PRE-PRODUCTION ISSUE

SUZUKI OUTBOARD MOTOR

DF150
DF175 FOUR STROKE

SERVICE MANUAL

FOREWORD

This manual contains an introductory description of the SUZUKI DF150/175 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 2006 (K6) model.

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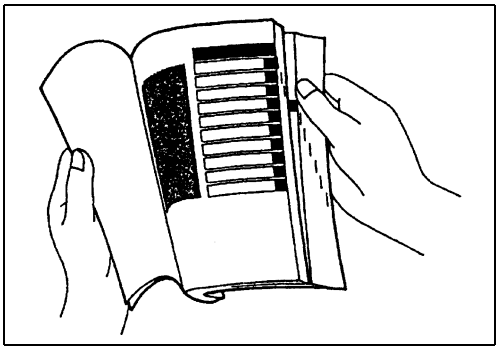
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HOW TO USE THIS MANUAL

TO LOCATE WHAT YOU ARE LOOKING FOR:

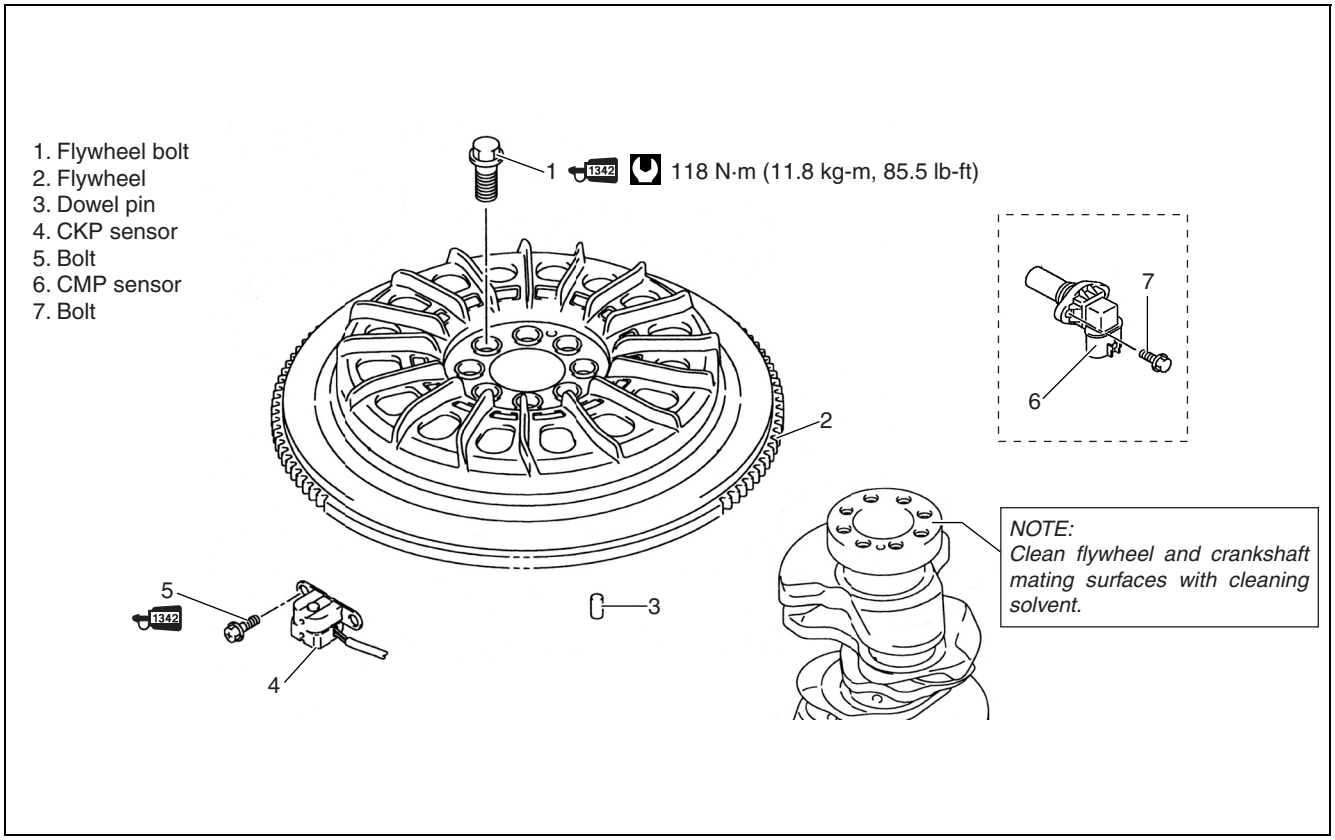
1. The text of this manual is divided into sections.
2. The section titles are listed on the previous page in a GROUP INDEX. Select the section needed for reference.
3. Holding the manual as shown at the right will allow you to find the first page of the section easily.
4. The first page of each section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



COMPONENT PARTS AND IMPORTANT ITEM ILLUSTRATIONS

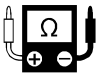
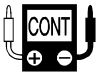
Under the name of each system or unit, an exploded view is provided with work instructions and other service information such as the tightening torque, lubrication and locking agent points.

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 SUZUKI SILICONE SEAL.
	Apply oil. Use the engine oil unless otherwise specified.		Apply THREAD LOCK “1342”.
	Apply molybdenum oil solution. (Mixture of engine oil and SUZUKI MOLY PASTE in a ratio of 1 : 1)		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 MOLY PASTE. 99000-25140		Measure in continuity test range.
	Apply SUZUKI WATER RESISTANT GREASE.		Use peak voltmeter “Stevens CD-77”.
	Apply SUZUKI BOND “1104”.		Use special tool.
	Apply SUZUKI BOND “1207B”.		

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

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 judgment 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

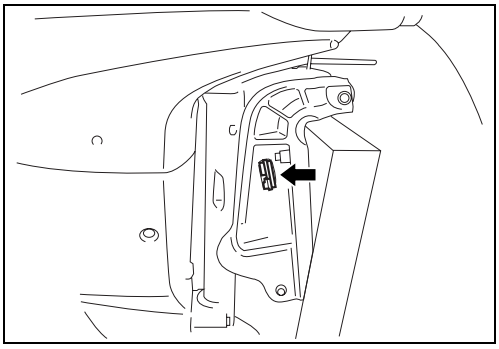
- **If parts replacement is necessary, replace the parts with Suzuki Genuine Parts or their equivalent.**
- **When removing parts that are to be reused, keep them arranged in an orderly manner so that they may be reinstalled in the proper order and orientation.**
- **Be sure to use special tools where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

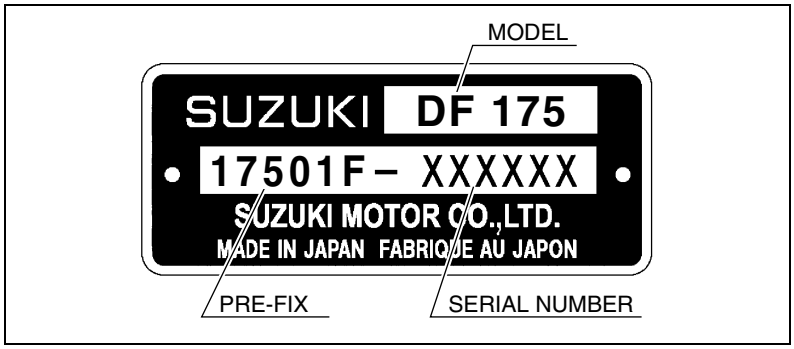
IDENTIFICATION NUMBER LOCATION

MODEL, PRE-FIX, SERIAL NUMBER

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

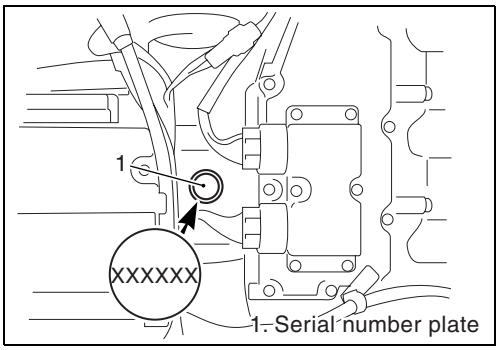


Example



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

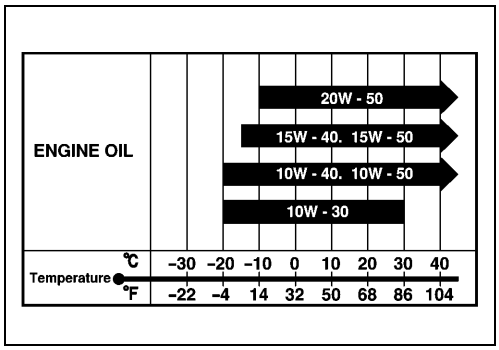
If leaded gasoline is used, engine damage may result. Use only unleaded gasoline.

ENGINE OIL

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

The viscosity rating should be SAE (or NMMA FC-W) 10W-40.

If SAE (or NMMA FC-W) 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 the 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 planning.

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 DF150/175 models are shown below.

Recommended full throttle speed range	**DF150**	**5 000 – 6 000 r/min**
	DF175	**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					Counter rotation models				
Blade	×	**Dia. (in.)**	×	**Pitch (in.)**	**Blade**	×	**Dia. (in.)**	×	**Pitch (in.)**
3	×	15 and 1/2	×	17	3	×	15 and 1/2	×	17
3	×	15 and 1/4	×	19	3	×	15 and 1/4	×	19
3	×	15	×	21	3	×	15	×	21
3	×	14 and 3/4	×	23	3	×	14 and 3/4	×	23
3	×	14 and 1/2	×	25	3	×	14 and 1/2	×	25
3	×	14 and 1/2	×	27	3	×	14 and 1/2	×	27
3	×	16	×	17	3	×	16	×	17
3	×	16	×	18 and 1/2	3	×	16	×	18 and 1/2
3	×	16	×	20	3	×	16	×	20
3	×	16	×	21 and 1/2	3	×	16	×	21 and 1/2
3	×	16	×	23	3	×	16	×	23
3	×	16	×	24 and 1/2	3	×	16	×	24 and 1/2
3	×	16	×	26	3	×	16	×	26
3	×	16	×	27 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 the case of twin installation, always use the same size right-hand rotation and counter-rotation propellers on both engines.

POWERHEAD DIRECTION OF ROTATION

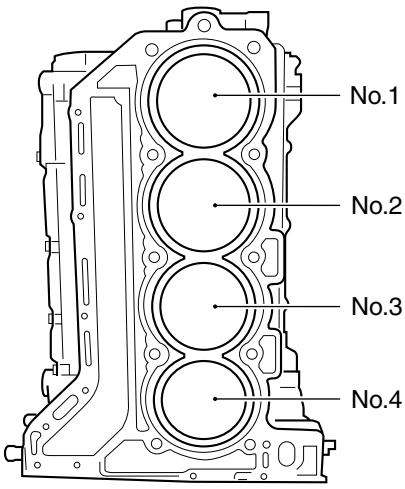
This outboard motor is designed with a L.H. (left hand) rotation powerhead utilizing an offset crankshaft.
This design has the advantage of reducing the size of the motor and keeping the overall motor's weight closer to the boat transom and therefore closer to the boat C/G (center of gravity).

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.

Item	Unit	Data			
		DF150T	DF150Z	DF175T	DF175Z
PRE-FIX		15001F	15001Z	17501F	17501Z

DIMENSIONS & WEIGHT

Overall length (front to back)		mm (in.)	839 (33.0)
Overall width (side to side)		mm (in.)	519 (20.4)
Overall height	L	mm (in.)	1714 (67.5)
	X	mm (in.)	1841 (72.5)
Weight (without engine oil)	L	kg (lbs)	211 (465.2)
	X	kg (lbs)	215 (474.0)
Transom height	L	mm (in. type)	500 (20)
	X	mm (in. type)	627 (25)

PERFORMANCE

Maximum output	kW (PS)	110 (150)	129 (175)
Recommended operating range	r/min	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		4
Bore	mm (in.)	97 (3.82)
Stroke	mm (in.)	97 (3.82)
Total displacement	cm^3 (cu. in)	2 867 (174.9)
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			
		DF150T	DF150Z	DF175T	DF175Z

FUEL & OIL

Fuel		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.
Engine oil		• API classification : SE, SF, SG, SH, SJ or NMMA FC-W classification : SE, SF, SG, SH, SJ • Viscosity rating : SAE 10W-40 or NMMA FC-W 10W-40
Engine oil amounts	L (US/Imp. qt)	8.0 (8.5/7.0) : Oil change only 8.5 (9.0/7.5) : 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 – 21 (PTT system)
Number of trim position		PTT system
Maximum tilt angle	degree	74

LOWER UNIT

Reversing system	Gear
Transmission	Forward-Neutral-Reverse
Reduction system	Bevel gear
Gear ratio	12 : 25 (2.08)
Drive line impact protection	Spline drive rubber hub
Propeller shaft rotation (when shift into forward)	DF150T/175T : Clockwise DF150Z/175Z : Counterclockwise
Propeller	Right-hand rotation models
	Blade × Dia. (in.) × Pitch (in.)
	3 × 15 and 1/2 × 17 3 × 15 and 1/4 × 19 3 × 15 × 21 3 × 14 and 3/4 × 23 3 × 14 and 1/2 × 25 3 × 14 and 1/2 × 27 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 3 × 16 × 26 3 × 16 × 27 and 1/2

Item	Unit	Data			
		DF150T	DF150Z	DF175T	DF175Z

Propeller	Counter rotation models		
	Blade ×	Dia. (in.) ×	Pitch (in.)
	3 ×	15 and 1/2 ×	17
	3 ×	15 and 1/4 ×	19
	3 ×	15 ×	21
	3 ×	14 and 3/4 ×	23
	3 ×	14 and 1/2 ×	25
	3 ×	14 and 1/2 ×	27
	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
	3 ×	16 ×	26

REDUCTION SYSTEM

1st reduction gear ratio (Crankshaft drive gear: Driven gear)	30 : 36 (1.20)
2nd reduction gear ratio (Lower unit gear)	12 : 25 (2.08)
Total reduction gear ratio	2.50 (36/30 × 25/12)

* SERVICE DATA

* These service data are subject to change without notice.

Item	Unit	Data	
		DF150T/Z	DF175T/Z

POWERHEAD

Recommended operating range	r/min	5 000 – 6 000	5 500 – 6 100
Idle speed	r/min	650 ± 50 (in-gear: Approx. 650)	
**Cylinder compression	kPa (kg/cm², psi)	1 100 – 1 700 (11 – 17, 156 – 242)	
**Cylinder compression max. difference between cylinders	kPa (kg/cm², psi)	100 (1.0, 14)	
**Engine oil pressure	kPa (kg/cm², 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 or NMMA FC-W classification : SE, SF, SG, SH, SJ • Viscosity rating : SAE 10W-40 or NMMA FC-W 10W-40	
Engine oil amounts	L (US/lpm. qt))	8.0 (8.5/7.0) : Oil change only 8.5 (9.0/7.5) : Oil filter change	
Thermostat operating temperature	°C (°F)	58 – 62 (136 – 144)	

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

Item			Unit	Data	
				DF150T/Z	DF175T/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.)	42.520 – 42.680 (1.6740 – 1.6803)	44.420 – 44.580 (1.7488 – 1.7551)
		Limit	mm (in.)	42.420 (1.6701)	44.320 (1.7449)
	EX	STD	mm (in.)	42.420 – 42.580 (1.6701 – 1.6764)	44.420 – 44.580 (1.7488 – 1.7551)
		Limit	mm (in.)	42.320 (1.6661)	44.320 (1.7449)
Camshaft journal oil clearance	Top, 2nd, 3rd, 4th, 5th	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, 5th	STD	mm (in.)	26.000 – 26.021 (1.0236 – 1.0244)	
		Limit	mm (in.)	—	
Camshaft journal outside diameter	Top, 2nd, 3rd, 4th, 5th	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	
				DF150T/Z	DF175T/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.)	0.30 – 0.34 (0.012 – 0.013)
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	
		DF150T/Z	DF175T/Z

CYLINDER/PISTON/PISTON RING

Cylinder distortion		Limit	mm (in.)	0.03 (0.001)
Piston to cylinder clearance		STD	mm (in.)	0.085 – 0.105 (0.0033 – 0.0041)
		Limit	mm (in.)	0.15 (0.0059)
Cylinder bore		STD	mm (in.)	97.000 – 97.020 (3.8189 – 3.8197)
Cylinder measuring position			mm (in.)	50 (1.969) from cylinder top surface
Piston skirt diameter		STD	mm (in.)	96.905 – 96.925 (3.8152 – 3.8159)
Piston measuring position			mm (in.)	9 (0.354) from piston skirt end
Cylinder bore wear		Limit	mm (in.)	0.10 (0.039)
Piston ring end gap	1st	STD	mm (in.)	0.20 – 0.30 (0.0079 – 0.0118)
		Limit	mm (in.)	0.70 (0.028)
	2nd	STD	mm (in.)	0.30 – 0.45 (0.0118 – 0.0177)
		Limit	mm (in.)	1.00 (0.039)
Piston ring free end gap	1st	STD	mm (in.)	Approx. 13.5 (0.5315)
		Limit	mm (in.)	10.8 (0.4252)
	2nd	STD	mm (in.)	Approx. 13.6 (0.5354)
		Limit	mm (in.)	10.9 (0.4291)
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.)	—
		Limit	mm (in.)	—
Piston pin outside diameter		STD	mm (in.)	21.995 – 22.000 (0.8659 – 0.8661)
		Limit	mm (in.)	—
Piston pin hole diameter		STD	mm (in.)	22.006 – 22.014 (0.8664 – 0.8667)
		Limit	mm (in.)	—
Pin clearance in conrod small end		STD	mm (in.)	—
		Limit	mm (in.)	—
Conrod small end bore		STD	mm (in.)	21.968 – 21.979 (0.8649 – 0.8653)

Item		Unit	Data	
			DF150T/Z	DF175T/Z

CRANKSHAFT/CONROD

Conrod small end inside diameter	STD	mm (in.)	21.968 – 21.979 (0.8649 – 0.8653)
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.)	22.750 – 22.800 (0.8957 – 0.8976)
Crank pin width	STD	mm (in.)	23.100 – 23.200 (0.9094 – 0.9134)
Crankshaft center journal runout	Limit	mm (in.)	0.04 (0.002)
Crankshaft journal oil clearance	STD	mm (in.)	0.030 – 0.050 (0.0012 – 0.0020)
	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.)	64.982 – 65.000 (2.5583 – 2.5591)
Crankshaft journal outside diameter difference (out-of-round and taper)	Limit	mm (in.)	0.010 (0.0004)
Crankshaft bearing thickness	STD	mm (in.)	2.497 – 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	
			DF150T/Z	DF175T/Z

ELECTRICAL

Ignition timing		Degrees at r/min	BTDC 5 – 26 ± 3	
Over revolution limiter		r/min	6 200	6 300
CKP sensor resistance		Ω at 20 °C	168 – 252	
CMP sensor resistance		Ω at 20 °C	—	
Ignition coil resistance	Primary	Ω at 20 °C	—	
	Secondary	kΩ at 20 °C	—	
Battery charge coil resistance		Ω at 20 °C	0.14 – 0.20	
Battery charge coil output (12V)		Watt	528	
Standard spark plug	Type	NGK	BKR6E	
	Gap	mm (in.)	0.7 – 0.8 (0.028 – 0.031)	
Fuse amp. rating		A	Main fuse : 60 Starter motor : 30 Ignition coil, Injector, ECM : 30 PTT switch : 10 IAC, CMP, VSV, VVT : 10 Isolator : 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 coil resistance		Ω at 20 °C	145 – 190	
Starter motor relay coil resistance		Ω at 20 °C	145 – 190	
PTT motor relay coil resistance		Ω at 20 °C	25 – 37	

STARTER MOTOR

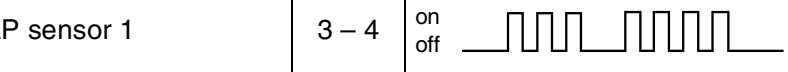
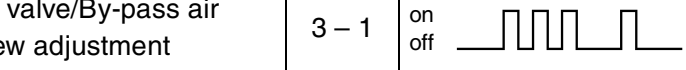
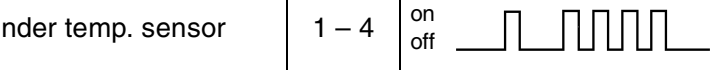
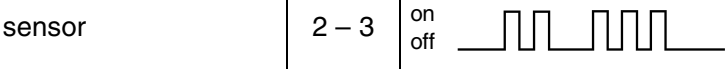
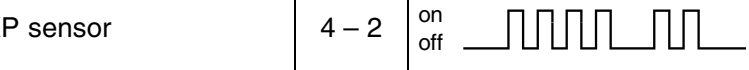
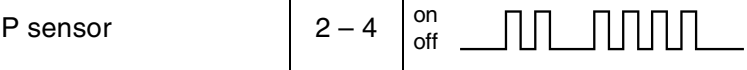
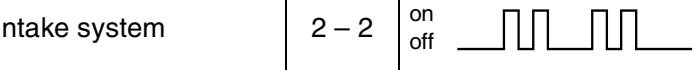
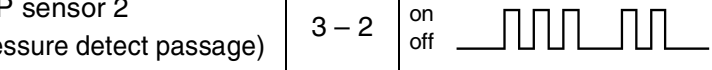
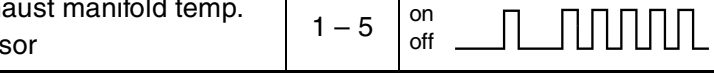
Max. continuous time of use		Sec.	30
Motor output		kW	1.4
Brush length	STD	mm (in.)	16.0 (0.63)
	Limit	mm (in.)	12.0 (0.47)
Commutator undercut	STD	mm (in.)	0.5 – 0.8 (0.02 – 0.03)
	Limit	mm (in.)	0.2 (0.01)
Commutator outside diameter	STD	mm (in.)	29.0 (1.14)
	Limit	mm (in.)	28.0 (1.10)
Commutator outside 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		YES
2	IAC valve/By-pass air screw adjustment	3 – 1		NO
3	Cylinder temp. sensor	1 – 4		YES
4	IAT sensor	2 – 3		YES
5	CKP sensor	4 – 2		NO
6	CMP sensor	2 – 4		YES
7	Air intake system	2 – 2		YES
8	MAP sensor 2 (Pressure detect passage)	3 – 2		NO
9	Exhaust manifold temp. sensor	1 – 5		YES

PRIORITY *	FAILED ITEM	CODE	LAMP FLASHING PATTERN	FAIL-SAFE SYSTEM ACTIVATING
10	Fuel injector	4 – 3		NO
11	Throttle position sensor	2 – 1		YES
12	Shift position sensor	1 – 2		YES
13	CMP sensor (VVT)	2 – 6		YES
14	VVT advance	5 – 2		YES
15	Neutral switch	3 – 3		NO
16	Model discrimination	4 – 1		YES
17	Oil control valve	6 – 2		NO
18	Rectifier & regulator (Over-charging)	1 – 1		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

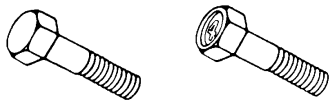
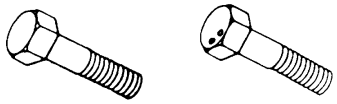
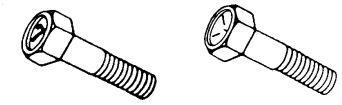
ITEM		THREAD DIAMETER	TIGHTENING TORQUE		
			N·m	kg-m	lb-ft
Cylinder head cover bolt		6 mm	11	1.1	8.0
Cylinder head bolt		8 mm	23	2.3	16.6
		12 mm	86	8.6	62.0
Crankcase bolt	Outside	10 mm	37	3.7	26.8
	Inside	11 mm	58	5.8	41.9
Crankshaft drive gear bolt		10 mm	48	4.8	34.7
Conrod cap bolt		9 mm	63	6.3	45.6
Camshaft housing bolt		6 mm	12	1.2	8.7
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		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	14 mm	35	3.5	25.5
	Lower	14 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 nut		14 mm	100	10.0	72.3
Upper mount cover bolt		10 mm	50	5.0	36.0
Lower mount bolt		14 mm	100	10.0	72.3
Clamp bracket shaft nut		7/8-14 UNF	43	4.3	31.0
Water pump case bolt		8 mm	17	1.7	12.3
Driveshaft oil seal housing		—	100	10.0	72.5

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	16 mm	145	14.5	105.0
Propeller nut	18 mm	55	5.5	40.0

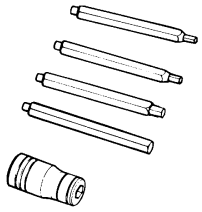
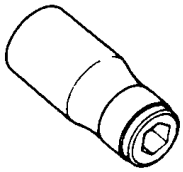
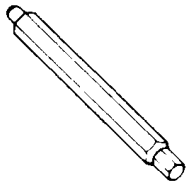
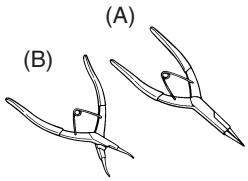
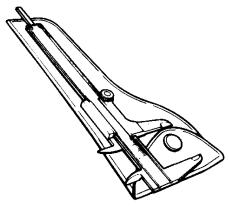
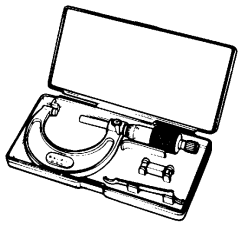
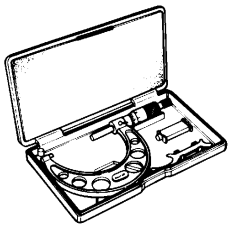
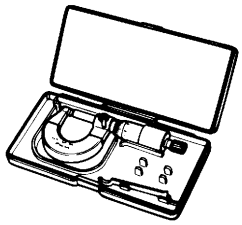
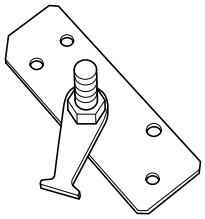
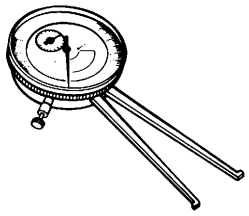
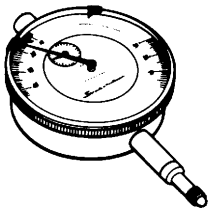
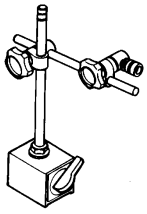
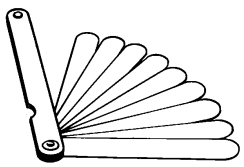
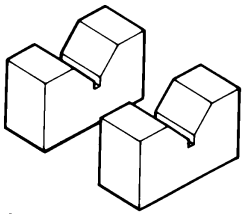
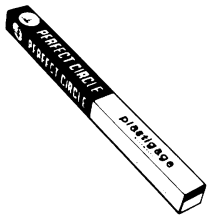
Tightening torque – General bolt

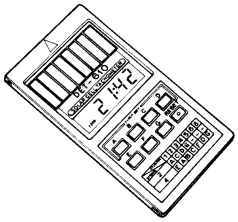
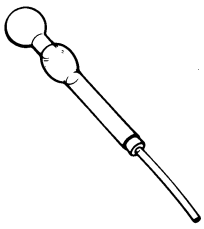
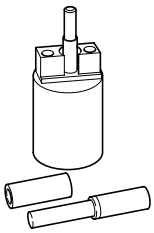
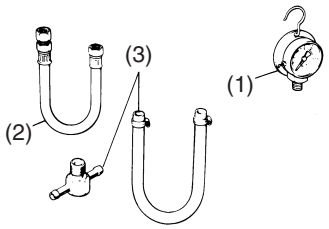
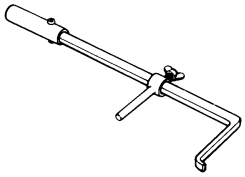
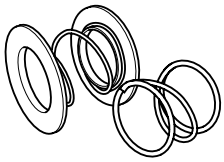
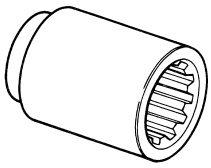
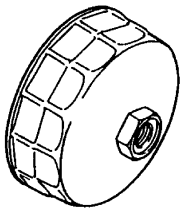
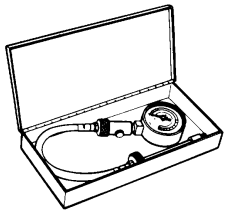
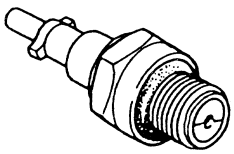
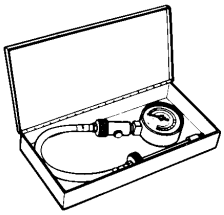
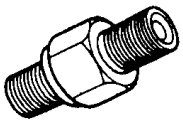
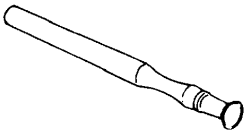
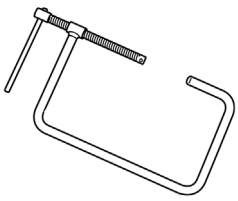
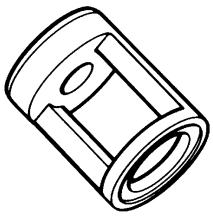
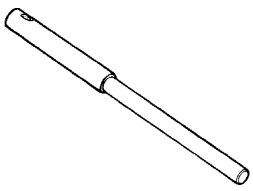
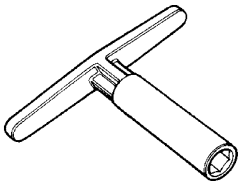
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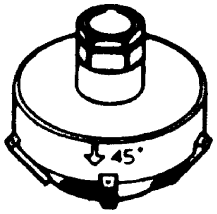
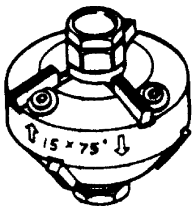
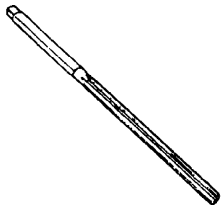
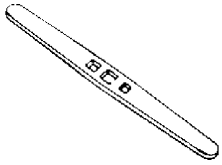
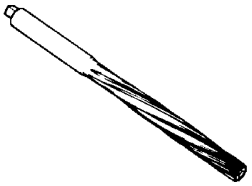
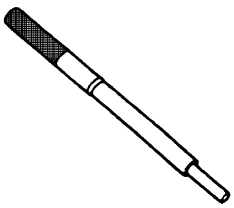
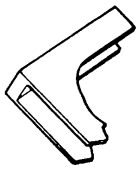
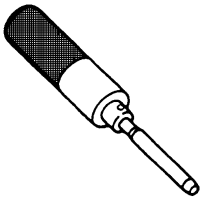
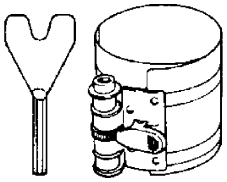
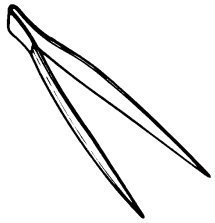
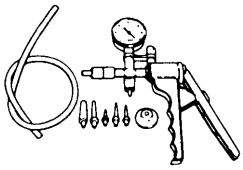
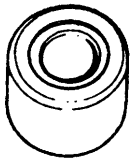
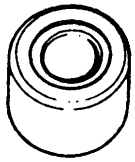
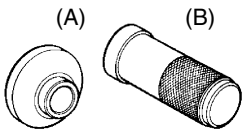
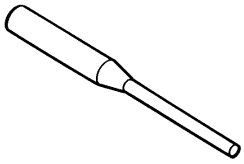
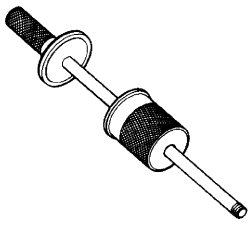
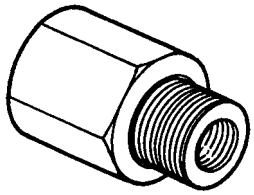
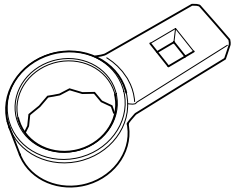
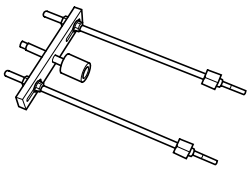
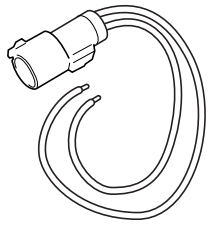
These value are only applicable when torque for a general bolt is not listed in the "Important Fasteners" table.

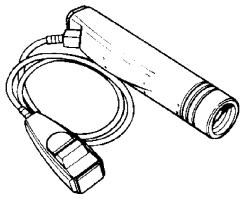
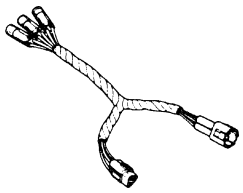
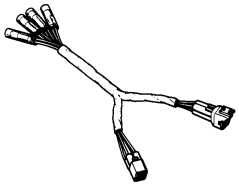
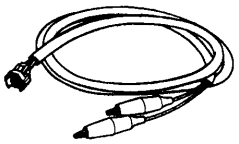
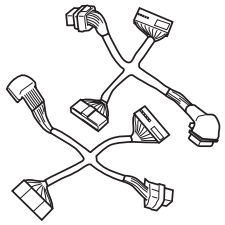
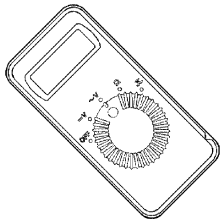
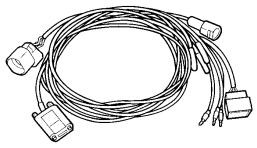
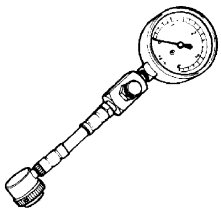
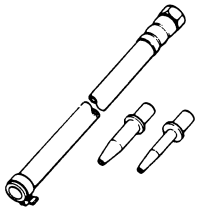
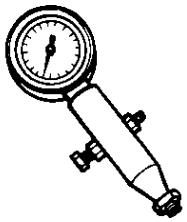
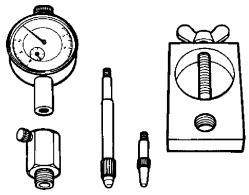
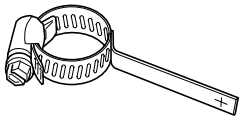
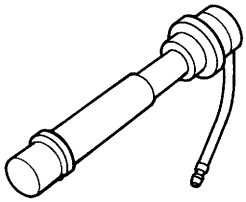
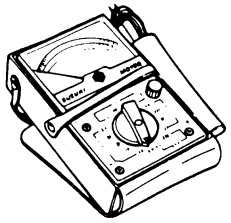
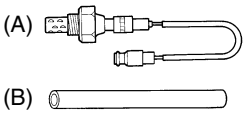
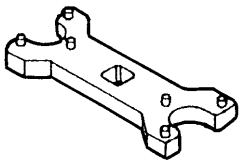
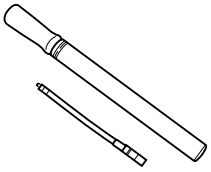
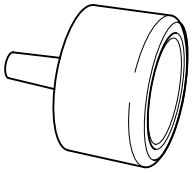
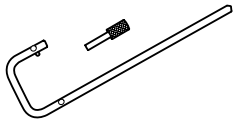
TYPE OF BOLT	THREAD DIAMETER	TIGHTENING TORQUE		
		N·m	kg-m	lb-ft
 **(Conventional or "4" marked bolt)**	5 mm	2 – 4	0.2 – 0.4	1.5 – 3.0
	6 mm	4 – 7	0.4 – 0.7	3.0 – 5.0
	8 mm	10 – 16	1.0 – 1.6	7.0 – 11.5
	10 mm	22 – 35	2.3 – 3.5	16.0 – 25.5
 **(Stainless steel bolt)**	5 mm	2 – 4	0.2 – 0.4	1.5 – 3.0
	6 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

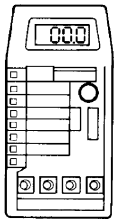
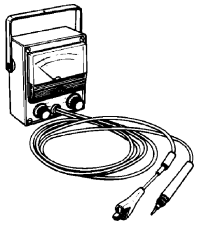
SPECIAL TOOLS

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.**  **09916-99311** **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.**  **09910-39610** **Piston pin remover and installer**	**19.**  **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**	
20.  **09913-50121** **Oil seal remover**	**21.**  **09951-09310** **Gear adjust spring set**	**22.**  **09921-29410** **Driveshaft holder**	**23.**  **09915-47341** **Oil filter wrench**	**24.**  **09915-64512** **Compression gauge**
25.  **09915-67010** **Compression gauge hose attachment**	**26.**  **09915-64530** **Compression gauge hose**	**27.**  **09915-77311** **Oil pressure gauge**	**28.**  **09915-78211** **Oil pressure gauge adapter**	**29.**  **09916-10911** **Valve lapper**
30.  **09916-19030** **Valve lifter**	**31.**  **09916-14521** **Valve lifter attachment**	**32.**  **09916-24450** **Solid pilot (N-100-5.52)** **Solid pilot Neway N-150-5.5**	**33.**  **09916-54910** **Handle (N-505)**	**34.**  **09916-22420** **Valve seat cutter (60°) (N-114)**

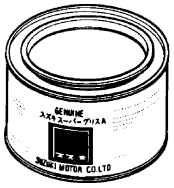
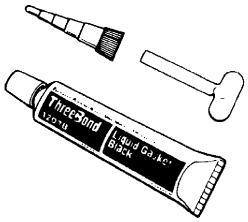
35.  **Valve seat cutter (45°) (Neway 128)**	**36.**  **Valve seat cutter (15°) (Neway 212)**	**37.**  **09916-34550** **Valve guide reamer (ϕ 5.5 mm)**	**38.**  **09916-34542** **Valve guide reamer handle**	**39.**  **09916-37320** **Valve guide reamer (ϕ 10.5 mm)**
40.  **09916-44310** **Valve guide remover**	**41.**  **09916-69310** **Tappet holder**	**42.**  **09916-57330** **Valve guide installer**	**43.**  **09916-77310** **Piston ring compressor**	**44.**  **09916-84511** **Tweezers**
45.  **09917-47011** **Vacuum pump gauge**	**46.**  **09916-56011** **Valve guide installer attachment**	**47.**  **09917-98221** **Valve guide stem seal installer attachment**	**48.**  **(A) 09922-59410** **Propeller shaft housing installer** **(B) 09922-59420** **Housing installer handle**	**49.**  **09922-89810** **Shift lock pin remover**
50.  **09930-30104** **Sliding hammer**	**51.**  **09930-30161** **Propeller shaft remover**	**52.**  **09926-29310** **Driveshaft housing remover**	**53.**  **09951-99310** **Gear holder**	**54.**  **09945-79310** **PTT cable extension**

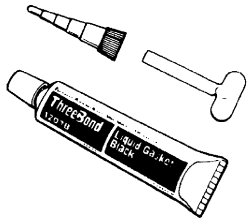
55.  **09930-76420** **Timing light**	**56.**  **09930-89220** **3-pin connector test cord**	**57.**  **09930-89240** **4-pin connector test cord**	**58.**  **09930-89260** **Injector test cord A**	**59.**  **09930-89340** **26-pin & 34-pin test cord**
60.  **09930-99320** **Digital tester**	**61.**  **09932-79910** **Diagnostic harness** **09932-89910** **SDS adapter**	**62.**  **09940-44121** **Air pressure gauge**	**63.**  **09940-44130** **Attachment**	**64.**  **09950-69512** **Gearcase oil leakage tester**
65.  **09951-09511** **Gear adjusting gauge**	**66.**  **09952-09310** **Back lash indicator tool**	**67.**  **09930-89350** **H·T cord adapter**	**68.**  **09900-25002** **Pocket tester**	**69.**  **(A) 18213-74F00** **O2 sensor** **(B) 18498-99E70** **Protector**
70.  **09944-09420** **PTT cylinder cap tool**	**71.**  **09952-99310** **Hand air pump**	**72.**  **09917-49610** **Vacuum pump adapter**	**73.**  **09917-29610** **Scissors gear alignment tool set**	

74.	75.	76.
		
99954-53008-820* Digital voltmeter	99954-53873* Stevens CD-77 Peak reading volt-meter	99954-53883* Gear oil filler

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

MATERIALS REQUIRED

SUZUKI OUTBOARD MOTOR GEAR OIL	SUZUKI SUPER GREASE "A"	WATER RESISTANT GREASE	SUZUKI SILICONE SEAL	SUZUKI BOND "1104"
				
99000-22540 (400 ml × 24 pcs)	99000-25030* 99000-25010 (500 g)	99000-25160 (250 g)	99000-31120 (50 g)	99000-31030 (100 g)

SUZUKI BOND "1207B"	THREAD LOCK "1342"	THREAD LOCK SUPER "1333B"	4-Stroke Motor Oil
			
99104-33140* 99000-31140 (100 g)	99000-32050 (50 g)	99000-32020 (50 g)	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 fuel hose every 2 years.			
Breather hose	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.			
High pressure fuel filter	Replace every 1 000 hours.			
Ignition timing	—	—	—	I
Idle speed	I	—	—	I
Tappet clearance	—	—	—	I
Water pump	—	—	—	I
Water pump impeller	—	—	—	R
Propeller nut & pin	I	—	I	I
Balancer chain	Replace every 1 600 hours.			
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 3-44 for function and operation.*
- *See page 2-5 for reset information.*

MAINTENANCE AND TUNE-UP PROCEDURES

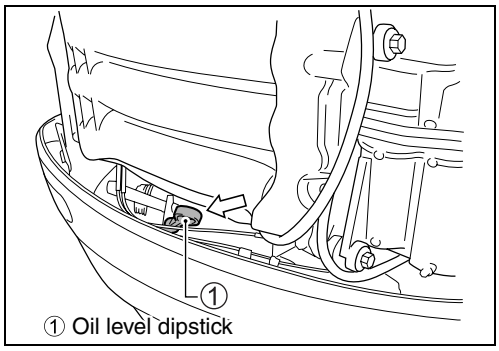
This section describes servicing procedures for each periodic maintenance requirement.

ENGINE OIL/ENGINE OIL FILTER

ENGINE OIL LEVEL CHECK

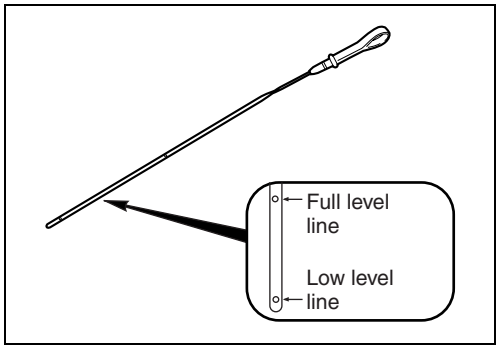
Inspect oil level before every use.

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.



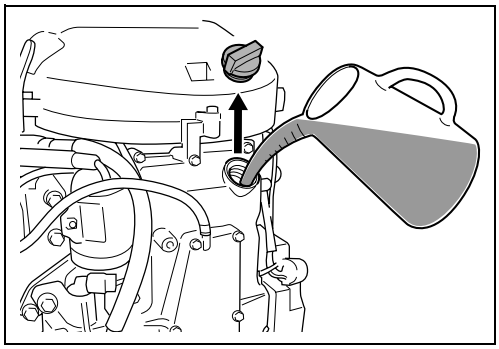
5. Oil level should be between full level Max. mark (hole) and low level Min. mark (hole).

   If level is low, add recommended oil to full level Max. mark.



Recommended oil:

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



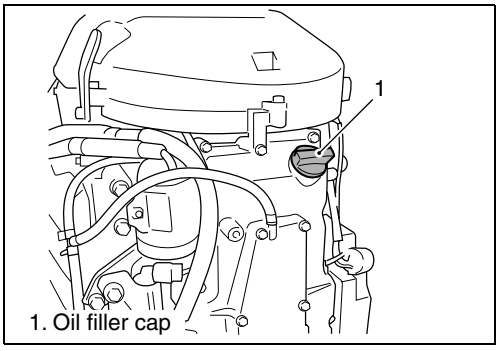
ENGINE OIL CHANGE/ENGINE OIL FILTER REPLACEMENT

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

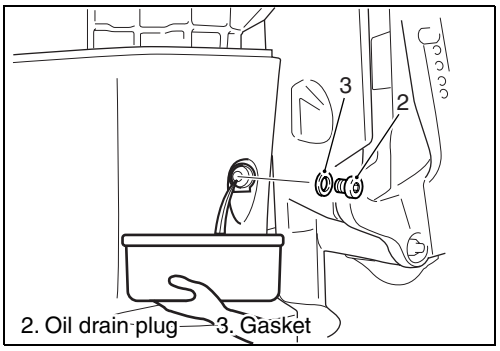
ENGINE OIL FILTER
Replace initially after 20 hours (1 month) and every 200 hours (12 months).

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

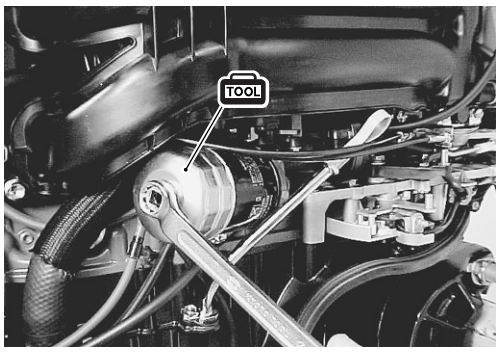


2. Oil drain plug 3. Gasket

5. ENGINE OIL FILTER REPLACEMENT

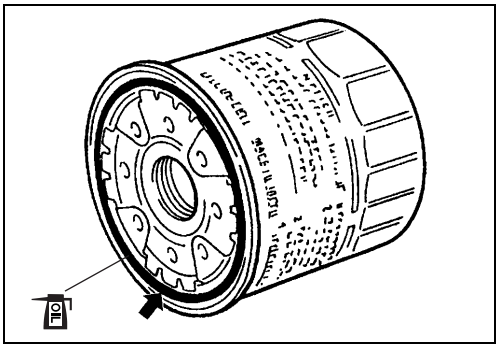
NOTE:
For engine oil change only, go to step 6.

To replace engine oil filter:
(1) Remove STBD side cover. (See page 7-2.)
(2) Using oil filter wrench to loosen the oil filter, then remove filter and O-ring.



TOOL 09915-47341: Oil filter wrench

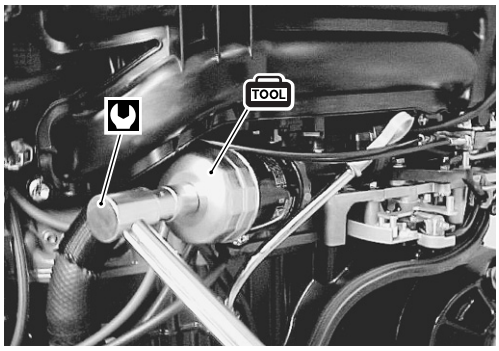
NOTE:
Before fitting new oil filter, be sure to oil O-ring.



(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

(5) Install STBD side cover.

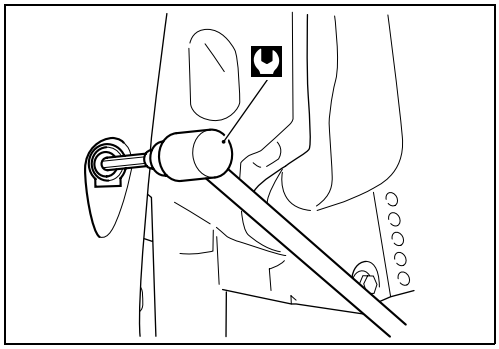


6. Install new gasket and oil drain plug.
Tighten engine oil drain plug to specified torque.

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

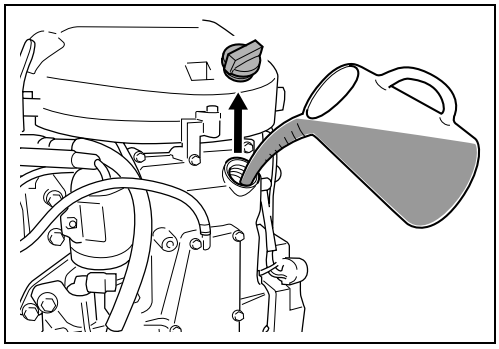
CAUTION

To avoid water entry into oil pan or oil leakage into the environment do not reuse gasket once removed. Always use a new gasket.

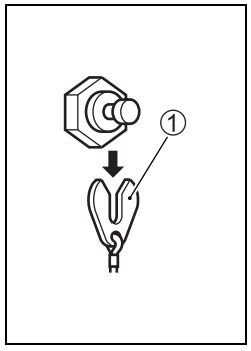


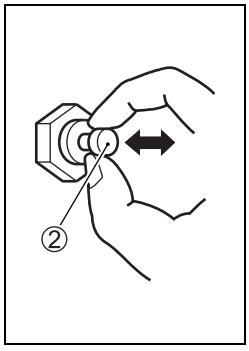
7. Pour recommended engine oil into oil filler opening, then install oil filler cap.

Engine oil amounts
Oil change only: 8.0 L (8.5/7.0 US/Imp. qt)
Oil filter change: 8.5 L (9.0/7.5 US/Imp. qt)



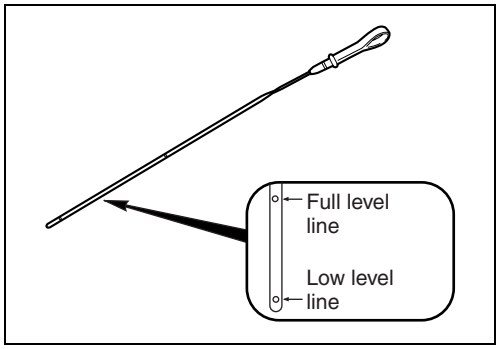
8. To reset oil change reminder system's operation time to zero (cancellation);
(1) Turn ignition key to "ON" position.
(2) Pull out emergency stop switch plate ①.
(3) Pull up emergency stop switch knob ② three times in ten seconds. A short beep will be heard if cancellation is successfully finished.
(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 3-44.

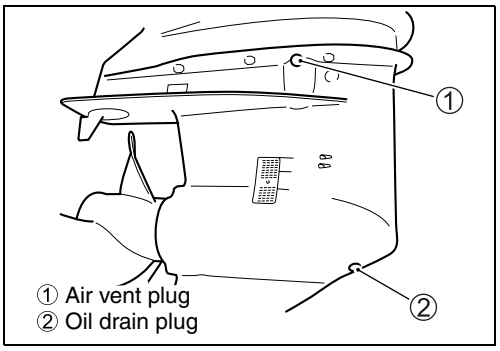
9. Start engine and allow it to run for several minutes at idle speed.
Check oil filter for oil leakage.
Turn off engine and wait for approx. two minutes, then recheck engine oil level.



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 air vent plug and drain gear oil.

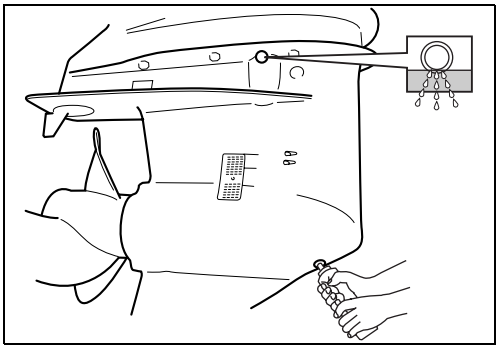


① Air vent plug
② Oil drain plug

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

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

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



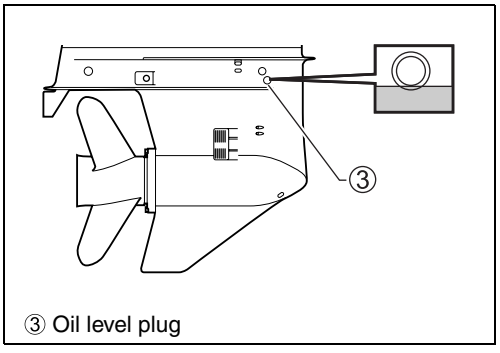
5. Install air vent plug before removing oil filler tube from drain hole.
6. Install oil drain plug.

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.

7. To check the gear oil level:
   (a) Remove the oil level plug.
   (b) If oil can be seen at oil level plug level, the unit is full.
   (c) If oil level is low, re-fill with gear oil through oil level hole.
   (d) Install oil level plug.



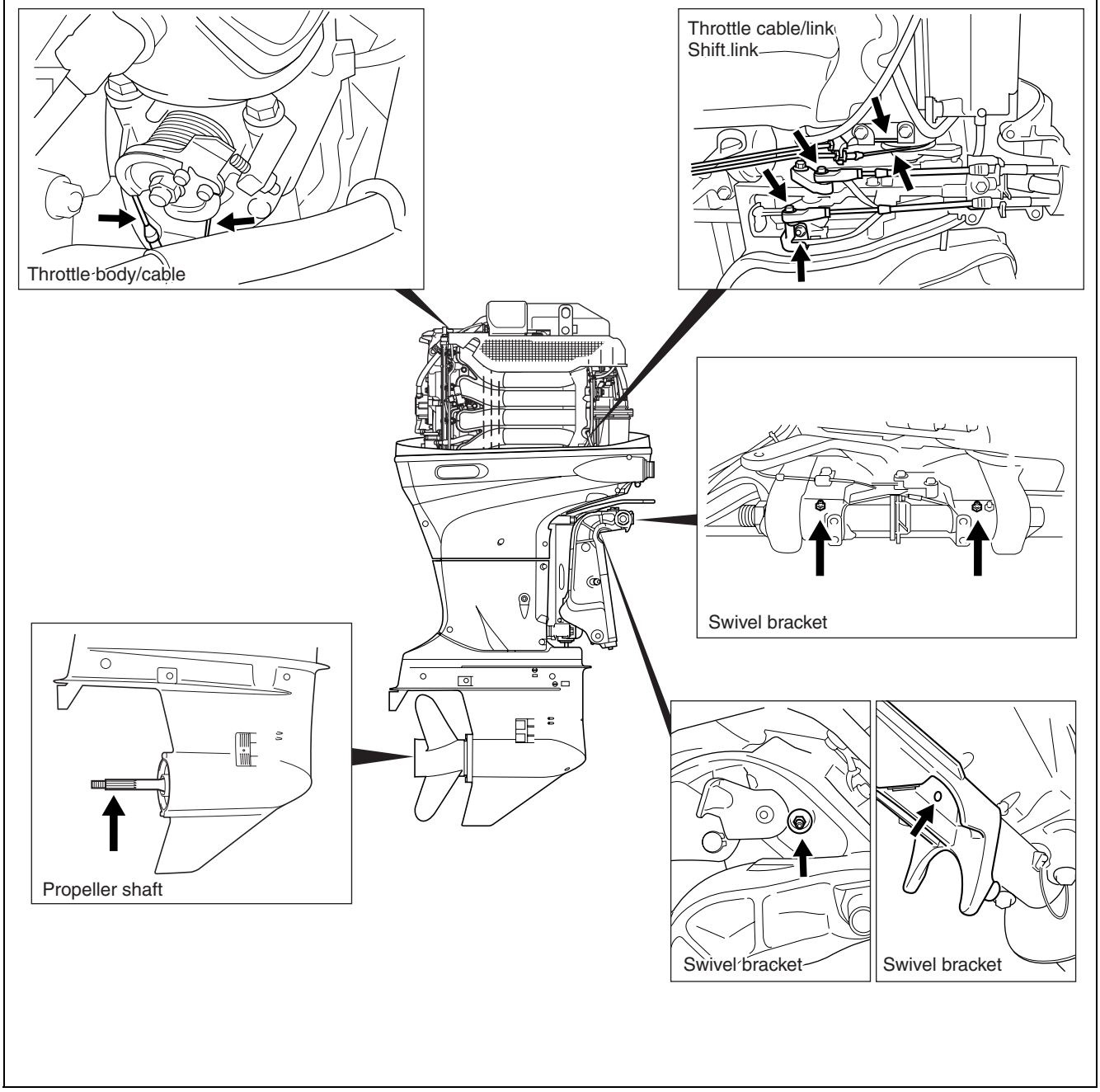
③ Oil level plug

LUBRICATION

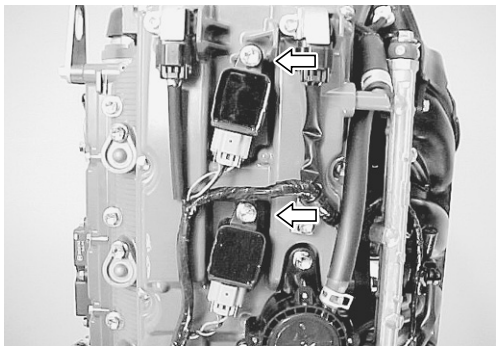
Inspect every 50 hours (3 months).

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

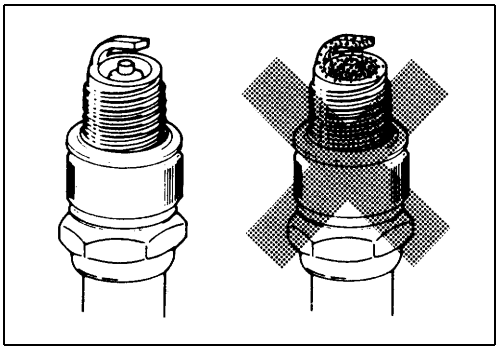
Only resistor (R) type spark plugs must be used with this engine. Using a non-resistor spark plug will cause ignition and fuel injection system malfunctions.

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.

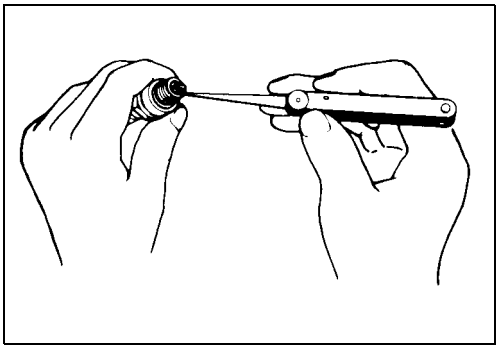


SPARK PLUG GAP

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

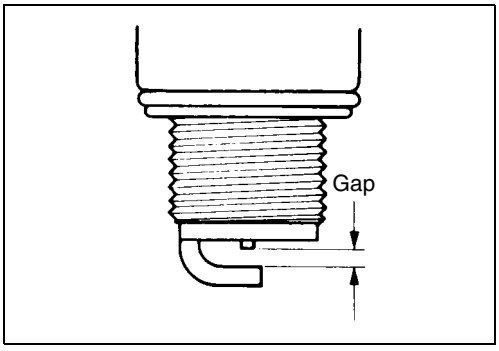
Spark plug gap: 0.7 – 0.8 mm (0.028 – 0.031 in)

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.



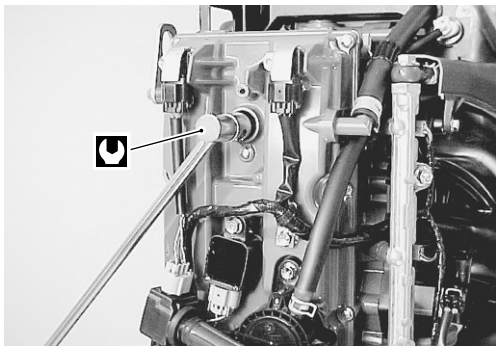
CAUTION

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

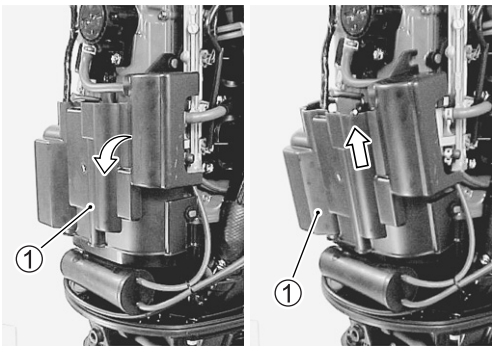
Inspect every 200 hours (12 months).

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:

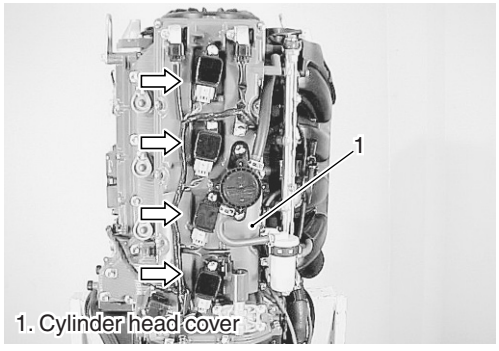
- during scheduled periodic inspection.
- when valve mechanism is serviced.
- when camshafts are disturbed by removing them for inspection.

CHECKING AND ADJUSTING TAPPET CLEARANCE

1. To remove the cover ①, pull the upper part outward, then lift up.

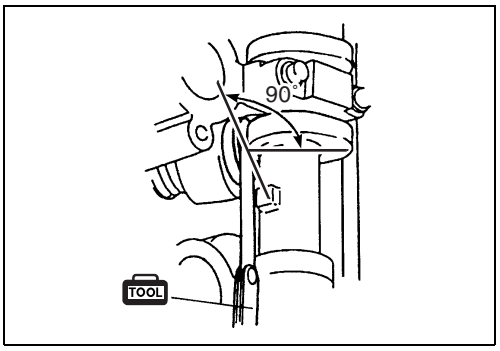


2. Remove following parts:
   - Engine side lower cover (See page 7-2.)
   - Ring gear cover and air intake silencer case (See page 6-2.)
   - Ignition coils
   - Spark plugs
3. Remove the cylinder head cover. (See page 6-11.)



4. Rotate crankshaft counterclockwise to bring cam nose vertical to shim surface.
5. 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 a left hand (LH) rotation powerhead.
Rotate crankshaft counterclockwise to prevent water pump impeller damage.

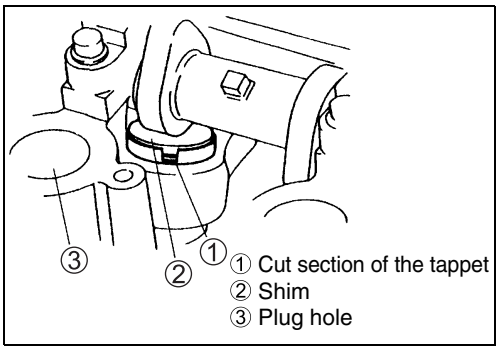
NOTE:
- *Rotate crankshaft and measure clearance for each tappet respectively by bringing cam nose vertical to shim surface.*
- *All tappet clearances can be measured during two crankshaft rotations.*

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

ADJUSTMENT

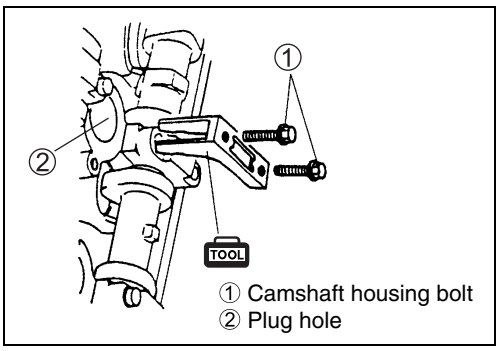
Tappet clearances are adjusted by replacing tappet shim.

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

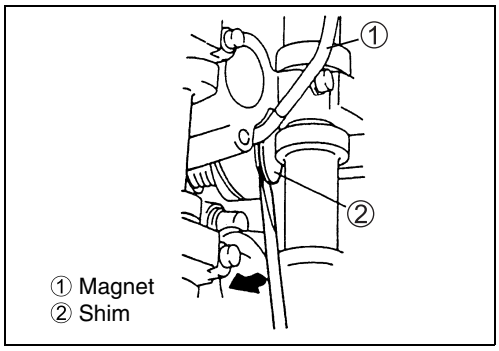


2. Rotate crankshaft to open (lift up) valve and then remove camshaft housing bolts where shim is to be replaced.
3. Install special tool with camshaft housing bolts as shown in figure.

TOOL 09916-69310: Tappet holder



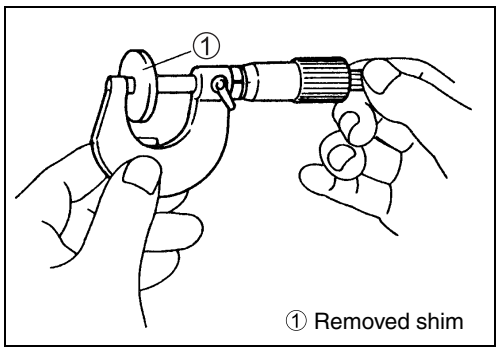
4. Rotate top of cam 90 degree counterclockwise and remove shim from cut-away at tappet.
   (Two tappets can be adjusted at the same time.)



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.

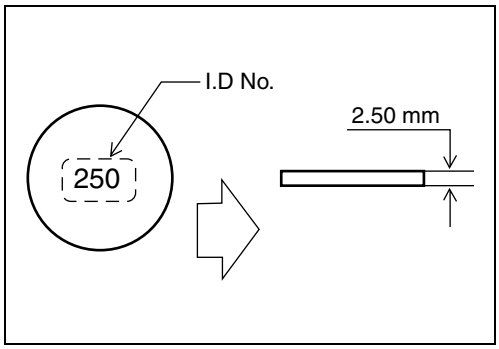


TOOL 09900-20205: Micrometer

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

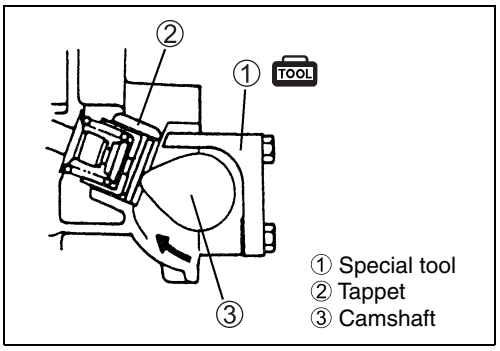
A: Correct thickness of shim for proper tappet clearance (mm)
B: Thickness of original shim (mm)
C: Original tappet clearance (mm)

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		



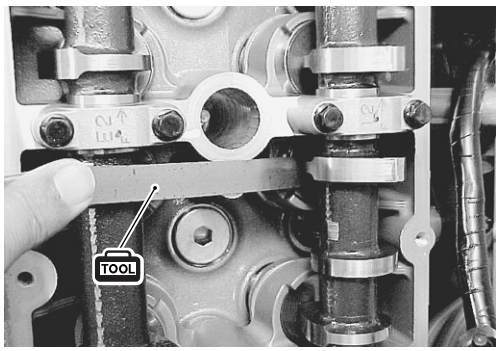
6. Install shim. Identification number should face down (towards tappet).
7. Rotate crankshaft to be open (lift up) valve.
8. Remove tappet holder ① and tighten camshaft housing bolts to specified torque.

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

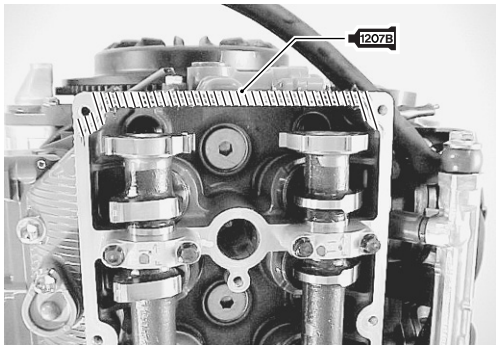


9. Recheck tappet clearance.

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

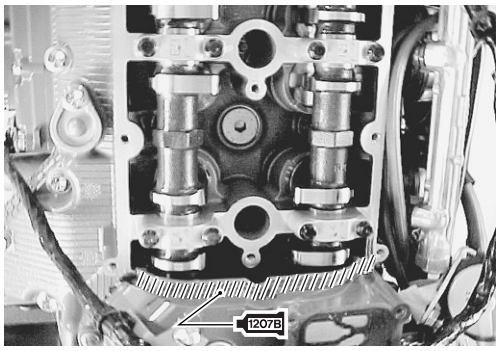


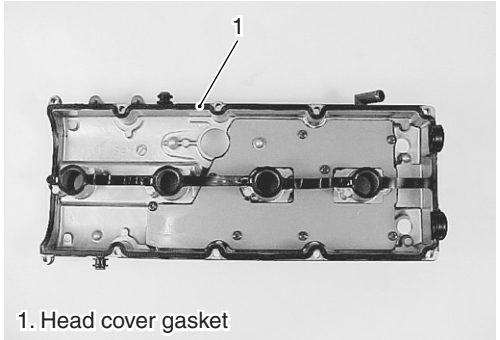
REASSEMBLY
After checking and adjusting all valves, reinstall parts removed earlier.
Installation is reverse order of removal.



Cylinder head cover
Install the cylinder head cover. (See page 6-13.)

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

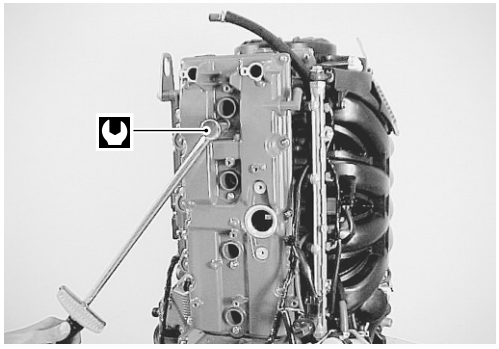




1. Head cover gasket

- 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)

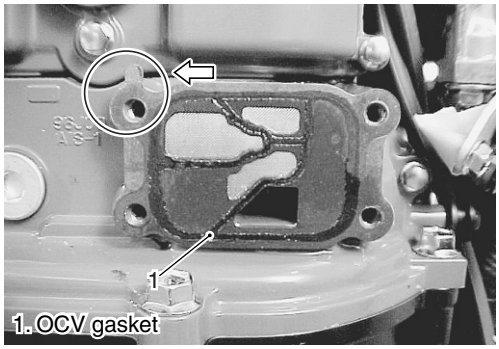
- Install gasket and OCV, and then tighten bolts securely.

NOTE:

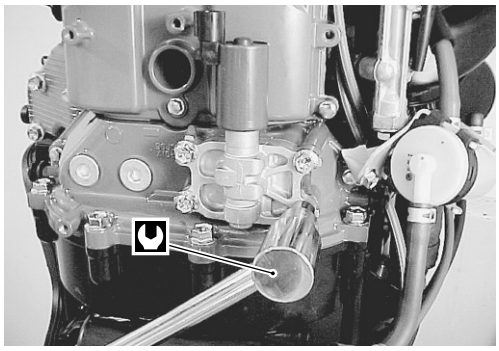
Position the OCV gasket tab as shown the right.

CAUTION

Do not reuse OCV gasket. Always replace with new one.



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



FINAL ASSEMBLY CHECK

- All parts removed have been returned to their original positions.
- Check hose and wire routing. (See page 11-4 to 11-17.)
- Check oil leakage.

TAPPET SHIM SELECTION CHART [IN. side]

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

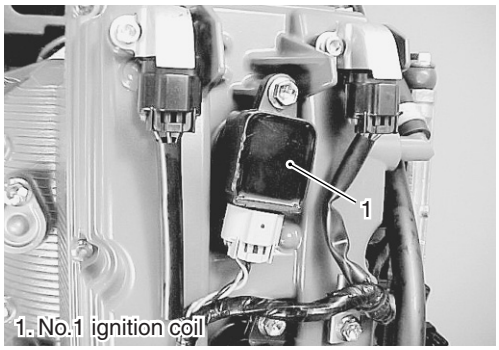
Shim ID No. / Present shim size (mm) / Tappet clearance (mm)	218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300
	2.18	2.20	2.23	2.25	2.28	2.30	2.33	2.35	2.38	2.40	2.43	2.45	2.48	2.50	2.53	2.55	2.58	2.60	2.63	2.65	2.68	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													218	220	223	225	228	230	233	235	238	240	243	245	248	250	253	255	258	260	263	265	268	270
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	275
0.10 – 0.14									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
0.15 – 0.19							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
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	290
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	295
0.30 – 0.34	SPECIFIED CLEARANCE / NO. ADJUSTMENT REQUIRED																																	
0.35 – 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	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	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	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	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	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	253	255	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300														
0.70 – 0.74	258	260	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300																
0.75 – 0.79	263	265	268	270	273	275	278	280	283	285	288	290	293	295	298	300																		
0.80 – 0.84	268	270	273	275	278	280	283	285	288	290	293	295	298	300																				
0.85 – 0.89	273	275	278	280	283	285	288	290	293	295	298	300																						
0.90 – 0.94	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 — 2.50 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.

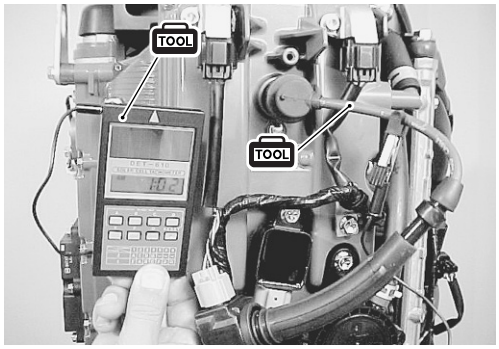
TOOL 09930-89350: H·T cord with plug cap adapter

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.

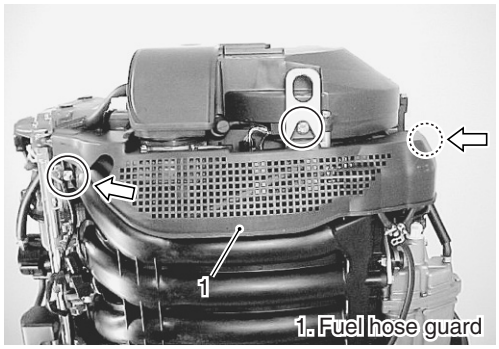
   Idle speed (in neutral gear): 600 – 700 r/min.



ADJUSTMENT:

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

6. Remove the three (3) bolts and fuel hose guard.
7. Shift into Neutral and close the throttle fully (this will cause a full close throttle signal to be input to the ECM).
8. To set the IAC valve duty to constant 10%, turn the ignition key from ON to START five times within ten seconds.
   At this time, the 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 10% duty, the caution buzzer will sound in a repeating pattern of 0.5 second on with an interval of 3 seconds off.*
- *The 10% fixed mode of IAC valve duty will continue for 5 minutes after which it will automatically cancel.*

9. 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.

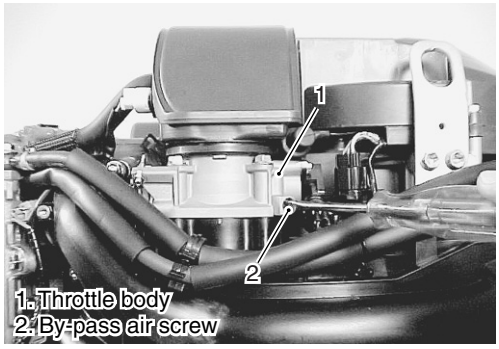
10. When finished adjusting the idle speed, opening the throttle will automatically cancel the IAC fixed mode.

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

11. 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 3-26.

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 specification.

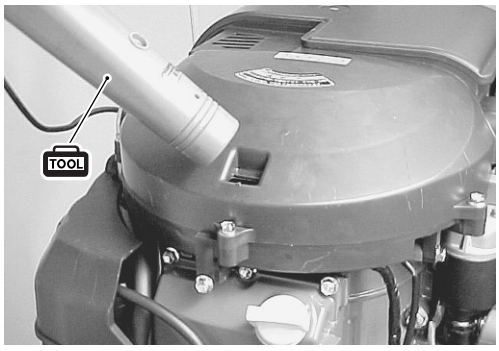
1. Start the engine and allow to warm up.
2. Attach the timing light cord to the No. 1 ignition coil primary wire.

TOOL 09930-76420: Timing light

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

   Ignition timing: Approx. BTDC 10° at 1 000 r/min.

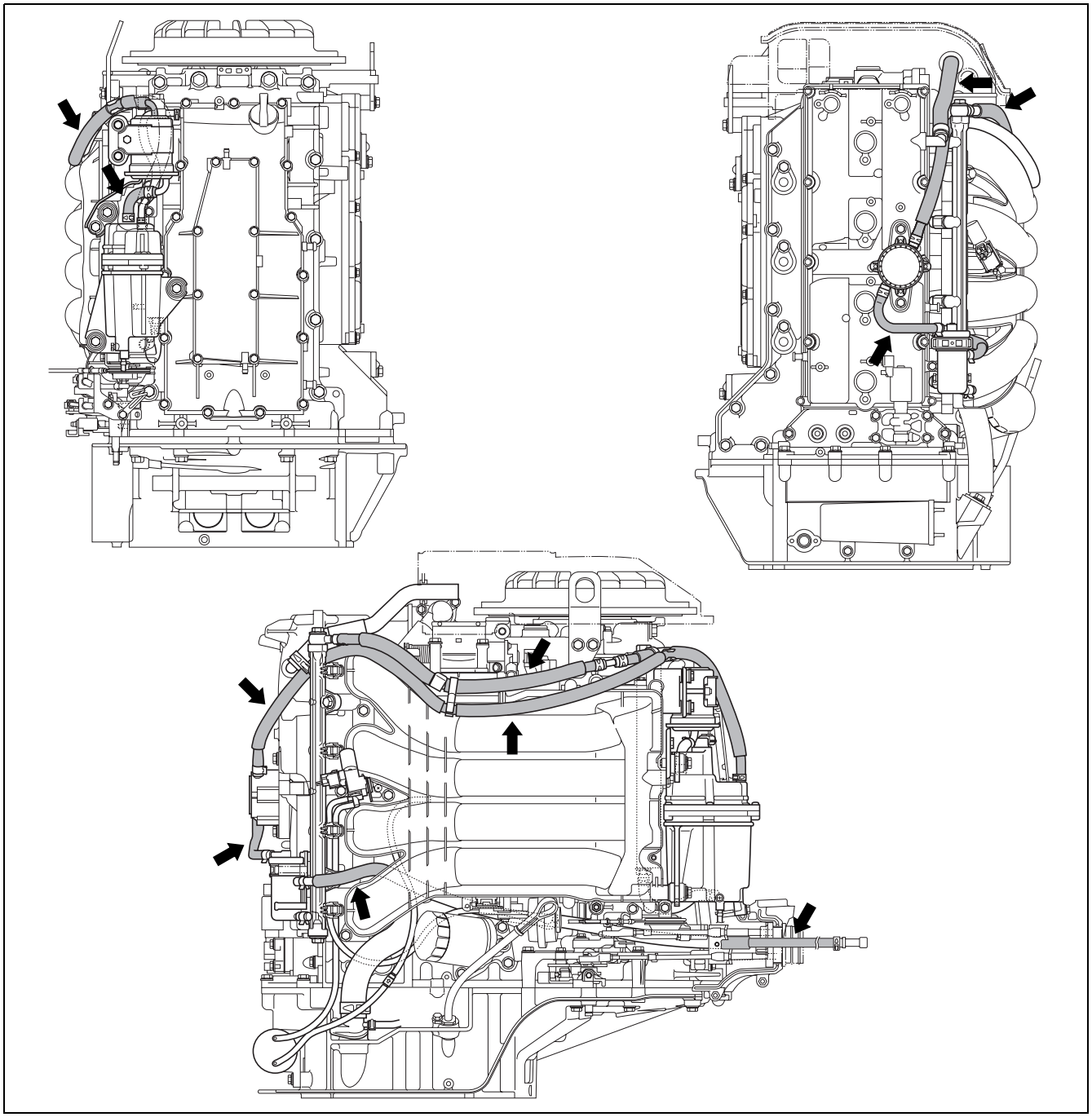




BREATHER AND FUEL LINE

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

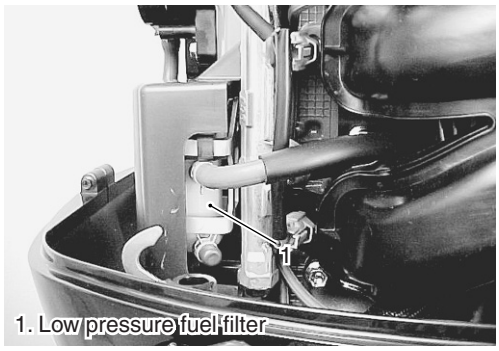
If leakage, cracks, swelling or other damage is found, replace the breather hose and/or fuel line.



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.



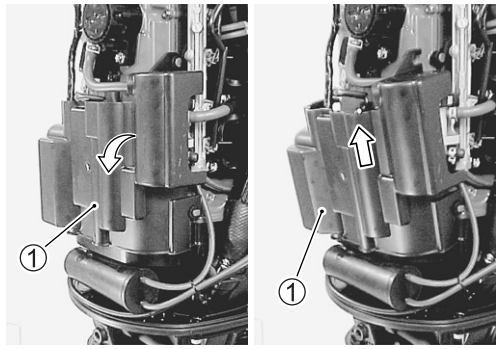
1. Low pressure fuel filter

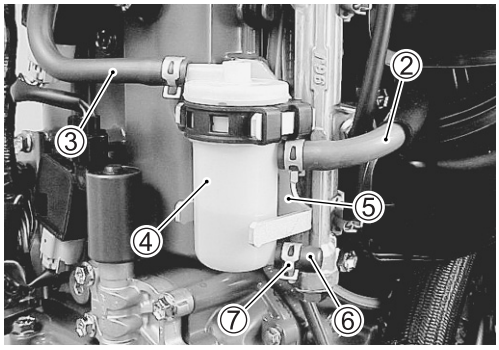
Inspect and Cleaning

⚠ 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. To remove the cover ①, pull the upper part outward, then lift up.
3. Disconnect the inlet hose ② and outlet hose ③ from fuel filter ④.
4. Remove the fuel filter from filter bracket ⑤.
5. Remove the cap ⑥, then drain and clean fuel filter.
6. Install the cap, then secure it with clamp ⑦.
7. Install fuel filter to filter bracket properly.
8. Connect the fuel inlet and outlet hose to fuel filter, then secure the fuel hoses to the fuel filter with the hose clamp.
9. Restart the engine and check that there are no leaks around the fuel filter.
10. Install the cover.

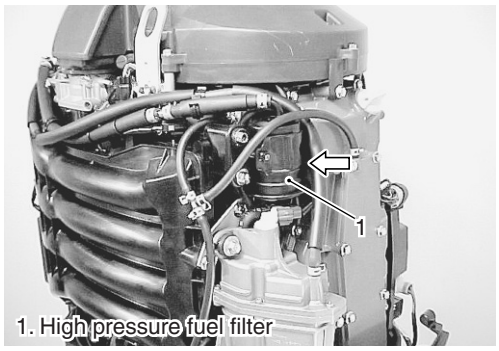




HIGH PRESSURE FUEL FILTER

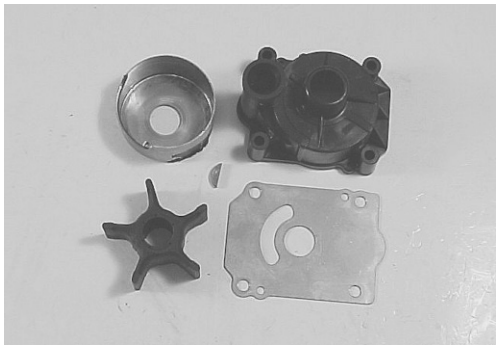
Replace every 1 000 hours.

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



1. High pressure fuel filter

WATER PUMP/WATER PUMP IMPELLER



WATER PUMP
Inspect every 200 hours (12 months).

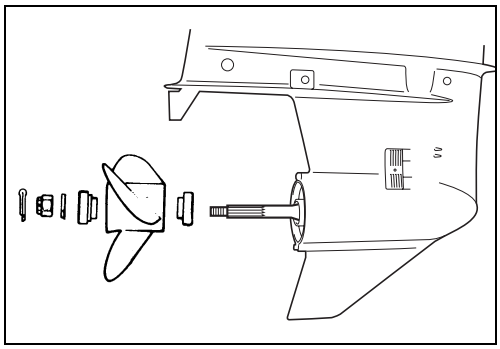
Inspect water pump case, inner sleeve and under panel.
Replace if wear, cracks, distortion or corrosion is found.

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

SUZUKI recommends that replacing the water pump impeller every 200 hours (12 months).
Inspect water pump impeller.
Replace if vanes are cut, torn or worn.

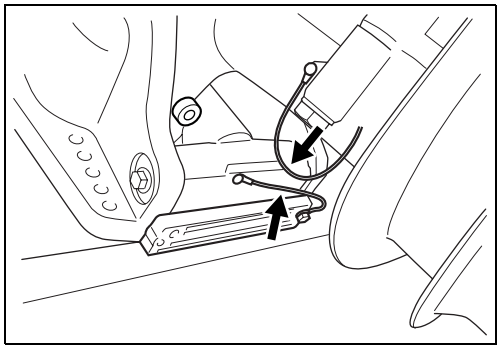
PROPELLER/NUT/COTTER PIN

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.

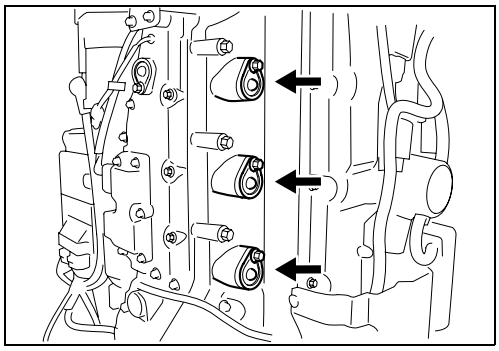
BONDING WIRES



Inspect every 50 hours (3 months).

- 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).

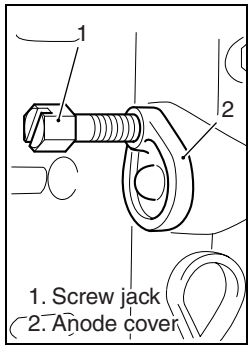
ANODES

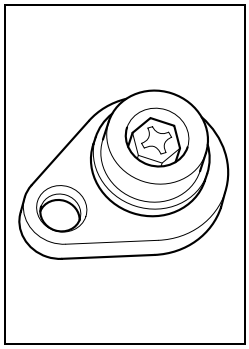
If 2/3 of zinc anode has corroded away, replace anode.

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 to function as a screw jack.





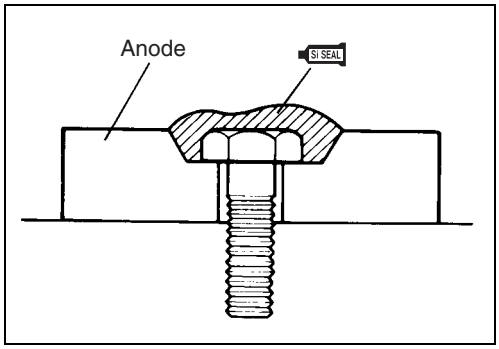
CAUTION

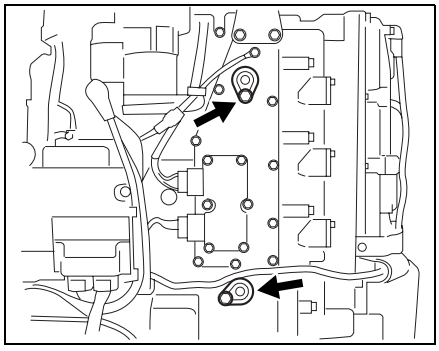
Never paint the anode.

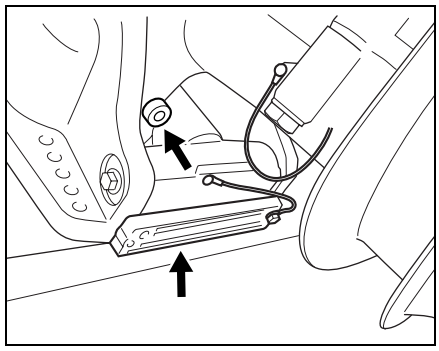
NOTE:

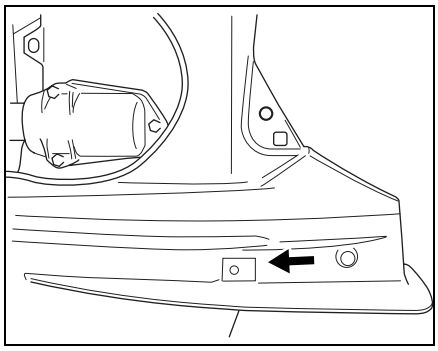
The anode securing bolt should be covered with SUZUKI SILICONE SEAL.

