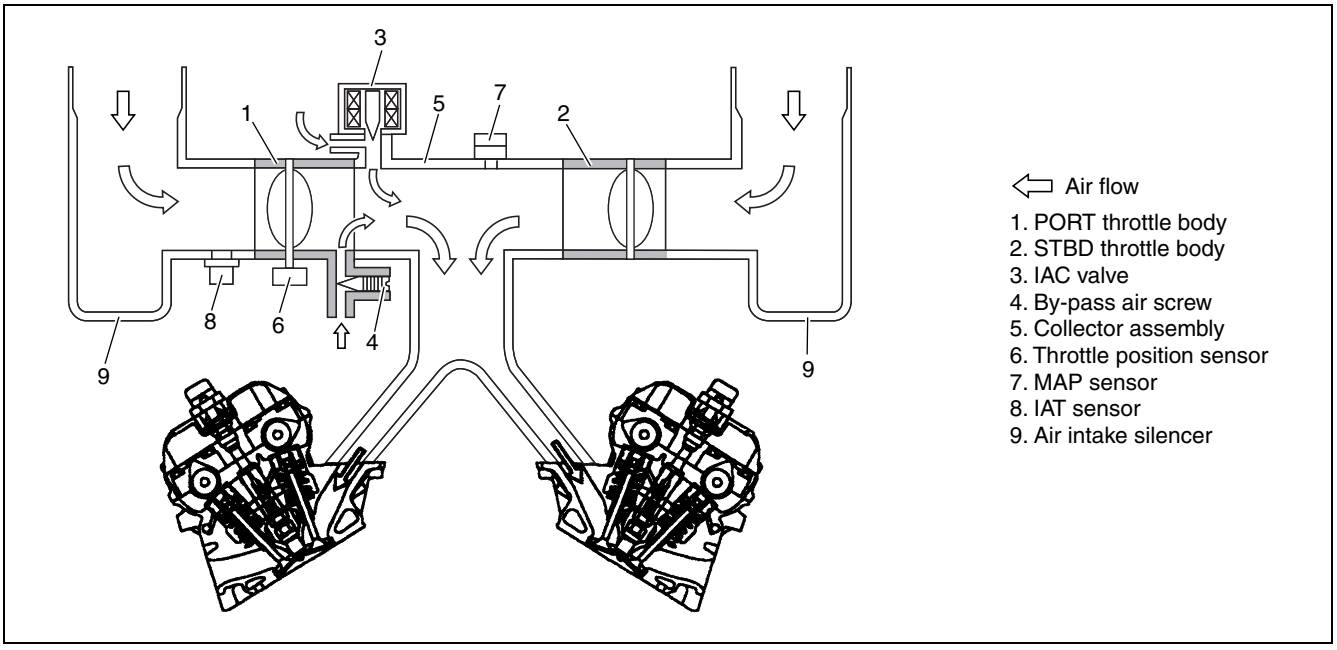
1. Purge valve
2. Hose (Vapor separator to purge valve)
3. Hose (Purge valve to air intake case)

NOTE:

- *The purge valve is driven by a duty cycle control signal from the ECM.*
  During the engines "hot soak period", the valve opens at approx. 2000 r/min. and a 40 – 50% duty control takes place.
  Otherwise, the valve opens after the engine has started and a 30 – 50% *duty control takes place.*
- *Evaporative emissions can occur when fuel heats up and evaporates from the vapor separator. They are also released from a hot engine when it is running and/or idling.*
  After the engine is turned off, engine heat rises slightly as the cooling system water flow ceases, causing a small portion of the fuel in the vapor separator to vaporize. This is generally termed the "hot soak period." Vapors are also released during engine operation as new fuel enters the vapor separator pushing air and fuel vapors out.
- *See page 5-17 for the evaporation purge system check.*

AIR INTAKE COMPONENTS

Air, after entering through the silencer case, passes through the throttle bodies and flows into the collector assembly (surge tank) where it is then distributed to the cylinder intake manifold.
Collector assembly (surge tank) 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 collector assembly (surge tank) air necessary to sustain engine idle passes through the by-pass air passage.
To maintain engine idle speed at specification, the ECM controlled IAC valve supplies a regulated amount of additional air through the IAC (idle air control) passage.

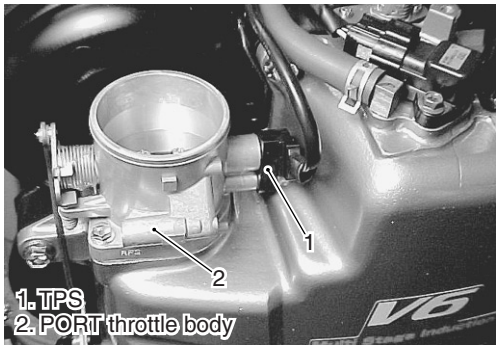


THROTTLE BODY

- Two throttle bodies are located on top of the collector assembly.
- The PORT throttle body assembly consists of the main bore, throttle valve, by-pass air passage, by-pass air screw and TPS (Throttle position sensor).
- The STBD throttle body assembly consists of the main bore and throttle valve.
- The throttle body adjusts the intake air amount with the throttle valve which is connected to the throttle lever linkage.
- The TPS installed on the PORT throttle body informs of throttle valve opening angle.



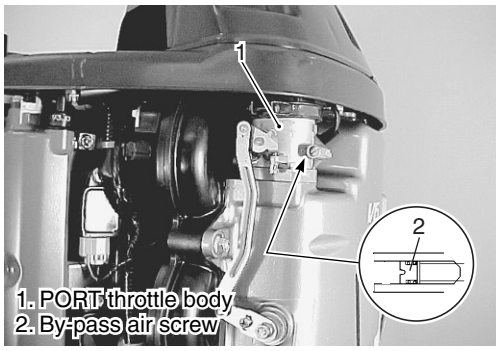
NOTE:
Do not try to adjust or remove any of the throttle body component parts (Throttle position sensor, throttle valve, throttle stop screw, etc.).
These components have been factory adjusted to precise specifications.



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 page 2-16 for the by-pass air screw adjustment procedure.

IAC VALVE/PASSAGE

The IAC valve is a stepper motor type mounted on the collector assembly.

Its purpose is to control the amount of intake air flowing from the IAC passage.

The IAC valve consists of a stepper motor, rod, valve and other parts.

As the stepper motor is controlled by signals from the ECM, valve position changes will increase or decrease the air flow through the IAC passage.



IDLE AIR CONTROL SYSTEM

OUTLINE

The ECM controls the position of the IAC' valve to regulate a portion of the intake air flow to the collector assembly.

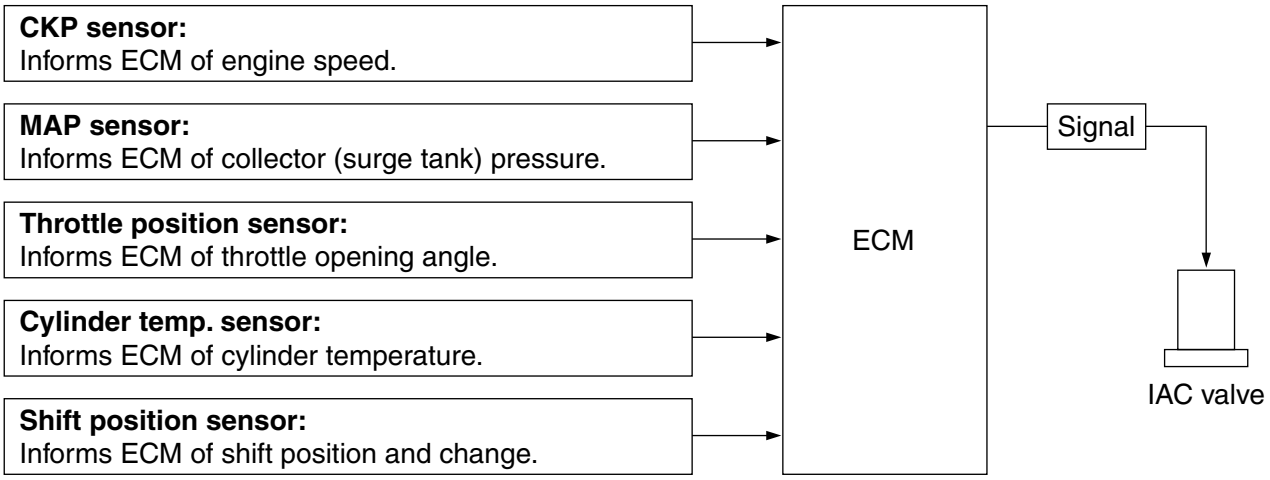
This system is used for the following purposes:

- To keep idling/trolling at 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.

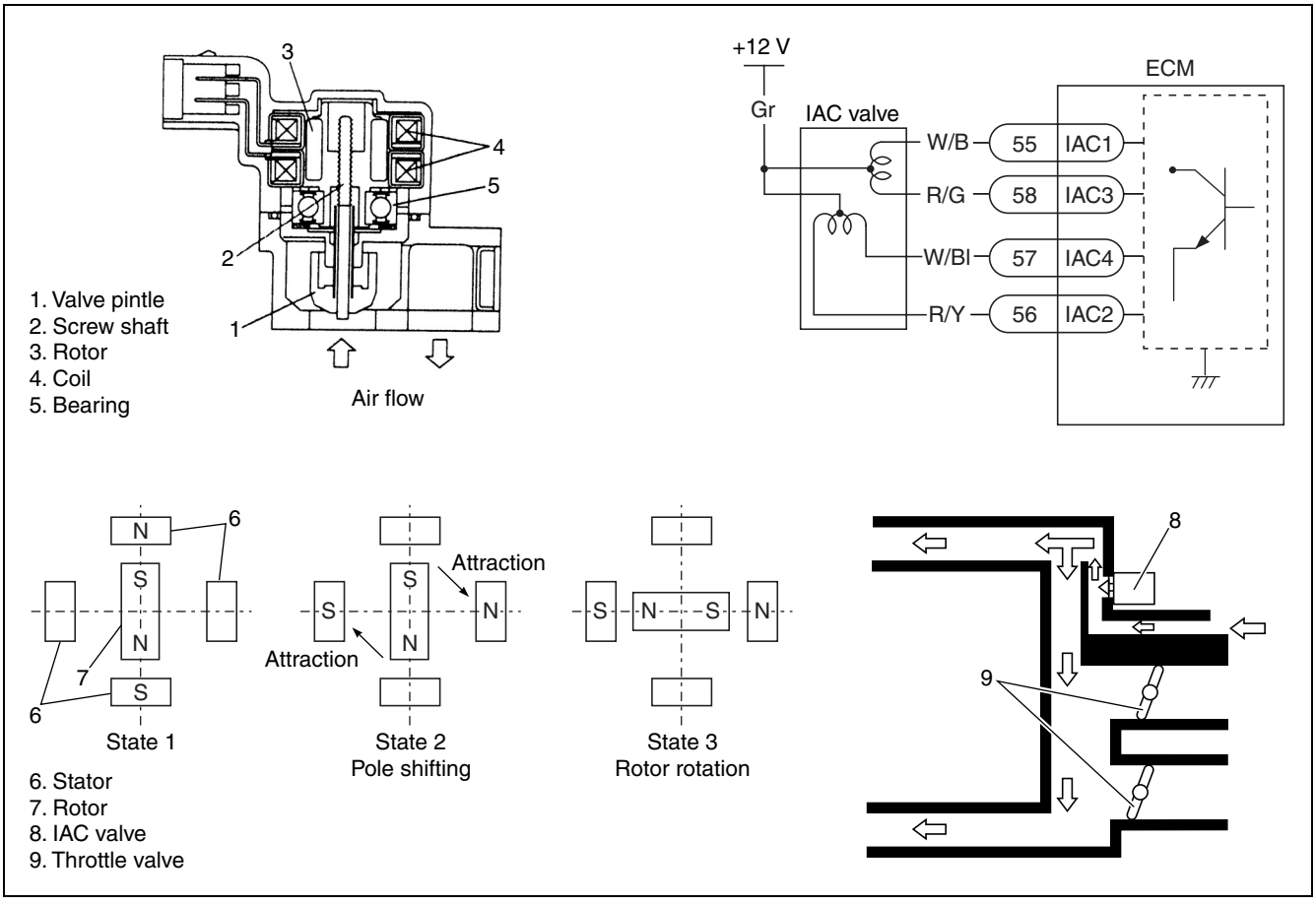
Based on these signals, the ECM determines the IAC valve opening necessary to achieve the target engine revolution and outputs the signal for actuating the stepper motor inside the IAC valve.

The rotor of the stepper motor then turns in an amount equal to the steps of the signal supplied from the ECM, moving the valve via a screw shaft.



IAC VALVE

- The IAC valve uses a stepper type motor.
- The IAC valve is installed on the intake collector assembly.
- The IAC valve controls the volume of bypass air to stabilize the idling/trolling speed.
- The transistor driving the IAC is inside the ECM and turns ON/OFF when a signal (command) is received from the CPU.
  This signal operates the stepper motor inside the IAC valve, causing it to be driven equal to the number of command signal steps. Through this procedure, the system is able to attain a very precise target idling/trolling speed.
- The stepper motor rotates by means of magnetic attraction between the stator and rotor. More specifically, shifting the stator excitation in State (1) of below illustration to that in State (2) will develop a magnetic torque to cause the rotor to rotate and then stabilize in State (3). (The illustration at below shows the operating principle of a simple stepper motor. This example differs slightly from the 2-phase excitation method used in the actual application). This operation is repeated equal to the number of command signal steps from the ECM resulting in rotation of the rotor. With the screw shaft installed, this rotation is converted to a linier motion of the valve pintle that changes the volume of IAC air flow.
- Battery voltage is applied to the center tap of each coil through the ECM main relay when the ignition switch is turned on. The Each coil end connects to one of the ECM terminals “IAC 1-4”.
  The terminal voltage at ECM terminals “IAC 1-4” is 1 V MAX when current flows and battery voltage at all other times.



CONTROL MODE

BEFORE START:

The IAC valve is initialized at 70% opening position when engine is not running (Ignition switch OFF).

WHEN CRANKING:

The IAC valve is controlled to operate at approx. 50 – 100% duty.
Duty change depends on cylinder temperature.

AFTER START (FAST-IDLE FUNCTION):

The IAC valve is controlled to operate at approx. 40 – 70% duty until the timer, (set according to cylinder temperature at cranking) expires, then decrease duty gradually to reach the set rpm at idle.

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 of approx. 30% but will vary slightly as idling/trolling conditions change.

WHEN RUNNING (NORMAL OPERATION):

The IAC valve is controlled to operate at 20 – 90% duty, dependent on current engine conditions.

WHEN DECELERATING (DASH-POT EFFECT):

When the throttle valve is suddenly returned to full close and the throttle position sensor signal changes to “fully closed”, 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. 30 ± 5% duty at the engine idling/trolling specification. See page 2-16 for the by-pass air screw adjustment procedure.

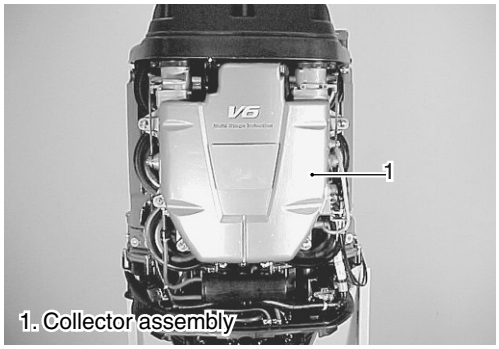
MULTI-STAGE INDUCTION

OUTLINE

The multi-stage induction system is designed to improve the intake efficiency by changing the intake tract volume in accordance with the engine speed.
This system improves low and mid range torque and increases power output at the higher rpm ranges.

SYSTEM COMPOSITION

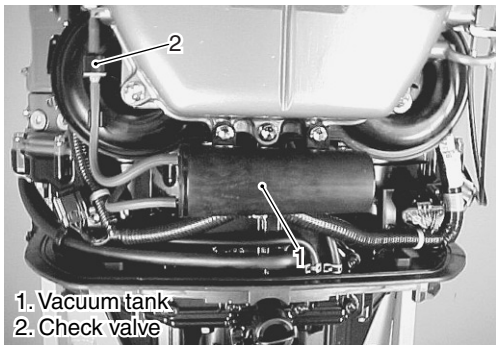
Located between the STBD and PORT banks, a collector assembly provides air for the low/mid range intake tract and high speed range tracts. Mounted on the collector are two throttle bodies, VSV (Vacuum Switching Valve), vacuum tank, depression chamber for operating the system and the shut off valve for switching the intake tract. System connection components include one check valve and hose to form the vacuum passage.



1. Collector assembly

• VACUUM TANK

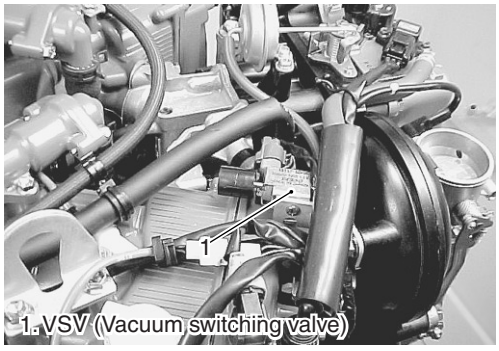
The vacuum tank stores vacuum created during engine operation. The vacuum tank' purpose is to supply a stable vacuum to the depression chamber under the varying vacuum conditions normally occurring within the collector, thereby making it possible to control the shut off valve accurately.
A hose and check valve connects one side of the vacuum tank to the collector. The other side of the tank is connected to the VSV with a hose.



1. Vacuum tank
2. Check valve

• VSV (Vacuum switching valve)

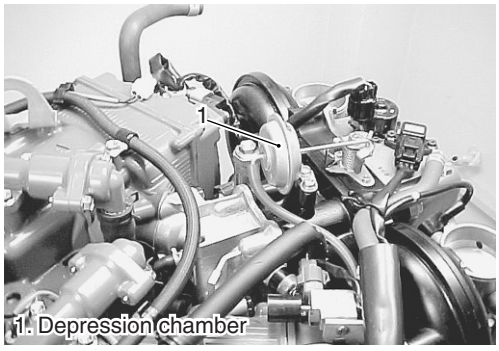
One side of the VSV is connected via hose to the vacuum tank, the other side is connected via hose to the depression chamber. The VSV receives operating signals from the ECM. When the ECM signals OFF, the VSV releases vacuum to the atmosphere. When the ECM signals ON, the VSV supplies vacuum to the depression chamber.



1. VSV (Vacuum switching valve)

• DEPRESSION CHAMBER

The depression chamber is designed to open/close the shut off valve.
When vacuum is applied to the depression chamber, the rod in the chamber is pulled in closing the shut off valve.
When vacuum is not applied to the chamber, the rod returns to the original position, opening the shut off valve.



1. Depression chamber

SYSTEM OPERATION

This system is operated by the vacuum created during engine operation and controlled by the ECM.
To operate the system (open/close the shut off valve to change the intake tract), the collector, check valve, vacuum tank, VSV and depression chamber are connected with hoses as shown in the illustration.
A rod is used to connect the shut off valve and depression chamber for opening and closing the valve.

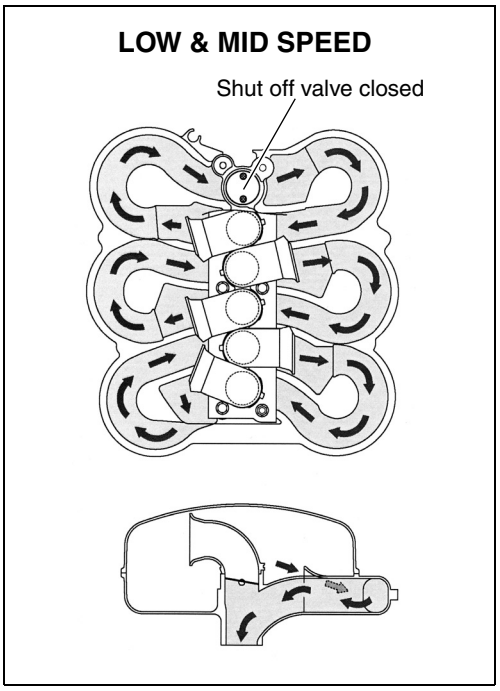
• LOW & MID SPEED RANGE

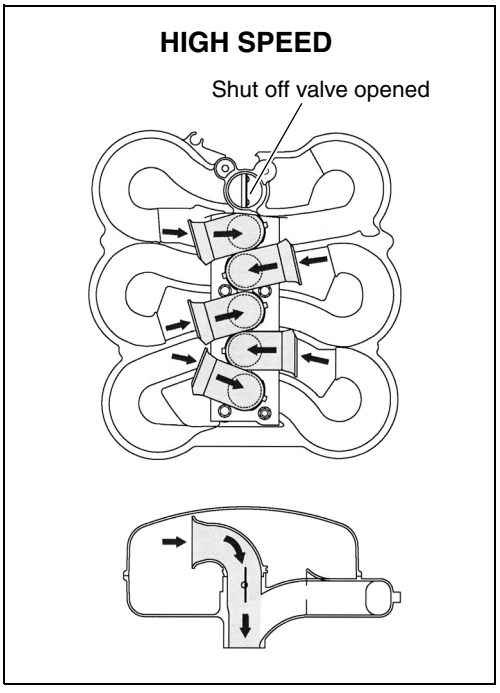
When engine speed is below the preset value (*), the ECM generates a signal to turn the VSV ON, applying vacuum to the depression chamber which closes the shut off valve.
With the valve closed during the engines low to mid speed range, intake air is supplied through the low/mid speed intake tract only.
In this operating mode, intake air speed is boosted and, combined with the resonance effect, increases low and mid speed range engine torque.

*: Preset value;
DF225: approx. 4 200 r/min DF250: approx. 4 800 r/min

• HIGH SPEED RANGE

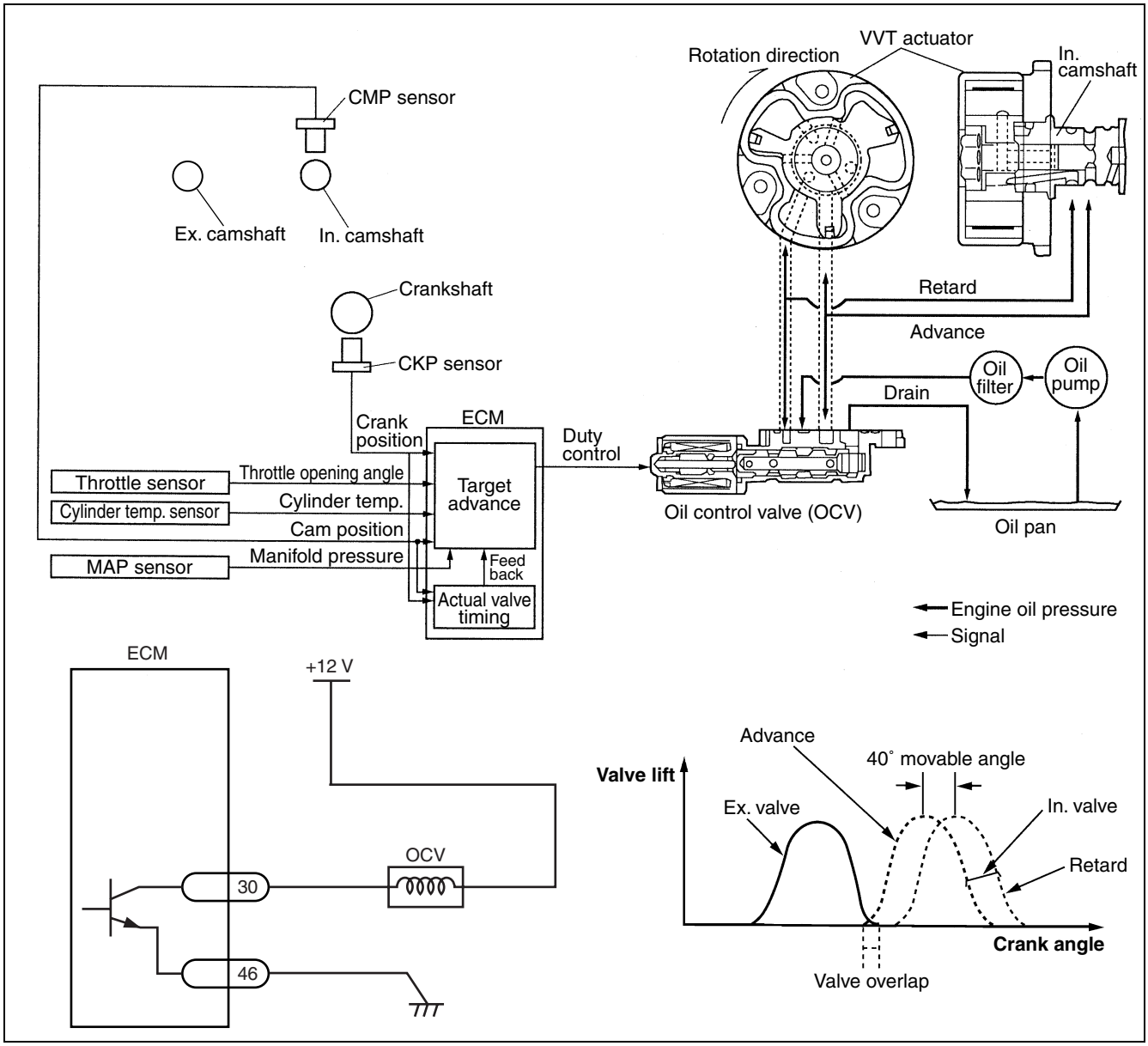
When the engine speed is above the preset value (*), the ECM generates a signal to turn the VSV OFF, and vacuum is no longer applied to the depression chamber.
Without vacuum the shut off valve return spring returns and holds the valve in its normal open position.
In this operating mode, intake air is supplied to the engine through the high speed intake tract only.
This enlarges the intake tract volume, improves intake inertia and efficiency, which increases the engines output power.





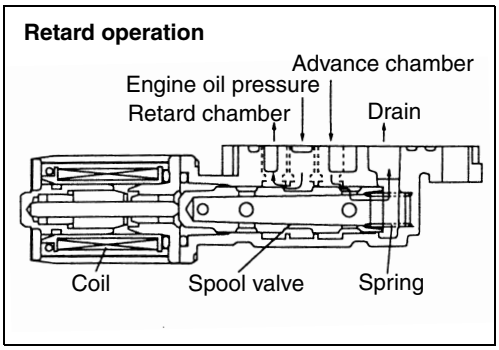
VVT (Variable Valve Timing) SYSTEM

- The VVT system is designed to continuously vary intake valve timing to best fit the engines current operating condition.
- The intake cam timing sprocket assembly (VVT actuator) is located at the front end of the intake camshaft. The timing sprocket' internal rotor is operated by engine oil pressure. Since the rotor and intake camshaft are bolted together, the rotor and camshaft move together. Varying the intake valve timing is accomplished by changing the intake camshaft phase angle relative to the intake cam timing sprocket using pressurized engine oil applied to the rotor through an ECM controlled oil control valve.
- The oil control valve (OCV) directs engine oil pressure to the advance chamber or retard chamber inside the intake cam timing sprocket assembly (VVT actuator). The oil control valve operates on a duty cycle controlled by the ECM.
- The ECM determines the optimum valve timing (advance angle) under various operating conditions based on engine speed, throttle opening and cylinder wall temperature. These input values are then used to control the position of the oil control valve (OCV). The ECM also detects the actual advance angle from the CMP sensor inputs to perform feedback control and accurately maintain the target advance angle.



OCV (Oil Control Valve)
Two OCV are used, one installed on each (PORT/STBD) lower camshaft housing.

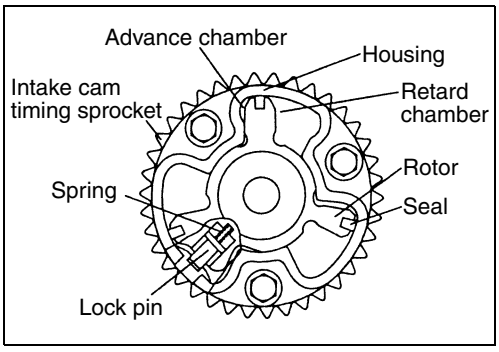
RETARD OPERATION
When the duty ratio of the ECM is small, the OCV spool valve is pushed away from the coil by spring force and engine oil pressure is applied to the retard chamber.
Engine oil remaining in the advance chamber is drained out through the spool valve.



ADVANCE OPERATION
When the duty ratio of the ECM is large, the spool valve is towards the coil by magnetic force, compressing the spring and applying engine oil pressure to the advance chamber side.
Engine oil remaining in the retard chamber side is drained out through the spool valve.

RETAINING OPERATION
When the duty ratio of the ECM is medium, the OCV coil magnetic and return spring forces are equal. This positions the spool valve between the advance and retard chamber, closing both oil passages.

INTAKE CAM TIMING SPROCKET ASSY
Inside the intake cam timing sprocket assembly (VVT actuator), there are separate advance chamber and retard chamber formed by partition of the rotor.
The rotor moves inside the housing as engine oil pressure is applied to the advance or retard chamber.
The intake cam timing sprocket is part of the sprocket housing assembly. Since the rotor and intake camshaft are bolted together, when the rotor moves inside the housing, a change of phase angle takes place in the relative position between the intake camshaft and intake cam timing sprocket. The rotor has a spring pressured lock pin which engages with the housing when spring force is greater than oil pressure, locking the rotor in the most retarded position. This prevents a change of phase angle between the intake camshaft and intake cam timing sprocket when the engine oil pressure is low at engine start.
When the engine is started and the engine oil pressure is applied to the advance chamber, the lock pin is forced up, compressing the return spring, releasing the rotor and allowing the VVT actuator to function.



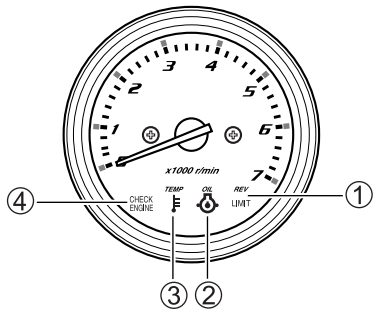
CAUTION SYSTEM

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

OVER-REVOLUTION CAUTION SYSTEM

CONDITION:

The ECM controlled over revolution limiter will engage at the engine speeds shown below. Once engaged it will initiate an intermittent fuel injection signal to reduce engine speed.

Over revolution limiter

DF200/DF225 : 6 200 r/min
DF250 : 6 300 r/min

ACTION:

Engine speed	Automatically reduced to approx. 3 000 r/min by intermittent fuel injection signal.
Caution lamp	"REV-LIMIT" lamp lights continuously.
Caution buzzer	No buzzer sounds.

RESET:

Close throttle to reduce engine speed below approx. 3 000 r/min for one second.

LOW OIL PRESSURE CAUTION SYSTEM

CONDITION:

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

ACTION:

Engine speed	Automatically reduced to approx. 3 000 r/min by intermittent fuel injection signal if the system is activated at 3 000 r/min or higher.
Caution lamps	“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 engine and check engine oil level. Refill 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 the 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. 3 000 r/min or less engine speed operation.
However, the engine must be stopped and checked immediately once the system is activated.

OVERHEAT CAUTION

CONDITION 1 (Maximum temperature)

Immediate activation of system when:

- Cylinder temperature reaches 120 °C (248 °F)
- Exhaust manifold temperature reaches 114 °C (237.2 °F)

CONDITION 2 (Temp. rise vs Time)

Immediate activation of system when:

- The average temperature difference during three consecutive 10 second 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
88 – 99 °C (190 – 210 °F)	Approx. 8 °C (46 °F)
99 °C – (210 °F)	Approx. 1.5 °C (35 °F)

- The average temperature difference during three consecutive 10 second 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 – 95 °C (176 – 203 °F)	Approx. 14 °C (57.2 °F)
95 °C – (203 °F)	Approx. 1.7 °C (35 °F)

ACTION:

Engine speed	Automatically reduced to approx. 3 000 r/min by intermittent fuel injection and ignition signals if the system is activated at 3 000 r/min or higher.
Caution lamps	“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 throttle completely and then shift into neutral.

System reset will occur when cylinder temperature drops below the limits shown below. 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. 78 °C (172 °F)
Condition 2 (Temperature rise vs Time)	Approx. 76 °C (169 °F)

LOW BATTERY VOLTAGE CAUTION SYSTEM

CONDITION 1:
System activated when battery voltage decreases to less than 9 volts for 30 seconds.

CONDITION 2:
System activated if battery voltage is less than 2 V for more than 2 seconds with the ignition switch turned "ON" and engine not running.

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.

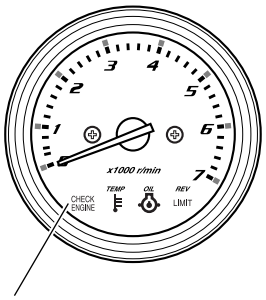
RESET:
CONDITION 1:
This caution system is automatically reset when battery voltage increases to more than 9 volts. Refrain from using electrical equipment requiring high amperage such as hydraulic trim tabs, hydraulic jack plate, etc. after this caution is activated.

CONDITION 2:
For the caution system to engage under this condition possibilities such as deteriorated battery, poor battery cable connection, battery switch in OFF condition, etc. must be inspected.
To cancel the caution system activation for these conditions, check all power source related items and eliminate the problem.

SELF-DIAGNOSTIC SYSTEM

The self-diagnostic system alerts the operator when an abnormality occurs in a signal from 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 engine is running, the buzzer sounds a series of short (0.2 sec) beeps.
When 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.

MONITOR-TACHOMETER



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	IAC valve/By-pass air screw adjustment		3 – 1	ON OFF	NO
3	Cylinder temp. sensor		1 – 4	ON OFF	YES
4	IAT sensor		2 – 3	ON OFF	YES
5	CKP sensor [NOTE 1]		4 – 2	ON OFF	YES
6	CMP sensor		2 – 4	ON OFF	YES
7	Air intake system		2 – 2	ON OFF	YES
8	MAP sensor 2 (Pressure detect passage)		3 – 2	ON OFF	NO
9	Rectifier & regulator (Over-charging) [NOTE 2]		1 – 1	ON OFF	NO
10	Exhaust manifold temp. sensor	STBD	1 – 5	ON OFF	YES
11		PORT	1 – 6	ON OFF	
12	Fuel injector		4 – 3	ON OFF	NO
13	Throttle position sensor		2 – 1	ON OFF	YES
14	Shift position sensor		1 – 2	ON OFF	YES
15	CMP sensor (VVT·STBD)		2 – 5	ON OFF	YES
16	CMP sensor (VVT·PORT)		2 – 6	ON OFF	YES
17	VVT advance (STBD)		5 – 1	ON OFF	YES
18	VVT advance (PORT)		5 – 2	ON OFF	YES
19	Neutral switch		3 – 3	ON OFF	NO
20	Model discrimination/ Check code wire [NOTE 3]		4 – 1	ON OFF	YES
21	Oil control valve (STBD)		6 – 1	ON OFF	NO
22	Oil control valve (PORT)		6 – 2	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 cylinder temp. sensor, exhaust manifold temp. sensor or 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:

To cancel the diagnostic display of CKP sensor, perform the following procedures after the failure has been corrected:

(1) Start the engine. The diagnostic code for CKP sensor failure will continue to be displayed until a normal signal sequence is received by the ECM. Thereafter only the display being conceled. At this stage of the diagnostic system reset process the diagnostic code for a failed CKP sensor is not displayed but the engine is still controlled using the CMP sensor signal.

(2) Stop the engine and restart. At the second restart, complete canceling of the CKP sensor failure code will occur.

NOTE 2:

This self-diagnostic indication may not display (be canceled) by turning the 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.

NOTE 3:

The diagnostic code for model discrimination is displayed when a failure (either open or short circuit) exists in No.13 terminal of the wiring harness connector.

When this code is displayed, the first check should be for a failure in the wiring harness.

When this code is displayed, do not replace the ECM.

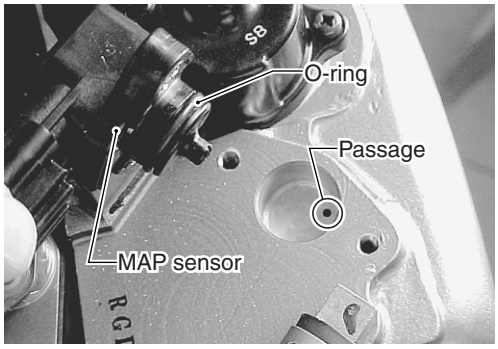
Replacing the ECM may cause improper execution of the self-diagnostic for model discrimination possibly leading to engine trouble.

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 (1.46 – 33.86 inHg) (0.50 – 4.84 V)" signal (With engine running)
IAC valve/By-pass air screw adjustment	• IAC valve operates at 80% duty or higher when ECM receives fully closed position signal from throttle position sensor. [NOTE 1]
Cylinder temp. sensor	• No signal • Receiving an out of range "– 46 to +170 °C (– 114.8 – +338 °F) (0.10 – 4.6 V)" signal
IAT sensor	• No signal • Receiving an out of range "– 46 to +169 °C (– 114.8 – +336.2 °F) (0.10 – 4.6 V)" signal
CKP sensor	• During one crankshaft rotation, 34 signals are not input to ECM.
CMP sensor	• During two crankshaft rotation, 4 signals are not input to the ECM.
Air intake system	• During the ECM's receiving input of the complete close signal from the throttle position sensor, the engine operates at an abnormally high speed. (Criterion: 2 500 r/min MIN)
MAP sensor 2 (Pressure detect passage)	• Receiving unchanging signal regardless engine speed change. [NOTE 2]
Rectifier & Regulator. (Over-charging)	• Receiving 16 volts or higher signal
Exhaust manifold temp. sensor (PORT or STBD)	• No signal • Receiving an out of range "– 46 to +170 °C (– 114.8 – +338 °F) (0.10 – 4.6 V)" signal
Fuel injector	• No operation signal from the ECM
Throttle position sensor	• No signal
Shift position sensor	• No signal
CMP sensor (VVT PORT or STBD)	• During two crankshaft rotation, 4 signals are not input to ECM.
VVT advance (PORT or STBD)	• There is a large difference between the target advance angle and the actual advance angle.
Neutral switch	• While the shift sensor outputs the forward or reverse signal, the ECM receives input of the neutral signal from the neutral switch.
Model discrimination	• There is discrepancy of signal between the ECM memory storage and the model discrimination terminal. • [No.13 terminal open. (DF200)] • [No.13 terminal short circuit. (DF225/250)]
Oil control valve (PORT or STBD)	• OCV not operating.

NOTE 1:
These conditions 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 clogged pressure detect passage in collector assembly.



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	• 280 – 560 mmHg (11.02 – 22.05 inHg)/(The control takes place in accordance with the engine speed.) [NOTE 1]
CKP sensor	Based on signals from CMP sensor: • The ignition timing is controlled in 0 – 10 degree range in accordance with the engine condition. • Normal sequential fuel injection.
CMP sensor	Based on signals from CKP sensor: (a) Failed with engine running • Normal ignition timing. • Normal sequential fuel injection. • VVT advance is fixed at the most retarded angle. (b) Failed prior to engine start • The ignition timing is controlled in 0 – 10 degree range in accordance with the engine condition. • 1 simultaneous injection for all cylinders per 2 crankshaft rotations. • VVT advance is fixed at the most retarded angle.
Air intake system	• The control is executed with the maximum engine speed as 2000 r/min.
Cylinder temp. sensor	• 60 °C (140 °F)
IAT sensor	• 45 °C (113 °F)
Exhaust manifold temp. sensor	• 60 °C (140 °F)
Throttle position sensor	• The control is executed with the throttle opening as 5 degrees. • VVT advance is fixed at the most retarded angle.
Shift position sensor	• The shift position whether neutral or other is detected with the neutral switch signal. • The IAC control is operated in the forward map.
CMP sensor (VVT)	• VVT advance is fixed at the most retarded angle.
VVT advance	• VVT advance is fixed at the most retarded angle. • The ECM cyclically outputs the drive and stop signals for the OCV and when the difference between the VVT's target advance angle and the actual advance angle has come to the normal range, the diagnostic code display is canceled.
Model discrimination	• The original model discrimination is retained.

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

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 flash.

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

MONITOR-TACHOMETER

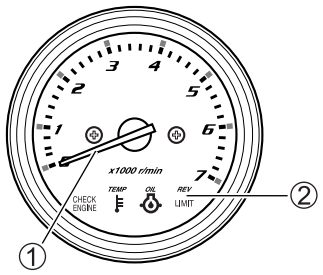


CHART OF TOTAL OPERATING HOURS INDICATION

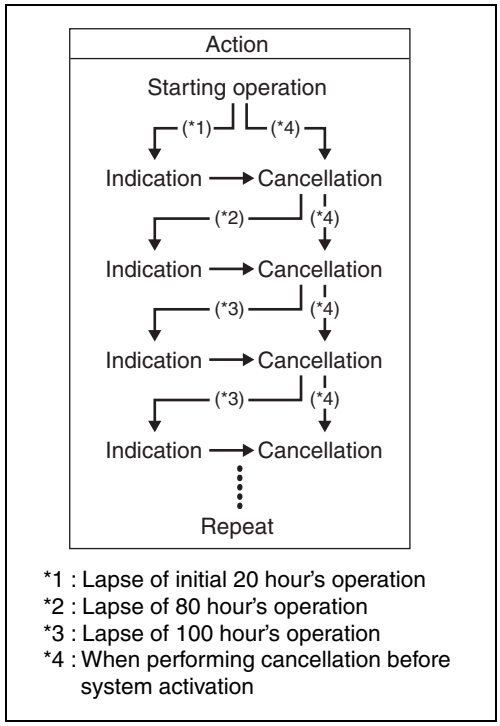
Total operating hours	MONITOR-TACHOMETER	
	Needle ① indication	REV-LIMIT lamp ② flashing *
0 h – (49 h)	No	No
50 h	500 r/min	
60 h	600 r/min	
⋮	⋮	
540 h	5400 r/min	
550 h	500 r/min	1 time
560 h	600 r/min	
⋮	⋮	
1040 h	5400 r/min	
1050 h	500 r/min	2 times
⋮	⋮	
1540 h	5400 r/min	
1550 h	500 r/min	3 times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

* : One flashing is corresponded to 500 hours.

OIL CHANGE REMINDER SYSTEM

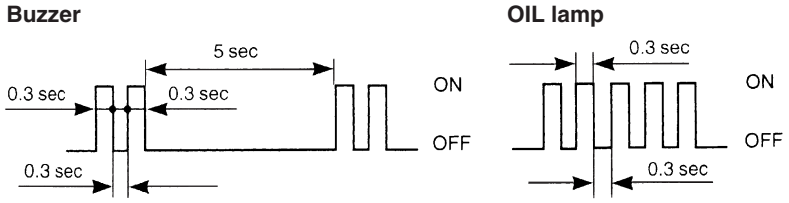
This system informs the operator of the time for replacing ENGINE OIL on the basis of the recommended maintenance schedule. When the total motor operating hours have reached the preprogrammed hours, the "OIL" lamp will flash, and the buzzer will begin a series of double beeps if engine is not running (but ignition switch is ON). The above mentioned indication will repeat until the activated system is manually cancelled.

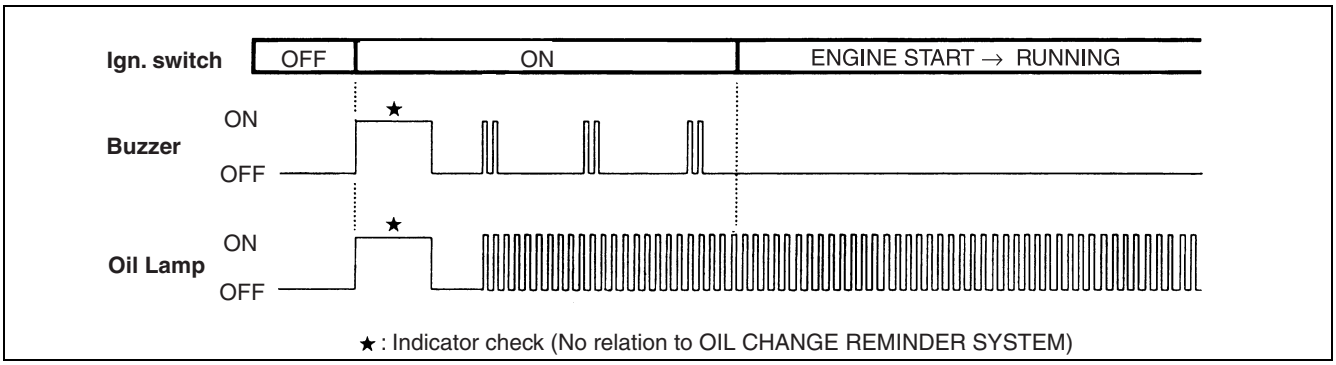
NOTE:
This system will activate up to 2 100 hour's operation.



*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

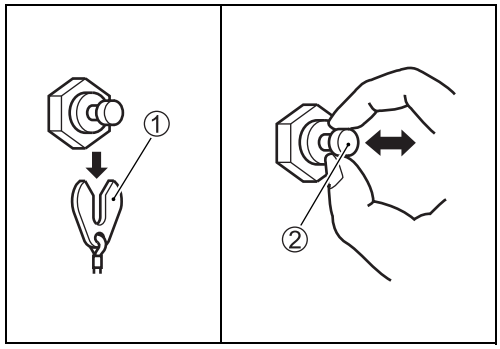




CANCELLATION

Procedure

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

■ Control by Neutral switch

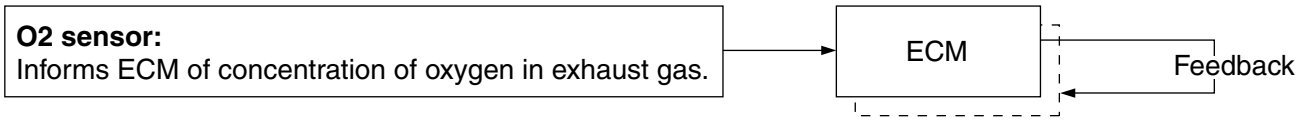
A switch to detect neutral gear position is located on the throttle lever holder and operated by the clutch control lever.
This ON/OFF type switch is ON in neutral and OFF in forward or reverse.
On starting the engine, the ECM detects the shift position using the neutral switch.
When the neutral switch is OFF, the ECM does not provide starter motor relay operating signal.

■ Control by Shift position sensor

A shift position sensor is installed on the throttle lever holder and detects the shift position with the clutch lever operation interlocked.
This sensor is a variable resistor that changes resistance in accordance with the shift position.
The resistance changes (increase/decrease) the voltage signal output from the sensor to the ECM. Based on the sensor voltage, the ECM calculates and detects shift position.
On starting the engine, the ECM does not provide an injector operating signal when a shift lever in-gear position is detected.

O2 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 O2 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 speeds of 3 000, 4 000, and 5 000 r/min.
The ECM uses the input data from the O2 sensor to correct the compensation coefficient of the fuel injection duration map within the ECM itself.



TOOL 18213-74F00: O2 sensor

NOTE:
For fuel mixture check (O2 feedback) operation procedure, refer to "Suzuki Diagnostic System Operation Manual".

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 fuel injector operation:**
  •Disconnect all fuel injector wire connectors.
- **When performing tests related to fuel injector operation:**
  •Relieve fuel pressure in line. (See page 5-3.)
  •Disconnect high pressure fuel pump wire connector located on fuel vapor separator.

CAUTION

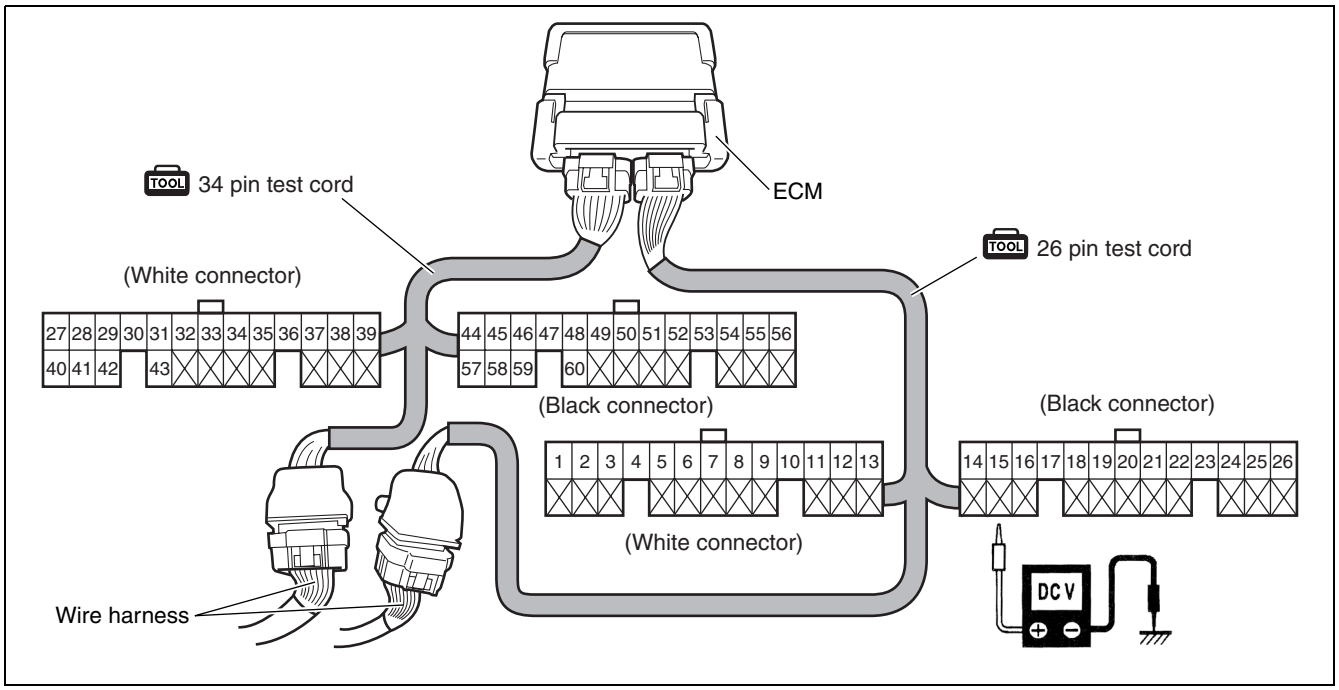
- **Always turn ignition switch "OFF" and disconnect battery cables when wires are being disconnected or connected.**
- **Hold and pull connector pieces when disconnecting. Do not pull wires.**

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

26-PIN & 34-PIN TEST CORD

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

TOOL 09930-89340: 26-pin & 34-pin test cord



INSPECTION FOR ECM CIRCUIT VOLTAGE

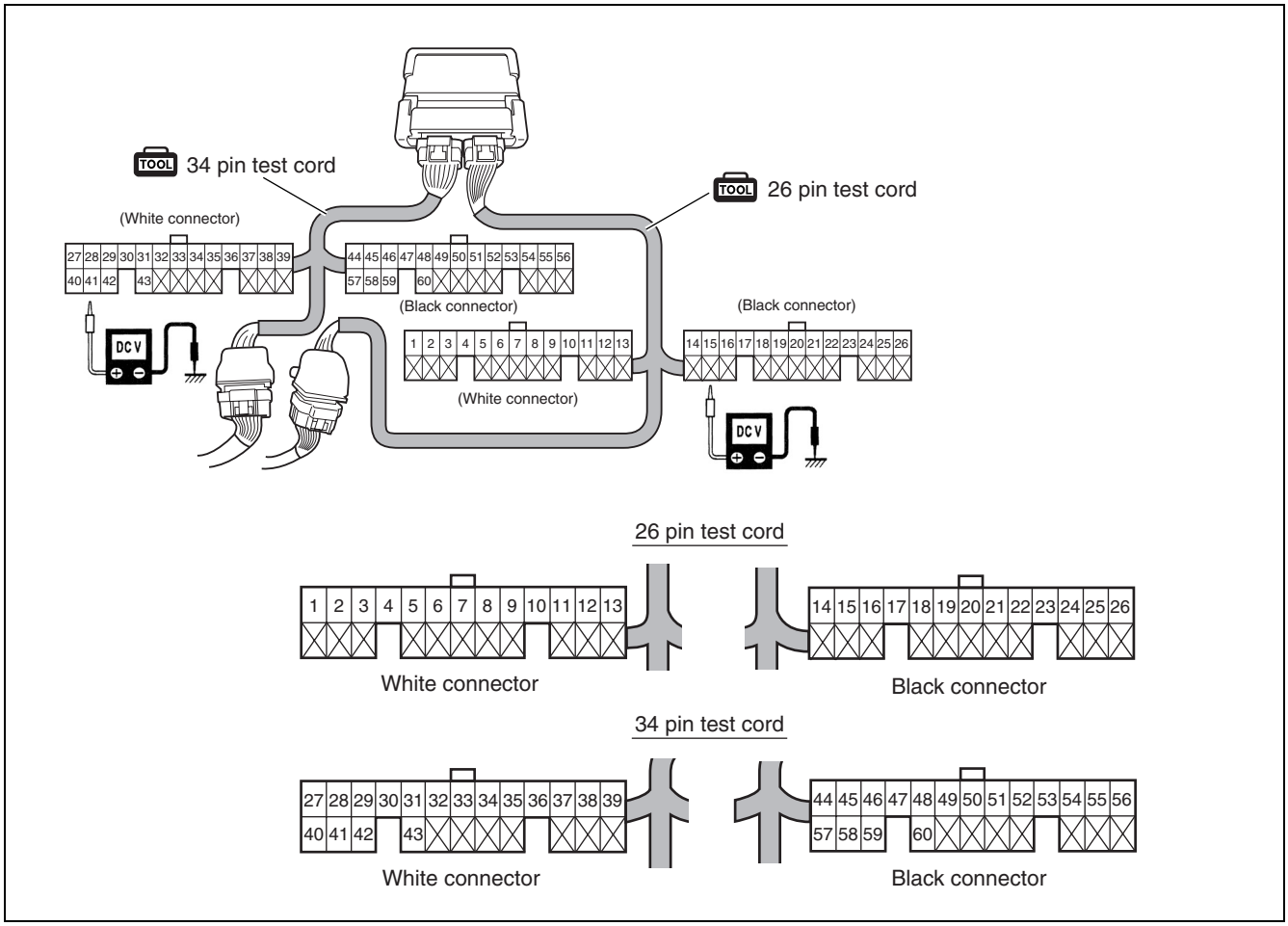
CAUTION

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

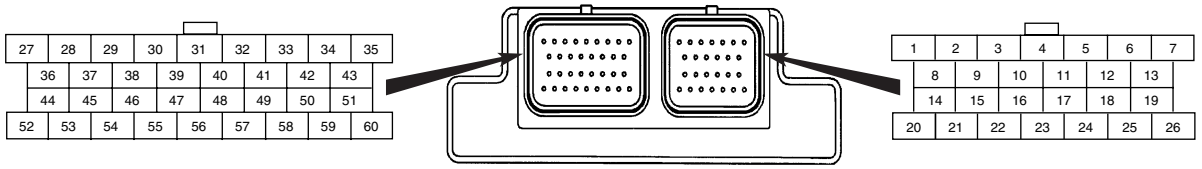
09930-89340: 26-pin & 34-pin test cord
09930-99320: Digital tester

Tester range: ⎓ DCV (See chart for range.)

1. Turn ignition switch OFF.
2. Connect the 26-pin & 34-pin test cord between ECM and wire harness as shown in figure.
3. Turn ignition switch ON.
4. Connect the tester probe ("⊖", Black) to body ground, and measure voltage according to the "CIRCUIT VOLTAGE TABLE".



CIRCUIT VOLTAGE TABLE



(FRONT VIEW)

TERMINAL	WIRE COLOR	CIRCUIT	STANDARD VOLTAGE	CONDITION/REMARKS
1	Dg	Starter relay control	Approx. 1.3 V	Ignition switch ON, stop switch plate OUT
			Approx. 0.5 V	Ignition switch ON, stop switch plate IN
2	B/G	O2 Feedback	—	—
3	—	—	—	—
4	R/B	CKP sensor	—	—
5	Y/Bl	CMP sensor #1	Approx. 0.3 V or 5 V	Ignition switch ON
6	B/O	CMP sensor #3 (VVT_STBD)	Approx. 0.3 V or 5 V	Ignition switch ON
7	O/G	CMP sensor #2 (VVT_PORT)	Approx. 0.3 V or 5 V	Ignition switch ON
8	V/W	Ex. manifold temp. sensor #1	0.14 – 4.75 V	Ignition switch ON
9	Lg/W	Cylinder temp. sensor	0.14 – 4.75 V	Ignition switch ON
10	G/R	Ex. manifold temp. sensor #2	0.14 – 4.75 V	Ignition switch ON
11	P/Bl	Shift position sensor	Approx. 2 V	Ignition switch ON, Shift in Neutral
			Approx. 4 V	Ignition switch ON, Shift in Forward
			Approx. 0.6 V	Ignition switch ON, Shift in Reverse
12	W	MAP sensor	0.20 – 4.53 V	Ignition switch ON
13	B (DF200 only)	Model distinction	Approx. 5 V	Ignition switch ON
14	R	Power source for sensor	Approx. 5 V	Ignition switch ON
15	Bl/R	Emergency stop switch	Approx. 11 V	Ignition switch ON, Stop switch plate IN
			Approx. 0 V	Ignition switch ON, Stop switch plate OUT
16	Br/Y	Throttle position sensor	Approx. 3.8 V	Ignition switch ON, Throttle WOT
			Approx. 0.7 V	Ignition switch ON, Throttle FCT
17	P/B	Ground for ECM main relay	—	—
18	Br	Neutral/Cranking switch	Approx. 0.7 V	Ignition switch ON, Engine stopped shift into NEUTRAL
			Approx. 2.5 V	Ignition switch ON, Shift into FOWARD or REVERSE
			Approx. 10 V	While engine cranking
19	Bl	Oil pressure switch	Approx. 5 V	While engine running
			Approx. 0 V	Engine stopped (Ignition switch ON)
20	Gr	ECM power source	Approx. 12 V	Ignition switch ON
21	Y	PC communication	—	—
22	O/Y	PC communication	—	—
23	B/Bl	Engine switch	Approx. 12 V	Ignition switch ON
24	O	Buzzer cancel	Approx. 12 V	Ignition switch ON, Key pushed in
			Approx. 0 V	Ignition switch ON, Key not pushed in
25	Lg/B	IAT sensor	0.04 – 4.46 V	Ignition switch ON

TERMINAL	WIRE COLOR	CIRCUIT	STANDARD VOLTAGE	CONDITION/REMARKS
26	—	—	—	—
27	O/Bl	No. 5 Fuel injector	Approx. 12 V	Ignition switch ON
28	R/W	No. 3 Fuel injector	Approx. 12 V	Ignition switch ON
29	Y/R	No. 6 Fuel injector	Approx. 12 V	Ignition switch ON
30	Br/W	No. 1 OCV	Approx. 12 V	Ignition switch ON
31	Br/R	No. 2 OCV	Approx. 12 V	Ignition switch ON
32	O/W	Purge valve	Approx. 12 V	Ignition switch ON
33	Gr/R	Variable intake control valve (VSV)	Approx. 12 V	Ignition switch ON
34	P	REV-LIMIT lamp	—	—
35	Y/B	Tachometer	—	—
36	B/Br	No. 2 Fuel injector	Approx. 12 V	Ignition switch ON
37	W/G	No. 5 Ignition coil	Approx. 0 V	Ignition switch ON
38	Bl/Y	No. 6 Ignition coil	Approx. 0 V	Ignition switch ON
39	Gr/Y	No. 3 Ignition coil	Approx. 0 V	Ignition switch ON
40	—	—	—	—
41	—	—	—	—
42	O	No. 1 Ignition coil	Approx. 0 V	Ignition switch ON
43	Bl/W	Buzzer	—	—
44	B/Y	Low pressure fuel pump (–)	Approx. 0 V	• Stop switch plate IN, For 6 sec after ignition switch ON • While engine running
			Approx. 12 V	Engine stopped, Ignition switch ON, stop switch plate IN
45	Lg/R	No. 4 Ignition coil	Approx. 0 V	Ignition switch ON
46	B	Ground for power	—	—
47	B	Ground for power	—	—
48	B	Ground for ECM	—	—
49	B/W	Ground for sensors	—	—
50	Bl	No. 2 Ignition coil	Approx. 0 V	Ignition switch ON
51	Bl/B	Oil lamp	—	—
52	B/R	High pressure fuel pump (–)	Approx. 0 V	• Stop switch plate IN, For 6 sec after ignition switch ON • While engine running
			Approx. 12 V	Engine stopped, Ignition switch ON, stop switch plate IN
53	Lg	No. 4 Fuel injector	Approx. 12 V	Ignition switch ON
54	O/B	No. 1 Fuel injector	Approx. 12 V	Ignition switch ON
55*	W/B	IAC valve #1	Approx. 12 V or 0 V	Ignition switch ON
56*	R/Y	IAC valve #2	Approx. 12 V or 0 V	Ignition switch ON
57*	W/Bl	IAC valve #4	Approx. 12 V or 0 V	Ignition switch ON
58*	R/G	IAC valve #3	Approx. 12 V or 0 V	Ignition switch ON
59	G/W	“CHECK ENGINE” lamp	—	—
60	G/Y	“TEMP” lamp	—	—

* :When 12 V is displayed at No. 55 (57) terminal, 0 (zero) V is displayed at No. 58 (56) terminal. Conversely, if 0 V is displayed at No. 55 (57) terminal, 12 V will be displayed at No. 58 (56) terminal.

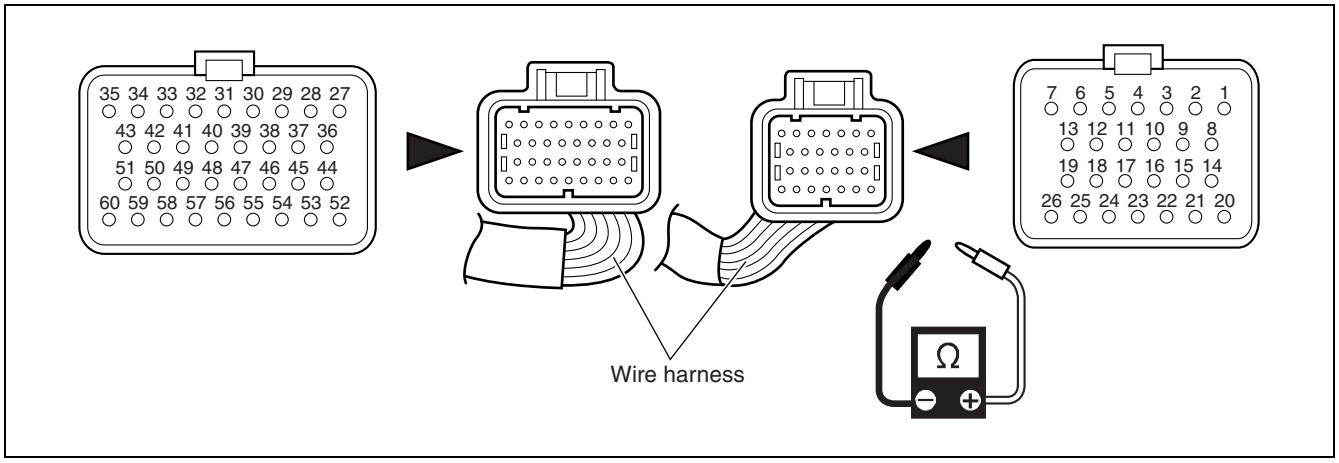
INSPECTION FOR RESISTANCE

09930-99320: Digital tester

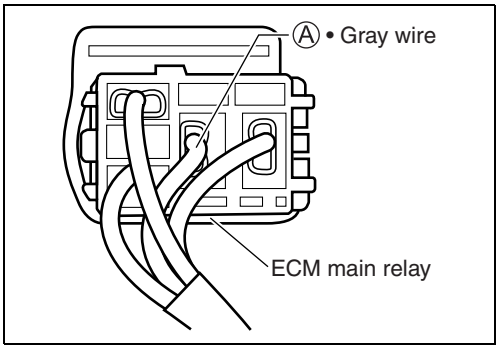
Tester range: Ω (Resistance, See chart for range.)

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

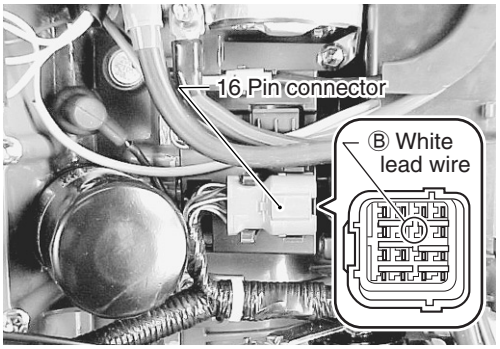
1. Turn ignition switch OFF.
2. Disconnect battery cables from battery.
3. Disconnect wire harness connector from ECM.
4. Connect the tester probes to terminal (wire harness side) and measure resistance according to the "RESISTANCE TABLE".



NOTE 1:
Pull out ECM main relay, and connect tester probe to terminal ("Ⓐ", Gray wire) of ECM main relay.



NOTE 2:
Disconnect remote control wire harness and connect tester probe to terminal ("Ⓑ", White wire).



RESISTANCE TABLE

ITEM	TERMINAL FOR TESTER PROBE CONNECTION	STANDARD RESISTANCE (at 20 °C)
CKP sensor	4 (R/B) to 49 (B/W)	168 – 252 Ω
Fuel injector No. 1	54 (O/B) to Terminal Ⓐ [NOTE 1]	10 – 14 Ω
Fuel injector No. 2	36 (B/Br) to Terminal Ⓐ [NOTE 1]	
Fuel injector No. 3	28 (R/W) to Terminal Ⓐ [NOTE 1]	
Fuel injector No. 4	53 (Lg) to Terminal Ⓐ [NOTE 1]	
Fuel injector No. 5	27 (O/Bl) to Terminal Ⓐ [NOTE 1]	
Fuel injector No. 6	29 (Y/R) to Terminal Ⓐ [NOTE 1]	
IAC valve #1	55 (W/B) to Terminal Ⓐ [NOTE 1]	25 – 34 Ω
IAC valve #2	56 (R/Y) to Terminal Ⓐ [NOTE 1]	
IAC valve #3	58 (R/G) to Terminal Ⓐ [NOTE 1]	
IAC valve #4	57 (W/Bl) to Terminal Ⓐ [NOTE 1]	
OCV (Oil control valve) #1	30 (Br/W) to Terminal Ⓐ [NOTE 1]	6.0 – 8.3
OCV (Oil control valve) #2	31 (Br/R) to Terminal Ⓐ [NOTE 1]	
Purge valve	32 (O/W) to Terminal Ⓐ [NOTE 1]	28 – 35
VSV (Vacuum switching valve)	33 (Gr/R) to Terminal Ⓐ [NOTE 1]	34 – 46
IAT sensor	25 (Lg/B) to 49 (B/W)	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 (Lg/W) to 49 (B/W)	
Ex-manifold temperature sensor #1	8 (V/W) to 49 (B/W)	
Ex-manifold temperature sensor #2	10 (G/R) to 49 (B/W)	
ECM main relay	17 (P/B) to Terminal Ⓑ [NOTE 2]	145 – 190 Ω

COMPONENT INSPECTIONS

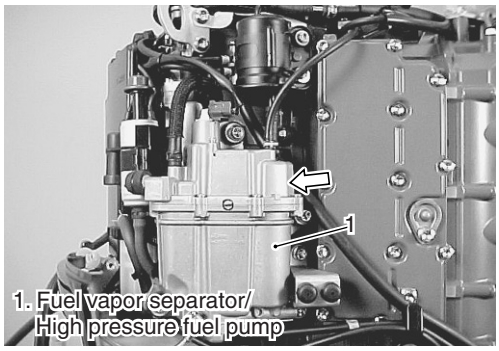
FUEL PUMP 6 SEC OPERATING SOUND

[High pressure side]

1. Install the emergency stop switch lock plate in position.
2. Turn ignition switch ON and check for fuel pump operating sound.

   Fuel pump operating sound:
   Sounds for approx. 6 seconds only

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

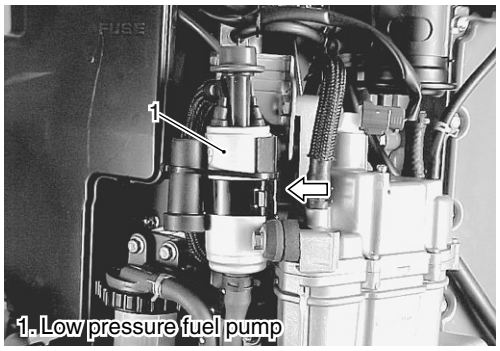


1. Fuel vapor separator/ High pressure fuel pump

[Low pressure side]

1. Install the emergency stop switch lock plate in position.
2. Turn ignition switch ON and check for fuel pump operating sound.

   Fuel pump operating sound:
   Sounds for approx. 6 seconds only

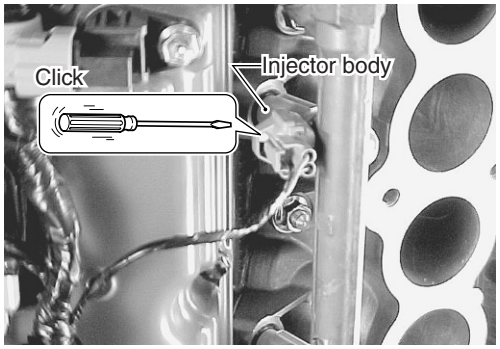


FUEL INJECTOR OPERATING SOUND (CRANKING)

1. Remove the collector assembly. (See page 6-3, 6-6)
2. Touch a sound scope or long blade screw driver to fuel injector body as shown.
3. Crank engine and check for injector operating sound.

   Injector operating sound: "Click"

4. Reinstall the collector assembly. (See page 6-5, 6-7.)



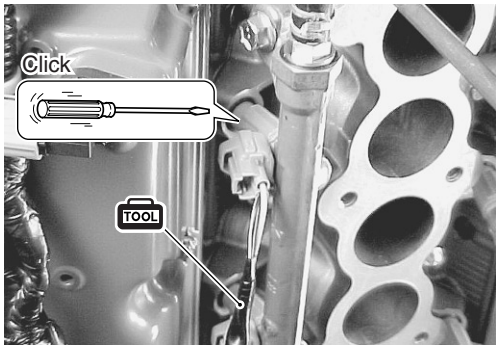
FUEL INJECTOR OPERATING SOUND (INDIVIDUAL)

1. Remove the collector assembly. (See page 6-3, 6-6)
2. Disconnect fuel injector wire and connect test cord.

TOOL 09930-89260: Injector test cord A

3. Connect Gray wire to body ground.
4. Momentarily touch Black/Yellow wire to starter motor magnetic switch "B" terminal (connected to battery positive ⊕ terminal) and check for injector operating sound.

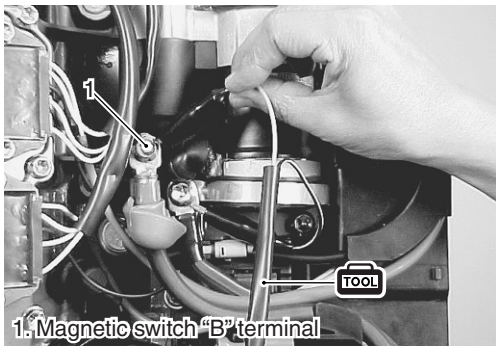
   Injector operating sound: "Click"



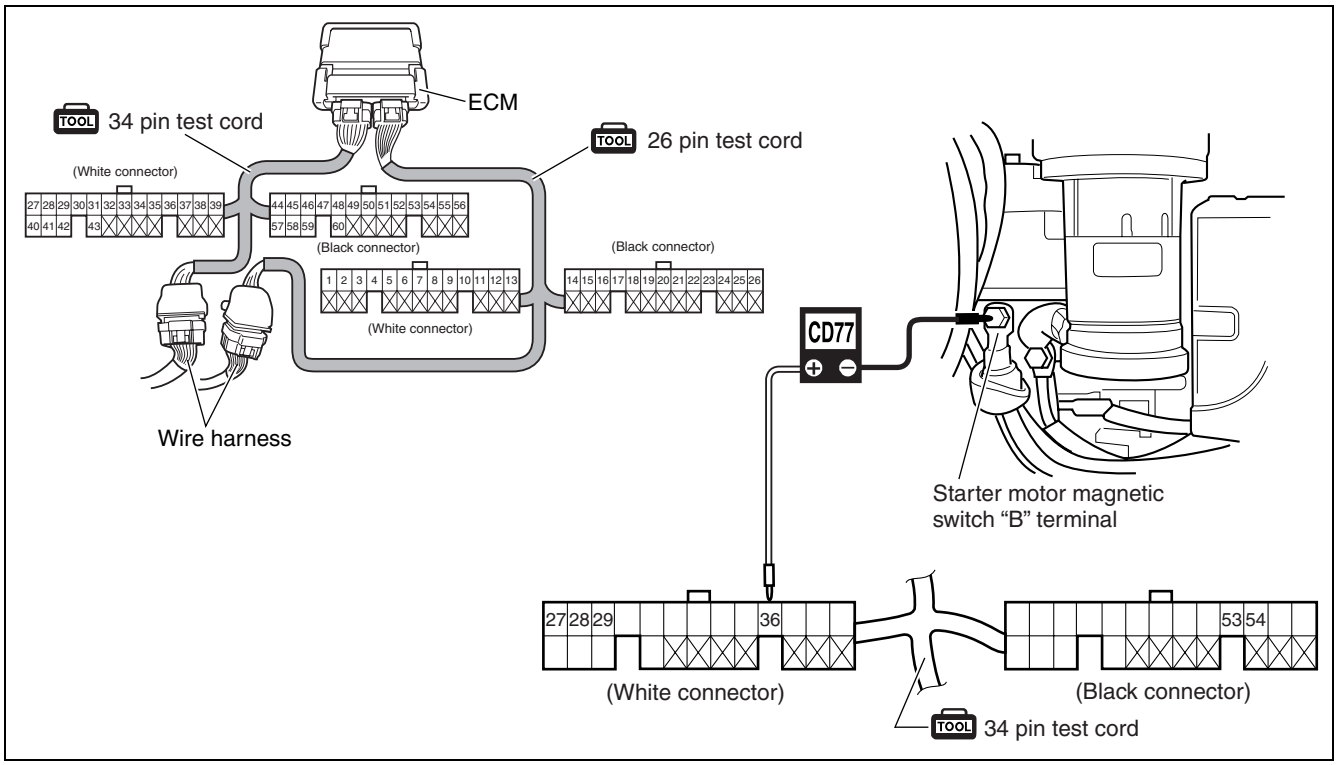
CAUTION

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

5. Reinstall the collector assembly. (See page 6-5, 6-7.)



FUEL INJECTOR OPERATING SIGNAL



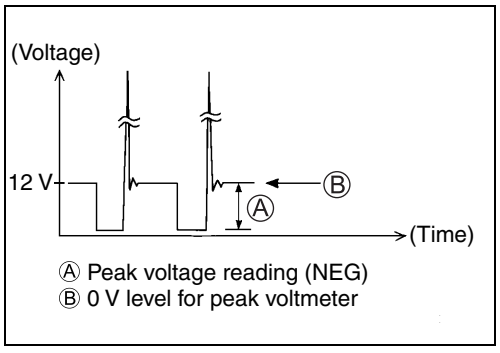
TOOL 09930-89340: 26-pin & 34-pin test cord

Peak voltmeter Stevens CD-77

Tester range: NEG 50

1. Connect test cord between ECM and wire harness as shown in figure then turn ignition switch ON.
2. Connect the tester probe ("⊖", Black) to starter motor magnetic switch "B" terminal (connected to battery positive ⊕ terminal) as shown in figure.
3. Connect the tester probe ("⊕", Red) to each terminal.

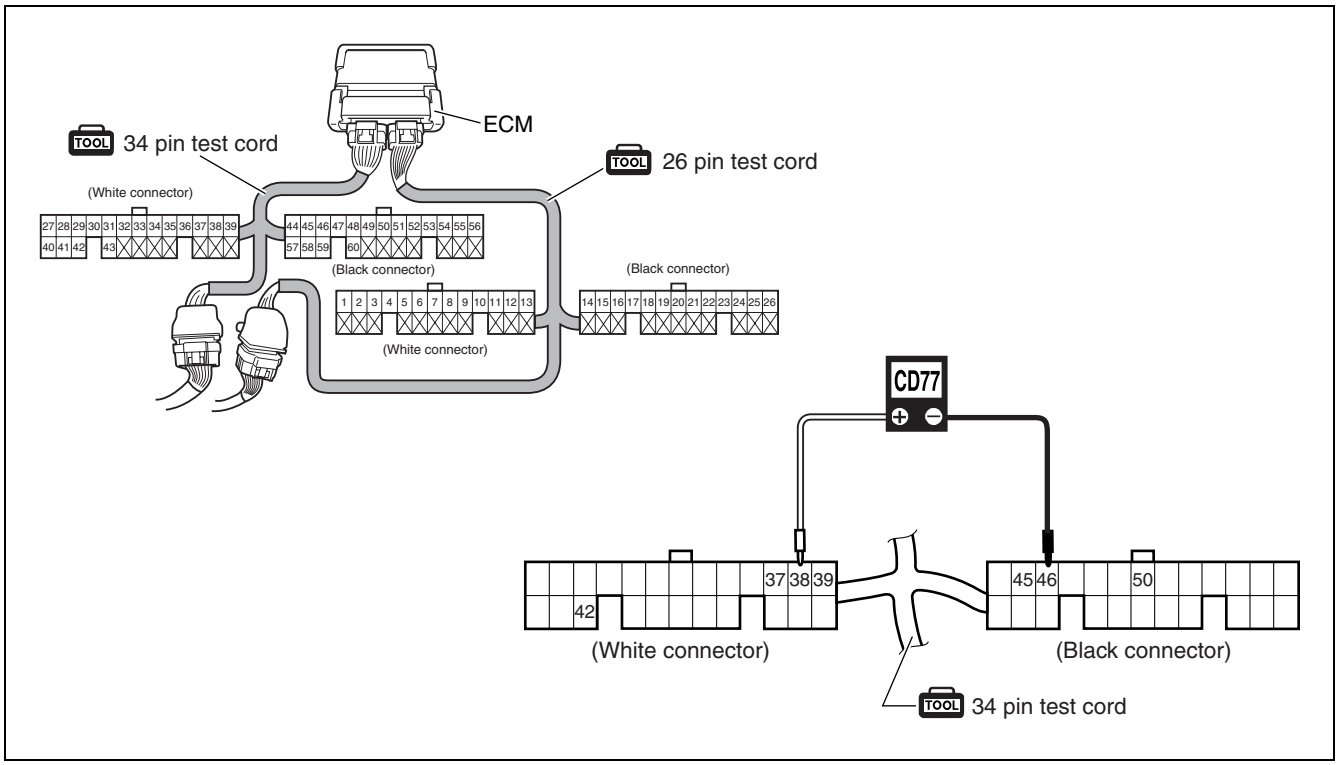
Injector	Terminal	Wire color (engine harness)
No. 1	54	O/B
No. 2	36	B/Br
No. 3	28	R/W
No. 4	53	Lg
No. 5	27	O/Bl
No. 6	29	Y/R



4. Crank engine and measure voltage.

   Fuel injector operating signal: 6 – 10 V

IGNITION COIL OPERATING SIGNAL



TOOL 09930-89340: 26-pin & 34-pin test cord

Peak voltmeter Stevens CD-77

Tester range: SEN 50

1. Connect test cord between ECM and wire harness as shown in figure then turn ignition switch ON.
2. Connect the tester probe ("⊕", Red) to each terminal.

Ignition coil	Terminal	Wire color (engine harness)
No. 1	42	O
No. 2	50	Bl
No. 3	39	Gr/Y
No. 4	45	Lg/R
No. 5	37	W/G
No. 6	38	Bl/Y

3. Connect the tester probe ("⊖" Black) to No. 46 terminal (or to body ground).
4. Crank engine and measure voltage.

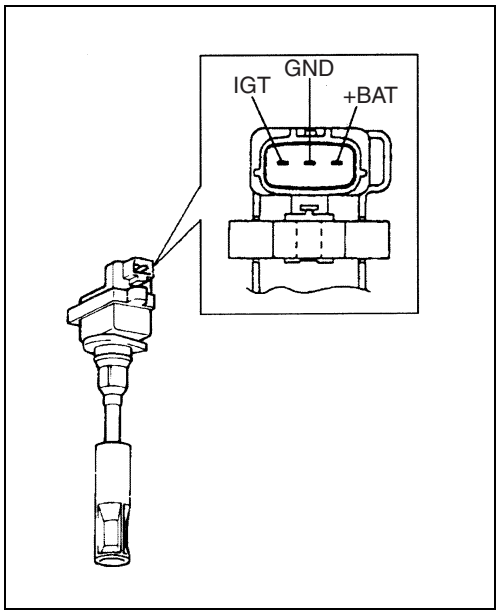
Ignition coil operating signal: Approx. 5 V

IGNITION COIL ASSEMBLY

09930-99320: Digital tester

Tester range: ⎓ DCV (See chart for range.)

NOTE:
The ignition coil power transistor and high-tension lead are an integral part of the coil' internal circuit. Using resistance measurements to check for a defect on either the primary or secondary coil is not possible.



1. Turn ignition key OFF.
2. Disconnect ignition coil connector.
3. Check for continuity between GND ⊖ terminal on the wiring harness side connector and the engine body ground.
4. Turn the ignition key to ON position. Check for battery voltage by measureing between the BAT ⊕ terminal and GND terminal on the wiring harness side connector.
5. Connect the wiring harness connector to the ignition coil and measure the ignition operating signal. (See page 3-56.)
6. If any failure exists, check for open circuit, short-circuited battery, short-circuited lead and connector's contact condition for each circuit.
7. If there is no spark even with the wiring harness and spark plug in sound condition, perform inspection again using an ignition coil that is known to be in good condition (new or used from another cylinder that is operating properly).
8. If there is still no spark even with the wiring harness, spark plug and ignition coil in sound condition, replace the ECM and perform inspection again.

CMP SENSOR SIGNAL

09930-89340: 26-pin & 34-pin test cord
09930-99320: Digital tester

Tester range: ⎓ DCV (See chart for range.)

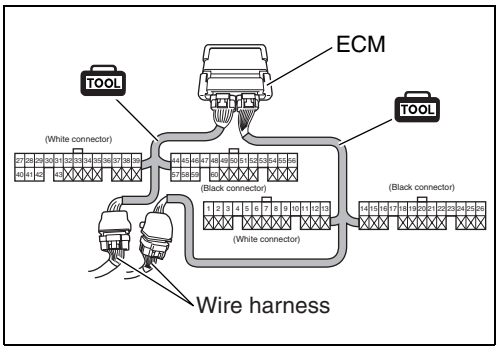
1. Turn ignition switch OFF.
2. Remove CMP sensor. (See page 3-69.)
3. Connect the 26-pin & 34-pin test cord between ECM and wire harness as shown in figure.
4. Connect the tester probe ("⊕", Red) to each terminal.

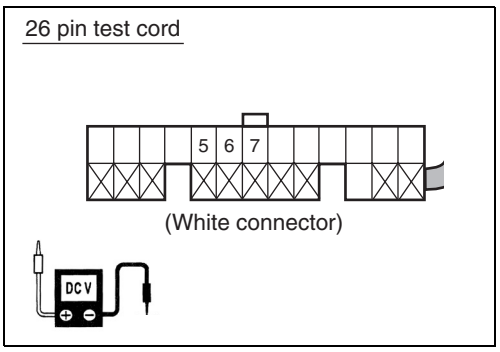
CMP sensor	Terminal	Wire color (engine harness)
No. 1	5	Y/Bl
No. 2 (VVT_PORT)	7	O/G
No. 3 (VVT_STBD)	6	B/O

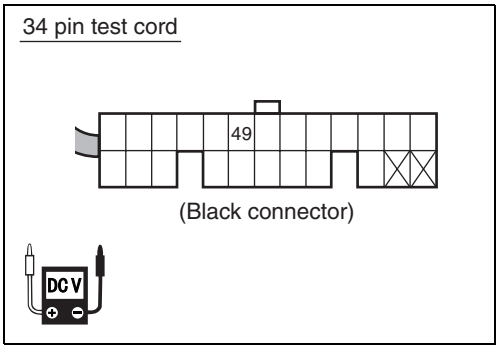
5. Connect the tester probe ("⊖", Black) to No. 49 terminal (or to body ground).
6. Turn ignition switch ON.
7. Measure the voltage when the tip of a steel screwdriver is brought near and then pulled away from the sensor tip.

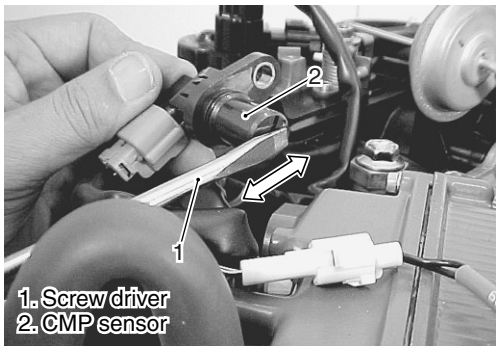
   When screwdriver is brought near: Approx. 5 V
   When screwdriver is pulled away: Approx. 0.3 V

   If the voltage does not change in the above test, replace the sensor.





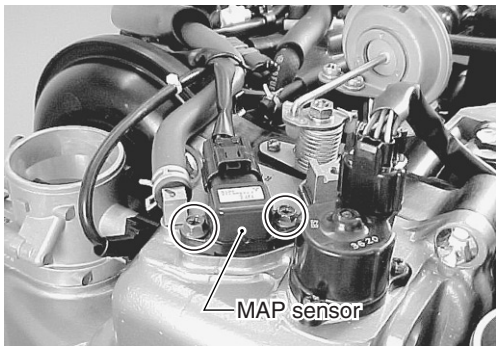




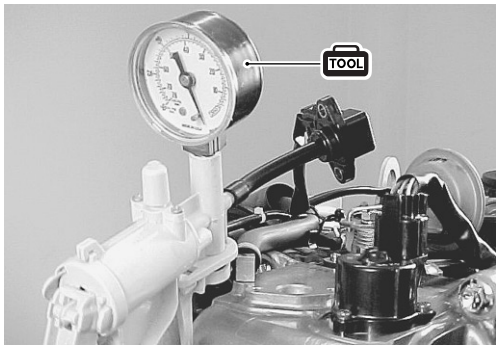
MAP SENSOR OUTPUT VOLTAGE CHANGE

09917-47011: Vacuum pump gauge
09930-89340: 26-pin & 34-pin test cord
09930-99320: Digital tester

Tester range: ⎓ DCV (See chart for range.)



1. Remove ring gear cover and silencer case. (See page 6-2.)
2. Remove bolts and MAP sensor from collector assembly.

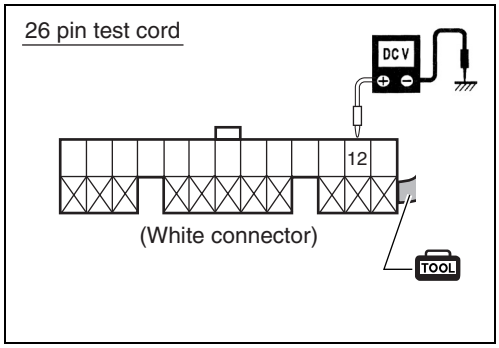


3. Connect vacuum pump gauge (with hose) to MAP sensor as shown in figure.
4. Turn ignition switch ON.
5. While applying negative pressure (vacuum) to MAP sensor, measure "12" terminal voltage. (See page 3-49 and 3-50 for procedure.)

MAP sensor output voltage change:

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

(at 759.8 mmHg, 29.91 inHg, 1013 hPa barometric pressure)

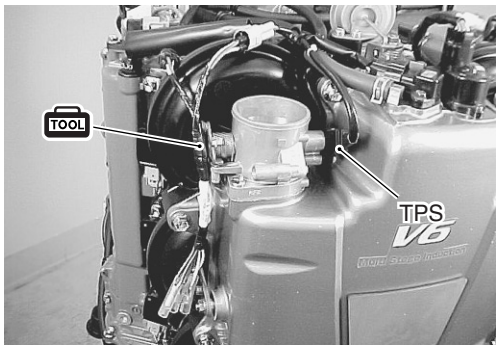


TPS (Throttle position sensor)

09930-99320: Digital tester
09930-89220: 3-pin test cord
Tester range: ⎓ DCV (See chart for range.)

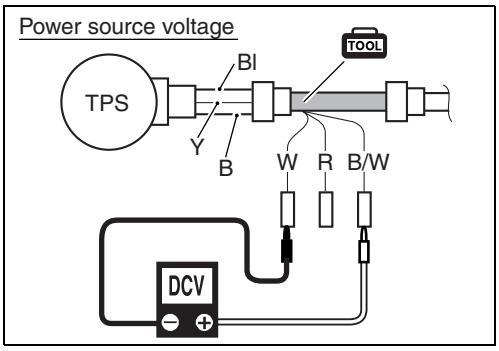
1. Turn ignition switch OFF.
2. Remove ring gear cover and silencer case. (See page 6-2.)
3. Connect 3-pin test cord between TPS and wire harness as shown in figure.
4. Turn the ignition switch ON.
5. Connect tester probe as shown in the illustration and check for sensor power source voltage.

   Sensor power source voltage: Approx. 5 V

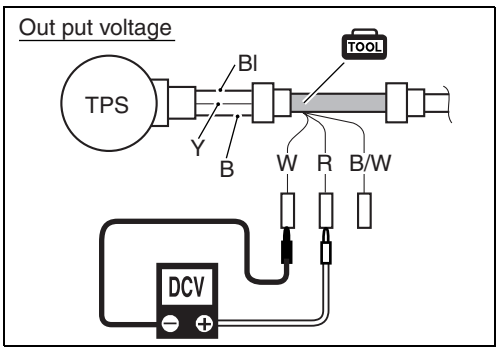


6. Connect tester probe as shown in the illustration and check for sensor output voltage.
   Slowly move the throttle lever to open, and check if voltage changes linearly within specification, according to throttle valve opening angle.

   Sensor output voltage:
   FCT position : Approx. 0.7 V
   WOT position : Approx. 3.8 V



NOTE:
Do not try to adjust or remove any of the throttle body component parts (Throttle position sensor, throttle valve, throttle stop screw, etc.).
These components have been factory adjusted to precise specifications.

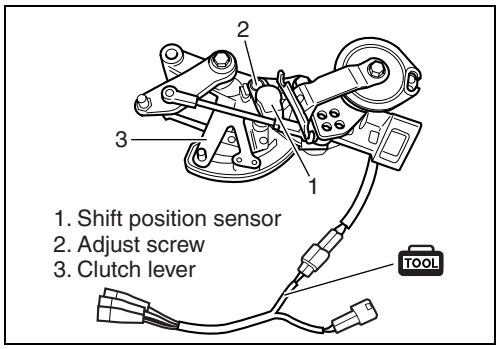


SHIFT POSITION SENSOR

09930-99320: Digital tester
09930-89220: 3-pin test cord
Tester range: ⎓ DCV (See chart for range.)

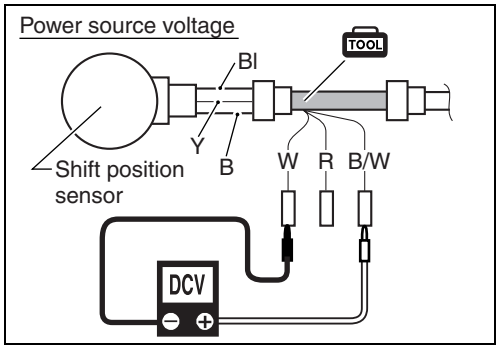
1. Turn ignition switch OFF.
2. Connect 3-pin test cord between shift position sensor and wire harness as shown in figure.
3. Turn the ignition switch ON.
4. Connect tester probe as shown in the illustration and check for sensor power source voltage.

   Sensor power source voltage: Approx. 5 V



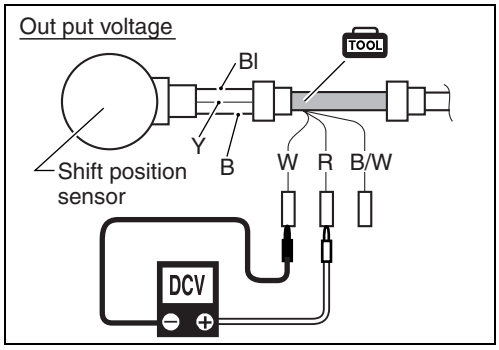
5. Connect tester probe as shown in the illustration.
   Check for sensor output voltage while operating remo-con handle.
   Sensor output voltage:

Shift position	Output voltage
Forward	Approx. 4.1 V
Neutral	Approx. 2.3 V
Reverse	Approx. 0.8 V



If out of specification:
- 1st Check sensor position adjustment, readjust if necessary.
- 2nd Replace shift position sensor.

NOTE:
After installing shift position sensor, check for proper correct function by operating remo-con handle.



OIL PRESSURE SWITCH

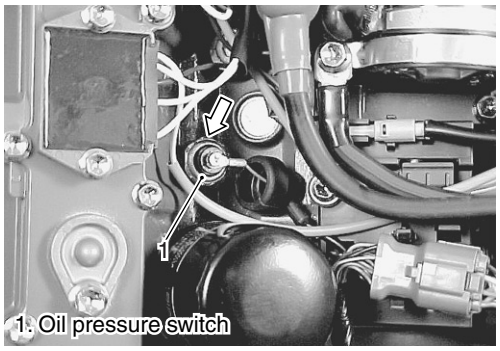
NOTE:
Before checking the oil pressure switch, make sure the engine oil pressure is within specification.

1. Remove the blue lead wire from oil pressure switch.
2. Check the continuity between the switch terminal and engine body ground.

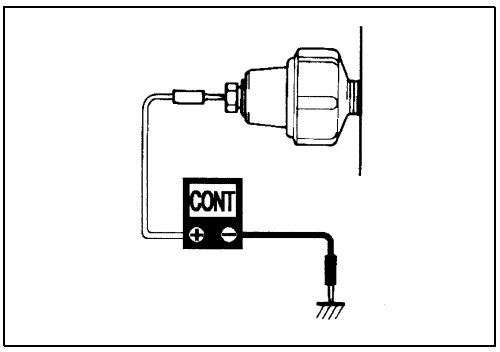
09930-99320: Digital tester

Tester range: (Continuity)

Engine running	Infinity
Engine stopped	Continuity



If measurement exceeds specification, replace oil pressure switch.



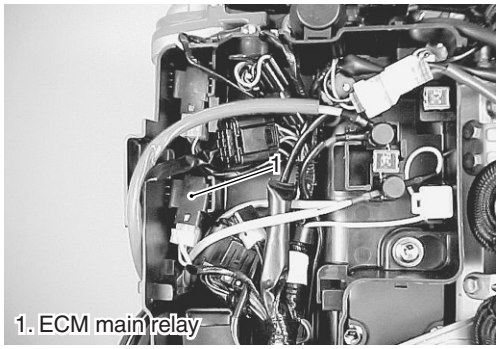
3. Reinstall parts removed earlier.

ECM MAIN RELAY

09930-99320: Digital tester

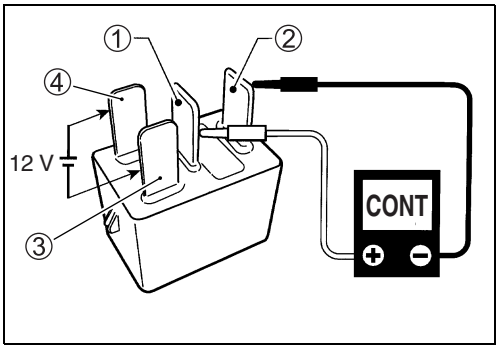
Tester range: (Continuity)

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



ECM main relay function:

12 V power	Continuity
Applied	Yes
Not applied	No



CAUTION

Do not touch 12 V power supply wires to each other or with other terminals.

IAC VALVE

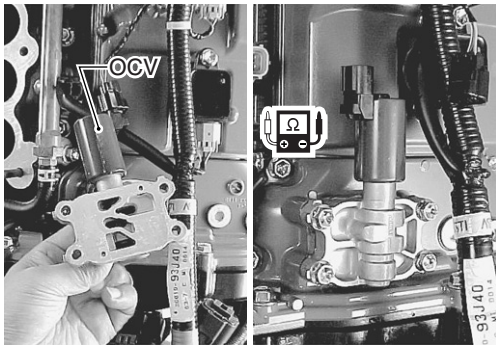
1. Remove IAC valve. (See page 3-69.)
2. When the ignition switch is turned ON and OFF, check that the rotary valve turns to open and returns to closed.
3. If the valve does not turn, check the wiring harness for continuity (between ECM and IAC valve) and connector contact condition.



OCV (Oil control valve)

1. Remove OCV. (See page 3-70.)
2. Check for operating sound (ticking sound) when battery voltage applied to and removed from the terminals of oil control valve.
3. Check resistance between the two OCV terminals.

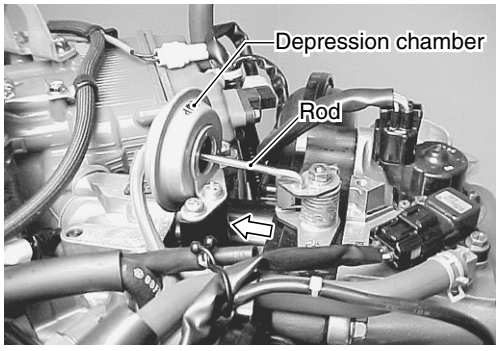
   OCV resistance: 6.0 – 8.0 Ω



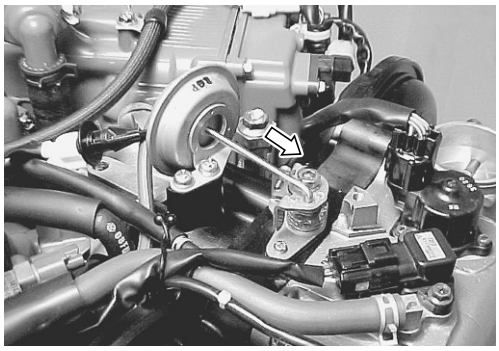
MULTI-STAGE INDUCTION

SYSTEM INSPECTION

- Ensure the depression chamber rod pulls the shut off valves to the complete close position after engine start.



- Ensure the shut off valve return spring returns the shut off valves to the full open position when the engine is turned off.

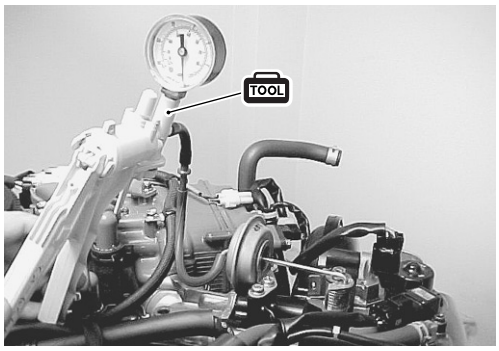


DEPRESSION CHAMBER

TOOL 09917-47011: Vacuum pump gauge

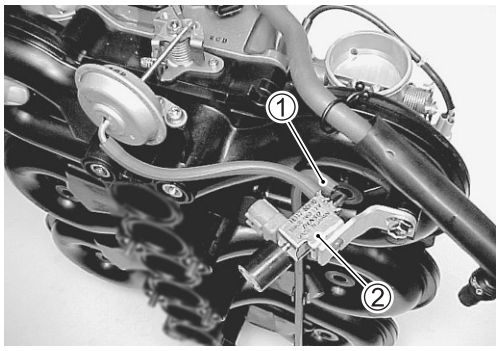
- Ensure the shut off valve fully close when vacuum is applied to the depression chamber with a vacuum pump tool.

  Operation start vacuum: 1 – 8 mmHg
  Operation end vacuum: 18 – 20 mmHg



VACUUM PASSAGE INSPECTION

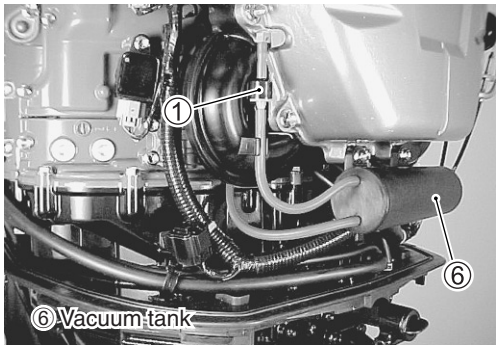
1. Disconnect vacuum hose ① from vacuum switching valve ②.
2. Start engine and run it at idle speed.
   Place a finger over vacuum hose end ① and engine vacuum is present.
3. If vacuum is not present, clean vacuum passage with compressed air, start engine and check again for vacuum.



CHECK VALVE

Inspection

1. Remove check valve ①.
2. Blow air (moderate pressure) through hose fitting on black side of check valve. Air should not pass through valve from collector assembly (black side ③) to orange side ②.
3. Blow air (low pressure) through hose fitting on orange side of check valve. Air should pass through to black side.
4. If air passes through valve in Step 2) or high pressure is required to cause air to pass in Step 3), replace check valve.



⚠ WARNING

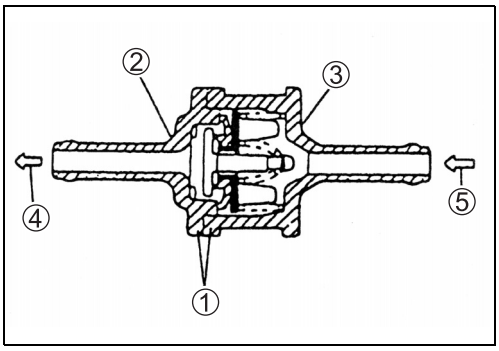
DO NOT SUCK air through check valve.
Fuel vapor inside the valve is harmful.

5. Install check valve.

NOTE:

The check valve is directional. Refer to the figure for correct installation.

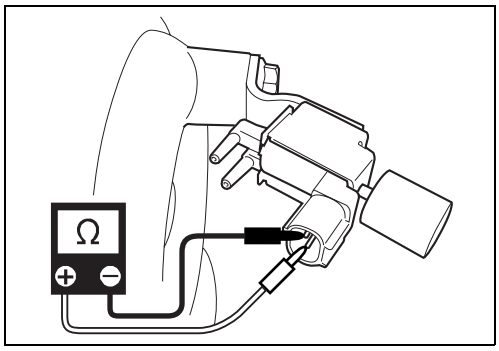
④ *To vacuum tank*
⑤ *From collector assembly*



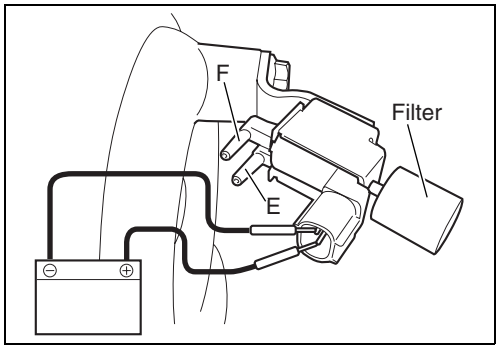
VSV (Vacuum switching valve)

1. With ignition switch OFF, disconnect connector from VSV.
2. Check resistance between VSV terminals.

   Resistance of VSV: 37 – 44 Ω



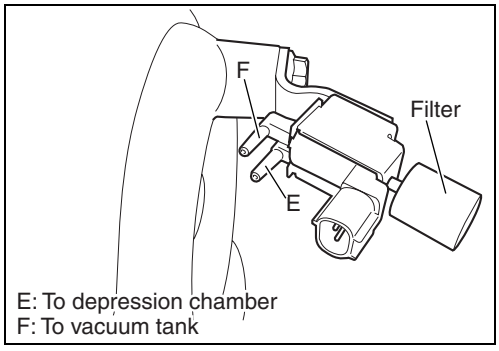
3. Disconnect two hoses from VSV.
4. With 12 V applied between the VSV terminals, check that port (E) connects to port (F) but not to the filter section.
5. Without voltage applied to the VSV terminals, check that port (E) connects to the filter section but not to port (F).



VSV AIR PASSAGE CONTINUITY

Passage continuity between ports / VSV electrical power	E	F	Filter section
Power ON	○——○		
Power OFF	○		○

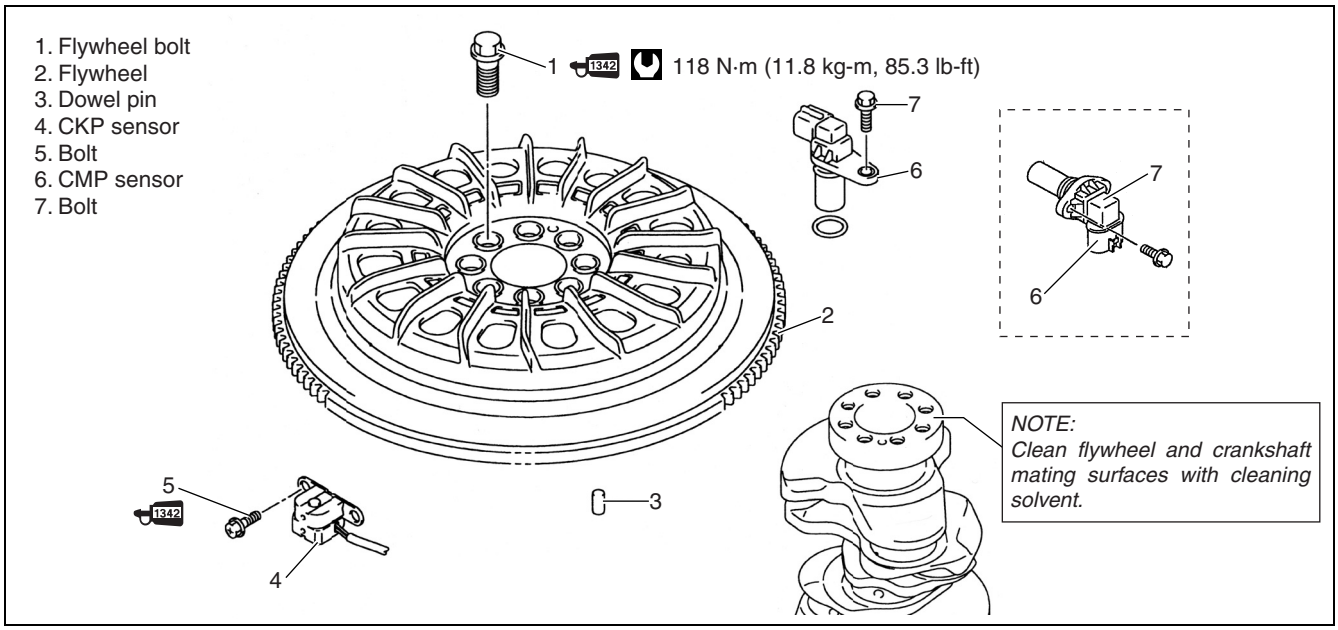
○——○: Air passage



NOTE:
Before removing hoses to check VSV, mark each hose for position to ensure correct hose connection on assembly.

REMOVAL/INSTALLATION

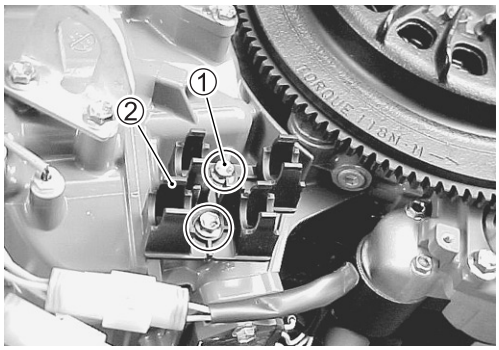
FLYWHEEL



REMOVAL

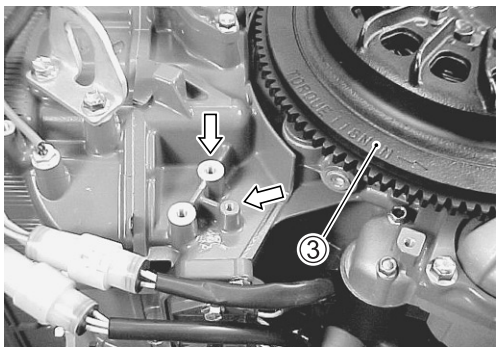
Prior to removing flywheel:
- **Disconnect battery cables from battery.**

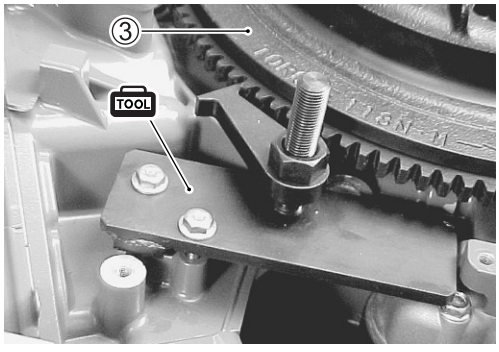
1. Remove ring gear cover and air intake silencer case. (See page 6-2.)
2. Remove screws ① and battery charge coil connector holder ② from cylinder.



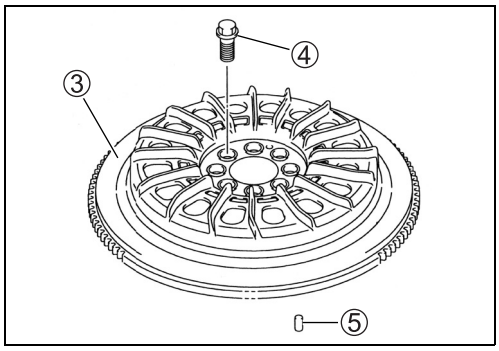
3. To lock the flywheel ③, use special tool shown in figure. Use screws and threaded holes on top of cylinder to attach special tool.

TOOL 09916-99310: Flywheel holder





4. Remove eight (8) flywheel bolts ④.
5. Remove flywheel ③ and dowel pin ⑤.



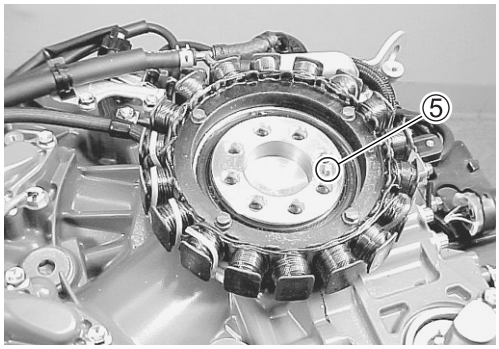
INSTALLATION

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

- Install dowel pin ⑤.
- Install flywheel ③ onto crankshaft making sure to align dowel pin hole.

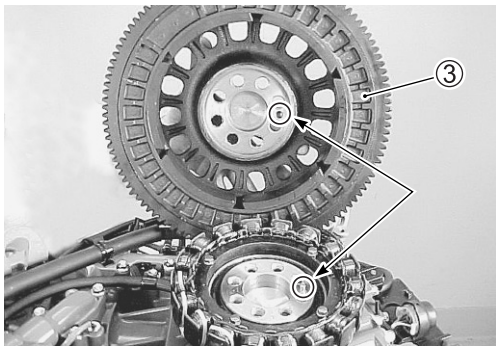
NOTE:

Before installing the flywheel magneto, wipe the crankshaft and flywheel clean.



CAUTION

Before tightening flywheel bolts, make sure the flywheel dowel pin hole and crankshaft dowel pin align or severe damage may result.

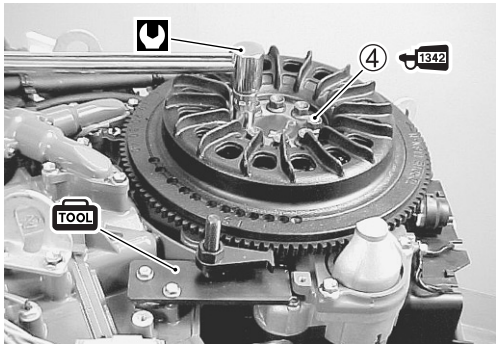


- Apply THREAD LOCK "1342" to flywheel bolts ④ before installing.
- Tighten flywheel bolts ④ to specified torque. To lock flywheel, use special tool as shown in figure.

Flywheel bolt: 118 N·m (11.8 kg-m, 85.3 lb-ft)

09916-99310: Flywheel holder

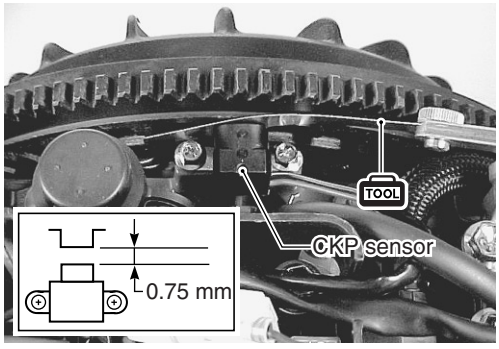
99000-32050: THREAD LOCK "1342"



- After installing flywheel and torquing bolts to specification, check air gap between CKP sensor and reluctor bars on flywheel.

Air gap: 0.75 mm (0.030 in)

- Check to ensure that all removed parts are back in original position.

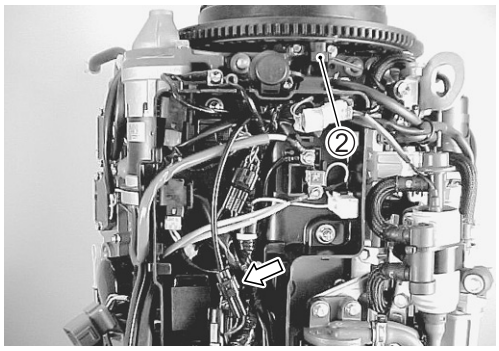


CKP SENSOR

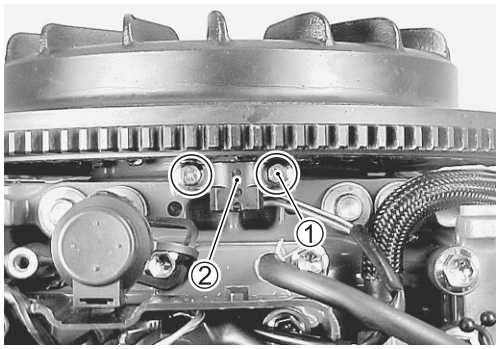
REMOVAL

Prior to removing CKP sensor:
- **Disconnect battery cables from battery.**

1. Remove ring gear cover and air intake silencer case. (See page 6-2.)



2. Disconnect CKP sensor lead wire connector in electric parts holder.
3. Remove two (2) screws ① and CKP sensor ②.

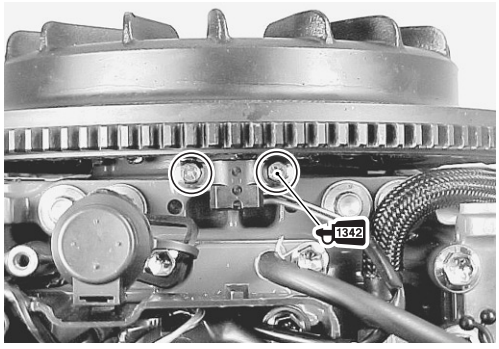


INSTALLATION

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

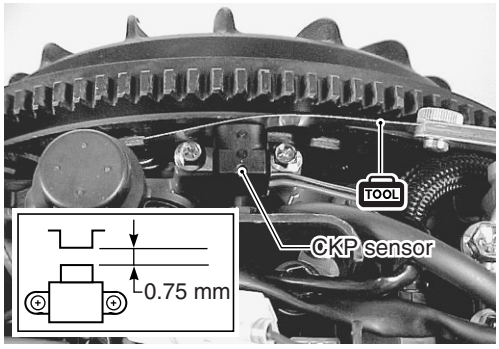
- Apply THREAD LOCK “1342” to the sensor mounting screws.

1342 99000-32050: THREAD LOCK “1342”



- Install CKP sensor with air gap of 0.75 mm between sensor and reluctor bar on flywheel, then tighten sensor mounting screws securely.

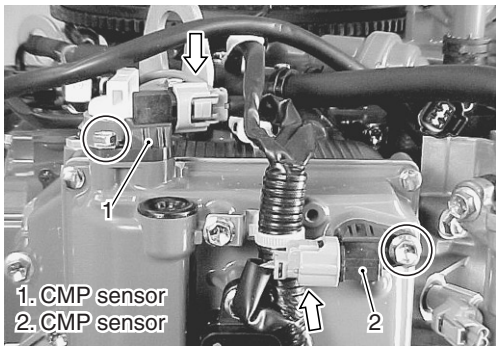
  Air gap: 0.75 mm (0.030 in)



CMP SENSOR

REMOVAL

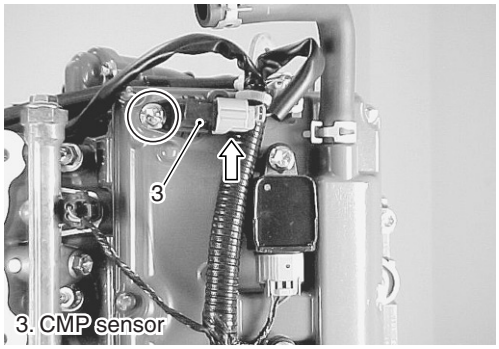
1. Remove collector assembly. (See page 6-3, 6-6.)
2. Disconnect CMP sensor lead wire connector at sensor.
3. Remove bolt and CMP sensor.



INSTALLATION

Installation is reverse order of removal.

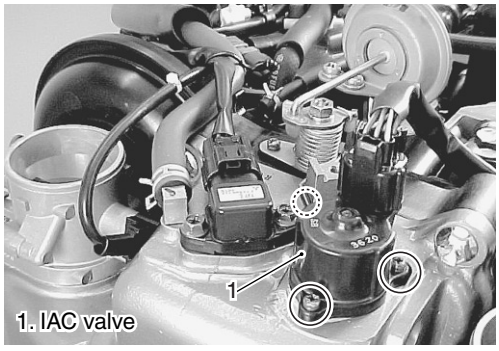
- Install CMP sensor, then tighten sensor mounting screw securely.
- Connect sensor lead wire connector to CMP sensor.
- Check to ensure that all removed parts are back in original position.



IAC VALVE

REMOVAL

1. Remove the ring gear cover and air intake silencer case. (See page 6-2.)
2. Disconnect IAC valve lead wire connector at IAC valve.
3. Remove screws and IAC valve.



INSTALLATION

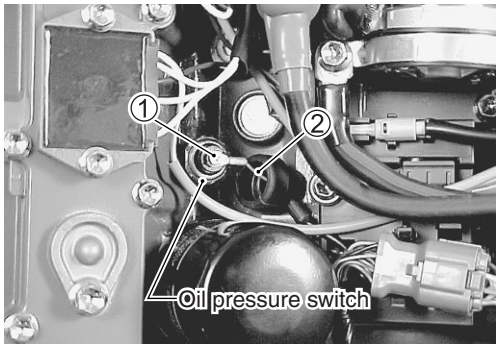
Installation is reverse order of removal.

- Install IAC valve, then tighten mounting screw securely.
- Connect IAC valve lead wire connector to IAC valve.
- Check to ensure that all removed parts are back in original position.

OIL PRESSURE SWITCH

REMOVAL

1. Loosen screw ① and disconnect blue lead wire ② from switch.
2. Remove oil pressure switch from cylinder block.



INSTALLATION

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

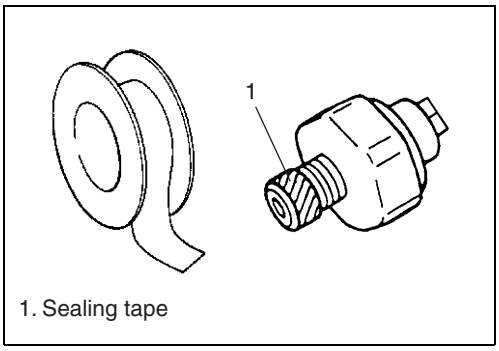
- Before installing oil pressure switch, wrap screw threads with sealing tape then tighten switch to specified torque.

NOTE:

Cut off any excess sealing tape from switch threads before installation.

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

- Start engine and check oil pressure switch for oil leakage. Reseal switch if oil leakage is found.

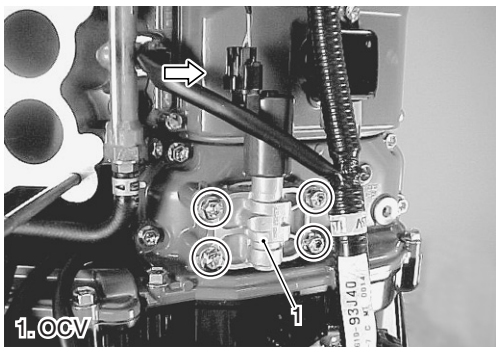


1. Sealing tape

OCV (Oil control valve)

REMOVAL

1. Remove collector assembly. (See page 6-3, 6-6.)
2. Disconnect OCV lead wire connector at OCV.
3. Remove the four (4) bolts securing OCV, then remove OCV and discard OCV gasket.



INSTALLATION

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

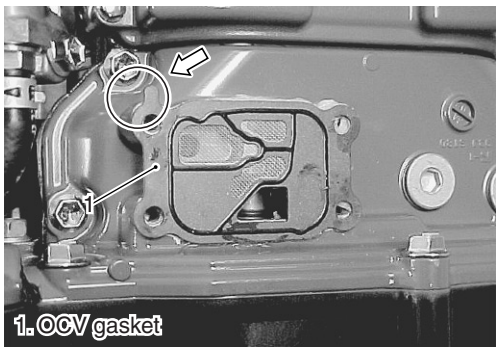
- Install gasket and OCV, then tighten bolts securely.

NOTE:

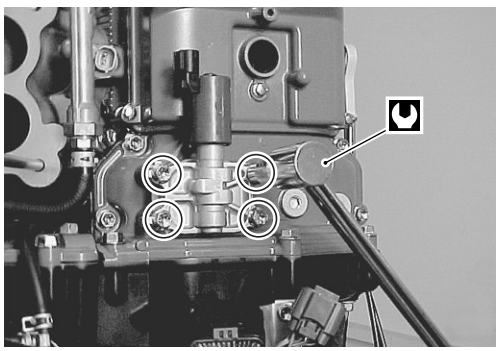
Position the projection of OCV gasket as shown the right.

CAUTION

Do not re-use the OCV gasket, always replace with new one.



OCV bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



- Install collector assembly.
  Refer to “Collector assembly” in this section for assembly.
- Check to ensure that all removed parts are back in original position.

THROTTLE CONTROL

SYNCHRONIZING THROTTLE BODIES

1. Check that the throttle link operates smoothly.

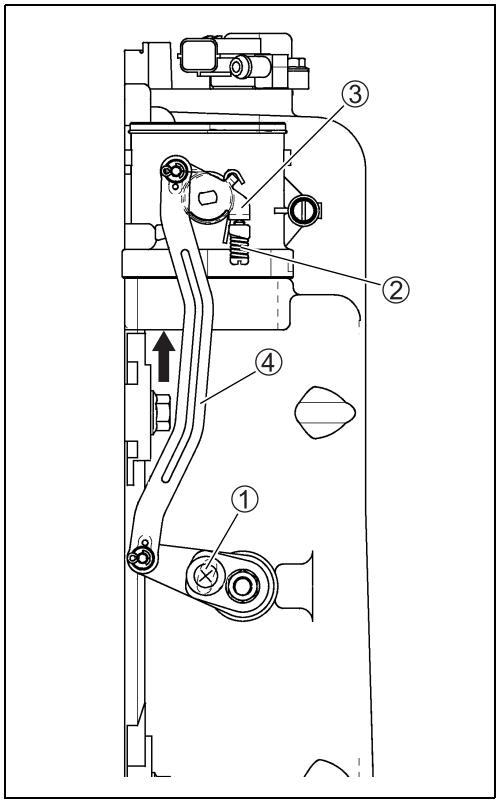


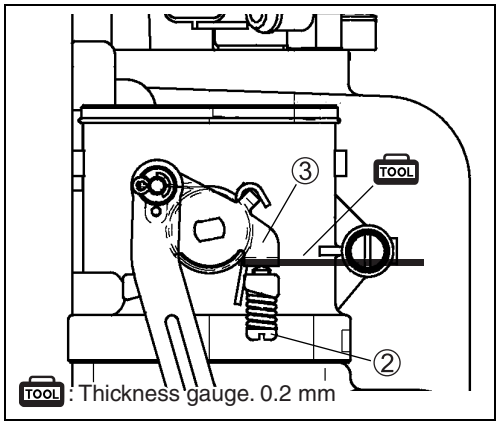
2. Loosen screw ①.
3. Check that the tip of both the STBD and PORT throttle stop screws ② contacts the throttle lever stop ③.
   This condition indicates the throttle valve is completely closed.

CAUTION

Do not attempt to adjust the throttle stop screw.

4. In the condition of step 3, insert a thickness gauge of 0.2 mm (0.008 in) between the throttle stop screw ② and throttle lever stop ③.
   With the link rod ④ pushed up lightly, tighten screw ① securely.
5. Operate the throttle lever from complete close position to full open position 2 – 3 times repeatedly and check that both the STBD and PORT throttle valves open and close completely. Also check that both the throttle valves start to open simultaneously when the throttle lever is gradually opened from the complete close position.
6. As necessary, repeat steps 2 – 5.

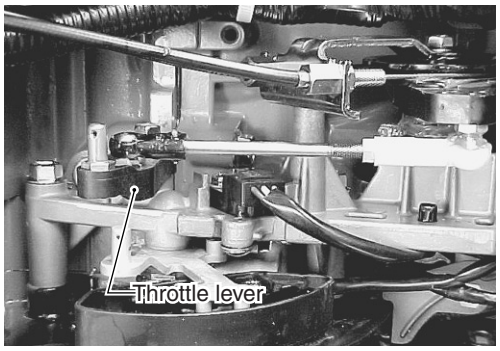




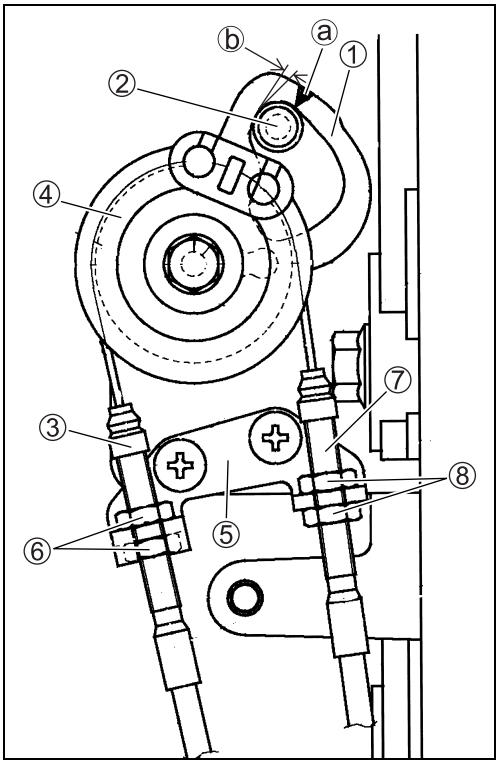
THROTTLE CONTROL CABLE

Installation and Adjustment

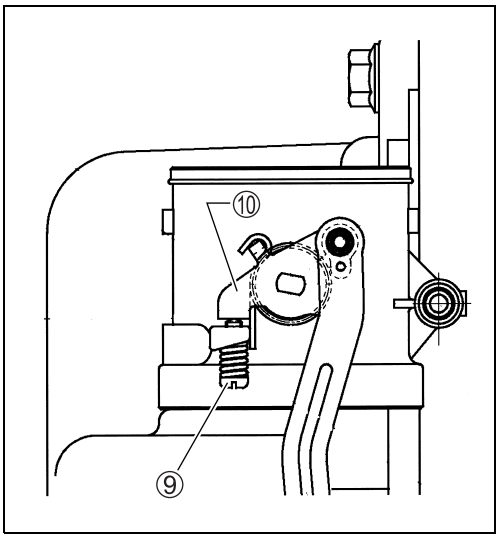
1. Lightly push throttle lever to bring the throttle to full close.



2. Align the match mark ⓐ (▲) on throttle cam ① with the center of throttle lever roller ② and hold this position.
3. Install throttle control cable ③ to throttle drum ④ and cable holder ⑤.
4. Turn lock nut ⑥ in the appropriate direction to install cable with no sag.
5. Tighten the lock nuts ⑥ to secure throttle cable to cable holder.
6. Turn throttle cam ① to the position where the clearance ⓑ between throttle lever roller ② and throttle cam becomes 0 (zero) mm.
   Hold this condition unmoved and install throttle cable ⑦ to throttle drum ④ and cable holder ⑤.
   Turn the lock nut ⑧ so as to remove play on the inner cable. Tighten lock nut securely.



7. Pull and push the throttle lever from fully closed position to fully open position several times.
   With the throttle lever in complete close position, check that the tip of throttle stop screw ⑨ contacts throttle lever stop ⑩ and the clearance ⓑ is 0 (zero) mm.



ELECTRICAL

CONTENTS

BATTERY CHARGING SYSTEM 4- 2
- OUTLINE 4- 2
- INSPECTION 4- 3
- REMOVAL/INSTALLATION 4- 5

ELECTRIC STARTER SYSTEM 4- 7
- OUTLINE 4- 7
- TROUBLESHOOTING 4- 9
- INSPECTION 4-10
- STARTER MOTOR 4-13

MONITOR-TACHOMETER 4-25
- INSPECTION 4-25

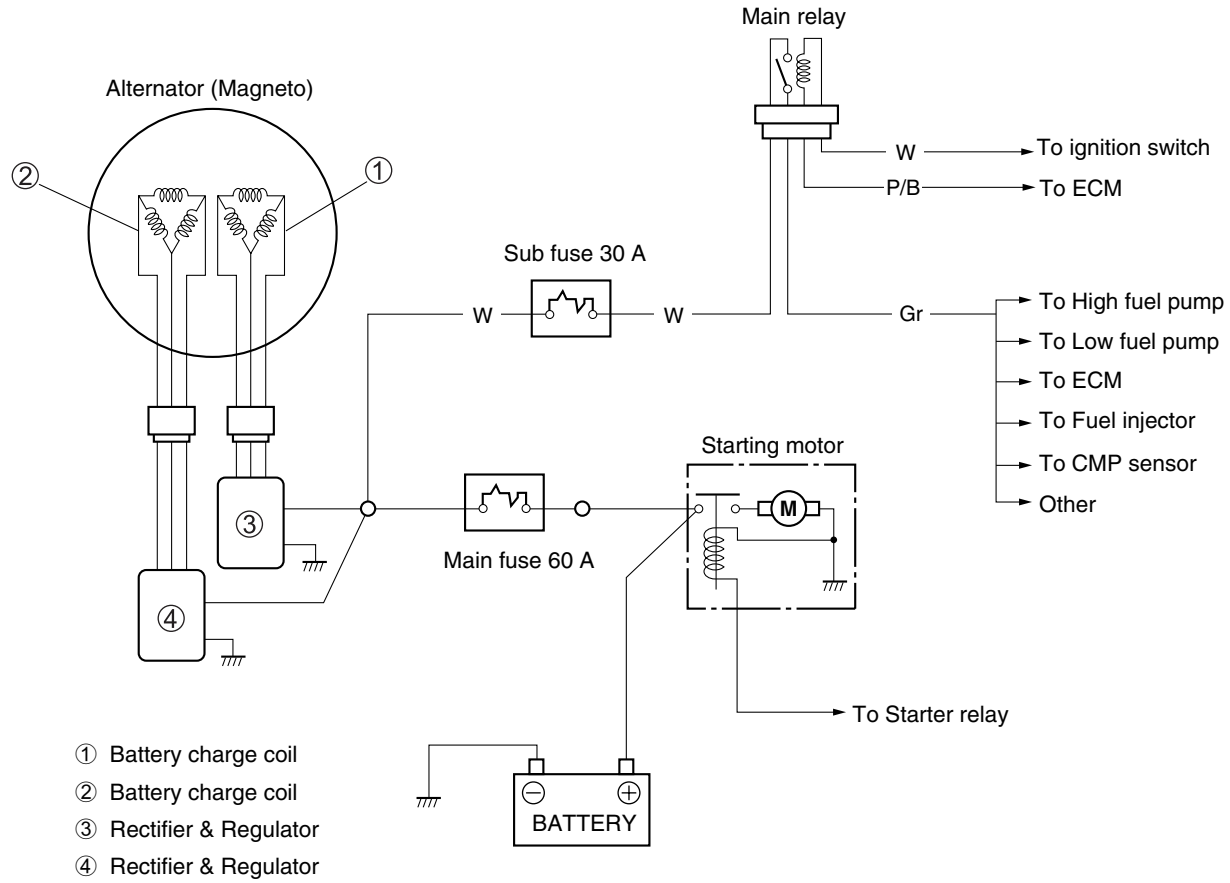
ELECTRIC PARTS HOLDER 4-26
- REMOVAL 4-26
- INSTALLATION 4-26

BATTERY CHARGING SYSTEM

OUTLINE

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

OUTPUT	**12 V 54 A (648 W)/3 000 r/min.**
REGULATED VOLTAGE	**14.2 – 15.2 V**



INSPECTION

BATTERY CHARGE COIL

Measure battery charge coil resistance.

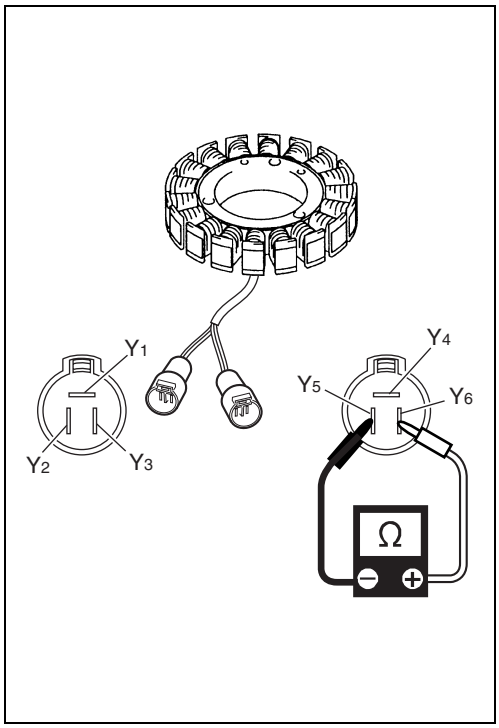
09930-99320: Digital tester

Tester range: Ω (Resistance)

1. Disconnect battery charge coil leads from rectifier & regulators.
2. Measure resistance between leads in the combinations shown.

Battery charge coil resistance:

Terminal for tester probe connection	Resistance
Yellow 1 to Yellow 2	0.32 – 0.48 Ω
Yellow 2 to Yellow 3	
Yellow 3 to Yellow 1	
Yellow 4 to Yellow 5	0.32 – 0.48 Ω
Yellow 5 to Yellow 6	
Yellow 6 to Yellow 4	



If measurement exceeds specification, replace battery charge coil.

FUSE CASE/FUSE

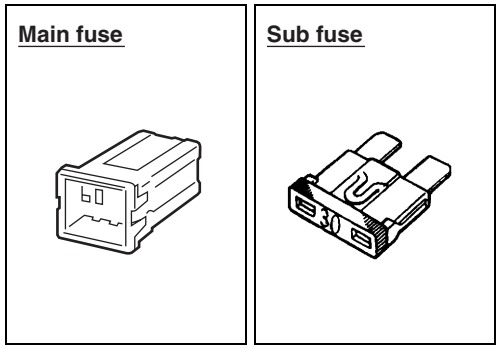
09930-99320: Digital tester

Tester range: (Continuity)

Fuse

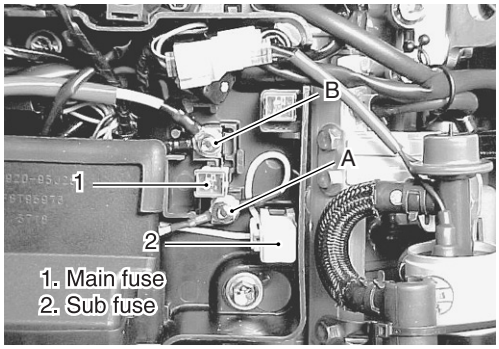
1. Remove the fuse from fuse case (or fuse terminal).
2. Inspect continuity between both terminals of fuse.
   If no continuity is indicated, replace fuse.

   Main fuse : 60 A
   Sub fuse : 30 A



Main fuse terminal

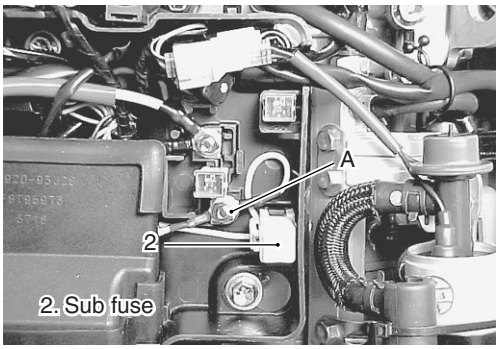
Inspect continuity between terminal (A) and (B).
If no continuity is indicated, replace fuse terminal and/or fuse.

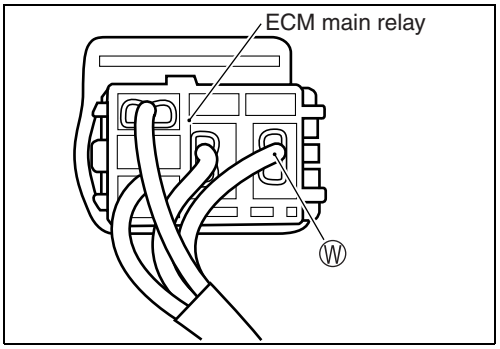


Sub fuse case

1. Disconnect battery cables from battery.
2. Disconnect white lead wire of fuse case from terminal (A).
3. Check continuity between White lead wire with plate terminal and the white lead wire Ⓦ of ECM main relay connector.

If no continuity is indicated, replace main harness and/or fuse.





RECTIFIER & REGULATOR

09900-25002: Pocket tester

Tester range: ×1 kΩ (Resistance)

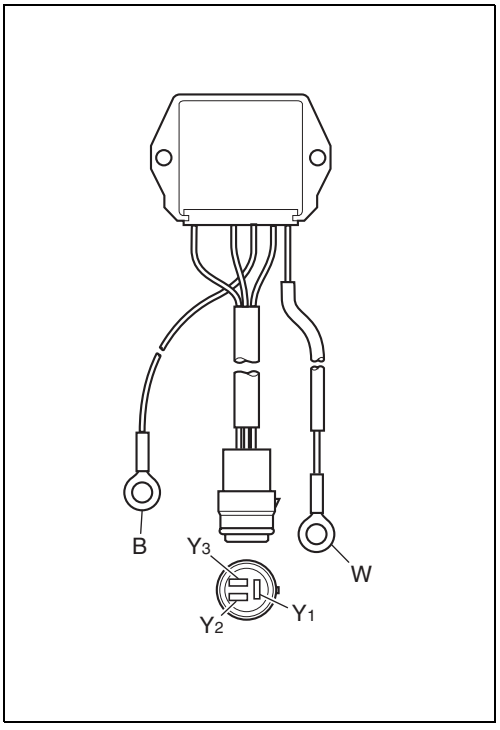
1. Disconnect all lead wires of rectifier & regulator.
2. Measure resistance between leads in the combinations shown.

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

Rectifier & regulator resistance:

Unit: Approx. kΩ

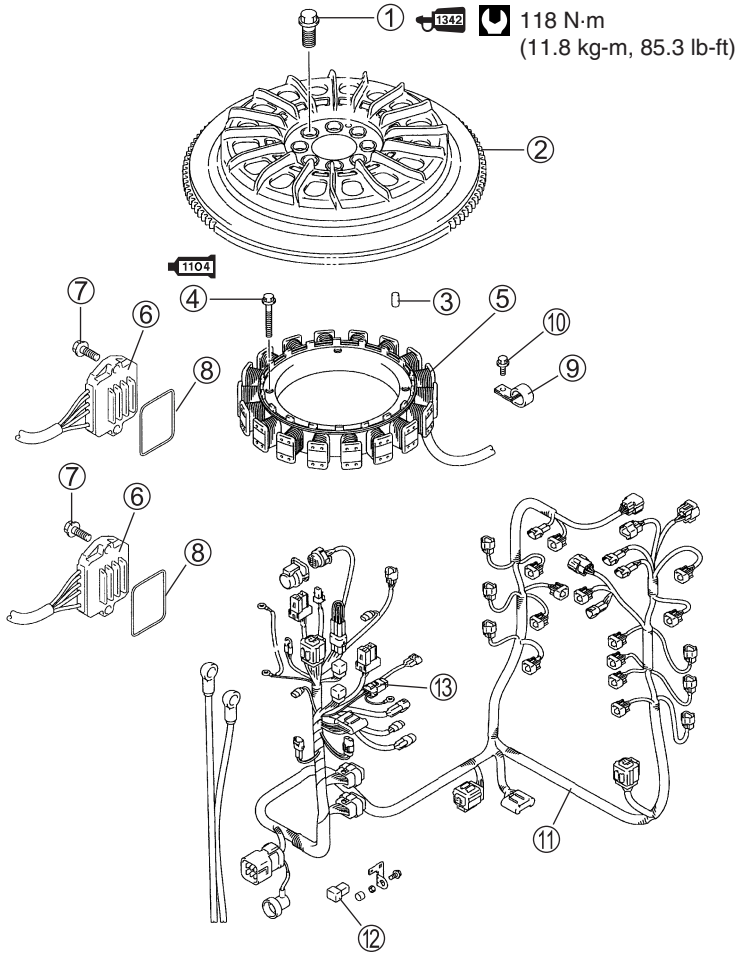
		Tester probe ⊕ (Red)				
		Black	**White**	**Yellow 1**	**Yellow 2**	**Yellow 3**
Tester probe ⊖ (Black)	**Black**		3.0 – 4.6	1.8 – 2.8	1.8 – 2.8	1.8 – 2.8
	White	∞		∞	∞	∞
	Yellow 1	2 – 3.2	2 – 3.4		4 – 7	4 – 7
	Yellow 2	2 – 3.2	2 – 3.4	4 – 7		4 – 7
	Yellow 3	2 – 3.2	2 – 3.4	4 – 7	4 – 7	



If measurement exceeds specification, replace rectifier & regulator.

REMOVAL/INSTALLATION

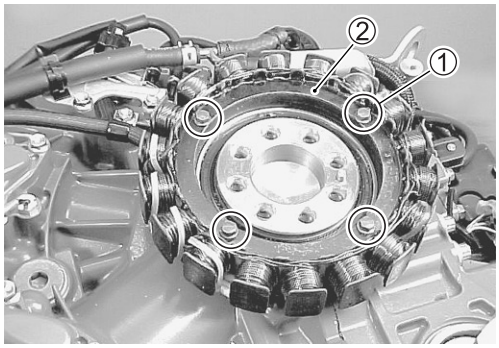
System construction



① **Bolt**
② **Flywheel**
③ **Dowel pin**
④ **Screw**
⑤ **Battery charge coil**
⑥ **Rectifier & regulator**
⑦ **Bolt**
⑧ **Seal ring**
⑨ **Clamp**
⑩ **Bolt**
⑪ **Main harness**
⑫ **Main fuse 60 A**
⑬ **Sub fuse 30 A**

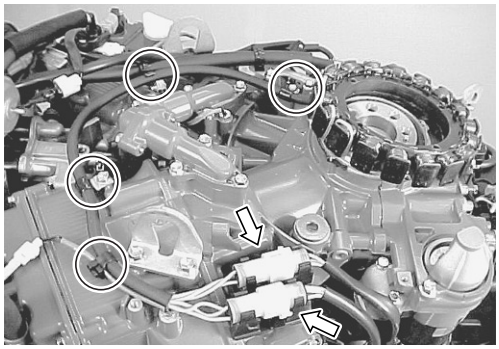
REMOVAL

Prior to removing electrical parts:
- **Disconnect battery cables from battery.**



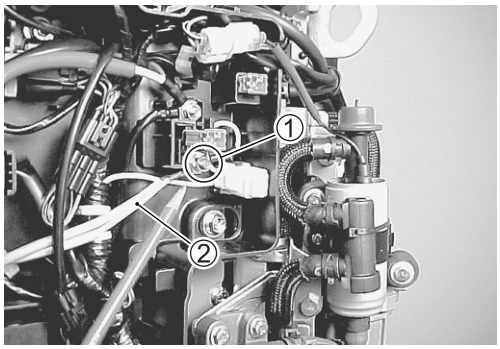
Battery charge coil

- Remove flywheel magneto. (See page 3-66.)
- Remove four (4) screws ① securing the battery charge coil ②.
- Disconnect battery charge coil lead wire connectors from Rectifier & regulator.
- Remove the lead wire clamps and battery charge coil.

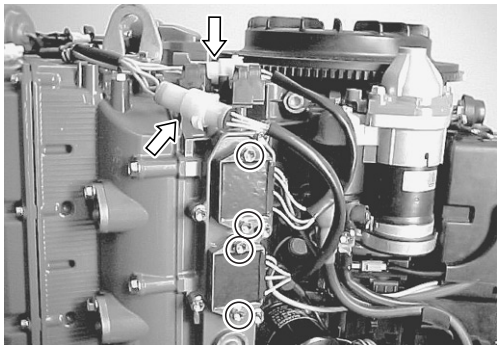


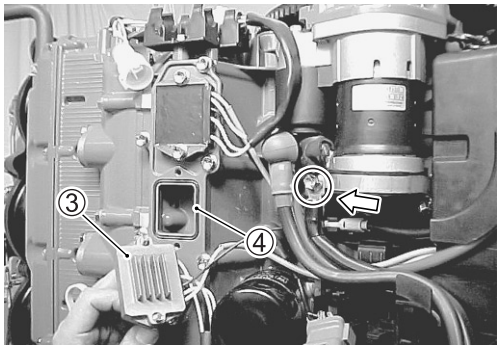
Rectifier & regulator

- Remove the electric parts holder cover.
- Remove the nut ① and charge output (white) leads ② from main fuse terminal.



- Disconnect battery charge coil lead wire connector from Rectifier & regulator.
- Remove the bolt securing ground lead wire of Rectifier & regulator.
- Remove the bolts securing the Rectifier & regulator.
- Remove the rectifier & regulator ③ and seal ring ④.





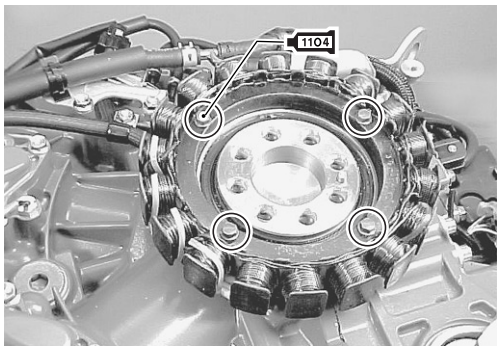
INSTALLATION

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

Battery charge coil

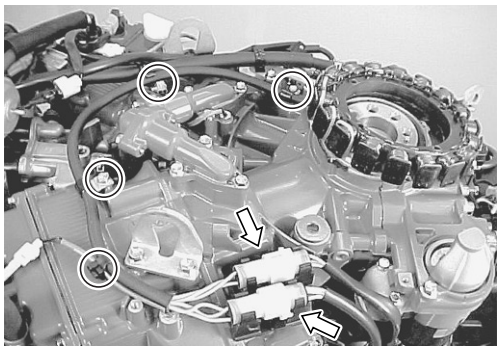
Apply Suzuki Bond No.1104 to the coil securing screws.

1104 99000-32050: SUZUKI BOND NO. 1104



Wire routing

Secure coil lead wire with lead wire clamps, then check that coil lead wire is routed properly and away from hot or rotating parts.
(For wire routing – See page - to - .)



ELECTRIC STARTER SYSTEM

OUTLINE

The starting circuit consists of the battery, starting motor, ignition switch, neutral switch and related electrical wiring.

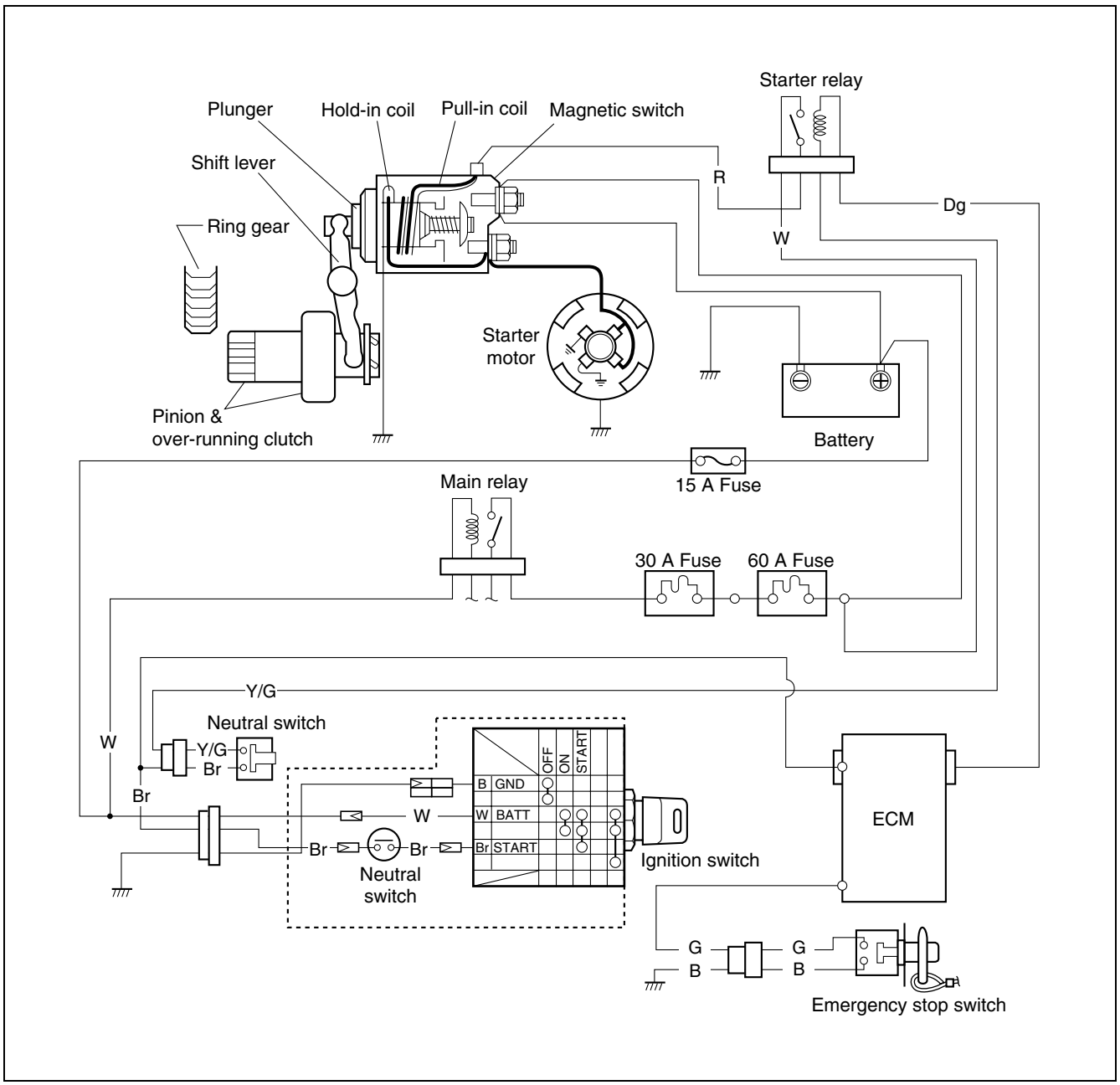
These components are connected electrically as shown in figure below.

STARTING SYSTEM CIRCUIT

In the circuit shown in figure below, the magnetic switch coils are magnetized when the ignition switch is closed (turn to “START”).

The resulting plunger and pinion shift lever movement causes the pinion to engage the engine flywheel gear, the magnetic switch main contacts to close, and engine cranking to take place.

When the engine starts, the pinion over-running clutch protects the armature from excessive speed until the switch is opened, at which time the torsion spring causes the pinion to disengage.



STARTER MOTOR OPERATION CONDITION

The starter motor relay will only engage when the ignition switch is turned to the “START” position if the all of the following conditions are satisfied.

- Lock plate is attached to emergency stop switch.
- Neutral switch is in “ON” position.
- Engine is not already operating.

NOTE:

If a failure exists in the Sub-battery cable or the 15 amp. fuse in its circuit, the starter motor relay circuit will not function properly.

STARTER ENGAGEMENT MECHANISM

A solenoid (electromagnetic force) type starter switch, utilizing a torsion spring and shift lever, engages the pinion gear to the flywheel.

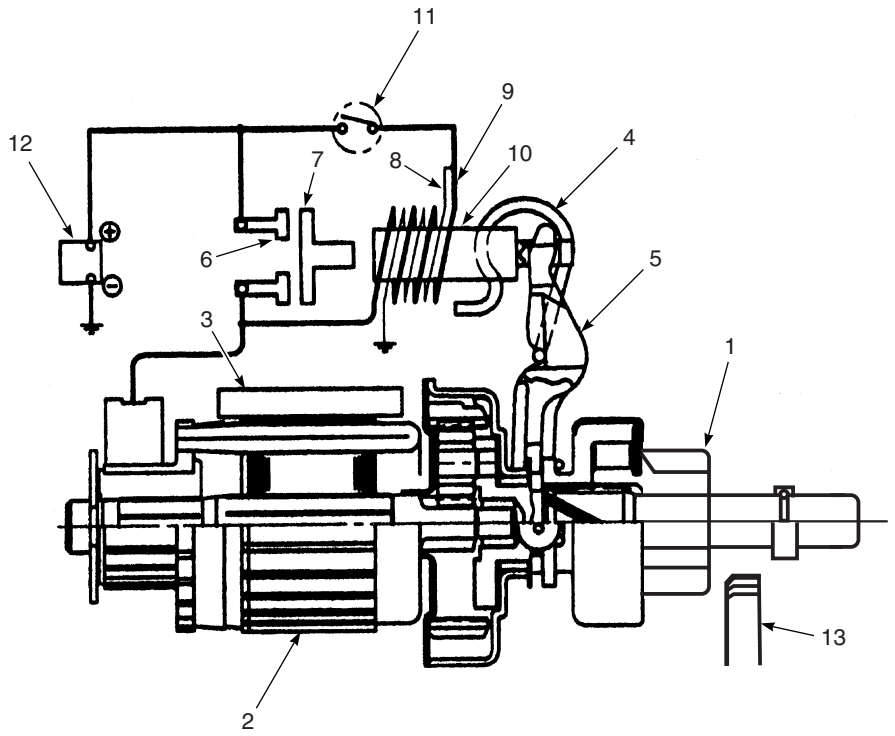
When the ignition key is turned to “START”, current flows through the switch winding creating an electro-magnet pulling the plunger in.

The shift lever, attached to the plunger, then pushes the pinion up into engagement with the flywheel. Plunger and shift lever movement also compresses the torsion spring, which applies pressure against the shift lever and pinion gear to maintain positive engagement.

Final plunger movement closes the starter switch contacts, which allows current to flow through the starter motor windings, rotating the starter motor armature, pinion gear and flywheel.

When the ignition key is released from start, current flow to the switch is shut off and electromagnetic force ceases. The torsion spring then pulls the plunger out, disengaging the pinion gear from the flywheel through the shift lever.

Movement of the plunger also opens the switch contacts, stopping current flow to the starter motor windings, shutting off the starter motor.



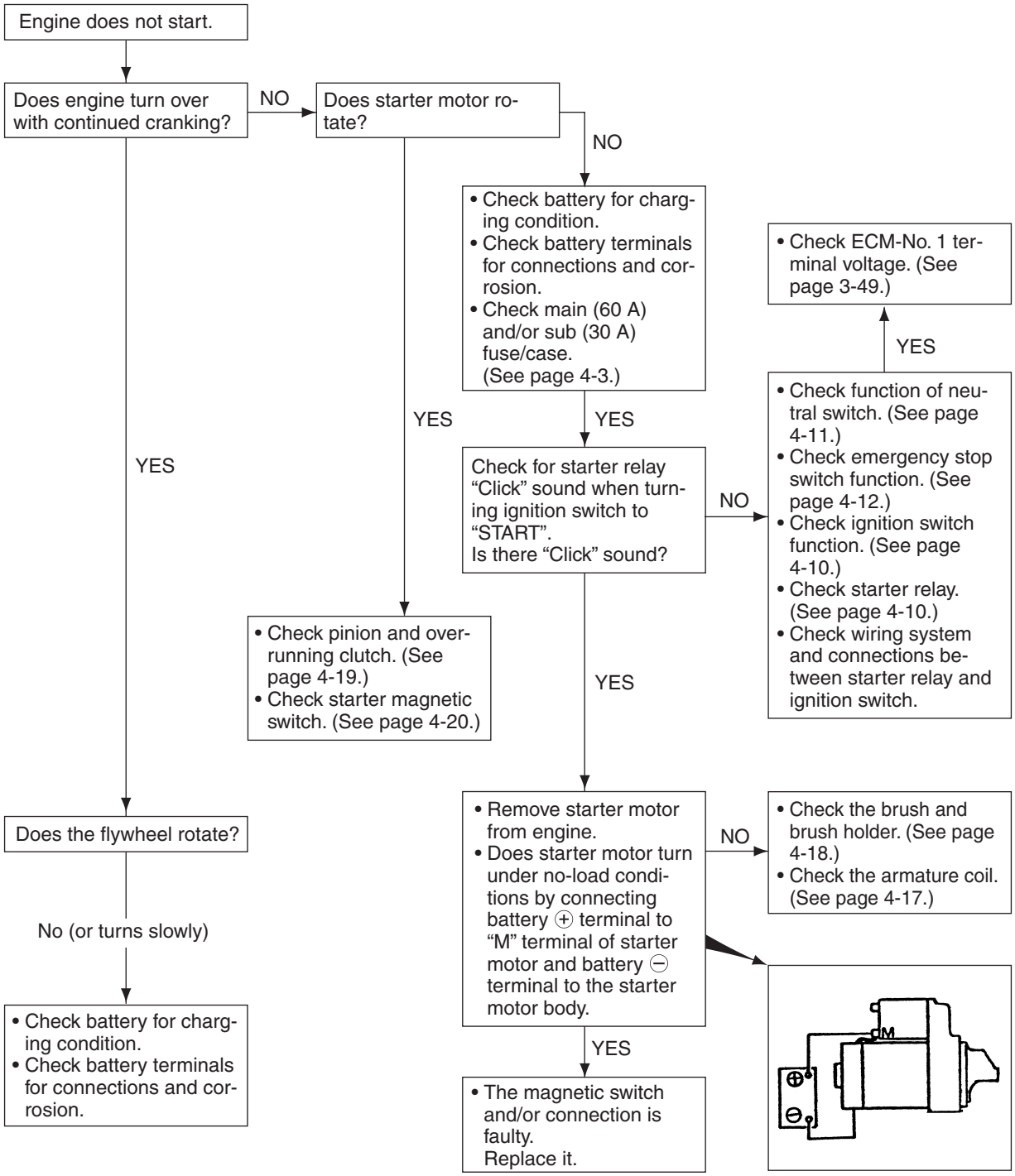
1. Pinion
2. Armature
3. Magnet
4. Torsion spring
5. Shift lever
6. Stationary contact
7. Movable contact
8. Hold-in coil
9. Pull-in coil
10. Plunger
11. Ignition switch
12. Battery
13. Ring gear

TROUBLESHOOTING

NOTE:
Before troubleshooting the electric starter system, make sure of the following:
- *Battery is fully charged.*
- *All cables/wires are securely connected.*
- *Shift is in "NEUTRAL" position.*
- *Emergency stop switch lock plate is set in place.*

CAUTION

If any abnormality is found, immediately disconnect battery cables from battery.



INSPECTION

IGNITION SWITCH

09930-99320: Digital tester

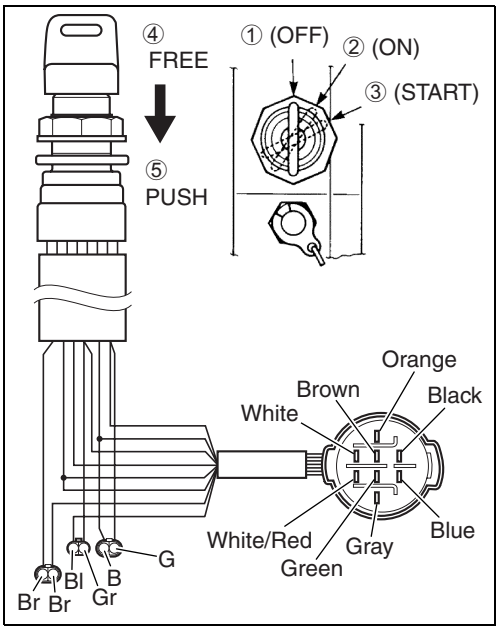
Tester range: (Continuity)

1. Disconnect the ignition switch from remo-con box wiring harness.
2. Check continuity between wiring leads at the key positions shown in the chart.

Key Position	Switch Lead Wires					
	Black	Green	White	Gray	Brown	Orange
① OFF	○	○				
② ON			○	○		
③ START			○	○	○	
④ FREE						
⑤ PUSH			○	○		○

○——○: Continuity

If out of specification, replace ignition switch.

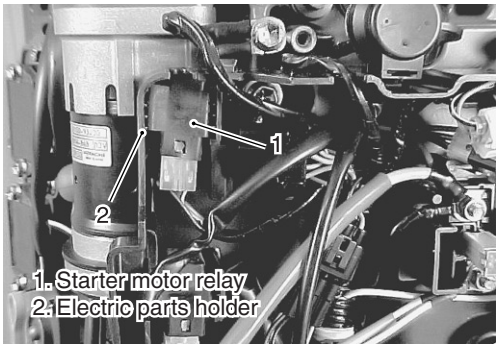


STARTER MOTOR RELAY

09930-99320: Digital tester

Tester range: (Continuity)

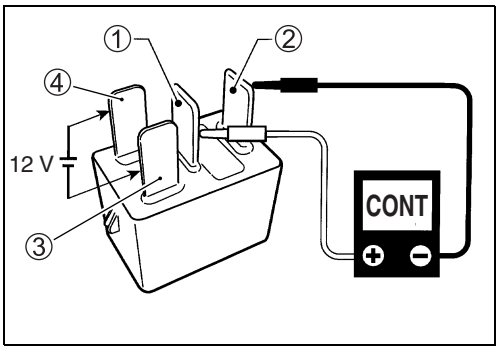
1. Disconnect starter motor relay from wire.



2. Check continuity between terminal ① and ② each time 12 V is applied. Connect positive ⊕ side to terminal ④, and negative ⊖ side to terminal ③.

Starter motor 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 other terminals.

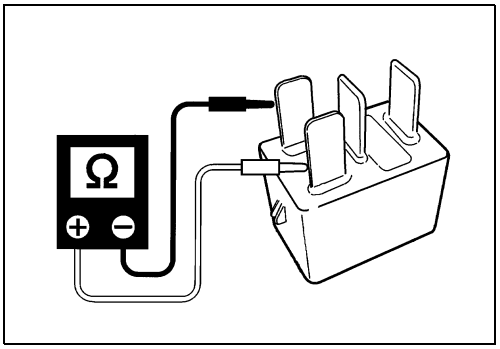
3. Measure resistance between relay terminals ③ and ④.

Tester range: Ω (Resistance)

Starter motor relay solenoid coil resistance:

145 – 190 Ω

If out of specification, replace starter motor relay.



NEUTRAL SWITCH

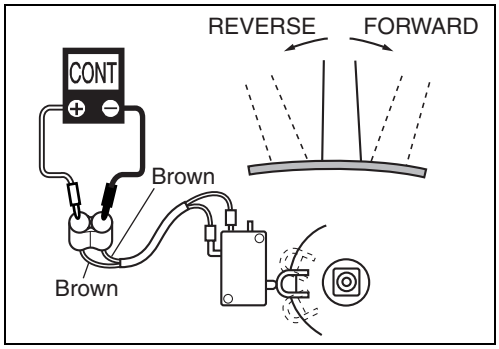
Check for continuity/infinity of the neutral switch.

09930-99320: Digital tester

Tester range: (Continuity)

Neutral switch in remo-con box

1. Disconnect neutral switch lead wire connector from ignition switch.
2. Check continuity/infinity between switch brown wire leads while operating remo-con handle.

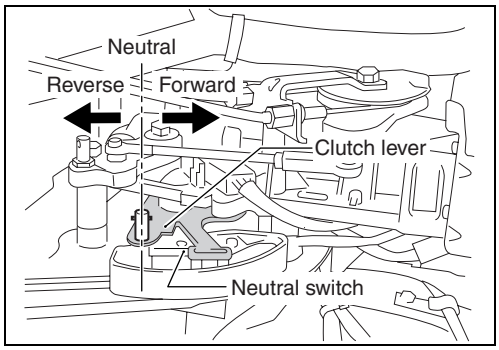


Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity

If out of specification, replace neutral switch.

Neutral switch on engine side

1. Disconnect neutral switch lead wire connector.
2. Check continuity/infinity between Yellow/Green and Brown lead wires while operating remo-con handle.



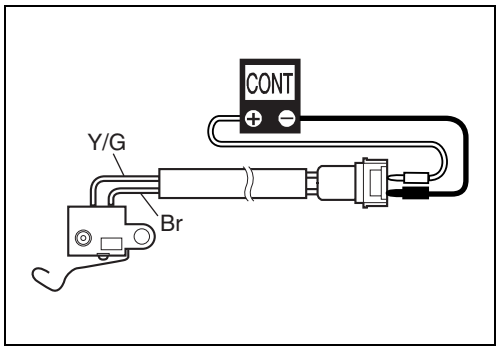
Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity

If out of specification:

- 1st Check switch position adjustment, readjust if necessary.
- 2nd Replace neutral switch.

NOTE:

After installing neutral switch, check for correct function by operating remo-con handle.

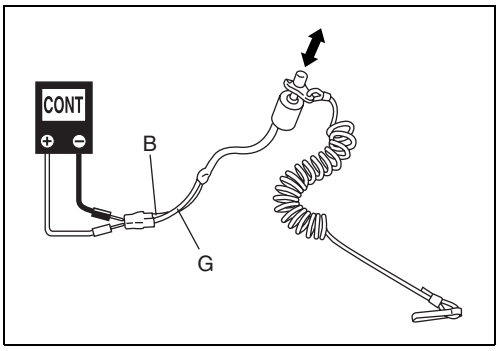


EMERGENCY STOP SWITCH

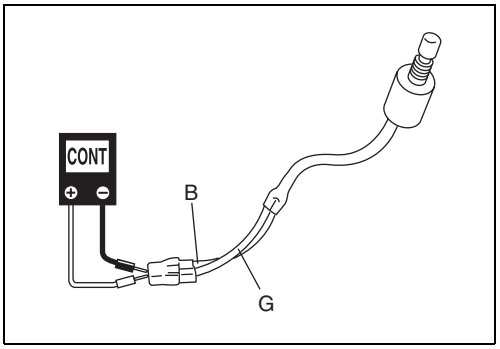
09930-99320: Digital tester

Tester range: (Continuity)

1. Disconnect the emergency stop switch lead wire.



2. Check continuity/infinity between the wiring leads under the condition shown below.



	Tester probe connection		Tester indicates
	Red (+)	Black (–)	
Lock plate installed	Green	Black	Infinity
Lock plate removed			Continuity

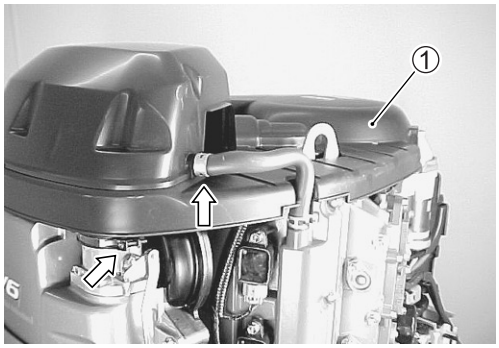
3. If out of specification, replace switch.

STARTER MOTOR

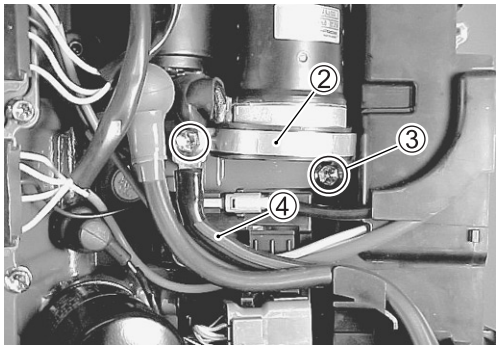
REMOVAL

Prior to removing starter motor:
- **Disconnect battery cables from battery.**

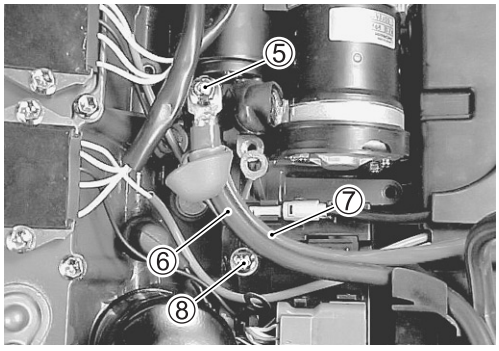
1. Remove bolts and ring gear cover with air intake silencer case ①. (See page 6-2.)



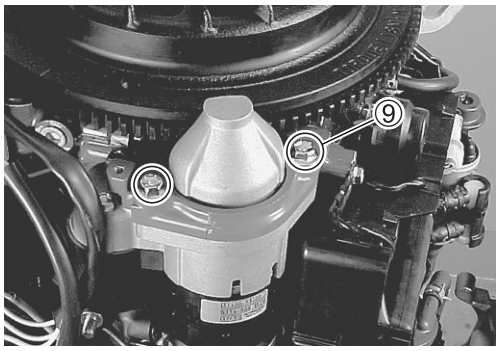
2. Remove the two (2) bolts ③, negative ⊖ battery cable ④ and starter motor band ②.



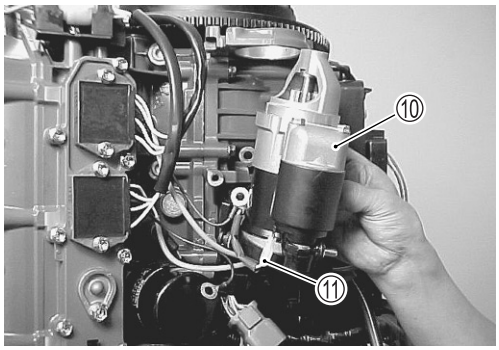
3. Remove nut ⑤ and positive ⊕ battery cable ⑥, positive ⊕ battery charge cable ⑦ from the magnetic switch of starter motor.
4. Remove the bolt ⑧ securing the remote control cable connector holder.



5. Remove the two bolts ⑨ securing starter motor.



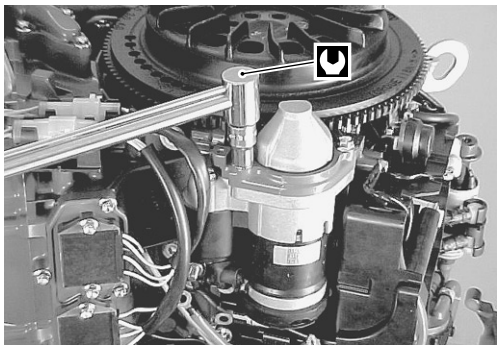
6. Remove the starter motor ⑩, then disconnect the red lead wire ⑪ from "S" terminal of starter magnetic switch.



INSTALLATION

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

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



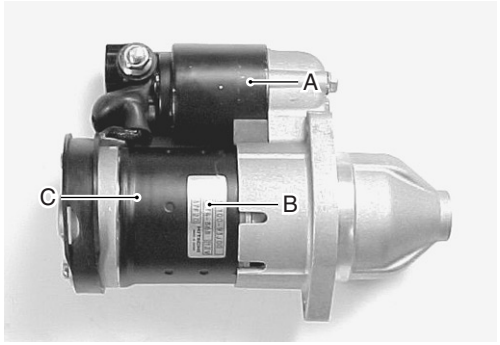
Starter motor mounting bolt:
23 N·m (2.3 kg-m, 16.5 lb-ft)

DISASSEMBLY

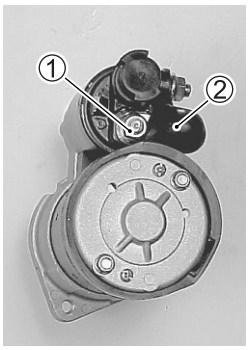
When overhauling starting motor, it is recommended that component parts be cleaned thoroughly.

However, the yoke assembly, armature coil, over-running clutch assembly, magnetic switch assembly, and rubber or plastic parts should not be washed in a degreasing tank or with a grease dissolving solvent. These parts should be cleaned with compressed air or wiped with clean cloth.

NOTE:
Before disassembling starting motor, be sure to put match marks at three locations (A, B and C) as shown in figure at right to avoid any possible component alignment mistakes.

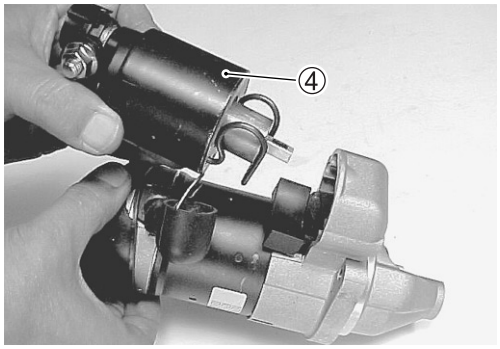


1. Remove nut ① from magnetic switch, then disconnect the connecting wire ②.
2. Remove two bolts ③ securing magnetic switch.

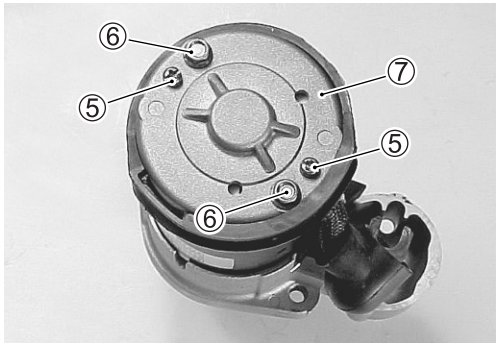




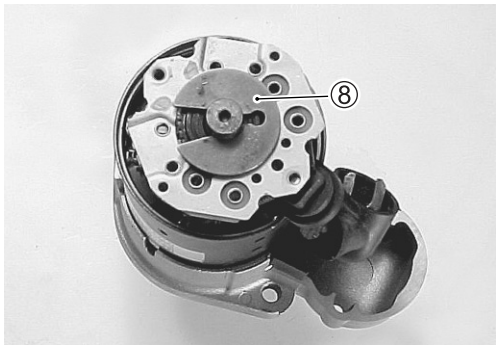
3. Remove the magnetic switch ④.



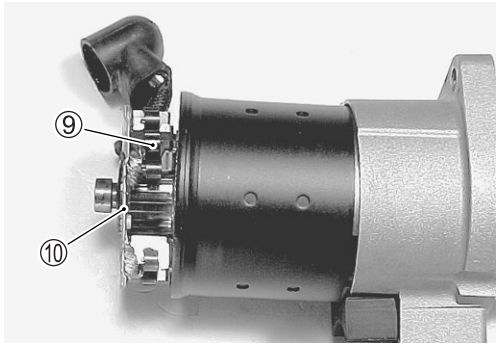
4. Remove screws ⑤, long through bolts ⑥ and rear cover ⑦.



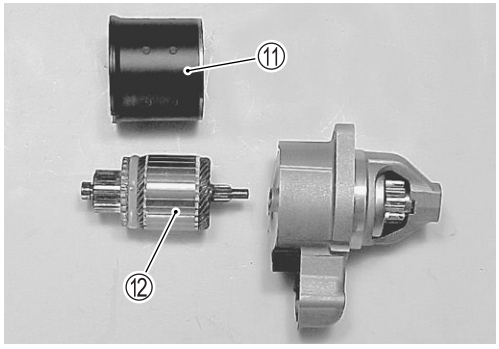
5. Remove thrust washer ⑧ with screwdriver.



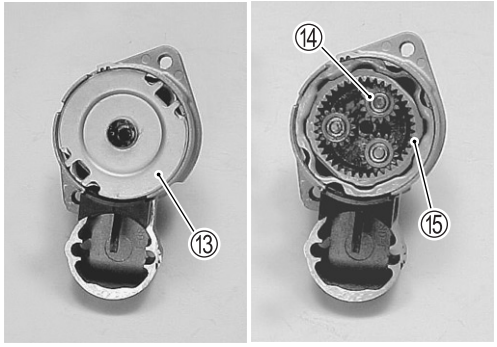
6. Pull the brush spring ⑨ up to separate the brush from the surface of the commutator, then remove the brush holder ⑩.



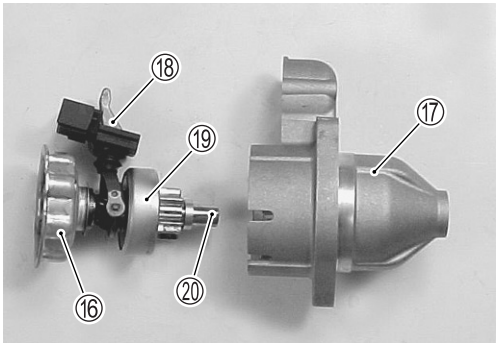
7. Remove the yoke ⑪ and armature ⑫.



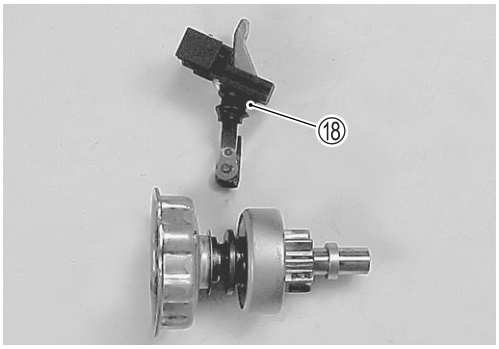
8. Remove the center cover plate ⑬.
9. Remove the planetary gears ⑭ and internal gear ⑮.



10. Remove the center bracket ⑯ (with shift lever ⑱, pinion ⑲ and pinion shaft ⑳) from front housing ⑰.



11. Remove the shift lever ⑱.

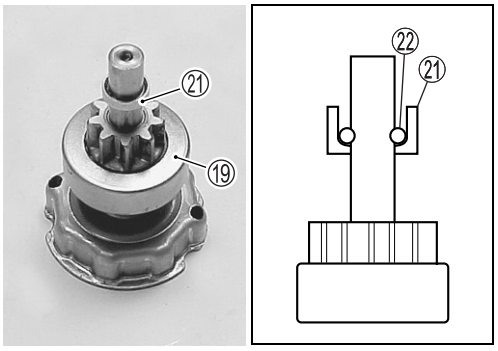


12. Push the pinion stopper ㉑ down, then remove stopper ring ㉒.
    Remove the pinion stopper and pinion ⑲.

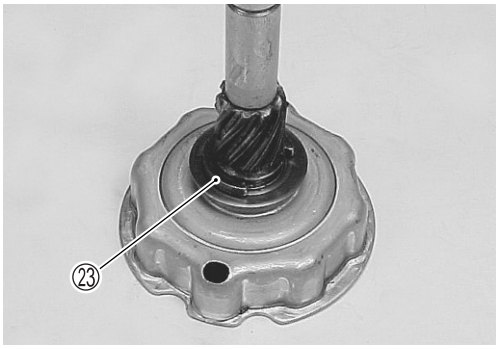
⚠ WARNING

Wear safety grasses when disassembling and assembling stopper ring.

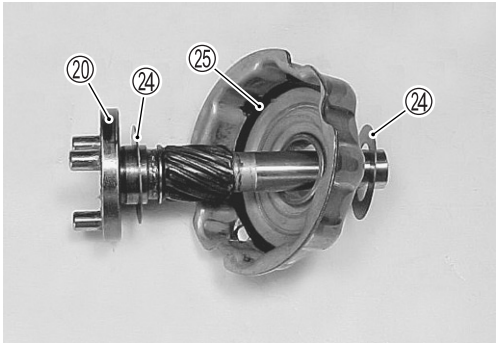
NOTE:
Using a screw-driver, pry off the stopper ring.



13. Remove the E-ring ㉓.



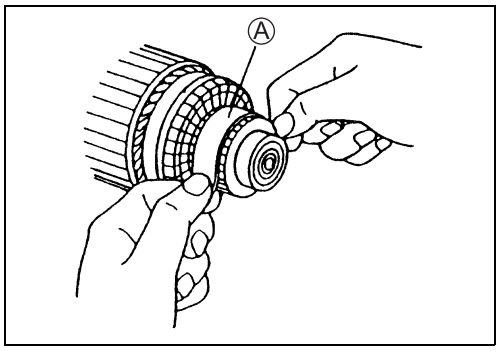
14. Remove the pinion shaft ⑳, washers ㉔ and rubber ring ㉕ from center bracket.



INSPECTION AND SERVICING

Armature and Commutator

- Inspect the commutator surface.
  If surface is gummy or dirty, clean with #500 grit emery paper Ⓐ.

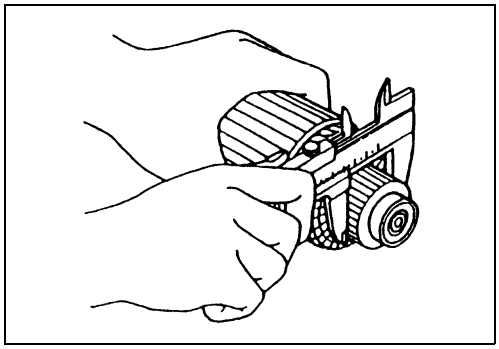


- Measure commutator outside diameter.

TOOL 09900-20101: Vernier calipers

Commutator outside diameter:
Standard: 29.0 mm (1.14 in)
Service limit: 28.0 mm (1.10 in)

If measurement exceeds service limit, replace armature.

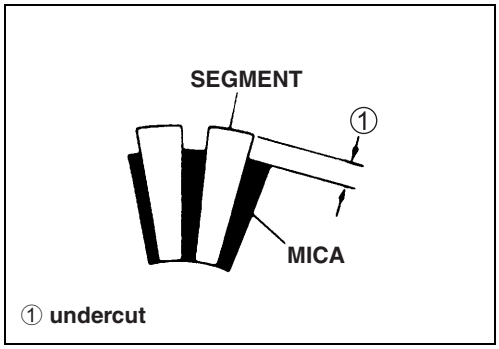


- Check that mica (insulator) between the segments is undercut to specified depth.

Commutator undercut ①:
Standard: 0.5 – 0.8 mm (0.02 – 0.03 in)
Service limit: 0.2 mm (0.01 in)

If measurement exceeds service limit, cut to specified depth.

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



① **undercut**

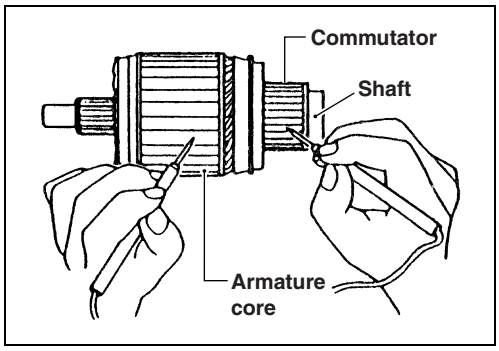
⚠ WARNING

Wear safety grasses when using compressed air.

- Check for continuity between the commutator and the armature core/shaft.
  Replace armature if continuity is indicated.

TOOL 09930-99320: Digital tester

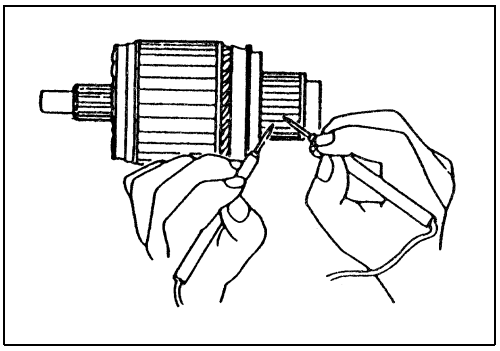
Tester range: (Continuity)



• Check for continuity between adjacent commutator segments. Replace armature if no continuity is indicated.

09930-99320: Digital tester

Tester range: (Continuity)



BRUSHES

Check the length of each brush.

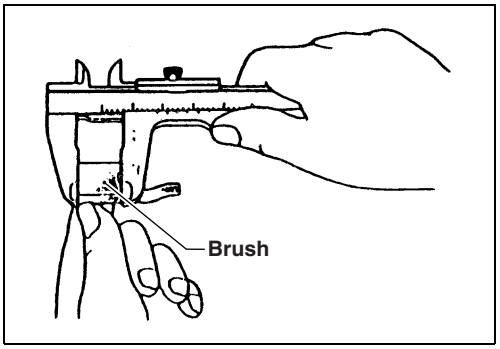
09900-20101: Vernier calipers

Brush length:

Standard: 16.0 mm (0.63 in)

Service limit: 12.0 mm (0.47 in)

If brushes are worn down to the service limit, they must be replaced.



BRUSH HOLDER

• Check brush holder continuity.

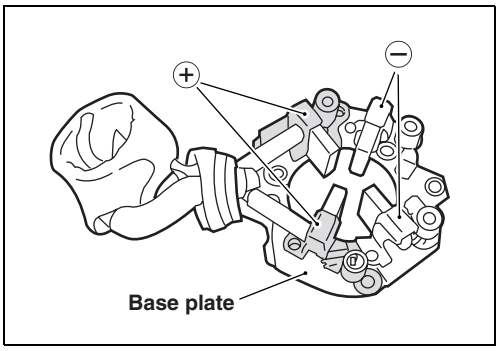
09930-99320: Digital tester

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

Replace brush holder if the tester doesn't show the above.



BRUSH SPRING

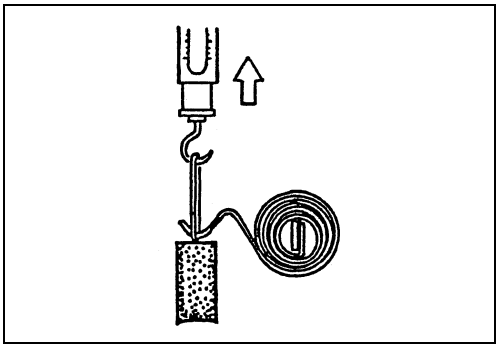
Inspect brush spring for wear, damage or other abnormal conditions.

Check the brush spring tension.

Replace if necessary.

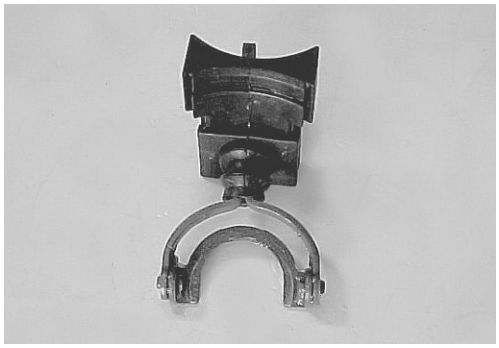
Brush spring tension

Standard: 15 – 18 N (1.5 – 1.8 kg, 3.3 – 4.0 lb)



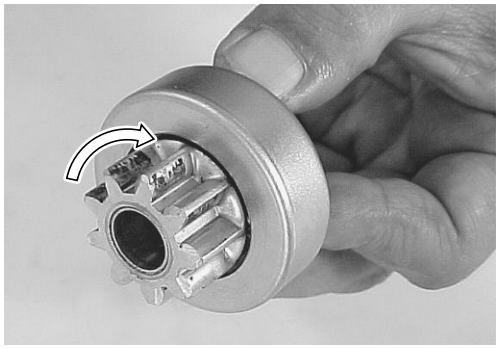
SHIFT LEVER

Inspect shift lever for wear.
Replace if necessary.

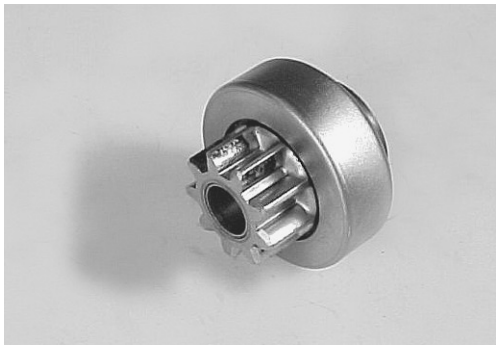


PINION AND OVER-RUNNING CLUTCH

- Inspect pinion for wear, damage or other abnormal conditions. Check that clutch locks up when turned in direction of drive and rotates smoothly in reverse direction.
  Replace if necessary.

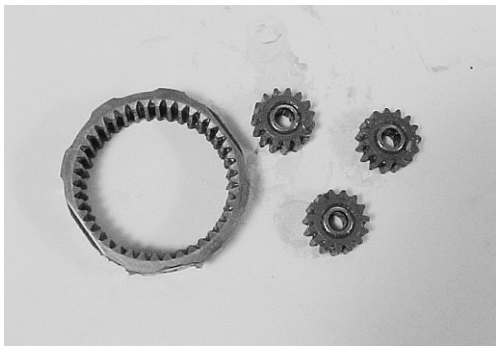


- Inspect spline teeth for wear or other damage.
  Inspect pinion for smooth movement.
  Replace if necessary.



GEAR

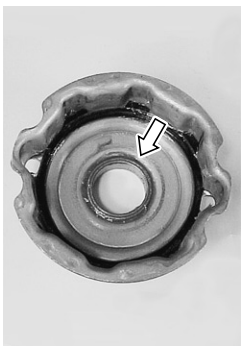
- Inspect planetary gears and internal gear for wear, damage or other abnormal conditions.
  Replace if necessary.



PINION SHAFT/PINION SHAFT BUSH

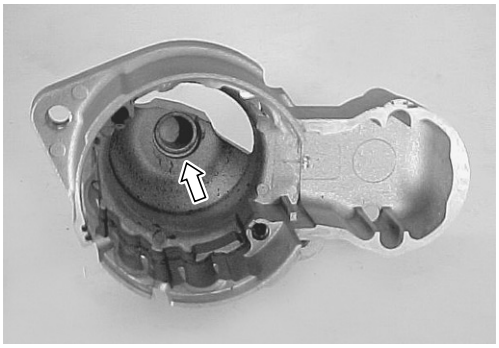
- Inspect pinion shaft for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect pinion shaft bush for wear or other damage.
  Replace if necessary.





FRONT HOUSING

- Inspect front housing for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect bush for wear or other damage. Replace if necessary.



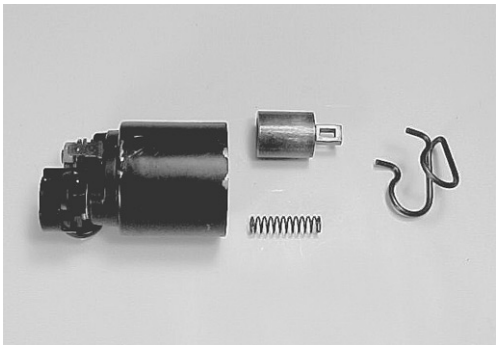
ARMATURE SHAFT BUSH

Inspect bush for wear or other damage.
Replace if necessary.



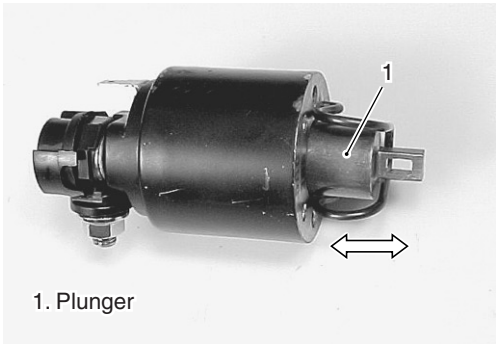
PLUNGER

Inspect plunger for wear or other damage.
Replace if necessary.



MAGNETIC SWITCH

Push in plunger and release. The plunger should return quickly to its original position.
Replace if necessary.



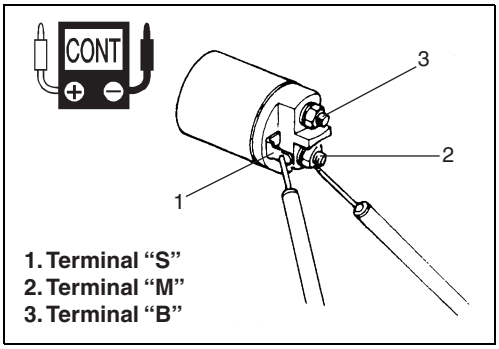
1. Plunger

Pull-in coil Open circuit Test

09930-99320: Digital tester

Tester range: (Continuity)

Check for continuity across magnetic switch “S” terminal and “M” terminal.
If no continuity exists, the coil is open and should be replaced.



1. Terminal “S”
2. Terminal “M”
3. Terminal “B”

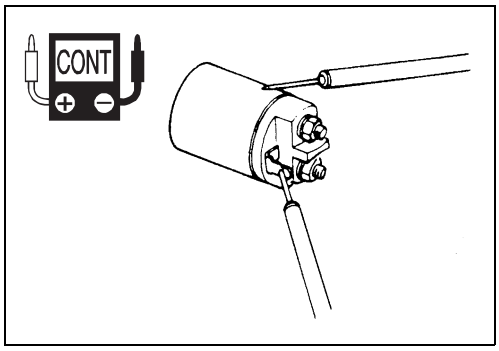
Hold-in coil Open circuit Test

09930-99320: Digital tester

Tester range: (Continuity)

Check for continuity across magnetic switch “S” terminal and coil case.

If no continuity exists, the coil is open and should be replaced.



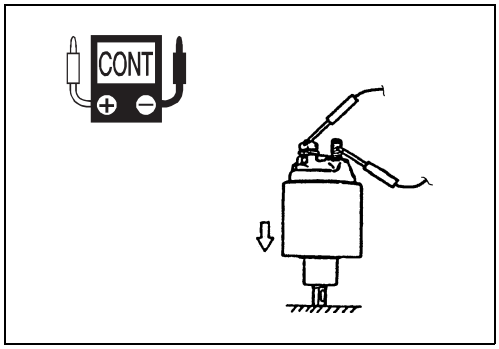
Contact points Test

09930-99320: Digital tester

Tester range: (Continuity)

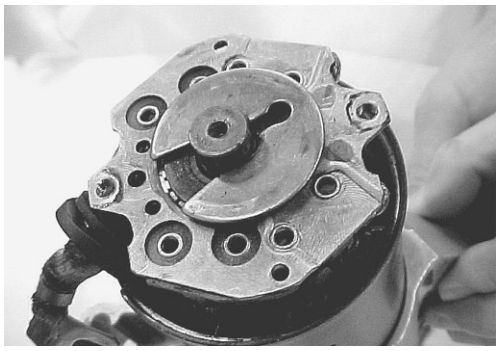
Put the plunger on the under side and then push the magnetic switch down. At this time, check for continuity between terminal “B” and terminal “M”.

Continuity indicates proper condition. If no continuity exists, replace the magnetic switch and/or plunger.



ASSEMBLY

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

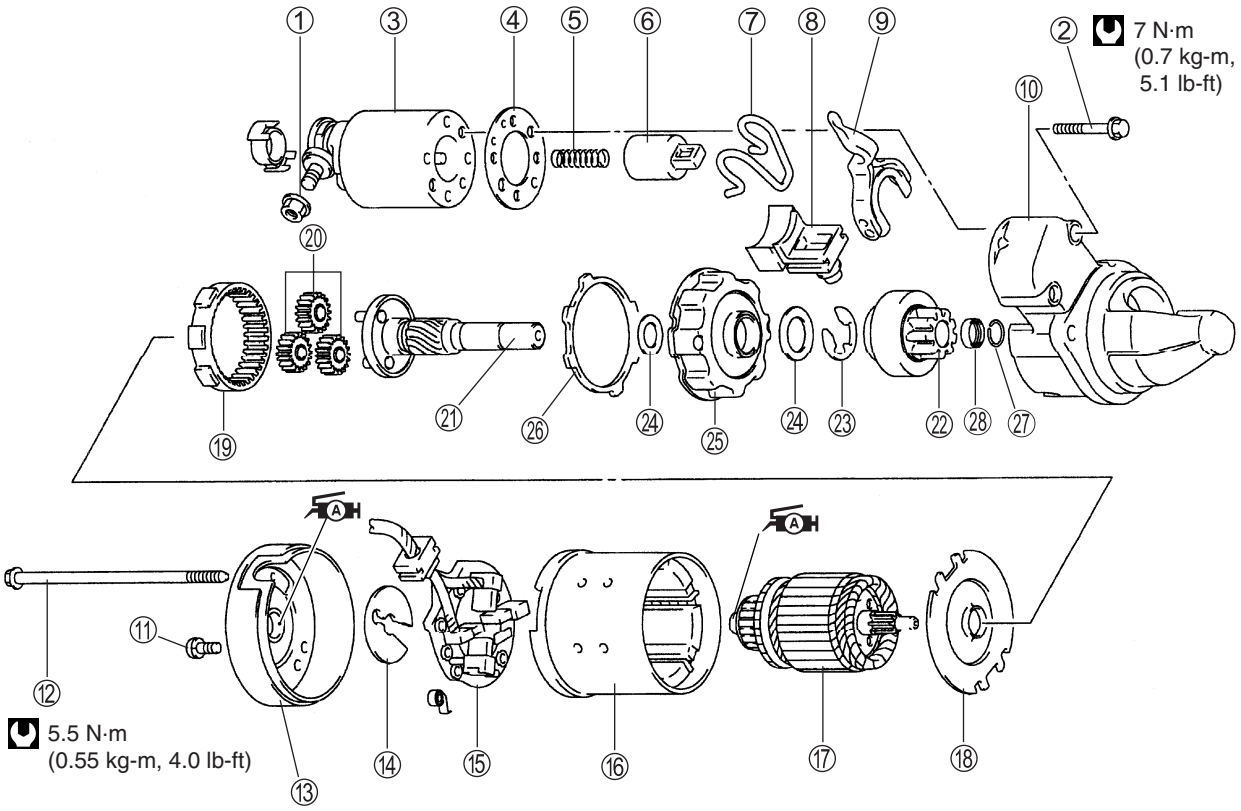


CAUTION

When installing armature, use care to avoid breaking brushes.

When installing pinion shift lever, refer to figure in construction diagram for installation direction.

Construction diagram



① Nut
② Bolt
③ Magnetic switch
④ Gasket
⑤ Spring
⑥ Plunger
⑦ Torsion spring
⑧ Rubber packing
⑨ Shift lever
⑩ Front housing
⑪ Screw
⑫ Through bolt
⑬ Rear cover
⑭ Thrust washer
⑮ Brush holder
⑯ Yoke
⑰ Armature
⑱ Center cover plate
⑲ Internal gear
⑳ Planetary gear
㉑ Pinion shaft
㉒ Pinion
㉓ E-ring
㉔ Washer
㉕ Center bracket
㉖ Rubber ring
㉗ Stopper ring
㉘ Pinion stopper

PERFORMANCE TEST

CAUTION

Each test must be performed within 3 – 5 seconds to avoid coil damage from overheating.

⚠ WARNING

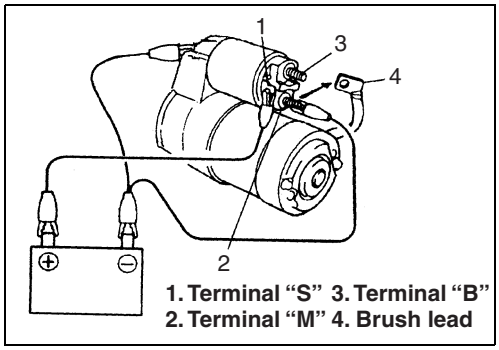
When performing the following test, be sure to connect the battery and the starting motor with a lead wire of the same size as original equipment used there.

PULL-IN/HOLD-IN TEST

Connect battery to magnetic switch as shown in figure.

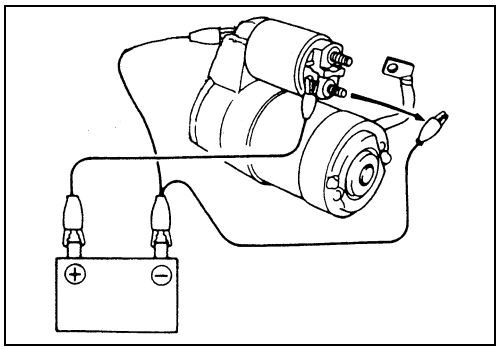
- Check that plunger and pinion (over-running clutch) move outward.
  If plunger and pinion don't move, replace magnetic switch.

NOTE:
Before testing, disconnect brush lead from terminal "M".



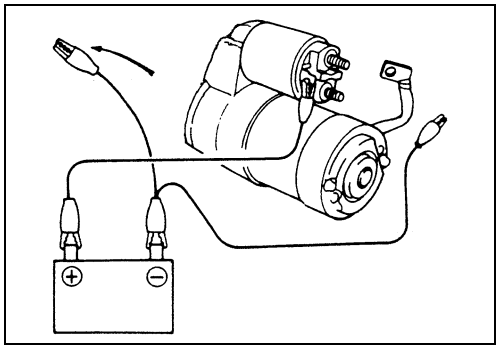
1. Terminal "S" 3. Terminal "B"
2. Terminal "M" 4. Brush lead

- While connected as above with plunger out, disconnect negative lead from terminal "M".
  Check that plunger and pinion remain out.
  If plunger and pinion return inward, replace magnetic switch.



PLUNGER AND PINION RETURN TEST

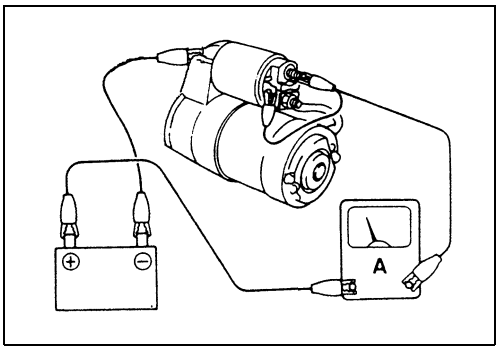
Disconnect negative lead from switch/motor body.
Check that plunger and pinion return inward.
If plunger and pinion don't return inward, replace magnetic switch.



NO-LOAD PERFORMANCE TEST

CAUTION

Before performing following test, secure the starter motor to the test bench.



1. Connect battery and ammeter to starter motor as shown.
2. Check that starter rotates smoothly and steadily with pinion moving out. Check that ammeter indicates specified current.

   No load current: Within 90 A at 11 V

MONITOR-TACHOMETER

INSPECTION

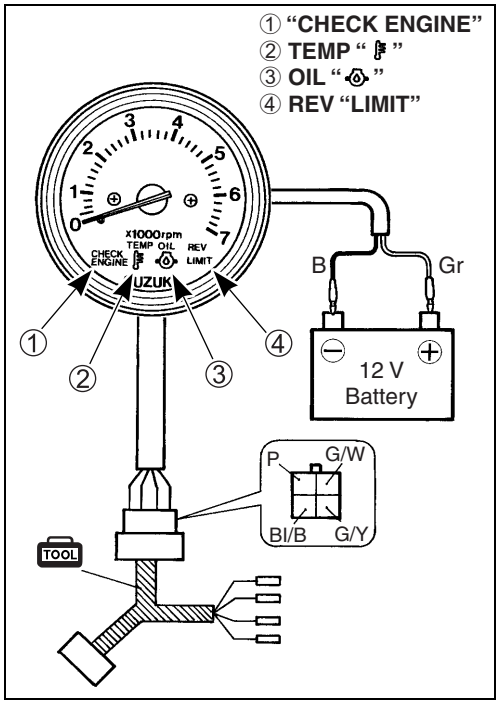
MONITOR LAMP CHECK

1. Connect test cord as shown in figure.

TOOL 09930-89240: 4-pin test cord

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

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

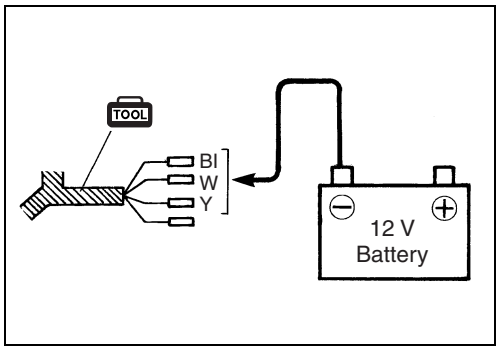


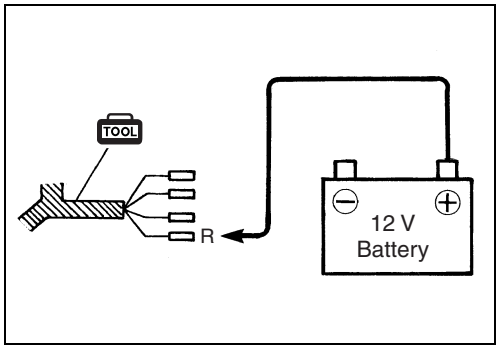
3. Check if lamp lights when connecting battery to test cord terminal as shown.

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 out of specification, replace monitor-tachometer.

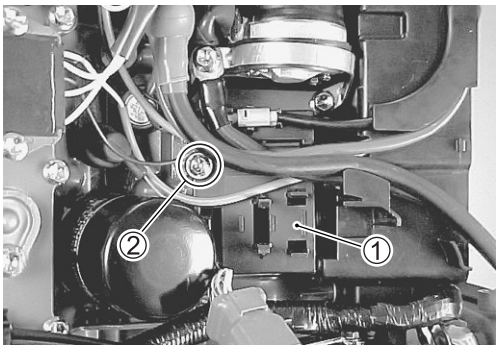




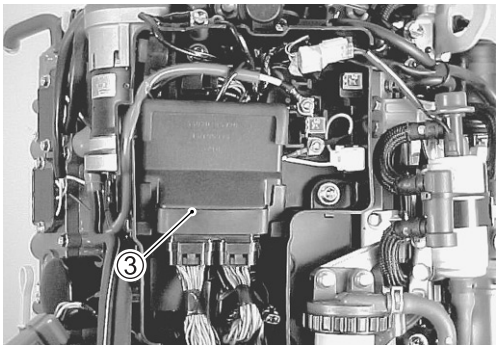
ELECTRIC PARTS HOLDER

REMOVAL

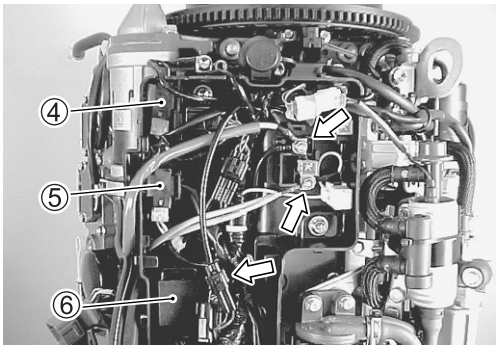
Before removing electric parts holder:
- **Disconnect battery cables from battery.**

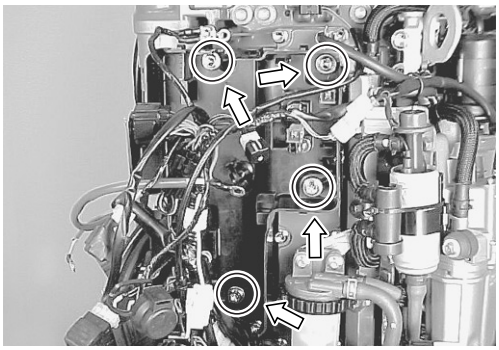


- Remove bolt ②, then remove remo-con cable holder ① by sliding it upward.
- Remove electric parts holder cover.
- Disconnect lead wire connectors from ECM ③, then remove ECM.
- Disconnect following lead wires in electric parts holder.
  - Two (2) White Rectifier & Regulator lead wires and White 30 A fuse lead on 60 A main fuse lower terminal.
  - Red battery charge lead and Red lead of PTT relay unit on 60 A main fuse upper terminal.
  - Harness connector at CKP sensor.



- Remove starter motor relay ④, ECM main relay ⑤, PTT relay unit ⑥, 30 A fuse case from electric parts holder.
- Remove four (4) bolts securing electric parts holder, then remove electric parts holder.





INSTALLATION

Installation is reverse order of removal.

Final check:
- All parts removed have been returned to their original position.
- Check wire routing. (See page x-xx to x-xx.)

FUEL SYSTEM

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PRECAUTIONS WHEN SERVICING FUEL SYSTEM

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 when battery power is required for servicing/inspection.**
- **Keep the working area well ventilated and 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.
- **Keep a fully charged CO2 fire extinguisher and readily available for use.**
- **Always use appropriate safety equipment and wear safety glasses when working around pressurized fuel system.**
- **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.**

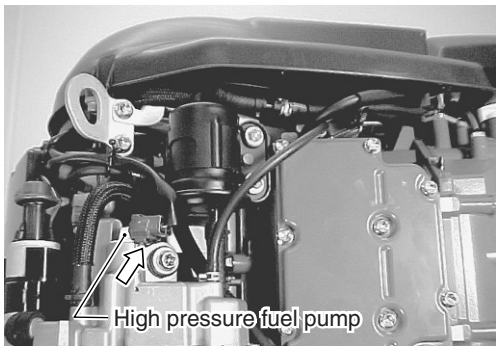
⚠ WARNING

Fuel components and fuel hoses 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.

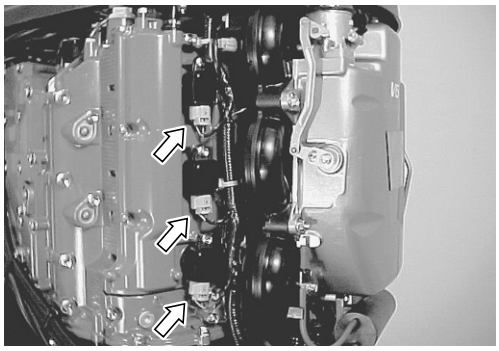
FUEL PRESSURE RELIEF PROCEDURE

After making sure that engine is cold, relieve fuel pressure as follows.

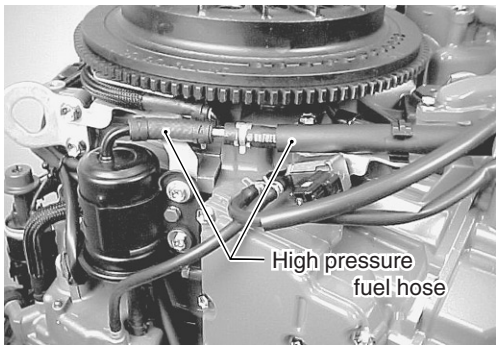
1. Turn OFF ignition switch.
2. Disconnect high pressure fuel pump lead wire connector at high pressure fuel pump.



3. Disconnect the ignition coil primary lead wire connector from all ignition coils.
4. Crank the engine 5 – 10 times (3 seconds each time) to dissipate fuel pressure in lines.



5. Make sure fuel pressure has been removed by pinching high pressure fuel hose between finger tips (line should feel soft without pressure).
6. Upon completion of servicing, connect ignition coil primary lead wire and high pressure fuel pump lead wire.



FUEL LINE

REMOVAL/INSTALLATION

Pay special attention to the following steps when removing or installing fuel hoses.

⚠ WARNING

Fuel components and fuel hoses 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.

CAUTION

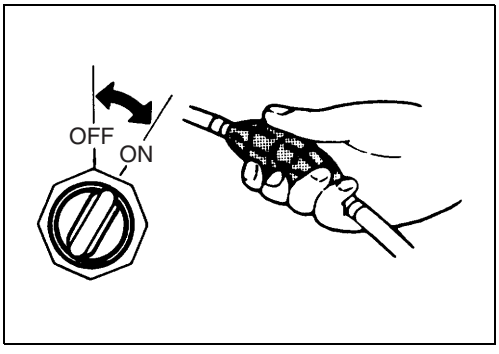
- **Do not over bend (kink) or twist hoses when installing.**
- **When installing hose clamps, position tabs to avoid contact with other parts.**
- **Be sure hoses do not contact rods, levers or other components with engine either operating or at rest.**
- **Extreme care should be taken not to cut, abrade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

NOTE:
- *Check fuel hose routing. (See page xx-xx and xx-xx.)*
- *Check for fuel leakage.*

FUEL LEAKAGE CHECK PROCEDURE

After performing any fuel system service, always be sure there is no fuel leakage by checking as follows.

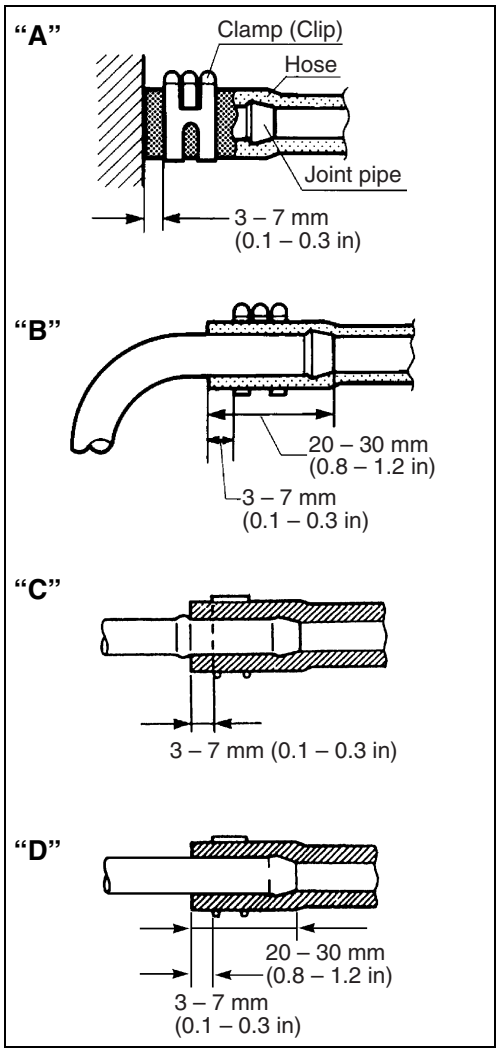
1. Squeeze fuel primer bulb until you feel resistance.
2. Ensure emergency stop switch lock plate is in place.
3. Turn ignition switch “ON” for 6 seconds (to operate fuel pump), then turn it “OFF”.
   Repeat this (ON and OFF) procedure 3 or 4 times to pressurize the fuel system.
4. Once pressurized, check all connections and components for any signs of leakage.



FUEL HOSE CONNECTION

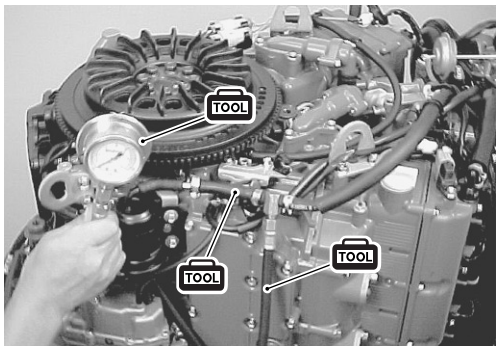
Note that fuel hose connection varies with each type of pipe. Be sure to connect and clamp each hose correctly by referring to the figure.

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



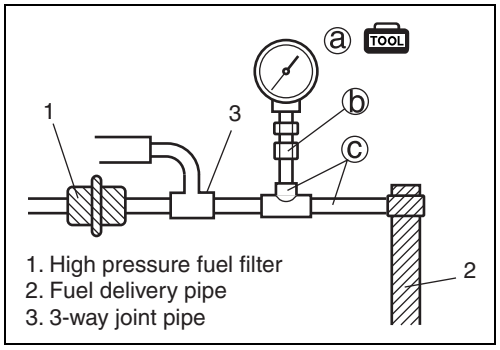
FUEL PRESSURE INSPECTION

1. Relieve fuel pressure in fuel feed line. (See page 5-3.)
2. Remove the ring gear cover and air intake silencer case. (See page 6-xx.)
3. Disconnect high pressure fuel feed hose from 3-way joint pipe.



4. Connect special tools (pressure gauge, pressure hose & pressure joint) between fuel feed hose and 3-way joint pipe as shown in figure.
   Clamp hose securely to ensure no leaks occur during checking.

TOOL **09912-58442: Pressure gauge – ⓐ**
09912-58432: Fuel pressure hose – ⓑ
09912-58490: Fuel pressure joint – ⓒ

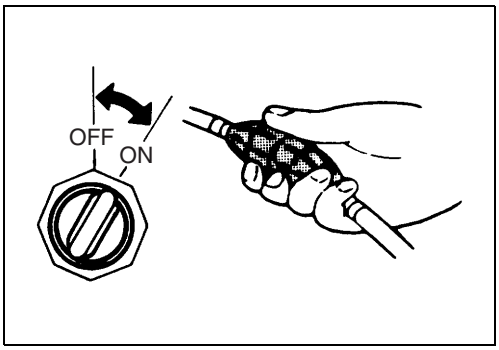


CAUTION

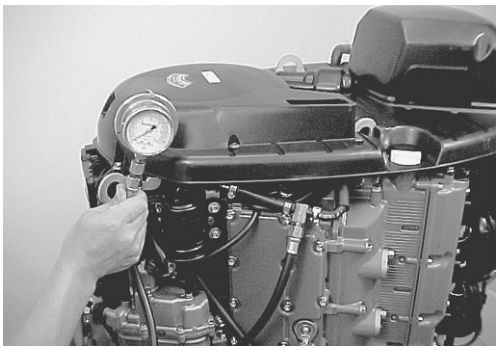
A small amount of fuel may be released when the fuel feed hose is disconnected.
Place container under the fuel feed hose or 3-way joint pipe with a shop cloth so that released fuel is caught in container or absorbed in cloth. Place fuel soaked cloth in an approved container.

5. Ensure emergency stop switch lock plate is in place.

6. Squeeze fuel primer bulb until you feel resistance.
7. Turn ignition switch “ON” for 6 seconds (to operate fuel pump), then turn it “OFF”.
8. Repeat this (“ON” and “OFF”) procedure 3 or 4 times to pressurize the fuel system and then check fuel pressure.
9. Check for any signs of fuel leakage, then reinstall the ring gear cover and air intake silencer case.
10. Measure fuel pressure in line at cranking or idle speed operation.



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

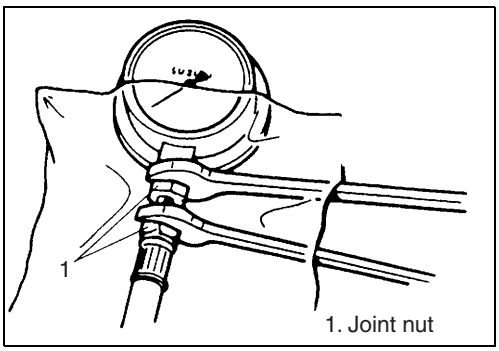


11. Stop engine and wait 5 minutes.
Check residual fuel pressure in line.

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

CAUTION

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



1. Joint nut

12. After checking fuel pressure, remove fuel pressure gauge.
13. Reconnect fuel line.
14. With engine not running and ignition switch “ON”, check fuel system for leaks .
15. Reinstall the ring gear cover and air intake silencer case.

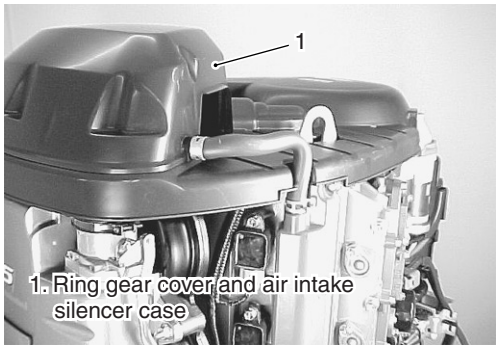
LOW PRESSURE FUEL PUMP/FUEL VAPOR SEPARATOR SET

REMOVAL

⚠ WARNING

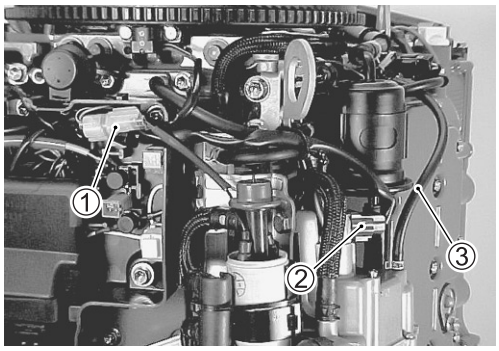
Fuel components and fuel hoses after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing components.

1. Relieve fuel pressure in fuel feed line. (See page 5-3.)
2. Remove the ring gear cover and air intake silencer case. (See page 6-2.)

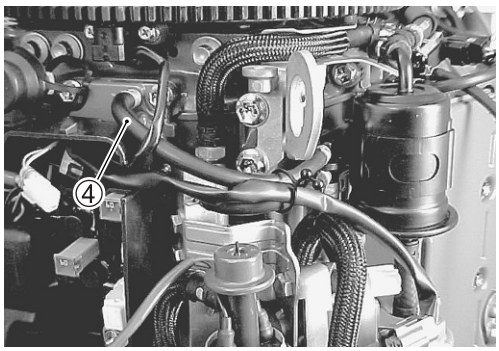


1. Ring gear cover and air intake silencer case

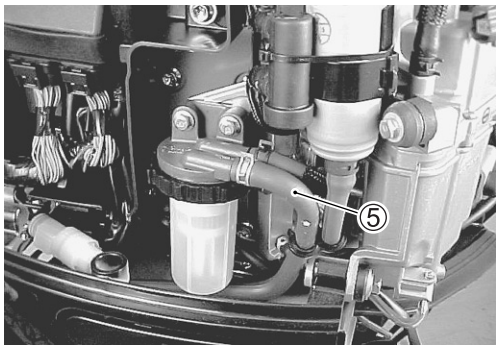
3. Disconnect low pressure fuel pump lead wire connector ①. Disconnect high pressure fuel pump lead wire connector ② at fuel pump.
4. Disconnect purge valve hose ③ from fuel vapor separator.



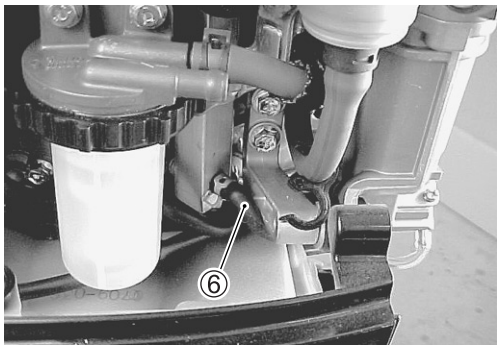
5. Disconnect water outlet hose ④ from crankcase water jacket cover.



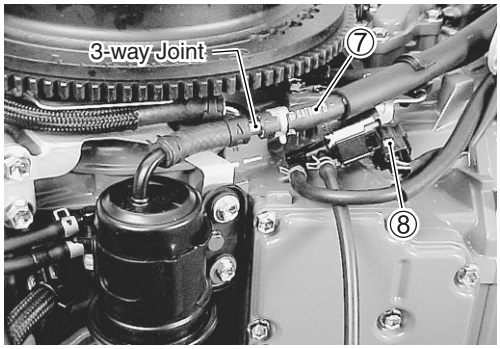
6. Disconnect fuel inlet hose ⑤ from low pressure fuel filter.



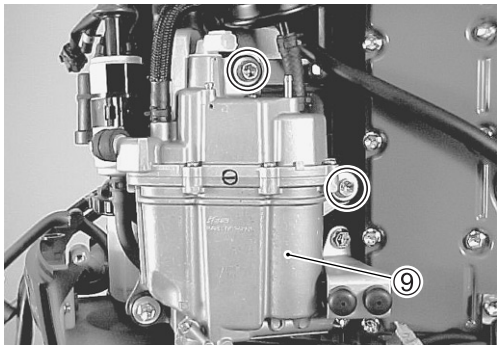
7. Disconnect water inlet hose ⑥ from fuel cooler.



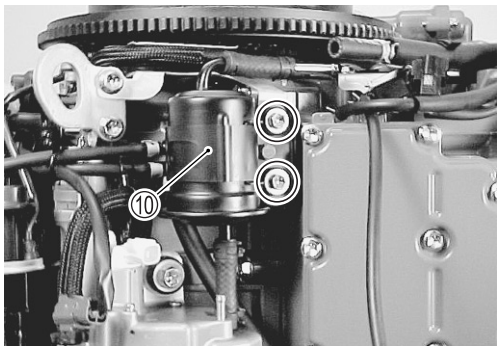
8. Disconnect high pressure fuel feed hose ⑦ from 3-way joint pipe.
   Disconnect purge valve lead wire connector ⑧ at purge valve.



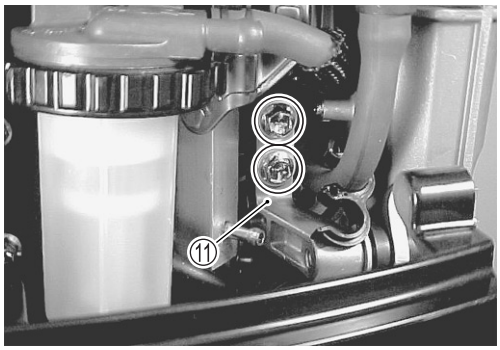
9. Remove the two (2) bolts securing fuel vapor separator ⑨ to crankcase.



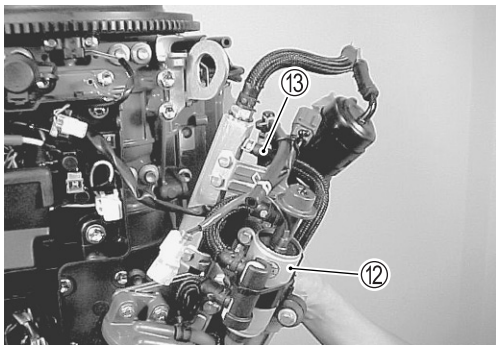
10. Remove the two (2) bolts securing high pressure fuel filter ⑩ to crankcase.



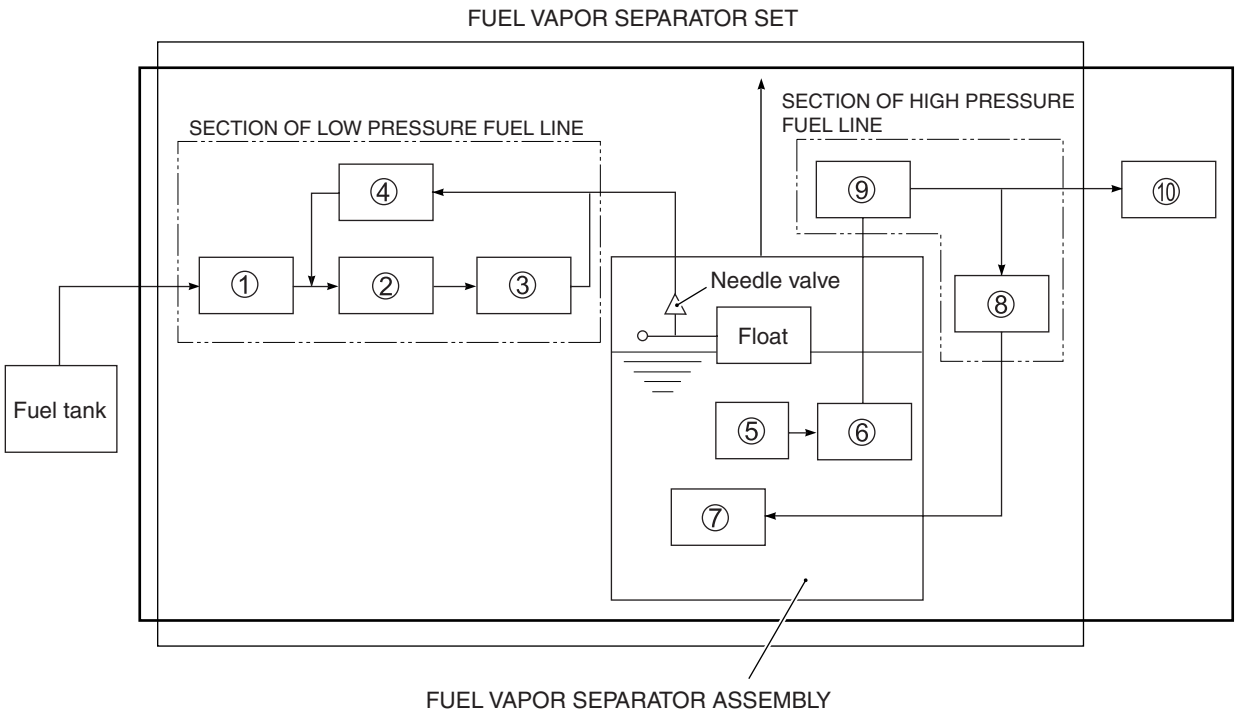
11. Remove the two (2) bolts securing fuel vapor separator bracket ⑪.



12. Remove the low pressure fuel pump/fuel vapor separator set ⑫, then disconnect cooling water outlet hose ⑬ from fuel cooler.

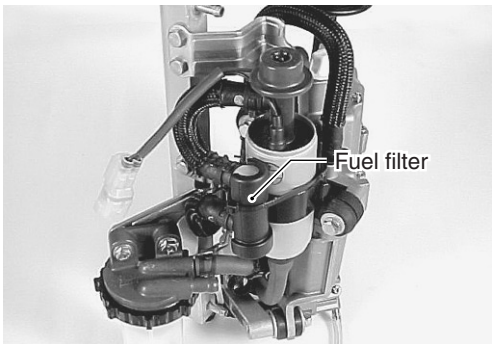


FUEL SYSTEM DIAGRAM



① Low pressure fuel filter
② Low pressure fuel pump
③ Fuel filter
④ Relief valve
⑤ Fuel filter
⑥ High pressure fuel pump
⑦ Pressure regulator
⑧ Fuel cooler
⑨ High pressure fuel filter
⑩ Fuel delivery pipe

INSPECTION



FUEL FILTER

- Remove the fuel filter.
- Inspect filter for clog or other damage.
  Replace or clean if necessary.
- Reinstall fuel filter, then secure the hose with hose clamp (clip).



RELIEF VALVE

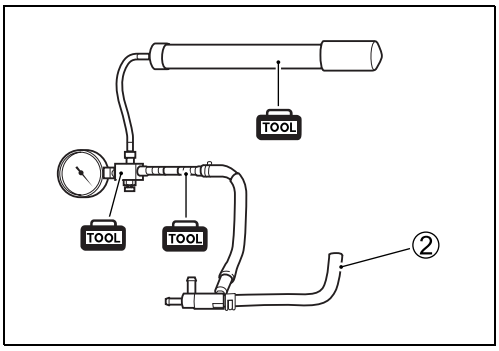
Check the relief valve operation.

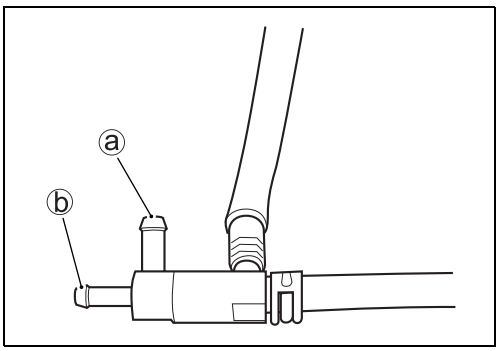
TOOL **09952-99310 : Hand air pump**
09940-44121 : Air pressure gauge
09940-44130 : Attachment

1. Remove the relief valve ①.
2. Connect special tool to inlet side of relief valve as shown in figure.
3. Plug the outlet hose ②.
4. Pump air into the relief valve using hand air pump until air is released through fitting ⓐ·ⓑ.
5. Read pressure on gauge when air is released.

   Relief valve operating pressure:
   70 – 80 kPa (0.7 – 0.8 kg/cm², 10 – 11.4 psi)

   If out of specification, replace relief valve.
6. Reinstall relief valve, then secure the hose with hose clamp (clip).





INSTALLATION

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

Final Check

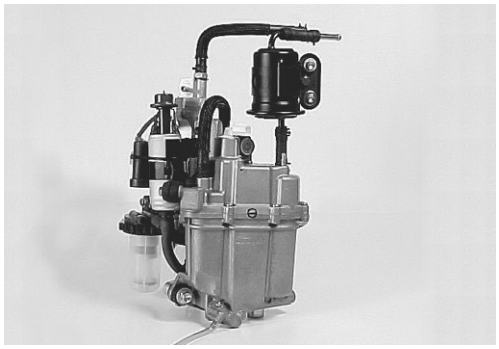
- Check to ensure that all removed parts are back in place.
- Check fuel and water hose routing. (See page x-xx.)
- Check wire routing. (See page x-xx to x-xx.)
- Check for fuel leakage. (See page 5-4.)
- Check for water leakage.

FUEL VAPOR SEPARATOR/HIGH PRESSURE FUEL PUMP

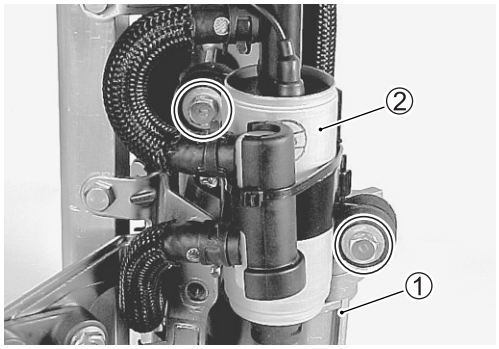
REMOVAL AND DISASSEMBLY

⚠ WARNING

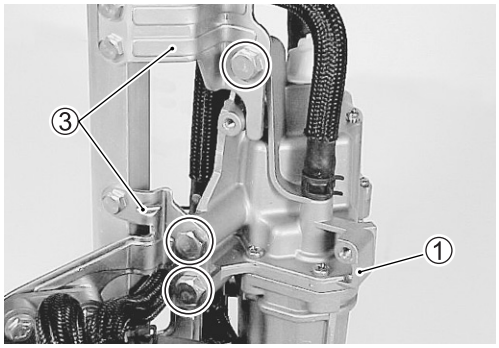
Fuel components and fuel hoses after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing components



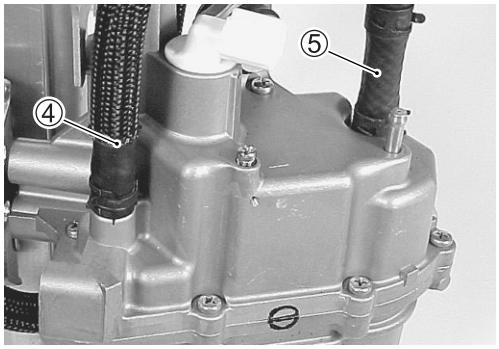
1. Remove the low pressure fuel pump/fuel vapor separator set. (See page 5-7.)



2. Remove the two (2) bolts securing low pressure fuel pump ② to fuel vapor separator ①.

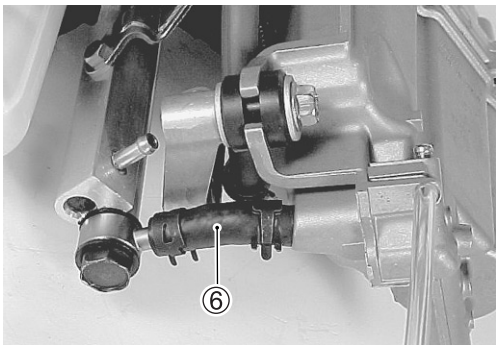


3. Remove the three (3) bolts securing fuel cooler bracket ③ to fuel vapor separator ①.

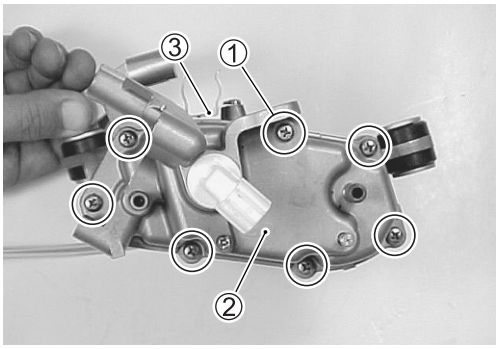


4. Disconnect fuel inlet hose ④ and fuel outlet hose ⑤ from fuel vapor separator.

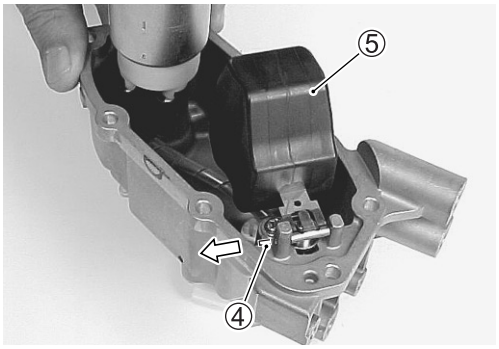
5. Disconnect fuel return hose ⑥ from fuel vapor separator.



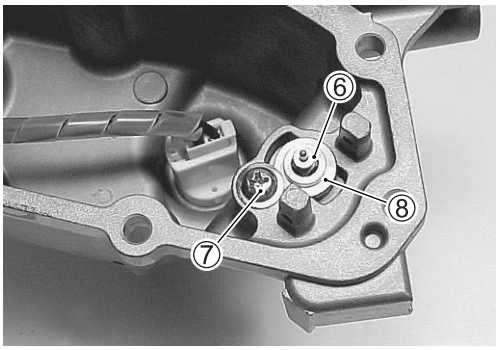
6. Remove seven (7) screws ①.
   Remove separator cover ② with high pressure fuel pump from separator case ③.



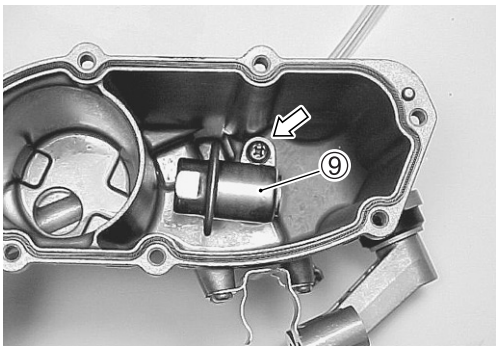
7. Remove float pin ④ and float ⑤.



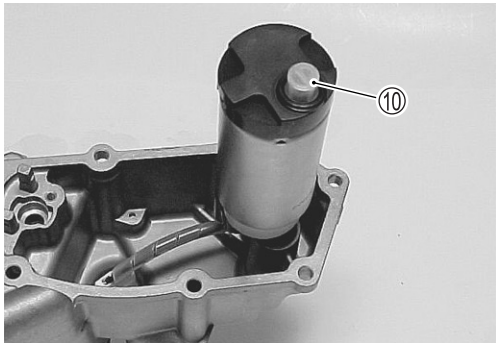
8. Remove needle valve ⑥, screw ⑦ and valve seat ⑧.



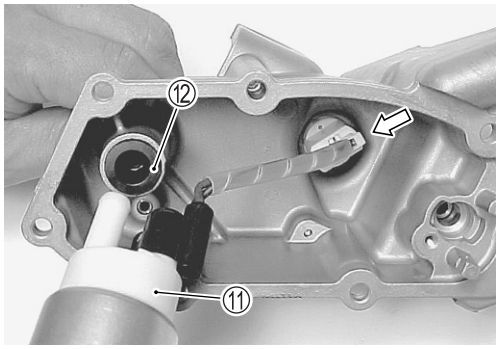
9. Remove screw and fuel pressure regulator ⑨ from separator case.



10. Remove suction filter ⑩.



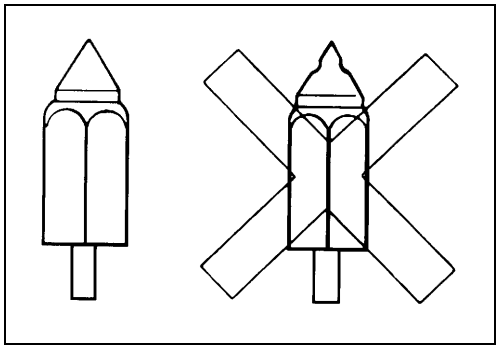
11. Remove high pressure fuel pump ⑪ and grommet ⑫ from separator cover and then disconnect pump lead wire connector.



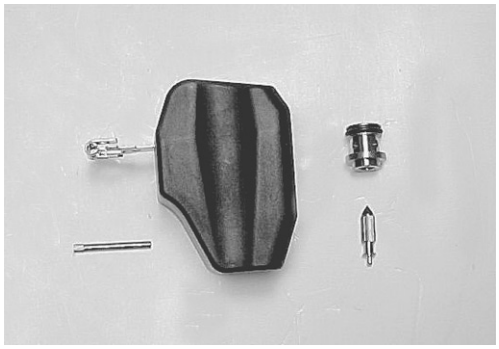
INSPECTION

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

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



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



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



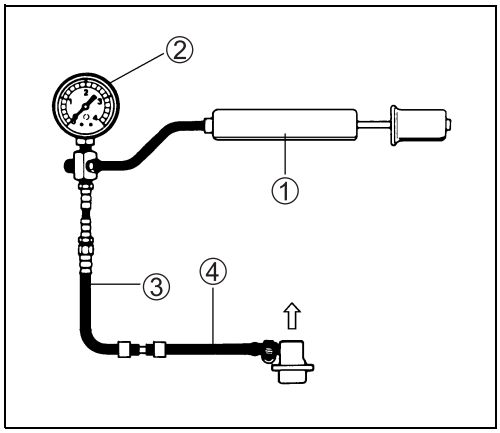
Fuel pressure regulator
Check fuel pressure regulator operation.

TOOL **09952-99310 : Hand air pump ①**
09940-44121 : Air pressure gauge ②
09940-44130 : Attachment ③
09912-58490 : Hose ④

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

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

   If out of specification, replace regulator.



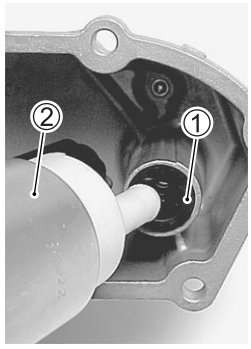
ASSEMBLY

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

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

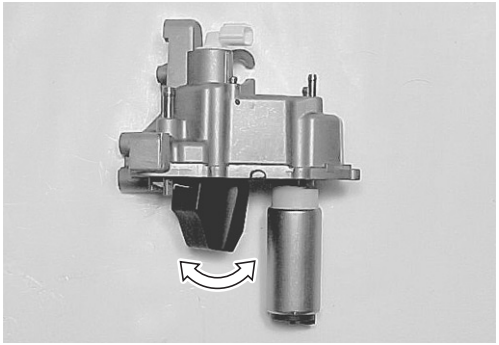
NOTE:
Apply fuel to grommet before installing.





Float/Float pin
Install float and float pin.

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

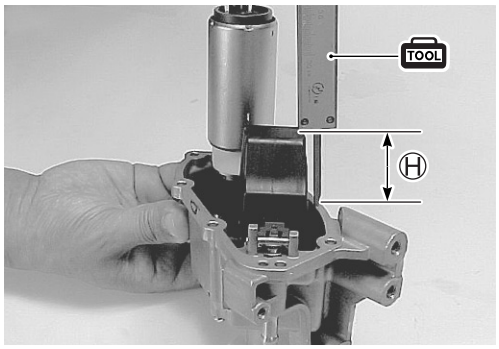


Checking float height
Measure float height.

TOOL 09900-20101: Vernier calipers

Float height Ⓗ: 43 ± 1 mm

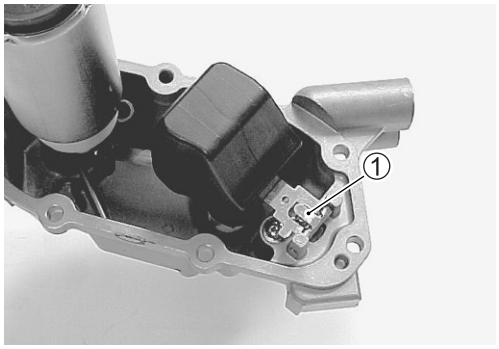
NOTE:
Make sure that float weight is not applied to needle valve.



Setting float height
To correct specification, bend only adjustment tab ①.

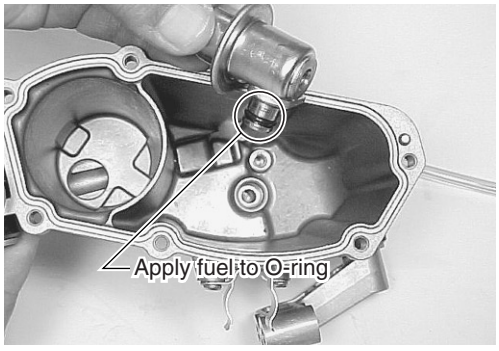
CAUTION

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



Fuel pressure regulator
Install fuel pressure regulator and tighten screw securely.

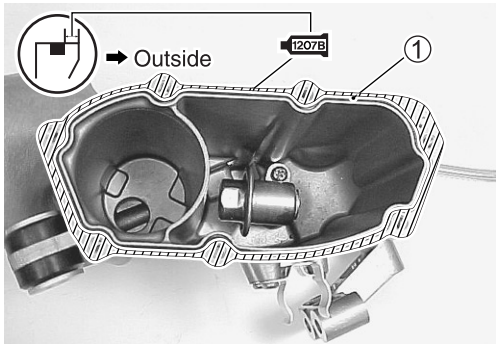
NOTE:
Apply fuel to O-ring before installing regulator.



Separator cover/Separator case
1. Install seal ring ①, then apply SUZUKI BOND evenly to only the outside mating surface of separator case as shown in figure.

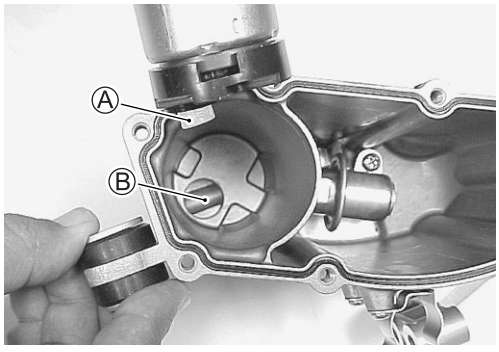
1207B 99000-31140: SUZUKI BOND "1207B"

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

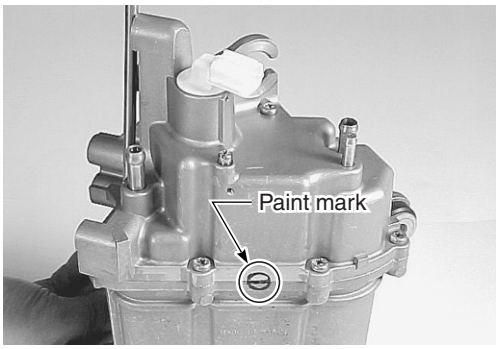


2. Install separator case, then tighten screws securely.

NOTE:
When installing separator case, align suction hole Ⓐ with hole Ⓑ of separator case.



NOTE:
Separator cover and case are a set.
Make sure paint marks on both items are matched when assembling.



Final check

- Check to ensure that all removed part are back in place.
- Check fuel and water hose routing. (See page x-xx.)
- Check for fuel leakage. (See page 5-4.)

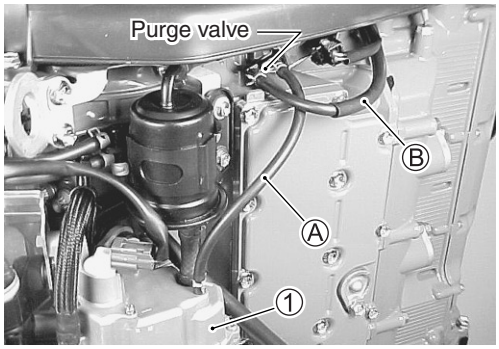
EVAPORATION PURGE SYSTEM

SYSTEM INSPECTION

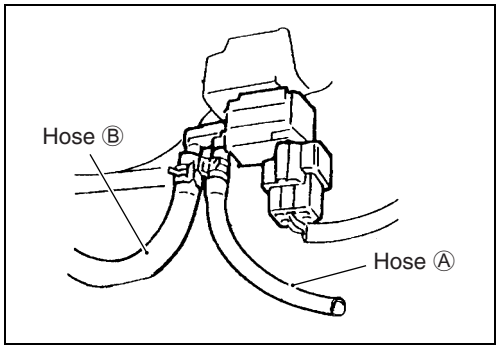
1. Warm up engine to normal operating temperature.
2. Disconnect purge hose Ⓐ from fuel vapor separator ①.

⚠ WARNING

Do not suck air through valve.
Fuel vapor inside valve is harmful.



3. Blow into hose Ⓐ, air should come out of hose Ⓑ.
4. Stop engine, blow into hose Ⓐ.
   Air should not come out of hose Ⓑ.
5. If check results are not satisfactory, check vacuum passage, hose, purge valve, wire harness and ECM. (See page 3-xx.)



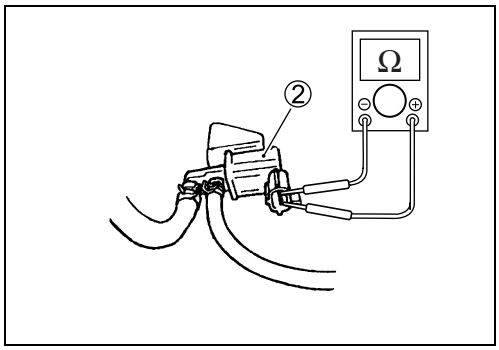
PURGE VALVE

INSPECTION

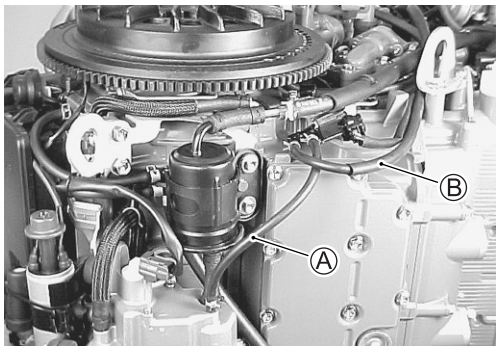
1. With ignition switch OFF, disconnect connector from purge valve ②.
2. Check resistance between two terminals of purge valve.

   Resistance of purge valve: 28 – 35 Ω at 20 °C

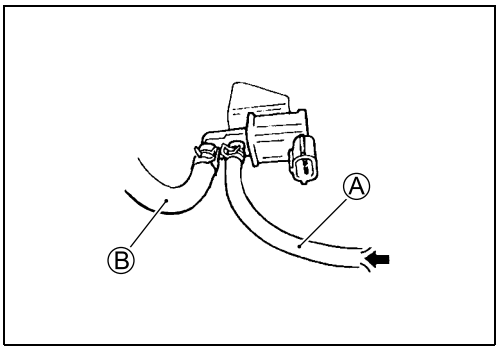
   If resistance is as specified, proceed to next operation check.



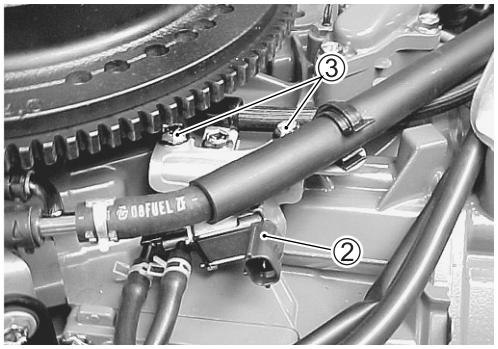
3. Remove the ring gear cover and air intake silencer case. (See page x-xx.)
   Disconnect purge hose Ⓐ from fuel vapor separator.