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.**

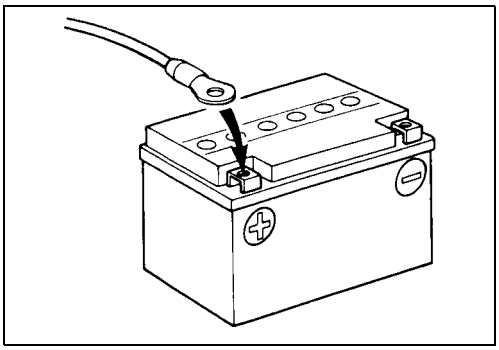
Recommended battery: 12 V 100 AH (360 kC) or larger

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.

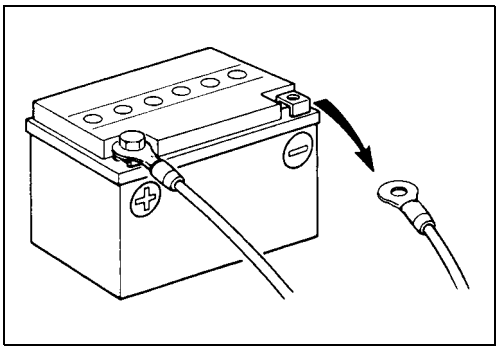


How to disconnect:

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.



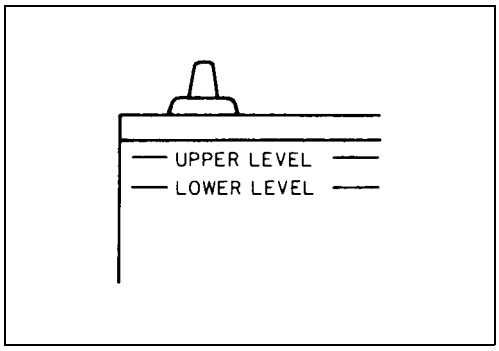
BATTERY SOLUTION LEVEL CHECK

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.

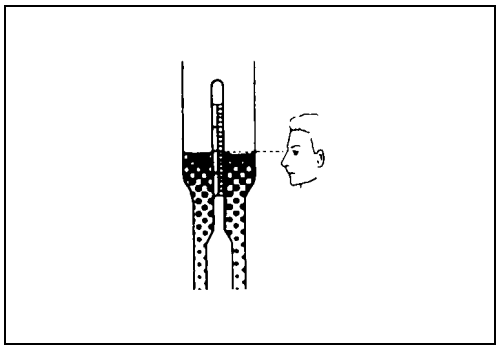


BATTERY SOLUTION GRAVITY CHECK

Measure the gravity of battery solution using a hydrometer.

Battery solution gravity: 1.28 at 20 °C

09900-28403: Hydrometer



BALANCER CHAIN

Replace every 1 600 hours.

SUZUKI recommends replacing the balancer chain, chain tensioner and chain guide every 1 600 hours.

For balancer chain replacement procedure, see the "POWER UNIT/TIMING CHAIN/BALANCER CHAIN" section on page 6-31 or 6-44.

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
Intake manifold bolt	8 mm	23	2.3	16.5
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	7/8-14 UNF	43	4.3	31.0
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 3-46 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.

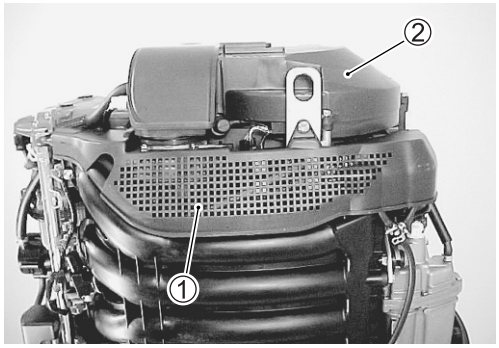
NOTE:
The figure shown above is a guideline only, not an absolute service limit.

If oil pressure is lower or higher than specification, the following causes may be considered.
(See page 6-108 for oil passage locations.)

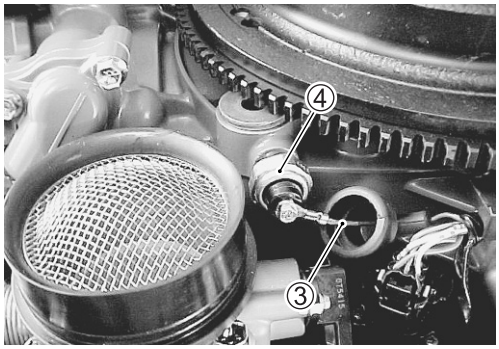
Low oil pressure
- Clogged oil filter
- Leakage from oil passages
- Defective oil pump
- Defective oil pressure regulator
- Damage O-ring
- Combination of above items

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. Remove the three (3) bolts and fuel hose guard ①.
3. Remove the ring gear cover and air intake silencer case ②. (See page 6-2.)

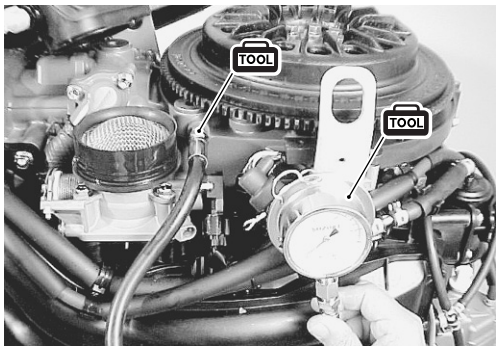


4. Loosen screw and disconnect blue lead wire ③ from oil pressure switch ④.
   Remove the oil pressure switch.



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

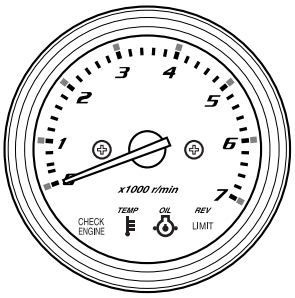
09915-77311: Oil pressure gauge
09915-78211: Oil pressure gauge adapter



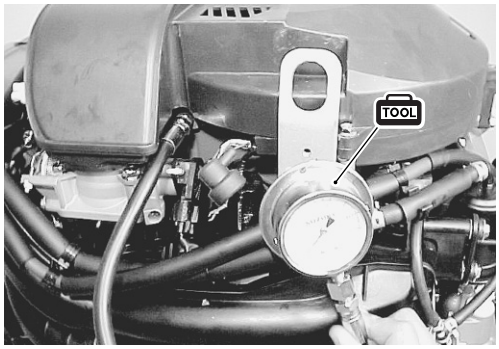
6. Install the ring gear cover and air intake silencer case.
7. Start engine and allow to warm up as follows:

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

8. After warming up, shift into forward gear and increase engine speed to 3 000 r/min., then compare pressure indicated on gauge to specifications.
9. After testing, reinstall oil pressure switch.
   (See page 3-70.)



Monitor-tachometer



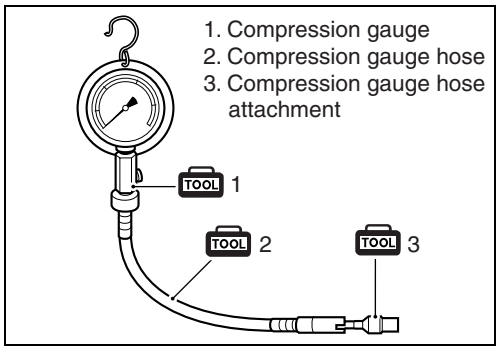
CYLINDER COMPRESSION

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

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

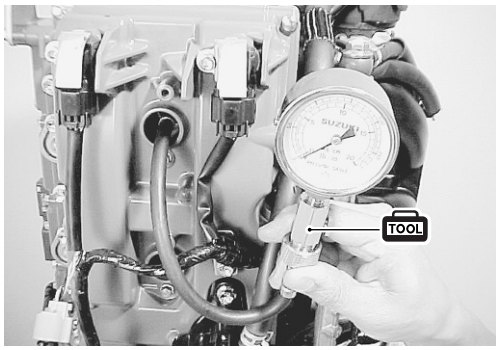
Low compression pressure can indicate one or more of following:

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



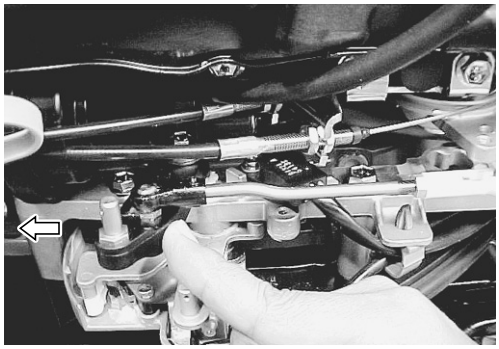
TEST PROCEDURE

1. Start engine and allow to warm up, then shut engine off.
2. Disconnect all fuel injector connectors at fuel injector.
3. Disconnect all ignition coil connectors.
4. Remove the bolts securing the ignition coil, then remove all ignition coils and spark plugs.
5. 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

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

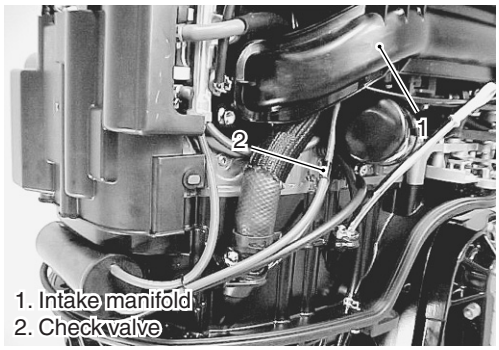


ENGINE VACUUM CHECK

Engine vacuum is required for proper operation of the Multi-Stage Induction system used on the DF150 & DF175. 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 check valve.
3. Connect special tools (vacuum gauge, hose and 3-way joint) between engine vacuum hose and check valve.

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

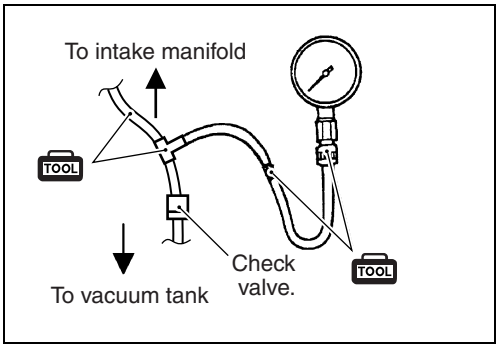


1. Intake manifold
2. Check valve

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

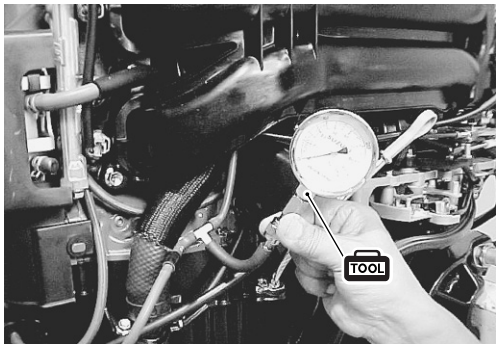
   Vacuum specification
   (idle speed at 759.8 mmHg, sea level)
   61 – 71 kPa (457 – 533 mmHg, 18 – 21 inHg)

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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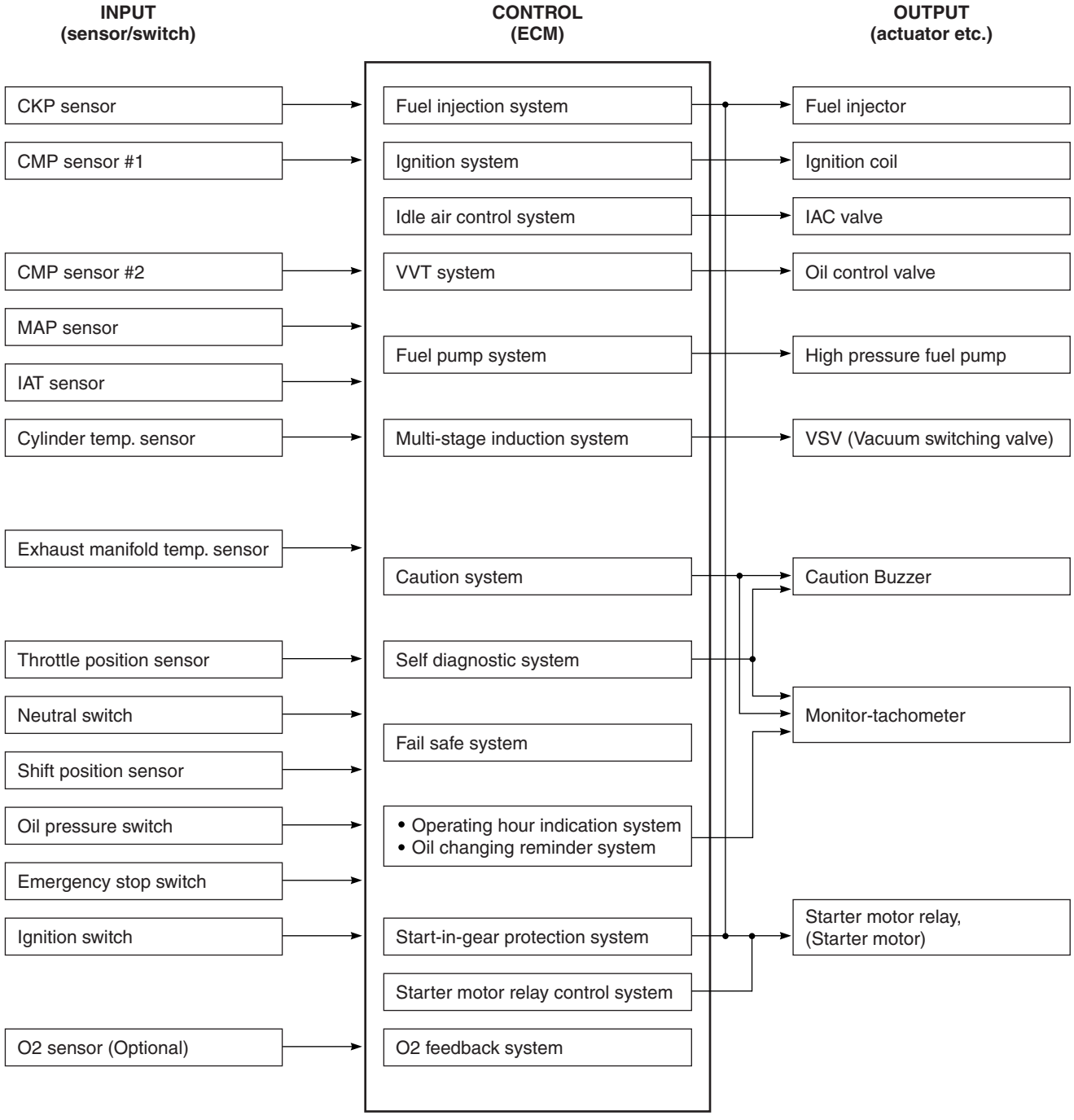
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ENGINE CONTROL SYSTEM STRUCTURE

The DF150/DF175 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

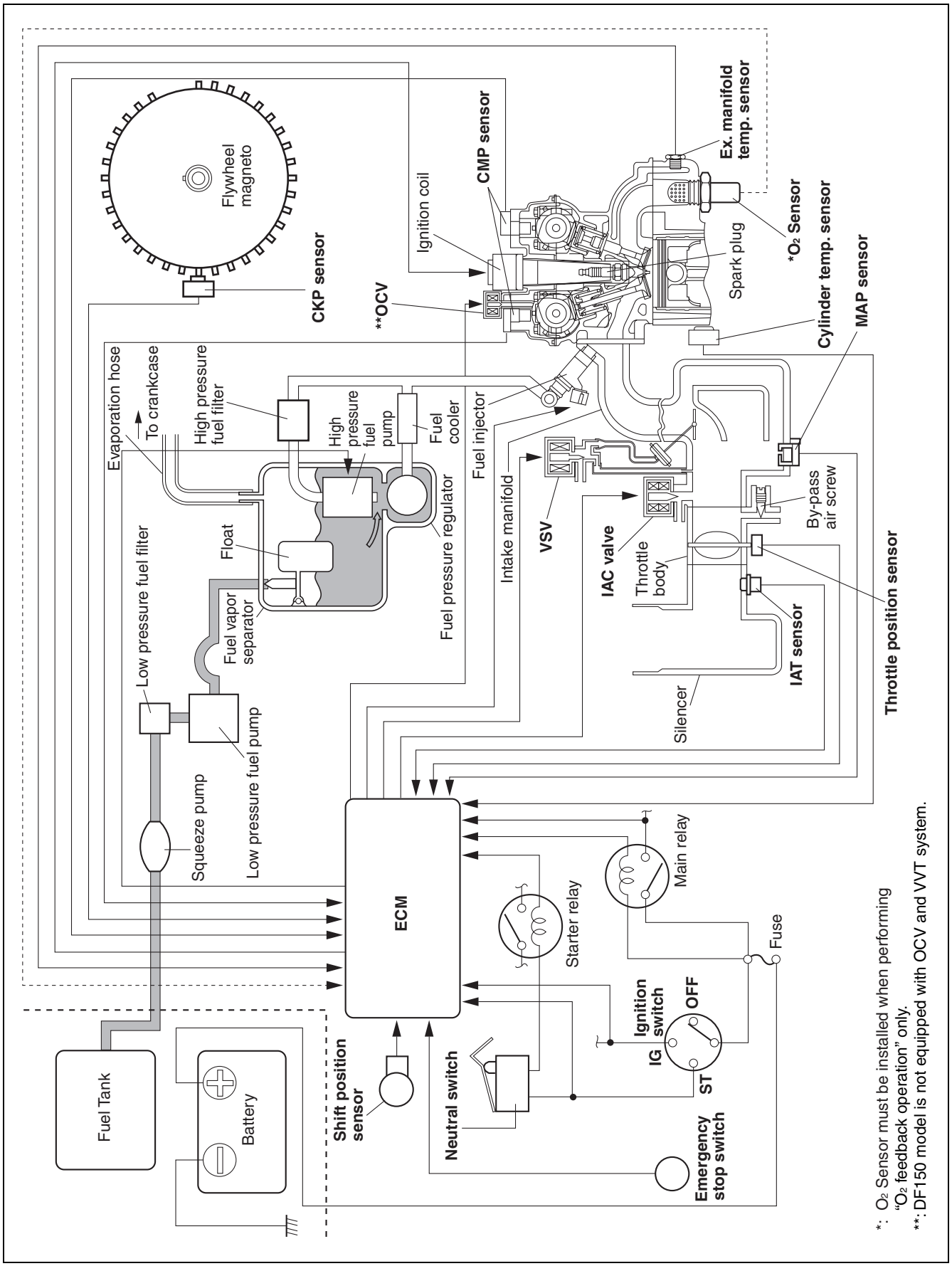


NOTE:

- *DF150 model is not equipped with CMP sensor #2 and VVT system.*

SYSTEM STRUCTURE 2

[DF150/175]



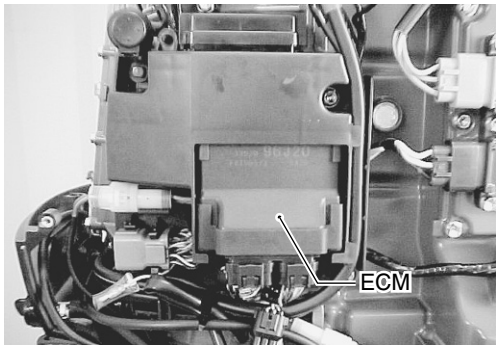
COMPONENTS FOR SYSTEM CONTROL

ENGINE CONTROL MODULE (ECM)

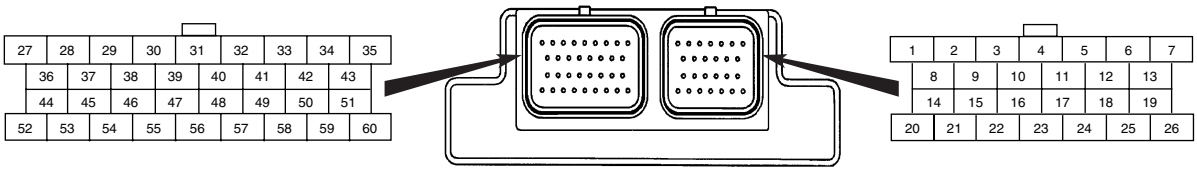
The ECM sends signals to control the actuators based on the information inputs from each sensor/switch. Major controls are as follows:

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.
Multi-stage induction system	• Changing the length of intake manifold pipes according to engine speed.
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:
Information related to the Caution system, Self-Diagnostic System, Total operating hour indication system and O2 feedback system is retained in ECM memory.



ECM CONNECTOR/TERMINALS LAYOUT

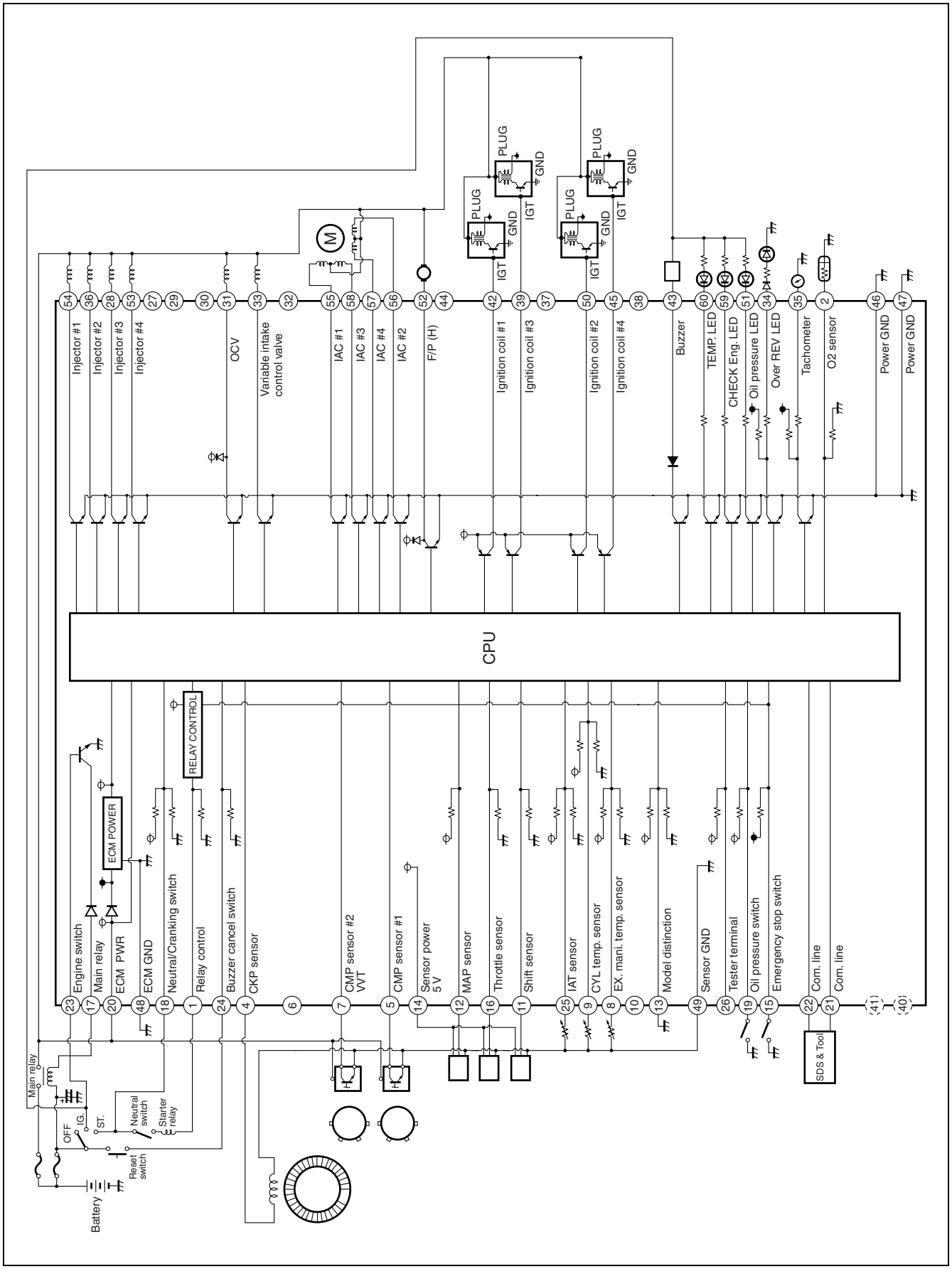


(FRONT VIEW)

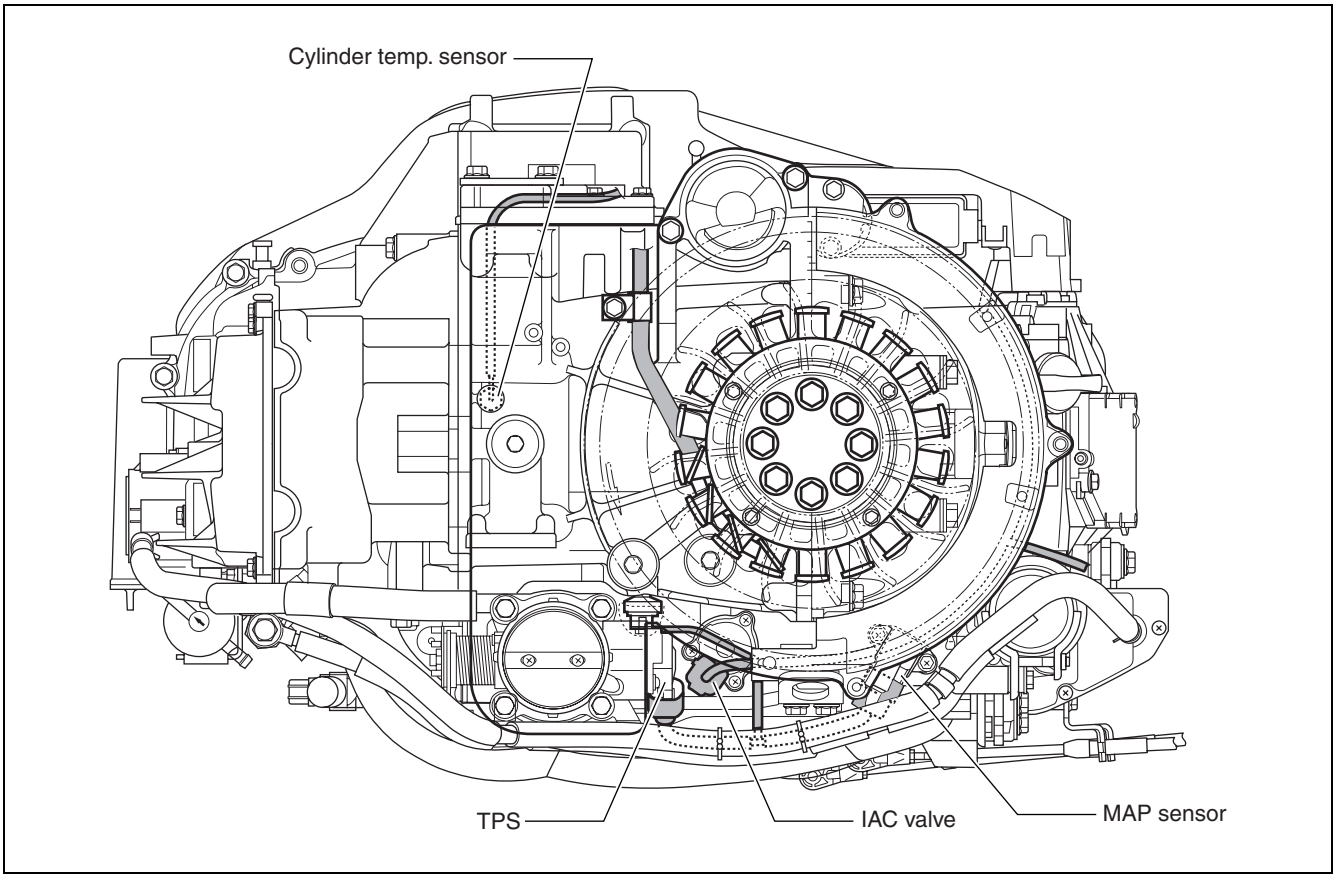
TERMINAL	WIRE COLOR	CIRCUIT
1	G	Starter relay control
2	B/G	O2 Feedback
3	—	—
4	R/B	CKP sensor
5	Y/Bl	CMP sensor #1
6	—	—
7	O/G	CMP sensor #2 (VVT)
8	V/W	Ex-manifold temp. sensor
9	Lg/W	Cylinder temp. sensor
10	—	—
11	P/Bl	Shift position sensor
12	W	MAP sensor
13	B	Model distinction (DF150 only)
14	R	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	—	—
28	R/W	No. 3 Fuel injector (–)
29	—	—
30	—	—

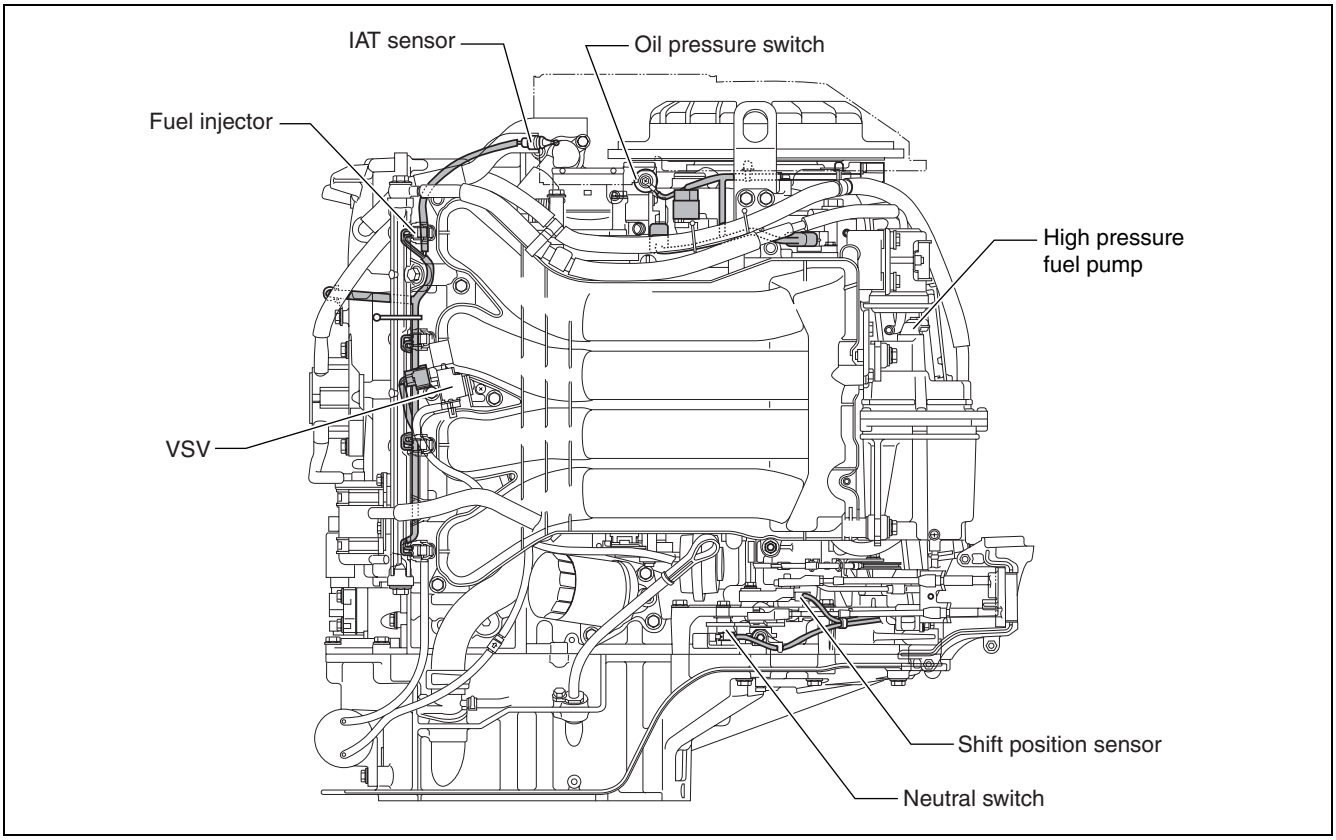
TERMINAL	WIRE COLOR	CIRCUIT
31	Br/R	OCV (–)
32	—	—
33	Gr/G	Variable intake control valve (VSV)
34	P/W	Rev-Limit lamp
35	Y/B	Tachometer
36	B/Br	No. 2 Fuel injector (–)
37	—	—
38	—	—
39	Gr/Y	No. 3 Ignition coil
40	—	—
41	—	—
42	O	No. 1 Ignition coil
43	Bl/W	Buzzer
44	—	—
45	Lg/R	No. 4 Ignition coil
46	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

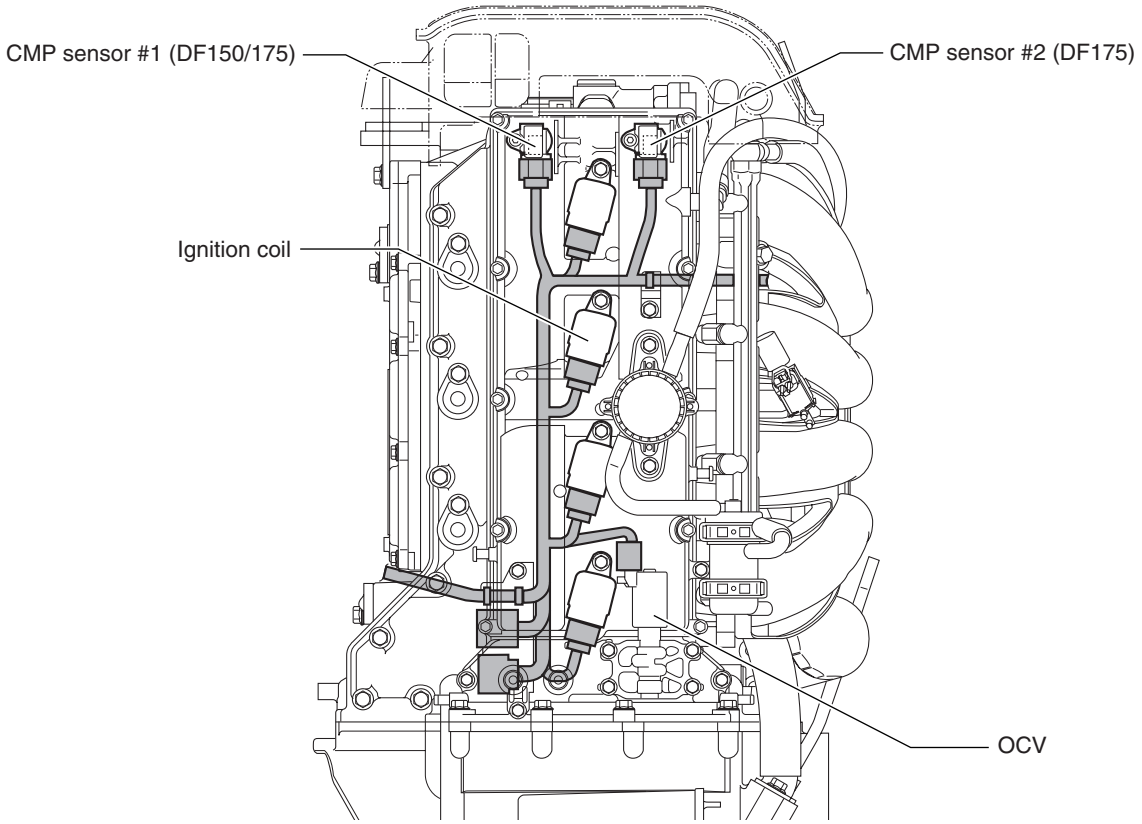
ECM INTERNAL STRUCTURE

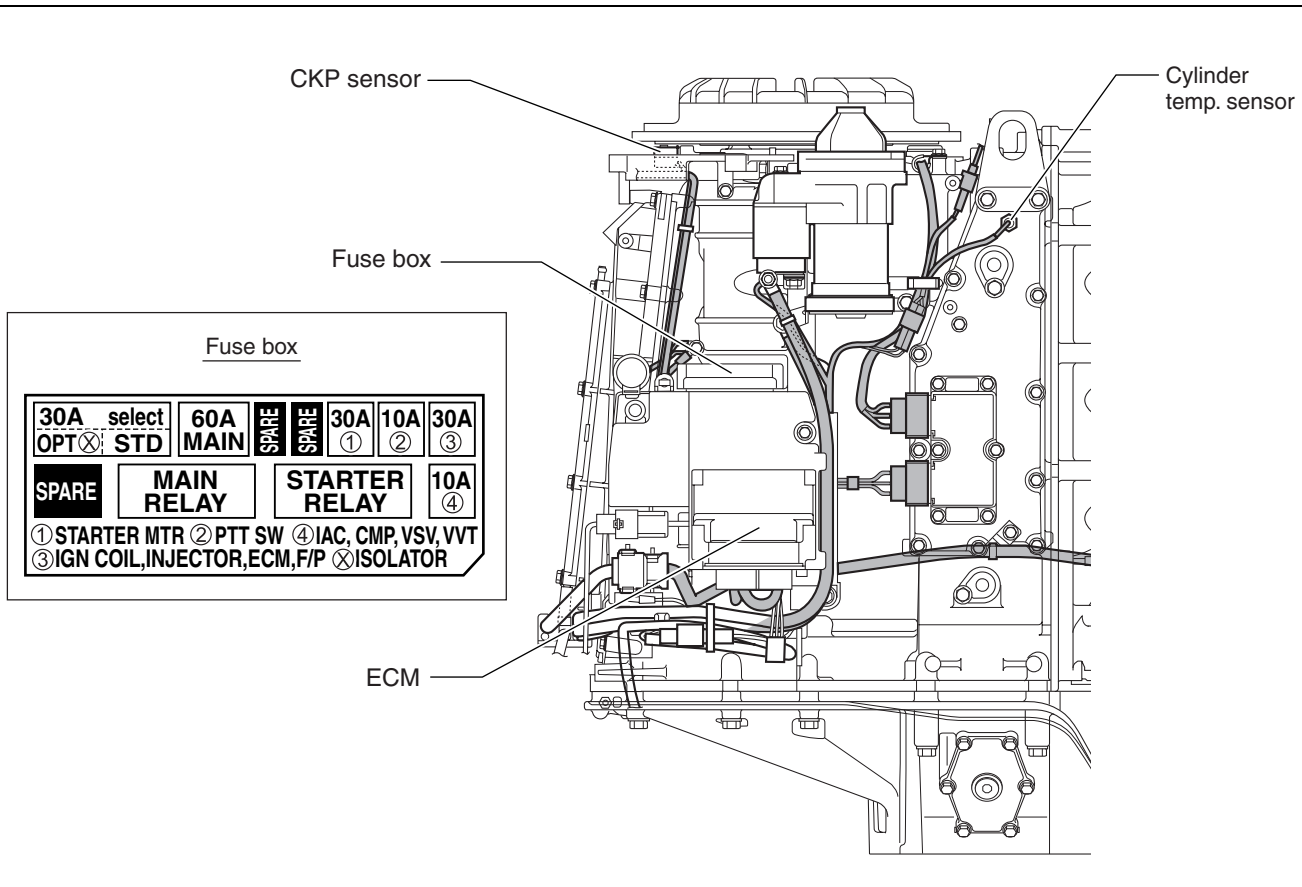


LOCATION OF SENSOR AND SWITCH






CMP sensor #1 (DF150/175)
CMP sensor #2 (DF175)
Ignition coil
OCV


CKP sensor
Cylinder temp. sensor
Fuse box
ECM
Fuse box
30A select
OPT ⓧ STD
60A MAIN
SPARE
SPARE
30A ①
10A ②
30A ③
SPARE
MAIN RELAY
STARTER RELAY
10A ④
①STARTER MTR ②PTT SW ④IAC, CMP, VSV, VVT
③IGN COIL,INJECTOR,ECM,F/P ⓧISOLATOR

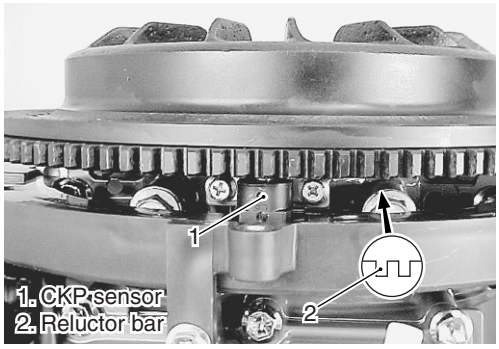
SENSOR AND SWITCH

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.

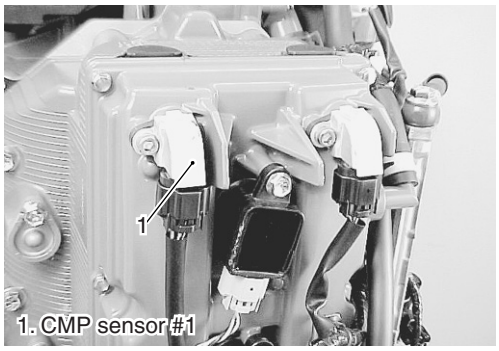
This is the fundamental signal used to judge engine speed and crankshaft angle.

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

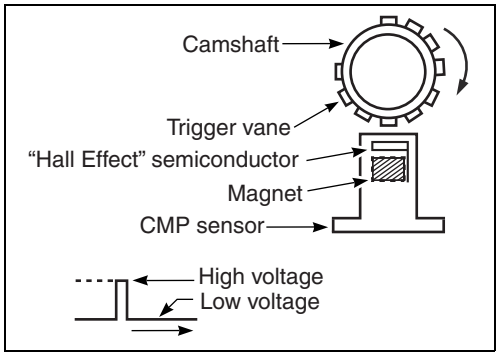
- CMP sensor #1 is mounted on the cylinder head cover with trigger vanes pressed onto the end of the exhaust camshaft. This sensor detects piston position.
- Signals received from this sensor are also used by the ECM to determine sequential fuel injection and ignition control.



- 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.

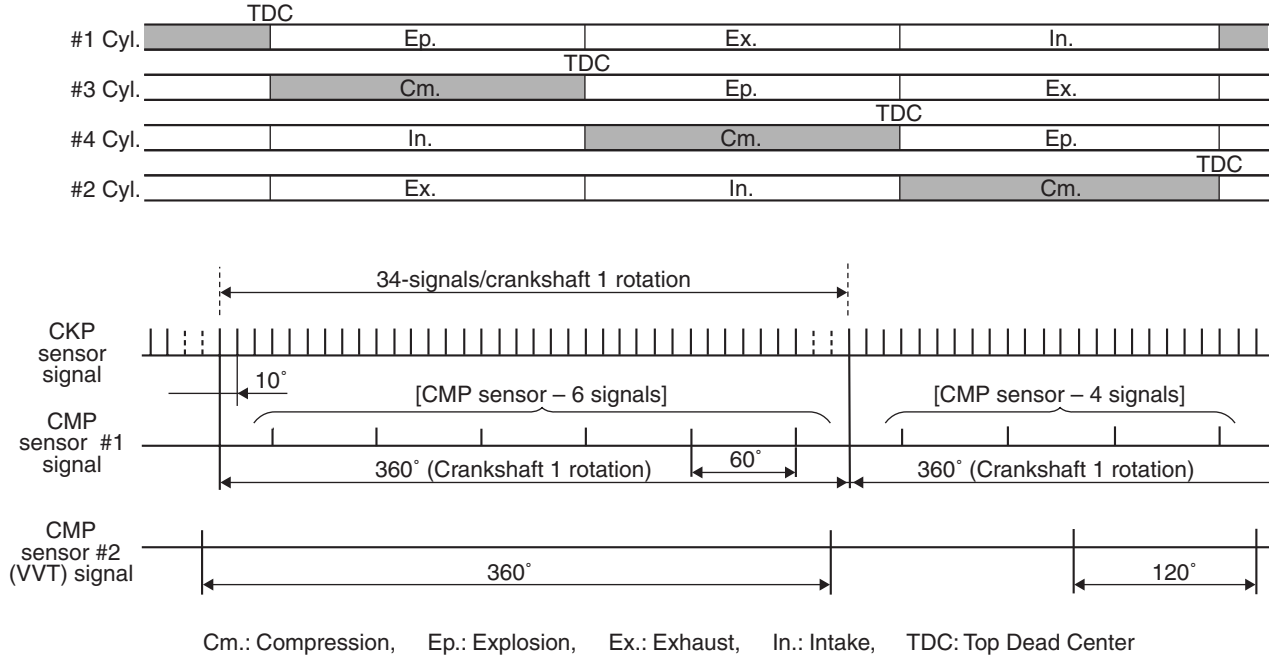
  These generated voltages are rectified to create “ON” (high voltage) & “OFF” (low voltage) signals to the ECM.

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



ECM cylinder identification:

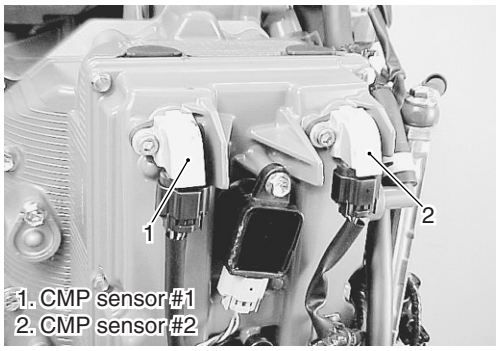
Cylinders are identified by a calculation combined from two signals; one from the CKP sensor and one from the CMP sensor.



Cm.: Compression, Ep.: Explosion, Ex.: Exhaust, In.: Intake, TDC: Top Dead Center

CMP (Camshaft position) SENSOR #2

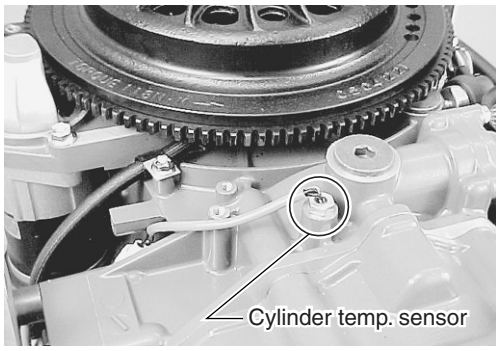
- For DF175 model:
  CMP sensor #2 is mounted on the cylinder head cover with trigger vanes pressed onto the end of the intake camshaft. This sensor detects camshaft position.
- This sensor is the same type as the CMP sensor #1, and inputs signals to ECM. This signal is used to control intake camshaft valve timing through OCV (Oil control valve).

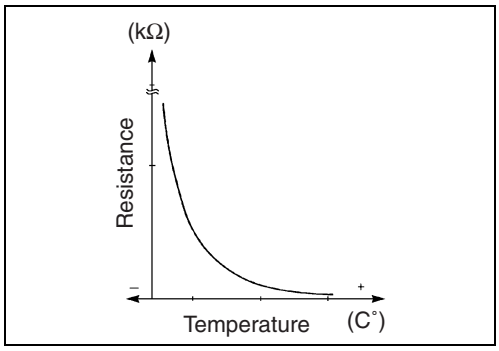


1. CMP sensor #1
2. CMP sensor #2

CYLINDER TEMPERATURE SENSOR

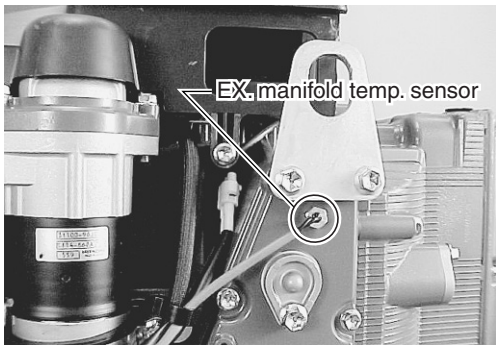
The cylinder temperature sensor is installed on the cylinder (top side) and used to detect the cylinder temperature.
This is a thermistor type sensor (resistance of which changes depending on temperature) and inputs a signal to the ECM as a voltage value. This signal is used to compensate the fuel injection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





EXHAUST MANIFOLD TEMPERATURE SENSOR

The exhaust manifold temperature sensor is installed on the exhaust manifold and used to detect 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.



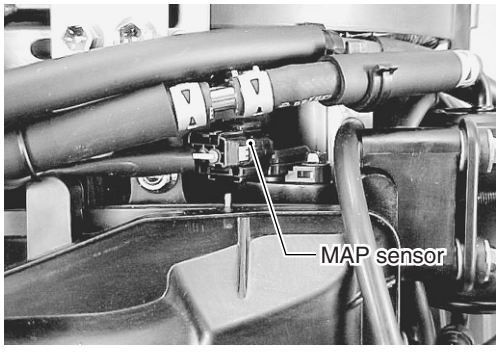
IAT (Intake Air Temperature) SENSOR

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



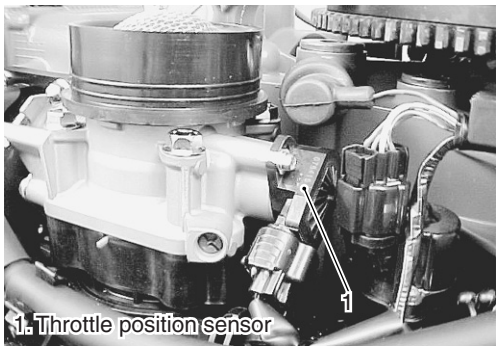
TPS (Throttle Position Sensor)

The TPS is installed on the throttle body and detects the degree of throttle opening. The throttle shaft is interlocked with the TPS shaft.

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.).



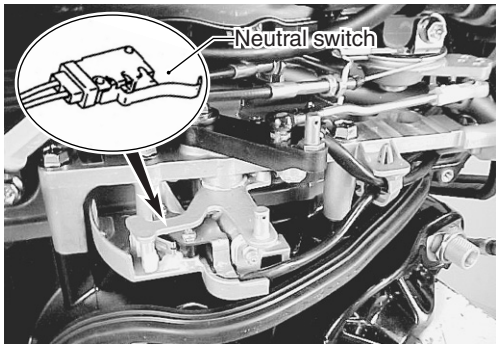
NEUTRAL SWITCH

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 3-45.)



SPS (Shift Position Sensor)

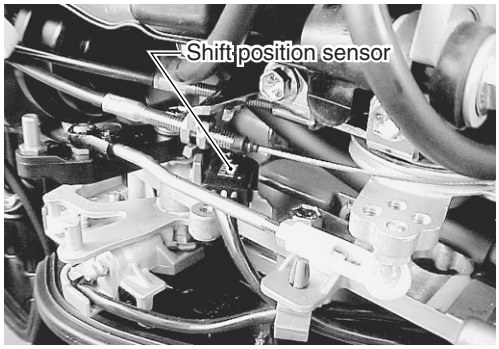
The SPS is installed on the throttle lever holder and detects the shift position. The clutch lever is interlocked with the SPS shaft.

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.

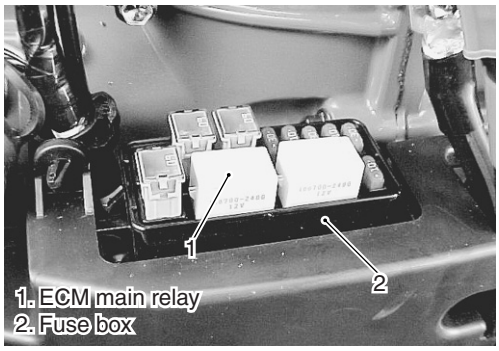
Based on the SPS voltage, the ECM calculates and determines the change of shift position and executes the following controls.

- 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 fuse box. 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 pressure fuel pump, OCV (Oil control valve) and VSV (Vacuum switching valve).

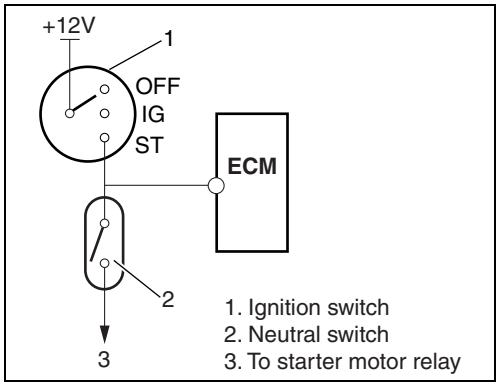


CRANKING SWITCH SIGNAL

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.



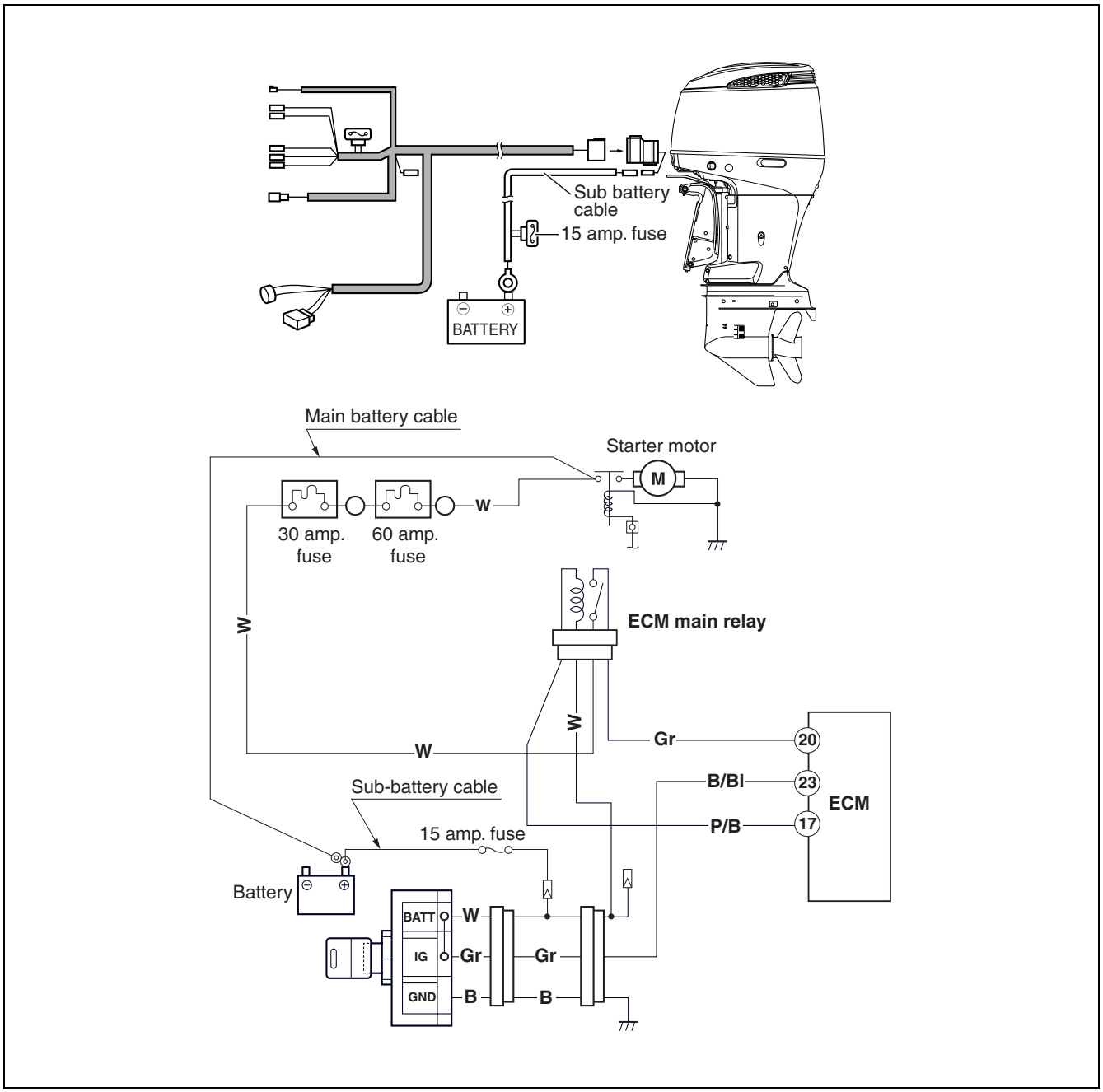
SUB BATTERY CABLE (ECM POWER SOURCE LINE)

The ECM is battery dependent and must be provided with its own dedicated 12V power supply. The electrical circuits which provide this supply are:

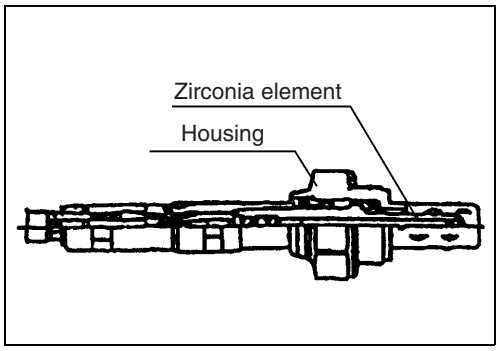
1. The sub battery cable to the white lead wire in the remote control extension harness to the ignition switch.
   When the ignition switch is turned ON, battery power passes from the white lead wire, through the ignition switch contacts to the gray output lead wire to the No.23 terminal of ECM.

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.

2. The engine wiring harness to the main relay. When the ECM main relay is energized by turning the ignition switch ON, a circuit is formed which supplies battery voltage to the No.20 terminal of ECM.



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 DF150/DF175 is a fully transistorized, electronic microcomputer timing advanced type.

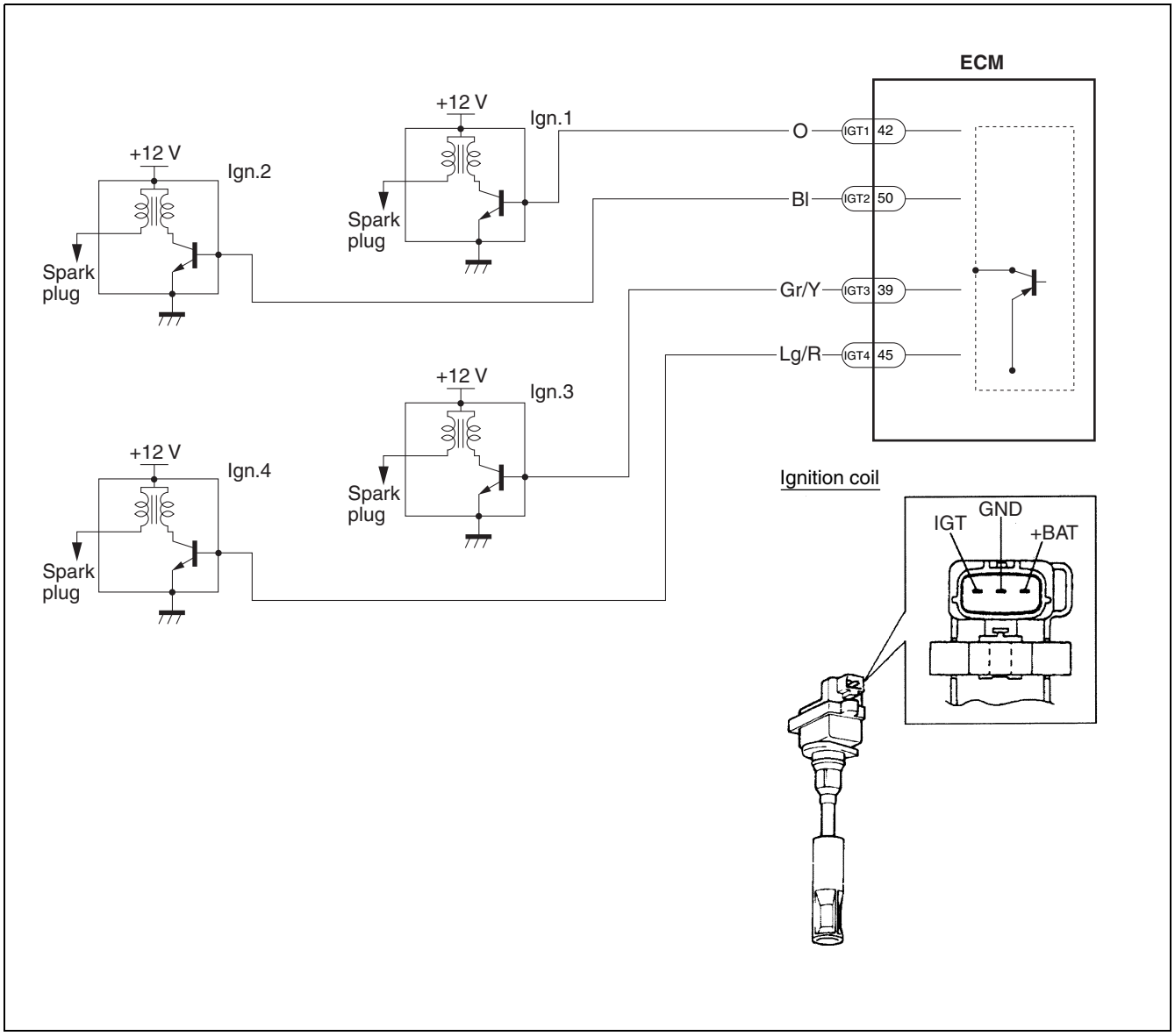
This system is totally battery powered, with the ECM controlling all ignition timing functions.

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 controlling current flow (ignition) to the primary winding of ignition coil.

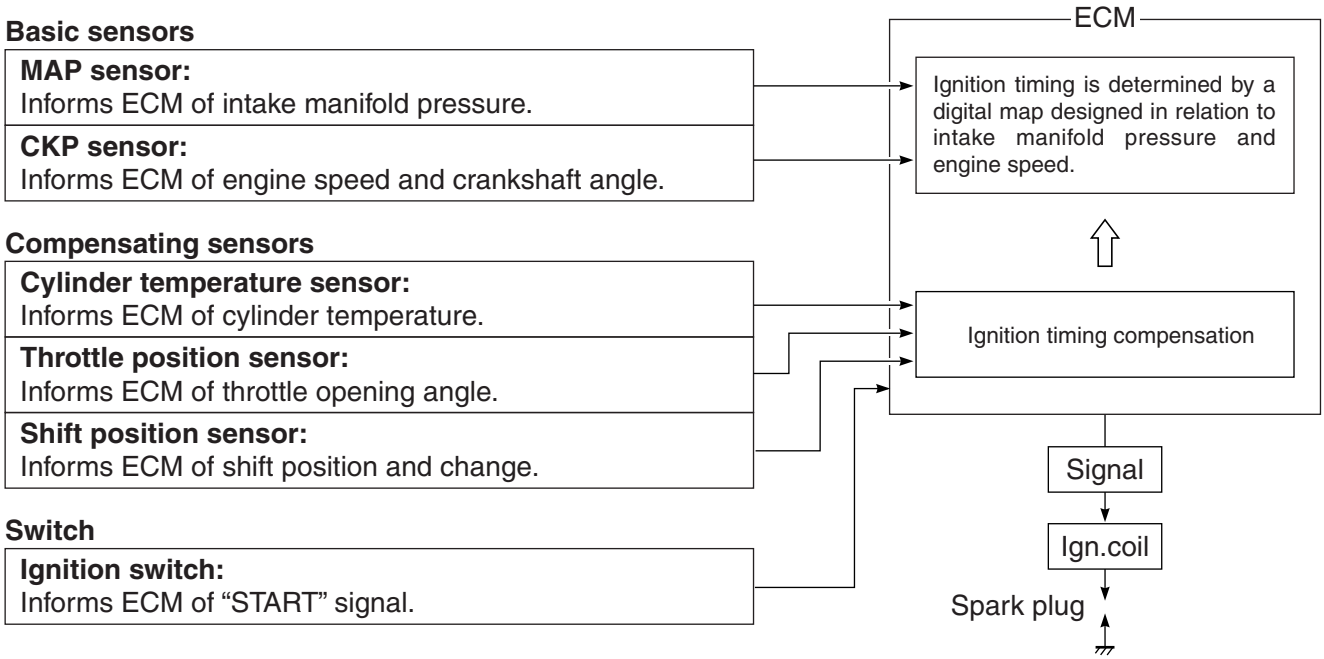
In this way, a mutual induction high voltage occurs in the ignition coil secondary side and spark is generated.



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.

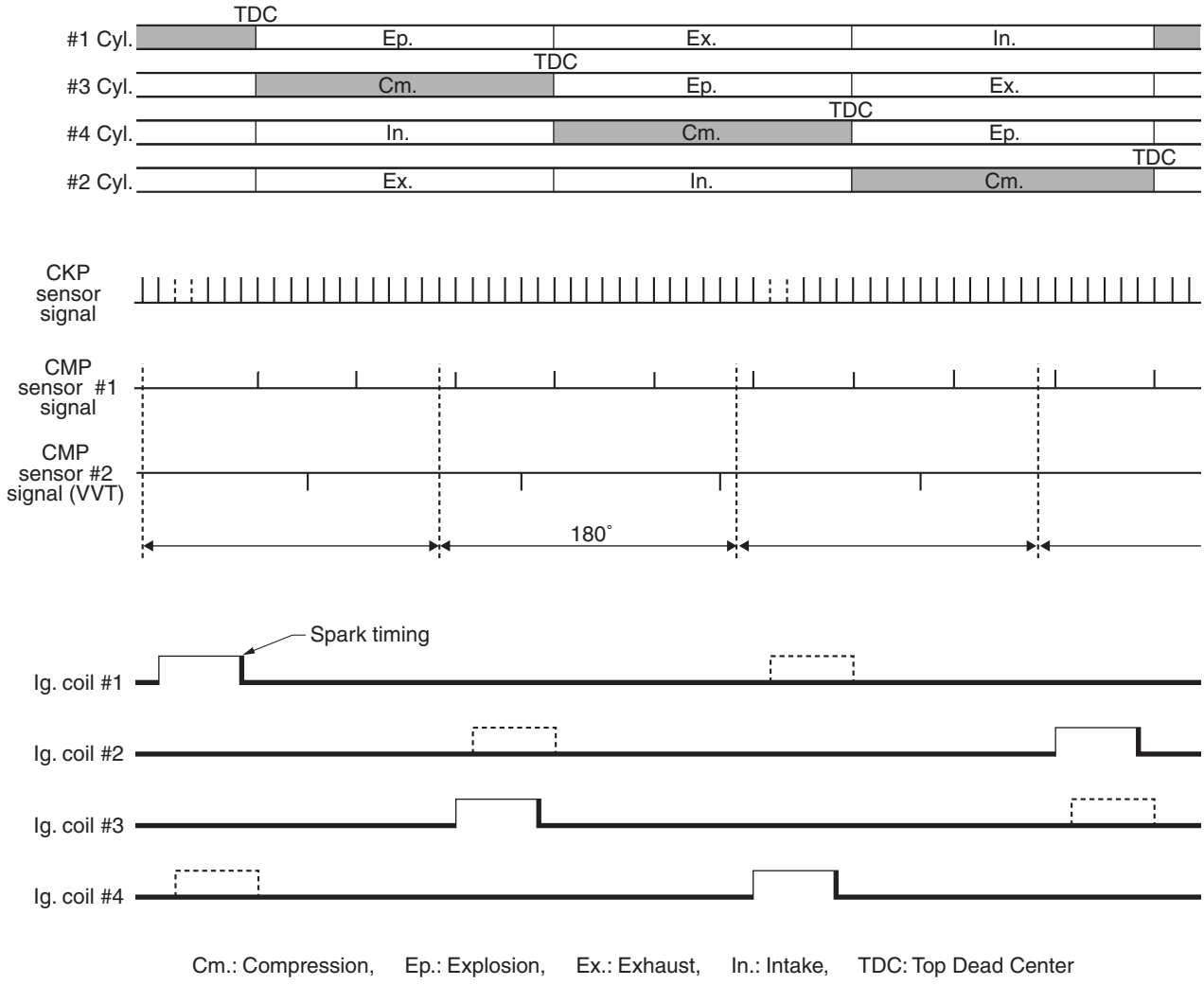


SPECIFICATION

Ignition system	Full-transistorized ignition
Advance	Electronic microcomputer control
Ignition timing	BTDC 5° – BTDC 26° (DF150) BTDC 5° – BTDC 26° (DF175)
Firing order	1 – 3 – 4 – 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° until the engine starts.

WHEN IDLING/TROLLING:

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

WHEN RUNNING (NORMAL OPERATION):

The ignition timing ranges between BTDC 5° – 26°, depending on current engine operating conditions.

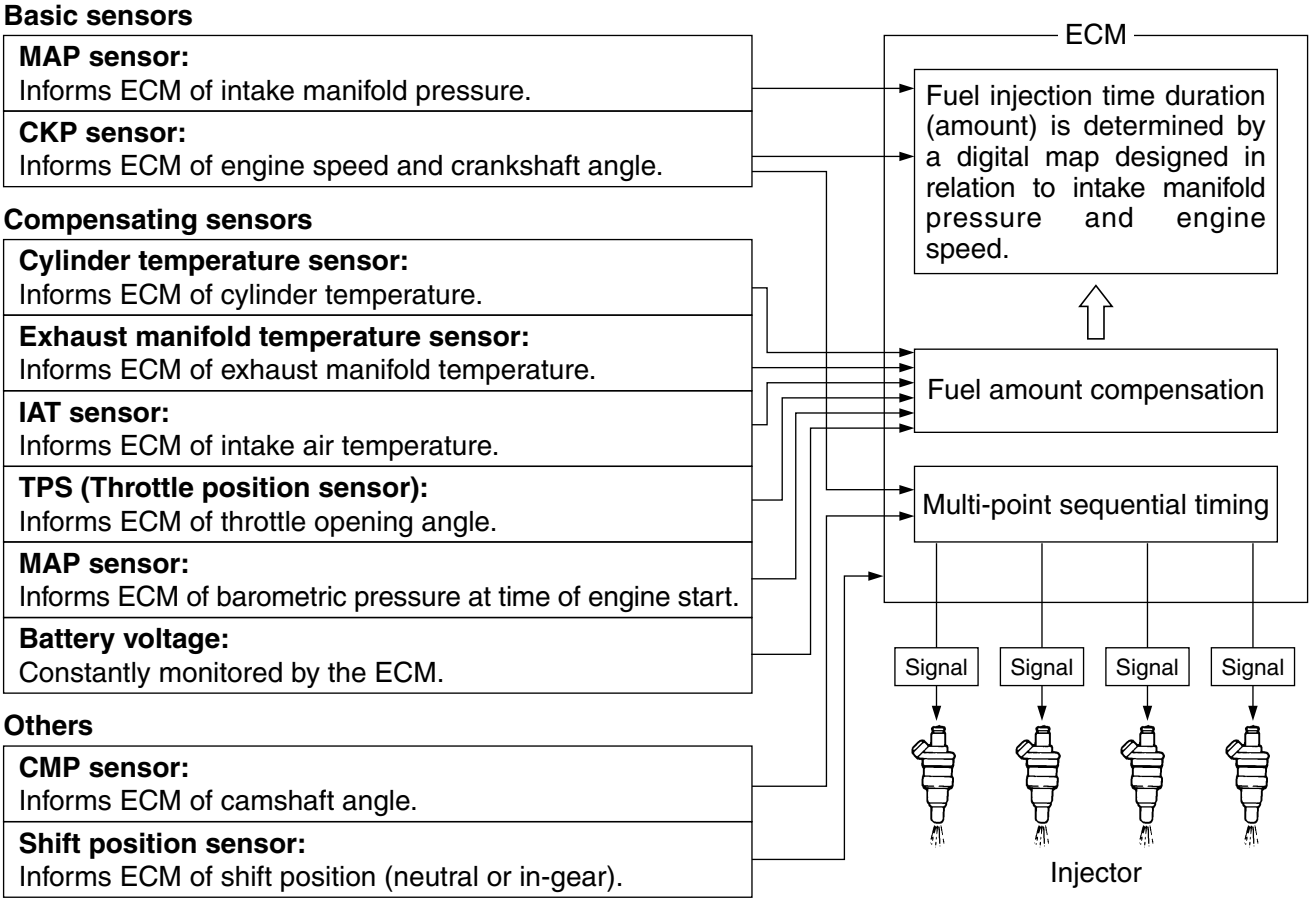
ELECTRONIC FUEL INJECTION SYSTEM

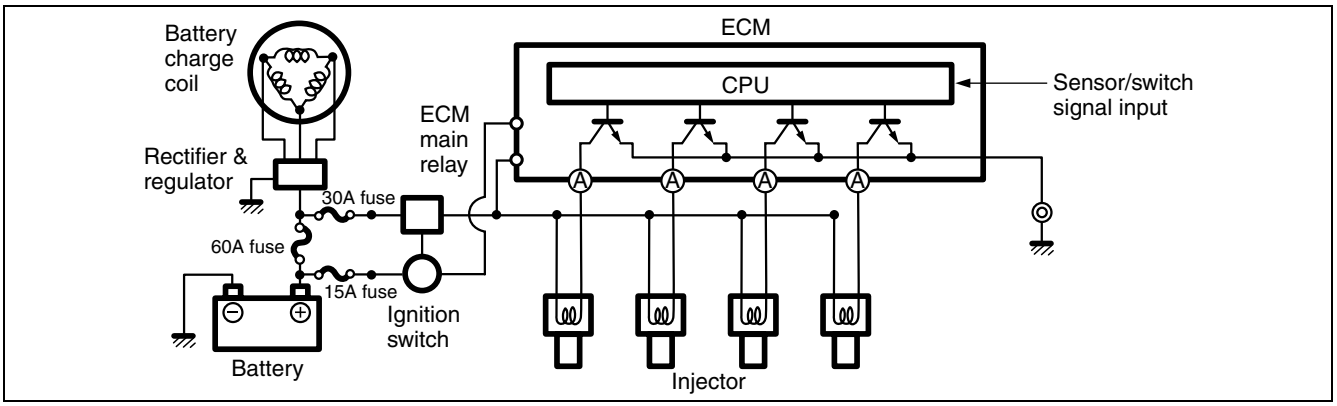
The fuel injection system used by the DF150/DF175 is a speed-density, multi-point, sequential, electronic fuel injection type.
The fuel injection system is composed of the fuel line components, air intake components, and components for system control (ECM, sensors, switches, etc.).

FUEL INJECTION CONTROL SYSTEM

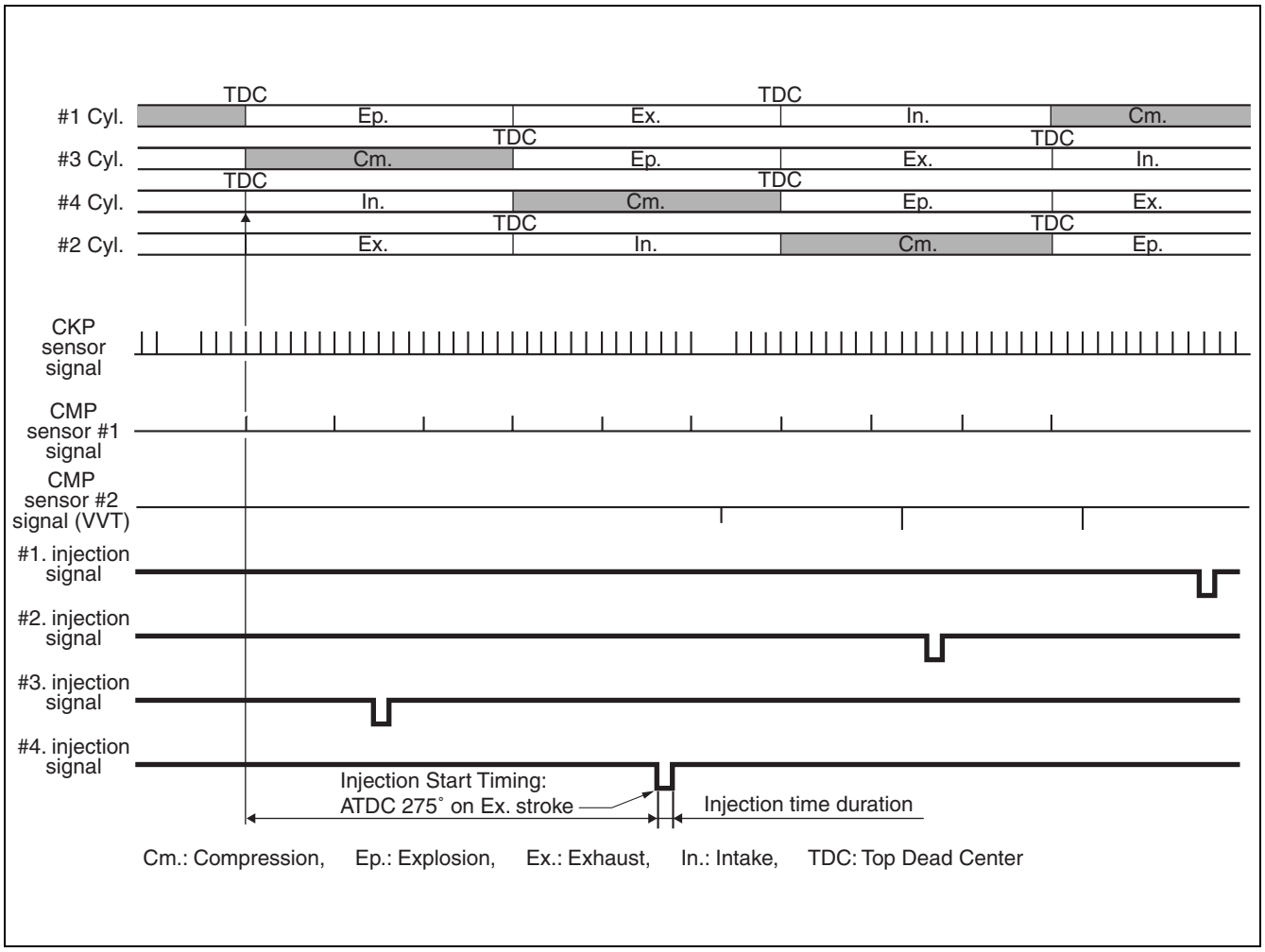
OUTLINE

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 275° on the exhaust stroke.





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 intake manifold. 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.

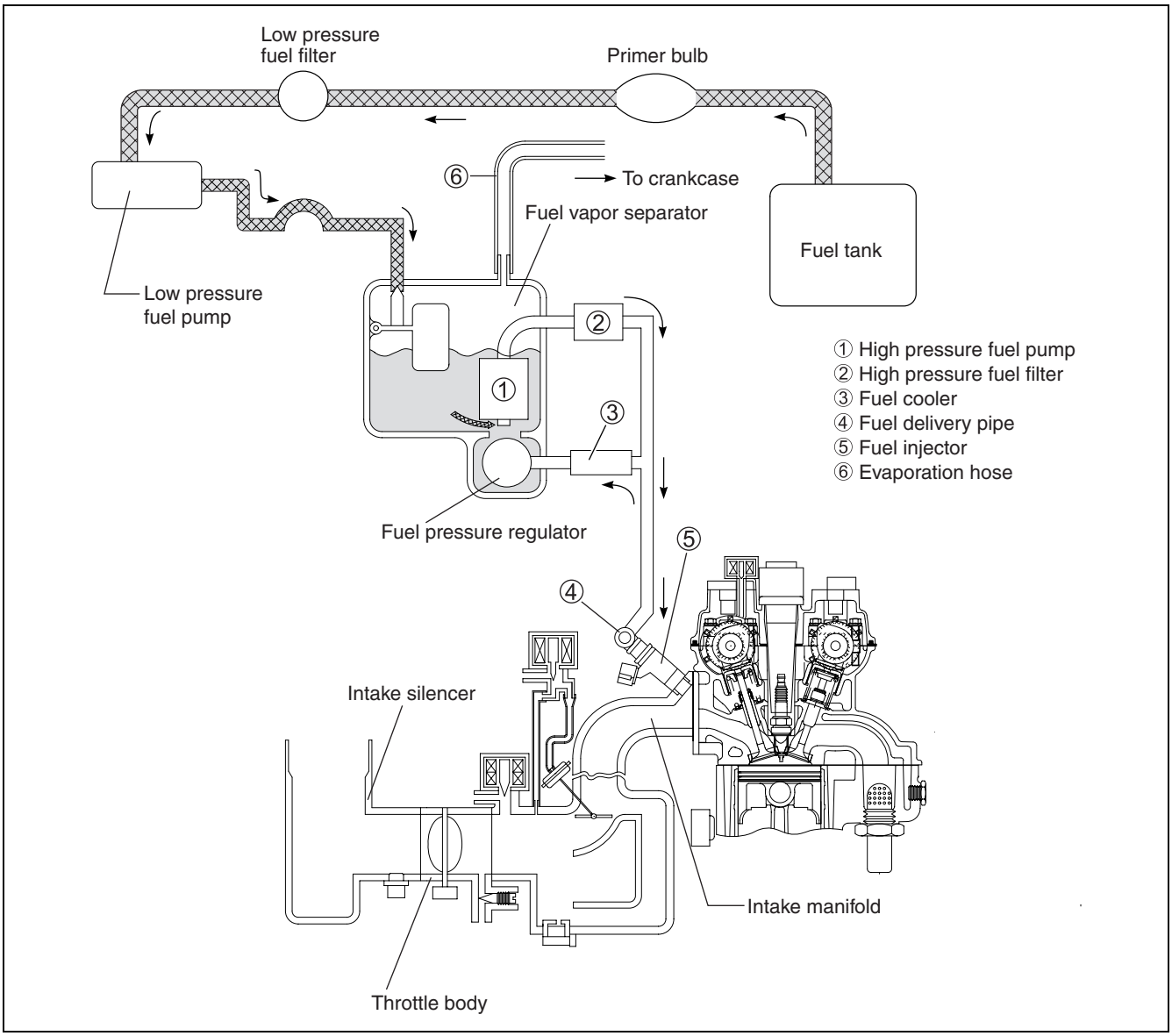
Fuel flow from the fuel vapor separator is pressurized by the high pressure fuel pump and supplied through the high pressure fuel filter and fuel delivery pipe to the fuel injectors.

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.

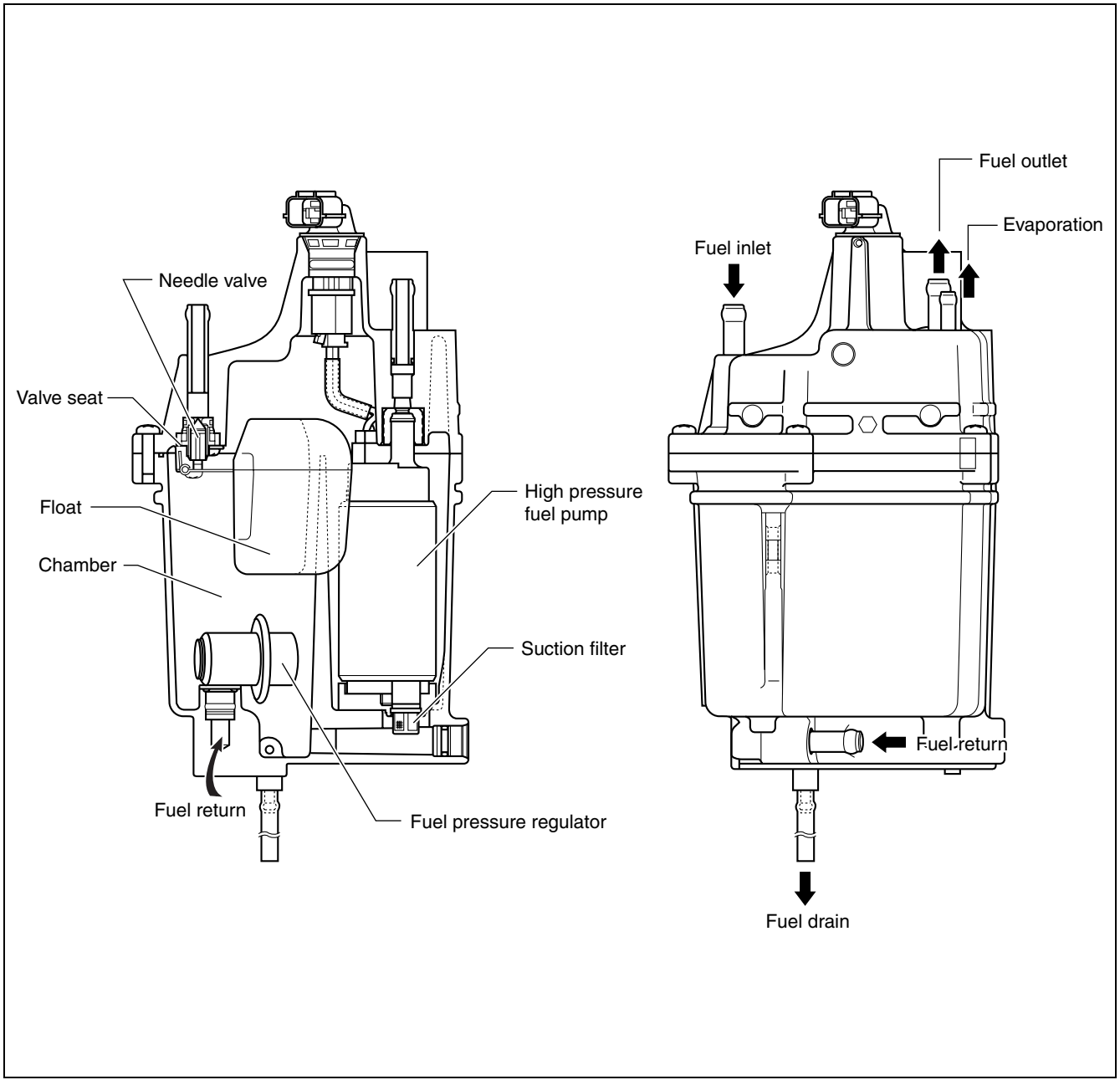
The function of this unit is to separate vapors from fuel delivered by the low pressure fuel pump or fuel returned from the fuel pressure regulator.

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

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

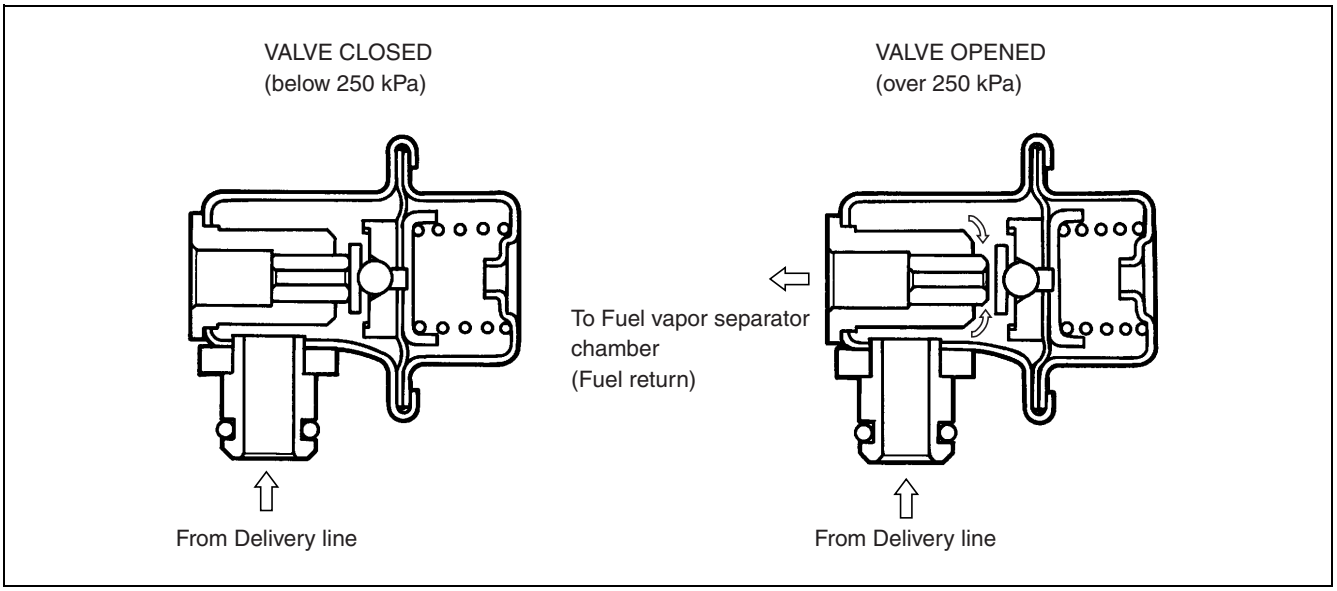
The fuel pressure regulator is located in the fuel vapor separator.

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.



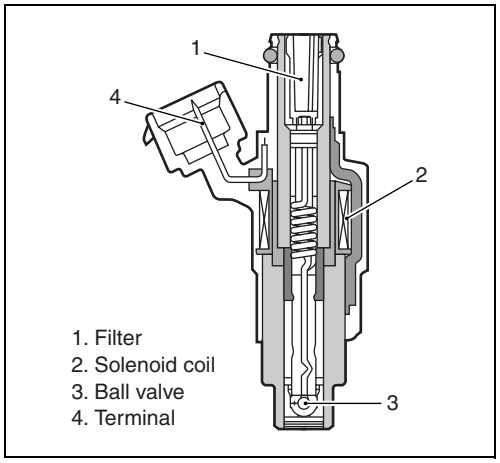
FUEL INJECTOR

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.