4. With connector disconnected, blow into hose Ⓐ. Air should not come out of hose Ⓑ.



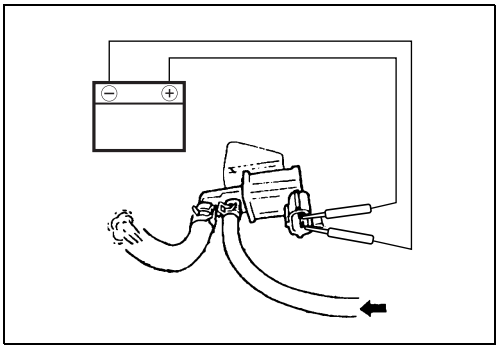
5. Remove two (2) bolts ③, purge valve ② and purge valve bracket.



6. Connect 12-V battery to purge valve terminals. With voltage applied, blow into hose Ⓐ.
   Air should come out of hose Ⓑ.
   If check result is not as described, replace purge valve.

⚠ WARNING

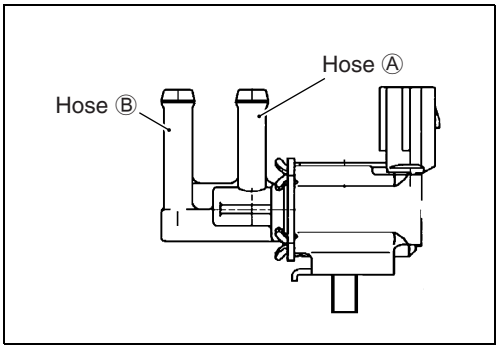
Do not suck air through valve.
Fuel vapor inside valve is harmful.



7. Install purge valve and purge valve bracket, then connect purge hose.
   Install the ring gear cover and air intake silencer case.

   Hose Ⓐ: Vapor separator to purge valve.
   Hose Ⓑ: Purge valve to air intake silencer case.

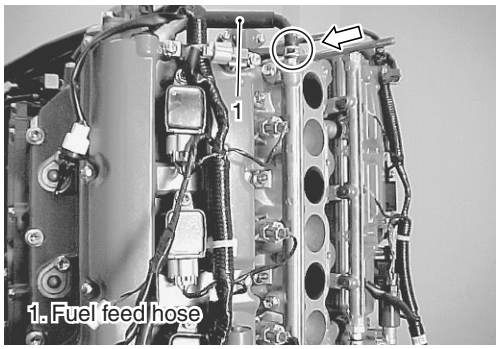
8. Connect purge valve connector securely.



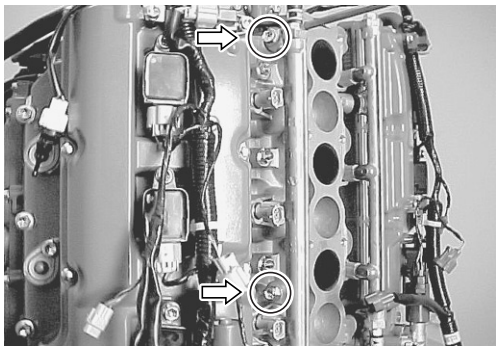
FUEL INJECTOR

REMOVAL

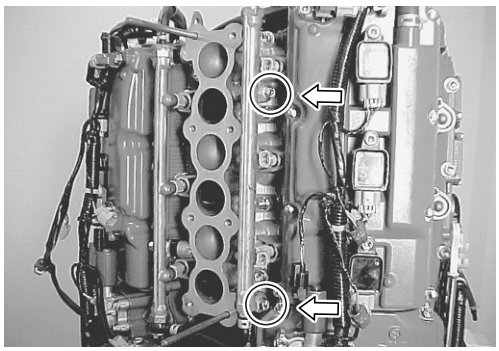
1. Relieve fuel pressure according to procedure described on page 5-3.
2. Remove the collector assembly. (See page x-xx.)
3. Loosen clamp and place a large cloth over end of fuel feed hose.
   Slowly pull fuel feed hose from PORT side fuel delivery pipe.
   Drain any excess fuel in hose into a small container.



4. Disconnect six (6) fuel injector connectors.
5. For PORT side bank:
   Loosen the two (2) bolts securing fuel delivery pipe.

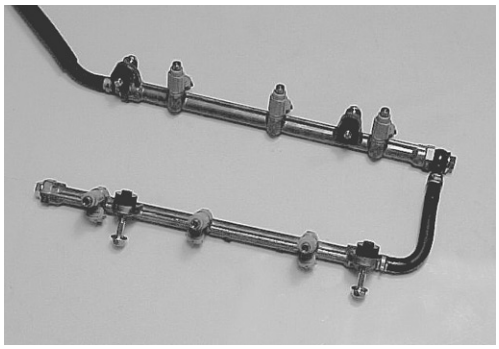


6. For STBD side bank:
   Loosen the two (2) bolts securing fuel delivery pipe.
7. Remove PORT/STBD fuel delivery pipes (with fuel injectors), delivery pipe bolts and collars.

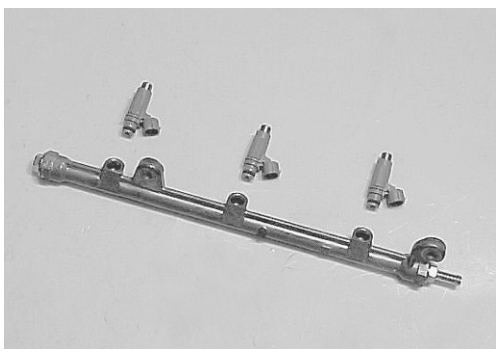


CAUTION

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.



8. Remove each injector from delivery pipe.



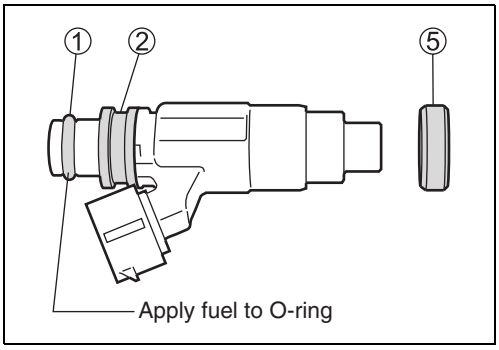
INSTALLATION

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

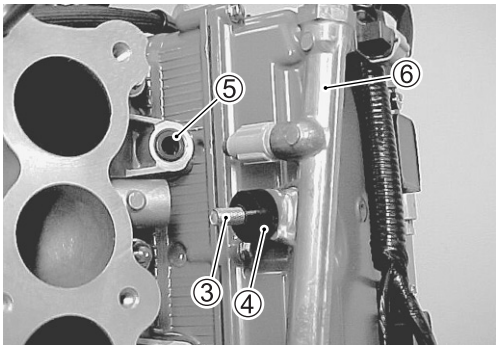
CAUTION

Do not re-use O-ring and cushion once removed. Always use new parts.

1. Replace injector O-ring ① with new one using care not to damage it. Install grommet ② to injector.
2. Place delivery pipe bolts ③ and four (4) insulators (collars) ④ in position.

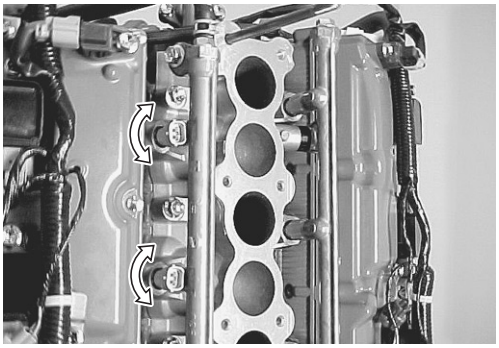


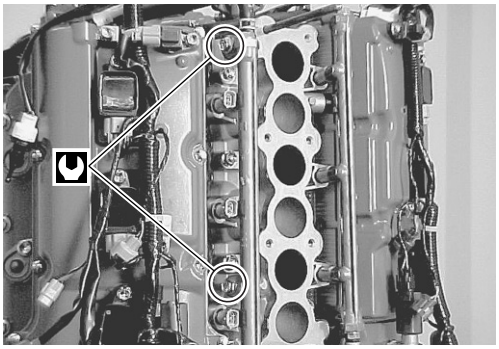
3. Replace injector cushion ⑤ with new one and install it to intake manifold.
4. Apply thin coat of fuel to injector O-rings, then install injectors into delivery pipes ⑥ and intake manifold.
   Make sure that injectors rotate smoothly.



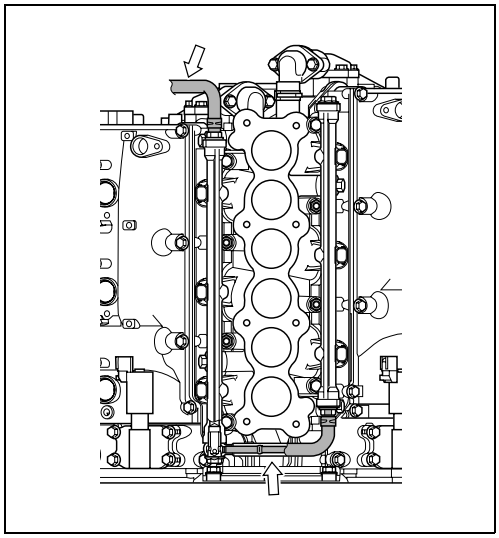
5. Tighten delivery pipe bolts and make sure that injectors rotate smoothly.

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





6. Reconnect fuel feed hose securely.
7. Connect lead wire connector to injectors securely.



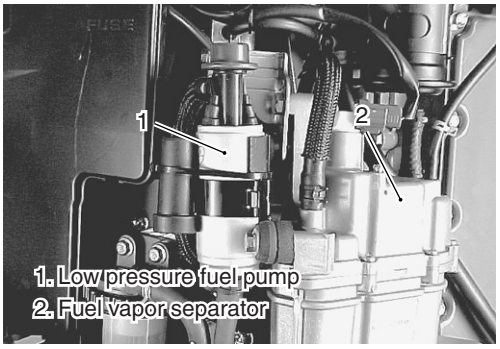
8. Make sure the emergency stop switch lock plate is in place.

NOTE:
Because some sensor leads are disconnected when removing the collector assembly, a diagnosis code will temporarily be displayed during inspection.

9. Squeeze fuel primer bulb until you feel resistance.
   Turn ignition switch “ON” for 6 seconds (to operate fuel pump), then turn it “OFF”.
   Repeat this (ON and OFF) procedure 3 or 4 times to pressurize fuel system.
   Check for fuel leaks around fuel injector.
10. Install collector assembly. (See page x-xx.)

LOW PRESSURE FUEL PUMP

The low pressure fuel pump is a non-serviceable component.
If it is defective, it must be replaced as a complete unit.
The following procedure will determine whether or not the pump is defective.



INSPECTION

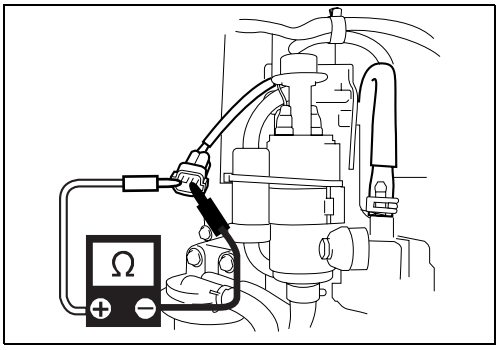
NOTE:
To prevent damage to the low pressure fuel pump, fill the fuel feed lines with fuel prior to operating the pump.

1. Install the emergency stop switch lock plate in position.
2. When the ignition key is turned to ON from OFF, check that a pump operating sound is heard for six (6) seconds.
3. If no pump operating sound is heard:
   (a) Turn the ignition key to OFF and disconnect the pump lead connector.
   (b) Check for contact failure in the lead connector.
   (c) Measure resistance between the two terminals of pump lead connector.

09930-99320: Digital tester

Tester range: Ω (Resistance)

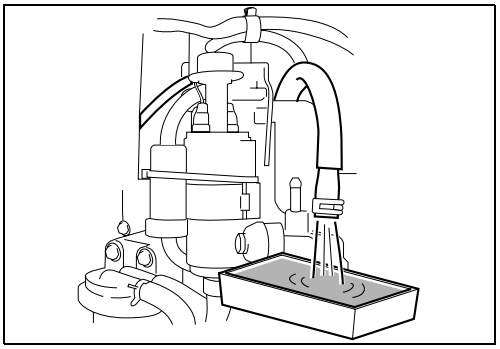
Pump resistance: Standard 1 – 5 Ω



If the measurement is out of specification, replace the pump.

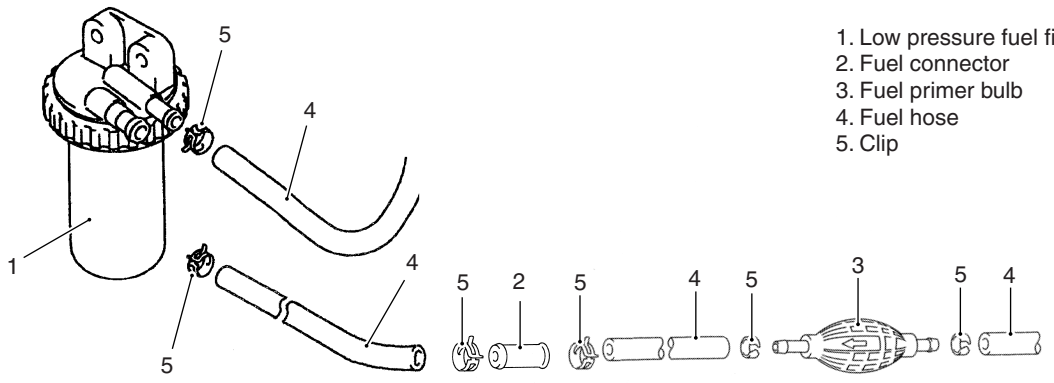
   (d) Check that pump drive voltage is output from ECM and no abnormal condition exists in the engine main wiring harness. (See page 3-xx.)

4. If the pump operating sound is heard:
   (1) Remove the fuel feed hose from the vapor separator.
   (2) Operate the pump by turning the ignition key from OFF to ON and discharge fuel into a suitable container.
   (3) If no fuel is discharged, check for clogging or other failure in the fuel feed line. If no failure is found, replace the pump.



LOW PRESSURE FUEL FILTER/FUEL HOSE

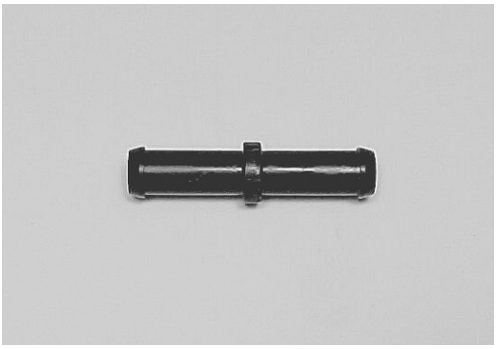
When disassembling or reassembling fuel line, refer to the construction diagram below.



INSPECTION

FUEL CONNECTOR

Inspect fuel connector for leakage, deterioration or other damage. Replace if necessary.

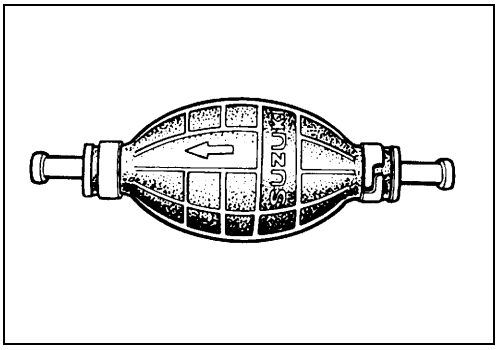


FUEL HOSE

Inspect fuel hose for cuts, cracks, leakage, tears or deterioration. Replace if necessary.

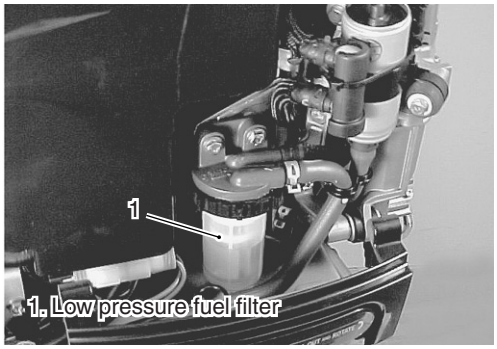
FUEL PRIMER BULB

Inspect fuel primer bulb for cracks, leakage, deterioration or check valve function.
Replace if necessary.



LOW PRESSURE FUEL FILTER

To perform fuel filter inspection, refer to “PERIODIC MAINTENANCE/LOW PRESSURE FUEL FILTER” section on page 2-19.



POWER UNIT

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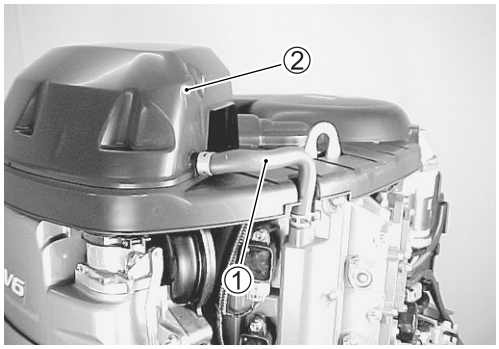
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RING GEAR COVER AND AIR INTAKE SILENCER CASE

REMOVAL

Prior to removing Ring gear cover:
- **Disconnect battery cables from battery.**

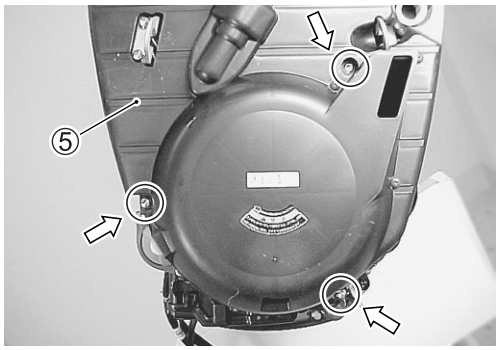
1. Loosen the clamp securing breather hose ①, then remove the breather hose from silencer case ②.



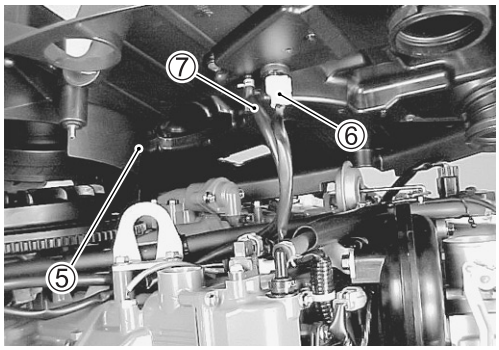
2. Loosen the clamps ③ securing STBD and PORT outlet tube to throttle body ④.



3. Remove the three (3) bolts securing ring gear cover ⑤.



4. Raise the ring gear cover and air intake silencer case ⑤ slightly and remove the intake air temp. sensor ⑥ and purge valve hose ⑦ from air intake silencer case.
   Continue raising and remove the cover and case.



INSTALLATION

Installation is reverse order of removal.

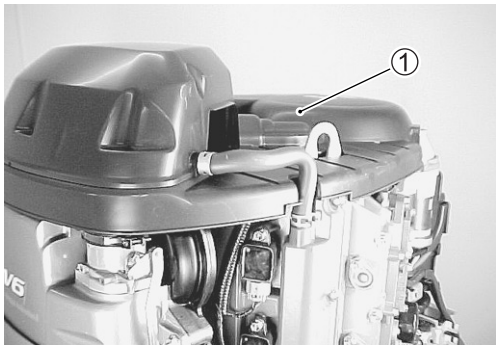
COLLECTOR ASSEMBLY

(For multi-stage induction model)

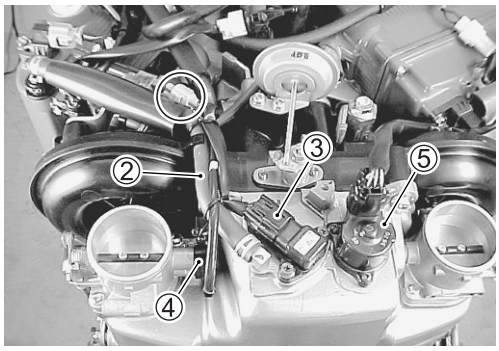
REMOVAL

Before removing collector assembly:
- **Disconnect battery cables from battery.**
- **Remove both side covers. (See page 7-2.)**

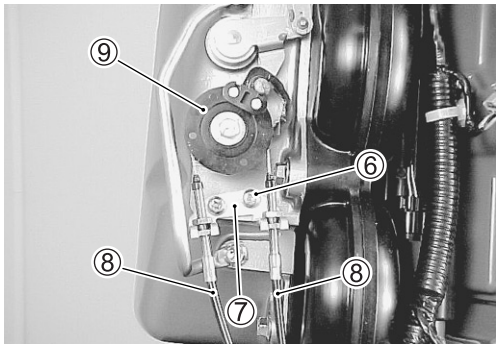
1. Remove the ring gear cover and air intake silencer case ①. (See page 6-2.)



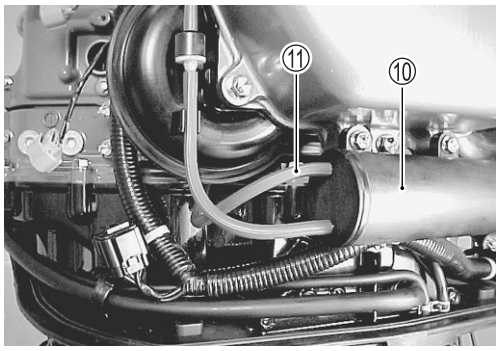
2. On the PORT side bank:
   Loosen the clamp securing PCV hose ②, then remove the PCV hose from collector cover.
3. Disconnect MAP sensor lead wire connector at MAP sensor ③.
4. Disconnect Throttle sensor lead wire connector from TPS (Throttle Position Sensor) ④.
5. Disconnect IAC valve lead wire connector at IAC valve ⑤.



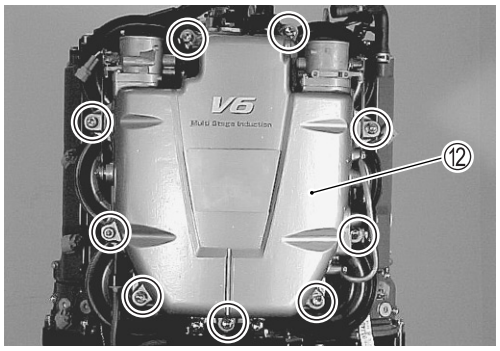
6. Remove two (2) screws ⑥ and cable bracket ⑦.
   Remove throttle cables ⑧ from throttle drum ⑨.



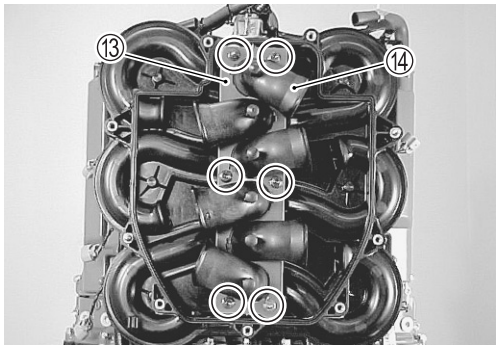
7. Remove the vacuum hose ⑪ from vacuum chamber ⑩.



8. Remove the seven (7) bolts and two (2) nuts securing collector cover ⑫, then remove the collector cover.



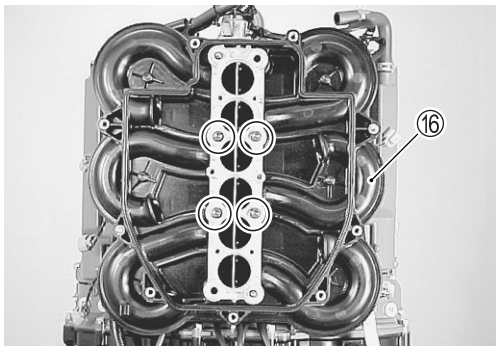
9. Remove the four (4) bolts and two (2) nuts securing funnel bracket ⑬, then remove six funnels ⑭ and funnel bracket.



10. Disconnect lead wire connector from VSV (Vacuum Switching Valve) ⑮.



11. Remove four (4) bolts and collector ⑯.



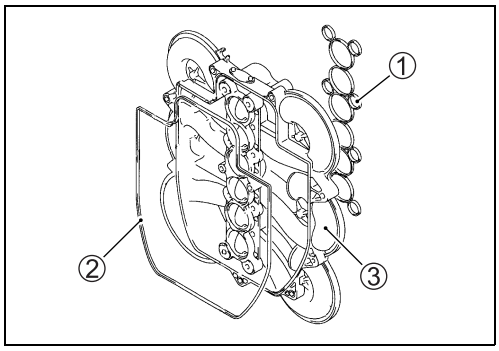
SYSTEM INSPECTION

Refer to “Multi-stage induction system/inspection” in section 3.

INSTALLATION

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

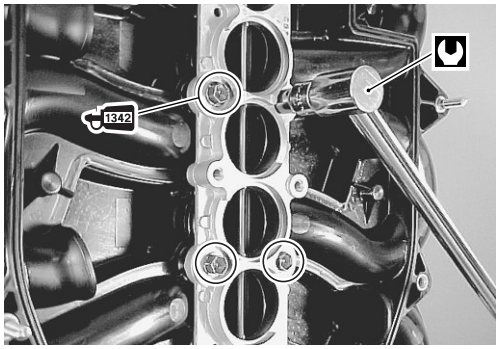
NOTE:
Do not re-use gasket. Always use a new gasket.



- Install gasket ①·② and collector ③, then tighten bolts, pre-coated with thread lock, to specified torque.

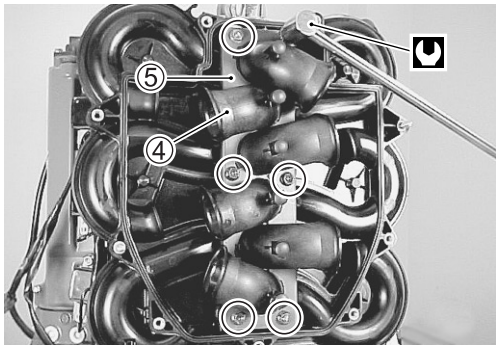
Collector bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)

1342 99000-32050: Thread lock "1342"

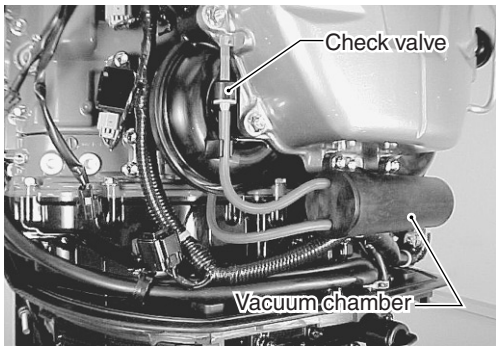


- Install funnels ④ and funnel bracket ⑤, then tighten bolts and nuts securely.

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

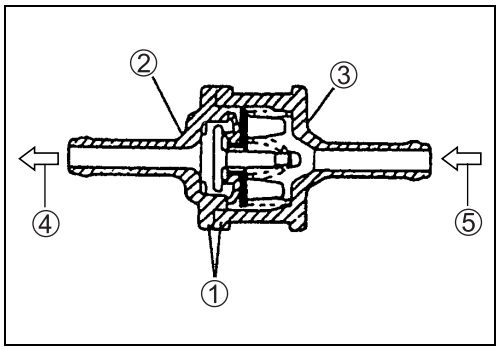


- Check to ensure that all removed parts are back in place.



NOTE:
Refer to figure at right when connecting check valve between vacuum hoses.

① Check valve ② Orange side
③ Black side ④ To vacuum chamber
⑤ From collector assembly



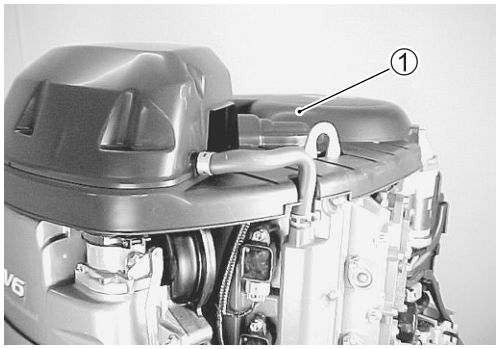
COLLECTOR ASSEMBLY

(For single-stage induction model)

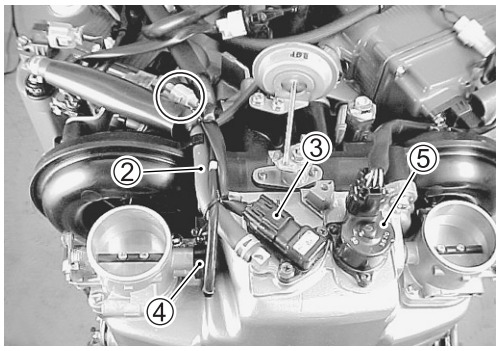
REMOVAL

Before removing collector assembly:
- **Disconnect battery cables from battery.**
- **Remove both side covers. (See page 7-2.)**

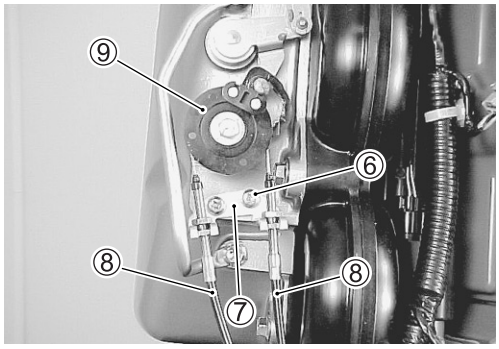
1. Remove the ring gear cover and air intake silencer case ①. (See page 6-2.)



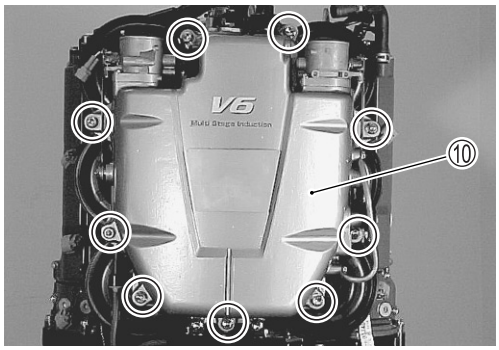
2. On the PORT side bank:
   Loosen the clamp securing PCV hose ②, then remove the PCV hose from collector cover.
3. Disconnect MAP sensor lead wire connector at MAP sensor ③.
4. Disconnect Throttle sensor lead wire connector from TPS (Throttle Position Sensor) ④.
5. Disconnect IAC valve lead wire connector at IAC valve ⑤.



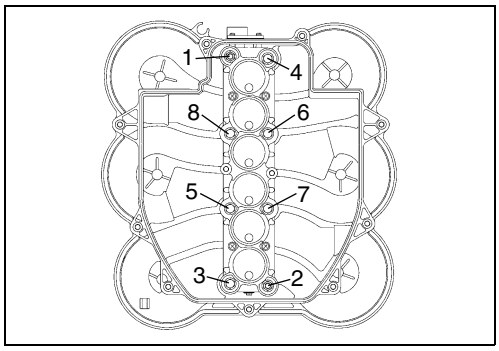
6. Remove two (2) screws ⑥ and cable bracket ⑦.
   Remove throttle cable ⑧ from throttle drum ⑨.



7. Remove the seven (7) bolts and two (2) nuts securing collector cover ⑩, then remove the collector cover.



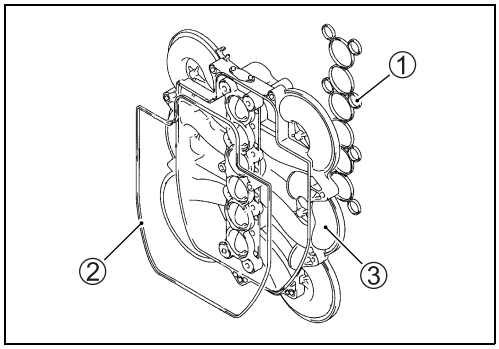
8. Remove the six (6) bolts and two (2) nuts securing collector ⑪, then remove collector.



INSTALLATION

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

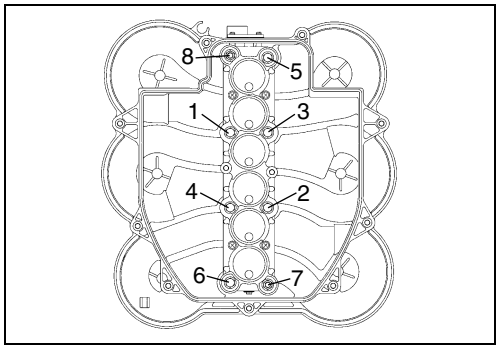
NOTE:
Do not re-use gasket. Always use a new gasket.

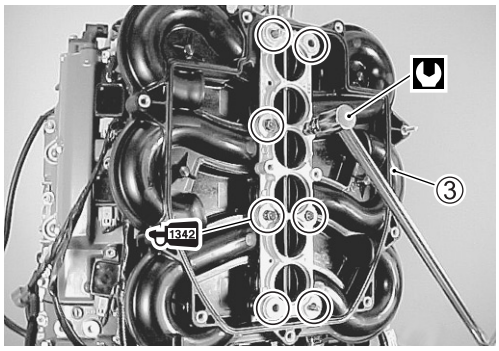


- Install gasket ①·② and collector ③, then tighten bolts and nut, pre-coated with thread lock, to specified torque.

Collector bolt: 23 N·m (2.3 kg-m, 16.5 lb-ft)

1342 99000-32050: Thread lock "1342"





- Check to ensure that all removed parts are back in place.

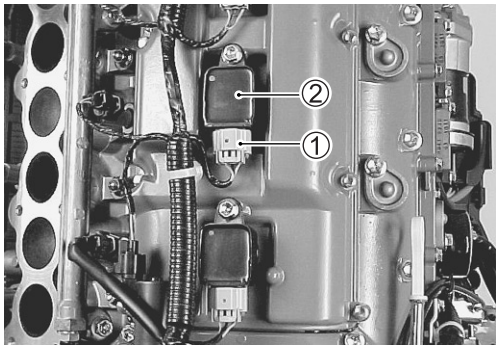


CYLINDER HEAD COVER

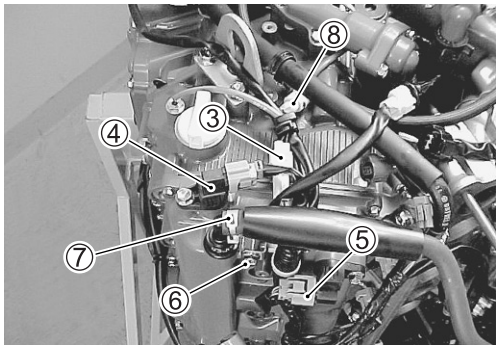
REMOVAL

Before removing cylinder head cover:
- **Disconnect battery cables from battery.**

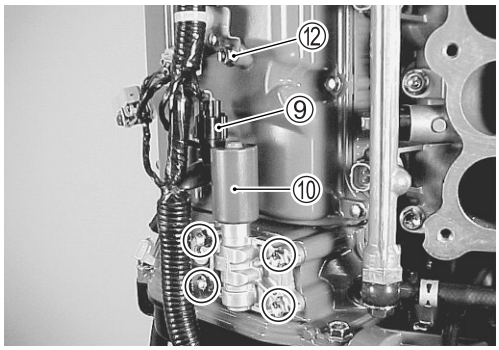
1. Remove the collector assembly. (See page 6-3, 6-6.)
2. Disconnect ignition coil connectors ①.
   Remove the bolts securing the ignition coils.
   Remove all ignition coils ② and spark plugs.



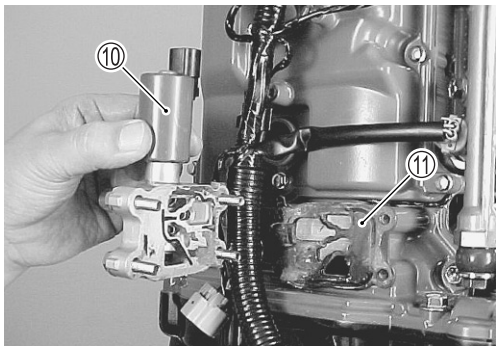
3. On the PORT side bank:
   - Disconnect EX. manifold temperature sensor lead wire connector ③.
   - On DF250 model, disconnect EX. CMP sensor lead wire connector ④ at sensor.
   - On DF250 model, disconnect IN. CMP sensor lead wire connector ⑤ at sensor.
   - Remove the bolt securing lead wire clamp plate ⑥.
   - Remove PCV valve ⑦ from cylinder head cover.



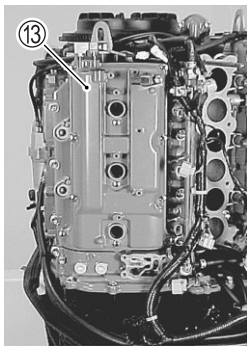
   - Disconnect cylinder temperature sensor lead wire connector ⑧.
   - On DF250 model, disconnect OCV lead wire connector ⑨ at OCV.
     Remove the four (4) bolts securing OCV ⑩, then remove OCV and discard OCV gasket ⑪.
   - Remove the bolt securing lead wire clamp plate ⑫.

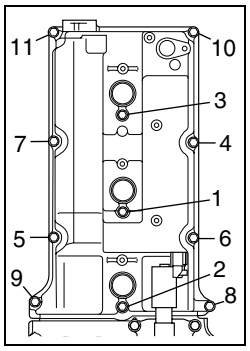


NOTE:
DF200/225 models are not equipped with OCV.

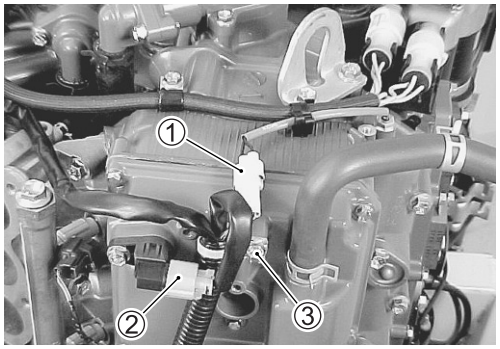


- Remove the eleven (11) bolts securing cylinder head cover ⑬ to the cylinder head, then remove the cylinder head cover.

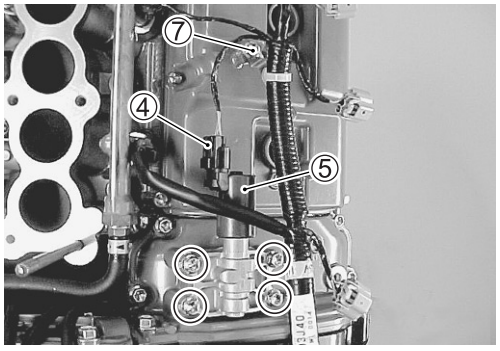




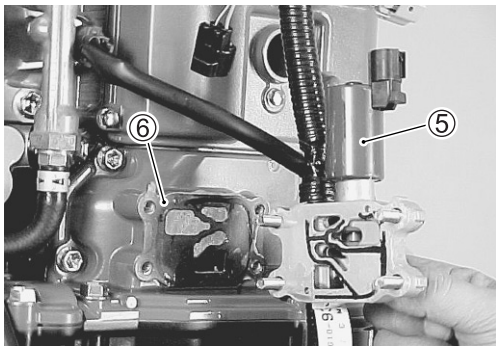
4. On the STBD side bank:
   - Disconnect EX. manifold temperature sensor lead wire connector ①.
   - Disconnect IN. CMP sensor lead wire connector ② at sensor.
   - Remove the bolt securing lead wire clamp plate ③.



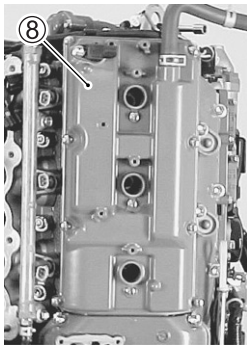
   - On DF250 model, disconnect OCV lead wire connector ④ at OCV.
     Remove the four (4) bolts securing OCV ⑤, then remove OCV and discard OCV gasket ⑥.
   - Remove the bolt securing lead wire clamp plate ⑦.

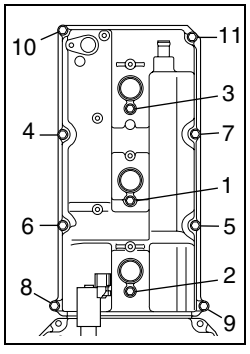


NOTE:
DF200/225 models are not equipped with OCV.



   - Remove the eleven (11) bolts securing cylinder head cover ⑧ to the cylinder head, then remove the cylinder head cover.



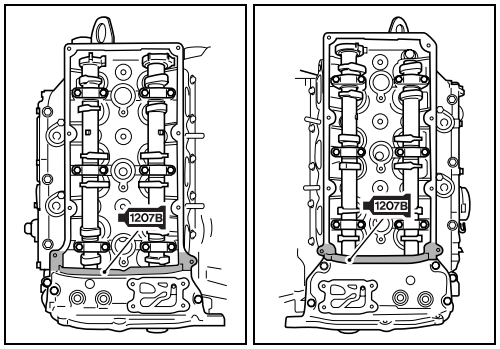


INSTALLATION

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

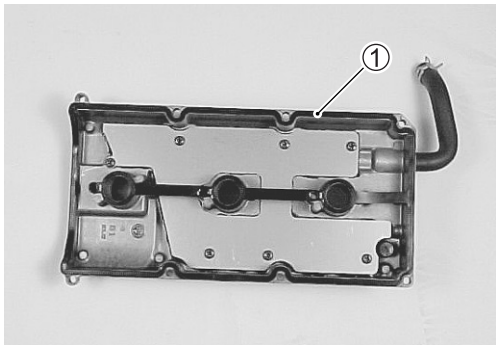
- Clean sealing surfaces on cylinder heads and covers.
- Remove oil, old sealant, and dust from sealing surfaces.
- After cleaning, apply sealant to cylinder heads sealing surface area as shown in figure.

1207B 99000-31140: SUZUKI BOND "1207B"



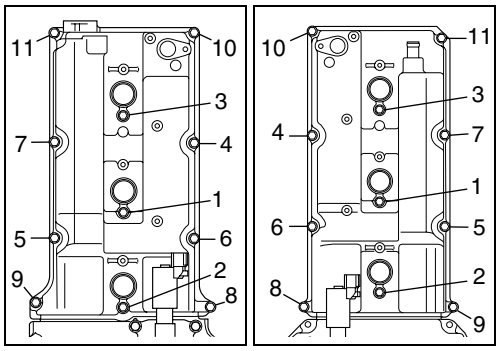
- Install new cylinder head cover gasket ① to head cover.

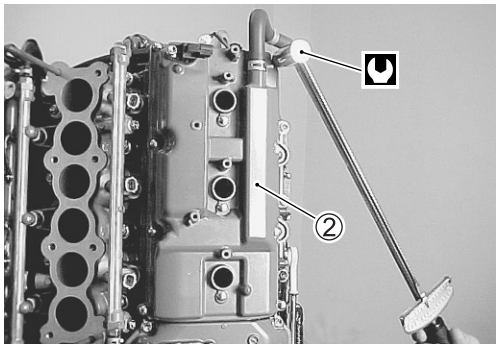
NOTE:
Examine cylinder head cover gasket for damage.
Always replace gasket with new one.



- Install cylinder head covers ② to cylinder heads, then tighten cylinder head cover bolts to specified torque.

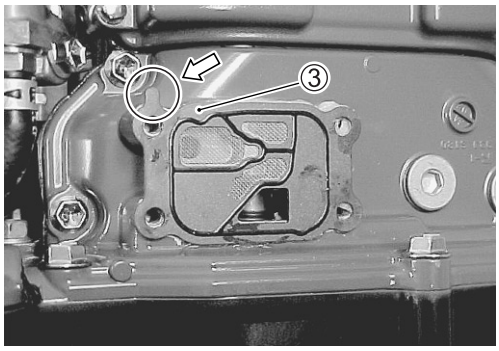
Cylinder head cover bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)





- On the DF250 model, install gasket ③ and OCV ④ and then tighten bolts securely.

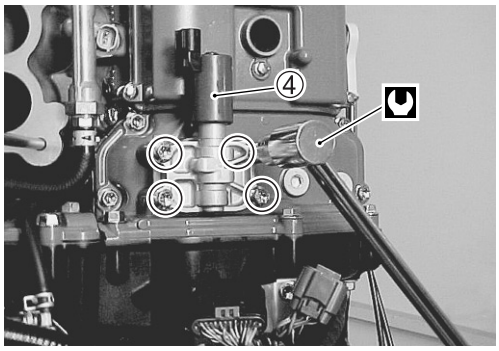
NOTE:
Position the projection of OCV gasket as shown right.



CAUTION

Do not re-use the OCV gasket, always replace with new one.

OCV bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



- Install collector assembly.
  Refer to “Collector assembly” in this section for assembly.



FINAL ASSEMBLY CHECK

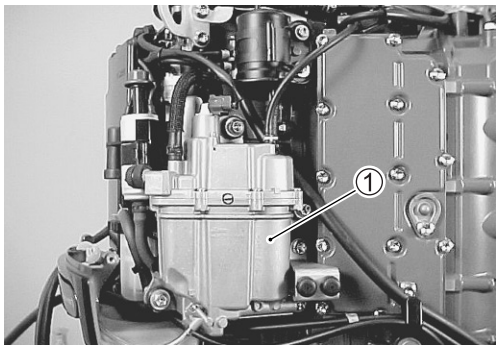
- All parts removed have been returned to their original positions.
- Wire and hose routing match’s service manual illustration.
- No oil leakage is evident during final test running.

POWER UNIT

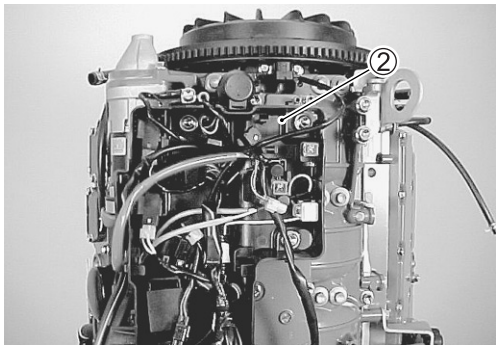
REMOVAL

Before removing power unit;
- **Relieve fuel pressure. (See page 5-3.)**
- **Drain engine oil.**
- **Disconnect battery cables from battery.**

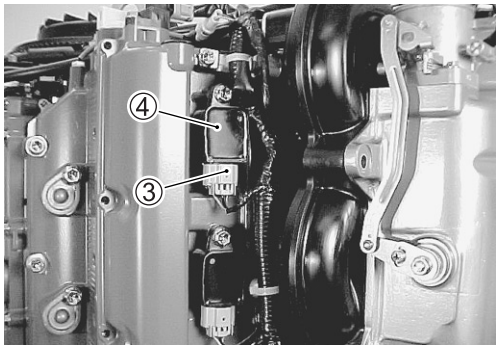
Remove the low pressure fuel pump/fuel vapor separator ① as a set. (See page 5-7.)



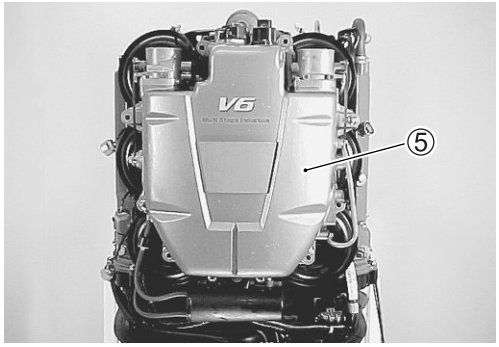
Remove the electric parts holder ②. (See page 4-26.)



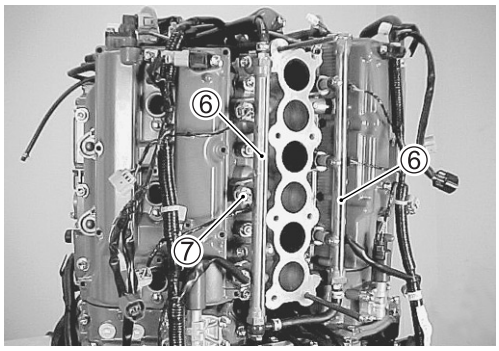
Disconnect ignition coil connectors ③.
Remove bolts securing the ignition coils ④.
Remove all ignition coils ④ and spark plugs.



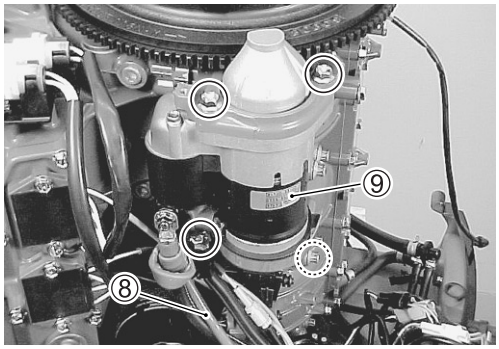
Remove the collector assembly ⑤. (See page 6-3, 6-6.)



Remove bolts securing fuel delivery pipe ⑥, then remove fuel delivery pipes and all fuel injectors ⑦. (See page 5-19.)

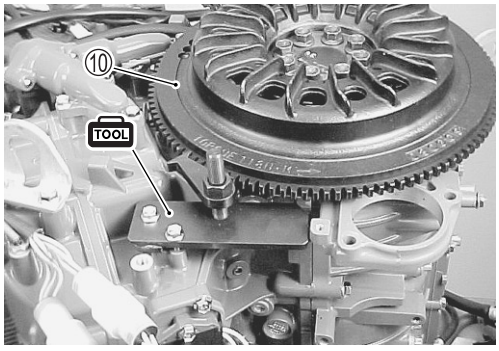


Remove nut and positive battery cable ⑧.
Remove starter motor ⑨. (See page 4-13.)

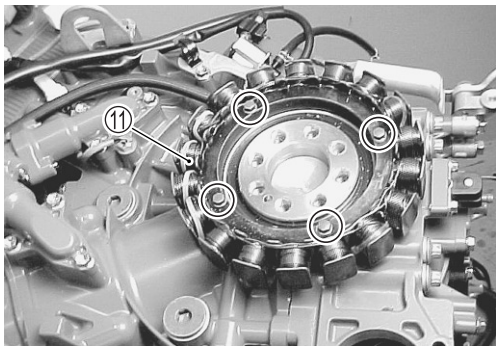


Remove flywheel ⑩. (See page 3-66.)

09916-99310: Flywheel holder

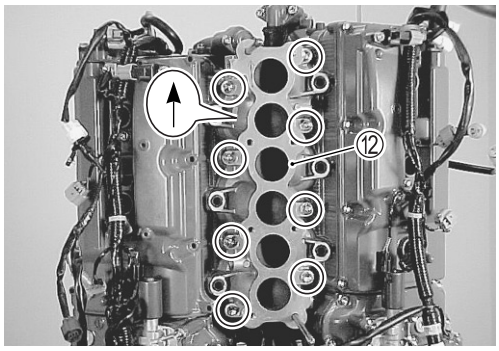


Remove battery charge coil ⑪. (See page 4-5.)

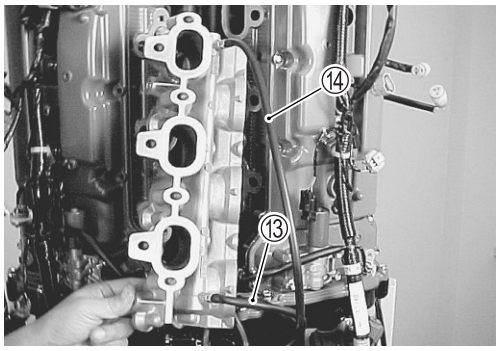


Remove four (4) bolts and four (4) nuts, then remove intake manifold ⑫.

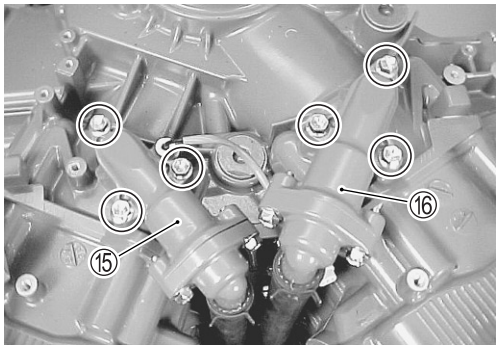
NOTE:
To prevent accidentally reversing the intake manifold on assembly, put an ID mark on top of the intake manifold.



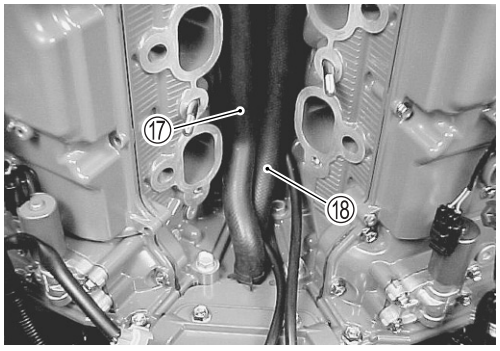
Disconnect water inlet hose ⑬ and outlet hose ⑭ from intake manifold.



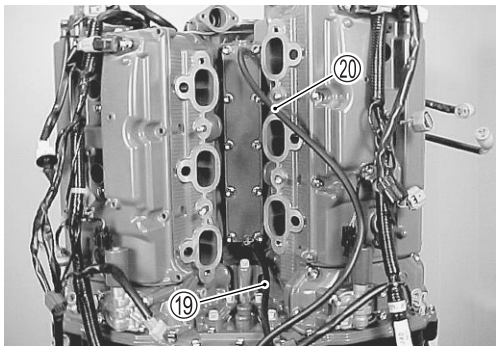
Remove three (3) bolts and PORT thermostat housing ⑮.
Remove three (3) bolts and STBD thermostat housing ⑯.



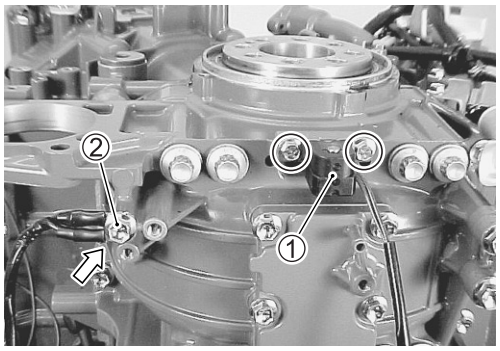
Disconnect PORT and STBD water return hose ⑰·⑱ from engine holder.



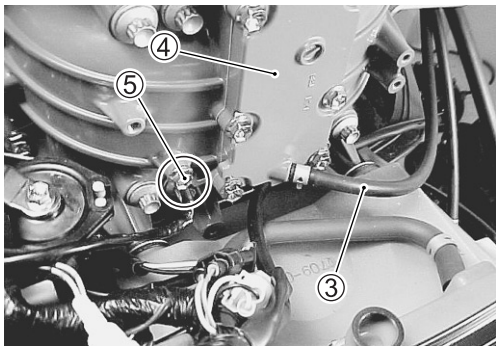
Disconnect water inlet hose ⑲ and outlet hose ⑳ from rear crankcase water jacket cover.



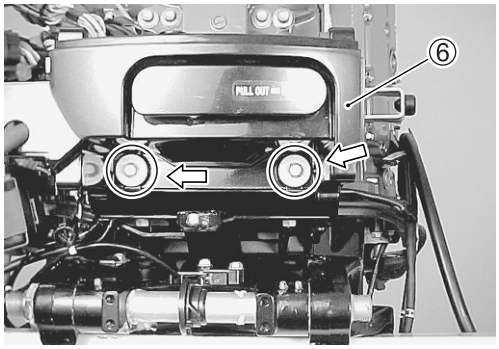
Remove screws and CKP sensor ①.
Remove the bolt ② securing the ground lead wire of engine main harness.



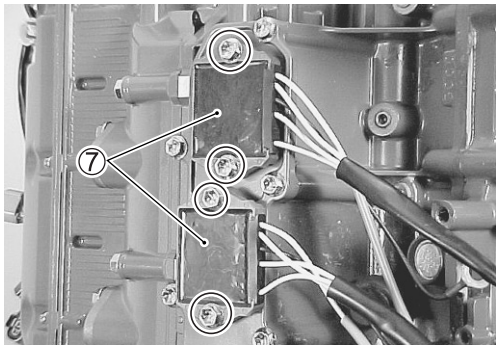
Disconnect water inlet hose ③ from the front crankcase water jacket cover ④.
Remove the bolt ⑤ securing the ground lead wire of PTT relay.



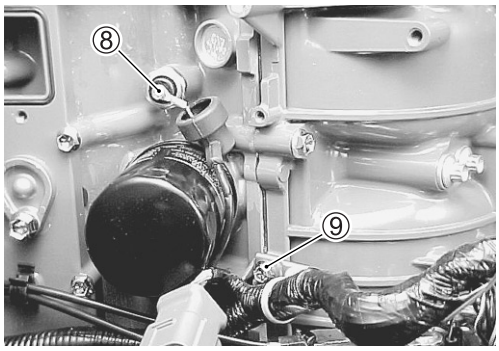
Remove two (2) bolts and front panel ⑥.



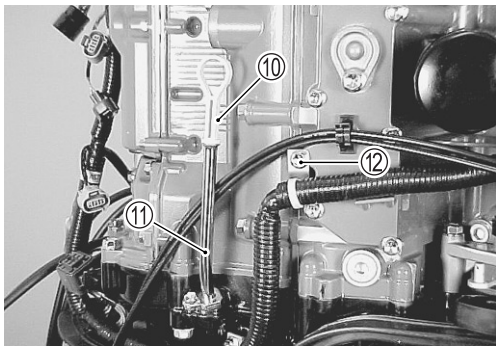
Remove bolts and two (2) Rectifier & regulators ⑦.
(See page 4-6.)



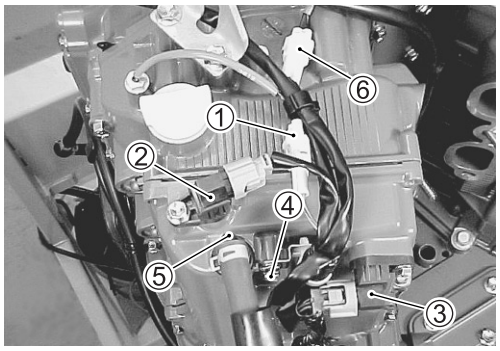
Loosen screw ⑧ and disconnect lead wire from oil pressure switch.
Remove the bolt ⑨ securing the engine main harness clamp plate.



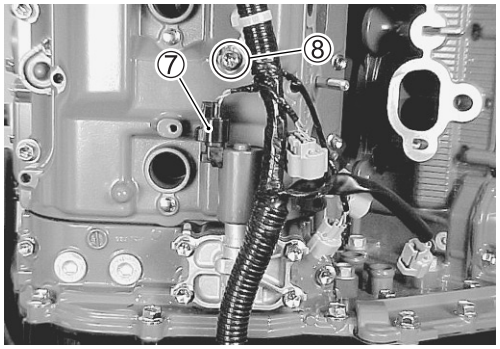
Remove oil level dipstick ⑩.
Remove bolt and oil level dipstick guide ⑪.
Remove the bolt ⑫ securing the engine main harness clamp plate.



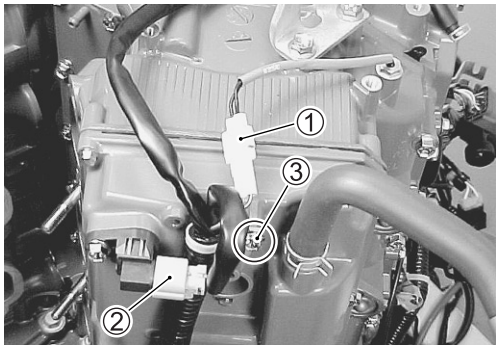
On the PORT side bank
- Disconnect EX. manifold temperature sensor lead wire connector ①.
- On DF250 model, disconnect EX. CMP sensor lead wire connector at sensor ②.
- On DF250 model, disconnect IN. CMP sensor lead wire connector at sensor ③.
- Remove the bolt ④ securing lead wire clamp plate.
- Remove PCV valve ⑤ from cylinder head cover.



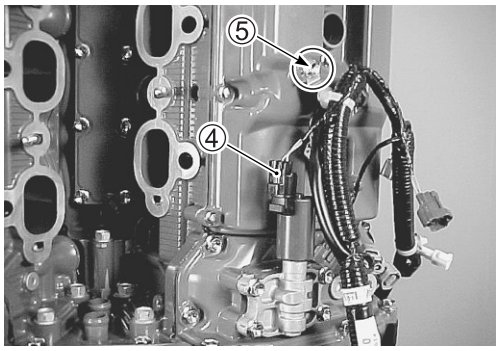
- Disconnect cylinder temperature sensor lead wire connector ⑥.
- On DF250 model, disconnect OCV lead wire connector ⑦ at OCV.
- Remove the bolt ⑧ securing lead wire clamp plate.



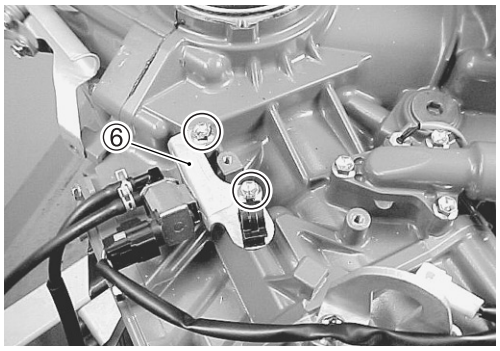
On the STBD side bank
- Disconnect EX. manifold temperature sensor lead wire connector ①.
- Disconnect IN. CMP sensor lead wire connector ② at sensor.
- Remove the bolt ③ securing lead wire clamp plate.



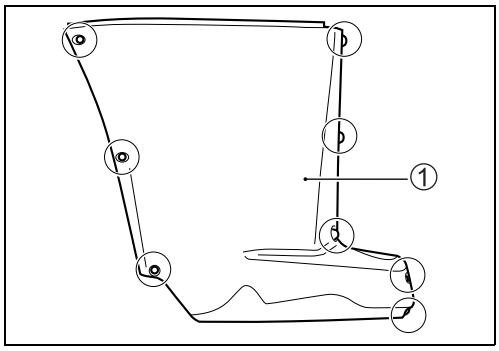
- On DF250 model, disconnect OCV lead wire connector ④ at OCV.
- Remove the bolt ⑤ securing lead wire clamp plate.



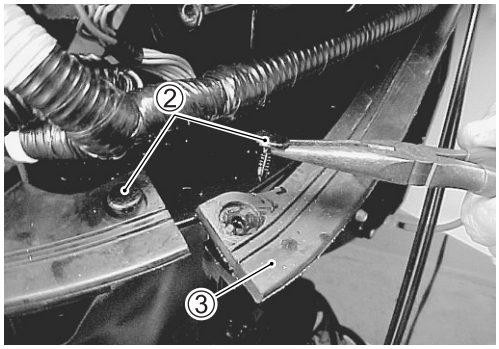
Remove bolts and purge valve bracket ⑥ (with purge valve).



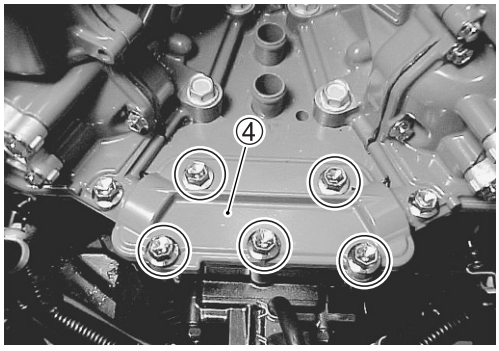
Remove oil pan cover ①. (See page 7-2.)



Remove pins ② and side cover seal ③.

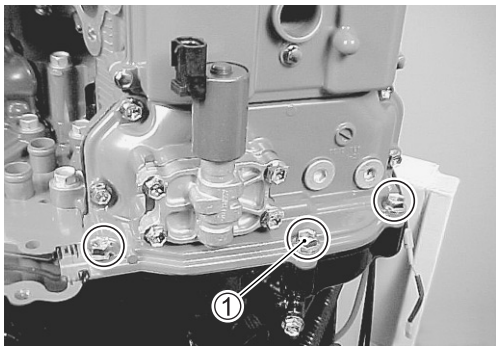


Remove five (5) bolts and upper engine holder cover ④.

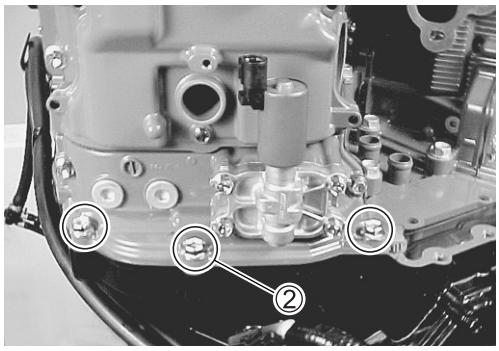


[From engine upper side]

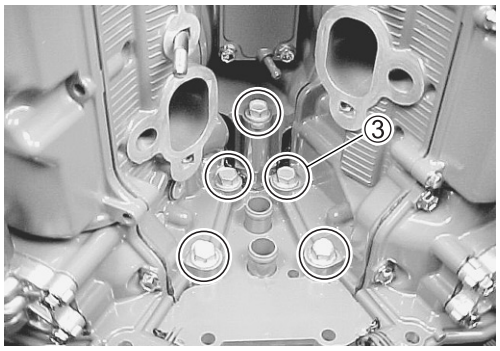
- On the STBD bank, remove three (3) bolts ①.



- On the PORT bank, remove three (3) bolts ②.

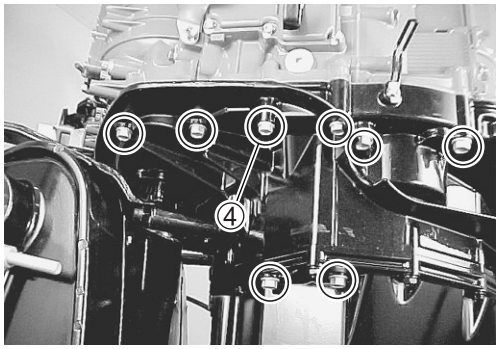


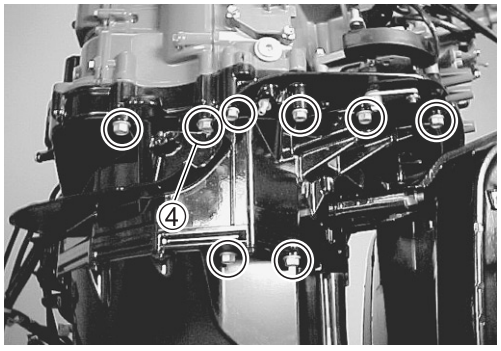
• Remove five (5) bolts ③.



[From engine under side]

• Remove sixteen (16) bolts ④.
Lift up and remove power unit from engine holder.





INSTALLATION

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

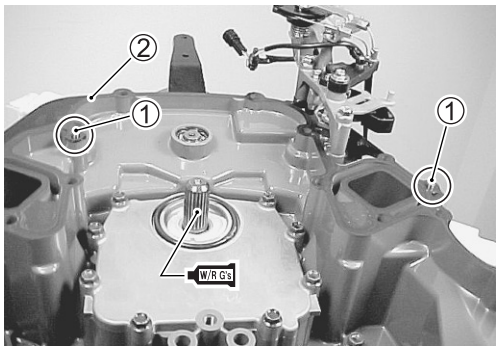
CAUTION

Do not re-use gaskets, O-rings and seals.
Always replace with new parts.

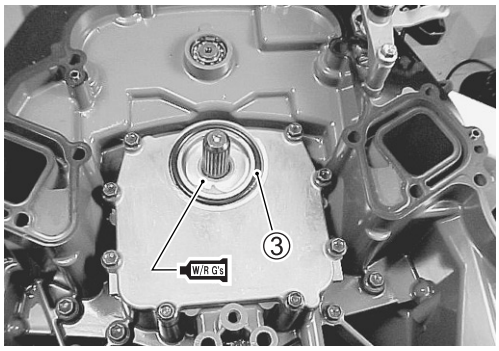
POWER UNIT

• Install dowel pins ①, gasket ②.
Apply Water Resistant Grease to driveshaft splines.

W/R G's 99000-31140: SUZUKI WATER RESISTANT GREASE

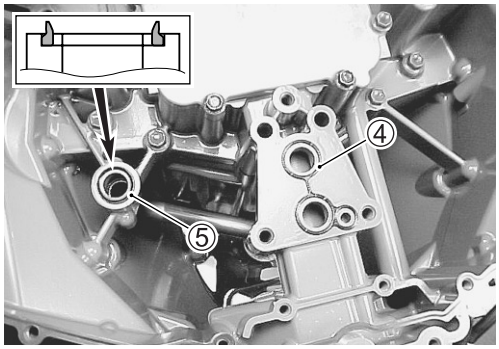


- Install O-ring ③ to mount oil seal cover, then apply enough Water Resistant Grease on O-ring.



- Install the water return seal ④ and engine holder seal ⑤.

NOTE:
Install seal ⑤ with lip facing upward.

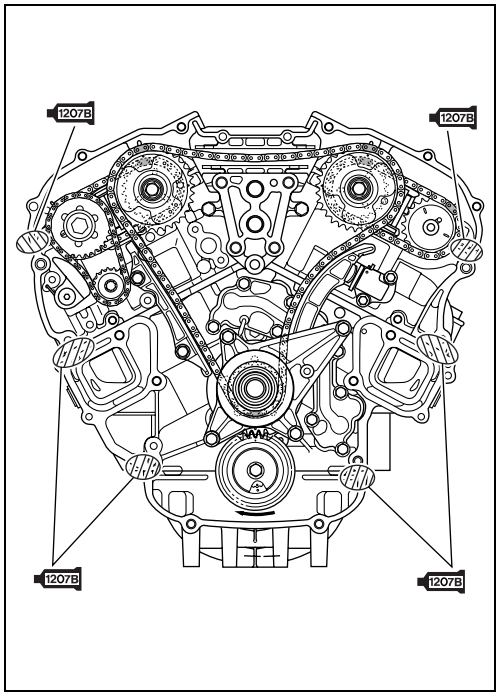


NOTE:
Before installing power unit, apply sealant to the six hatched areas shown in the illustration at right.

1207B 99000-31140: SUZUKI BOND "1207B"

- Lower the power unit onto engine holder.

NOTE:
Rotate crankshaft to aid alignment of driveshaft and counter shaft splines.

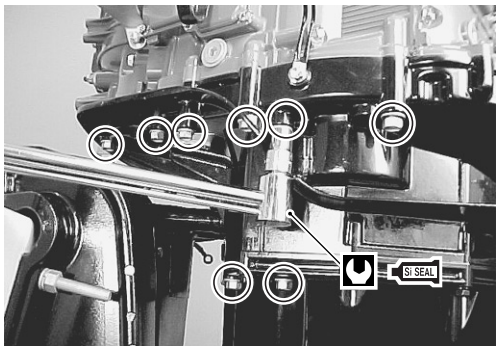


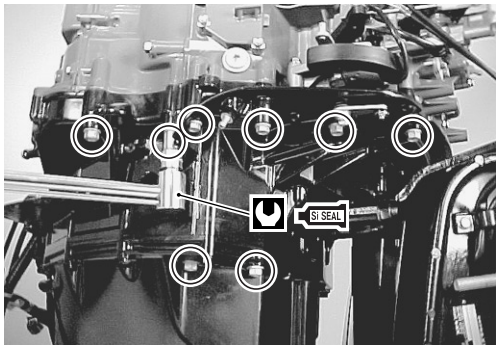
- Apply Suzuki Silicone seal to power unit mounting bolts and tighten bolts to specified torque.

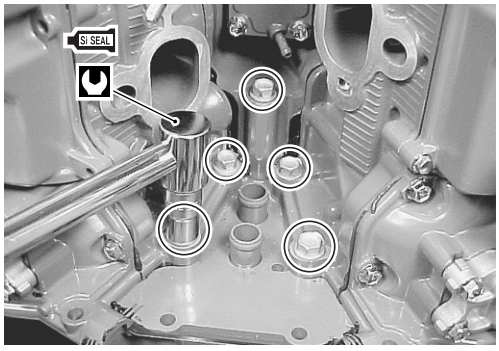
Si SEAL 99000-31120: SUZUKI SILICONE SEAL

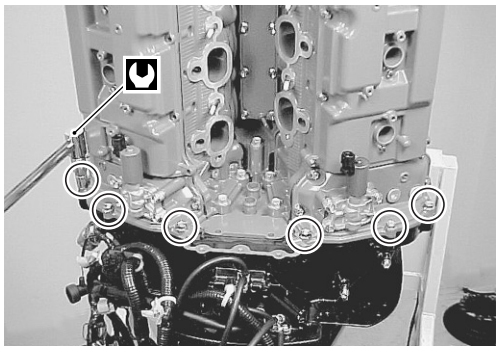
Power unit mounting bolt:

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)**



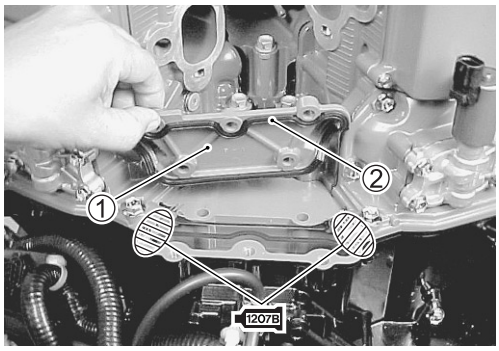






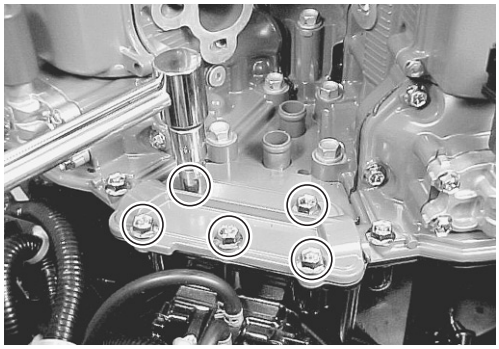
- Assemble new seal ② to upper engine holder cover ①, then install engine holder cover and tighten cover bolts to specified torque.

Engine holder cover bolt:
8 mm 23 N·m (2.3 kg-m, 16.5 lb-ft)



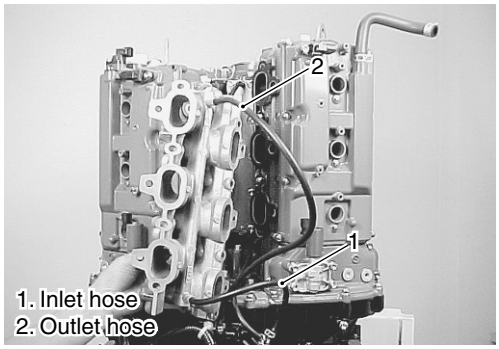
NOTE:
Before installing upper engine holder cover, apply sealant to the two hatched areas shown in the illustration at right.

1207B 99000-31140: SUZUKI BOND "1207B"



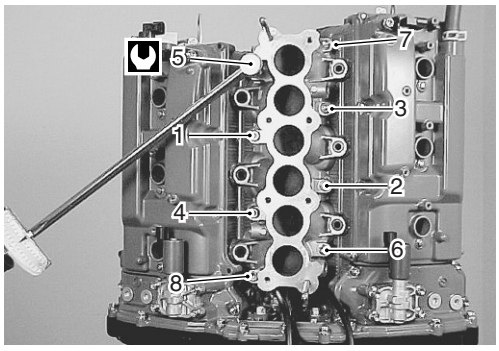
INTAKE MANIFOLD

- Connect inlet and outlet water hoses to the correct intake manifold fittings.



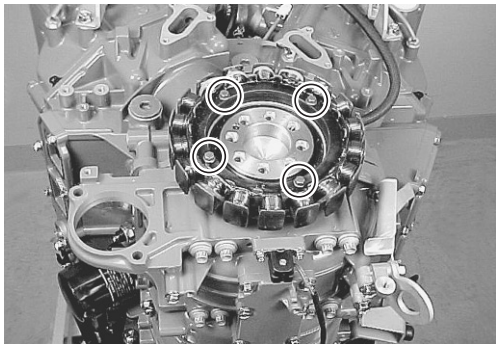
- Install gasket and intake manifold, then tighten bolts and nuts to specified torque.

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



FLYWHEEL

- Install battery charge coil. (See page 4-6.)

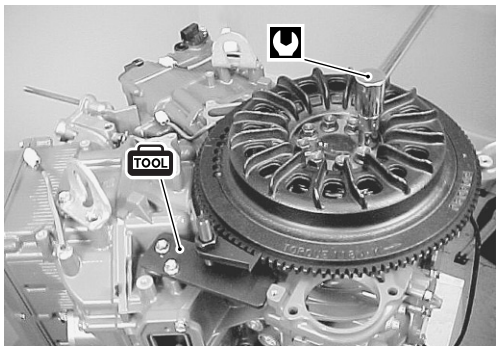


- Install flywheel and tighten flywheel bolts to specified torque. (See page 3-67.)

TOOL 09916-99310: Flywheel holder

Flywheel bolt: 118 N·m (11.8 kg-m, 85.3 lb-ft)

- Install CKP sensor. (See page 3-68.)



FUEL INJECTORS

- Install fuel injectors and fuel delivery pipes. (See page 5-20.)



COLLECTOR ASSEMBLY

- Install collector assembly.
  For collector assembly installation, see page 6-5, 6-7.



FINAL ASSEMBLY CHECK

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

- All parts removed have been returned to their original positions.
- Fuel and water hose routing match's service manual illustration. (See page x-xx to x-xx.)
- Wire routing match's service manual illustration. (See page x-xx to x-xx.)
- No fuel leakage is evident when fuel system is pressurized. (See page 5-4.)
- No water leakage is evident during final test running.

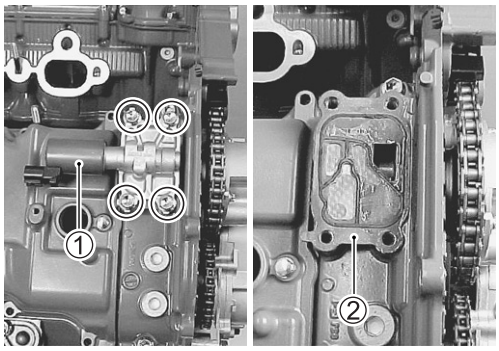
OIL PUMP

REMOVAL

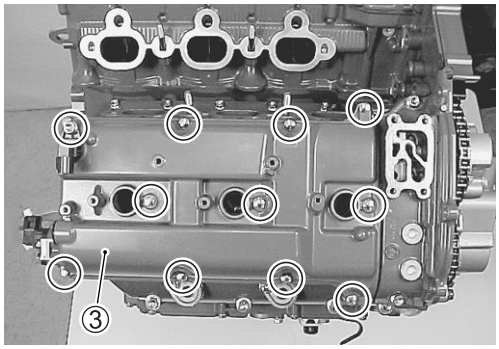
1. Remove the power unit. (See page 6-12 to 6-18.)

[On the PORT side bank]

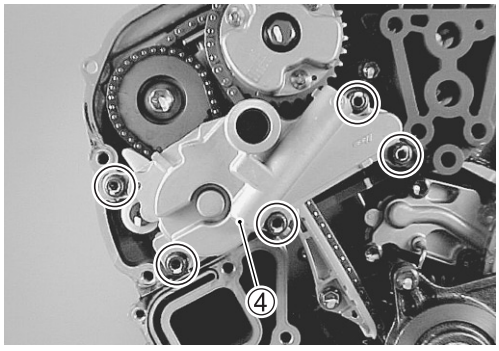
2. On DF250 model, remove the four (4) bolts securing OCV ①, then remove OCV and gasket ②.



3. Remove the eleven (11) bolts securing cylinder head cover ③ to cylinder head, then remove the cylinder head cover.

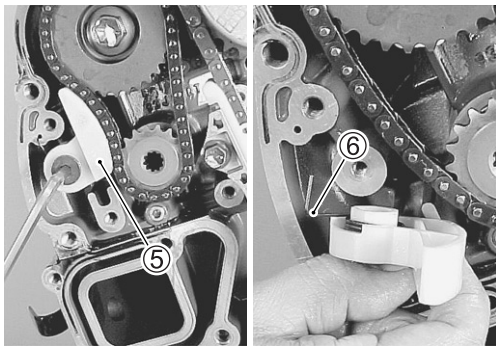


4. Remove the five (5) bolts securing oil pump ④, then remove the oil pump.
   Account for shim washer.

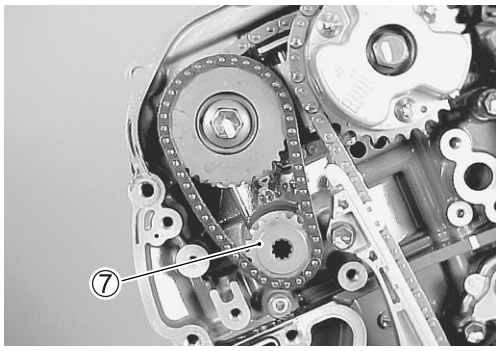




5. Remove the bolt, oil pump chain tensioner ⑤ and tensioner spring ⑥.

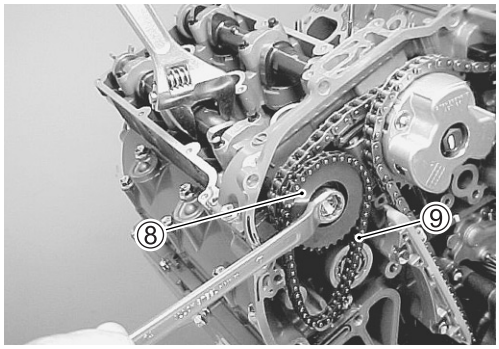


6. Remove the oil pump driven gear ⑦.



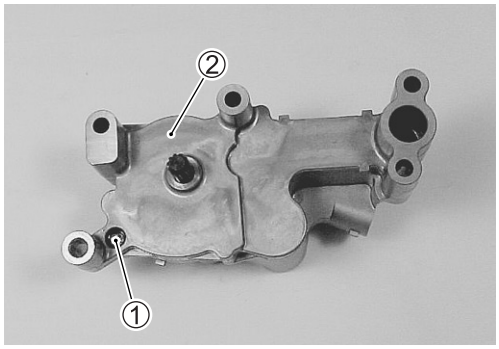
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*

7. Remove the bolt securing oil pump drive sprocket ⑧ to camshaft, then remove the oil pump drive sprocket and chain ⑨.

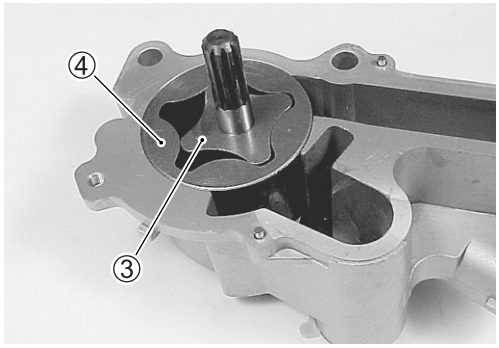


DISASSEMBLY

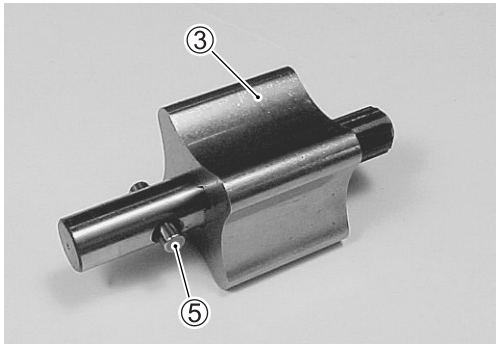
1. Remove the screw ① securing oil pump rotor plate ② to the oil pump case, then remove the oil pump rotor plate.



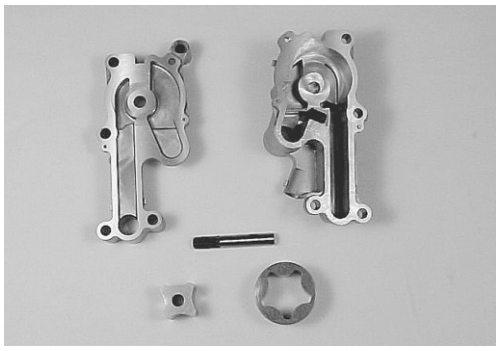
2. Take out inner rotor ③ and outer rotor ④.



3. Remove the pin ⑤ and inner rotor ③.



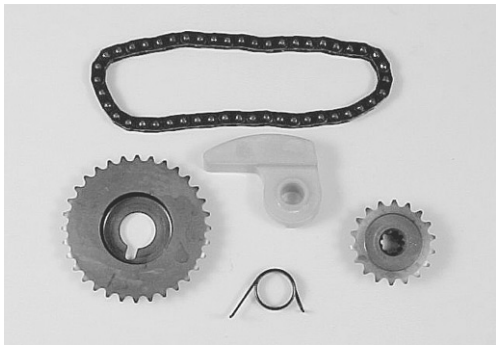
INSPECTION



OIL PUMP ASSEMBLY

Check outer and inner rotors, rotor plate and oil pump case for excessive wear or damage.
Replace as necessary.

NOTE:
If any repair is required on outer rotor, inner rotor and oil pump case/plate, replace them as an oil pump assembly.



DRIVE/DRIVEN SPROCKET

Check teeth of sprocket for wear or damage.
Replace as necessary.

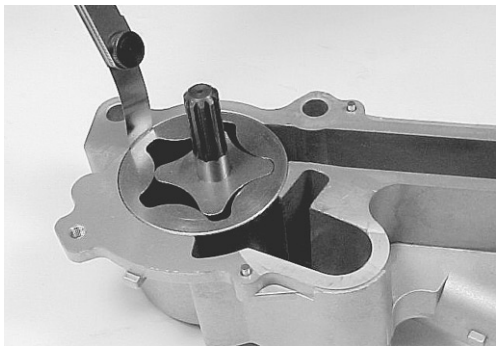
OIL PUMP DRIVE CHAIN

Check oil pump drive chain. Replace if worn or damage.

CHAIN TENSIONER

Check chain tensioner. Replace if worn or damage.

MEASURING PUMP COMPONENTS

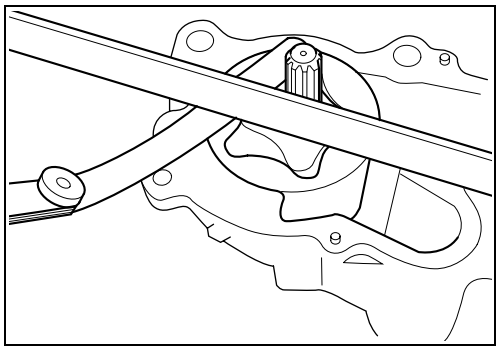


RADIAL CLEARANCE

Using a feeler gauge, measure radial clearance between outer rotor and case.

Radial clearance:
Service limit: 0.31 mm (0.0122 in)

If measurement is not within specifications, replace the outer rotor and/or case.



SIDE CLEARANCE

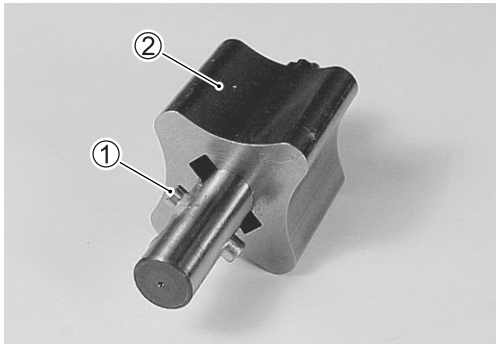
Using straightedge and feeler gauge, measure side clearance.

Side clearance:
Service limit: 0.15 mm (0.0059 in)

If measurement is not within specifications, replace the outer rotor and/or pump case.

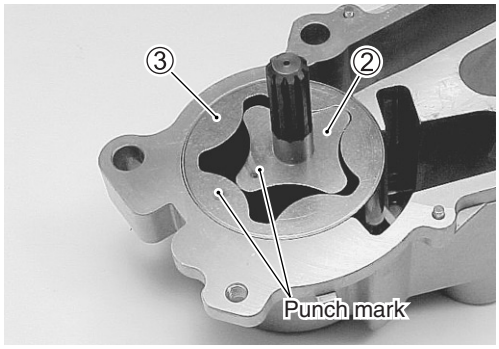
ASSEMBLY

1. Wash, clean and then dry all disassembled parts.
2. Apply thin coat of engine oil to inner and outer rotors, inside surfaces of oil pump case and plate.
3. Assemble pin ① and inner rotor ② to oil pump shaft.

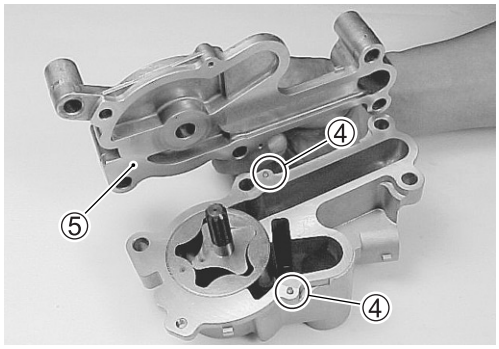


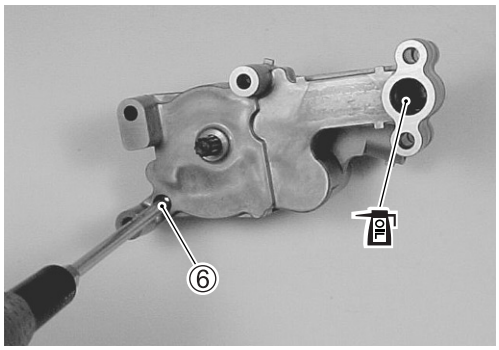
4. Install outer ③ and inner rotor ② to pump case.

NOTE:
When installing outer and inner rotors, the punch mark on each rotor must face rotor plate.



5. Install dowel pins ④ and rotor plate ⑤, and then tighten screw ⑥ securely.
   After mounting the rotor plate, make sure that each rotor turns smoothly by hand.
6. Pour approx. 50 ml (1.7 oz.) of engine oil into pump case for initial lubrication.



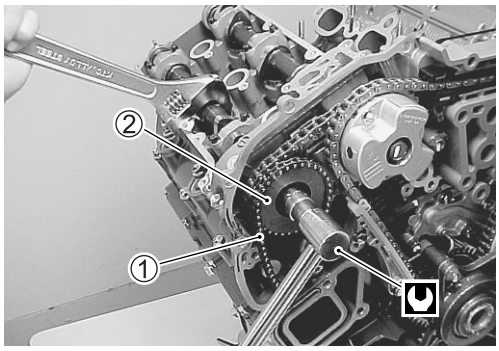


INSTALLATION

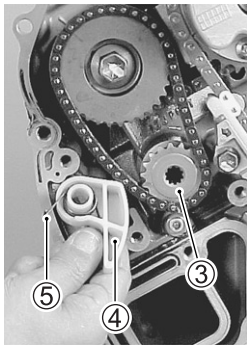
Installation is reverse order of removal with special attention to following steps.

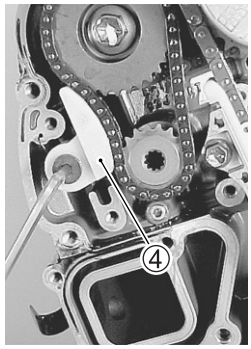
- Install oil pump drive chain ① and pump drive sprocket ② and tighten bolt securely.

Oil pump drive sprocket bolt: 78 N·m (7.8 kg-m, 56 lb-ft)



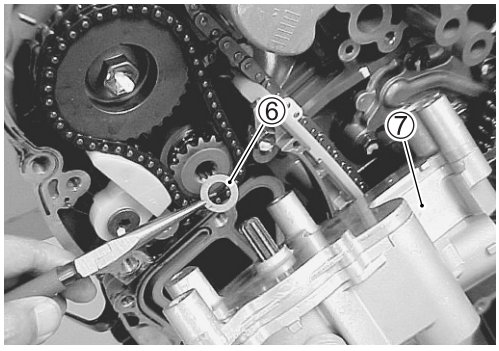
- Install oil pump driven gear ③, chain tensioner ④ and tensioner spring ⑤ as shown in figure, then tighten bolt securely.

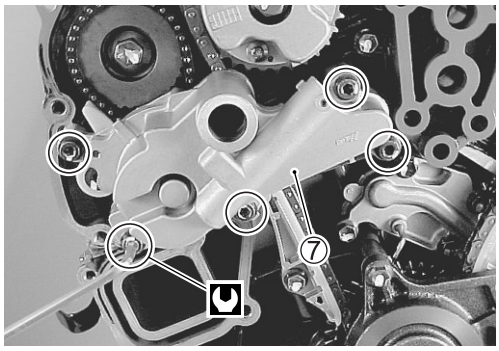




- Install washer ⑥ and oil pump assembly ⑦, then tighten five (5) bolts securely.

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



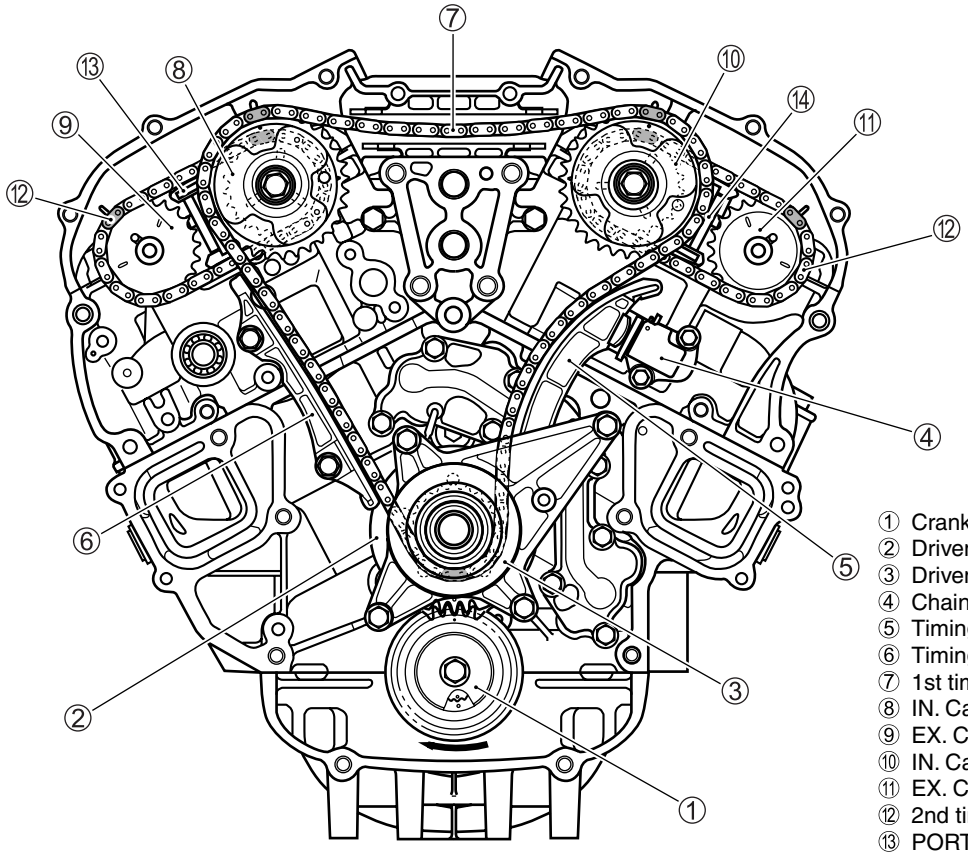


- Install cylinder head cover. (See page 6-10.)

TIMING CHAIN (VVT model)

REMOVAL

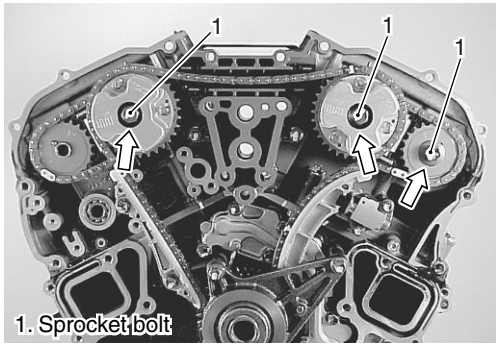
Prior to this service work:
- **Remove the power unit. (See page 6-12 to 6-18.)**



① Crankshaft/Drive gear
② Driven gear/Timing sprocket
③ Driven gear holder
④ Chain tensioner adjuster No. 1
⑤ Timing chain tensioner
⑥ Timing chain guide No. 2
⑦ 1st timing chain
⑧ IN. Camshaft timing sprocket (PORT)
⑨ EX. Camshaft timing sprocket (PORT)
⑩ IN. Camshaft timing sprocket (STBD)
⑪ EX. Camshaft timing sprocket (STBD)
⑫ 2nd timing chain
⑬ PORT chain tensioner
⑭ STBD chain tensioner

1. Remove the cylinder head cover. (See page 6-8 to 6-9.)
2. Remove the oil pump. (See page 6-23 to 6-24.)
3. Loosen the bolts securing IN./EX. camshaft timing sprockets to each cam shaft.

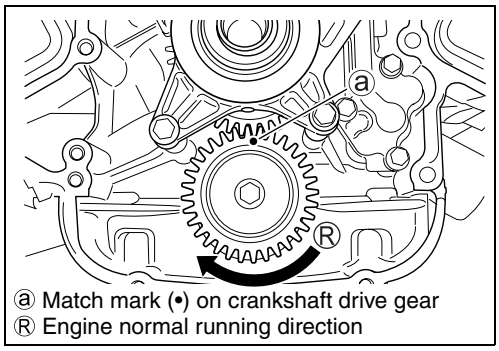
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*



4. Turn the crankshaft in its normal running direction (Ⓡ_LH direction) until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

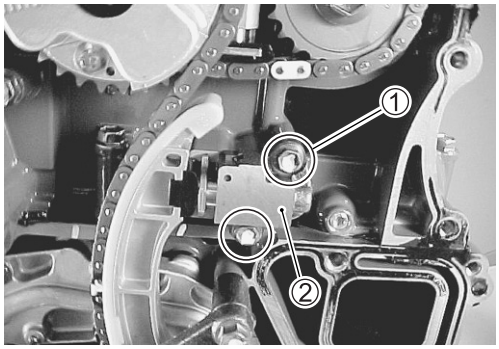
CAUTION

When timing chain has been removed, never turn crankshaft or camshaft.

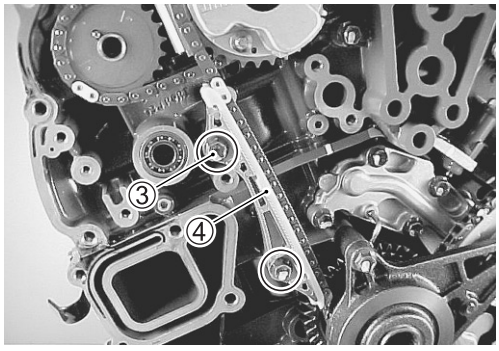


ⓐ Match mark (•) on crankshaft drive gear
Ⓡ Engine normal running direction

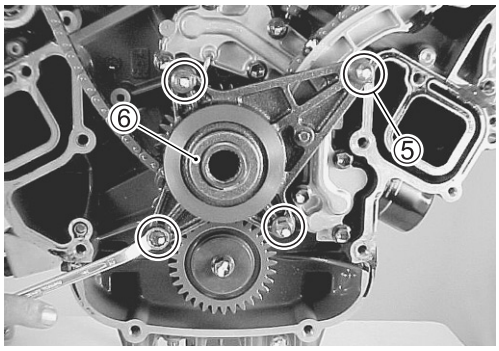
5. Remove the bolts ① and chain tensioner adjuster No. 1 ②.



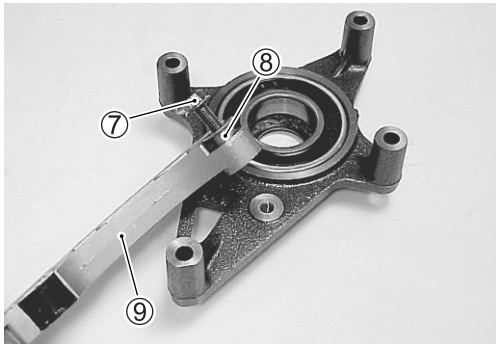
6. Remove the bolts ③ and timing chain guide No. 2 ④.



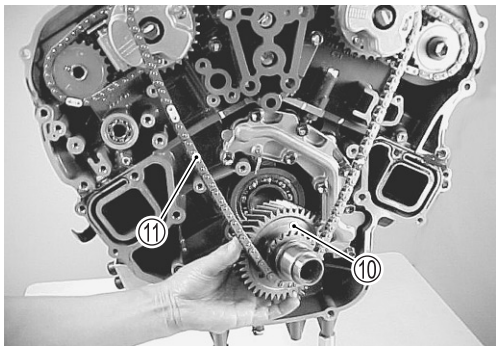
7. Remove the four (4) bolts ⑤ securing driven gear holder ⑥, then remove the driven gear holder (with timing chain tensioner).



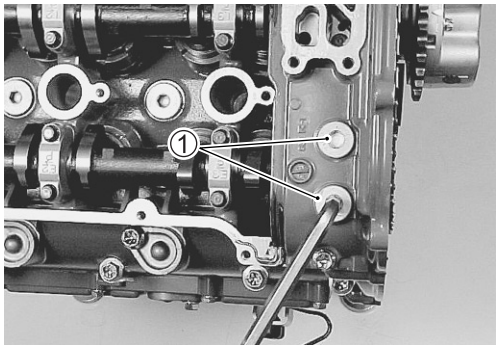
8. Remove the bolt ⑦, spacer ⑧, and timing chain tensioner ⑨.



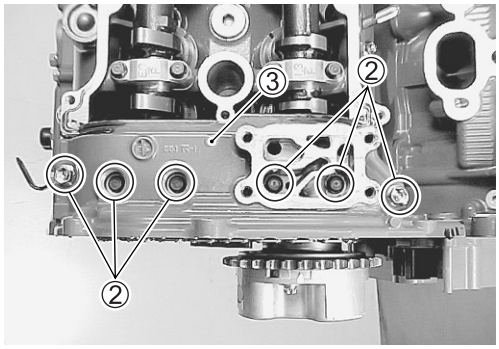
9. Remove the driven gear ⑩ and 1st timing chain ⑪.



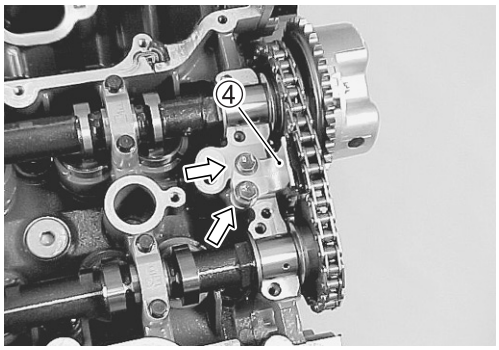
10. **[**On the PORT side bank**]**
    - Remove two (2) plugs ①.



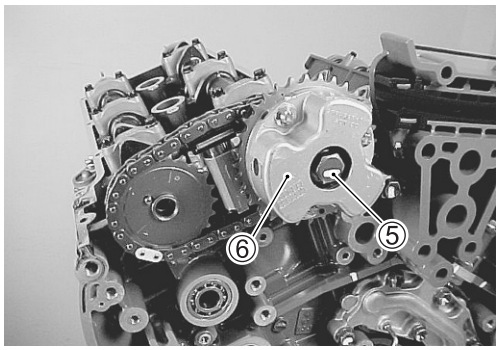
    - Remove the bolts ② securing lower camshaft housing ③, then remove the lower camshaft housing and dowel pins.



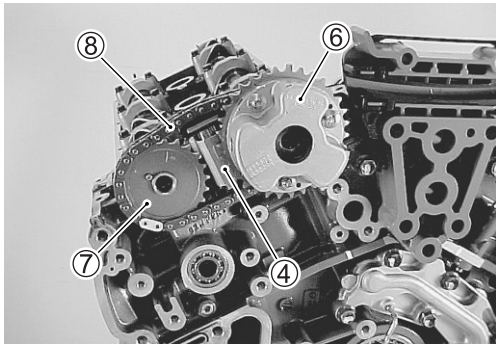
    - Remove two (2) bolts securing PORT chain tensioner ④.



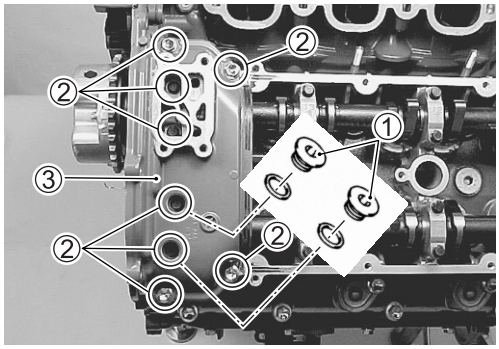
    - Remove the bolt ⑤ securing IN. camshaft timing sprocket ⑥.



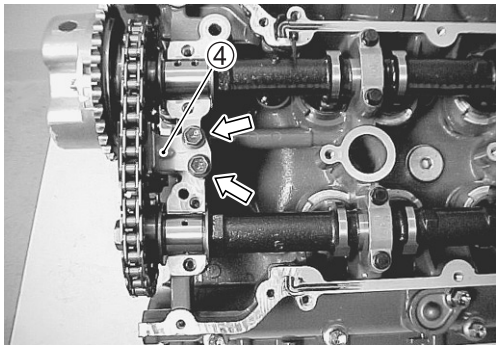
- Remove the IN. camshaft timing sprocket ⑥, EX. camshaft timing sprocket ⑦, 2nd timing chain ⑧ and PORT chain tensioner ④.
- Remove dowel pins from IN./EX. camshaft.



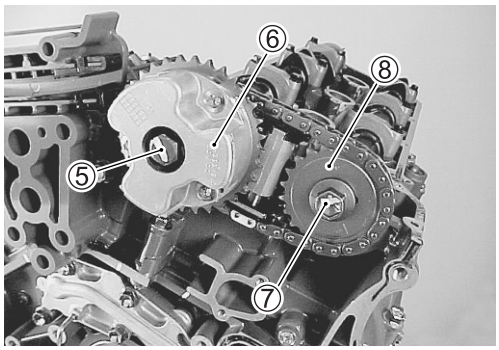
11. [On the STBD side bank]
    - Remove two (2) plugs ①.
    - Remove the bolts ② securing lower camshaft housing ③, then remove the lower camshaft housing and dowel pins.



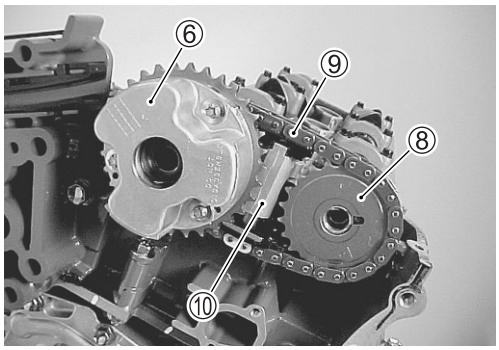
- Remove two (2) bolts securing STBD chain tensioner ④.



- Remove the bolt ⑤ securing IN. camshaft timing sprocket ⑥.
- Remove the bolt ⑦ securing EX. camshaft timing sprocket ⑧.



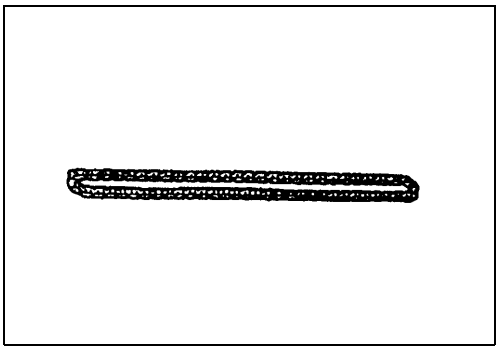
- Remove the IN. camshaft timing sprocket ⑥, EX. camshaft timing sprocket ⑧, 2nd timing chain ⑨ and STBD chain tensioner ⑩.
- Remove dowel pins from IN./EX. camshaft.



INSPECTION

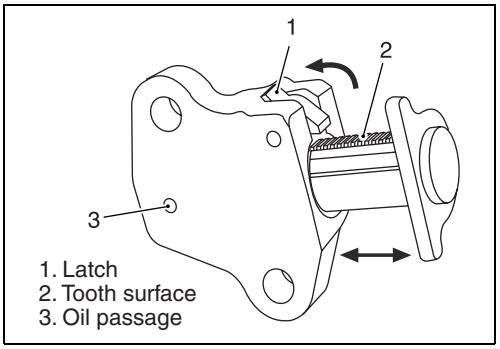
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

1ST TIMING CHAIN
- Inspect 1st timing chain.
  Replace if worn or damaged.

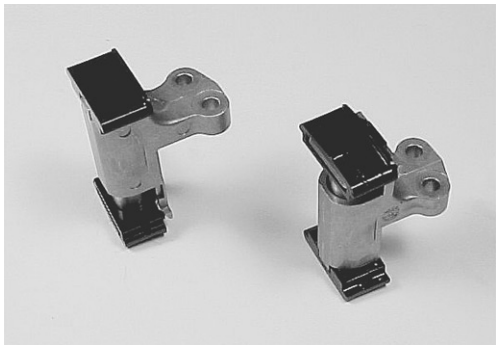


2ND TIMING CHAIN
- Inspect 2nd timing chain.
  Replace if worn or damaged.

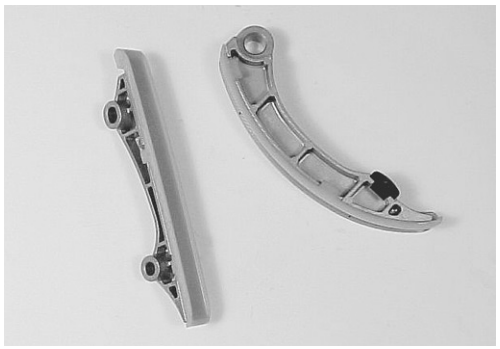
TENSIONER ADJUSTER NO. 1
- Inspect tensioner adjuster for smooth operation.
  Replace if faulty.
  Check oil delivery passage to tensioner.



PORT/STBD CHAIN TENSIONER
- Inspect chain tensioner for smooth operation.
  Replace if faulty.



TIMING CHAIN TENSIONER/CHAIN GUIDE NO. 2
- Check shoe for wear or damage.

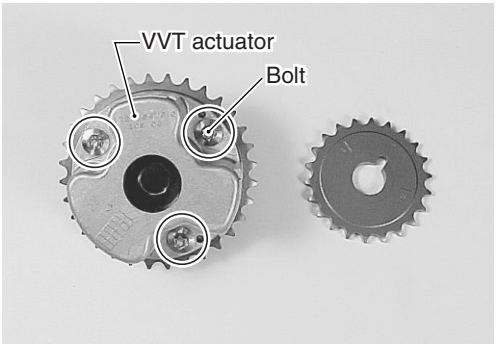


CAMSHAFT TIMING SPROCKET

- Check teeth of sprocket for wear or damage.

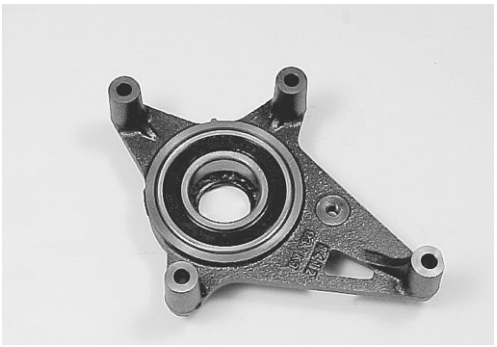
CAUTION

Do not attempt to remove bolts or disassemble the VVT actuator.

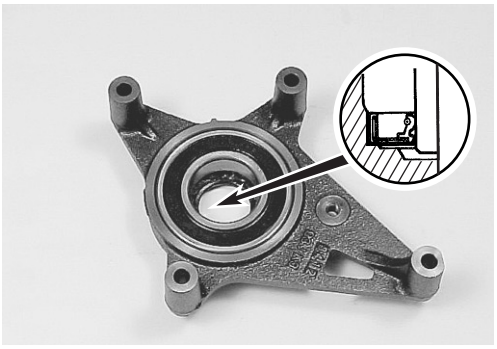


DRIVEN GEAR HOLDER

- Check driven gear holder.
  If cracks or other damage is found, replace holder.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.
- Check oil seal.
  If excessive wear or other damage is found, replace seal.



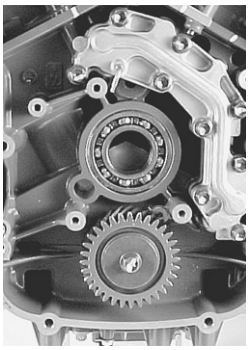
NOTE:
Install oil seal lip (spring side) facing as shown in figure.



DRIVE GEAR/DRIVEN GEAR/BEARING

- Inspect drive and driven gears.
  Replace gear if damaged or worn.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.

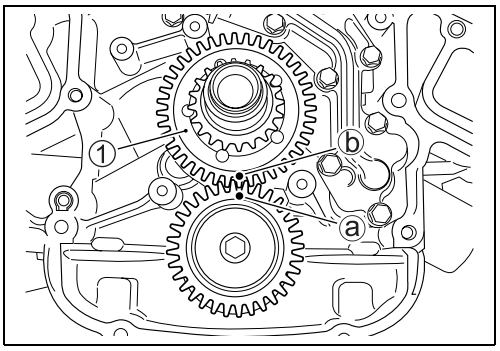




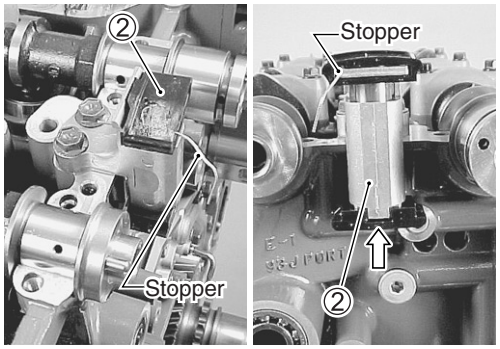
INSTALLATION

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

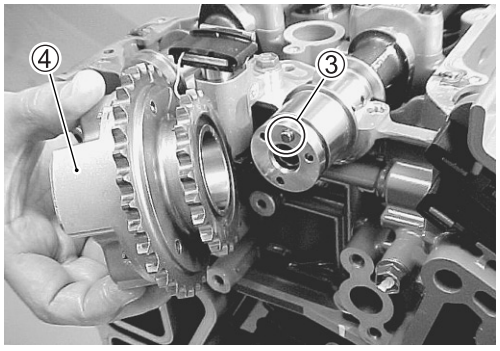
1. Check that the match mark (•) ⓐ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).
2. Install the driven gear ① on the cylinder block so that the match mark (•) ⓐ aligns with match mark (•) ⓑ on the driven gear as shown in the illustration.



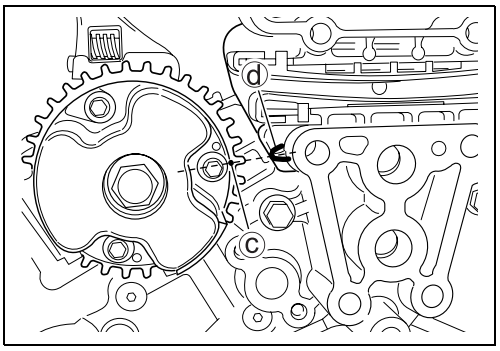
3. On the PORT side bank:
   (1) Install PORT tensioner ② and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket ④ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓒ·ⓓ are correctly aligned as shown in the illustration.

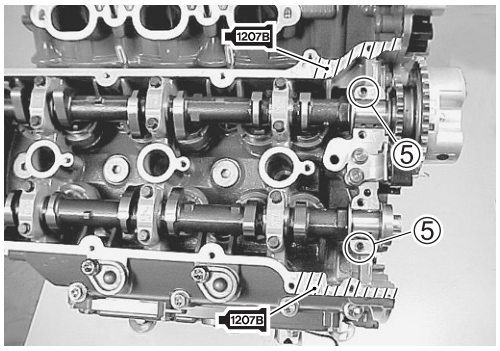


   Match mark ⓒ: •
   Match mark ⓓ: <



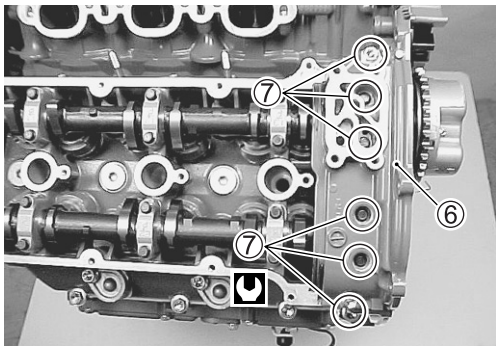
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑤.

1207B **99000-31140: SUZUKI BOND "1207B"**

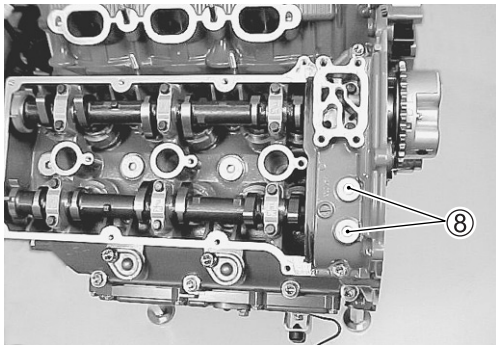


(6) Install lower camshaft housing ⑥.
Tighten lower camshaft housing bolts ⑦, pre-coated with engine oil, to specified torque.

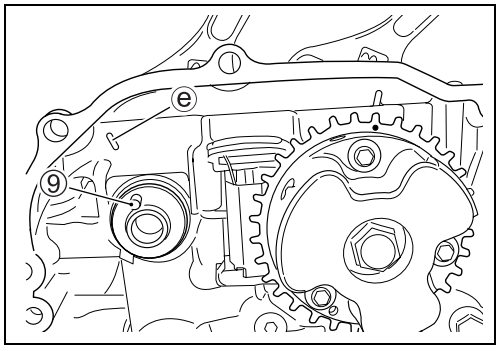
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



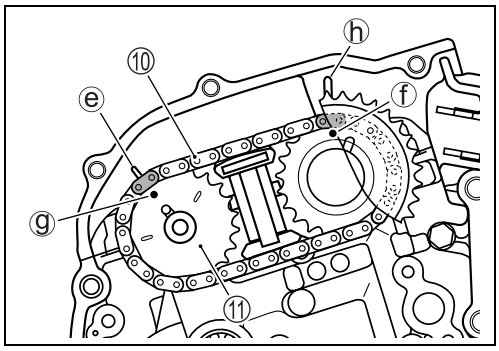
(7) Install plugs ⑧ in lower camshaft housing.



(8) Fit the dowel pin ⑨ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓔ on the lower camshaft housing as shown in the illustration.

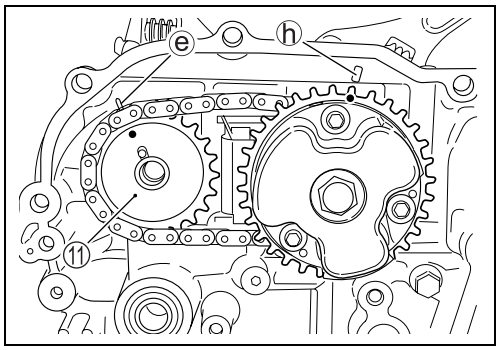


(9) Align the yellow plate of 2nd timing chain ⑩ with the match mark (•) ⓕ on the IN. camshaft timing sprocket, and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓖ on the EX. camshaft timing sprocket ⑪ and fit the chain on the sprocket.

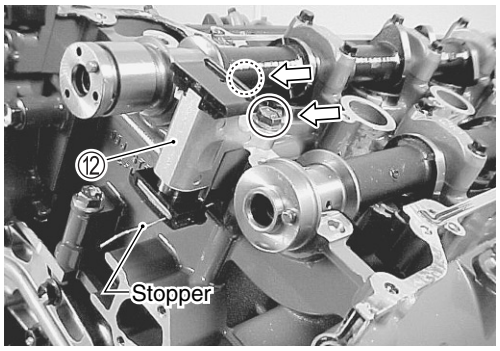


NOTE:
Install the sprocket so that the match mark and slit mark are both visible.

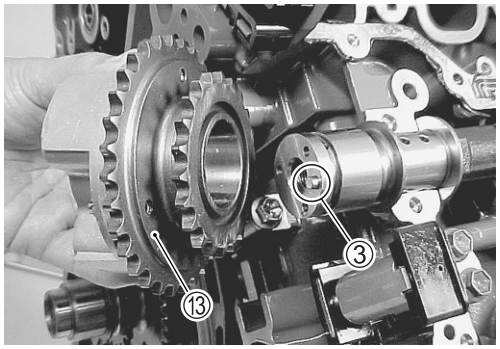
(11) Install the EX. camshaft timing sprocket ⑪ on the EX. camshaft.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓔ/ⓗ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from PORT tensioner.
(13) Apply engine oil to 2nd chain.



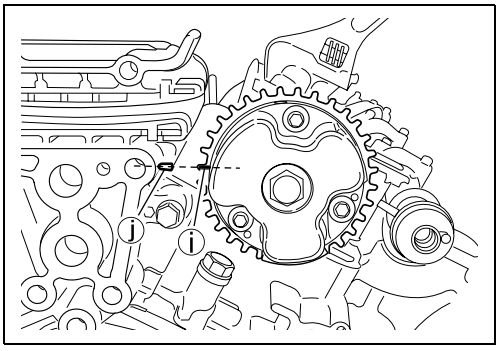
4. On the STBD side bank:
   (Install the STBD side 2nd timing chain in the same manner as the PORT side bank.)
   (1) Install STBD tensioner ⑫ and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket ⑬ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓘ/ⓙ are correctly aligned as shown in the illustration.

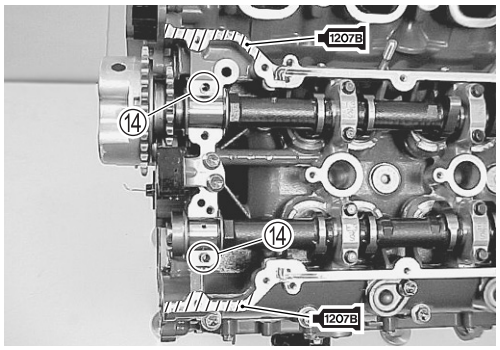


   Match mark ⓘ: ▪
   Match mark ⓙ: ▶



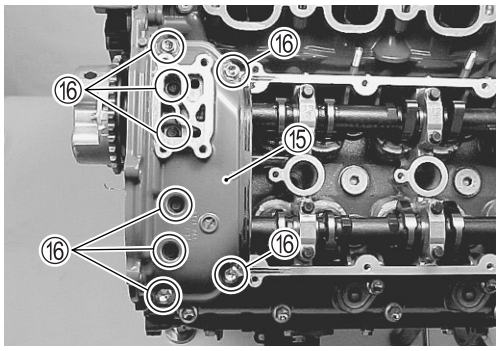
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑭.

1207B **99000-31140: SUZUKI BOND "1207B"**

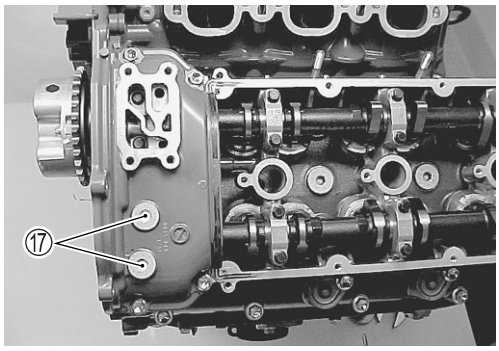


   (6) Install lower camshaft housing ⑮.
   Tighten lower camshaft housing bolts ⑯, pre-coated with engine oil, to specified torque.

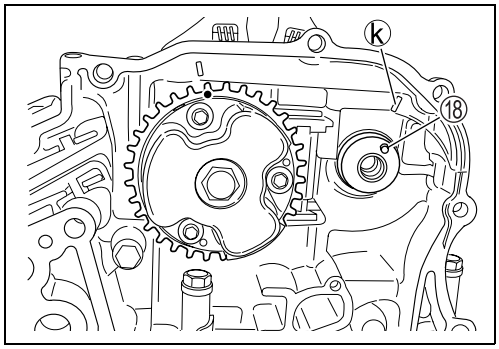
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ⑰ in lower camshaft housing.

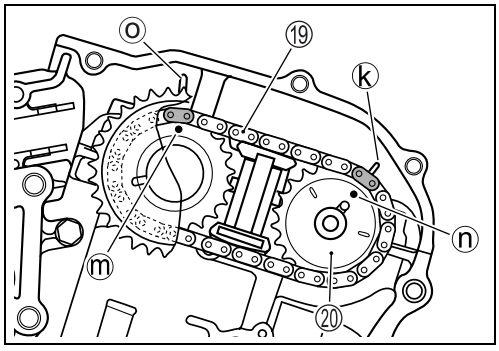


(8) Fit the dowel pin ⑱ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓚ on the lower camshaft housing as shown in the illustration.

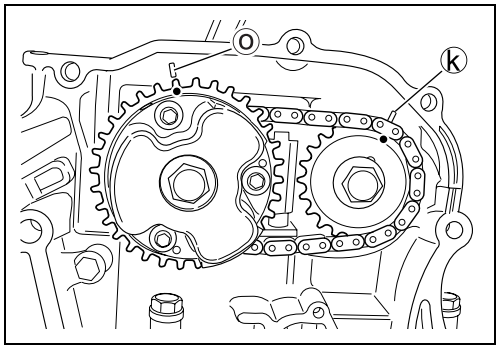


(9) Align the yellow plate of 2nd timing chain ⑲ with the match mark (•) ⓜ on the IN. camshaft timing sprocket and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓝ on the EX. camshaft timing sprocket ⑳ and fit the chain on the sprocket.

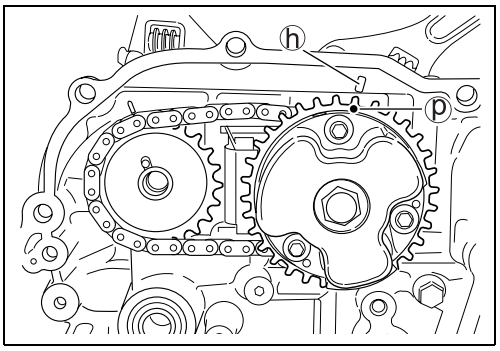
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.

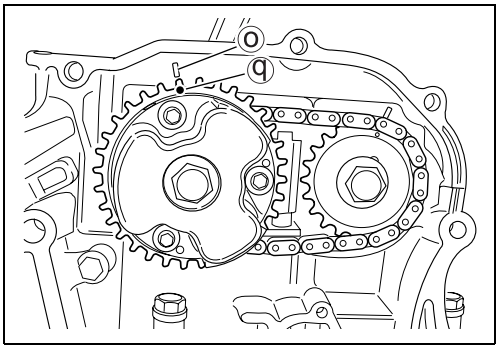


(11) Install the EX. camshaft timing sprocket ⑳ on the EX. camshaft, then tighten sprocket temporarily with the bolt.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓞ/ⓚ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from STBD tensioner.
(13) Apply engine oil to 2nd chain.

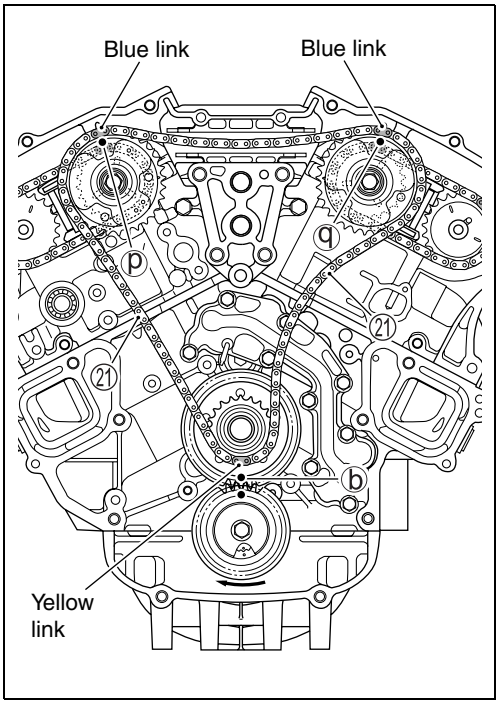


5. Check that the match marks (•) ⓟ/ⓠ on both the PORT & STBD side IN. camshaft timing sprockets are correctly aligned with the match marks ⓗ·ⓞ on the camshaft housing as shown in the illustration.

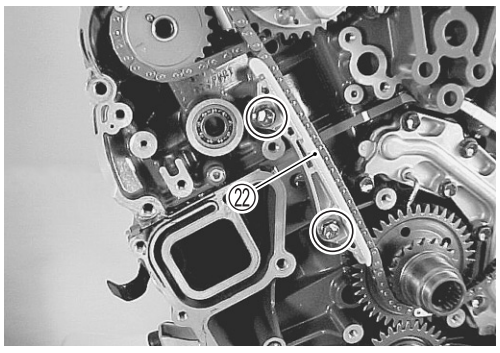




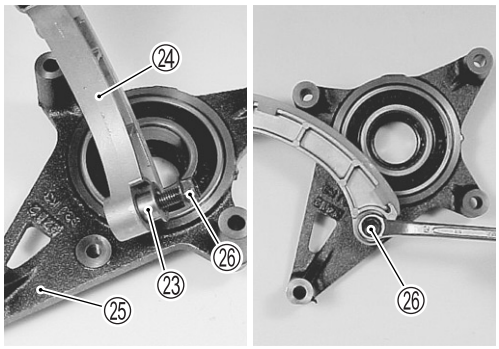
6. As shown in the illustration, fit the 1st timing chain ㉑ with one blue link aligned with the match mark (•) ⓟ on the PORT side IN. camshaft timing sprocket and one blue link aligned with the match mark (•) ⓠ on the STBD side IN. camshaft timing sprocket.
7. As shown in the illustration, fit the 1st timing chain with its yellow link aligned with the match mark (•) ⓑ on the driven gear.



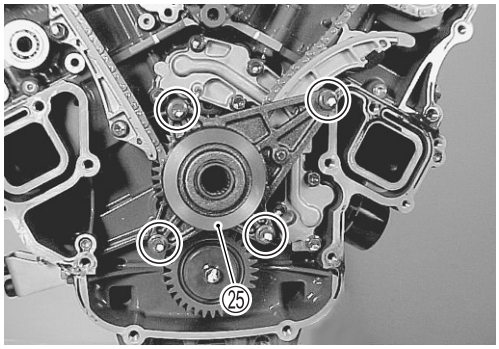
8. Install No. 2 timing chain guide ㉒, then tighten bolts securely. Apply engine oil to chain guide.



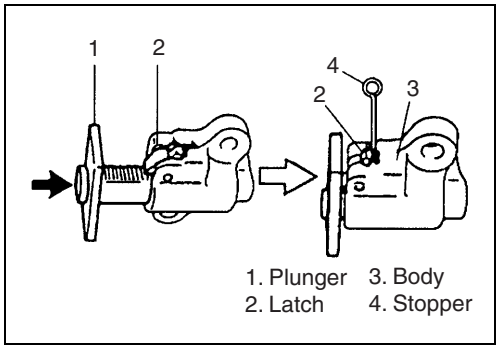
9. Insert the spacer ㉓ into chain tensioner ㉔.
   Install chain tensioner to driven gear holder ㉕, then tighten bolt ㉖ securely.
   Apply engine oil to chain tensioner.



10. Install driven gear holder ㉕, then tighten four (4) bolts securely.



11. With latch of tensioner adjuster ㉖ pushed in and plunger pushed back into body, insert stopper into latch and body.
    After inserting stopper, check to make sure that plunger will not come out.

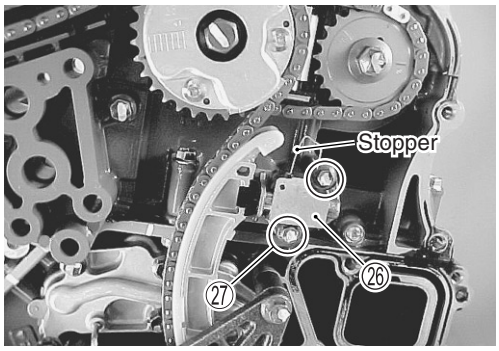


12. Install timing chain tensioner adjuster ㉖, then tighten bolts ㉗ to specified torque.

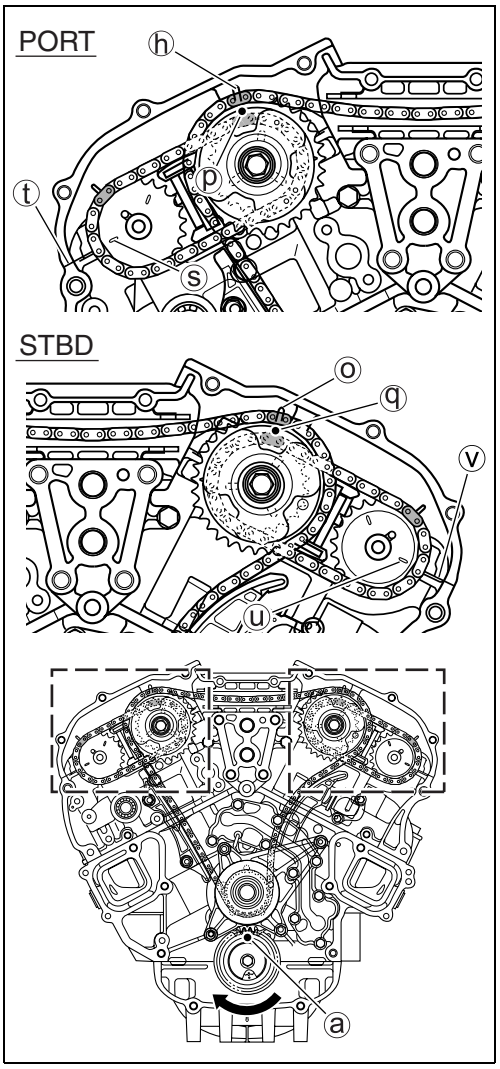
Tensioner adjuster bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)

Apply engine oil to timing chain.

13. Remove the stopper from tensioner adjuster.



14. Turn the crankshaft two (2) complete rotations in direction shown in figure.
    As shown in the illustration, check that all match marks are in alignment as written below when the match mark (•) ⓐ on the drive gear is pointing to 12:00 o'clock.
    - The match mark (•) ⓟ on the PORT side IN. sprocket aligns with the match mark ⓗ on the camshaft housing.
    - The match mark (•) ⓠ on the STBD side IN. sprocket aligns with the match mark ⓞ on the camshaft housing.
    - The match mark (slit) ⓢ on the PORT side EX. sprocket aligns with the mating face ⓣ of lower camshaft housing.
    - The match mark (slit) ⓤ on the STBD side EX. sprocket aligns with the mating face ⓥ of lower camshaft housing.

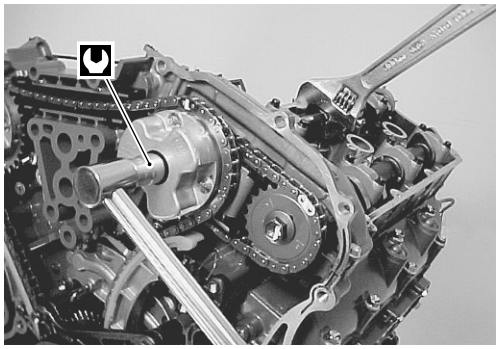


15. Tighten PORT/STBD IN. camshaft timing sprocket bolts to specified torque.

IN. camshaft timing sprocket bolt:
60 N·m (6.0 kg-m, 43.4 lb-ft)

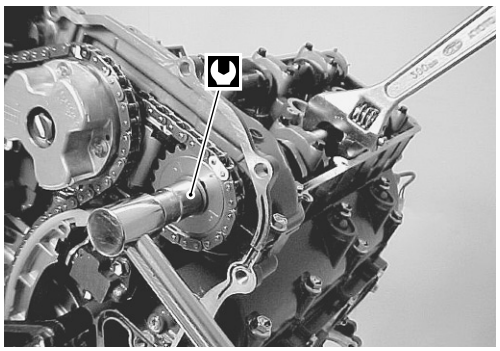
CAUTION

Do not over tighten to avoid damaging VVT actuator.



16. Tighten PORT/STBD EX. camshaft timing sprocket bolts to specified torque.

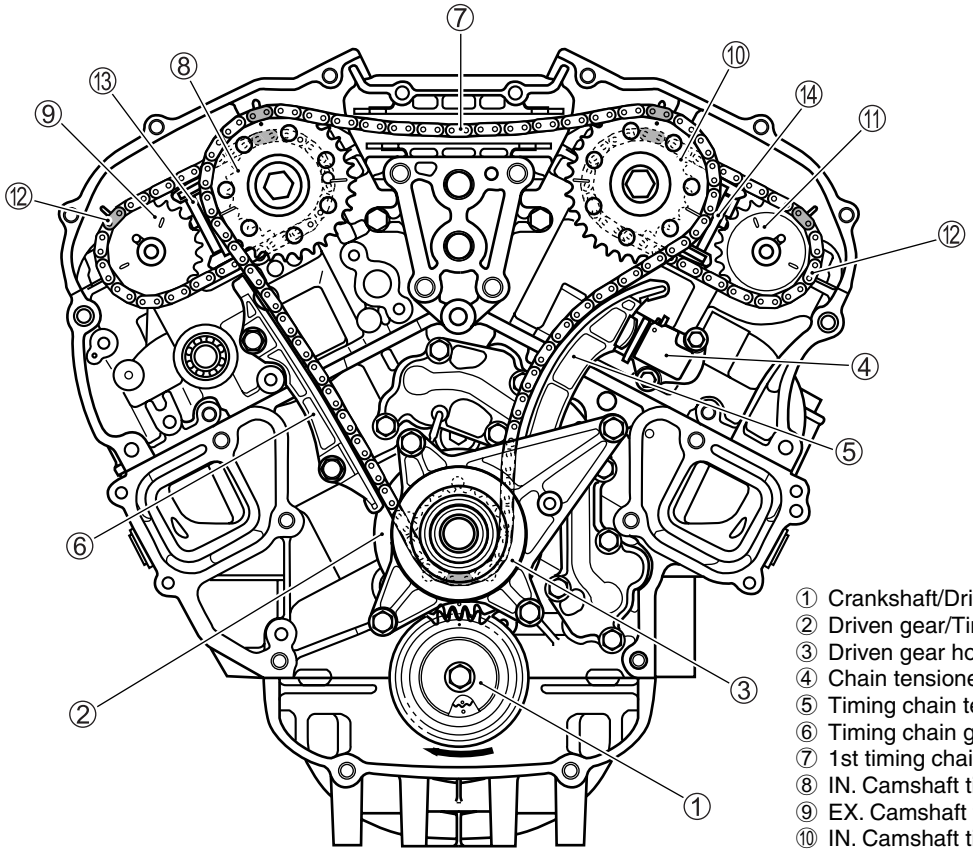
EX. camshaft timing sprocket bolt:
78 N·m (7.8 kg-m, 56 lb-ft)



TIMING CHAIN (Non-VVT model)

REMOVAL

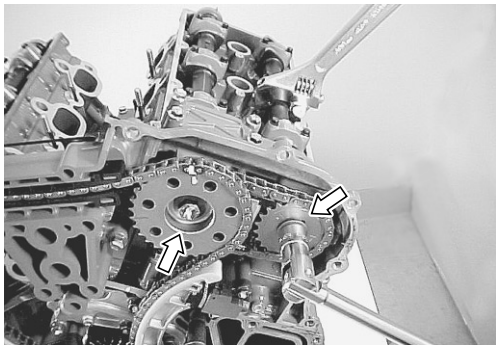
Prior to this service work:
- **Remove the power unit. (See page 6-12 to 6-18.)**



① Crankshaft/Drive gear
② Driven gear/Timing sprocket
③ Driven gear holder
④ Chain tensioner adjuster No. 1
⑤ Timing chain tensioner
⑥ Timing chain guide No. 2
⑦ 1st timing chain
⑧ IN. Camshaft timing sprocket No. 1 & 2 (PORT)
⑨ EX. Camshaft timing sprocket (PORT)
⑩ IN. Camshaft timing sprocket No. 1 & 2 (STBD)
⑪ EX. Camshaft timing sprocket (STBD)
⑫ 2nd timing chain
⑬ PORT chain tensioner
⑭ STBD chain tensioner

1. Remove the cylinder head cover. (See page 6-8 to 6-9.)
2. Remove the oil pump. (See page 6-23 to 6-24.)
3. Loosen the bolts securing IN./EX. camshaft timing sprockets to each cam shaft.

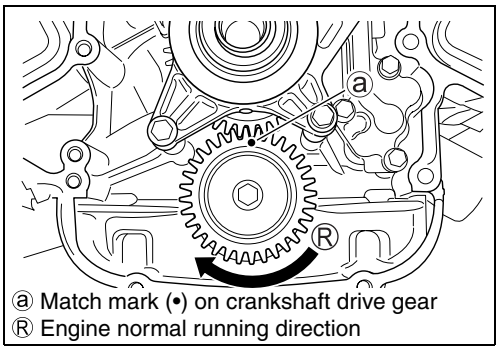
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*



4. Turn the crankshaft in its normal running direction (Ⓡ_LH direction) until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

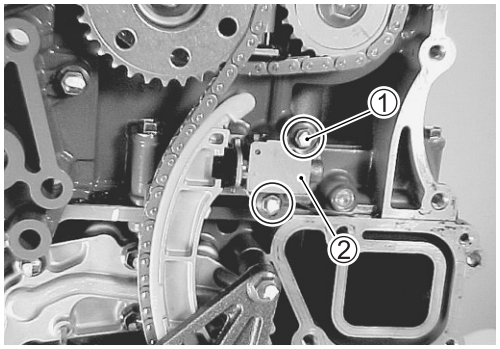
CAUTION

When timing chain has been removed, never turn crankshaft or camshaft.

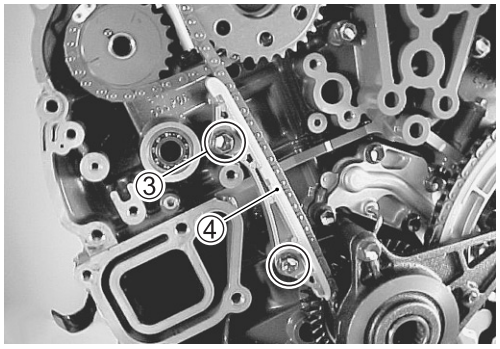


ⓐ Match mark (•) on crankshaft drive gear
Ⓡ Engine normal running direction

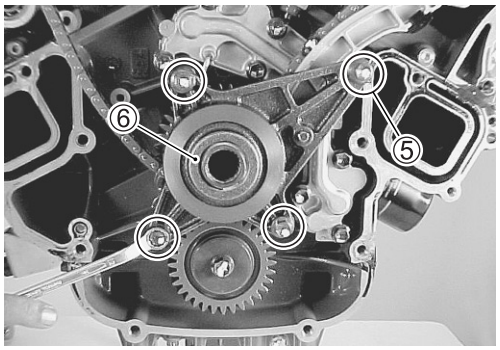
5. Remove the bolts ① and chain tensioner adjuster No. 1 ②.



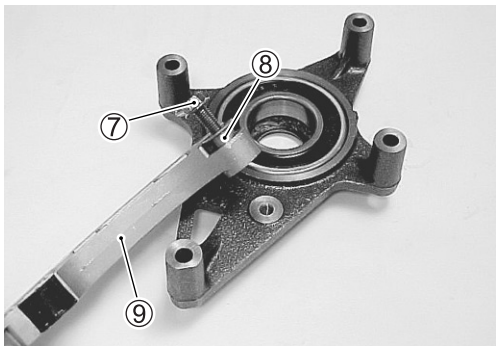
6. Remove the bolts ③ and timing chain guide No. 2 ④.



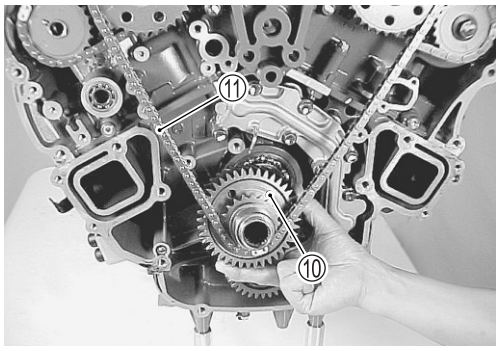
7. Remove the four (4) bolts ⑤ securing driven gear holder ⑥, then remove the driven gear holder (with timing chain tensioner).



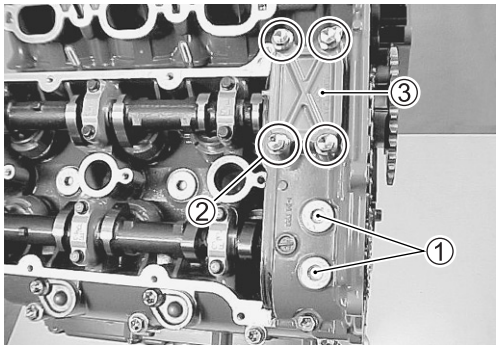
8. Remove the bolt ⑦, spacer ⑧, and timing chain tensioner ⑨.



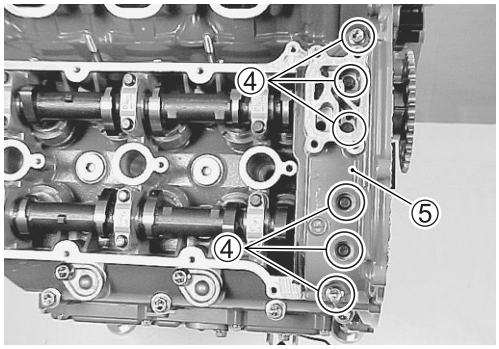
9. Remove the driven gear ⑩ and 1st timing chain ⑪.



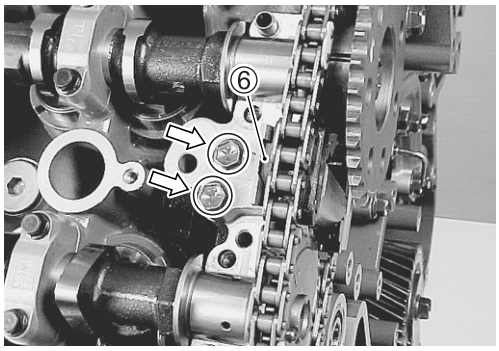
10. [On the PORT side bank]
    - Remove two (2) plugs ①.
    - Remove four bolts ② and plate ③.



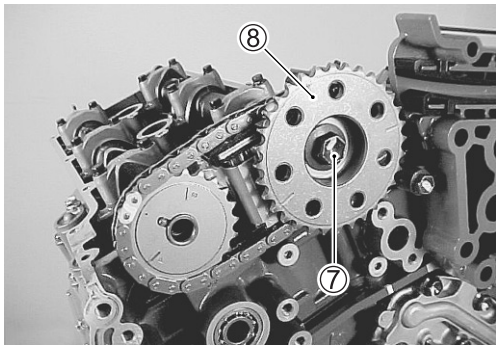
- Remove the bolts ④ securing lower camshaft housing ⑤, then remove the lower camshaft housing and dowel pins.



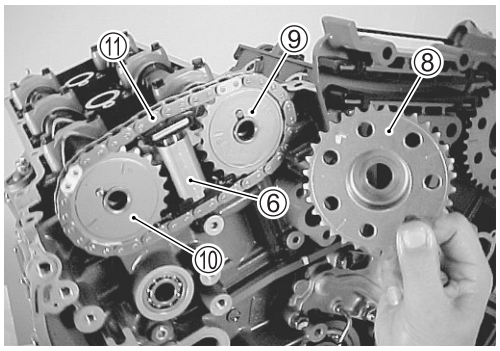
- Remove two (2) bolts securing PORT chain tensioner ⑥.



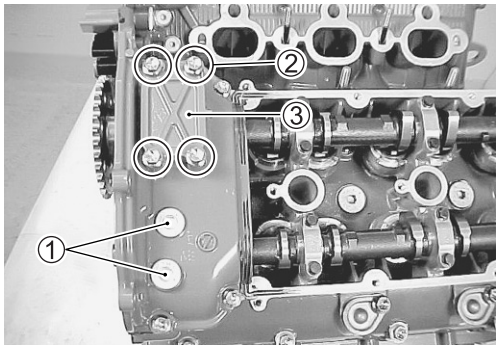
- Remove the bolt ⑦ securing IN. camshaft timing sprocket ⑧.



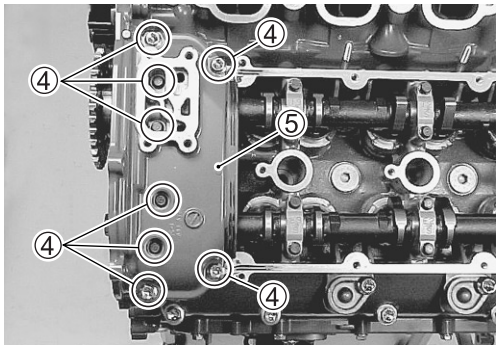
- Remove the IN. camshaft timing sprocket No. 1 ⑧, IN. camshaft timing sprocket No. 2 ⑨, EX. camshaft timing sprocket ⑩, 2nd timing chain ⑪ and PORT chain tensioner ⑥.
- Remove dowel pins from IN./EX. camshaft.



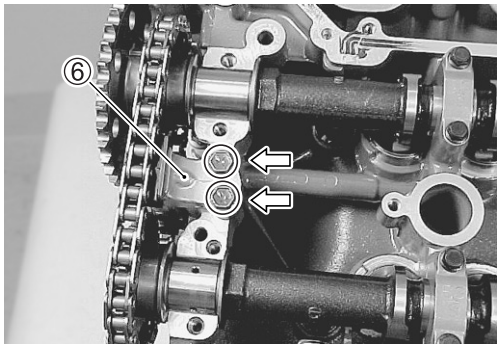
11. [On the STBD side bank]
    - Remove two (2) plugs ①.
    - Remove four bolts ② and plate ③.



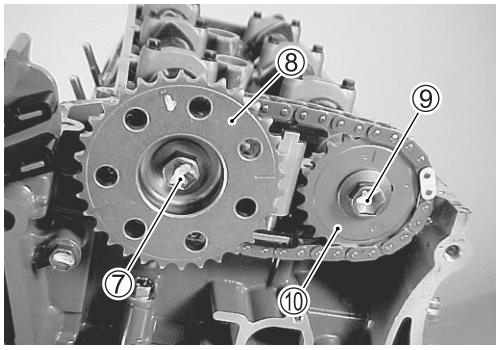
- Remove the bolts ④ securing lower camshaft housing ⑤, then remove the lower camshaft housing and dowel pins.



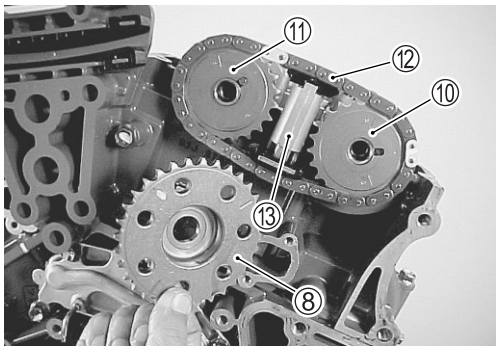
- Remove two (2) bolts securing STBD chain tensioner ⑥.



- Remove the bolt ⑦ securing IN. camshaft timing sprocket ⑧.
- Remove the bolt ⑨ securing EX. camshaft timing sprocket ⑩.



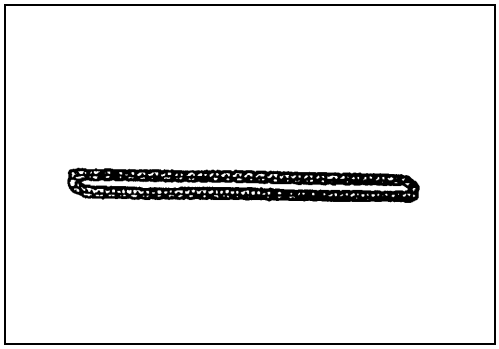
- Remove the IN. camshaft timing sprocket No. 1 ⑧, IN. camshaft timing sprocket No. 2 ⑪, EX. camshaft timing sprocket ⑩, 2nd timing chain ⑫ and STBD chain tensioner ⑬.
- Remove dowel pins from IN./EX. camshaft.



INSPECTION

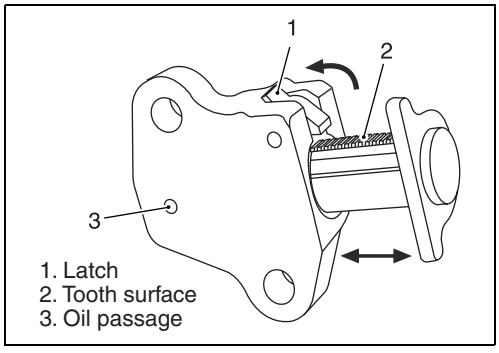
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

1ST TIMING CHAIN
- Inspect 1st timing chain.
  Replace if worn or damaged.

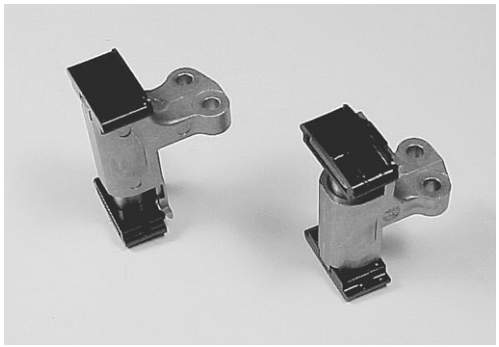


2ND TIMING CHAIN
- Inspect 2nd timing chain.
  Replace if worn or damaged.

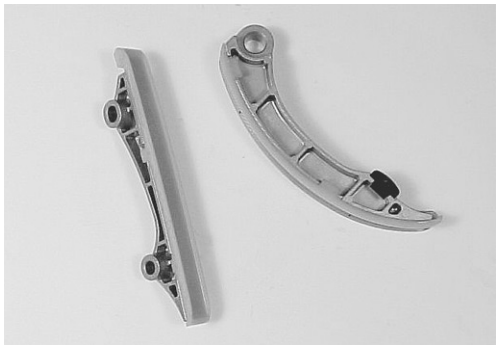
TENSIONER ADJUSTER NO. 1
- Inspect tensioner adjuster for smooth operation.
  Replace if faulty.
  Check oil delivery passage to tensioner.



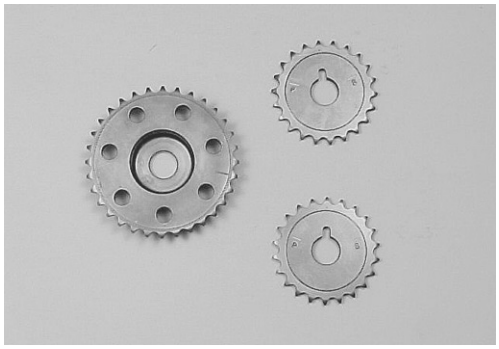
PORT/STBD CHAIN TENSIONER
- Inspect chain tensioner for smooth operation.
  Replace if faulty.



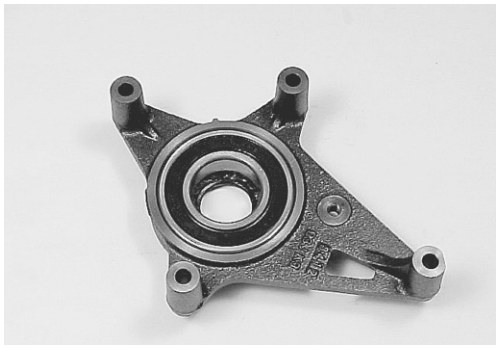
TIMING CHAIN TENSIONER/CHAIN GUIDE NO. 2
- Check shoe for wear or damage.



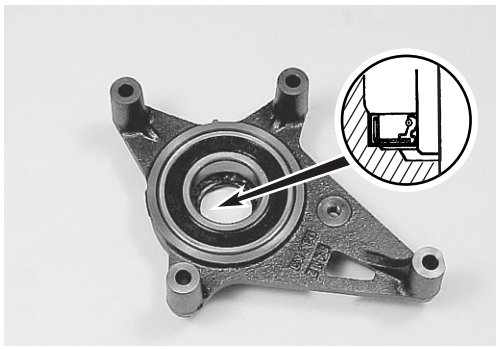
CAMSHAFT TIMING SPROCKET
- Check teeth of sprocket for wear or damage.



DRIVEN GEAR HOLDER
- Check driven gear holder.
  If cracks or other damage is found, replace holder.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.
- Check oil seal.
  If excessive wear or other damage is found, replace seal.

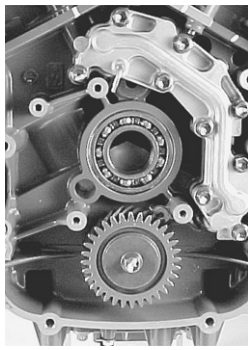


NOTE:
Install oil seal lip (spring side) facing as shown in figure.



DRIVE GEAR/DRIVEN GEAR/BEARING
- Inspect drive and driven gears.
  Replace gear if damaged or worn.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough.

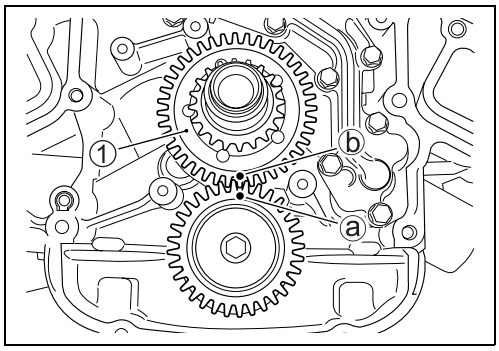




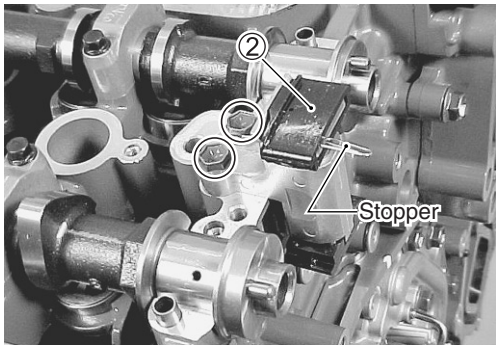
INSTALLATION

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

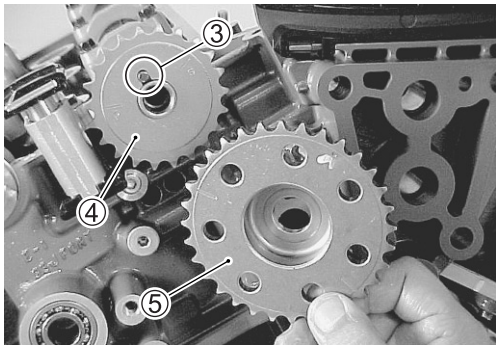
1. Check that the match mark (•) ⓐ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).
2. Install the driven gear ① on the cylinder block so that the match mark (•) ⓐ aligns with match mark (•) ⓑ on the driven gear as shown in the illustration.



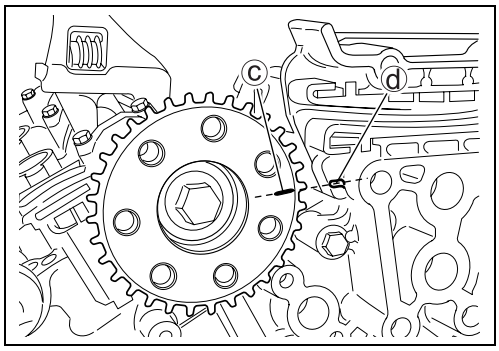
3. On the PORT side bank:
   (1) Install PORT tensioner ② and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket No. 2 ④, timing sprocket No. 1 ⑤ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓒ·ⓓ are correctly aligned as shown in the illustration.

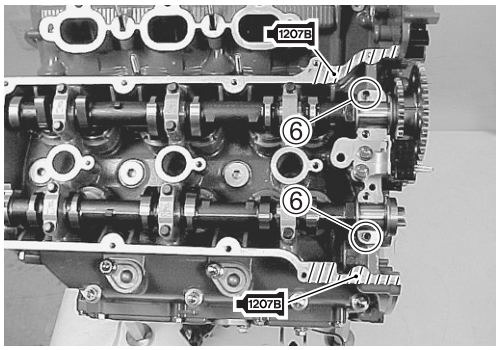


   Match mark ⓒ: —
   Match mark ⓓ: <



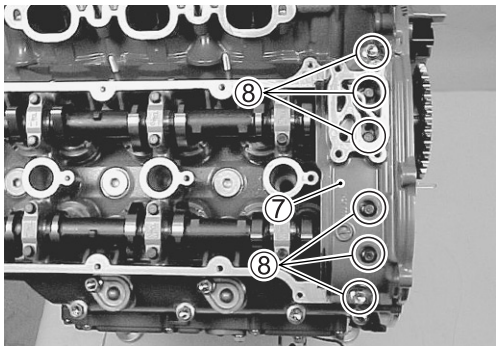
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑥.

1207B **99000-31140: SUZUKI BOND "1207B"**

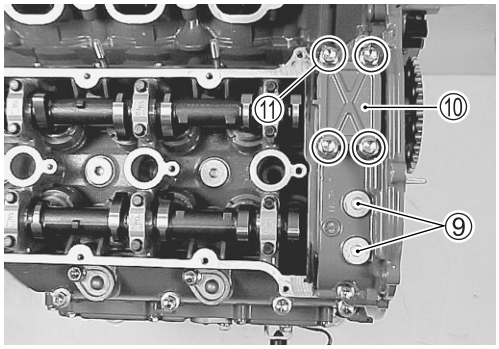


(6) Install lower camshaft housing ⑦.
Tighten lower camshaft housing bolts ⑧, pre-coated with engine oil, to specified torque.

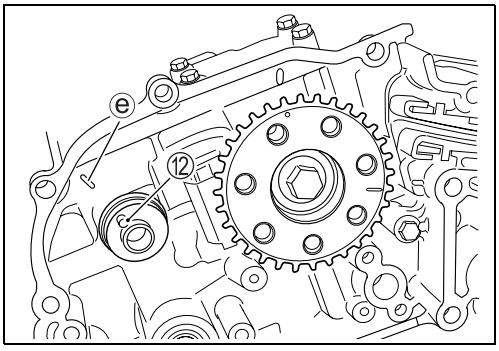
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ⑨ in lower camshaft housing.
Install plate ⑩, then tighten bolts ⑪ securely.

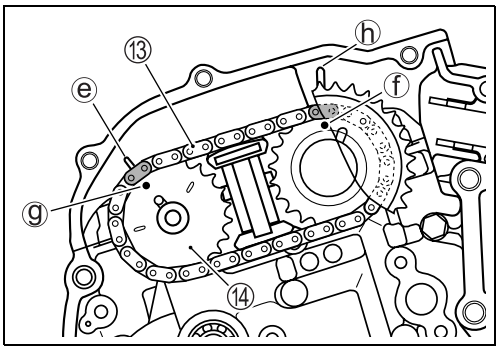


(8) Fit the dowel pin ⑫ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓔ on the lower camshaft housing as shown in the illustration.

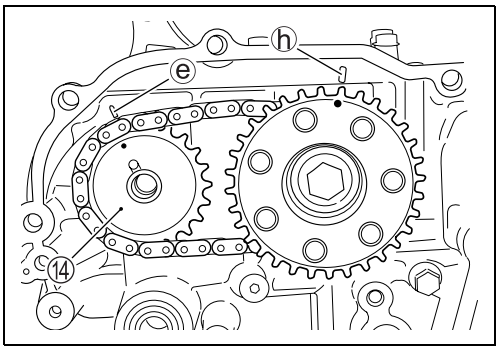


(9) Align the yellow plate of 2nd timing chain ⑬ with the match mark (•) ⓕ on the IN. camshaft timing sprocket No.2, and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓖ on the EX. camshaft timing sprocket ⑭ and fit the chain on the sprocket.

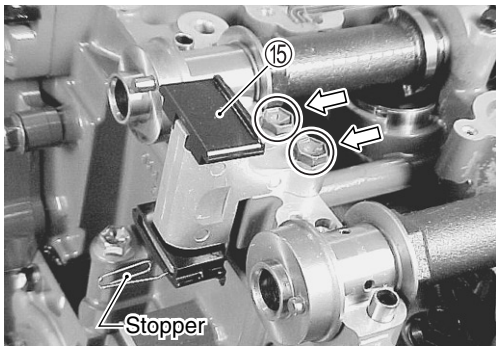
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.



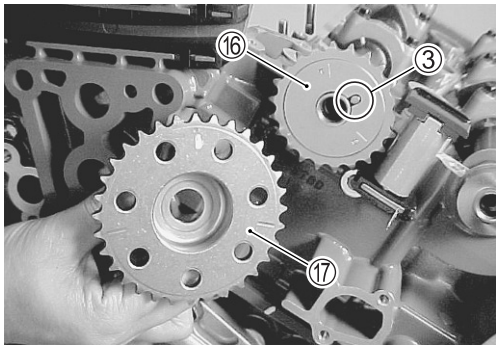
(11) Install the EX. camshaft timing sprocket ⑭ on the EX. camshaft.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓔ/ⓗ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from PORT tensioner.
(13) Apply engine oil to 2nd chain.



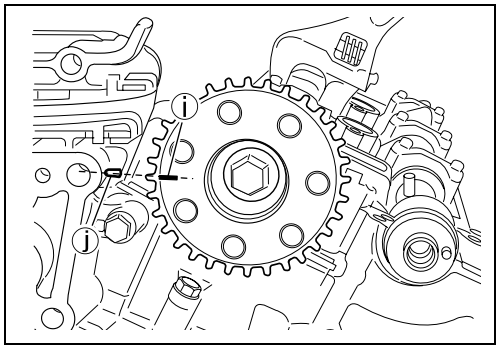
4. On the STBD side bank:
   (Install the STBD side 2nd timing chain in the same manner as the PORT side bank.)
   (1) Install STBD tensioner ⑮ and secure with bolts.
   (2) With plunger pushed back into body, insert stopper into body as shown in the illustration.
   After inserting stopper, check to make sure that plunger will not come out.



   (3) On the IN. camshaft, fit the dowel pin ③ and IN. camshaft timing sprocket No. 2 ⑯, timing sprocket No. 1 ⑰ and tighten the sprocket temporarily with the bolt.
   Check that the match marks ⓘ/ⓙ are correctly aligned as shown in the illustration.

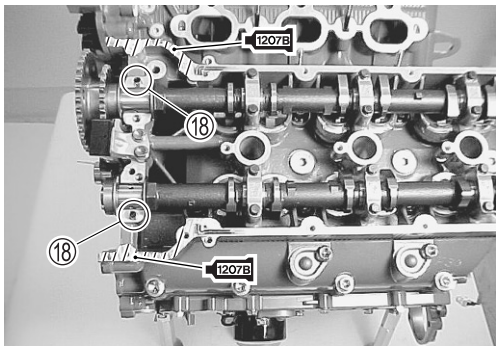


   Match mark ⓘ: —
   Match mark ⓙ: ➢



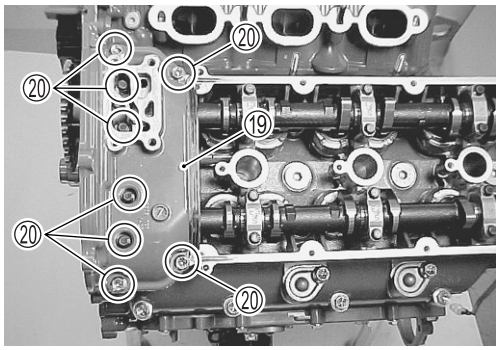
   (4) Remove oil, old sealant, and dust from sealing surface.
   (5) Apply sealant to lower camshaft housing sealing surface area as shown in figure.
   Install camshaft housing pins ⑱.

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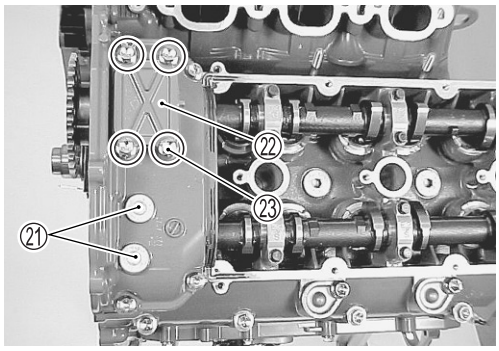


   (6) Install lower camshaft housing ⑲.
   Tighten lower camshaft housing bolts ⑳, pre-coated with engine oil, to specified torque.

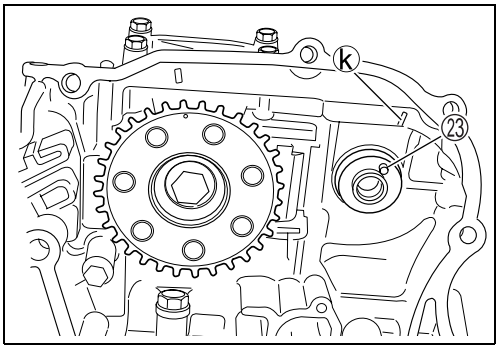
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.6 lb-ft)



(7) Install plugs ㉑ in lower camshaft housing.
Install plate ㉒, then tighten bolts ㉓ securely.

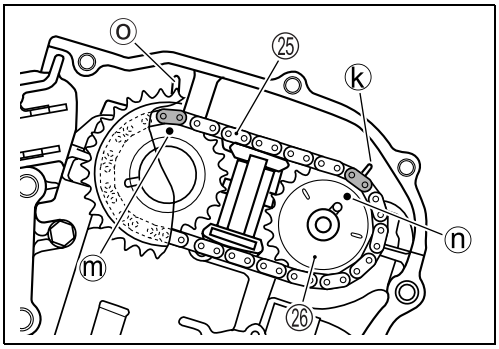


(8) Fit the dowel pin ㉔ on the EX. camshaft.
Check that the dowel pin is correctly aligned with the match mark ⓚ on the lower camshaft housing as shown in the illustration.

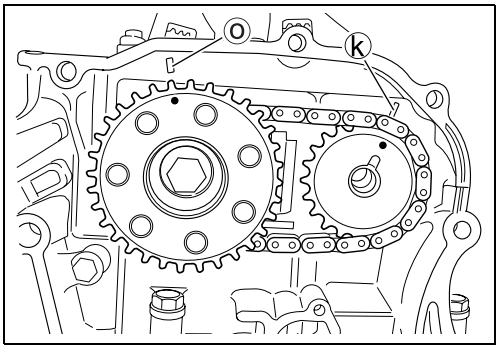


(9) Align the yellow plate of 2nd timing chain ㉕ with the match mark (•) ⓜ on the IN. camshaft timing sprocket No.2 and fit the chain on the sprocket.
(10) Align the yellow plate of 2nd timing chain with the match mark (•) ⓝ on the EX. camshaft timing sprocket ㉖ and fit the chain on the sprocket.

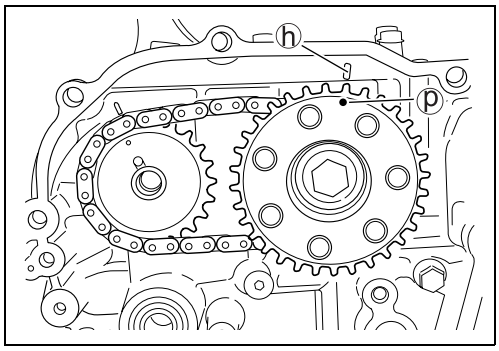
NOTE:
Install the sprocket so that the match mark and slit mark are both visible.

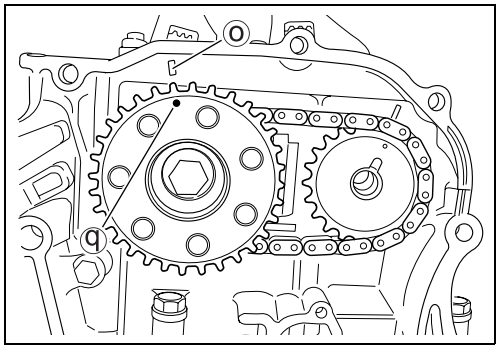


(11) Install the EX. camshaft timing sprocket ㉖ on the EX. camshaft, then tighten sprocket temporarily with the bolt.
Check that two yellow plates of the chain are correctly aligned with the match marks ⓞ/ⓚ on the camshaft housing as shown in the illustration.
(12) Remove the stopper from STBD tensioner.
(13) Apply engine oil to 2nd chain.

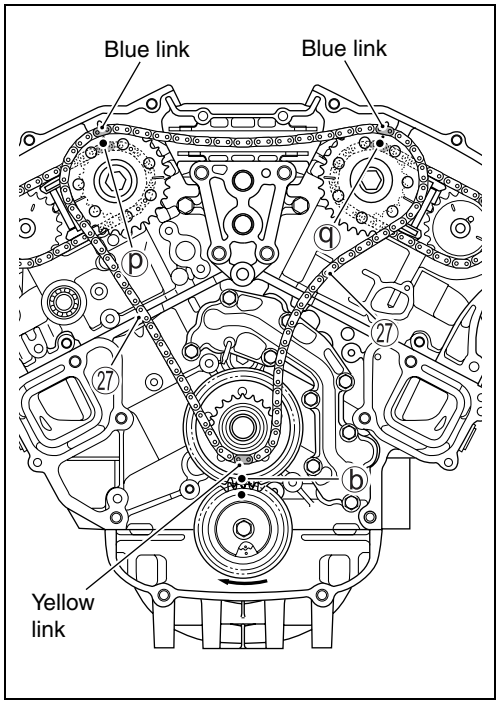


5. Check that the match marks (•) ⓟ/ⓠ on both the PORT & STBD side IN. camshaft timing sprockets No. 1 are correctly aligned with the match marks ⓗ·ⓞ on the camshaft housing as shown in the illustration.

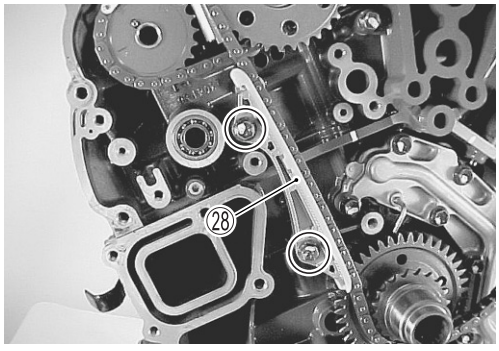




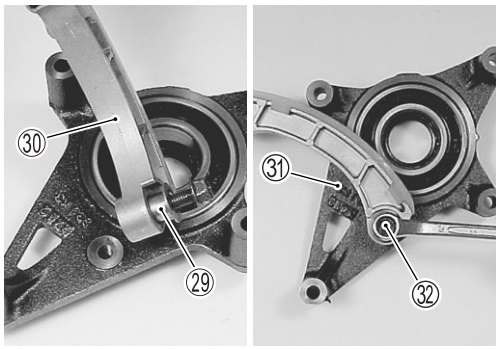
6. As shown in the illustration, fit the 1st timing chain ㉗ with one blue link aligned with the match mark (•) ⓟ on the PORT side IN. camshaft timing sprocket No. 1 and one blue link aligned with the match mark (•) ⓠ on the STBD side IN. camshaft timing sprocket. No. 1
7. As shown in the illustration, fit the 1st timing chain with its yellow link aligned with the match mark (•) ⓑ on the driven gear.



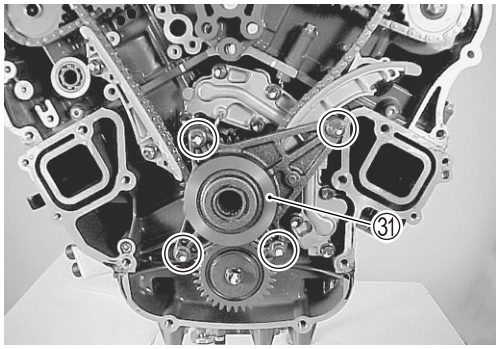
8. Install No. 2 timing chain guide ㉘, then tighten bolts securely. Apply engine oil to chain guide.



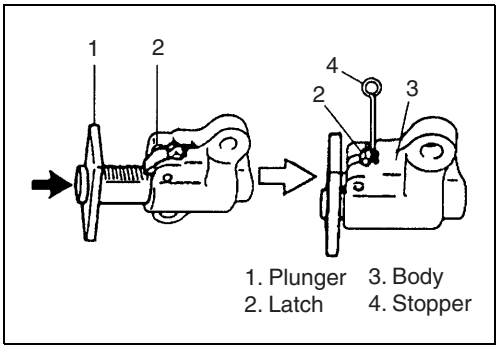
9. Insert the spacer ㉙ into chain tensioner ㉚.
   Install chain tensioner to driven gear holder ㉛, then tighten bolt ㉜ securely.
   Apply engine oil to chain tensioner.



10. Install driven gear holder ㉛, then tighten four (4) bolts securely.



11. With latch of tensioner adjuster ㉜ pushed in and plunger pushed back into body, insert stopper into latch and body.
    After inserting stopper, check to make sure that plunger will not come out.

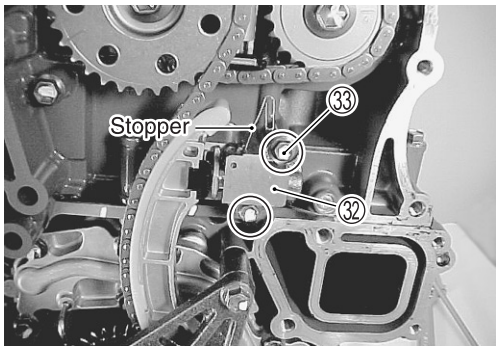


12. Install timing chain tensioner adjuster ㉜, then tighten bolts ㉝ to specified torque.

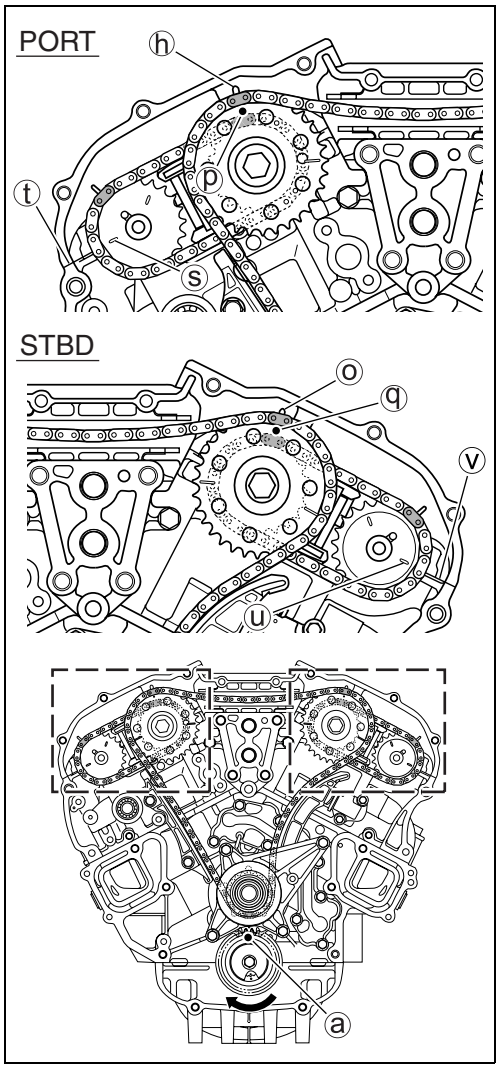
Tensioner adjuster bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)

Apply engine oil to timing chain.

13. Remove the stopper from tensioner adjuster.

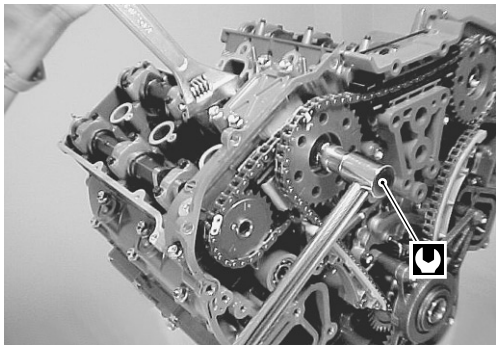


14. Turn the crankshaft two (2) complete rotations in direction shown in figure.
    As shown in the illustration, check that all match marks are in alignment as written below when the match mark (•) ⓐ on the drive gear is pointing to 12:00 o'clock.
    - The match mark (•) ⓟ on the PORT side IN. sprocket No. 1 aligns with the match mark ⓗ on the camshaft housing.
    - The match mark (•) ⓠ on the STBD side IN. sprocket No. 1 aligns with the match mark ⓞ on the camshaft housing.
    - The match mark (slit) ⓢ on the PORT side EX. sprocket aligns with the mating face ⓣ of lower camshaft housing.
    - The match mark (slit) ⓤ on the STBD side EX. sprocket aligns with the mating face ⓥ of lower camshaft housing.



15. Tighten PORT/STBD IN. and EX. camshaft timing sprocket bolts to specified torque.

IN. and EX. camshaft timing sprocket bolt:
78 N·m (7.8 kg-m, 56 lb-ft)



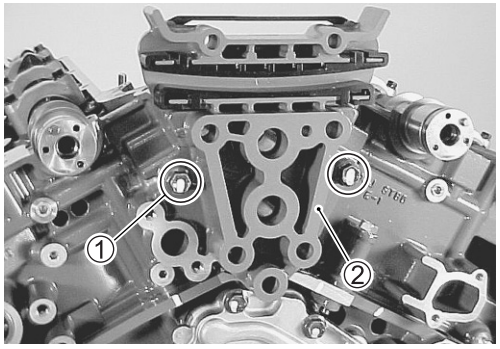
CYLINDER HEAD ASSEMBLY

(Cylinder head/valve/camshaft)

REMOVAL

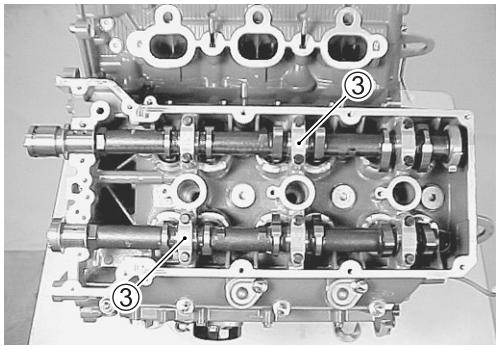
Prior to removing cylinder head:
- **Remove the power unit. (See page 6-12 to 6-18.)**
- **Remove the timing chain. (See page 6-28, 6-41.)**

1. Remove the bolts ① and timing chain guide base ②.



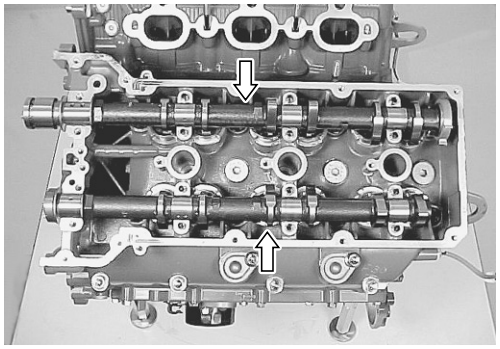
2. Remove the bolts securing the camshaft housing ③ to cylinder head, then remove each camshaft housing.

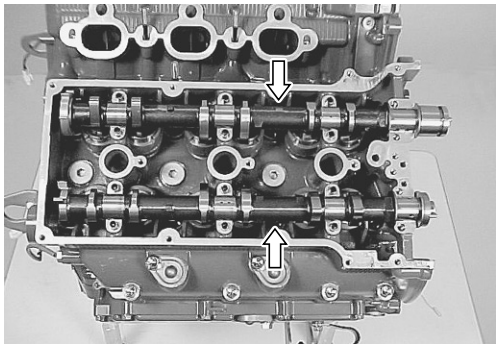
NOTE:
For ease of assembly, note position of each individual camshaft housing.



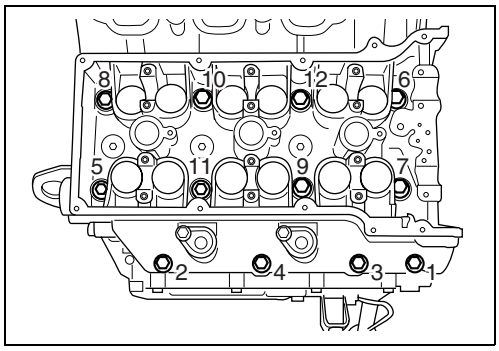
3. Remove intake/exhaust camshafts, tappets and tappet shims.

NOTE:
For ease of assembly, lay out tappets and record shim thickness for each individual cylinder/valve position.

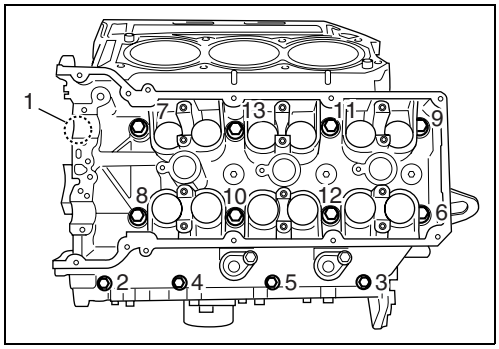




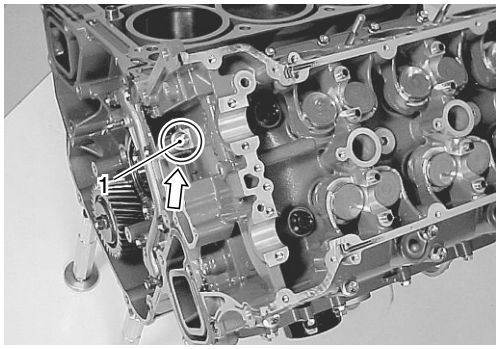
4. On the PORT side bank, loosen and remove twelve (12) cylinder head bolts in the order indicated in figure.
   Remove cylinder head assembly and head gasket.



5. On the STBD side bank, loosen first, then remove thirteen (13) cylinder head bolts according to sequence in figure. Remove cylinder head assembly and head gasket.



NOTE:
Do not forget to remove bolt in shown figure.



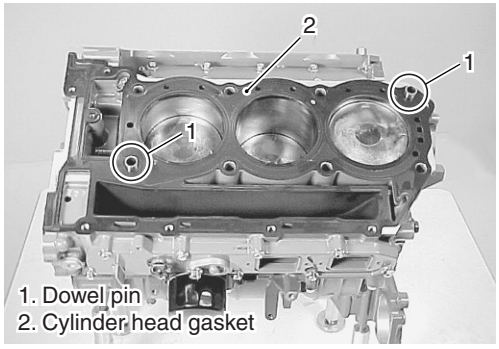
ASSEMBLY

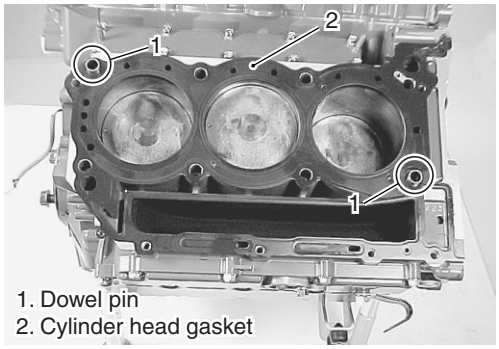
Assemble in reverse order of removal paying special attention to the following steps.

CAUTION

Do not re-use gasket. Always use a new gasket.

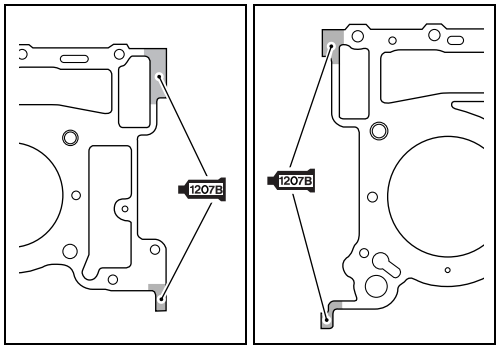
1. Insert the dowel pins and place a new cylinder head gasket into position on the cylinder.





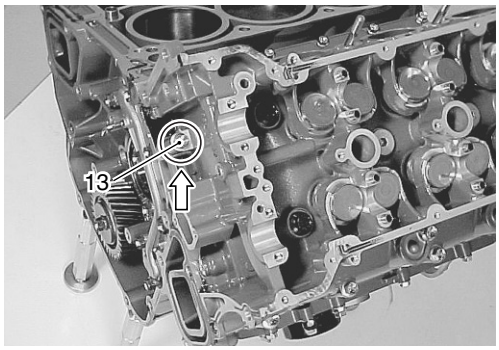
NOTE:
Before installing cylinder head gasket, apply sealant to both surfaces of the hatched areas shown in illustration.

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2. Position cylinder head on cylinder.
3. Apply engine oil to cylinder head bolts and tighten them gradually as follows.

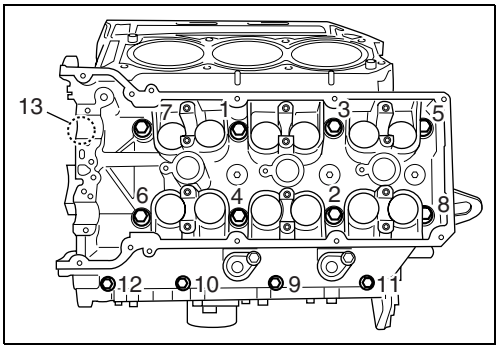
NOTE:
Do not forget to install bolt shown in figure.



(a) Tighten all bolts to 50 percent (%) of specified torque according to sequence in figure.

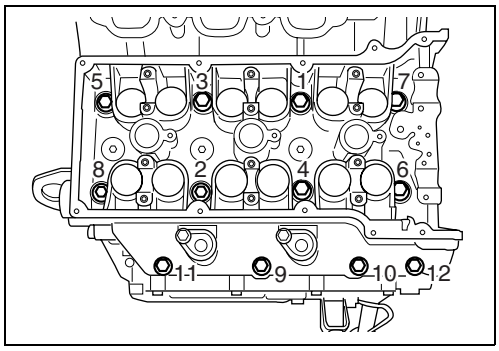
Cylinder head bolt:

1st step 11 mm 43 N·m (4.3 kg-m, 31.1 lb-ft)
8 mm 12 N·m (1.2 kg-m, 8.7 lb-ft)



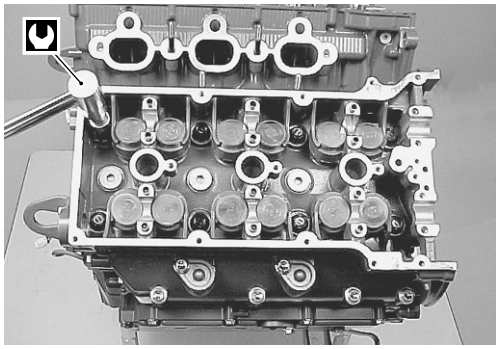
(b) Loosen all bolts to 0 N·m (0 kg-m, 0 lb-ft) according to reverse sequence in figure.
(c) Again tighten all bolts to 50 percent (%) of specified torque according to sequence in figure.

Cylinder head bolt:
3rd step 11 mm 43 N·m (4.3 kg-m, 31.1 lb-ft)
8 mm 13 N·m (1.2 kg-m, 8.7 lb-ft)



(d) Finally tighten all bolts to specified torque according to sequence in figure.

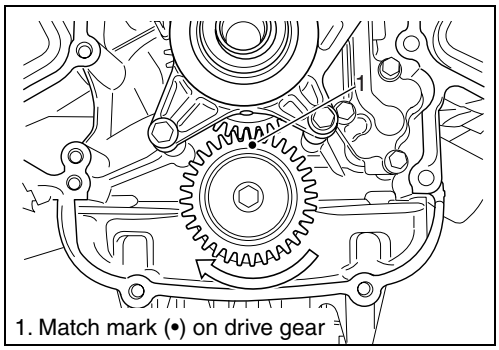
Cylinder head bolt:
Final step 11 mm 86 N·m (8.6 kg-m, 62.2 lb-ft)
8 mm 23 N·m (2.3 kg-m, 16.6 lb-ft)



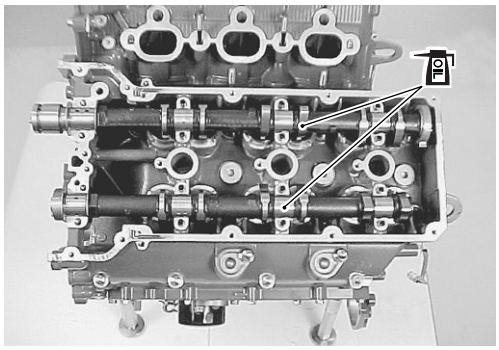
4. Apply engine oil around tappets and install in their original position.
Install tappet shims in their original position.



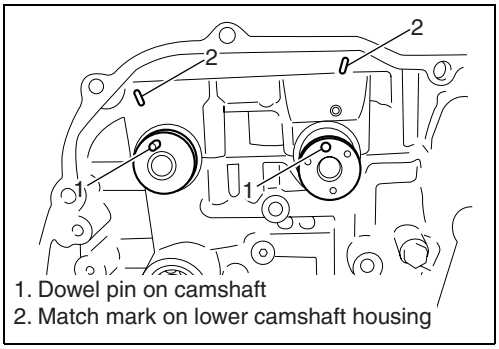
NOTE:
Before installing camshafts, turn crankshaft until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).


1. Match mark (•) on drive gear

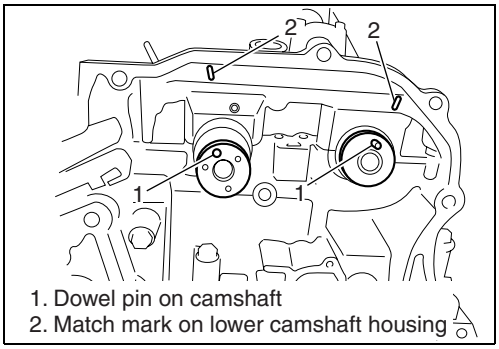
5. Apply engine oil to the surface of each camshaft lobe and journal, then install them as shown in figure.



NOTE:
When installing the camshaft, aligns dowel pin on the camshafts with the match mark on lower camshaft housing.

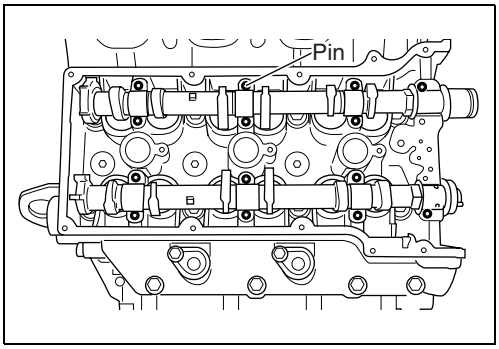


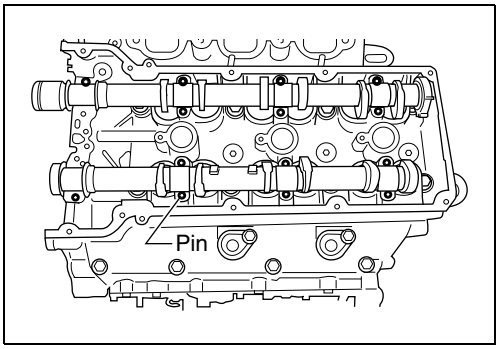
1. Dowel pin on camshaft
2. Match mark on lower camshaft housing



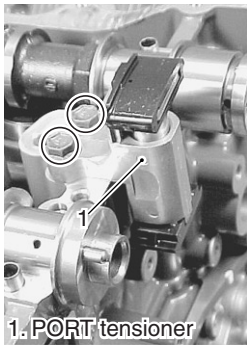
1. Dowel pin on camshaft
2. Match mark on lower camshaft housing

6. Install camshaft housing pins as shown in figure.



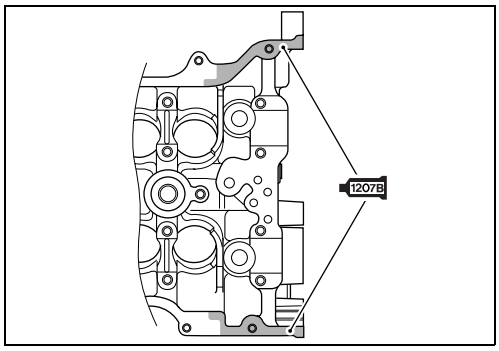


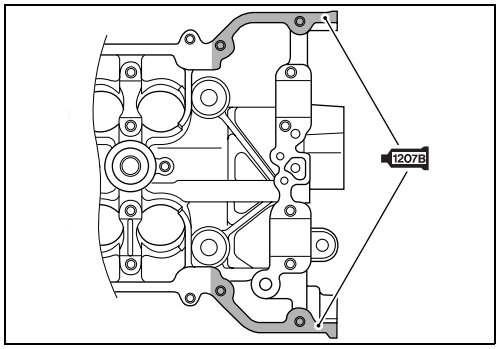
7. Install PORT tensioner and bolts, then tighten bolts securely.
   Install STBD tensioner and bolts, then tighten bolts securely.



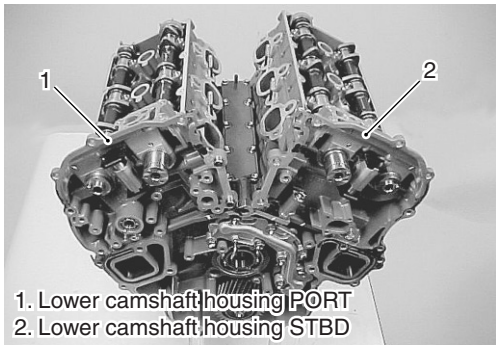
8. Apply sealant to lower camshaft housing sealing surface area as shown in figure.

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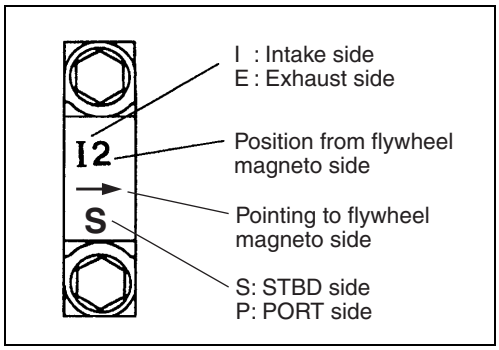


9. Install the lower camshaft housing.



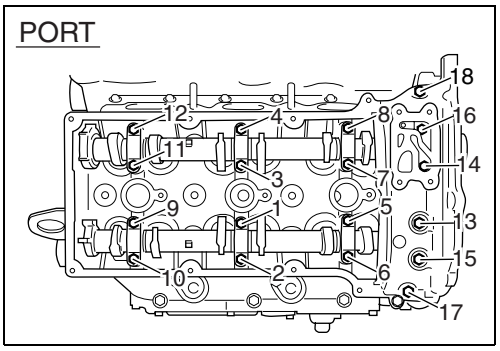
10. Check position of camshaft housing.
    - Embossed marks are provided on each camshaft housing indicating position and direction of installation.

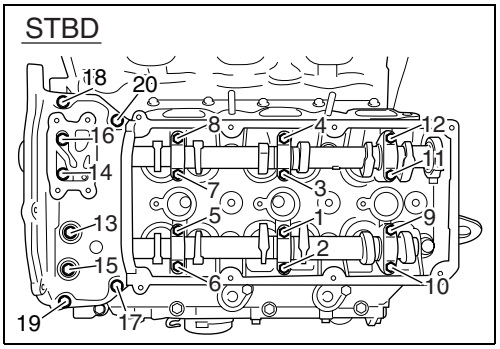
    Install housings as indicated by these marks.



11. Apply engine oil to housing bolts.
12. Lightly seat all housing bolts at first.
    Following sequence in figure, tighten bolts to 1/3 of specified torque, then 2/3 of specified torque and finally to full specified torque.

Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.7 lb-ft)

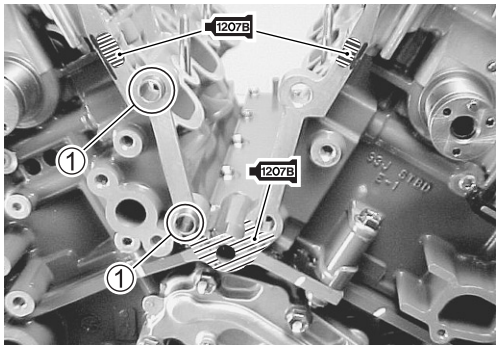


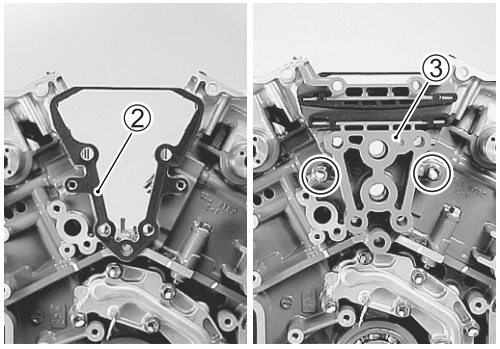


13. Install dowel pins ①, gasket ② and timing chain guide base ③, then tighten bolts securely.

NOTE:
Before installing timing chain guide base, apply sealant to hatched areas shown in illustration.

1207B 99000-31140: SUZUKI BOND "1207B"





14. Install timing chain. (See page 6-34, 6-47.)

15. Install oil pump assembly. (See page 6-27.)

16. Check tappet clearance and adjust as necessary. (See page 2-9.)

DISASSEMBLY

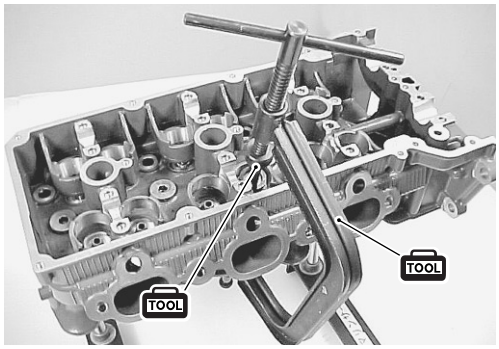
1. Remove tappets with shims.

NOTE:
For ease of assembly, lay out tappets and record shim thickness for each individual cylinder/valve position.

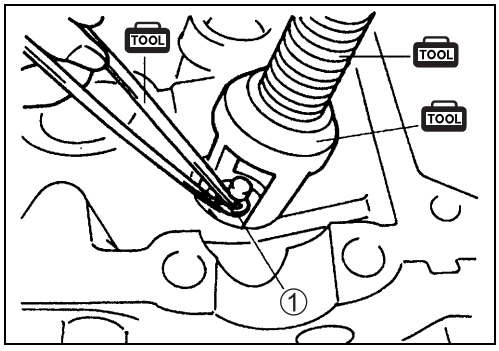


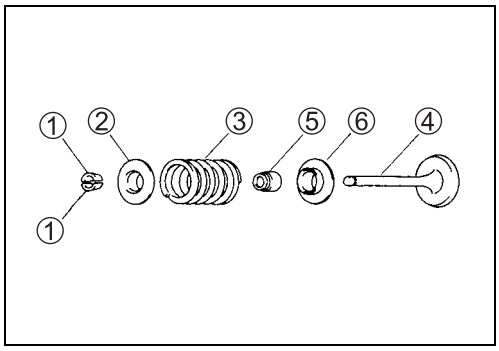
2. Using valve lifter and attachment, remove valve cotters ① while compressing valve spring.

TOOL **09916-14510: Valve lifter**
09916-14521: Attachment
09916-84511: Tweezers



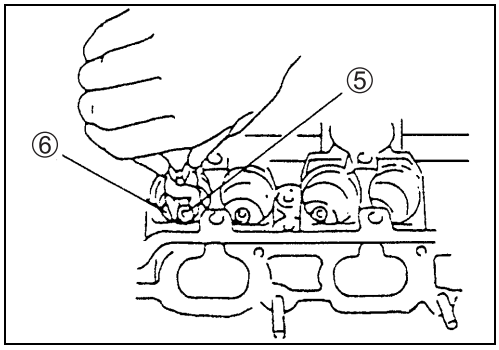
3. Remove valve spring retainer ②, valve spring ③ and valve ④.





4. Remove valve stem seal ⑤ and valve spring seat ⑥.

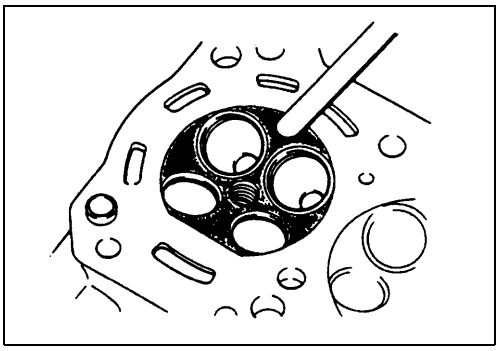
NOTE:
Reassemble each valve and valve spring in their original positions.



INSPECTION/SERVICING

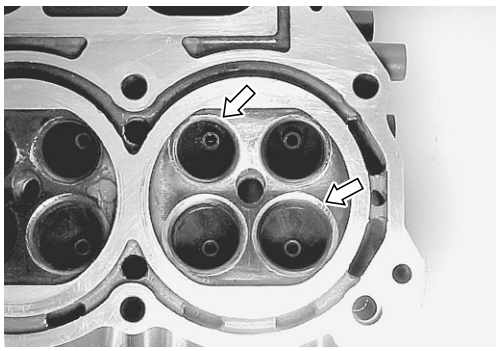
NOTE:
If cracks, excessive wear or other damage is found on any component, replace component.

CYLINDER HEAD
Remove all carbon from combustion chambers.



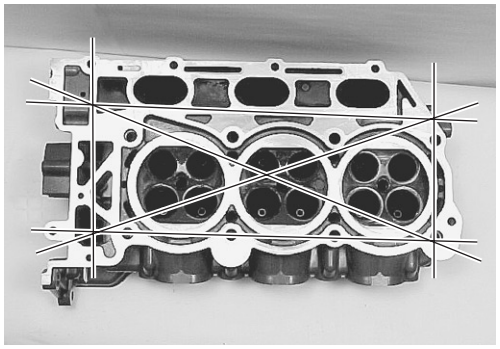
NOTE:
- *Do not use any sharp edged tool to scrape carbon off cylinder head or its components.*
- *Be careful not to scuff or nick metal surfaces when decarboning.*

Check cylinder head for cracks in intake and exhaust ports, combustion chambers, and head surface.



Valve seat
Check valve seat, if cracks or other damage is found, replace cylinder head.

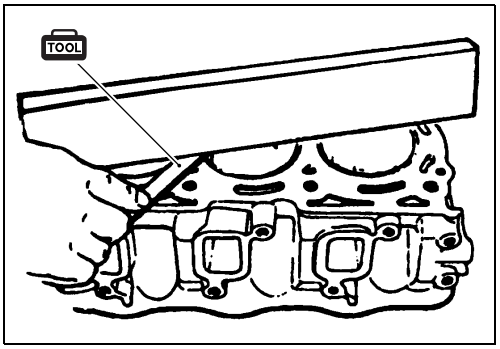
Cylinder head distortion
Using a straightedge and thickness gauge, measure cylinder head distortion (gasket surface) at a total of six (6) locations as shown.



TOOL 09900-20803: Thickness gauge

Cylinder head distortion
Service limit: 0.03 mm (0.001 in)

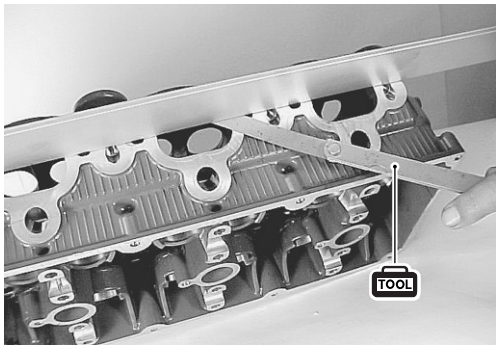
If measurement exceeds service limit, resurface or replace cylinder head.



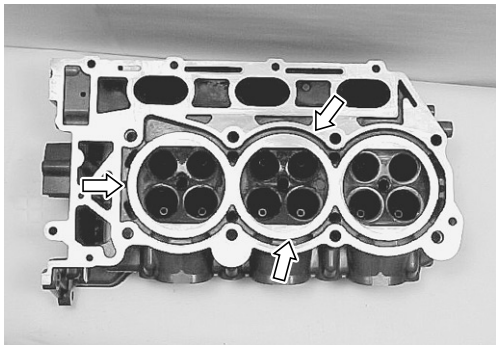
Manifold seating faces distortion
Using a straightedge and thickness gauge, check cylinder head to manifold seating faces.

Manifold seating faces distortion
Service limit: 0.10 mm (0.004 in)

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



Water jackets
Check water jackets. If clogged or obstructed, clean water jackets.



CAMSHAFT
Cam face
Inspect cam face for scratches and wear.

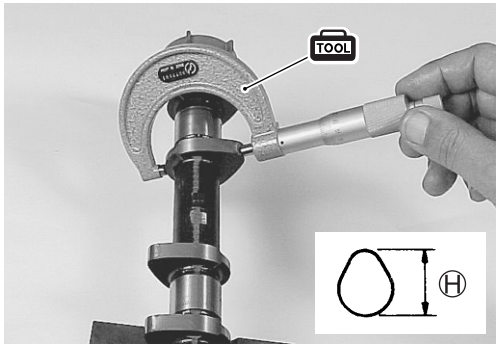
Cam wear
Using micrometer, measure cam height Ⓗ.

TOOL 09900-20202: Micrometer

Cam height
Standard:

DF200 IN. 43.020 – 43.180 mm (1.6937 – 1.700 in)
EX. 43.620 – 43.780 mm (1.7173 – 1.7236 in)
DF225 IN. 42.420 – 42.580 mm (1.6701 – 1.6764 in)
EX. 43.620 – 43.780 mm (1.7173 – 1.7236 in)
DF250 IN. 44.920 – 45.080 mm (1.7685 – 1.7748 in)
EX. 44.420 – 44.580 mm (1.7488 – 1.7551 in)

Service limit
DF200 IN. 42.920 mm (1.6898 in)
EX. 43.520 mm (1.7134 in)
DF225 IN. 42.320 mm (1.6661 in)
EX. 43.520 mm (1.7134 in)
DF250 IN. 44.820 mm (1.7646 in)
EX. 44.320 mm (1.7449 in)

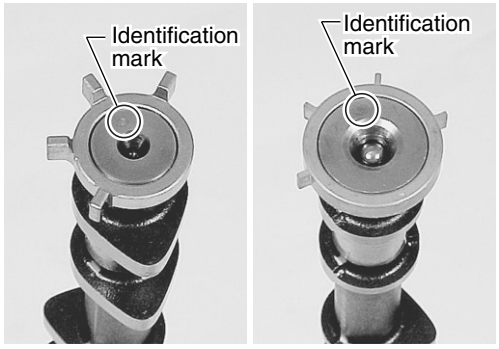


If measurement exceeds service limit, replace camshaft.

Camshaft identification

DF200, DF225 and DF250 camshafts differ as indicated below.

Model	Identification mark	
	IN.	EX.
DF200	0	0
DF225	1	0
DF250	2	2



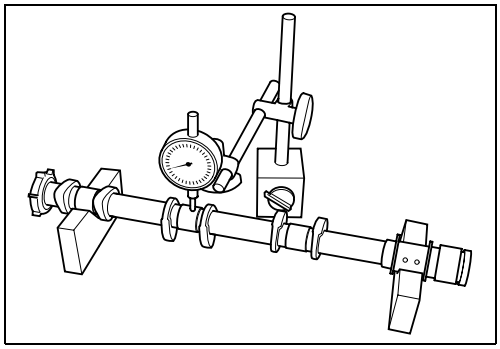
Camshaft runout

Support camshaft on a surface plate using a set of V-blocks.
Measure runout using a dial gauge.

09900-20606: Dial gauge
: "V" block set
09900-20701: Magnetic stand

Camshaft runout
Service limit: 0.10 mm (0.004 in)

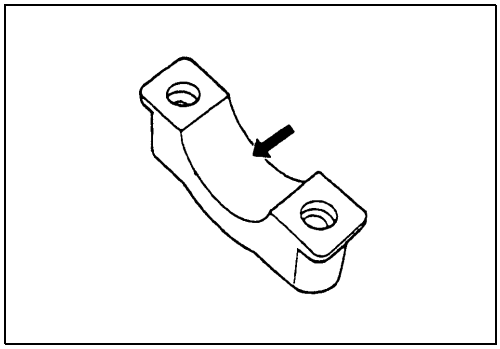
If measurement exceeds service limit, replace camshaft.



CAMSHAFT JOURNAL

Check camshaft journals and camshaft housing for pitting, scratches, wear or damage.
If any of the above conditions are found, replace camshaft or cylinder head with housing.

NOTE:
Camshaft housing and cylinder head must be replaced as a set.

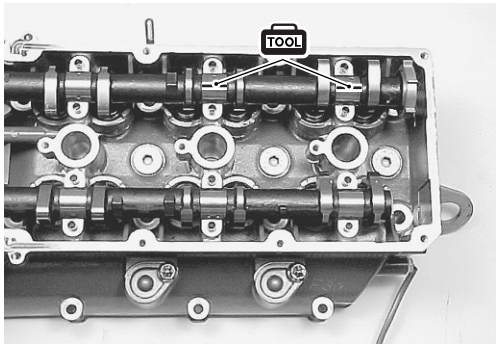


Camshaft journal oil clearance

Check journal oil clearance using Plastigauge as follows.

1. Clean housing and camshaft journals.
2. Install camshaft to cylinder head.
3. Place Plastigauge across the full width of camshaft journal (parallel to camshaft).

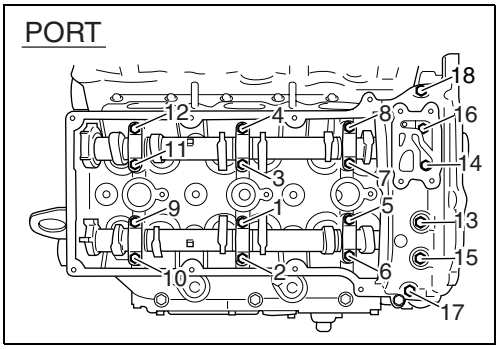
09900-22302: Plastigauge

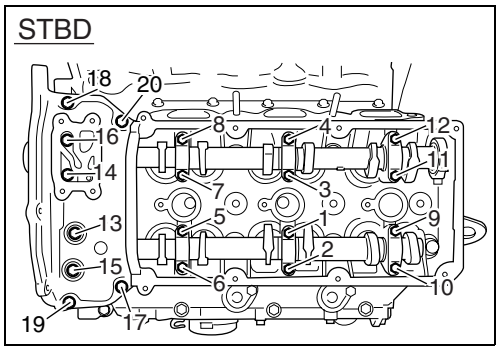


4. Install camshaft housing. Tighten housing bolts in 3 steps (1/3 of specification, 2/3 of specification, full torque specification) in the indicated order.

Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.7 lb-ft)

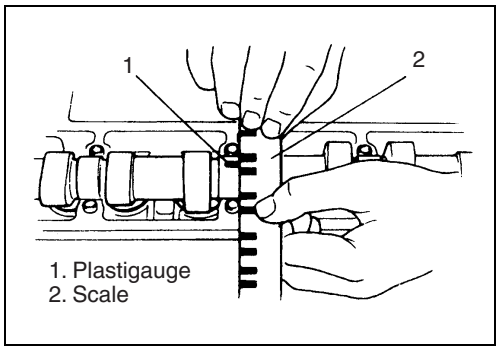
NOTE:
Do not rotate camshaft while Plastigauge is installed.





5. Remove camshaft housing.
6. Using scale on Plastigauge envelope, measure Plastigauge at its widest point.

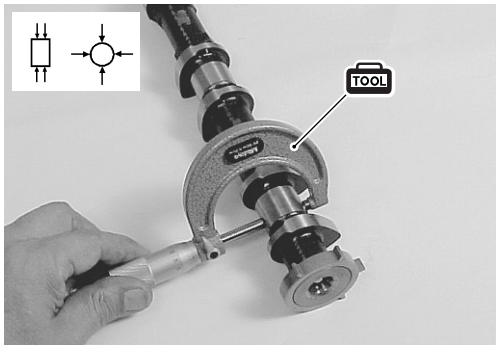
Camshaft journal oil clearance
Standard: 0.043 – 0.085 mm (0.0017 – 0.0033 in)
Service limit: 0.12 mm (0.0047 in)



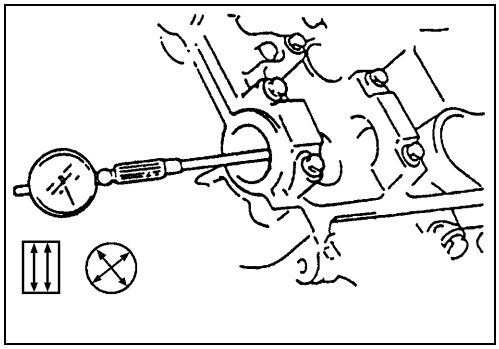
If journal oil clearance exceeds the service limit, measure camshaft journal (outside dia.) and camshaft housing (inner dia.). Based on measurements, replace camshaft and/or cylinder head with camshaft housing.

09900-20202: Micrometer (25 – 50 mm)

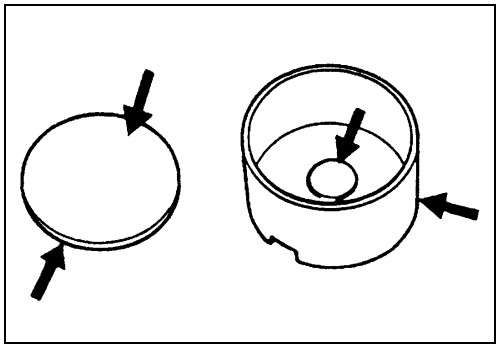
Camshaft journal outside diameter
Standard: 25.936 – 25.957 mm (1.0211 – 1.0219 in)



Camshaft journal (housing) inside diameter
Standard: 26.000 – 26.021 mm (1.0236 – 1.0244 in)



TAPPET/TAPPET SHIM
Wear of tappet and shim
Check tappet and shim for pitting, scratches, or damage.
If any above conditions are found, replace component.



Measure cylinder head bore and tappet outside diameter to determine cylinder head to tappet clearance.

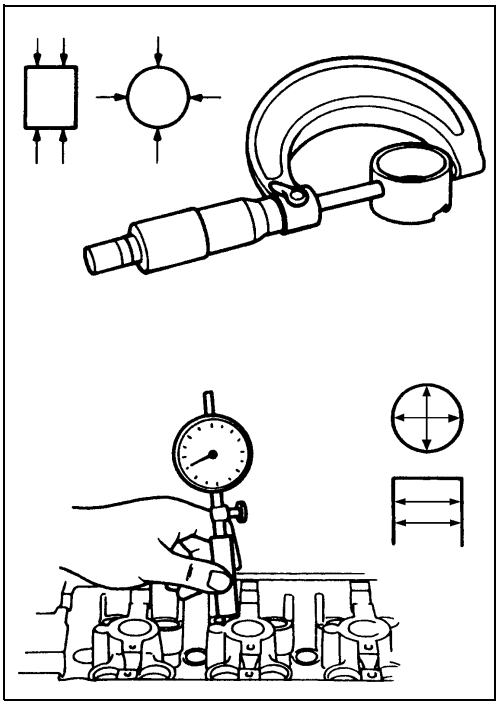
TOOL 09900-20202: Micrometer

If measurement exceeds service limit, replace tappet or cylinder head.

Cylinder head bore to tappet clearance
Standard: 0.025 – 0.066 mm (0.0010 – 0.0026 in)
Service limit: 0.150 mm (0.0059 in)

Tappet outer diameter
Standard: 33.959 – 33.975 mm (1.3370 – 1.3376 in)

Cylinder head bore
Standard: 34.000 – 34.025 mm (1.3386 – 1.3396 in)



VALVE/VALVE GUIDE

Valve guide to valve stem clearance

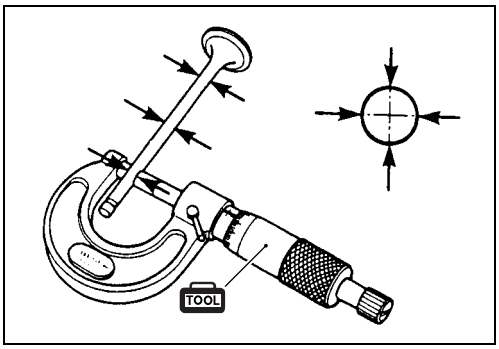
Using a micrometer and bore gauge, take diameter readings on valve stems and guides to check guide to stem clearance.
Be sure to take readings at more than one place along the length of each stem and guide.

TOOL 09900-20205: Micrometer

Valve stem outside diameter

Using micrometer, measure valve stem outside diameter.

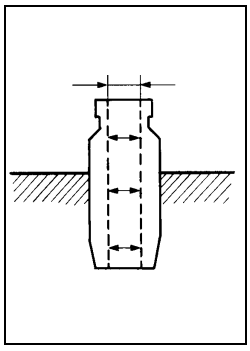
Valve stem outside diameter
Standard:
IN. 5.465 – 5.480 mm (0.2152 – 0.2157 in)
EX. 5.440 – 5.455 mm (0.2142 – 0.2148 in)

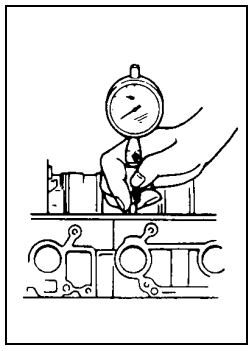


Valve guide inside diameter

Using a small bore gauge, measure valve guide inside diameter.

Valve guide inside diameter
Standard:
IN. 5.500 – 5.512 mm (0.2165 – 0.2170 in)
EX. 5.500 – 5.512 mm (0.2165 – 0.2170 in)





Valve guide to valve stem clearance

Valve guide to valve stem clearance

Standard:

IN. 0.020 – 0.047 mm (0.0008 – 0.0019 in)

EX. 0.045 – 0.072 mm (0.0018 – 0.0028 in)

Service limit:

IN. 0.070 mm (0.0028 in)

EX. 0.090 mm (0.0035 in)

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

NOTE:

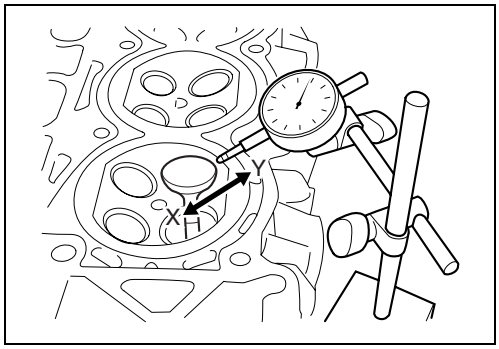
For valve guide replacement, see "VALVE GUIDE REPLACEMENT" section on page 6-70.

Valve stem deflection

If unable to measure valve guide inside diameter, check "Valve stem deflection".

TOOL **09900-20606: Dial gauge**

09900-20701: Magnetic stand



Measure valve stem deflection as follows:

(1) Install valve into valve guide.

(2) Position valve head at approx. 5 mm away from valve seat.

(3) Move valve head in the direction "X – Y", and measure deflection.

Valve stem deflection

Service limit:

IN. 0.14 mm (0.0055 in)

EX. 0.18 mm (0.0071 in)

If measurement exceeds service limit, replace valve.

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

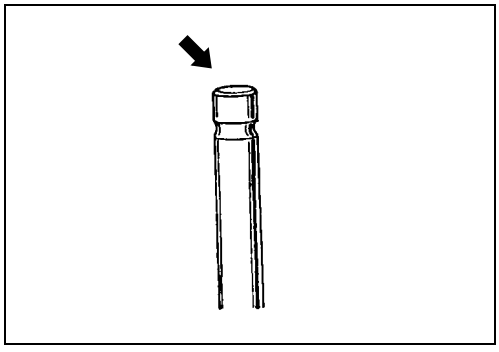
Valve stem end

Inspect valve stem end face for pitting and wear.

If pitting or wear is found, valve stem end may be resurfaced.

Use caution when resurfacing, do not grind away stem end chamfer.

When chamfer has been worn away, replace valve.



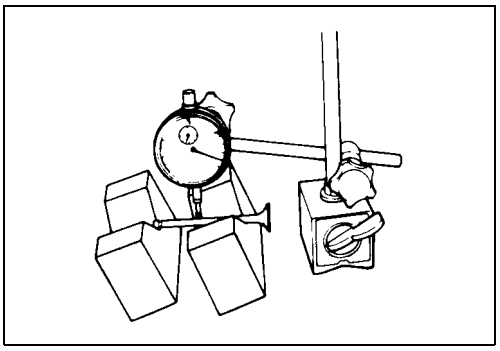
Valve stem runout

Measure valve stem runout.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09900-21304: "V" block set

Valve stem runout
Service limit: 0.05 mm (0.0020 in)

If measurement exceeds service limit, replace valve.



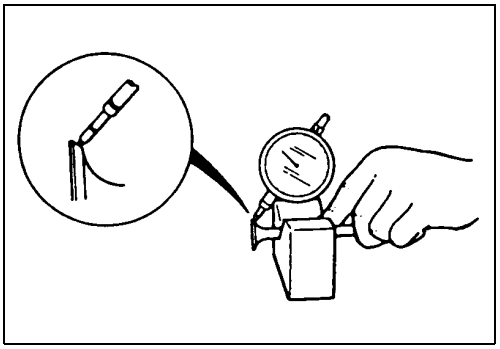
Valve head radial runout

Measure valve head radial runout.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09900-21304: "V" block set

Valve head radial runout
Service limit: 0.08 mm (0.0031 in)

If measurement exceeds service limit, replace valve.



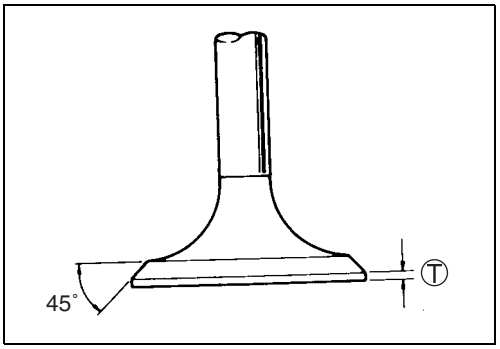
Valve head thickness

Measure thickness Ⓣ of valve head.

09900-20101: Vernier calipers

Valve head thickness
Standard:
IN. 1.1 mm (0.0433 in)
EX. 1.0 mm (0.0394 in)
Service limit:
IN. 0.7 mm (0.0276 in)
EX. 0.7 mm (0.0276 in)

If measurement exceeds service limit, replace valve.



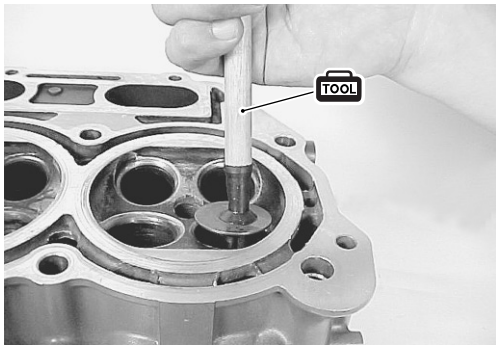
Valve seat contact width

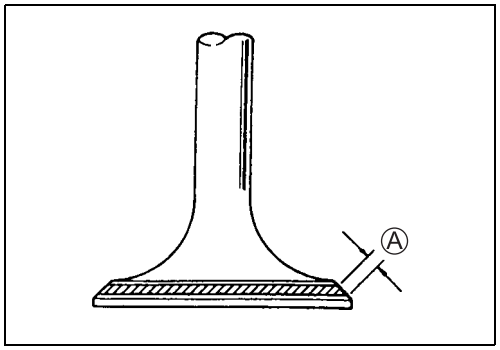
Measure valve seat contact width as follows:

(1) Remove all carbon from valve and seat.
(2) Coat valve seat evenly with Prussian blue (or equivalent).
(3) Install valve into valve guide.
(4) Put valve lapper on valve.

09916-10910: Valve lapper

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





09900-20101: Vernier calipers

Valve seat contact width Ⓐ
Standard:
IN., EX. 1.1 – 1.3 mm (0.0433 – 0.0512 in)

If measurement exceeds specification, repair valve seat.

NOTE:
For valve seat repair, see "Valve seat servicing" section on page 6-69.

VALVE SEAT SERVICING

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

- **Valve seat angle**
  Intake side : 15°, 45°, 60°
  Exhaust side : 15°, 45°, 60°

: Valve seat cutter (NEWAY634) 45°
: Valve seat cutter (NEWAY217) 15°
09916-22420: Valve seat cutter (NEWAY114) 60°

09916-24450: Solid pilot (NEWAY. N-100-5.52)
09916-54910: Handle (N-505)

NOTE:
Turn cutter clockwise, never counterclockwise.

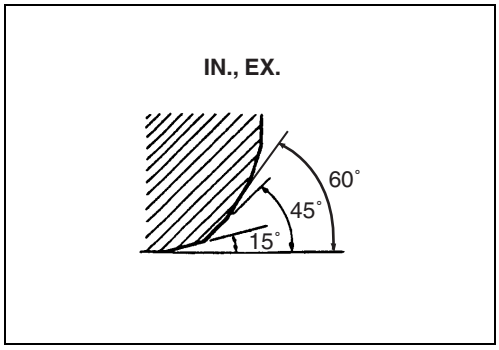
(1) Remove all carbon from valve and valve seat.
(2) Using 45° angle cutter, reface valve seat.
(3) Check valve seat contact width Ⓐ.
See the "Valve seat contact width" section on page 6-68.

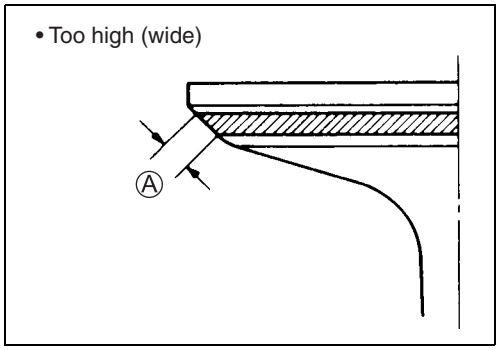
(4) • If width Ⓐ is too high (or wide), reface valve seat using 15° angle cutter.
• If width Ⓐ is too low (or narrow), reface valve seat using 60° angle cutter.

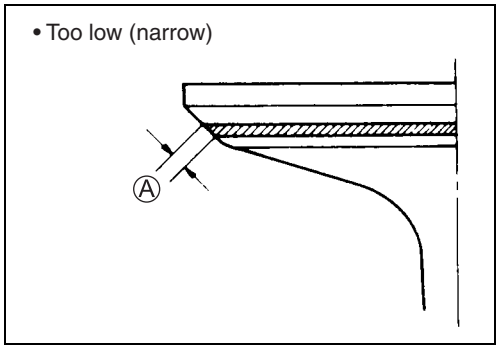
(5) Clean up any burrs using 45° angle cutter very lightly.

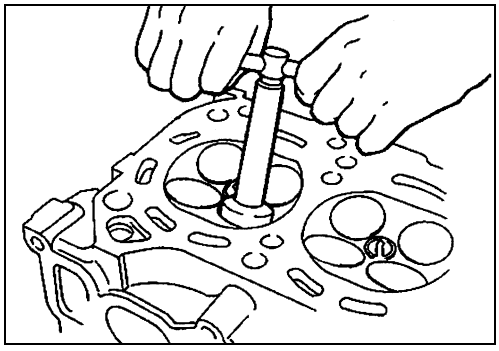
CAUTION

Cut seat areas minimally only.
Do not cut more than necessary.



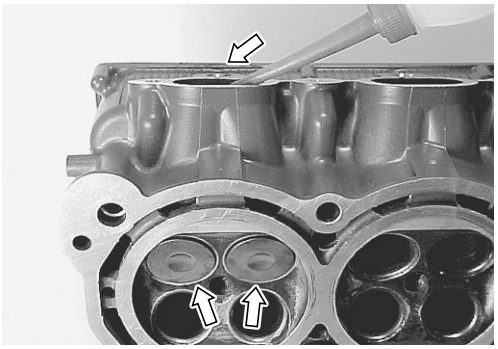






(6) Lap valve on seat in two steps, first with coarse grit lapping compound applied to face and the second with fine grit compound.
(7) Recheck valve seat contact width Ⓐ.

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



VALVE GUIDE REPLACEMENT

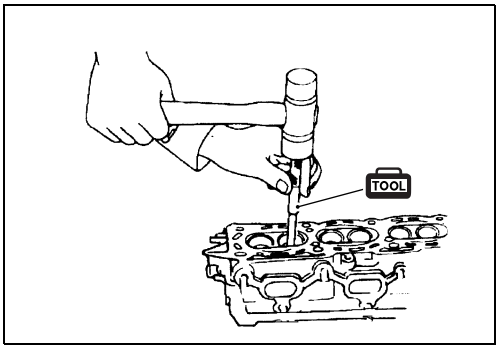
CAUTION

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

(1) Using valve guide remover, drive valve guide out from combustion chamber side towards valve spring side.

TOOL 09916-44310: Valve guide remover

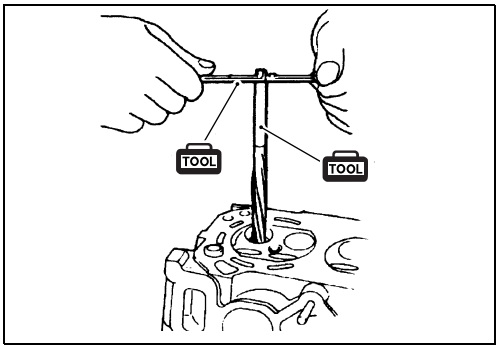
NOTE:
Do not reuse valve guide once it has been removed.
Always use a new valve guide (oversize) when assembling.



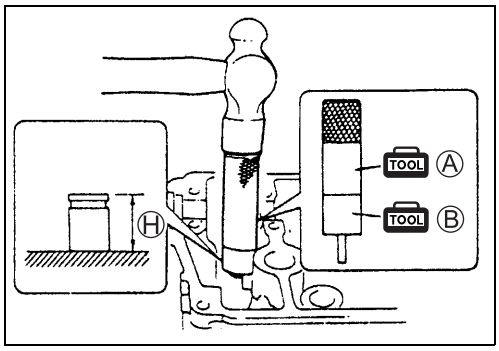
(2) Ream valve guide hole with ϕ10.5 mm reamer to true hole and remove burrs.

TOOL 09916-37320: Valve guide reamer (ϕ10.5 mm)
09916-34542: Reamer handle

NOTE:
Turn reamer clockwise, never counterclockwise.



(3) Install valve guide to cylinder head.
- Heat cylinder head to a temperature of 80 – 100 °C (176 – 212 °F).
  Apply heat uniformly so that head will not be distorted.
- Use special tools to drive new valve guide into hole.
  Drive in new valve guide until special tool (valve guide installer attachment) contacts cylinder head.
- After installing, check valve guide protrusion Ⓗ.

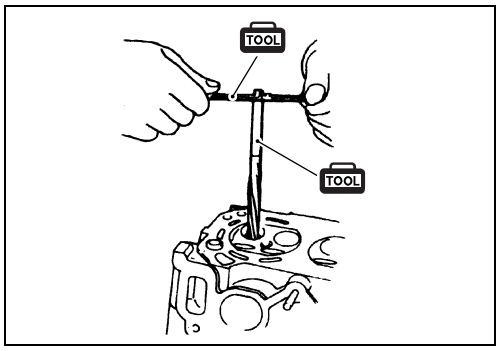


TOOL **09916-57330: Valve guide installer handle Ⓐ**
09916-56011: Valve guide installer attachment Ⓑ

Valve guide protrusion Ⓗ
standard:
IN. & EX. 11.5 mm (0.4528 in)

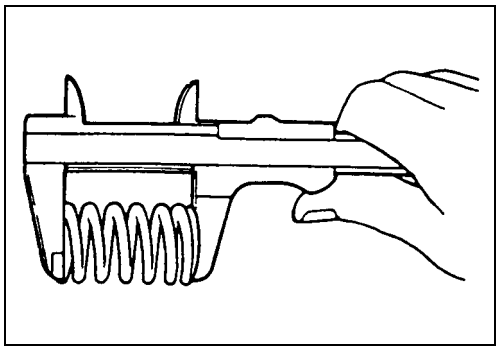
(4) Ream valve guide bore with ϕ5.5 mm reamer.

TOOL **09916-34550: Valve guide reamer (ϕ5.5 mm)**
09916-34542: Reamer handle



NOTE:
Clean and oil valve guide bore after reaming.

VALVE SPRING
Valve spring free length
Check spring strength by measuring free length.

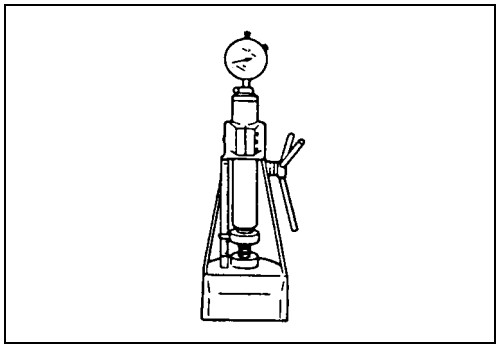


TOOL **09900-20101: Vernier calipers**

Valve spring free length
Standard:
IN. & EX. 40.20 mm (1.5827 in)
Service limit:
IN. & EX. 38.60 mm (1.5200 in)

If lower than service limit, replace valve spring.

Valve spring preload
Measure valve spring preload.



TOOL **09900-20101: Vernier calipers**

Valve spring preload
Standard:
IN. & EX. 147 – 173 N (15.0 – 17.7 kg, 33.0 – 38.9 lbs)
for 31.1 mm (1.22 in)
Service limit:
IN. & EX. 136 N (13.9 kg, 30.6 lbs)
for 31.1 mm (1.22 in)

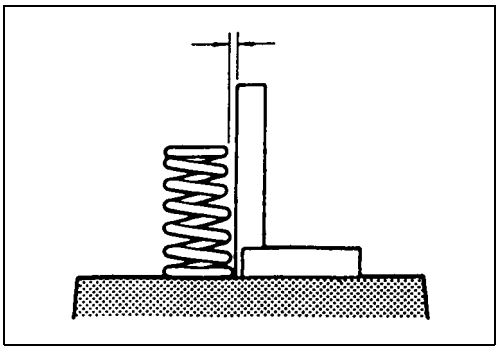
If lower than service limit, replace valve spring.

Valve spring squareness
Use a square and surface plate to check each spring for squareness (clearance between end of valve spring and square).

09900-20101: Vernier calipers

Valve spring squareness
Service limit:
IN. & EX. 2.0 mm (0.079 in)

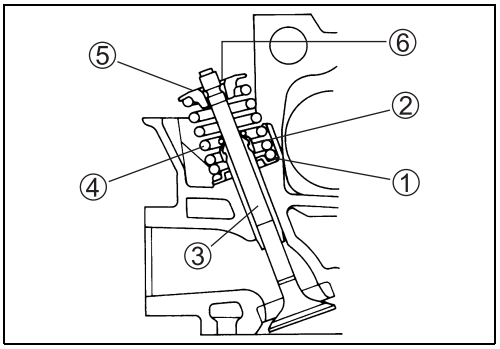
If measurement exceeds service limit, replace valve spring.



REASSEMBLY

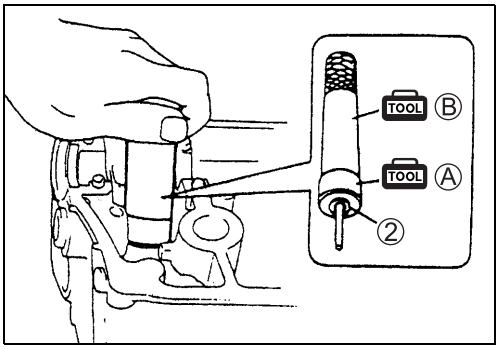
Reassemble in reverse order of disassembly paying special attention to the following steps.

VALVE
Install valve spring seat ① to cylinder head.



After applying engine oil to stem seal ② and spindle of special tool (Installer attachment), fit stem seal to spindle.
Then, pushing special tool by hand, install stem seal to valve guide.
Check to be sure that seal is properly fixed to valve guide.

09917-98221: Installer attachment Ⓐ
09916-57330: Installer handle Ⓑ



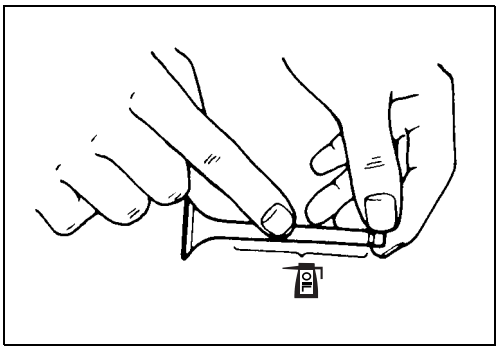
CAUTION

Do not reuse stem seal once removed.
Always install new seal.

Apply engine oil to stem seal, valve guide bore and valve stem.

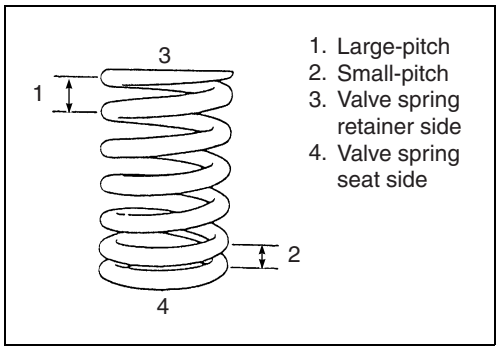
Install valve ③ to valve guide.

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



Install valve spring ④, and valve retainer ⑤.

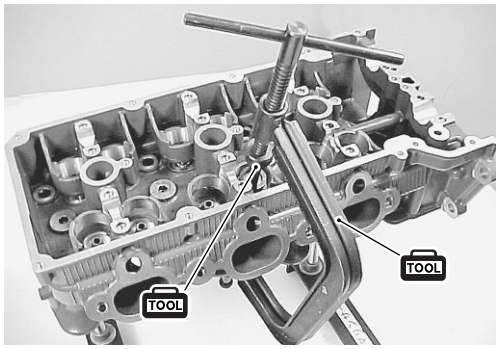
NOTE:
Set valve spring in place with narrow spiral area facing valve seat.

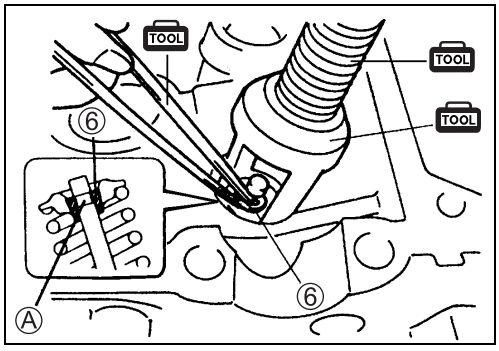


Hold valve spring compressed with special tool and install valve cotters ⑥.

Make sure valve cotters are properly seated in groove Ⓐ.

09916-14510: Valve lifter
09916-14521: Attachment
09916-84511: Tweezers



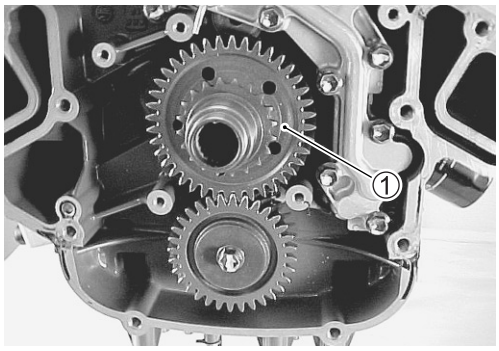


CYLINDER/CRANKSHAFT/PISTON

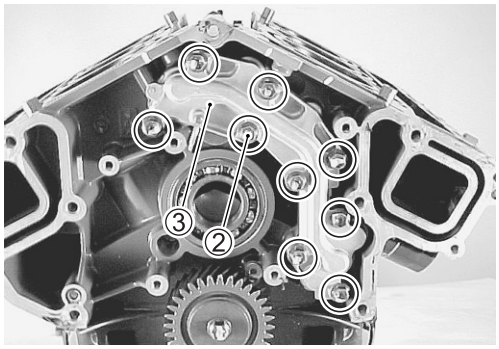
DISASSEMBLY

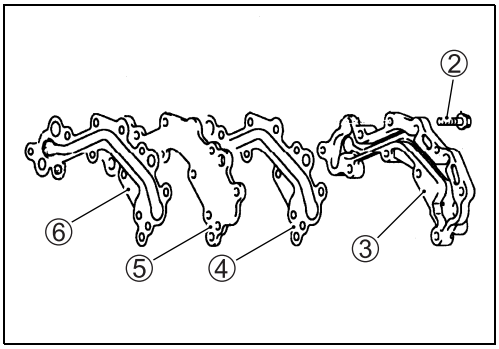
Before performing service work in this section:
- **Remove power unit. (See page 6-12 to 6-18.)**
- **Remove timing chain. (See page 6-28 to 6-53.)**
- **Remove cylinder head. (See page 6-54.)**

Remove the driven gear ①.

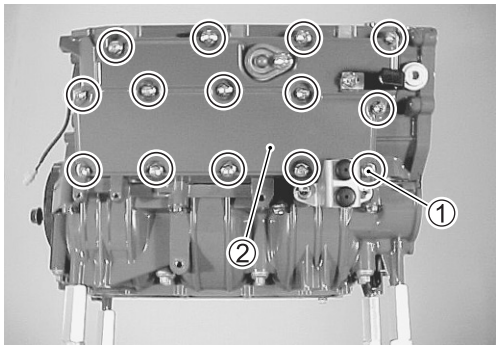


Remove the nine (9) bolts ② securing the oil gallery cover ③, then remove oil gallery cover ③, gasket ④, oil gallery plate ⑤ and gasket ⑥.





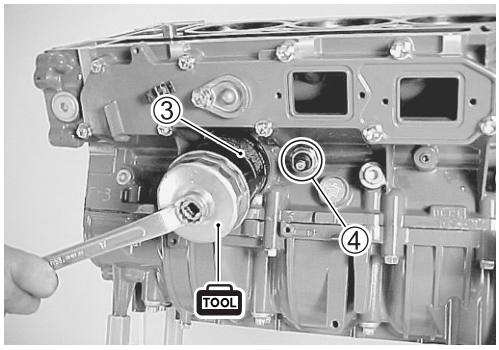
Remove the bolts ① and PORT exhaust cover ②.



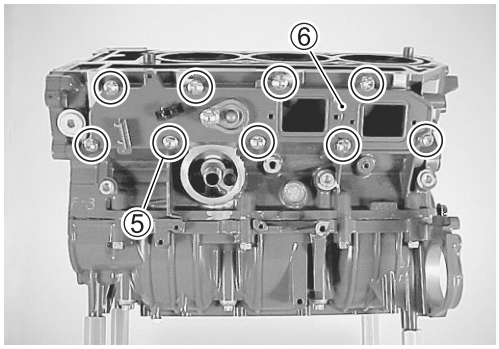
Remove oil filter ③.

09915-47341: Oil filter wrench

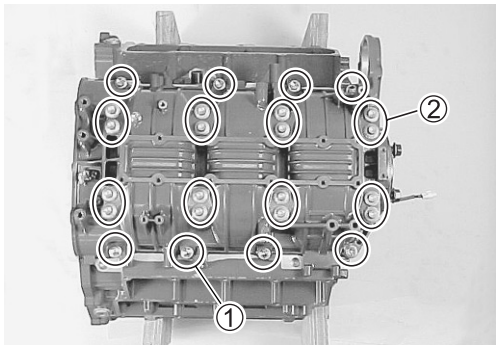
Remove oil pressure switch ④.



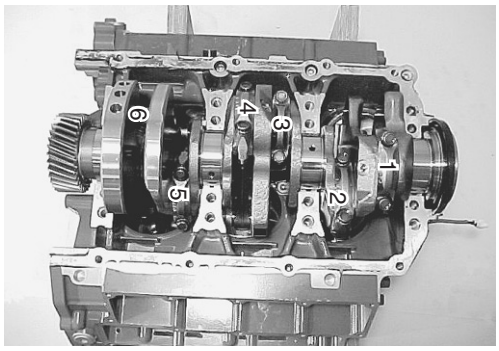
Remove the bolts ⑤ and STBD exhaust cover ⑥.



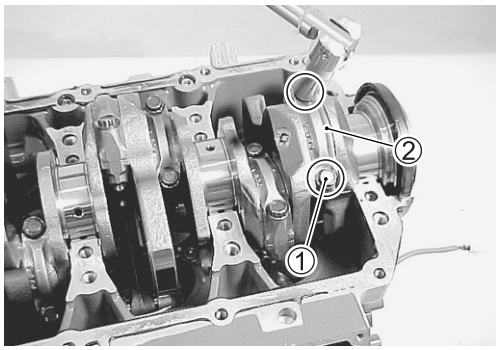
Remove eight (8) bolts ①.
Remove sixteen (16) bolts ②.
Remove crankcase from cylinder block.



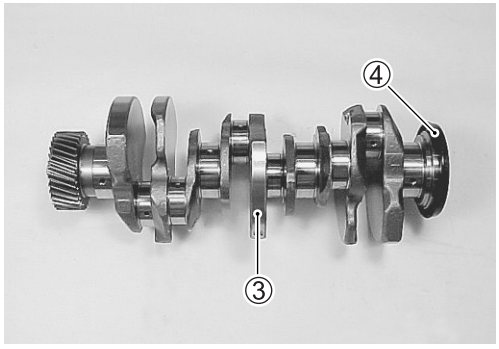
NOTE:
For proper assembly, mark cylinder number on all pistons, connrods, and conrod caps, using quick drying paint.



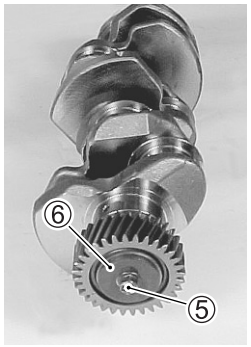
Remove all conrod cap bolts ① and conrod caps ②.

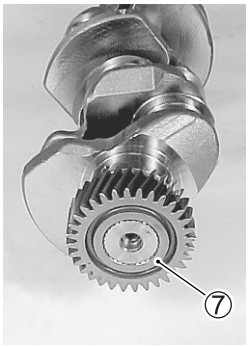


Remove crankshaft ③.
Remove oil seal ④ from crankshaft.

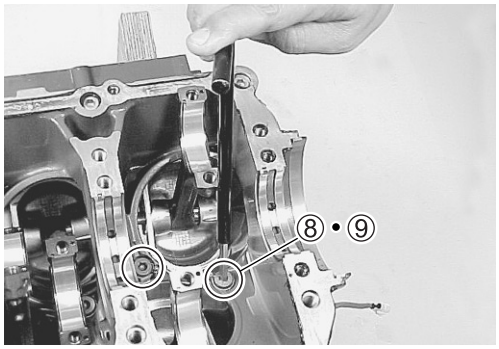


Remove the bolt ⑤, washer ⑥ and drive gear ⑦.





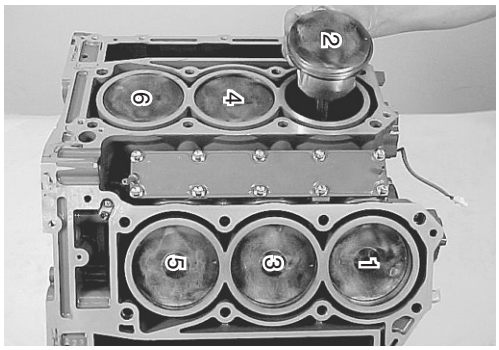
Remove bolts ⑧ and piston cooling jets ⑨ from each cylinder.



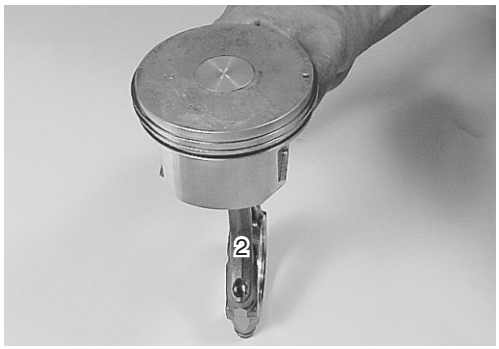
Mark cylinder number on pistons using quick dry paint.
Push piston (with conrod) out through the top of cylinder bore.