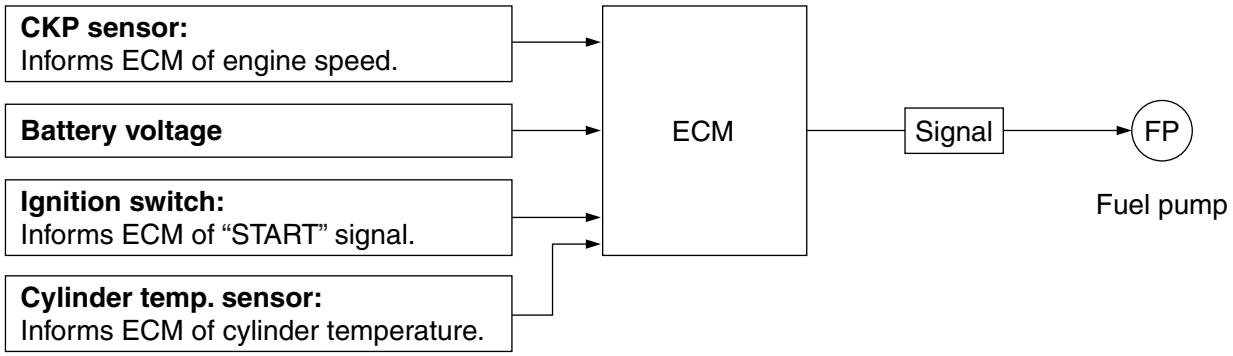


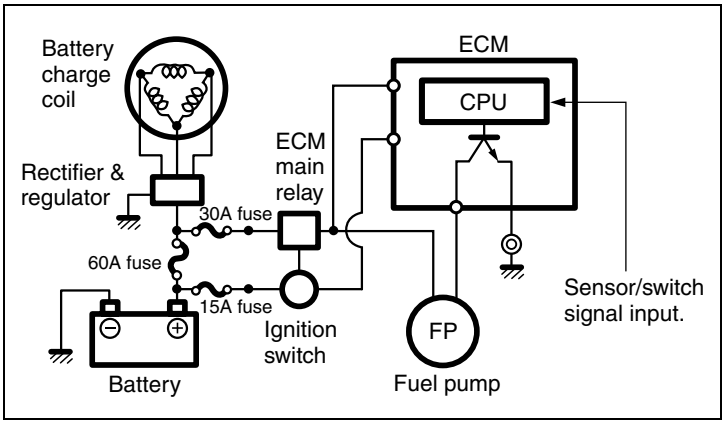
HIGH PRESSURE FUEL PUMP CONTROL SYSTEM

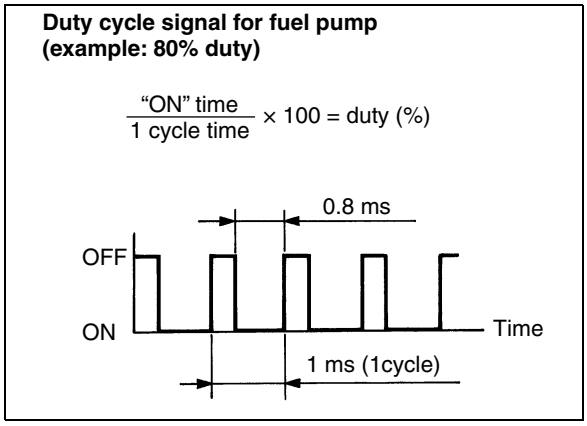
OUTLINE

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 50 – 100% duty.

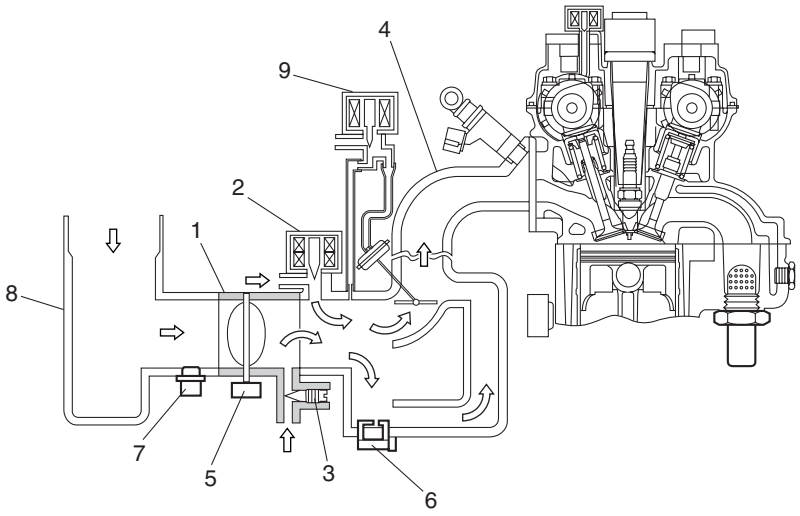
Duty change depends on cylinder temperature.

WHEN RUNNING (NORMAL OPERATION):

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

AIR INTAKE COMPONENTS

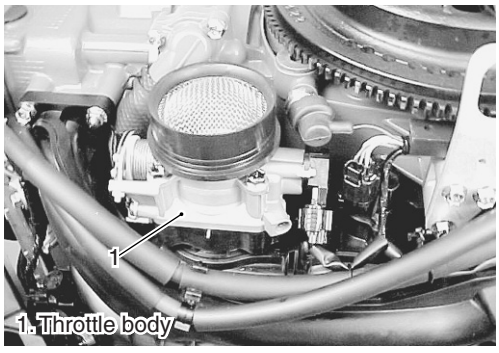
Air, after entering through the silencer case, passes through the throttle body and flows into the surge tank where it is then distributed to the cylinder intake manifold.
Intake manifold pressure, monitored by the MAP sensor, is an indirect measure of the intake air amount.
When the throttle is fully closed, the main supply of intake manifold air necessary to sustain 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.



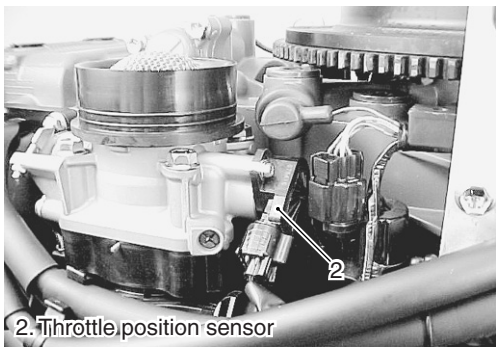
⇦ Air flow
1. Throttle body
2. IAC valve
3. By-pass air screw
4. Intake manifold
5. Throttle position sensor
6. MAP sensor
7. IAT sensor
8. Air intake silencer
9. VSV

THROTTLE BODY

- The throttle body assembly consists of the main bore, throttle valve, by-pass air passage, by-pass air screw and TPS (Throttle position sensor).
- 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 throttle body informs of throttle valve opening angle.



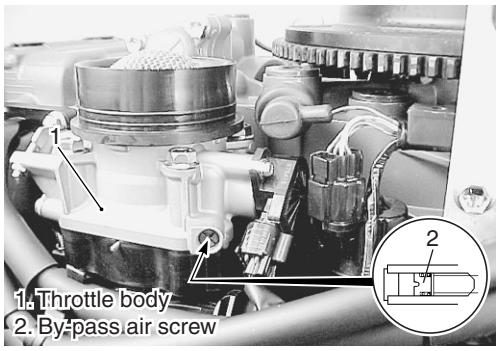
NOTE:
Do not try to adjust or remove any of the throttle body component parts (Throttle position sensor, throttle valve, throttle stop screw, etc.).
These components have been factory adjusted to precise specifications.



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.

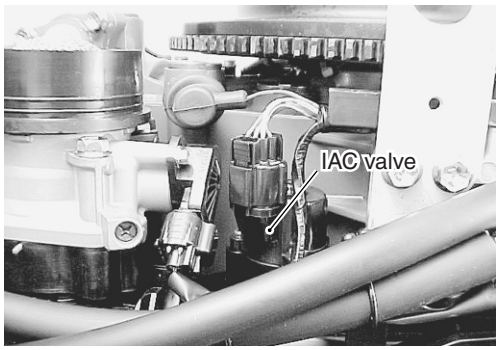
IAC VALVE/PASSAGE

The IAC valve is a stepper motor type mounted on the intake manifold.

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 intake manifold.

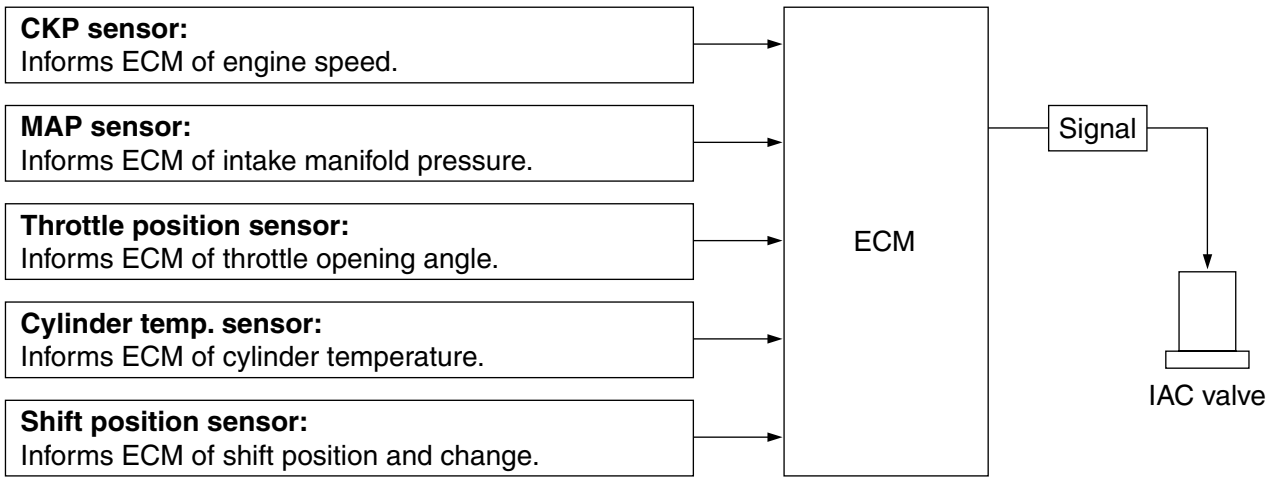
This system is used for the following purposes:

- To keep idling/trolling at specified speed.
- To improve drivability 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.

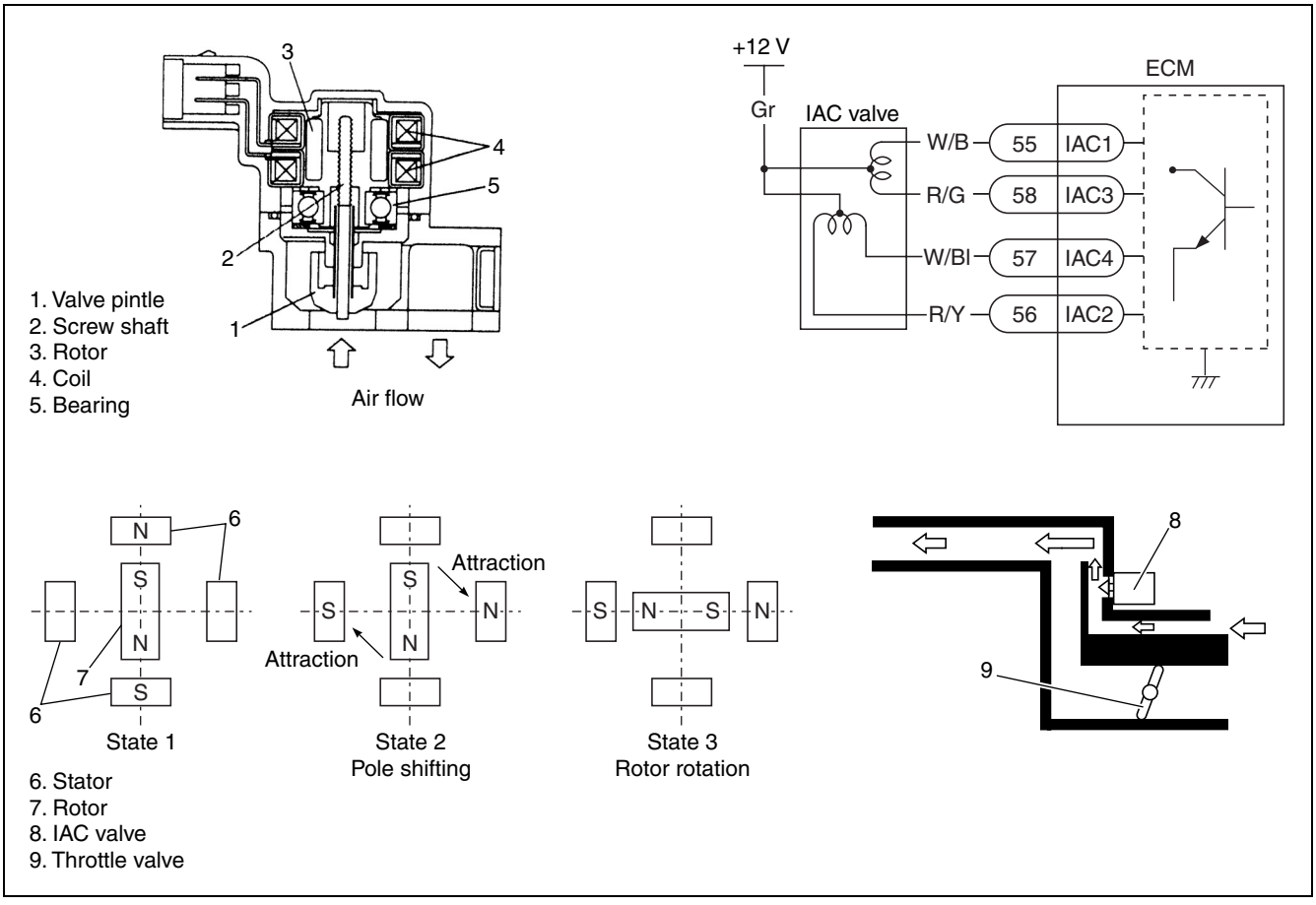
Based on these signals, the ECM determines the IAC valve opening necessary to achieve the target engine revolution and outputs the signal for actuating the stepper motor inside the IAC valve.

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 manifold.
- 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 the illustration below to that in State (2) will develop a magnetic torque to cause the rotor to rotate and then stabilize in State (3). (The illustration 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. 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. 40 – 100% duty.
Duty change depends on cylinder temperature.

AFTER START (FAST-IDLE FUNCTION):

The IAC valve is controlled to operate at approx. 10 – 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 engine speed is stable at the idling/trolling speed specified.
During this period, the IAC valve has a duty of approx. 10% but will vary slightly as idling/trolling conditions change.

WHEN RUNNING (NORMAL OPERATION):

The IAC valve is controlled to operate at 10 – 70% 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. 10 ± 5% duty at the engine idling/trolling specification. See page 2-16 for the by-pass air screw adjustment procedure.

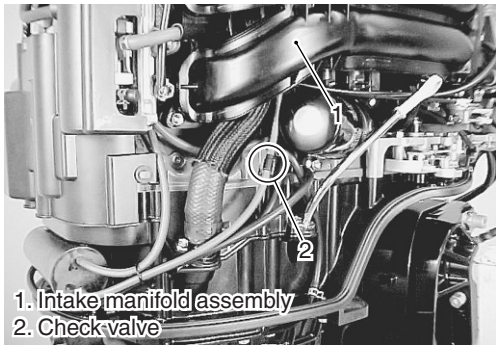
MULTI-STAGE INDUCTION

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.

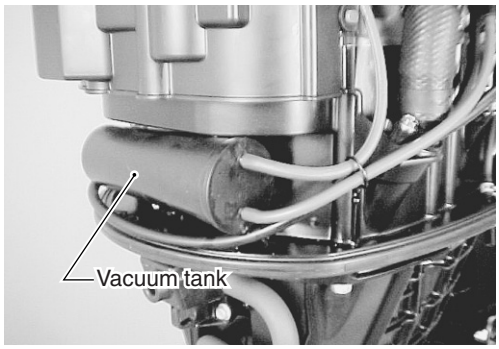
SYSTEM COMPOSITION

The intake manifold assembly provides air for the low/mid range intake tract and high speed range tracts. Mounted on the intake manifold are throttle body, 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.



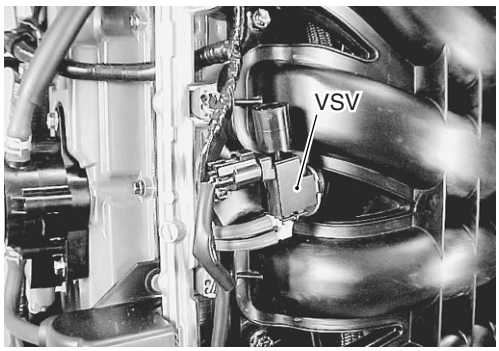
• VACUUM TANK

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 intake manifold, 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 intake manifold. The other side of the tank is connected to the VSV with a hose.



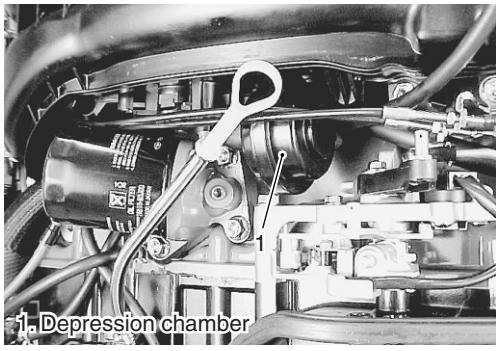
• VSV (Vacuum Switching Valve)

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.



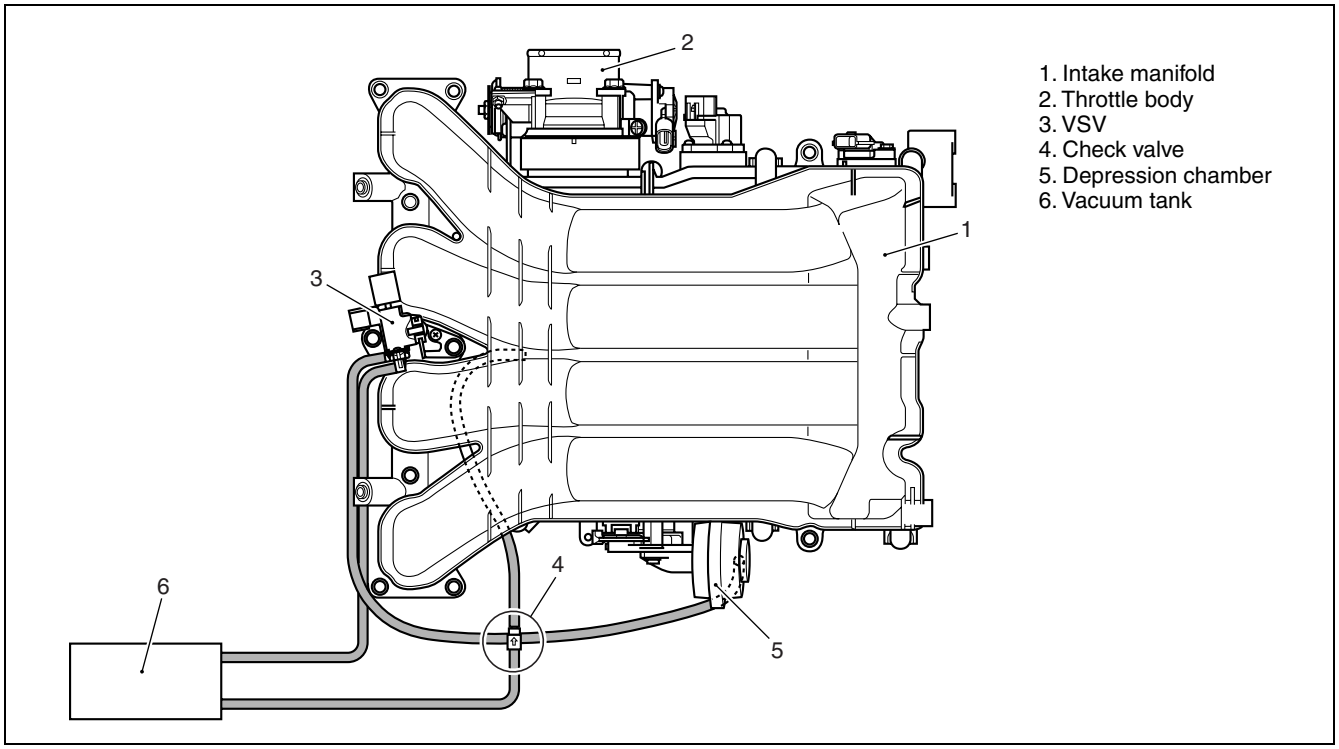
• DEPRESSION CHAMBER

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.



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 intake manifold, 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.

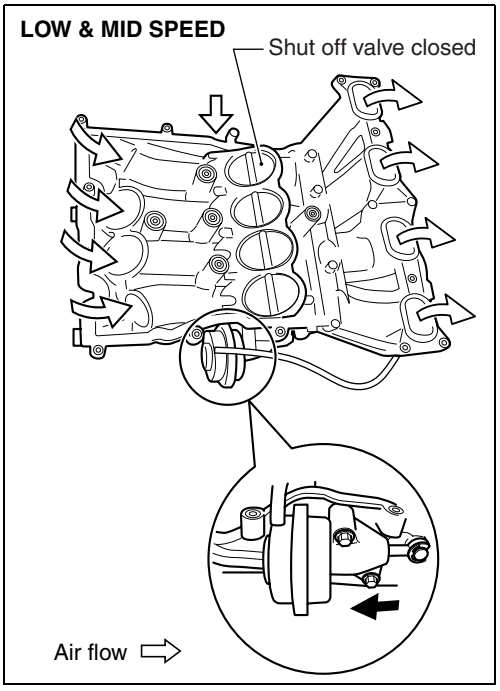


1. Intake manifold
2. Throttle body
3. VSV
4. Check valve
5. Depression chamber
6. Vacuum tank

• 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 inertia effect to the long intake tract, increases low and mid speed range engine torque.

*: Preset value;
DF150: approx. 4 700 r/min DF175: approx. 4 800 r/min



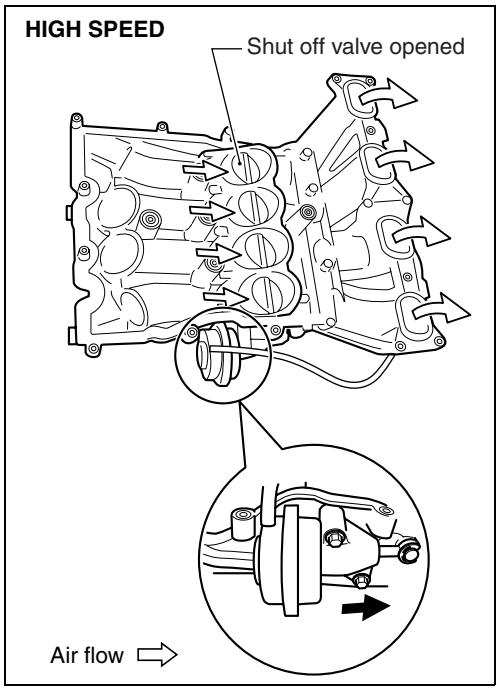
• HIGH SPEED RANGE

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.

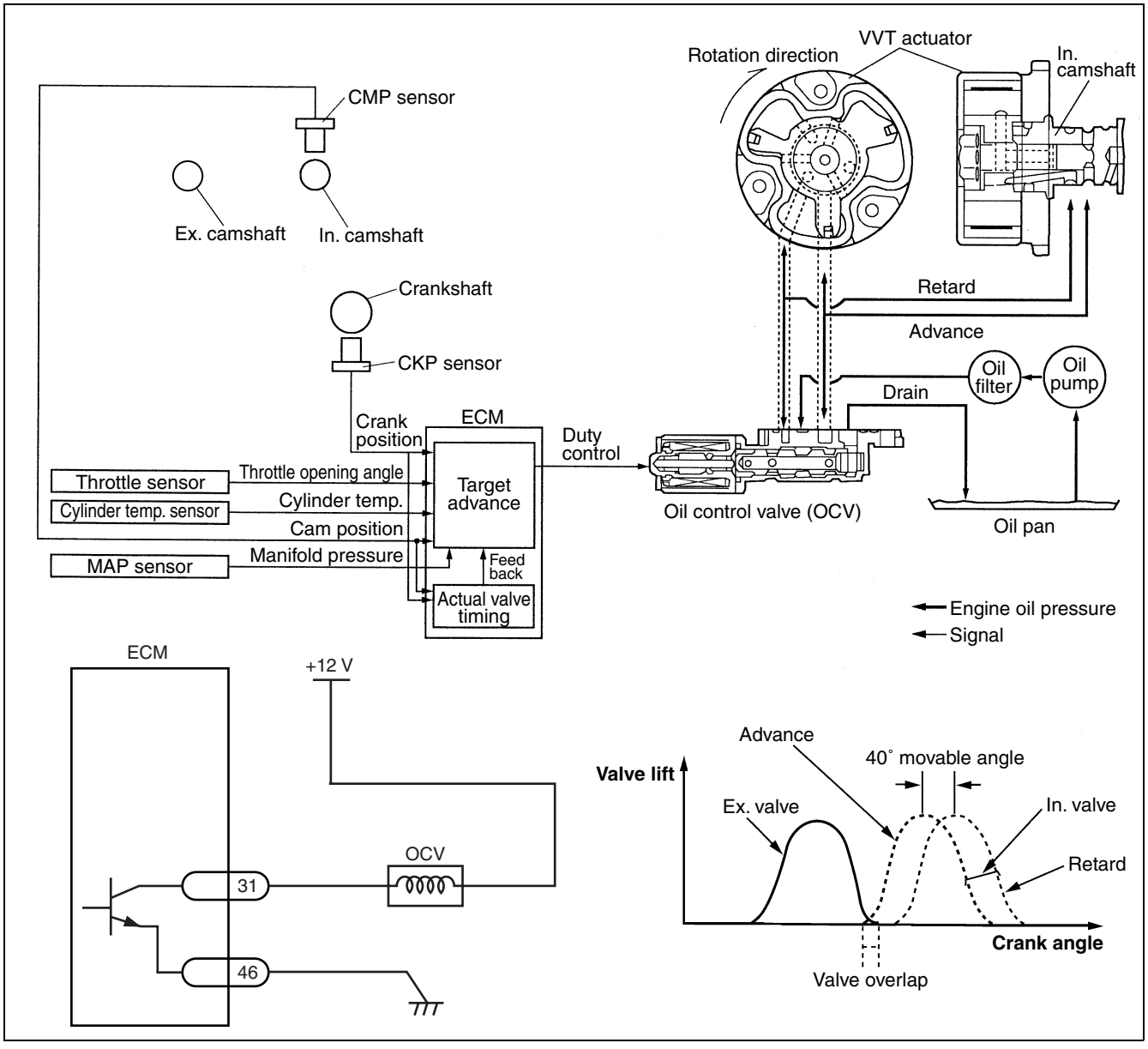
In this operating mode, intake air is supplied to the engine through the high speed intake tract only.

This enlarges the intake tract volume, improves intake inertia and efficiency, which increases the engines output power.



VVT (Variable Valve Timing) SYSTEM

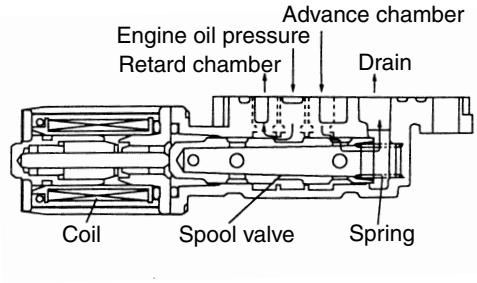
- The VVT system is designed to continuously vary intake valve timing to best fit the engines current operating condition.
- The intake cam timing sprocket assembly (VVT actuator) is located at the front end of the intake camshaft. The timing sprocket' internal rotor is operated by engine oil pressure. Since the rotor and intake camshaft is 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)
The OCV is used to regulate oil flow and is installed on the 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.

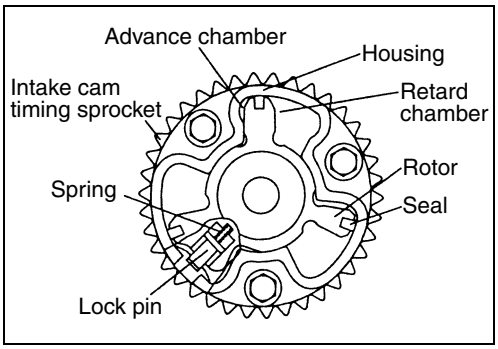
Retard operation



ADVANCE OPERATION
When the duty ratio of the ECM is large, the spool valve is pulled 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 and retard chambers formed by a 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.



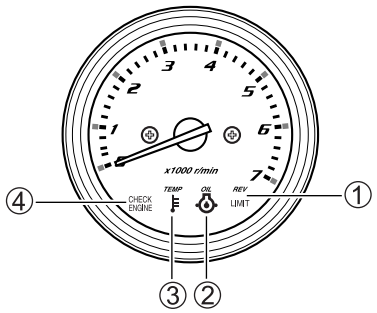
CAUTION SYSTEM

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 (3 000 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

DF150: 6 200 r/min

DF175: 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. 1 000 r/min by intermittent fuel injection signal if the system is activated at 1 000 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. 1 000 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. 86 °C (187 °F)
Condition 2 (Temperature rise vs Time)	Approx. 84 °C (183 °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:

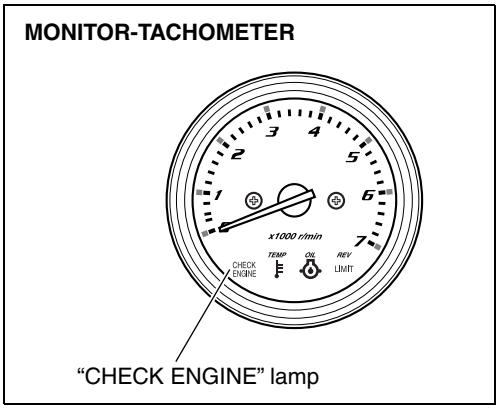
Engine speed	No engine speed limiter is activated.
Caution lamp	"CHECK ENGINE" lamp lights continuously.
Caution buzzer	Sounds in a series of long (1.5 sec) beeps.

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.



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	4 – 2	ON/OFF	NO
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	Exhaust manifold temp. sensor	1 – 5	ON/OFF	YES
10	Fuel injector	4 – 3	ON/OFF	NO
11	Throttle position sensor	2 – 1	ON/OFF	YES
12	Shift position sensor	1 – 2	ON/OFF	YES
13	CMP sensor (VVT)	2 – 6	ON/OFF	YES
14	VVT advance	5 – 2	ON/OFF	YES
15	Neutral switch	3 – 3	ON/OFF	NO
16	Model discrimination/ Check code wire [NOTE 2]	4 – 1	ON/OFF	YES
17	Oil control valve	6 – 2	ON/OFF	NO
18	Rectifier & regulator (Over-charging) [NOTE 1]	1 – 1	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:

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 2:

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.

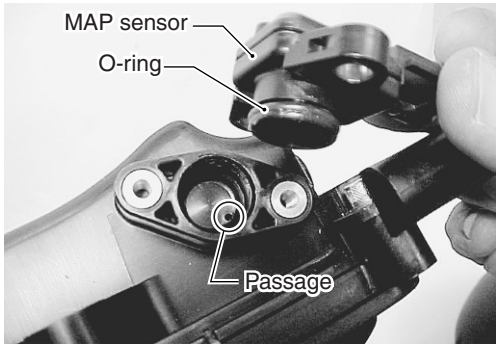
Replacing the ECM may cause improper execution of the self-diagnostic for model discrimination possibly leading to engine trouble.

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 90% 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, 10 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: 2 100 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	• 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 • Receiving an out of range "0.2 – 4.8 V" signal.
Shift position sensor	• No signal • Receiving an out of range "0.2 – 4.8 V" signal.
CMP sensor (VVT)	• During two crankshaft rotation, 4 signals are not input to ECM.
VVT advance	• 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 between the ECM memory storage and the model discrimination terminal. • [No.13 terminal open. (DF150)] • [No.13 terminal short circuit. (DF175)]
Oil control valve	• 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 intake manifold.



FAIL-SAFE SYSTEM

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

PRE-PROGRAMMED VALUE FOR FAIL-SAFE SYSTEM

FAILED ITEM	PRE-PROGRAMMED VALUE
MAP sensor 1	• 260 – 760 mmHg (10.2 – 30 inHg)/(The control takes place in accordance with the engine speed.) [NOTE 1]
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 fixed at BTDC 10 degree. • 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 2 000 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.
Shift position sensor	• The shift position (Fwd/Neu/Rev) is detected with the neutral switch signal. • The IAC control follows the forward gear 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

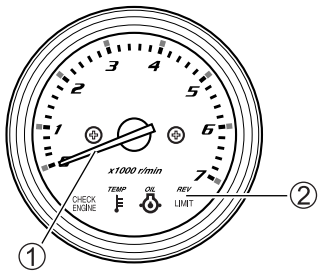


CHART OF TOTAL OPERATING HOURS INDICATION

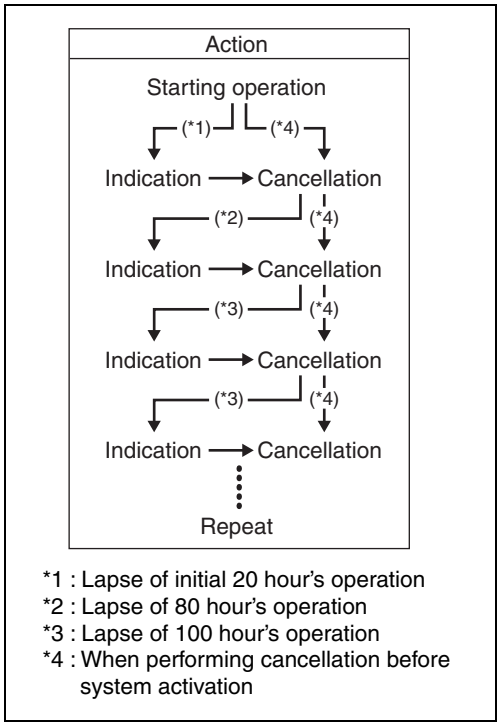
Total operating hours	MONITOR-TACHOMETER	
	Needle ① indication	REV-LIMIT lamp ② flashing *
0 h – (49 h)	No	No
50 h	500 r/min	
60 h	600 r/min	
⋮	⋮	
540 h	5 400 r/min	
550 h	500 r/min	1 time
560 h	600 r/min	
⋮	⋮	
1 040 h	5 400 r/min	
1 050 h	500 r/min	2 times
⋮	⋮	
1 540 h	5 400 r/min	
1 550 h	500 r/min	3 times
⋮	⋮	
2 030 h	5 300 r/min	
2 040 h or over	5 400 r/min	3 times

* : One lamp flash corresponds to 500 hours.

OIL CHANGE REMINDER SYSTEM

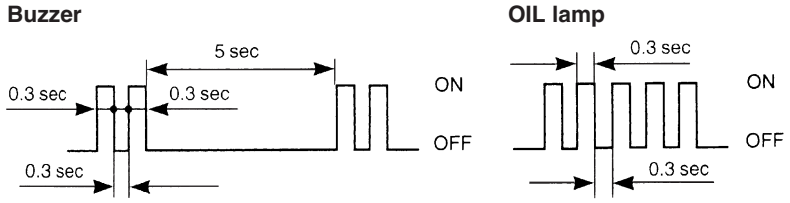
This system informs the operator it is time to change ENGINE OIL based on the recommended maintenance schedule. When the total motor operating hours have reached the preprogrammed hours, the “OIL” lamp will flash, and the buzzer will begin a series of double beeps if engine is not running (but ignition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

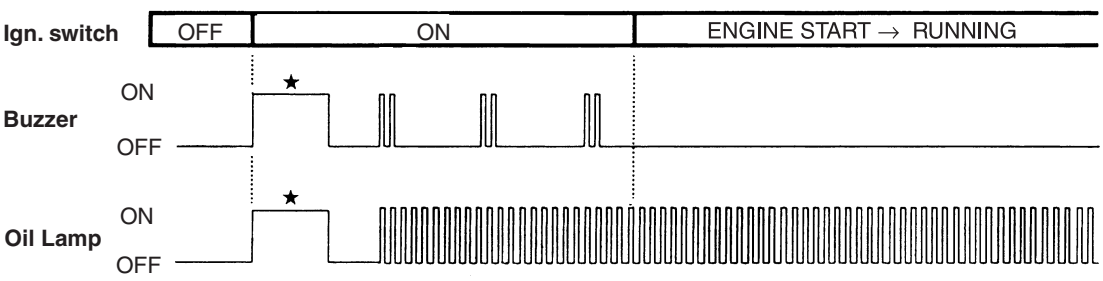
NOTE:
This system will activate up to 2 100 hour’s operation.



*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



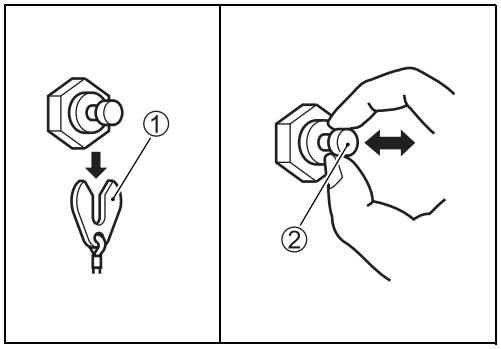


★ : Indicator check (No relation to OIL CHANGE REMINDER SYSTEM)

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.

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.

Operation by Neutral switch on engine starting

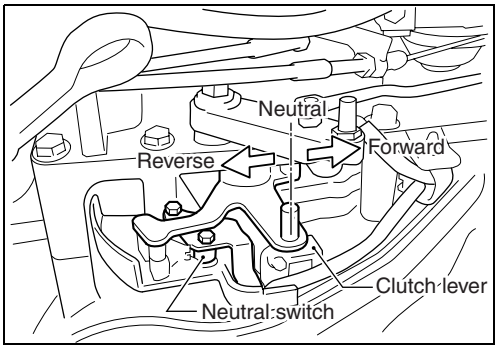
Shift position	OPERATION			
	Fuel injection	Ignition	High pressure Fuel pump	Starter motor
Neutral	YES	YES	YES	YES
Forward/Reverse	NO (✻-1: YES)	NO (✻-1: YES)	NO (✻-1: YES)	NO

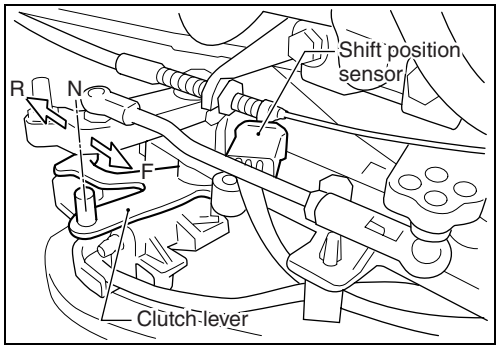
✻-1: If it is in neutral judged by the ECM according to the shift position sensor signal.

Operation by Shift position sensor on engine starting

Shift position	OPERATION			
	Fuel injection	Ignition	High pressure Fuel pump	Starter motor
Neutral	YES	YES	YES	YES
Forward/Reverse	NO (✻-2: YES)	NO (✻-2: YES)	NO (✻-2: YES)	YES

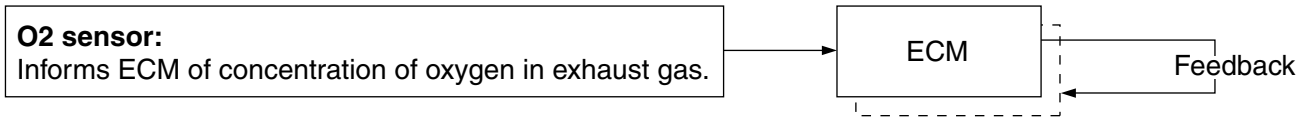
✻-2: If it is in neutral judged by the ECM according to ON signal from the neutral switch.





O2 FEEDBACK SYSTEM

After extended usage, the engine components may become deteriorated or worn.
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:

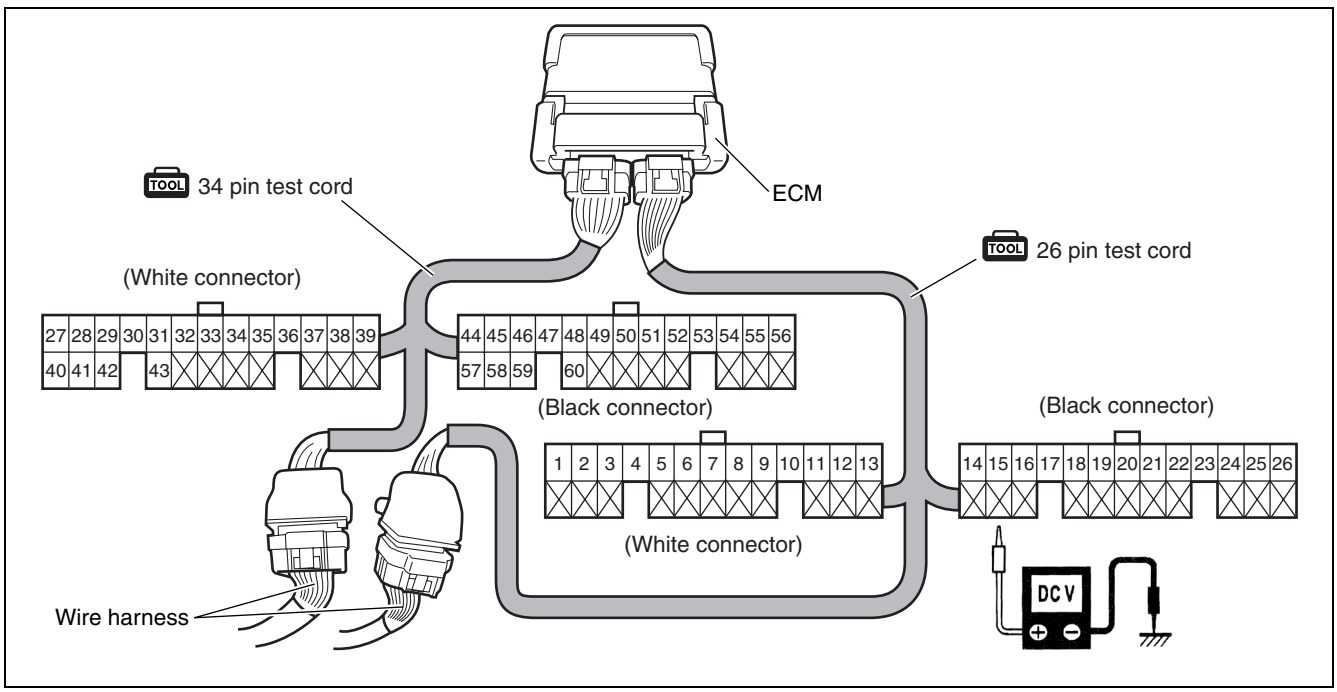
- *The self-diagnostic codes memory in ECM will remain even if battery is disconnected.*
- *As each terminal voltage is affected by battery voltage, use a full-charged battery.*
- *Make sure all ground points have good electrical contact.*
- *Make sure all wires/cables are securely connected.*

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

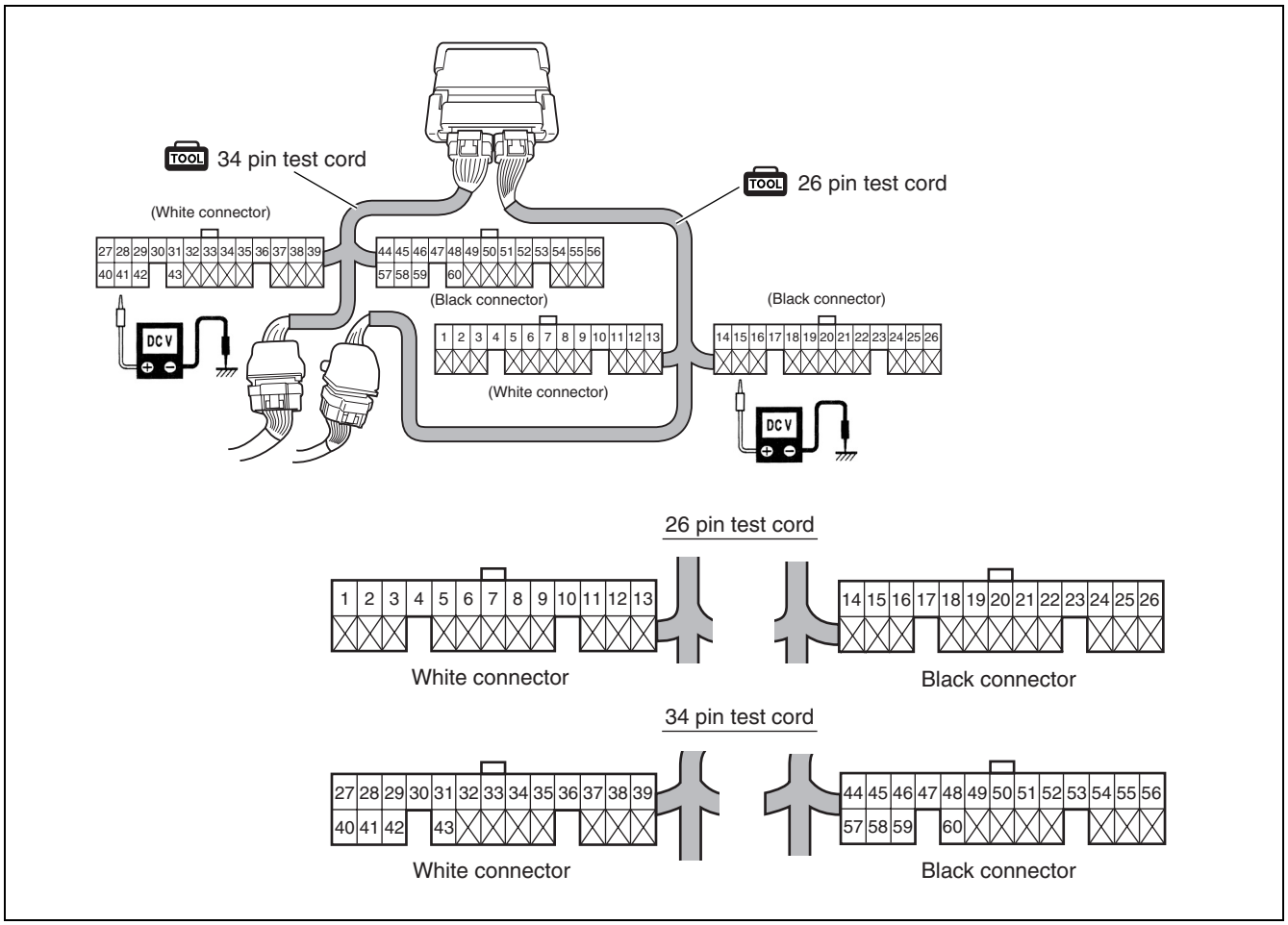
CAUTION

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.

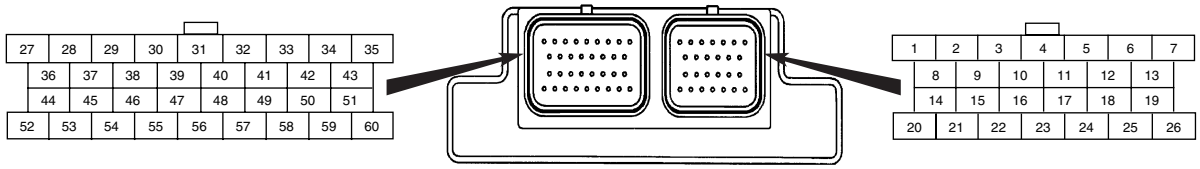
09930-89340: 26-pin & 34-pin test cord
09930-99320: Digital tester

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	G	Starter relay control	Approx. 1.3 V	Ignition switch ON, Shift in Neutral, stop switch plate OUT
			Approx. 0.5 V	Ignition switch ON, Shift in Neutral, 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	—	—	—	—
7	O/G	CMP sensor #2 (VVT)	Approx. 0.3 V or 5 V	Ignition switch ON
8	V/W	Ex. manifold temp. sensor	0.14 – 4.75 V	Ignition switch ON
9	Lg/W	Cylinder temp. sensor	0.14 – 4.75 V	Ignition switch ON
10	—	—	—	—
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 (DF150 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, Stop switch plate IN, Engine stopped, shift into NEUTRAL
			Approx. 2.5 V	Ignition switch ON, Shift into FORWARD 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	—	—	—	—
28	R/W	No. 3 Fuel injector	Approx. 12 V	Ignition switch ON
29	—	—	—	—
30	—	—	—	—
31	Br/R	OCV	Approx. 12 V	Ignition switch ON
32	—	—	—	—
33	Gr/G	Variable intake control valve (VSV)	Approx. 12 V	Ignition switch ON
34	P/W	REV-LIMIT lamp	—	—
35	Y/B	Tachometer	—	—
36	B/Br	No. 2 Fuel injector	Approx. 12 V	Ignition switch ON
37	—	—	—	—
38	—	—	—	—
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	—	—	—	—
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, Shift in Neutral. For 6 sec after ignition switch ON • While engine running
			Approx. 12 V	Engine stopped, Ignition switch ON, stop switch plate IN, Shift in Neutral.
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.

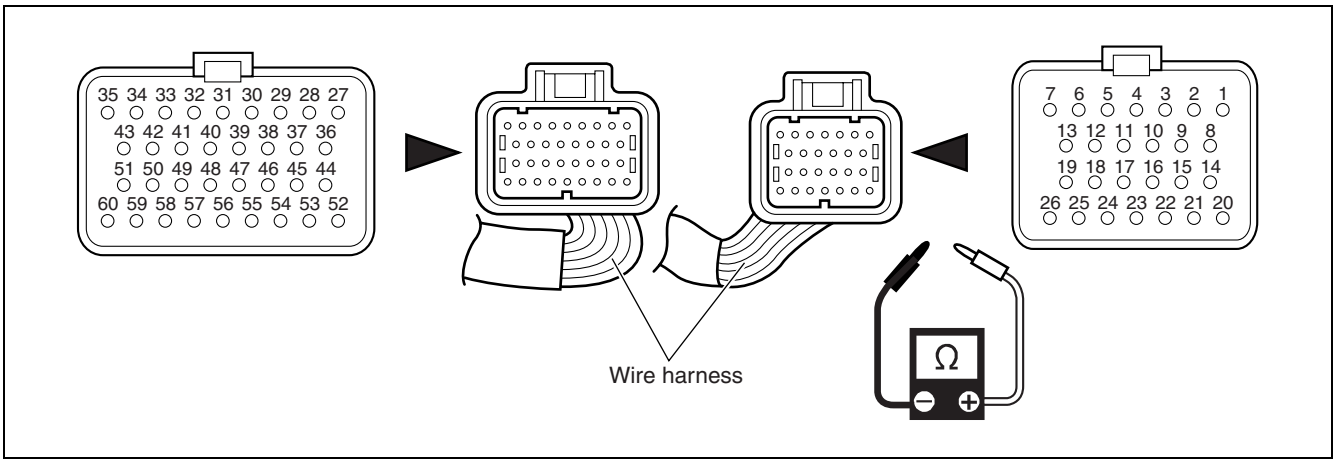
INSPECTION FOR RESISTANCE

09930-99320: Digital tester

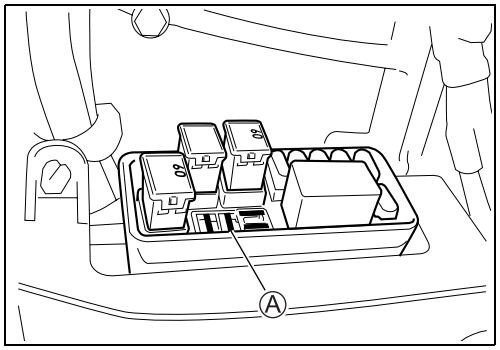
Tester range: Ω (Resistance, See chart for range.)

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

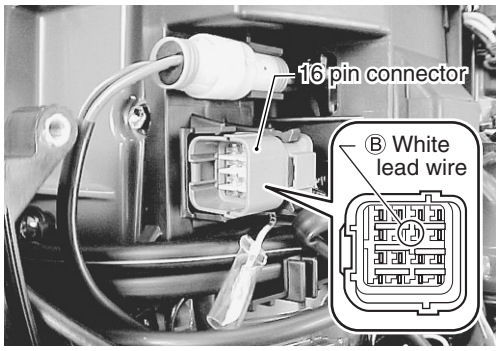
1. Turn ignition switch OFF.
2. Disconnect battery cables from battery.
3. Disconnect wire harness connector from ECM.
4. Connect the tester probes to terminal (wire harness side) and measure resistance according to the "RESISTANCE TABLE".



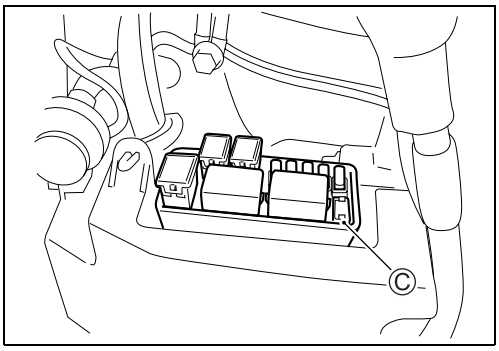
NOTE 1:
Disconnect ECM main relay from fuse box, and connect tester probe to relay terminal "Ⓐ" of fuse box side.



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



NOTE 3:
Disconnect 10 amp. (IAC, CMP) fuse from fuse box and connect tester probe to fuse terminal "Ⓒ" of fuse box side.



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]	
IAC valve #1	55 (W/B) to Terminal Ⓒ [NOTE 3]	25 – 34 Ω
IAC valve #2	56 (R/Y) to Terminal Ⓒ [NOTE 3]	
IAC valve #3	58 (R/G) to Terminal Ⓒ [NOTE 3]	
IAC valve #4	57 (W/Bl) to Terminal Ⓒ [NOTE 3]	
OCV (Oil control valve)	31 (Br/R) to Terminal Ⓒ [NOTE 3]	6.0 – 8.3 Ω
VSV (Vacuum switching valve)	33 (Gr/G) to Terminal Ⓒ [NOTE 3]	34 – 46 Ω
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	8 (V/W) to 49 (B/W)	
ECM main relay	17 (P/B) to Terminal Ⓑ [NOTE 2]	145 – 190 Ω

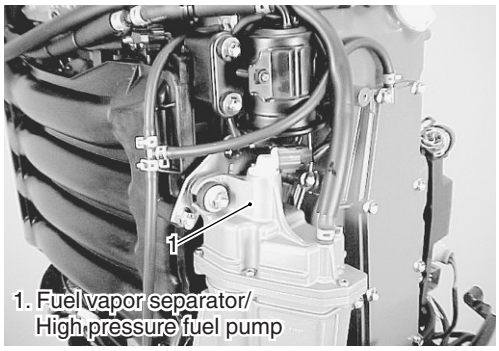
COMPONENT INSPECTIONS

HIGH PRESSURE FUEL PUMP 6 SEC OPERATING SOUND

1. Install the emergency stop switch lock plate in position.
2. Shift into Neutral.
3. 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.

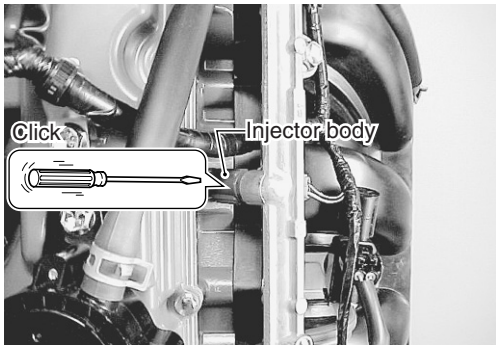


1. Fuel vapor separator/ High pressure fuel pump

FUEL INJECTOR OPERATING SOUND (CRANKING)

1. Disconnect all ignition coil connectors.
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"



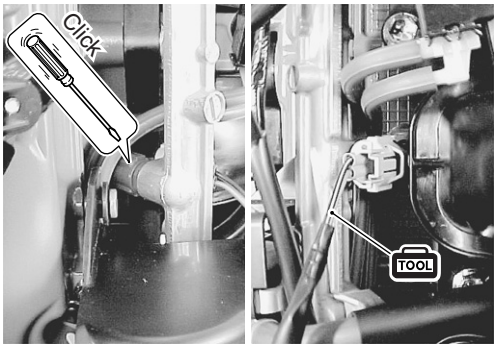
FUEL INJECTOR OPERATING SOUND (INDIVIDUAL)

1. Disconnect fuel injector wire and connect test cord.

   TOOL 09930-89260: Injector test cord A

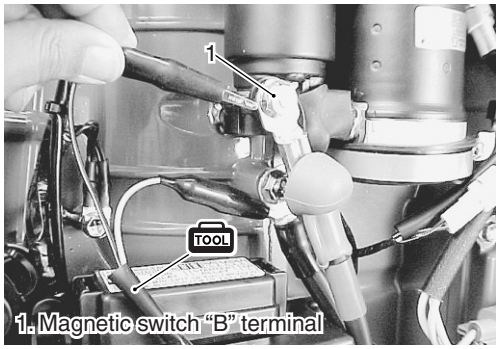
2. Connect Gray wire to body ground.
3. Momentarily touch Black/Yellow wire to starter motor magnetic switch "B" terminal (connected to battery positive ⊕ terminal) and check for injector operating sound.

   Injector operating sound: "Click"



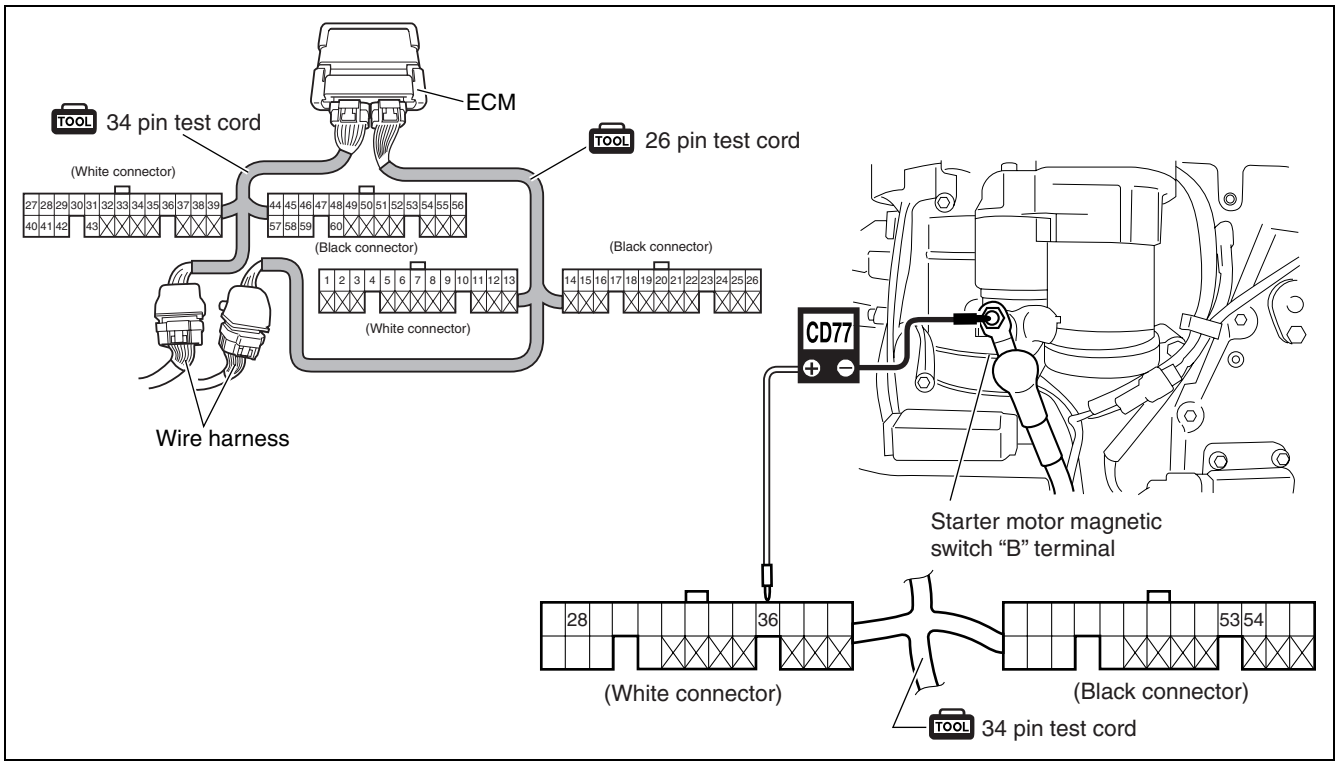
CAUTION

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



1. Magnetic switch "B" terminal

FUEL INJECTOR OPERATING SIGNAL



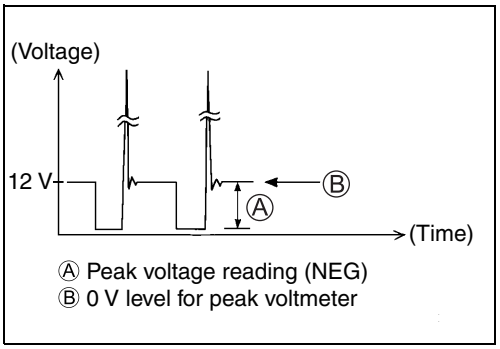
TOOL 09930-89340: 26-pin & 34-pin test cord

Peak voltmeter Stevens CD-77

Tester range: NEG 50

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

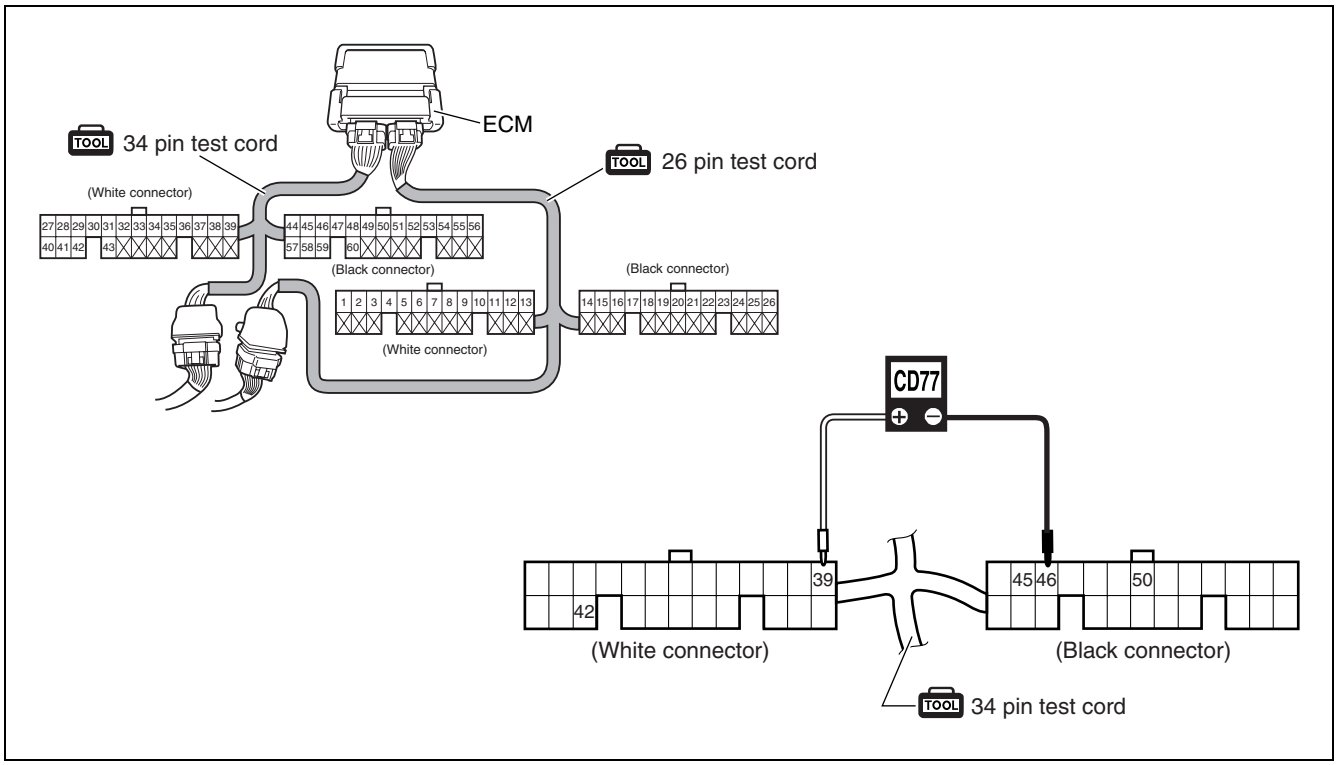
Injector	Terminal	Wire color (engine harness)
No. 1	54	O/B
No. 2	36	B/Br
No. 3	28	R/W
No. 4	53	Lg



5. 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

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

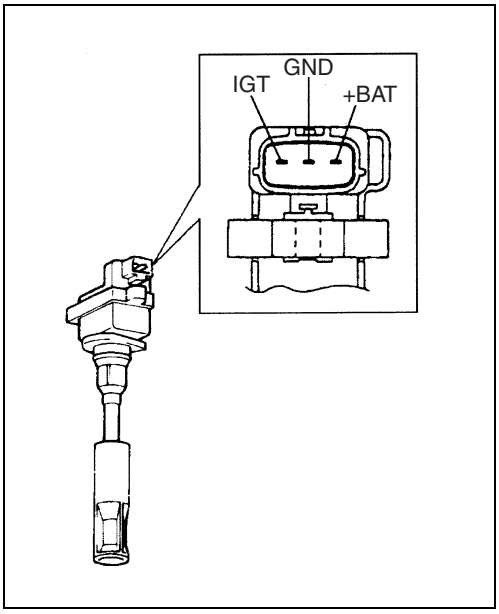
   Ignition coil operating signal: Approx. 5 V

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 3-55.)
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.)

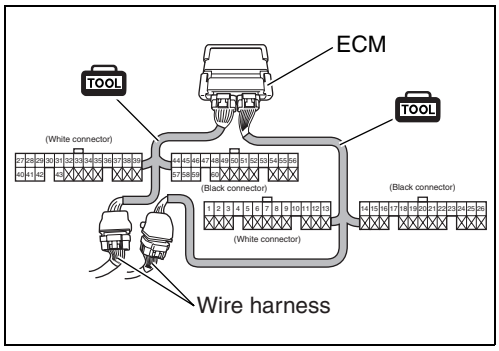
1. Turn ignition switch OFF.
2. Remove CMP sensor. (See page 3-69.)
3. Connect the 26-pin & 34-pin test cord between ECM and wire harness as shown in figure.
4. Connect the tester probe ("⊕", Red) to each terminal.

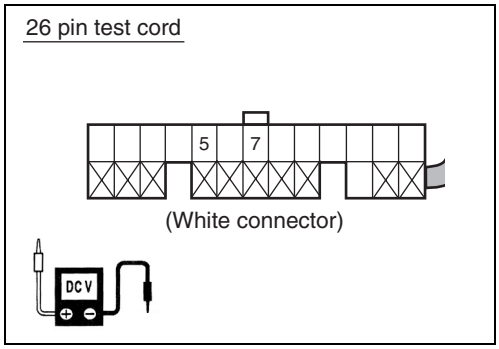
CMP sensor	Terminal	Wire color (engine harness)
No. 1	5	Y/Bl
No. 2 (VVT)	7	O/G

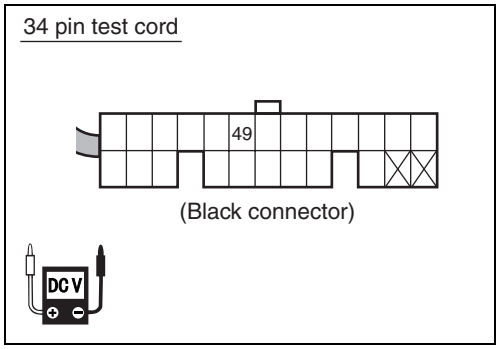
5. Connect the tester probe ("⊖", Black) to No. 49 terminal (or to body ground).
6. Turn ignition switch ON.
7. Measure the voltage when the tip of a steel screwdriver is brought near and then pulled away from the sensor tip.

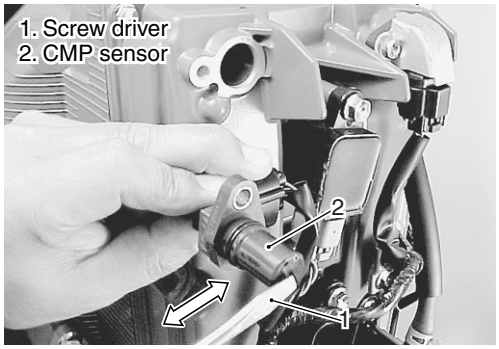
   When screwdriver is brought near: Approx. 5 V
   When screwdriver is pulled away: Approx. 0.3 V

   If the voltage does not change in the above test, check wire harnesses for open and short.
   If wire harnesses are in good condition, replace CMP sensor and recheck.





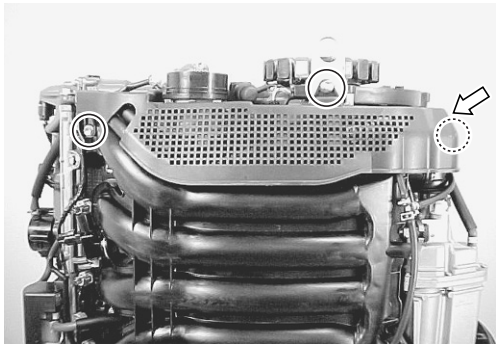




MAP SENSOR OUTPUT VOLTAGE CHANGE

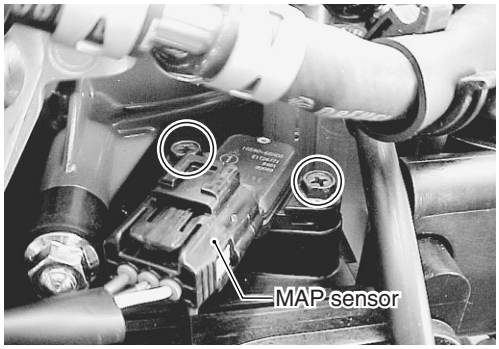
09917-47011: Vacuum pump gauge
09930-89340: 26-pin & 34-pin test cord
09930-99320: Digital tester

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



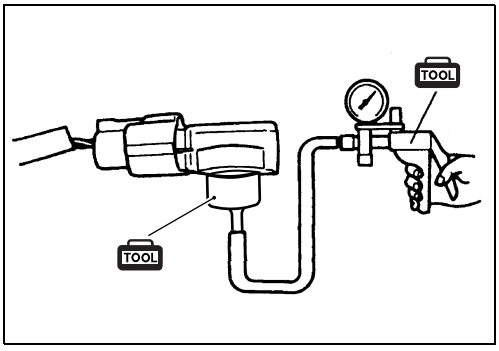
1. Remove flywheel. (See page 3-66.)
2. Remove the three bolts and fuel hose guard.

3. Remove bolts and MAP sensor from intake manifold.

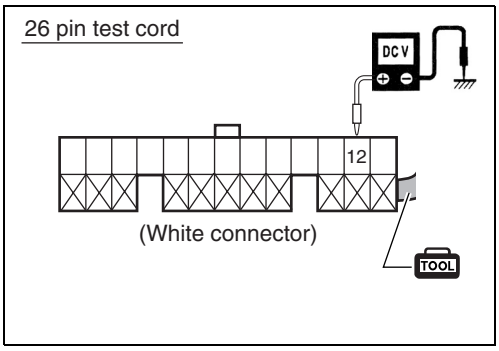


4. Install MAP sensor into special tool.

09917-49610: Vacuum pump adaptor



5. Connect vacuum pump gauge (with hose) to MAP sensor (special tool) as shown in figure.
6. Turn ignition switch ON.
7. While applying negative pressure (vacuum) to MAP sensor, measure "12" terminal voltage. (See page 3-48 and 3-49 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

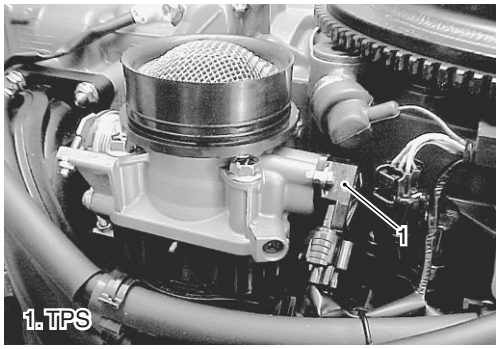
(at 759.8 mmHg, 29.91 inHg, 1013 hPa barometric pressure)

8. If out of specification, check wire harnesses for open and short. If wire harnesses are in good condition, replace MAP sensor and recheck.

TPS (Throttle position sensor)

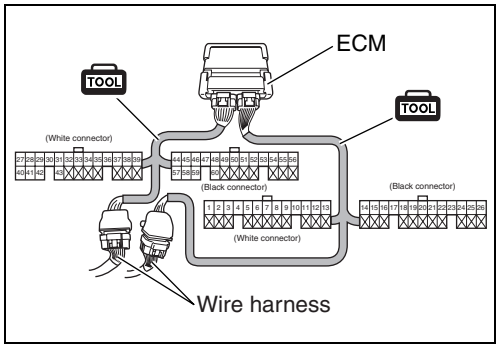
09930-99320: Digital tester
09930-89340: 26-pin & 34-pin test cord
Tester range: ⎓ DCV (See chart for range.)

1. Turn ignition switch OFF.
2. Connect the 24-pin & 34-pin test cord between ECM and wire harness as shown in figure.
3. Connect tester probe ("⊕", Red) to No.16 terminal.
4. Connect tester probe ("⊖", Black) to No.49 terminal (or to body ground).
5. Turn the ignition switch ON.

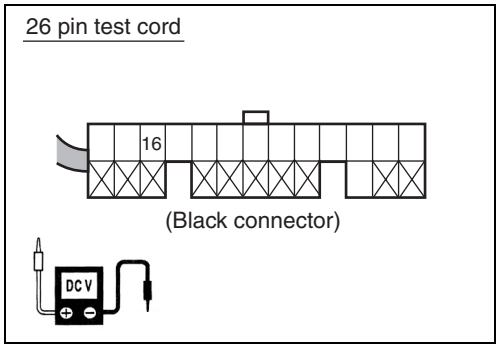


6. Check for sensor output voltage.
   Slowly move the throttle lever to open, and check if voltage changes linearly within specification, according to throttle valve opening angle.

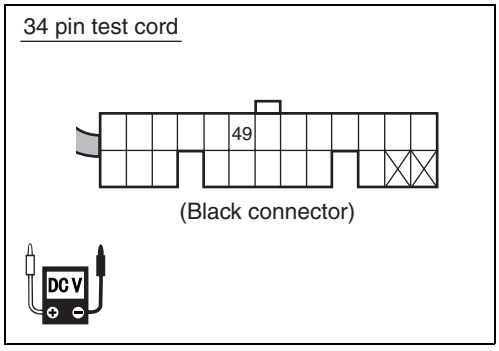
   Sensor output voltage:
   FCT position : Approx. 0.7 V
   WOT position : Approx. 3.8 V



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.



7. If out of specification, check wire harnesses for open and short. If wire harnesses are in good condition, replace throttle body and recheck.

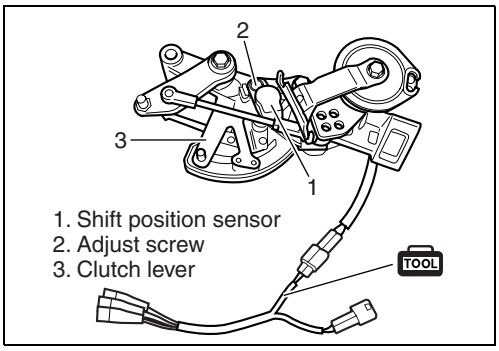


SHIFT POSITION SENSOR

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

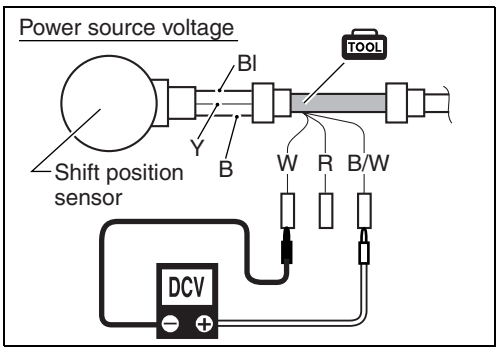
1. Turn ignition switch OFF.
2. Connect 3-pin test cord between shift position sensor and wire harness as shown in figure.
3. Turn the ignition switch ON.
4. Connect tester probe as shown in the illustration and check for sensor power source voltage.

   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:

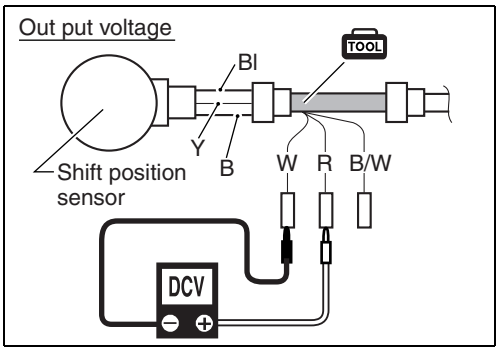
Shift position	Output voltage
Forward	Approx. 4.1 V
Neutral	Approx. 2.3 V
Reverse	Approx. 0.8 V



If out of specification:

- 1st Check remo-con cable adjustment, readjust if necessary.
- 2nd Check wire harnesses for open and short.
  If wire harnesses are in good condition, replace shift position sensor and recheck.

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



OIL PRESSURE SWITCH

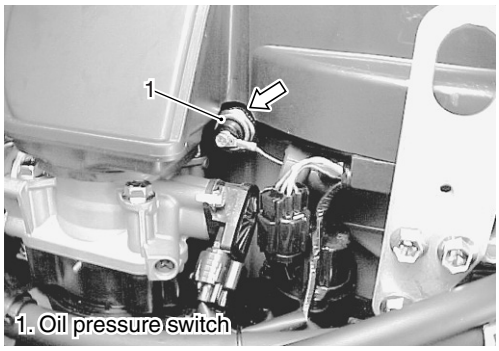
NOTE:
Before checking the oil pressure switch, make sure the engine oil pressure is within specification.

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

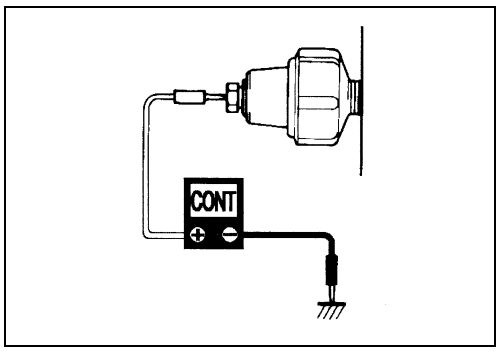
09930-99320: Digital tester

Tester range: (Continuity)

Engine running	Infinity
Engine stopped	Continuity



If measurement exceeds specification, replace oil pressure switch.



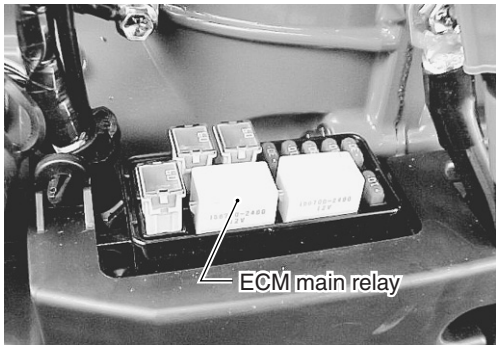
3. Reinstall parts removed earlier.

ECM MAIN RELAY

09930-99320: Digital tester

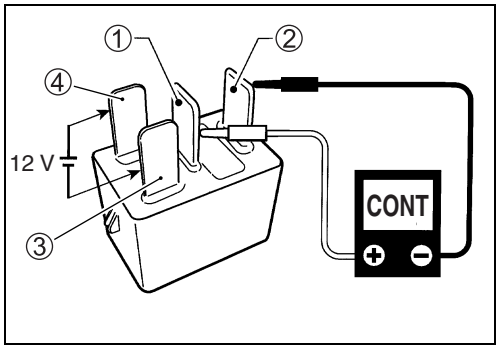
Tester range: (Continuity)

1. Disconnect ECM main relay from fuse box.
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



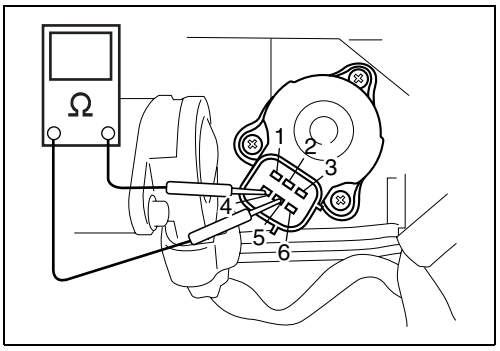
CAUTION

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

IAC VALVE

1. Disconnect connector from IAC valve.
2. Check each coil of IAC valve for resistance.

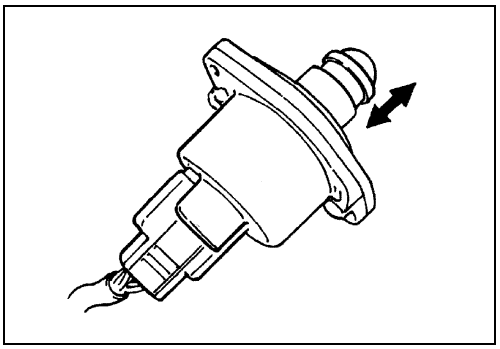
Terminals	Resistance
Between "1" and "2" "3" and "2" "4" and "5" "6" and "5"	25 – 34 Ω



If out of specification, replace IAC valve.

3. Remove IAC valve from intake manifold. (See page 3-69.)
4. Connect connector to IAC valve.

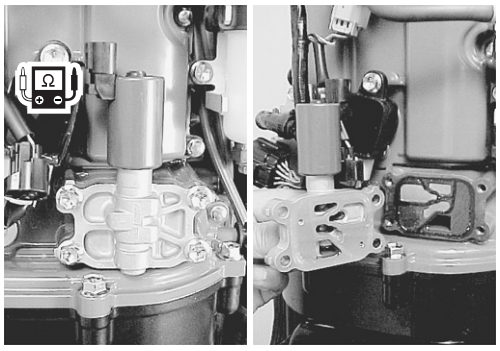
5. When the ignition switch is turned ON and OFF, check that the rotary valve turns to open and returns to closed.
6. If the valve does not turn, check the wiring harness for continuity (between ECM and IAC valve) and connector contact condition.

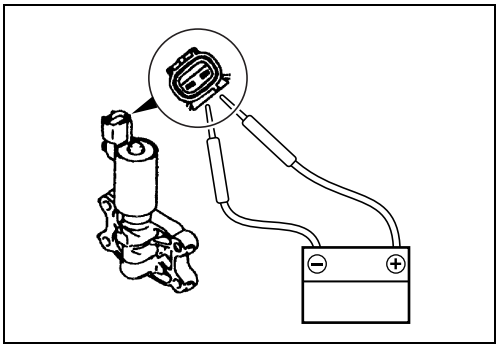


OCV (Oil control valve)

1. Remove OCV. (See page 3-71.)
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

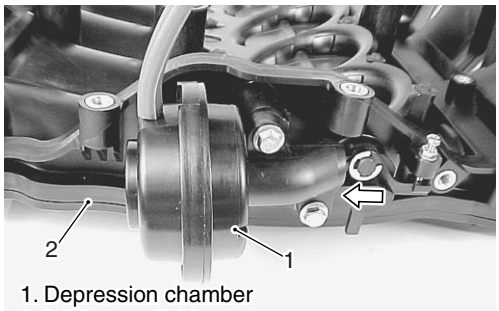




MULTI-STAGE INDUCTION

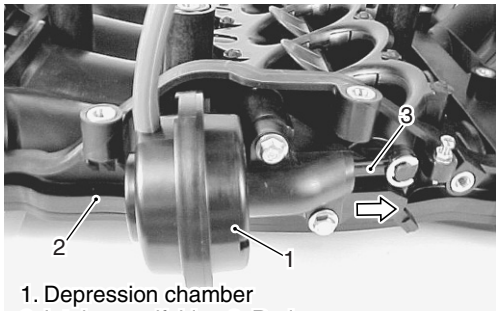
SYSTEM INSPECTION

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



1. Depression chamber
2. Intake manifold

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

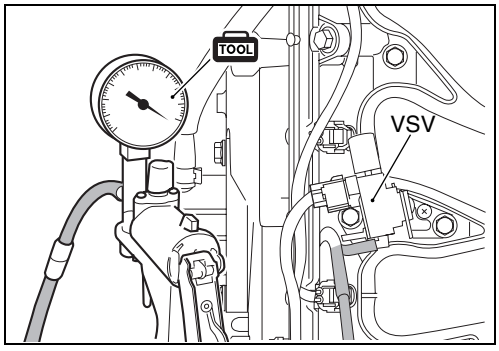


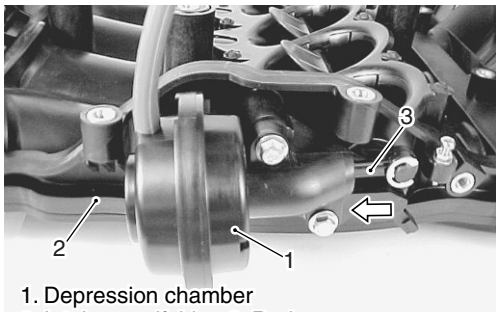
1. Depression chamber
2. Intake manifold 3. Rod

DEPRESSION CHAMBER

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.

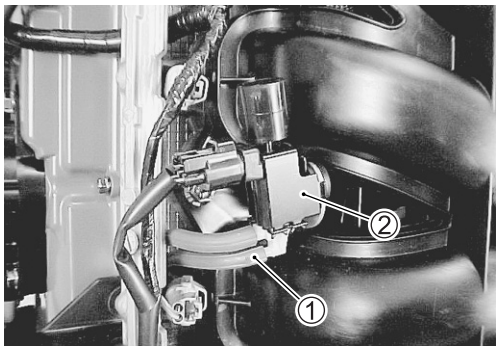




1. Depression chamber
2. Intake manifold 3. Rod

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 white side of check valve. Air should not pass through valve from intake manifold (white side ③) to green side ②.
3. Blow air (low pressure) through hose fitting on green side of check valve. Air should pass through to white 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.

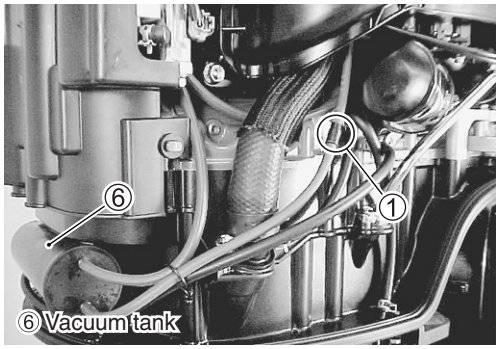
⚠ WARNING

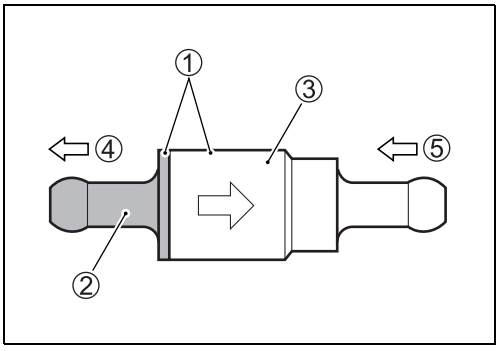
DO NOT SUCK air through check valve.
Fuel vapor inside the valve is harmful.