NOTE:

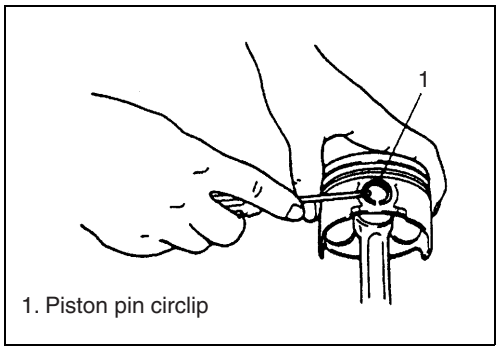
- *To prevent damage to piston rings, decarbon top of cylinder bore wall before removing piston.*
- *Reassemble each conrod cap to its original position after removing piston from bore.*



Remove two compression rings (top and 2nd) and oil ring from piston.
Mark cylinder number on conrod using quick dry paint.



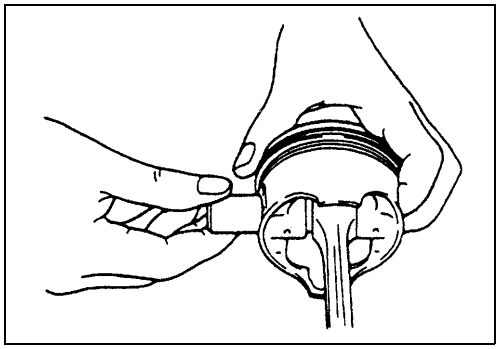
Remove piston pin circlips as shown.



1. Piston pin circlip

Remove piston pin from conrod.

NOTE:
Reassemble each piston, piston pin and conrod in their original combination and position.



INSPECTION/SERVICING

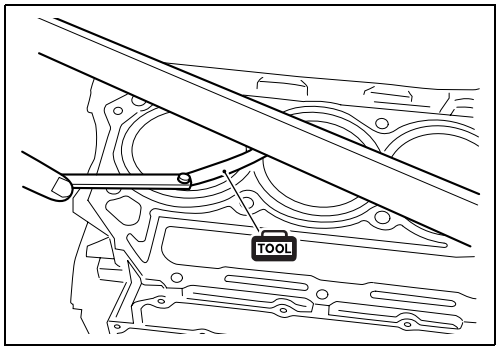
NOTE:
If cracks, excessive wear or other damage is found on any component, replace component.

CYLINDER

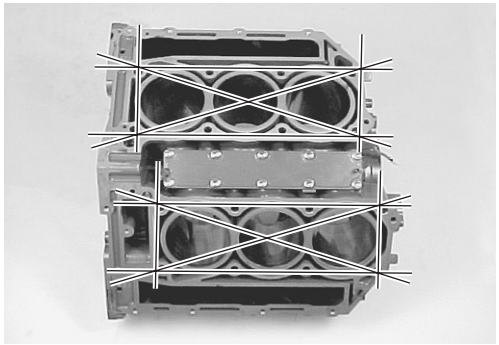
- **Cylinder distortion**
  Using a straightedge and thickness gauge, measure cylinder distortion (gasket surface) at a total of six (6) locations as shown.

09900-20803: Thickness gauge

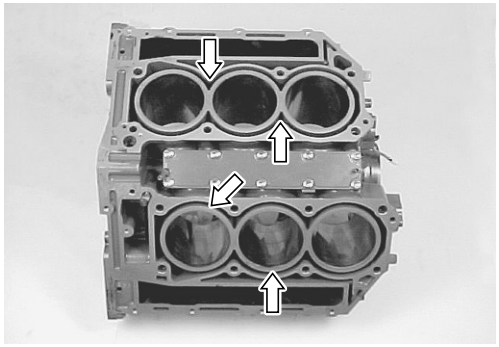
Cylinder distortion
Service limit: 0.05 mm (0.0020 in)



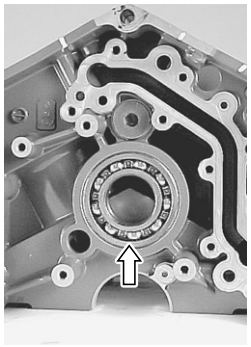
If measurement exceeds service limit, resurface or replace cylinder.



- **Water jackets**
  Check water jackets.
  If clog or obstruction is found, clean water jacket.



- **Driven gear/bearing**
  Inspect driven gear. Replace gear if damaged or worn.
  Inspect driven gear bearing. Replace bearing if pitted, noisy or rough.

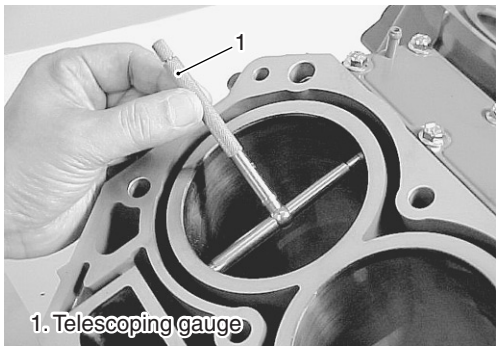




- **Cylinder bore**
  Inspect cylinder walls for scratches, roughness, or ridges which indicate excessive wear.
  If cylinder bore is very rough, deeply scratched or ridged, bore cylinder and use oversize piston.

- **Cylinder bore wear (difference)**
  Using telescoping gauge, measure cylinder bore in both axial (vertical line, following crankshaft) and transverse (horizontal line across crankshaft) directions at two positions as shown in figure.

NOTE:
Purchase a commercially available telescoping gage for this measurement.

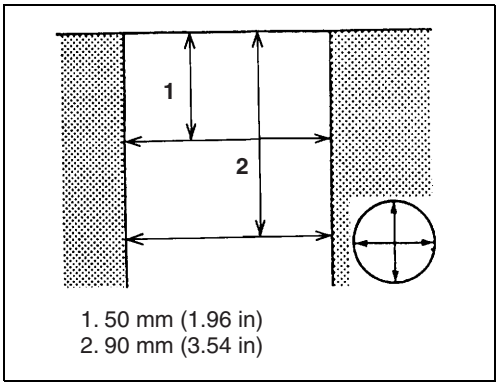


1. Telescoping gauge

Check for followings:
- Difference between measurements at the two positions (taper).
- Difference between axial and transverse measurement (out-of-round).

Cylinder bore wear (difference)
Service limit: 0.10 mm (0.039 in)

If measurement exceeds service limit, bore or replace cylinder.



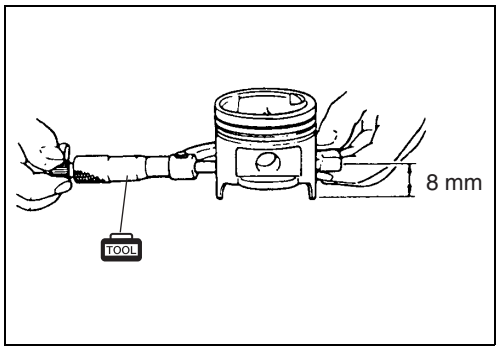
1. 50 mm (1.96 in)
2. 90 mm (3.54 in)

PISTON TO CYLINDER CLEARANCE

(1) Measure the piston diameter at a point 8 mm (0.315 in) above the piston skirt at a right angle to the piston pin bore.

TOOL 09900-20204: Micrometer

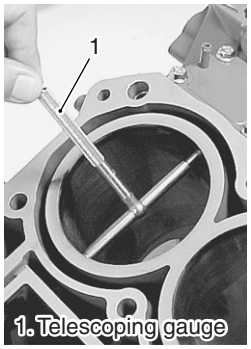
Piston skirt diameter
Standard: 94.970 – 94.990 mm (3.7390 – 3.7398 in)

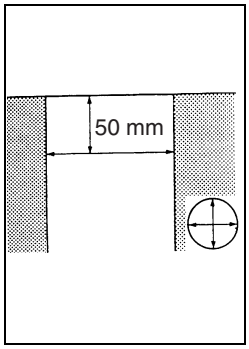


(2) Measure the cylinder bore at 50 mm (1.969 in) below the cylinder head gasket surface at a right angle to the crankshaft pin.

NOTE:
Purchase a commercially available telescoping gage for this measurement.

Cylinder bore diameter
Standard: 95.000 – 95.020 mm (3.7402 – 3.7409 in)





(3) Calculate the piston/cylinder clearance (Clearance equals difference between piston diameter and cylinder bore measurements).

Piston to cylinder clearance
Standard: 0.020 – 0.040 mm (0.0008 – 0.0016 in)
Service limit: 0.100 mm (0.0039 in)

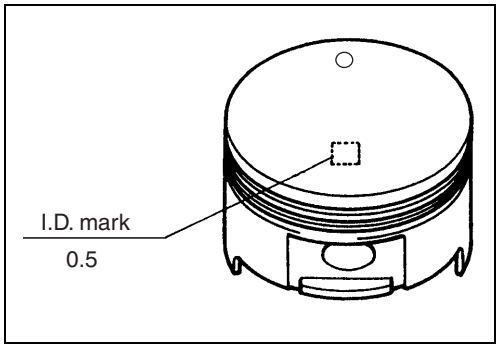
If clearance exceeds service limit, replace piston and/or cylinder or bore cylinder.

Identification of oversize piston/piston ring

One oversize piston/piston ring components, 0.50 mm, is available.
Oversize piston/piston ring are marked as shown, below.

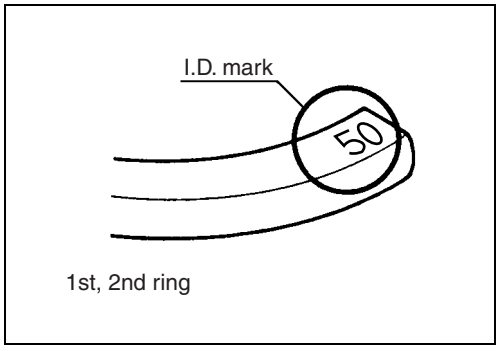
- **Piston**

Oversize	I.D. mark
0.50 mm	0.5



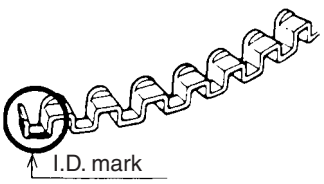
- **1st & 2nd Piston ring**

Oversize	I.D. mark
0.50 mm	50



• **Oil ring**

Oversize	I.D. mark
0.50 mm	One (1) Red paint



Oil ring spacer

PISTON

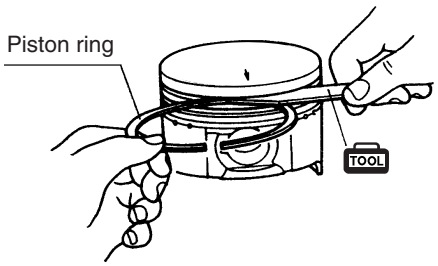
• Inspect piston for faults, cracks or other damage. Damaged or faulty piston(s) should be replaced.

• **Piston ring to groove clearance**

Before checking, piston grooves must be clean, dry and free of carbon.

Fit piston ring into piston groove, and measure clearance between ring and ring groove using thickness gauge.

09900-20803: Thickness gauge



Piston ring to groove clearance

Standard:

1st 0.030 – 0.070 mm (0.0012 – 0.0028 in)

2nd 0.020 – 0.060 mm (0.0008 – 0.0024 in)

Service limit:

1st 0.12 mm (0.0047 in)

2nd 0.10 mm (0.0039 in)

If measurement exceeds service limit, replace piston and/or piston ring.

Piston ring groove width

Standard:

1st 1.22 – 1.24 mm (0.0480 – 0.0488 in)

2nd 1.21 – 1.23 mm (0.0476 – 0.0484 in)

Oil 2.51 – 2.53 mm (0.0988 – 0.0996 in)

Piston ring thickness

Standard:

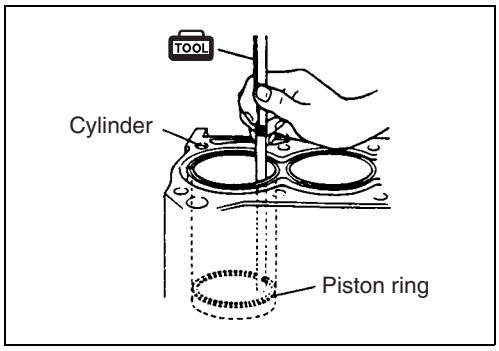
1st 1.17 – 1.19 mm (0.0461 – 0.0469 in)

2nd 1.17 – 1.19 mm (0.0461 – 0.0469 in)

PISTON RING

Piston ring end gap

Measure piston ring end gap with piston ring in the lowest position of cylinder bore.



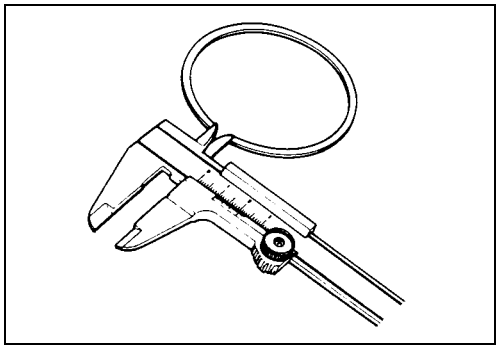
TOOL 09900-20803: Thickness gauge

Piston ring end gap
Standard:
1st 0.20 – 0.33 mm (0.0079 – 0.0130 in)
2nd 0.33 – 0.48 mm (0.0130 – 0.0189 in)
Service limit:
1st 0.70 mm (0.0276 in)
2nd 1.00 mm (0.0394 in)

If measurement exceeds service limit, replace piston ring.

Piston ring free end gap

Measure piston ring free end gap using vernier calipers.



TOOL 09900-20101: Vernier calipers

Piston ring free end gap
Standard:
1st Approx. 11.7 mm (0.4606 in)
2nd Approx. 13.2 mm (0.5197 in)
Service limit:
1st 9.3 mm (0.3661 in)
2nd 10.5 mm (0.4134 in)

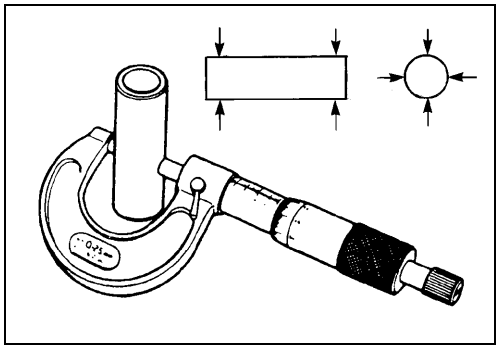
If measurement exceeds service limit, replace piston ring.

PISTON PIN

Check piston pin, conrod small end bore and piston pin hole for wear or damage.
If badly worn or damaged, replace component.

Piston pin clearance

- Check the piston pin clearance in the conrod small end. Replace the conrod if its small end is badly worn or damaged or if clearance exceeds service limit.



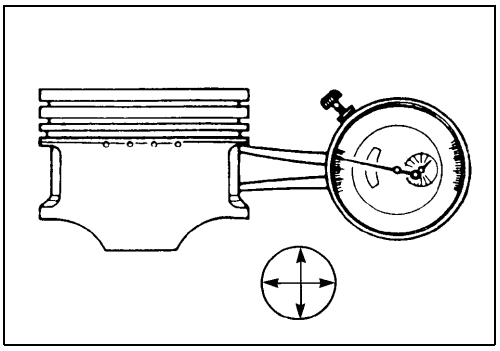
TOOL 09900-20205: Micrometer
09900-20605: Dial calipers

Piston pin outside diameter
standard: 21.996 – 22.000 mm (0.8660 – 0.8661 in)
Service limit: 21.980 mm (0.8654 in)

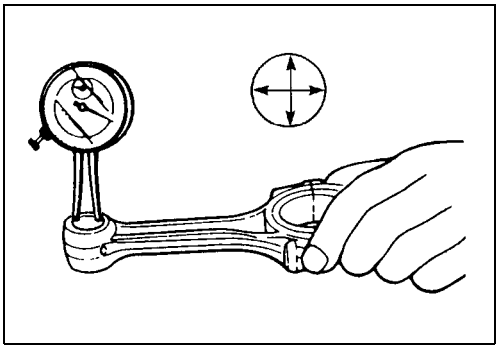
Piston pin hole diameter
Standard: 22.006 – 22.014 mm (0.8664 – 0.8667 in)
Service limit: 22.030 mm (0.8673 in)

Conrod small end bore
Standard: 22.003 – 22.011 (0.8663 – 0.8666 in)

Pin clearance in piston pin hole
Standard: 0.006 – 0.017 mm (0.0002 – 0.0007 in)
Service limit: 0.040 mm (0.0016 in)



Pin clearance in conrod small end
Standard: 0.003 – 0.014 mm (0.0001 – 0.0006 in)
Service limit: 0.05 mm (0.002 in)



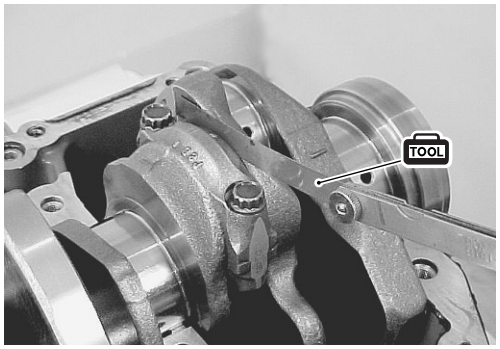
CONROD BIG END SIDE CLEARANCE

Measure conrod big end side clearance with conrod installed on crank pin as shown.

09900-20803: Thickness gauge

Conrod big end side clearance
Standard: 0.300 – 0.450 mm (0.0118 – 0.0177 in)
Service limit: 0.55 mm (0.0217 in)

If measurement exceeds service limit, replace conrod and/or crankshaft.



Conrod big end width
Standard: 20.750 – 20.800 mm (0.8169 – 0.8189 in)

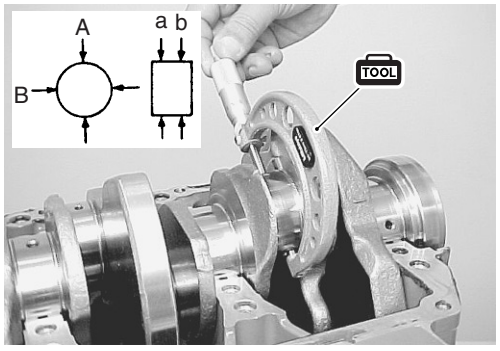
Crank pin width
Standard: 21.100 – 21.200 mm (0.8307 – 0.8346 in)

CRANK PIN

Inspect crank pin for uneven wear or damage.
Measure crank pin for out-of-round or taper with micrometer.
If crank pin is damaged, out-of-round or taper is out of service limit, replace crankshaft.

09900-20203: Micrometer

Out-of-round : A – B
Taper : a – b



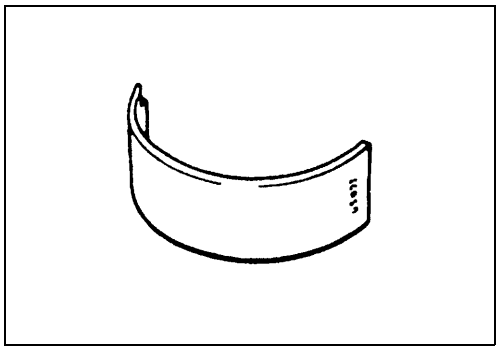
Out-of-round and taper
Service limit: 0.01 mm (0.0004 in)

Crank pin diameter
Standard: 53.982 – 54.000 mm (2.1253 – 2.1260 in)

CONROD BEARING

Inspect bearing shell for proper contact pattern and signs of fusion, pitting, burning or flaking.

Bearing shells found in defective condition must be replaced.



Conrod big end oil clearance

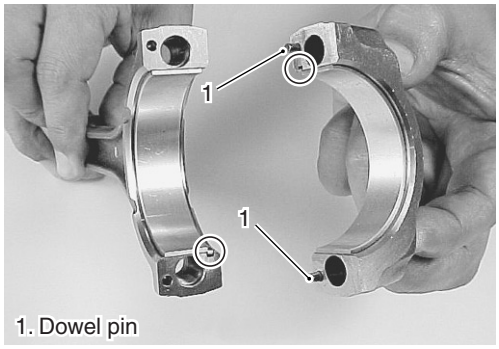
Check conrod big end oil clearance as follows;

(1) Clean surface of conrod, conrod cap, conrod bearing, and crank pin.

(2) Install conrod bearing onto conrod and conrod cap.

NOTE:

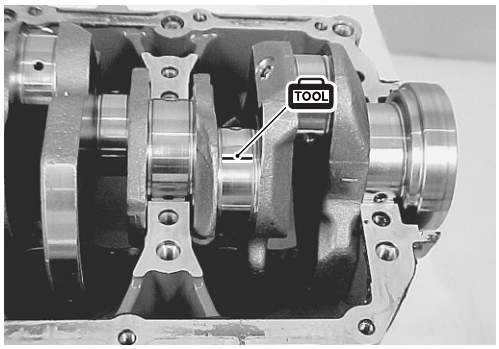
- *Reassemble each bearing and conrod cap to their original position.*
- *Do not apply oil to bearing.*



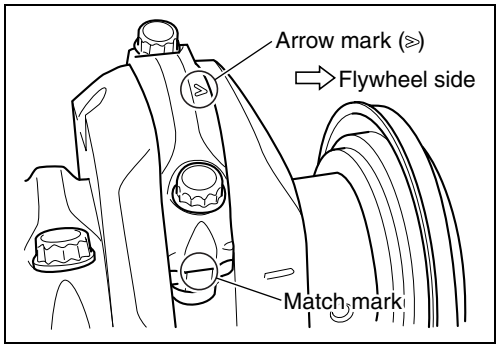
1. Dowel pin

(3) Place a piece of Plastigauge on crank pin parallel to crankshaft. Avoid placing Plastigauge over oil hole.

09900-22301: Plastigauge



(4) Install conrod cap (with bearing) to conrod with the arrow mark on cap toward flywheel side.



(5) Apply engine oil to conrod bolts and tighten bolt in two steps.

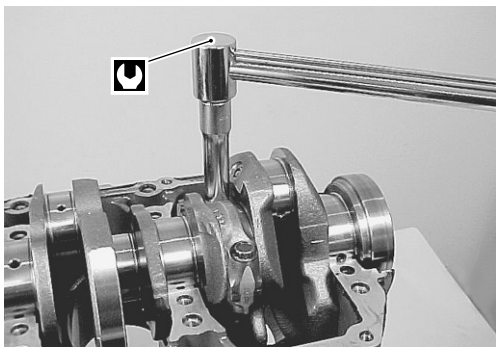
Conrod cap bolt:

1st step 31 N·m (3.1 kg-m, 22.4 lb-ft)

Final step 63 N·m (6.3 kg-m, 45.6 lb-ft)

NOTE:

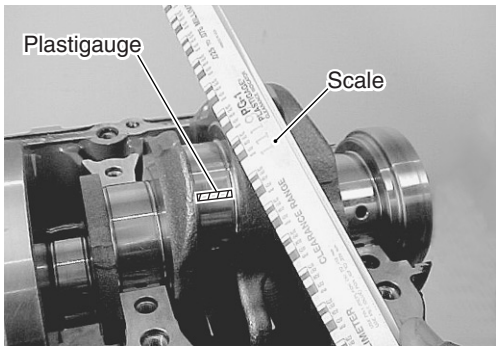
Do not rotate conrod with Plastigauge in place.



(6) Remove conrod and conrod cap from crank pin.
(7) Using scale on Plastigauge envelope, measure Plastigauge width at its widest point.

Conrod big end oil clearance
Standard: 0.045 – 0.063 mm (0.0018 – 0.0025 in)
Service limit: 0.080 mm (0.0031 in)

If measurement exceeds service limit, replace conrod bearing.



CRANKSHAFT

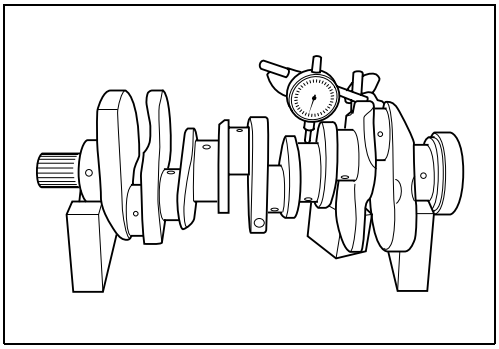
■ Crankshaft runout

Using a dial gauge, measure runout at center journal.

09900-20606: Dial gauge
09900-20701: Magnetic stand

Crankshaft runout
Service limit: 0.04 mm (0.0016 in)

If measurement exceeds service limit, replace crankshaft.



■ Crankshaft thrust play

Measure thrust play with crankshaft, thrust bearing, journal bearing and crankcase/cylinder block assembled in a normal manner.
Tighten crankcase bolts to specified torque.

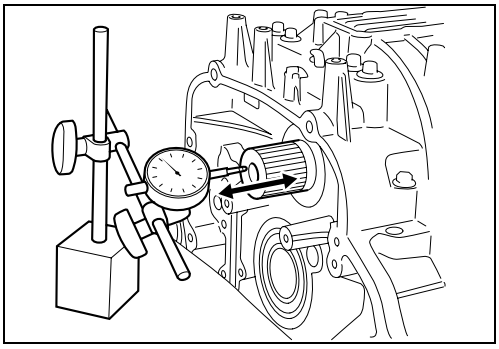
Crankcase bolt:
8 mm 27 N·m (2.7 kg-m, 19.5 lb-ft)
10 mm 52 N·m (5.2 kg-m, 37.6 lb-ft)

Use a dial gauge to read displacement in axial (thrust) direction of crankshaft.

Crankshaft thrust play
Standard: 0.11 – 0.31 mm (0.0043 – 0.0122 in)
Service limit: 0.35 mm (0.0138 in)

If measurement exceeds service limit, replace crankshaft thrust bearing.

Crankshaft thrust bearing thickness
Standard: 2.425 – 2.475 mm (0.0955 – 0.0974 in)

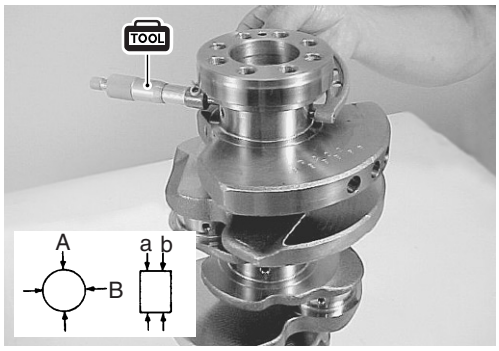


■ **Out-of-round and taper (uneven wear) of journals**

An unevenly worn crankshaft journal shows up as a difference in diameter at a cross section or along its length (or both).

This difference, if any, is determined by taking micrometer readings.

If any journal is badly damaged or if measurements exceed service limit, replace crankshaft.



09900-20203: Micrometer

Out-of-round: A – B
Taper : a – b

Out-of-round and taper
Service limit: 0.01 mm (0.0004 in)

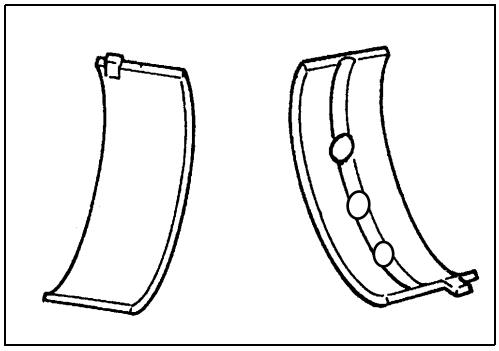
Crankshaft journal outside diameter
Standard: 64.988 – 65.006 mm (2.5586 – 2.5593 in)

CRANKSHAFT MAIN BEARING

Check bearings for pitting, scratches, wear or damage.

If any improper condition is found, replace both upper and lower halves.

Always replace both bearing halves, never replace only one half of a bearing set.



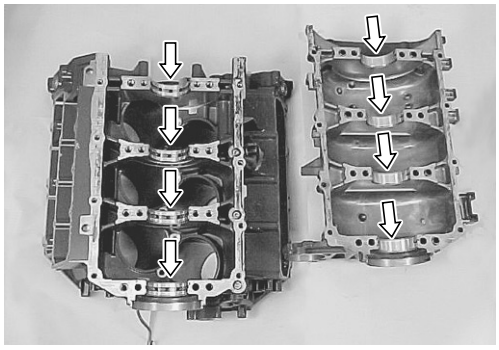
CRANKSHAFT JOURNAL OIL CLEARANCE

Check clearance using Plastigauge according to the following procedure.

NOTE:

Assemble each bearing in its original position before checking clearance.

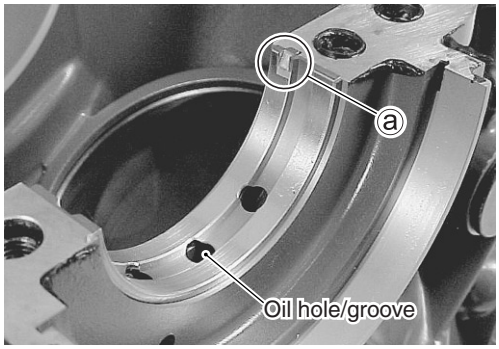
(1) Clean surface of bearing holder (crankcase, and cylinder), bearing, and main bearing journal.



(2) Install main bearing to cylinder and crankcase.

NOTE:

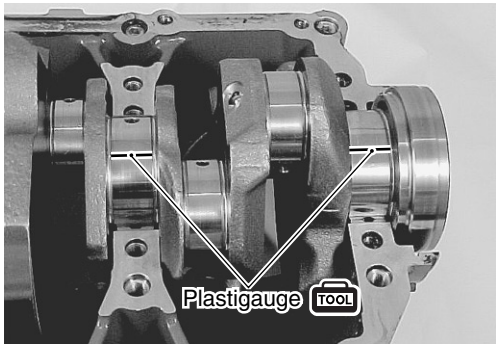
- *Align tab ⓐ of bearing with notch in cylinder and crankcase.*
- *Do not apply engine oil to bearing.*
- *Install lower bearing half with oil hole/groove towards cylinder side.*



(3) Install crankshaft to cylinder.
(4) Place a piece of Plastigauge across full width of bearing (parallel to crankshaft) on journal.
Do not place Plastigauge over oil hole.

09900-22301: Plastigauge

NOTE:
Do not rotate crankshaft while Plastigauge is installed.

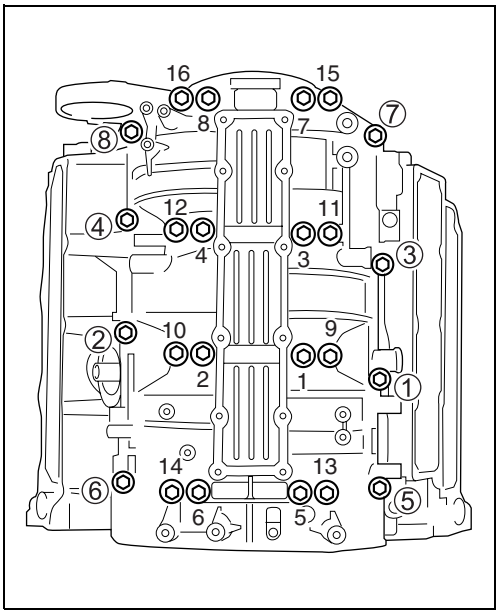


(5) Assemble crankcase to cylinder.
(6) Apply engine oil to crankcase bolts.
Tighten crankcase bolts in three (3) steps following the order indicated below.

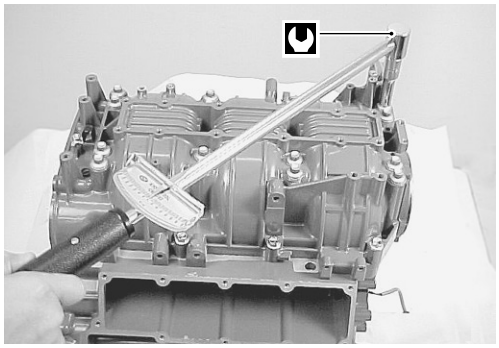
NOTE:
Tighten 10 mm (0.394 in) thread diameter bolts first (following the order shown in figure), then tighten 8 mm (0.315 in) thread diameter bolts.

Crankcase bolt (10 mm thread diameter):
1st step 11 N·m (1.1 kg-m, 8.0 lb-ft)
2nd step 42 N·m (4.2 kg-m, 30.0 lb-ft)
Final step 52 N·m (5.2 kg-m, 37.6 lb-ft)

Crankcase bolt (8 mm thread diameter):
1st step 6 N·m (0.6 kg-m, 4.3 lb-ft)
2nd step 21 N·m (2.1 kg-m, 15.0 lb-ft)
Final step 27 N·m (2.7 kg-m, 19.5 lb-ft)



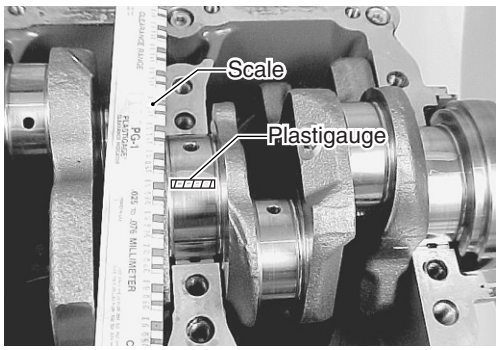
NOTE:
Crankcase must be torqued to specification in order to assure proper compression of Plastigauge and accurate reading of clearance.



(7) Remove crankcase from cylinder.
(8) Using scale on Plastigauge envelope, measure Plastigauge width at its widest point.

Crankshaft journal oil clearance
Standard: 0.024 – 0.044 mm (0.0009 – 0.0017 in)
Service limit: 0.065 mm (0.0026 in)

If measurement exceeds service limit, replace crankshaft main bearing.



NOTE:
For bearing replacement, see the "SELECTION OF MAIN BEARING" section on page 6-87.

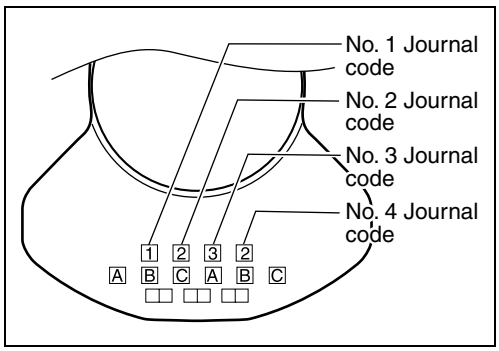
SELECTION OF MAIN BEARING

Whenever a bearing requires replacement, select a new bearing according to following procedure.

(1) First, check journal diameter.

As shown in figure, upper (flywheel side) crank web of No.1 cylinder has four (4) stamped code numerals.

The numerals (1, 2 & 3) represent the journal diameters shown below.

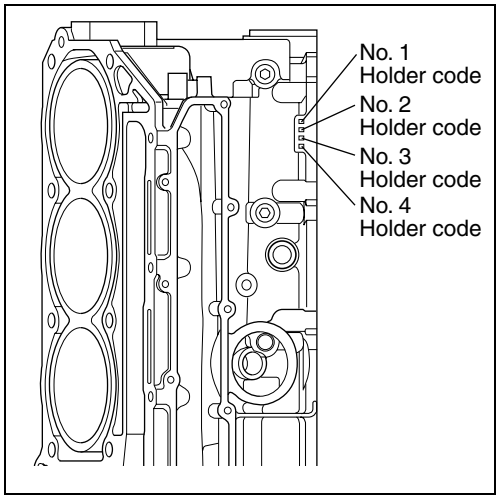


Numeral stamped	Journal diameter
1	65.000 – 65.006 mm (2.5591 – 2.5593 in)
2	64.994 – 65.000 mm (2.5588 – 2.5591 in)
3	64.988 – 64.994 mm (2.5586 – 2.5588 in)

(2) Next, check bearing holder inside diameter without bearing.

As shown in figure, the cylinder block STBD side has four (4) stamped code letters.

The letters (A, B & C) represent the bearing holder inside diameters shown below.

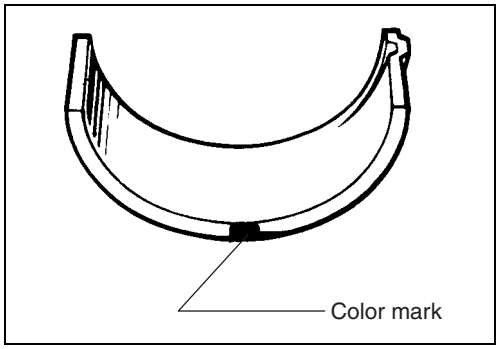


Code	Crank bearing holder inside diameter (w/o bearing)
A	70.000 – 70.006 mm (2.7559 – 2.7561 in)
B	70.006 – 70.012 mm (2.7561 – 2.7564 in)
C	70.012 – 70.018 mm (2.7564 – 2.7566 in)

(3) There are five (5) main bearings available, each of differing thickness.

To distinguish them, a color mark is painted at the position indicated in figure.

Each color represents the following thickness measured at the center of the bearing.



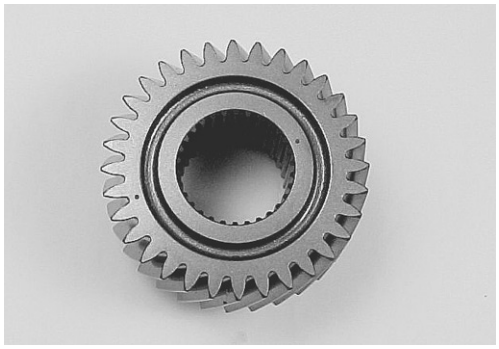
Color mark	Bearing thickness
Black	2.496 – 2.500 mm (0.0983 – 0.0984 in)
No color mark	2.499 – 2.503 mm (0.0984 – 0.0985 in)
Yellow	2.502 – 2.506 mm (0.0985 – 0.0987 in)
Blue	2.505 – 2.509 mm (0.0986 – 0.0988 in)
Pink	2.508 – 2.512 mm (0.0987 – 0.0989 in)

(4) Select crankshaft main bearing referring the below table.

		Numeral stamped on crank web (journal outside diameter)		
		1	2	3
Code stamped on cylinder block (Bearing holder inside diameter)	A	Black	No color	Yellow
	B	No color	Yellow	Blue
	C	Yellow	Blue	Pink

NOTE:
Measure crankshaft journal oil clearance again after installing new bearing selected. (See page 6-85.)

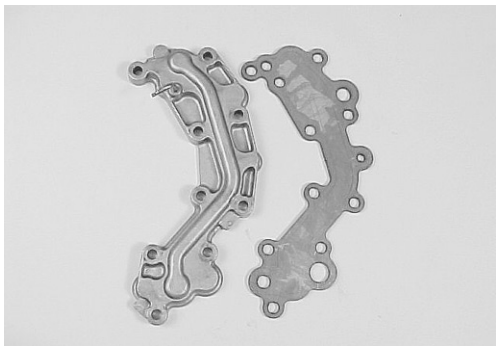
CRANKSHAFT DRIVE GEAR
Inspect drive gear. Replace gear if damaged or worn.



PISTON COOLING JET
Check the piston cooling jet.
If crack or other damage is found, replace the jet.
Clean the jet thoroughly to ensure there is no obstruction.



OIL GALLERY COVER/PLATE
Check the oil gallery cover and plate.
If crack or other damage is found, replace it.
Clean the oil jet thoroughly to ensure there is no obstruction.



OIL SEAL
Inspect condition. If cracked, cut or damaged, replace.



REASSEMBLY

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

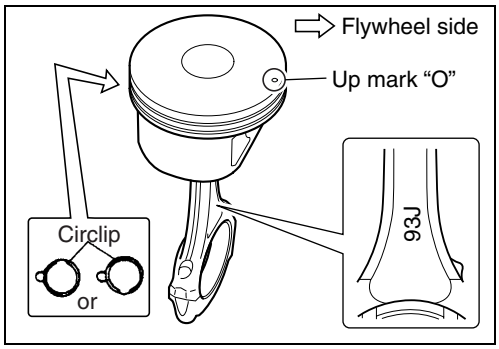
CAUTION

If original components are not replaced, each piston, piston pin and conrod is to be assembled and installed in its original order and position.

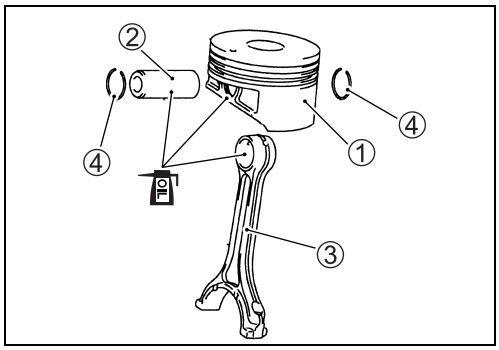
PISTON TO CONROD
Apply engine oil to piston pin ②, piston pin bore and conrod ③.
Assemble conrod ③ to piston ① as shown in figure and insert piston pin ② through piston and conrod.
Install piston pin circlips ④.

NOTE:

- *"93J" mark on conrod and up mark (○) on piston dome must face toward flywheel side.*



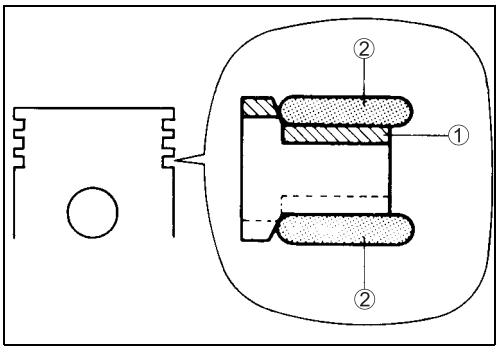
- *Circlip should be installed with gap facing either up or down as shown in figure.*
- *Always use new piston pin circlip.*



PISTON RING TO PISTON

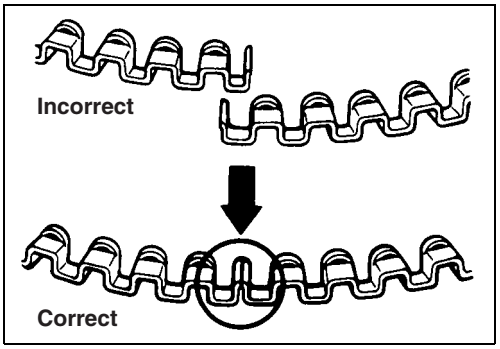
■ Oil ring

- Apply engine oil to piston rings.
- Install spacer ① first, then side rails ② to piston.



CAUTION

When installing spacer, do not allow spacer ends to overlap in groove.

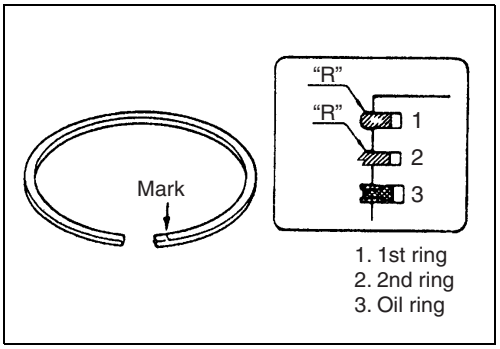


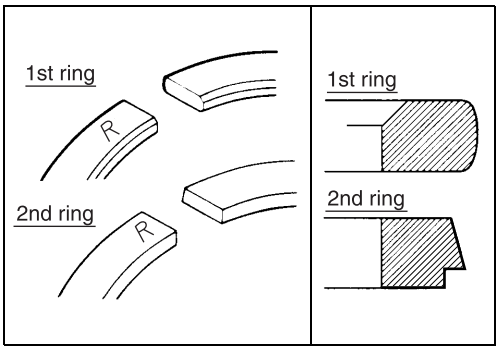
■ 1st and 2nd piston ring

- Apply engine oil to piston ring.
- Install 2nd ring and 1st ring to piston.

NOTE:

- *1st and 2nd ring differ in shape and color as shown in figure.*
- *Also indicated in figure, the 1st and 2nd ring are marked with the letter "R" which must face towards top of piston.*

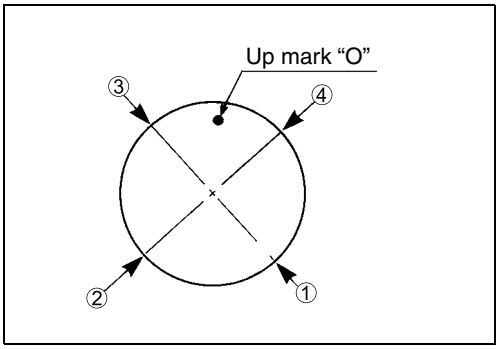




■ Ring gap direction

Position piston rings so gaps are staggered at approximately 90 degree angles as shown.

① 1st ring ③ 2nd ring
② Oil ring lower side rail ④ Oil ring upper side rail



CAUTION

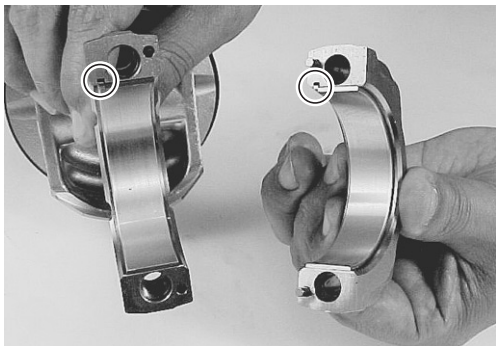
Failure to stagger piston ring gaps may result in crankcase oil dilution.

PISTON TO CYLINDER

Install conrod bearing to conrod and conrod cap.

CAUTION

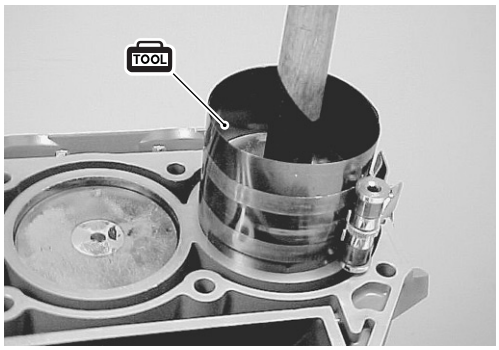
- **Assemble each conrod bearing to its original position.**
- **Do not apply oil between conrod and bearing or between bearing cap and bearing.**



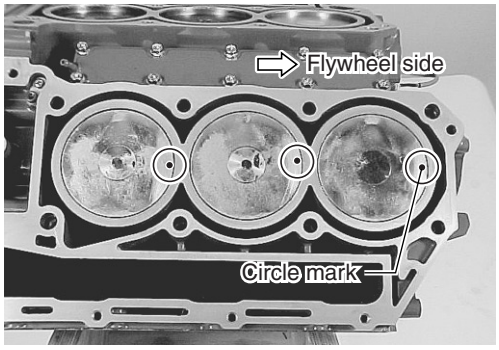
Apply engine oil to piston and cylinder walls.

Insert piston and conrod assembly into cylinder bore from cylinder head side using special tool.

09916-77310: Piston ring compressor



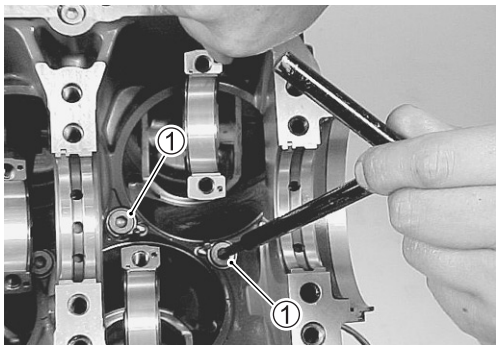
NOTE:
Position the "circle" mark (○) on piston head to flywheel side.



PISTON COOLING JET

Install the piston cooling jet ① in position, then tighten bolt securely.

Piston cooling jet: 20 N·m (2.0 kg-m, 14.5 lb-ft)



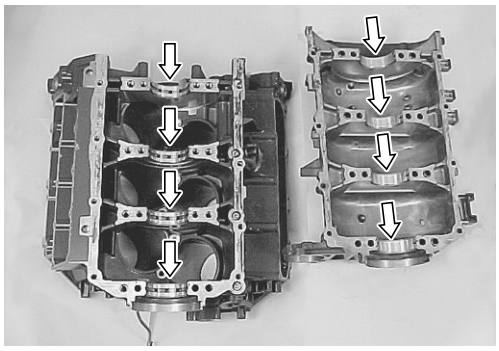
CRANKSHAFT TO CYLINDER

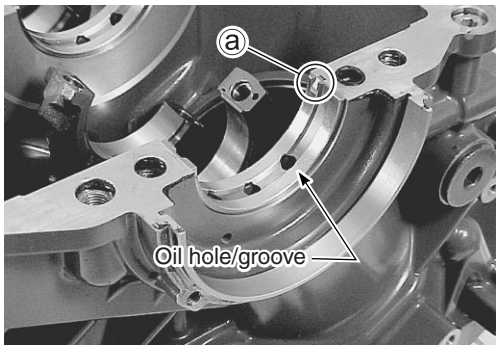
Install crankshaft main bearings in cylinder and crankcase.
Apply engine oil to bearings.

CAUTION

- **Assemble each bearing to its original position.**
- **Assemble main bearing half containing oil groove/hole to cylinder block.**
  Assemble the half without oil groove to crankcase.
- **Do not apply oil between crank bearing holder and crank main bearing.**

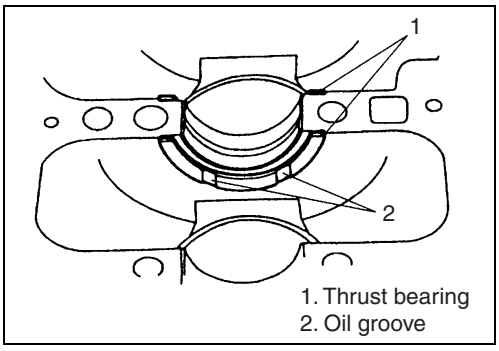
NOTE:
Align bearing tab ⓐ with notch in cylinder and crankcase.





Thrust bearing

Apply engine oil to the thrust bearing and install in cylinder block overlaping both sides of the No. 3 main journal.
Oil groove on the thrust bearing must face towards crank webs.



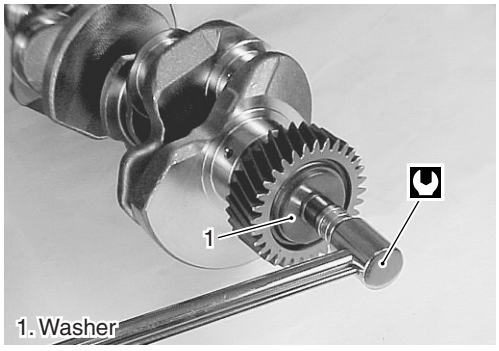
1. Thrust bearing
2. Oil groove

Crankshaft drive gear

To assemble the drive gear on crankshaft, align the dot (•) mark on drive gear with the dot (•) mark on crankshaft, then install washer and secure with bolt.

Drive gear bolt: 48 N·m (4.8 kg-m, 34.7 lb-ft)





1. Washer

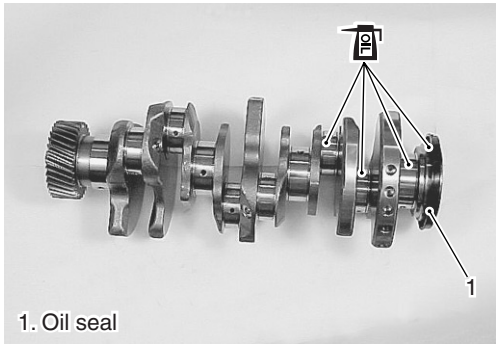
Crankshaft

Apply engine oil to upper oil seal lip.
Install upper oil seal to crankshaft.

CAUTION

Do not re-use seal removed. Be sure to use new seal.

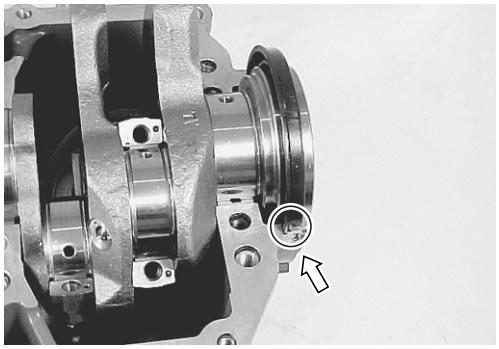
NOTE:
Install upper oil seal with its spring/lipped side facing inward.



1. Oil seal

Apply engine oil to crank pin and crankshaft main journal and install crankshaft in cylinder.

NOTE:
When installing crankshaft to cylinder, be sure to fit tab of seal in groove of cylinder.

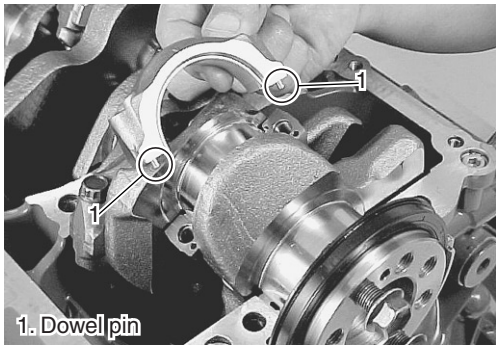


CONROD CAP

Apply engine oil to crank pin and conrod bearing.
Install dowel pins and conrod cap (with bearing) to conrod with arrow mark on cap toward flywheel side.

CAUTION

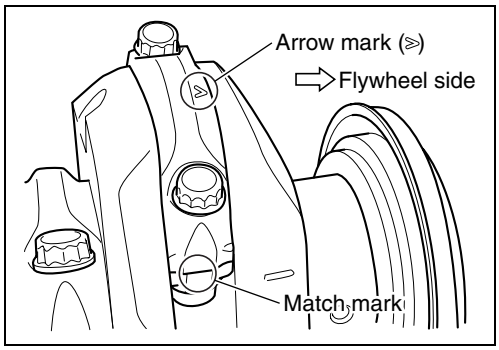
Reassemble each conrod cap to its original position.

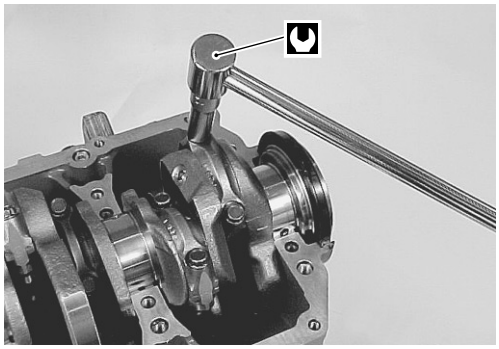


1. Dowel pin

Apply engine oil to conrod bolts.
Tightening conrod cap bolts in two steps.

Conrod cap bolt:
1st step 31 N·m (3.1 kg-m, 22.4 lb-ft)
Final step 63 N·m (6.3 kg-m, 45.6 lb-ft)





CRANKCASE TO CYLINDER

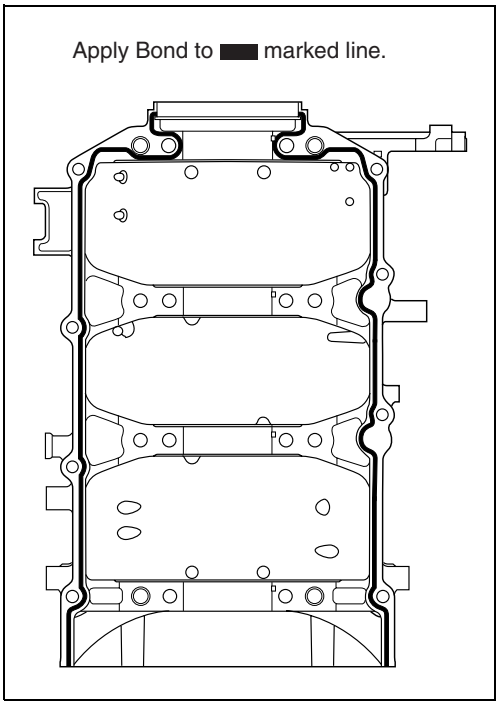
Clean mating surface of cylinder and crankcase.

Apply SUZUKI BOND to mating surface of crankcase as shown.

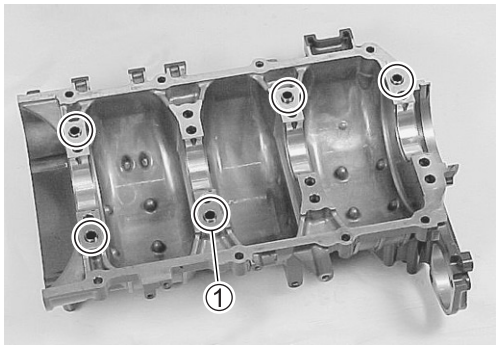
CAUTION

Apply bond to mating surface only.
Do not allow bond to contact surface of bearing.

1104 99000-31030: SUZUKI BOND No. "1104"



Install five (5) dowel pins ①.



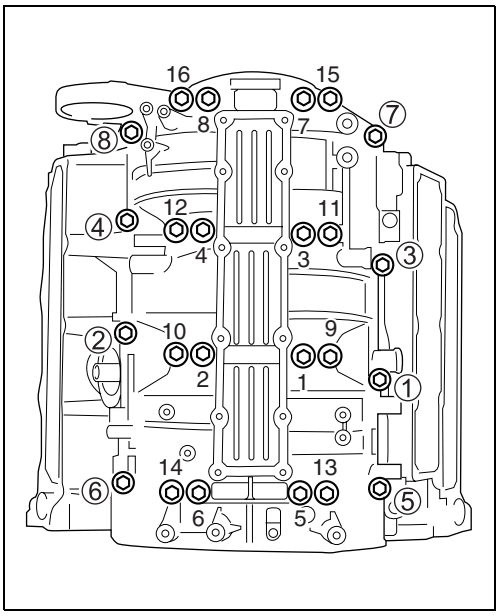
Install crankcase to cylinder.

Apply engine oil to crankcase bolts.

Tighten crankcase bolts in three (3) steps following the order indicated below.

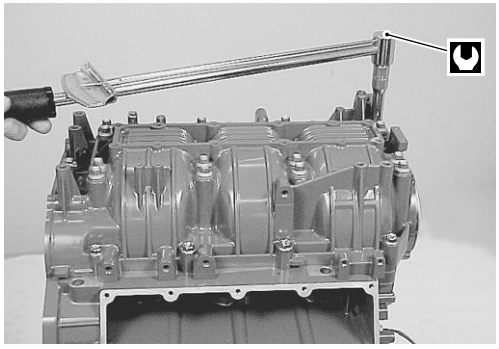
NOTE:

Tighten 10 mm (0.394 in) thread diameter bolts first (following the order shown in figure), then tighten 8 mm (0.315 in) thread diameter bolts.



Crankcase bolt (10 mm thread diameter):
1st step 11 N·m (1.1 kg-m, 8.0 lb-ft)
2nd step 42 N·m (4.2 kg-m, 30.0 lb-ft)
Final step 52 N·m (5.2 kg-m, 37.6 lb-ft)

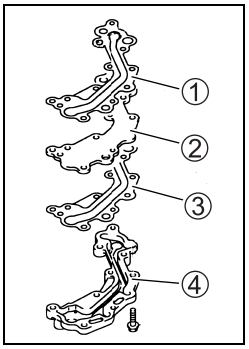
Crankcase bolt (8 mm thread diameter):
1st step 6 N·m (0.6 kg-m, 4.3 lb-ft)
2nd step 21 N·m (2.1 kg-m, 15.0 lb-ft)
Final step 27 N·m (2.7 kg-m, 19.5 lb-ft)

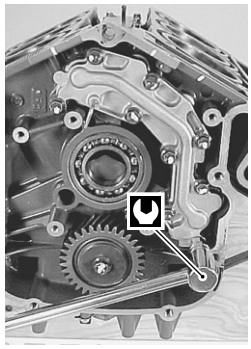


NOTE:
After tightening crankcase bolts, check to be sure that crankshaft rotates smoothly when turned by hand.

OIL GALLERY COVER/PLATE
Install the gasket ①, oil gallery plate ②, gasket ③ and oil gallery cover ④, then secure with bolts.

Oil gallery cover: 23 N·m (2.3 kg-m, 16.6 lb-ft)





CYLINDER HEAD
Install cylinder head. (See page 6-56 to 6-60.)

TIMING CHAIN
Install timing chain. (See page 6-34 to 6-40, 6-47 to 6-53.)

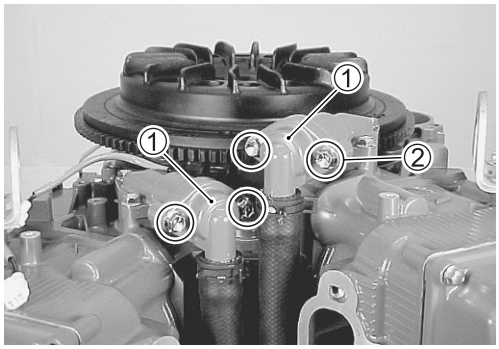
OIL PUMP
Install oil pump assembly. (See page 6-27.)

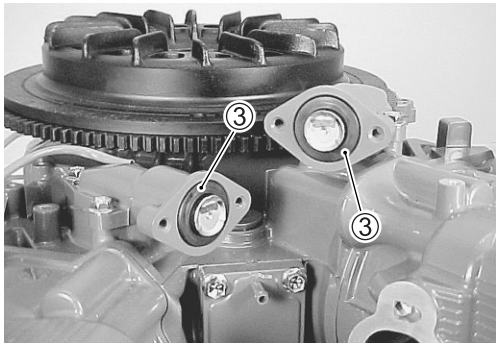
POWER UNIT
Install power unit. (See page 6-18 to 6-22.)

THERMOSTAT

REMOVAL

- Remove the ring gear cover and air intake silencer case. (See page 6-2.)
- Remove the two (2) bolts ② securing the thermostat cover ①, then remove the cover ① and thermostat ③.





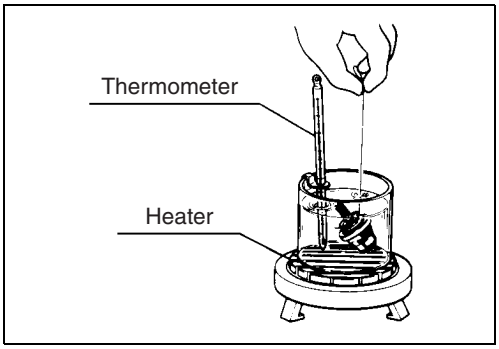
INSPECTION

- If salt deposits, corrosion, wear or other damage is found, clean or replace.



- **Thermostat operation**
  Check thermostat opening temperature as follows:
  - Insert a length of thread between thermostat valve/body and suspend thermostat in a container filled with water.
  - Place thermometer in container and heat water.
    Observe water temperature when thermostat valve opens and releases thread.

  Thermostat operating temperature
  Standard: 58 – 62 °C (136 – 143 °F)



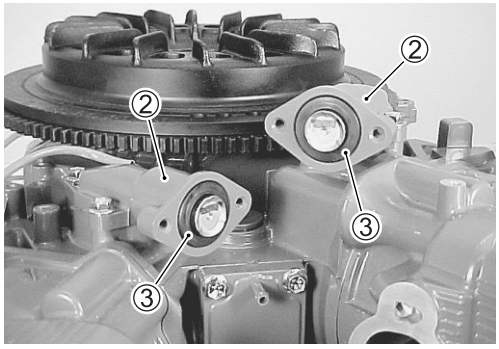
INSTALLATION

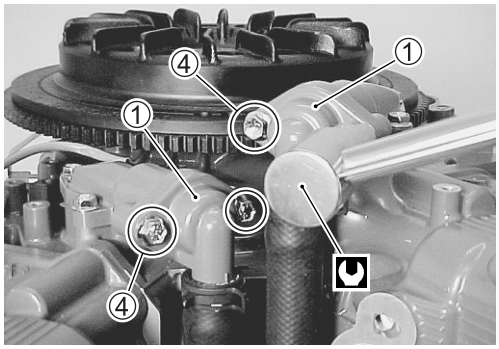
Installation is reverse order of removal with special attention to the following steps.

- Assemble thermostat ③ and thermostat cover ① to thermostat housing ② and secure with bolts ④.

Thermostat cover bolt: 10 N·m (1.0 kg-m, 7.2 lb-ft)

- Check to ensure that all removed parts are back in place.





OPERATION

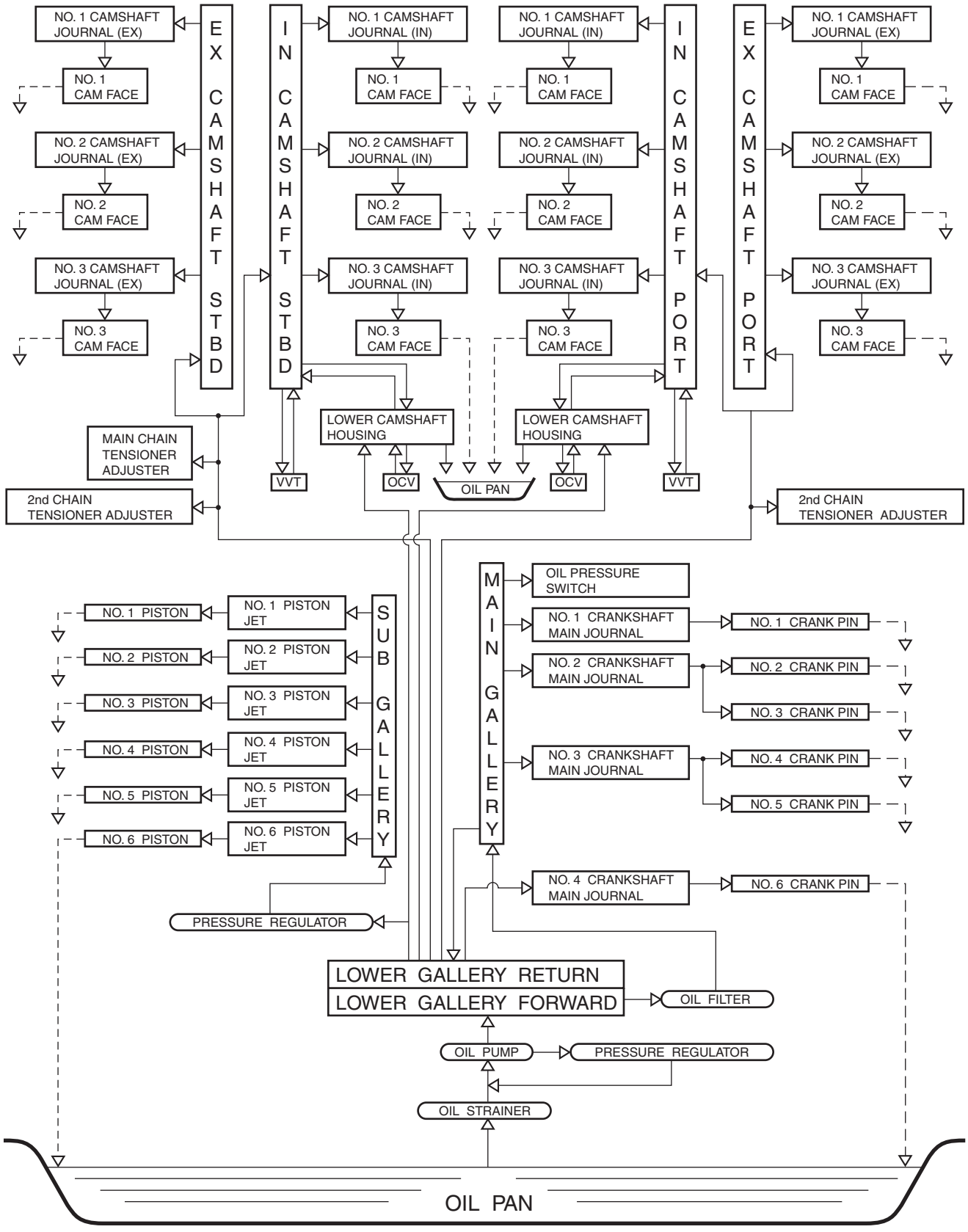
ENGINE LUBRICATION SYSTEM

The engine lubrication system uses a camshaft-driven oil pump that pressure feeds engine oil to the engine' moving parts. The chart below shows the lubrication system oil flow.

Engine oil is drawn up by the oil pump through the oil strainer. After passing through the oil filter, engine oil flows to the main gallery and lower gallery from which various passages distribute oil for lubrication and other engine functions requiring engine oil pressure to operate.

- Oil from the main gallery:
  Lubricates crankshaft journal bearings #1 through #3.
  Lubricates crank pins #1 through #5.
- Oil from the lower gallery:
  - Lubricates crank journal bearing #4 and crank pin #6.
  - Passes through the sub-gallery and sprays through six cylinder lubrication jets to lubricate the cylinder, piston pin and cylinder wall.
  - Passes through the cylinder head oil passage to lubricate the IN. and EX. camshaft journals and cam faces.
  - Flows to OCV, supplying pressurized engine oil to operate the VVT system. From the ECM controlled OCV, oil flows to the VVT actuator to advance, retard or maintain intake valve timing.

ENGINE OIL LUBRICATION CHART

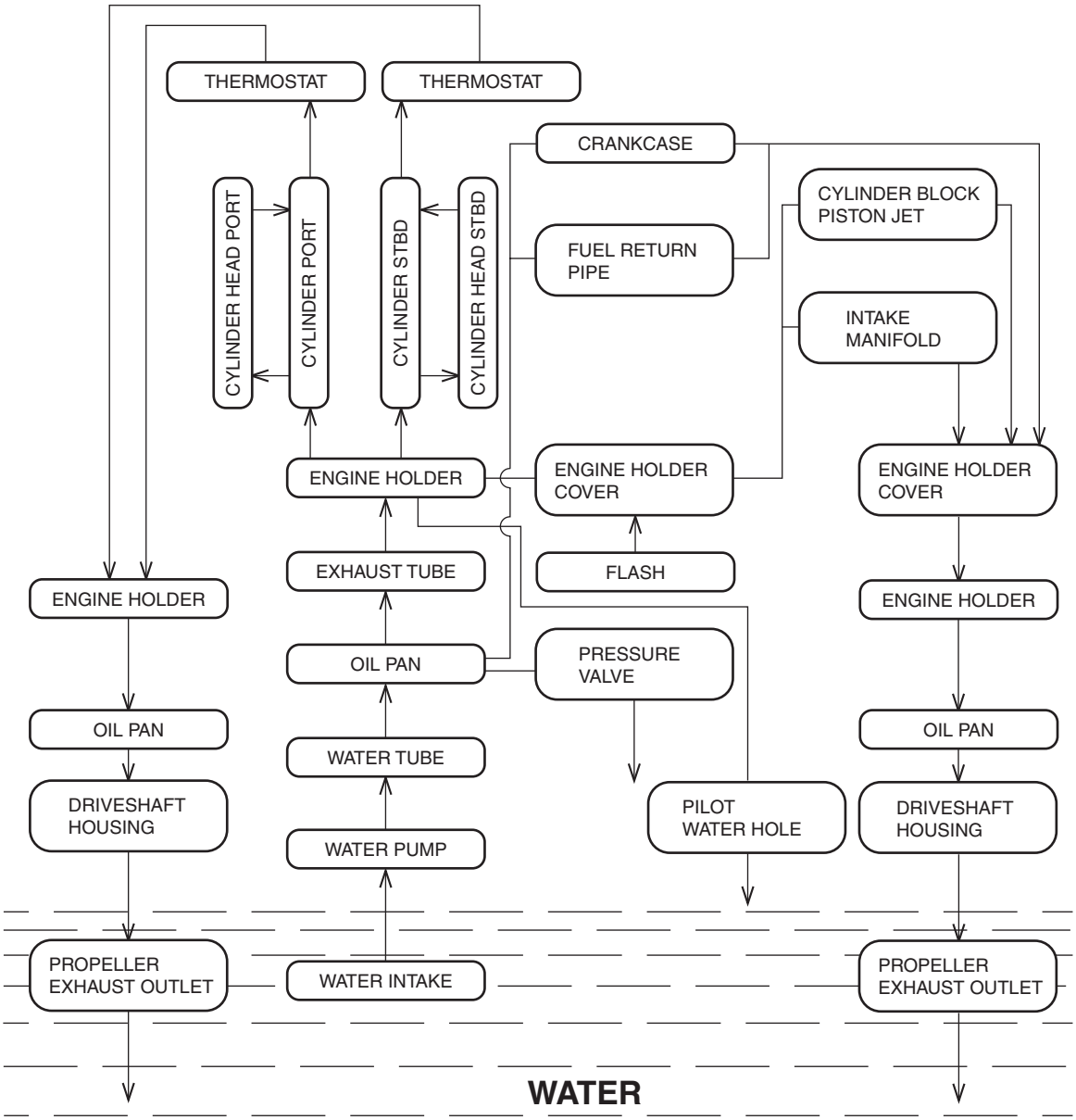


WATER COOLING SYSTEM

The water cooling system includes the lower unit water pump, lower unit to power unit water supply tube, oil pan water pressure valve, power unit water passages and thermostats.
This system cools both the power unit and exhaust and is shown in schematic form below.
If overheating occurs, the components of the cooling system must be inspected for blockage, corrosion build-up or component damage.

Component inspection **Refer to page**

Water pump/Impeller..... 9-11, 10-11
Water tube 7-9
Thermostat..... 6-96
Water pressure valve 7-26
Cylinder head..... 6-63
Cylinder block 6-78



PCV SYSTEM

(PCV: POSITIVE CRANKCASE VENTILATION)

Due to the necessary piston to cylinder clearance, unburned combustion gasses (blow-by) will naturally pass through and enter the crankcase.
The PCV system is provided to recirculate these gasses back to the combustion chamber to be reburned.
The system consists of cylinder head cover, PCV valve, breather hose, throttle body and collector.

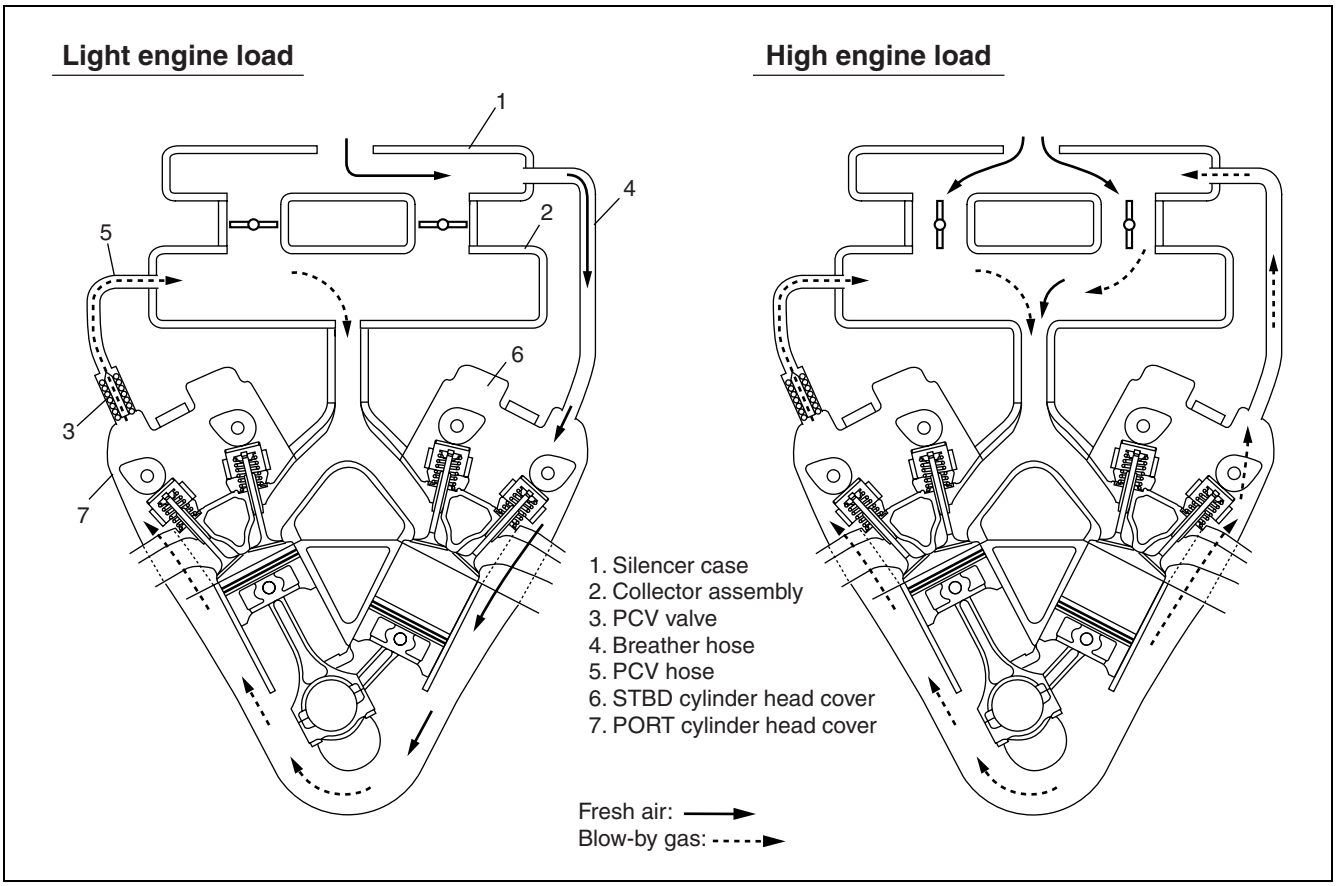


UNDER LIGHT ENGINE LOAD CONDITIONS

When the throttle valve opening is small, air entering from the air intake silencer case is directed through the breather hose to the cam chamber. At this time, a high vacuum occurs inside the collector resulting in a minimal PCV valve opening.
Due to this high vacuum condition, blow-by gasses inside the cam chamber are taken into the collector (scavenged) along with the air flowing from the breather hose.
The volume of gasses is small at this time.

UNDER HIGH ENGINE LOAD CONDITIONS

When the throttle valve opening is large, the vacuum inside the collector decreases causing the PCV valve, assisted by an internal spring, to open fully.
With the PCV fully open, blow-by gasses inside the cam chamber are now directed (scavenged) through the valve into the collector.
At the same time, gasses passing through the breather hose are still being directed into the silencer case.



MID UNIT

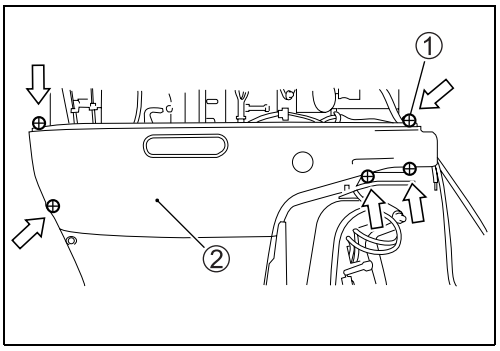
CONTENTS

ENGINE SIDE COVER 7- 2
REMOVAL 7- 2
INSTALLATION 7- 2
DRIVESHAFT HOUSING AND OIL PAN 7- 3
REMOVAL 7- 3
INSPECTION 7- 8
ASSEMBLY 7-10
SWIVEL BRACKET, STEERING BRACKET AND CLAMP BRACKET 7-17
REMOVAL 7-17
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REASSEMBLY 7-21
WATER PRESSURE VALVE 7-26
REMOVAL 7-26
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INSTALLATION 7-26

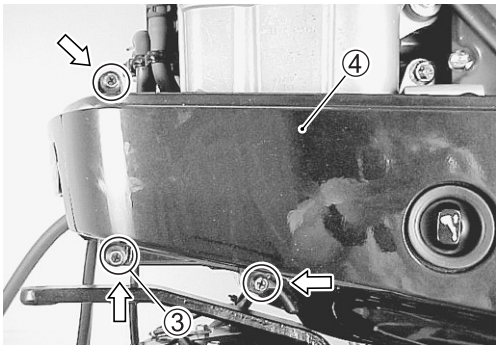
ENGINE SIDE COVER

REMOVAL

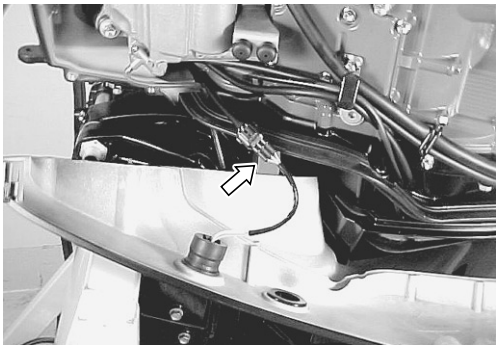
Remove five (5) screws ① and STBD side cover ②.



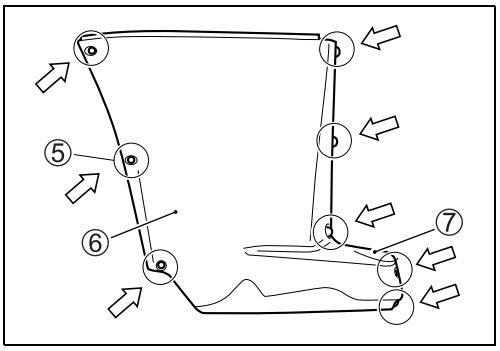
Remove three (3) screws ③ and PORT side cover ④.



Disconnect PTT switch lead connector.



Remove eight (8) screws ⑤ and STBD/PORT oil pan covers ⑥/⑦.



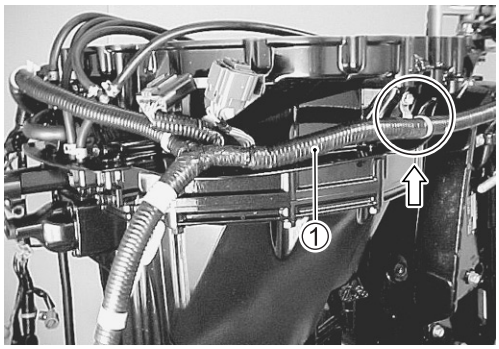
INSTALLATION

Installation is reverse order of removal.

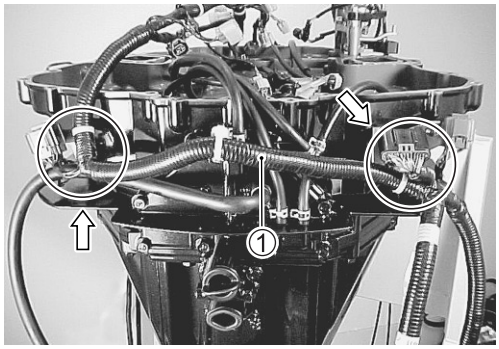
DRIVESHAFT HOUSING AND OIL PAN

REMOVAL

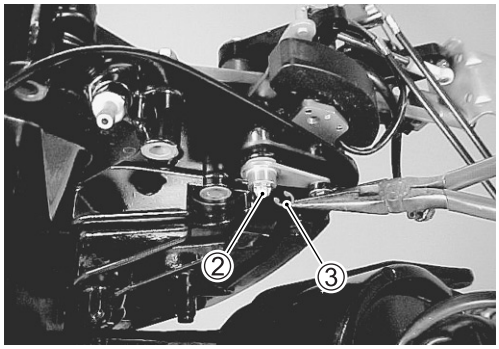
Remove power unit. (See page 6-12 to 6-18.)
Remove lower unit. (See page 9-2.)



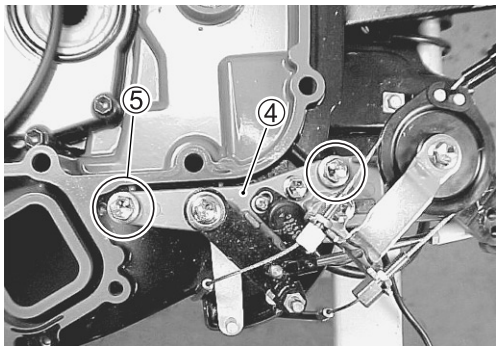
Remove the bolts securing harness clamp plates to engine holder, then remove the engine wiring harness ①.



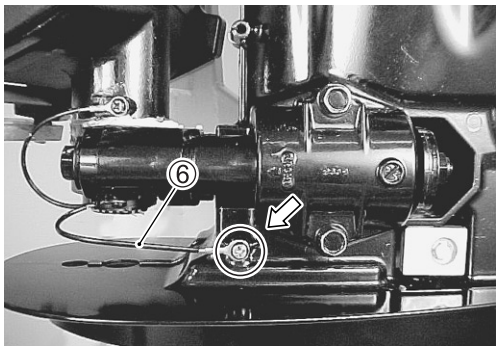
Remove E-ring ③ from clutch lever shaft ②.



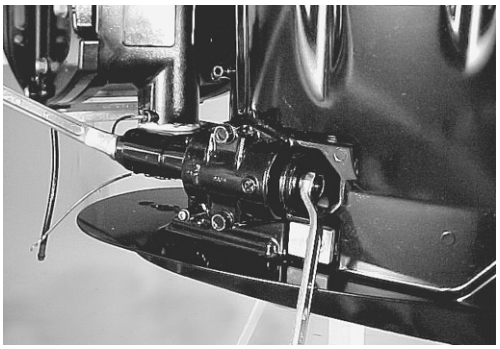
Remove two (2) bolts ⑤ and throttle lever holder ④.

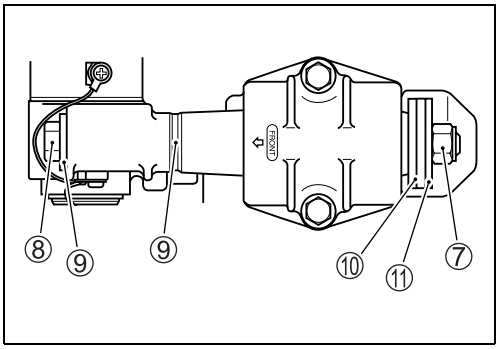


Remove screw and bonding wire ⑥ from driveshaft housing.

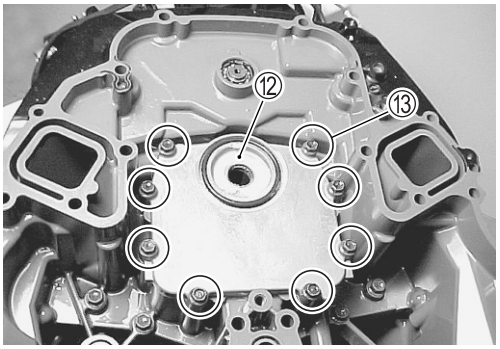


Remove STBD/PORT lower mount nuts ⑦ and lower mount bolts ⑧.
Account for washers ⑨, dampers ⑩ and washer ⑪.

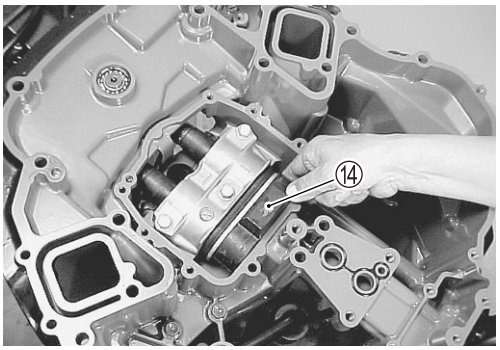




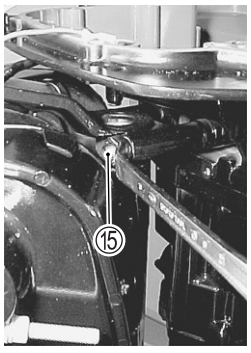
Remove eight (8) bolts ⑬ and the mount·oil seal cover ⑫.
Account for two (2) dowel pins.

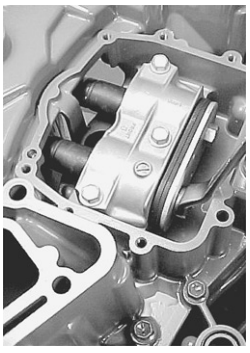


Remove thrust mount ⑭.

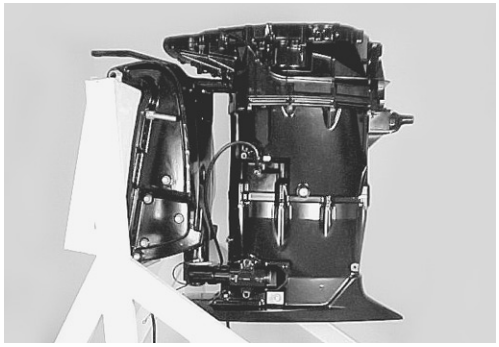


Remove STBD/PORT upper mount nuts ⑮ and washers.

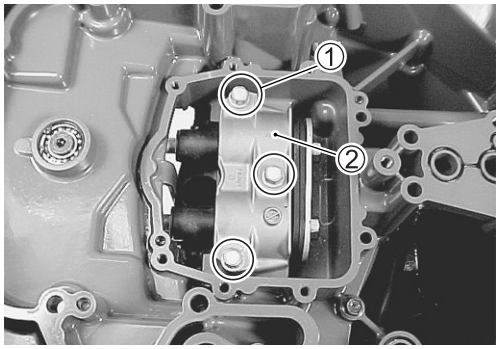




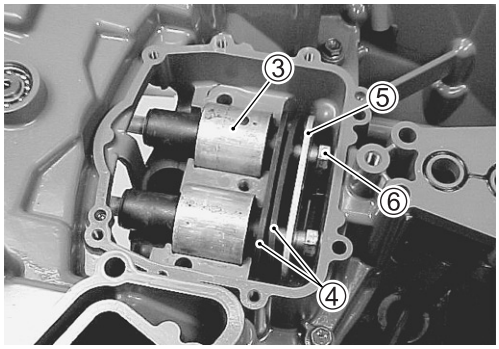
Remove driveshaft housing with oil pan.



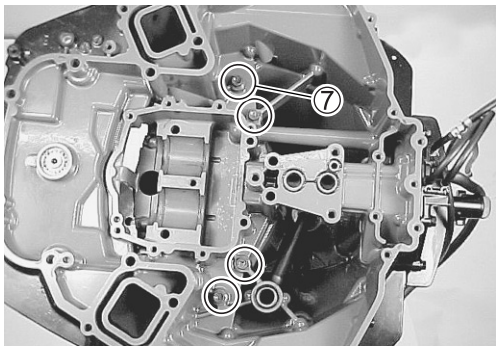
Remove three (3) bolts ① and upper mount cover ②.



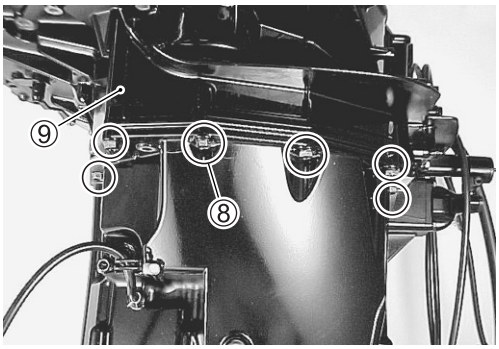
Remove upper mounts ③, thrust stoppers ④, mount plate ⑤ and mount bolts ⑥.

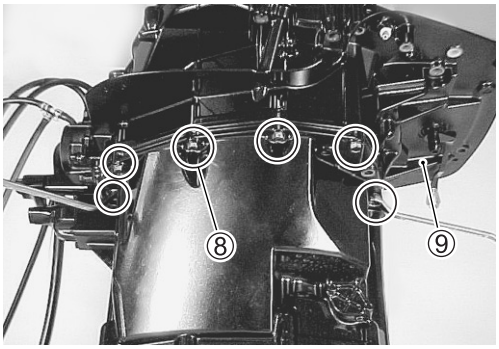


Remove four (4) exhaust tube bolts ⑦.

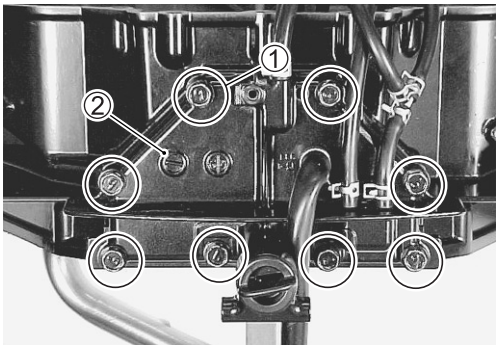


Remove twelve (12) bolts ⑧ and engine holder ⑨.

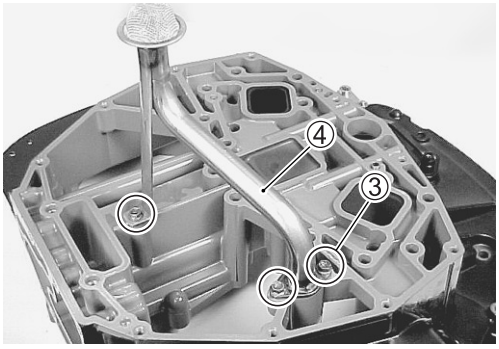




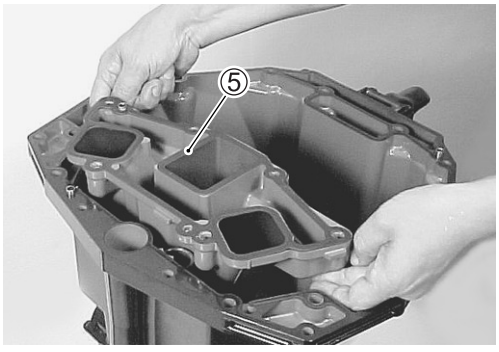
Remove eight (8) bolts ① and engine holder cover ②.



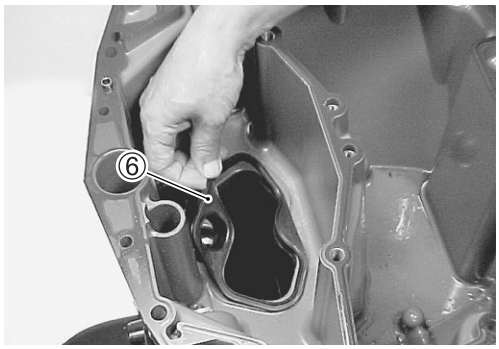
Remove three (3) bolts ③ and oil strainer ④.



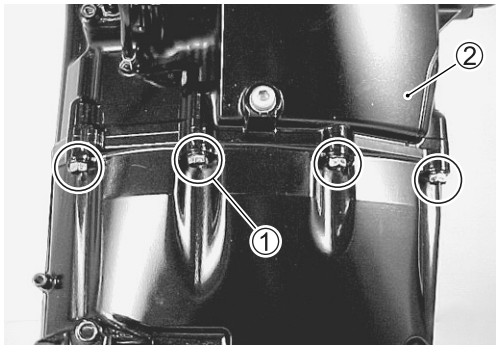
Remove the exhaust tube ⑤.



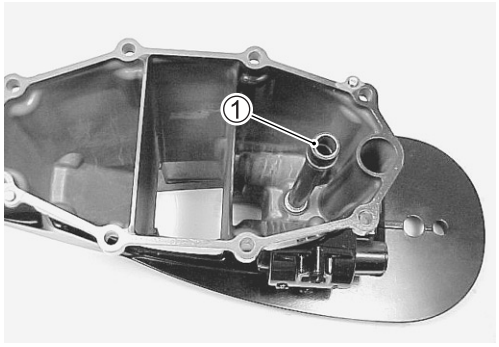
Remove the exhaust tube seal ⑥ from oil pan.



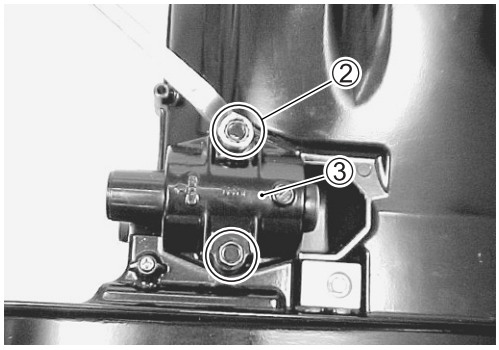
Remove eight (8) bolts ① and oil pan ②.

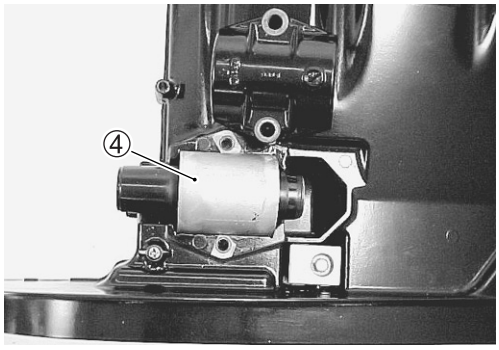


Remove water tube ①.



Remove bolts ②, lower mount cover ③ and lower mounts ④.



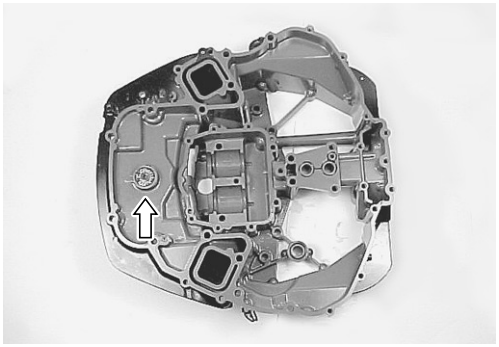


INSPECTION

NOTE:
If any component is found to be excessively worn, cracked, defective or damaged in any way, it must be replaced.

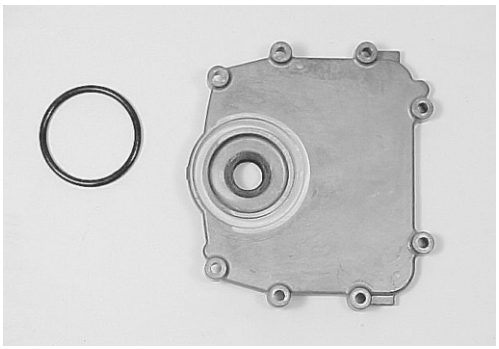
ENGINE HOLDER

- Inspect engine holder. Replace if cracked, damaged, or other abnormal condition.
- Check water passage. If clogged or obstructed, clean water passage.
- Visually check the clutch shaft bearing. Replace if pitted, noisy, rough or other abnormal condition.

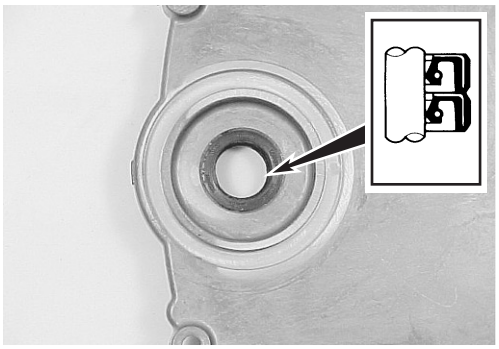


MOUNT·OIL SEAL COVER

- Inspect mount·oil seal cover. Replace if cracked, damaged or other abnormal condition.
- Check condition of O-ring. Replace O-ring if nicked, cut, worn or other abnormal condition.
- Check condition of oil seal. Replace oil seal if nicked, cut, worn or other abnormal condition.

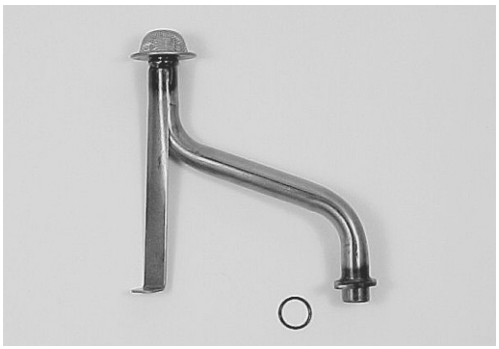


NOTE:
Install oil seal with lip (spring side) facing downward (oil pan side).



OIL STRAINER

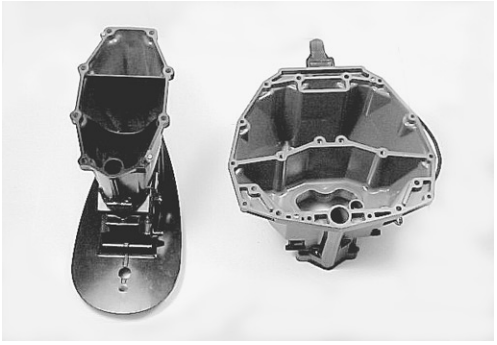
- Inspect oil strainer. Replace if cracked, damaged or other abnormal condition.
  If clog or obstruction, clean oil strainer.
- Check condition of O-ring. Replace O-ring if nicked, cut, worn or other abnormal condition.



OIL PAN/DRIVESHAFT HOUSING

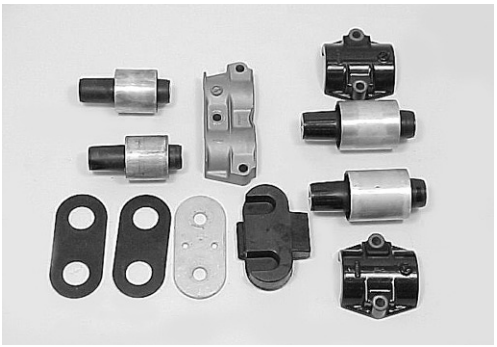
Check oil pan, driveshaft housing.

If cracks, defects or other damage is found, replace it.



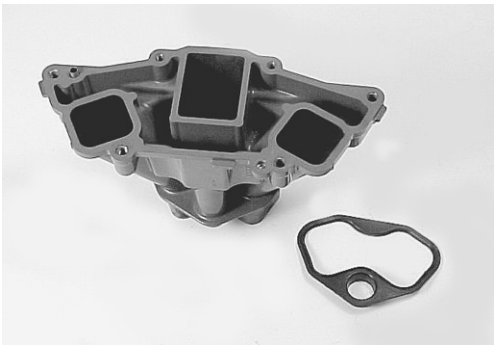
MOUNT

- Check upper, lower and thrust mounts.
  If excessive wear, corrosion or other damage is found, replace mount.
- Inspect mount cover. Replace if cracked, damaged or other abnormal condition.



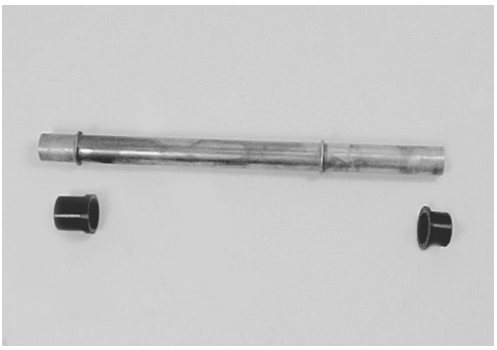
EXHAUST TUBE/SEAL

- Inspect exhaust tube. Replace if cracked, damaged or other abnormal condition.
- Check water passage. If clogged or obstructed, clean water passage.
- Check exhaust passage. If clogged or obstructed, clean exhaust passage.
- Check exhaust tube seal. If excessive wear or other damage is found, replace seal.



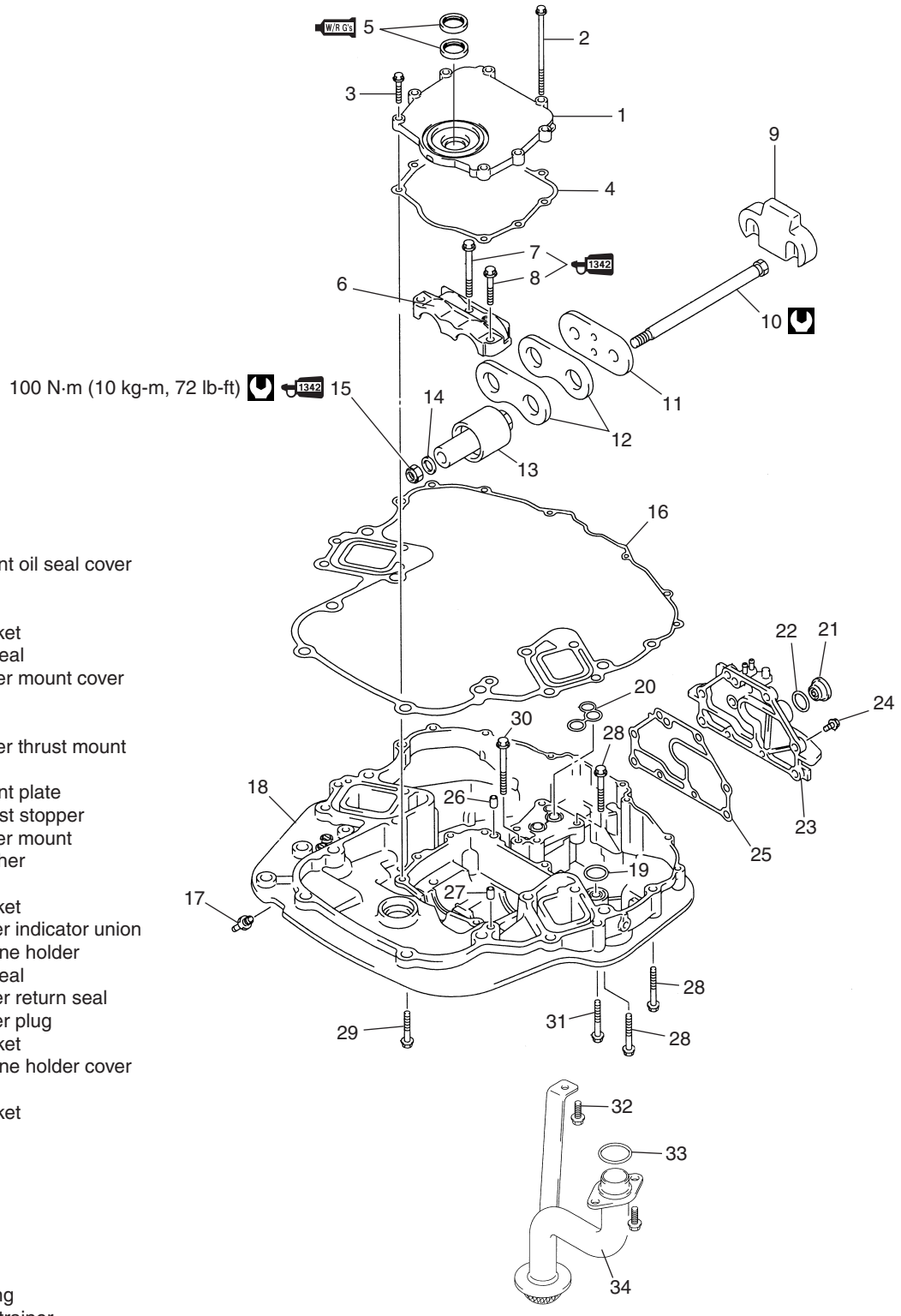
WATER TUBE

- Check water tube.
  If a clog or obstruction is found, clean water tube.
  If cracks, corrosion or other damage is found, replace water tube.
- Check water tube grommet.
  If excessive wear or other damage is found, replace grommet.

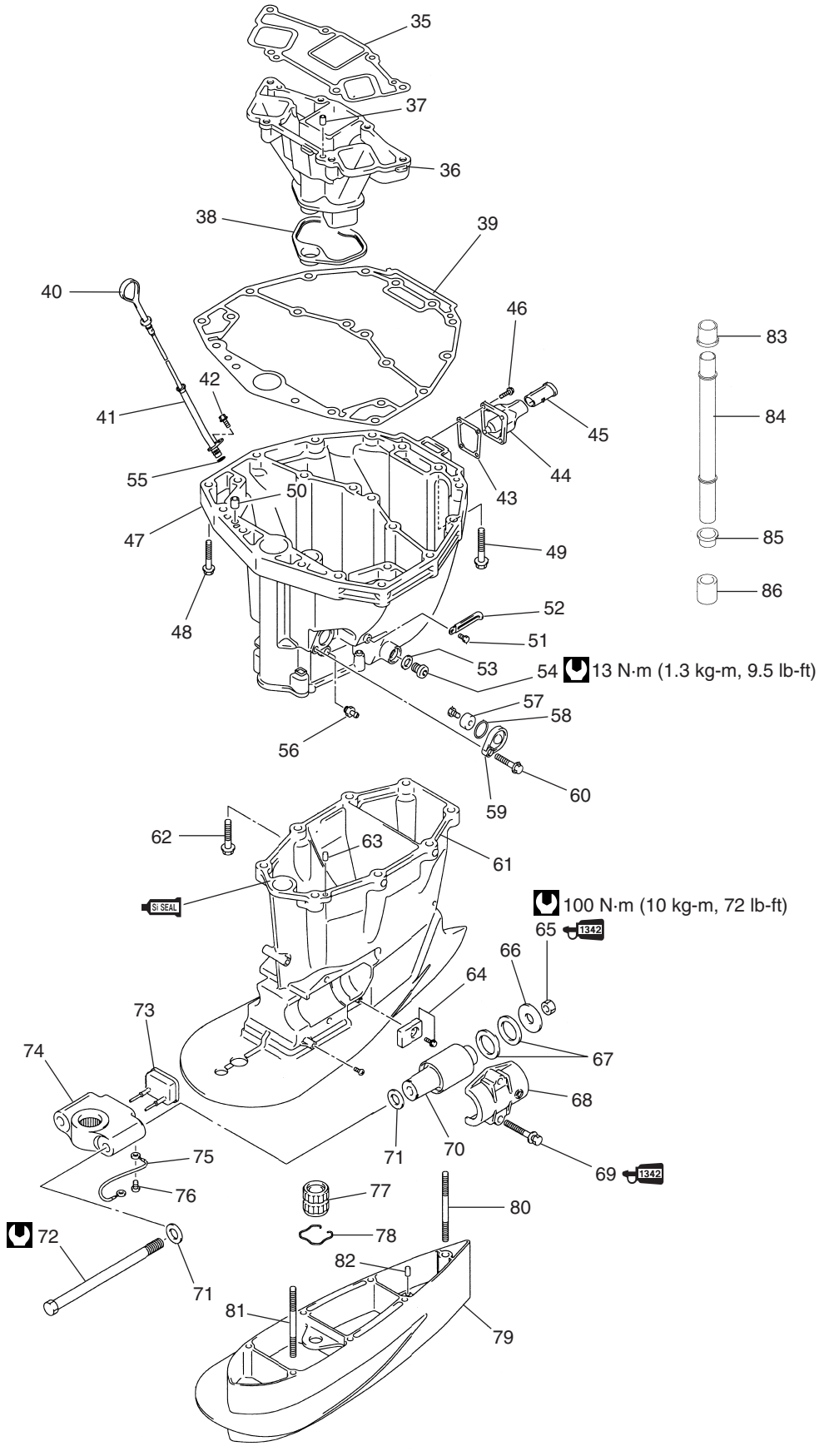


ASSEMBLY

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



1. Mount oil seal cover
2. Bolt
3. Bolt
4. Gasket
5. Oil seal
6. Upper mount cover
7. Bolt
8. Bolt
9. Upper thrust mount
10. Bolt
11. Mount plate
12. Thrust stopper
13. Upper mount
14. Washer
15. Nut
16. Gasket
17. Water indicator union
18. Engine holder
19. Oil seal
20. Water return seal
21. Water plug
22. Gasket
23. Engine holder cover
24. Bolt
25. Gasket
26. Pin
27. Pin
28. Bolt
29. Bolt
30. Bolt
31. Bolt
32. Bolt
33. O-ring
34. Oil strainer



35. Exhaust tube gasket
36. Exhaust tube
37. Pin
38. Exhaust tube seal
39. Gasket
40. Oil level gauge
41. Oil level gauge guide
42. Bolt
43. Gasket
44. Exhaust pipe
45. Exhaust release pipe
46. Bolt
47. Oil pan
48. Bolt
49. Bolt
50. Pin
51. Bolt
52. Clamp
53. Gasket
54. Drain plug
55. O-ring
56. Union
57. Anode
58. O-ring
59. Anode cover
60. Bolt
61. Driveshaft housing
62. Bolt
63. Pin
64. Anode
65. Nut
66. Washer
67. Damper
68. Mount cover
69. Bolt
70. Lower mount
71. Washer
72. Lower mount bolt
73. Thrust mount
74. Lower mount bracket
75. Bonding wire
76. Screw
77. Bush
78. Snap ring
79. Extension case (Type_XX)
80. Bolt
81. Bolt
82. Pin
83. Bush
84. Water tube
85. Bush
86. Water tube spacer

LOWER MOUNT/MOUNT COVER

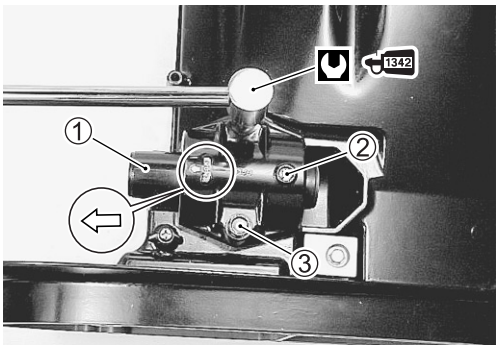
- Install lower mount ① and lower mount cover ②.
  Tighten mount cover bolts ③, pre-coated with thread lock, to specified torque.

NOTE:

Install the lower mount cover to driveshaft housing with arrow (→) mark facing forward.

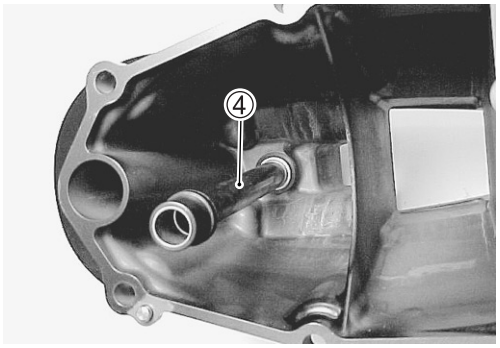
1342 99000-32050: THREAD LOCK "1342"

Lower mount cover bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)



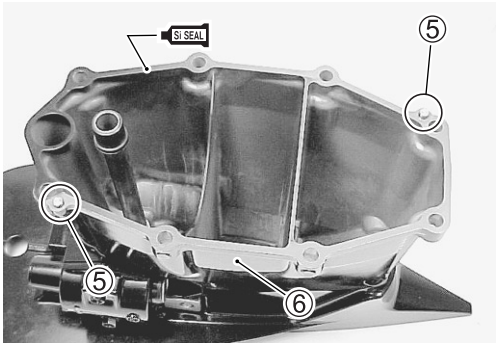
OIL PAN TO DRIVESHAFT HOUSING

- Install water tube ④.



- Install two dowel pins ⑤ to driveshaft housing ⑥.
  Apply sealant to mating surfaces of driveshaft housing and oil pan.

Si SEAL 99000-31120: SUZUKI SILICONE SEAL

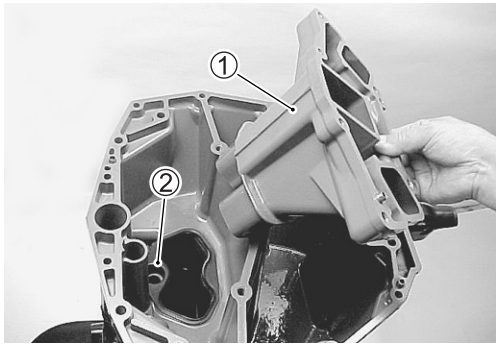


- Install oil pan ⑦ to driveshaft housing ⑥, then tighten eight (8) bolts ⑧ securely.



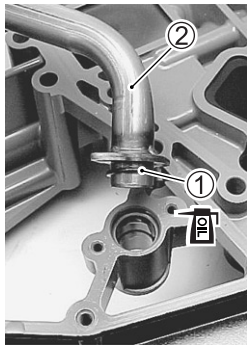
EXHAUST TUBE

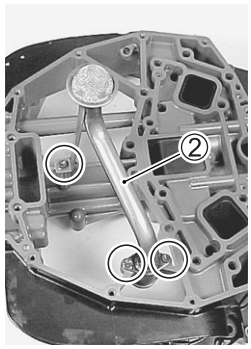
- Place exhaust tube seal ② into oil pan, then install exhaust tube ①.



ENGINE HOLDER TO OIL PAN

- Apply engine oil to O-ring ①, then install O-ring to oil strainer ②.
- Install oil strainer to engine holder, then tighten bolts securely.

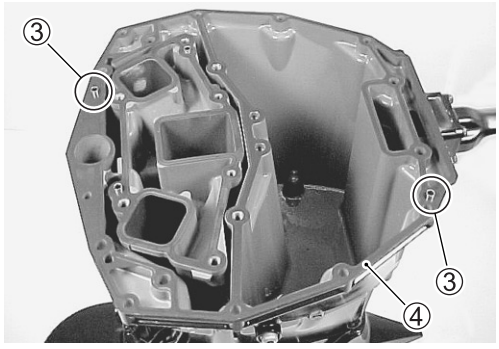




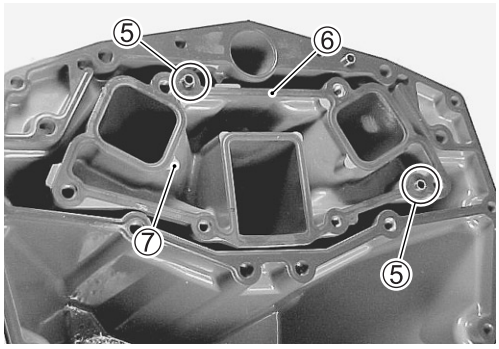
- Install two (2) dowel pins ③ and gasket ④ to oil pan.

CAUTION

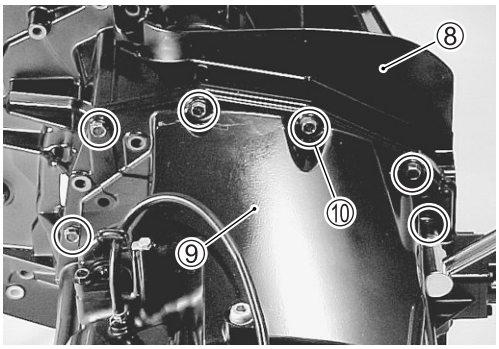
Do not re-use gasket. Always assemble with a new gasket.

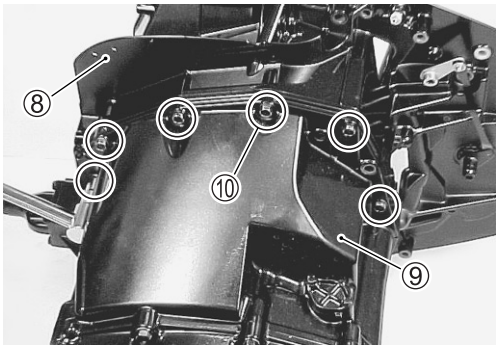


- Install two (2) dowel pins ⑤ and gasket ⑥ to exhaust tube ⑦.

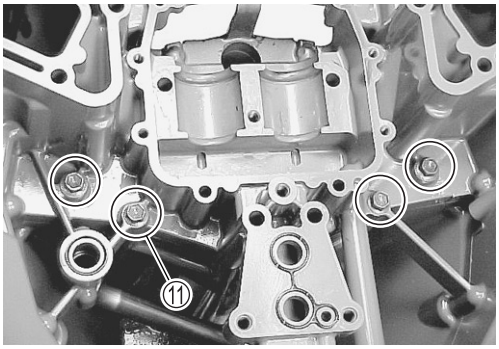


- Install engine holder ⑧ to oil pan ⑨, then securely tighten it with engine holder bolts ⑩.



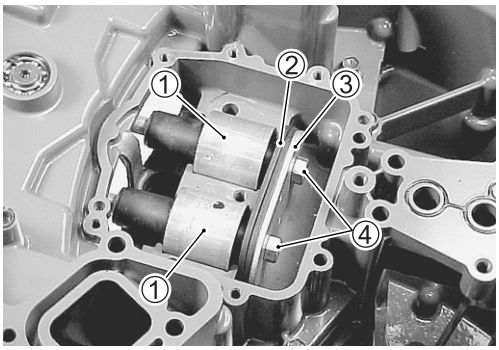


- Install exhaust tube bolts ⑪, then tighten four (4) exhaust tube bolts securely.



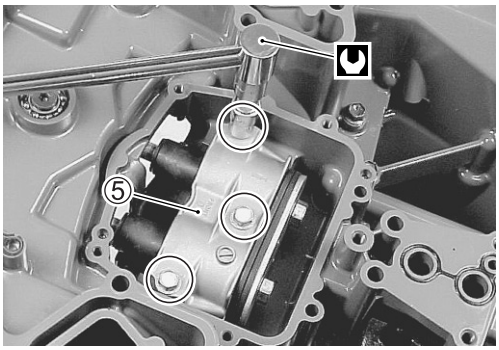
UPPER MOUNT AND MOUNT COVER

- Assemble these items in the following sequence:
  Place upper mount plate ③, thrust stopper plates ② and upper mounts ① on upper mount bolts ④.
- Place upper mount assembly and upper mount cover ⑤ into position.
- Tighten upper mount cover bolts, pre-coated with thread lock, to specified torque.



1342 99000-32050: THREAD LOCK "1342"

Upper mount cover bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

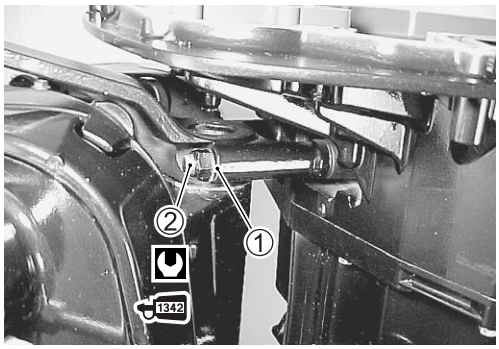


DRIVESHAFT HOUSING/OIL PAN

- Install driveshaft housing/oil pan to steering bracket.
- Install washer ① and upper mount nut ②, then tighten two (2) nuts, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

Upper mount nut: 100 N·m (10.0 kg-m, 72.3 lb-ft)

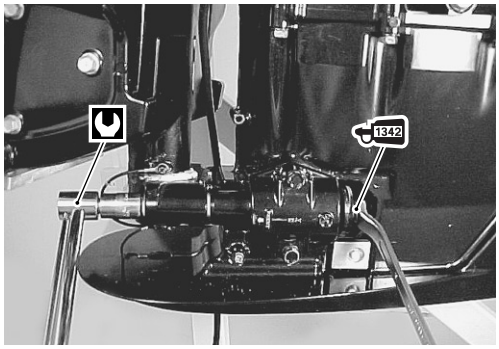


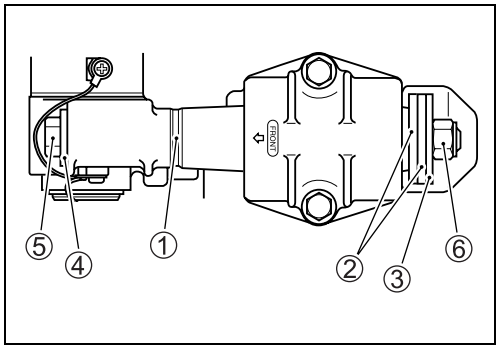
LOWER MOUNT BOLT/NUT

- Place washer ①, dampers ② and washer ③ into driveshaft housing.
- Install lower mount bolt ⑤, washer ④ and nut ⑥, then tighten nut, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

Lower mount bolt/nut: 100 N·m (10.0 kg-m, 72.3 lb-ft)



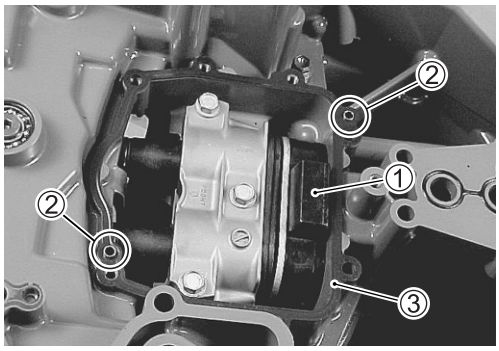


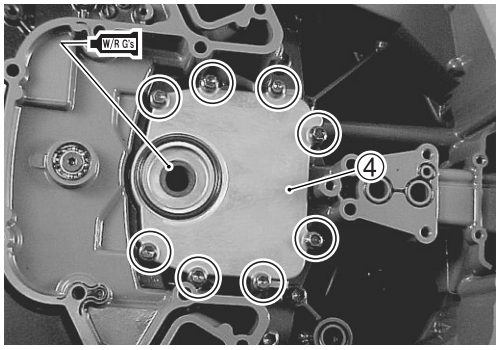
MOUNT·OIL SEAL COVER

- Install thrust mount ①.
- Apply Water Resistant Grease to oil seal.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

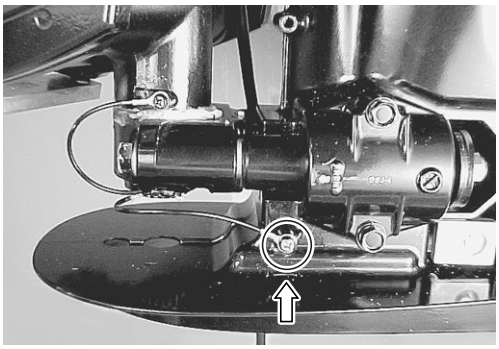
- Install dowel pins ②, gasket ③ and mount·oil seal cover ④, then tighten eight (8) cover bolts securely.





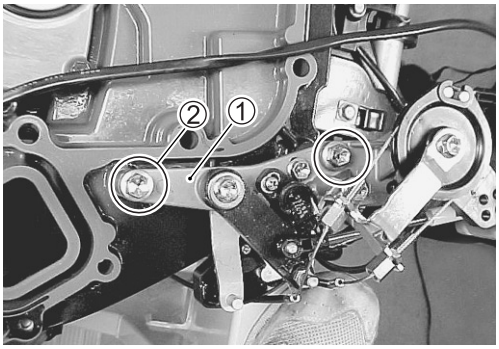
BONDING WIRE

Reattach bonding wire to driveshaft housing and tighten screw securely.

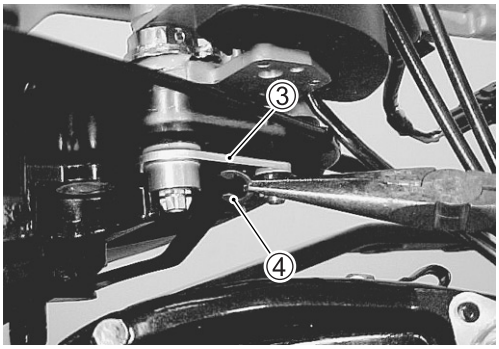


THROTTLE LEVER HOLDER

- Install throttle lever holder ① to engine holder, then tighten two (2) bolts ② securely.