5. Install check valve.

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

④ *To vacuum tank*
⑤ *From intake manifold assembly*

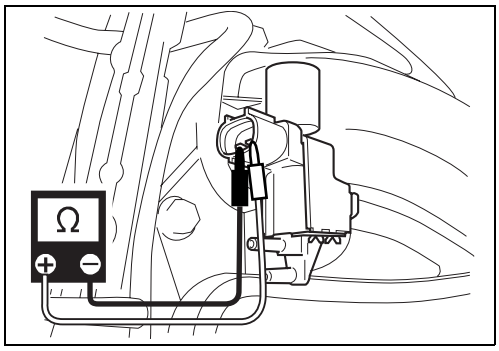




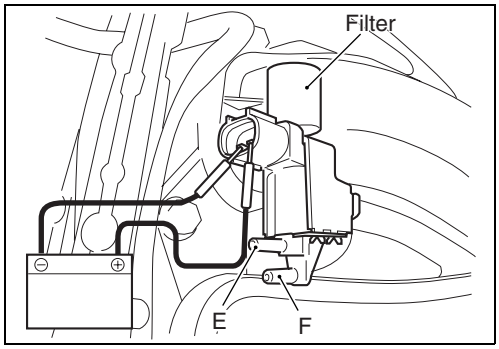
VSV (Vacuum switching valve)

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

   Resistance of VSV: 37 – 44 Ω



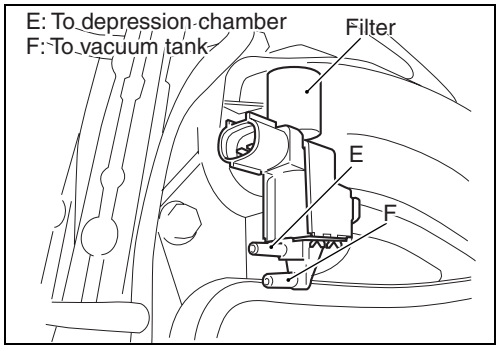
3. Disconnect two hoses from VSV.
4. With 12 V applied between the VSV terminals, check that port (E) connects to port (F) but not to the filter section.
5. Without voltage applied to the VSV terminals, check that port (E) connects to the filter section but not to port (F).



VSV AIR PASSAGE CONTINUITY

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

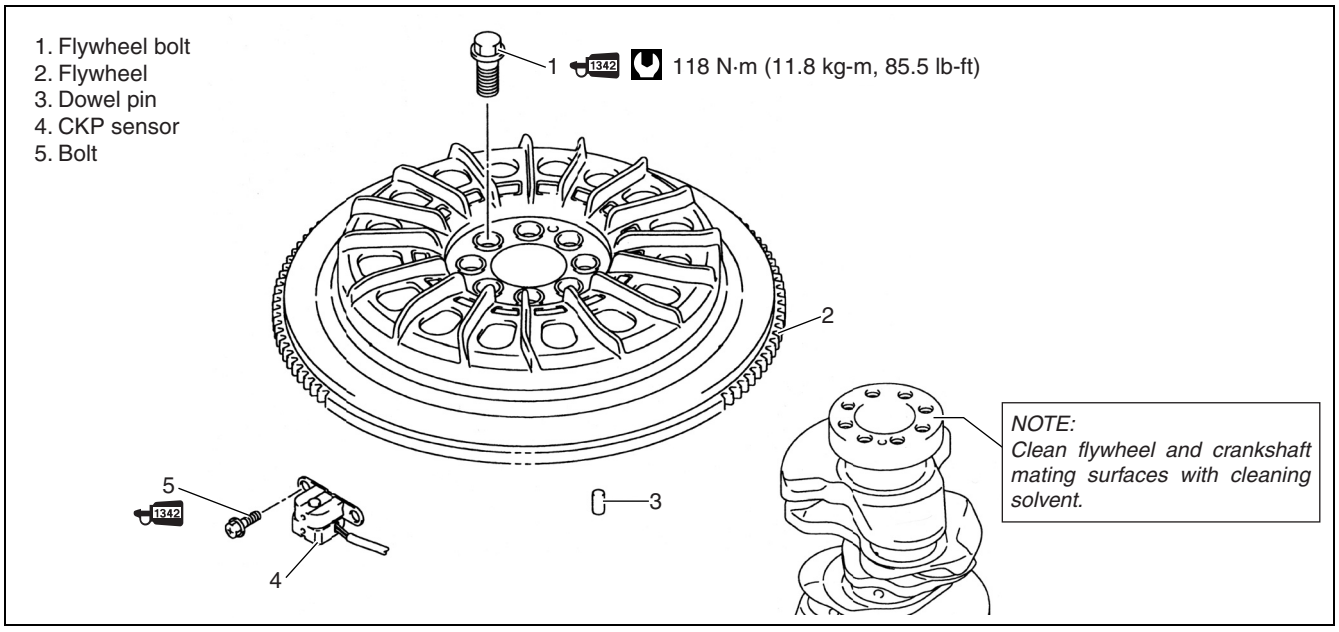
○——○: Air passage



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

REMOVAL/INSTALLATION

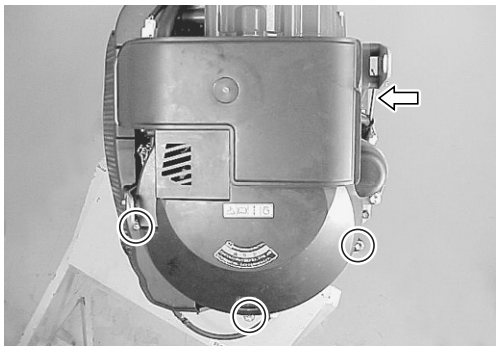
FLYWHEEL



REMOVAL

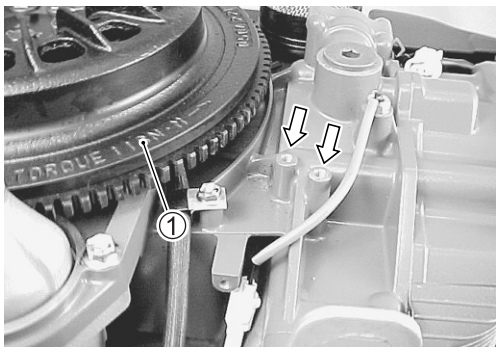
Prior to removing flywheel:
- **Disconnect battery cables from battery.**

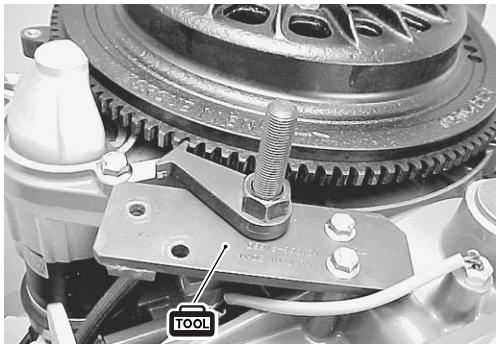
1. Remove ring gear cover and air intake silencer case. (See page 6-2.)



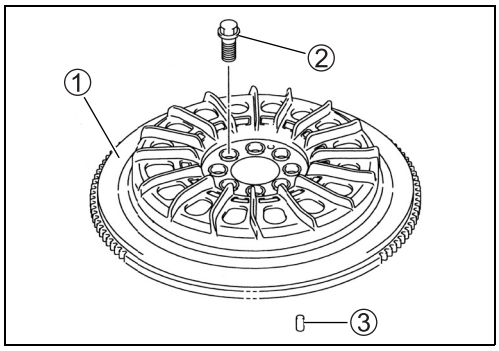
2. To lock the flywheel ① when removing attaching bolts, use special tool shown in figure.
   Use screws and threaded holes on top of cylinder to attach special tool.

TOOL **09916-99311: Flywheel holder**





3. Remove eight (8) flywheel bolts ②.
4. Remove flywheel ① and dowel pin ③.



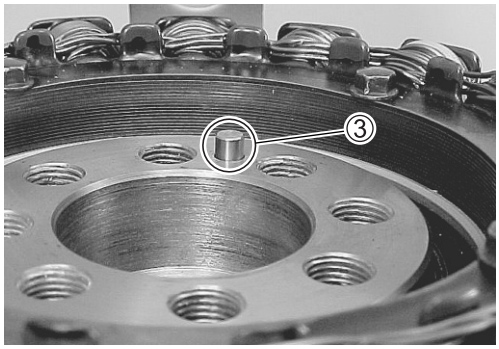
INSTALLATION

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

- Install dowel pin ③.
- Install flywheel ① onto crankshaft making sure to align dowel pin hole.

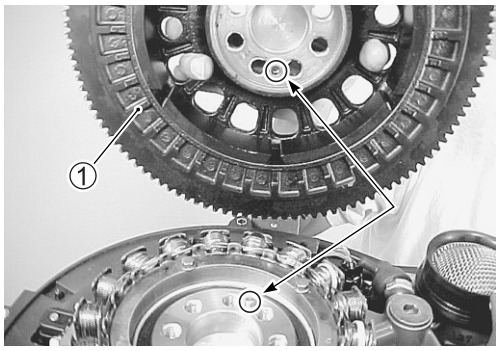
NOTE:

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.

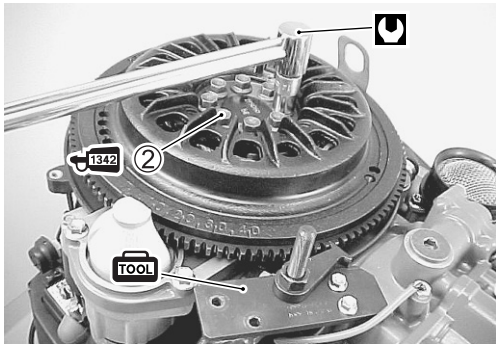


- Apply THREAD LOCK "1342" to flywheel bolts ② before installing.
- Tighten flywheel bolts ② to specified torque. To lock flywheel, use special tool as shown in figure.

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

09916-99311: Flywheel holder

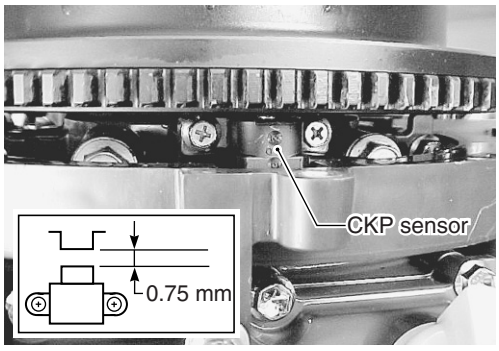
99000-32050: THREAD LOCK "1342"



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

Air gap: 0.75 mm (0.030 in)

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

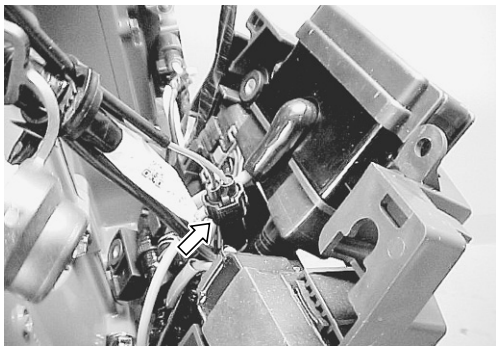


CKP SENSOR

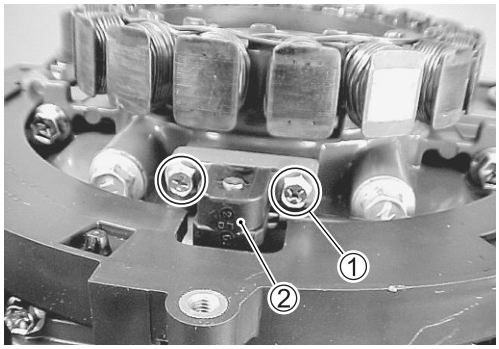
REMOVAL

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

1. Remove flywheel. (See page 3-66.)



2. Remove the electric parts holder. (See page 4-30.)
3. Disconnect CKP sensor lead wire connector in electric parts holder.
4. Remove two (2) screws ① and CKP sensor ②.

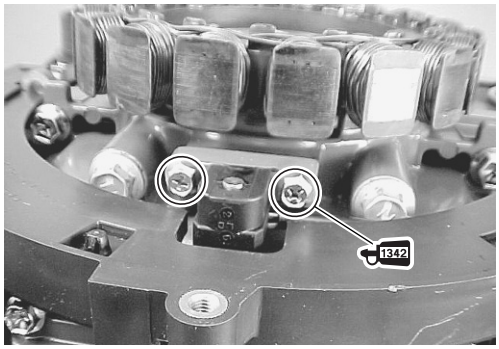


INSTALLATION

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

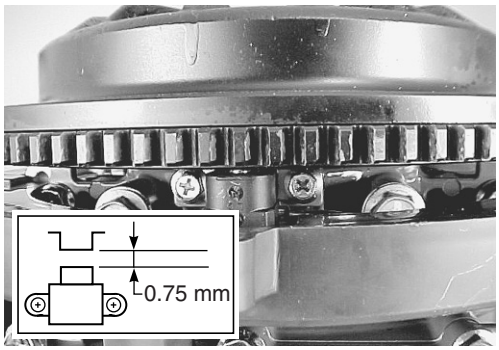
- Apply THREAD LOCK “1342” to the sensor mounting screws.

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)

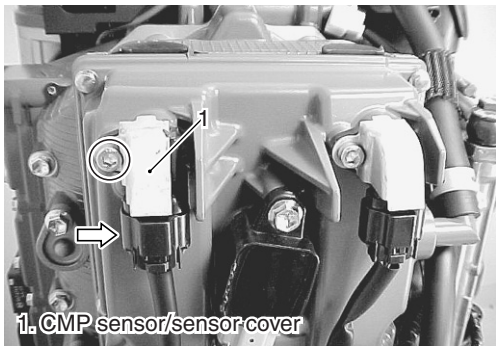


- Check to ensure that all removed parts are back in original position.
- Check wire routing. (See page 11-4 to 11-10.)

CMP SENSOR

REMOVAL

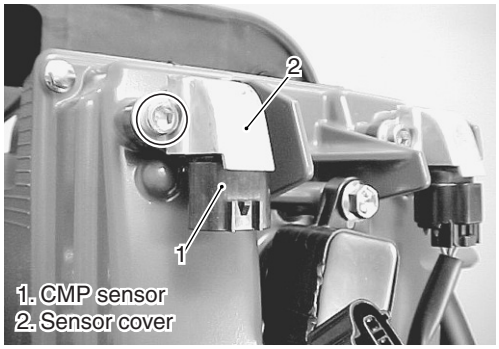
1. Disconnect CMP sensor lead wire connector at sensor.
2. Remove bolt, CMP sensor and sensor cover.



INSTALLATION

Installation is reverse order of removal.

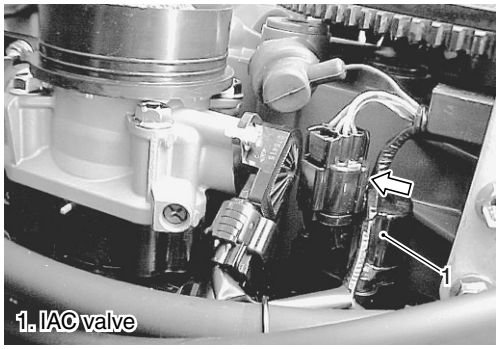
- Install CMP sensor and sensor cover, then tighten sensor mounting screw securely.
- Connect sensor lead wire connector to CMP sensor.



IAC VALVE

REMOVAL

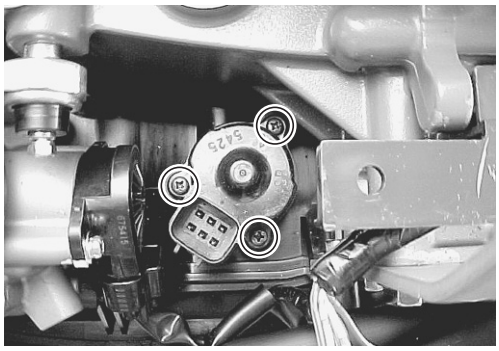
1. Remove flywheel. (See page 3-66.)
2. Disconnect IAC valve lead wire connector at IAC valve.
3. Remove screws and IAC valve.



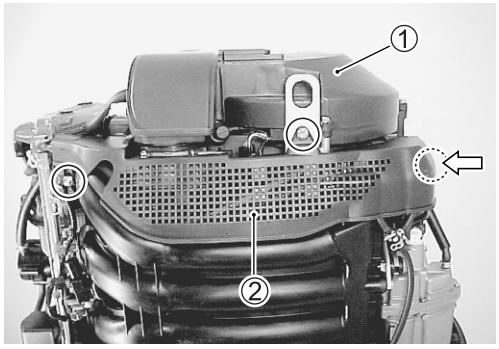
INSTALLATION

Installation is reverse order of removal.

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

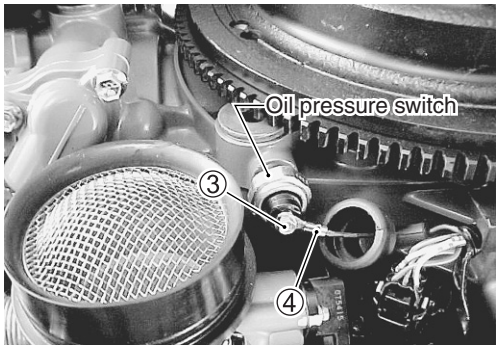


OIL PRESSURE SWITCH



REMOVAL

1. Remove the ring gear cover and air intake silencer case ①. (See page 6-2.)
2. Remove the three bolts and fuel hose guard ②.



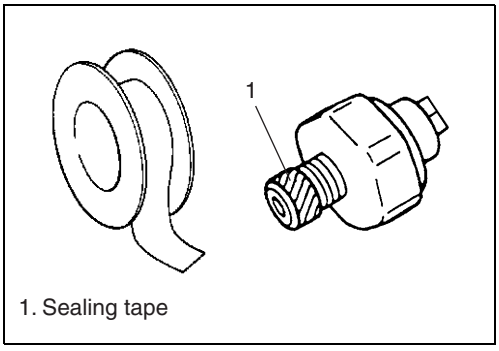
3. Loosen screw ③ and disconnect blue lead wire ④ from switch.
4. Remove oil pressure switch from cylinder block.

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.

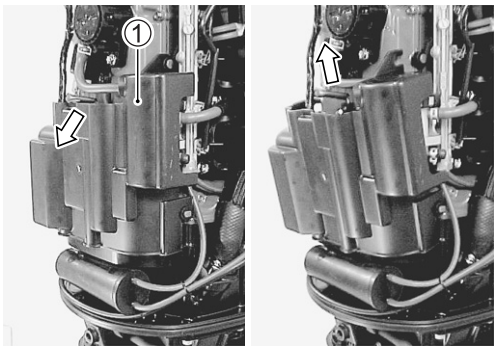


1. Sealing tape

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

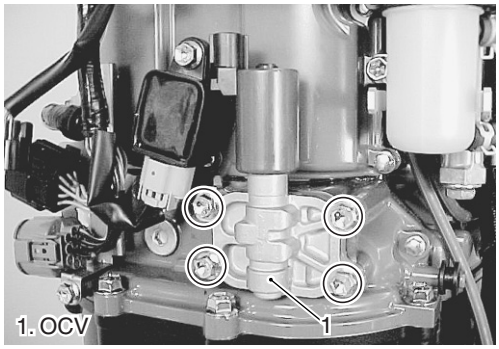
- Install the ring gear cover and air intake silencer case.
- Start engine and check oil pressure switch for oil leakage. Reseal switch if oil leakage is found.

OCV (Oil control valve)



REMOVAL

1. To remove the cover ①, pull the upper part outward, then lift up.
2. Disconnect OCV lead wire connector at OCV.
3. Remove the four (4) bolts securing OCV, then remove OCV and discard OCV gasket.



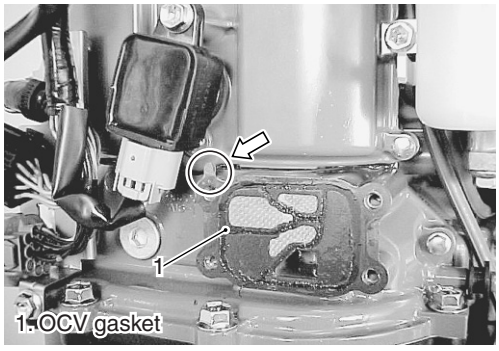
INSTALLATION

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

- Install gasket and OCV, then tighten bolts securely.

NOTE:

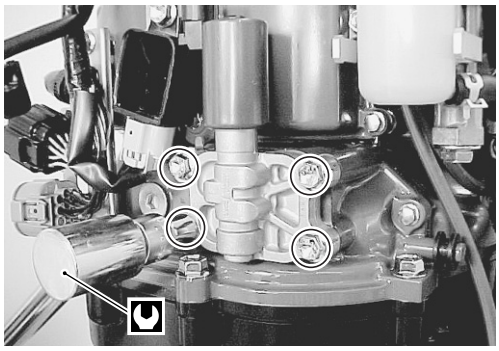
Position the OCV gasket tab as shown at right.



CAUTION

Do not reuse the OCV gasket, always replace with new one.

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



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

TROUBLESHOOTING

⚠ WARNING

Before starting troubleshooting, read and follow the "PRECAUTION ON SYSTEM INSPECTION" section on page 3-47.

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

NOTE:
For troubleshooting of "Starter motor will not run", see page (4-13).

CHART 1: SELF-DIAGNOSTIC CODE "3-4" MAP sensor

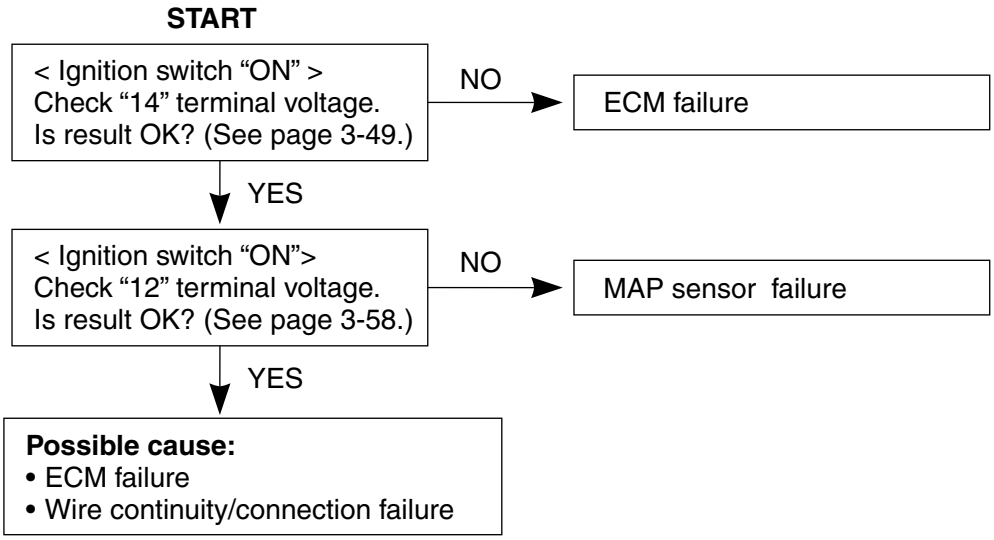


CHART 2: SELF-DIAGNOSTIC CODE "3-1" IAC system

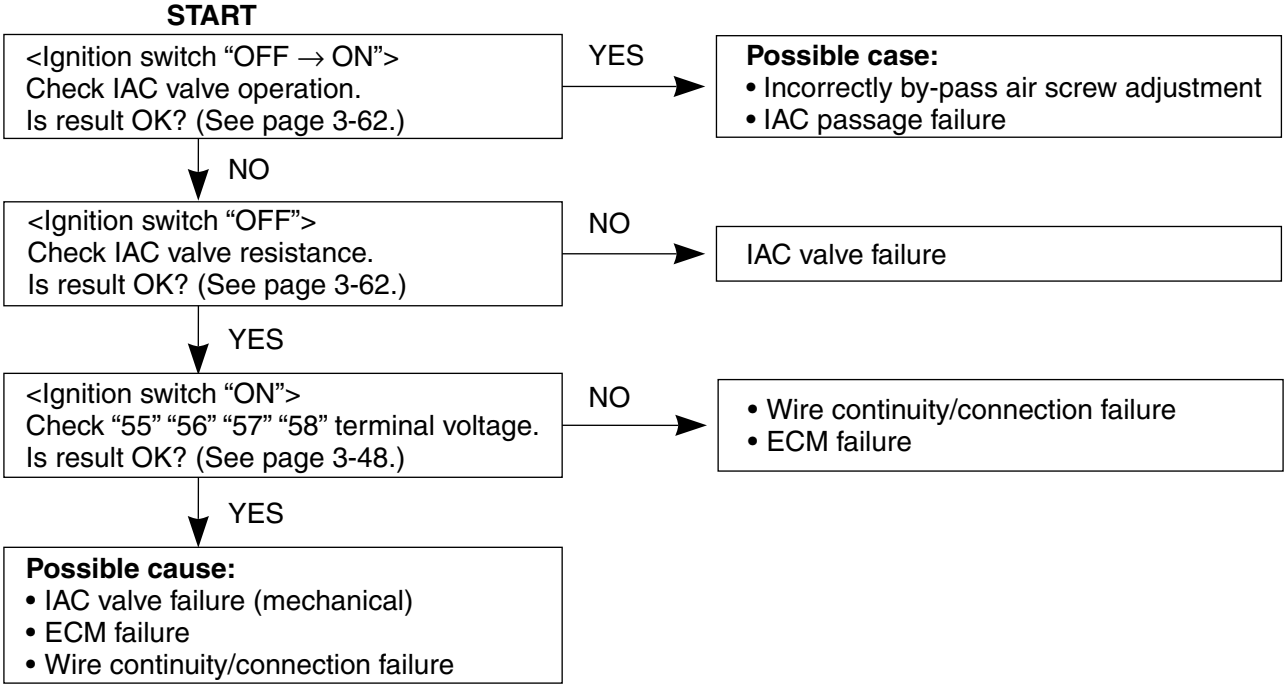


CHART 3: SELF-DIAGNOSTIC CODE “1-4” Cylinder temp. sensor

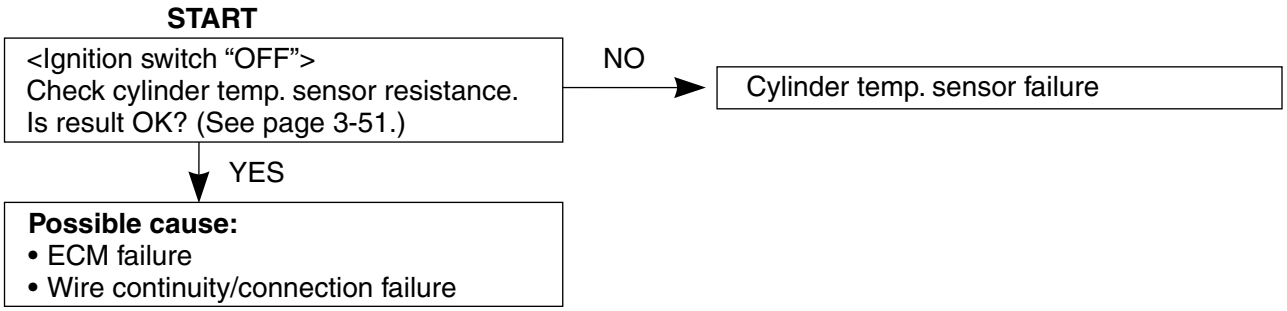


CHART 4: SELF-DIAGNOSTIC CODE “2-3” IAT sensor

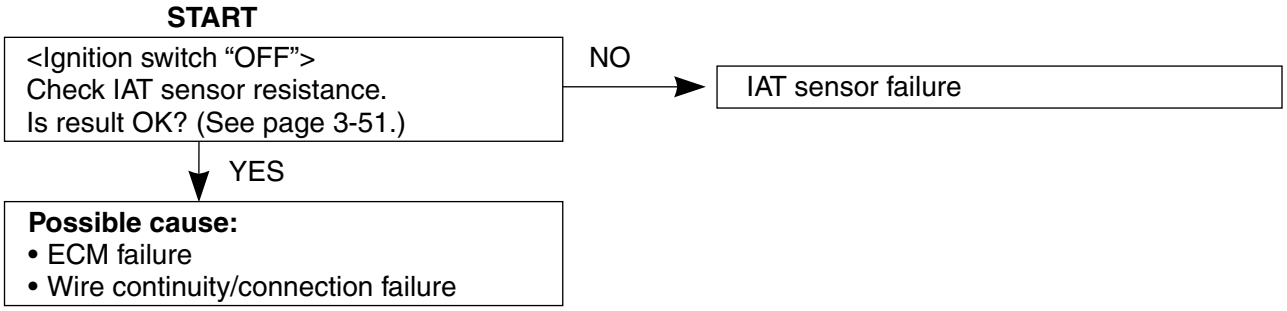


CHART 5: SELF-DIAGNOSTIC CODE “4-2” CKP sensor

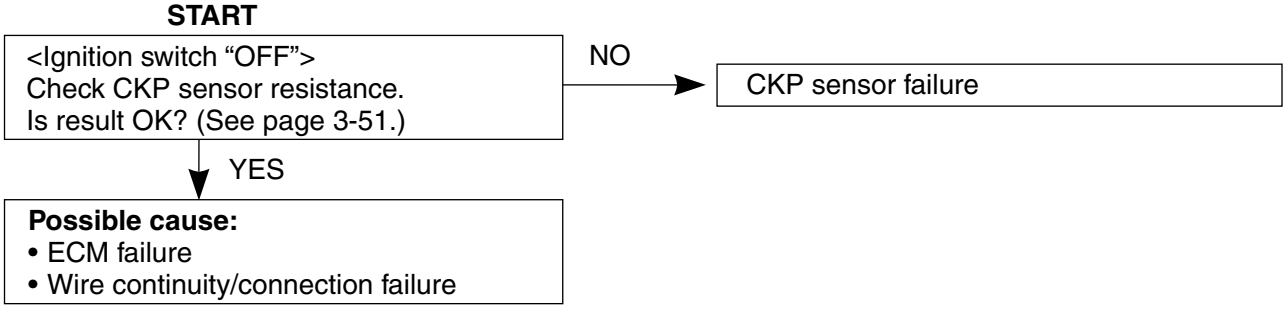


CHART 6: SELF-DIAGNOSTIC CODE “2-4” CMP sensor

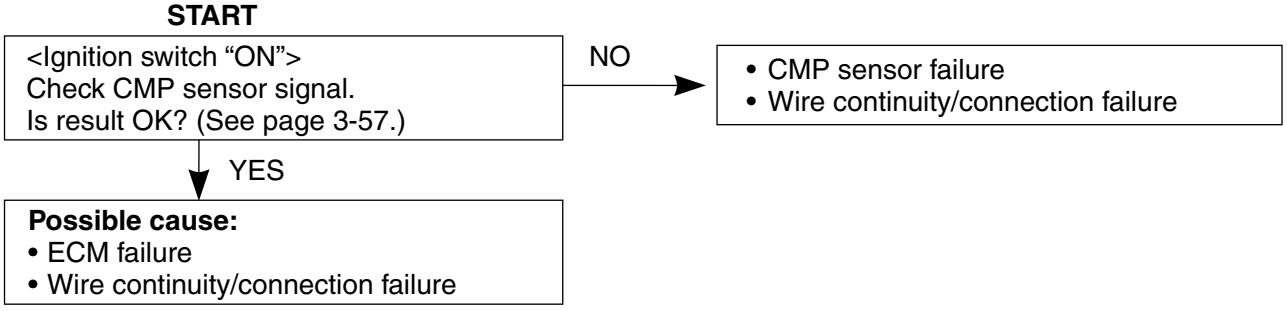


CHART 7: SELF-DIAGNOSTIC CODE “2-2” Air intake system

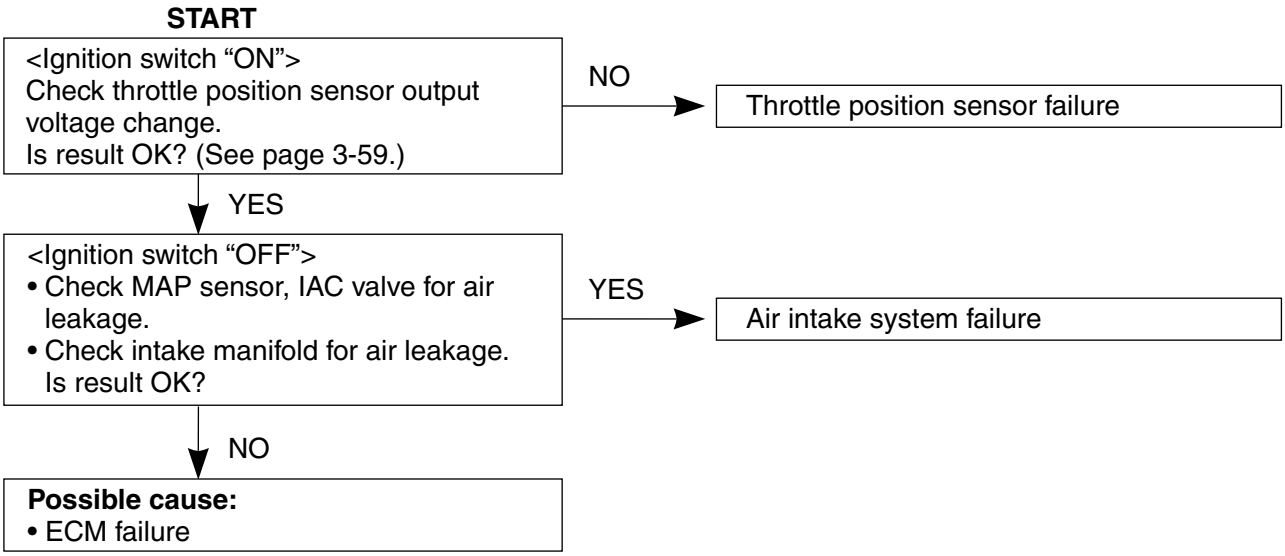


CHART 8: SELF-DIAGNOSTIC CODE “3-2” MAP sensor 2

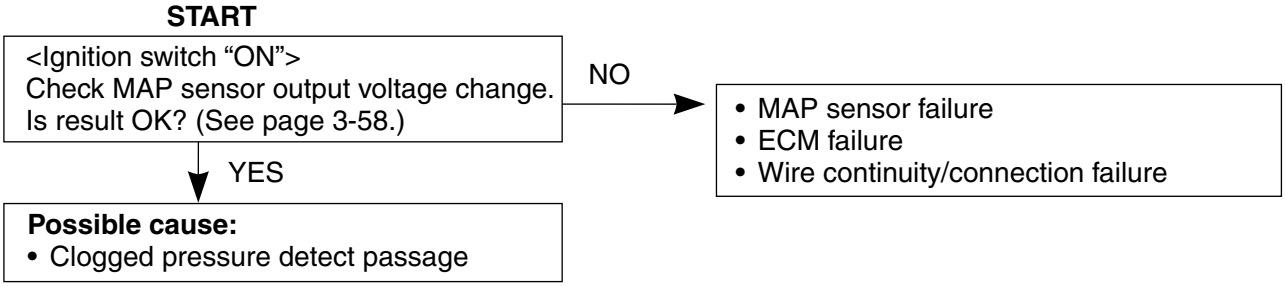


CHART 9: SELF-DIAGNOSTIC CODE “1-5” Ex. mani. temp. sensor

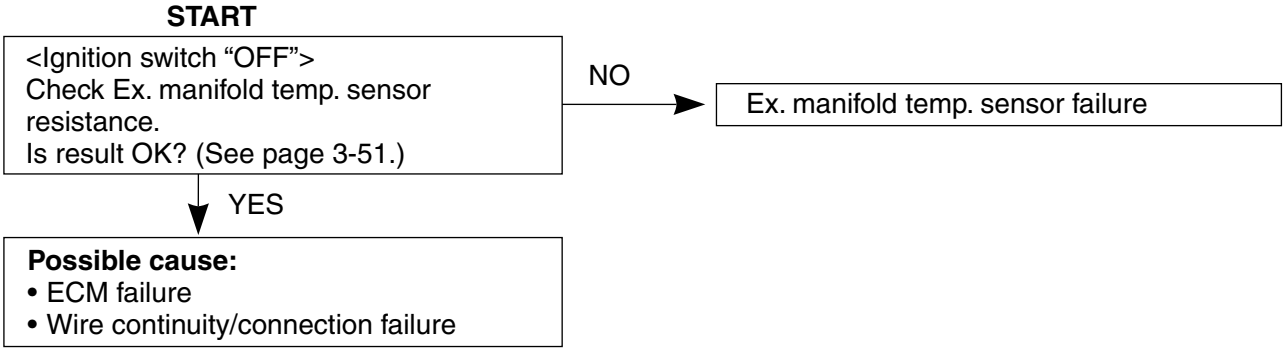


CHART 10: SELF-DIAGNOSTIC CODE “4-3” Fuel injector

START

<Ignition switch “ON”>
Check “28” “36” “53” “54” terminal voltage.
Is result OK? (See page 3-48.)

NO → • ECM failure
• Wire continuity/connection failure

YES ↓

<Ignition switch “ON”>
Check fuel injector operating signal.
Is result OK? (See page 3-54.)

NO → • ECM failure
• Wire continuity/connection failure

YES ↓

<Ignition switch “OFF”>
Check fuel injector operating sound (individual).
Is result OK? (See page 3-53.)

NO → • Fuel injector failure

YES ↓

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

CHART 11: SELF-DIAGNOSTIC CODE “2-1” Throttle position sensor

START

<Ignition switch “ON”>
Check throttle position sensor output voltage change.
Is result OK? (See page 3-59.)

NO → • Throttle position sensor failure
• Wire continuity/connection failure

YES ↓

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

CHART 12: SELF-DIAGNOSTIC CODE “1-2” Shift position sensor

START

<Ignition switch “ON”>
Check shift position sensor output voltage change.
Is result OK? (See page 3-60.)

NO → • Shift position sensor failure
• Wire continuity/connection failure

YES ↓

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

CHART 13: SELF-DIAGNOSTIC CODE “2-6” CMP sensor (VVT)

START

<Ignition switch “ON”>
Check CMP sensor (VVT) signal.
Is result OK? (See page 3-57.)

NO → • CMP sensor failure
• Wire continuity/connection failure

YES ↓

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

CHART 14: SELF-DIAGNOSTIC CODE “5-2” VVT advance

START

<Ignition switch “ON”>
Check “20” “23” terminal voltage (ECM power source voltage).
Is result OK? (See page 3-48.)

NO → ECM power source (battery, battery switch, sub-battery cable, etc.) failure.

YES ↓

<Ignition switch “OFF”>
Check OCV operation and OCV gasket filter condition.
Is result OK? (See page 3-62.)

NO → OCV and/or OCV gasket failure

YES ↓

Possible cause:
• ECM failure
• Wire continuity/connection failure
• OCV oil passage failure
• VVT actuator failure

CHART 15: SELF-DIAGNOSTIC CODE “3-3” Neutral switch

START

<Ignition switch “OFF”>
Check neutral switch function.
Is result OK? (See page 4-15.)

NO → Neutral switch failure

YES ↓

Possible cause:
• ECM failure
• Wire short circuit
• Shift position sensor lever damage

CHART 16: SELF-DIAGNOSTIC CODE “4-1” Model discrimination

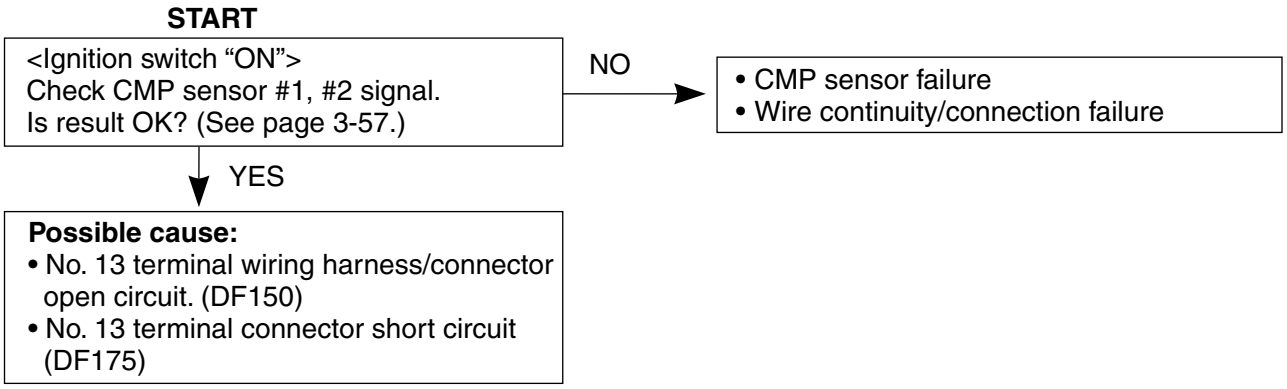


CHART 17: SELF-DIAGNOSTIC CODE “6-2” OCV

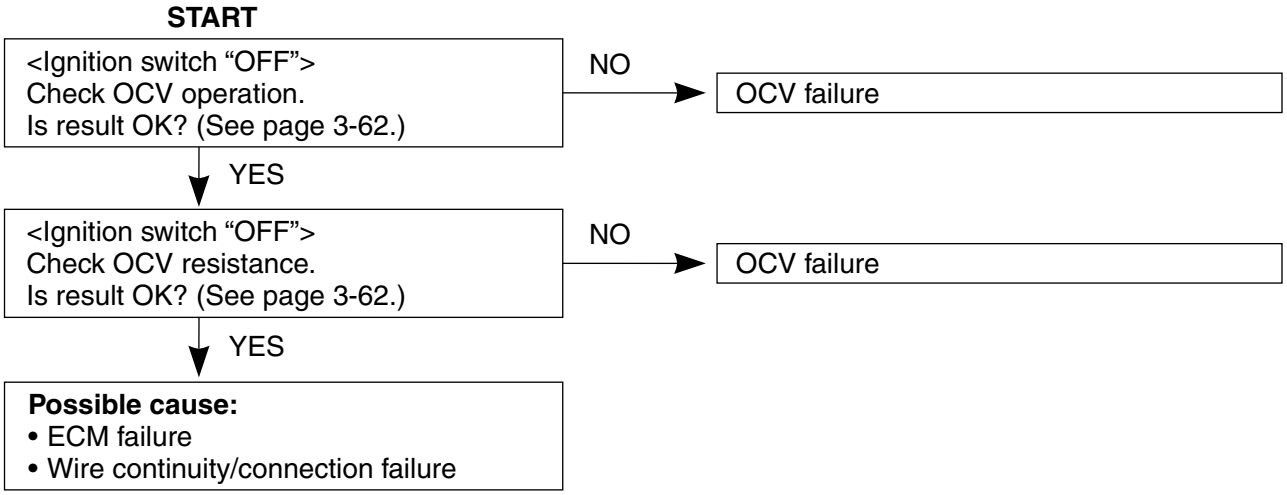
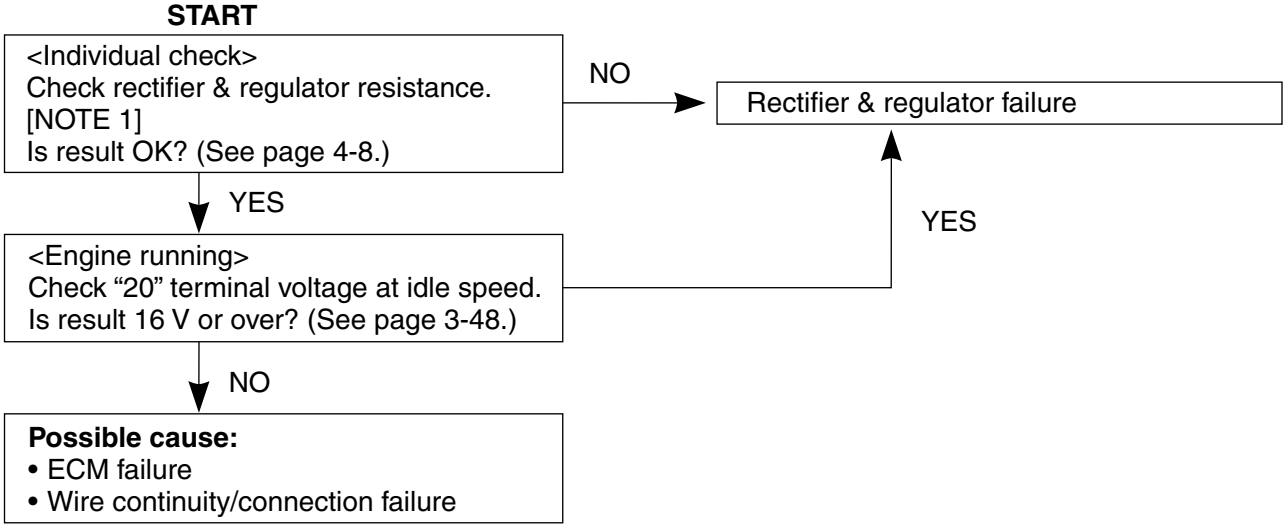


CHART 18: SELF-DIAGNOSTIC CODE “1-1” Over charging



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

NOTE 1:
It is difficult to check rectifier & regulator completely. Before replacing with new one, check if its ground point has good electrical contact.

CHART 19: ENGINE CRANKED, BUT NOT START (OR STOPS SHORTLY AFTER STARTING)

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

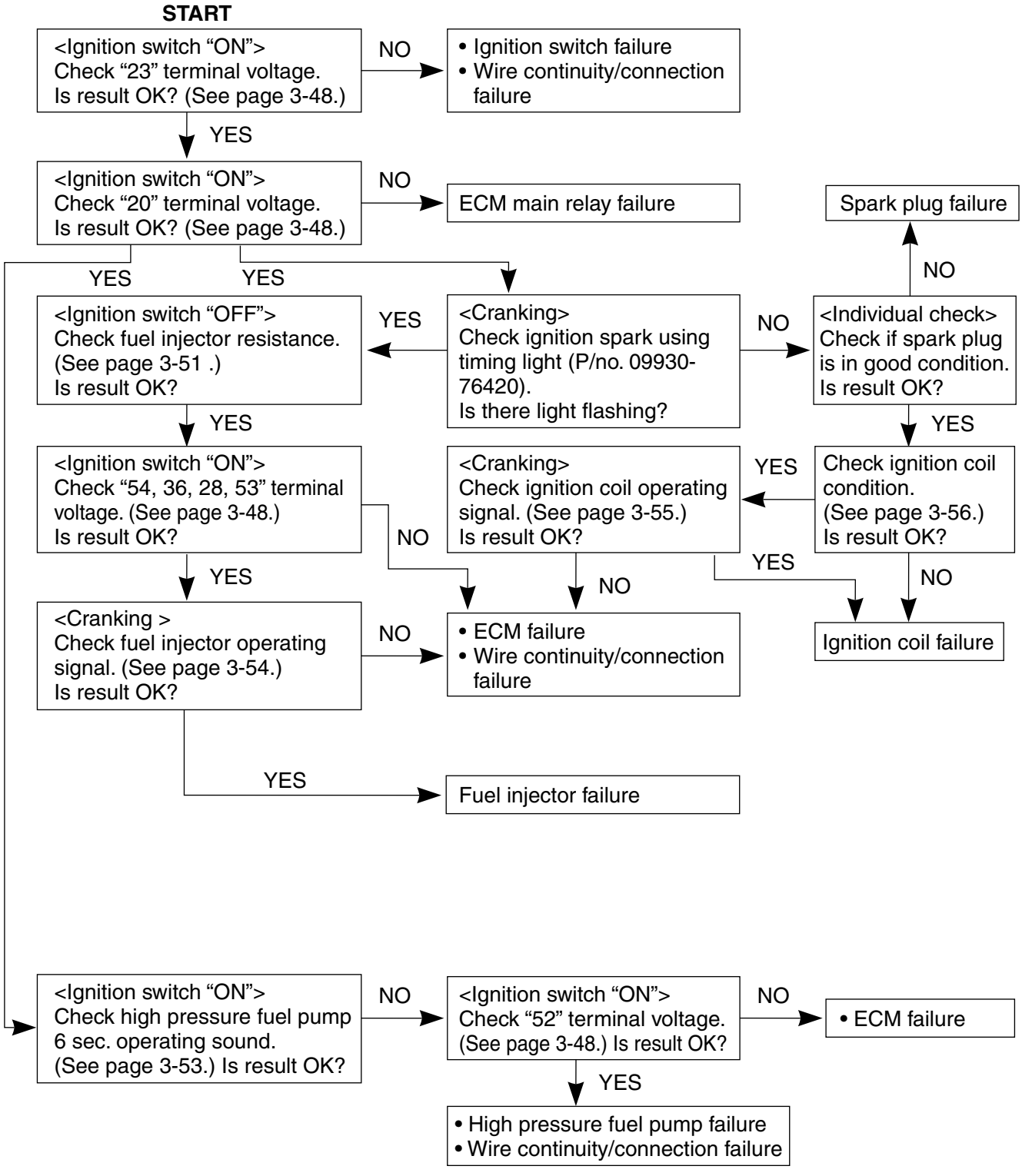


CHART 20: UNSTABLE IDLING/TROLLING (OR ENGINE TENDS TO STALL)

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

START

<Ignition switch "ON">
Check shift position sensor output voltage change. (See page 3-60.)
Is result OK?

NO →
- Shift position sensor failure [NOTE 1]
- Wire continuity/connection failure

YES ↓

<Ignition switch "ON">
Check throttle position sensor output voltage change. (See page 3-59.)
Is result OK?

NO →
- Throttle position sensor failure [NOTE 2]
- Wire continuity/connection failure

YES ↓

Possible cause:
- Incorrect by-pass air screw adjustment [NOTE 3]
- IAC valve failure [NOTE 3]
- IAC passage failure (clogged, etc.) [NOTE 3]
- Spark plug failure
- Ignition coil failure
- ECM failure
- Wire continuity/connection failure
- Failure of high pressure fuel system components:
  - Fuel injector (clog, stuck valve, etc.)
  - Fuel pressure regulator (incorrect regulated pressure, etc.)
  - Fuel pump (clogged suction filter, leakage in tank, etc.)
  - Fuel filter (clog, etc.)
  - Hose (clog, kink, leakage, etc.)

NOTE 1
If shift position sensor has failed (while engine running), engine will tend to stall when shifting into gear.

NOTE 2
If throttle position sensor has failed, engine will tend to stall when decelerating.

NOTE 3
- *The self-diagnostic code "3-1" may not be indicated because IAC valve condition depends on ECM control. (See page 3-40.)*
- *If IAC valve has failed, "Fast-idle function (warm-up mode)" won't operate.*

ENGINE ELECTRICAL

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- INSPECTION 4- 4
- REMOVAL/INSTALLATION 4- 9

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- OUTLINE 4-11
- TROUBLESHOOTING 4-13
- INSPECTION 4-14
- STARTER MOTOR 4-17

MONITOR-TACHOMETER 4-29
- INSPECTION 4-29

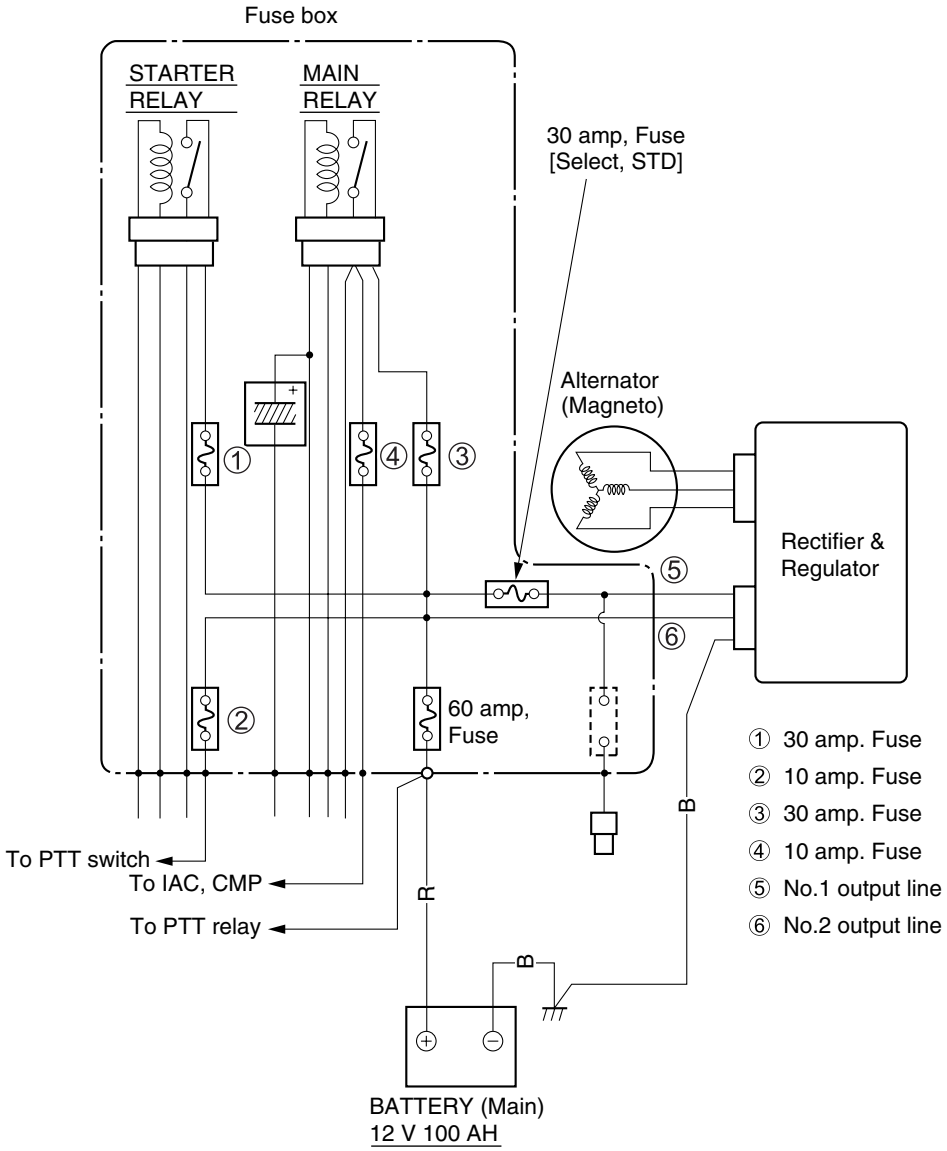
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BATTERY CHARGING SYSTEM

OUTLINE

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

OUTPUT	**12 V 44 A (528 W)/3 000 r/min.**
REGULATED VOLTAGE	**14.2 – 15.2 V**



ISOLATOR FUNCTION

The battery charging system is equipped with an isolator function.

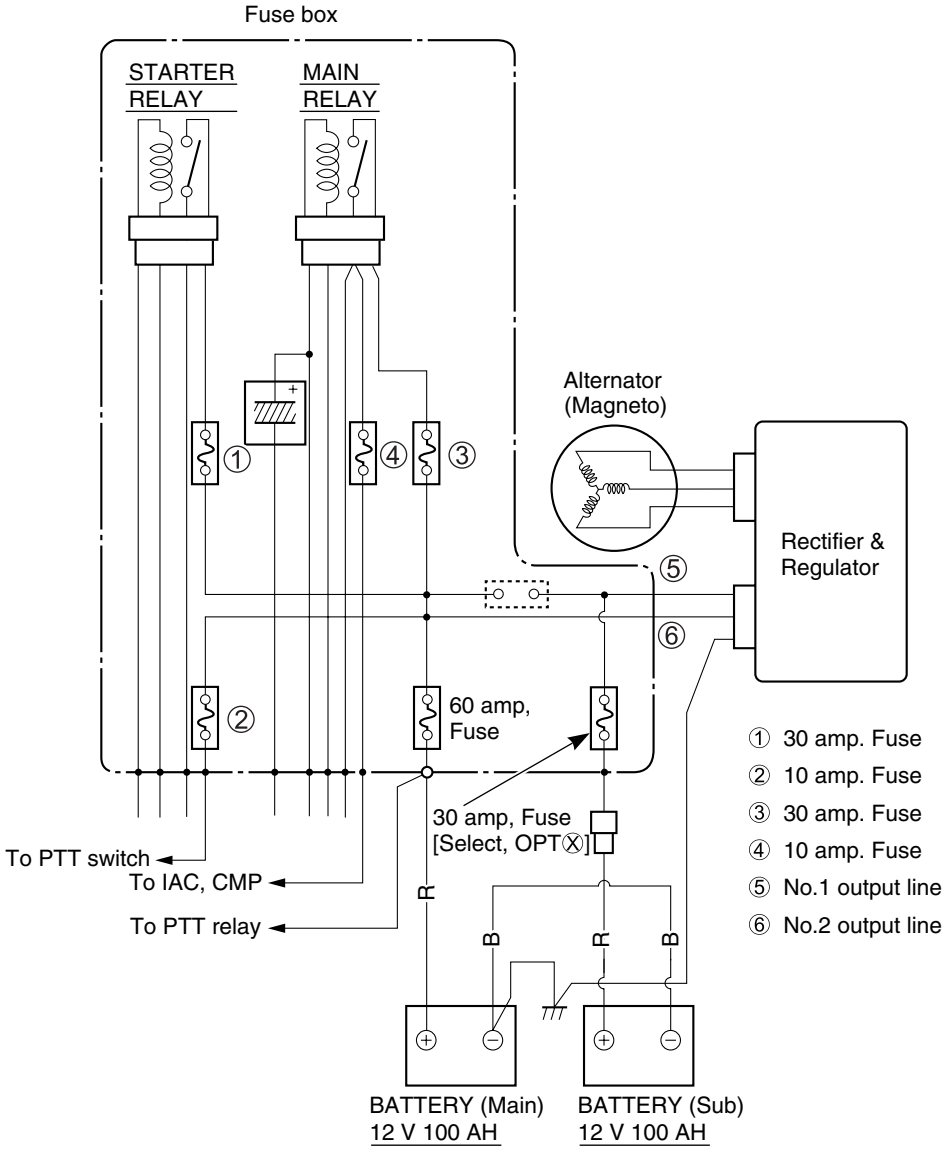
When a sub battery is used in addition to the main battery for engine operation, this function allows both the batteries to be charged at the same time.

To modify the charging circuit and distribute the power to the individual batteries, relocate the 30 amp fuse in [STD] position to [OPT ⓧ] position in the fuse box.

Relocation of the 30 amp fuse to [OPT ⓧ] position modifies the charging circuit so the No.2 red output lead of the Rectifier & Regulator can charge the main battery for engine operation and the No.1 red output lead can charge the sub battery.

NOTE:

For proper charging circuit operation, the negative terminals of both batteries, main and sub batteries, must be connected with a cable of the same size as the existing battery cable.



INSPECTION

BATTERY CHARGE COIL

Measure battery charge coil resistance.

09930-99320: Digital tester

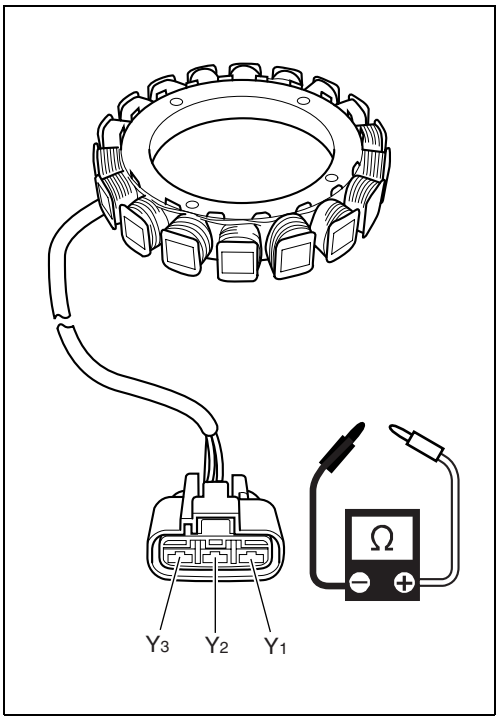
Tester range: Ω (Resistance)

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

Battery charge coil resistance:

Terminal for tester probe connection	Resistance
Yellow 1 to Yellow 2	0.14 – 0.20 Ω
Yellow 2 to Yellow 3	
Yellow 3 to Yellow 1	

If measurement exceeds specification, replace battery charge coil.



FUSE BOX/FUSE

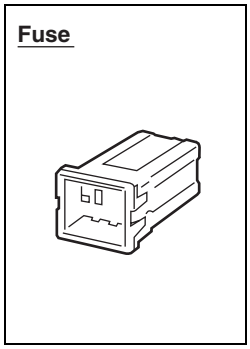
09930-99320: Digital tester

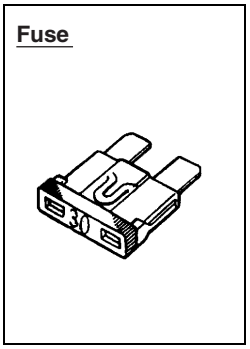
Tester range: (Continuity)

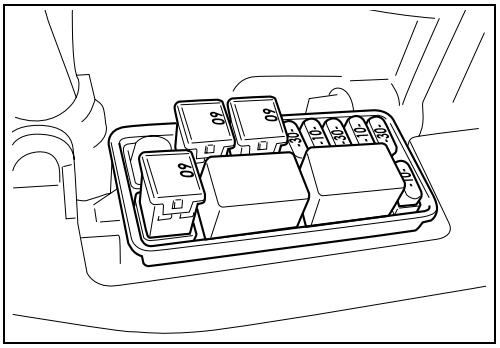
Fuse

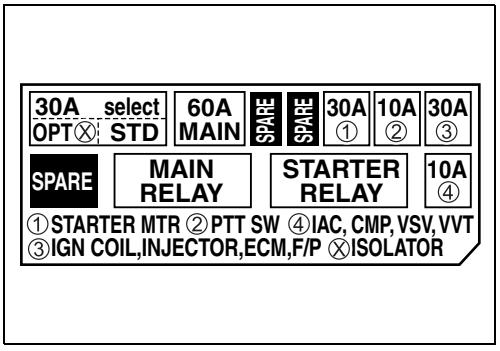
1. Remove the fuse from fuse box.
2. Inspect continuity between both terminals of fuse.
   If no continuity is indicated, replace fuse.

Main fuse: 60A
Isolator select fuse: 30 A
Starter motor relay fuse: 30A
ECM/Ign. coil/Injector/Fuel pump fuse: 30 A
PTT switch fuse: 10 A
IAC/VVT/VSV/CMP fuse: 10 A



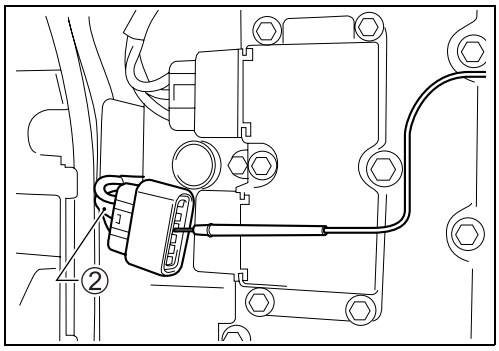




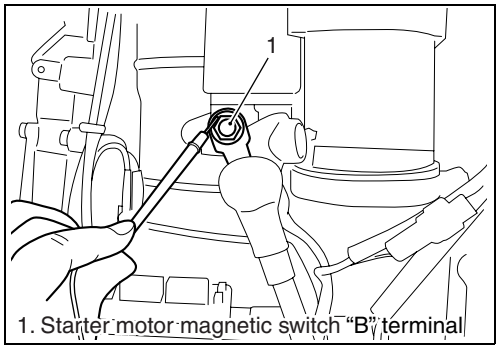


60 amp. main fuse line

1. Disconnect battery cables from battery.
2. Disconnect output lead wire connector from rectifier & regulator.



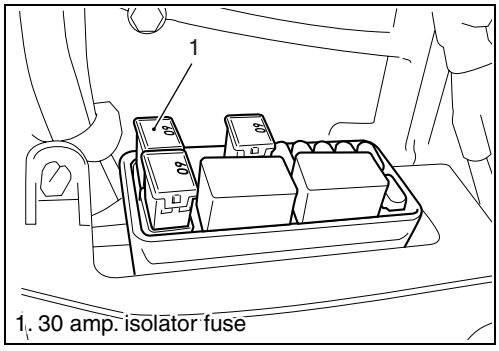
3. Inspect continuity between the red output lead wire ② of rectifier & regulator and “B” terminal of starter motor magnetic switch.
4. If no continuity is indicated, replace fuse and/or main harness.



1. Starter motor magnetic switch “B” terminal

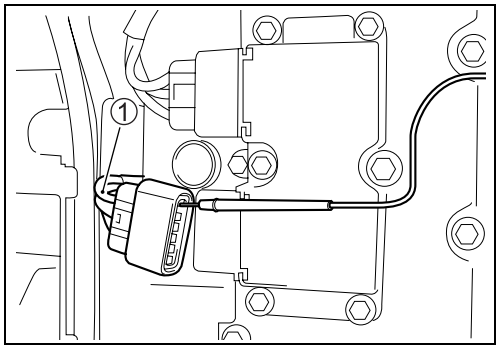
30 amp. Isolator select fuse line

1. Disconnect battery cables from battery.
2. Install 30 amp. isolator select fuse to “OPT Ⓧ” position.

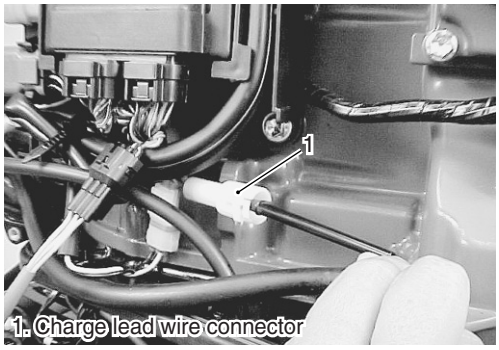


1. 30 amp. isolator fuse

3. Disconnect output lead wire connector from rectifier & regulator.



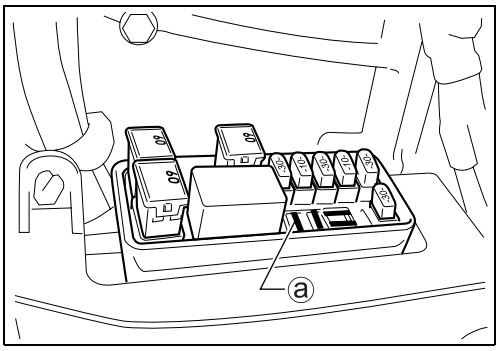
4. Inspect continuity between the red output lead wire ① of rectifier & regulator and charge lead wire connector as shown.
5. If no continuity is indicated, replace fuse and/or main harness.



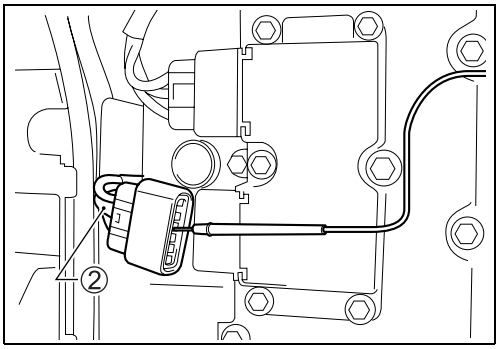
1. Charge lead wire connector

30 amp. starter motor relay fuse line

1. Disconnect battery cables from battery.
2. Disconnect starter motor relay from fuse box.
3. Disconnect output lead wire connector from rectifier & regulator.

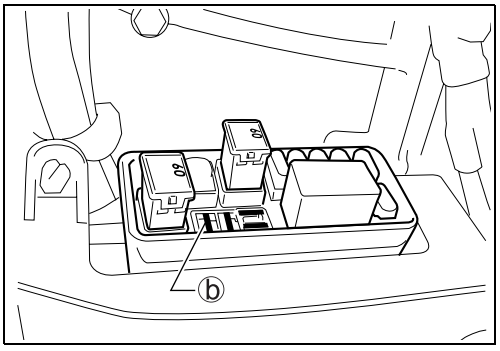


4. Inspect continuity between the lead wire terminal ⓐ of starter motor relay and the red output lead wire ② of rectifier & regulator.
5. If no continuity is indicated, replace fuse and/or main harness.

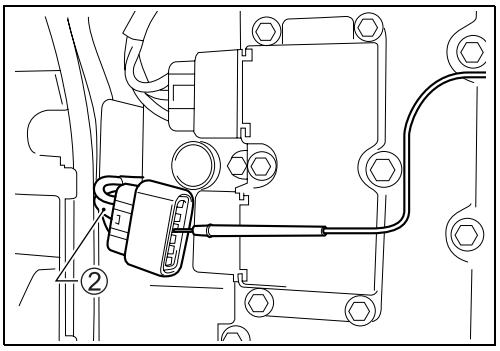


30 amp. ECM/Ign. coil etc. fuse line

1. Disconnect battery cables from battery.
2. Disconnect main relay from fuse box.
3. Disconnect output lead wire connector from rectifier & regulator.

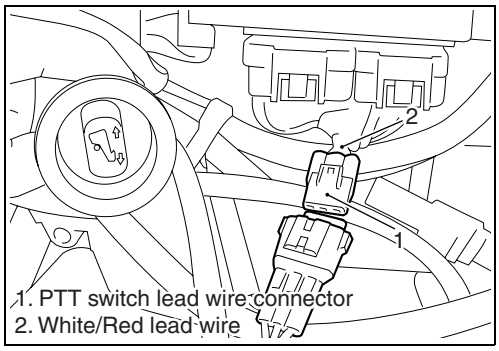


4. Inspect continuity between the lead wire terminal ⓑ of main relay and the red output lead wire ② of rectifier & regulator.
5. If no continuity is indicated, replace fuse and/or main harness.

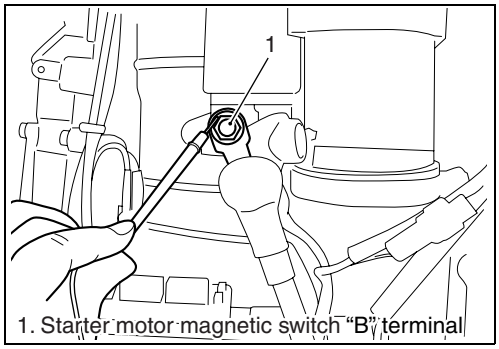


10 amp. PTT switch fuse line

1. Disconnect battery cables from battery.
2. Disconnect PTT switch lead wire connector from switch.

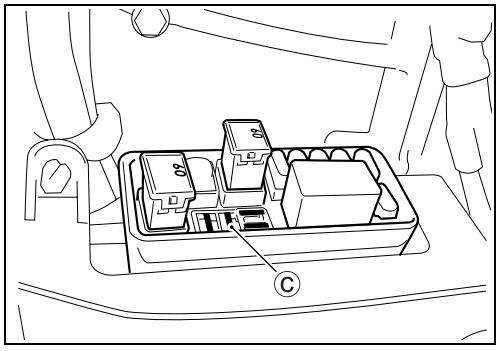


3. Inspect continuity between the White/Red lead wire of main harness and “B” terminal of starter motor magnetic switch.
4. If no continuity is indicated, replace fuse and/or main harness.

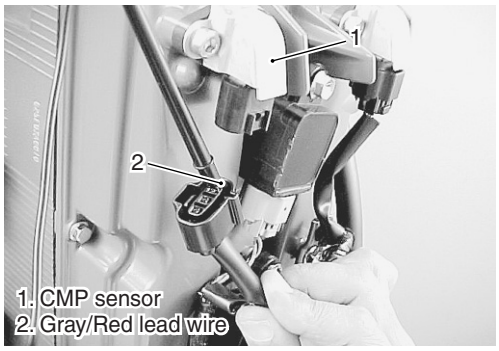


10 amp. IAC/VVT/VSV/CMP fuse line

1. Disconnect battery cables from battery.
2. Disconnect main relay from fuse box.
3. Disconnect lead wire connector from CMP sensor.



4. Inspect continuity between the Gray/Red lead wire of main harness and lead wire terminal ⓒ of main relay.
5. If no continuity is indicated, replace fuse and/or main harness.

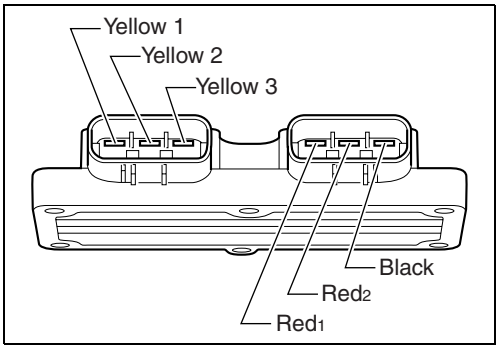


RECTIFIER & REGULATOR

09900-25002: Pocket tester

Tester range: ×1 kΩ (Resistance)

1. Disconnect all lead wires of rectifier & regulator.
2. Measure resistance between terminals 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

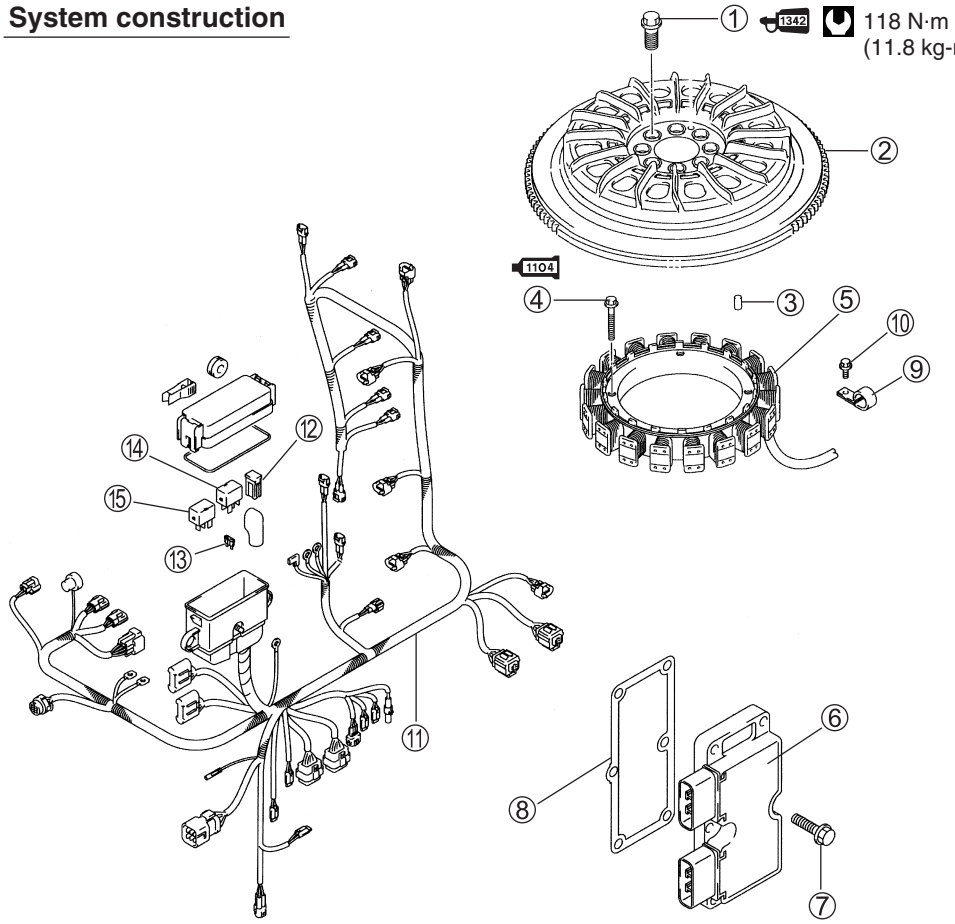
		Tester probe ⊕ (Red)					
		Black	**Red 1**	**Red 2**	**Yellow 1**	**Yellow 2**	**Yellow 3**
Tester probe ⊖ (Black)	**Black**		2 – 25	2 – 25	1 – 7	1 – 7	1 – 7
	Red 1	500 – ∞		500 – ∞	500 – ∞	500 – ∞	500 – ∞
	Red 2	500 – ∞	500 – ∞		500 – ∞	500 – ∞	500 – ∞
	Yellow 1	500 – ∞	1 – 7	1 – 7		500 – ∞	500 – ∞
	Yellow 2	500 – ∞	1 – 7	1 – 7	500 – ∞		500 – ∞
	Yellow 3	500 – ∞	1 – 7	1 – 7	500 – ∞	500 – ∞	

∞: Infinity

If measurement exceeds specification, replace rectifier & regulator.

REMOVAL/INSTALLATION

System construction



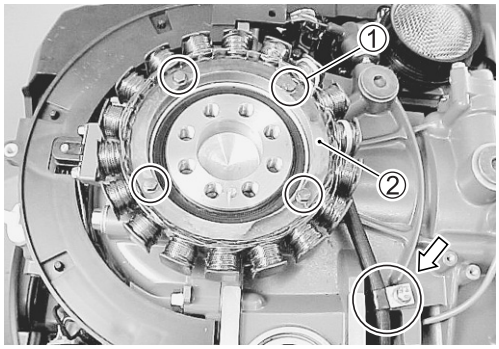
① Bolt
② Flywheel
③ Dowel pin
④ Screw
⑤ Battery charge coil
⑥ Rectifier & regulator
⑦ Bolt
⑧ Gasket
⑨ Clamp
⑩ Bolt
⑪ Main harness
⑫ Main fuse 60 A
⑬ Fuse
⑭ ECM relay
⑮ Starter motor relay

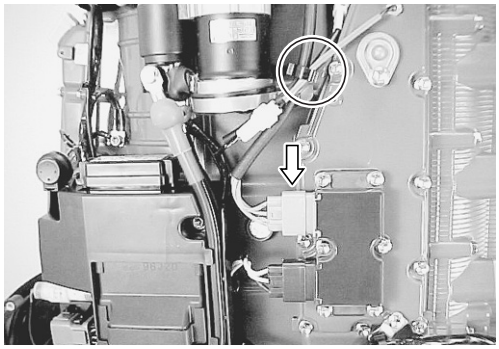
REMOVAL

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

Battery charge coil

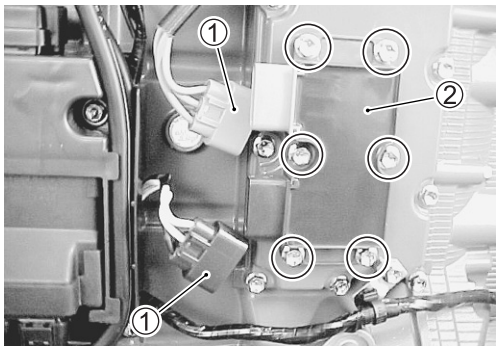
- Remove flywheel magneto. (See page 3-66.)
- Remove four (4) screws ① securing the battery charge coil ②.
- Remove the lead wire clamp and battery charge coil.
- Disconnect battery charge coil lead wire connector from Rectifier & regulator.





Rectifier & regulator

- Disconnect lead wire connectors ① from Rectifier & regulator ②.
- Remove the six (6) bolts and Rectifier & regulator.



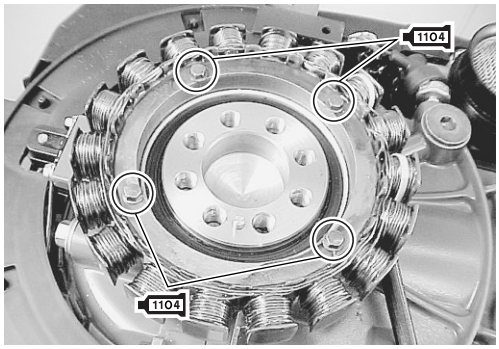
INSTALLATION

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

Battery charge coil

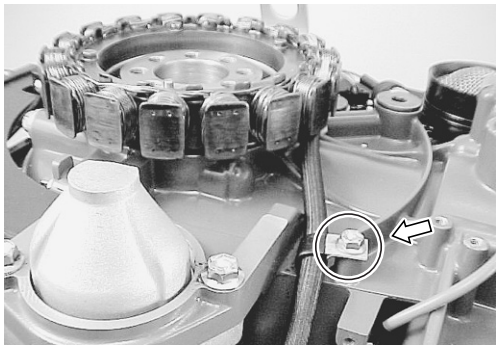
Apply Suzuki Bond No.1104 to the coil securing screws.

1104 99000-31030: 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 11-4 to 11-10.)

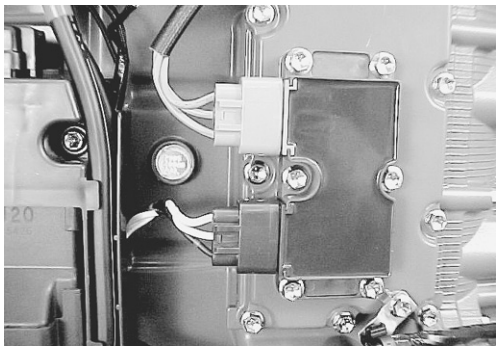


Rectifier & regulator

Install gasket and rectifier & regulator, then tighten bolts securely.

CAUTION

Do not reuse gasket, always replace with new one.



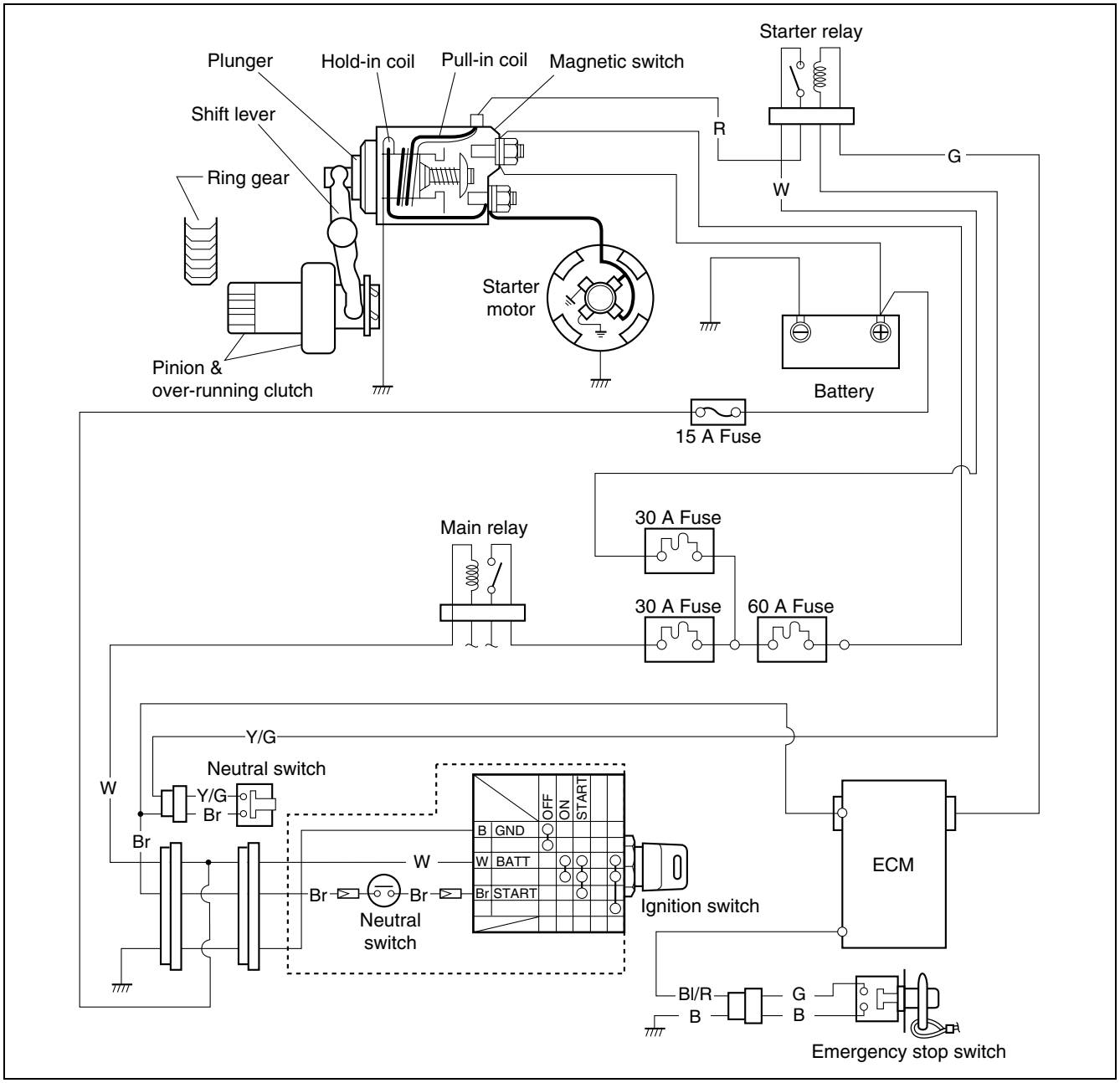
ELECTRIC STARTER SYSTEM

OUTLINE

The starting circuit consists of the battery, starting motor, ignition switch, neutral switch, starter relay 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 and starter relay coil are magnetized when the ignition switch is closed (turned 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 is controlled by the ECM.

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.

STARTER ENGAGEMENT MECHANISM

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

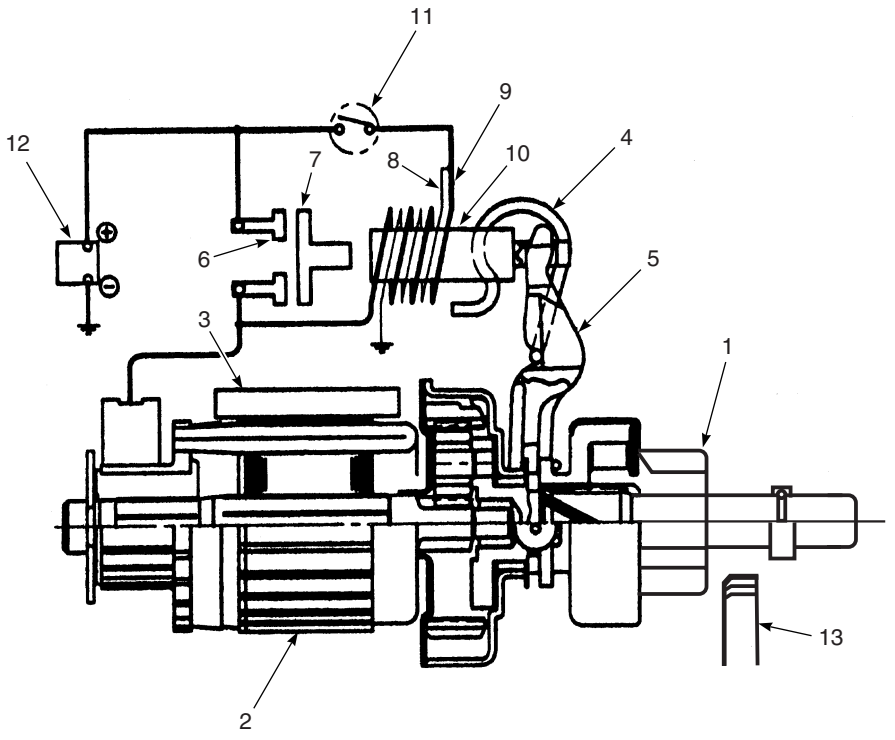
When the ignition key is turned to “START”, current flows through the switch winding creating an electro-magnet pulling the plunger in.

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.



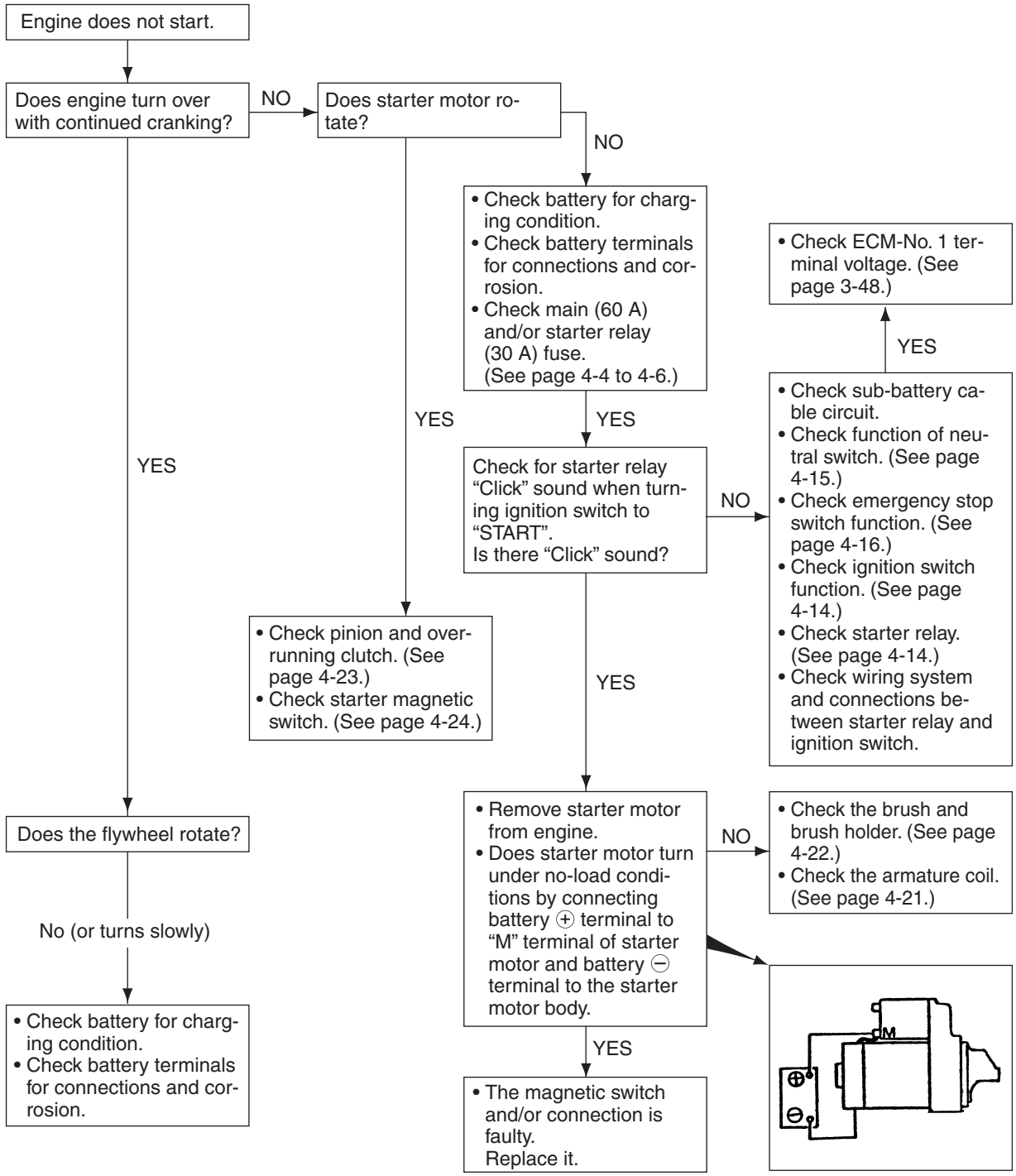
1. Pinion
2. Armature
3. Magnet
4. Torsion spring
5. Shift lever
6. Stationary contact
7. Movable contact
8. Hold-in coil
9. Pull-in coil
10. Plunger
11. Ignition switch
12. Battery
13. Ring gear

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

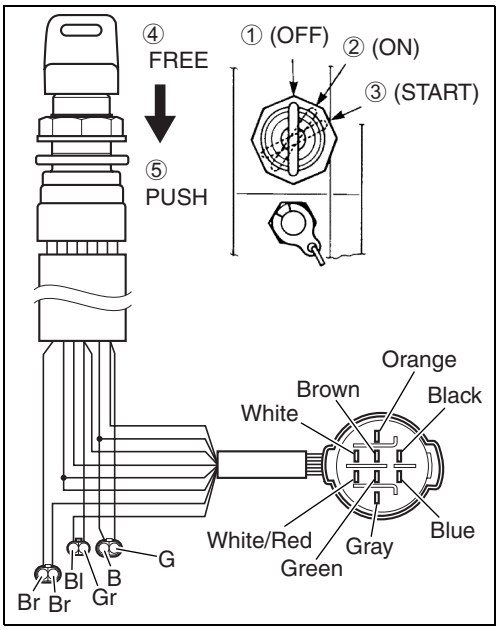
Tester range: (Continuity)

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.

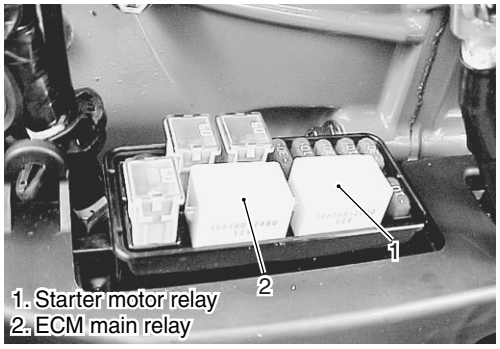


STARTER MOTOR RELAY

09930-99320: Digital tester

Tester range: (Continuity)

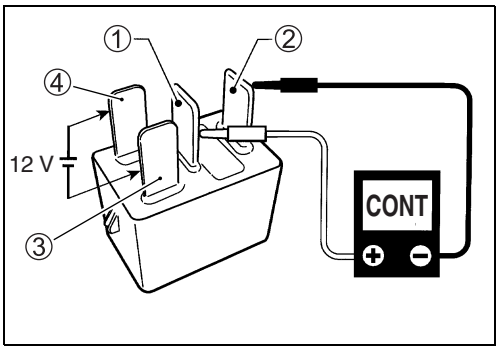
1. Disconnect starter motor relay from fuse box.



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.

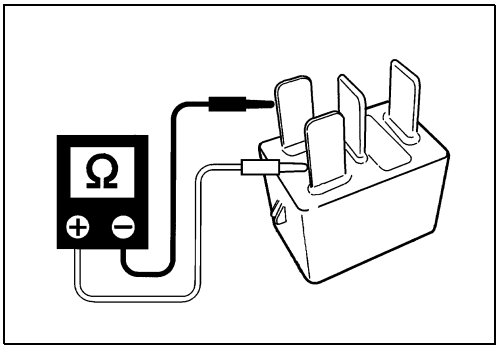
3. Measure resistance between relay terminals ③ and ④.

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.

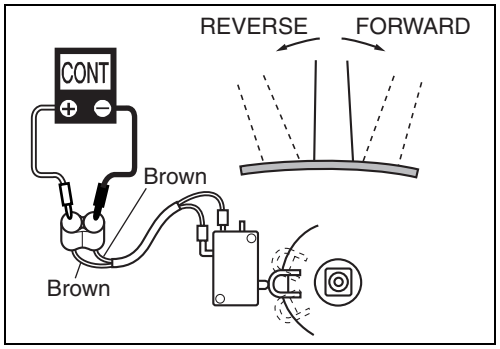
09930-99320: Digital tester

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

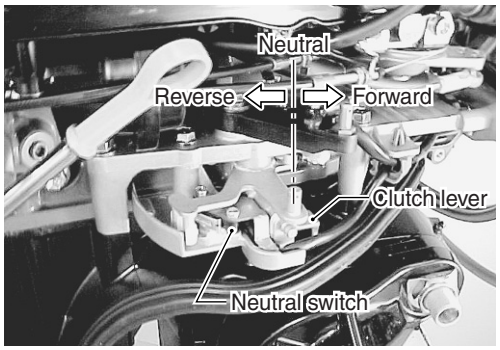


If out of specification, replace neutral switch.

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.

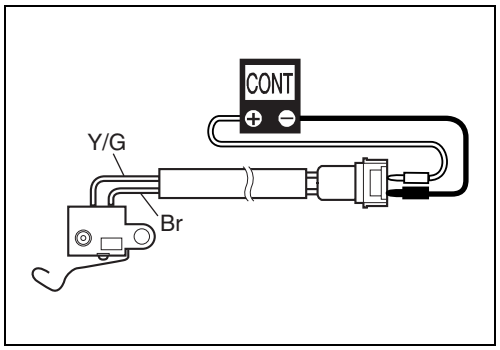
Shift position	Tester indicates
Neutral	Continuity
Forward	Infinity
Reverse	Infinity



If out of specification:

- 1st Check remo-con cable adjustment, readjust if necessary.
- 2nd Check wire harnesses for open and short.
  If wire harnesses are in good condition, replace neutral switch and recheck.

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

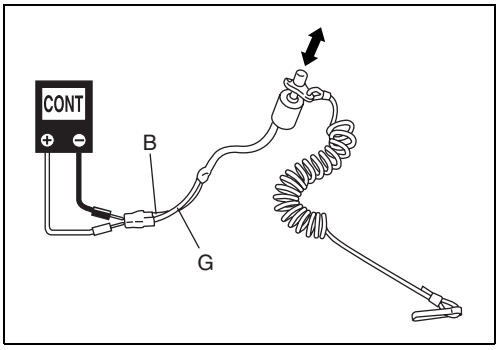


EMERGENCY STOP SWITCH

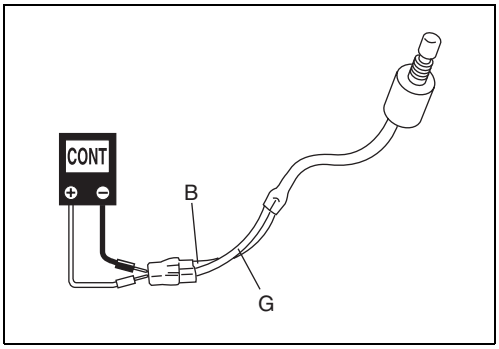
09930-99320: Digital tester

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

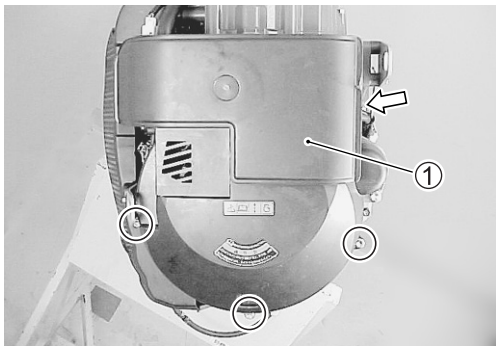
3. If out of specification, replace switch.

STARTER MOTOR

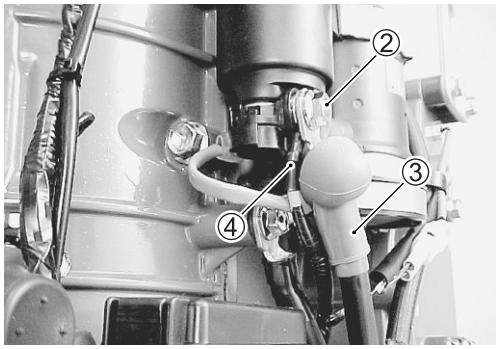
REMOVAL

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

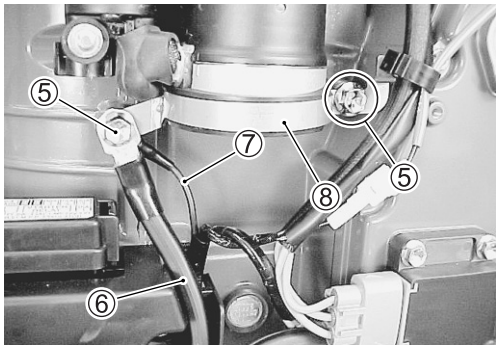
1. Remove bolts and ring gear cover with air intake silencer case ①. (See page 6-2.)



2. Remove nut ②, positive ⊕ battery cable ③ and positive ⊕ battery charge cable ④ from the starter motor magnetic switch.



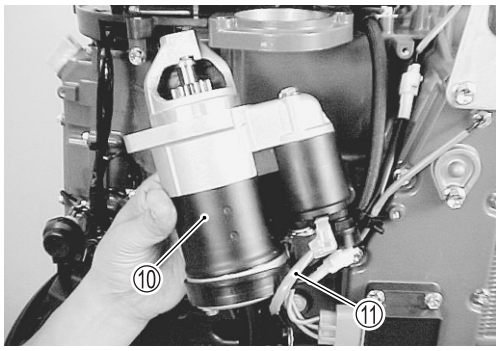
3. Remove the two (2) bolts ⑤, negative ⊖ battery cable ⑥, harness GND lead wire ⑦ and starter motor band ⑧.



4. Remove the two bolts ⑨ securing starter motor.



5. 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)



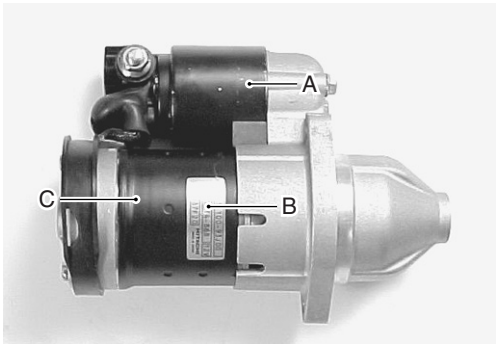
DISASSEMBLY

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

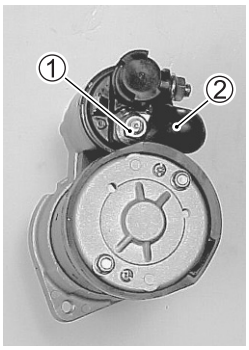
However, the yoke assembly, armature coil, over-running clutch assembly, magnetic switch assembly and rubber or plastic parts should not be washed in a degreasing tank or with a grease dissolving solvent. These parts should be cleaned with compressed air or wiped with clean cloth.

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.

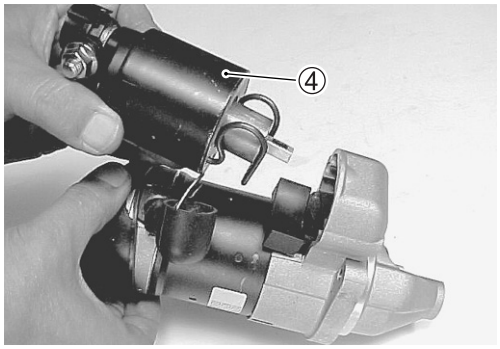


1. Remove nut ① from magnetic switch, then disconnect the connecting wire ②.
2. Remove two bolts ③ securing magnetic switch.

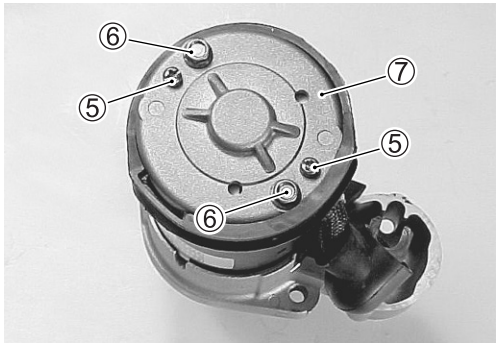




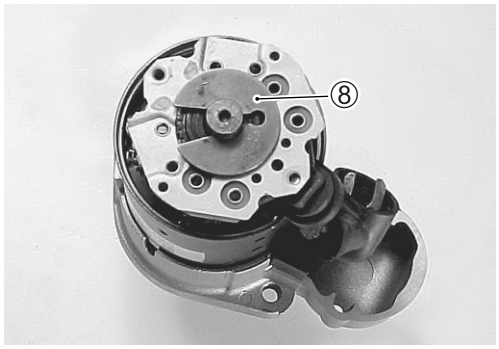
3. Remove the magnetic switch ④.



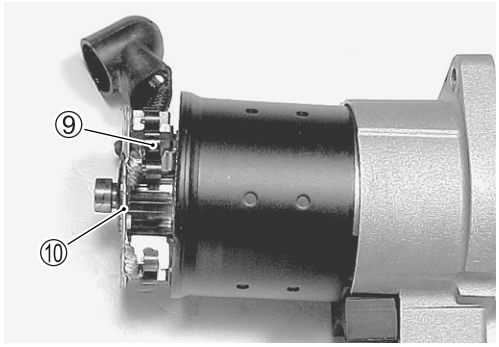
4. Remove screws ⑤, long through bolts ⑥ and rear cover ⑦.



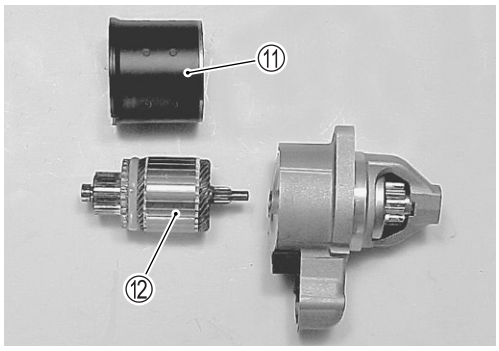
5. Remove thrust washer ⑧ with screwdriver.



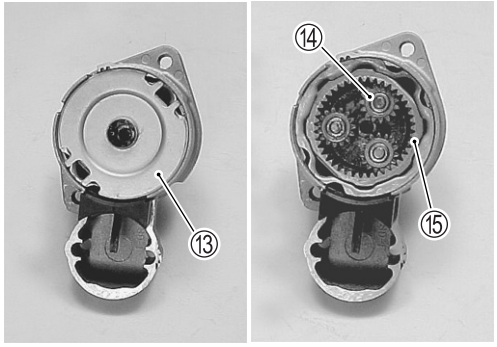
6. Pull the brush spring ⑨ up to separate the brush from the surface of the commutator, then remove the brush holder ⑩.



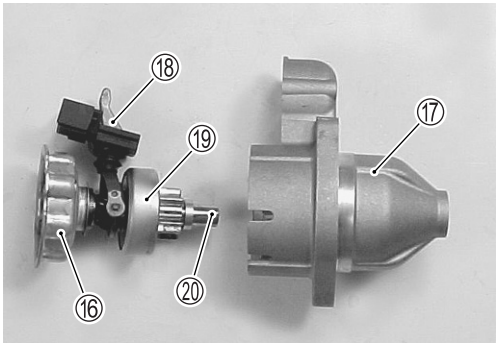
7. Remove the yoke ⑪ and armature ⑫.



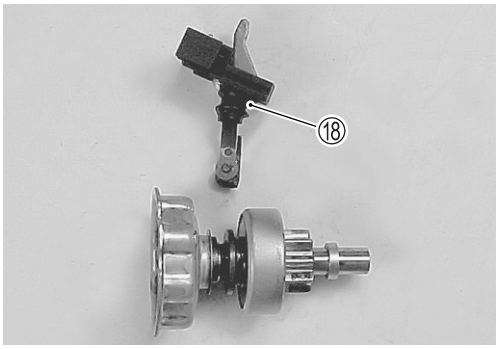
8. Remove the center cover plate ⑬.
9. Remove the planetary gears ⑭ and internal gear ⑮.



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.

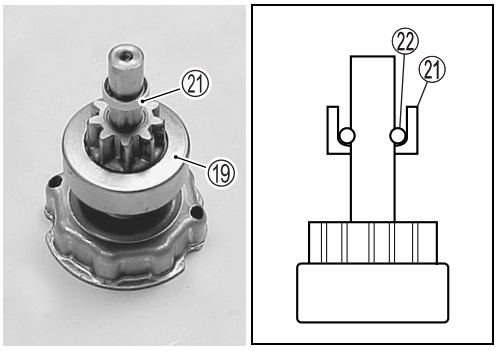


12. Push the pinion stopper ㉑ down, then remove stopper ring ㉒.
    Remove the pinion stopper and pinion ⑲.

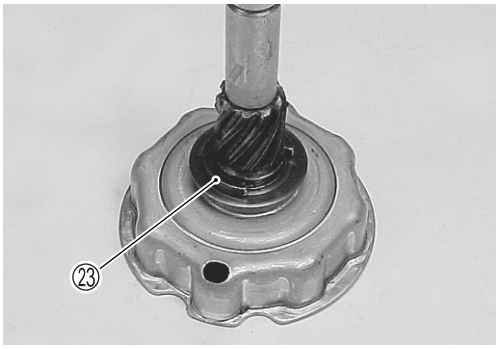
⚠ WARNING

Wear safety glasses when disassembling and assembling stopper ring.

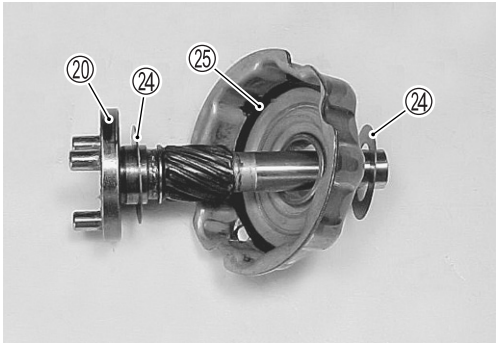
NOTE:
Using a screw-driver, pry off the stopper ring.



13. Remove the E-ring ㉓.



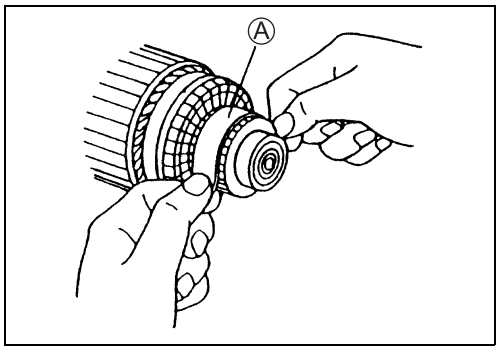
14. Remove the pinion shaft ⑳, washers ㉔ and rubber ring ㉕ from center bracket.



INSPECTION AND SERVICING

Armature and Commutator

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

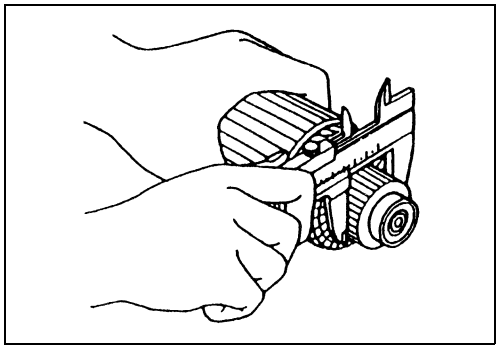


- Measure commutator outside diameter.

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.

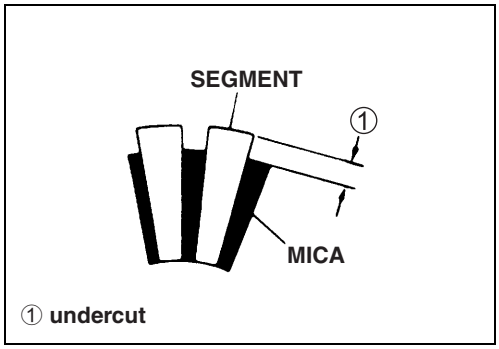


- Check that mica (insulator) between the segments is undercut to specified depth.

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**

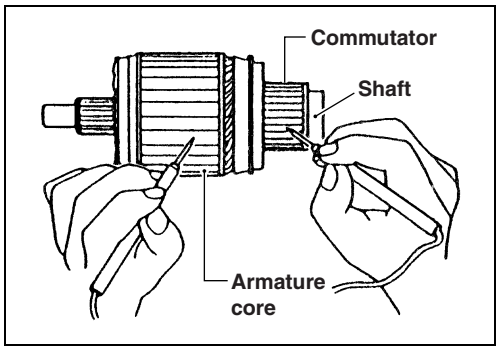
⚠ WARNING

Wear safety glasses 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

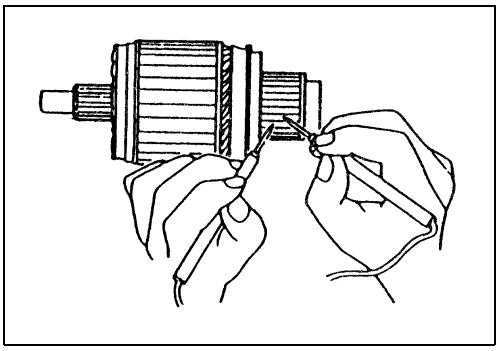
Tester range: (Continuity)



• 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.

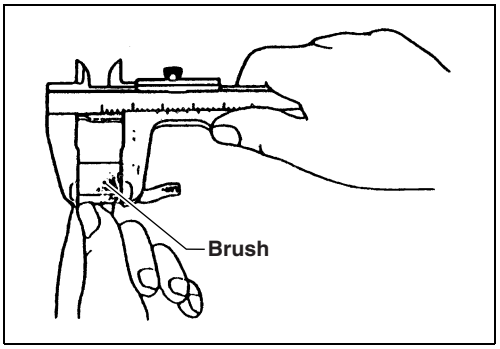
09900-20101: Vernier calipers

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.

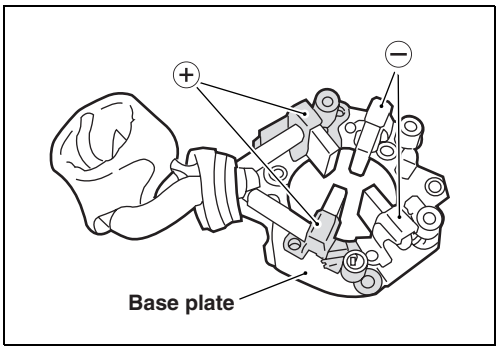
09930-99320: Digital tester

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

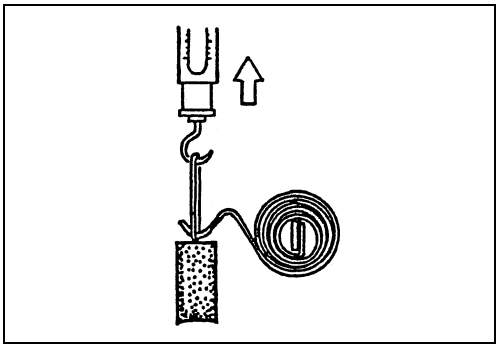
Inspect brush spring for wear, damage or other abnormal conditions.

Check the brush spring tension.

Replace if necessary.

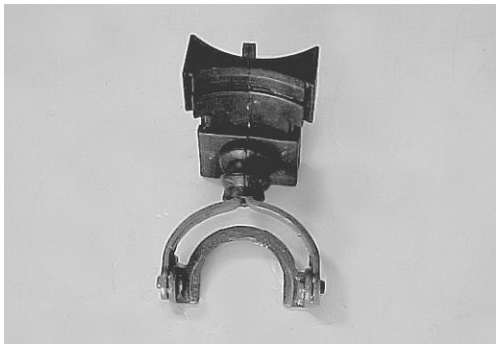
Brush spring tension

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



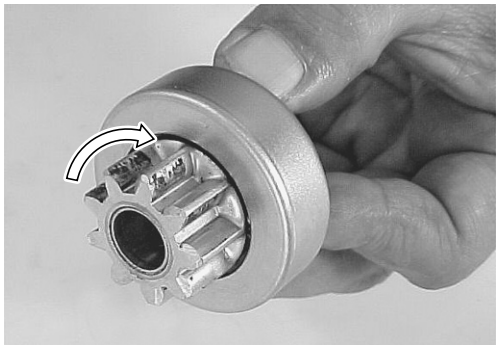
SHIFT LEVER

Inspect shift lever for wear.
Replace if necessary.

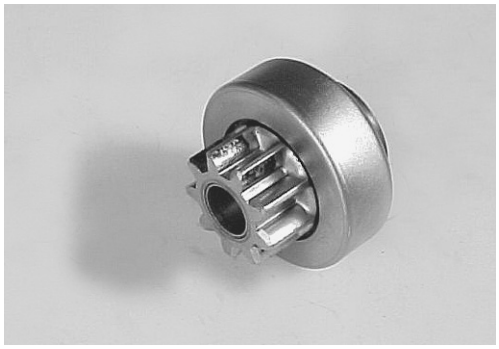


PINION AND OVER-RUNNING CLUTCH

- 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.

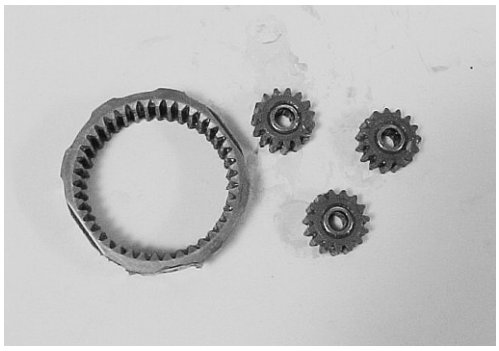


- Inspect spline teeth for wear or other damage.
  Inspect pinion for smooth movement.
  Replace if necessary.



GEAR

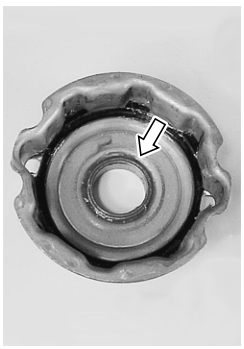
- Inspect planetary gears and internal gear for wear, damage or other abnormal conditions.
  Replace if necessary.



PINION SHAFT/PINION SHAFT BUSH

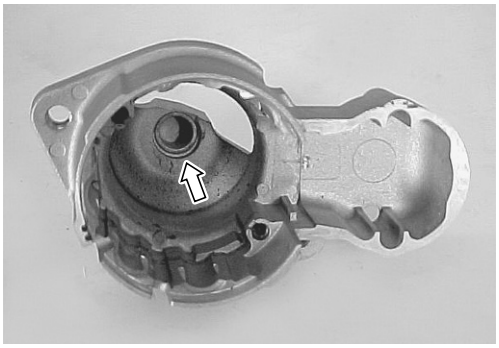
- Inspect pinion shaft for wear, damage or other abnormal conditions. Replace if necessary.
- Inspect pinion shaft bush for wear or other damage.
  Replace if necessary.





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.



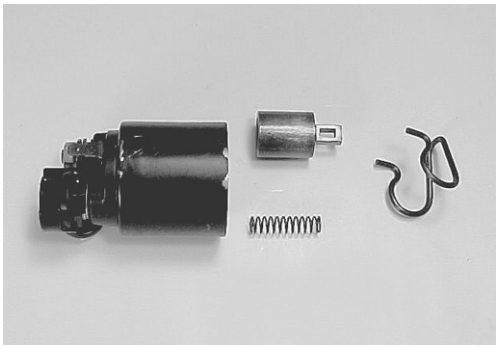
ARMATURE SHAFT BUSH

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



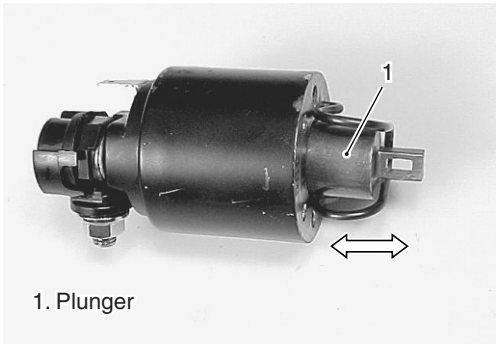
PLUNGER

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.



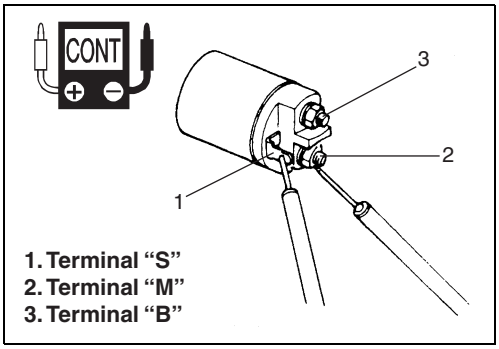
1. Plunger

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”

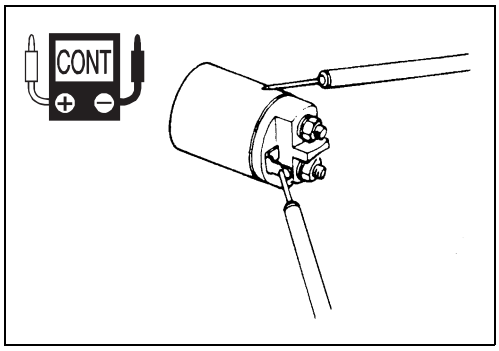
Hold-in coil Open circuit Test

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.



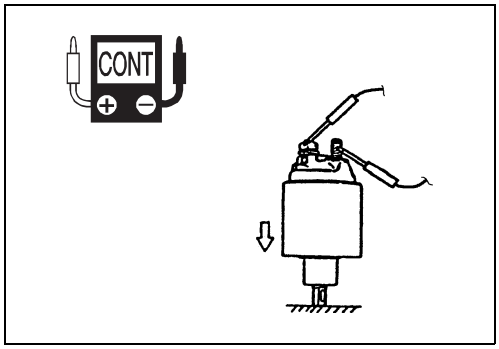
Contact points Test

09930-99320: Digital tester

Tester range: (Continuity)

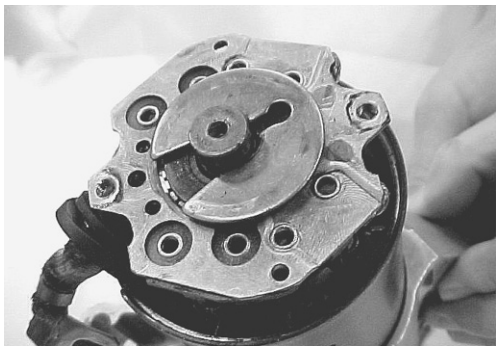
Put the plunger on the under side and then push the magnetic switch down. At this time, check for continuity between terminal “B” and terminal “M”.

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.

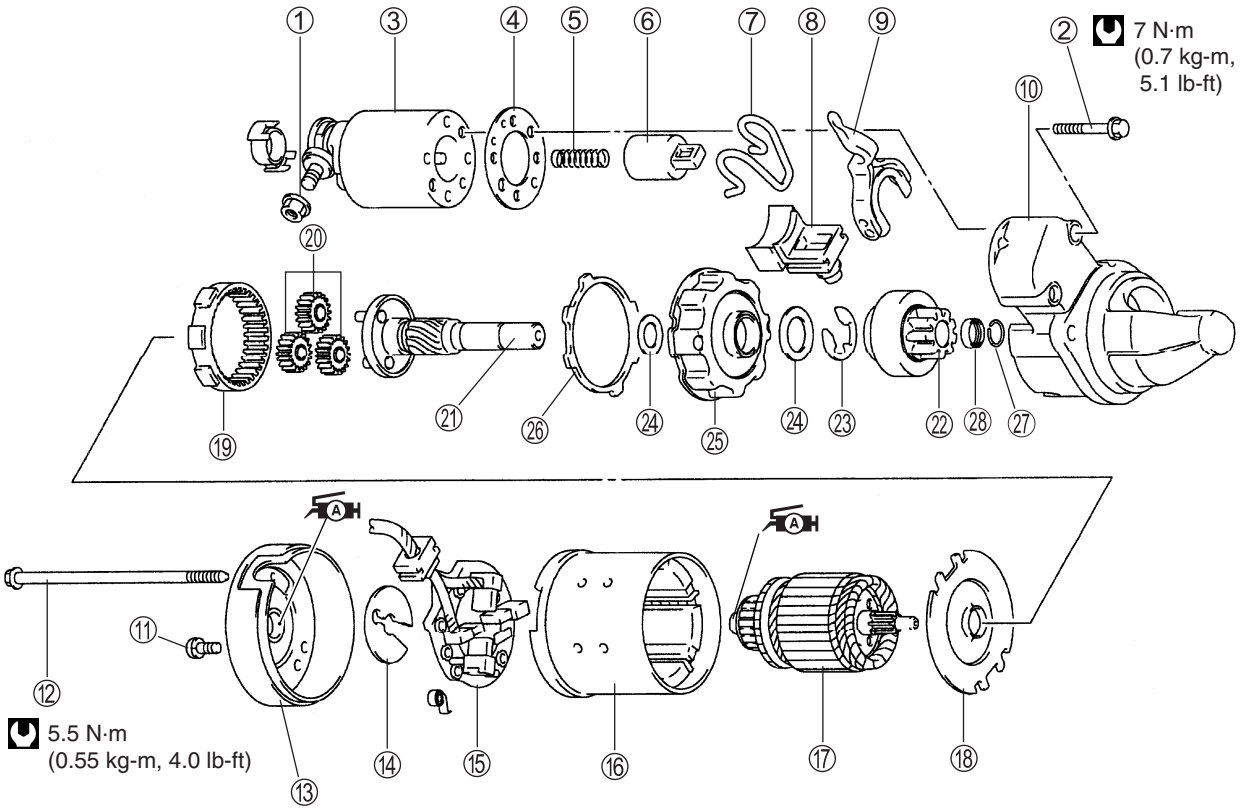


CAUTION

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

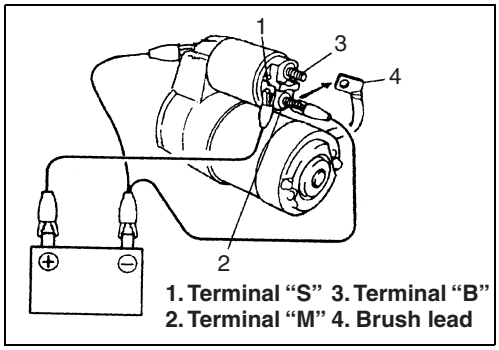
When performing the following test, be sure to connect the battery and the starting motor with a lead wire of the same size as original equipment.

PULL-IN/HOLD-IN TEST

Connect battery to magnetic switch as shown in figure.

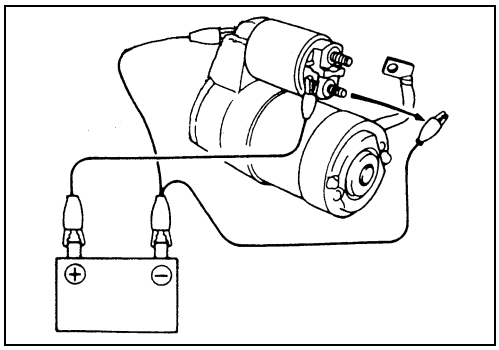
- Check that plunger and pinion (over-running clutch) move outward.
  If plunger and pinion don't move, replace magnetic switch.

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



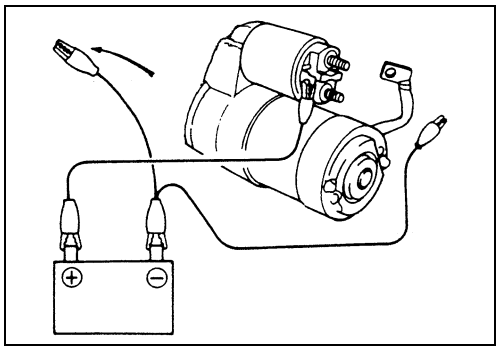
1. Terminal "S" 3. Terminal "B"
2. Terminal "M" 4. Brush lead

- 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

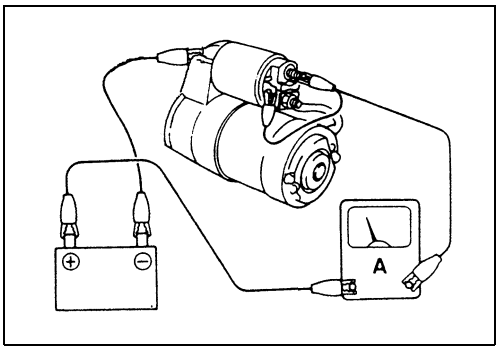
Disconnect negative lead from switch/motor body.
Check that plunger and pinion return inward.
If plunger and pinion don't return inward, replace magnetic switch.



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

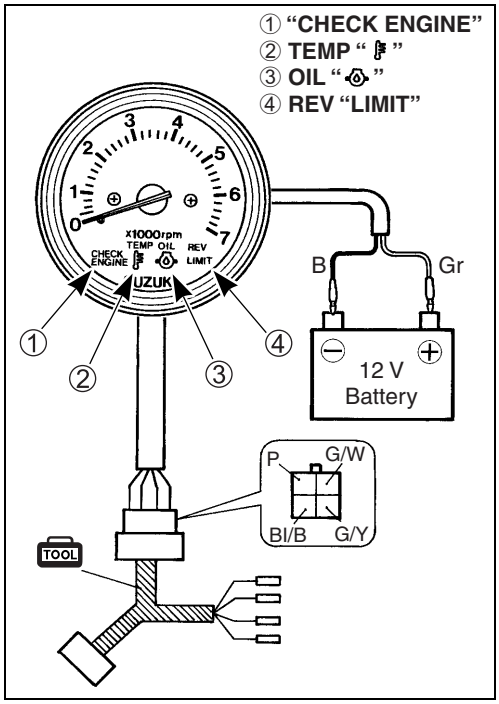
MONITOR LAMP CHECK

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.

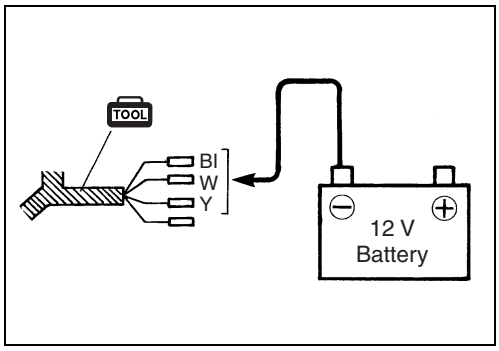


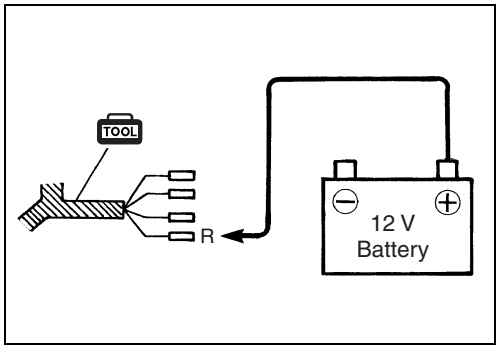
3. Check if lamp lights when connecting battery to test cord terminal as shown.

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.

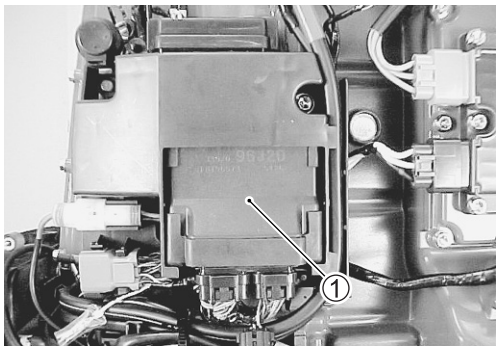




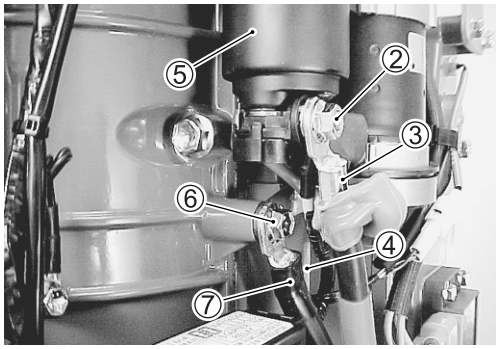
ELECTRIC PARTS HOLDER

REMOVAL

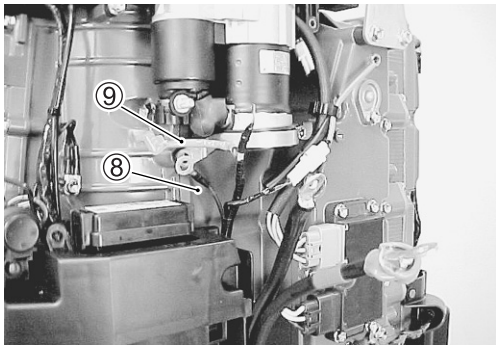
Before removing electric parts holder:
- **Disconnect battery cables from battery.**

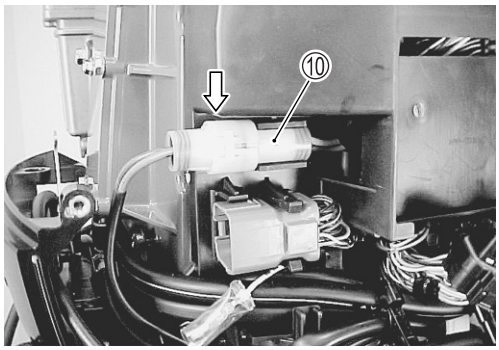


1. Disconnect lead wire connectors from ECM ①, then remove ECM.

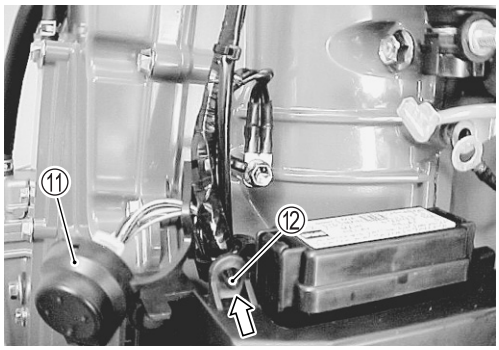


2. Remove nut ②, positive ⊕ battery cable ③ and positive lead wire ④ from magnetic switch ⑤ of starter motor.
   Remove bolt ⑥, negative ⊖ battery cable ⑦ and GND lead wire ⑧.
   Disconnect red lead wire ⑨ from magnetic switch “S” terminal.
   Pull battery cables out of electric parts holder.



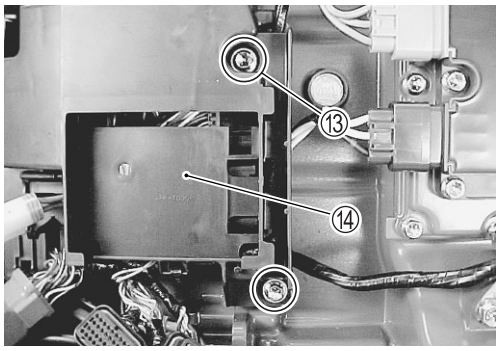


3. Disconnect PTT relay connector ⑩ from PTT motor cable wire.

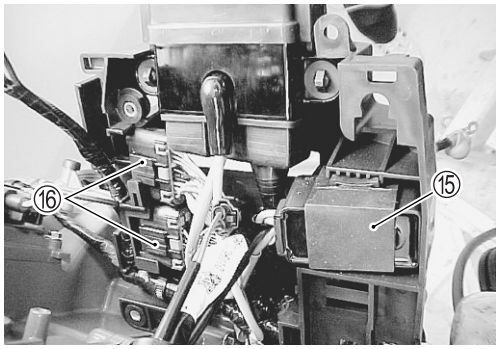


4. Remove communication connector ⑪ from electric parts holder.
   Remove cable clamp ⑫ from electric parts holder by releasing clamps’ lock.

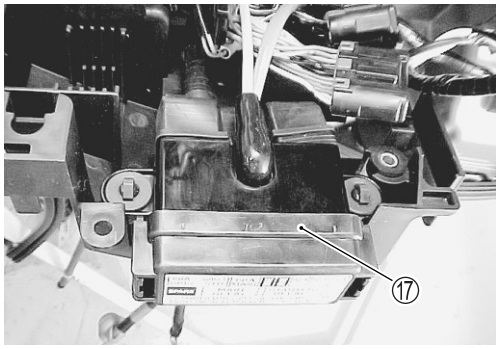
5. Remove the two (2) bolts ⑬ securing electric parts holder ⑭.
   Slide the electric parts holder upward, then remove it from cylinder block.



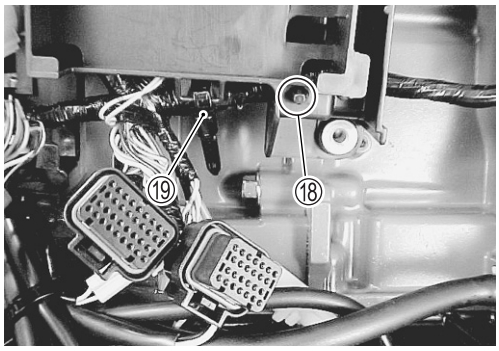
6. Remove PTT motor relay ⑮ and joint connectors ⑯ from electric parts holder.



7. Pull and remove fuse box ⑰ from electric parts holder.



8. Remove cable clamp ⑱ from electric parts holder by releasing clamps' lock.
9. To free the electric parts holder, unfasten the cable tie ⑲ securing main harness.



INSTALLATION

Installation is reverse order of removal.
Final check:

- All parts removed have been returned to their original position.
- Check wire routing. (See page 11-4 to 11-10.)

FUEL SYSTEM

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- FUEL PRESSURE RELIEF PROCEDURE 5- 3

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5

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.**

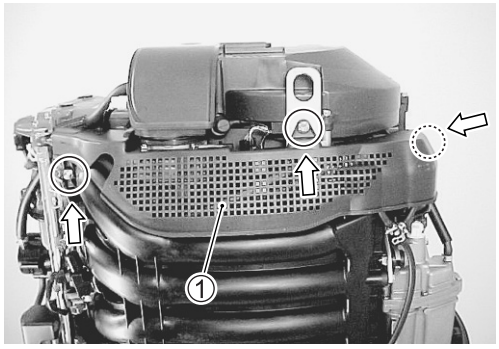
⚠ WARNING

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.

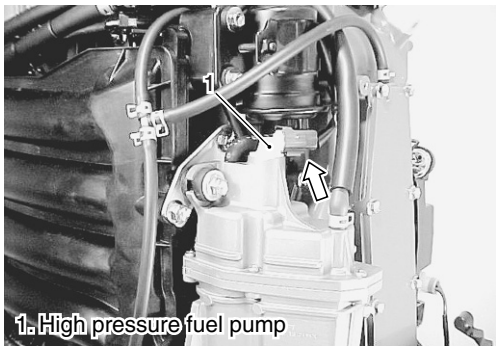
FUEL PRESSURE RELIEF PROCEDURE

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

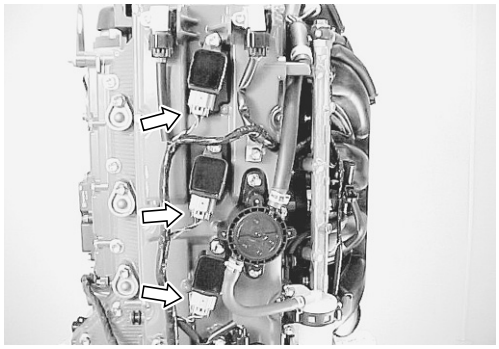
1. Turn OFF ignition switch.
2. Remove the three (3) bolts and fuel hose guard ①.



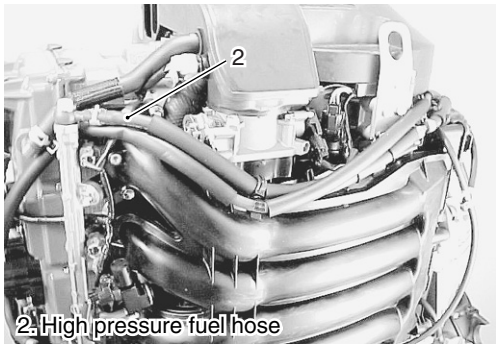
3. Disconnect high pressure fuel pump lead wire connector at high pressure fuel pump.



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



6. Make sure fuel pressure has been removed by pinching high pressure fuel hose between finger tips (line should feel soft without pressure).
7. 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

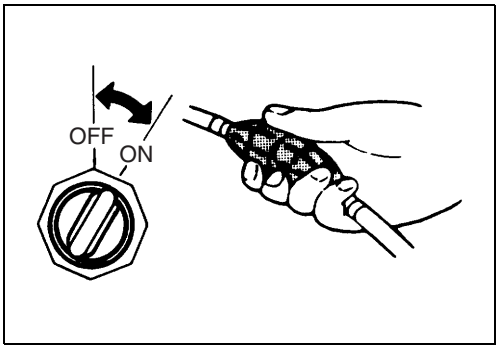
- **Do not over bend (kink) or twist hoses when installing.**
- **When installing hose clamps, position tabs to avoid contact with other parts.**
- **Be sure hoses do not contact rods, levers or other components with engine either operating or at rest.**
- **Extreme care should be taken not to cut, abrade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

NOTE:
- *Check fuel hose routing. (See page 11-11 and 11-17.)*
- *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.

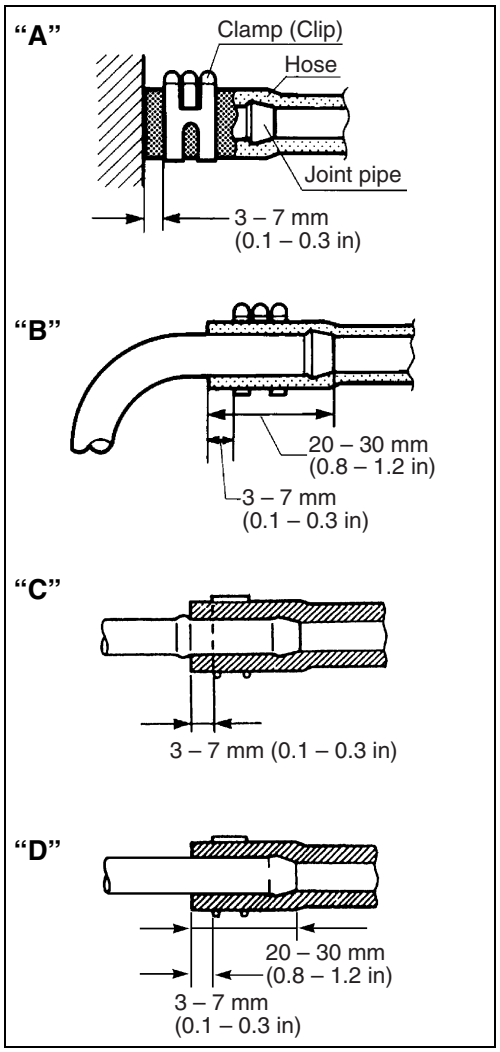
1. Squeeze fuel primer bulb until you feel resistance.
2. Shift into “NEUTRAL” position.
3. Ensure emergency stop switch lock plate is in place.
4. Turn ignition switch “ON” for 6 seconds (to operate fuel pump), then turn it “OFF”.
   Repeat this (ON and OFF) procedure 3 or 4 times to pressurize the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



FUEL HOSE CONNECTION

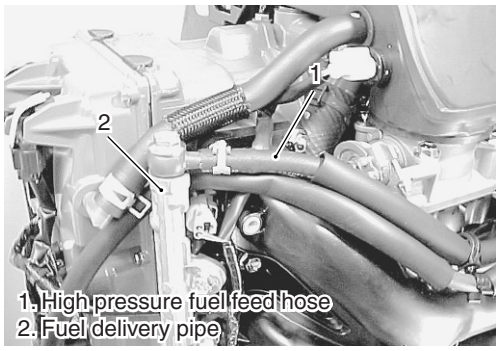
Note that fuel hose connection varies with each type of pipe. Be sure to connect and clamp each hose correctly by referring to the figure.

- 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).



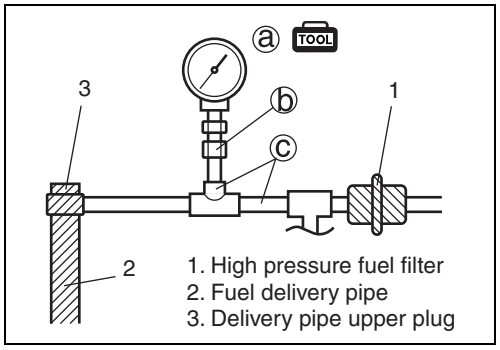
FUEL PRESSURE INSPECTION

1. Relieve fuel pressure in fuel feed line. (See page 5-3.)
2. Disconnect high pressure fuel feed hose from fuel delivery pipe upper union.



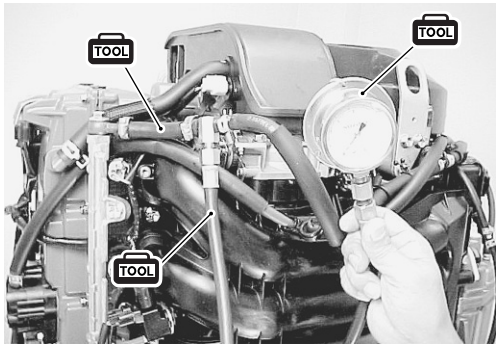
3. Connect special tools (pressure gauge, pressure hose & pressure joint) between fuel feed hose and fuel delivery pipe upper union as shown in figure.
   Clamp hose securely to ensure no leaks occur during checking.

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

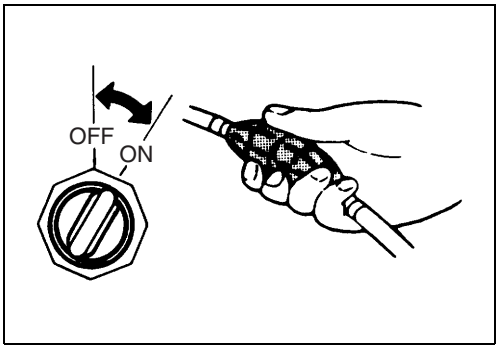


CAUTION

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



4. Ensure emergency stop switch lock plate is in place.
   Shift into “NEUTRAL” position.



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

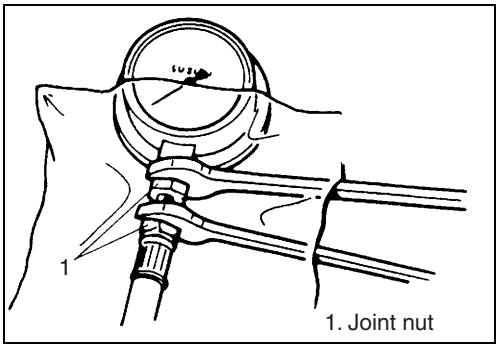
   Fuel pressure: Approx. 255 kPa
   (2.55 kg/cm², 36.3 psi)

10. 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 fuel pressure relief procedures mentioned earlier. Use the following procedures to remove fuel pressure gauge.
- **Place container under joint to catch fuel.**
- **Cover joint with rag and loosen joint nut slowly to gradually release any residual fuel pressure.**



1. Joint nut

11. After checking fuel pressure, remove fuel pressure gauge.
12. Reconnect fuel line.
13. With engine not running and ignition switch “ON”, check fuel system for leaks .

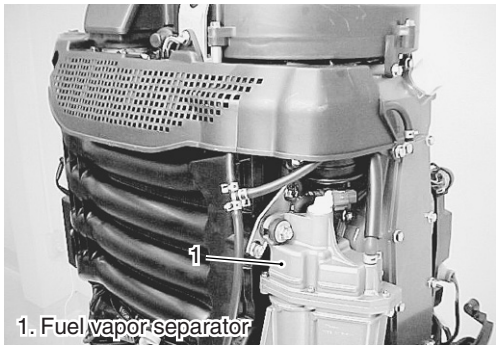
FUEL VAPOR SEPARATOR SET/HIGH PRESSURE FUEL PUMP

REMOVAL

⚠ WARNING

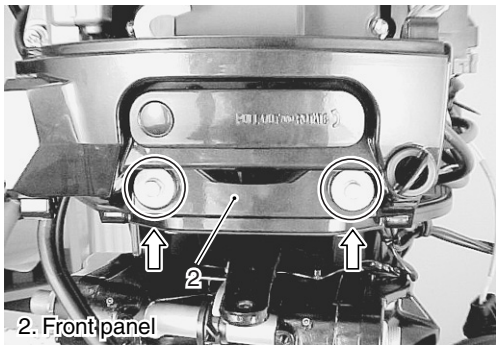
Fuel components and fuel hoses after the high pressure fuel pump remain pressurized at all times.
To protect against fuel spray, relieve fuel line pressure before disconnecting or removing components.

1. Relieve fuel pressure in fuel feed line. (See page 5-3.)
2. Remove the engine side lower cover. (See page 7-2.)



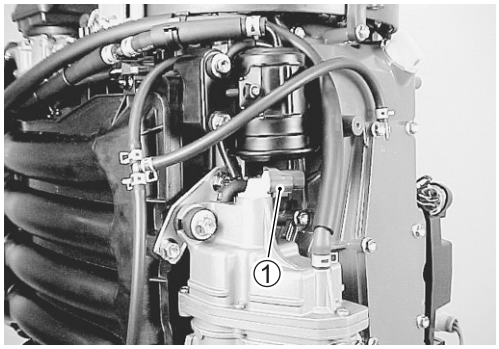
1. Fuel vapor separator

3. Remove the two bolts securing front panel.

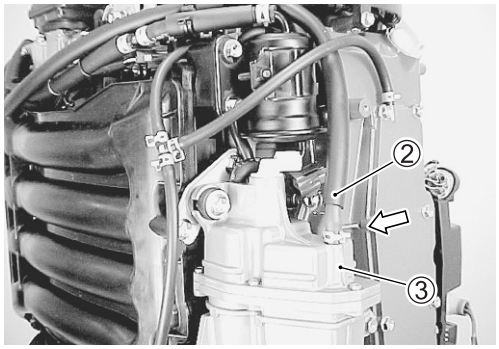


2. Front panel

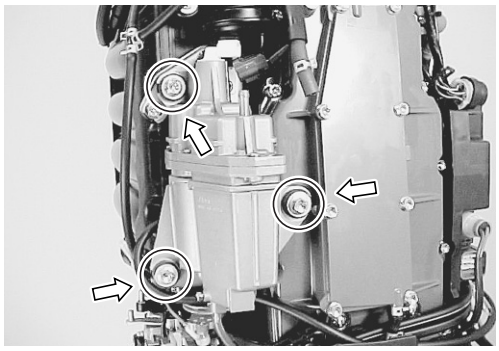
4. Disconnect high pressure fuel pump lead wire connector ① at fuel pump.



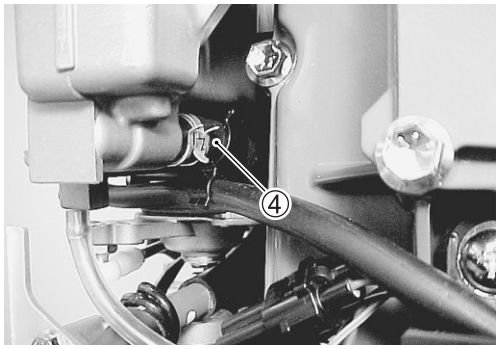
5. Disconnect fuel inlet hose ② from vapor separator ③.



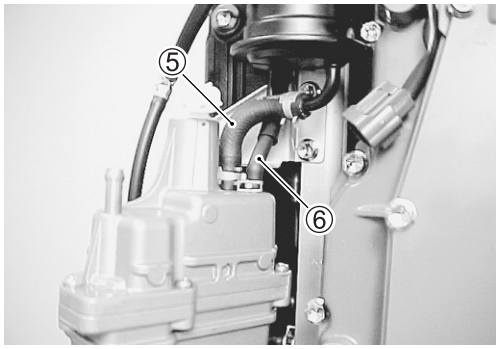
6. Remove the three (3) bolts securing fuel vapor separator to crankcase.



7. Disconnect fuel return hose ④ from fuel vapor separator.

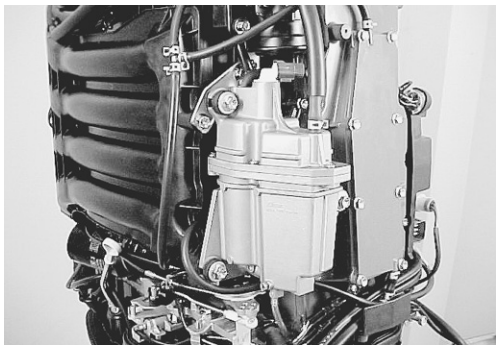


8. Disconnect fuel outlet hose ⑤ from high pressure fuel filter, then remove evaporation hose ⑥ from fuel vapor separator.



INSTALLATION

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

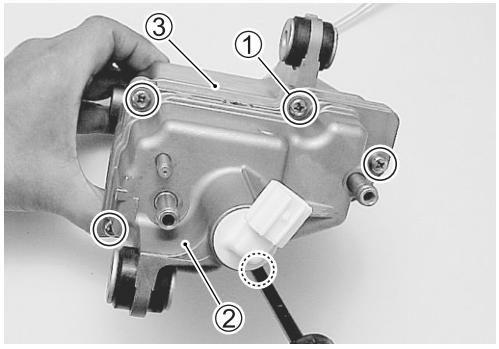


Final Check

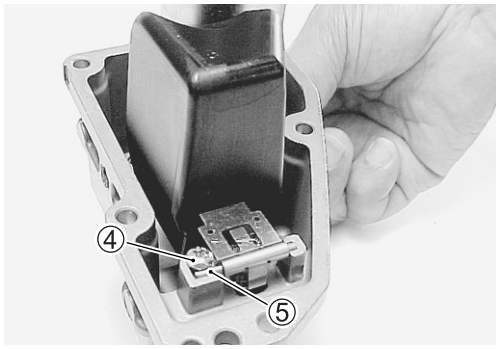
- Check to ensure that all removed parts are back in place.
- Check fuel hose routing. (See page 11-11 to 11-17.)
- Check for fuel leakage. (See page 5-4.)

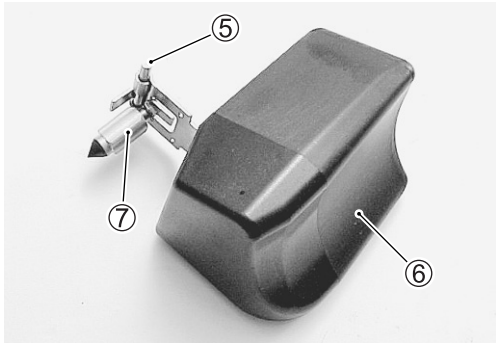
DISASSEMBLY

1. Remove five (5) screws ①.
   Remove separator cover ② with high pressure fuel pump from separator case ③.

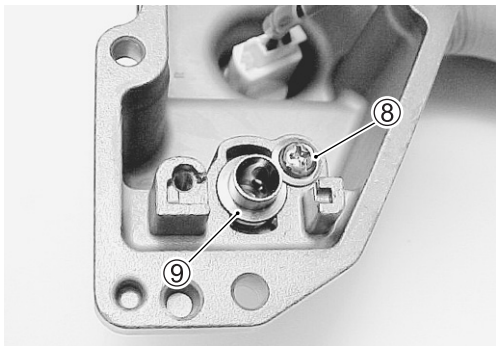


2. Remove the screw ④ securing float pin ⑤.
   Remove the float ⑥, float pin ⑤ and needle valve ⑦.

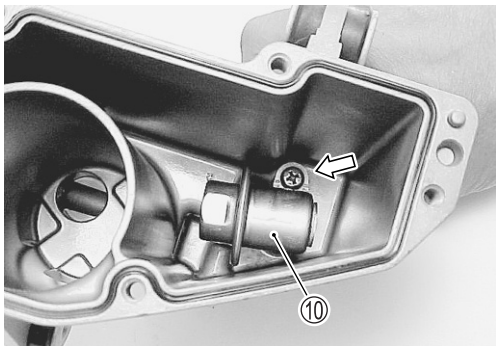




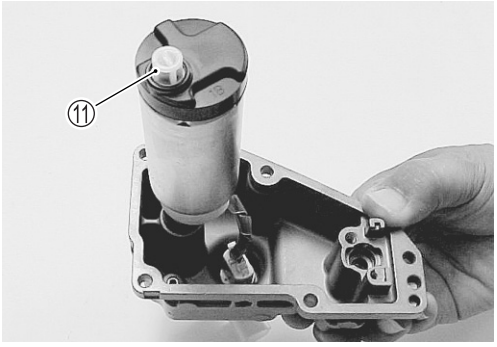
3. Remove screw ⑧ and valve seat ⑨.



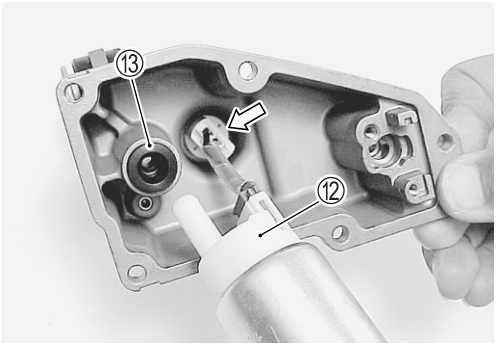
4. Remove screw and fuel pressure regulator ⑩ from separator case.



5. Remove suction filter ⑪.



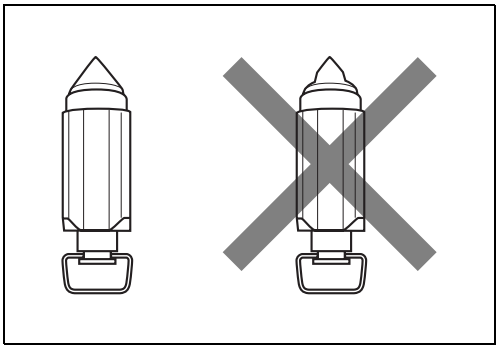
6. Remove high pressure fuel pump ⑫ and grommet ⑬ from separator cover and then disconnect pump lead wire connector.



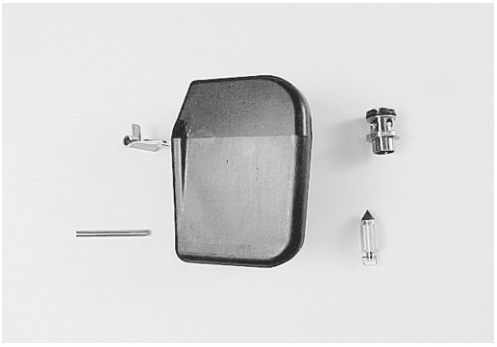
INSPECTION

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 cracks or other damage.
Replace if necessary.



Filter

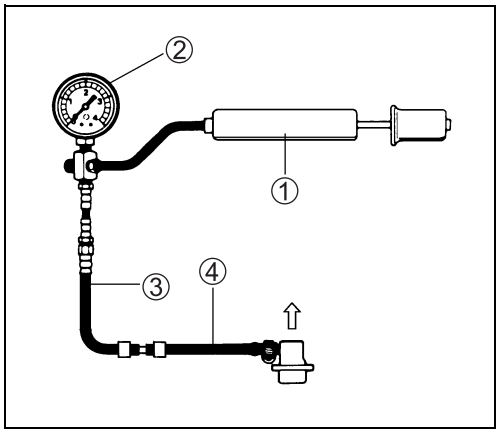
Inspect pump suction filter for clog or other damage.
Replace or clean if necessary.



Fuel pressure regulator

Inspect fuel pressure regulator for damage or corrosion.
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



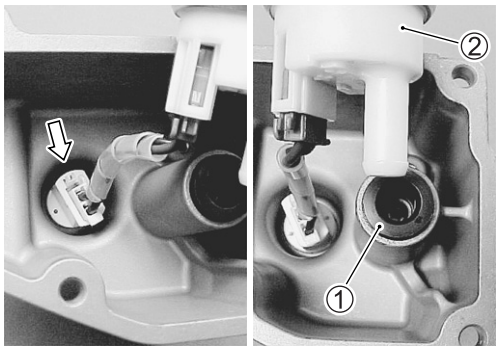
1. Connect special tools to inlet side of regulator as shown in figure.
2. Pump air into regulator using pump ① until air is released through outlet side.
3. Read pressure on gauge when air is released.

   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

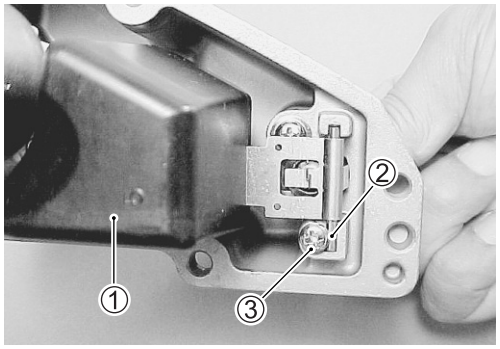
Connect pump lead wire connector, then install grommet ① and fuel pump ②.

NOTE:

Apply fuel to grommet before installing.

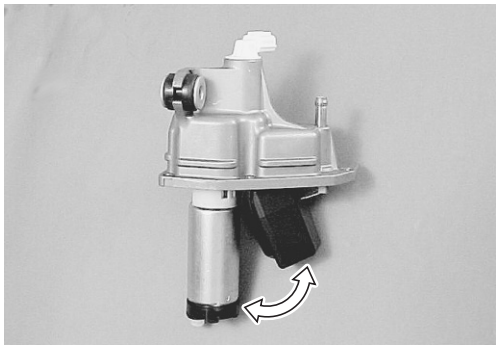
Float/Float pin

Install float ① and float pin ②, then secure float pin with screw ③.



NOTE:

After assembling, check for smooth and free float movement.



Checking float height

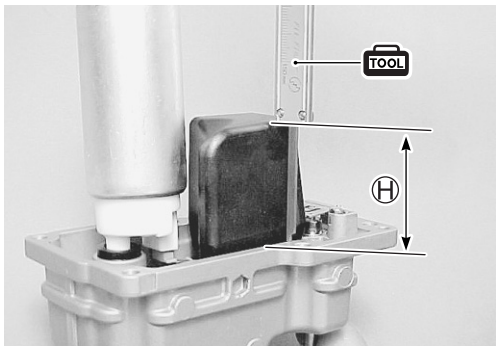
Measure float height.

09900-20101: Vernier calipers

Float height Ⓗ: 43 ± 1 mm

NOTE:

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

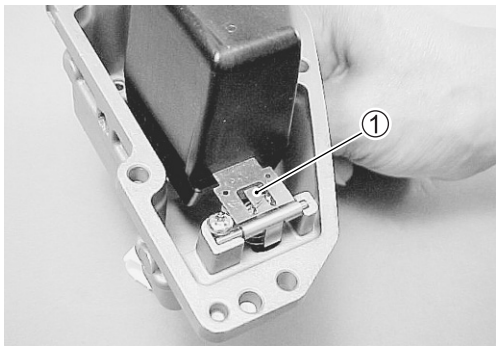


Setting float height

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.

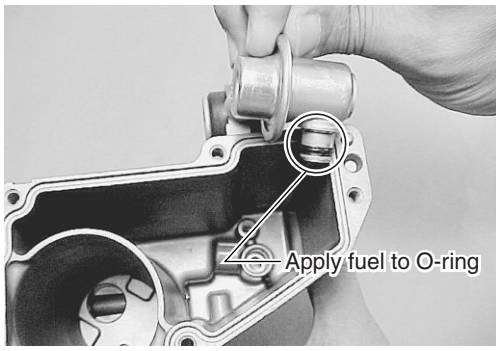


Fuel pressure regulator

Install fuel pressure regulator and tighten screw securely.

NOTE:

Apply fuel to O-ring before installing regulator.



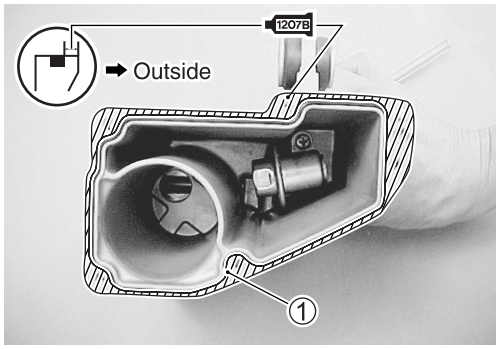
Separator cover/Separator case

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:

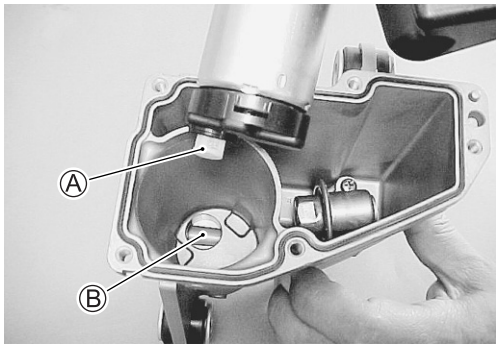
- *Clean mating surfaces before applying bond.*
- *Do not apply bond to seal ring , groove and inside mating surface.*



2. Install separator case, then tighten screws securely.

NOTE:

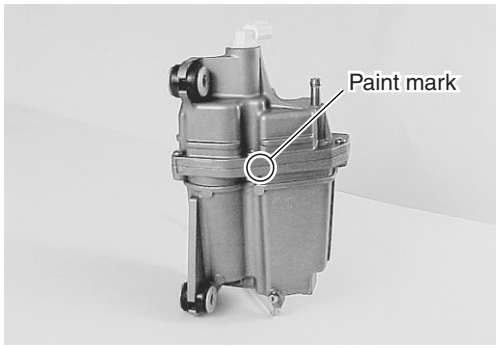
When installing separator case, align suction hole Ⓐ with hole Ⓑ of separator case.



NOTE:

Separator cover and case are a set.

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



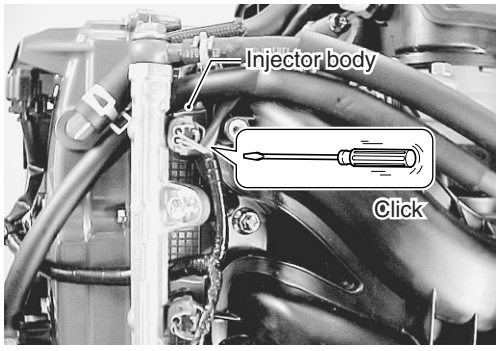
Final Assembly Check

- Check to ensure that all removed part are back in place.
- Check fuel hose routing. (See page 11-11 to 11-17.)
- Check for fuel leakage. (See page 5-4.)

FUEL INJECTOR

INSPECTION

1. Using sound scope or equivalent, check operating sound of fuel injector when engine is running or cranking.
   Injector operating sound cycle should vary according to engine speed.
   If no sound or an unusual sound is heard, check injector circuit (wire or connector) or injector.



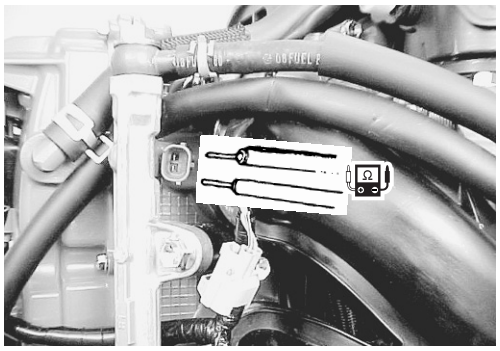
2. Disconnect lead wire connector from fuel injector.
3. Connect digital tester between terminals of injector and measure resistance.

09930-99320: Digital tester

Tester range: Ω (Resistance)
Fuel injector resistance: 10.0 – 14.0 Ω

If out of specification, replace fuel injector.

4. Connect lead wire connector to fuel injector securely.

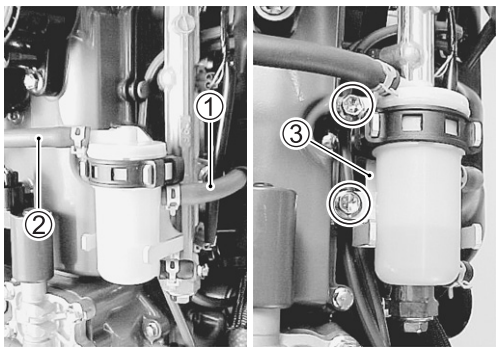


REMOVAL

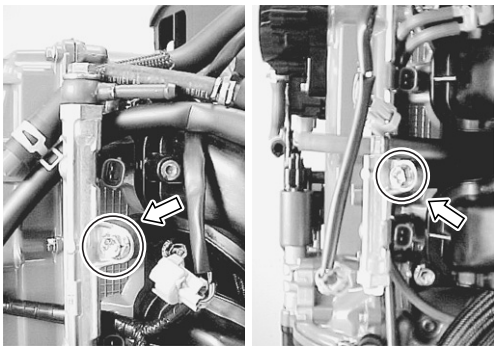
1. Relieve fuel pressure according to procedure described on page 5-3.
2. Loosen clamp and place a large cloth over end of fuel feed hose.
   Slowly pull fuel feed hose from fuel delivery pipe.
   Drain any excess fuel in hose into a small container.



3. Disconnect the inlet hose ① and outlet hose ② from low pressure fuel filter.
4. Remove bolts and fuel filter bracket ③.

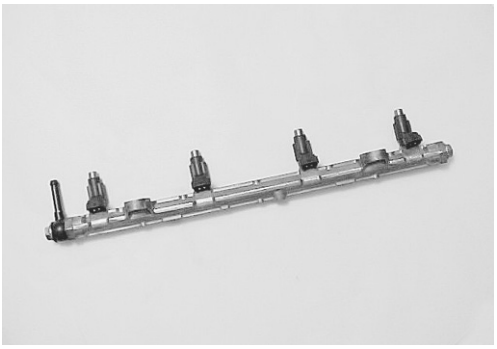


5. Disconnect four fuel injector connectors.
6. Remove two bolts and fuel delivery pipe (with fuel injectors).

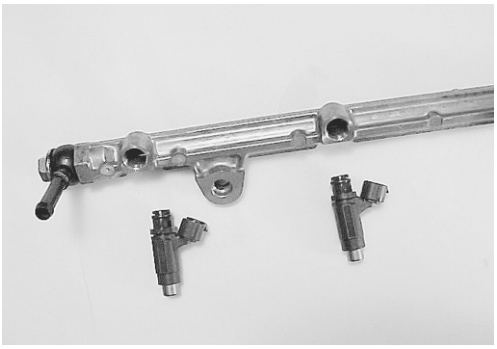


CAUTION

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



7. Remove each injector from delivery pipe.



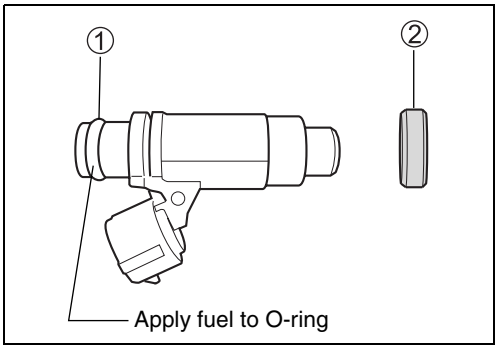
INSTALLATION

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

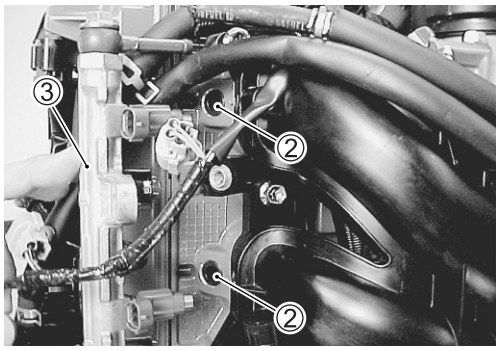
CAUTION

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

1. Replace injector O-ring ① with new one using care to avoid nicks or cuts during installation.

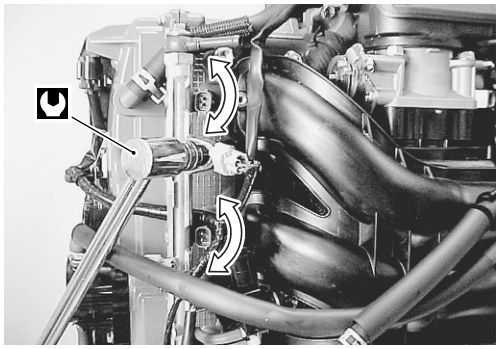


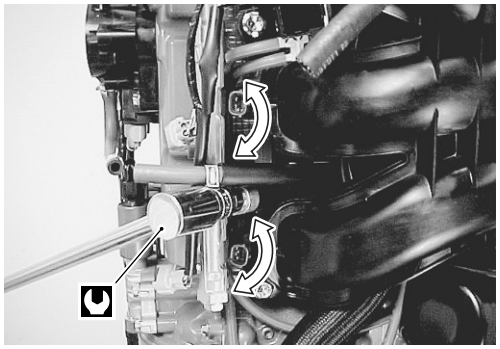
2. Replace injector cushion ② with new one and install to cylinder head.
3. Apply thin coat of fuel to injector O-rings, then install injectors into delivery pipe ③ and cylinder head.
   Make sure that injectors rotate smoothly.



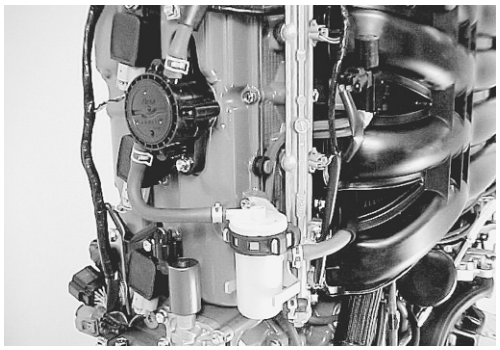
4. Tighten delivery pipe bolts and make sure that injectors rotate smoothly.

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





5. Install fuel filter bracket and tighten bolts securely.
6. Reconnect fuel feed hose and fuel line securely.
7. Connect lead wire connector to injectors securely.



8. Make sure the emergency stop switch lock plate is in place.
   Shift into “NEUTRAL” position.
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.

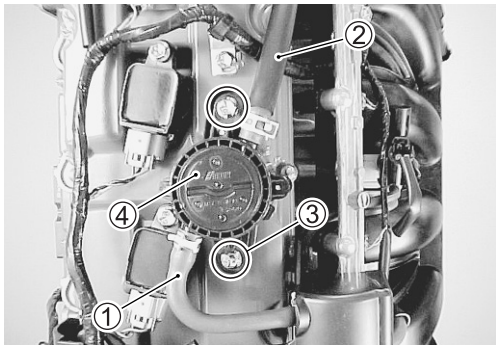
LOW PRESSURE FUEL PUMP

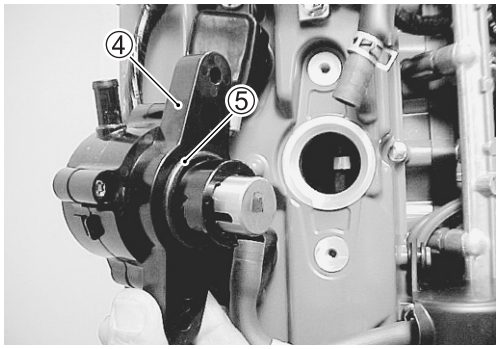
The low pressure fuel pump is a non-repairable component.
Do not attempt to disassemble the low pressure pump. It must be replaced as a complete unit if it is defective.

REMOVAL/INSTALLATION

REMOVAL

1. Disconnect inlet hose ① and outlet hose ② from low pressure fuel pump.
2. Remove two bolts ③.
3. Remove fuel pump ④.
   Note position before removing O-ring ⑤.



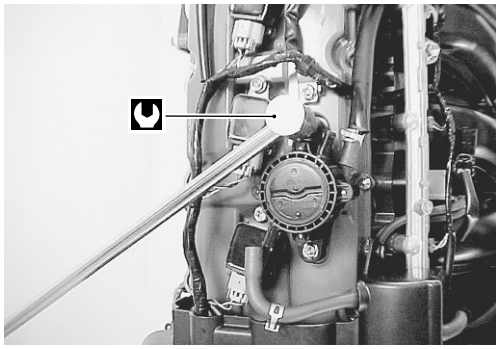


INSTALLATION

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

CAUTION

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



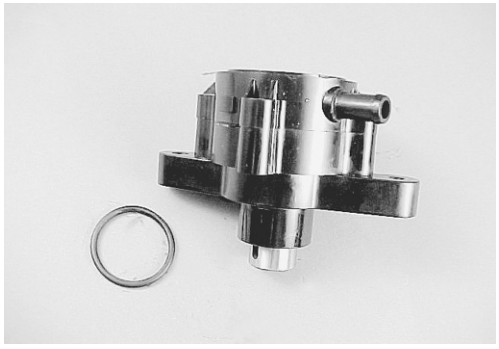
Low pressure fuel pump bolt: 10 N·m (1.0 kg-m, 7.0 lb-ft)

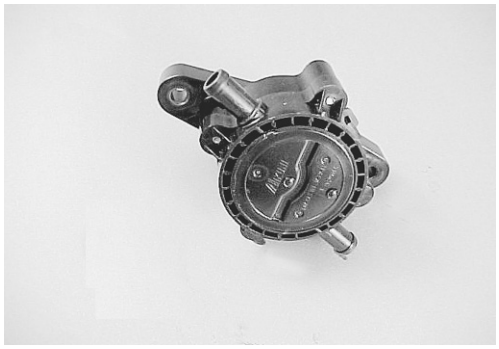
INSPECTION

Fuel pump assembly

Inspect fuel pump.

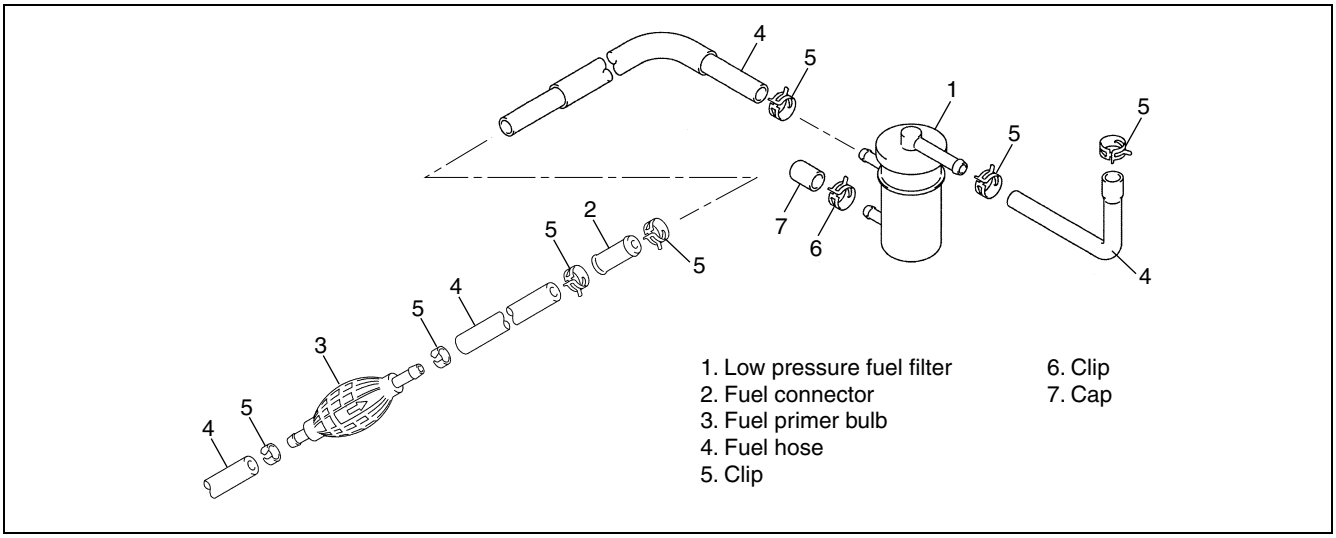
If leakage, cracks, damage or other abnormal condition is found, replace fuel pump assembly.