- Install clutch lever shaft ③ and E-ring ④.



POWER UNIT

Install power unit. (See page 6-18 to 6-22.)

Tighten power unit mounting bolts and engine holder bolts to specified torque.

Power unit mounting bolt & Engine holder bolt:

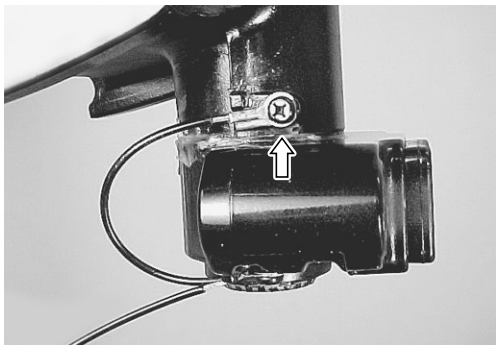
8 mm 23 N·m (2.3 kg-m, 16.5lb-ft)

10 mm 50 N·m (5.0 kg-m, 36.0 lb-ft)

SWIVEL BRACKET, STEERING BRACKET AND CLAMP BRACKET

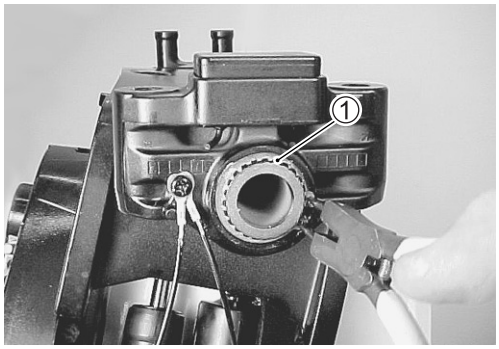
REMOVAL

Remove driveshaft housing/oil pan.
(See page 7-3.)

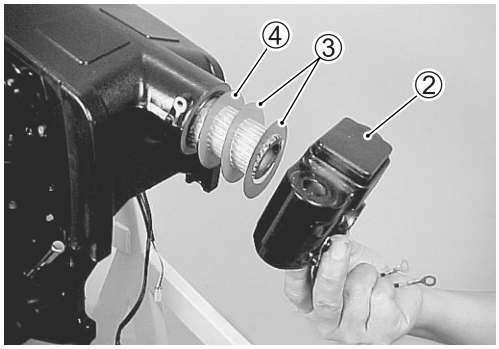


Remove screw and bonding wire from lower mount bracket.

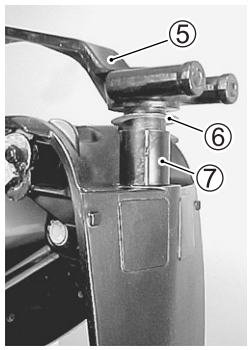
Remove circlip ①.

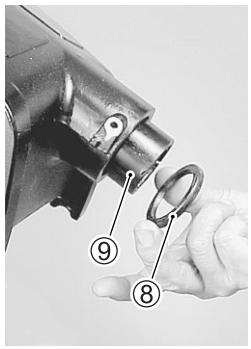


Remove lower mount bracket ②, shims ③ and washer ④ from the steering shaft.

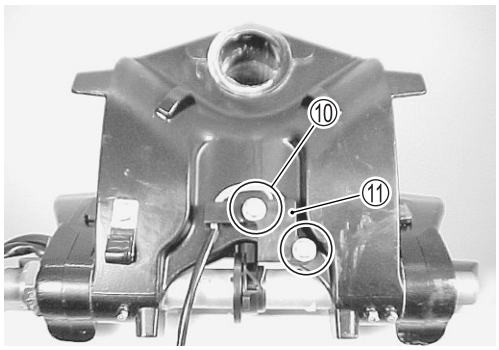


Lift steering bracket ⑤ upward to remove from swivel bracket.
Remove washer ⑥ and upper bushing ⑦.
Remove swivel bracket seal ⑧ and lower bushing ⑨.



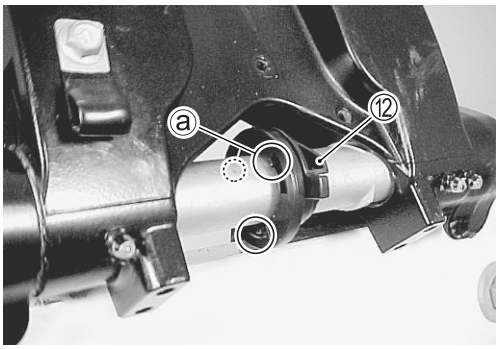


Remove two (2) bolts ⑩ and tilt limit switch ⑪.



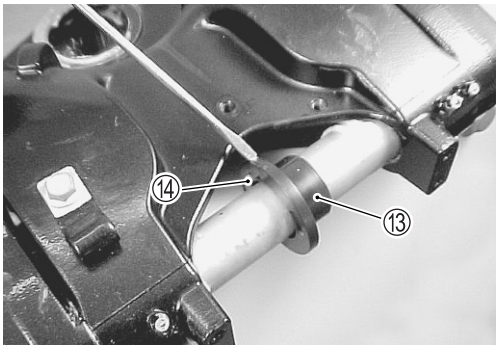
Remove tilt limit switch cam ⑫.

NOTE:
Unfasten three (3) stoppers ⓐ from the tilt limit switch cam to remove it from cam holder.

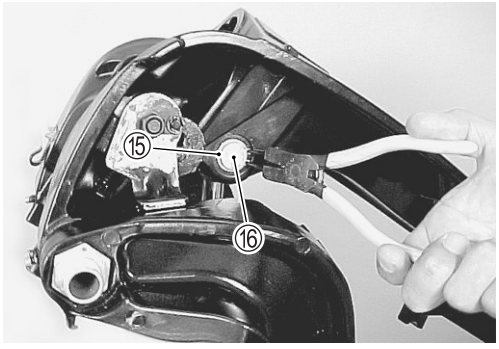


Remove upper cam holder ⑬ and lower cam holder ⑭ from clamp bracket shaft.

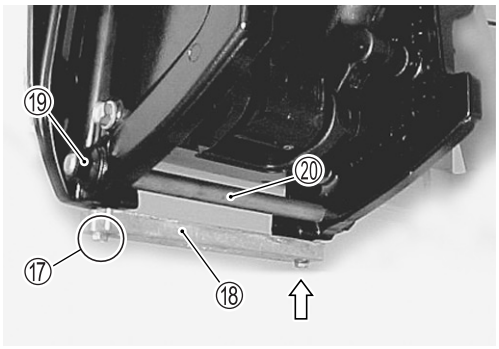
NOTE:
Use thin flat screw-driver to release the two hooks to separate the cam holder upper and lower halves.



Remove circlip ⑮ and push out tilt cylinder upper rod ⑯.



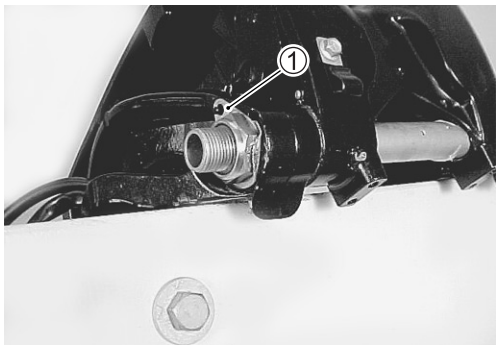
Remove bolts ⑰ and anode ⑱.
Remove nut ⑲ and tilt pin ⑳.



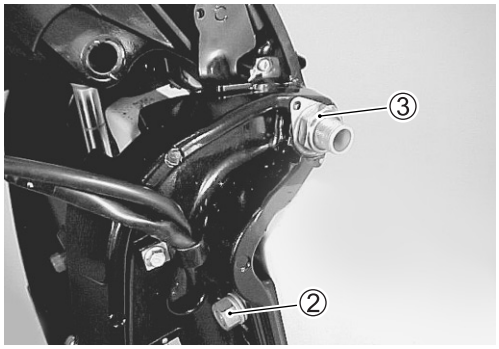
Remove bolts ㉑ securing PTT unit to the STBD and PORT clamp brackets.



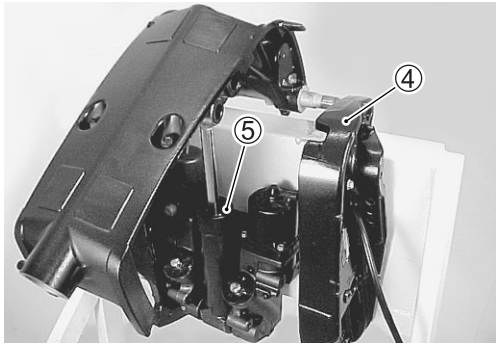
Using flat screw-driver, drive locking edge of lock washer ① to clamp bracket side.



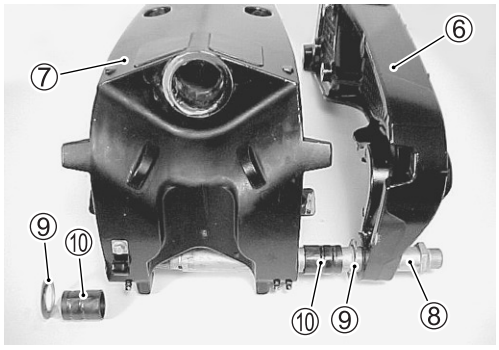
Remove the two STBD motor mounting bolts ②.
Remove the clamp bracket shaft nut ③ and washer.



Slide STBD clamp bracket ④ off clamp bracket shaft, then remove PTT unit ⑤.



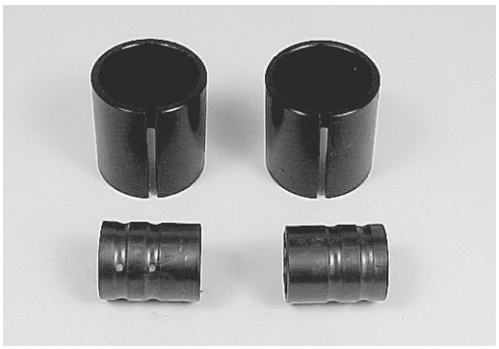
Pull PORT clamp bracket ⑥ outward to remove clamp bracket and bracket shaft ⑧ from swivel bracket ⑦.
Remove washer ⑨ and bushing ⑩ from each side of swivel bracket.



INSPECTION

NOTE:
If any component is found to be excessively worn, cracked, defective or damaged in any way, it must be replaced.

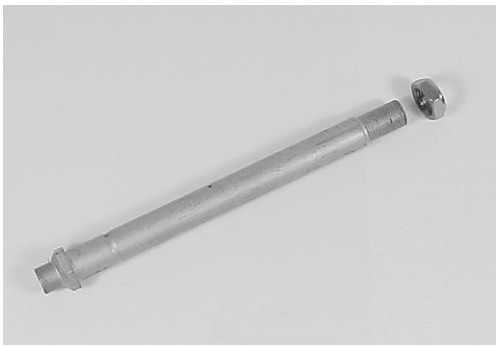
BUSHINGS
Check all bushings.
If excessive wear or other damage is found, replace bushing.
If bushing fit is loose when installing, replace bushing.



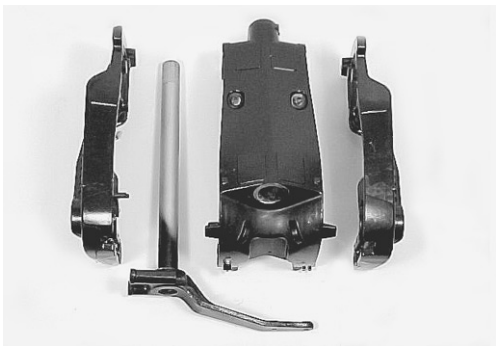
OIL SEAL
Check swivel bracket seal.
If excessive wear or other damage is found, replace seal.



CLAMP BRACKET SHAFT
Check clamp bracket shaft.
If clamp bracket shaft is bent or twisted, replace shaft.

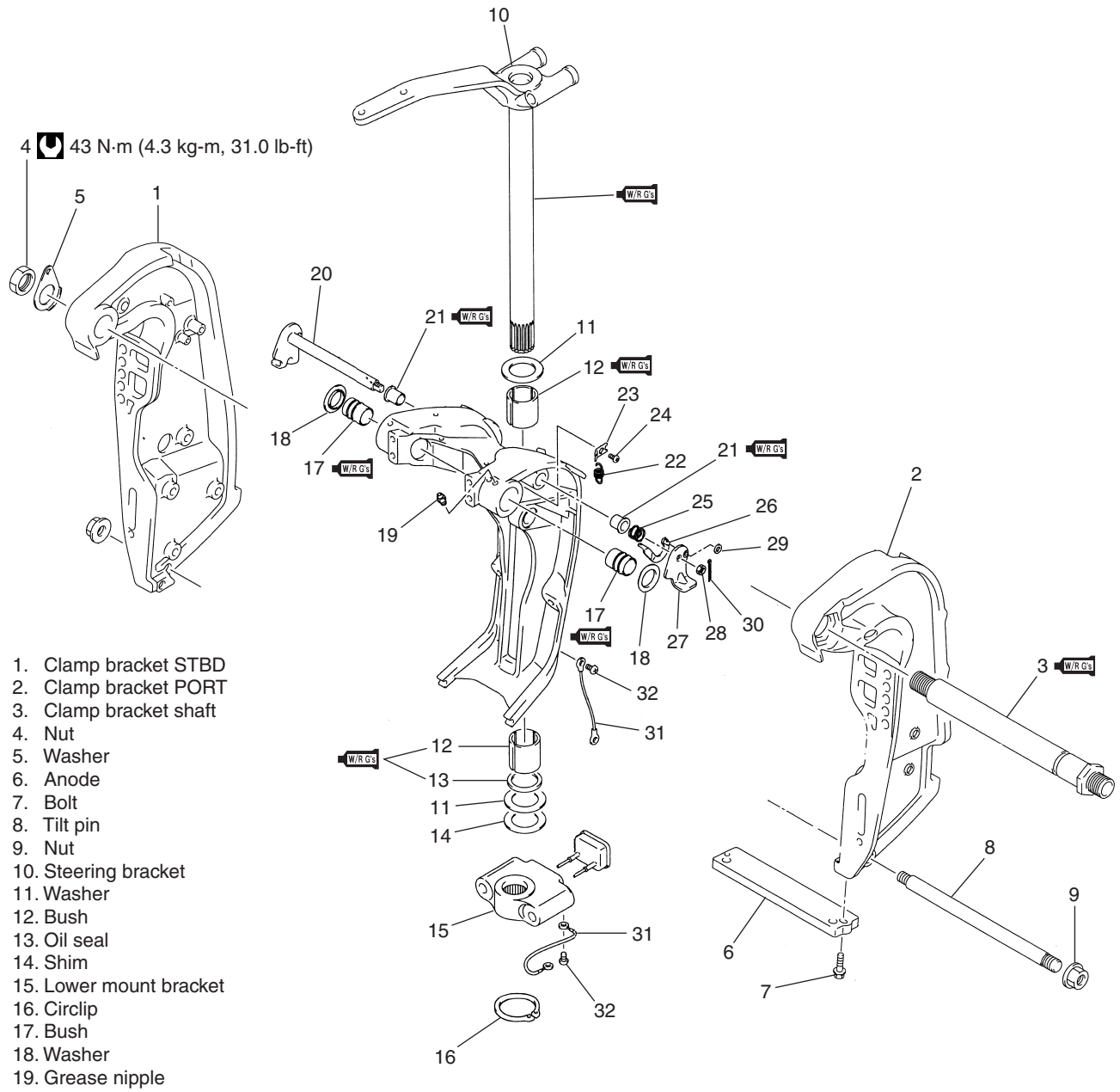


BRACKET
Check clamp brackets, steering bracket and swivel bracket.
If cracks or other damage is found, replace bracket (s).



REASSEMBLY

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

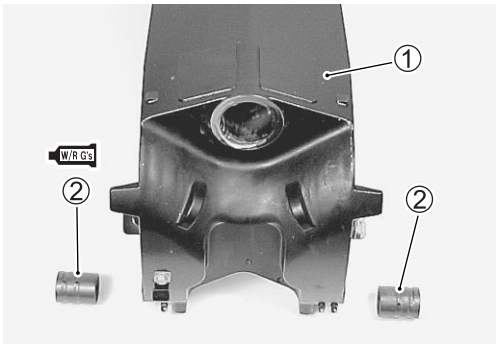


1. Clamp bracket STBD
2. Clamp bracket PORT
3. Clamp bracket shaft
4. Nut
5. Washer
6. Anode
7. Bolt
8. Tilt pin
9. Nut
10. Steering bracket
11. Washer
12. Bush
13. Oil seal
14. Shim
15. Lower mount bracket
16. Circlip
17. Bush
18. Washer
19. Grease nipple
20. Tilt lock lever
21. Bush
22. Spring
23. Bracket
24. Screw
25. Spring
26. Link
27. Tilt lock lever PORT
28. Nut
29. Washer
30. Pin
31. Bonding wire
32. Screw

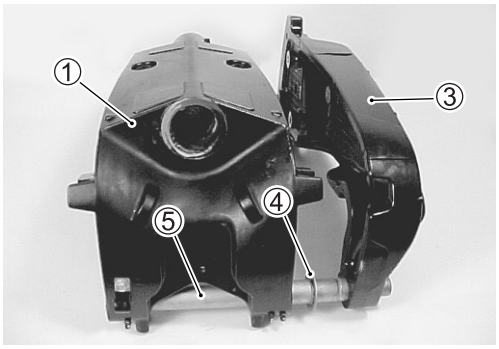
CLAMP BRACKET AND SWIVEL BRACKET

NOTE:
Before installing clamp bracket to swivel bracket, apply grease to clamp bracket shaft and bushings.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

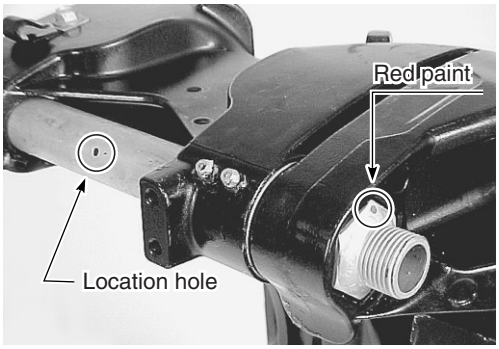


- Insert PORT and STBD bushings ② into the swivel bracket ①.

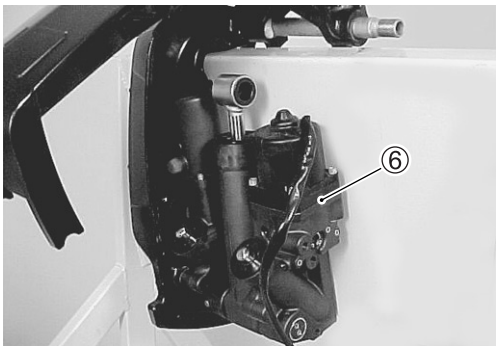


- Assemble port clamp bracket ③, washer ④, clamp bracket shaft ⑤ and swivel bracket ①.

NOTE:
For proper operation of the tilt limit device, install the clamp bracket shaft to the port clamp bracket so the red paint mark on the hex section and the cam holder location hole on the clamp bracket shaft are positioned as shown in the illustration.

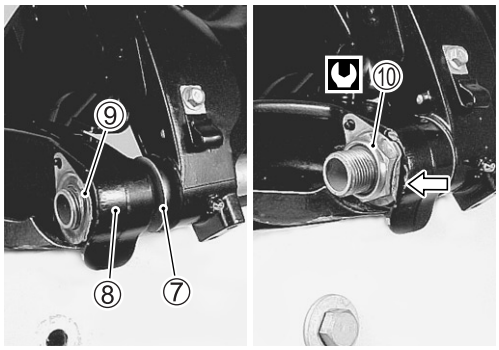


- Install PTT unit assembly ⑥.
  (For PTT unit assembly installation, see page 8-18 to 8-19.)



- Install washer ⑦, STBD clamp bracket ⑧, lock washer ⑨ and clamp bracket shaft nut ⑩, then tighten clamp bracket shaft nut to specified torque.

Clamp bracket shaft nut: 43 N·m (4.3 kg-m, 31.0 lb-ft)

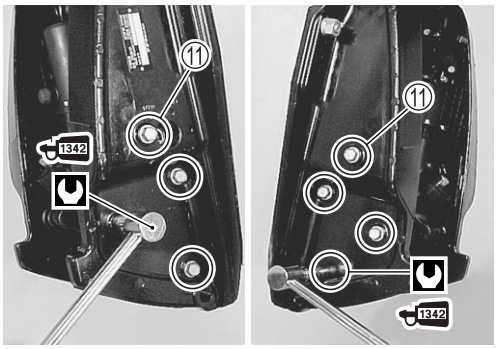


- After tightening clamp bracket shaft nut with specific torque, bend lock washer edge toward nut for locking.

- Tighten eight (8) PTT unit retaining bolts ⑪, pre-coated with thread lock, to specified torque.

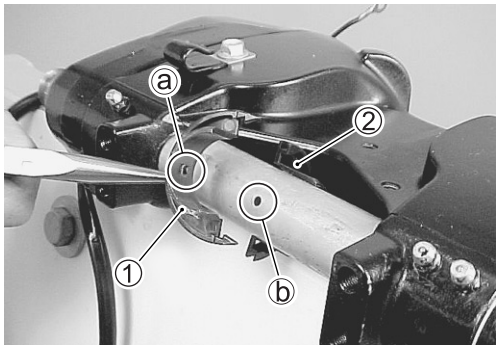
1342 99000-32050: THREAD LOCK "1342"

PTT retaining bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

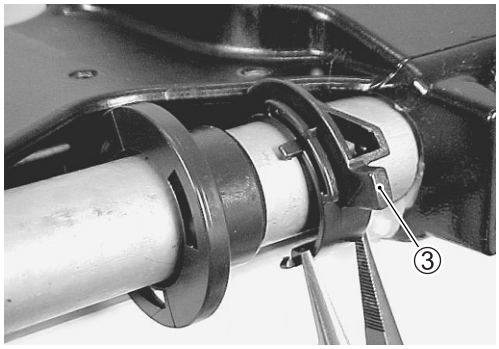


TILT LIMIT DEVICE

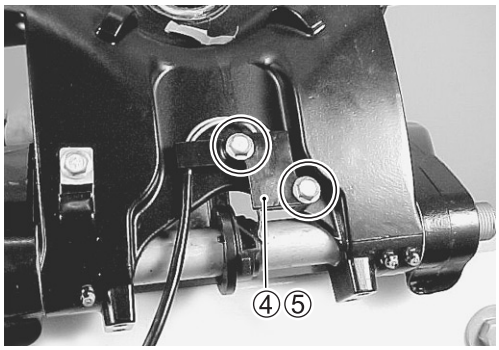
- Install the lower cam holder ① engaging its locating pin ⓐ with the clamp bracket shaft hole ⓑ, then install the upper cam holder ②.



- Install tilt limit switch cam ③.



- Install tilt limit switch ④ and switch holder ⑤, then secure with bolts.



STEERING BRACKET

- Apply Water Resistant Grease to steering bracket shaft.

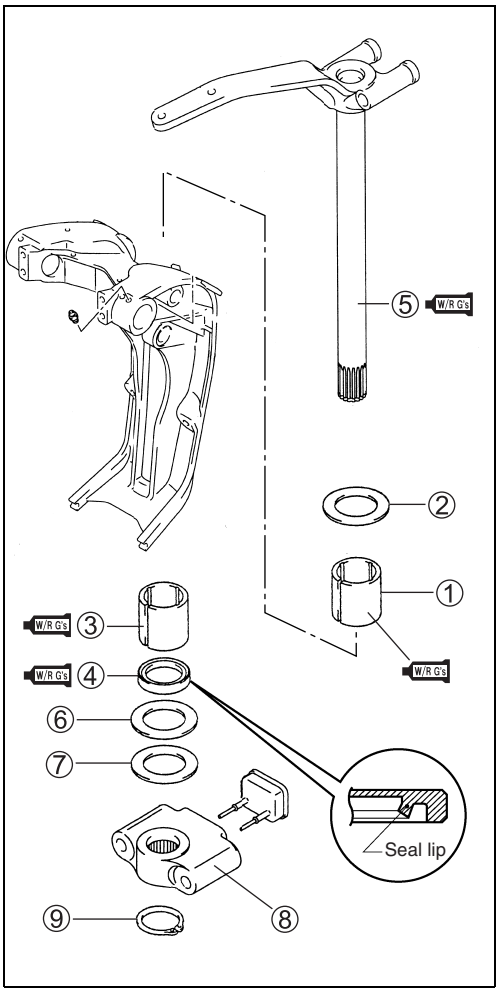
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

NOTE:
Apply grease to bushings, oil seal lip and pilot shaft portion of steering bracket.

- Install upper bushing ① and washer ② to swivel bracket.
- Install lower bushing ③ and swivel bracket seal ④ to swivel bracket.

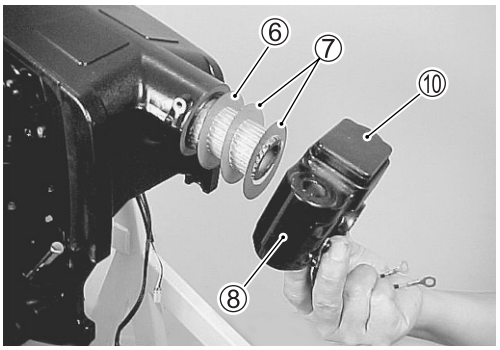
NOTE:
Install seal ④ with lip (spring side) facing downward.

- Install steering bracket ⑤ to swivel bracket.



LOWER MOUNT BRACKET

- Install lower thrust mount ⑩ to lower mount bracket ⑧.
- Install washer ⑥ and shim ⑦, and then slide the lower mount bracket ⑧ upward on the splines until it contacts the shim.
- Install circlip ⑨ to retain bracket.



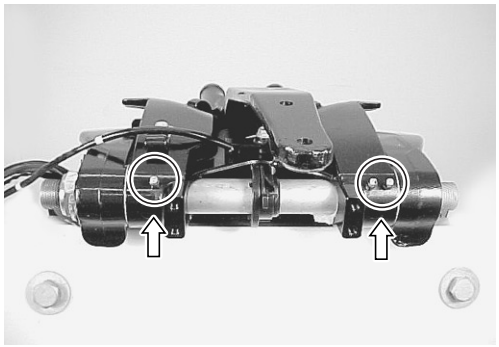


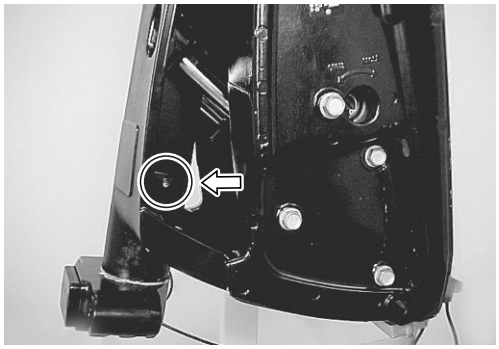
BONDING WIRE
Reattach bonding wire, tightening screw securely.



LUBRICATION
After completing reassembly of the mid unit, apply grease through each grease nipple.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**

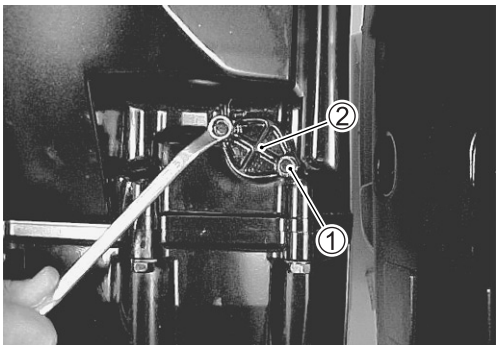


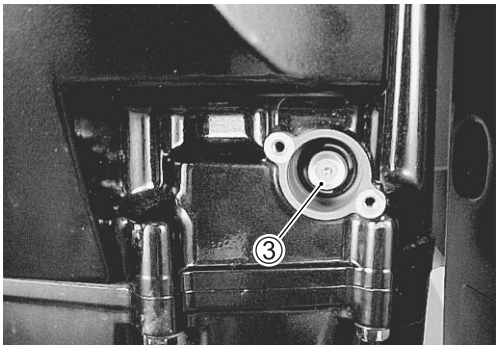


WATER PRESSURE VALVE

REMOVAL

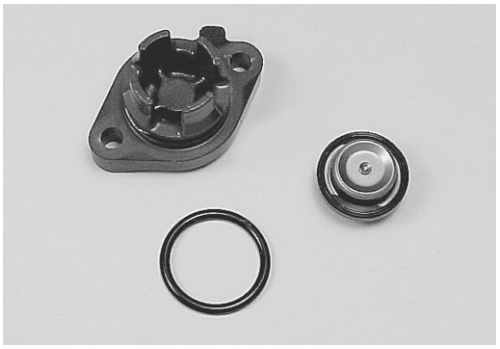
- Remove oil pan cover. (See page 7-2.)
- Remove two bolts ①, pressure valve cover ② and water pressure valve ③.





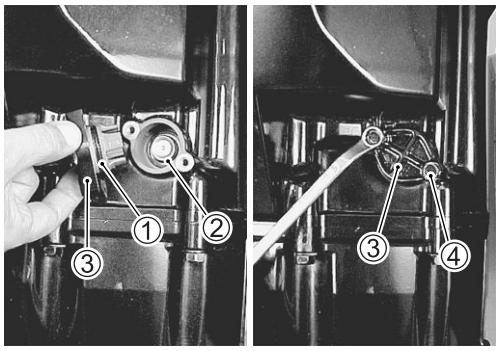
INSPECTION

- If salt deposits, corrosion, wear or other damage is found, clean or replace.
- Inspect O-ring. Replace if nicked, cut or torn.



INSTALLATION

- Install O-ring ① to pressure valve cover.
- Install pressure valve ② and pressure valve cover ③ to oil pan and secure with bolts ④.

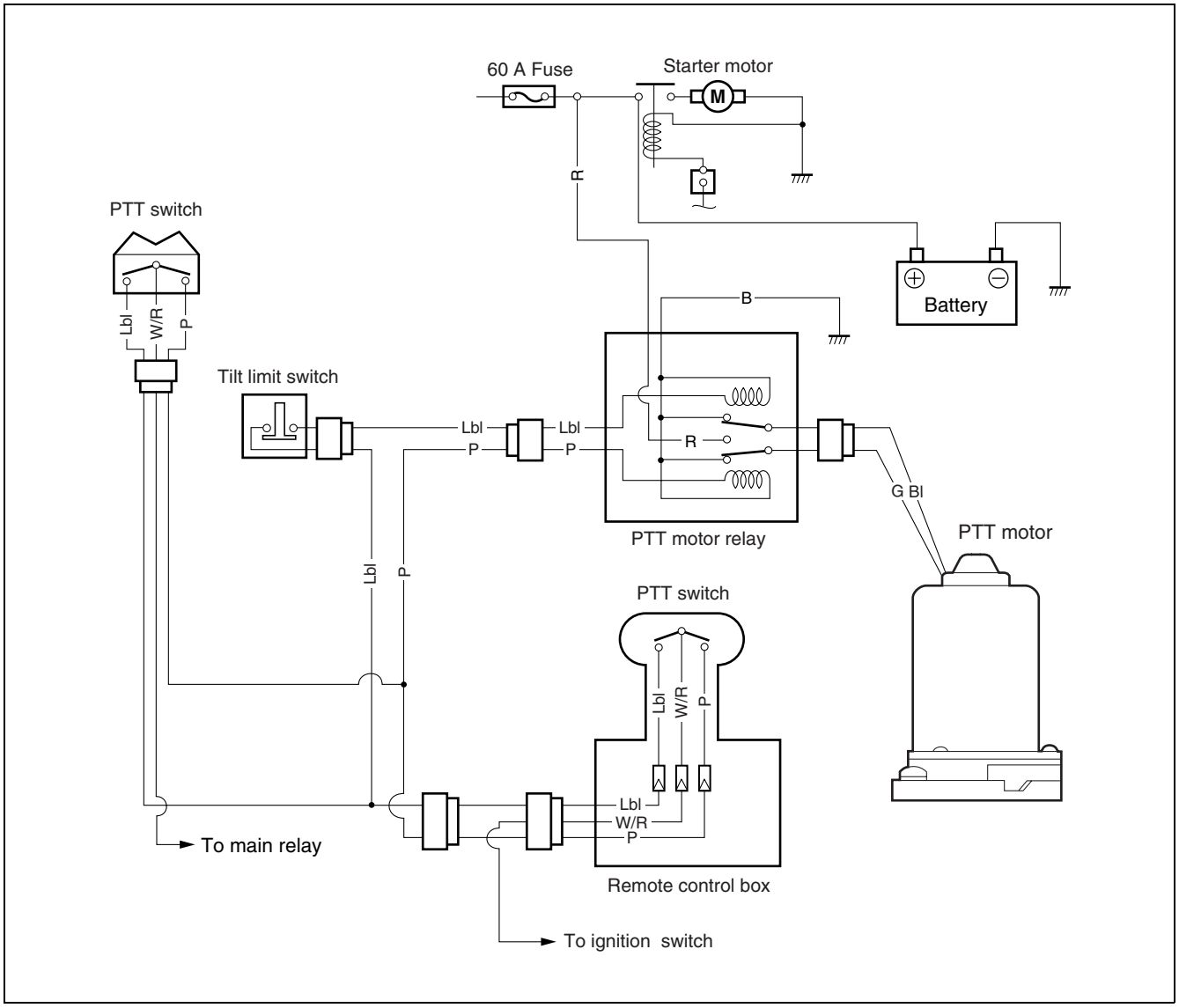


POWER TRIM AND TILT

CONTENTS

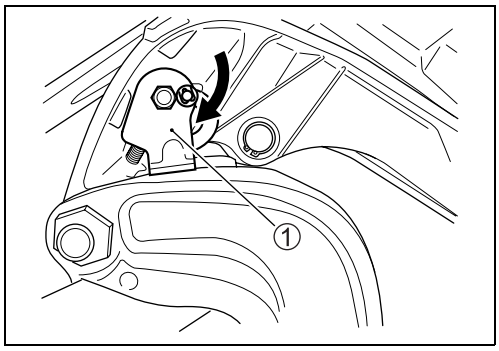
SYSTEM WIRING DIAGRAM 8- 2
SERVICE PROCEDURE 8- 3
OIL LEVEL 8- 3
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SYSTEM WIRING DIAGRAM

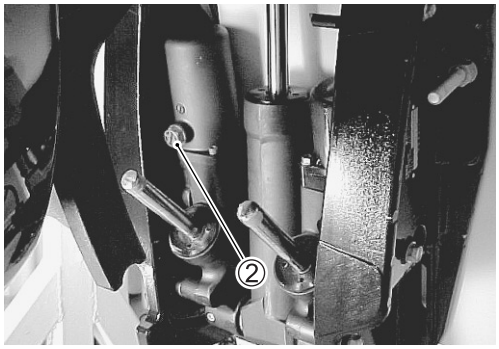


SERVICE PROCEDURE

OIL LEVEL



To check the PTT oil level:
1. Raised the engine to a full-tilt position.
2. Lower the manual tilt lock lever ①.



3. Remove the oil filler plug ②.
4. If oil can be seen at filler plug level, the unit is full.
5. If oil level is low, refill with the recommended oil.

Recommended oil:

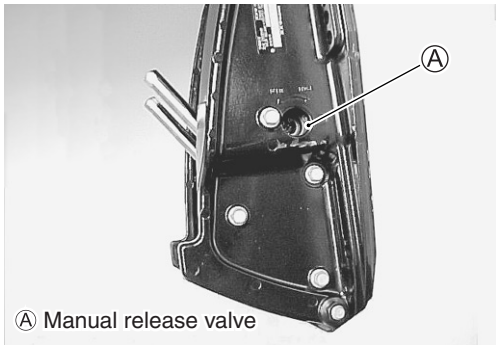
Dexron Ⅲ automatic transmission fluid or equivalent

CAUTION

To ensure consistent pump operation, do not mix different types of oil.

6. Reinstall oil filler plug.

AIR BLEEDING



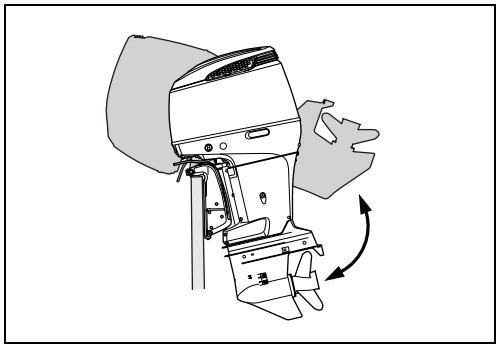
1. Check that the manual release valve is tightened to the specified torque.

Manual release valve: 3.5 N·m (0.36 kg-m, 2.6 lb-ft)

CAUTION

Do not over-tighten manual release valve.

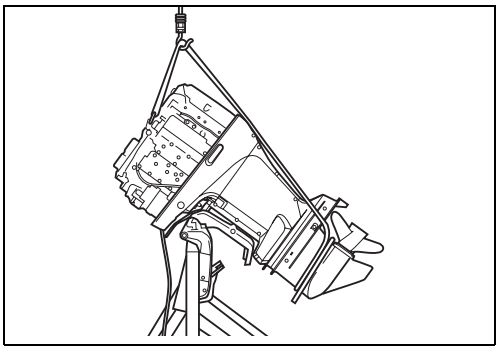
Counterclockwise = Open
Clockwise = Close



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 oil level, topping off if necessary.
4. Reinstall oil filler plug.

POWER TRIM AND TILT UNIT

REMOVAL

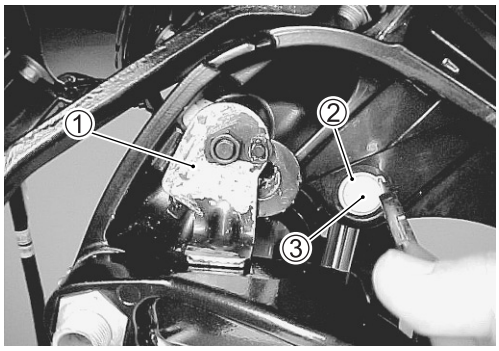


Raise the engine to the full tilt position and lower the manual tilt lock levers ①.

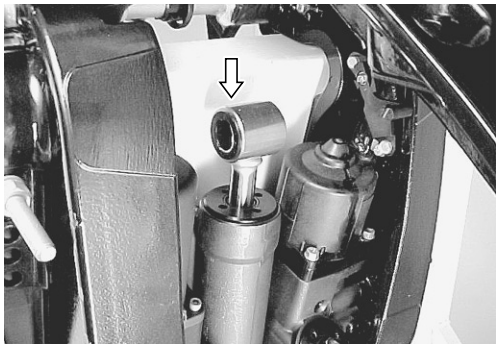
⚠ WARNING

During the following procedures, the engine must be firmly secured and its weight fully supported. (See right.)

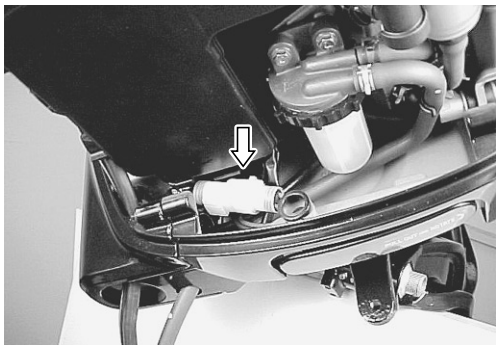
Remove the tilt rod snap ring ② and push tilt cylinder upper shaft pin ③ out.



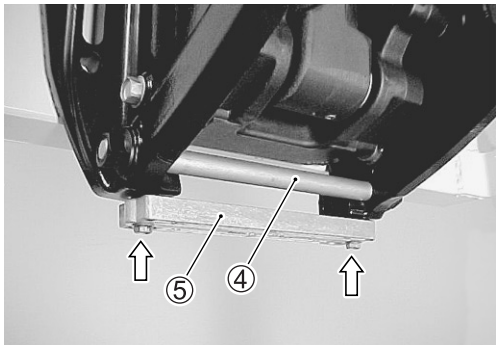
Lower tilt rod to full down position and disconnect the battery cable.



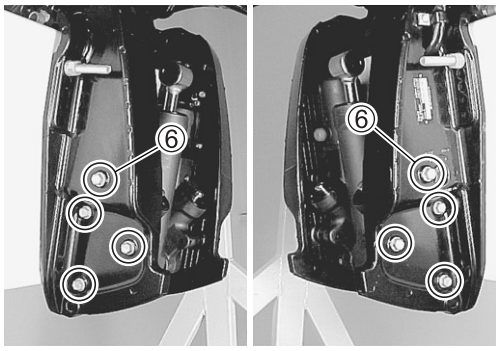
Disconnect the PTT motor cable wire connector from the PTT relay.
Remove the PTT motor cable from engine lower cover.



Remove the tilt pin ④.
Remove two (2) bolts and anode ⑤.

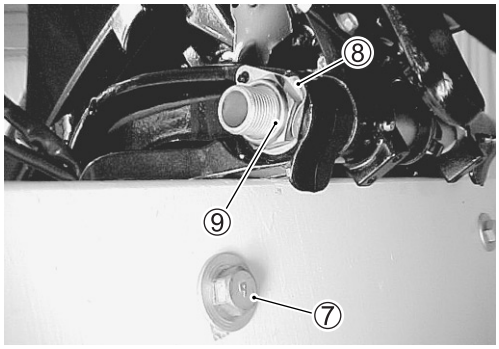


Remove the eight (8) bolts ⑥ securing PTT unit to STBD/PORT clamp bracket.

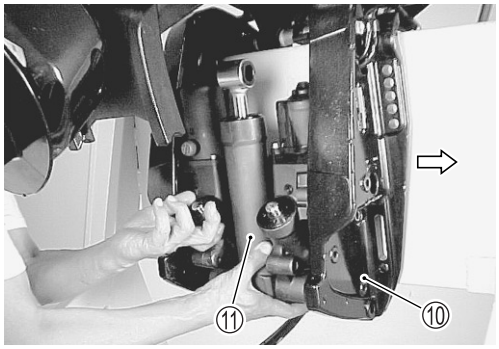


Remove two STBD motor mounting bolts ⑦.
Using flat screw driver, drive locking edge of lock washer ⑧ to clamp bracket side.
Loosen the clamp bracket shaft nut ⑨.

NOTE:
Complete removal of the clamp bracket shaft nut is not required. Nut should be loosened as far as the end of the shaft threads only to facilitate removal of the PTT unit.



Slide the STBD clamp bracket ⑩ fully outward to the right hand side.
Remove the PTT unit ⑪ from between the clamp brackets.

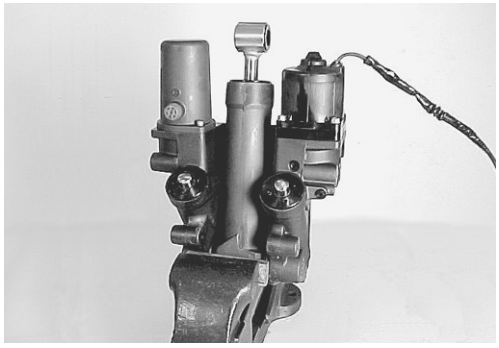


DISASSEMBLY

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.

Place the lower of the PTT unit in a vise. Tighten the vise only enough to secure the PTT unit, DO NOT OVER TIGHTEN.

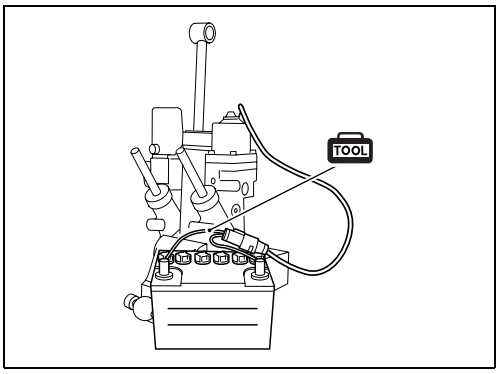
NOTE:
To prevent damage to the PTT cylinder use wood blocks, vise jaw protectors, etc., between the vise jaws and PTT components before tightening vise.



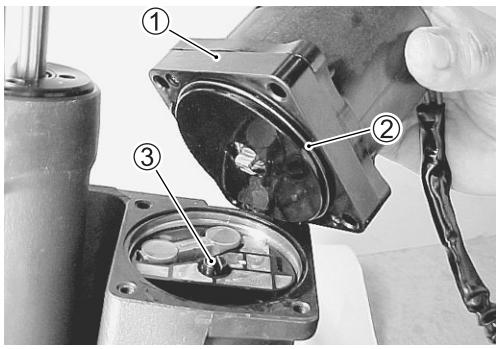
Connect the PTT cable extension to PTT motor cable connector.

TOOL 09945-79310: PTT cable extension

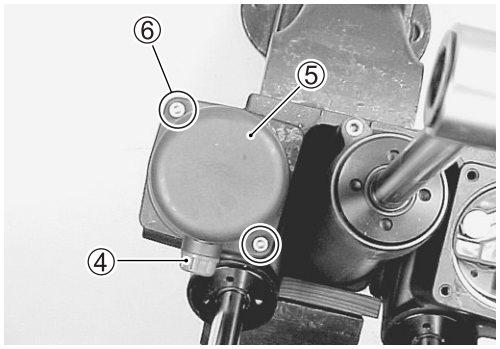
Connect the PTT cable extension leads (G, Bl) to battery and operate PTT motor until tilt piston rod is at maximum stroke. (full-tilt up position)



Remove the PTT motor assembly ①. (See page 8-14.)
Note the position of drive joint ③ and O-ring ②, before removing them.

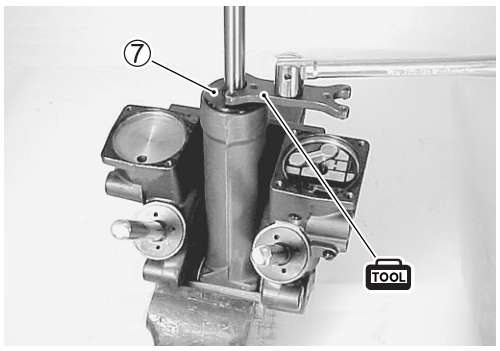


Unscrew the filler plug ④ and drain PTT oil into suitable container.
Remove the two (2) screws ⑥ securing reservoir ⑤, then detach the reservoir from PTT manifold.
Note the position of O-ring and remove it.

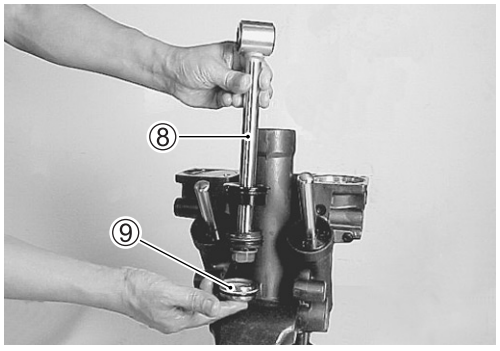


Using special tool, unscrew the PTT cylinder head ⑦.

TOOL 09944-09420: PTT cylinder cap tool



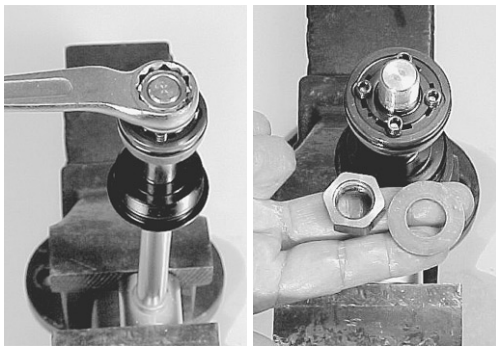
Pull the tilt rod/piston assembly ⑧ out of the cylinder body.
Remove the free piston ⑨ from the cylinder body.



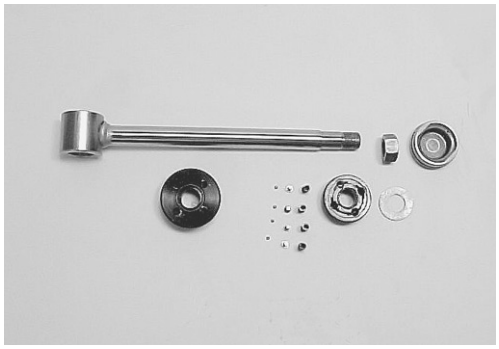
Disassembly of tilt rod/piston assembly

Unscrew the piston retaining nut from the bottom of the tilt rod and remove the washer.

Carefully retain and account for four shock valves, each composed of spring, rod and ball.



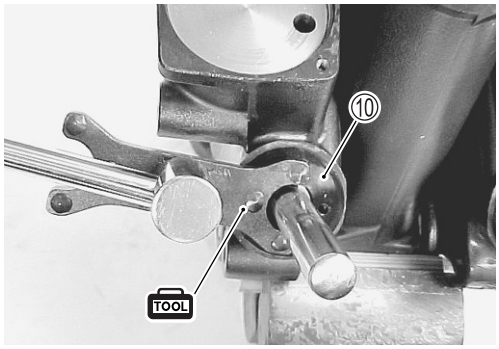
Remove the piston assembly and PTT cylinder head from the tilt rod by sliding them down and off the rod end.



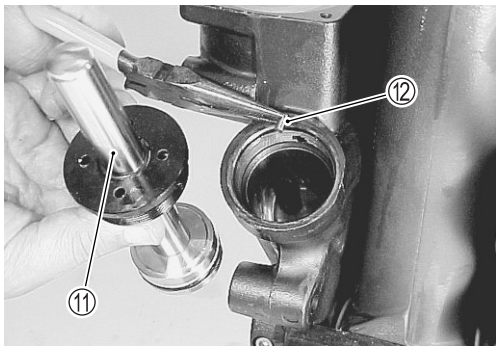
Disassembly of trim rod/piston assembly

Using special tool, unscrew the trim cylinder head ⑩.

TOOL 09944-09420: PTT cylinder cap tool



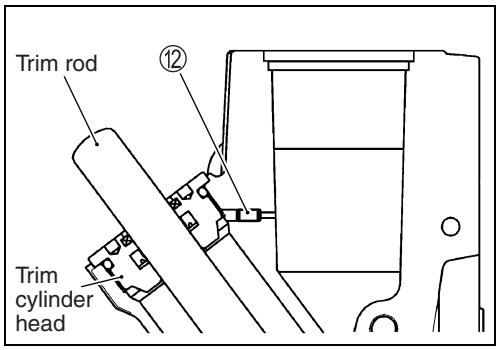
Pull the trim rod/piston assembly ⑪ out of the trim cylinder.



NOTE:

For PORT side trim cylinder:

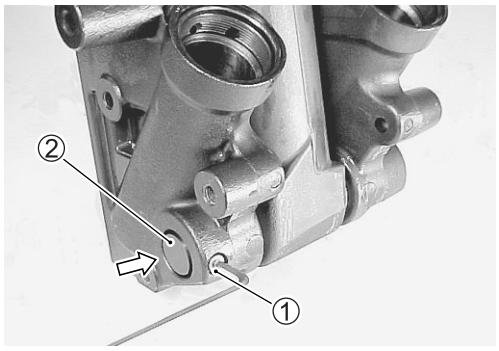
Be careful not to lose the trim chamber valve ⑫ on disassembly.



Disassembly of tilt cylinder assembly

Remove screw ①.

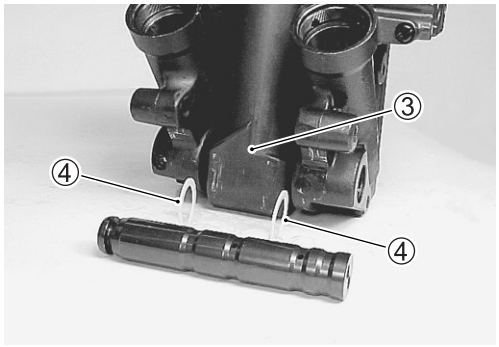
Push the lower rod ② out by tapping gently with a soft faced mallet.

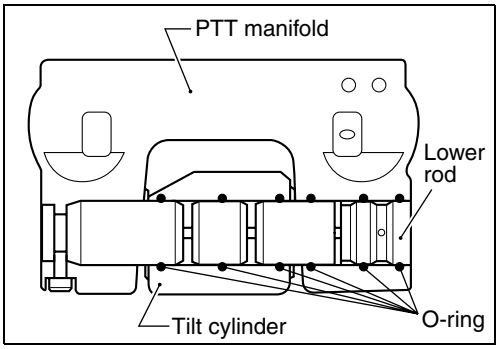


Detach the tilt cylinder ③ from PTT manifold.

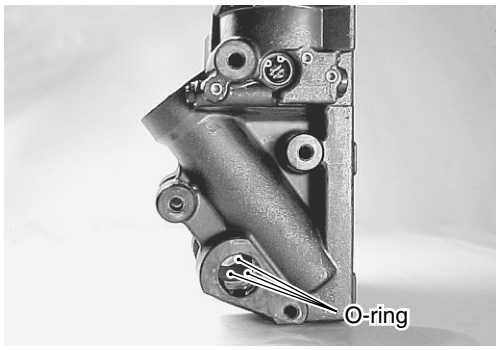
Note the position of three (3) O-rings and remove them from cylinder lower eyelet.

Remove washer ④ from each side of tilt cylinder lower eyelet.

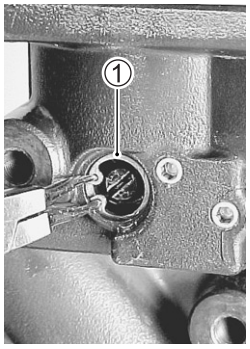


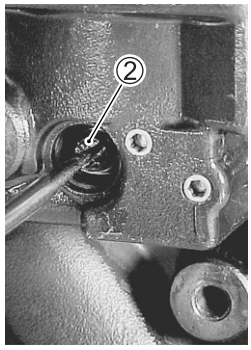


Remove three (3) O-rings from lower eyelet of PTT manifold.



Remove the manual release valve snap ring ①, then unscrew the manual release valve ②.

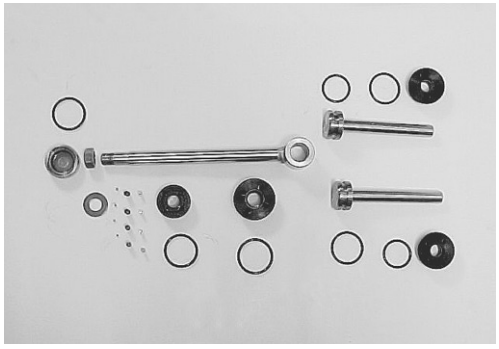




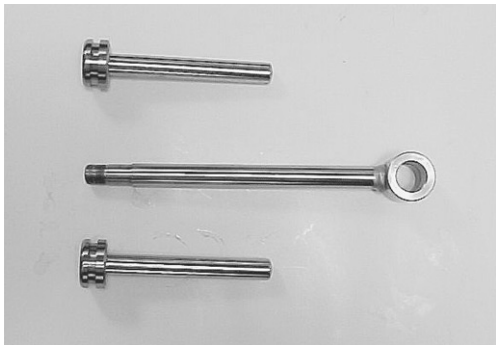
CLEANING AND INSPECTING

Thoroughly wash all metal components with cleaning solvent and dry them with compressed air.
Arrange all components on a clean sheet of paper.

NOTE:
Do not lay PTT components out on a rag, as dirt or lint may be transferred to these items which may cause possible system operating problems.



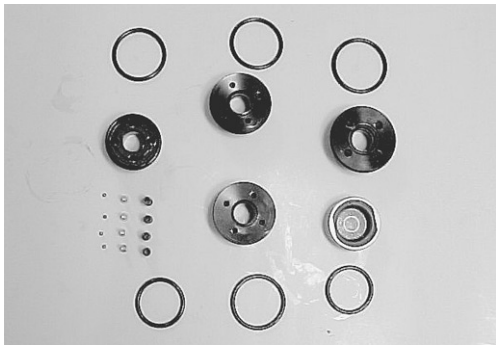
Inspect tilt rod and trim rod, replace if damaged or bent.
Inspect the surface of tilt rod and trim rod for scores, grooves or roughness.
Slight roughness may be removed with fine emery paper.
A badly scored or grooved rod must be replaced.



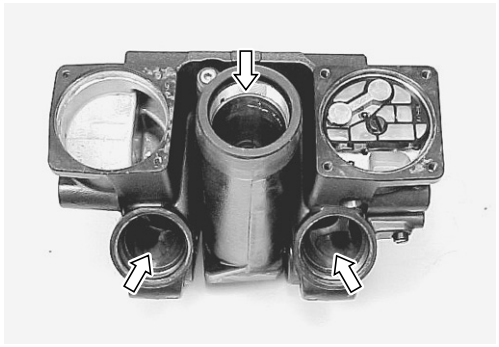
Inspect the PTT cap seal and O-ring.
Replace if cuts, nicks or excessive wear is found.

NOTE:
It is recommended that the O-ring always be replaced once the tilt/trim cylinder has been disassembled.

Inspect the shock valves (spring, rod and ball).
Replace if there are any signs of rust or pitting.



Inspect the cylinder bore for evidence of a rough or grooved surface.
Light honing may rectify slight surface roughness or scarring, but a deeply scarred surface will require replacement of the tilt cylinder.



Inspect manual release valve for damage.
Inspect manual release valve O-ring.
Replace if nicked or cut.



Inspect lower rod.
If a clog or obstruction is found, clean lower rod.
If bending, cracks, corrosion or other damage is found, replace lower rod.



Inspect 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 bushing.



REASSEMBLY

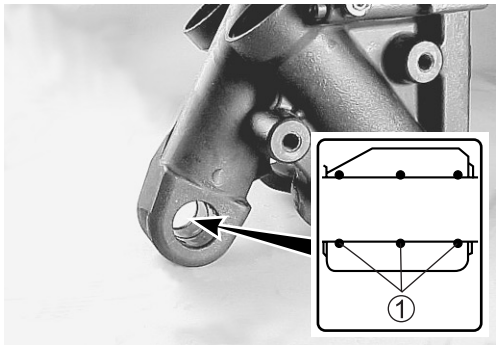
Assembly is reverse order of disassembly with special attention to following steps.

CAUTION

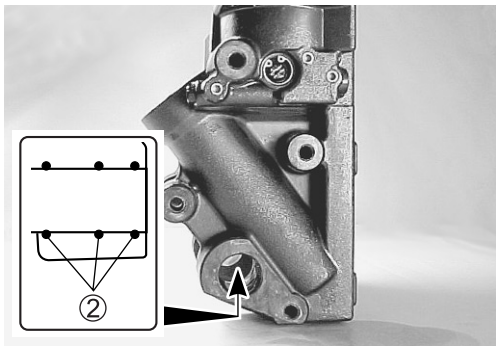
- **Do not reuse O-rings after removal, always use new O-rings.**
- **Lubricate all components and O-rings with PTT fluid before assembly.**
- **Do not reuse PTT fluid, always refill with new fluid.**

TILT CYLINDER

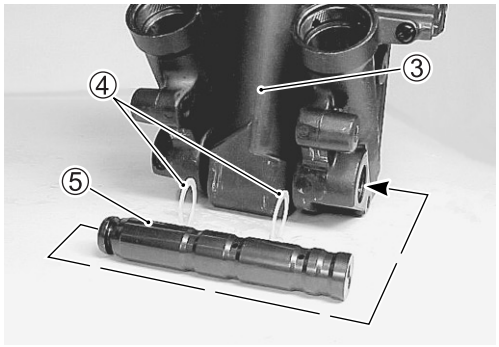
- Install three (3) O-rings ① into the grooves in the tilt cylinder lower eyelet.



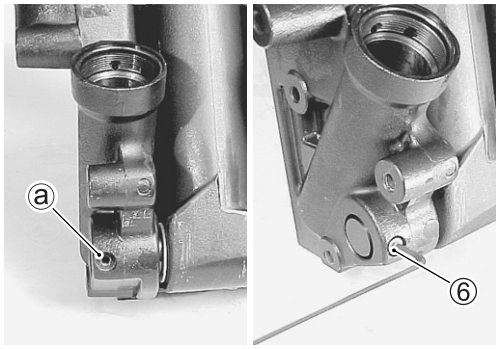
- Install three (3) O-rings ② into the grooves in the PTT manifold lower eyelet.



- Place the tilt cylinder ③ and washer ④ in position, then slide the lower rod ⑤ through both PTT manifold lower eyelets and tilt cylinder lower eyelet.



- Align threaded hole ⓐ on the PTT manifold with groove of lower rod, then tighten stopper screw ⑥ securely.

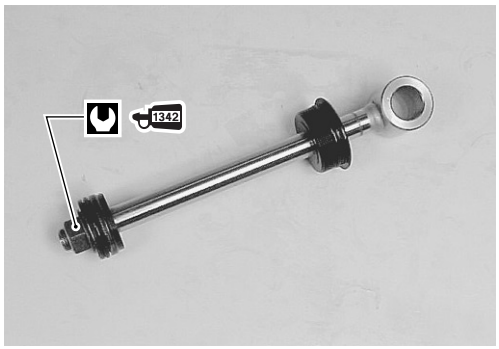


TILT ROD

When tightening the piston retaining nut on the tilt rod piston, apply Thread lock 1342 to the threads.
Tighten the nut to specified torque.

1342 99000-32050: THREAD LOCK "1342"

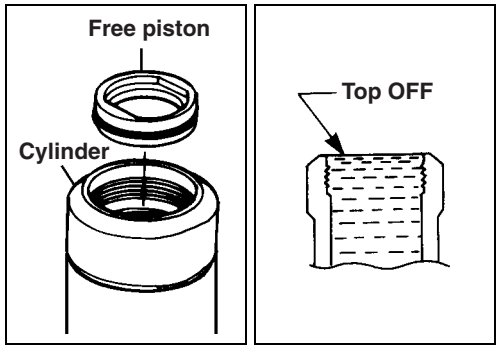
Piston retaining nut: 100 N·m (10 kg-m, 72 lb-ft)



Installing tilt rod/piston

Pour 100 ml (3.4 oz.) of PTT fluid into cylinder.
Insert the free piston into cylinder and push it down to the bottom of the cylinder.

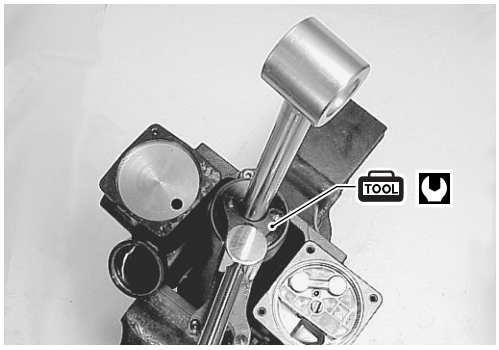
Pour PTT fluid into the cylinder until it is topped off.
Insert the tilt rod/piston into cylinder and thread the tilt cylinder head by hand until fully seated.



Tighten the cylinder head to specified torque using special tool.

Tilt cylinder head: 160 N·m (16 kg-m, 115.7 lb-ft)

09944-09420: PTT cylinder cap tool

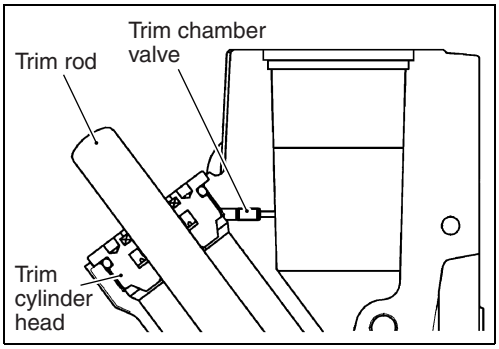


TRIM ROD

NOTE:

For PORT side trim cylinder:

Before installing trim rod/piston, make sure of trim chamber valve positioned correctly.



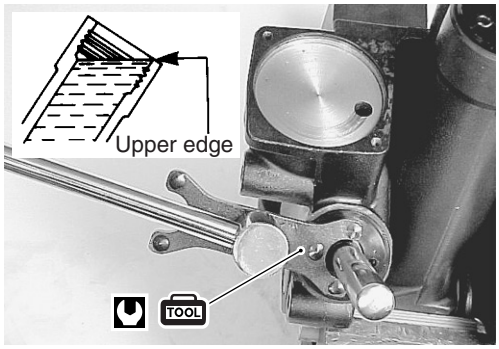
Pour PTT fluid into the trim cylinder until it is topped off.

Insert the trim rod/piston assembly into cylinder and thread the trim cylinder head by hand until fully seated.

Tighten the trim cylinder head to specified torque using special tool.

Trim cylinder head: 130 N·m (13 kg-m, 94 lb-ft)

09944-09420: PTT cylinder cap tool



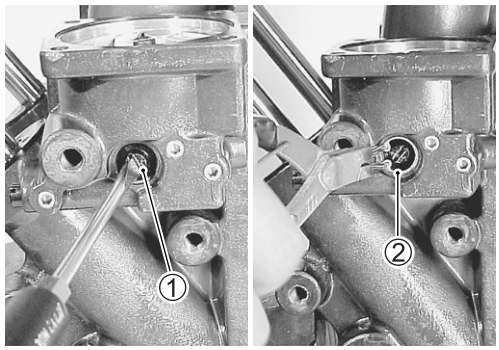
MANUAL RELEASE VALVE

Oil and install the manual release valve ①.

Tighten the valve to specified torque.

Install snap ring ②.

Manual release valve: 3.5 N·m (0.36 kg-m, 2.6 lb-ft)



PTT MOTOR

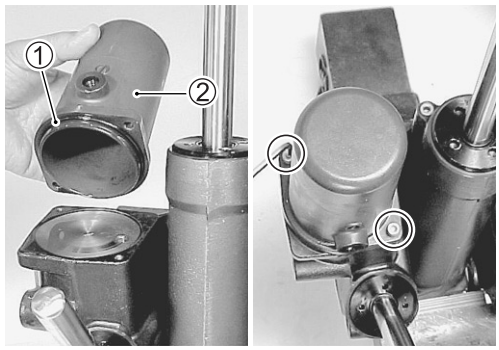
See the PTT motor installation section on page 8-17.

RESERVOIR

Install O-ring ① and reservoir ②, then tighten screws to specified torque.

Pour recommended PTT fluid into reservoir until specified level.

Reservoir screw: 5 N·m (0.5 kg-m, 3.5 lb-ft)



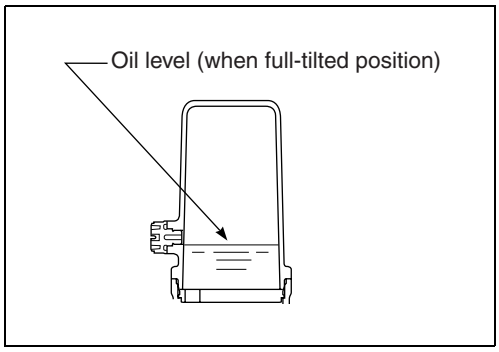
AIR BLEEDING

(Air bleeding on unit as alone)

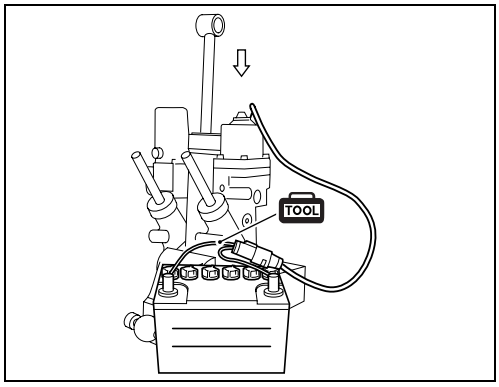
Before installing the PTT unit on the outboard motor, use the following procedure to bleed air from the system.

1. Support the PTT unit in an upright position in a vise.
2. Fill the reservoir with PTT oil to the specified level, then install oil filler plug.
3. Tighten the manual release valve to the specified torque.
4. Connect the PTT cable extension to the PTT motor cable connector.

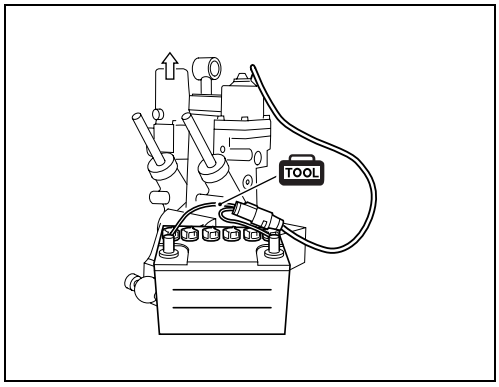
TOOL 09945-79310: PTT cable extension



5. Connect the two extension cable lead wires (Bl to pos./G to neg.) to the battery as shown in the illustration. Operate the PTT motor until the PTT rod is in the fully trimmed down position (completely contracted).
   If the rod does not come down smoothly, push it in by hand while operating the motor.



6. Reverse the two extension cable lead wires (G to pos./Bl to neg.).
   Operate the PTT motor until the PTT rod is in the full tilt up position (fully extended)
   If the rod does not come up smoothly, pull it up by hand while operating the motor.
7. Remove the reservoir oil filler plug and fill with PTT fluid to the specified level.
8. Repeat procedures 5 – 7 until the fluid level in the PTT unit stabilizes at the specified position.



NOTE:

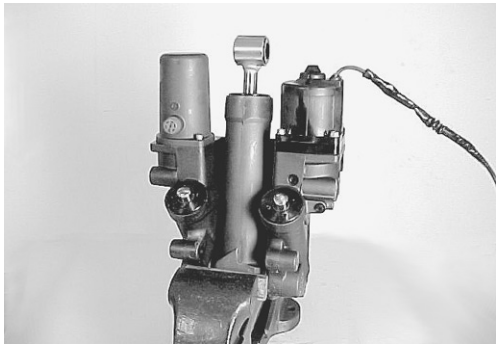
Repeat the air bleeding procedure after the PTT unit has been installed on the outboard motor.

(For air bleeding, see page 8-3.)

PTT MOTOR

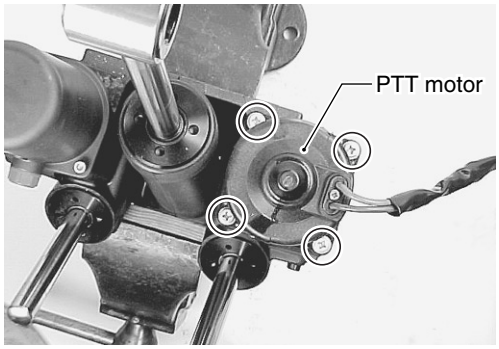
REMOVAL

NOTE:
Before removing 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.



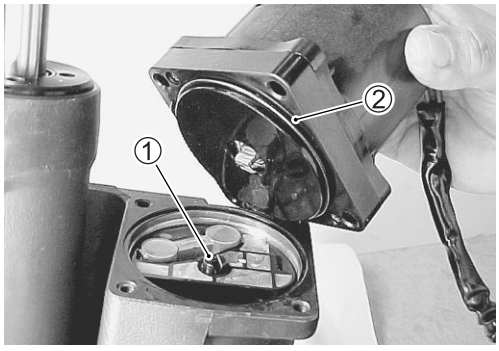
Place the lower of the PTT unit in a vise.
Tighten the vise only enough to secure the PTT unit, DO NOT OVER TIGHTEN.

NOTE:
To prevent damage to the PTT cylinder use wood blocks, vise jaw protectors, etc., between the vise jaws and PTT components before tightening vise.



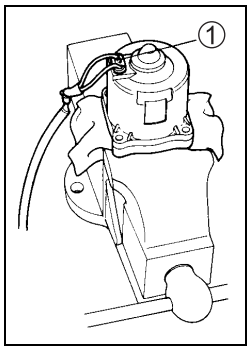
Remove the four (4) screws securing the PTT motor to the PTT manifold.

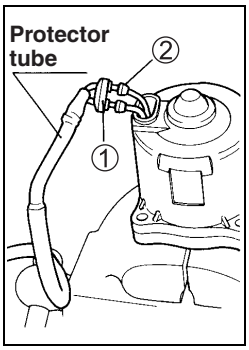
Detach the PTT motor from PTT manifold.
Note the position of drive joint ① and O-ring ② and remove them.



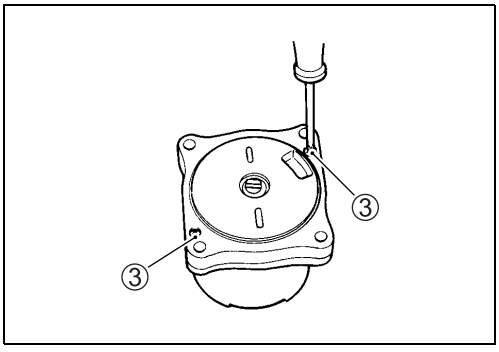
PTT MOTOR DISASSEMBLY

For correct assembly, scribe an alignment mark on the field case and brush holder.
Slide cable protector tube upward.
Remove the screw securing the motor cable holder ①, then slide motor cable holder and grommets ② out as shown in figure.



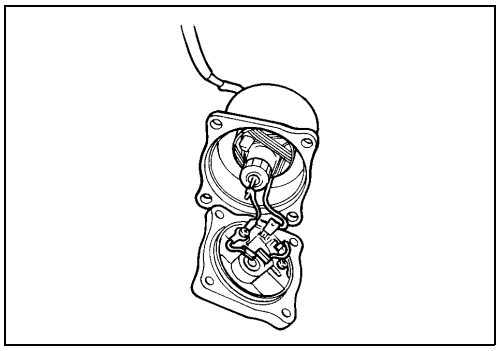


Remove the two (2) screws ③ securing the field case to the brush holder.

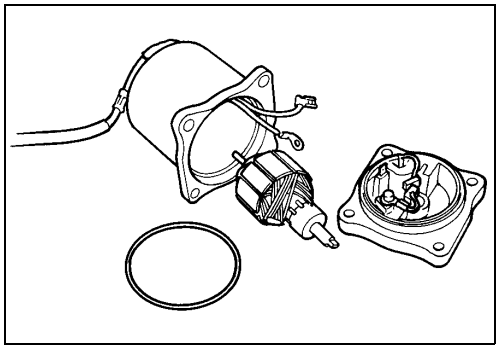


Slide the field case upward and away from the brush holder.

NOTE:
When separating field case from brush holder, push the PTT motor cables into brush holder as the field case is removed.



Disconnect PTT motor cables from brush holder.
Remove armature from field case.
Note the position of the O-ring encircling the brush holder.



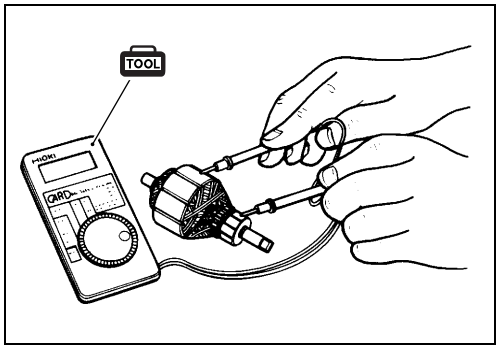
INSPECTION

Armature and commutator

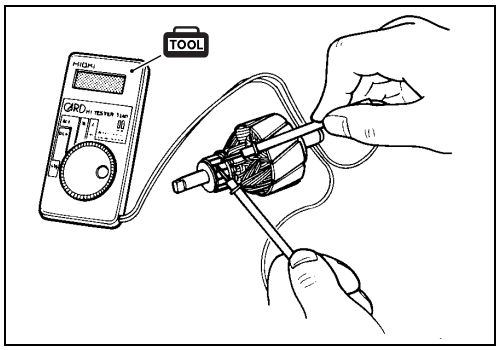
Check for continuity between the commutator and the armature core/shaft.
Replace armature if continuity is indicated.

TOOL 09930-99320: Digital tester

CONT Tester range: (Continuity)



Check continuity between adjacent commutator segments.
Replace armature if no continuity is indicated.



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

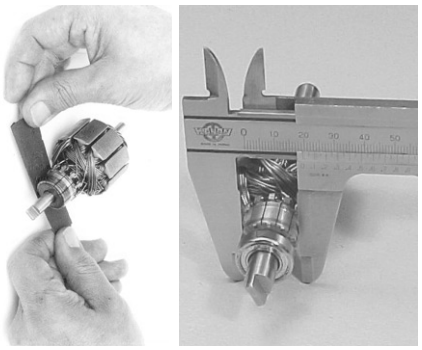
Measure commutator outside diameter.

TOOL 09900-20101: Vernier calipers

Commutator outside diameter:

Standard	**22 mm (0.87 in)**
Service limit	**21 mm (0.83 in)**

If measurement exceeds service limit, replace armature.



Ensure that the mica (insulator) between commutator segments is undercut to specified depth.

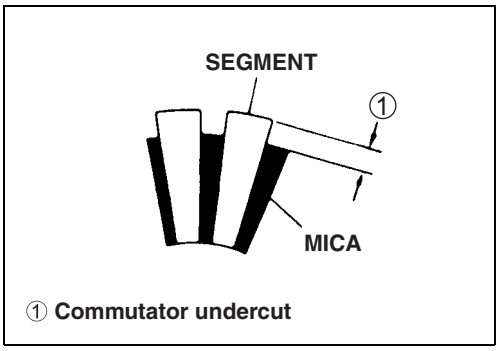
Commutator undercut:
Standard 1.6 – 1.9 mm (0.06 – 0.07 in)
Service limit 1.0 mm (0.04 in)

If undercut is less than service limit, cut to specified depth.

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

⚠ WARNING

Wear safety grasses when using compressed air.



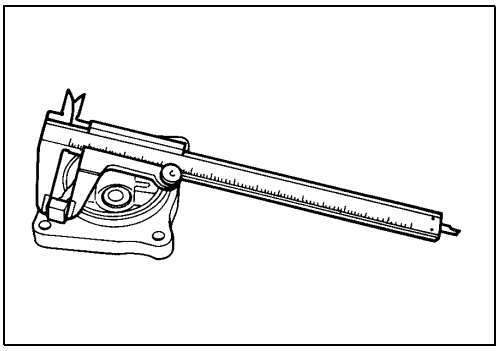
① **Commutator undercut**

Brushes
Check the length of each brush.

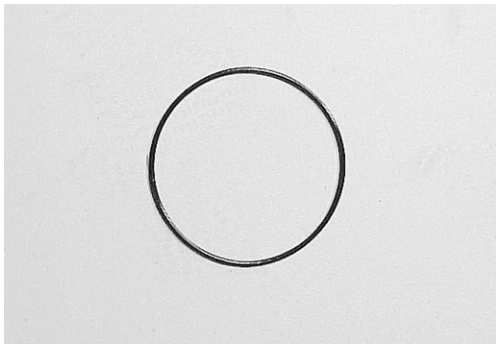
TOOL 09900-20101: Vernier calipers

Brush length:
Standard 9.8 mm (0.39 in)
Service limit 5.0 mm (0.20 in)

If brushes are worn down to the service limit, they must be replaced.

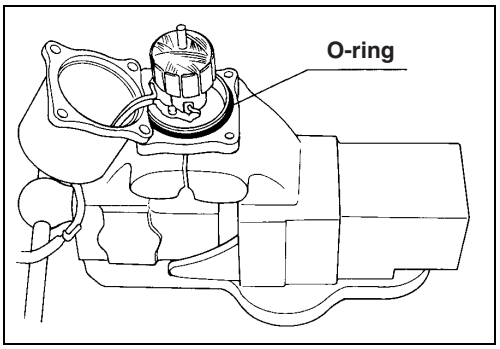


O-Ring
Inspect the O-ring between the PTT motor and PTT manifold. Replace if cuts, nicks or tears are found.

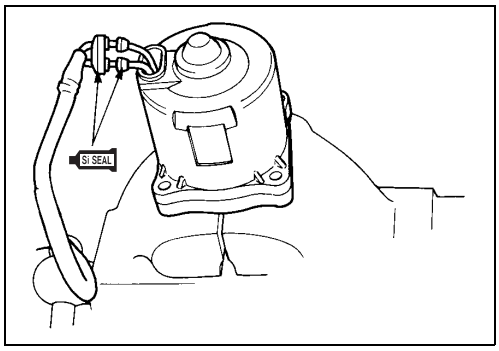


ASSEMBLY
Assembly is reverse of disassembly with special attention to following steps.

- Install armature to brush holder first.
  When installing the armature, use care to avoid breaking the brushes.
- Match up previously scribed alignment marks.
- When assembling field case to brush holder, pull out on the PTT motor cables at the field case is assembled into position.



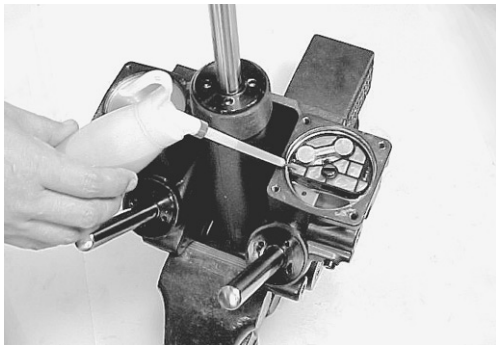
- Apply silicone seal to PTT motor cable holder and grommets and install cable holder screw.



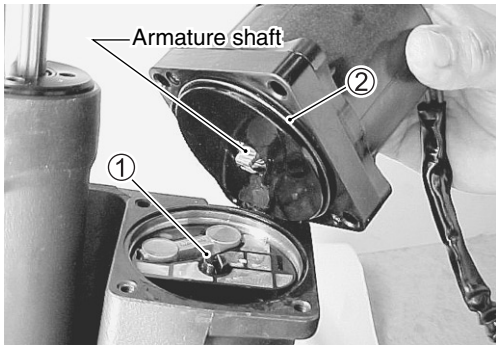
PTT MOTOR INSTALLATION

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

- Ensure that the drive joint ① is aligned and firmly inserted into the gear pump assembly.
- Fit O-ring ② to PTT motor.
- Check the level of PTT fluid contained in the PTT manifold. If level is low, add recommended PTT fluid until level with mating surface of PTT motor.



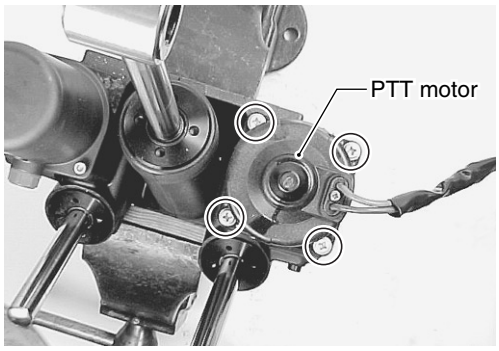
- Ensure that the faces of the PTT motor and pump unit are free of dirt or debris.
  When attaching the PTT motor to the PTT manifold, ensure that the tip of armature shaft fits firmly into the drive joint ①.



- Tighten the four (4) screws to specified torque.

PTT motor screw: 5 N·m (0.5 kg-m, 3.6 lb-ft)

- Pour recommended PTT fluid into reservoir until specified level.
- Perform the air bleeding procedure.
  For air bleeding, see page 8-13.



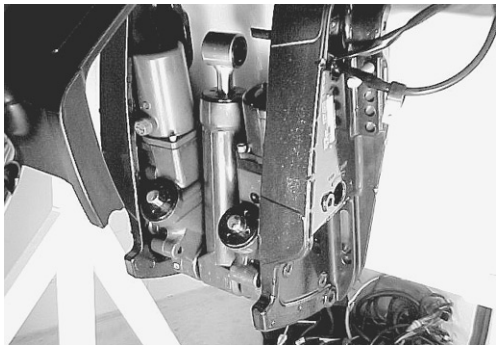
INSTALLATION

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

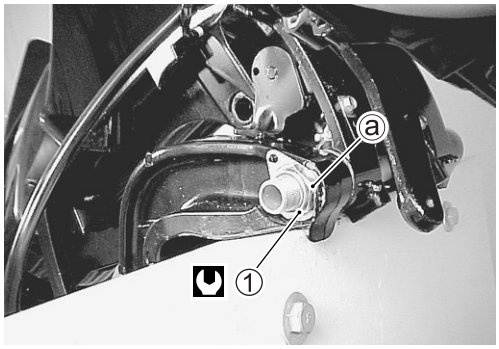
Lower tilt rod to full down position.

Place the PTT unit in position between the clamp brackets.
Tighten the clamp bracket shaft nut ① to specified torque.

Clamp bracket shaft nut: 43 N·m (4.3 kg-m , 31.0 lb-ft)



NOTE:
After tightening clamp bracket shaft nut with specific torque, bend lock washer edge ⓐ toward nut for locking.

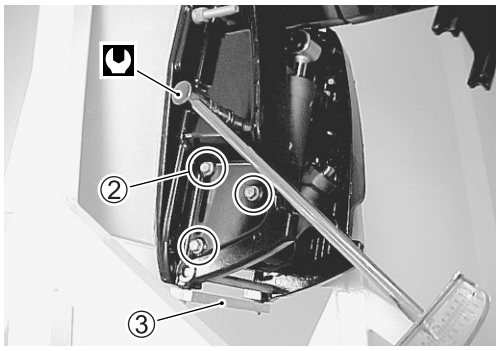


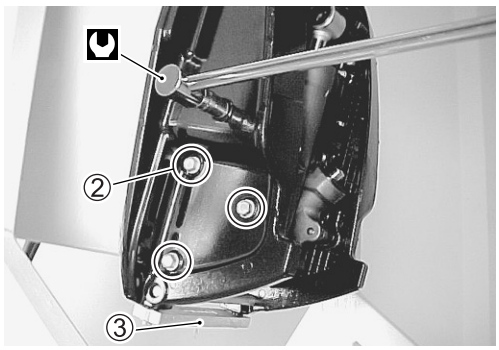
Tighten eight (8) PTT unit retaining bolts ②, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

PTT unit retaining bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

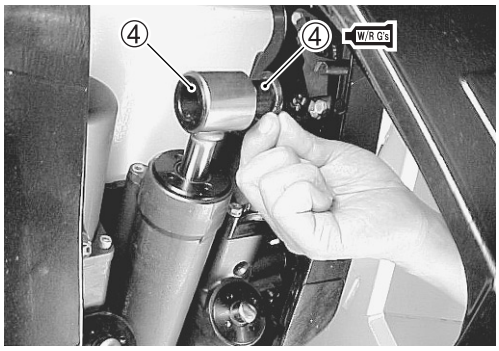
Install anode ③, then tighten bolts securely.





Apply Water Resistant Grease to tilt rod upper bushes ④, then install bushes in tilt rod.
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.

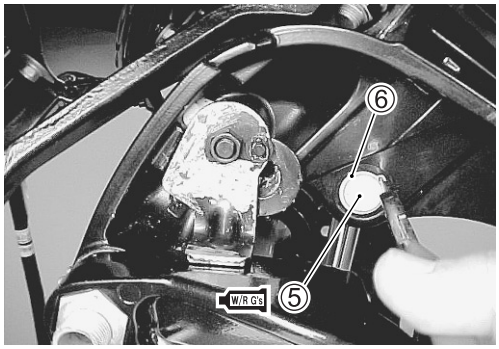
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



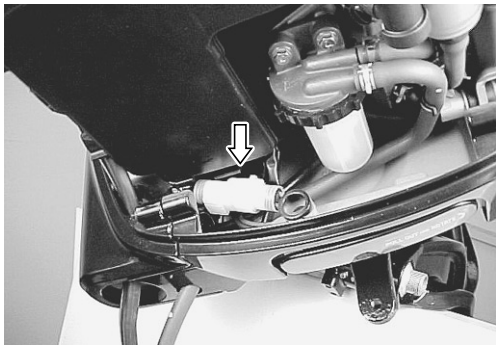
Apply Water Resistant Grease to the PTT rod upper shaft ⑤, then insert the shaft through the swivel bracket and tilt rod.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Secure the upper shaft with the snap ring ⑥.



Route the PTT motor cable in through the lower cover and connect the PTT cable connector to the PTT relay.
(Cable routing – See the WIRE/HOSE ROUTING section on page x-xx to x-xx.)



PTT MOTOR RELAY

INSPECTION

1. Disconnect battery cable from battery.
2. Disconnect all cables/lead wires from PTT relay.
3. Check resistance between each two (2) lead wires.

09930-99320: Digital tester

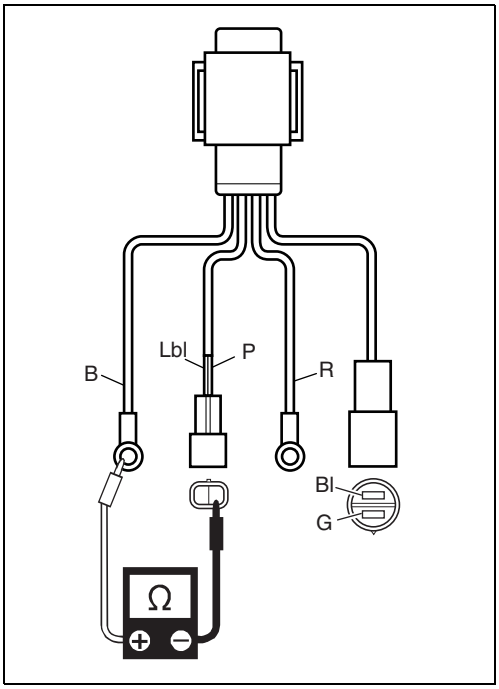
Tester range: Ω (Resistance)

Between "P" wire and "B" wire: 25 – 37 Ω
Between "Lbl" wire and "B" wire: 25 – 37 Ω

4. Connect "R" wire to positive ⊕ terminal, and black wire to negative ⊖ terminal of 12 V battery.

CAUTION

Each operation test must be performed within 3 – 5 seconds to avoid overheat damage to the relay coil.



5. Temporarily connect a jumper wire from the "P" lead wire to the battery positive ⊕ terminal, then check voltage between "G" wire and "B" wire.

09930-99320: Digital tester

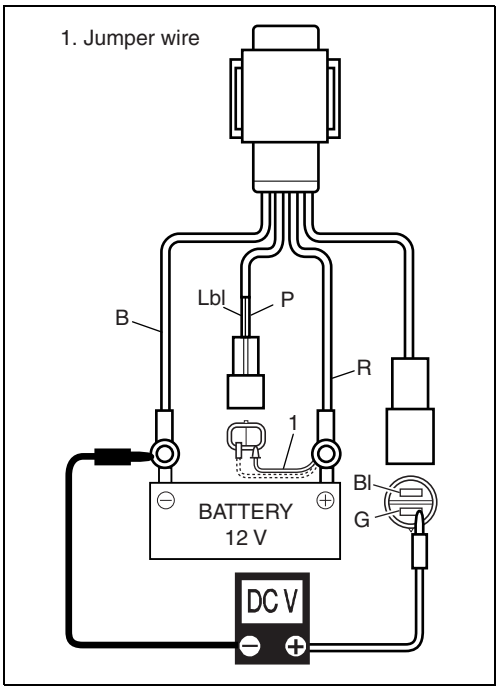
Tester range: DCV

Between "G" wire and "B" wire: 12 V (Battery voltage)

6. Temporarily connect a jumper wire from the "Lbl" lead wire to the battery positive ⊕ terminal, then check voltage between "Bl" wire and "B" wire.

Between "Bl" wire and "B" wire: 12 V (Battery voltage)

7. If inspection in step 3 and/or step 5, 6 fails, replace PTT relay.



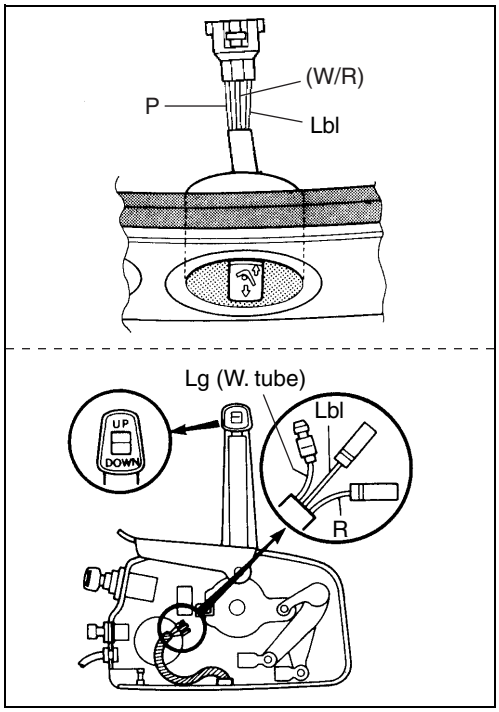
PTT SWITCH

Test continuity between the switch lead wires at each of the three switch positions.

09930-99320: Digital tester

Tester range: (Continuity)

	Tester probe connection		Tester indicates
	Red ⊕	**Black ⊖**	
DN side depressed	• Red	• Lg (with white tube)	Continuity
	• Pink	• White/Red	
UP side depressed	Light Blue	• Lg (with white tube)	Continuity
		• White/Red	
Not depressed	• Red • Pink	• Lg (with white tube)	Infinity
	Light Blue	• White/Red	



TILT LIMIT SWITCH

INSPECTION

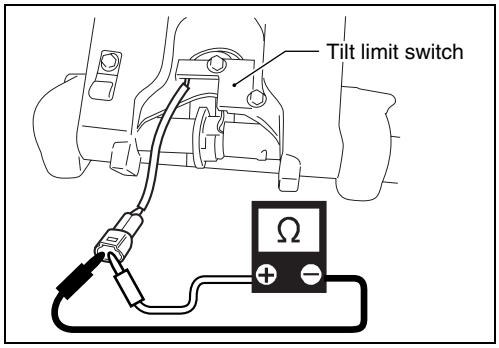
Test continuity between wires.

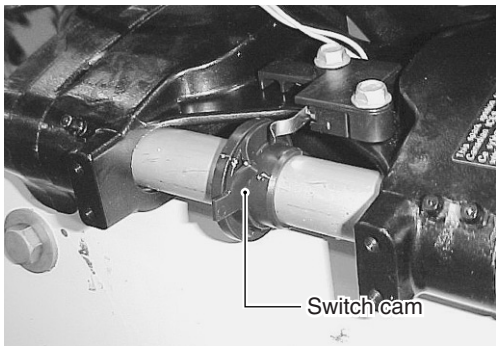
If found defective, replace switch.

09930-99320: Digital tester

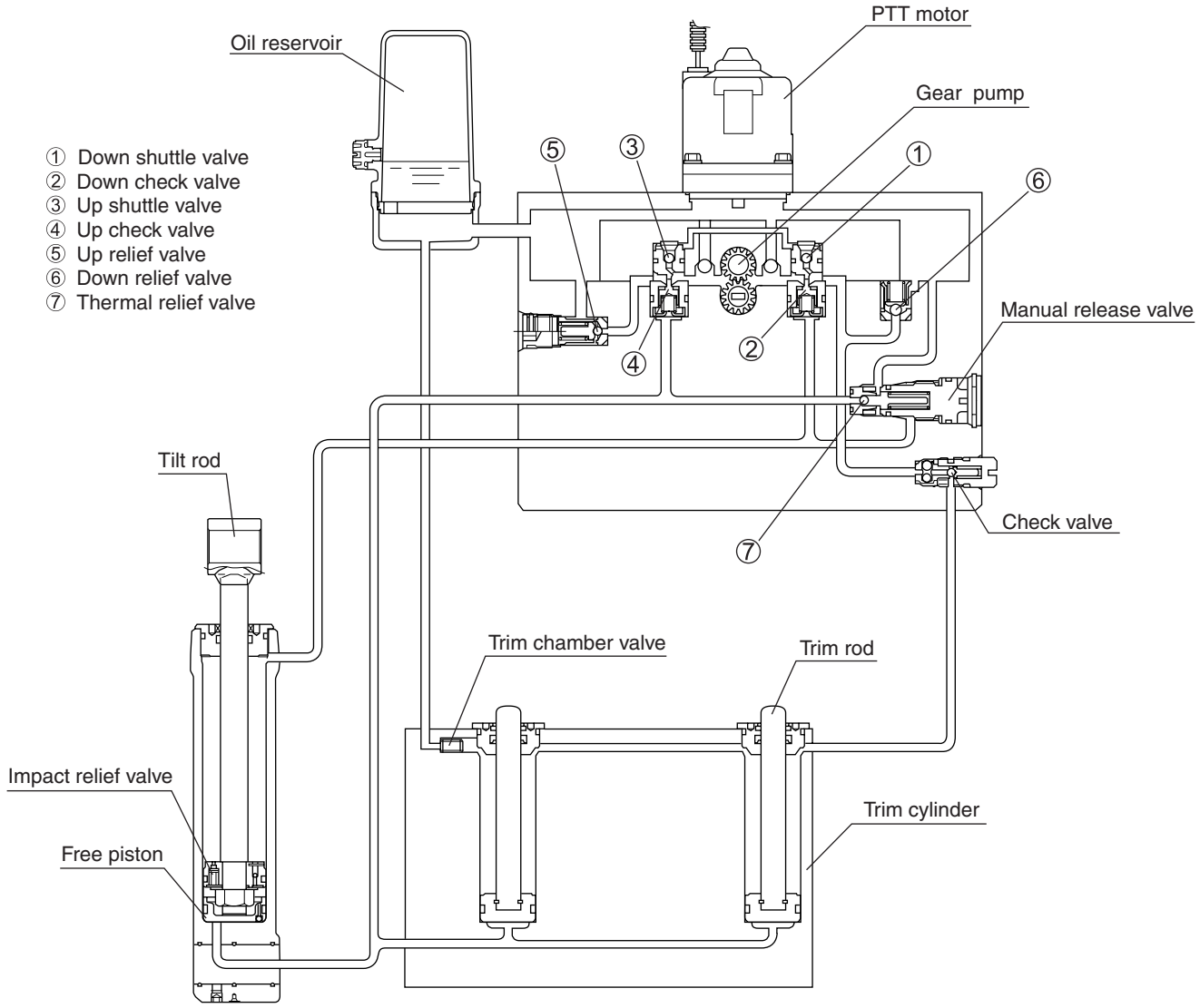
Tester range: (Continuity)

Push the switch actuator plate. (Full tilt up position)	No continuity
Release the switch actuator plate. (Except for full tilt up position)	Continuity





OPERATION
COMPONENT PARTS



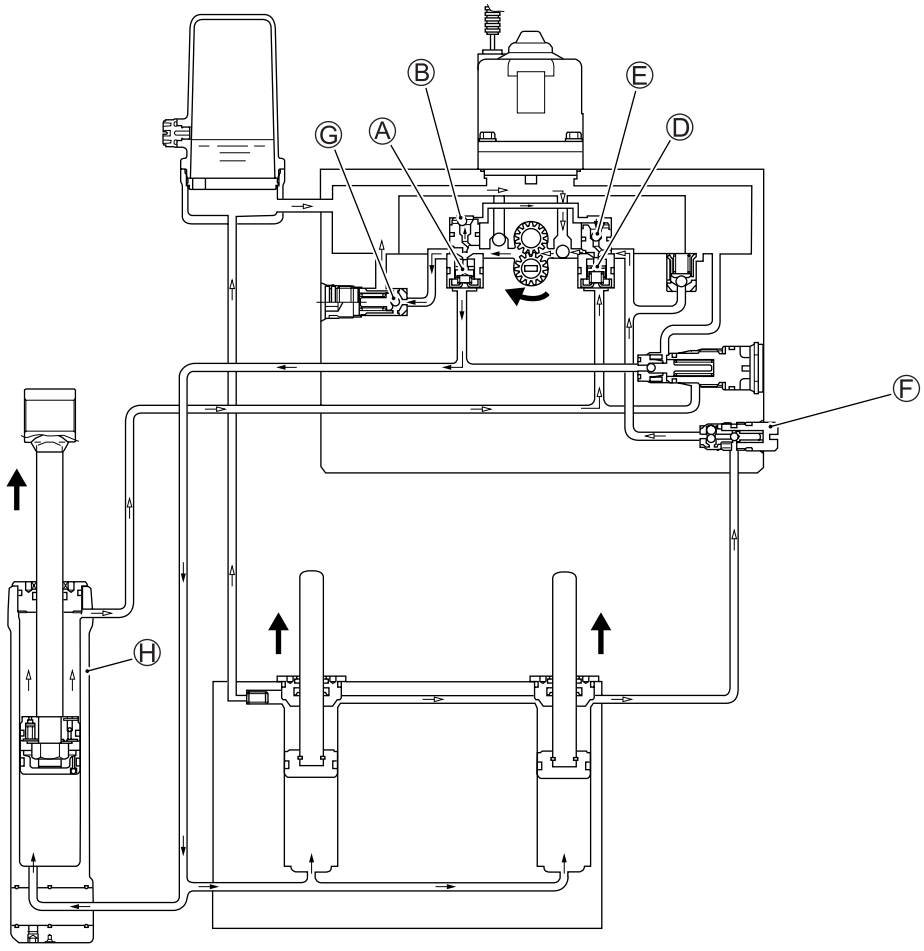
* When the manual valve is to be opened, turn the manual release valve to the left about three (3) turns.
* When the oil level of the system should be checked, inspect the reservoir by placing the motor in the full tilt up position.

PRINCIPLES OF OPERATION

By motor operation, the geared pump will be driven, and by turning the motor to the right or to the left, oil flow will change its direction, and this causes up and down movements of the piston rod of the tilt cylinder and the trim rod of the trim cylinder.

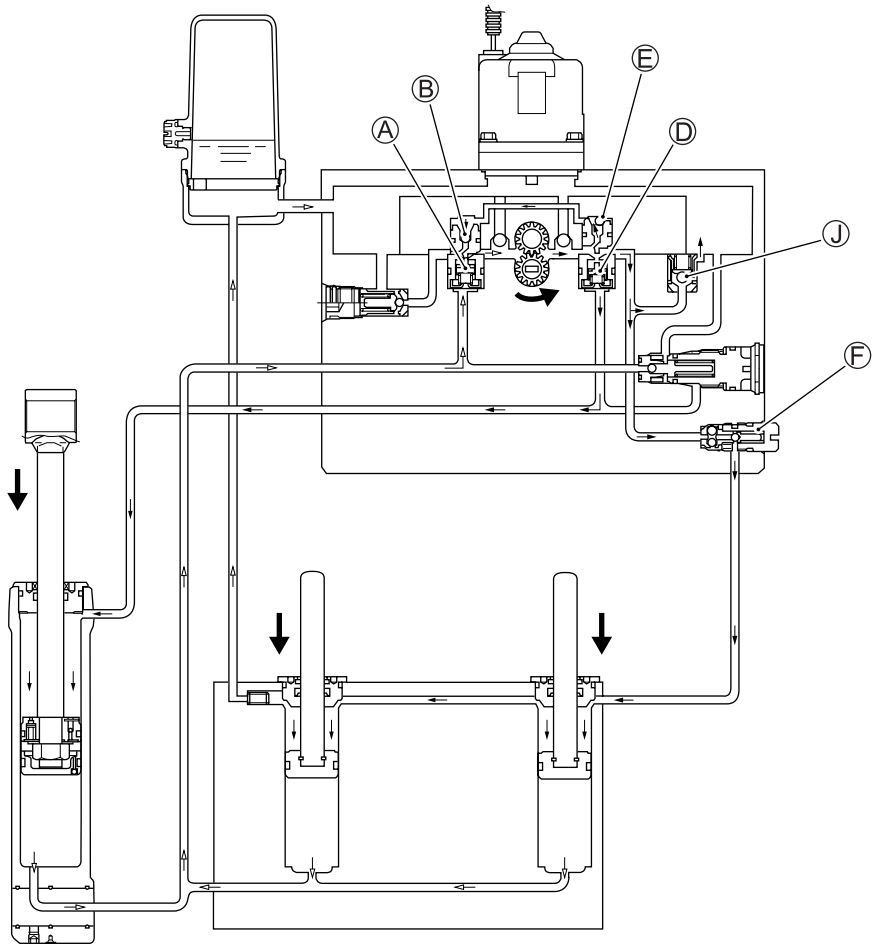
TRIM & TILT UP

(1) When the PTT switch is operated in the "UP" position, the motor and gear pump will rotate in a clockwise direction.
(2) Pressurized oil will open "Up" check valve Ⓐ and the oil will flow through "Up" shuttle valve Ⓑ to the "Down" shuttle valve Ⓔ. Following operation of valve Ⓔ, "Down" check valve Ⓓ will open mechanically.
(3) Pressurized oil flows through the "Up" check valve Ⓐ to the bottom of the trim and tilt cylinders, thereby pushing the trim and tilt pistons upward.
(4) Residual oil in the upper area of the tilt cylinder Ⓗ is returned to the geared pump through "Down" check valve Ⓓ.
(5) Any oil in the area above both trim cylinder pistons will be returned to the reservoir and to the geared pump through the check valve Ⓕ.
(6) Oil will then flow from the reservoir to the geared pump to stabilize the balance of the oil volumes.
(7) When the engine is fully tilted up, oil pressure will correspondingly increase in the lower chamber of the tilt and trim cylinders. But, to protect the PTT unit from excessively high pump pressure, the "Up" relief valve Ⓖ begins to open.



TILT DOWN & TRIM IN

(1) When the PTT switch is operated in the “DOWN” position, the motor and gear pump will rotate in a counterclockwise direction.
(2) The oil pressure will open the “Down” check valve Ⓓ and oil will be forced through the “Down” shuttle valve Ⓔ. When the oil reaches “Up” shuttle valve Ⓑ, the “Up” check valve Ⓐ will begin to open mechanically.
(3) The pressurized oil flows through “Down” check valve Ⓓ and then enters the upper area of the tilt cylinder. This thereby forces the tilt rod piston downward.
(4) When the swivel bracket contacts the trim rams, the check valve Ⓕ will begin to open, oil flows into the upper area in the trim cylinder.
This pressure forces the trim pistons downward.
(5) Oil from the lower area of the trim and tilt cylinders now returns to the pump through “Up” check valve Ⓐ.
(6) Throughout the tilt action operation range, there is a difference in oil volume between the upper and lower chambers of the tilt cylinder, and any surplus oil is therefore directed to the reservoir by means of the “Down” relief valve Ⓙ.
(7) Throughout trim operation range, oil will be discharged from the bottom of all three cylinders and the pump will supply oil to the upper chamber of the tilt and trim cylinders. Excess oil is then vented to the reservoir through the “Down” relief valve Ⓙ.
(8) To prevent damage from excessive oil pressure when all three rods are fully retraced, this pressure is relieved through the “Down” relief valve Ⓙ.

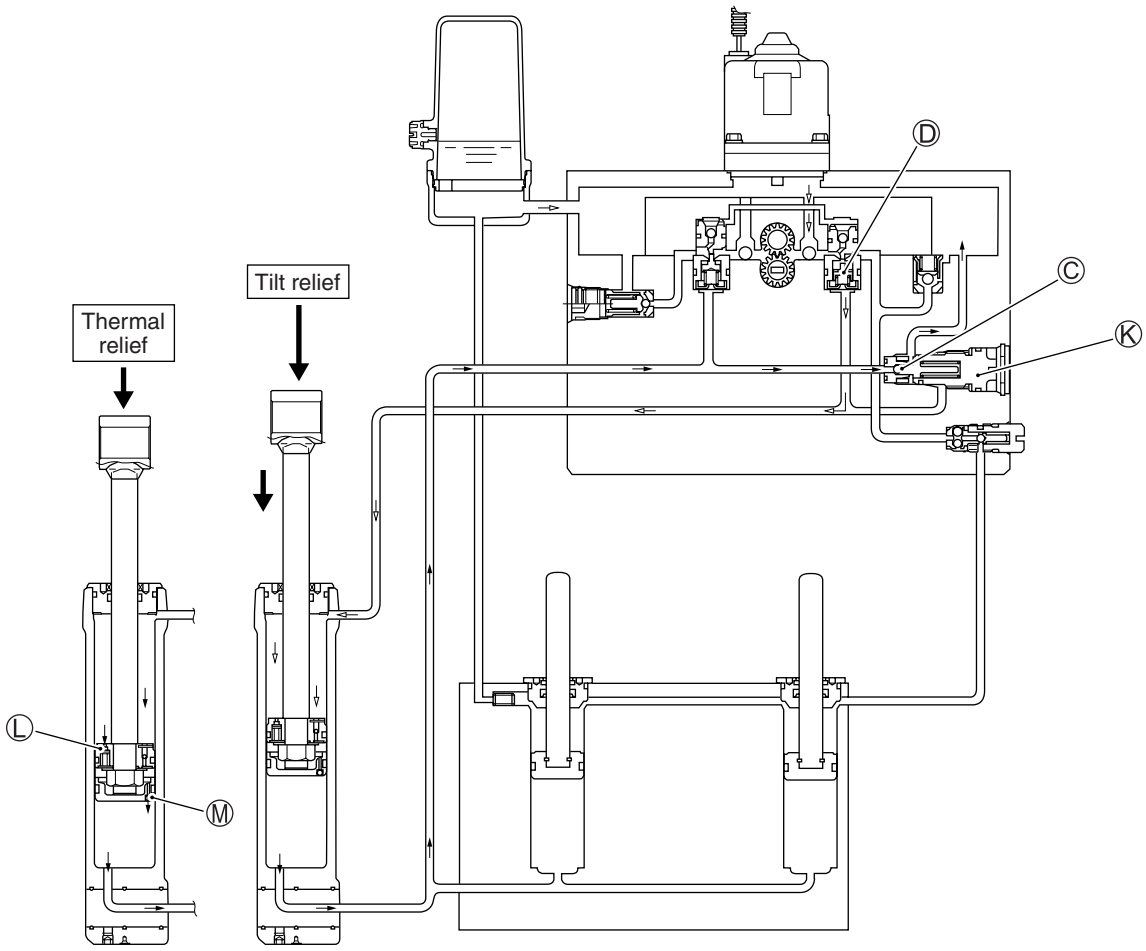


TILT SYSTEM PRESSURE RELIEF

(1) If engine speed exceeds approx. 1500 RPM when operating in shallow water drive mode, oil pressure will increase underneath the tilt piston. The relief valve Ⓒ (incorporated in the manual release valve Ⓚ) will then open.
(2) The oil below the tilt piston will then flow to the reservoir through the relief valve Ⓒ.
(3) As the power of the engine continues to exert downward force on the tilt piston, this will open "Down" check valve Ⓓ, thereby allowing oil from the reservoir to flow into the chamber above the tilt piston.
(4) In this way, high internal pressure is relieved and the engine will slowly tilt downward until it reaches the highest position in the Trim range.

THERMAL EXPANSION RELIEF

(1) High ambient temperature will, through thermal expansion, induce a build-up of oil pressure inside the PTT unit.
(2) Expansion of the oil and the resulting high pressure will open the relief valve Ⓒ, thereby providing unit protection by directing oil back to the reservoir.
Expanded oil in the tilt cylinder upper chamber will return to reservoir passing through impact relief valve Ⓛ⇨ free piston check valve Ⓜ⇨ thermal relief valve Ⓒ.

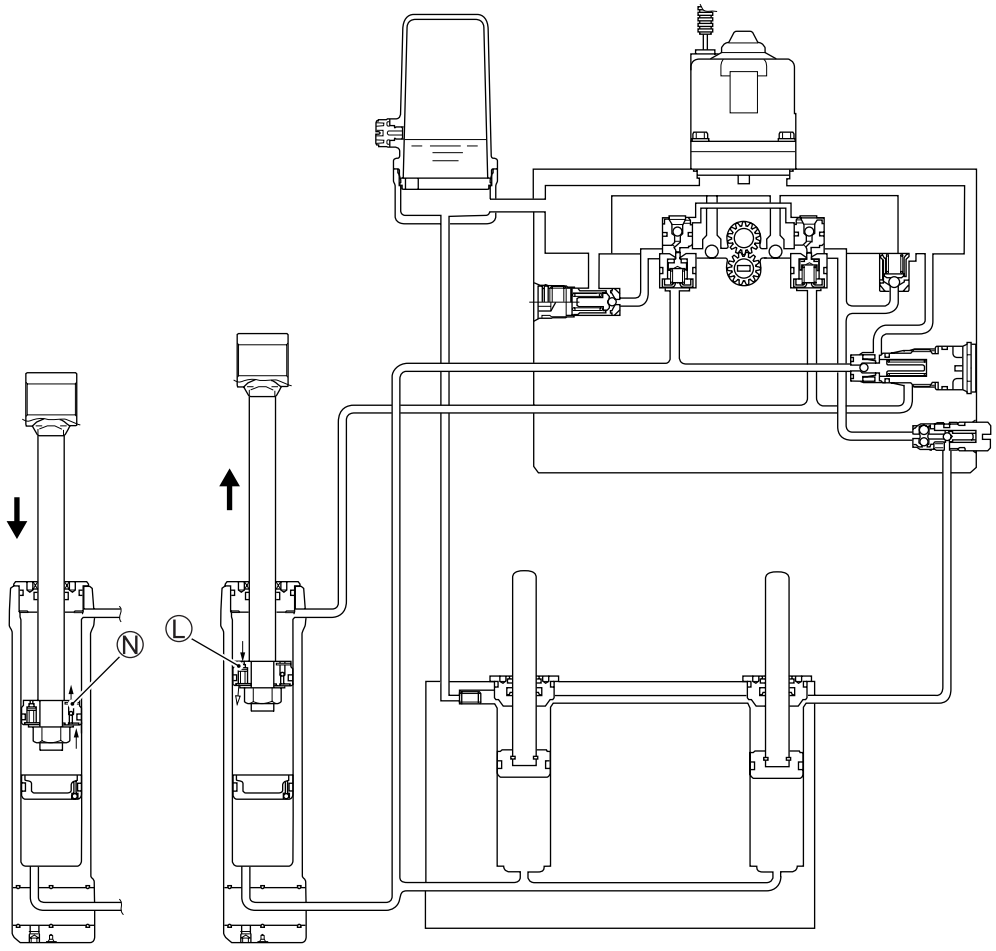


SHOCK ABSORBER CIRCUIT

This incorporated safety feature is for protection of the gearcase and prevention of internal PTT pressure build-up in the event of an impact.

(1) The pressure from a sudden impact will make impact relief valve Ⓛ open, allowing oil from the upper area of the tilt cylinder to flow into the area between the tilt rod piston and the free piston. The tilt rod will then extend.

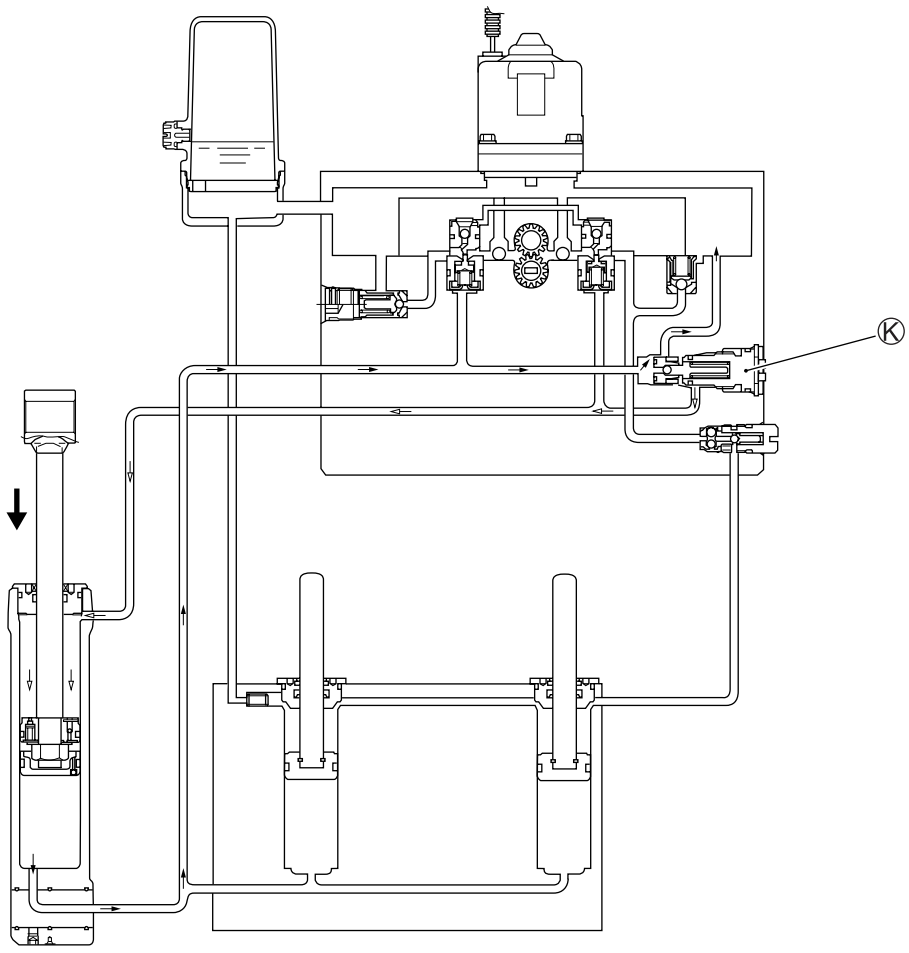
(2) When the moment of impact has passed, the PTT DOWN switch must be activated to return the engine to within the normal trim range. When the switch is pressed, the oil between the piston and free piston will be directed to the cylinder upper chamber via the return valve Ⓝ below the tilt piston.



MANUAL RELEASE CIRCUIT (DOWN MODE)

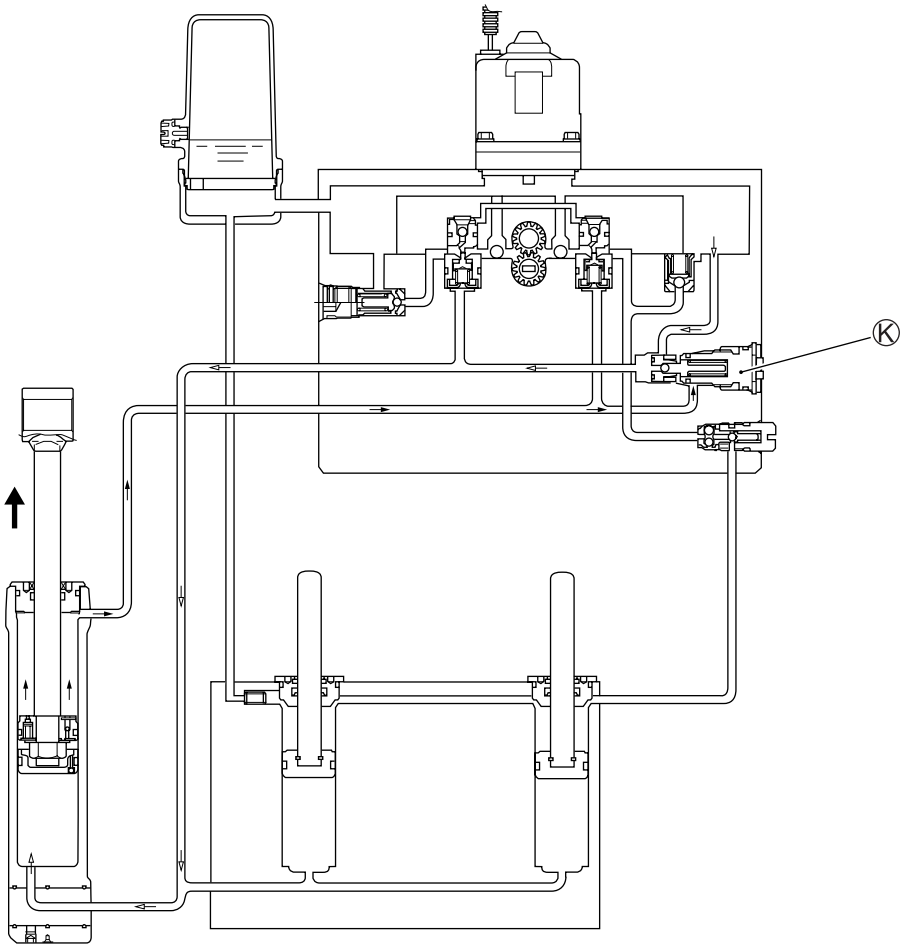
(1) By opening the manual release valve Ⓚ, the engine can be lowered manually to a running position. Oil underneath the tilt piston will be directed through this valve into the area above the tilt rod piston.

(2) The volume of oil flowing from under the tilt rod piston will be larger than the area above the tilt rod piston can accommodate. Excess oil therefore returns through the manual release valve Ⓚ to the reservoir.



MANUAL RELEASE CIRCUIT (UP MODE)

(1) With the manual release valve Ⓚ open, the engine can also be raised manually to the fully tilted position.
(2) Oil from the upper chamber of the tilt cylinder will flow through valve Ⓚ into the lower chamber of the cylinder.
(3) The upward movement of the piston rod will increase the cylinder area beneath it, thereby allowing oil from the reservoir to flow into this area.



LOWER UNIT [Standard rotation (Right-hand) model]

CONTENTS

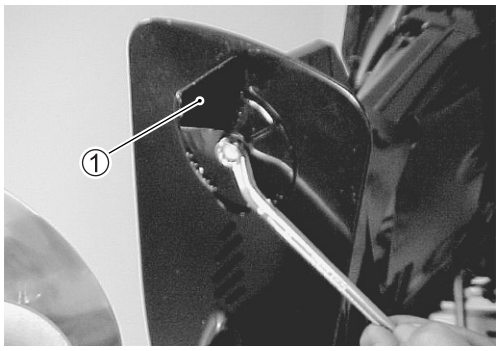
REMOVAL & DISASSEMBLY 9- 2
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REMOVAL & DISASSEMBLY

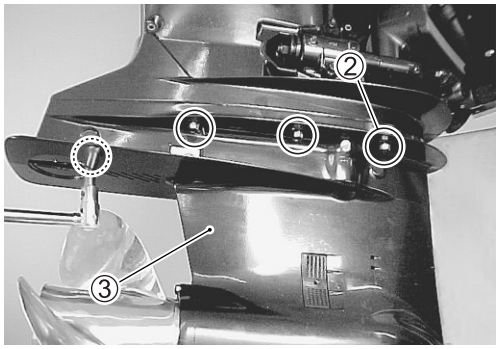
⚠ WARNING

Always disconnect the battery cable, before removing lower unit.

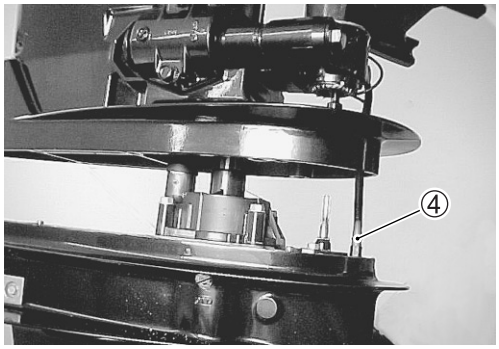
Shift to “NEUTRAL” position.
Remove bolt and trim tab ①.



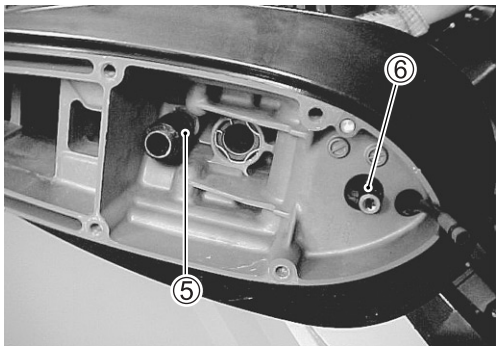
Remove seven (7) bolts ② and separate gearcase ③ from driveshaft housing.



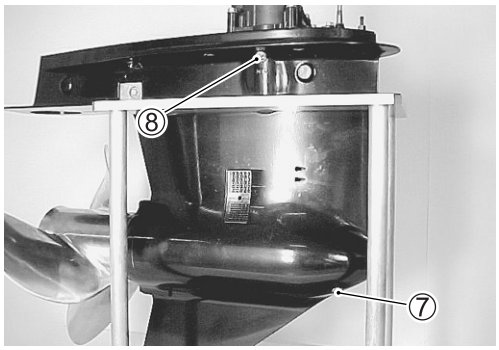
NOTE:
Before gearcase is removed completely, disconnect speedometer pick up tube ④ from gearcase.



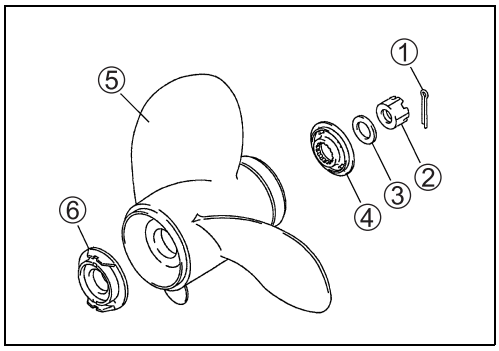
Remove water tube spacer ⑤.
Remove clutch rod ⑥ from clutch shaft (if necessary).



Place a drain pan under oil drain plug.
Remove oil drain plug ⑦ first then oil level plug ⑧ and allow gear oil to drain.
Inspect oil for water, contaminates or metal.

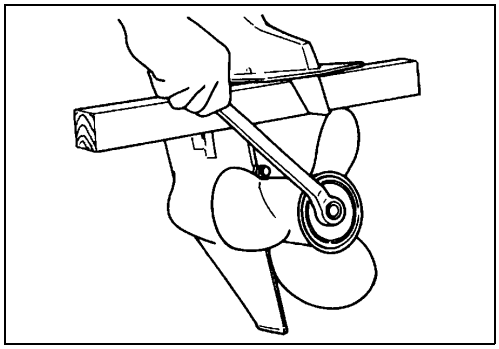


Remove cotter pin ① from propeller nut and remove propeller nut ②.
Remove washer ③, spacer ④, propeller ⑤ and stopper ⑥ from the propeller shaft.

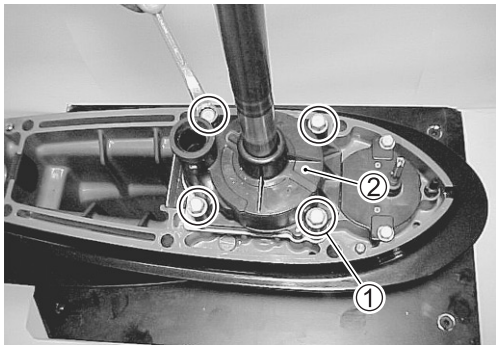


⚠ WARNING

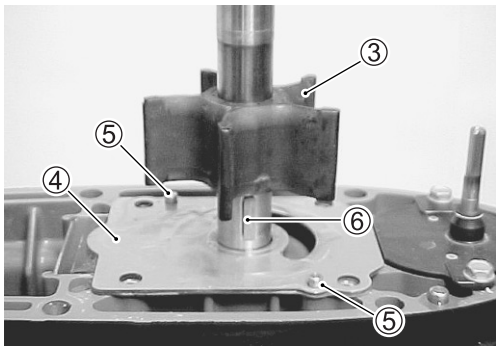
To prevent injury from propeller blades, wear gloves and place a block of wood between the anti-cavitation plate and the propeller blade tips to lock the propeller in place before attempting to remove propeller nut.



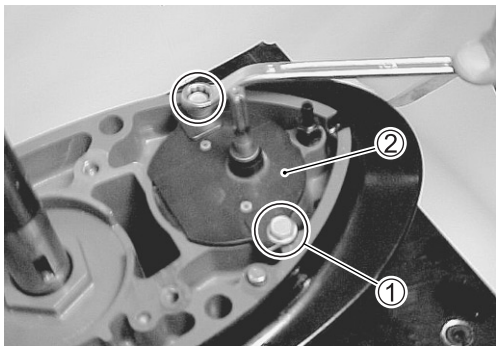
Loosen four (4) bolts ①, then remove water pump case ②.



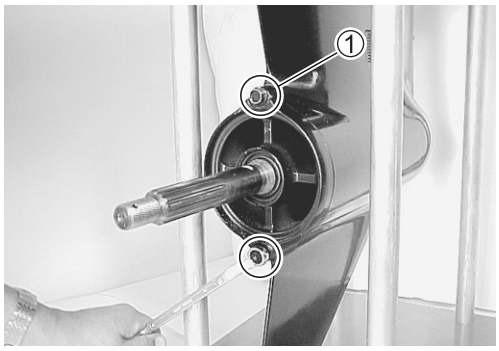
Remove impeller ③, impeller key ⑥, pump under plate ④ and dowel pins ⑤.
Keep impeller key ⑥ for reuse and discard the plate gasket.



Remove two (2) bolts ① and shift rod guide housing assembly ②.

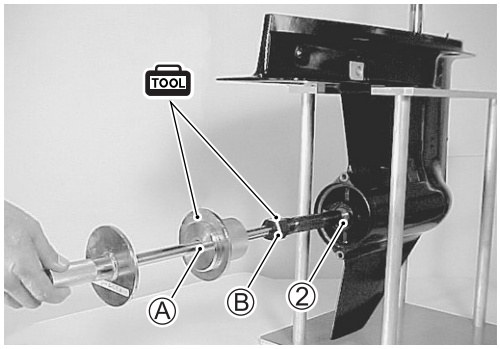


Remove two (2) bolts ① securing the propeller shaft bearing housing to the gearcase.



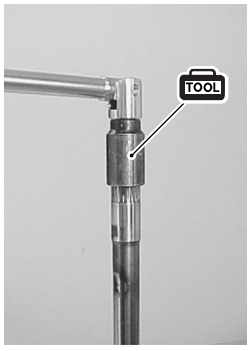
Using special tools, pull out the propeller shaft bearing housing. Remove the propeller shaft and bearing housing assembly ②.

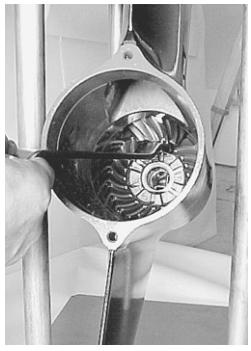
TOOL **09930-30102: Ⓐ Sliding hammer**
09930-30161: Ⓑ Propeller shaft remover

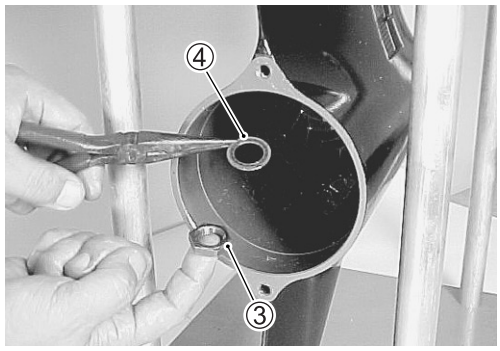


Hold the pinion nut securely, then fit special tool to the driveshaft and loosen the pinion nut.
Remove pinion nut ③ and washer ④.

TOOL **09921-29410: Driveshaft holder**

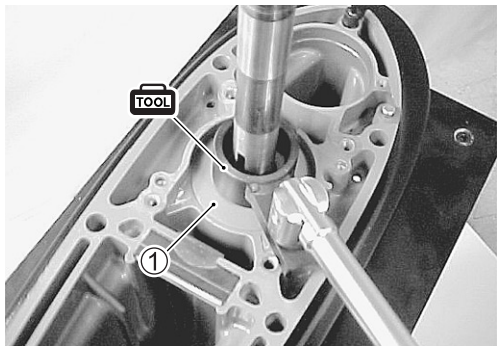




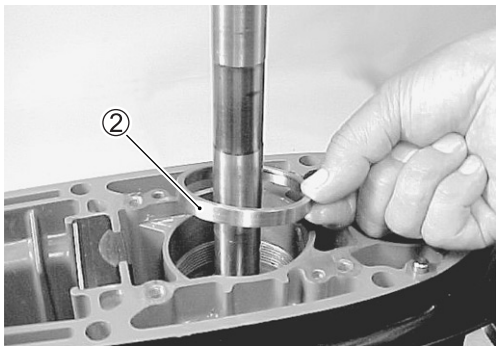


Use special tool to unscrew driveshaft oil seal housing ①, then remove oil seal housing from drive shaft.

TOOL **09926-29310: Driveshaft housing remover**

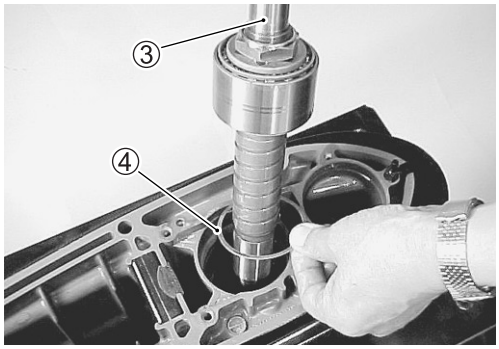


Remove driveshaft bearing spacer ②.

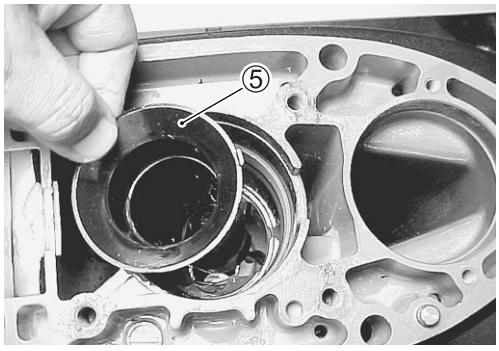


Slowly lift out driveshaft assembly ③.
Remove the pinion shim ④.

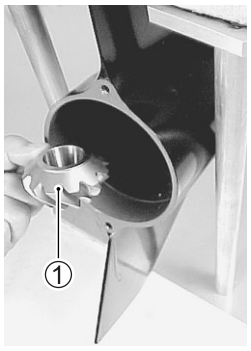
NOTE:
The driveshaft pinion gear bearing contains 28 loose roller bearings. Account for all roller bearings on disassembly.

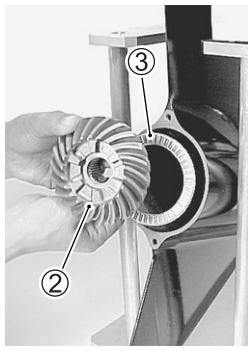


Remove the driveshaft collar ⑤.

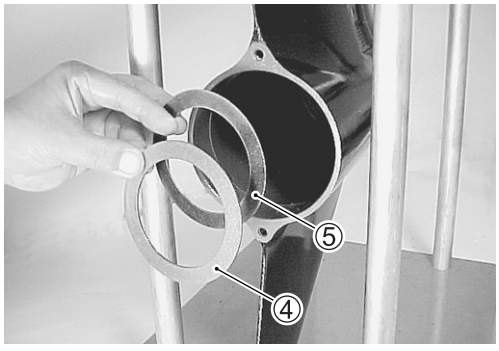


Remove the pinion gear ①.
Remove the forward gear ② and thrust bearing ③.



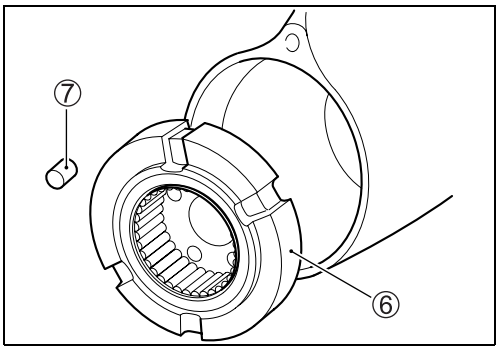


Remove the bearing thrust washer ④ and back-up shim ⑤.

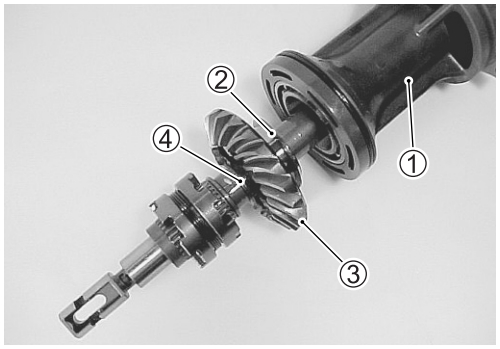


Remove the forward gear bearing housing ⑥.
Account for dowel pin ⑦.

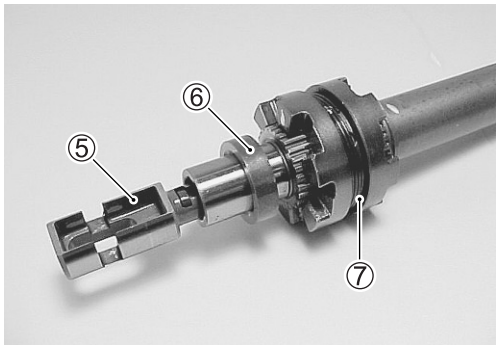
NOTE:
The forward gear radial bearing contains 35 loose roller bearing. Account for all roller bearings on disassembly.



Disassembly of propeller shaft components
Slide propeller shaft away from reverse gear ③ and bearing housing assembly ①.
Account for the reverse gear back-up shim ② and reverse gear thrust washer ④.

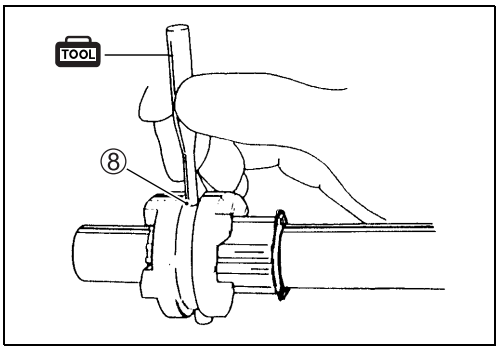


To disassemble propeller shaft components, refer to following:
(a) Remove horizontal slider ⑤ and forward gear thrust washer ⑥.
(b) Remove spring ⑦ from clutch dog shifter.

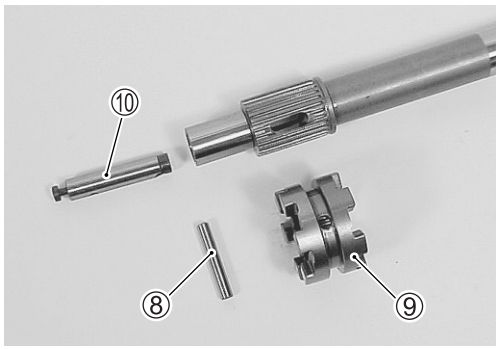


(c) Use special tool to push the dog pin ⑧ out of the clutch dog shifter.

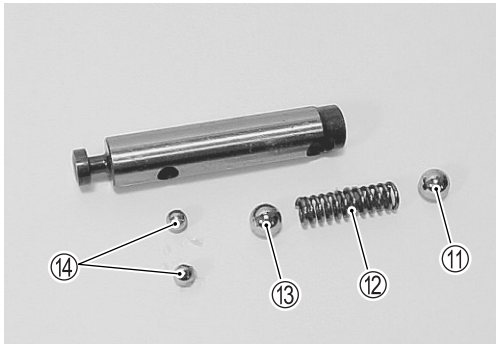
09922-89810: Shift pin remover



(d) Remove clutch dog shifter ⑨ and connector pin ⑩ from propeller shaft.



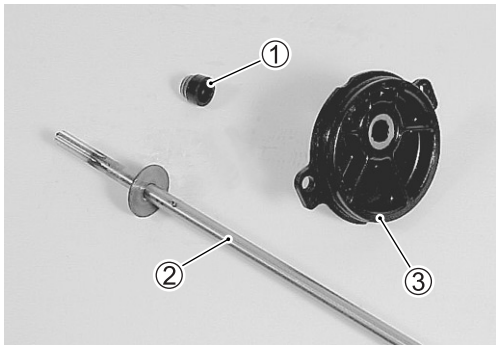
(e) Remove large detent ball ⑪, detent spring ⑫, large detent ball ⑬ and two (2) small detent balls ⑭ from connector pin.



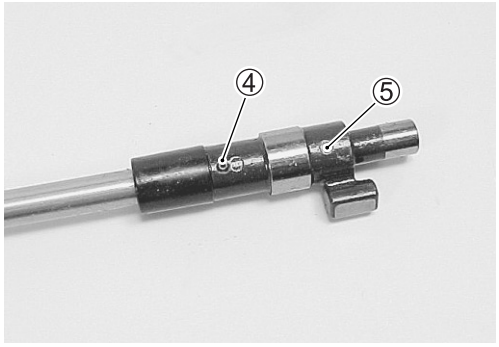
Disassembly of shift rod components

(a) Remove dust seal ①.

(b) Slide shift rod ② out of shift rod guide housing ③.



(c) Remove pin ④ and shifter yoke ⑤.

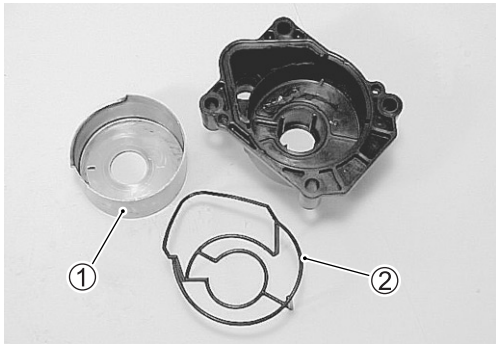


Disassembly of water pump case

Remove inner sleeve ① and rubber seal ring ②.

NOTE:

To facilitate the removal of inner sleeve from the pump case, warm up the entire case using a heater like hair dryer.



INSPECTION

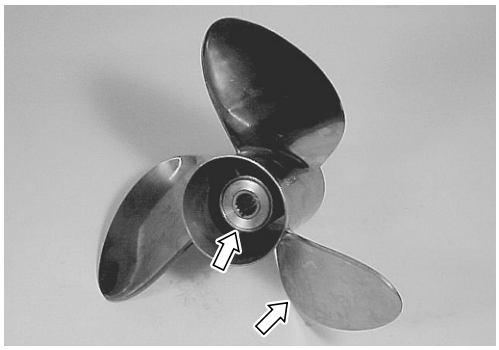
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

NOTE:
Thoroughly wash all metal components with cleaning solvent and dry with compressed air.

⚠ WARNING

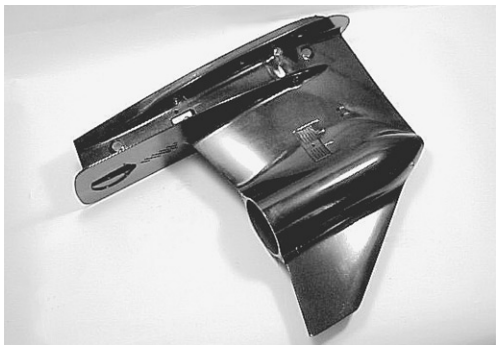
Wear safety grasses when using compressed air.

PROPELLER



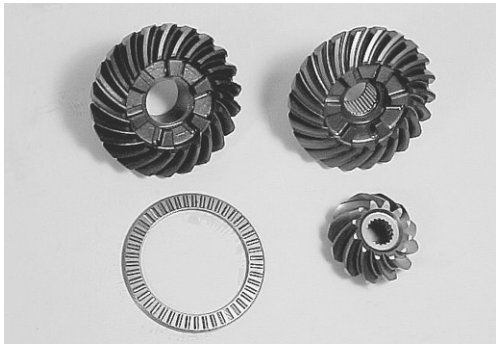
- Inspect propeller for bent, chipped or broken blades. Replace or repair propeller if in damaged condition.
- Inspect propeller bush splines. Replace or repair propeller if splines are worn or damaged.
- Inspect propeller bush for deterioration or slipping. Replace if necessary.

GEARCASE



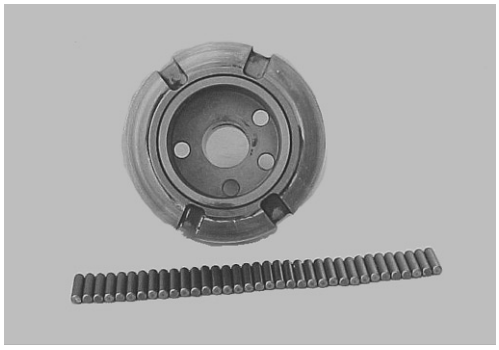
- Inspect the gearcase. Replace if cracked, damaged or other abnormal condition.
- Visually check the pinion bearing. Replace gearcase if pitted, noisy, rough or other abnormal condition.

GEARS/BEARING



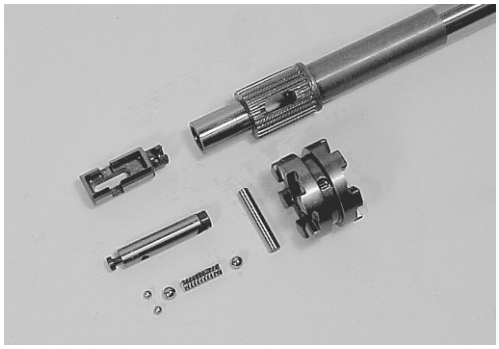
- Inspect forward, reverse and pinion gear teeth and engaging dogs.
  Replace gears if damaged, worn or other abnormal condition.
- Inspect propeller shaft forward bearing, forward gear thrust bearing.
  Replace bearing if pitted, noisy, rough or other abnormal condition.

FORWARD GEAR BEARING HOUSING



- Inspect forward gear bearing housing.
  Replace if cracked, damaged or other abnormal condition.
- Visually check bearing. Replace if pitted, rough or other abnormal condition.

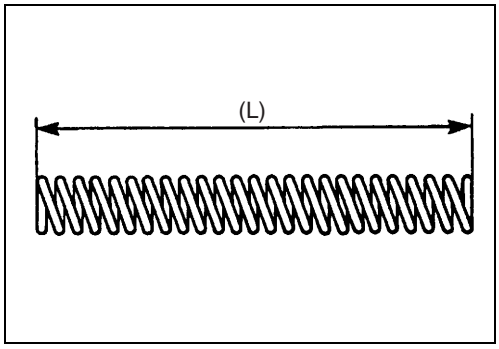
PROPELLER SHAFT COMPONENTS



- Inspect horizontal slider and connector pin.
  Replace if worn, damaged or other abnormal condition.
- Inspect clutch dog shifter. Replace if chipped, worn, damaged or other abnormal condition.
- Inspect dog pin. Replace if bent, worn or other abnormal condition.
- Inspect detent balls. Replace if wear, damage or other abnormal condition.



- Inspect propeller shaft/splines. Replace if worn, twisted, damaged or other abnormal condition.



- Check detent spring by measuring its free length. If free length is not within specifications, replace detent spring.

Detent spring free length (L)
Standard: 27.8 mm (1.09 in)
Service limit: 25 mm (0.98 in)

PROPELLER SHAFT BEARING HOUSING

- Inspect housing. Replace if cracked, damaged or other abnormal condition.
- Inspect reverse gear bearing. Replace bearing if pitted, noisy, rough or other abnormal condition.
- Check condition of oil seal and O-ring.
  Replace oil seal and O-ring if nicked, cut, worn or other abnormal condition.

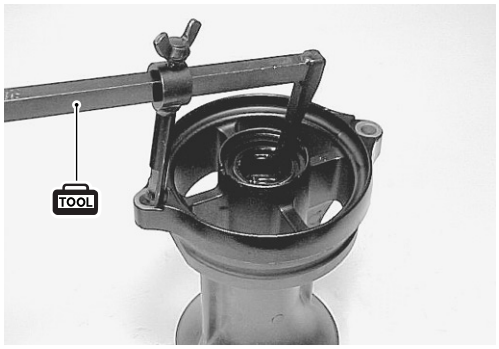




Replacing propeller shaft oil seal

1. Extract seals ① with oil seal remover.

09913-50121: Oil seal remover



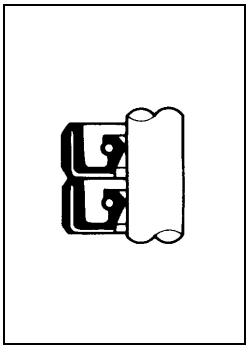
CAUTION

Do not reuse oil seal once removed.
Always use new oil seal.

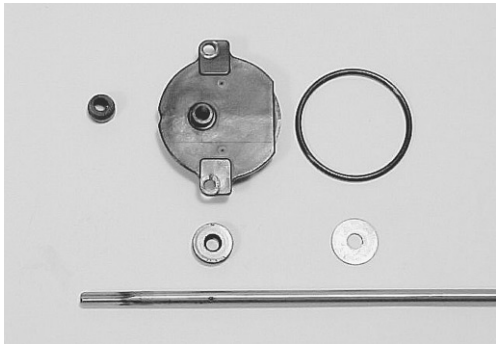
2. Apply Water Resistant Grease to the inner circumference of the housing.
3. Using an oil seal installer, drive the two oil seals (one at a time) into the propeller shaft bearing housing.
   The lipped portion of the seal must face towards the propeller.
   Apply Water Resistant Grease to the seal lips.

99000-25160: SUZUKI WATER RESISTANT GREASE

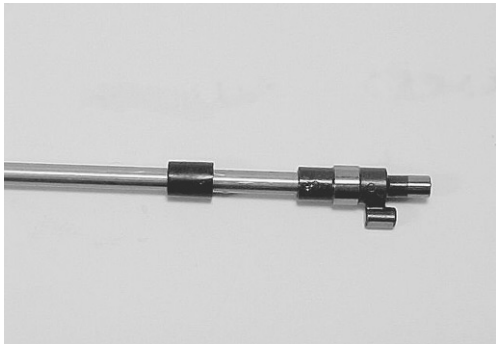




SHIFT ROD GUIDE HOUSING COMPONENTS

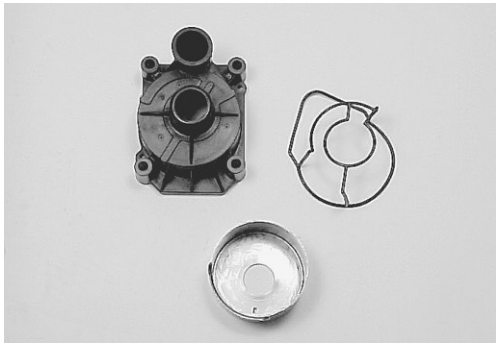


- Inspect shift rod guide housing. Replace if cracked, damaged or other abnormal condition.
- Inspect shifter yoke. Replace if wear, damaged or other abnormal condition.
- Inspect shift rod/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect O-ring. Replace if nicked, cut, torn, swollen or other abnormal condition.

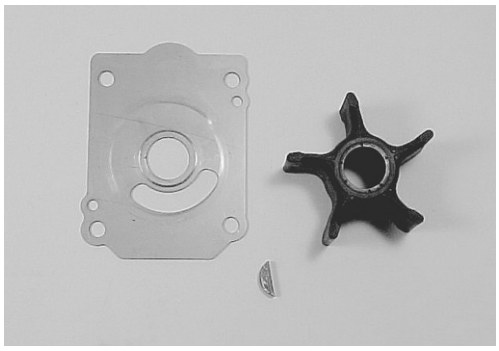


- Inspect oil seal and dust seal. Replace if nicked, cut, worn or other abnormal condition.

WATER PUMP AND RELATED ITEMS



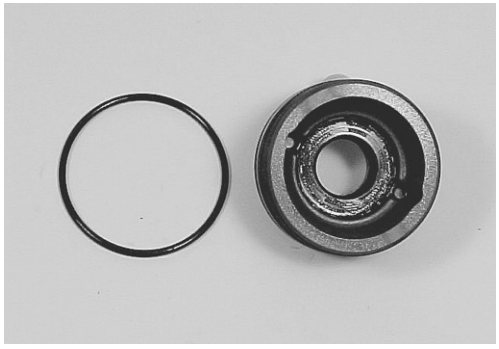
- Inspect impeller. Replace if vanes are cut, torn, worn or other abnormal condition.
- Inspect pump case. Replace if cracked, distorted or other abnormal condition.
- Inspect pump inner sleeve. Replace if worn, cracked, distorted, corroded or other abnormal condition.
- Inspect seal ring. Replace if nicked, cut, torn, swollen or other abnormal condition.



- Inspect under panel. Replace if cracked, distorted, corroded or other abnormal condition.

DRIVESHAFT OIL SEAL HOUSING

- Inspect housing. Replace if cracked, damaged or other abnormal condition.
- Check condition of oil seals. Replace if nicked, cut, worn or other abnormal condition.
- Inspect O-ring. Replace if worn, nicked, cut or other abnormal condition.



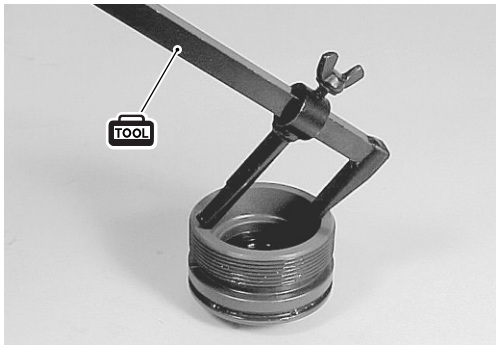
Replacing driveshaft oil seal

1. Using special tool, remove two (2) oil seals out of the driveshaft oil seal housing.

TOOL 09913-50121: Oil seal remover

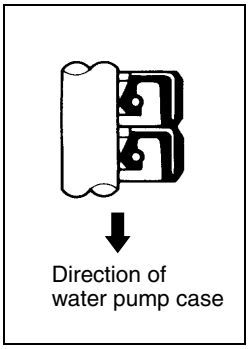
2. Apply Water Resistant Grease to inner circumference of driveshaft oil seal housing.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



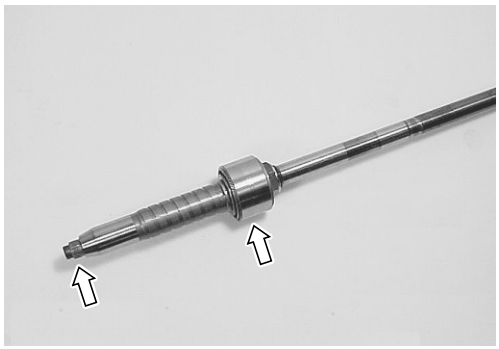
3. Grease the inner lips of oil seal. With the lips facing away from driveshaft bearing, place seal in position and drive it into the oil seal housing.

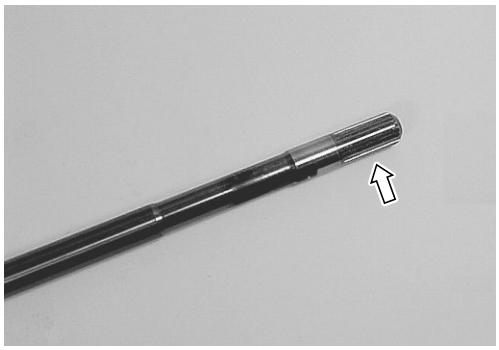




DRIVESHAFT

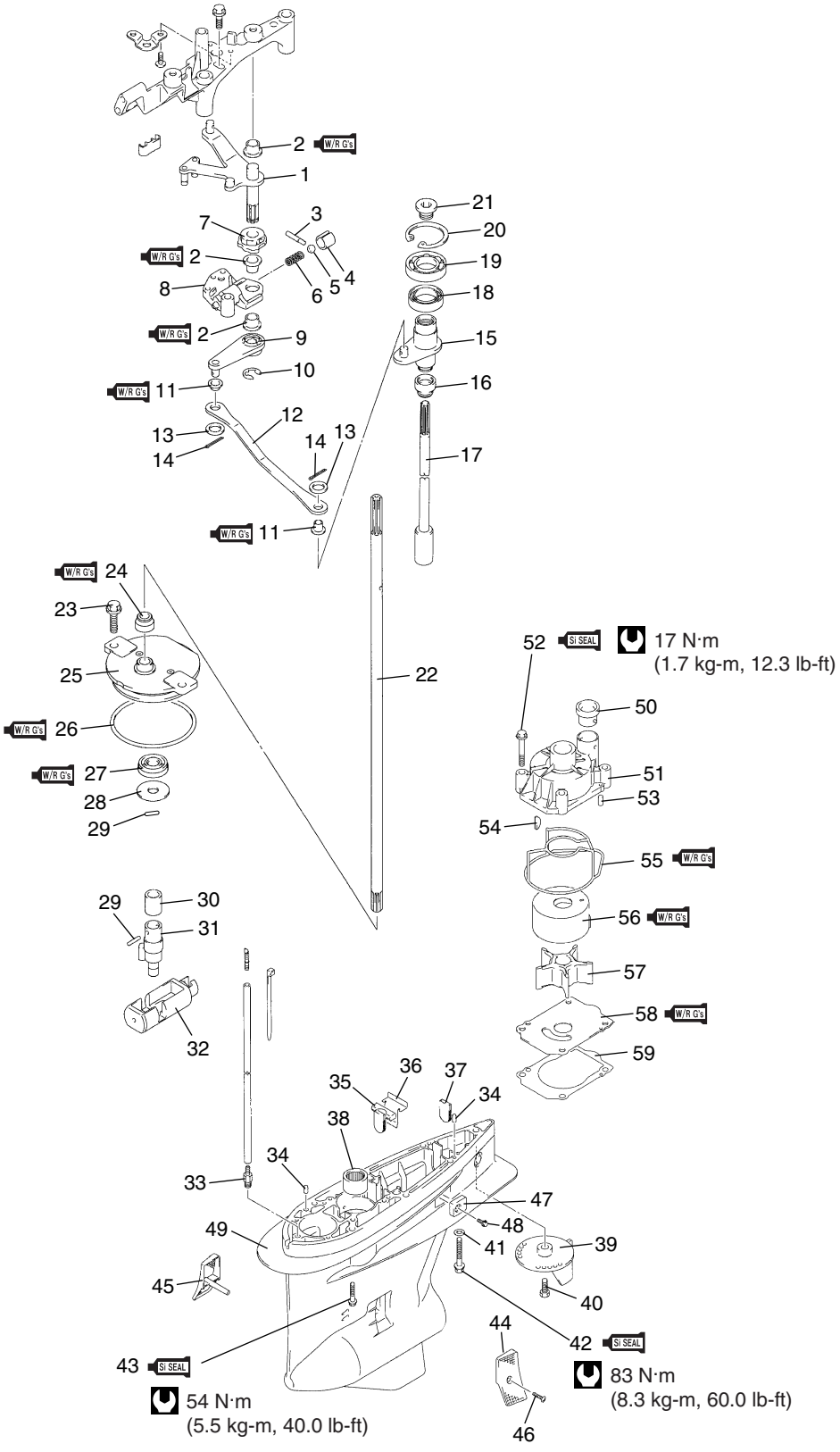
- Inspect driveshaft/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect driveshaft bearing, replace if pitted, noisy, rough or other abnormal condition.



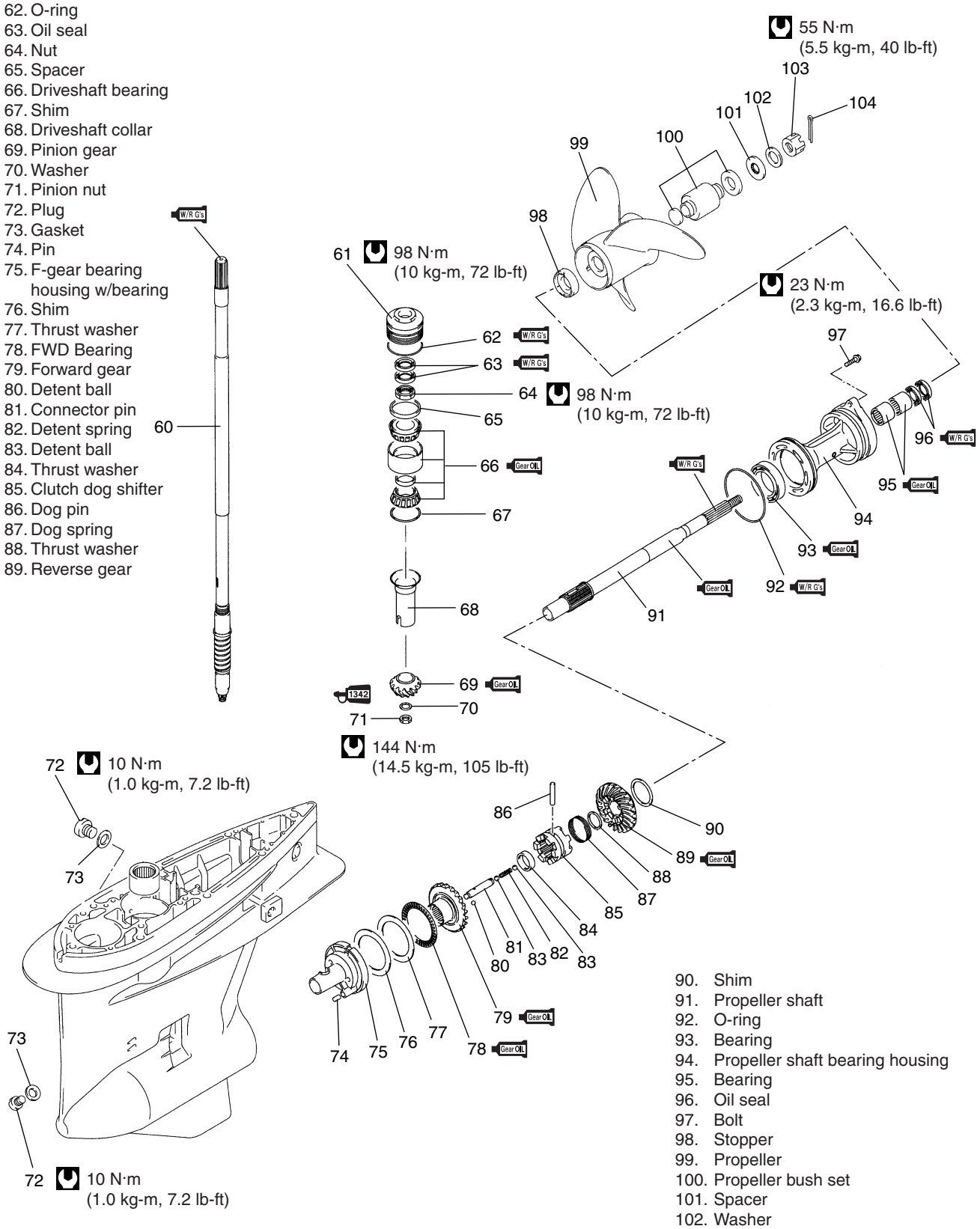


ASSEMBLY & INSTALLATION

Assembly & installation are reverse order of disassembly with special attention to the following steps.



1. Clutch lever
2. Bush
3. Pin
4. Pin
5. Ball
6. Spring
7. Clutch notch plate
8. Clutch lever holder
9. Clutch shaft arm
10. E-ring
11. Bush
12. Clutch lever link
13. Washer
14. Pin
15. Clutch shaft
16. Clutch rod cover
17. Clutch rod
18. Oil seal
19. Bearing
20. Circlip
21. Plug
22. Shift rod
23. Bolt
24. Clutch rod cover
25. Shift rod housing
26. O-ring
27. Oil seal
28. Washer
29. Pin
30. Magnet
31. Shifter yoke
32. Horizontal slider
33. Nipple
34. Pin
35. Exhaust rubber seal
36. Exhaust seal plate
37. Grommet
38. Pinion bearing
39. Trim tab
40. Bolt
41. Washer
42. Bolt
43. Bolt
44. Water filter PORT
45. Water filter STBD
46. Screw
47. Anode
48. Bolt
49. Gear case
50. Bush
51. Water pump case
52. Bolt
53. Pin
54. Key
55. Case sealing
56. Sleeve
57. Water pump impeller
58. Under panel
59. Gasket


60. Driveshaft
61. Oil seal housing
62. O-ring
63. Oil seal
64. Nut
65. Spacer
66. Driveshaft bearing
67. Shim
68. Driveshaft collar
69. Pinion gear
70. Washer
71. Pinion nut
72. Plug
73. Gasket
74. Pin
75. F-gear bearing housing w/bearing
76. Shim
77. Thrust washer
78. FWD Bearing
79. Forward gear
80. Detent ball
81. Connector pin
82. Detent spring
83. Detent ball
84. Thrust washer
85. Clutch dog shifter
86. Dog pin
87. Dog spring
88. Thrust washer
89. Reverse gear
55 N·m (5.5 kg-m, 40 lb-ft)
98 N·m (10 kg-m, 72 lb-ft)
23 N·m (2.3 kg-m, 16.6 lb-ft)
144 N·m (14.5 kg-m, 105 lb-ft)
10 N·m (1.0 kg-m, 7.2 lb-ft)
W/R G's
Gear OIL
1342
90. Shim
91. Propeller shaft
92. O-ring
93. Bearing
94. Propeller shaft bearing housing
95. Bearing
96. Oil seal
97. Bolt
98. Stopper
99. Propeller
100. Propeller bush set
101. Spacer
102. Washer
103. Nut
104. Pin

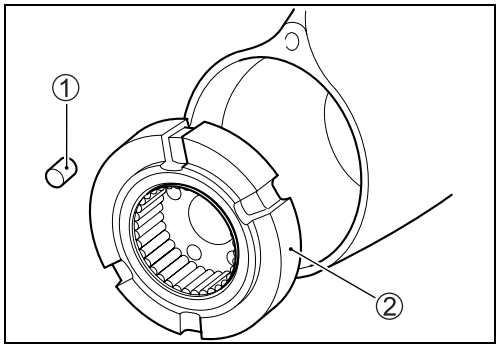
CAUTION

- **Make sure that all parts used in assembly are clean and lubricated.**
- **It is recommended that all seals, gaskets and O-rings be replaced with new on assembly.**
- **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 "GEARS SHIMMING AND ADJUSTMENT" section on page 9-26.)

FORWARD GEAR BEARING HOUSING

- Install dowel pin ① and forward gear bearing housing ②.

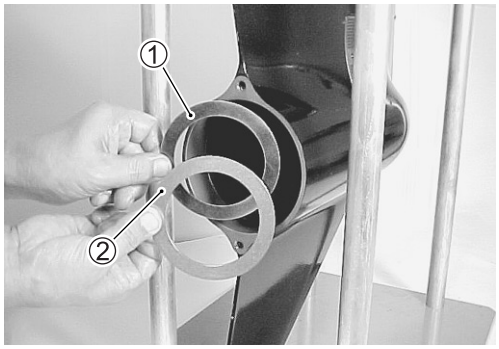
NOTE:
Before installing forward gear, check for correct amount and position of forward gear radial bearing rollers.
Use oil soluble grease to retain bearing rollers.

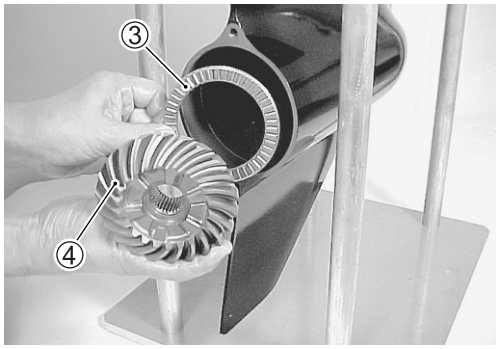


FORWARD GEAR

Place the forward gear back-up shim ①, thrust washer ②, forward gear thrust bearing ③ in position, then install forward gear ④.

Gear OIL **99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL**



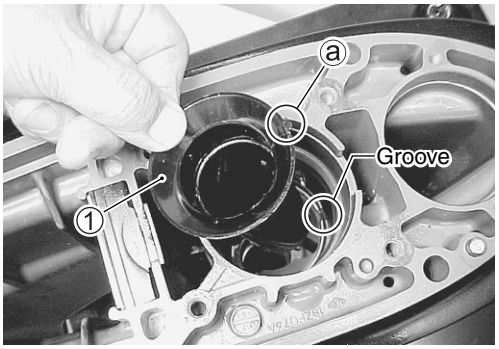


DRIVESHAFT COLLAR

Install driveshaft collar ①.

NOTE:

The tongue ⓐ of collar must be located into groove on the gearcase.



PINION GEAR

Place pinion gear in gearcase.

NOTE:

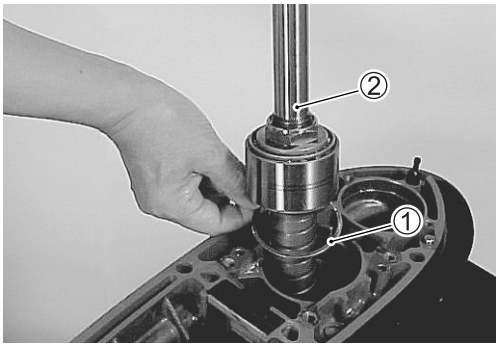
Before installing pinion gear, check for correct amount and position of pinion bearing rollers.

Use oil soluble grease to retain bearing rollers.



DRIVESHAFT

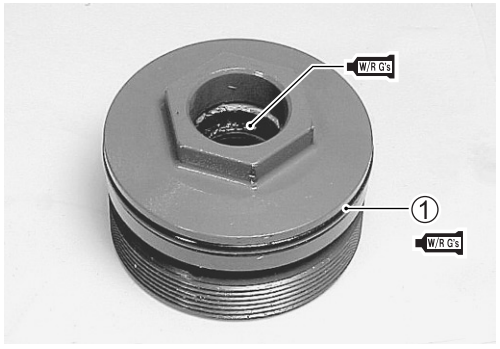
Install pinion shim ①, then lower the driveshaft assembly ② down into the gearcase until the bottom of shaft protrudes through center of pinion.



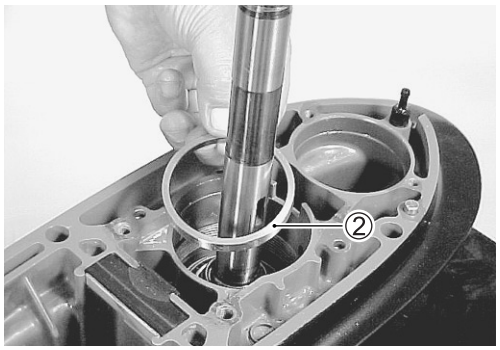
DRIVESHAFT OIL SEAL HOUSING

- Apply Water Resistant Grease to the driveshaft oil seal.
- Apply Water Resistant Grease to O-ring ①, then install O-ring into groove on the driveshaft oil seal housing.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



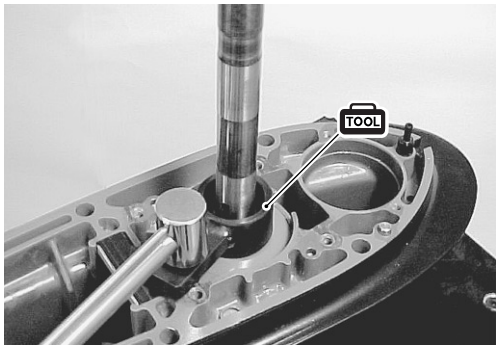
- Install driveshaft bearing spacer ②.



- Install driveshaft oil seal housing on gearcase, then tighten oil seal housing to specified torque.

Driveshaft oil seal housing: 98 N·m (10 kg-m, 72 lb-ft)

09926-29310: Driveshaft housing remover

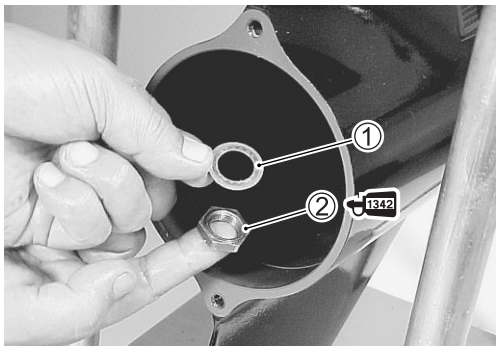


PINION NUT

- Apply THREAD LOCK 1342 to the threads of pinion nut ② before threading it onto driveshaft.

99000-32050: THREAD LOCK 1342

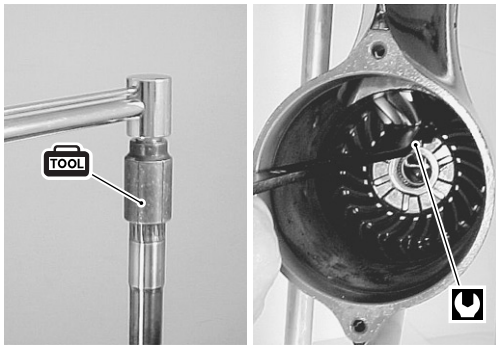
NOTE:
It is recommended the original pinion nut be used for the purposes of shimming during repair. A new pinion nut should be used on final assembly.



- Install washer ①, pinion nut ②, then tighten nut to specified torque.

Pinion nut: 144 N·m (14.5 kg-m, 105 lb-ft)

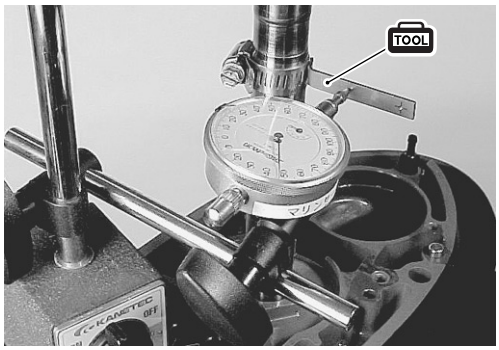
09921-29410: Driveshaft holder



CHECKING GEAR BACKLASH

Before installing reverse gear, gear backlash should checked. (See the "GEARS-SHIMMING AND ADJUSTMENT/CHECKING BACKLASH" section on page 9-27.)

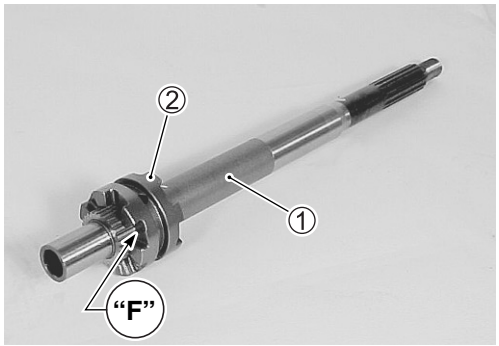
09952-09310: Backlash indicator tool



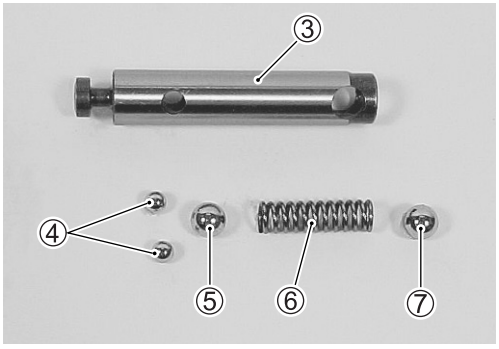
PROPELLER SHAFT

- Slide the clutch dog shifter ② onto the propeller shaft ①.

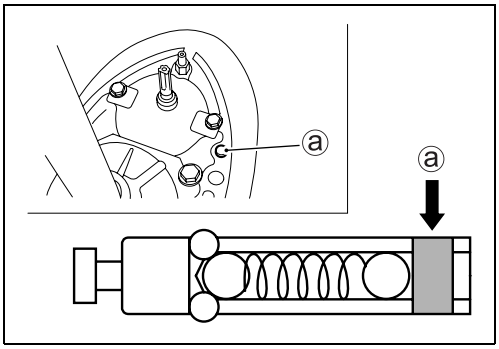
NOTE:
The side of the clutch dog shifter marked with the letter "F" must face towards forward gear.



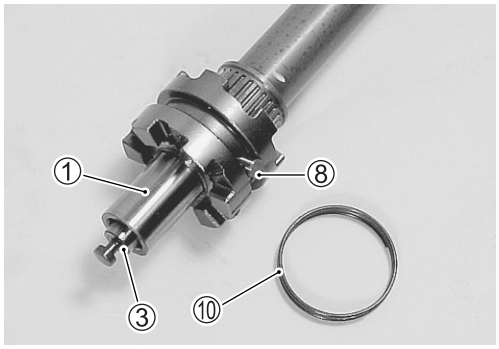
- Insert two (2) small detent balls ④, large detent ball ⑤, detent spring ⑥ and large detent ball ⑦ into connector pin ③. Then depress detent ball ⑦ and temporarily insert stopper pin ⓐ into dog pin hole of connector pin, as shown in right figure.



NOTE:
Temporarily insert a gearcase dowel pin ⓐ into the connector pin to prevent the detent ball from falling out.



- Insert the connector pin ③ (w/detent balls) into propeller shaft ①.
- Align the holes in the shifter dog and connector pin and then slide the dog pin ⑧ through both dog and connector pin. (save the temporarily installed dowel pin pushed out as the dog pin is inserted.)
- Install the dog pin retaining spring ⑩, ensuring that it fits snugly into the groove on the dog shifter.

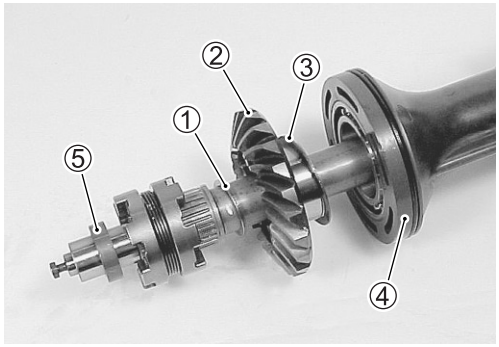


PROPELLER SHAFT/BEARING HOUSING

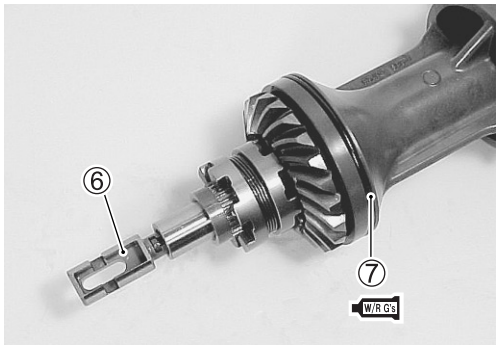
- Assemble the propeller shaft in the following sequence: forward thrust washer ⑤, reverse thrust washer ①, reverse gear ②, reverse gear back-up shim ③ and propeller shaft housing ④.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Gear OIL 99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL



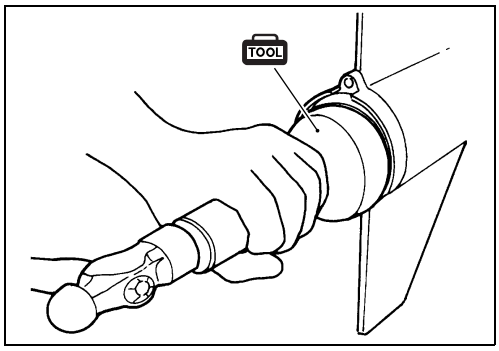
- Assemble horizontal slider ⑥ to connector pin.
- Apply Water Resistant Grease to bearing housing O-ring ⑦.



NOTE:
Before installing propeller shaft/bearing housing assembly, move shifter dog to bring horizontal slider to the neutral position.

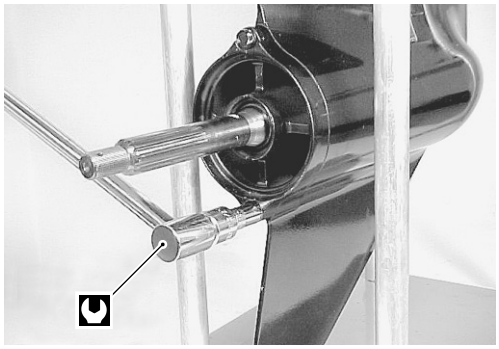
- Using special tools, install the propeller shaft and housing assembly in the gear case.

09922-59410: Propeller shaft housing installer
09922-59420: Housing installer handle



- When the housing is fully seated, tighten both retaining bolts to the specified torque.

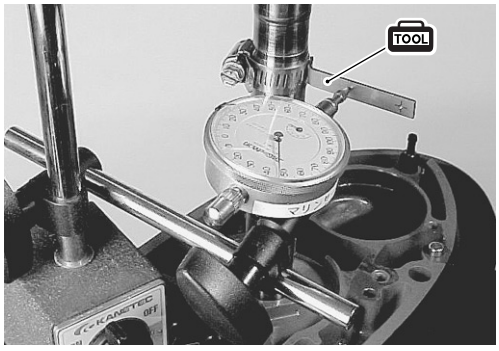
Bearing housing bolt: 23 N·m (2.3 kg-m, 16.6 lb-ft)



RECHECKING GEAR BACKLASH

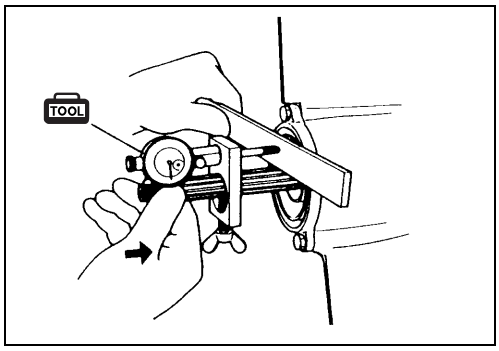
Recheck the gear backlash.
This should not be less than previously checked.
If less, reduce the number/thickness of reverse gear back-up shims.
(See the "GEARS-SHIMMING AND ADJUSTMENT/CHECKING BACKLASH" section on page 9-30.)

09952-09310: Backlash indicator tool



CHECKING PROPELLER SHAFT THRUST PLAY

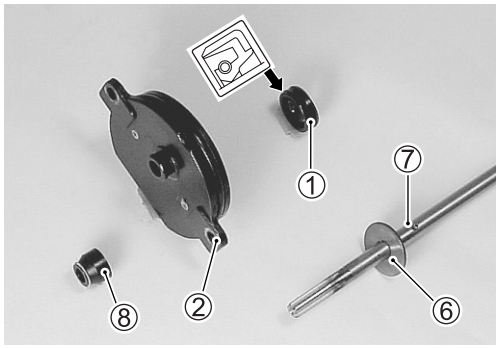
See the "GEARS-SHIMMING AND ADJUSTMENT/CHECKING PROPELLER SHAFT THRUST PLAY" section on page 9-31.



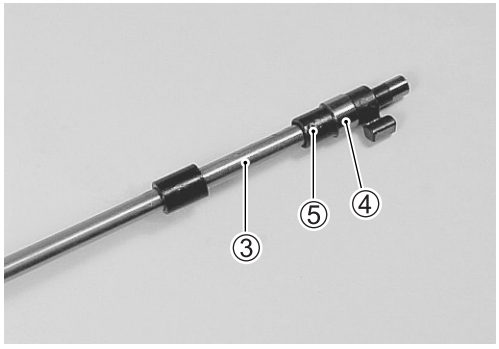
SHIFT ROD GUIDE HOUSING

- Using an oil seal installer, drive the oil seal ① into the shift rod guide housing ②.
  The lipped portion of oil seal must face towards the driveshaft housing.

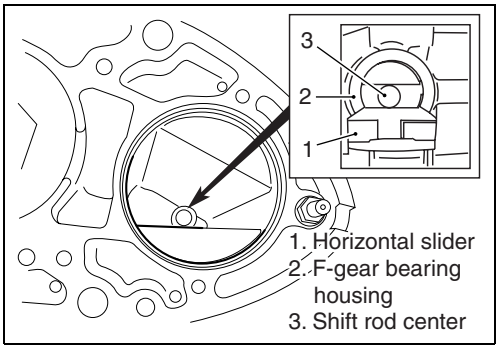
99000-25160: SUZUKI WATER RESISTANT GREASE



- Attach shifter yoke ④ to shift rod ③, then insert pin ⑤.
- Install pin ⑦ and washer ⑥ to shift rod, then slide shift rod guide housing onto shift rod.
- Install dust seal ⑧ to shift rod guide housing.



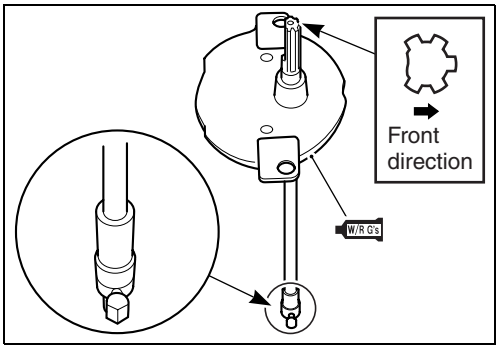
NOTE:
Be sure the horizontal slider is in the neutral position before installing the shift unit (shift rod guide housing assembly.).



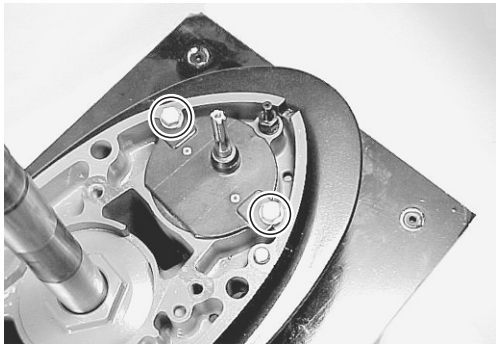
- Apply Water Resistant Grease to the shift rod guide housing O-ring.

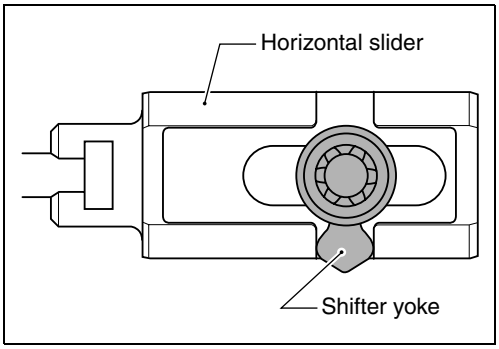
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

NOTE:
Before installing shift rod guide housing assembly, bring shifter yoke to neutral position by turning shift rod right or left.



- Install shift rod guide housing assembly by aligning shifter yoke with groove in horizontal slider, then tighten two (2) housing bolts securely.
- Turn shift rod from Neutral position to Forward and Reverse position to check proper gear engagement.

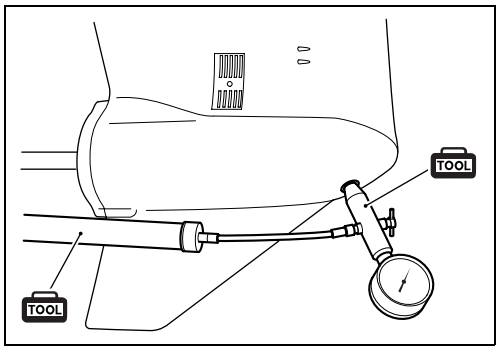




LEAKAGE CHECK

Check for leakage of oil seal and O-ring when applying specified pressure inside of the gearcase.

09950-69511: Oil leakage tester
09952-99310: Air pump



Procedure

1. Install the test tool into the oil drain hole.
2. Connect the air pump to the tester.
3. Rotate driveshaft and propeller shaft clockwise several times and then apply specified pressure for the test.

NOTE:
Apply low initial pressure of 20 – 40 kPa, (0.2 – 0.4 kg/cm², 2.8 – 5.7 psi) first, then apply specified pressure.

Leakage test pressure: 100 kPa (1.0 kg/cm², 14.2 psi)

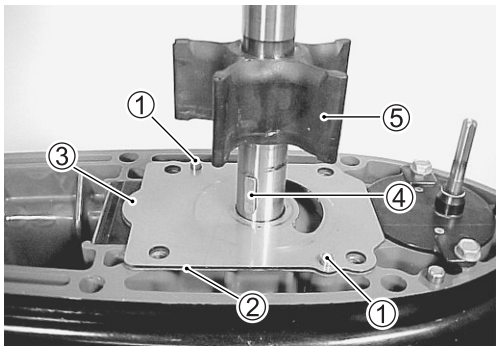
CAUTION

Do not exceed pressure of 110 kPa (1.1kg/cm², 15.6 psi) or damage to oil seals will result.

4. Once stabilized, pressure should remain steady for at least 5 min.
   If pressure does not fall, sealing performance is correct.

WATER PUMP (Impeller & case)

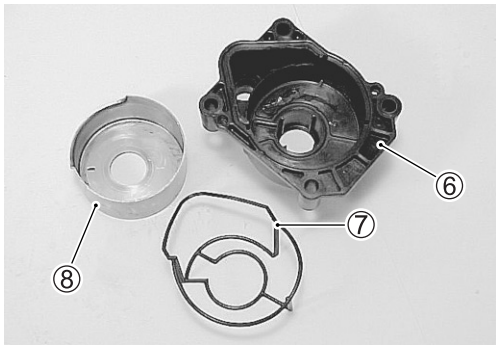
- Place the dowel pins ①, under panel gasket ② and under panel ③ into position.
- Insert the key ④ in the driveshaft and slide the impeller ⑤ onto driveshaft, ensuring that key and keyway are aligned.



- Place the seal ring ⑦ into groove of the pump case ⑥, then install inner sleeve ⑧ to pump case.

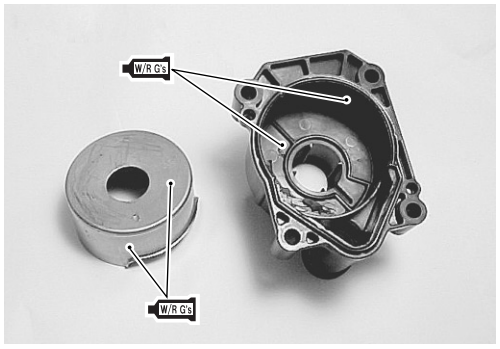
CAUTION

Do not re-use seal ring once removed.
Always use new ring.



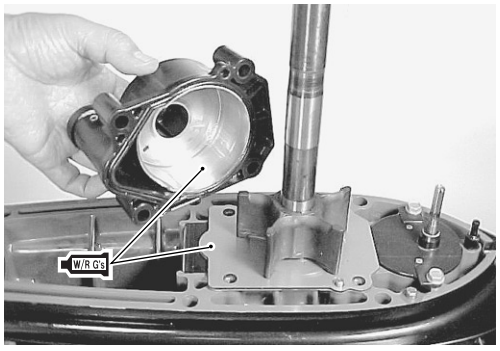
NOTE:
Before installing pump inner sleeve, apply water resistant grease lightly between inner sleeve and pump case mating surfaces.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



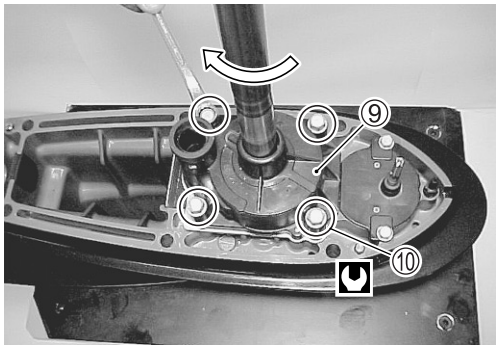
NOTE:
Before installing water pump case assembly, apply Water Resistant Grease lightly on pump case inner sleeve and under panel for initial lubrication.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



- Install the pump case assembly ⑨ while rotating driveshaft clockwise to flex the impeller vanes in the correct direction.
- Securely tighten the four (4) pump case bolts ⑩ to the specified torque.

Pump case bolt: 17 N·m (1.7 kg-m, 12.5 lb-ft)



PROPELLER INSTALLATION

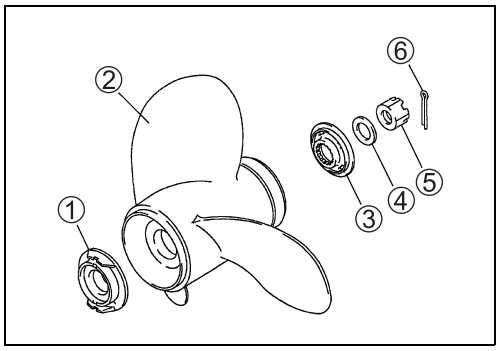
Install propeller stopper ① onto propeller shaft, then slide on the propeller ②.

Fit spacer ③, washer ④ and nut ⑤, then tighten nut to specified torque.

Push cotter pin ⑥ through nut and shaft, then bend to secure.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Propeller nut: 55 N·m (5.5 kg-m, 40.0 lb-ft)



LOWER UNIT INSTALLATION

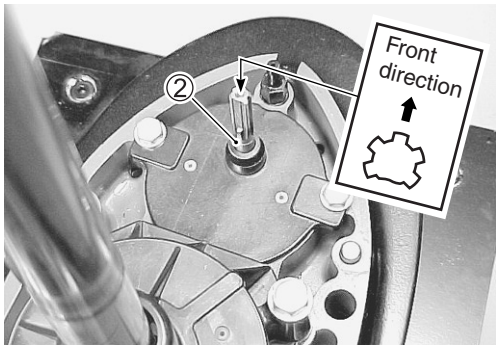
- Apply Water Resistant Grease to clutch rod splines, then install clutch rod ① by aligning clutch rod splines with splines in clutch shaft.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

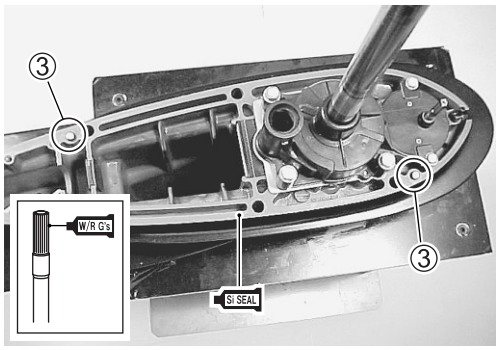


- Ensure that shift rod ② is at neutral position.

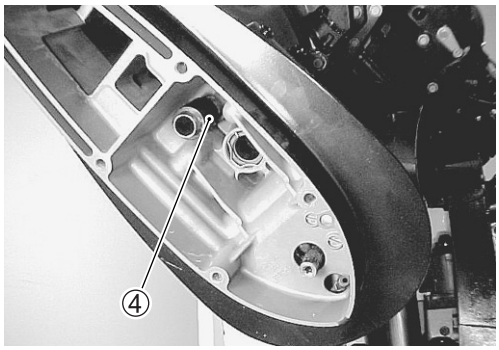
NOTE:
Before installing lower unit assembly, bring shift to neutral position by turning shift rod right or left.



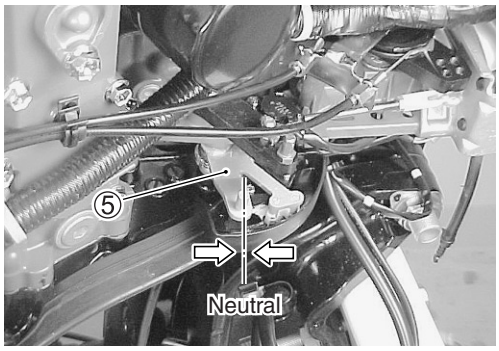
- Insert two (2) dowel pins ③.
- Apply Water Resistant Grease to driveshaft and shift rod splines.
- Apply a light coating of SUZUKI SILICONE SEAL to mating surfaces of gearcase and driveshaft housing.



- Install spacer ④ to water tube.



• Set the clutch control lever ⑤ at Neutral position, then slide the lower unit ⑥ into place, ensuring that the top of driveshaft engages properly with driven gear shaft and that water tube locates in water pump case outlet.



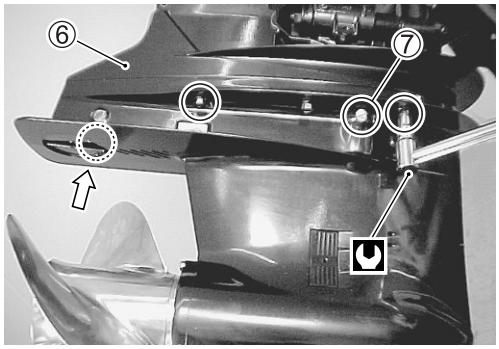
NOTE:
In order for shift rod and clutch rod splines to be aligned correctly, clutch rod may need to be turned slightly right or left.

• Apply SUZUKI SILICONE SEAL to seven (7) gearcase bolts ⑦ and tighten them to specified torque.

Gearcase bolt: 10 mm 54 N·m (5.5 kg-m, 40.0 lb-ft)
12 mm 83 N·m (8.3 kg-m, 60.0 lb-ft)

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Si SEAL 99000-31120: SUZUKI SILICONE SEAL

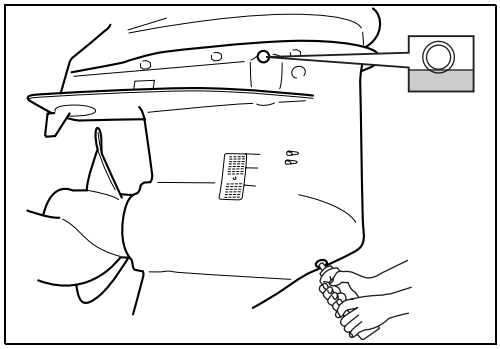


• Shift the clutch control lever to Forward and Reverse position from Neutral position to check proper gear engagement.

GEAR OIL

Fill the gearcase with specified gear oil for initial testing and recheck the level after 10 minutes. Top up if necessary.
(See “PERIODIC MAINTENANCE/GEAR OIL” section on page 2-6.)

Gear OIL 99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL



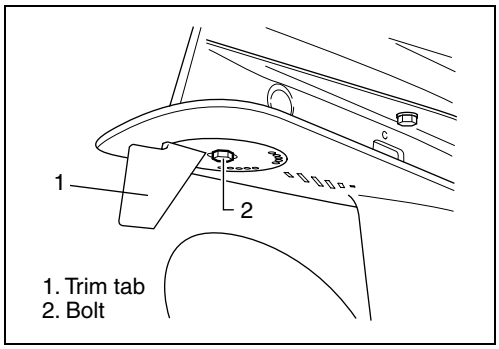
TRIM TAB

The trim tab counteracts or minimizes propeller torque “pull” felt through the steering system.

If the steering is pulled to starboard or port side, adjust trim tab with following procedure:

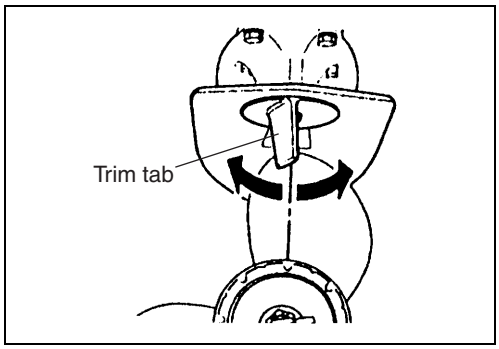
Adjusting

1. Loosen the bolt of trim tab.
2. Change direction of trim tab.
   - To compensate for a veer to starboard, set trailing edge of tab to the right (as viewed from behind).
   - To compensate for a veer to port, set trailing edge of tab to the left.



1. Trim tab
2. Bolt

3. Tighten the bolt of trim tab.
4. Test ride the boat and repeat the procedure 1 – 3 to set the trim tab in the best position.



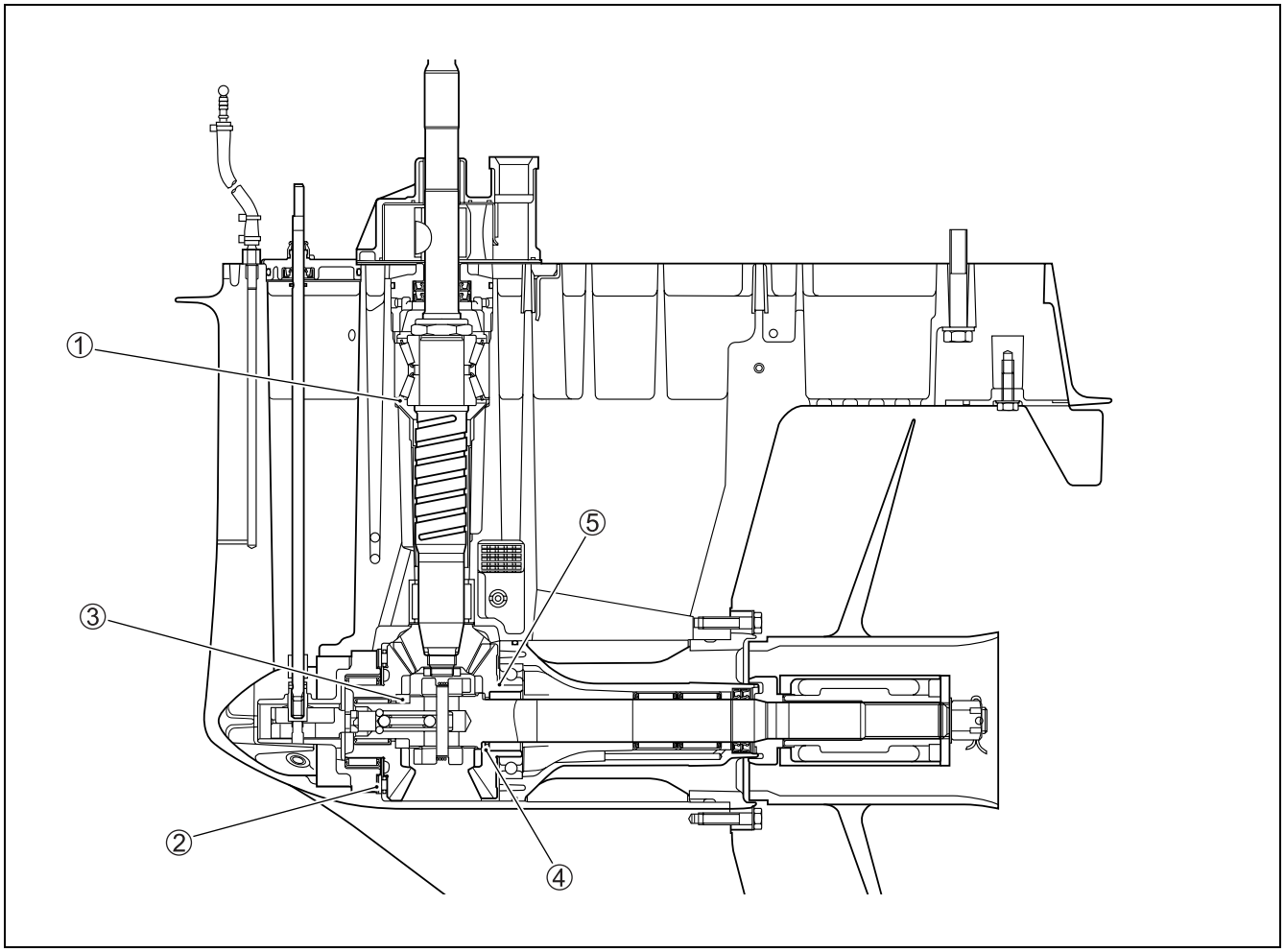
With a properly adjusted trim tab, steering should be neutral and there should be no tendency for the steering to be pulled to either port or starboard.

LOWER UNIT GEARS- SHIMMING AND ADJUSTMENT

If 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)
①	Pinion 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
②	Forward gear back-up shim	0.50, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.0	1.0
③	Forward gear thrust washer	9.5	9.5
④	Reverse gear thrust washer	1.5, 1.7, 1.9, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8	2.0
⑤	Reverse gear back-up shim	1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	1.5

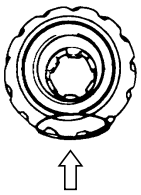


FORWARD GEAR/PINION GEAR

Follow the procedure below to adjust forward gear/pinion gear.

Step to prior to adjustment

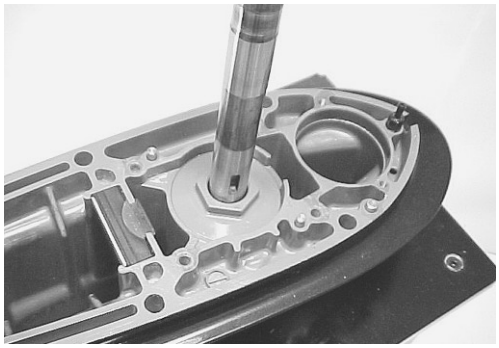
1. Install standard pinion gear back-up shim thickness modified according to ± design specification mark on gear.



± design
spec. mark

2. Correctly assemble driveshaft oil seal housing, driveshaft, forward gear, pinion gear and related components. (See page 9-15 to 9-17.)
   Do not install reverse gear at this time.
3. Tighten pinion nut to specified torque.

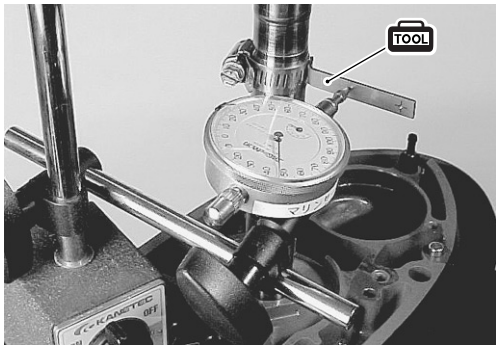
Pinion nut : 144 N·m (14.4 kg-m, 104 lb-ft)



Adjusting gear backlash

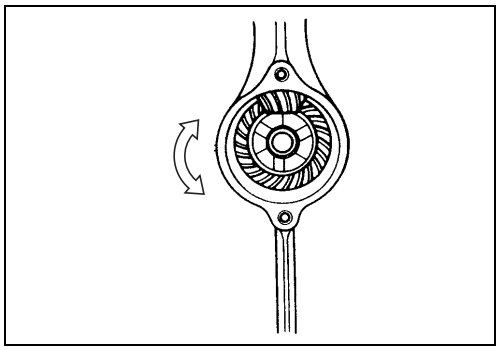
(a) Assemble special tool to driveshaft as shown in figure.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09952-09310: Backlash indicator tool

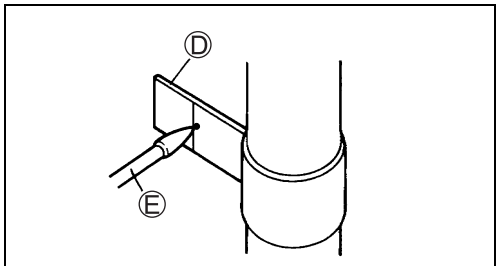


(b) Push forward gear inward and hold it by hand, align dial gauge pointer at 90 ° to the mark on the backlash indicator tool and read backlash on dial gauge by lightly moving drive-shaft clockwise and counterclockwise by hand.

Gear backlash: Approx. 0.3 – 0.5 mm (0.012 – 0.020 in)



- If the backlash measured is larger than the specification, add the amount over the specification to the temporary use forward gear back-up shim and install this shim.
- If the backlash measured is smaller than the specification, subtract the amount less than the specification from the temporary use forward gear back-up shim and install this shim.



Ⓓ Backlash indicator tool
Ⓔ Dial gauge

Checking and adjusting tooth contact pattern (Pinion and Forward gear)

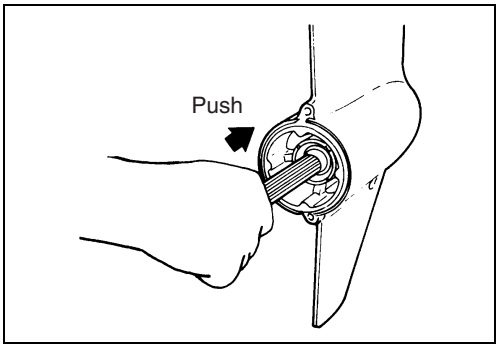
Check tooth contact pattern using the following procedure:

1. To assess tooth contact, apply a light coat of Prussian Blue on the convex surface of forward gear.

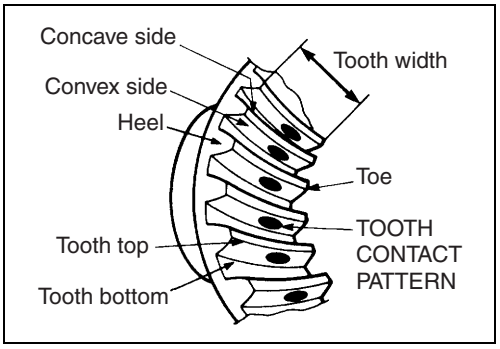


2. Install propeller shaft and housing assembly (minus reverse gear and internal components).
3. Push propeller shaft inward and hold in position.
4. Using driveshaft holder tool, rotate the driveshaft 5 – 6 times.

TOOL 09921-29410 : Driveshaft holder



5. Carefully pull out propeller shaft and housing to check tooth contact pattern.



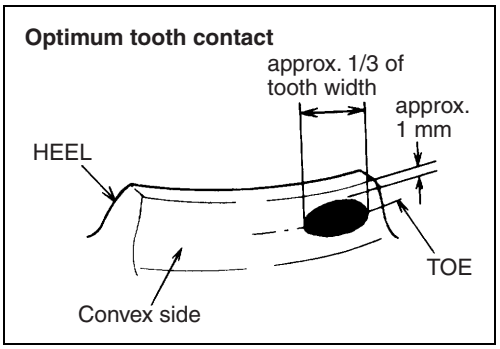
Optimum tooth contact

The optimum tooth contact is shown at right.

A shim adjustment may be necessary to obtain this contact pattern.

CAUTION

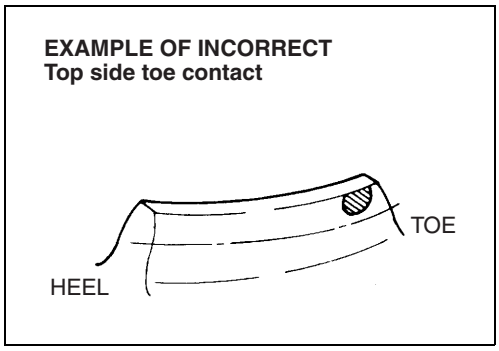
Gear backlash should be checked when increasing or decreasing shim thickness to adjust tooth contact.



Example (1)
Incorrect topside toe contact:
Correction measures:
- Decrease thickness of forward gear shim.
- Slightly decrease pinion gear shim thickness.

CAUTION

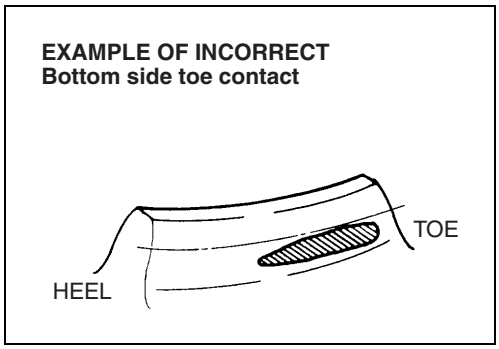
Do not set tooth contact in this position (top side toe contact). Damage and chipping of forward and pinion gear may result.



Example (2)
Incorrect bottom side toe contact:
Correction measures:
- Increase thickness of forward gear shim.
- Slightly increase pinion gear shim thickness.

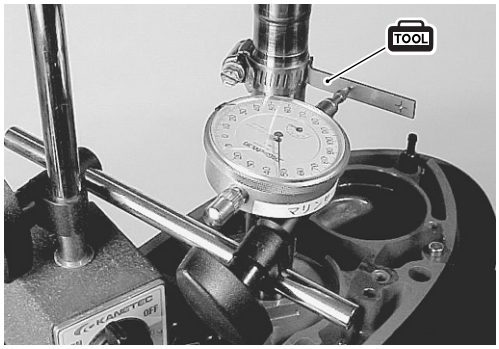
CAUTION

Do not set tooth contact in this position (bottom side toe contact). Chipping of pinion gear may result.



CHECKING GEAR BACKLASH
After obtaining optimum tooth contact, gear backlash should be measured.
(a) Assemble special tool as shown in figure.

TOOL **09900-20606 : Dial gauge**
09900-20701 : Magnetic stand
09900-09310 : Backlash indicator tool

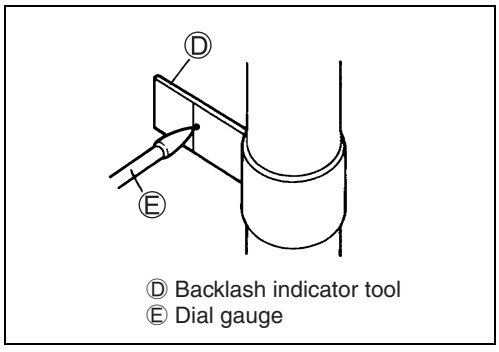


(b) Push the forward gear inward and fix it by hand, then read backlash on dial graduation by lightly moving driveshaft clockwise and counterclockwise by hand.

Designate this amount of gear backlash as (A).

Gear backlash: Approx. 0.3 – 0.5 mm (0.012 – 0.020 in)

NOTE:
Gear backlash (A) must be known to adjust reverse gear shim.



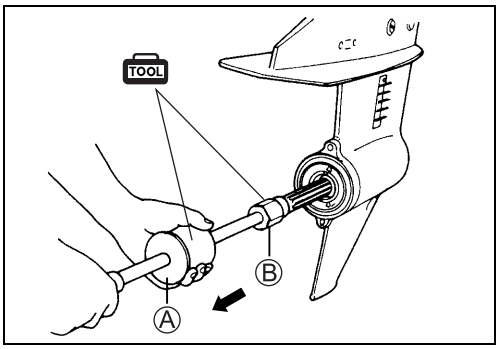
Ⓓ Backlash indicator tool
Ⓔ Dial gauge

RECHECKING GEAR BACKLASH
(Reverse gear back-up shim adjustment)

1. After adjusting forward gear tooth contact pattern, correctly assemble propeller shaft, housing assembly, reverse gear and related components. (See page 9-17 to 9-19.)

2. Thread slide hammer assembly onto propeller shaft and strike a few gentle outward taps.

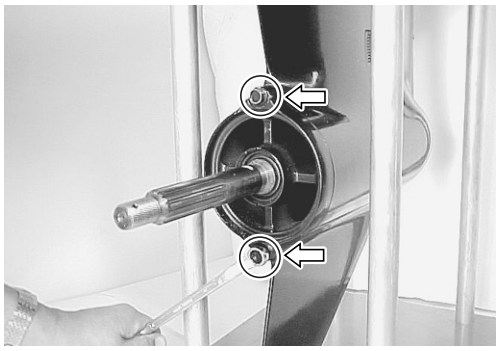
TOOL **09930-30161 : Propeller shaft remover – Ⓑ**
09930-30102 : Sliding hammer – Ⓐ



3. Assemble special tool in the following sequence.

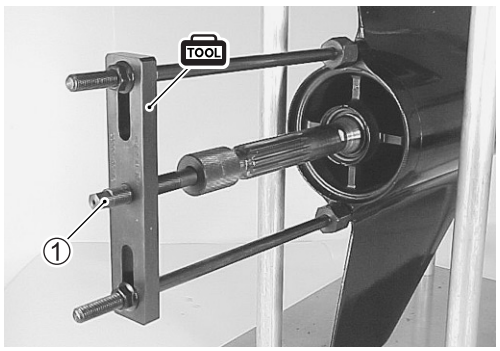
TOOL **09951-99310 : Gear holder**

(a) Remove two (2) bearing housing retaining bolts, then screw long bolts of special tool to secure the bearing housing.



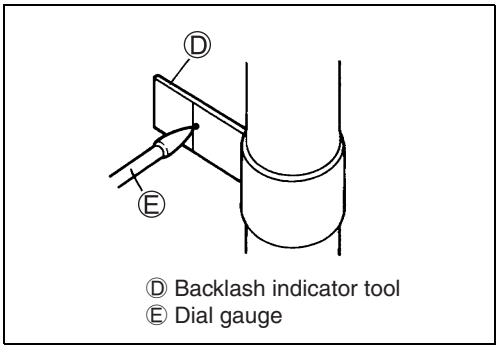
(b) Install the special tool and then attach it to the propeller shaft as shown.

4. Turn the bolt ① counterclockwise and tighten until the propeller shaft can rotate smoothly without play. Do not over tighten.



5. Assemble backlash indicator tool and dial gauge as shown in figure.

TOOL **09900-20606 : Dial gauge**
09900-20701 : Magnetic stand
09952-09310 : Backlash indicator tool



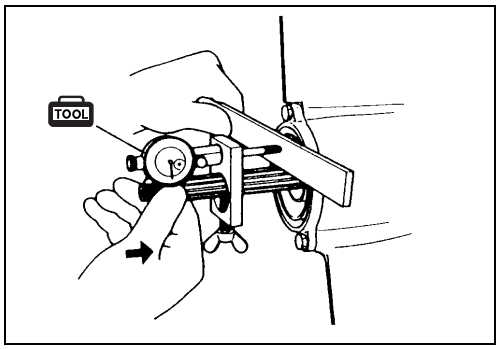
Ⓓ Backlash indicator tool
Ⓔ Dial gauge

6. Read backlash on dial gauge by lightly moving driveshaft clockwise and counterclockwise by hand.
   Designate this measurement as backlash (B).

7. Compare backlash (B) to backlash (A) (page – 9-29.).
8. Reverse gear back-up shim adjustment is correct if (B) is equal to (A).
   - If (B) is less than (A), reduce reverse gear back-up shim thickness .

CHECKING PROPELLER SHAFT THRUST PLAY

After adjusting all gear positions, measure the propeller shaft thrust play. If not within the following specification, a shim adjustment is required.



Propeller shaft thrust play : 0.2 – 0.4 mm (0.008 – 0.016 in)

NOTE:
Use only the reverse gear thrust washer to adjust thrust play.
The forward gear thrust washer must be maintained at standard thickness (9.5 mm).

Measurement step :

1. Assemble gear adjusting gauge to the propeller shaft.

TOOL 09951-09511: Gear adjusting gauge

2. Push propeller shaft inward.
3. Hold shaft in and set dial gauge pointer to zero.
4. Slowly pull shaft outward and read the maximum thrust play on the dial gauge.
   - If measurement is more than specification, increase reverse gear thrust washer thickness.
   - If measurement is less than specification, reduce reverse gear thrust washer thickness.

LOWER UNIT [Counter rotation (Left-hand) model]

CONTENTS

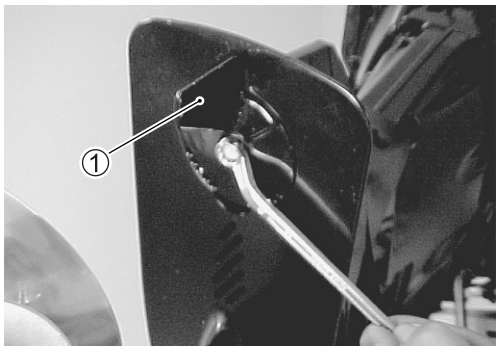
REMOVAL & DISASSEMBLY 10- 2
INSPECTION 10- 8
PROPELLER 10- 8
GEARCASE 10- 8
GEARS/BEARING 10- 9
REVERSE GEAR BEARING HOUSING/BEARING 10- 9
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REMOVAL & DISASSEMBLY

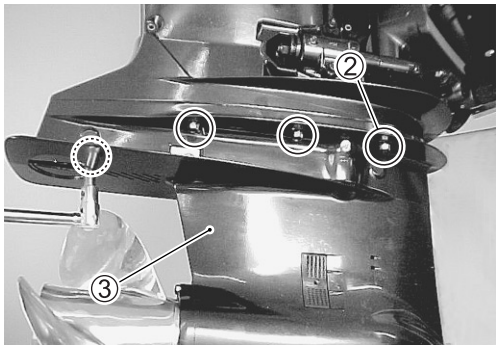
⚠ WARNING

Always disconnect the battery cable, before removing lower unit.

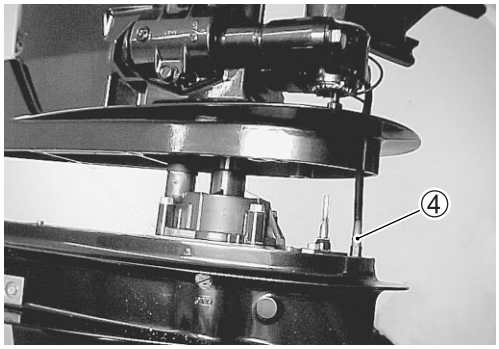
Shift to “NEUTRAL” position.
Remove bolt and trim tab ①.



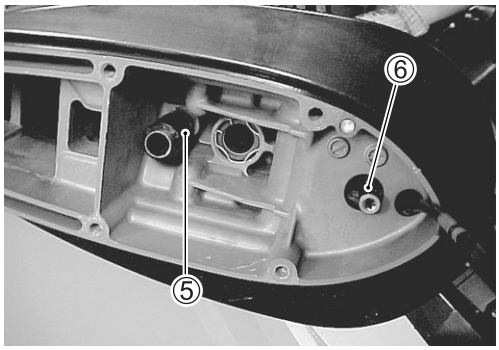
Remove seven (7) bolts ② and separate gearcase ③ from driveshaft housing.



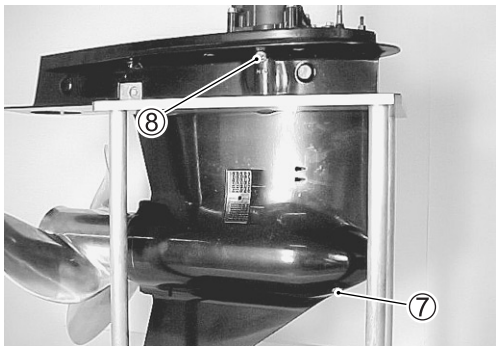
NOTE:
Before gearcase is removed completely, disconnect speedometer pick up tube ④ from gearcase.



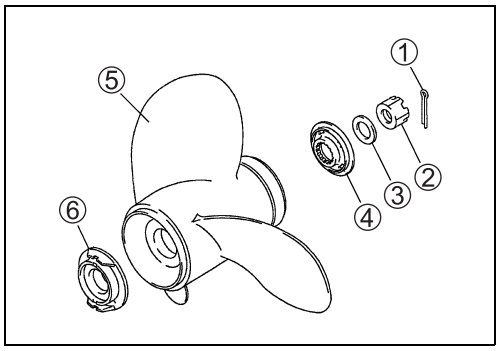
Remove water tube spacer ⑤.
Remove clutch rod ⑥ from clutch shaft (if necessary).



Place a drain pan under oil drain plug.
Remove oil drain plug ⑦ first then oil level plug ⑧ and allow gear oil to drain.
Inspect oil for water, contaminates or metal.

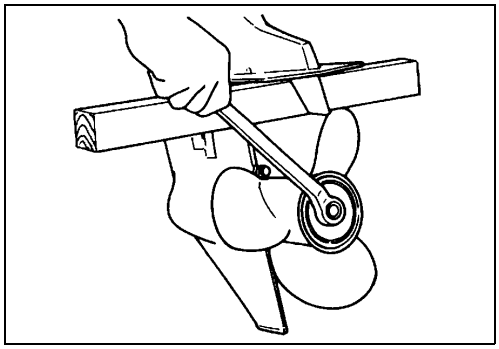


Remove cotter pin ① from propeller nut and remove propeller nut ②.
Remove washer ③, spacer ④, propeller ⑤ and stopper ⑥ from the propeller shaft.

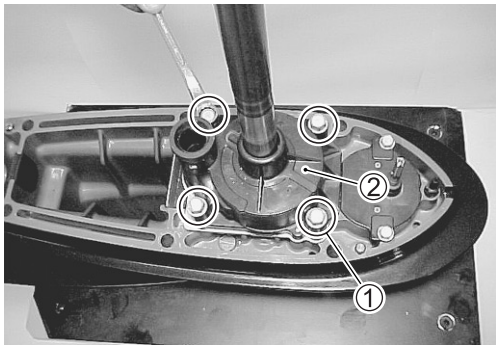


⚠ WARNING

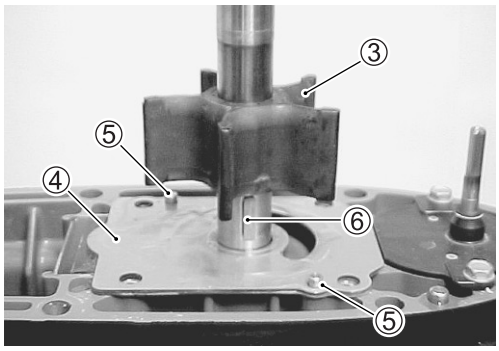
To prevent injury from propeller blades, wear gloves and place a block of wood between the anti-cavitation plate and the propeller blade tips to lock the propeller in place before attempting to remove propeller nut.



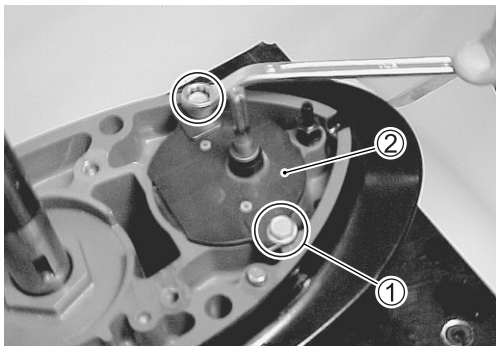
Loosen four (4) bolts ①, then remove water pump case ②.



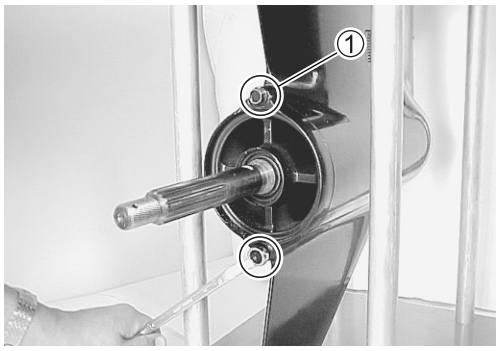
Remove impeller ③, impeller key ⑥, pump under plate ④ and dowel pins ⑤.
Keep impeller key ⑥ for reuse and discard the plate gasket.



Remove two (2) bolts ① and shift rod guide housing assembly ②.

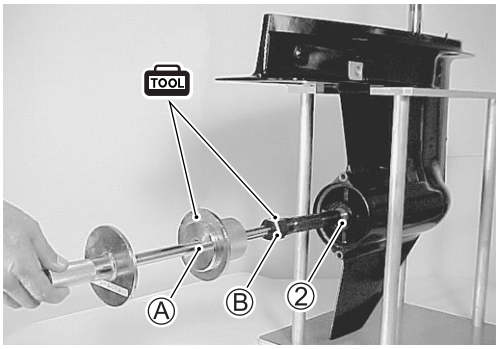


Remove two (2) bolts ① securing the propeller shaft bearing housing to the gearcase.



Using special tools, pull out the propeller shaft bearing housing. Remove the propeller shaft and bearing housing assembly ②.

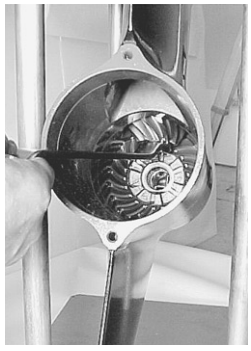
TOOL **09930-30102: Ⓐ Sliding hammer**
09930-30161: Ⓑ Propeller shaft remover

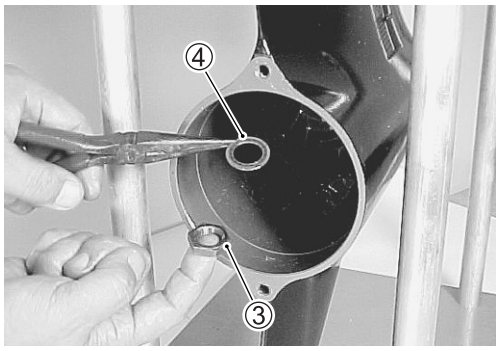


Hold the pinion nut securely, then fit special tool to the driveshaft and loosen the pinion nut.
Remove pinion nut ③ and washer ④.

TOOL **09921-29410: Driveshaft holder**

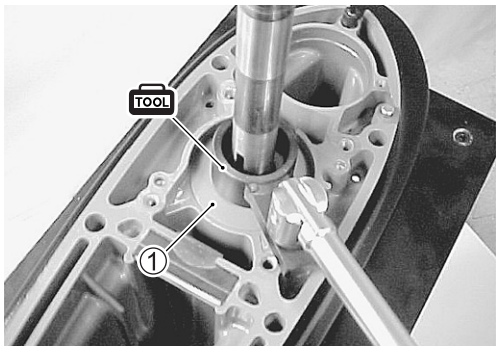




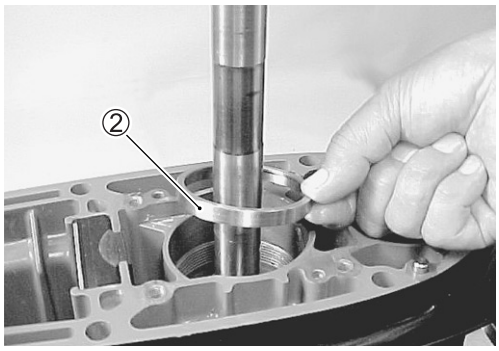


Use special tool to unscrew driveshaft oil seal housing ①, then remove oil seal housing from drive shaft.

TOOL **09926-29310: Driveshaft housing remover**

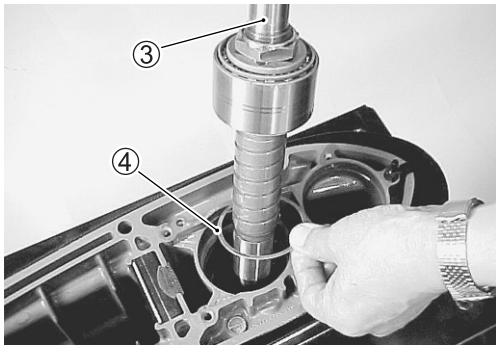


Remove driveshaft bearing spacer ②.

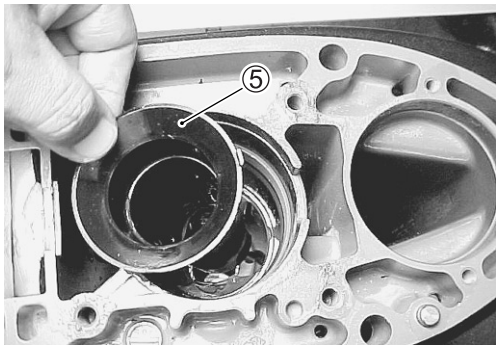


Slowly lift out driveshaft assembly ③.
Remove the pinion shim ④.

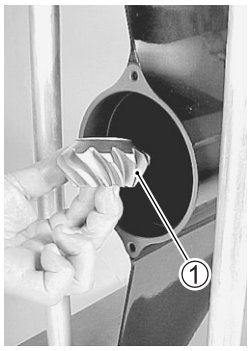
NOTE:
The driveshaft pinion gear bearing contains 28 loose roller bearings. Account for all roller bearings on disassembly.

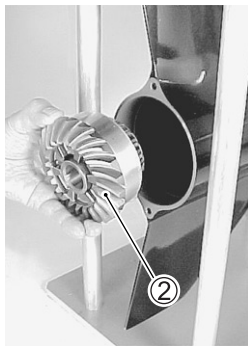


Remove the driveshaft collar ⑤.

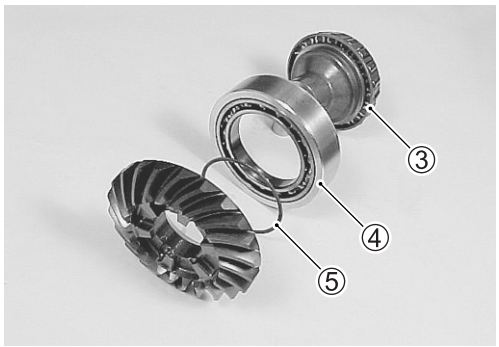


Remove the pinion gear ①.
Remove the reverse gear ② (with reverse gear bearing housing and thrust bearing).



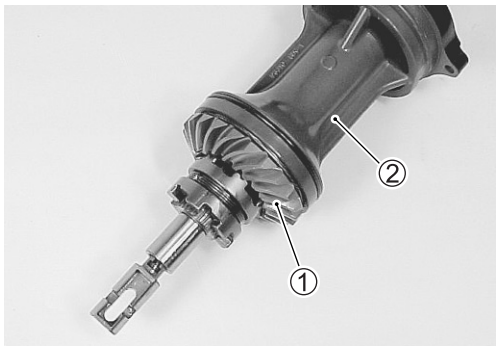


Remove the thrust bearing ③, reverse gear bearing housing ④ and back-up shim ⑤ from reverse gear.

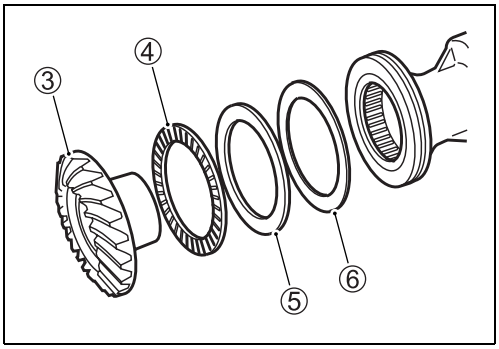


Disassembly of propeller shaft components

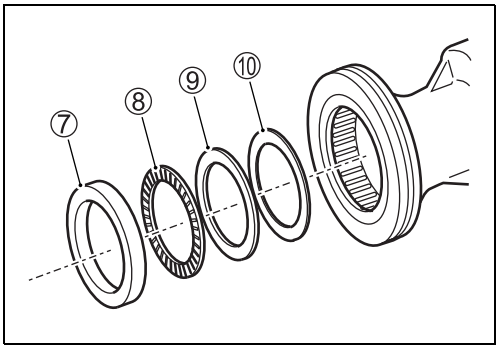
Slide propeller shaft away from forward gear ① and bearing housing assembly ②.



Remove the forward gear ③, forward gear thrust bearing ④, forward gear thrust washer ⑤, forward gear back-up shim ⑥.



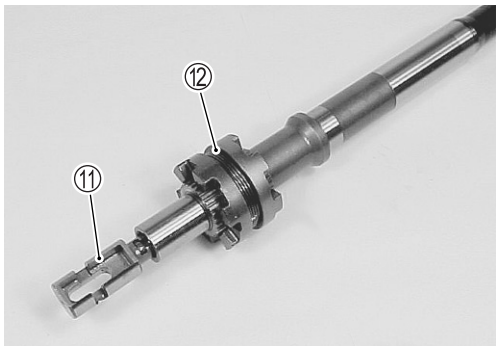
Remove the propeller shaft thrust washer ⑦, propeller shaft thrust bearing ⑧, bearing washer ⑨ and shim ⑩ from propeller shaft bearing housing.



To disassemble propeller shaft components, refer to following:

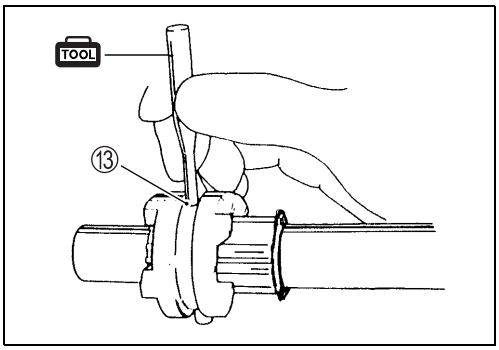
(a) Remove horizontal slider ⑪.

(b) Remove spring ⑫ from clutch dog shifter.

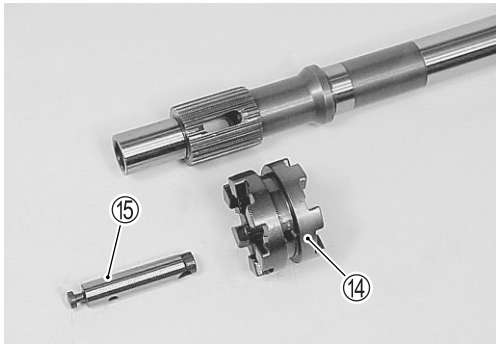


(c) Use special tool to push the dog pin ⑬ out of the clutch dog shifter.

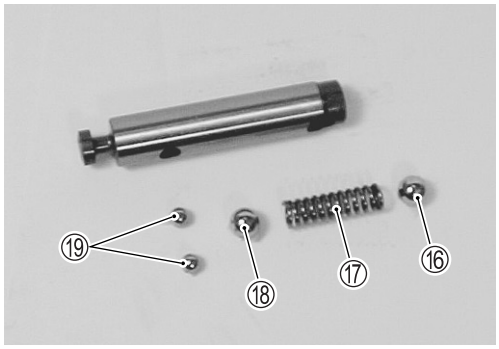
09922-89810: Shift pin remover



(d) Remove clutch dog shifter ⑭ and connector pin ⑮ from propeller shaft.

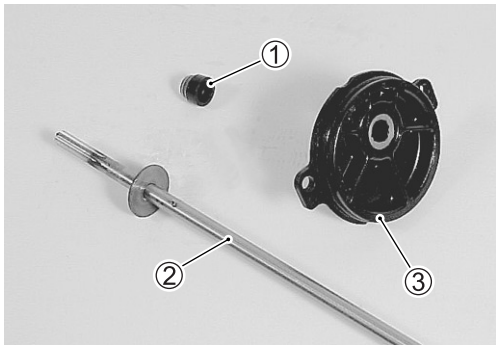


(e) Remove large detent ball ⑯, detent spring ⑰, large detent ball ⑱ and two (2) small detent balls ⑲ from connector pin.

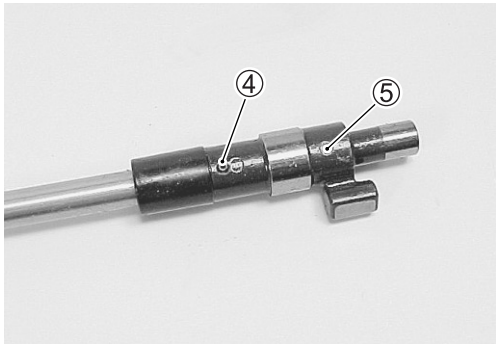


Disassembly of shift rod components

(a) Remove dust seal ①.
(b) Slide shift rod ② out of shift rod guide housing ③.



(c) Remove pin ④ and shifter yoke ⑤.

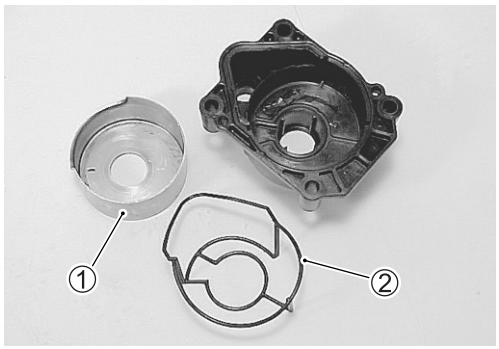


Disassembly of water pump case

Remove inner sleeve ① and rubber seal ring ②.

NOTE:

To facilitate the removal of inner sleeve from the pump case, warm up the entire case using a heater like hair dryer.



INSPECTION

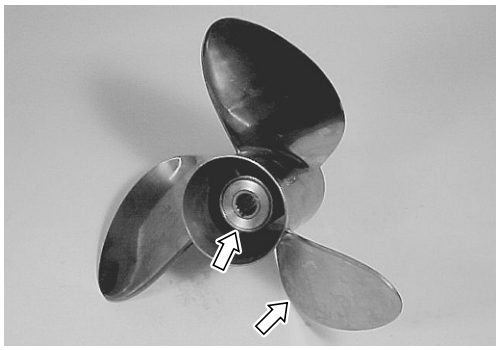
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

NOTE:
Thoroughly wash all metal components with cleaning solvent and dry with compressed air.

⚠ WARNING

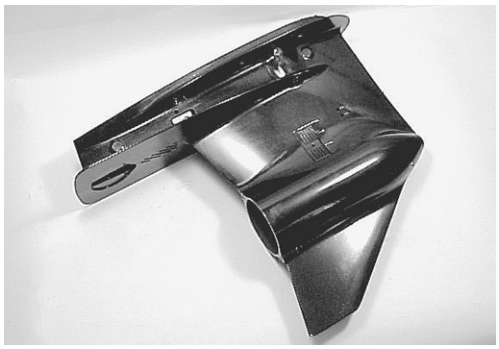
Wear safety grasses when using compressed air.

PROPELLER



- Inspect propeller for bent, chipped or broken blades. Replace or repair propeller if in damaged condition.
- Inspect propeller bush splines. Replace or repair propeller if splines are worn or damaged.
- Inspect propeller bush for deterioration or slipping. Replace if necessary.

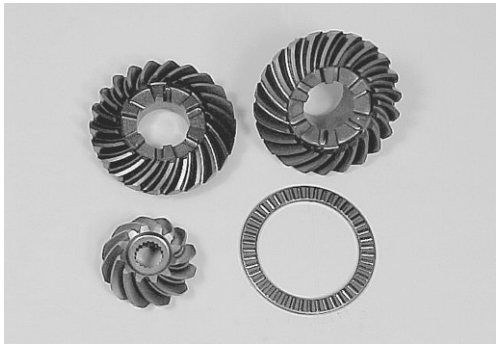
GEARCASE



- Inspect the gearcase. Replace if cracked, damaged or other abnormal condition.
- Visually check the pinion bearing. Replace gearcase if pitted, rough or other abnormal condition.
- Visually check shift cam housing. Replace gearcase if cracked, damaged, or other abnormal condition.



GEARS/BEARING



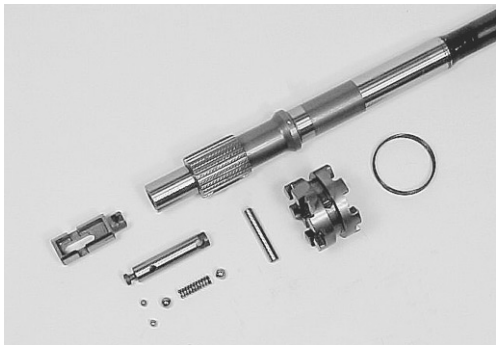
- Inspect forward, reverse and pinion gear teeth and engaging dogs.
  Replace gears if damaged, worn or other abnormal condition.
- Inspect forward gear thrust bearing.
  Replace bearing if pitted, noisy, rough or other abnormal condition.

REVERSE GEAR BEARING HOUSING/BEARING



- Inspect reverse gear bearing housing.
  Replace if cracked, damaged or other abnormal condition.
- Visually check bearing. Replace if pitted, noisy, rough or other abnormal condition.

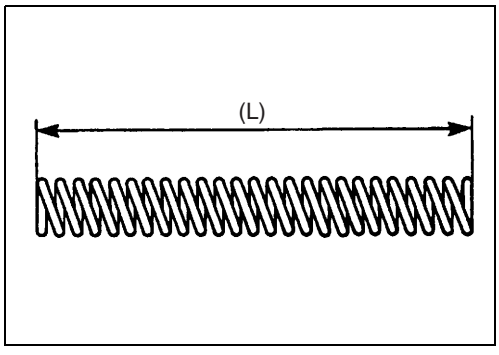
PROPELLER SHAFT COMPONENTS



- Inspect horizontal slider and connector pin.
  Replace if worn, damaged or other abnormal condition.
- Inspect clutch dog shifter. Replace if chipped, worn, damaged or other abnormal condition.
- Inspect dog pin. Replace if bent, worn or other abnormal condition.
- Inspect detent balls. Replace if wear, damage or other abnormal condition.



- Inspect propeller shaft/splines. Replace if worn, twisted, damaged or other abnormal condition.

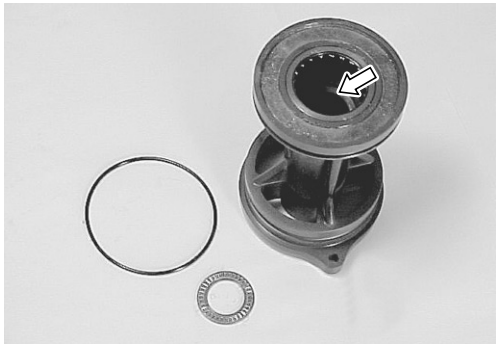


- Check detent spring by measuring its free length. If free length is not within specifications, replace detent spring.

  Detent spring free length (L)
  Standard: 27.8 mm (1.09 in)
  Service limit: 25 mm (0.98 in)

PROPELLER SHAFT BEARING HOUSING

- Inspect housing. Replace if cracked, damaged or other abnormal condition.
- Inspect forward gear bearing, propeller shaft thrust bearing and propeller shaft bearing. Replace bearing if pitted, noisy, rough or other abnormal condition.
- Check condition of oil seal and O-ring.
  Replace oil seal and O-ring if nicked, cut, worn or other abnormal condition.

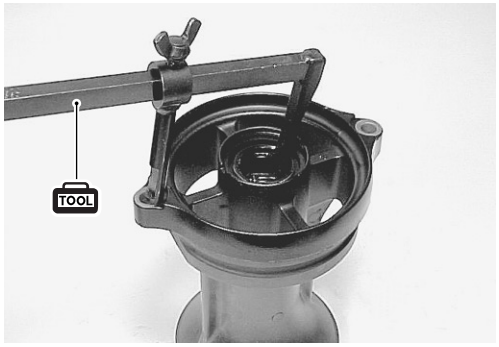




Replacing propeller shaft oil seal

1. Extract seals ① with oil seal remover.

09913-50121: Oil seal remover

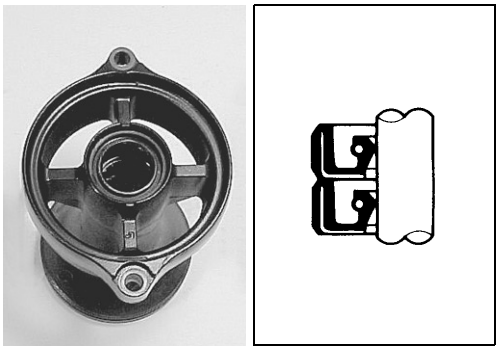


CAUTION

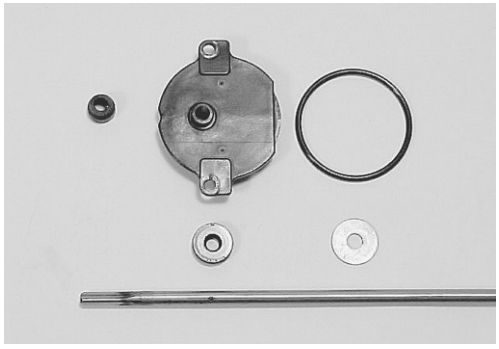
Do not reuse oil seal once removed.
Always use new oil seal.

2. Apply Water Resistant Grease to the inner circumference of the housing.
3. Using an oil seal installer, drive the two oil seals (one at a time) into the propeller shaft bearing housing.
   The lipped portion of the seal must face towards the propeller.
   Apply Water Resistant Grease to the seal lips.

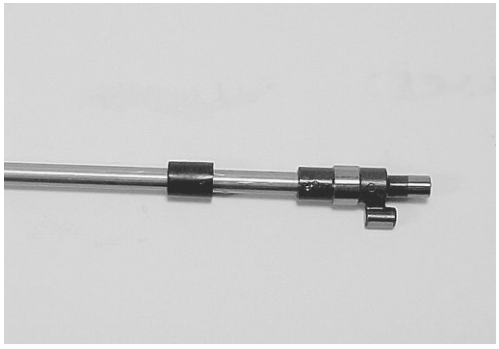
99000-25160: SUZUKI WATER RESISTANT GREASE



SHIFT ROD GUIDE HOUSING COMPONENTS

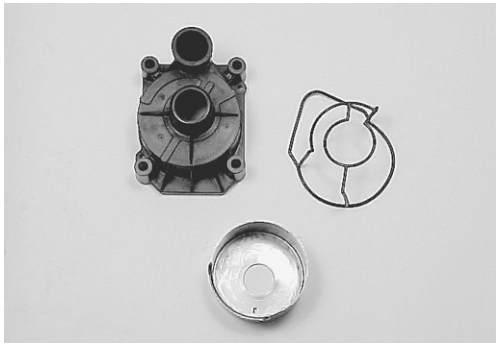


- Inspect shift rod guide housing. Replace if cracked, damaged or other abnormal condition.
- Inspect shifter yoke. Replace if wear, damaged or other abnormal condition.
- Inspect shift rod/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect O-ring. Replace if nicked, cut, torn, swollen or other abnormal condition.

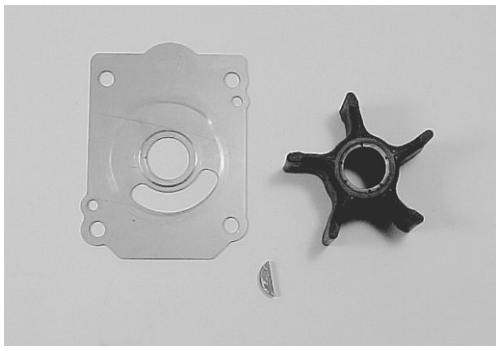


- Inspect oil seal and dust seal. Replace if nicked, cut, worn or other abnormal condition.

WATER PUMP AND RELATED ITEMS

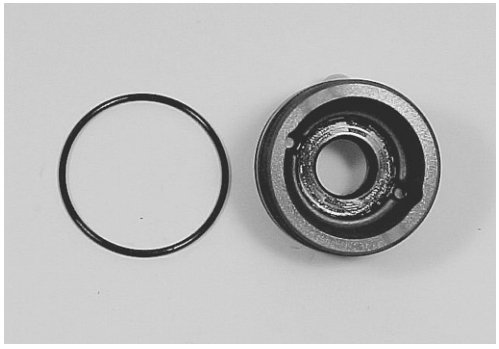


- Inspect impeller. Replace if vanes are cut, torn, worn or other abnormal condition.
- Inspect pump case. Replace if cracked, distorted or other abnormal condition.
- Inspect pump inner sleeve. Replace if worn, cracked, distorted, corroded or other abnormal condition.
- Inspect seal ring. Replace if nicked, cut, torn, swollen or other abnormal condition.



- Inspect under panel. Replace if cracked, distorted, corroded or other abnormal condition.

DRIVESHAFT OIL SEAL HOUSING

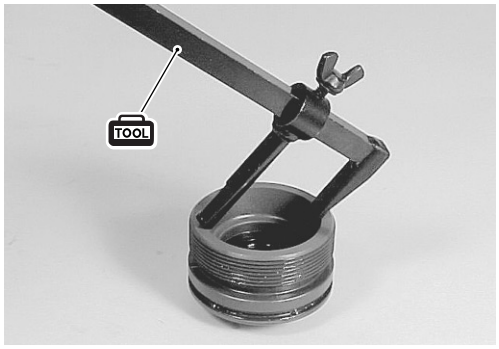


- Inspect housing. Replace if cracked, damaged or other abnormal condition.
- Check condition of oil seals. Replace if nicked, cut, worn or other abnormal condition.
- Inspect O-ring. Replace if worn, nicked, cut or other abnormal condition.

Replacing driveshaft oil seal

1. Using special tool, remove two (2) oil seals out of the driveshaft oil seal housing.

TOOL 09913-50121: Oil seal remover

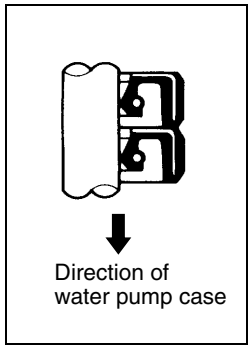


2. Apply Water Resistant Grease to inner circumference of driveshaft oil seal housing.

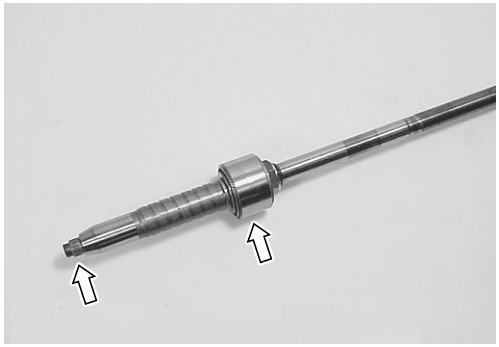
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

3. Grease the inner lips of oil seal. With the lips facing away from driveshaft bearing, place seal in position and drive it into the oil seal housing.