LOW PRESSURE FUEL FILTER/FUEL HOSE

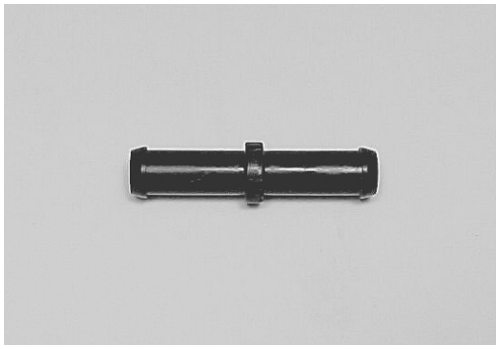
When disassembling or reassembling fuel line, refer to the construction diagram below.



INSPECTION

FUEL CONNECTOR

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

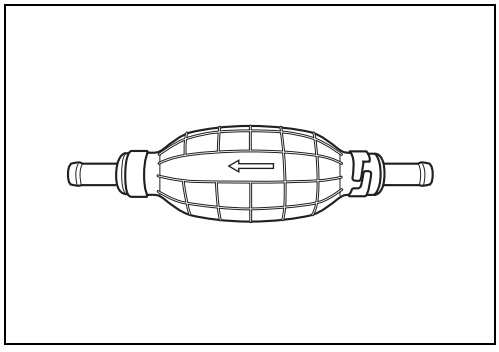


FUEL HOSE

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

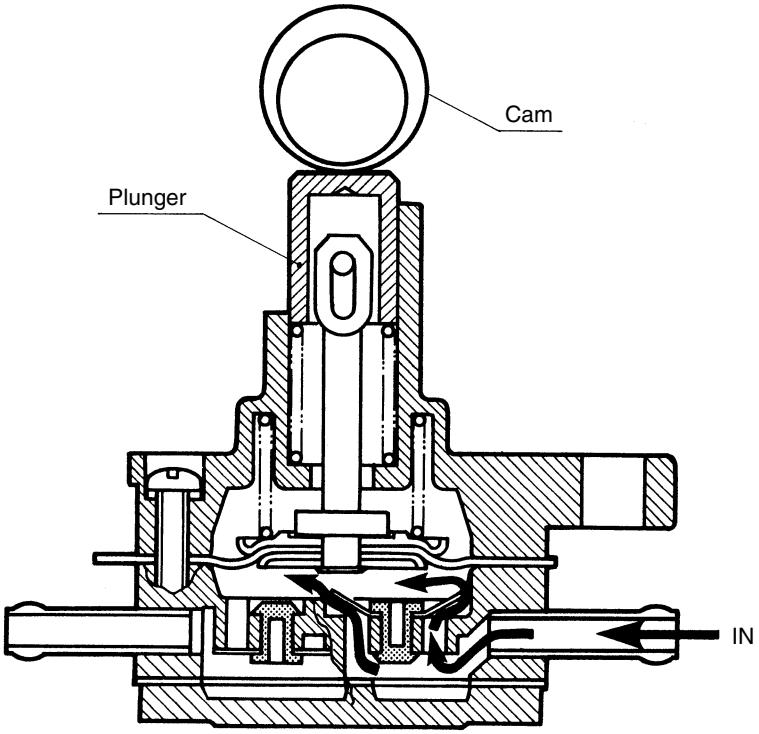
To perform fuel filter inspection, refer to “PERIODIC MAINTENANCE/LOW PRESSURE FUEL FILTER” section on page 2-19.

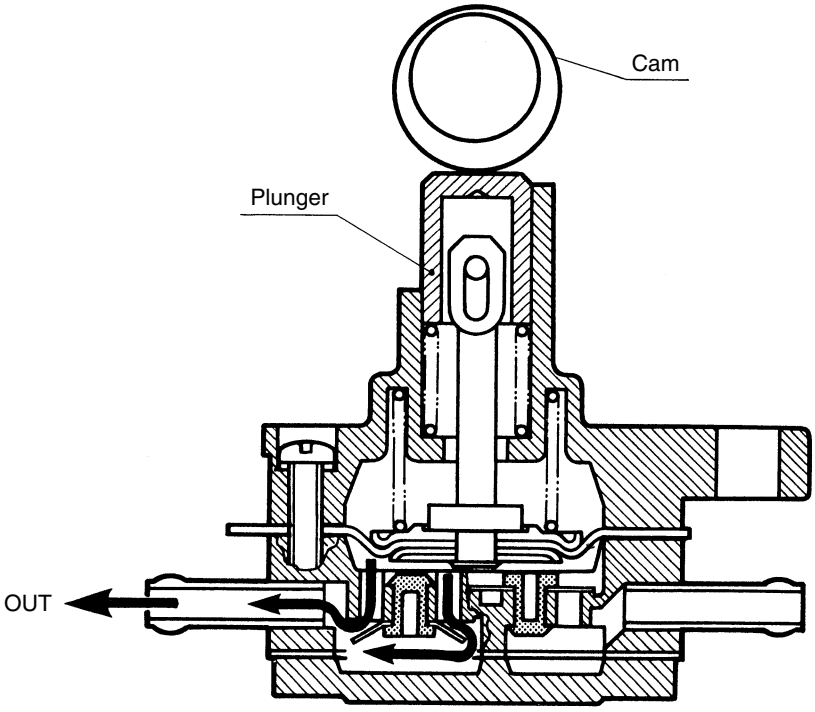


OPERATION

FUEL PUMP

The fuel pump is operated by the plunger contacting the cam.





POWER UNIT

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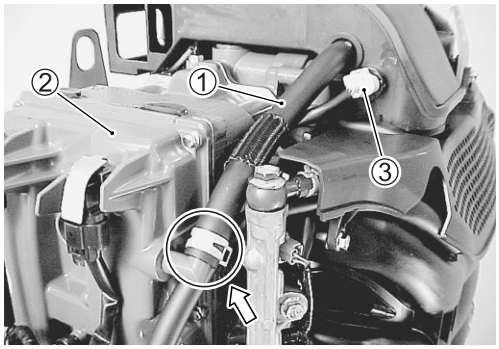
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RING GEAR COVER AND AIR INTAKE SILENCER CASE

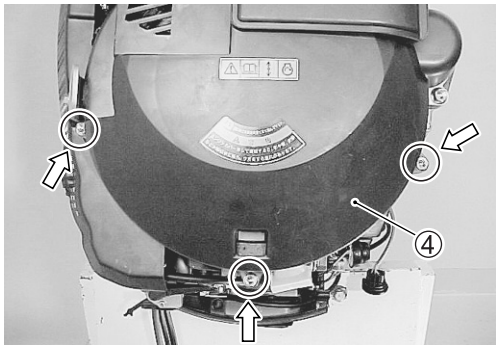
REMOVAL

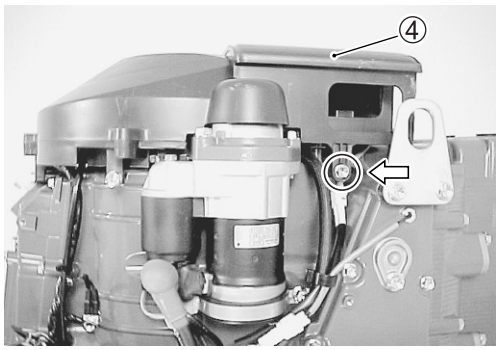
Prior to removing Ring gear cover:
- **Disconnect battery cables from battery.**

1. Loosen the clamp securing breather hose ①, then remove the breather hose from cylinder head cover ②.
2. Disconnect the intake air temp. sensor lead wire connector ③ at intake air temp. sensor.



3. Remove the four (4) bolts securing ring gear cover ④.
4. Remove the ring gear cover and intake silencer case.





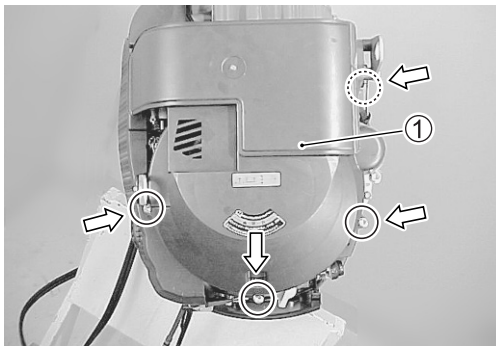
INSTALLATION

Installation is reverse order of removal.

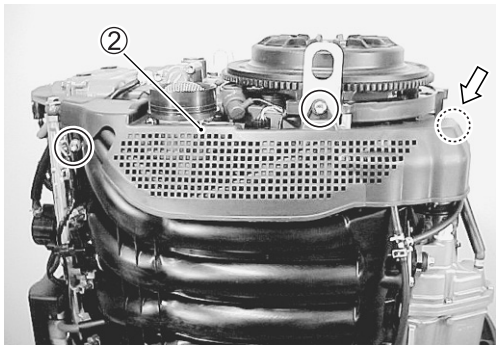
INTAKE MANIFOLD ASSEMBLY

REMOVAL

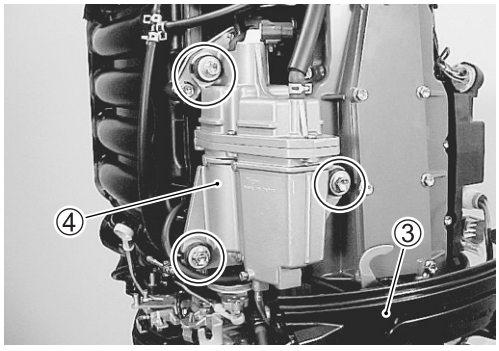
Before removing intake manifold:
- **Relieve fuel pressure. (See page 5-3.)**
- **Disconnect battery cables from battery.**
- **Remove both side covers. (See page 7-2.)**



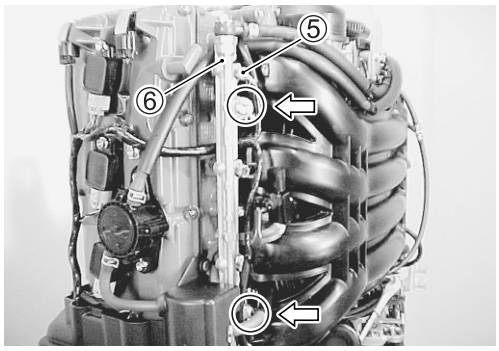
1. Remove ring gear cover and air intake silencer case ①. (See page 6-2.)
   Remove the three (3) bolts and fuel hose guard ②.



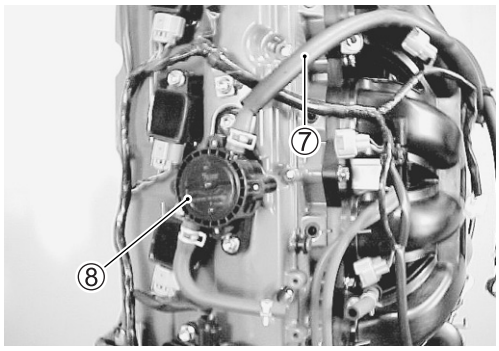
2. Remove the two (2) bolts and front panel ③.
   Remove fuel vapor separator ④. (See page 5-7.)



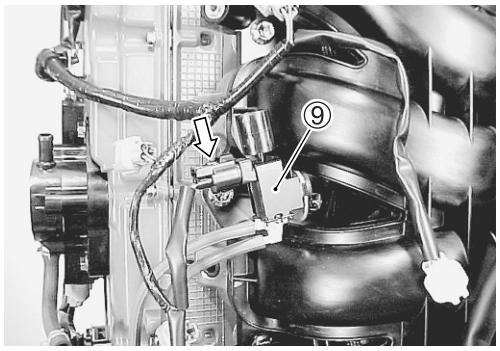
3. Remove fuel injectors ⑤ and fuel delivery pipe ⑥. (See page 5-14.)



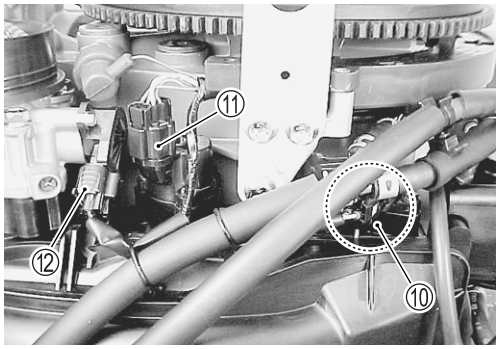
4. Disconnect fuel outlet hose ⑦ from low pressure fuel pump ⑧.



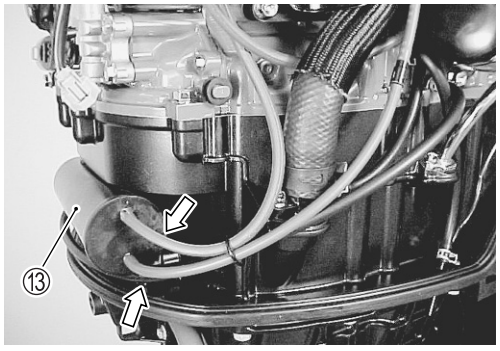
5. Disconnect VSV (Vacuum Switching Valve) connector from VSV ⑨.



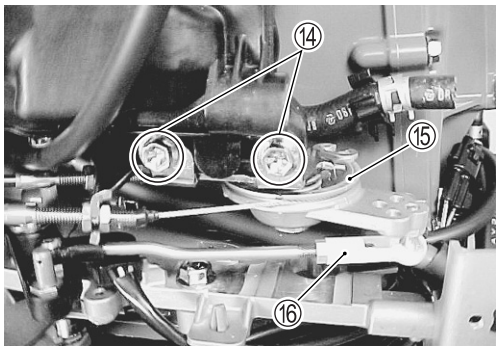
6. Disconnect MAP sensor connector ⑩.
   Disconnect IAC valve connector ⑪.
   Disconnect TPS (Throttle Position Sensor) connector ⑫.



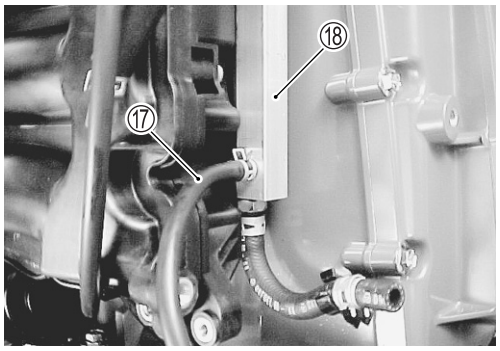
7. Disconnect vacuum hoses from vacuum tank ⑬.



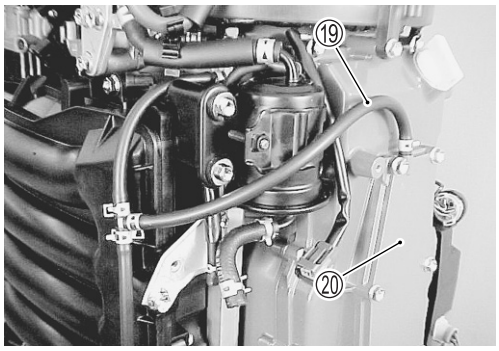
8. Remove the two bolts ⑭ securing throttle drum ⑮ to intake manifold.
   Remove the throttle link connector ⑯ from throttle drum.



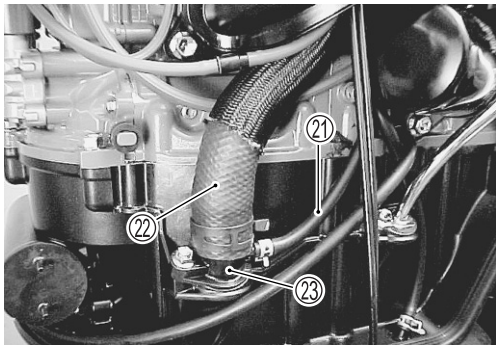
9. Disconnect water inlet hose ⑰ from fuel cooler ⑱.



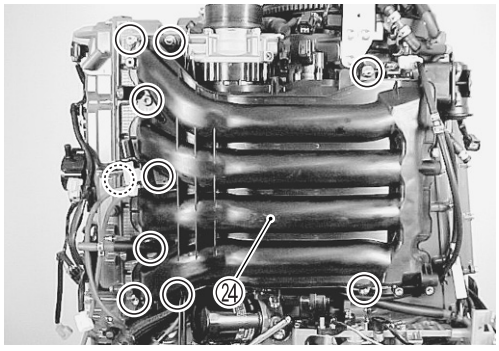
10. Disconnect cooling water outlet hose ⑲ from balancer water jacket cover ⑳.



11. Disconnect water outlet hose ㉑ and water return hose ㉒ from water return union ㉓.



12. Remove eight (8) bolts and two (2) nuts and then remove intake manifold assembly ㉔.



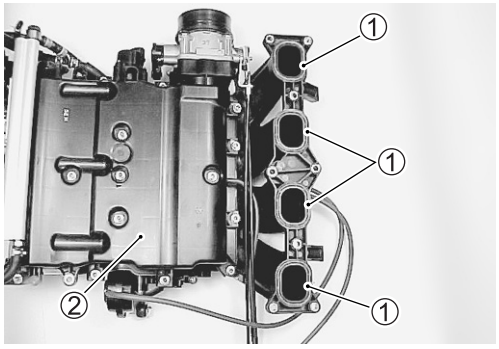
INSTALLATION

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

CAUTION

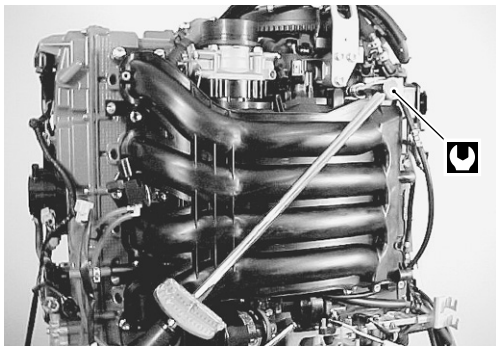
Do not reuse gasket once removed.
Always use a new gasket.

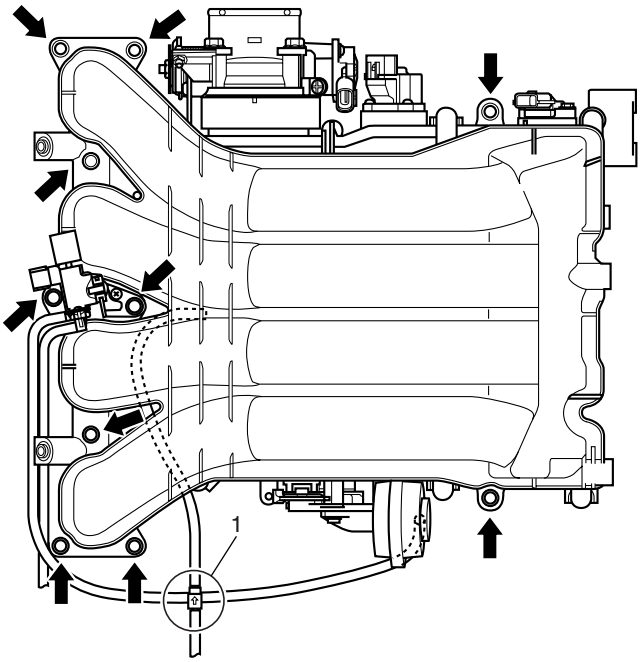
- Install gaskets ① into groove of intake manifold assembly ②.



• Install intake manifold assembly ②, then tighten bolts and nuts securely.

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

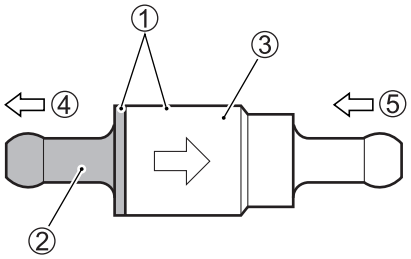




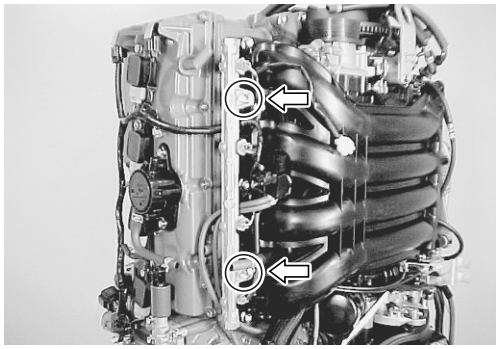
1. Check valve

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

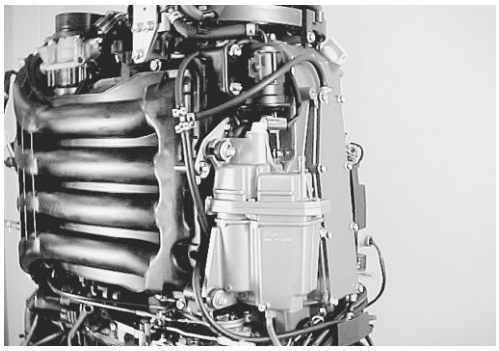
① Check valve
② Green side
③ White side
④ To vacuum chamber
⑤ From intake manifold assembly



• Install fuel injectors and fuel delivery pipe. (See page 5-15.)



- Install fuel vapor separator. (See page 5-8.)



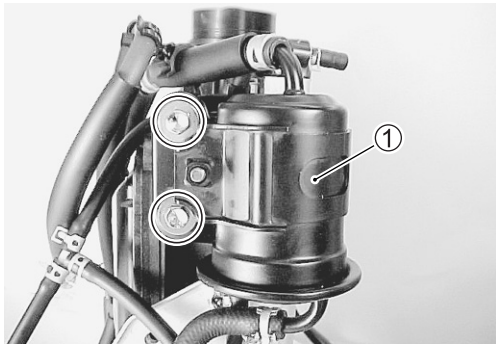
- Check to ensure that all removed parts are back in place.

FINAL ASSEMBLY CHECK

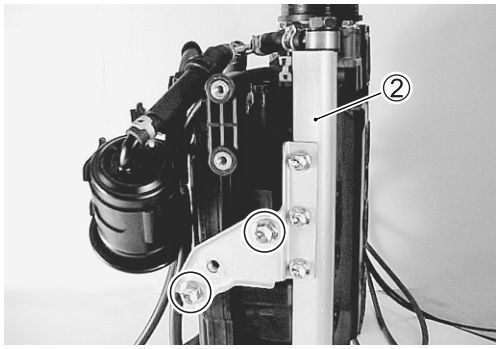
- Check fuel and water hose routing. (See page 11-11 to 11-17.)
- Check wire routing. (See page 11-4 to 11-10.)
- Check for fuel leakage.
- Check for water leakage.

DISASSEMBLY

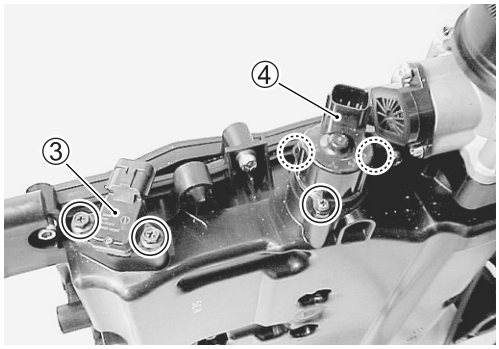
Remove bolts and high pressure fuel filter ①.



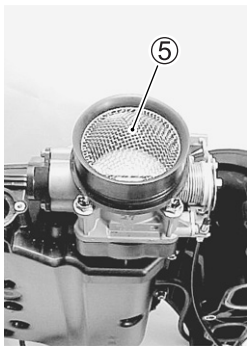
Remove bolts and fuel cooler ②.

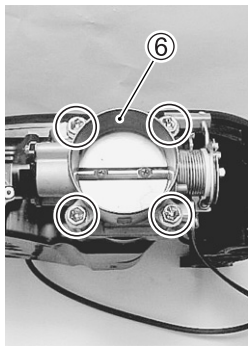


Remove screws and MAP sensor ③.
Remove screws and IAC valve ④.

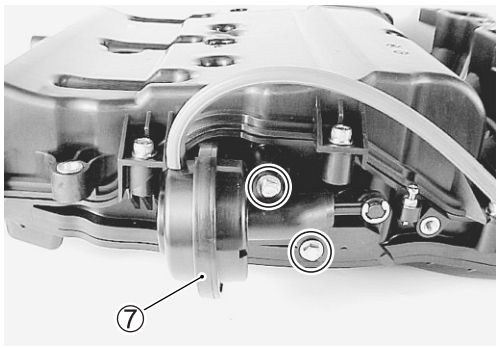


Remove flame arrester ⑤.
Remove bolts and throttle body assembly ⑥.

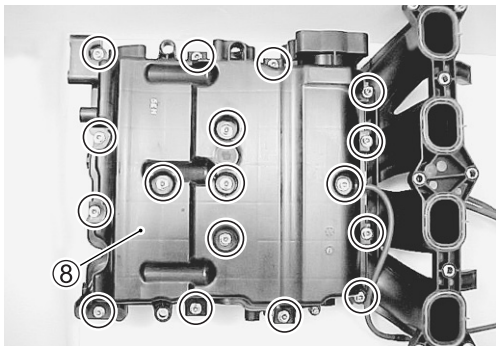




Remove screws and depression chamber ⑦.



Remove the seventeen (17) screws and intake manifold cover ⑧.



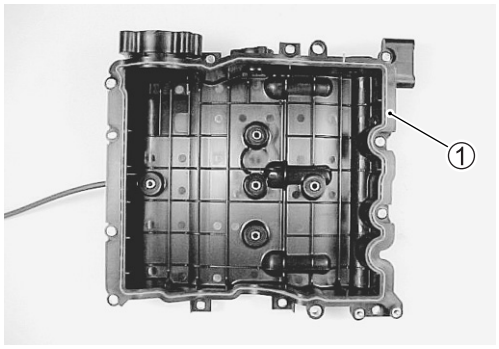
REASSEMBLY

Reassemble in reverse order of disassembly paying special attention to the following steps.

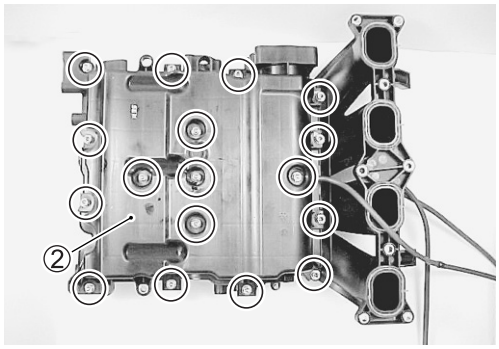
CAUTION

Do not reuse gasket, always replace with new one.

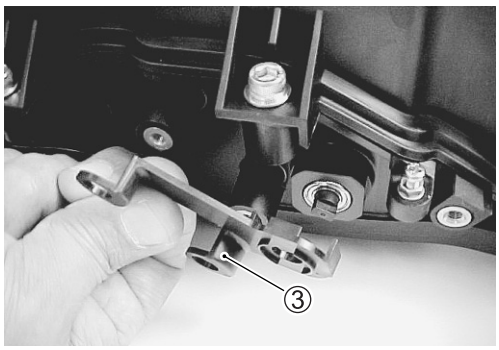
- Install new cover gasket ① to intake manifold cover.



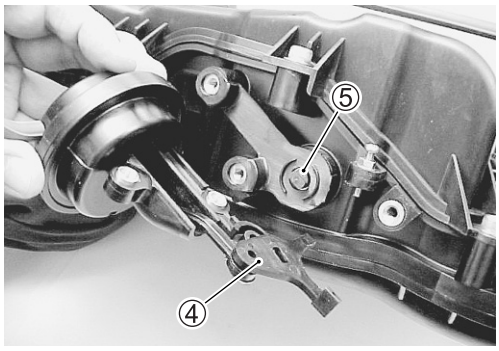
- Install intake manifold cover ② to intake manifold, then tighten manifold cover screws securely.



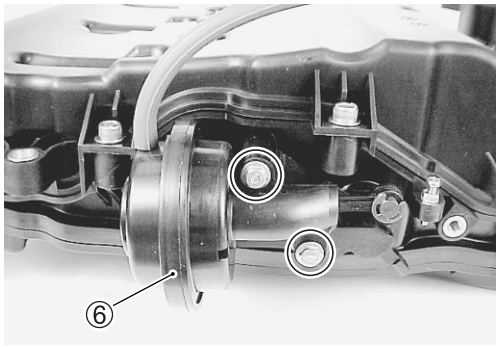
- Install spacer ③ to intake manifold.



- Install the lever ④ onto the pivot shaft ⑤, use care to align hole in lever with pivot shaft end.

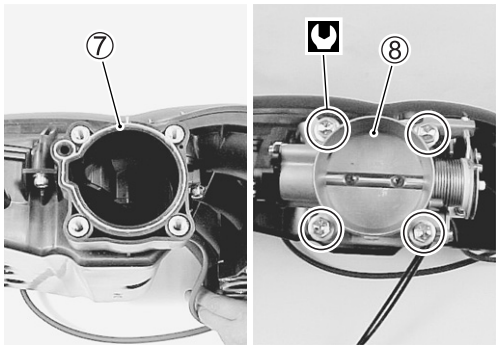


- Install depression chamber ⑥, then tighten screws securely.



- Install seal ring ⑦ and throttle body ⑧.
  Securely tighten the four (4) throttle body bolts to specified torque.

Throttle body bolt: 23 N·m (2.3 kg-m, 16.6 lb-ft)



FINAL ASSEMBLY CHECK

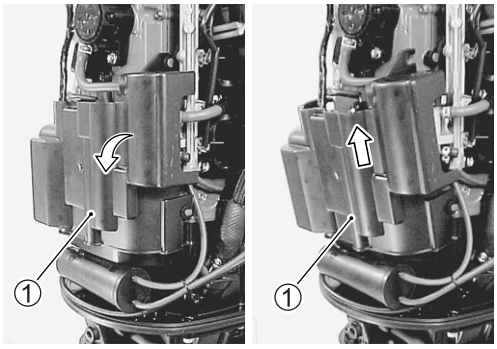
- All parts removed have been returned to their original positions.

CYLINDER HEAD COVER

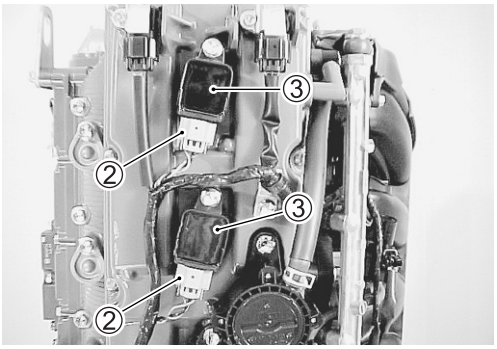
REMOVAL

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

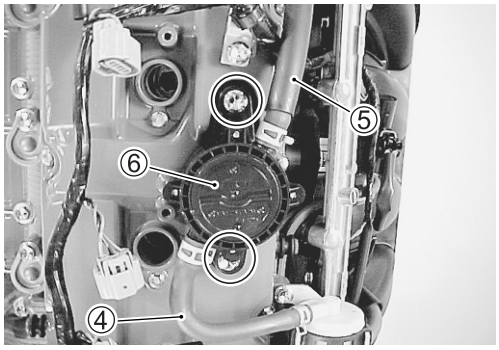
1. To remove the cover ①, pull the upper part outward, then lift up.



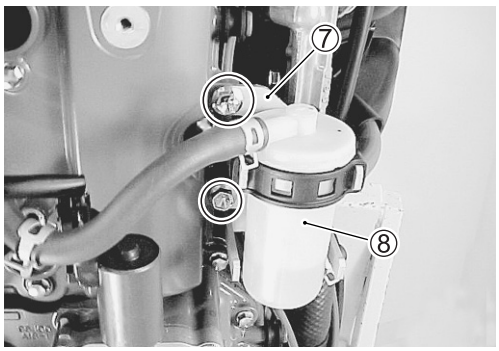
2. Remove the ring gear cover and air intake silencer case. (See page 6-2.)
3. Disconnect ignition coil connectors ②.
   Remove the bolts securing the ignition coils.
   Remove all ignition coils ③ and spark plugs.



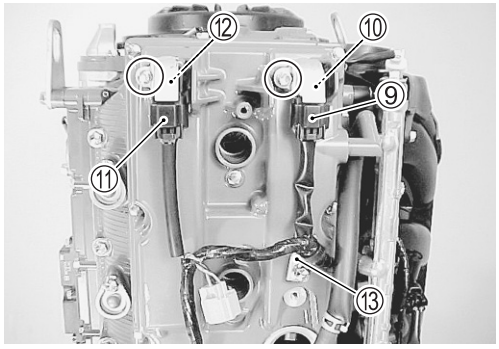
4. Disconnect inlet hose ④ and outlet hose ⑤ from low pressure fuel pump.
   Remove bolts and low pressure fuel pump ⑥.
   (See page 5-17.)



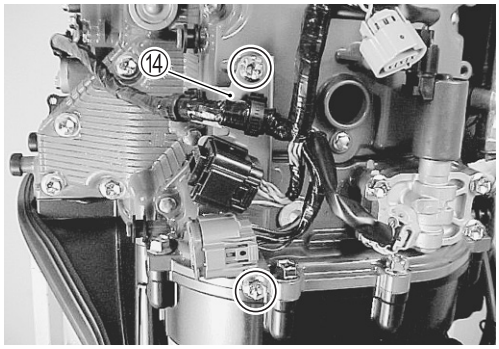
5. Remove the two bolts securing filter bracket ⑦, then remove low pressure fuel filter ⑧ and filter bracket.



6. On DF175 model;
   disconnect IN. CMP sensor lead wire connector ⑨ at sensor.
   Remove bolt and IN. CMP sensor ⑩.
7. Disconnect EX. CMP sensor lead wire connector ⑪ at sensor.
   Remove bolt and EX. CMP sensor ⑫.
8. Remove the bolt securing lead wire clamp plate ⑬.

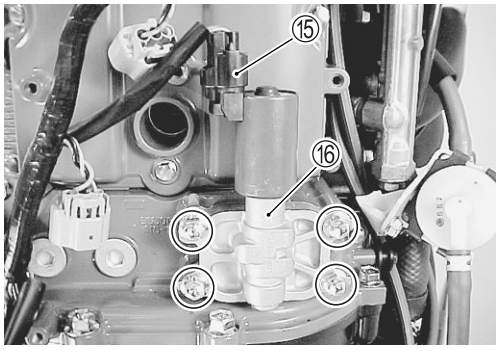


9. Remove the two bolts securing lead wire clamp plate ⑭.

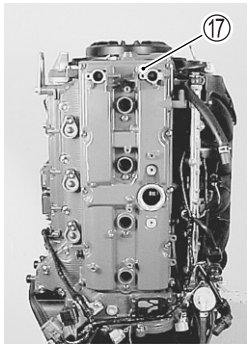


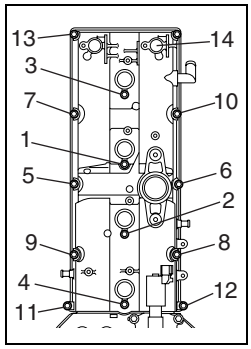
10. On DF175 model, disconnect OCV lead wire connector ⑮ at OCV.
    Remove the four (4) bolts securing OCV ⑯, then remove OCV and discard OCV gasket.

NOTE:
DF150 model is not equipped with OCV.



11. Remove the fourteen (14) bolts securing cylinder head cover ⑰ to the cylinder head, then remove the cylinder head cover.





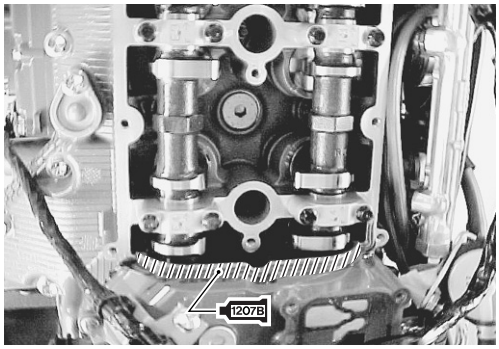
INSTALLATION

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

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

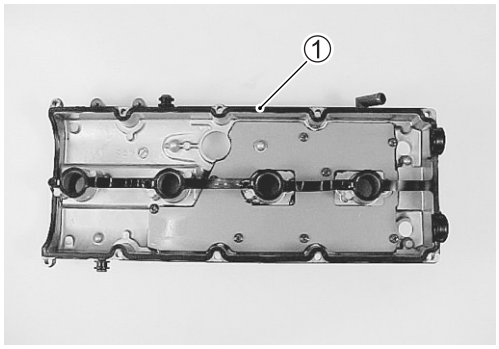
1207B 99000-31140: SUZUKI BOND "1207B"





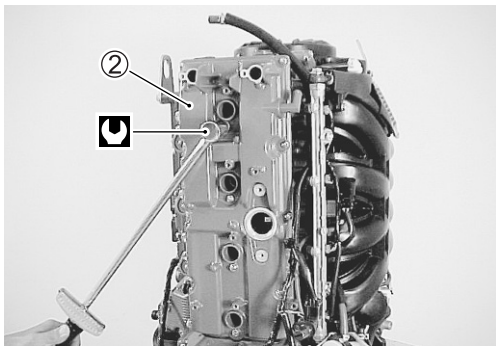
- Install new cylinder head cover gasket ① to head cover.

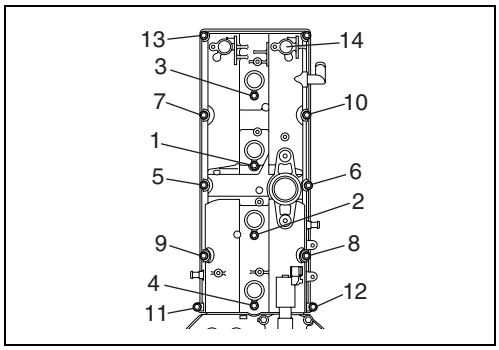
NOTE:
Examine cylinder head cover gasket for damage.
Always replace gasket with new one.



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

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





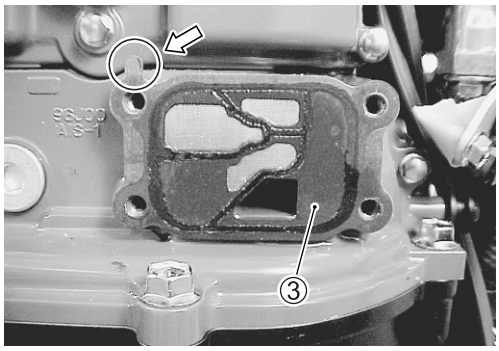
• On the DF175 model, install new gasket ③ and OCV ④, then tighten bolts securely.

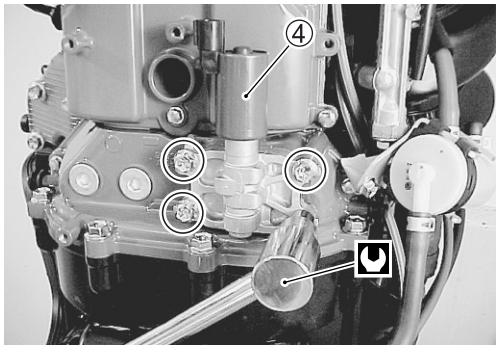
NOTE:
Position the OCV gasket tab as shown at right.

CAUTION

Do not reuse the OCV gasket, always replace with new one.

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





FINAL ASSEMBLY CHECK

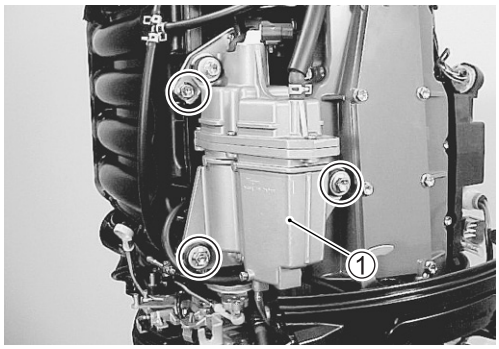
- All parts removed have been returned to their original positions.
- Wire and hose routing match's service manual illustration.
- No oil leakage is evident during final test running.

POWER UNIT

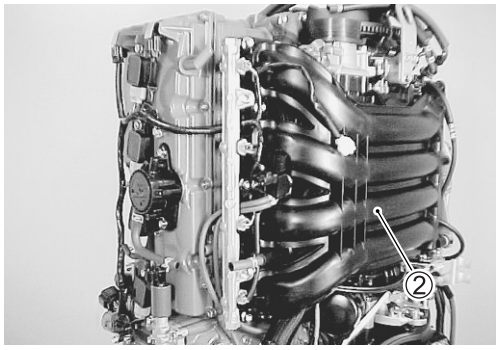
REMOVAL

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

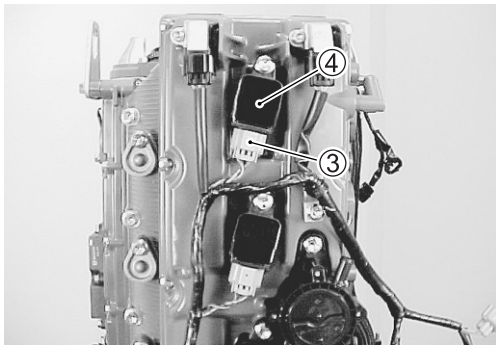
Remove the fuel vapor separator ①. (See page 5-7.)



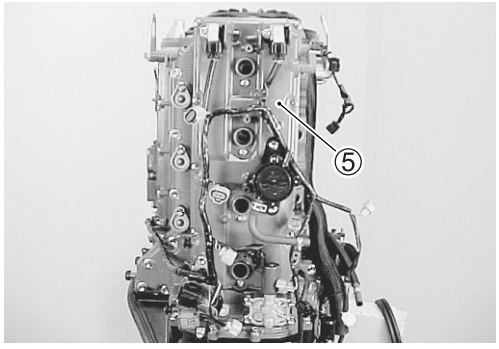
Remove the fuel injectors and intake manifold assembly ②. (See page 6-3 to 6-5.)



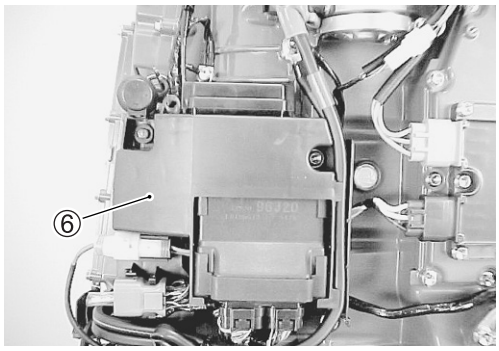
Disconnect ignition coil connectors ③.
Remove bolts securing the ignition coils ④.
Remove all ignition coils ④ and spark plugs.



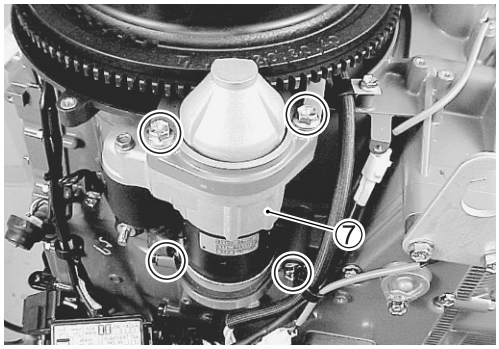
Remove the cylinder head cover ⑤. (See page 6-11 to 6-12.)



Remove the electric parts holder ⑥. (See page 4-30.)

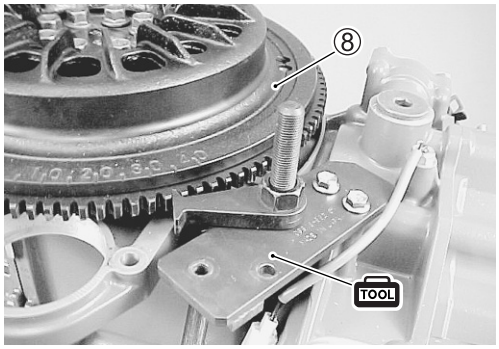


Remove starter motor ⑦. (See page 4-17.)

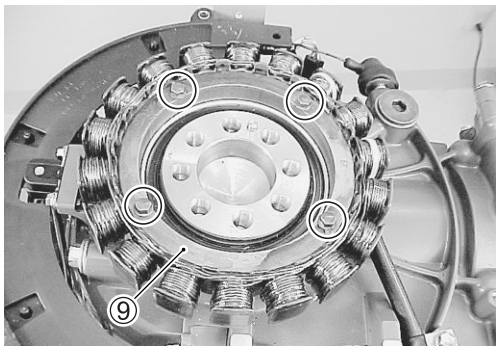


Remove flywheel ⑧. (See page 3-66.)

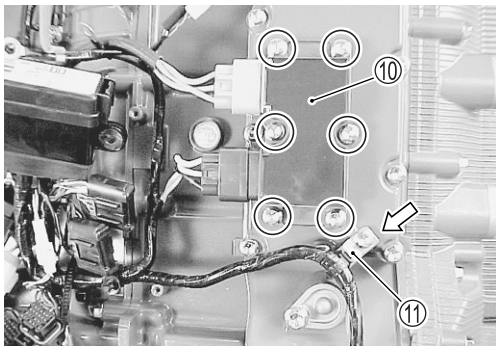
09916-99311: Flywheel holder



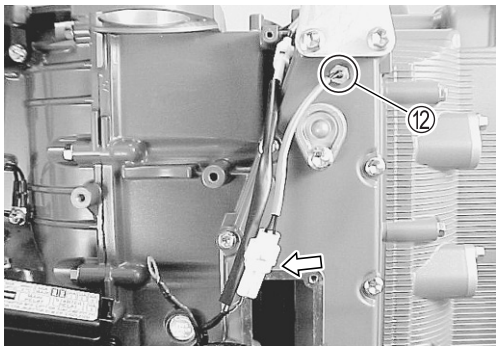
Remove battery charge coil ⑨. (See page 4-9.)



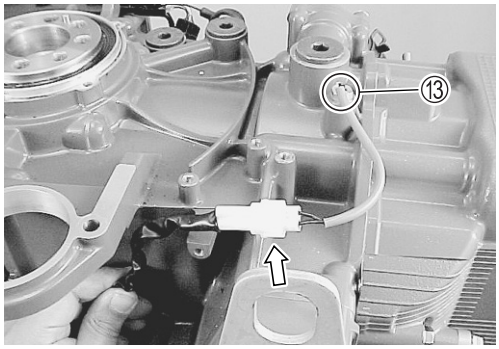
Disconnect charge output lead wire connector from Rectifier & regulator.
Remove six bolts and Rectifier & regulator ⑩.
Remove the bolt securing lead wire clamp plate ⑪.



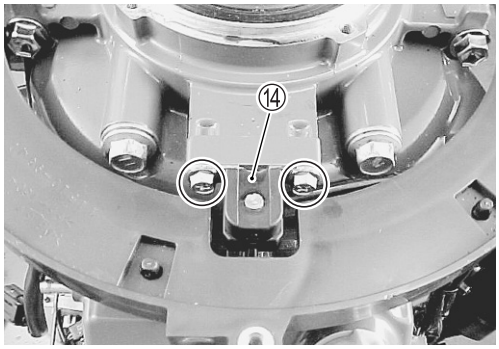
Disconnect EX. manifold temperature sensor lead wire connector.
Remove EX. manifold temperature sensor ⑫.



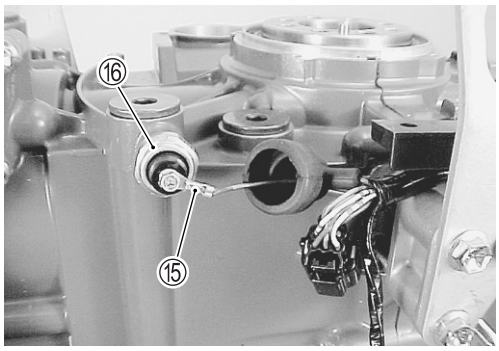
Disconnect cylinder temperature sensor lead wire connector.
Remove cylinder temperature sensor ⑬.



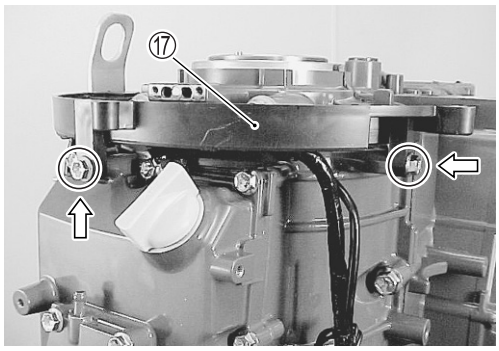
Remove screws and CKP sensor ⑭.
Disconnect CKP sensor lead wire connector.



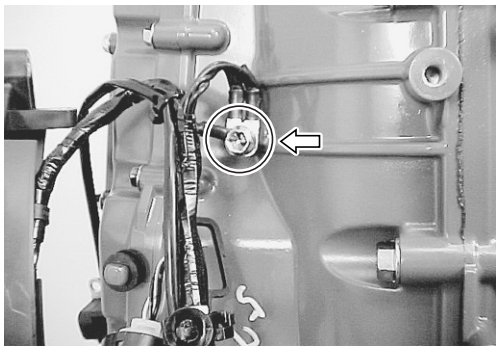
Loosen screw and disconnect blue lead wire ⑮ from oil pressure switch ⑯.



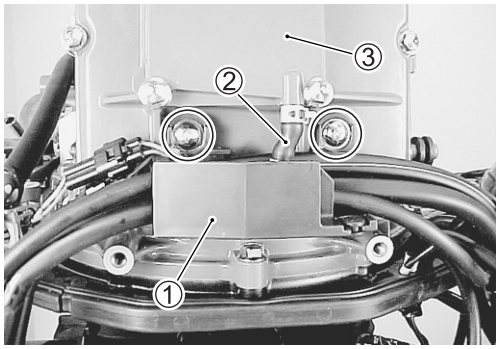
Remove the two bolts securing lower ring gear cover ⑰, then remove ring gear cover with wiring harness.



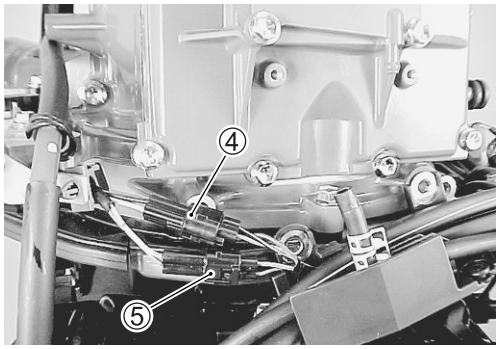
Remove the bolt securing GND lead wire terminals.



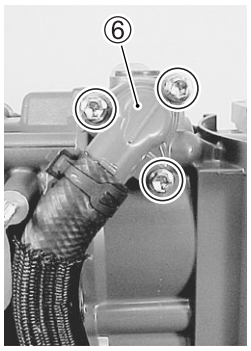
Remove the screws securing hose and harness holder ①.
Disconnect water inlet hose ② from balancer water jacket cover ③.

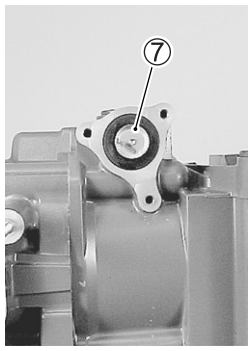


Disconnect shift position sensor lead wire connector ④.
Disconnect neutral switch lead wire connector ⑤.

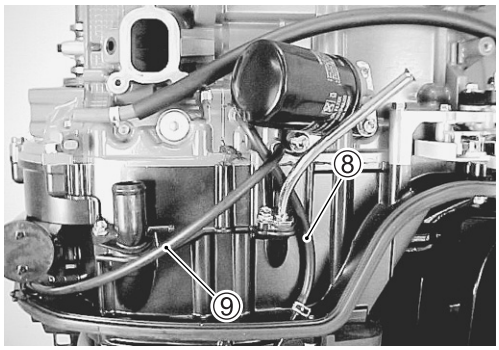


Remove three (3) bolts, thermostat cover ⑥ and thermostat ⑦.

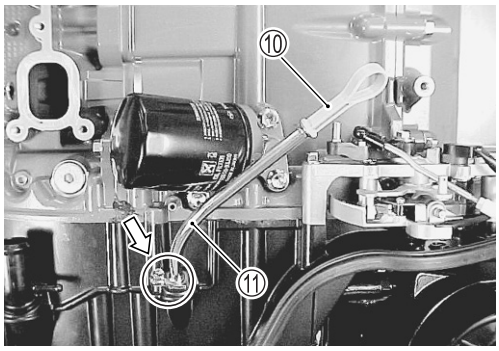




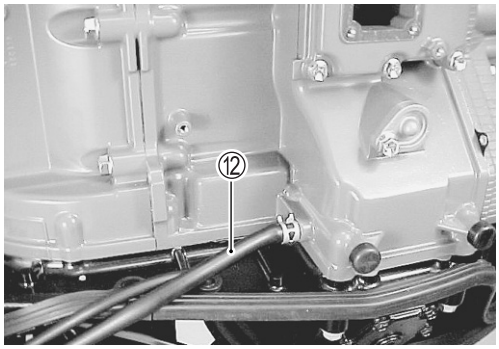
Disconnect pilot water hose ⑧ from cylinder block.
Disconnect water inlet hose ⑨ from cylinder block.



Remove oil level dipstick ⑩.
Remove bolt and oil dipstick tube ⑪.

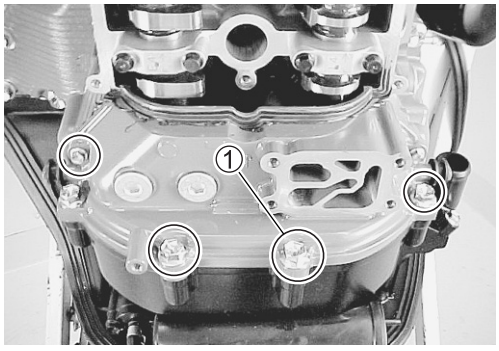


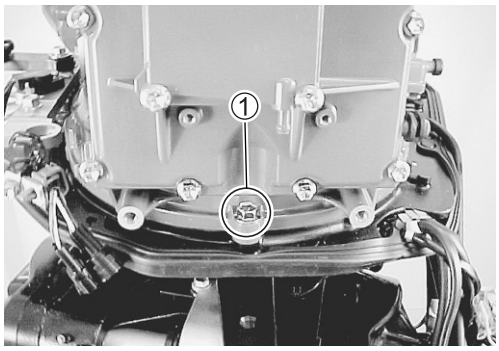
Remove water flush hose ⑫ from cylinder block.



[From engine upper side]

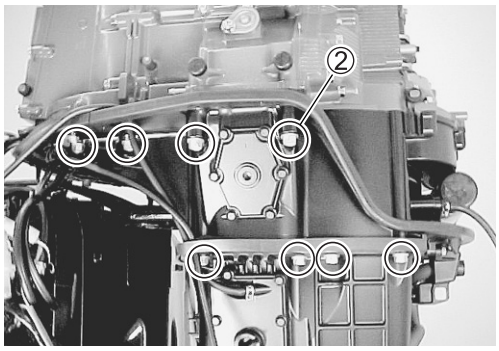
- Remove five (5) bolts ①.

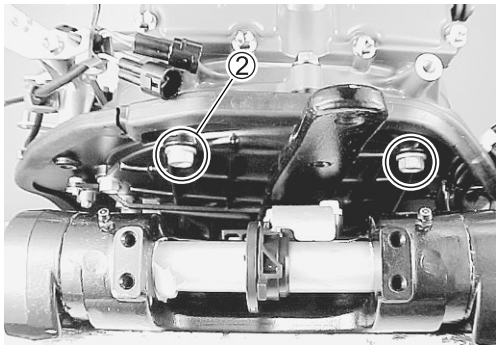


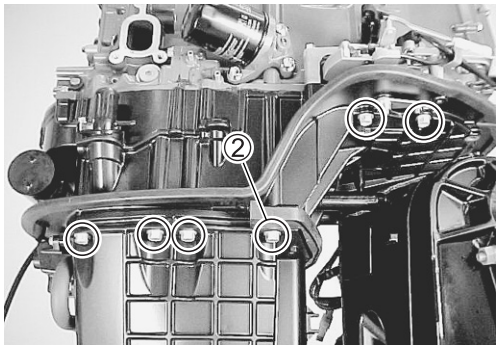


[From engine under side]

- Remove sixteen (16) bolts ②.







Lift up and remove power unit from engine holder.

INSTALLATION

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

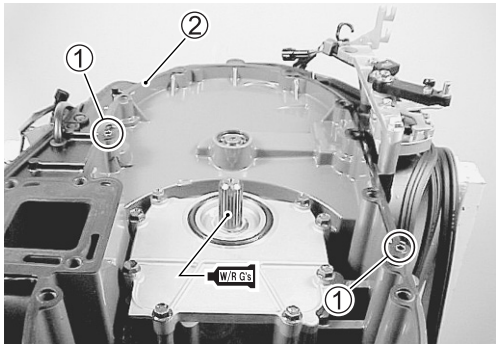
CAUTION

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

POWER UNIT

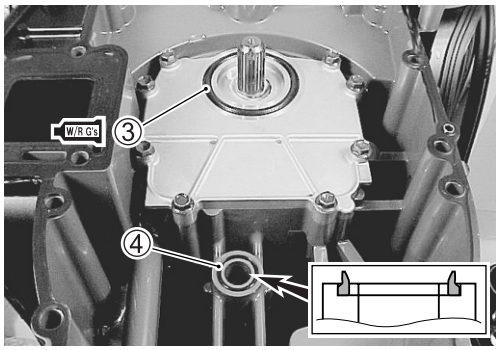
- Install dowel pins ①, gasket ②.
  Apply Water Resistant Grease to driveshaft splines.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



- Install O-ring ③ to mount oil seal cover, then apply Water Resistant Grease on O-ring.
- Install the engine holder seal ④.

NOTE:
Install seal ④ with lip facing upward.

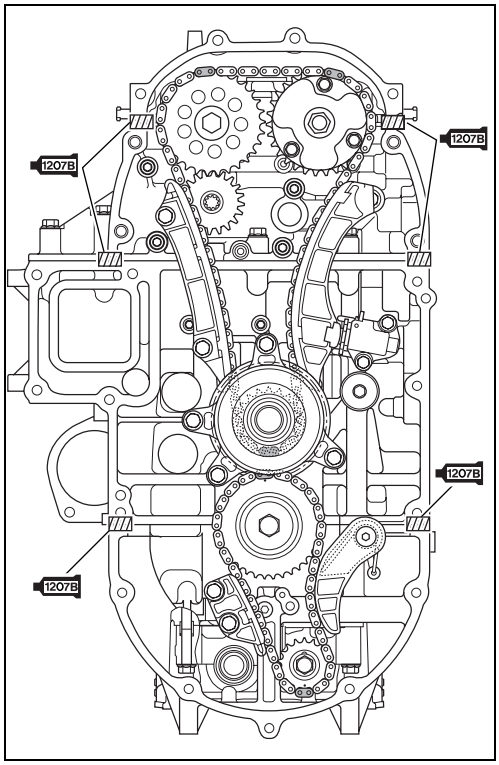


NOTE:
Before installing power unit, apply sealant to the six hatched areas shown in the illustration at right.

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.

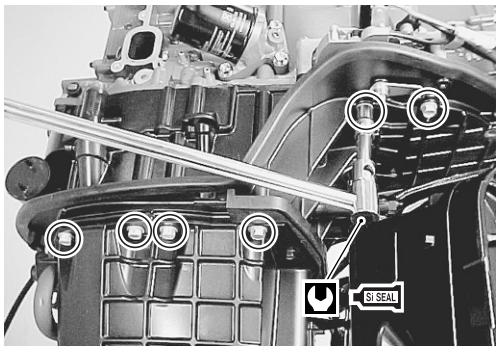


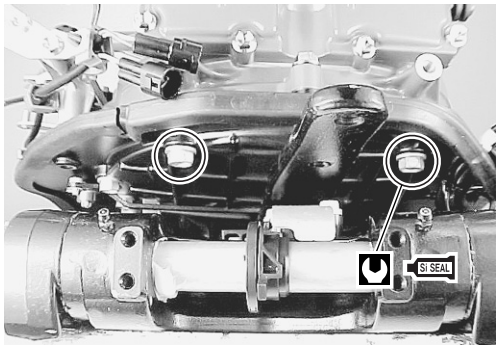
- Apply Suzuki Silicone seal to power unit mounting bolts and tighten bolts to specified torque.

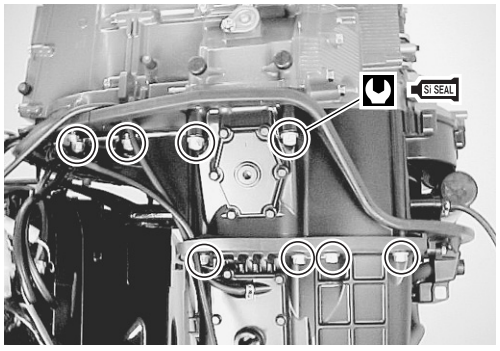
Si SEAL 99000-31120: SUZUKI SILICONE SEAL

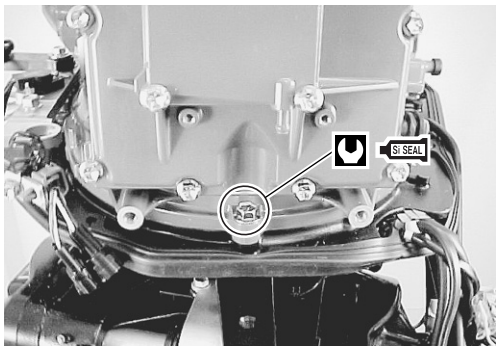
Power unit mounting bolt:

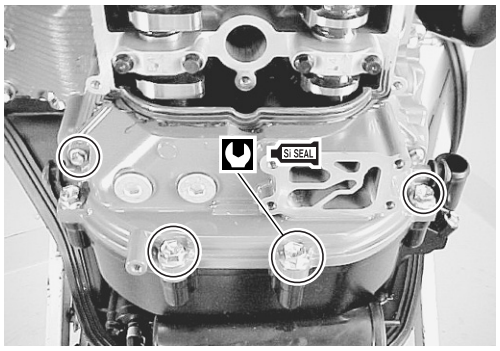
8 mm	**23 N·m (2.3 kg-m, 16.5 lb-ft)**
10 mm	**50 N·m (5.0 kg-m, 36.0 lb-ft)**





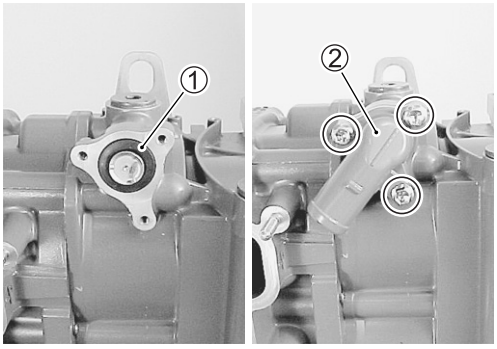




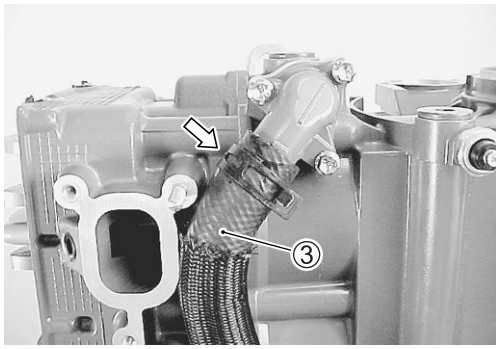


THERMOSTAT

- Assemble thermostat ① and thermostat cover ② to cylinder block and secure with bolts.

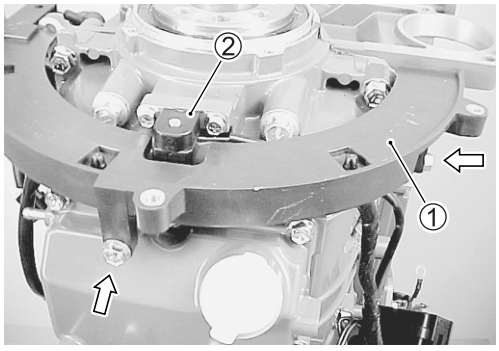


- Connect water return hose ③, then secure the hose to thermostat cover with hose clamp.

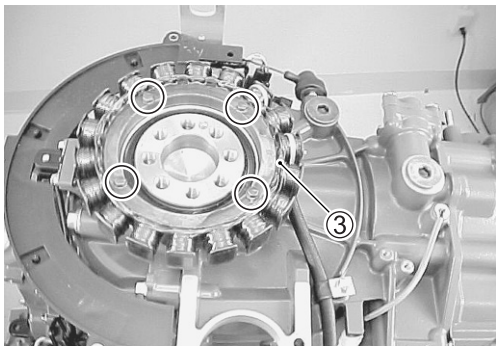


FLYWHEEL

- Install lower ring gear cover ①, then tighten bolts securely.
- Install CKP sensor ②. (See page 3-68.)



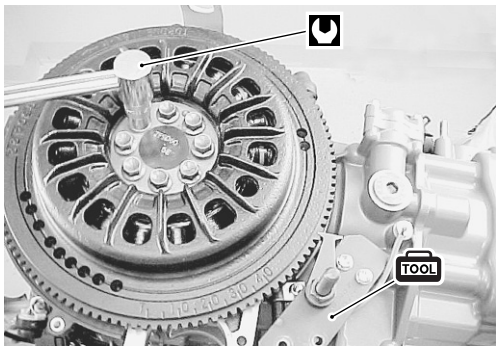
- Install battery charge coil ③. (See page 4-10.)



- Install flywheel and tighten flywheel bolts to specified torque. (See page 3-67.)

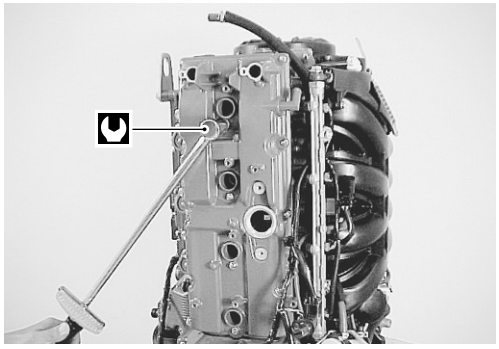
TOOL 09916-99311: Flywheel holder

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



CYLINDER HEAD COVER

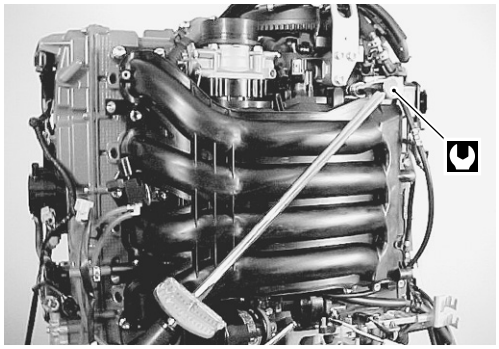
- Install cylinder head cover. (See page 6-13.)



INTAKE MANIFOLD

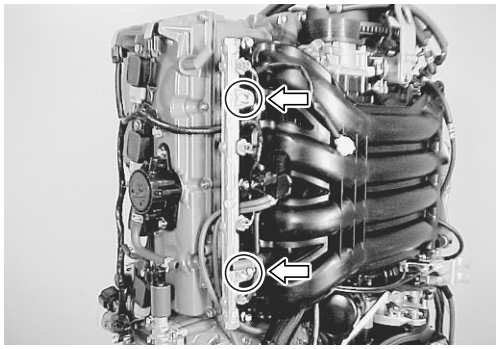
- Install gaskets and intake manifold, then tighten bolts and nuts to specified torque.
  For intake manifold assembly installation, see page 6-5.

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



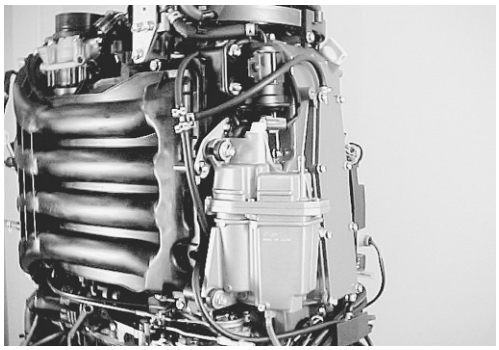
FUEL INJECTORS

- Install fuel injectors and fuel delivery pipe. (See page 5-15.)



VAPOR SEPARATOR

- Install vapor separator. (See page 5-8.)



FINAL ASSEMBLY CHECK

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

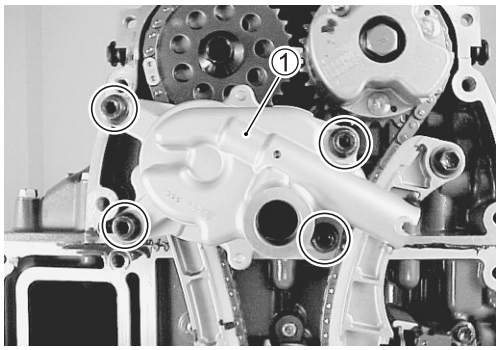
- All parts removed have been returned to their original positions.
- Fuel and water hose routing match's service manual illustration. (See page 11-11 to 11-17.)
- Wire routing match's service manual illustration. (See page 11-4 to 11-10.)
- No fuel leakage is evident when fuel system is pressurized. (See page 5-4.)
- No water leakage is evident during final test running.

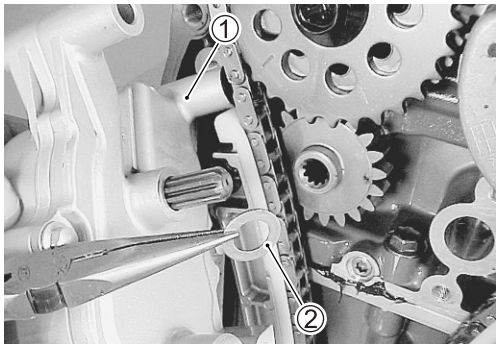
OIL PUMP

REMOVAL

1. Remove the power unit. (See page 6-15 to 6-20.)

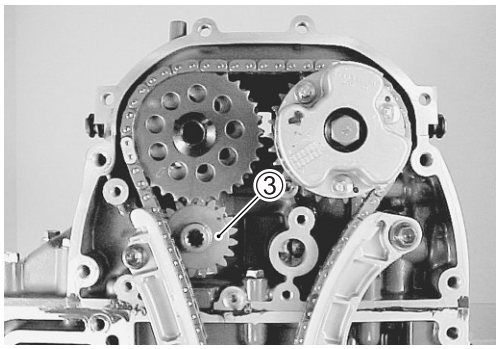
2. Remove the four (4) bolts securing oil pump ①, then remove the oil pump.
   Account for shim washer ②.





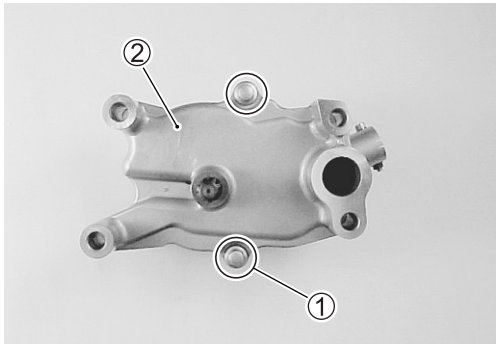
3. Remove the oil pump driven gear ③.

NOTE:
For oil pump drive gear removal, see page 6-31.

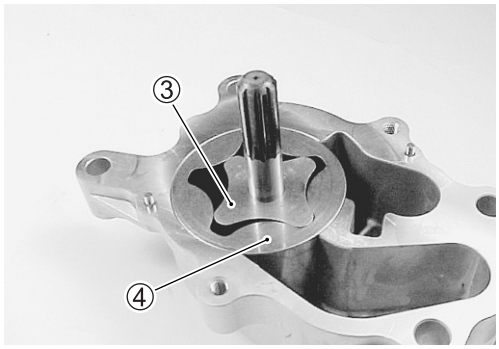


DISASSEMBLY

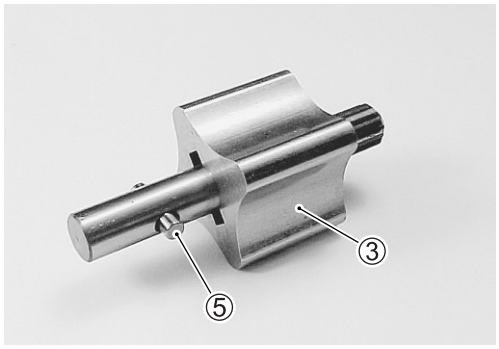
1. Remove the two (2) screws ① securing oil pump rotor plate ② to the oil pump case, then remove the oil pump rotor plate.



2. Take out inner rotor ③ and outer rotor ④.



3. Remove the pin ⑤ and inner rotor ③.

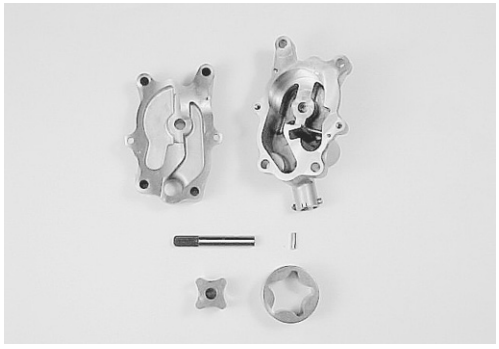


INSPECTION

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 assembly.



DRIVEN SPROCKET

Check teeth of sprocket for wear or damage.
Replace as necessary.



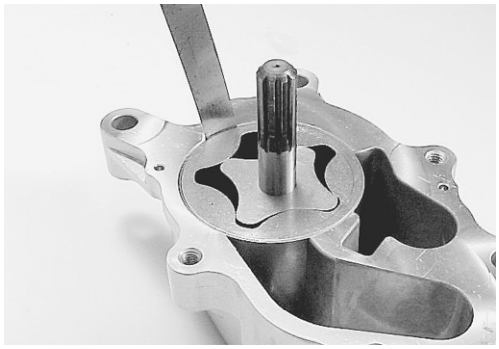
MEASURING PUMP COMPONENTS

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.

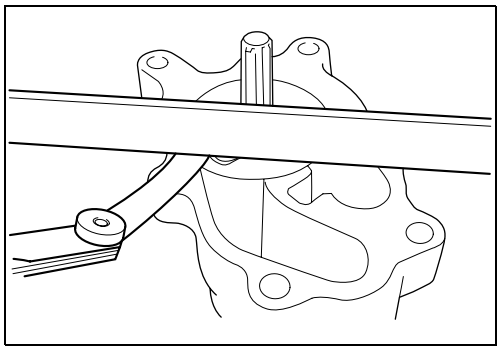


SIDE CLEARANCE

Using straightedge and feeler gauge, measure side clearance.

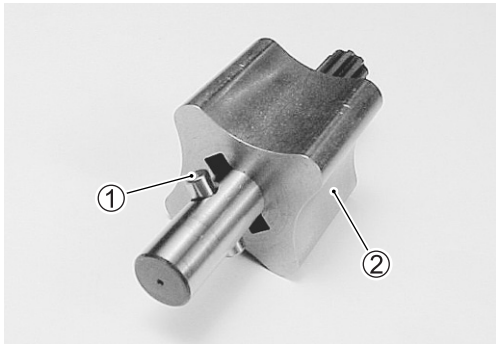
Side clearance:
Service limit: 0.15 mm (0.0059 in)

If measurement is not within specifications, replace the outer rotor and/or pump case.



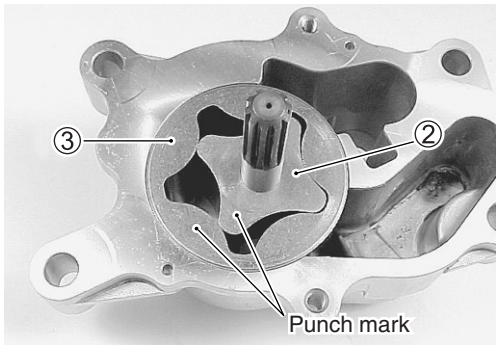
ASSEMBLY

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.

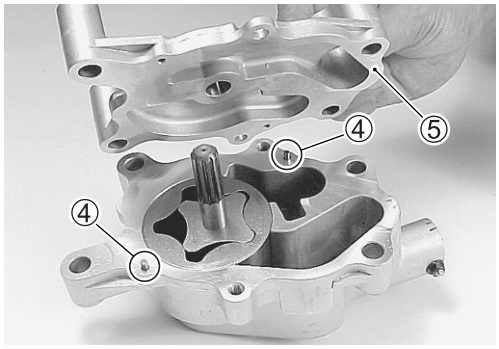


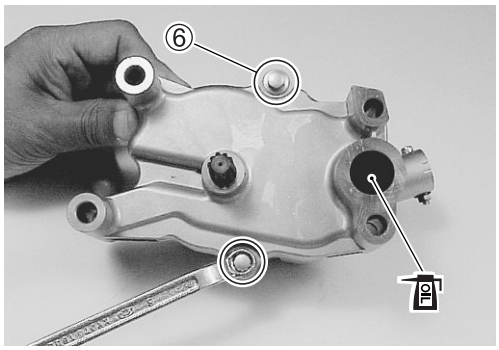
4. Install outer ③ and inner rotor ② to pump case.

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 screws 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.

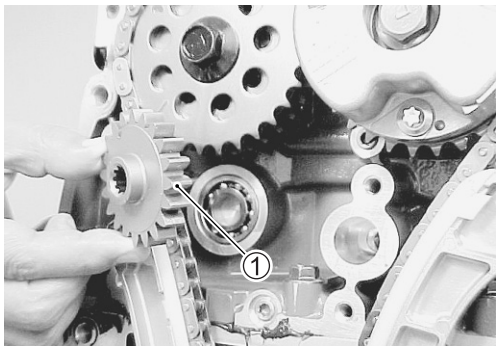


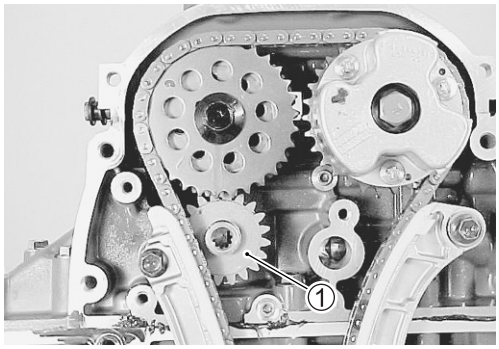


INSTALLATION

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

- Install oil pump driven gear ①.

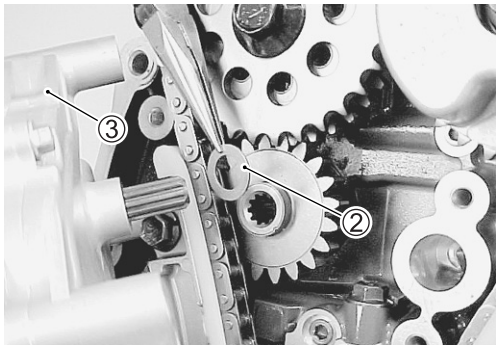


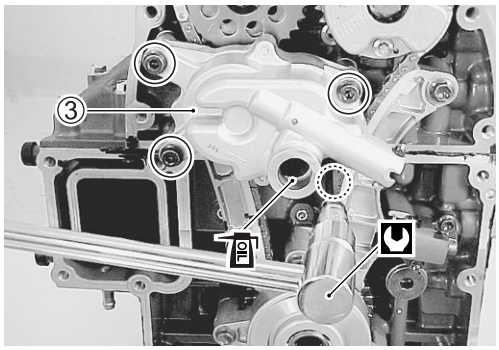


- Install washer ② and oil pump assembly ③, then tighten four (4) bolts securely.

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

- Pour approx. 50 ml (1.7 oz.) of engine oil into pump case for initial lubrication.



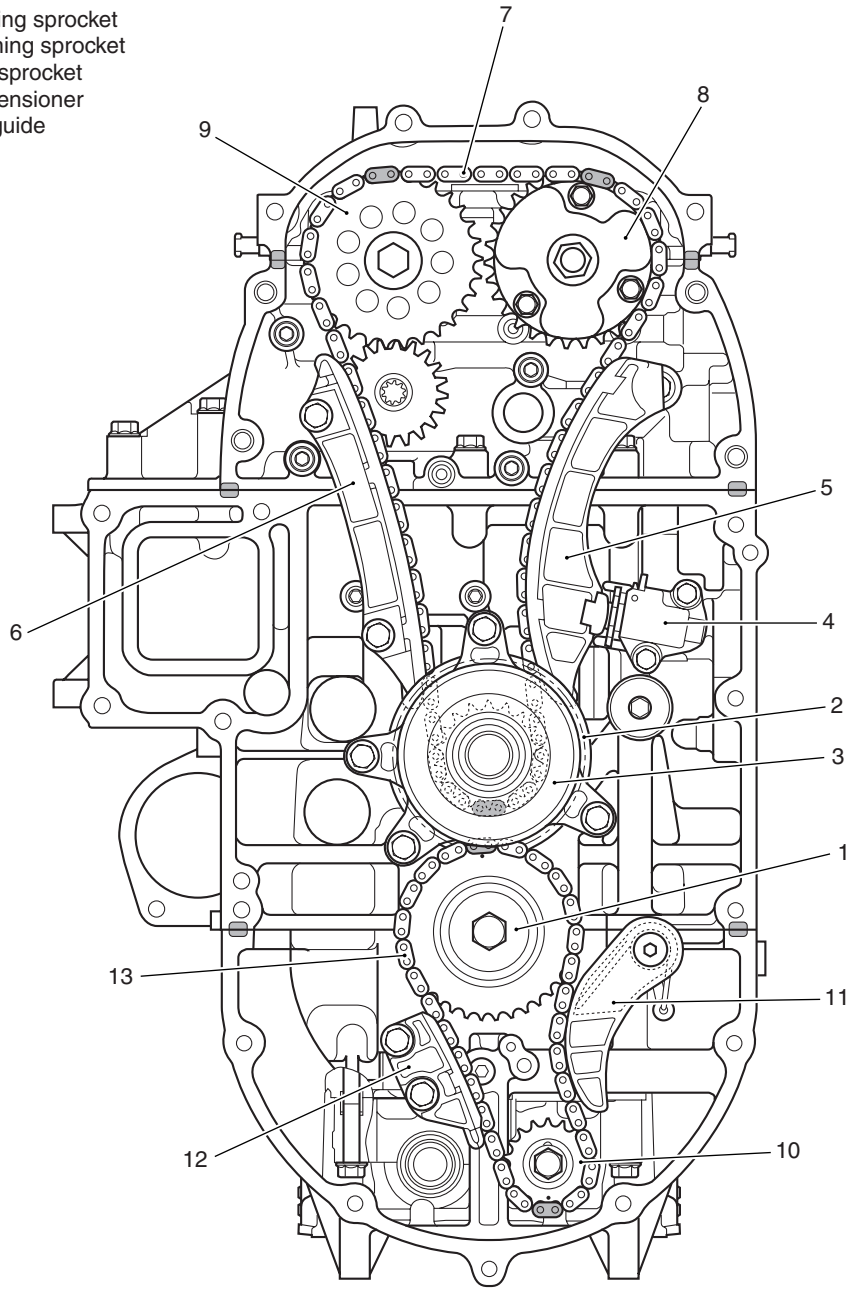


TIMING CHAIN/BALANCER CHAIN (VVT model)

REMOVAL

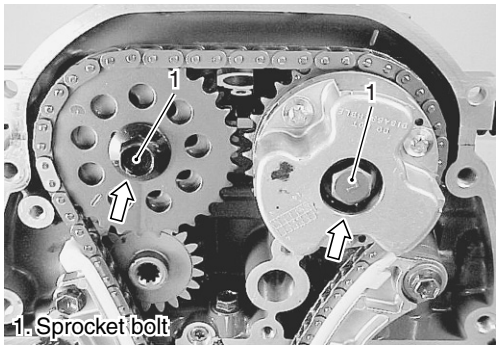
Prior to this service work:
- **Remove the power unit. (See page 6-15 to 6-20.)**

1. Crankshaft/Drive gear/Balancer drive gear
2. Driven gear/Timing sprocket
3. Driven gear holder
4. Chain tensioner adjuster
5. Timing chain tensioner
6. Timing chain guide
7. Timing chain
8. IN. camshaft timing sprocket
9. EX. camshaft timing sprocket
10. Balancer driven sprocket
11. Balancer chain tensioner
12. Balancer chain guide
13. Balancer chain

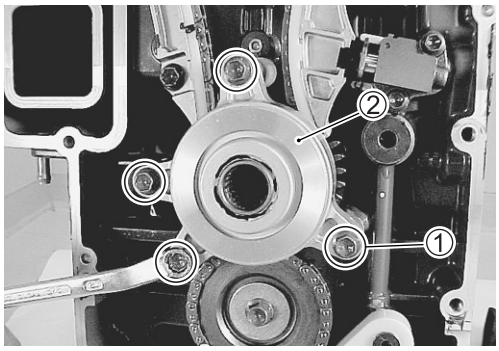


1. Remove the oil pump. (See page 6-26.)
2. Loosen the bolts securing IN./EX. camshaft timing sprockets to each cam shaft.

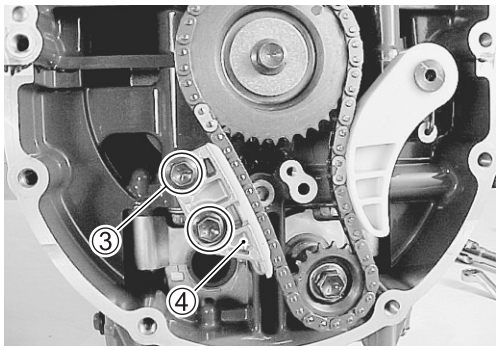
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*



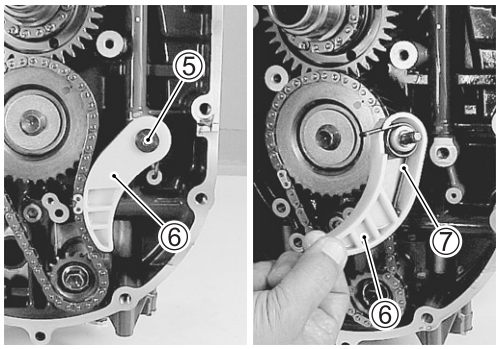
3. Remove the four (4) bolts ① securing driven gear holder ②, then remove the driven gear holder.



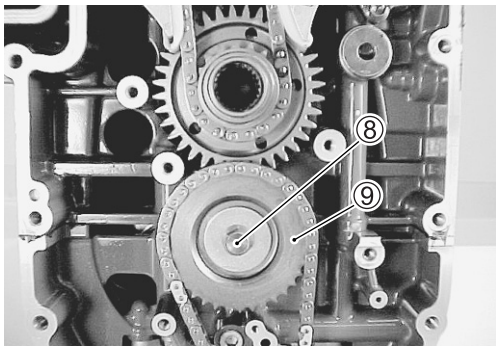
4. Remove bolts ③ and balancer chain guide ④.



5. Remove bolt ⑤, balancer chain tensioner ⑥ and spring ⑦.

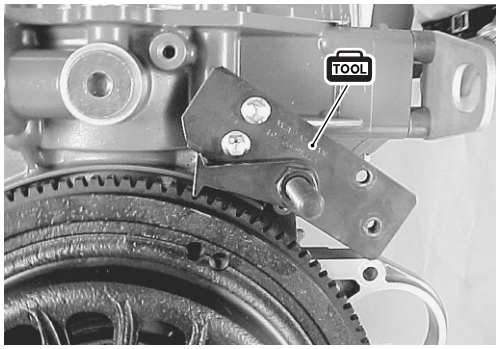


6. Loosen and remove the bolt ⑧ securing balancer drive sprocket ⑨ to crankshaft.

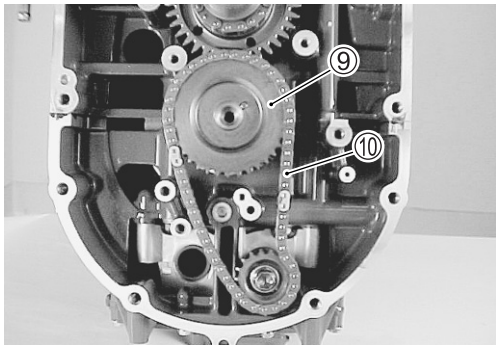


NOTE:
To hold the crankshaft, use special tool and flywheel as shown in figure.

TOOL 09916-99311: Flywheel holder



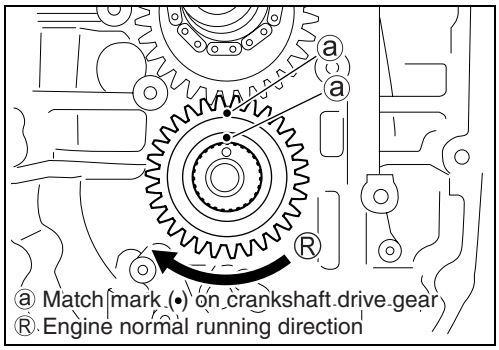
7. Remove the balancer drive sprocket ⑨ and balancer chain ⑩.



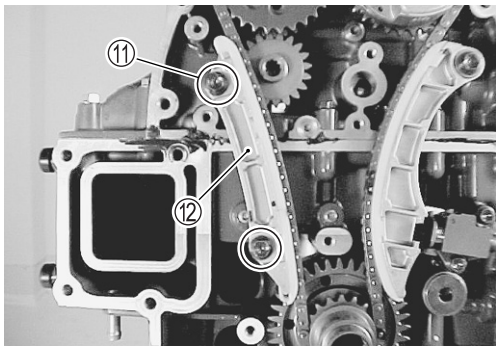
8. Turn the crankshaft in its normal running direction (Ⓡ_LH direction) until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

CAUTION

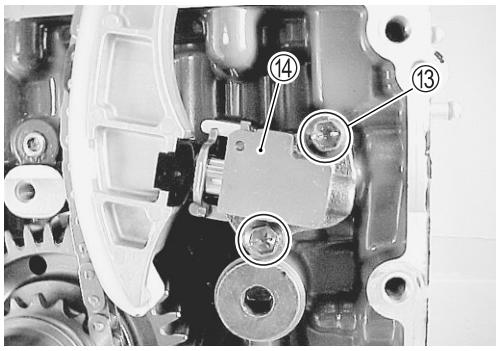
When timing chain has been removed, never turn crankshaft or camshaft.



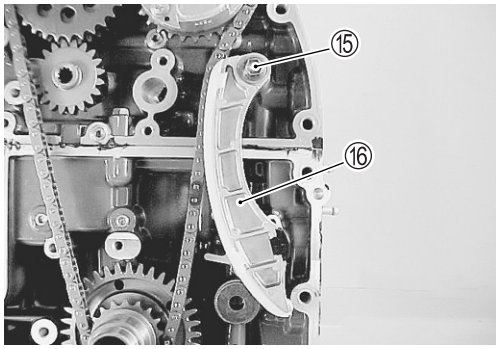
9. Remove bolts ⑪ and timing chain guide ⑫.



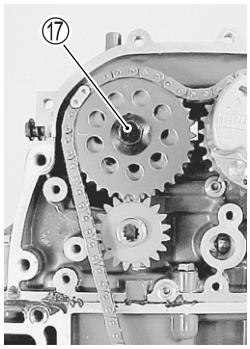
10. Remove bolts ⑬ and chain tensioner adjuster ⑭.

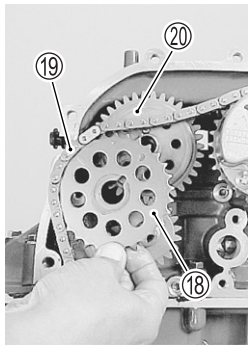


11. Remove bolt ⑮ and timing chain tensioner ⑯.

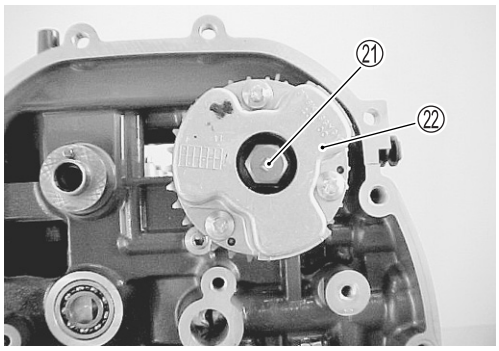


12. Remove bolt ⑰, EX. camshaft timing sprocket ⑱ and timing chain ⑲.
    Remove oil pump drive gear ⑳.

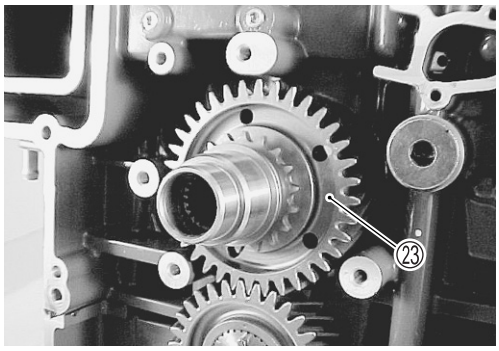




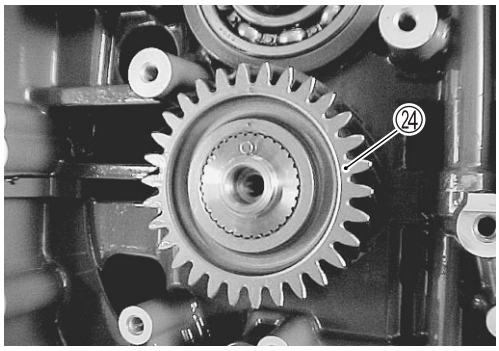
13. Remove bolt ㉑ and IN. camshaft timing sprocket ㉒.



14. Remove driven gear ㉓.



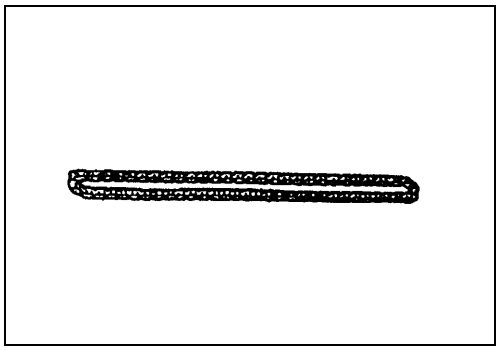
15. Remove drive gear ㉔.



INSPECTION

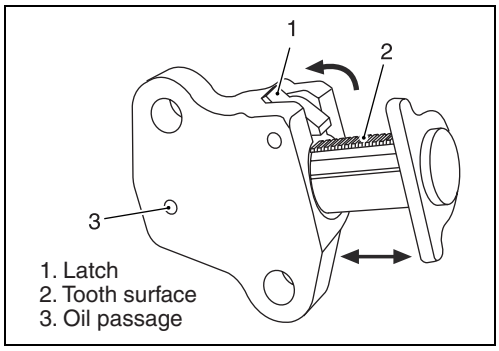
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

TIMING CHAIN
- Inspect timing chain.
  Replace if worn excessively or damaged.



BALANCER CHAIN
- Inspect balancer chain.
  Replace if worn excessively or damaged.

TENSIONER ADJUSTER
- Inspect tensioner adjuster for smooth operation.
  Replace if faulty.
  Check oil delivery passage to tensioner.



TIMING CHAIN TENSIONER/CHAIN GUIDE
- Check chain guide shoe for wear or damage.
  If excessive wear or other damage is found, replace it.



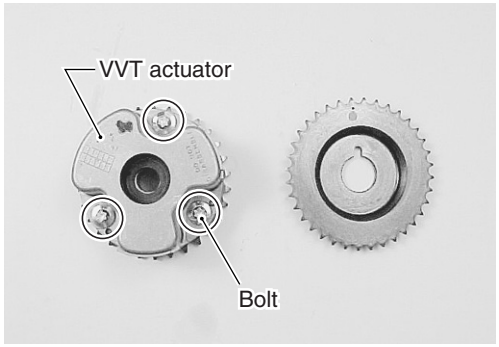
CAMSHAFT TIMING SPROCKET

- Check teeth of sprocket for wear or damage.

CAUTION

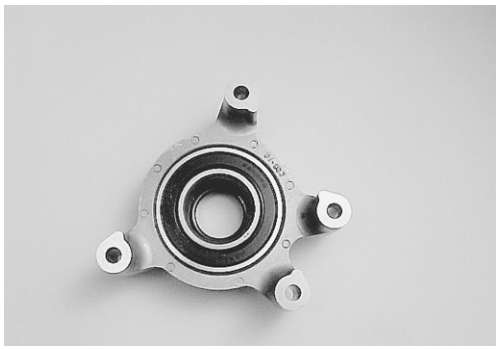
The VVT actuator is non-repairable.
Do not attempt to remove bolts or disassemble the VVT actuator.

If excessive wear or other damage is found, replace it.

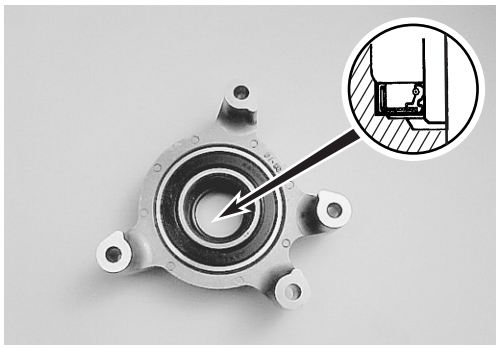


DRIVEN GEAR HOLDER

- Check driven gear holder.
  If cracks or other damage is found, replace holder.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough condition.
- Check oil seal.
  If excessive wear or other damage is found, replace oil seal.



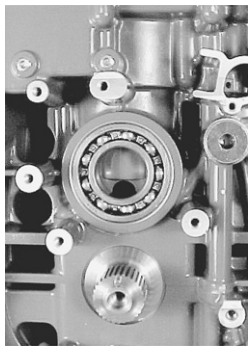
NOTE:
Install oil seal lip (spring side) facing as shown in figure.



DRIVE GEAR/DRIVEN GEAR/BEARING

- Inspect drive and driven gears.
  Replace gear if damaged or worn excessively.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough condition.

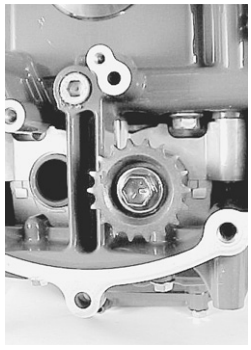




BALANCER SPROCKET

- Check teeth of sprocket for wear or damage.
  If excessive wear or other damage is found, replace it.





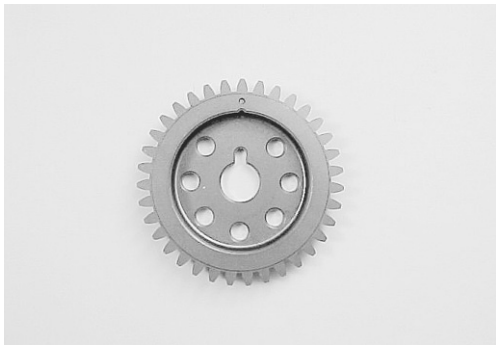
BALANCER CHAIN TENSIONER/CHAIN GUIDE

- Check tensioner for wear or damage.
  If excessive wear or other damage is found, replace it.
- Check chain guide for wear or damage.
  If excessive wear or other damage is found, replace it.



OIL PUMP DRIVE GEAR

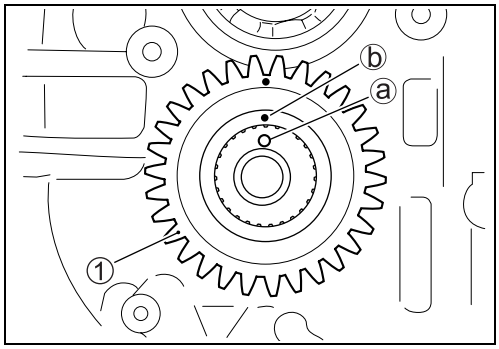
- Inspect drive gear.
  Replace gear if damaged or worn.



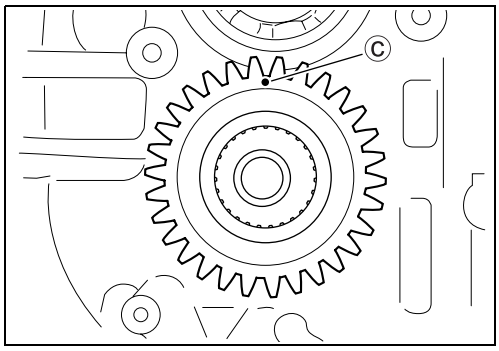
INSTALLATION

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

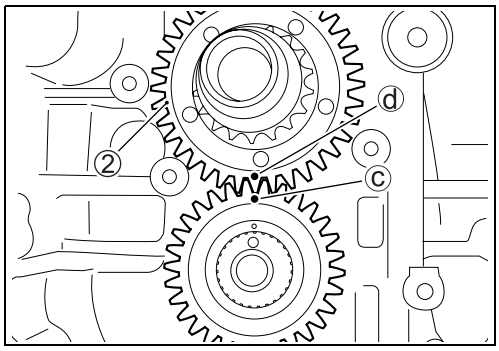
1. Install the drive gear ① on crankshaft so that dowel pin hole ⓐ aligns with match mark (•) ⓑ on the drive gear as shown in illustration.



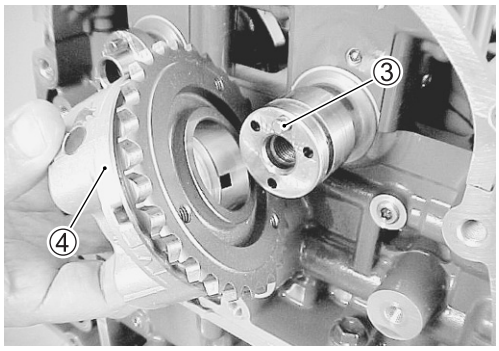
2. Check that match mark (•) ⓒ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).

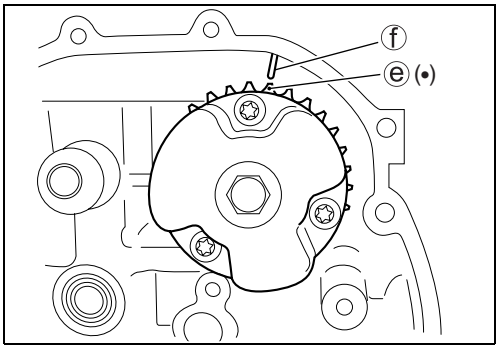


3. Install the driven gear ② on the cylinder block so that match mark (•) ⓒ aligns with match match mark (•) ⓓ on the driven gear as shown in illustration.

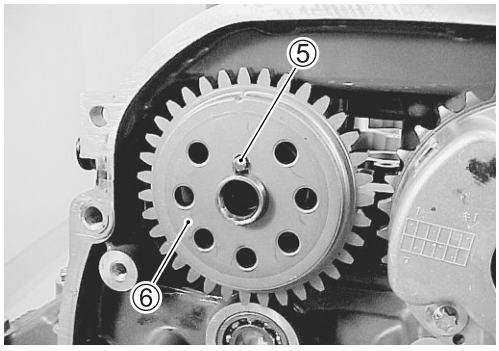


4. Fit the dowel pin ③ onto IN. camshaft. Fit IN. camshaft timing sprocket ④ and temporarily tighten the sprocket bolt. Check that match marks (•) ⓔ·ⓕ are correctly aligned as shown in illustration.

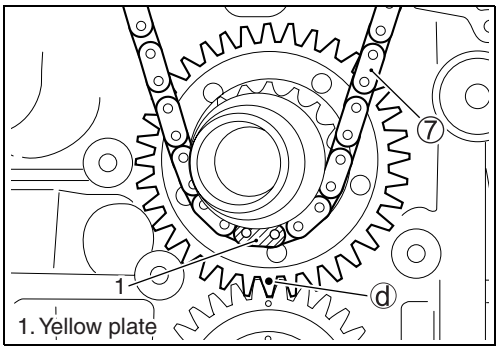




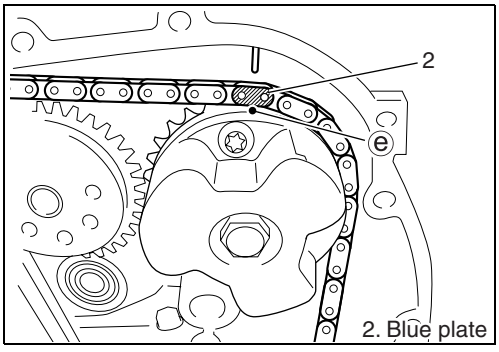
5. Fit the dowel pin ⑤ onto the EX. camshaft.
6. Install oil pump drive gear ⑥.



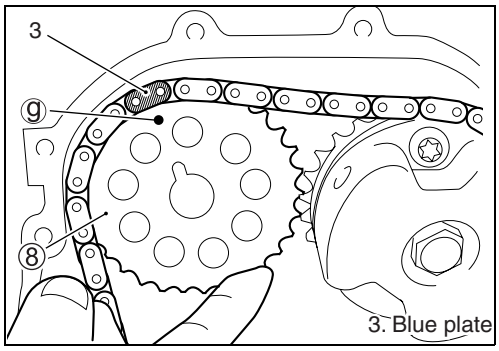
7. Align the yellow plate of timing chain ⑦ with the match mark (•) ⓓ on the driven gear and fit the chain onto the driven gear.



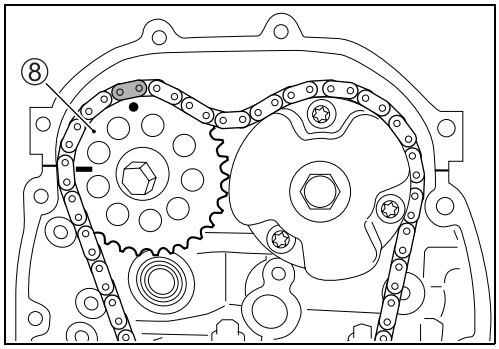
8. As shown in the illustration, fit the timing chain with one blue plate aligned with the match mark (△) (•) ⓔ onto the IN. camshaft timing sprocket.



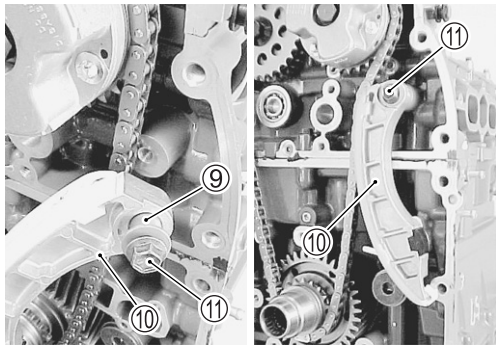
9. While aligning the one blue plate of timing chain with the match mark (•) ⓖ on the EX. camshaft timing sprocket ⑧, fit the chain onto the sprocket.



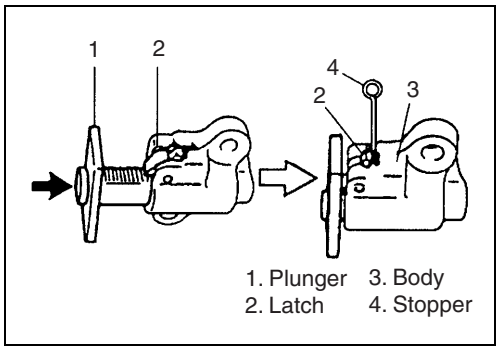
10. Install the EX. camshaft timing sprocket ⑧ on the EX. camshaft, then temporarily tighten the sprocket bolt.



11. Insert the spacer ⑨ into the chain tensioner ⑩.
Install chain tensioner, then tighten bolt ⑪ securely.
Apply engine oil to chain tensioner.



12. With latch of tensioner adjuster ⑫ 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.

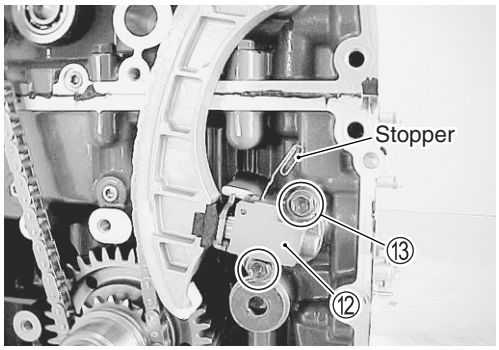


13. Install timing chain tensioner adjuster ⑫, then tighten bolts ⑬ to specified torque.

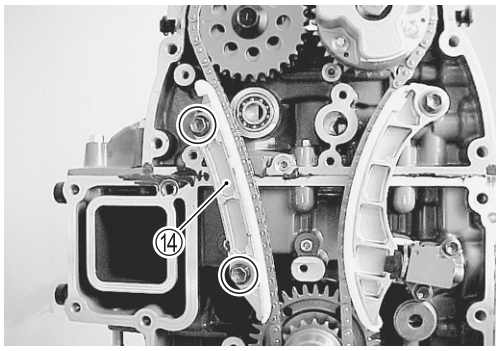
Tensioner adjuster bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)

Apply engine oil to timing chain.

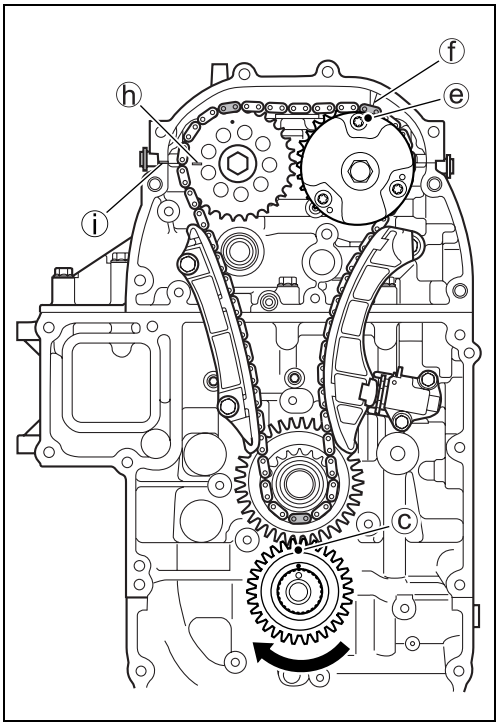
14. Remove the stopper from tensioner adjuster.



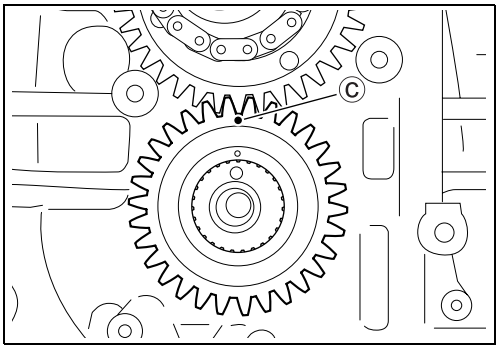
15. Install timing chain guide ⑭, then tighten bolts securely.
    Apply engine oil to chain guide.



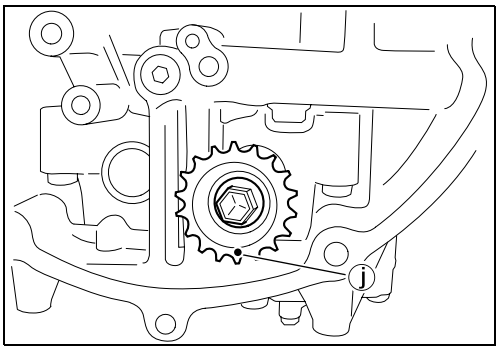
16. Turn the crankshaft two (2) complete rotations in direction shown in figure.
    As shown in the illustration, check that all match marks are in alignment as started below when the match mark (•) ⓒ on the drive gear is pointing to 12 o'clock.
    - The match mark (△) (•) ⓔ on the IN. sprocket aligns with the match mark ⓕ on the camshaft housing.
    - The match mark (engraved line) ⓗ on the EX. sprocket aligns with the mating face ⓘ between cylinder head and lower camshaft housing.



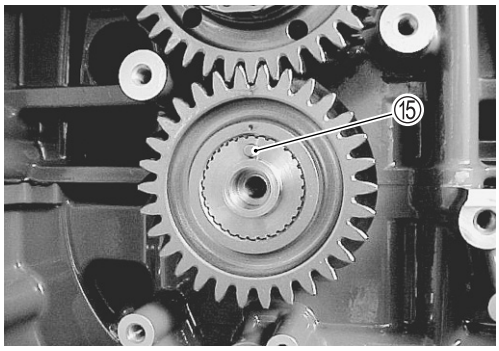
17. Check that match mark (•) ⓒ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).



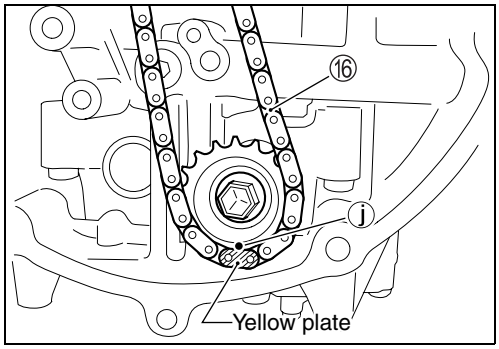
18. Check that match mark (•) ⓙ on the balancer driven sprocket points to 6 o'clock as shown in the illustration.



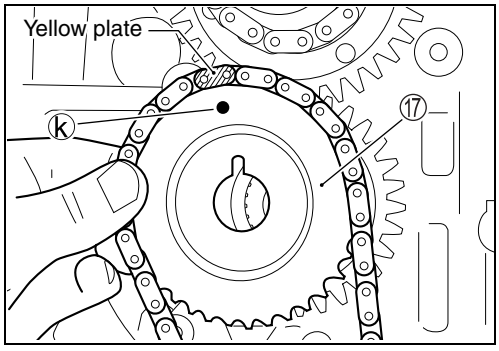
19. Fit the dowel pin ⑮ on the crankshaft.



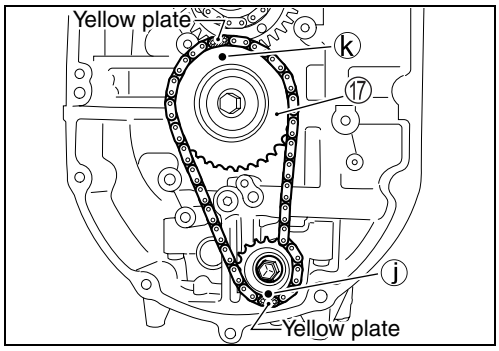
20. Align the yellow plate of balancer chain ⑯ with the match mark (•) ⓙ on the balancer driven sprocket and fit the chain on the sprocket.



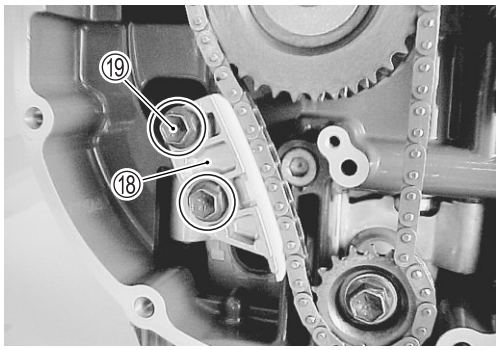
21. Align the yellow plate of balancer chain with the match mark (•) ⓚ on the balancer drive sprocket ⑰ and fit the chain on the sprocket.



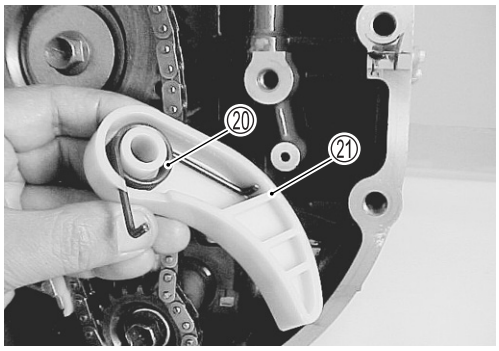
22. Install the balancer drive sprocket ⑰ on the crankshaft, then temporarily tighten the sprocket bolt and washer.
Check that match marks ⓙ and ⓚ are correctly aligned as shown in illustration.

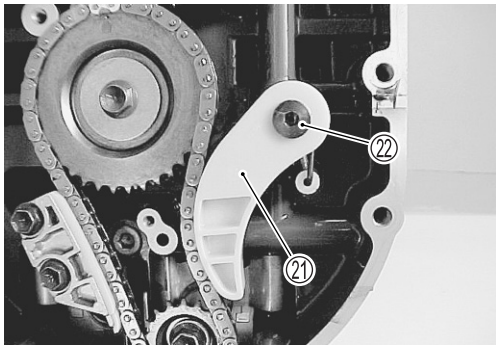


23. Install balancer chain guide ⑱, then tighten bolts ⑲ securely.



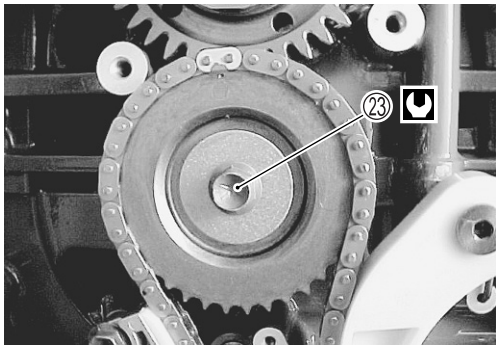
24. Assemble tensioner spring ⑳ and balancer chain tensioner ㉑.
    Install chain tensioner ㉑, then tighten bolt ㉒ securely.





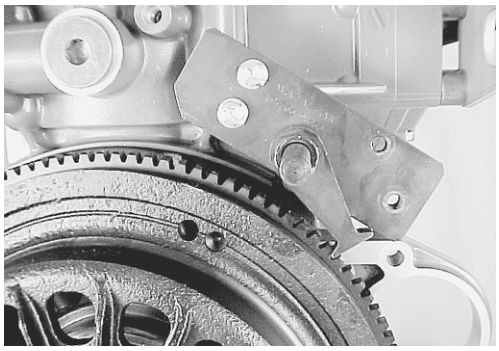
25. Tighten crankshaft drive gear bolt ㉓ to specified torque.

Crankshaft drive gear bolt: 48 N·m (4.8 kg-m, 34.7 lb-ft)



NOTE:
To hold the crankshaft, use special tool and flywheel as shown in figure.

09916-99311: Flywheel holder

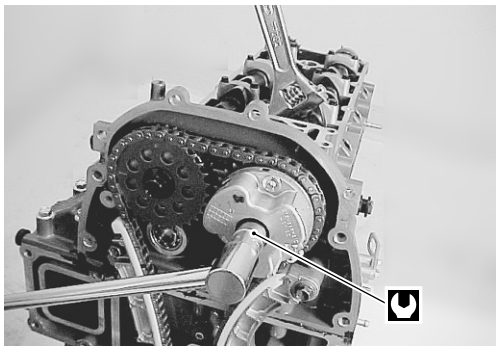


26. Tighten IN. camshaft timing sprocket bolt to specified torque.

IN. camshaft timing sprocket bolt:
60 N·m (6.0 kg-m, 43.4 lb-ft)

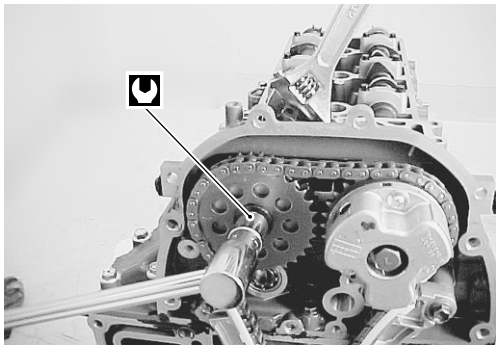
CAUTION

Do not over tighten to avoid damaging VVT actuator.

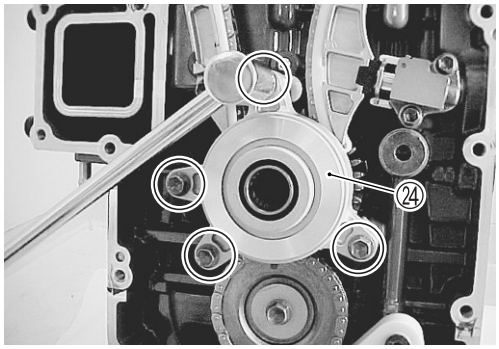


27. Tighten EX. camshaft timing sprocket bolt to specified torque.

EX. camshaft timing sprocket bolt:
78 N·m (7.8 kg-m, 56 lb-ft)



28. Install driven gear holder ㉔, then tighten four (4) bolts securely.

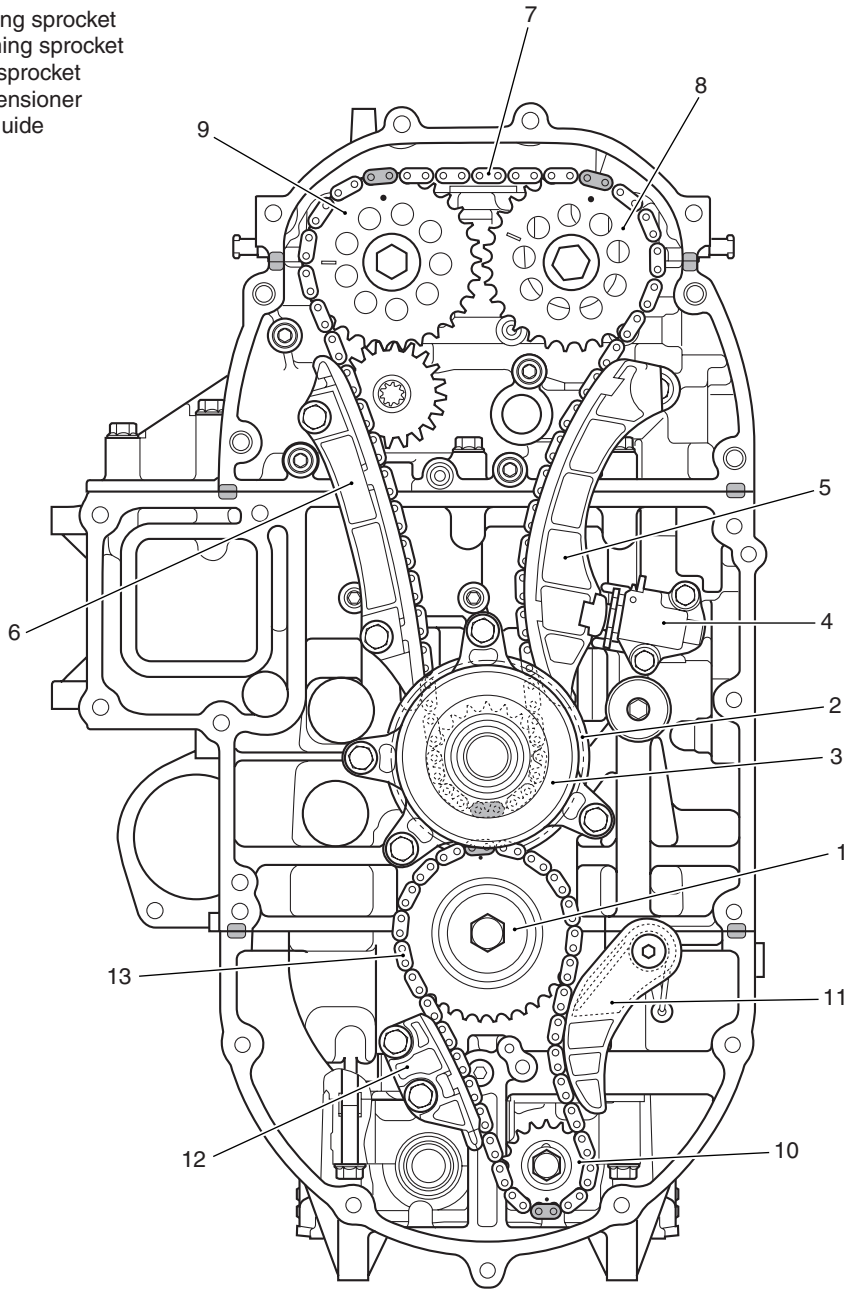


TIMING CHAIN/BALANCER CHAIN (Non-VVT model)

REMOVAL

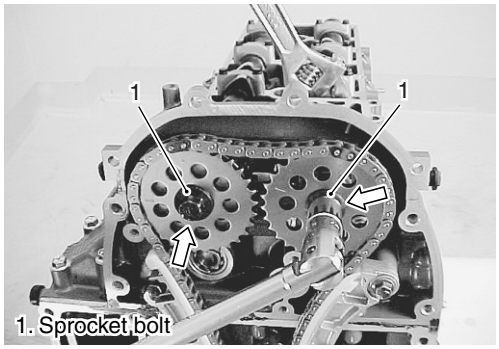
Prior to this service work:
- **Remove the power unit. (See page 6-15 to 6-20.)**

1. Crankshaft/Drive gear/Balancer drive gear
2. Driven gear/Timing sprocket
3. Driven gear holder
4. Chain tensioner adjuster
5. Timing chain tensioner
6. Timing chain guide
7. Timing chain
8. IN. camshaft timing sprocket
9. EX. camshaft timing sprocket
10. Balancer driven sprocket
11. Balancer chain tensioner
12. Balancer chain guide
13. Balancer chain

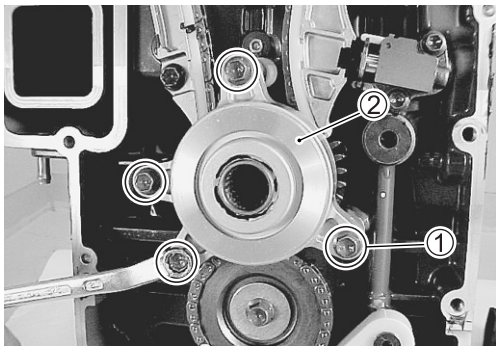


1. Remove the oil pump. (See page 6-26.)
2. Loosen the bolts securing IN./EX. camshaft timing sprockets to each cam shaft.

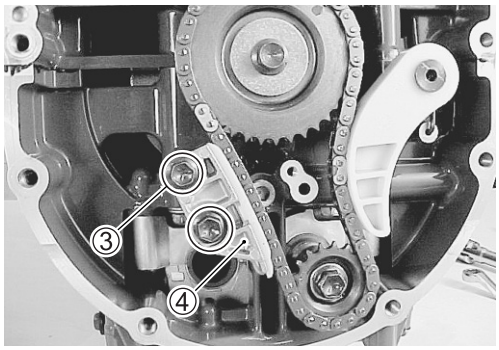
NOTE:
- *Sprocket bolt is LH thread.*
- *Hold camshaft by placing a wrench on the hexagon area of the camshaft.*



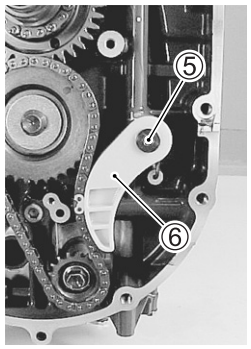
3. Remove the four (4) bolts ① securing driven gear holder ②, then remove the driven gear holder.

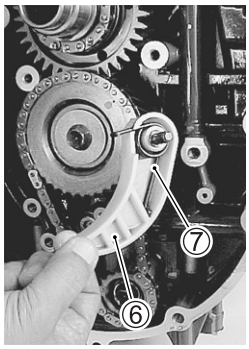


4. Remove bolts ③ and balancer chain guide ④.

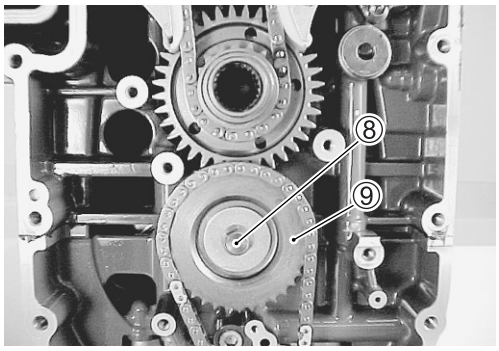


5. Remove bolt ⑤, balancer chain tensioner ⑥ and spring ⑦.



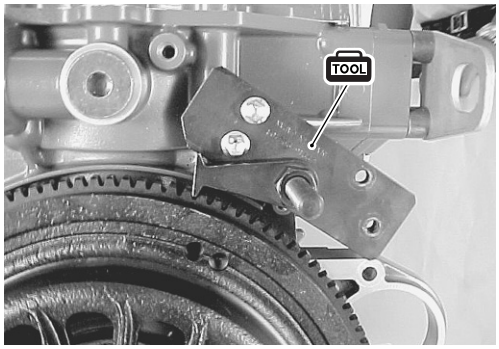


6. Loosen and remove the bolt ⑧ securing balancer drive sprocket ⑨ to crankshaft.

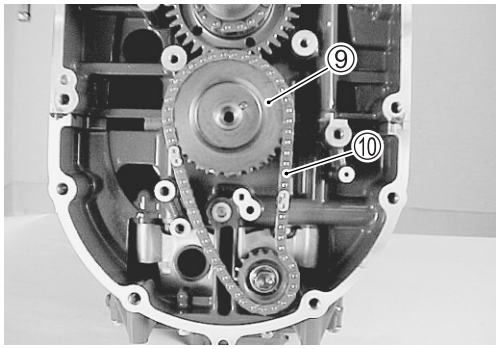


NOTE:
To hold the crankshaft, use special tool and flywheel as shown in figure.

TOOL 09916-99311: Flywheel holder



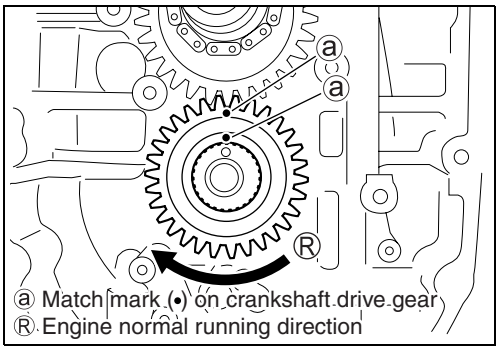
7. Remove the balancer drive sprocket ⑨ and balancer chain ⑩.



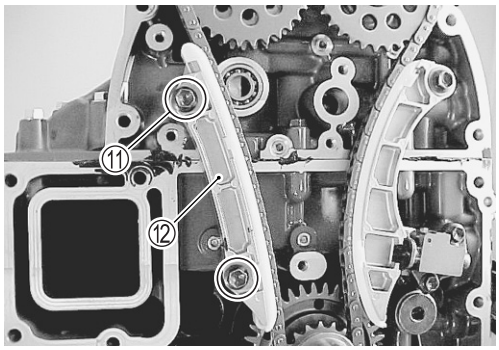
8. Turn the crankshaft in its normal running direction (Ⓡ_LH direction) until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

CAUTION

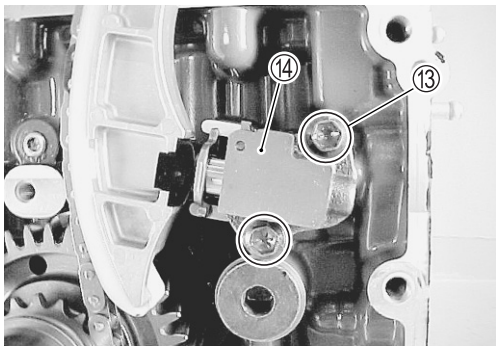
When timing chain has been removed, never turn crankshaft or camshaft.



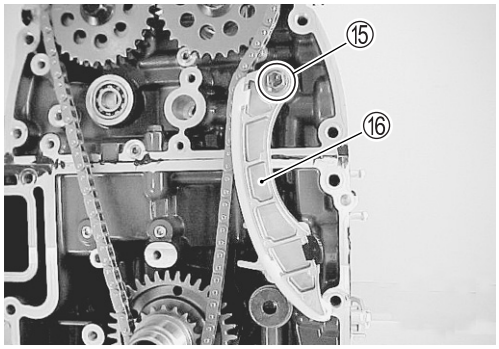
9. Remove bolts ⑪ and timing chain guide ⑫.



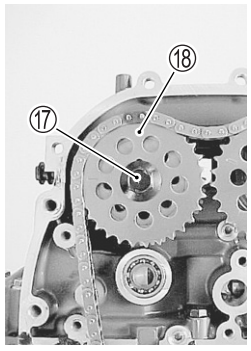
10. Remove bolts ⑬ and chain tensioner adjuster ⑭.

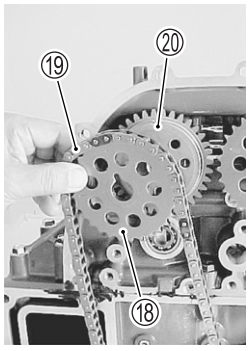


11. Remove bolt ⑮ and timing chain tensioner ⑯.

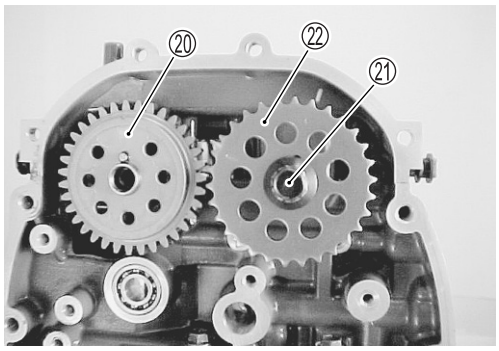


12. Remove bolt ⑰, EX. camshaft timing sprocket ⑱ and timing chain ⑲.
    Remove oil pump drive gear ⑳.

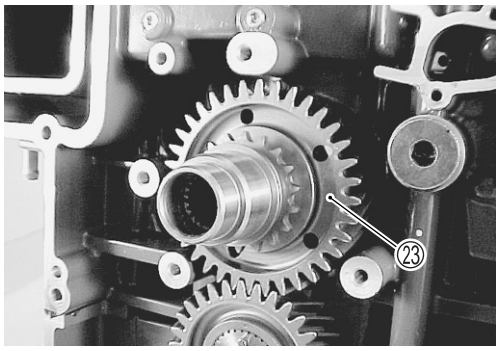




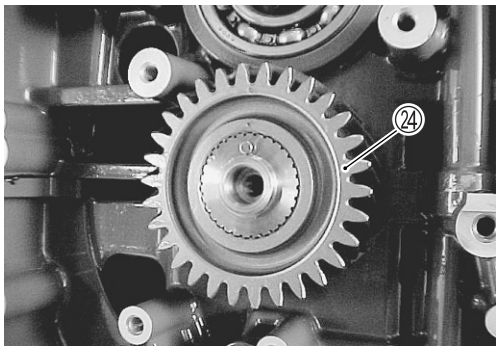
13. Remove bolt ㉑ and IN. camshaft timing sprocket ㉒.



14. Remove driven gear ㉓.



15. Remove drive gear ㉔.

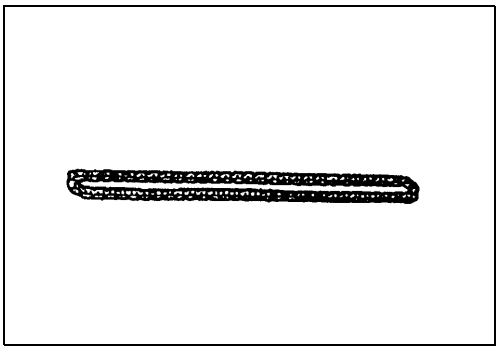


INSPECTION

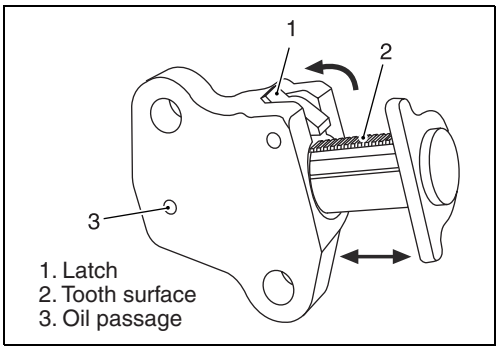
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

TIMING CHAIN
- Inspect timing chain.
  Replace if worn excessively or damaged.

BALANCER CHAIN
- Inspect balancer chain.
  Replace if worn excessively or damaged.



TENSIONER ADJUSTER
- Inspect tensioner adjuster for smooth operation.
  Replace if faulty.
  Check oil delivery passage to tensioner.

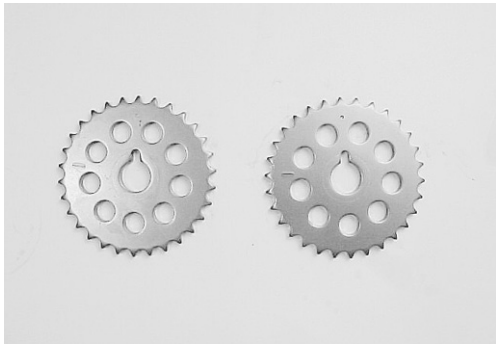


TIMING CHAIN TENSIONER/CHAIN GUIDE
- Check chain guide shoe for wear or damage.
  If excessive wear or other damage is found, replace it.



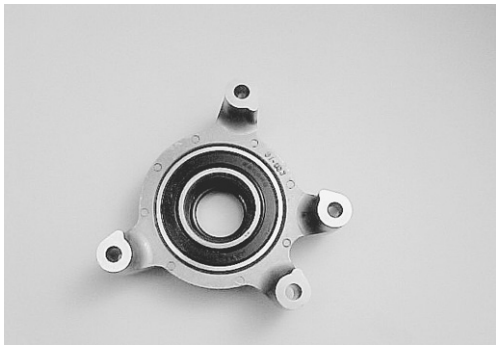
CAMSHAFT TIMING SPROCKET

- Check teeth of sprocket for wear or damage.
  If excessive wear or other damage is found, replace it.

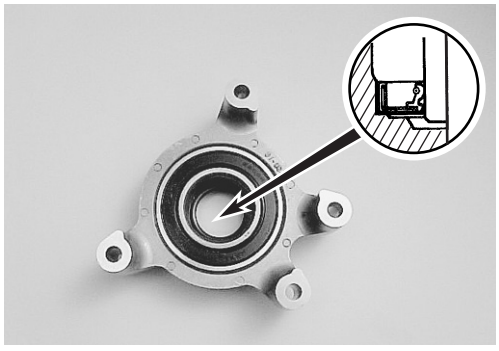


DRIVEN GEAR HOLDER

- Check driven gear holder.
  If cracks or other damage is found, replace holder.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough condition.
- Check oil seal.
  If excessive wear or other damage is found, replace oil seal.



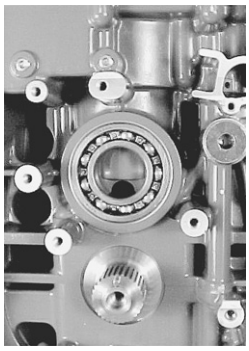
NOTE:
Install oil seal lip (spring side) facing as shown in figure.



DRIVE GEAR/DRIVEN GEAR/BEARING

- Inspect drive and driven gears.
  Replace gear if damaged or worn excessively.
- Check driven gear bearing.
  Replace bearing if pitted, noisy, or rough condition.

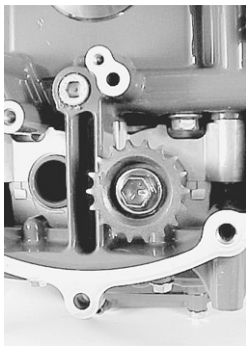




BALANCER SPROCKET

- Check teeth of sprocket for wear or damage.
  If excessive wear or other damage is found, replace it.





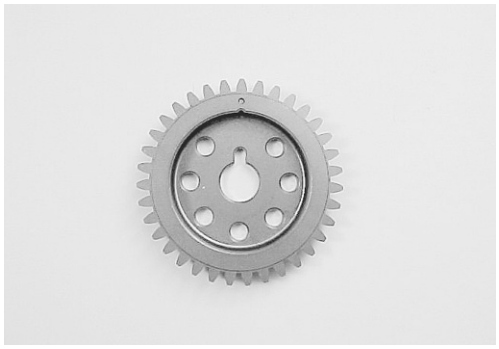
BALANCER CHAIN TENSIONER/CHAIN GUIDE

- Check tensioner for wear or damage.
  If excessive wear or other damage is found, replace it.
- Check chain guide for wear or damage.
  If excessive wear or other damage is found, replace it.



OIL PUMP DRIVE GEAR

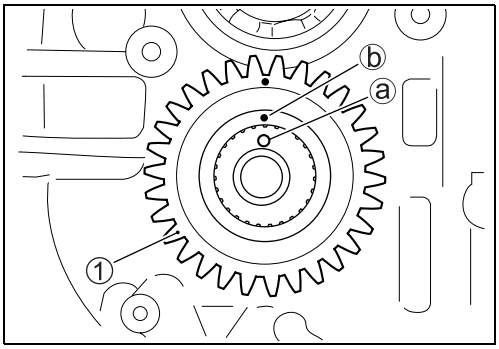
- Inspect drive gear.
  Replace gear if damaged or worn.



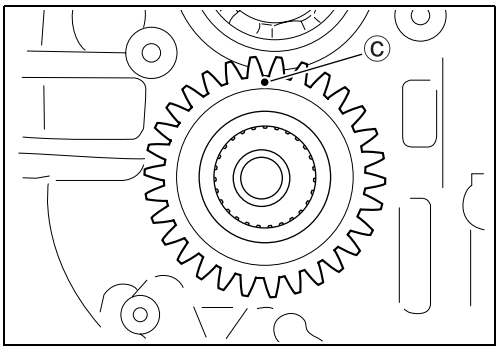
INSTALLATION

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

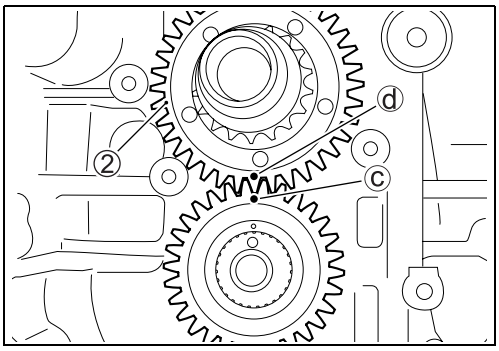
1. Install the drive gear ① on crankshaft so that dowel pin hole ⓐ aligns with match mark (•) ⓑ on the drive gear as shown in illustration.



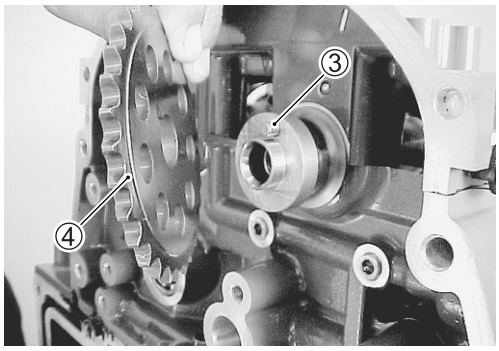
2. Check that match mark (•) ⓒ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).

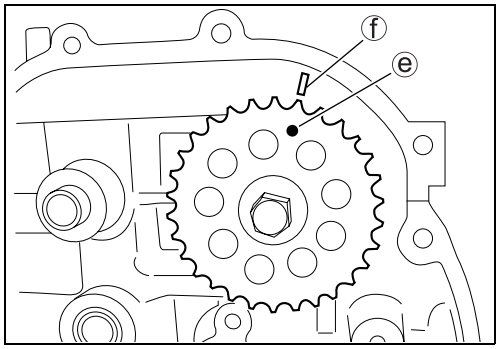


3. Install the driven gear ② on the cylinder block so that match mark (•) ⓒ aligns with match mark (•) ⓓ on the driven gear as shown in illustration.

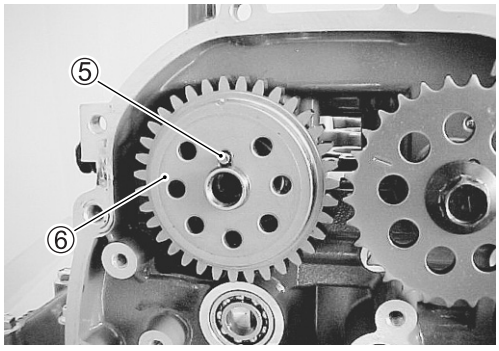


4. Fit the dowel pin ③ onto IN. camshaft. Fit IN. camshaft timing sprocket ④ and temporarily tighten the sprocket bolt. Check that match marks (•) ⓔ·ⓕ are correctly aligned as shown in illustration.

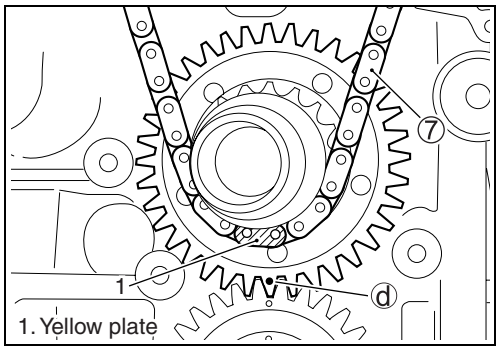




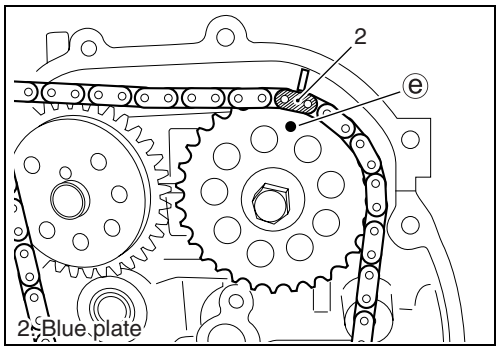
5. Fit the dowel pin ⑤ onto the EX. camshaft.
6. Install oil pump drive gear ⑥.



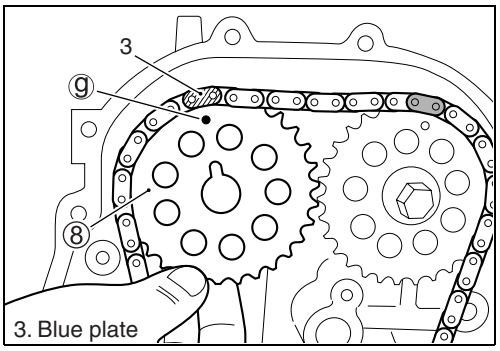
7. Align the yellow plate of timing chain ⑦ with the match mark (•) ⓓ on the driven gear and fit the chain onto the driven gear.



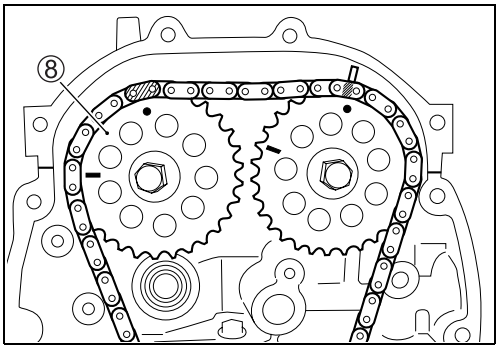
8. As shown in the illustration, fit the timing chain with one blue plate aligned with the match mark (•) ⓔ onto the IN. camshaft timing sprocket.



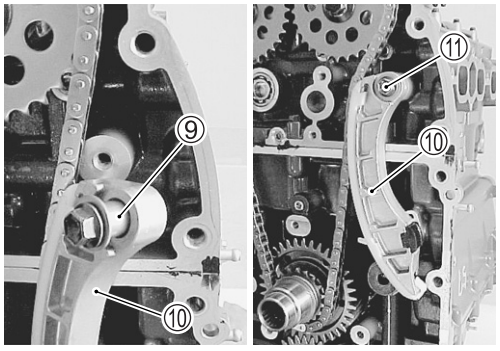
9. While aligning the one blue plate of timing chain with the match mark (•) ⑨ on the EX. camshaft timing sprocket ⑧, fit the chain onto the sprocket.



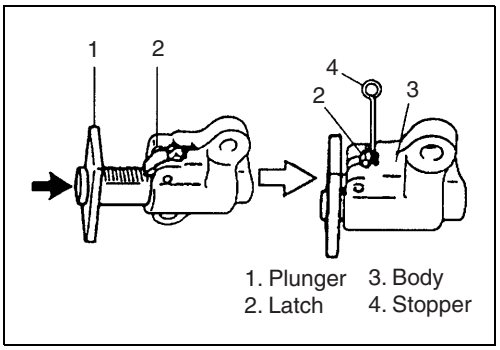
10. Install the EX. camshaft timing sprocket ⑧ on the EX. camshaft, then temporarily tighten the sprocket bolt.



11. Insert the spacer ⑨ into the chain tensioner ⑩.
Install chain tensioner, then tighten bolt ⑪ securely.
Apply engine oil to chain tensioner.



12. With latch of tensioner adjuster ⑫ 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.

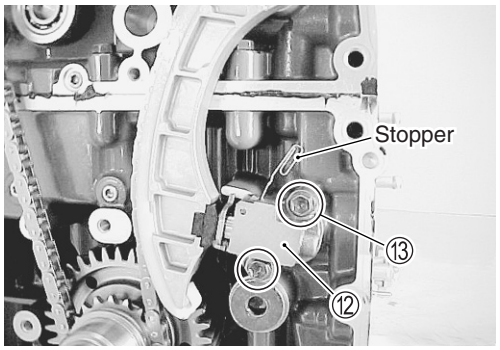


13. Install timing chain tensioner adjuster ⑫, then tighten bolts ⑬ to specified torque.

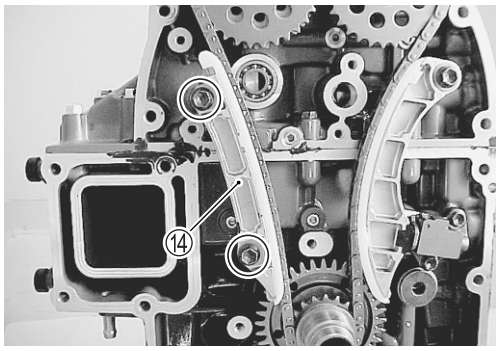
Tensioner adjuster bolt: 11 N·m (1.1 kg-m, 8.0 lb-ft)

Apply engine oil to timing chain.

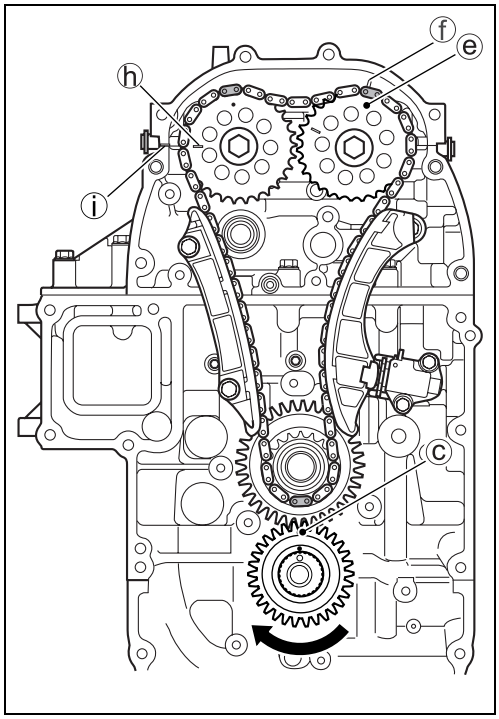
14. Remove the stopper from tensioner adjuster.



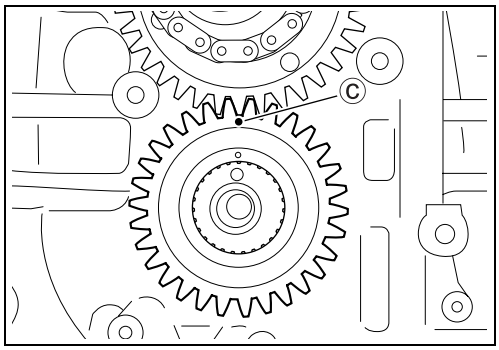
15. Install timing chain guide ⑭, then tighten bolts securely.
    Apply engine oil to chain guide.



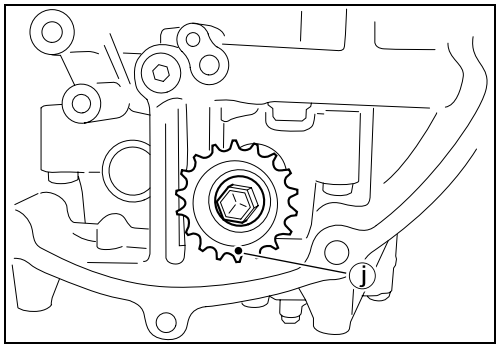
16. Turn the crankshaft two (2) complete rotations in direction shown in figure.
    As shown in the illustration, check that all match marks are in alignment as stated below when the match mark (•) ⓒ on the drive gear is pointing to 12 o'clock.
    - The match mark (•) ⓔ on the IN. sprocket aligns with the match mark ⓕ on the camshaft housing.
    - The match mark (engraved line) ⓗ on the EX. sprocket aligns with the mating face ⓘ between cylinder head and lower camshaft housing.



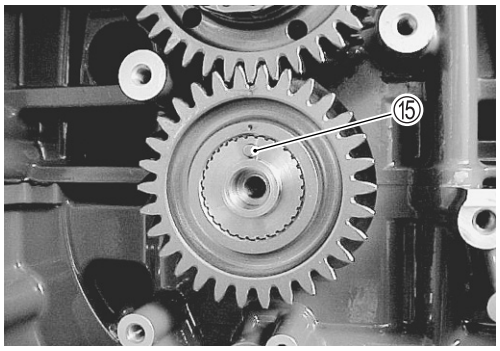
17. Check that match mark (•) ⓒ on the crankshaft drive gear points to 12 o'clock (towards cylinder head).



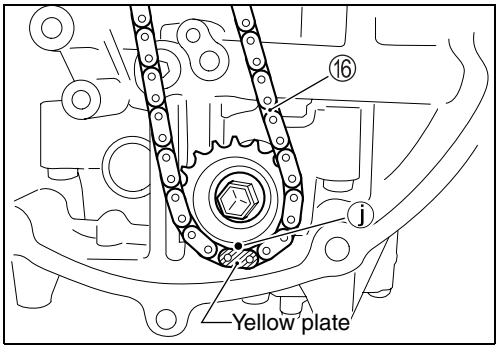
18. Check that match mark (•) ⓙ on the balancer driven sprocket points to 6 o'clock as shown in the illustration.



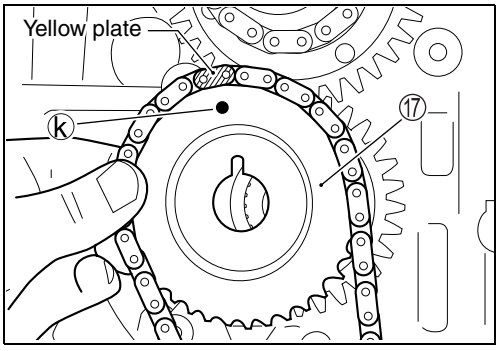
19. Fit the dowel pin ⑮ on the crankshaft.



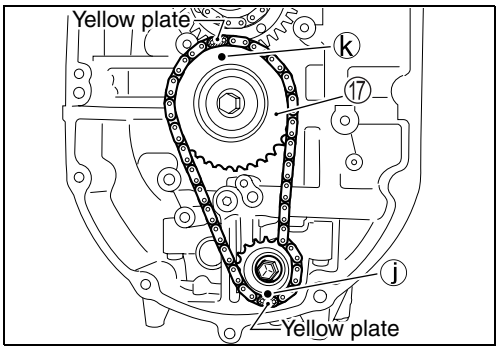
20. Align the yellow plate of balancer chain ⑯ with the match mark (•) ⓙ on the balancer driven sprocket and fit the chain on the sprocket.



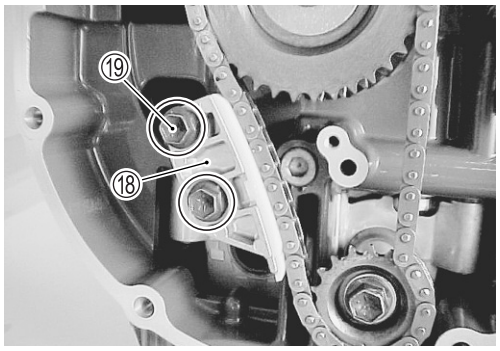
21. Align the yellow plate of balancer chain with the match mark (•) ⓚ on the balancer drive sprocket ⑰ and fit the chain on the sprocket.



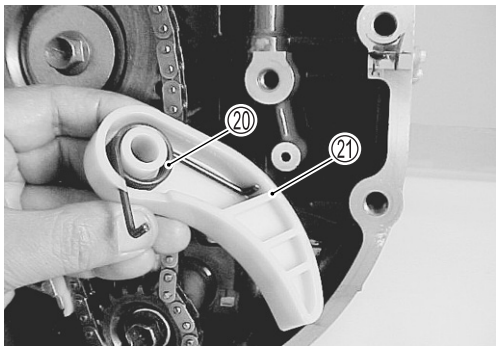
22. Install the balancer drive sprocket ⑰ on the crankshaft, then temporarily tighten the sprocket bolt and washer.
Check that match marks ⓙ and ⓚ are correctly aligned as shown in illustration.

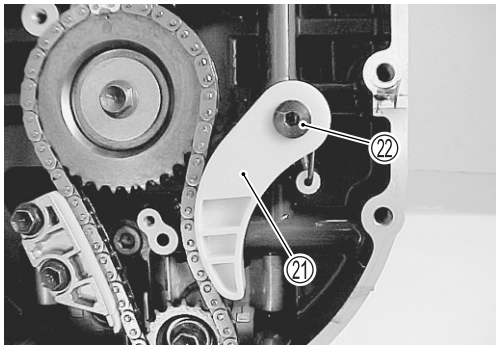


23. Install balancer chain guide ⑱, then tighten bolts ⑲ securely.



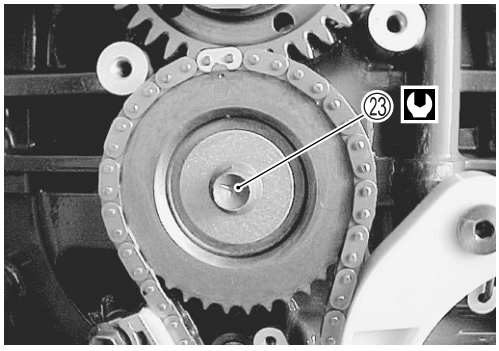
24. Assemble tensioner spring ⑳ and balancer chain tensioner ㉑.
    Install chain tensioner ㉑, then tighten bolt ㉒ securely.





25. Tighten crankshaft drive gear bolt ㉓ to specified torque.

Crankshaft drive gear bolt: 48 N·m (4.8 kg-m, 34.7 lb-ft)



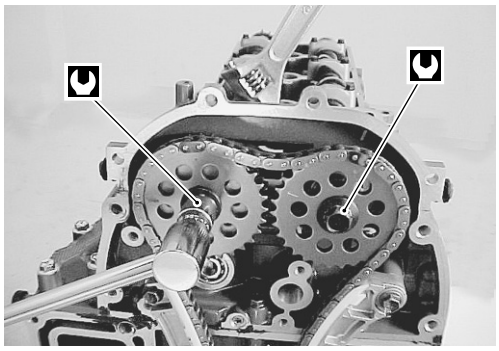
NOTE:
To hold the crankshaft, use special tool and flywheel as shown in figure.

09916-99311: Flywheel holder

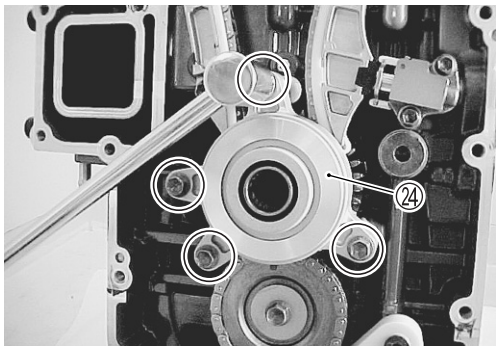


26. Tighten IN. and EX. camshaft timing sprocket bolt to specified torque.

IN. and EX. camshaft timing sprocket bolt:
78 N·m (7.8 kg-m, 56 lb-ft)



27. Install driven gear holder ㉔, then tighten four (4) bolts securely.



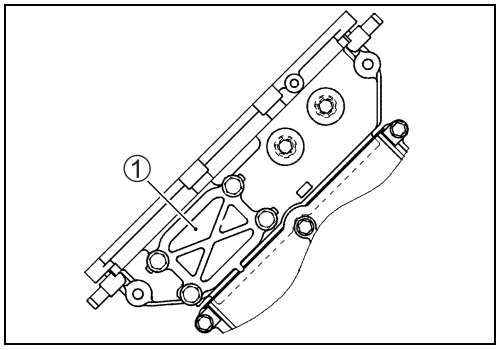
CYLINDER HEAD ASSEMBLY

(Cylinder head/valve/camshaft)

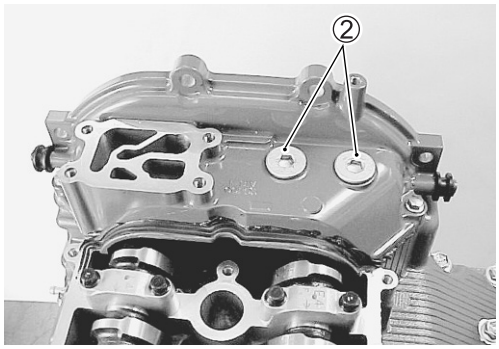
REMOVAL

Prior to removing cylinder head:
- **Remove the power unit. (See page 6-15 to 6-20.)**
- **Remove the timing chain. (See page 6-31 or 6-44.)**

1. On the DF150 model, remove the four (4) bolts and plate ①.

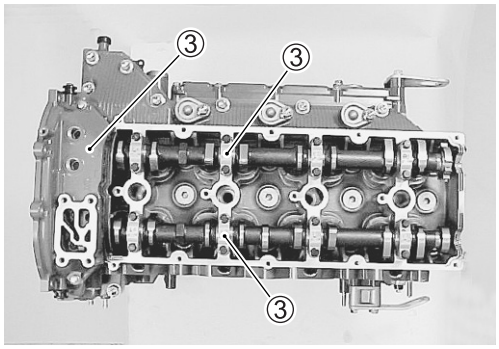


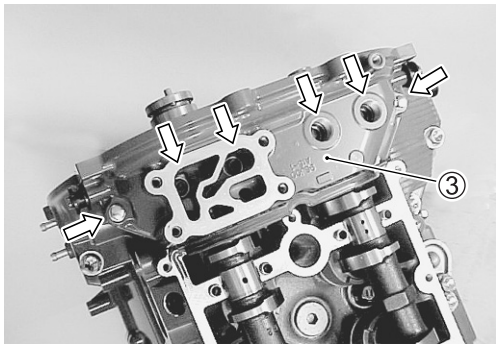
2. Remove two (2) plugs ②.



3. Remove the bolts securing the camshaft housing ③ to cylinder head, then remove each camshaft housing.

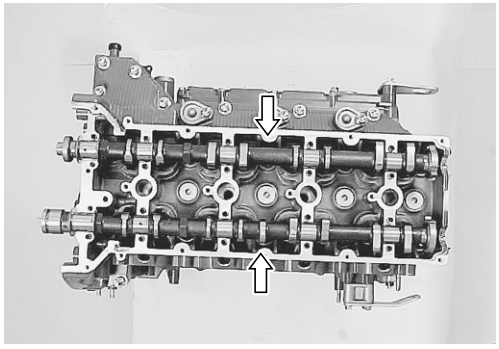
NOTE:
For ease of assembly, note position of each individual camshaft housing.



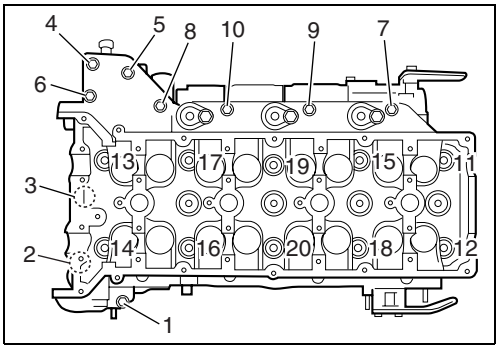


4. Remove intake/exhaust camshafts, tappets and tappet shims.

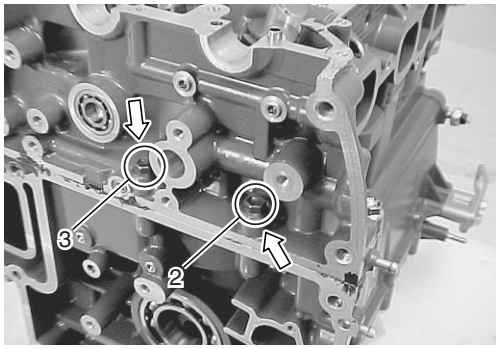
NOTE:
All tappets and tappet shims must be installed in their original positions.
For ease of assembly, lay out tappets and record shim thickness for each individual cylinder/valve position.



5. Loosen and remove twenty (20) cylinder head bolts in the order indicated in figure.
   Remove cylinder head assembly and head gasket.



NOTE:
Do not forget to remove all bolts in shown figure.



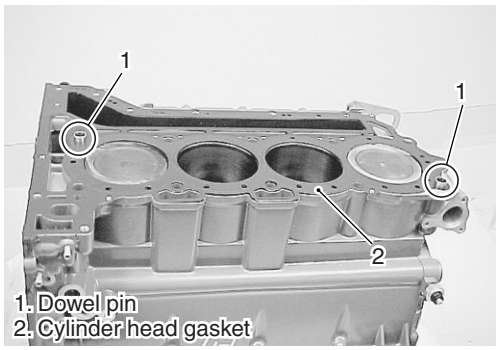
ASSEMBLY

Assemble in reverse order of removal paying special attention to the following steps.

CAUTION

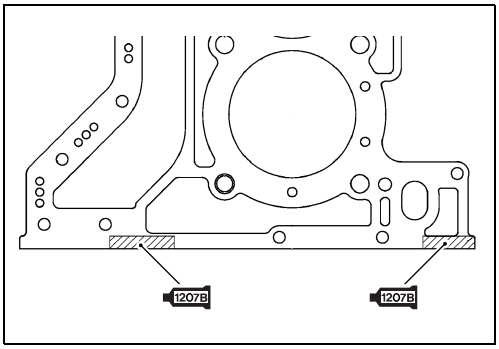
Do not reuse gasket. Always use a new gasket.

1. Insert the dowel pins and place a new cylinder head gasket into position on the cylinder.



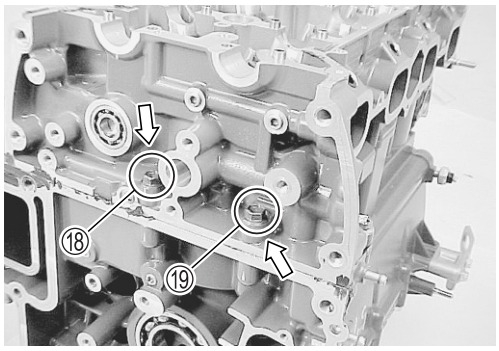
NOTE:
Before installing cylinder head gasket, apply sealant to both surfaces of the hatched areas shown in illustration.

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



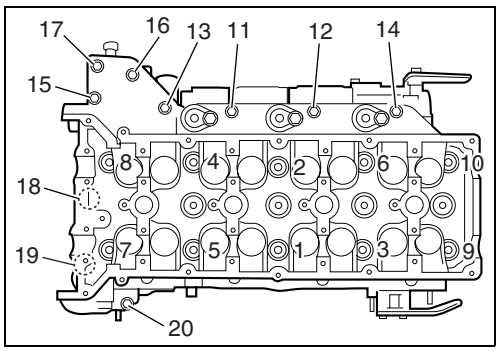
2. Position cylinder head on cylinder.
3. Apply engine oil to cylinder head bolts and tighten them gradually as follows.

NOTE:
Do not forget to install all bolt shown in figure.



(a) Tighten all bolts to 50 percent (%) of specified torque according to sequence in figure.

Cylinder head bolt:
1st step 12 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)

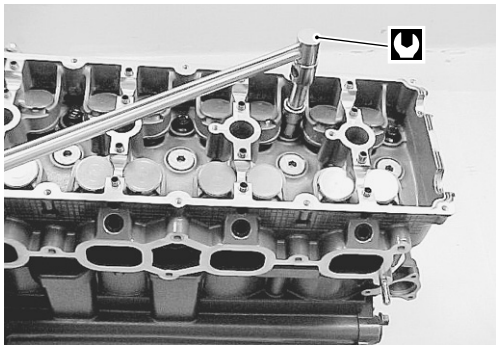


(b) Loosen all bolts to 0 N·m (0 kg-m, 0 lb-ft) according to reverse sequence in figure.
(c) Again tighten all bolts to 50 percent (%) of specified torque according to sequence in figure.

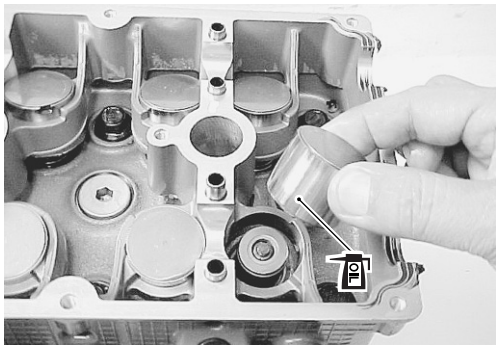
Cylinder head bolt:
3rd step 12 mm 43 N·m (4.3 kg-m, 31.1 lb-ft)
8 mm 12 N·m (1.2 kg-m, 8.7 lb-ft)

(d) Finally tighten all bolts to specified torque according to sequence in figure.

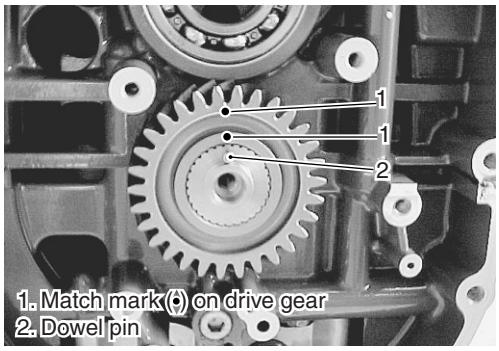
Cylinder head bolt:
Final step 12 mm 86 N·m (8.6 kg-m, 62.2 lb-ft)
8 mm 23 N·m (2.3 kg-m, 16.6 lb-ft)



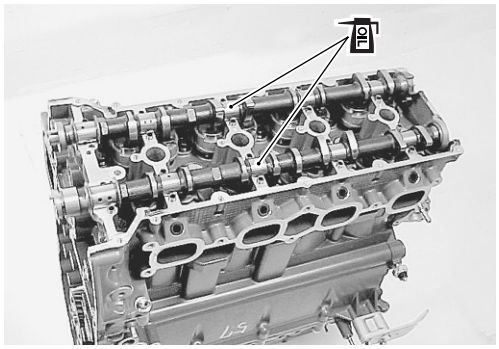
4. Apply engine oil around tappets and install in their original position.
Install tappet shims in their original position.



NOTE:
Before installing camshafts, turn crankshaft until the match mark (•) on the crankshaft drive gear points to 12 o'clock (toward cylinder head).

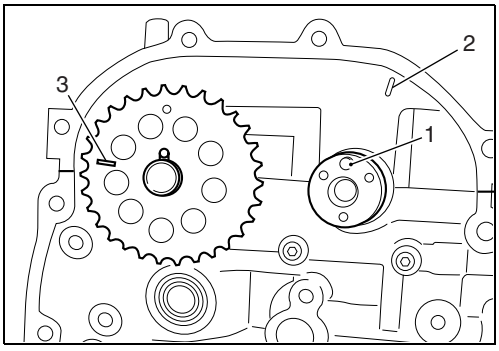


5. Apply engine oil to the surface of each camshaft lobe and journal, then install them as shown in figure.

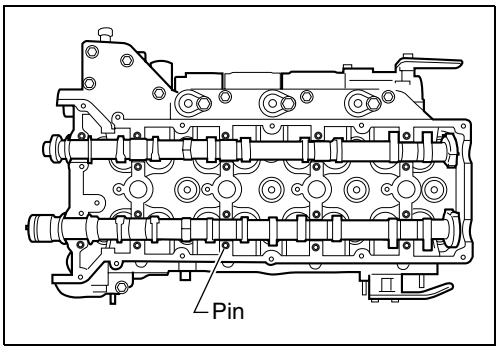


NOTE:
When installing the camshaft, align dowel pin on the IN. camshaft with match mark on lower camshaft housing and engraved line on EX. sprocket align with lower camshaft housing mating face.

1. Dowel pin on camshaft
2. Match mark on lower camshaft housing
3. Engraved line on EX. sprocket

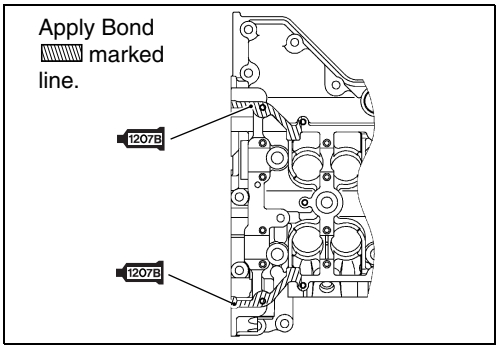


6. Install camshaft housing pins as shown in figure.

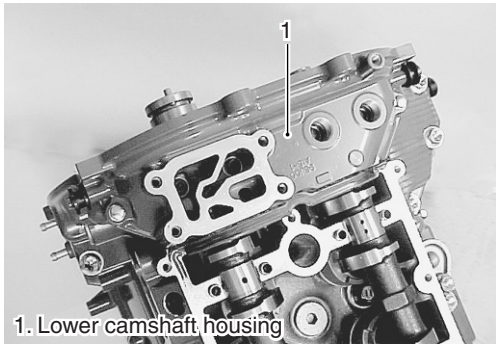


7. Apply sealant to lower camshaft housing sealing surface area as shown in figure.

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

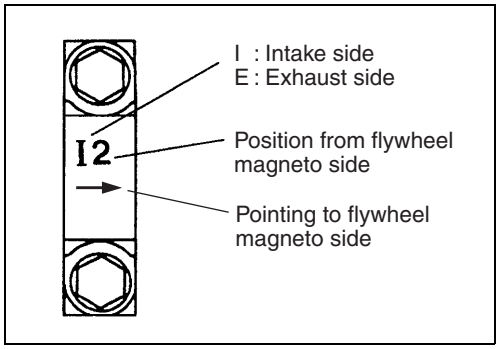


8. Install the lower camshaft housing.



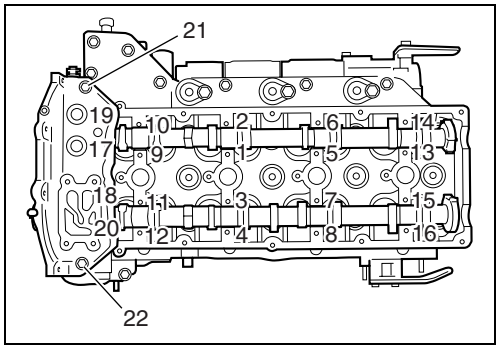
9. Check position of camshaft housing.
   - Embossed marks are provided on each camshaft housing indicating position and direction of installation.

   Install housings as indicated by these marks.

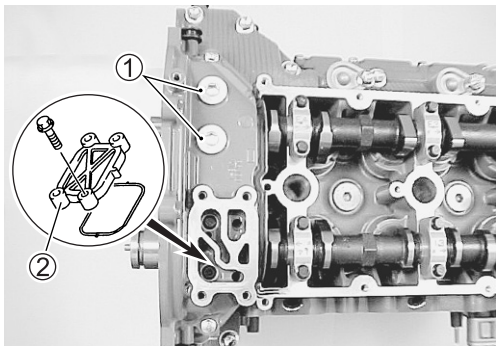


10. Apply engine oil to housing bolts.
11. Lightly seat all housing bolts at first.
    Following sequence in figure, tighten bolts to 1/3 of specified torque, then 2/3 of specified torque and finally to full specified torque.

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



12. Install plugs ① in lower camshaft housing.
13. On the DF150 model, install gasket and plate ②, tighten bolts securely.



14. Install timing chain and balancer chain.
    (See page 6-37 or 6-50.)
15. Install oil pump assembly. (See page 6-30.)
16. Check tappet clearance and adjust as necessary.
    (See page 2-9.)

DISASSEMBLY

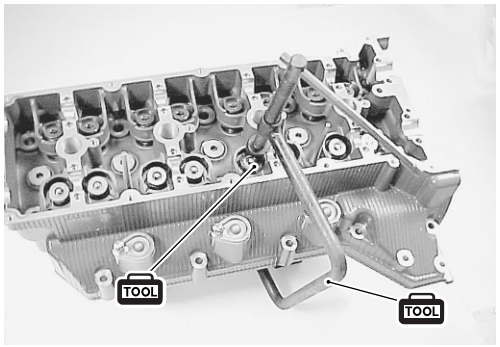
1. Remove tappets with shims.

NOTE:
All tappets and tappet shims must be installed in their original positions.
For ease of assembly, lay out tappets and record shim thickness for each individual cylinder/valve position.