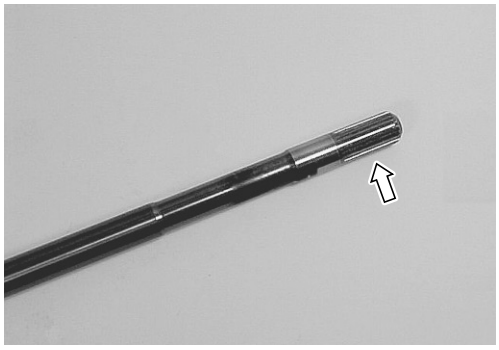




DRIVESHAFT

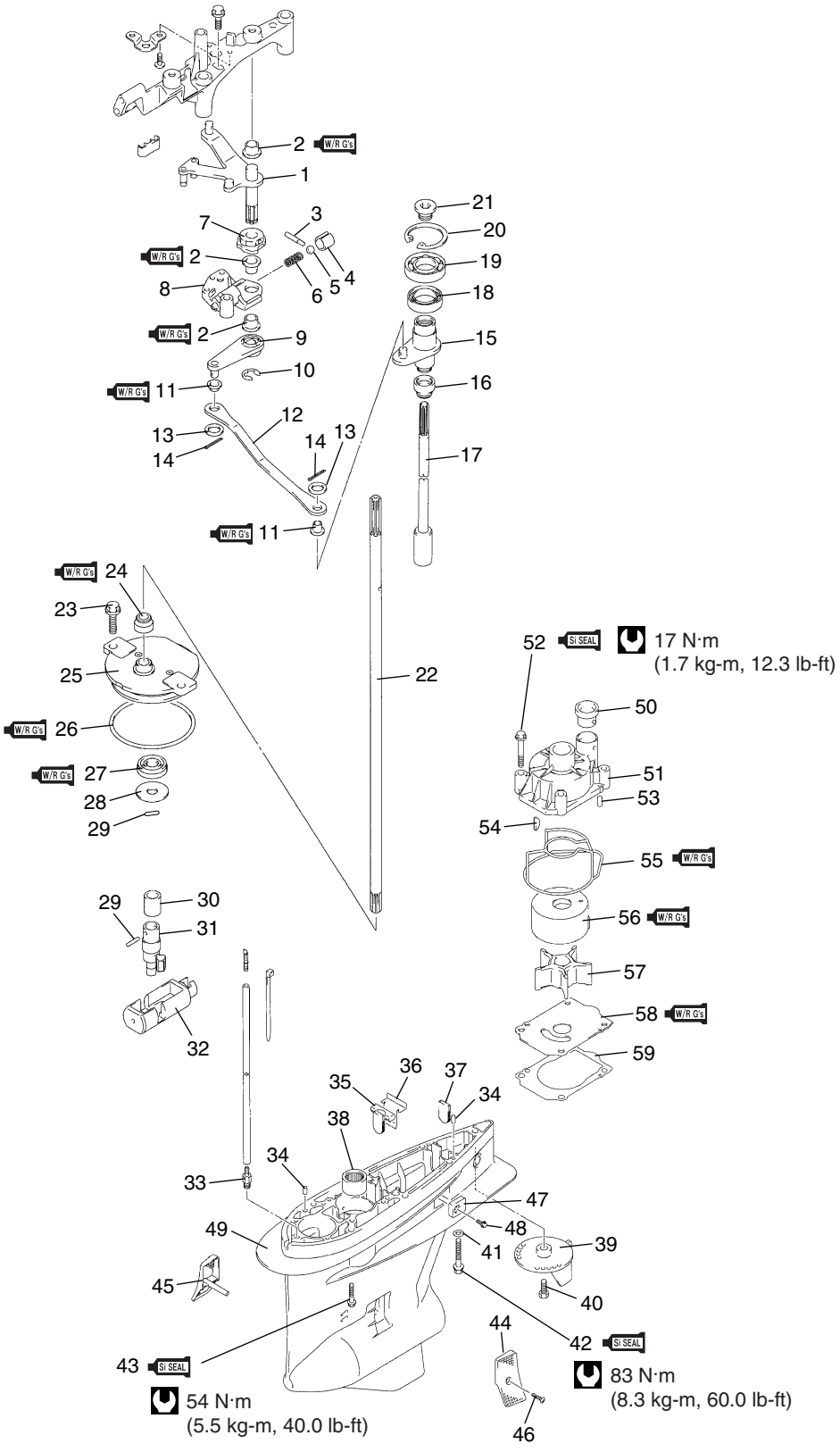


- Inspect driveshaft/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect driveshaft bearing, replace if pitted, noisy, rough or other abnormal condition.

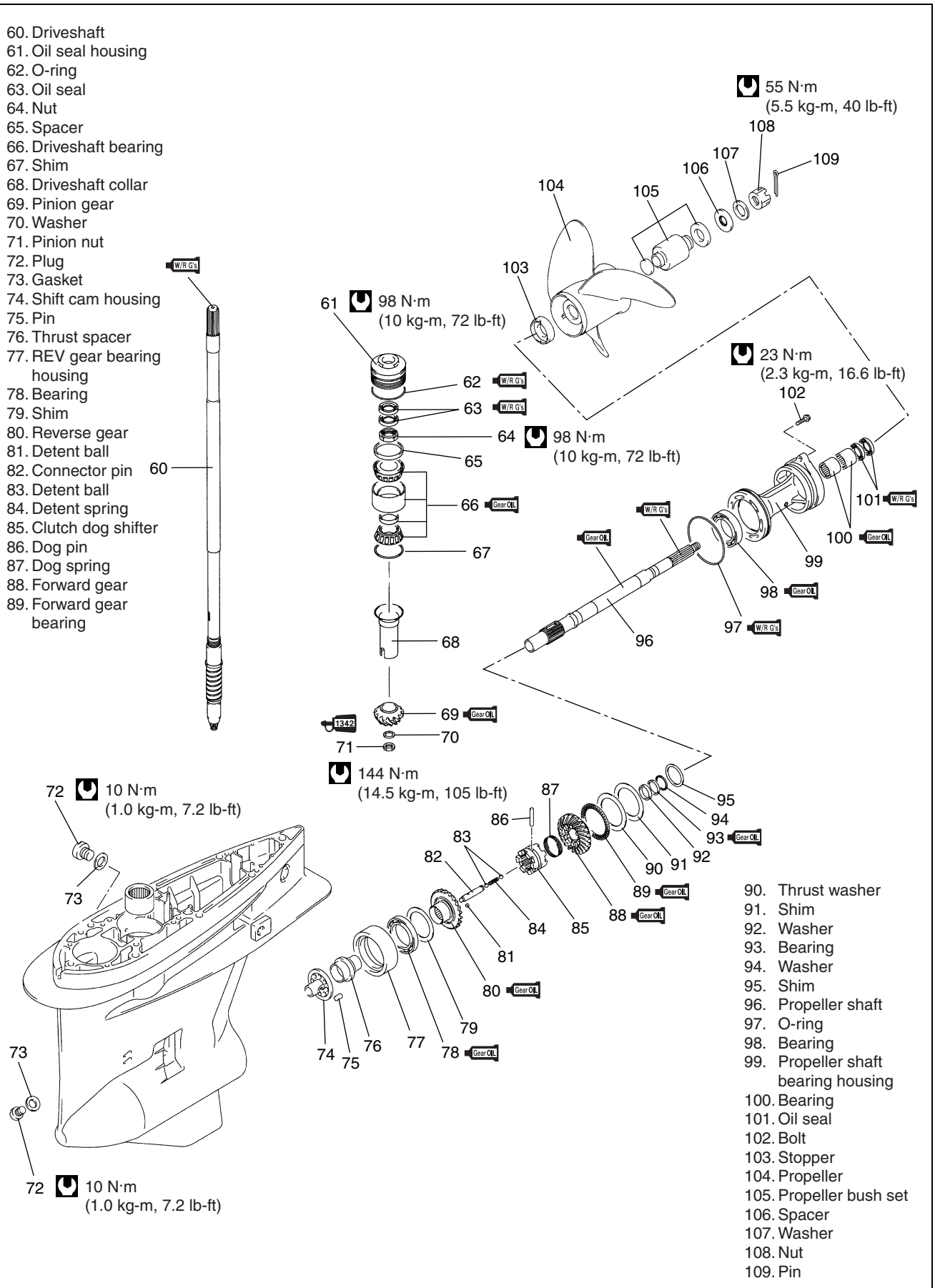


ASSEMBLY & INSTALLATION

Assembly & installation are reverse order of disassembly with special attention to the following steps.



1. Clutch lever
2. Bush
3. Pin
4. Pin
5. Ball
6. Spring
7. Clutch notch plate
8. Clutch lever holder
9. Clutch shaft arm
10. E-ring
11. Bush
12. Clutch lever link
13. Washer
14. Pin
15. Clutch shaft
16. Clutch rod cover
17. Clutch rod
18. Oil seal
19. Bearing
20. Circlip
21. Plug
22. Shift rod
23. Bolt
24. Clutch rod cover
25. Shift rod housing
26. O-ring
27. Oil seal
28. Washer
29. Pin
30. Magnet
31. Shifter yoke
32. Horizontal slider
33. Nipple
34. Pin
35. Exhaust rubber seal
36. Exhaust seal plate
37. Grommet
38. Pinion bearing
39. Trim tab
40. Bolt
41. Washer
42. Bolt
43. Bolt
44. Water filter PORT
45. Water filter STBD
46. Screw
47. Anode
48. Bolt
49. Gear case
50. Bush
51. Water pump case
52. Bolt
53. Pin
54. Key
55. Case sealing
56. Sleeve
57. Water pump impeller
58. Under panel
59. Gasket



60. Driveshaft
61. Oil seal housing
62. O-ring
63. Oil seal
64. Nut
65. Spacer
66. Driveshaft bearing
67. Shim
68. Driveshaft collar
69. Pinion gear
70. Washer
71. Pinion nut
72. Plug
73. Gasket
74. Shift cam housing
75. Pin
76. Thrust spacer
77. REV gear bearing housing
78. Bearing
79. Shim
80. Reverse gear
81. Detent ball
82. Connector pin
83. Detent ball
84. Detent spring
85. Clutch dog shifter
86. Dog pin
87. Dog spring
88. Forward gear
89. Forward gear bearing
90. Thrust washer
91. Shim
92. Washer
93. Bearing
94. Washer
95. Shim
96. Propeller shaft
97. O-ring
98. Bearing
99. Propeller shaft bearing housing
100. Bearing
101. Oil seal
102. Bolt
103. Stopper
104. Propeller
105. Propeller bush set
106. Spacer
107. Washer
108. Nut
109. Pin

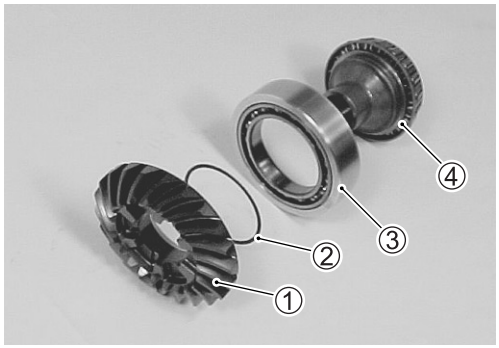
CAUTION

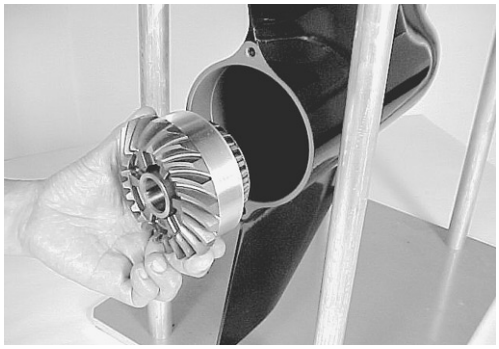
- **Make sure that all parts used in assembly are clean and lubricated.**
- **It is recommended that all seals, gaskets and O-rings be replaced with new on assembly.**
- **After assembly, check parts for tightness and smoothness of operation.**
- **Before final assembly, be absolutely certain that all gear contact, shim adjustments and tolerances are correct.**
  Failure to correctly adjust these areas will result in lower unit damage.
  (See "GEARS SHIMMING AND ADJUSTMENT" section on page 10-26.)

REVERSE GEAR

Assemble the reverse gear ①, back-up shim ②, reverse gear bearing housing ③ and reverse gear thrust bearing ④, then install reverse gear/bearing housing assembly.

Gear OIL **99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL**



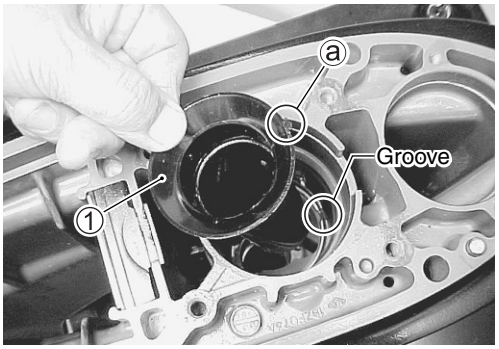


DRIVESHAFT COLLAR

Install driveshaft collar ①.

NOTE:

The tongue ⓐ of collar must be located into groove on the gearcase.



PINION GEAR

Place pinion gear in gearcase.

NOTE:

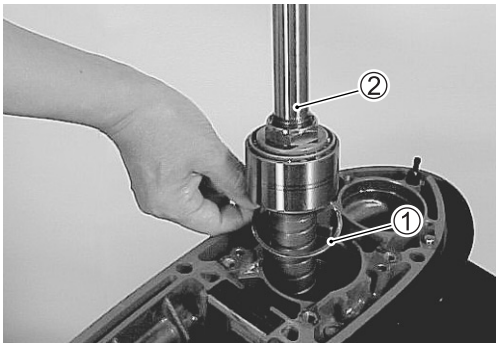
Before installing pinion gear, check for correct amount and position of pinion bearing rollers.

Use oil soluble grease to retain bearing rollers.



DRIVESHAFT

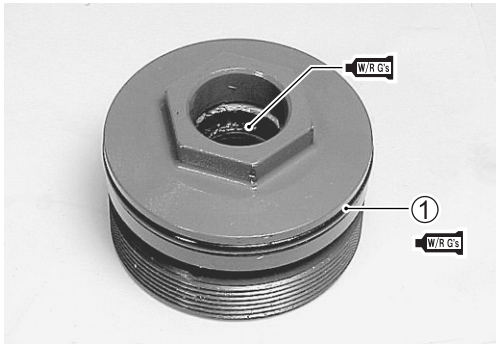
Install pinion shim ①, then lower the driveshaft assembly ② down into the gearcase until the bottom of shaft protrudes through center of pinion.



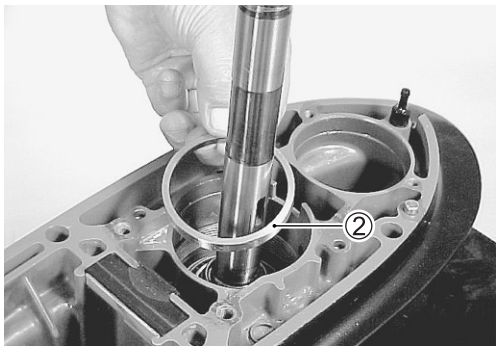
DRIVESHAFT OIL SEAL HOUSING

- Apply Water Resistant Grease to the driveshaft oil seal.
- Apply Water Resistant Grease to O-ring ①, then install O-ring into groove on the driveshaft oil seal housing.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



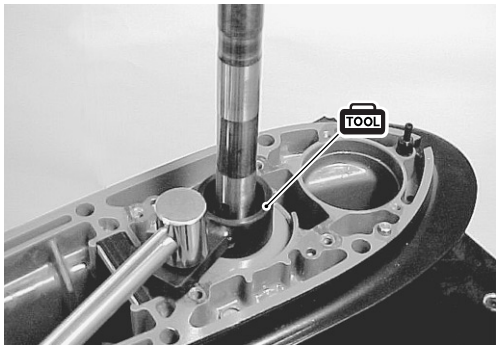
- Install driveshaft bearing spacer ②.



- Install driveshaft oil seal housing on gearcase, then tighten oil seal housing to specified torque.

Driveshaft oil seal housing: 98 N·m (10 kg-m, 72 lb-ft)

09926-29310: Driveshaft housing remover

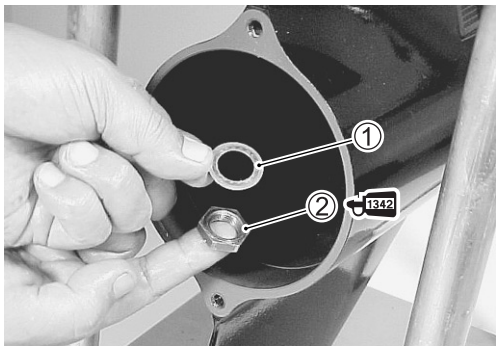


PINION NUT

- Apply THREAD LOCK 1342 to the threads of pinion nut ② before threading it onto driveshaft.

1342 99000-32050: THREAD LOCK 1342

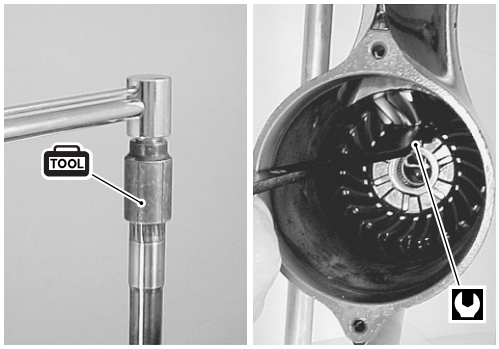
NOTE:
It is recommended the original pinion nut be used for the purposes of shimming during repair. A new pinion nut should be used on final assembly.



- Install washer ①, pinion nut ②, then tighten nut to specified torque.

Pinion nut: 144 N·m (14.5 kg-m, 105 lb-ft)

09921-29410: Driveshaft holder



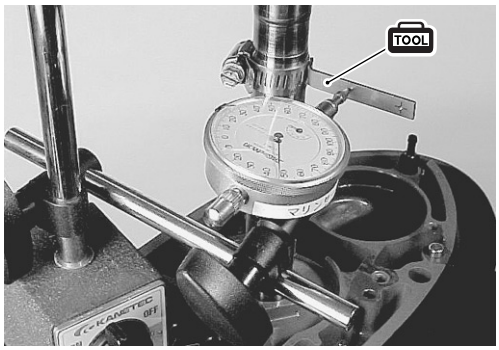
CHECKING GEAR BACKLASH

Before installing forward gear, gear backlash should checked.

Gear backlash: Approx. 0.6 – 0.8 mm (0.023 – 0.031 in)

(See the "GEARS-SHIMMING AND ADJUSTMENT/CHECKING BACKLASH" section on page 10-27.)

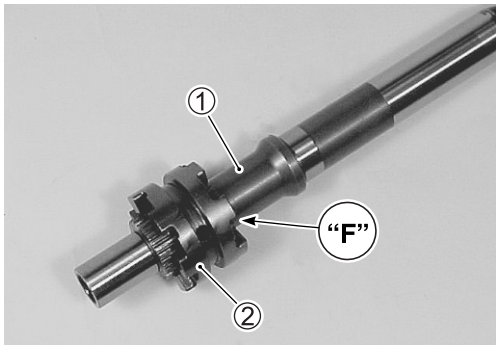
09952-09310: Backlash indicator tool



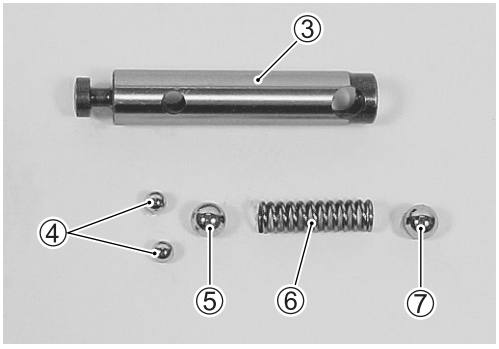
PROPELLER SHAFT

- Slide the clutch dog shifter ② onto the propeller shaft ①.

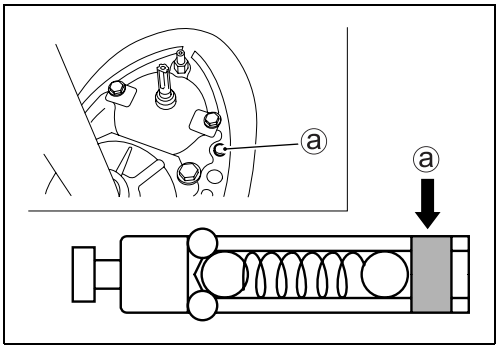
NOTE:
The side of the clutch dog shifter marked with the letter "F" must face towards forward gear.



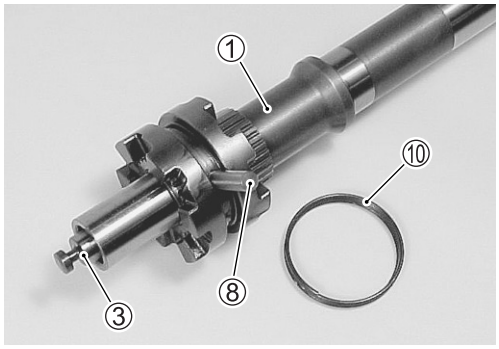
- Insert two (2) small detent balls ④, large detent ball ⑤, detent spring ⑥ and large detent ball ⑦ into connector pin ③. Then depress detent ball ⑦ and temporarily insert stopper pin ⓐ into dog pin hole of connector pin, as shown in right figure.



NOTE:
Temporarily insert a gearcase dowel pin ⓐ into the connector pin to prevent the detent ball from falling out.



- Insert the connector pin ③ (w/detent balls) into propeller shaft ①.
- Align the holes in the shifter dog and connector pin and then slide the dog pin ⑧ through both dog and connector pin. (save the temporarily installed dowel pin pushed out as the dog pin is inserted.)
- Install the dog pin retaining spring ⑩, ensuring that it fits snugly into the groove on the dog shifter.



FORWARD GEAR/PROPELLER SHAFT/BEARING HOUSING

- Assemble the propeller shaft in the following sequence:

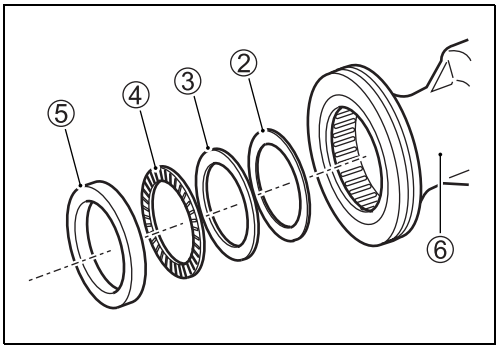
W/R G's 99000-25160 : Water Resistant Grease

Gear OIL 99000-22540 : Suzuki Outboard Motor Gear Oil

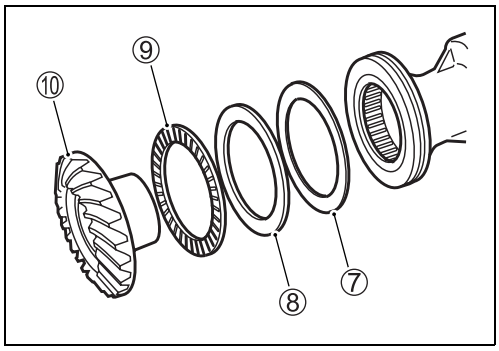
(a) Apply Water Resistant Grease to O-ring ①, then install the O-ring into the groove on the propeller shaft bearing housing.



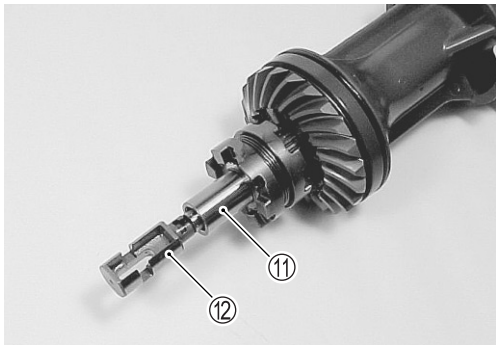
(b) Install shim ②, bearing washer ③, propeller shaft thrust bearing ④, propeller shaft thrust washer ⑤ into propeller shaft bearing housing ⑥.



(c) Install F-gear back-up shim ⑦, F-gear thrust washer ⑧, F-gear thrust bearing ⑨ and forward gear ⑩ to propeller shaft bearing housing.

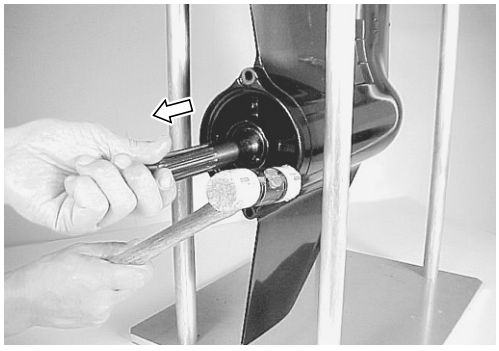


(d) Slide propeller shaft ⑪ into forward gear and propeller shaft bearing housing.
(e) Assemble horizontal slider ⑫ to connector pin.



NOTE:
Before installing propeller shaft/bearing housing assembly, move shifter dog to bring horizontal slider to the neutral position.

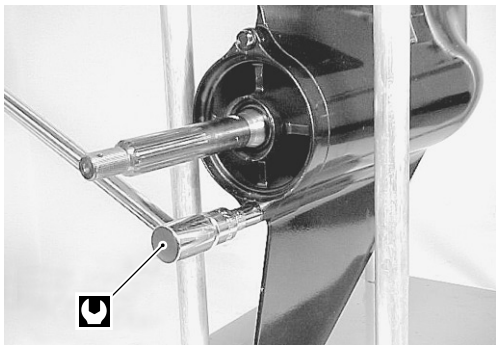
- To hold the correct bearing position, pull propeller shaft backward and then install propeller shaft and housing assembly in the gearcase.



NOTE:
To make the bearing housing fully seated in the gearcase, tap the housing gently with plastic mallet.

- When the housing is fully seated, tighten both retaining bolts to the specified torque.

Bearing housing bolt: 23 N·m (2.3 kg-m, 16.6 lb-ft)

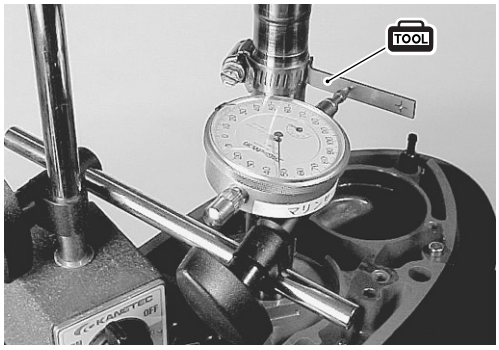


RECHECKING GEAR BACKLASH
Recheck the forward gear backlash.

Gear backlash: Approx 0.3 – 0.5 mm (0.012 – 0.020 in)

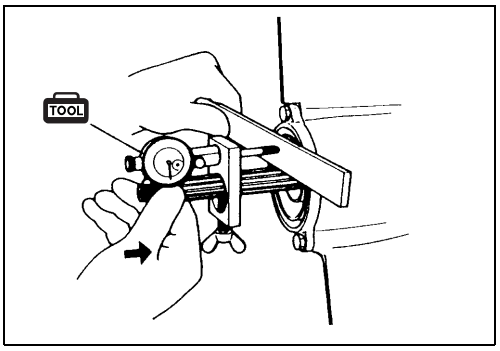
(See the "GEARS-SHIMMING AND ADJUSTMENT/CHECKING BACKLASH" section on page 10-28.)

09951-09310: Gear adjuster spring set
09952-09310: Backlash indicator tool



CHECKING PROPELLER SHAFT THRUST PLAY

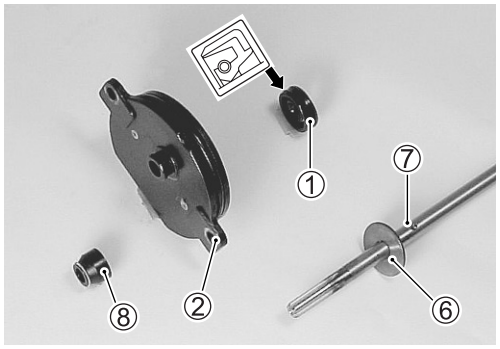
See the “GEARS-SHIMMING AND ADJUSTMENT/CHECKING PROPELLER SHAFT THRUST PLAY” section on page 10-30.



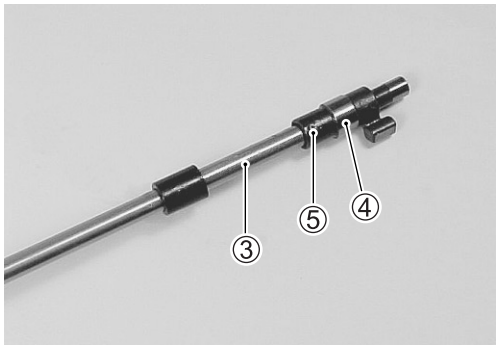
SHIFT ROD GUIDE HOUSING

- Using an oil seal installer, drive the oil seal ① into the shift rod guide housing ②.
  The lipped portion of oil seal must face towards the driveshaft housing.

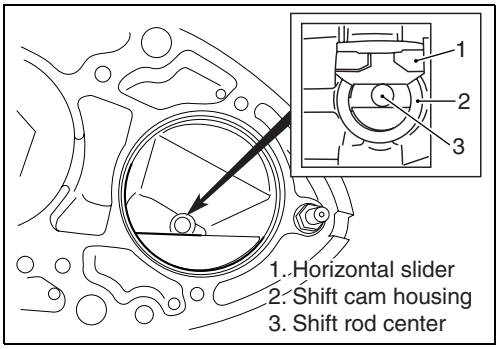
W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



- Attach shifter yoke ④ to shift rod ③, then insert pin ⑤.
- Install pin ⑦ and washer ⑥ to shift rod, then slide shift rod guide housing onto shift rod.
- Install dust seal ⑧ to shift rod guide housing.



NOTE:
Be sure the horizontal slider is in the neutral position before installing the shift unit (shift rod guide housing assembly.).

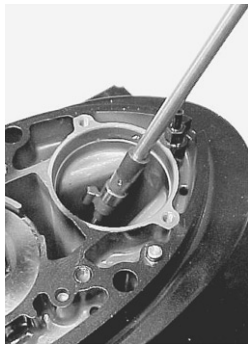


- Apply Water Resistant Grease to the shift rod guide housing O-ring.

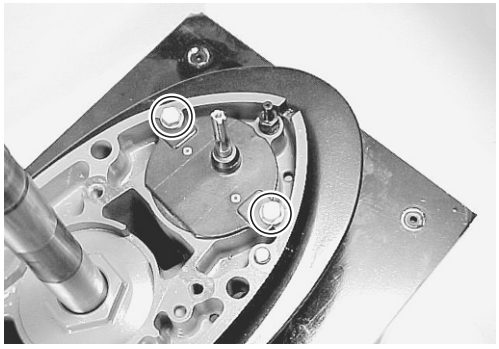
W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**

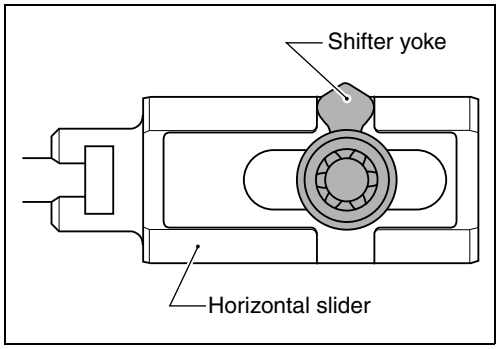
NOTE:
Before installing shift rod guide housing assembly, bring shifter yoke to neutral position by turning shift rod right or left.





- Install shift rod guide housing assembly by aligning shifter yoke with groove in horizontal slider, then tighten two (2) housing bolts securely.
- Turn shift rod from Neutral position to Forward and Reverse position to check proper gear engagement.

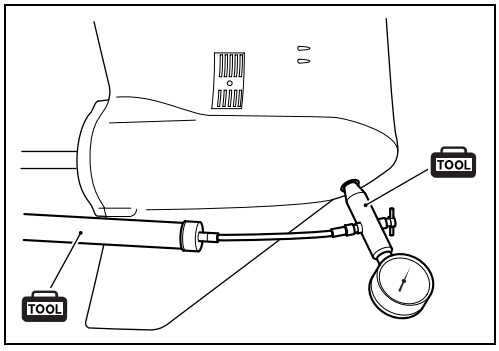




LEAKAGE CHECK

Check for leakage of oil seal and O-ring when applying specified pressure inside of the gearcase.

TOOL 09950-69511: Oil leakage tester
09952-99310: Air pump



Procedure

1. Install the test tool into the oil drain hole.
2. Connect the air pump to the tester.
3. Rotate driveshaft and propeller shaft clockwise several times and then apply specified pressure for the test.

NOTE:

Apply low initial pressure of 20 – 40 kPa, (0.2 – 0.4 kg/cm², 2.8 – 5.7 psi) first, then apply specified pressure.

Leakage test pressure: 100 kPa (1.0 kg/cm², 14.2 psi)

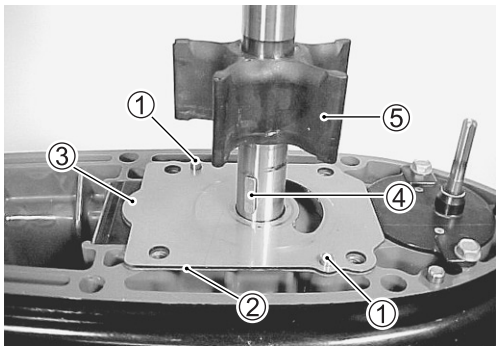
CAUTION

Do not exceed pressure of 110 kPa (1.1kg/cm², 15.6 psi) or damage to oil seals will result.

4. Once stabilized, pressure should remain steady for at least 5 min.
   If pressure does not fall, sealing performance is correct.

WATER PUMP (Impeller & case)

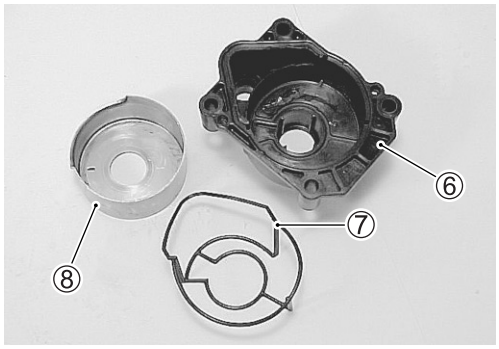
- Place the dowel pins ①, under panel gasket ② and under panel ③ into position.
- Insert the key ④ in the driveshaft and slide the impeller ⑤ onto driveshaft, ensuring that key and keyway are aligned.



- Place the seal ring ⑦ into groove of the pump case ⑥, then install inner sleeve ⑧ to pump case.

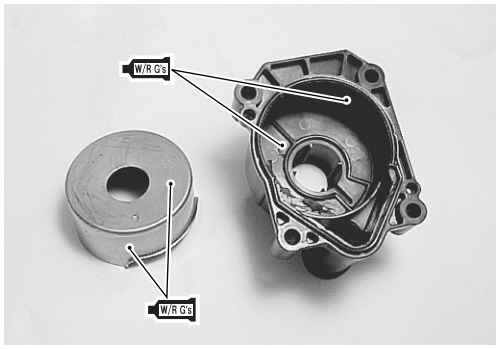
CAUTION

Do not re-use seal ring once removed.
Always use new ring.



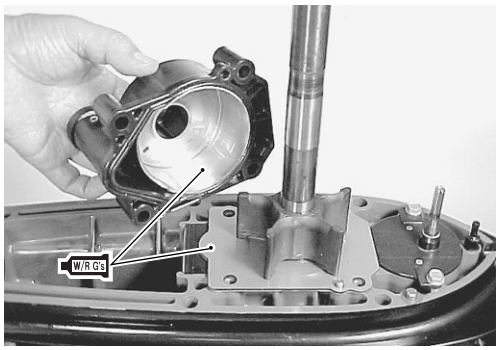
NOTE:
Before installing pump inner sleeve, apply water resistant grease lightly between inner sleeve and pump case mating surfaces.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



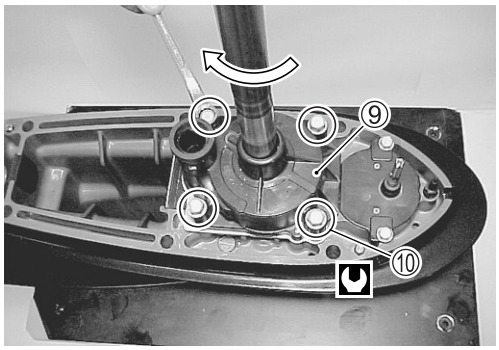
NOTE:
Before installing water pump case assembly, apply Water Resistant Grease lightly on pump case inner sleeve and under panel for initial lubrication.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



- Install the pump case assembly ⑨ while rotating driveshaft clockwise to flex the impeller vanes in the correct direction.
- Securely tighten the four (4) pump case bolts ⑩ to the specified torque.

Pump case bolt: 17 N·m (1.7 kg-m, 12.5 lb-ft)



PROPELLER INSTALLATION

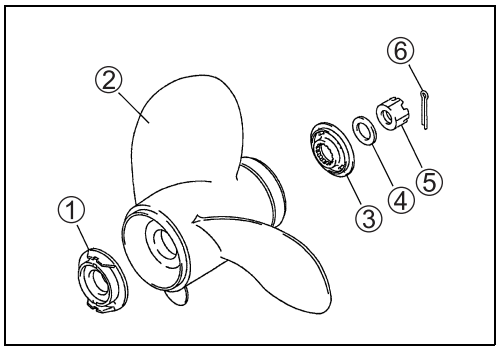
Install propeller stopper ① onto propeller shaft, then slide on the propeller ②.

Fit spacer ③, washer ④ and nut ⑤, then tighten nut to specified torque.

Push cotter pin ⑥ through nut and shaft, then bend to secure.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Propeller nut: 55 N·m (5.5 kg-m, 40.0 lb-ft)



LOWER UNIT INSTALLATION

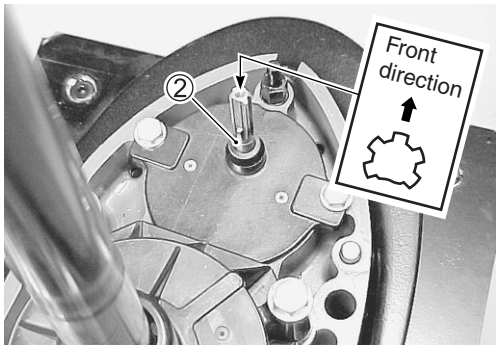
- Apply Water Resistant Grease to clutch rod splines, then install clutch rod ① by aligning clutch rod splines with splines in clutch shaft.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

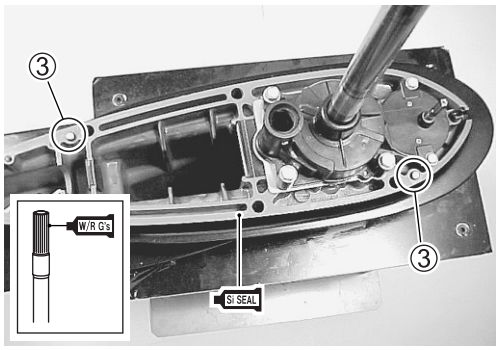


- Ensure that shift rod ② is at neutral position.

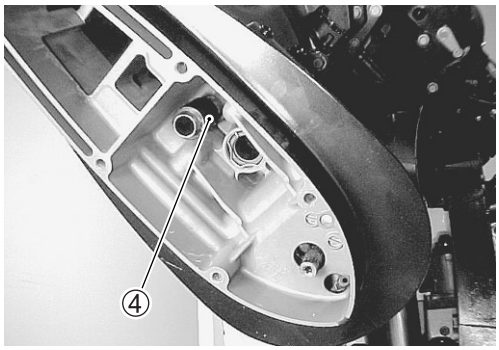
NOTE:
Before installing lower unit assembly, bring shift to neutral position by turning shift rod right or left.



- Insert two (2) dowel pins ③.
- Apply Water Resistant Grease to driveshaft and shift rod splines.
- Apply a light coating of SUZUKI SILICONE SEAL to mating surfaces of gearcase and driveshaft housing.

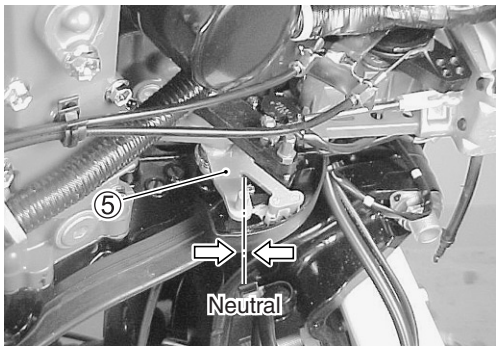


- Install spacer ④ to water tube.



• Set the clutch control lever ⑤ at Neutral position, then slide the lower unit ⑥ into place, ensuring that the top of driveshaft engages properly with driven gear shaft and that water tube locates in water pump case outlet.

NOTE:
In order for shift rod and clutch rod splines to be aligned correctly, clutch rod may need to be turned slightly right or left.



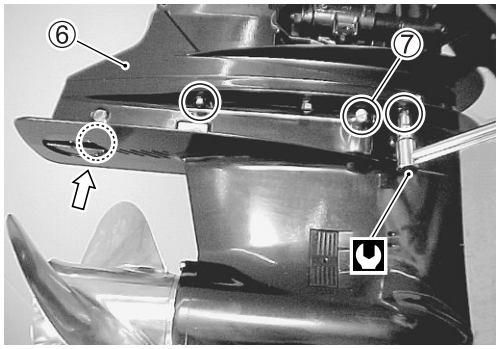
• Apply SUZUKI SILICONE SEAL to seven (7) gearcase bolts ⑦ and tighten them to specified torque.

Gearcase bolt: 10 mm 54 N·m (5.5 kg-m, 40.0 lb-ft)
12 mm 83 N·m (8.3 kg-m, 60.0 lb-ft)

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Si SEAL 99000-31120: SUZUKI SILICONE SEAL

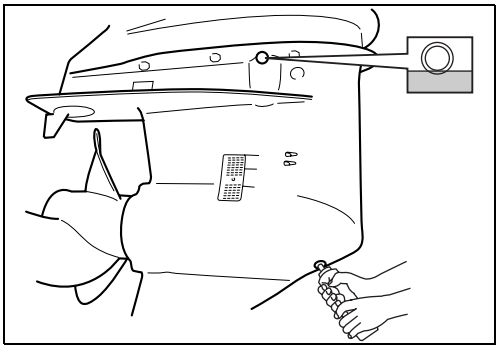
• Shift the clutch control lever to Forward and Reverse position from Neutral position to check proper gear engagement.



GEAR OIL

Fill the gearcase with specified gear oil for initial testing and recheck the level after 10 minutes. Top up if necessary.
(See “PERIODIC MAINTENANCE/GEAR OIL” section on page 2-6.)

Gear OIL 99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL



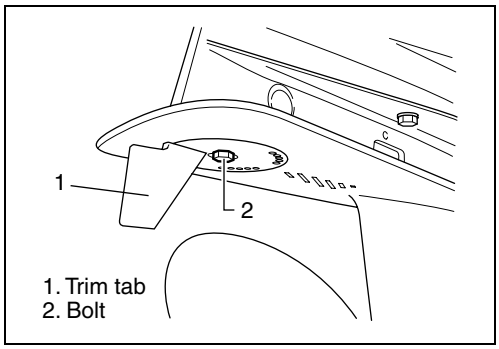
TRIM TAB

The trim tab counteracts or minimizes propeller torque “pull” felt through the steering system.

If the steering is pulled to starboard or port side, adjust trim tab with following procedure:

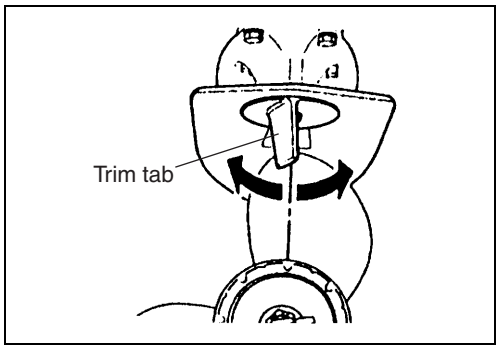
Adjusting

1. Loosen the bolt of trim tab.
2. Change direction of trim tab.
   - To compensate for a veer to starboard, set trailing edge of tab to the right (as viewed from behind).
   - To compensate for a veer to port, set trailing edge of tab to the left.



1. Trim tab
2. Bolt

3. Tighten the bolt of trim tab.
4. Test ride the 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 the steering to be pulled to either port or starboard.

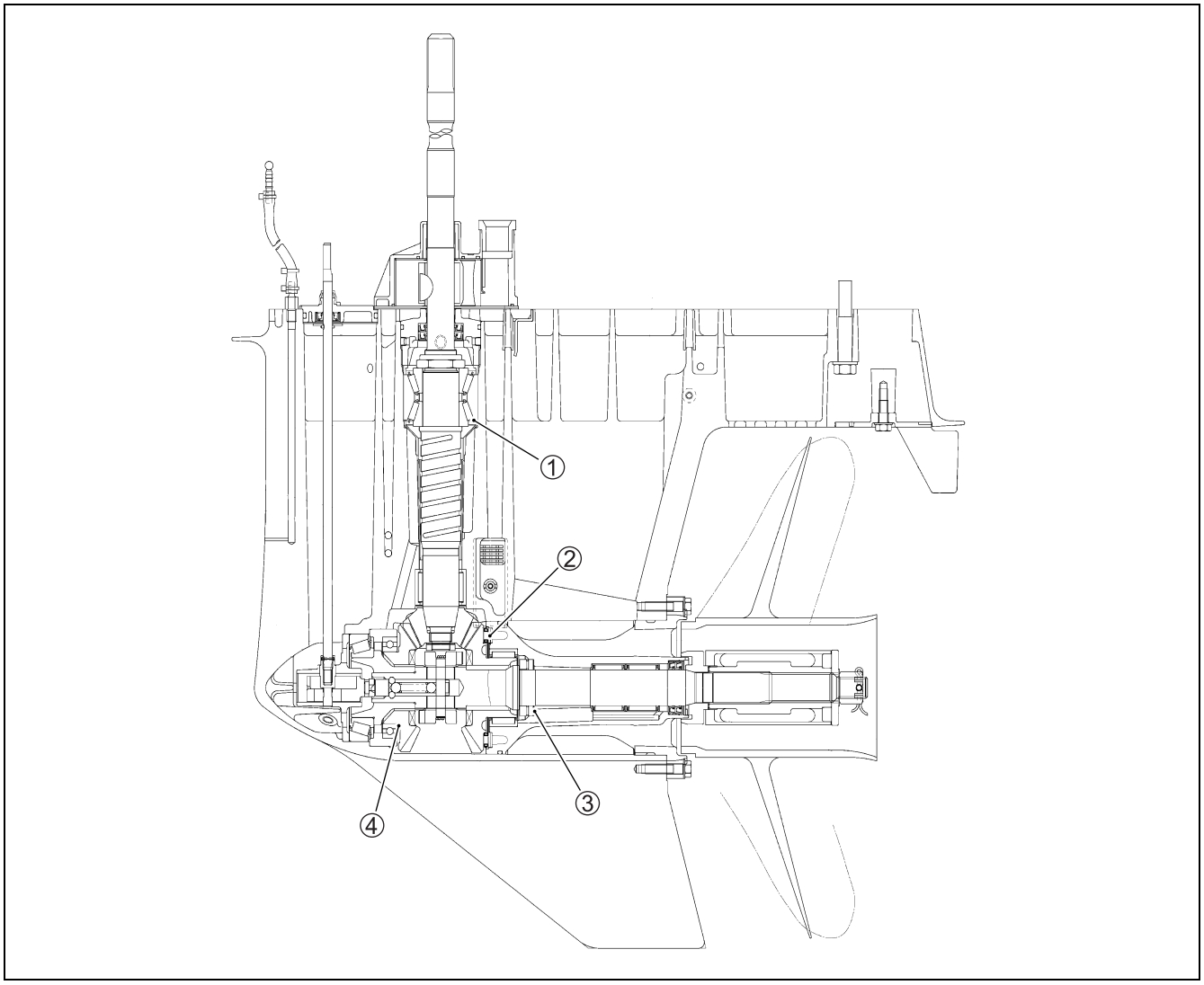
LOWER UNIT GEARS- SHIMMING AND ADJUSTMENT

(Counter rotation model)

If 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)
①	Pinion 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
②	Forward gear back up shim	0.50, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00	0.8
③	Propeller shaft thrust shim	0.60, 0.70, 0.80, 0.90, 0.95, 1.00, 1.05, 1.10, 1.15	1.0
④	Reverse 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

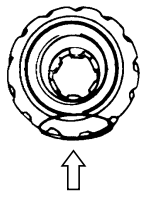


REVERSE GEAR/PINION GEAR

Follow the procedure below to adjust reverse gear/pinion gear.

STEP TO PRIOR TO ADJUSTMENT

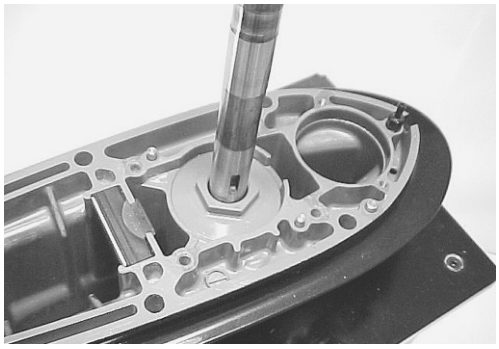
1. Install standard pinion gear back-up shim thickness modified according to ± design specification mark on gear.



± design
specification mark

2. Correctly assemble driveshaft oil seal housing, driveshaft, reverse gear, pinion gear and related components. (See page 10-15 to 10-17.)
   Do not install forward gear at this time.
3. Tighten pinion nut to specified torque.

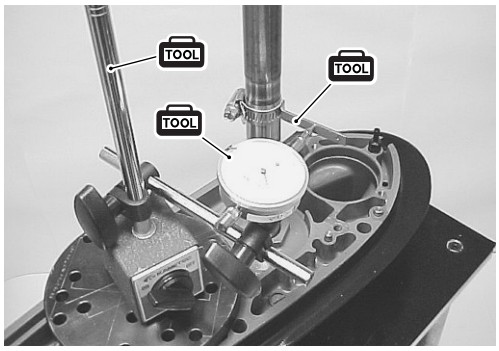
Pinion nut: 144 N·m (14.4 kg-m, 104 lb-ft)



ADJUSTIHG GEAR BACKLASH

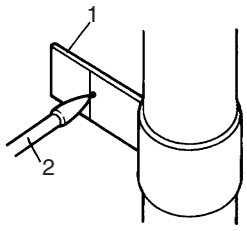
(a) Assemble special tool to driveshaft as shown in figure.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09952-09310: Backlash indicator tool



(b) Push reverse gear inward and hold it by hand, Align dial gauge pointer at 90 ° to the mark on the backlash indicator tool and read backlash on dial gauge by lightly moving drive-shaft clockwise and counterclockwise by hand.

Gear backlash: Approx. 0.6 – 0.8 mm (0.024 – 0.031 in)

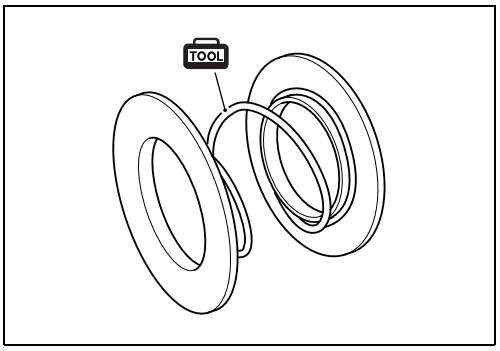


1. Backlash indicator tool
2. Dial gauge

- If the backlash measured is larger than the specification, add the amount over the specification to the temporary use reverse gear back-up shim and install this shim as the final shim.
- If the backlash measured is smaller than the specification, subtract the amount less than the specification from the temporary use reverse gear back-up shim and install this shim as the final shim.

FORWARD GEAR SHIM

After adjusting reverse gear backlash, follow the procedure below to adjust forward gear.

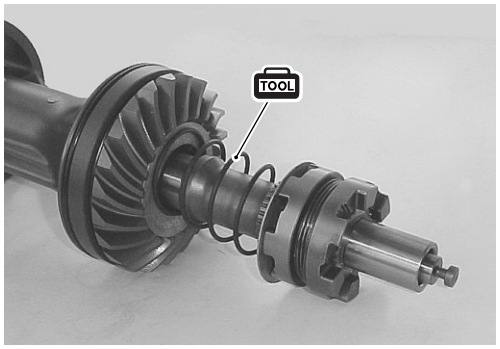


Adjusting gear backlash

1. Correctly assemble driveshaft oil seal housing, driveshaft, reverse gear, pinion gear and related components. (See page 10-15 to 10-17.)
2. Tighten pinion nut to specified torque.

Pinion nut: 144 N·m (14.4 kg-m, 104 lb-ft)

3. Correctly assemble forward gear, forward gear bearing, propeller shaft, propeller shaft thrust bearing, propeller shaft bearing housing and related components.
   When assemble the forward gear and propeller shaft housing assembly, place the special tool between clutch dog shifter and forward gear as shown in the illustration.



NOTE:
Before installing special tool, move shifter dog to reverse position.

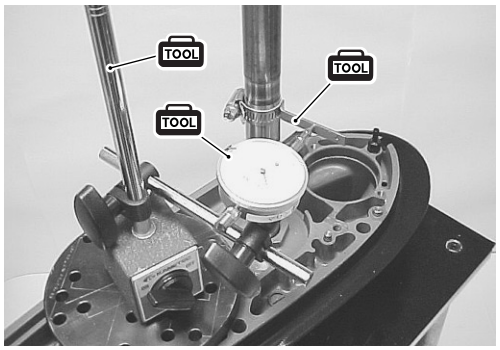
09951-09310: Gear adjuster spring set

4. Install forward gear and propeller shaft housing assembly into gearcase, then tighten both bearing housing retaining bolts to specified torque.



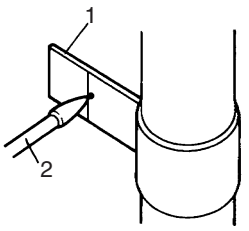
5. Assemble special tool to driveshaft as shown in figure.

09900-20606: Dial gauge
09900-20701: Magnetic stand
09952-09310: Backlash indicator tool



6. Align dial gauge pointer at 90 ° to the mark on the backlash indicator tool and read backlash on dial gauge by lightly moving driveshaft clockwise and counterclockwise by hand.

Gear backlash: Approx. 0.3 – 0.5 mm (0.012 – 0.020 in)



1. Backlash indicator tool
2. Dial gauge

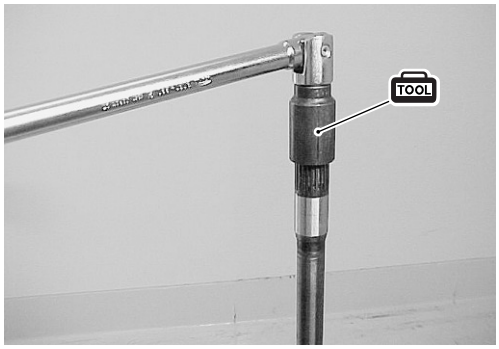
- If the backlash measured is larger than the specification, add the amount over the specification to the temporary use forward gear back-up shim and install this shim.
- If the backlash measured is smaller than the specification, subtract the amount less than the specification from the temporary use forward gear back-up shim and install this shim.

Checking and adjusting tooth contact pattern (Pinion and Forward gear)

Check tooth contact pattern using the following procedure:

1. To assess tooth contact, apply a light coat of Prussian Blue on the convex surface of forward gear.

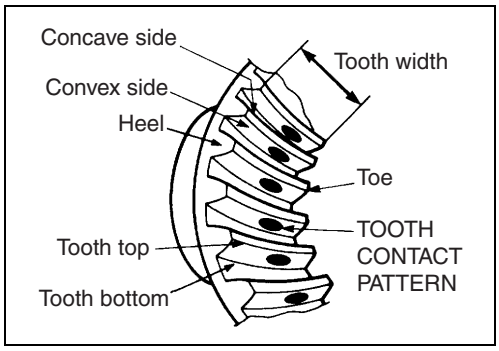
NOTE:
While assessing tooth contact, remove the special tool, gear adjust spring set (09951-09310).



2. Install forward gear and propeller shaft housing assembly into gearcase, then tighten both bearing housing retaining bolts to specified torque.
3. Using driveshaft holder tool, rotate the driveshaft 5 – 6 times.

TOOL 09921-29410 : Driveshaft holder

4. Carefully pull out propeller shaft and housing to check tooth contact pattern.

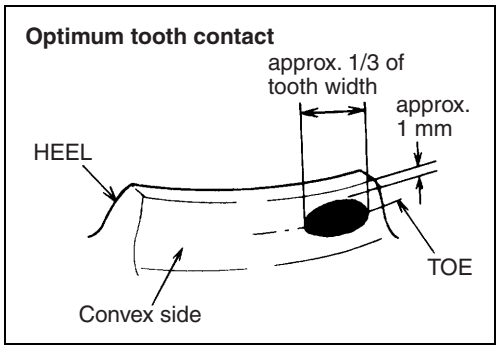


Optimum tooth contact

The optimum tooth contact is shown at right.
A shim adjustment may be necessary to obtain this contact pattern.

CAUTION

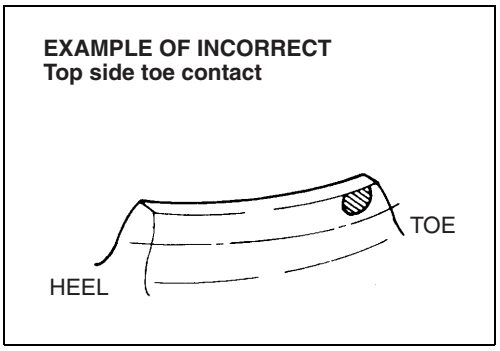
Gear backlash should be checked when increasing or decreasing shim thickness to adjust tooth contact.



Example (1)
Incorrect topside toe contact:
Correction measures:
- Decrease thickness of forward gear shim.
- Slightly decrease pinion gear shim thickness.

CAUTION

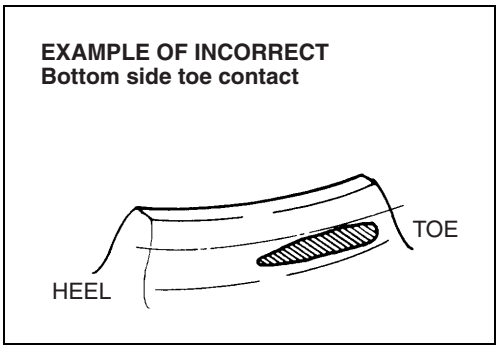
Do not set tooth contact in this position (top side toe contact). Damage and chipping of forward and pinion gear may result.



Example (2)
Incorrect bottom side toe contact:
Correction measures:
- Increase thickness of forward gear shim.
- Slightly increase pinion gear shim thickness.

CAUTION

Do not set tooth contact in this position (bottom side toe contact). Chipping of pinion gear may result.

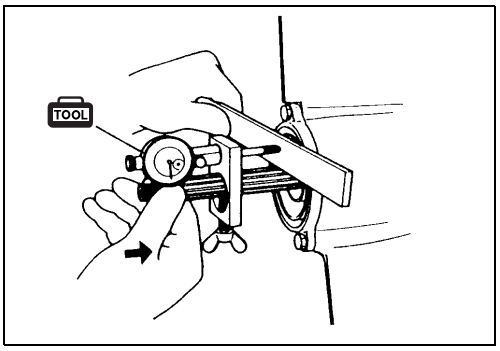


CHECKING PROPELLER SHAFT THRUST PLAY

After adjusting all gear positions, measure the propeller shaft thrust play. If not within the following specification, a shim adjustment is required.

Propeller shaft thrust play : 0.2 – 0.4 mm (0.008 – 0.016 in)

NOTE:
Use only the propeller shaft thrust shim to adjust thrust play.



Measurement step :
1. Assemble gear adjusting gauge to the propeller shaft.

TOOL 09951-09511: Gear adjusting gauge

2. Push propeller shaft inward.
3. Hold shaft in and set dial gauge pointer to zero.
4. Slowly pull shaft outward and read the maximum thrust play on the dial gauge.
   - If measurement is more than specification, increase propeller shaft thrust shim thickness.
   - If measurement is less than specification, reduce propeller shaft thrust shim thickness.

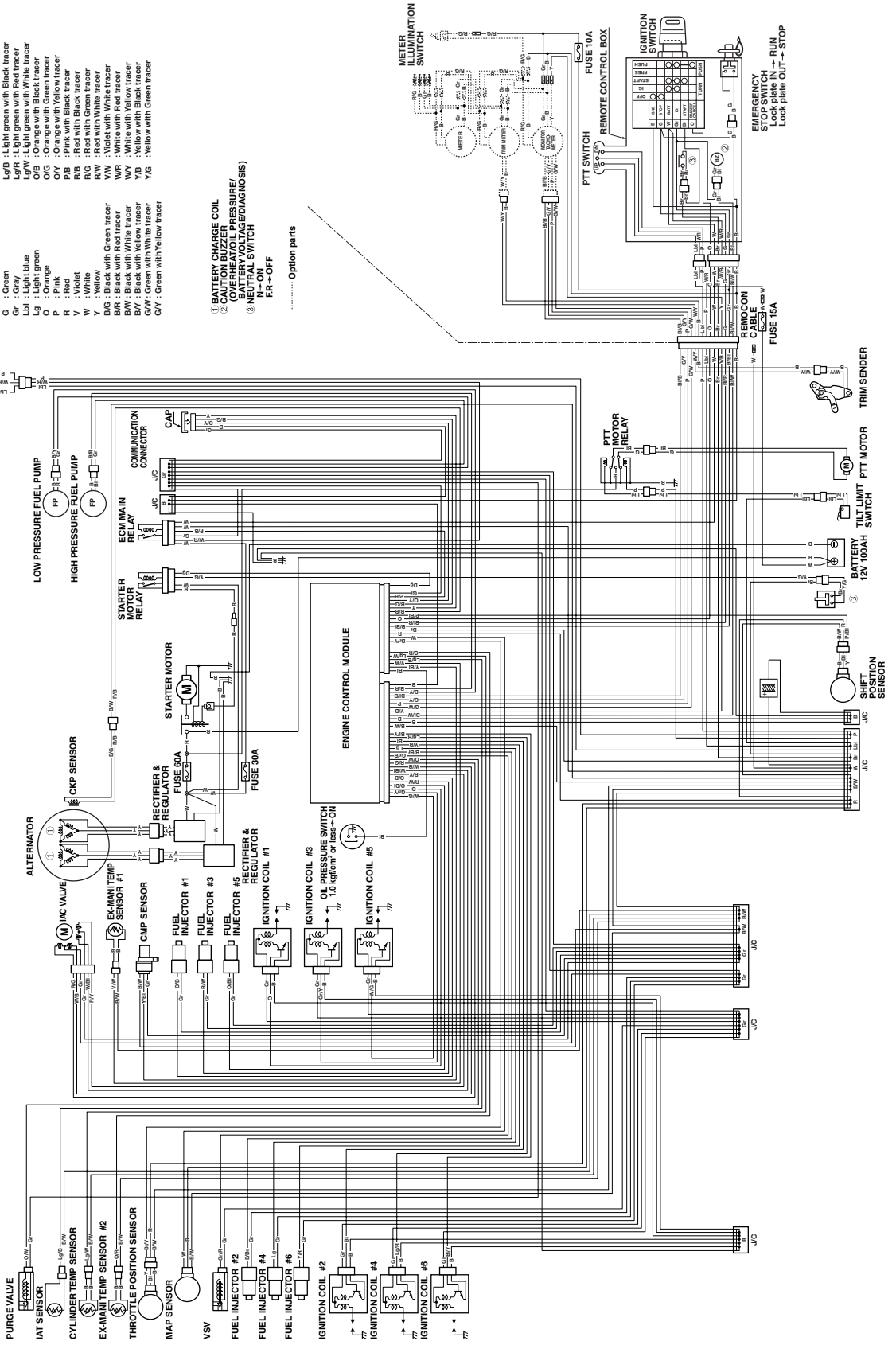
WIRE/HOSE ROUTING

CONTENTS

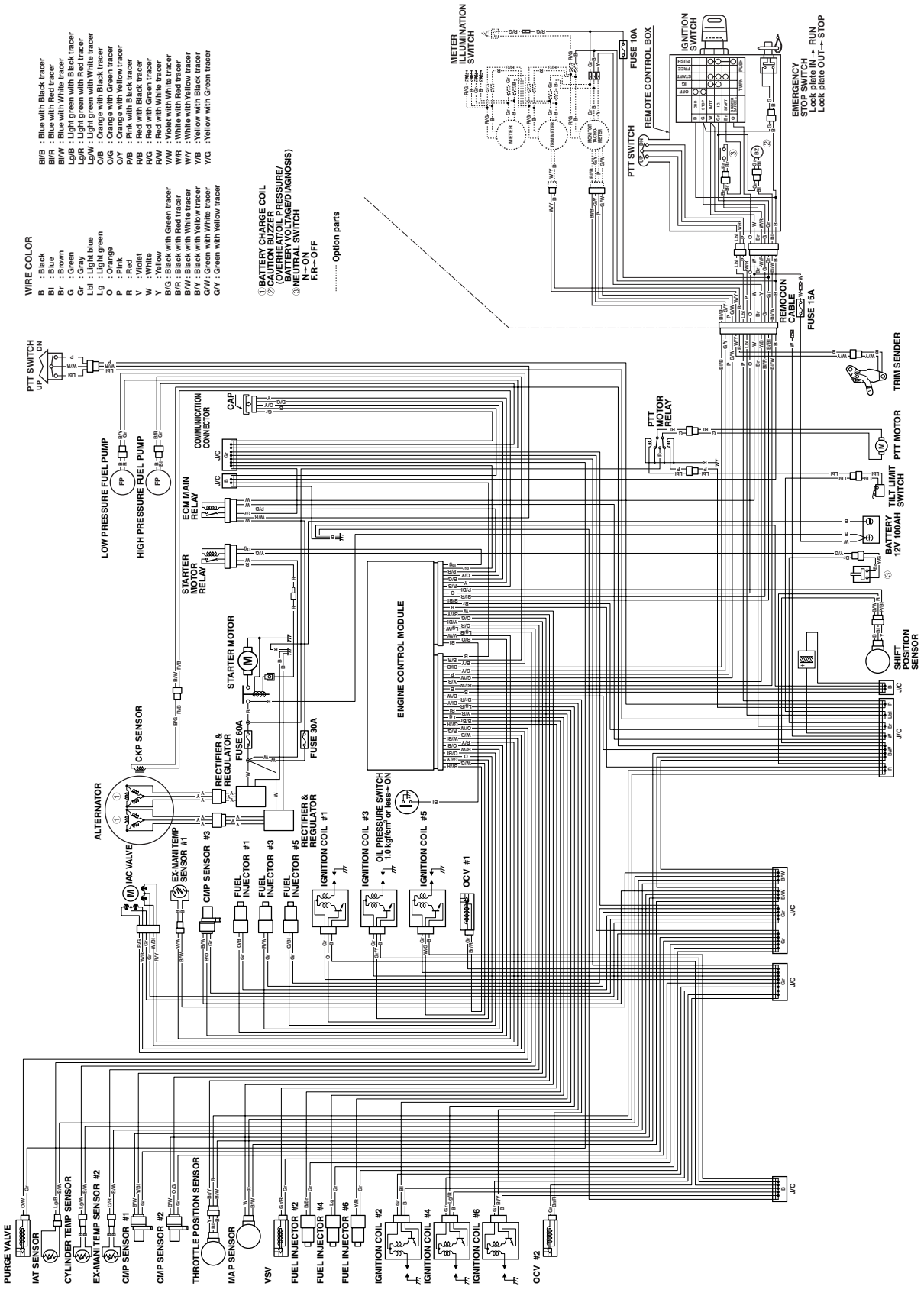
WIRING DIAGRAM 11- 2
DF200/DF225 .....11- 2
DF250 .....11- 3
WIRE ROUTING 11- 4
FUEL/WATER HOSE ROUTING 11-10

WIRING DIAGRAM

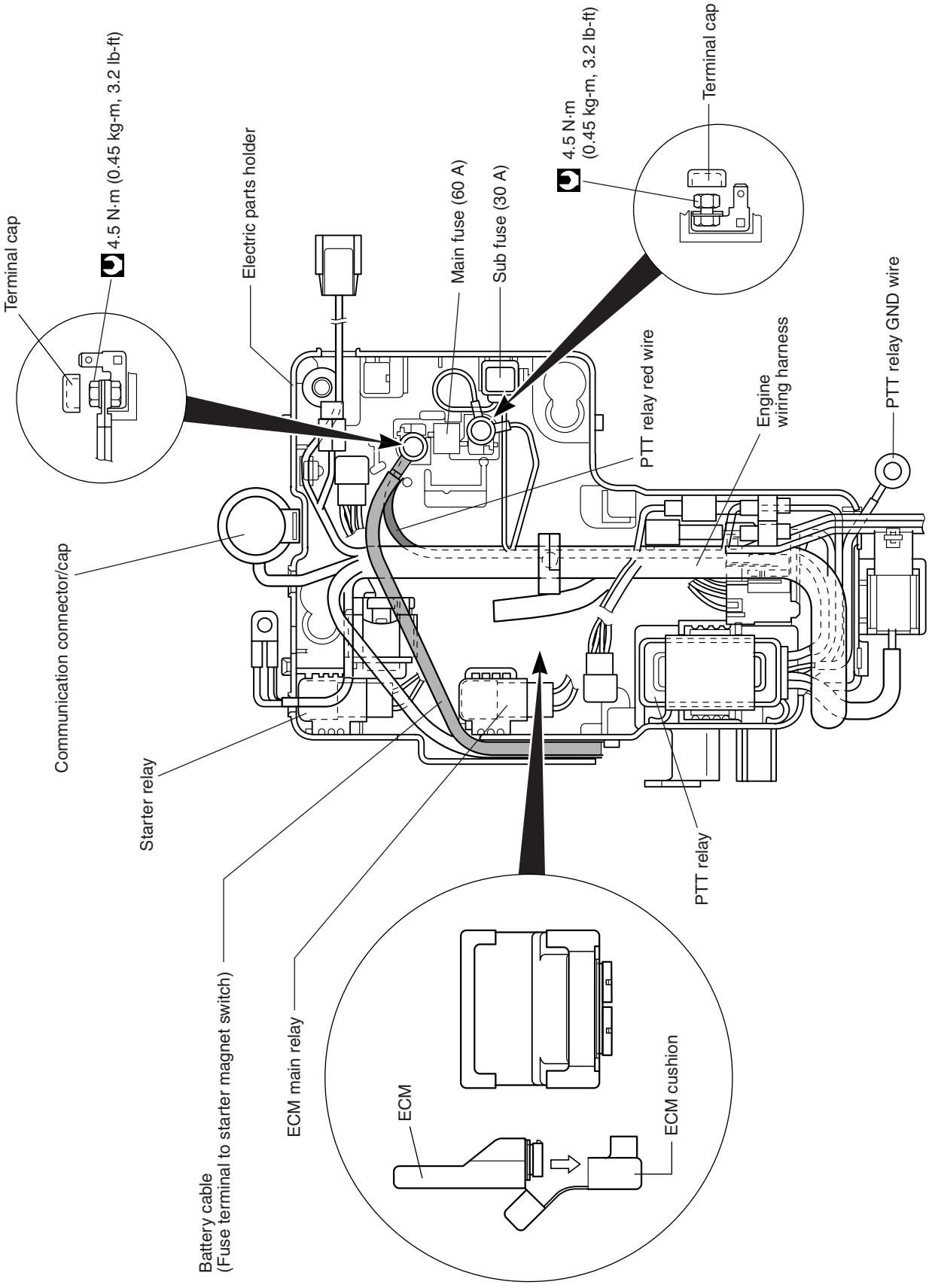
DF200/DF225

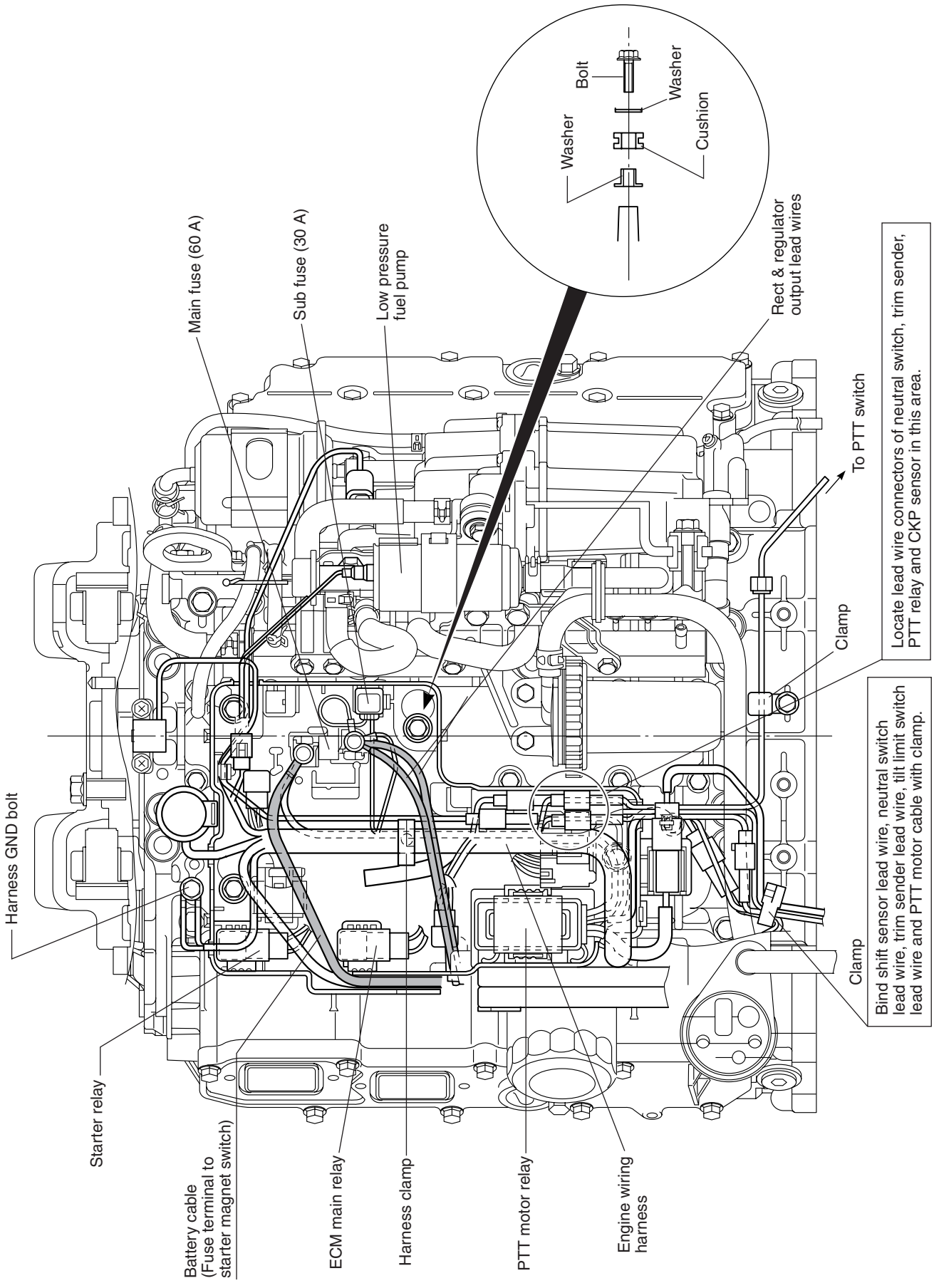


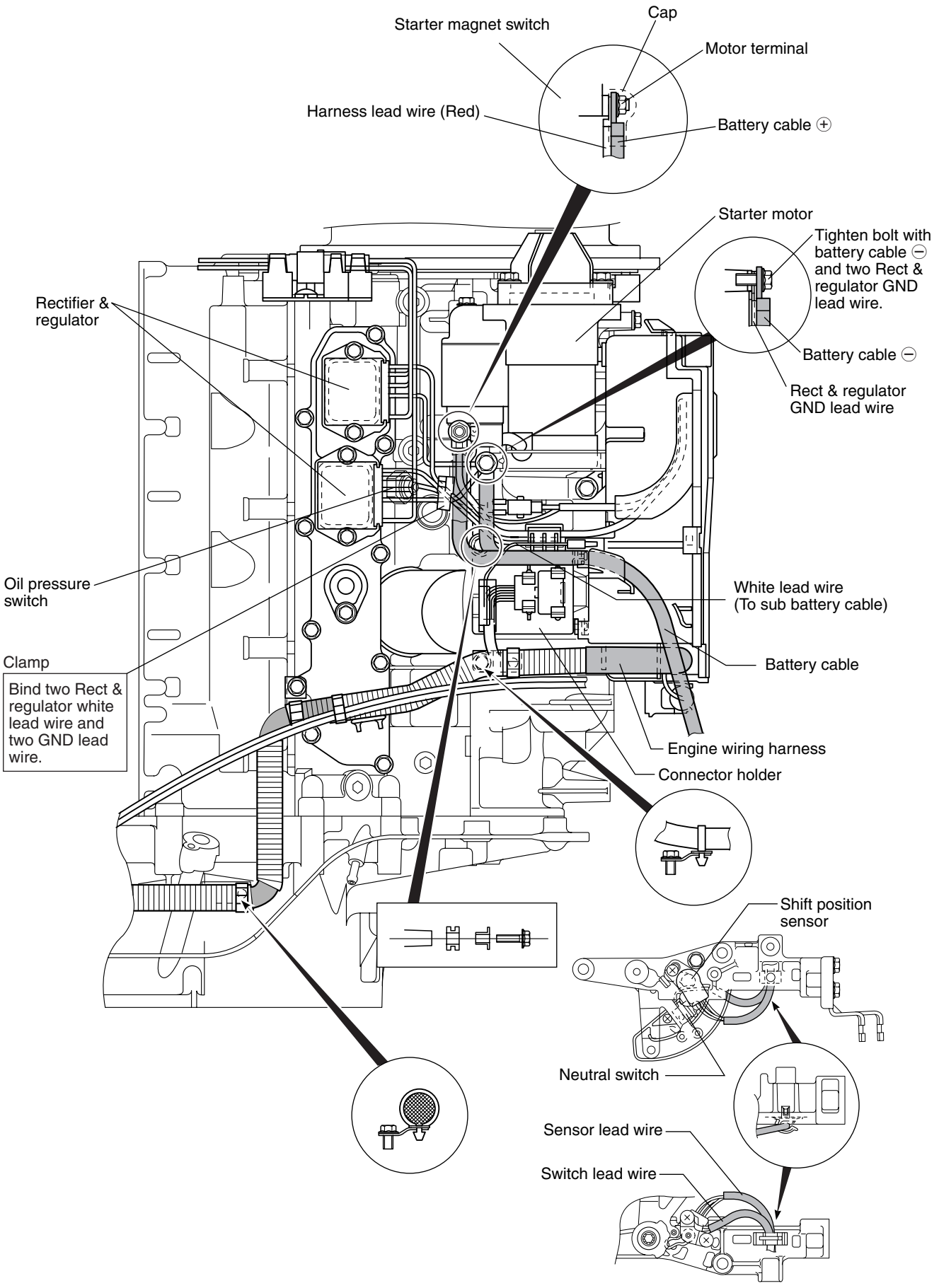
DF250

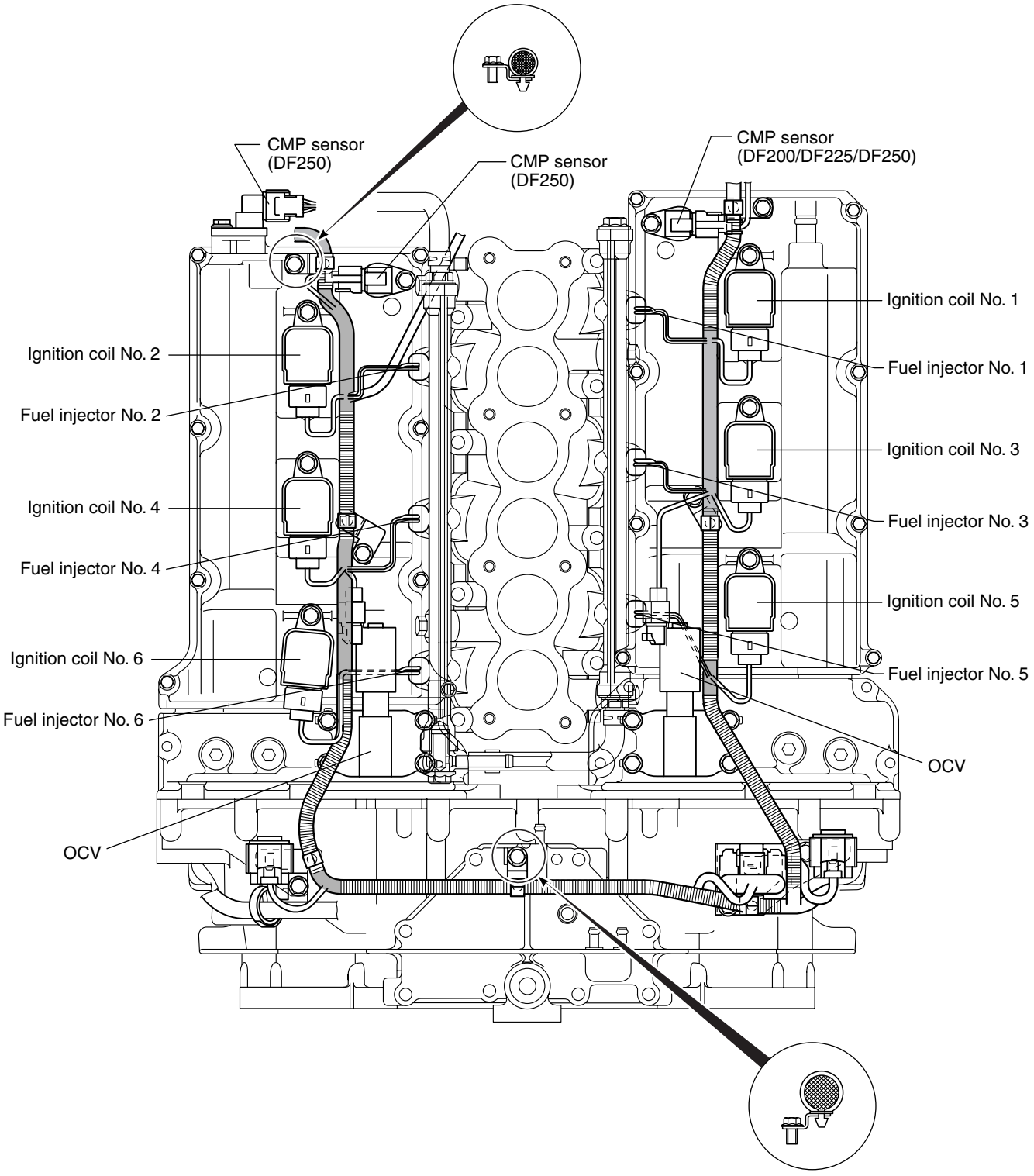

WIRE COLOR
B : Black
Bl : Blue
Br : Brown
G : Green
Gr : Gray
Lbl : Light blue
Lg : Light green
O : Orange
P : Pink
R : Red
V : Violet
W : White
Y : Yellow
B/G : Black with Green tracer
B/R : Black with Red tracer
B/W : Black with White tracer
B/Y : Black with Yellow tracer
G/W : Green with White tracer
G/Y : Green with Yellow tracer
Bl/B : Blue with Black tracer
Bl/R : Blue with Red tracer
Bl/W : Blue with White tracer
Lg/B : Light green with Black tracer
Lg/R : Light green with Red tracer
Lg/W : Light green with White tracer
O/B : Orange with Black tracer
O/G : Orange with Green tracer
O/Y : Orange with Yellow tracer
P/B : Pink with Black tracer
P/R : Red with Black tracer
R/G : Red with Green tracer
R/W : Red with White tracer
V/W : Violet with White tracer
W/R : White with Red tracer
W/Y : White with Yellow tracer
Y/B : Yellow with Black tracer
Y/G : Yellow with Green tracer
① BATTERY CHARGE COIL
② CAUTION BUZZER
(WATER PRESSURE/
BATTERY VOLTAGE/DIAGNOSIS)
③ NEUTRAL SWITCH
N→ON
F,R→OFF
Option parts
METER ILLUMINATION SWITCH
METER
TRIM METER
TRIM/TILT METER
IGNITION SWITCH
REMOTE CONTROL BOX
FUSE 10A
PTT SWITCH
EMERGENCY STOP SWITCH
Lock plate IN→ RUN
Lock plate OUT→ STOP
REMOCON CABLE
FUSE 15A
TRIM SENDER
PTT MOTOR RELAY
PTT MOTOR
TILT LIMIT SWITCH
BATTERY 12V 100AH
SHIFT POSITION SENSOR
PTT SWITCH UP DN
LOW PRESSURE FUEL PUMP
HIGH PRESSURE FUEL PUMP
COMMUNICATION CONNECTOR
CAP
ECM MAIN RELAY
STARTER MOTOR RELAY
STARTER MOTOR
CKP SENSOR
RECTIFIER & REGULATOR
FUSE 60A
FUSE 30A
ENGINE CONTROL MODULE
ALTERNATOR
IAC VALVE
EX-MANI TEMP SENSOR #1
CMP SENSOR #3
FUEL INJECTOR #1
FUEL INJECTOR #3
FUEL INJECTOR #5
RECTIFIER & REGULATOR
IGNITION COIL #1
IGNITION COIL #3
OIL PRESSURE SWITCH 1.0 kgf/cm² or less→ON
IGNITION COIL #5
OCV #1
PURGE VALVE
IAT SENSOR
CYLINDER TEMP SENSOR
EX-MANI TEMP SENSOR #2
CMP SENSOR #1
CMP SENSOR #2
THROTTLE POSITION SENSOR
MAP SENSOR
VSV
FUEL INJECTOR #2
FUEL INJECTOR #4
FUEL INJECTOR #6
IGNITION COIL #2
IGNITION COIL #4
IGNITION COIL #6
OCV #2
J/C

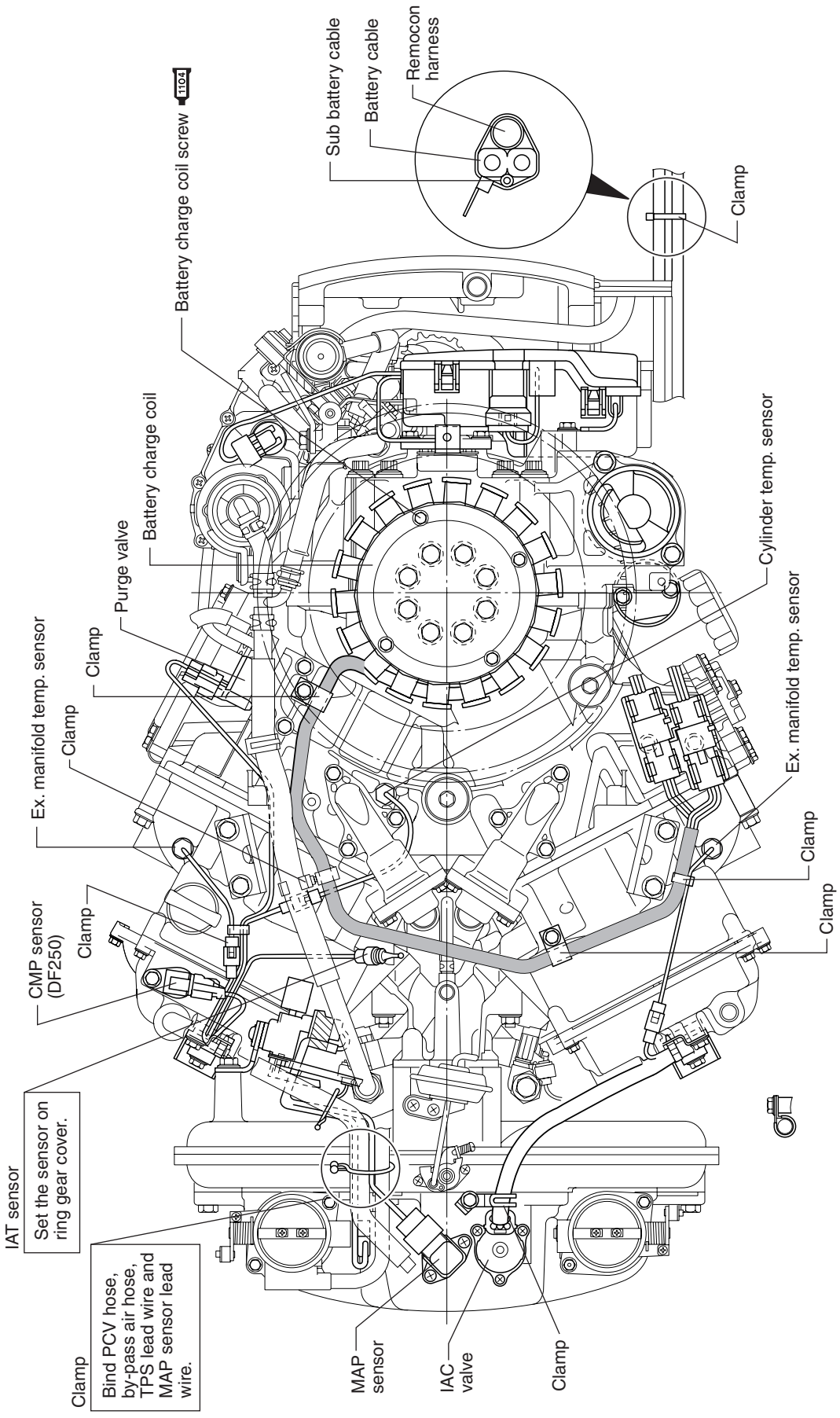
WIRE ROUTING

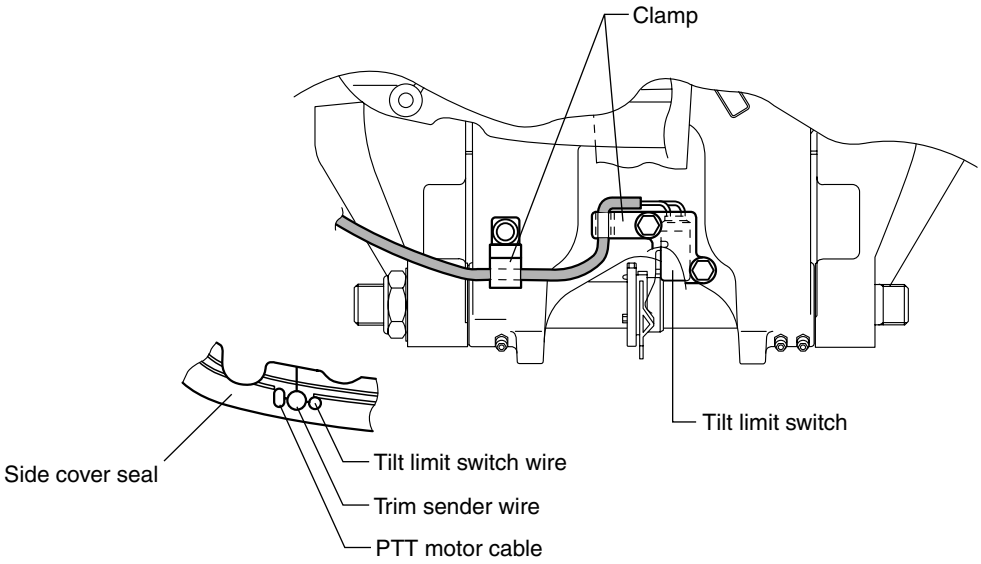


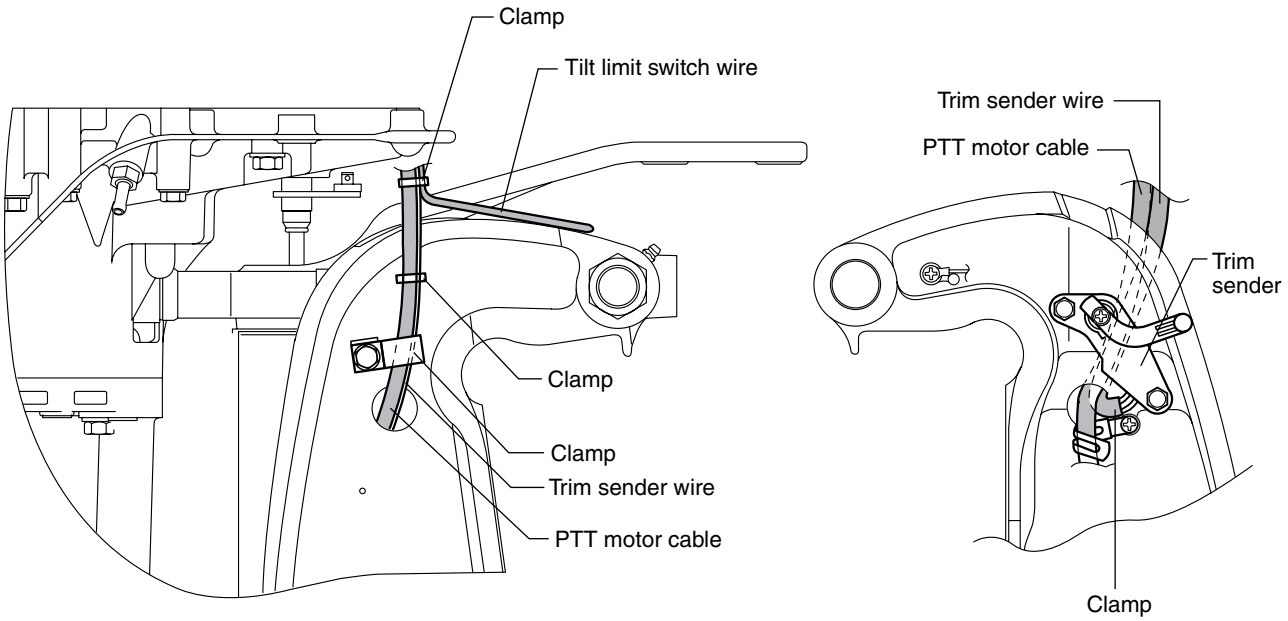

Harness GND bolt
Starter relay
Battery cable (Fuse terminal to starter magnet switch)
ECM main relay
Harness clamp
PTT motor relay
Engine wiring harness
Main fuse (60 A)
Sub fuse (30 A)
Low pressure fuel pump
Rect & regulator output lead wires
Bolt
Washer
Cushion
Washer
To PTT switch
Clamp
Clamp
Locate lead wire connectors of neutral switch, trim sender, PTT relay and CKP sensor in this area.
Bind shift sensor lead wire, neutral switch lead wire, trim sender lead wire, tilt limit switch lead wire and PTT motor cable with clamp.


Starter magnet switch
Cap
Motor terminal
Harness lead wire (Red)
Battery cable ⊕
Starter motor
Tighten bolt with battery cable ⊖ and two Rect & regulator GND lead wire.
Rectifier & regulator
Battery cable ⊖
Rect & regulator GND lead wire
Oil pressure switch
White lead wire (To sub battery cable)
Clamp
Bind two Rect & regulator white lead wire and two GND lead wire.
Battery cable
Engine wiring harness
Connector holder
Shift position sensor
Neutral switch
Sensor lead wire
Switch lead wire


CMP sensor (DF250)
CMP sensor (DF250)
CMP sensor (DF200/DF225/DF250)
Ignition coil No. 1
Fuel injector No. 1
Ignition coil No. 2
Fuel injector No. 2
Ignition coil No. 3
Fuel injector No. 3
Ignition coil No. 4
Fuel injector No. 4
Ignition coil No. 5
Fuel injector No. 5
Ignition coil No. 6
Fuel injector No. 6
OCV
OCV


Sub battery cable
Battery cable
Remocon harness
Clamp
1104
Battery charge coil screw
Battery charge coil
Purge valve
Clamp
Ex. manifold temp. sensor
Clamp
CMP sensor (DF250)
Clamp
IAT sensor
Set the sensor on ring gear cover.
Clamp
Bind PCV hose, by-pass air hose, TPS lead wire and MAP sensor lead wire.
MAP sensor
IAC valve
Clamp
Cylinder temp. sensor
Ex. manifold temp. sensor
Clamp
Clamp

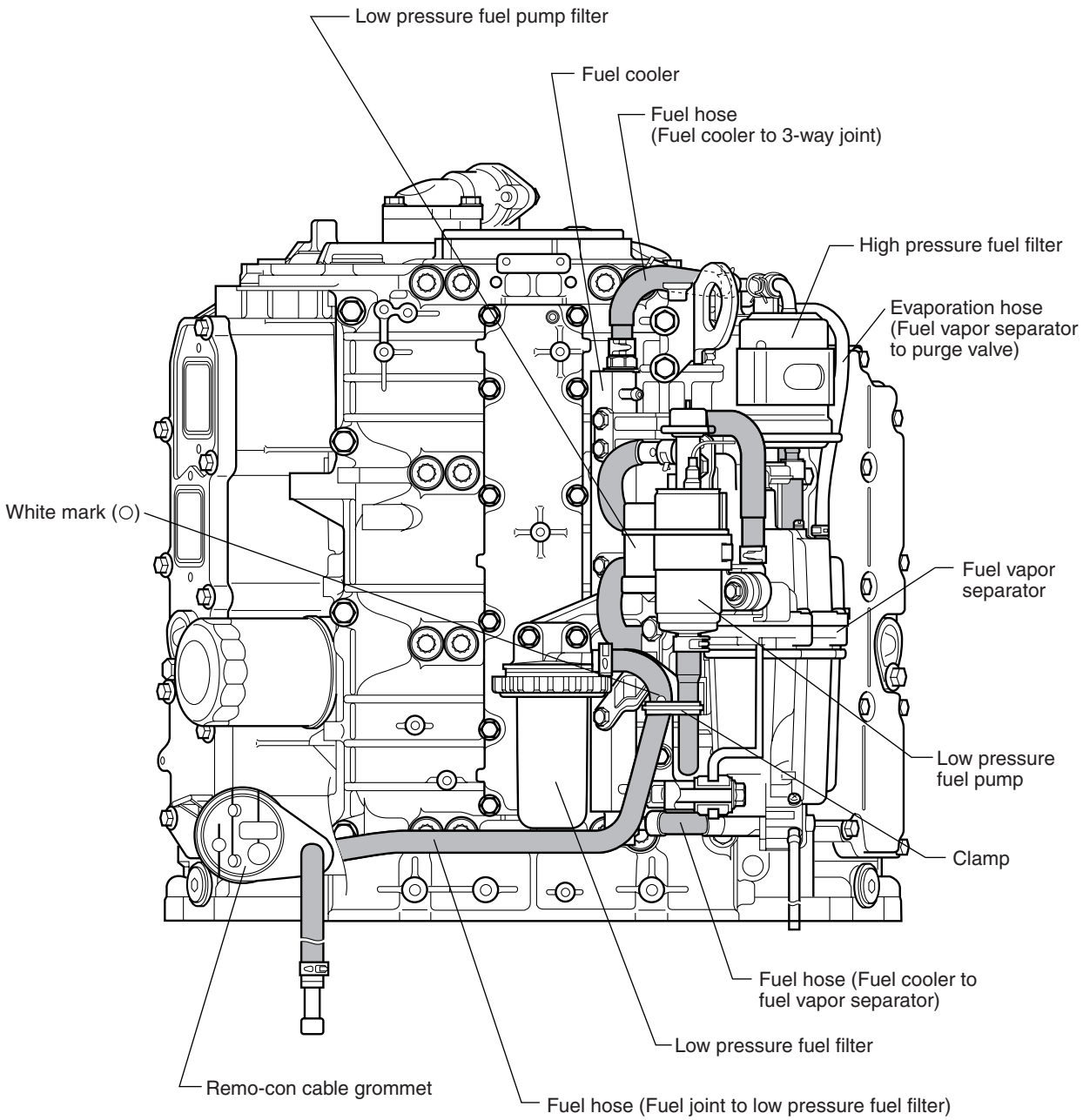

Clamp
Tilt limit switch
Side cover seal
Tilt limit switch wire
Trim sender wire
PTT motor cable

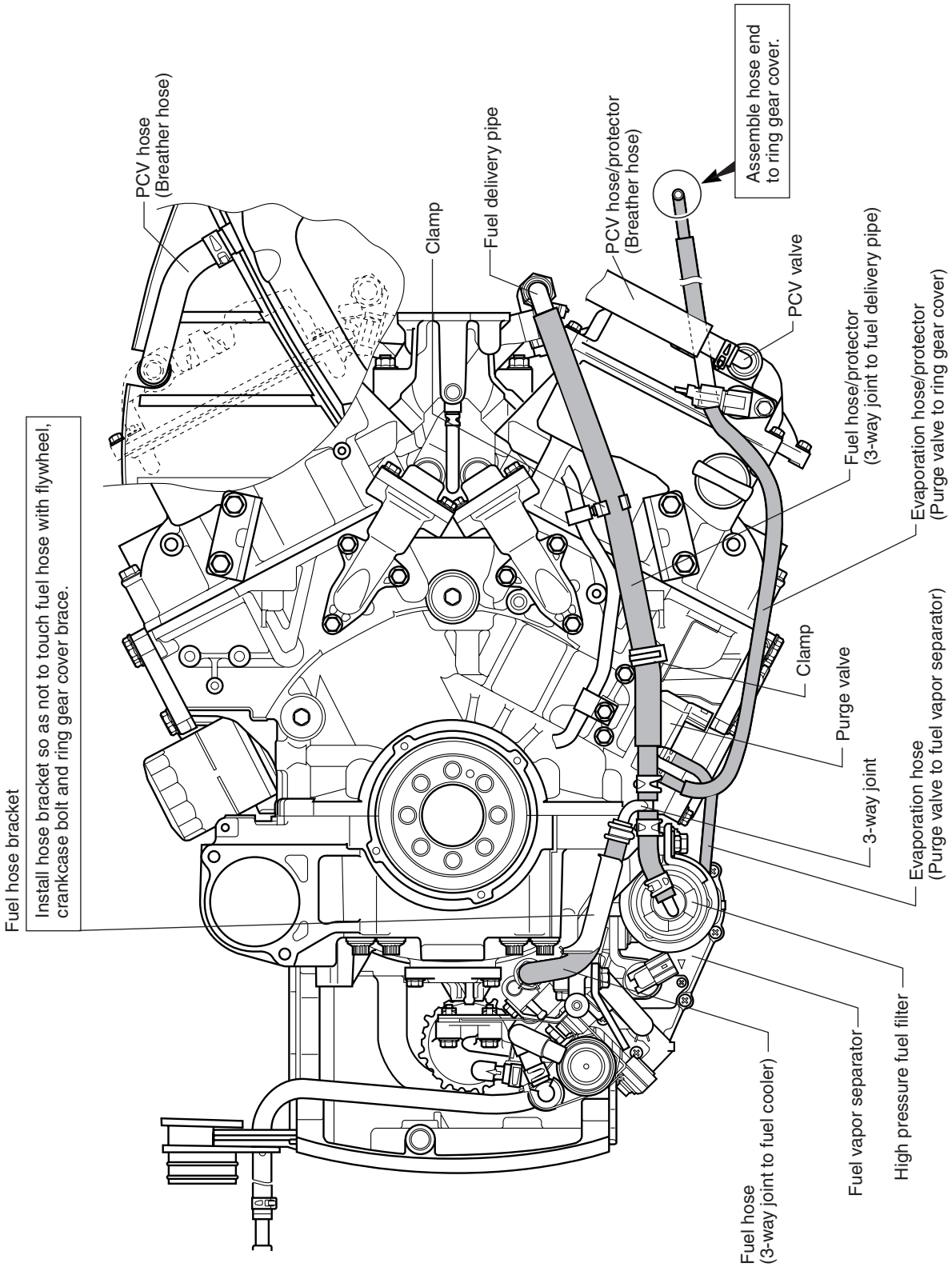

Clamp
Tilt limit switch wire
Clamp
Clamp
Trim sender wire
PTT motor cable
Trim sender wire
PTT motor cable
Trim sender
Clamp

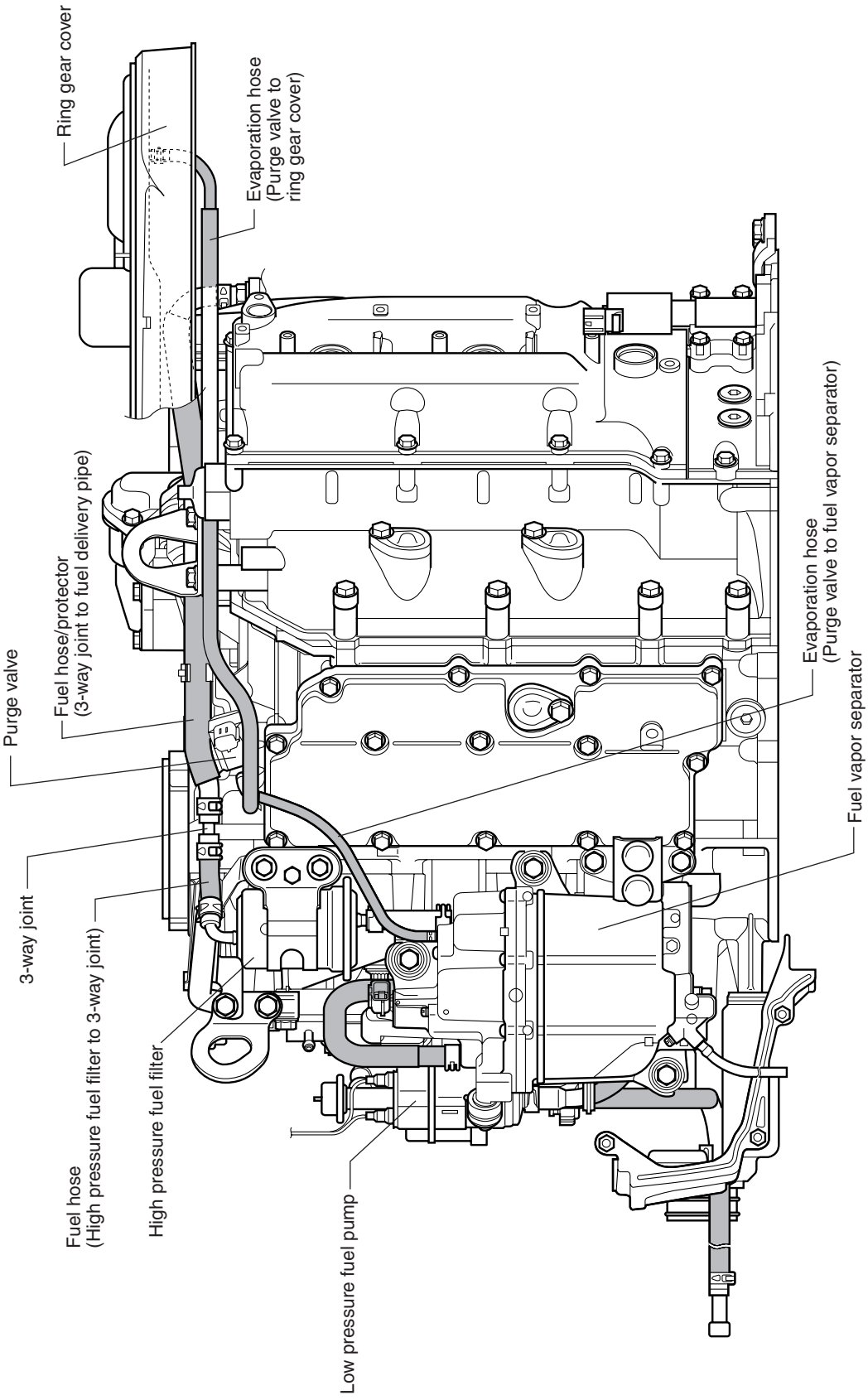
FUEL/WATER HOSE ROUTING

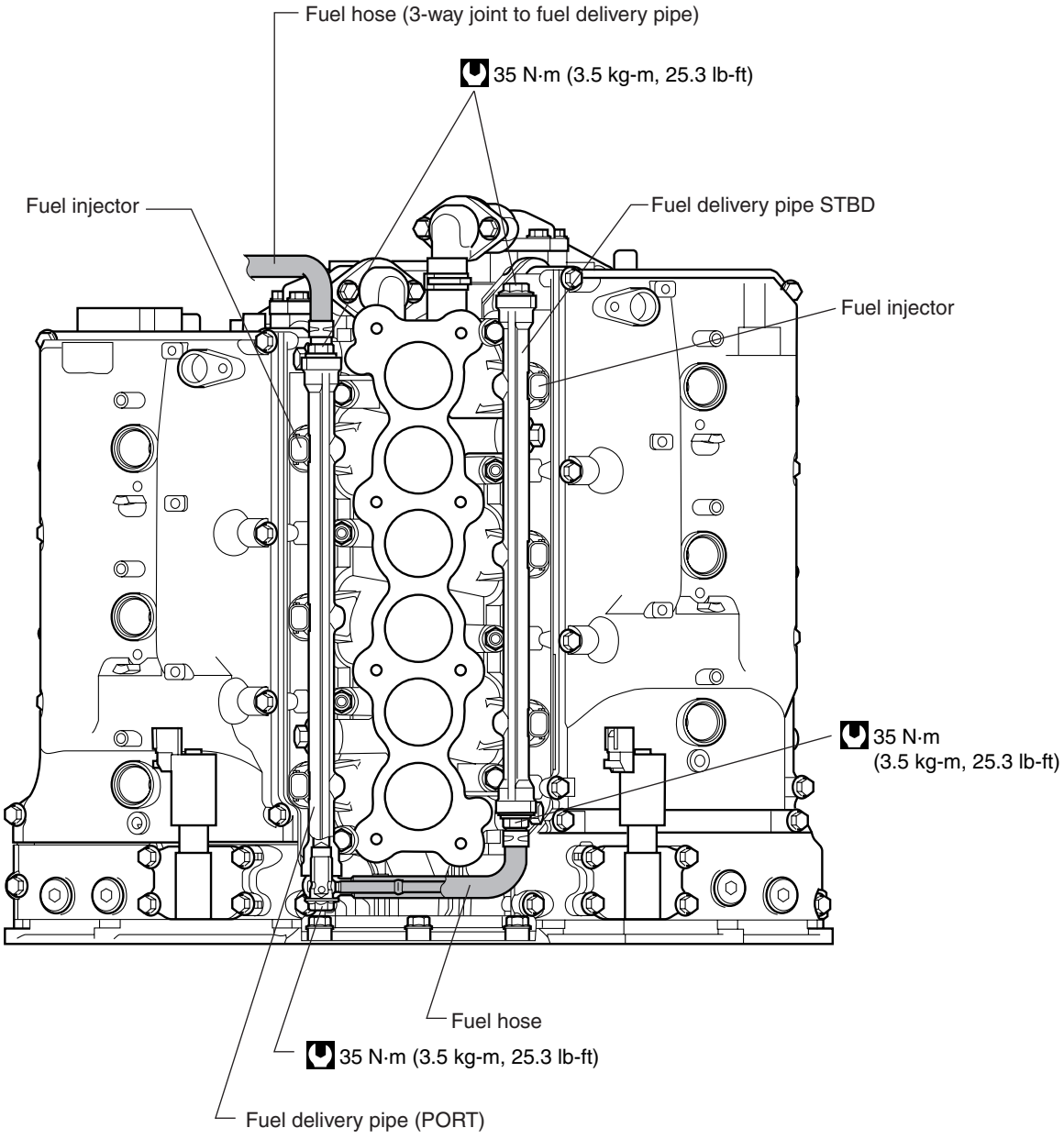
CAUTION

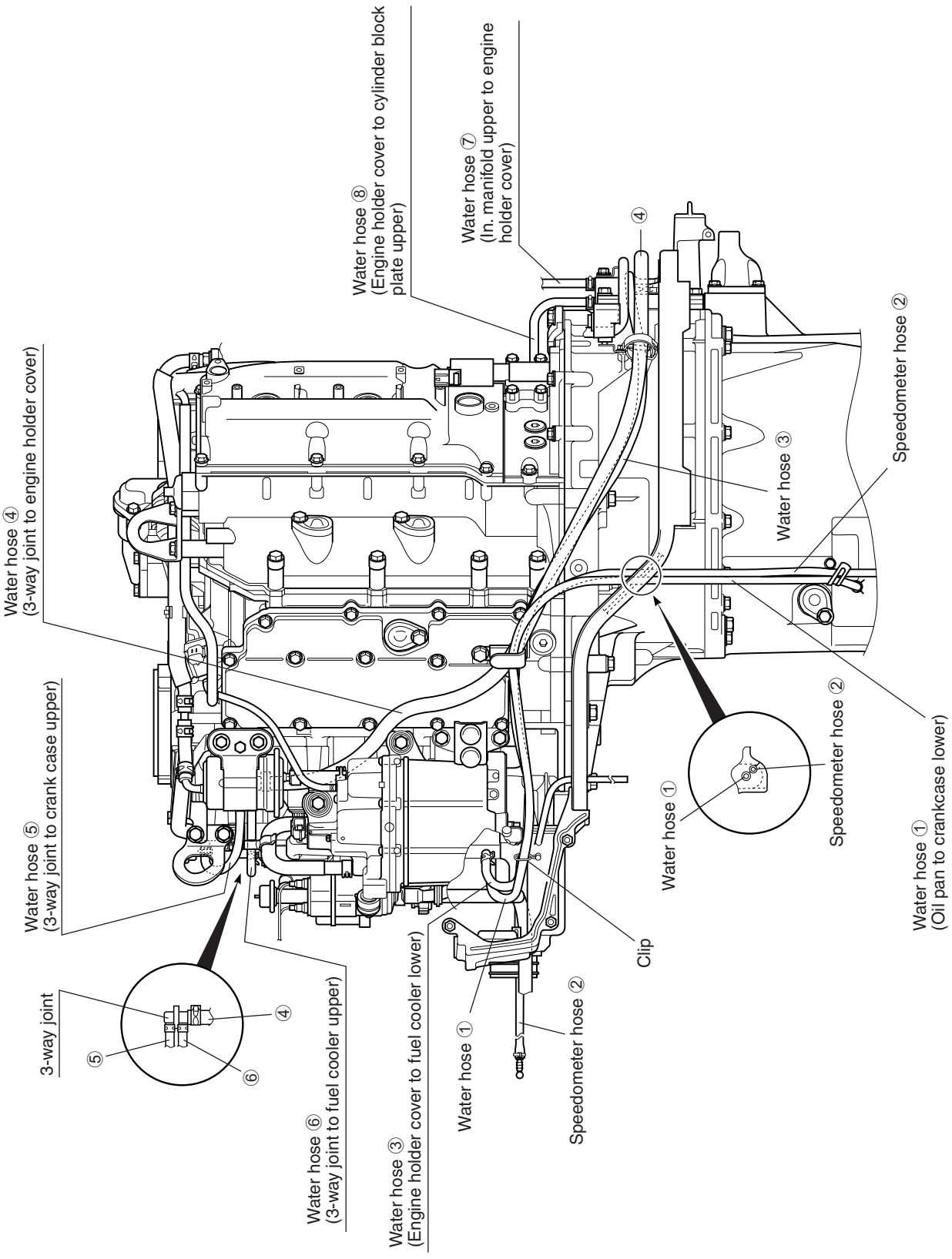
- **Do not over-bend (kink) or twist hose when installing.**
- **When installing hose clips, position tabs to avoid contact with other parts.**
- **Check that hoses do not contact rods and levers during either engine operation or standstill.**
- **Extreme care should be taken not to cut, abrade or cause any other damage on hoses.**
- **Care should be taken not to cause hoses to be compressed excessively by any clamp when fitted.**

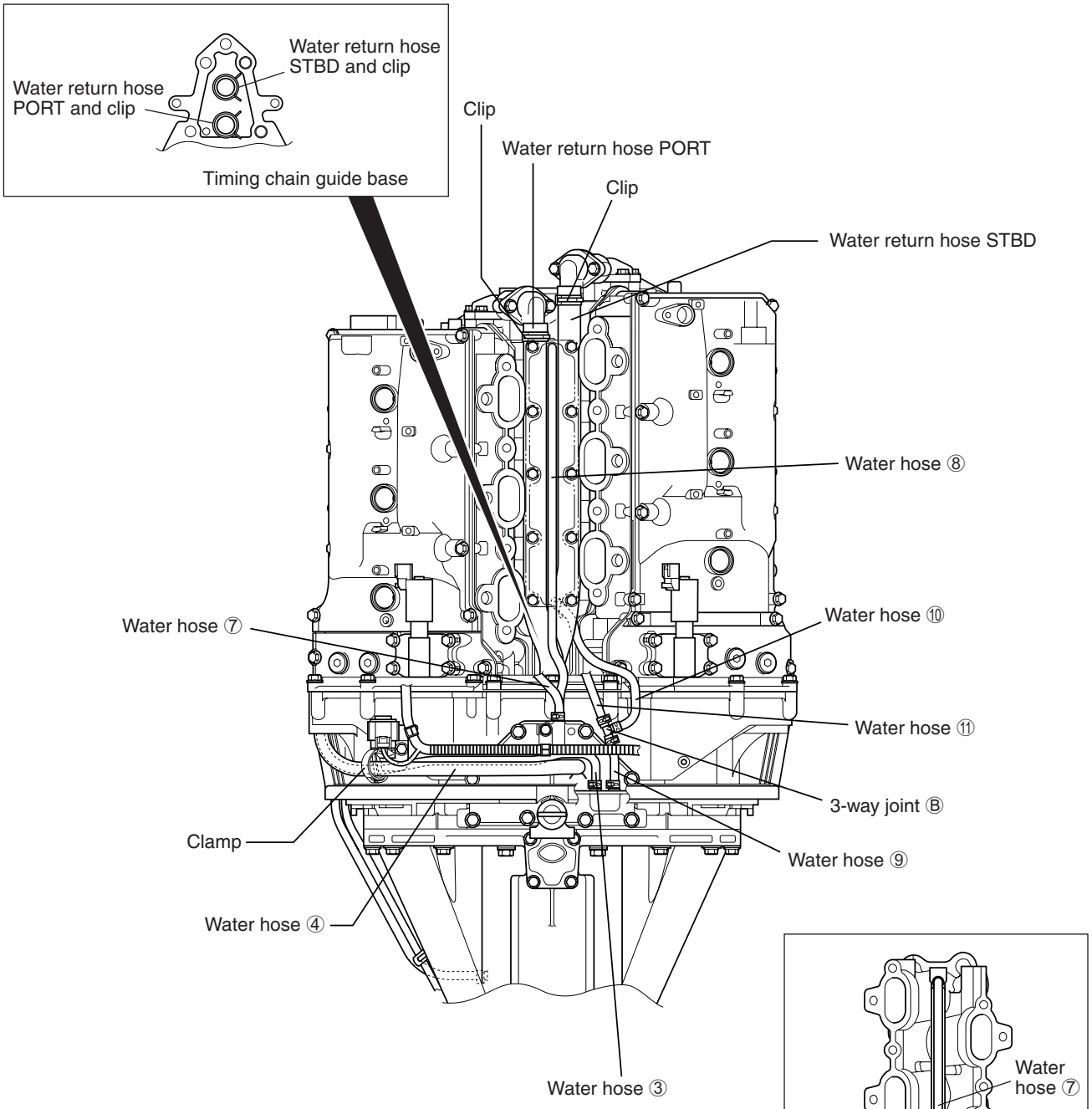



Fuel hose bracket
Install hose bracket so as not to touch fuel hose with flywheel, crankcase bolt and ring gear cover brace.
PCV hose (Breather hose)
Clamp
Fuel delivery pipe
PCV hose/protector (Breather hose)
Assemble hose end to ring gear cover.
PCV valve
Fuel hose/protector (3-way joint to fuel delivery pipe)
Evaporation hose/protector (Purge valve to ring gear cover)
Clamp
Purge valve
3-way joint
Evaporation hose (Purge valve to fuel vapor separator)
Fuel hose (3-way joint to fuel cooler)
Fuel vapor separator
High pressure fuel filter

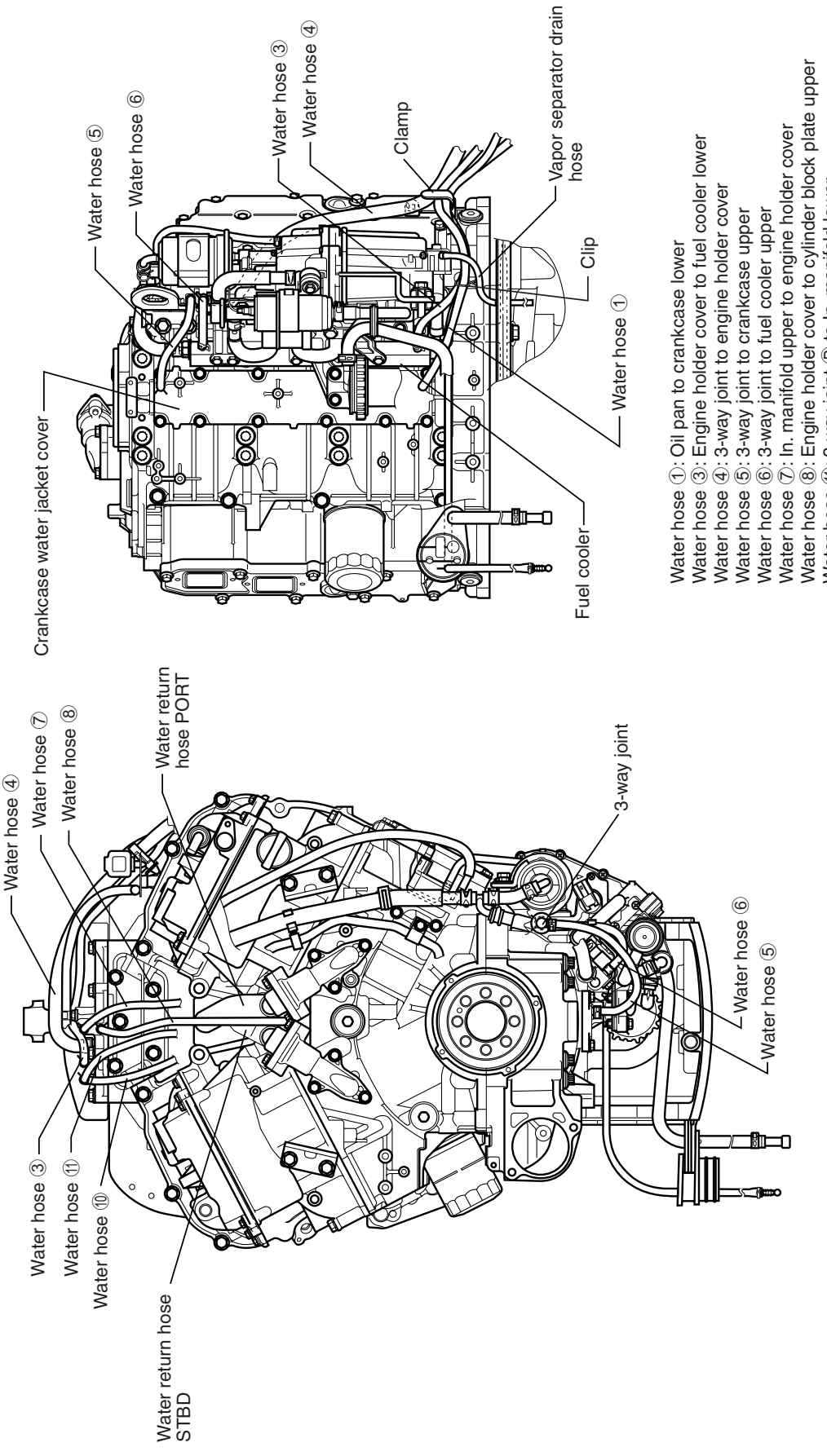

Ring gear cover
Evaporation hose
(Purge valve to
ring gear cover)
Fuel hose/protector
(3-way joint to fuel delivery pipe)
Purge valve
Evaporation hose
(Purge valve to fuel vapor separator)
3-way joint
Fuel vapor separator
Fuel hose
(High pressure fuel filter to 3-way joint)
High pressure fuel filter
Low pressure fuel pump


Fuel hose (3-way joint to fuel delivery pipe)
35 N·m (3.5 kg-m, 25.3 lb-ft)
Fuel injector
Fuel delivery pipe STBD
Fuel injector
35 N·m
(3.5 kg-m, 25.3 lb-ft)
Fuel hose
35 N·m (3.5 kg-m, 25.3 lb-ft)
Fuel delivery pipe (PORT)


Water hose ⑧
(Engine holder cover to cylinder block plate upper)
Water hose ⑦
(In. manifold upper to engine holder cover)
④
Water hose ④
(3-way joint to engine holder cover)
Water hose ③
Speedometer hose ②
Water hose ⑤
(3-way joint to crank case upper)
Water hose ①
Speedometer hose ②
Water hose ①
(Oil pan to crankcase lower)
Clip
3-way joint
⑤
④
⑥
Water hose ⑥
(3-way joint to fuel cooler upper)
Water hose ③
(Engine holder cover to fuel cooler lower)
Water hose ①
Speedometer hose ②



Water hose ③: Engine holder cover to fule cooler lower
Water hose ④: 3-way joint to engine holder cover
Water hose ⑦: In. manifold upper to engine holder cover
Water hose ⑧: Engine holder cover to cylinder block plate upper
Water hose ⑨: Engine holder cover to 3-way joint Ⓑ
Water hose ⑩: Engine holder cover to cylinder block plate lower
Water hose ⑪: 3-way joint Ⓑ to In. manifold lower


Water hose ⑤
Water hose ⑥
Water hose ③
Water hose ④
Clamp
Vapor separator drain hose
Clip
Water hose ①
Crankcase water jacket cover
Fuel cooler
Water hose ①: Oil pan to crankcase lower
Water hose ③: Engine holder cover to fuel cooler lower
Water hose ④: 3-way joint to engine holder cover
Water hose ⑤: 3-way joint to crankcase upper
Water hose ⑥: 3-way joint to fuel cooler upper
Water hose ⑦: In. manifold upper to engine holder cover
Water hose ⑧: Engine holder cover to cylinder block plate upper
Water hose ⑪: 3-way joint Ⓑ to In. manifold lower
Water hose ④
Water hose ⑦
Water hose ⑧
Water return hose PORT
3-way joint
Water hose ③
Water hose ⑪
Water hose ⑩
Water return hose STBD
Water hose ⑥
Water hose ⑤

SUZUKI MOTOR CORPORATION

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