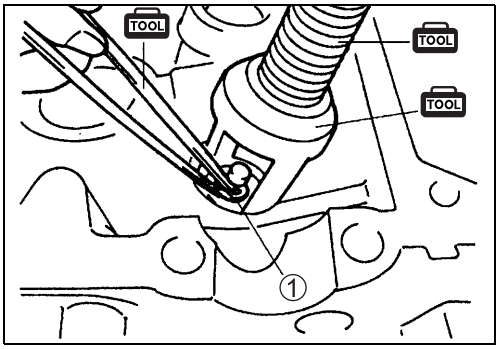


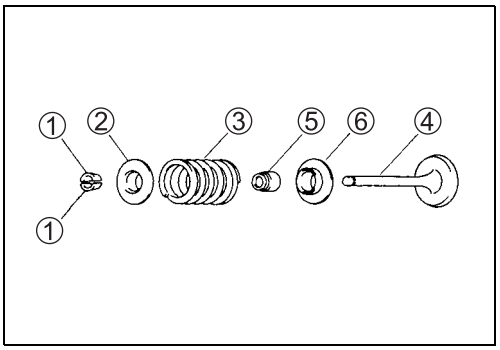
2. Using valve lifter and attachment, remove valve cotters ① while compressing valve spring.

09916-19030: Valve lifter
09916-14521: Attachment
09916-84511: Tweezers



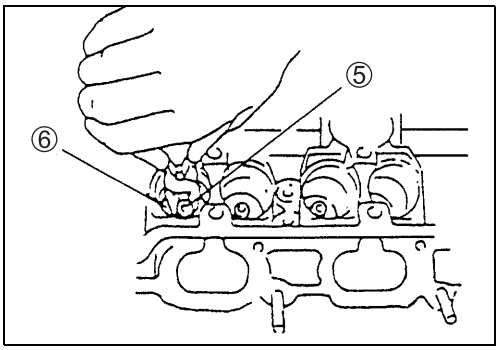
3. Remove valve spring retainer ②, valve spring ③ and valve ④.





4. Remove valve stem seal ⑤ and valve spring seat ⑥.

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

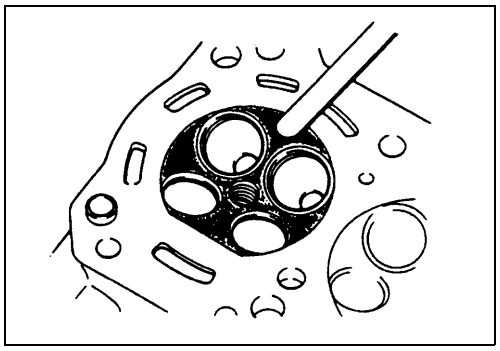


INSPECTION/SERVICING

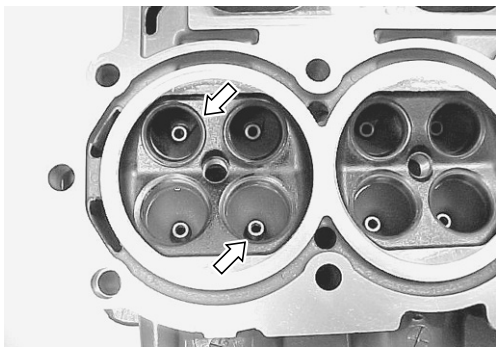
NOTE:
If cracks, excessive wear or other damage is found on any component, replace component.

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 decarbonizing.*



Check cylinder head for cracks in intake and exhaust ports, combustion chambers, and head surface.

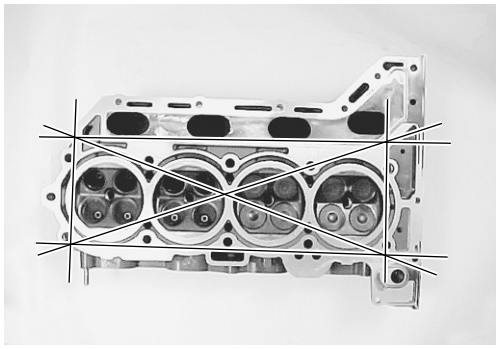


Valve seat
Check valve seat, if cracks or other damage is found, replace cylinder head.

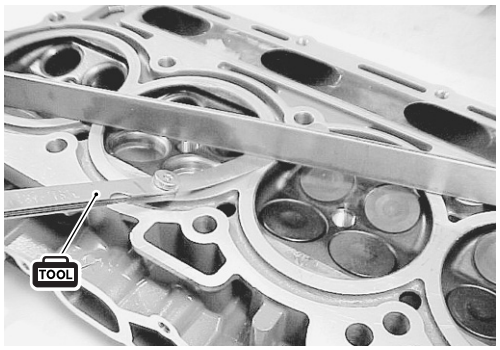
Cylinder head distortion
Using a straightedge and thickness gauge, measure cylinder head distortion (gasket surface) at a total of six (6) locations as shown.

TOOL 09900-20803: Thickness gauge

Cylinder head distortion
Service limit: 0.03 mm (0.001 in)



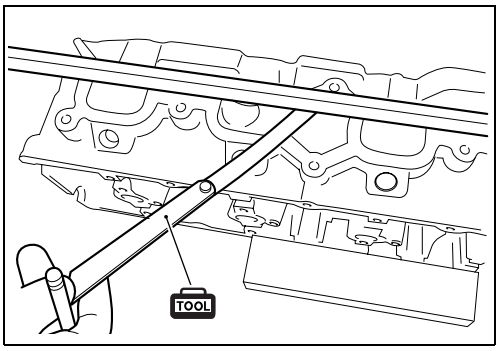
If measurement exceeds service limit, resurface or replace cylinder head.



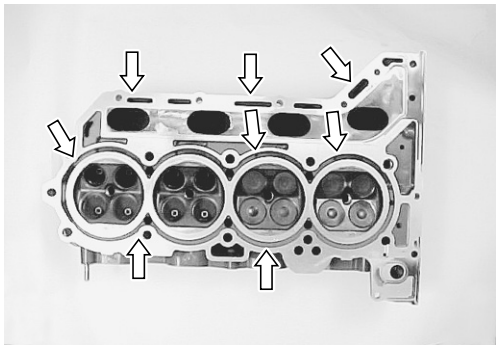
Manifold seating faces distortion
Using a straightedge and thickness gauge, check cylinder head to manifold seating faces.

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.



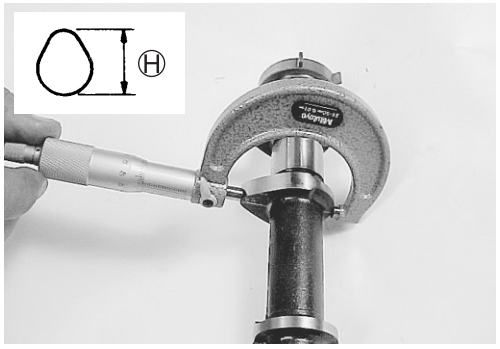
CAMSHAFT
Cam face
Inspect cam face for scratches and wear.

Cam wear
Using micrometer, measure cam height Ⓗ.

TOOL 09900-20202: Micrometer

Cam height
Standard:
DF175 IN. 44.420 – 44.580 mm (1.7488 – 1.7551 in)
EX. 44.420 – 44.580 mm (1.7488 – 1.7551 in)
DF150 IN. 42.520 – 42.680 mm (1.6740 – 1.6803 in)
EX. 42.420 – 42.580 mm (1.6701 – 1.6764 in)

Service limit
DF175 IN. 44.320 mm (1.7449 in)
EX. 44.320 mm (1.7449 in)
DF150 IN. 42.420 mm (1.6701 in)
EX. 42.320 mm (1.6661 in)

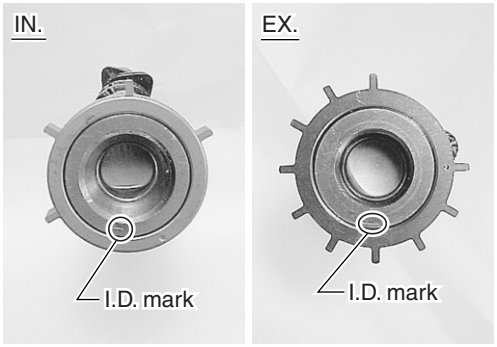


If measurement exceeds service limit, replace camshaft.

Camshaft identification

DF150 and DF175 camshafts differ as indicated below.

Model	Identification mark	
	IN.	EX.
DF150	0	A
DF175	1	B



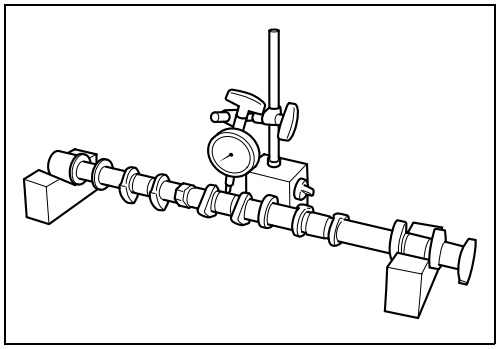
Camshaft runout

Support camshaft on a surface plate using a set of V-blocks.
Measure runout using a dial gauge.

TOOL 09900-20606: Dial gauge
: "V" block set
09900-20701: Magnetic stand

Camshaft runout
Service limit: 0.10 mm (0.004 in)

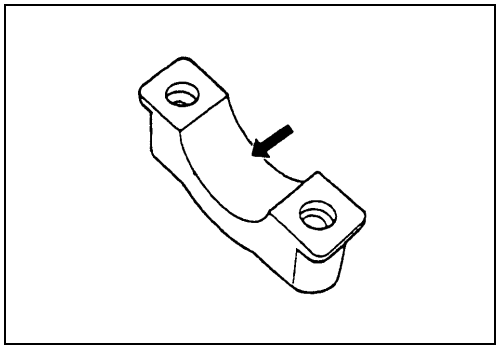
If measurement exceeds service limit, replace camshaft.



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.

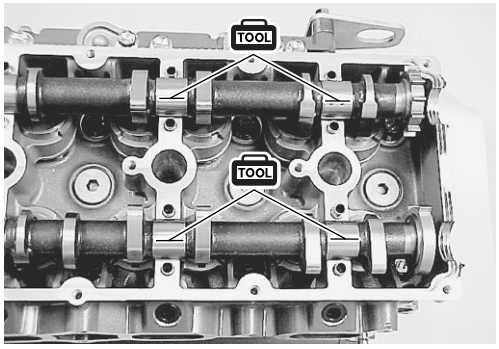


Camshaft journal oil clearance

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).

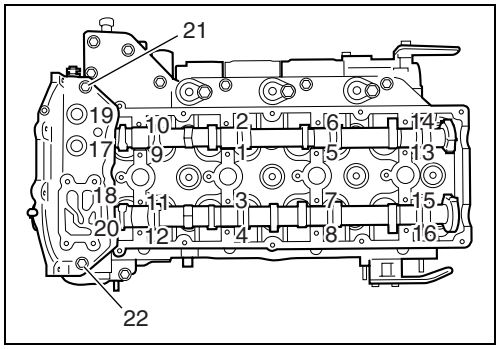
TOOL 09900-22302: Plastigauge



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.

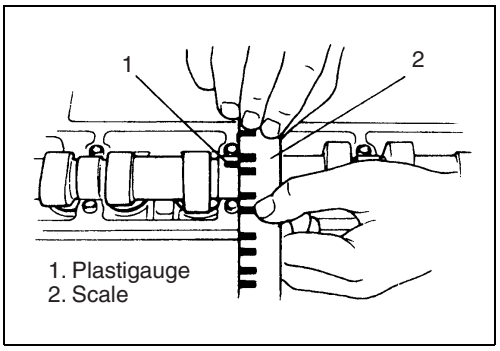
Camshaft housing bolt: 12 N·m (1.2 kg-m, 8.7 lb-ft)

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.

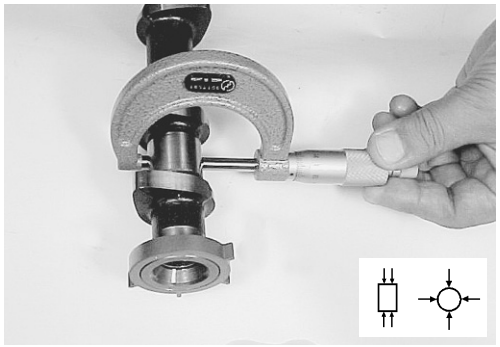
Camshaft journal oil clearance
Standard: 0.043 – 0.085 mm (0.0017 – 0.0033 in)
Service limit: 0.120 mm (0.0047 in)



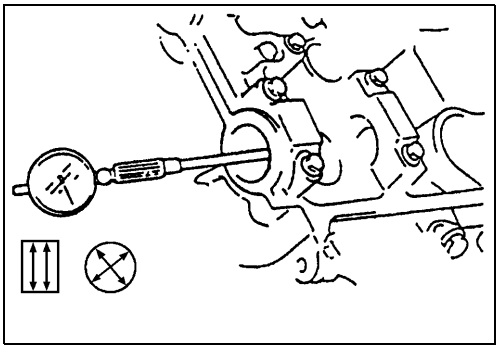
If journal oil clearance exceeds the service limit, measure camshaft journal (outside dia.) and camshaft housing (inner dia.). Based on measurements, replace camshaft and/or cylinder head with camshaft housing.

09900-20202: Micrometer (25 – 50 mm)

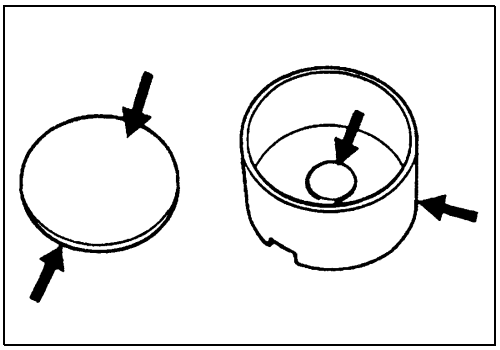
Camshaft journal outside diameter
Standard: 25.936 – 25.957 mm (1.0211 – 1.0219 in)



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.

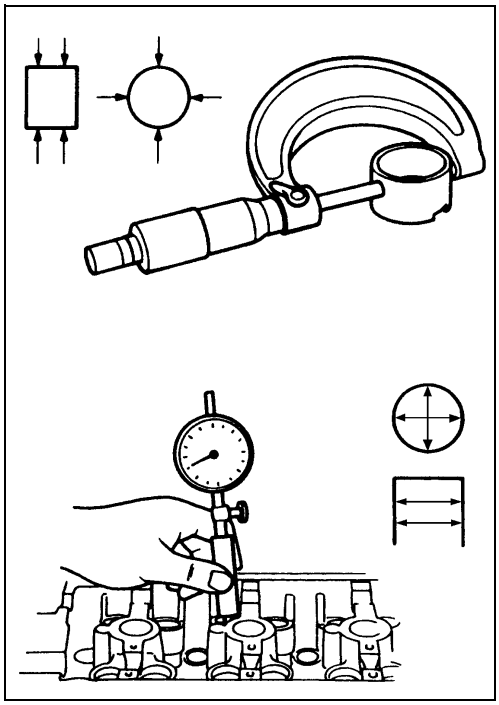
TOOL 09900-20202: Micrometer

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

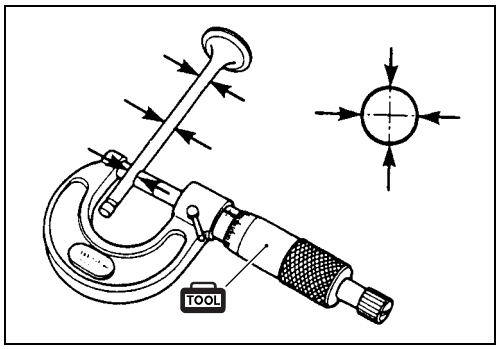
Using a micrometer and bore gauge, take diameter readings on valve stems and guides to check guide to stem clearance.
Be sure to take readings at more than one place along the length of each stem and guide.

TOOL 09900-20205: Micrometer

Valve stem outside diameter

Using micrometer, measure valve stem outside diameter.

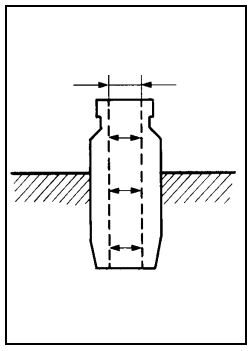
Valve stem outside diameter
Standard:
IN. 5.465 – 5.480 mm (0.2152 – 0.2157 in)
EX. 5.440 – 5.455 mm (0.2142 – 0.2148 in)

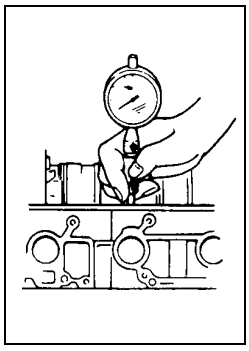


Valve guide inside diameter

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:

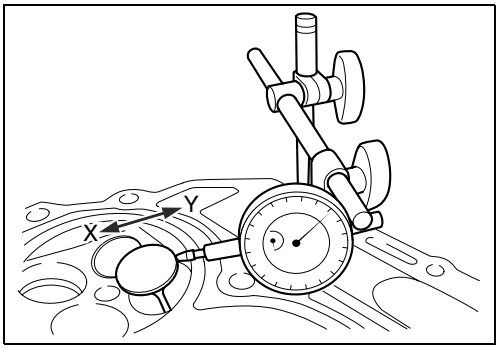
For valve guide replacement, see "VALVE GUIDE REPLACEMENT" section on page 6-71.

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.

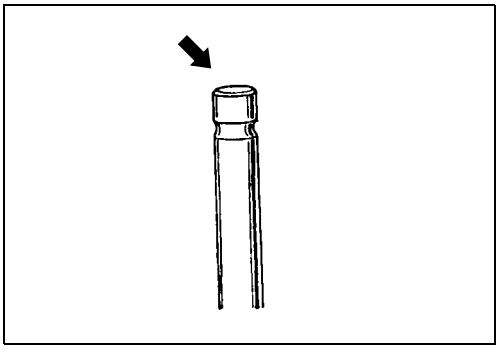
Valve stem end

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.

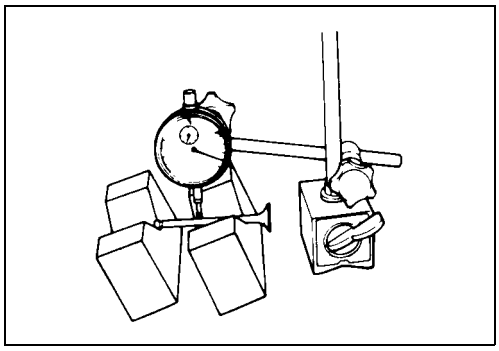


Valve stem runout
Measure valve stem runout.

TOOL 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.

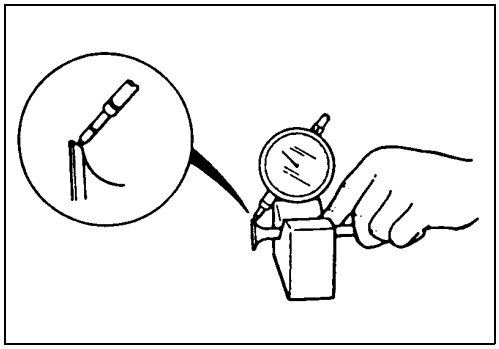


Valve head radial runout
Measure valve head radial runout.

TOOL 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.

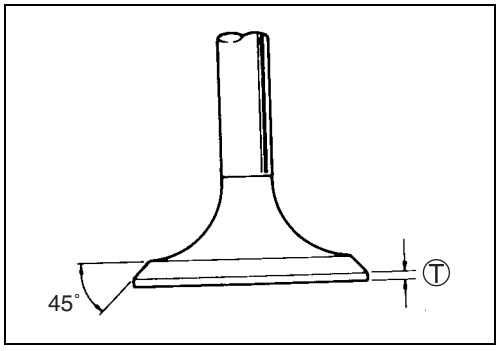


Valve head thickness
Measure thickness Ⓣ of valve head.

TOOL 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)

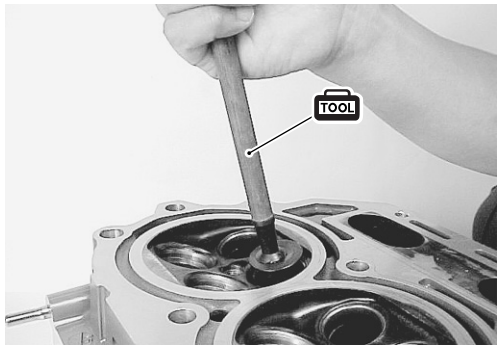
If measurement exceeds service limit, replace valve.

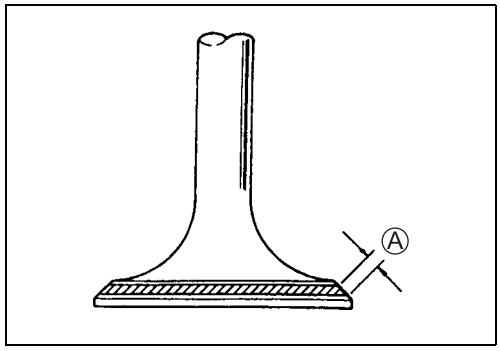


Valve seat contact width
Measure valve seat contact width as follows:
(1) Remove all carbon from valve and seat.
(2) Coat valve seat evenly with Prussian blue (or equivalent).
(3) Install valve into valve guide.
(4) Put valve lapper on valve.

TOOL 09916-10911: 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 Ⓐ.





TOOL 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 6-70.

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°

TOOL : Valve seat cutter (NEWAY128) 45°

: Valve seat cutter (NEWAY212) 15°

09916-22420: Valve seat cutter (NEWAY114) 60°

Solid pilot (NEWAY, N-150-5.5)

09916-24450: Solid pilot (NEWAY. N-100-5.52)

09916-54910: Handle (N-505)

NOTE:

Turn cutter clockwise, never counterclockwise.

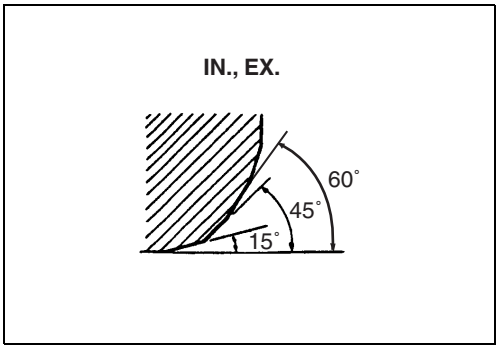
(1) Remove all carbon from valve and valve seat.

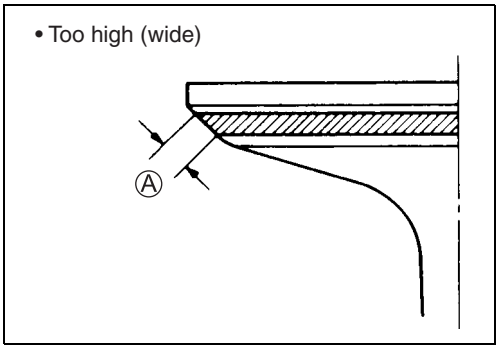
(2) Using 45° angle cutter, reface valve seat.

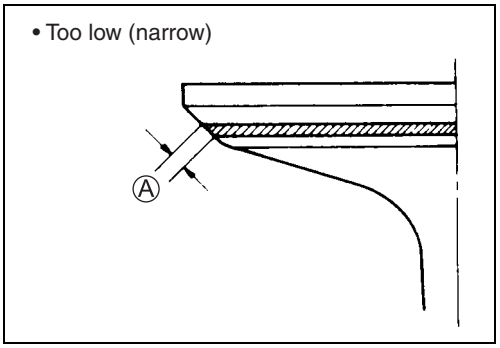
(3) Check valve seat contact width Ⓐ.
See the "Valve seat contact width" section on page 6-69.

(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.

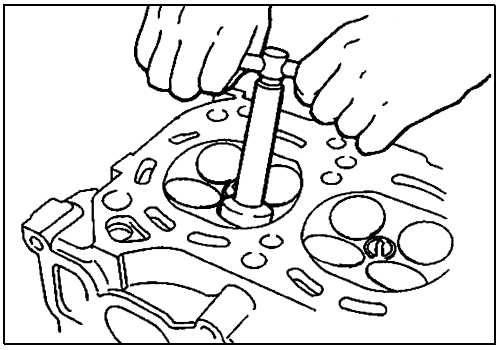






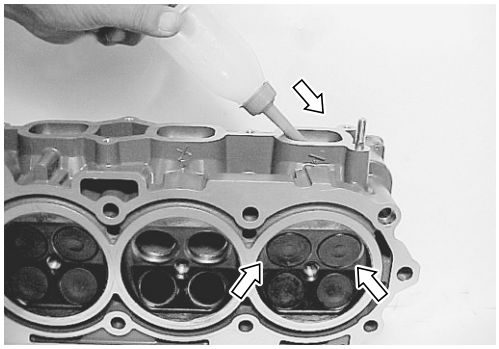
CAUTION

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

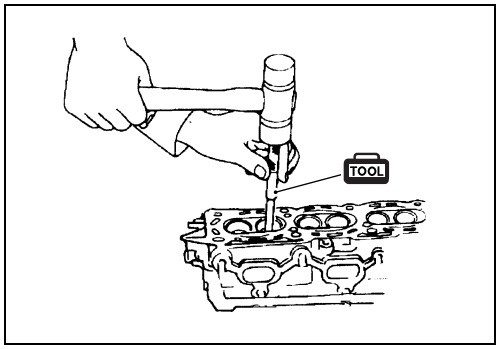
CAUTION

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

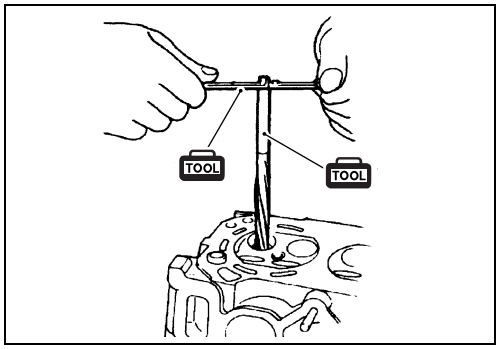
NOTE:
Do not reuse valve guide once it has been removed.
Always use a new valve guide (oversize) when assembling.



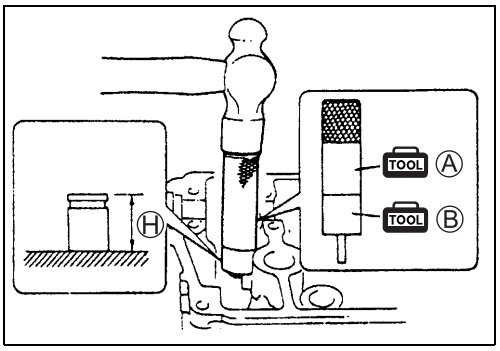
(2) Ream valve guide hole with ϕ10.5 mm reamer to true hole and remove burrs.

TOOL 09916-37320: Valve guide reamer (ϕ10.5 mm)
09916-34542: Reamer handle

NOTE:
Turn reamer clockwise, never counterclockwise.



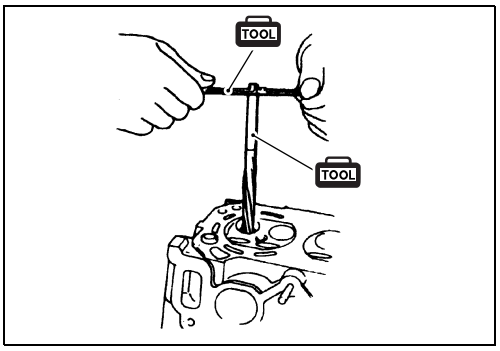
(3) Install valve guide to cylinder head.
- Heat cylinder head to a temperature of 80 – 100 °C (176 – 212 °F).
  Apply heat uniformly so that head will not be distorted.
- Use special tools to drive new valve guide into hole.
  Drive in new valve guide until special tool (valve guide installer attachment) 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.



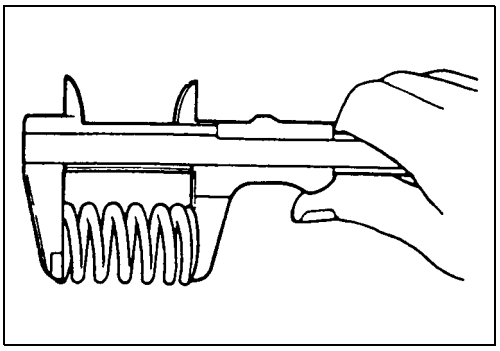
TOOL 09916-34550: Valve guide reamer (ϕ5.5 mm)
09916-34542: Reamer handle

NOTE:
Clean and oil valve guide bore after reaming.

VALVE SPRING

Valve spring free length

Check spring strength by measuring free length.



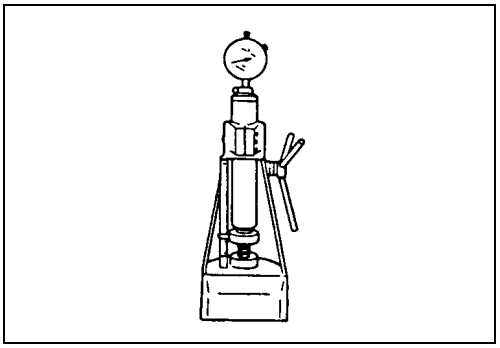
TOOL 09900-20101: Vernier calipers

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)

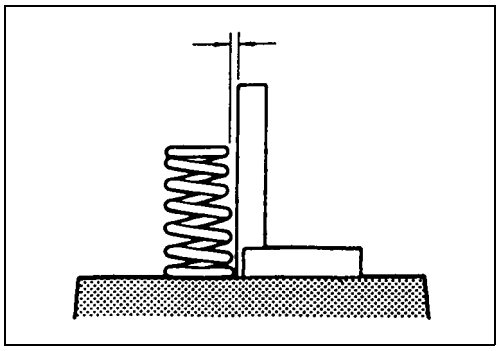
If lower than service limit, replace valve spring.

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)

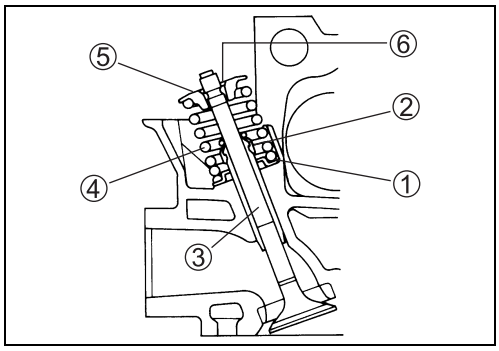
If measurement exceeds service limit, replace valve spring.



REASSEMBLY

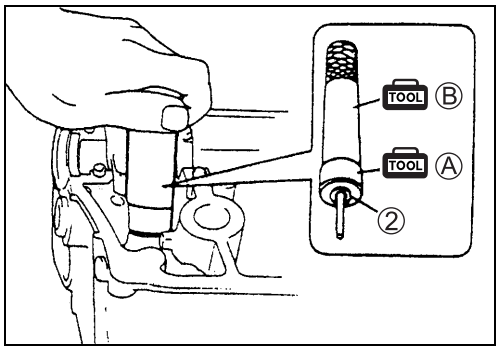
Reassemble in reverse order of disassembly paying special attention to the following steps.

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 Ⓑ



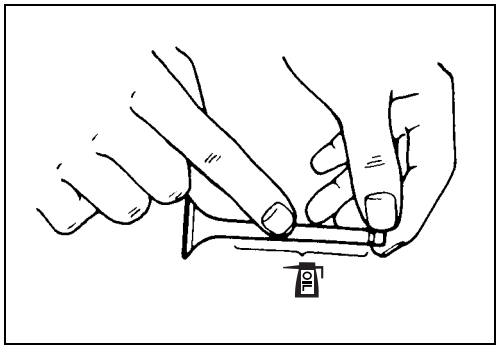
CAUTION

Do not reuse stem seal once removed.
Always install new seal.

Apply engine oil to stem seal, valve guide bore and valve stem.

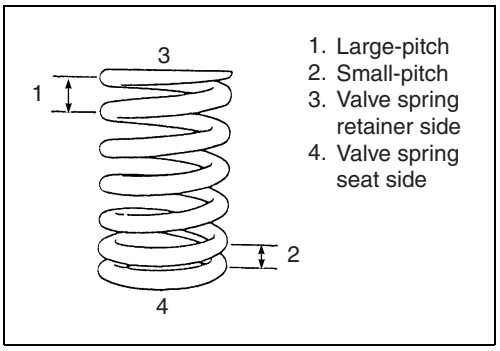
Install valve ③ to valve guide.

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



Install valve spring ④, and valve retainer ⑤.

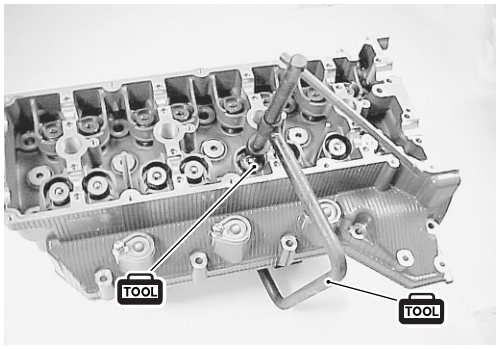
NOTE:
Set valve spring in place with narrow spiral area facing valve seat.

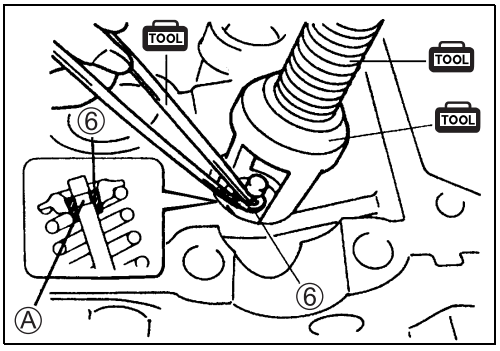


Hold valve spring compressed with special tool and install valve cotters ⑥.

Make sure valve cotters are properly seated in groove Ⓐ.

09916-19030: Valve lifter
09916-14521: Attachment
09916-84511: Tweezers



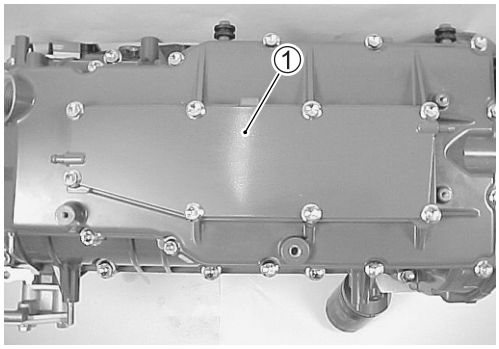


COUNTER-BALANCER MECHANISM

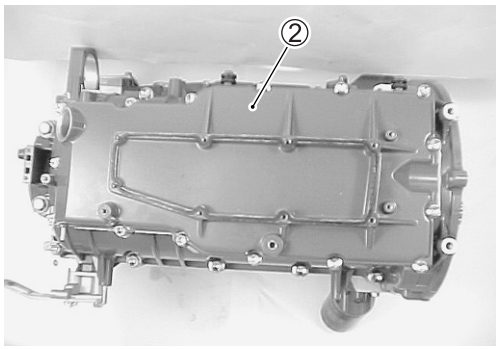
REMOVAL

Prior to removing counter-balancer mechanism assembly:
- **Remove the power unit. (See page 6-15 to 6-20.)**
- **Remove the balancer chain. (See page 6-31 or 6-44.)**

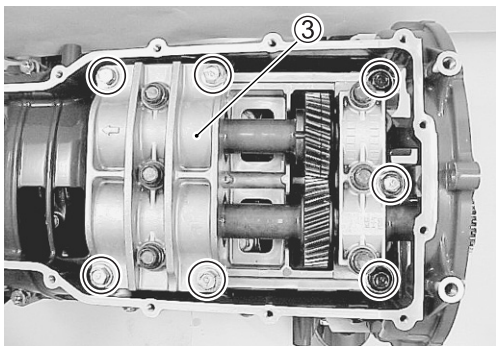
1. Remove bolts and water jacket cover ① (if necessary).



2. Remove the bolts securing balancer cover ② to crankcase, then remove balancer cover.

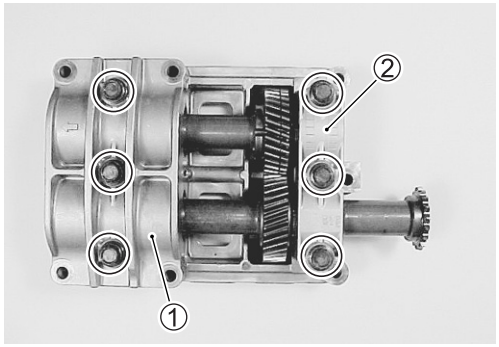


3. Remove the seven (7) bolts securing counter-balancer mechanism assembly ③ to crankcase, then remove counter-balancer mechanism assembly.



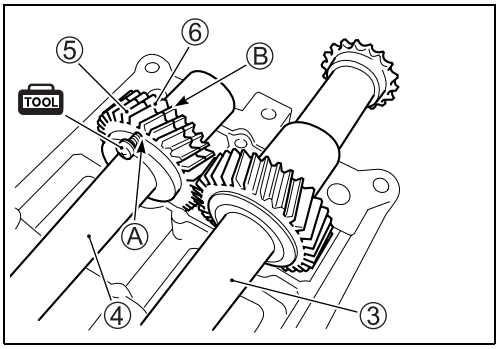
DISASSEMBLY

1. Remove the three (3) bolts and upper housing ①.
2. Remove the three (3) bolts and lower housing ②.

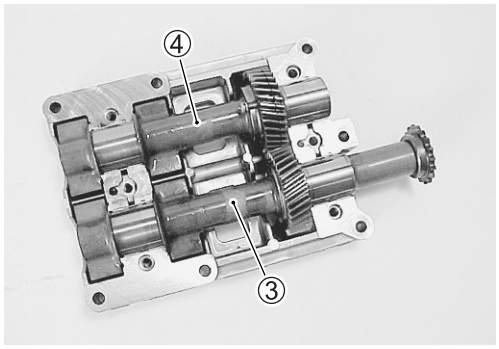


NOTE:
Before removing STBD balancer shaft ③ and/or PORT balancer shaft ④, insert special tool (pin) through hole Ⓐ on No.1 gear ⑤ and hole Ⓑ on No.2 gear ⑥ as shown.

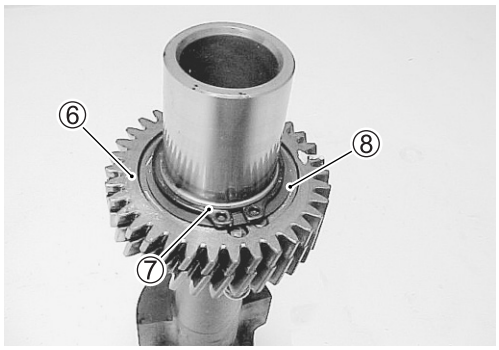
TOOL 09917-29610: Scissors gear alignment tool set



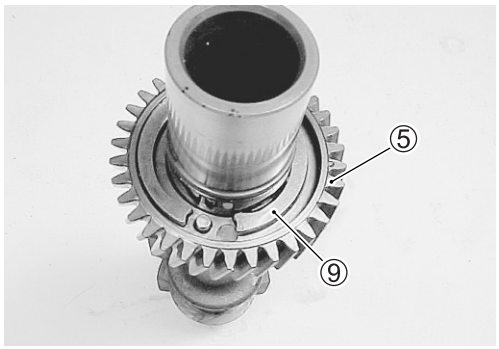
3. Remove STBD balancer shaft assembly ③.
   Remove PORT balancer shaft assembly ④.



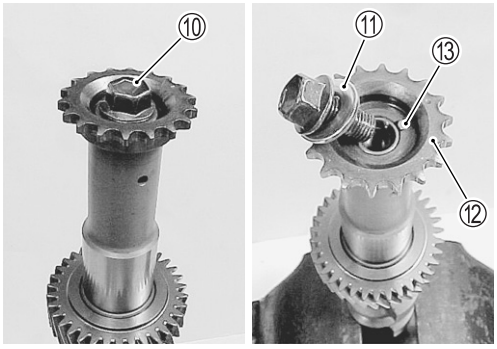
4. Remove circlip ⑦, washer ⑧ and No.2 gear ⑥.



5. Remove scissors spring plate ⑨ from No.1 gear ⑤.



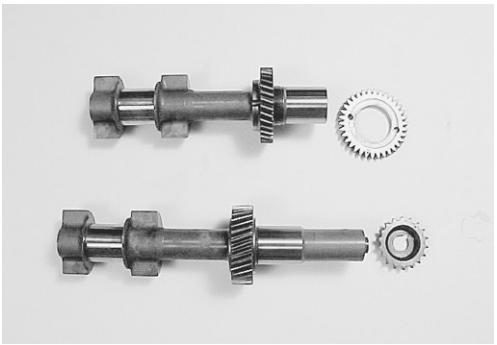
6. Secure STBD balancer shaft in a vise, then remove bolt ⑩, washer ⑪ and driven sprocket ⑫.
   Account for dowel pin ⑬.



INSPECTION

NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

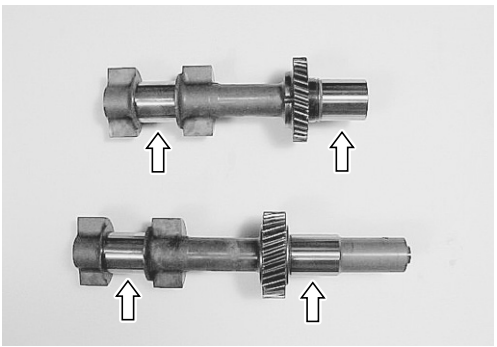
BALANCER GEAR
Inspect gears. Replace gear if damaged, worn excessively or other abnormal condition.



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.



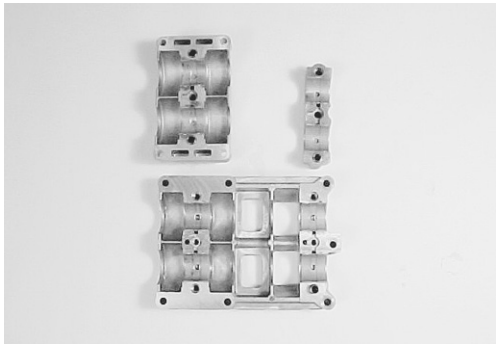
BALANCER SHAFT JOURNAL
Check balancer shaft journals for pitting, scratches, wear or damage.
If any of the above condition are found, replace balancer shaft.



HOUSING

Check base housing, upper housing and lower housing.
If cracks or other damage are found, replace housings as a set.

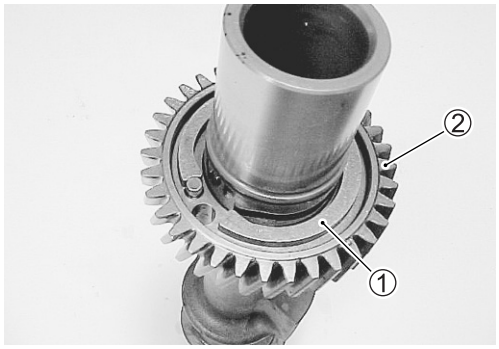
NOTE:
Base housing, upper housing and lower housing must be replaced as a set.



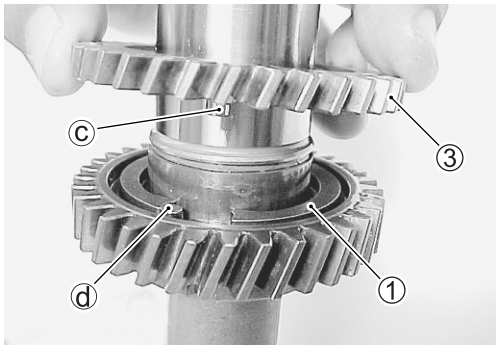
ASSEMBLY

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

1. Wash, clean and then dry all disassembled parts.
2. Put scissors spring plate ① onto No.1 gear ② as shown.

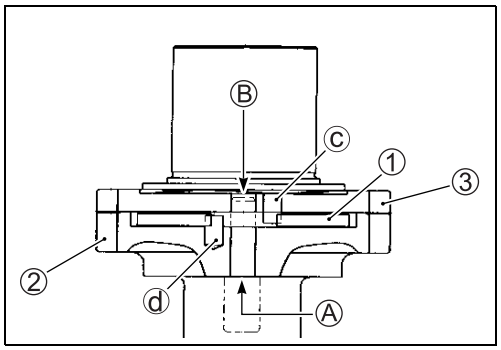


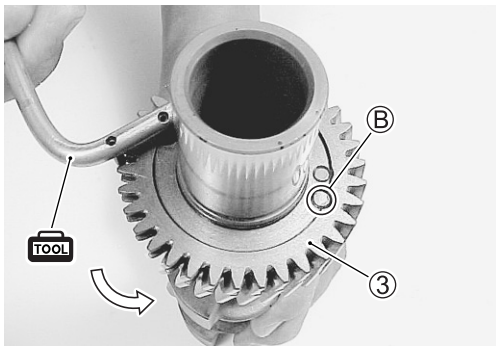
3. Install No.2 gear ③ on the PORT balancer shaft so that the pin ⓒ on No.2 gear contacts with end of scissors spring plate ①.
   Check that both scissors spring plate ends contact to pins ⓒ and ⓓ on each gear as shown.



4. Secure PORT balancer shaft in a vise.
   Turn the No.2 gear ③ counterclockwise by using special tool until hole Ⓐ on No.1 gear ② aligns with hole Ⓑ on No. 2 gear ③.

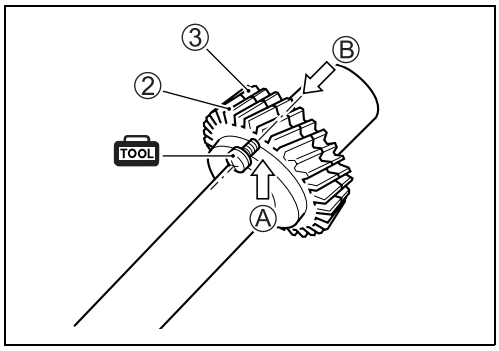
TOOL 09917-29610: Scissors gear alignment tool set



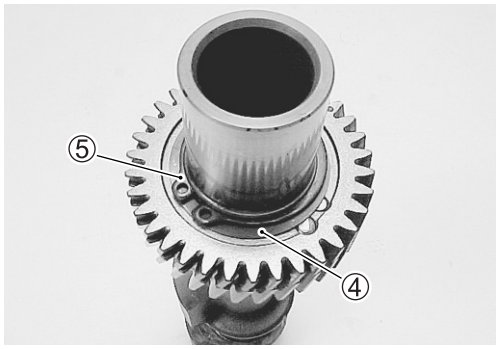


5. Insert special tool (pin) through hole Ⓐ on No.1 gear ② and hole Ⓑ on No.2 gear ③ as shown.

TOOL 09917-29610: Scissors gear alignment tool set

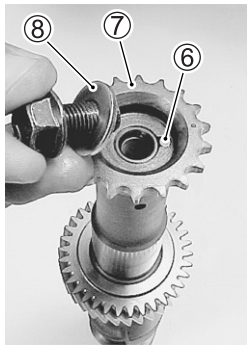


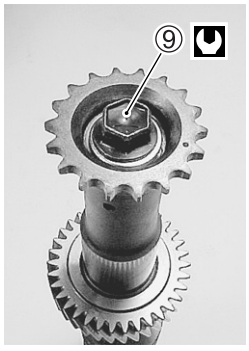
6. Install washer ④ and circlip ⑤.



7. Secure STBD balancer shaft in a vise.
   Install dowel pin ⑥, driven sprocket ⑦ and washer ⑧, then tighten bolt ⑨ to specified torque.

Balancer driven sprocket: 48 N·m (4.8 kg-m, 34.7 lb-ft)

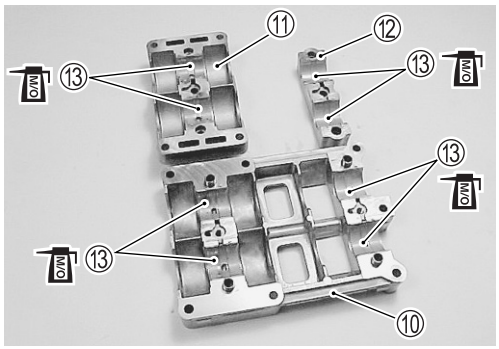




8. Install bearings ⑬ in base housing ⑩, upper housing ⑪ and lower housing ⑫.
   Apply molybdenum oil solution to each bearing.

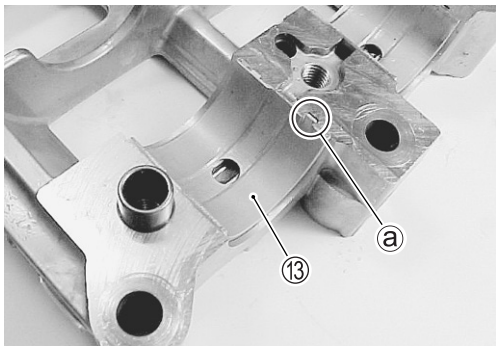
M/O MOLYBDENUM OIL SOLUTION

Mix equal amounts of engine oil and SUZUKI MOLY PASTE (p/no, 99000-25140) in a ratio of 1:1



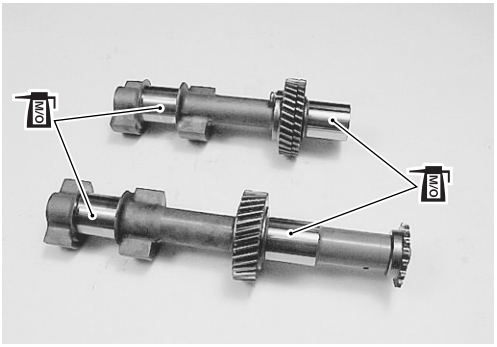
NOTE:

- *Align bearing tab ⓐ with notch in each housing.*
- *Assemble each bearing in its original position.*

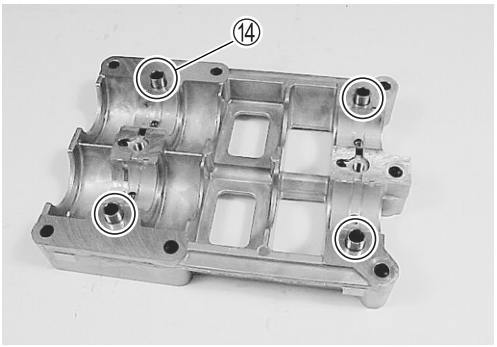


9. Apply molybdenum oil solution to balancer shaft journals.

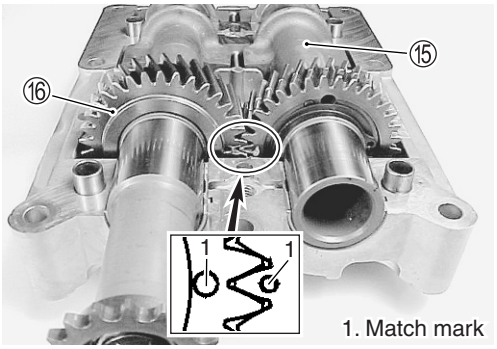
MOLYBDENUM OIL SOLUTION



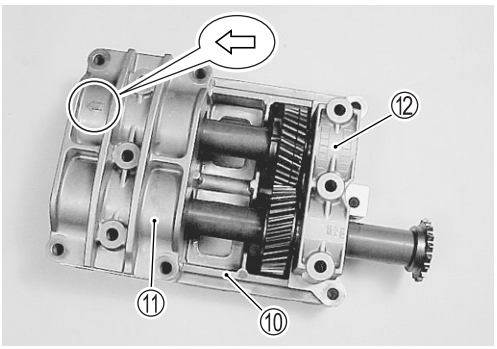
10. Install dowel pins ⑭.



11. Install PORT balancer shaft assembly ⑮ in base housing.
12. Install STBD balancer shaft ⑯ in base housing so that match mark (•) on STBD balancer gear aligns with match mark (•) on No.2 PORT balancer gear as shown in illustration.

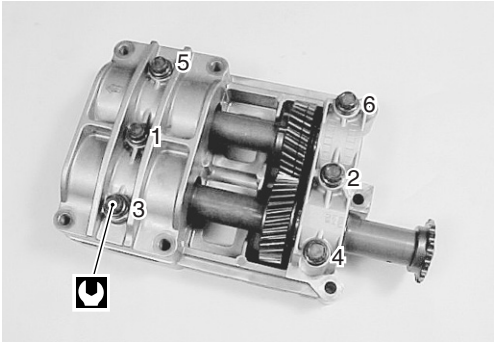


13. Install upper housing ⑪ to base housing ⑩ with arrow mark on upper housing toward flywheel side.
    Install lower housing ⑫ to base housing ⑩.



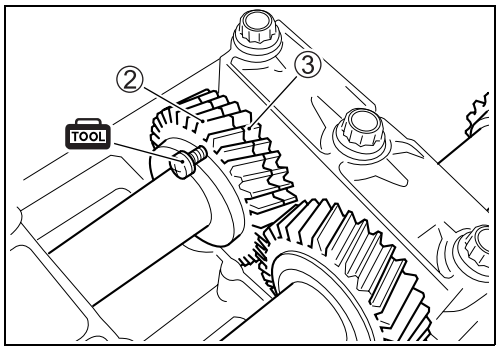
14. Apply engine oil to housing bolts.
15. Lightly seat all housing bolts at first.
    Following sequence in figure, tighten bolts in 2-steps. Tighten bolts to 1/2 of specified torque, then to full specified torque.

Balancer housing bolt: 30 N·m (3.0 kg-m, 21.7 lb-ft)



16. Remove the special tool (pin) from PORT balancer No.1 gear ② and No.2 gear ③.

TOOL 09917-29610: Scissors gear alignment tool set



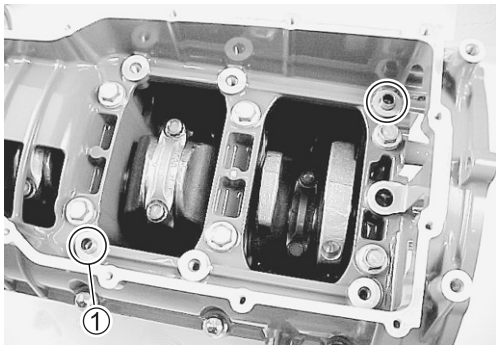
INSTALLATION

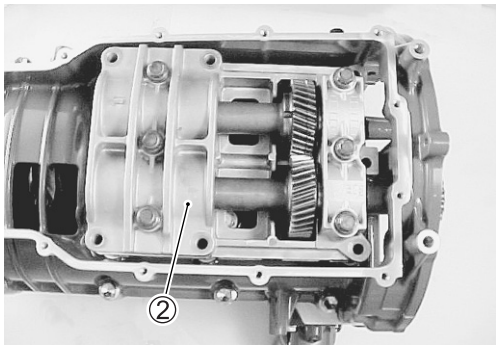
Installation is reverse order of removal with special attention to the following steps.

CAUTION

Do not reuse gaskets. Always replace with new one.

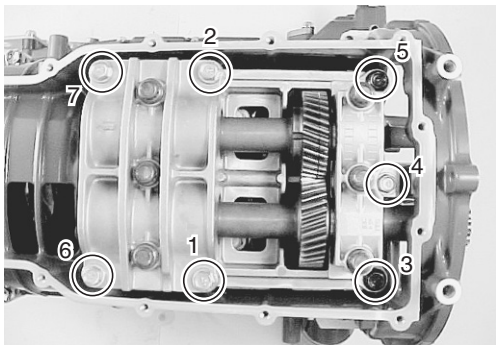
1. Insert the dowel pins ① and place counter-balancer mechanism assembly ② into position on the crankcase.





2. Apply engine oil to balancer housing bolts.
3. Lightly seat all balancer housing bolts at first.
   Following sequence in figure, tighten bolts in 3-steps. Tighten bolts to 1/3 of specified torque, then 2/3 of specified torque and finally to full specified torque.

Balancer mechanism mounting bolt:
25 N·m (2.5 kg-m, 18.1 lb-ft)



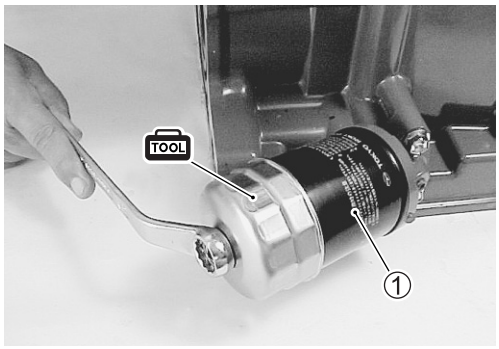
CYLINDER/CRANKSHAFT/PISTON

DISASSEMBLY

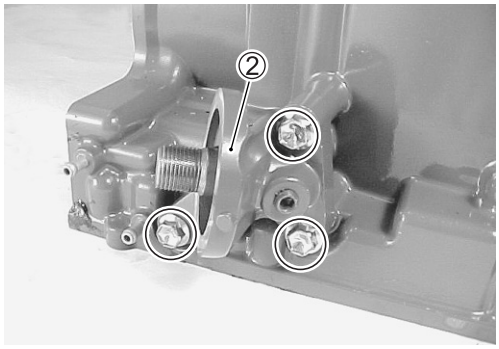
Before performing service work in this section:
- **Remove power unit. (See page 6-15 to 6-20.)**
- **Remove timing chain and balancer chain. (See page 6-31 or 6-44.)**
- **Remove cylinder head. (See page 6-57.)**
- **Remove counter-balancer mechanism. (See page 6-75.)**

Remove oil filter ①.

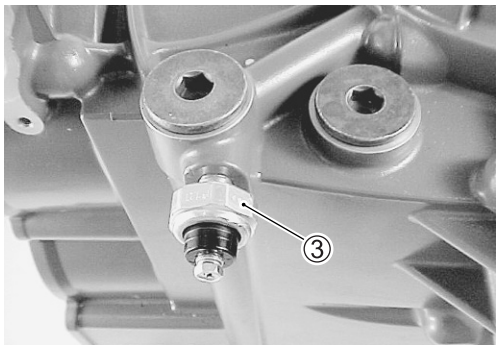
09915-47341: Oil filter wrench



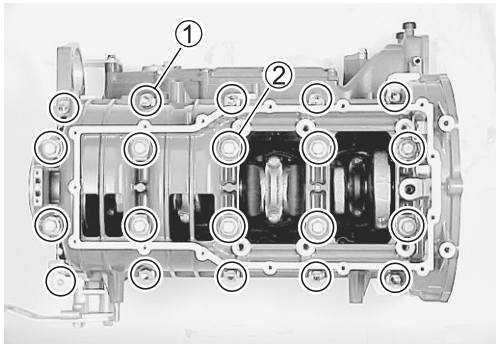
Remove the three (3) bolts securing oil filter housing ②, then remove oil filter housing ②.



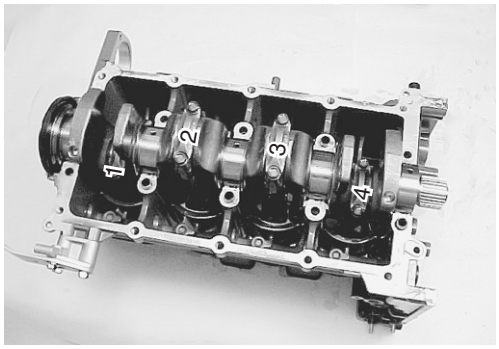
Remove oil pressure switch ③.



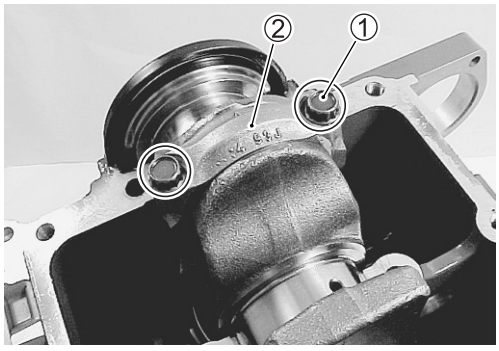
Remove ten (10) bolts ①.
Remove ten (10) bolts ②.
Remove crankcase from cylinder block.



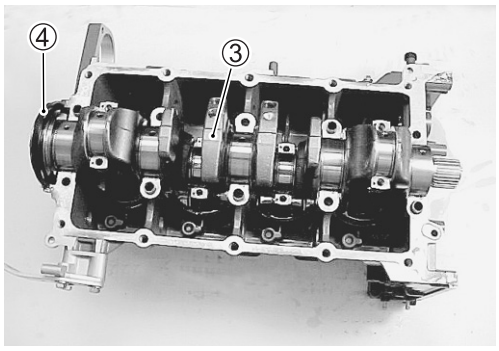
NOTE:
For proper assembly, mark cylinder number on all pistons, conrods, and conrod caps, using quick drying paint.



Remove all conrod cap bolts ① and conrod caps ②.



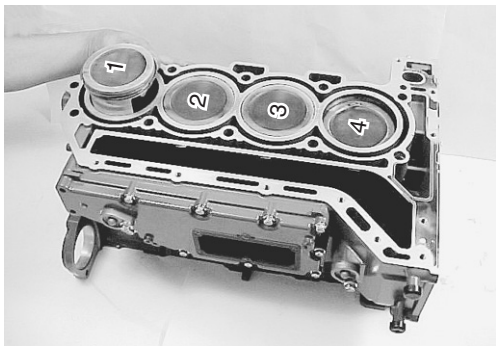
Remove crankshaft ③.
Remove oil seal ④ from crankshaft.



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.



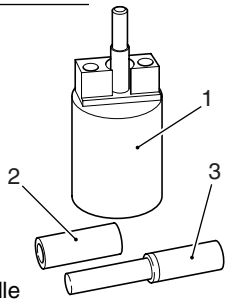
Remove piston pin from piston and conrod using special tool and arbor press as shown.

NOTE:

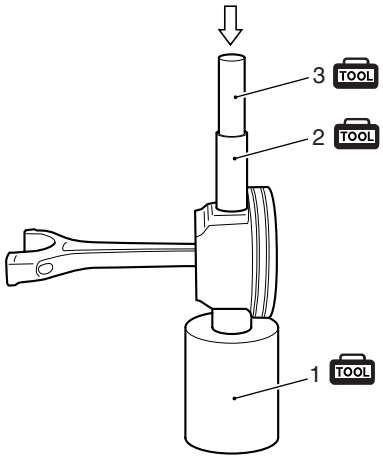
- *The piston pin is press fit into conrod small end.*
- *Reassemble each piston, piston pin and conrod in their original combination and position.*

TOOL 09910-39610: Piston pin remover & installer set

Piston pin remover set



1. Base
2. Collar
3. Driver handle



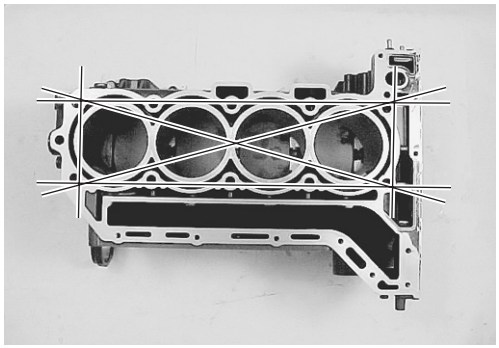
1. Base
2. Collar
3. Driver handle

INSPECTION/SERVICING

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

CYLINDER

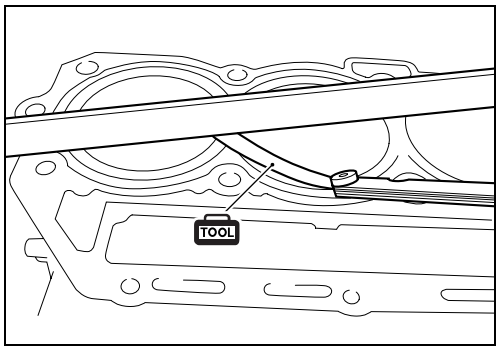
- **Cylinder distortion**
  Using a straightedge and thickness gauge, measure cylinder distortion (gasket surface) at a total of six (6) locations as shown.



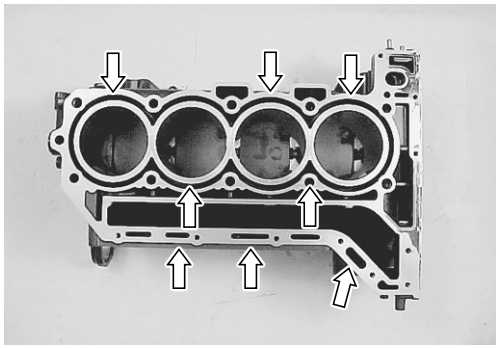
TOOL 09900-20803: Thickness gauge

Cylinder distortion
Service limit: 0.03 mm (0.0011 in)

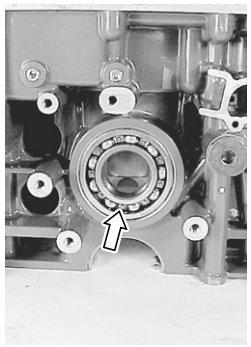
If measurement exceeds service limit, resurface or replace cylinder.



- **Water jackets**
  Check water jackets.
  If clog or obstruction is found, clean water jacket.



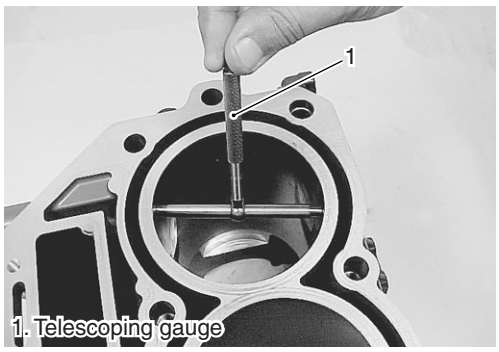
- **Driven gear bearing**
  Inspect driven gear bearing. Replace bearing if pitted, noisy or rough.





- **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.

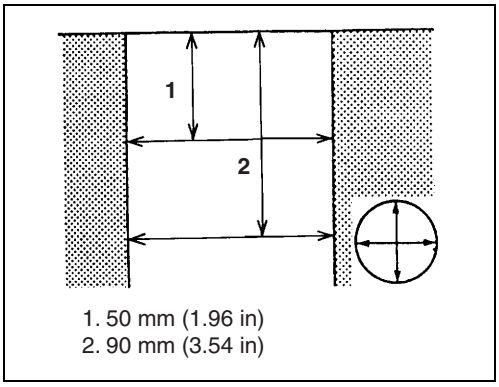


NOTE:
Purchase a commercially available telescoping gauge for this measurement.

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.

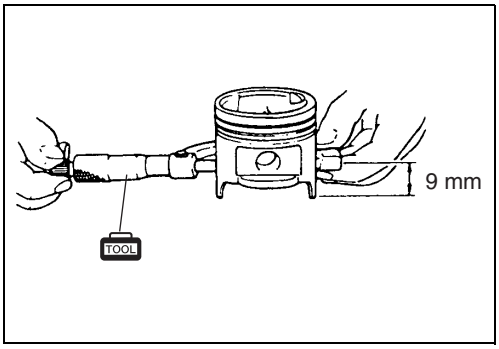


PISTON TO CYLINDER CLEARANCE

(1) Measure the piston diameter at a point 9 mm (0.354 in) above the piston skirt at a right angle to the piston pin bore.

TOOL 09900-20204: Micrometer

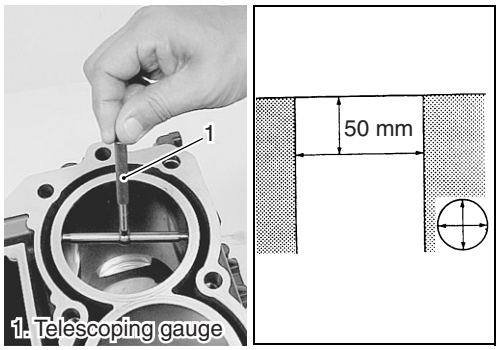
Piston skirt diameter
Standard: 96.905 – 96.925 mm (3.8152 – 3.8159 in)



(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 gauge for this measurement.

Cylinder bore diameter
Standard: 97.000 – 97.020 mm (3.8189 – 3.8197 in)



(3) Calculate the piston/cylinder clearance (Clearance equals difference between piston diameter and cylinder bore measurements).

Piston to cylinder clearance
Standard: 0.085 – 0.105 mm (0.0033 – 0.0041 in)
Service limit: 0.150 mm (0.0059 in)

If clearance exceeds service limit, replace piston and/or cylinder or bore cylinder.

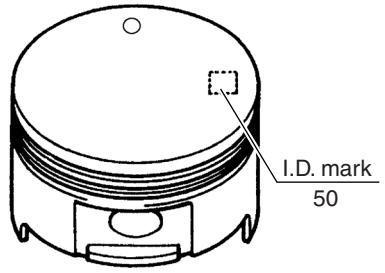
Identification of oversize piston/piston ring

One oversize piston/piston ring components, 0.50 mm, is available.

Oversize piston/piston ring are marked as shown, below.

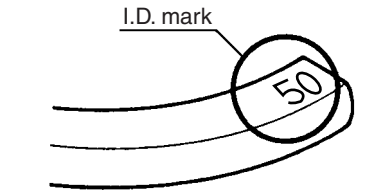
- **Piston**

Oversize	I.D. mark
0.50 mm	50



- **1st & 2nd Piston ring**

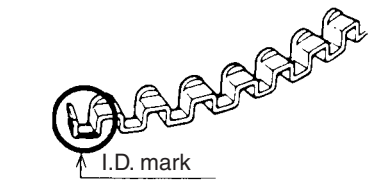
Oversize	I.D. mark
0.50 mm	50



1st, 2nd ring

- **Oil ring**

Oversize	I.D. mark
0.50 mm	One (1) Red paint

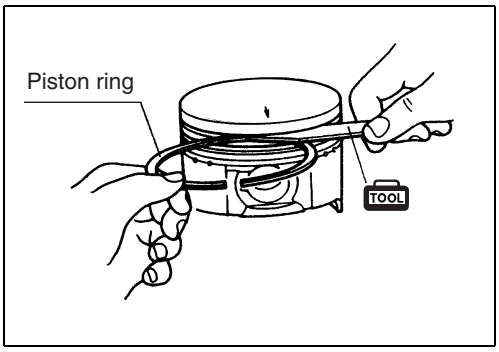


Oil ring spacer

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.



TOOL 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.

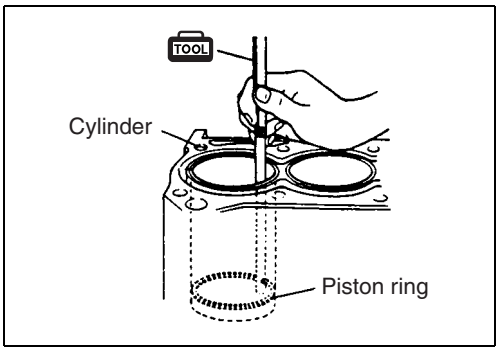
Piston ring groove width
Standard:
1st 1.22 – 1.24 mm (0.0480 – 0.0488 in)
2nd 1.21 – 1.23 mm (0.0476 – 0.0484 in)
Oil 2.51 – 2.53 mm (0.0988 – 0.0996 in)

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.



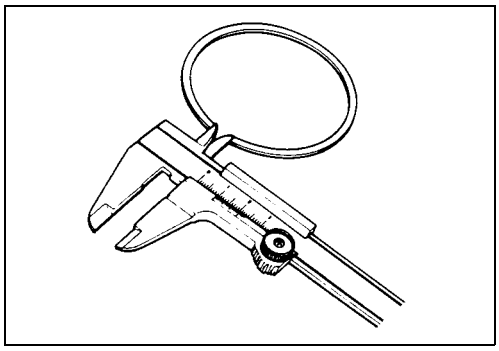
TOOL 09900-20803: Thickness gauge

Piston ring end gap
Standard:
1st 0.20 – 0.30 mm (0.0079 – 0.0118 in)
2nd 0.30 – 0.45 mm (0.0118 – 0.0177 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.

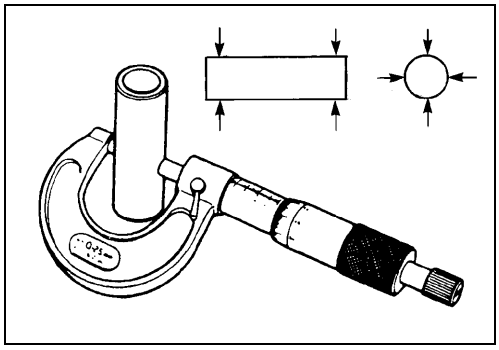


TOOL 09900-20101: Vernier calipers

Piston ring free end gap
Standard:
1st Approx. 13.5 mm (0.5315 in)
2nd Approx. 13.6 mm (0.5354 in)
Service limit:
1st 10.8 mm (0.4252 in)
2nd 10.9 mm (0.4291 in)

If measurement exceeds service limit, replace piston ring.

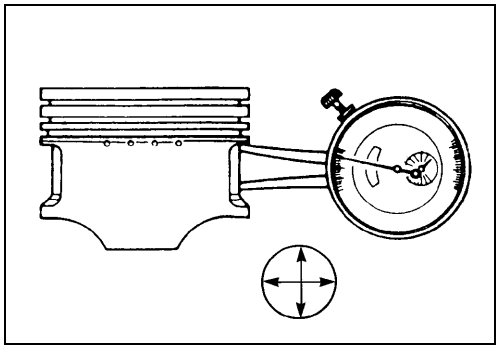
PISTON PIN/PISTON PIN HOLE/CONROD SMALL END BORE



- Check piston pin, conrod small end bore and piston pin hole for wear or damage.
  If badly worn or damaged, replace component.
- Apply engine oil on piston pin so that the piston pin can move smoothly in the piston pin hole.
  If improper condition is found, replace the piston pin and/or piston.
- Measure the following item:

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

Piston pin outside diameter
Standard: 21.995 – 22.000 mm (0.8659 – 0.8661 in)

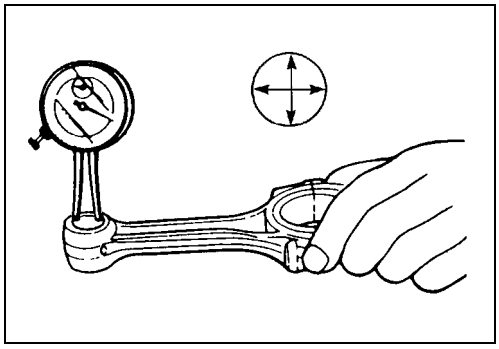


Piston pin hole diameter
Standard: 22.006 – 22.014 mm (0.8664 – 0.8667 in)

Conrod small end bore
Standard: 21.968 – 21.979 mm (0.8649 – 0.8653 in)

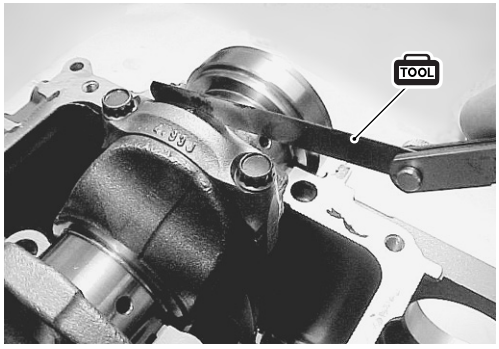
NOTE:
The piston pin is press-fit into the conrod small end bore.
There must be a negative clearance between the piston pin outside diameter and conrod small end inner diameter.

If measurement is out of specification, replace.



CONROD BIG END SIDE CLEARANCE

Measure conrod big end side clearance with conrod installed on crank pin as shown.



TOOL 09900-20803: Thickness gauge

Conrod big end side clearance
Standard: 0.300 – 0.450 mm (0.0118 – 0.0177 in)
Service limit: 0.550 mm (0.0217 in)

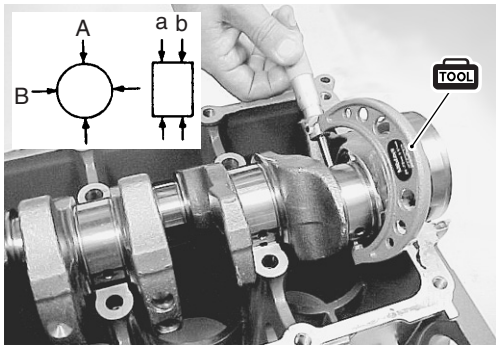
If measurement exceeds service limit, replace conrod and/or crankshaft.

Conrod big end width
Standard: 22.750 – 22.800 mm (0.8957 – 0.8976 in)

Crank pin width
Standard: 23.100 – 23.200 mm (0.9094 – 0.9134 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.



TOOL 09900-20203: Micrometer

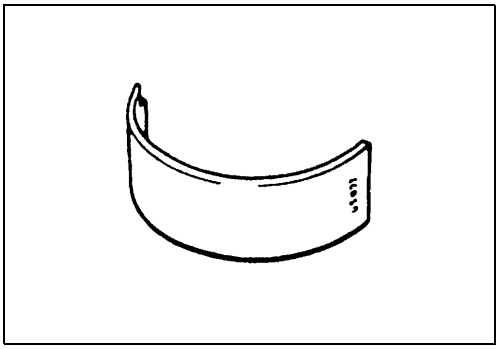
Out-of-round : A – B
Taper : a – b

Out-of-round and taper
Service limit: 0.010 mm (0.0004 in)

Crank pin diameter
Standard: 53.982 – 54.000 mm (2.1253 – 2.1260 in)

CONROD BEARING

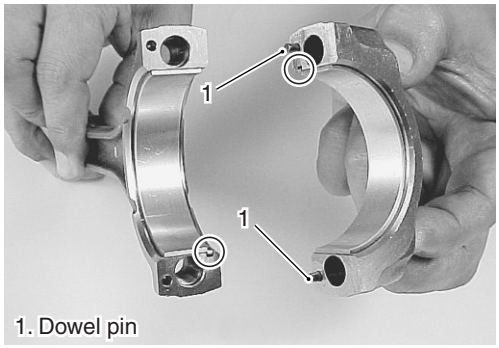
Inspect bearing shell for proper contact pattern and signs of fusion, pitting, burning or flaking.
Bearing shells found in defective condition must be replaced.



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.

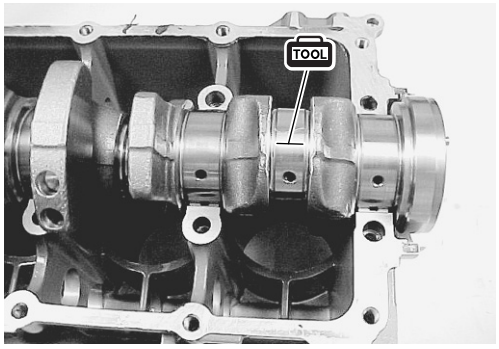
NOTE:
- *Reassemble each bearing and conrod cap to their original position.*
- *Do not apply oil to bearing.*



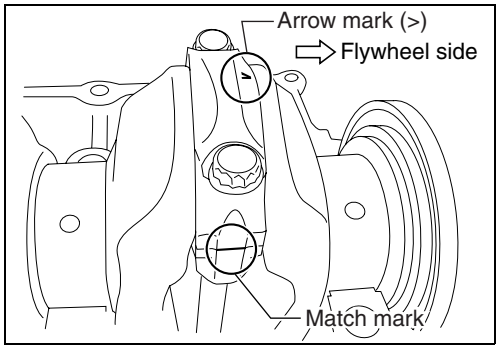
1. Dowel pin

(3) Place a piece of Plastigauge on crank pin parallel to crankshaft. Avoid placing Plastigauge over oil hole.

TOOL 09900-22301: Plastigauge



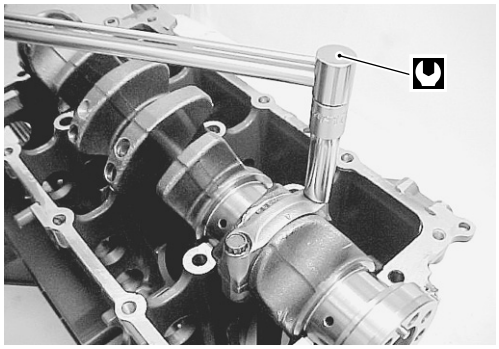
(4) Install conrod cap (with bearing) to conrod with the arrow mark on cap toward flywheel side.



(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)

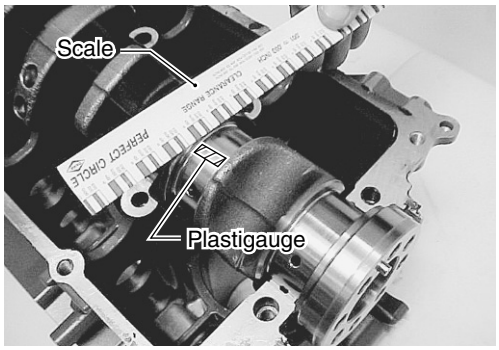
NOTE:
Do not rotate conrod with Plastigauge in place.



(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

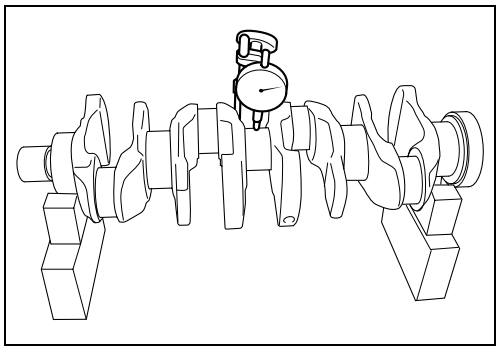
■ Crankshaft runout

Using a dial gauge, measure runout at center journal.

TOOL 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**

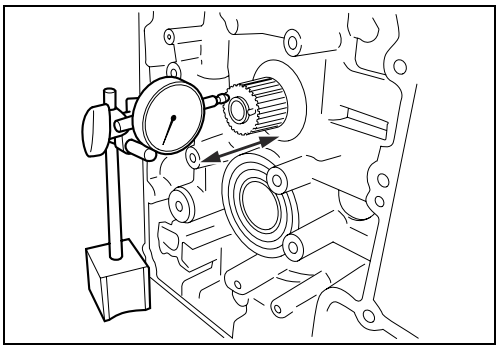
Measure thrust play with crankshaft, thrust bearing, journal bearing and crankcase/cylinder block assembled in a normal manner.

Tighten crankcase bolts to specified torque.

Crankcase bolt:

Outside (10 mm) 37 N·m (3.7 kg-m, 26.8 lb-ft)
Inside (11 mm) 58 N·m (5.8 kg-m, 41.9 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

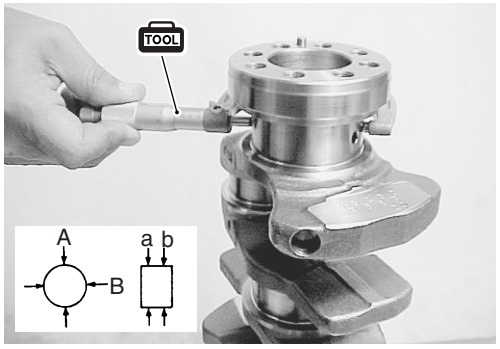
Standard: 2.425 – 2.475 mm (0.0955 – 0.0974 in)

■ **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: 0.010 mm (0.0004 in)

Crankshaft journal outside diameter

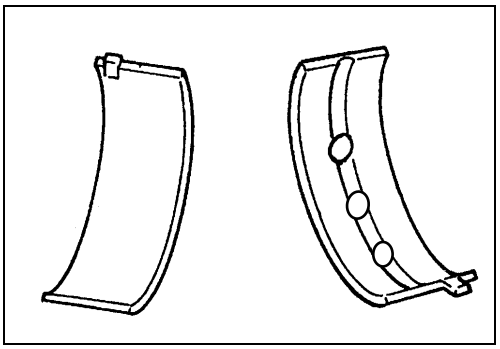
Standard: 64.982 – 65.000 mm (2.5583 – 2.5591 in)

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.

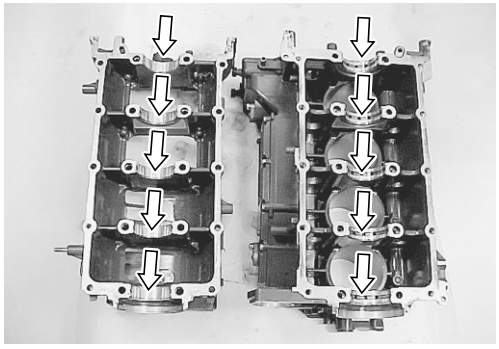


CRANKSHAFT JOURNAL OIL CLEARANCE

Check clearance using Plastigauge according to the following procedure.

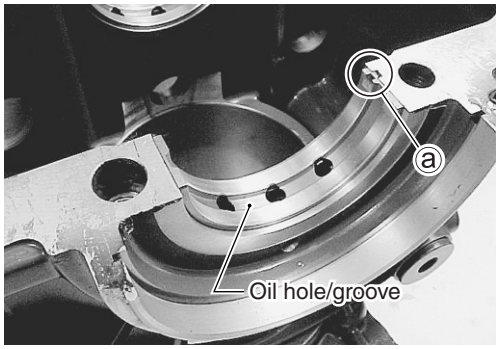
NOTE:
Assemble each bearing in its original position before checking clearance.

(1) Clean surface of bearing holder (crankcase, and cylinder), bearing, and main bearing journal.



(2) Install main bearing to cylinder and crankcase.

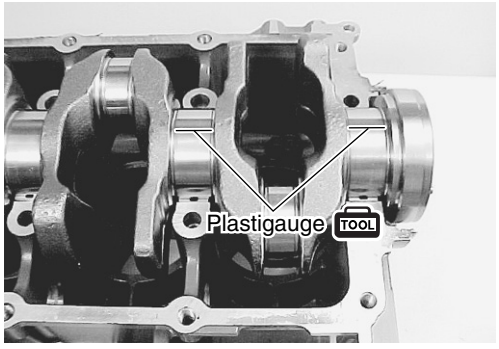
NOTE:
- *Align tab ⓐ of bearing with notch in cylinder and crankcase.*
- *Do not apply engine oil to bearing.*
- *Install lower bearing half with oil hole/groove towards cylinder side.*



(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.

TOOL 09900-22301: Plastigauge

NOTE:
Do not rotate crankshaft while Plastigauge is installed.

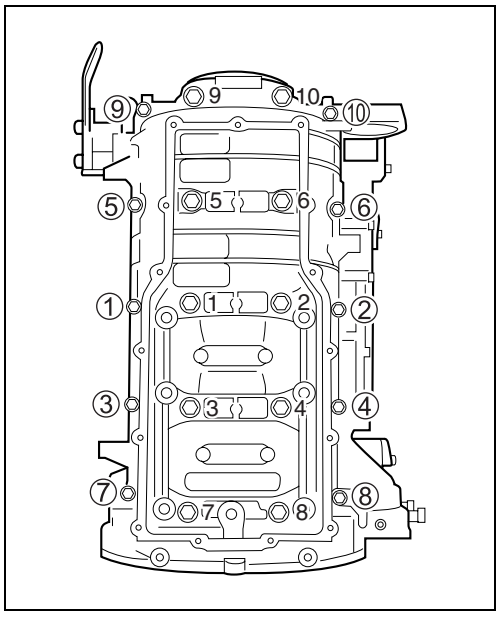


(5) Assemble crankcase to cylinder.
(6) Apply engine oil to crankcase bolts.
Tighten crankcase bolts in three (3) steps following the order indicated below.

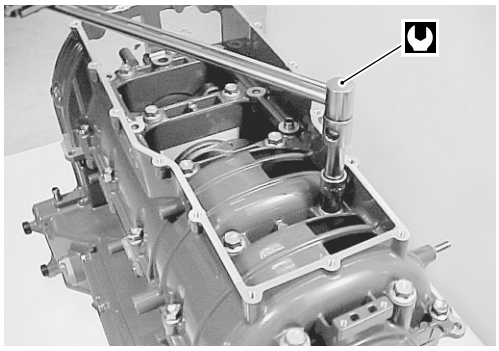
NOTE:
Tighten 11 mm (0.433 in) thread diameter bolts first (following the order shown in figure), then tighten 10 mm (0.394 in) thread diameter bolts.

Crankcase inside bolt (11 mm thread diameter):
1st step 11 N·m (1.1 kg-m, 8.0 lb-ft)
2nd step 46 N·m (4.6 kg-m, 33.3 lb-ft)
Final step 58 N·m (5.8 kg-m, 41.9 lb-ft)

Crankcase outside bolt (10 mm thread diameter):
1st step 10 N·m (1.0 kg-m, 7.2 lb-ft)
2nd step 30 N·m (3.0 kg-m, 21.7 lb-ft)
Final step 37 N·m (3.7 kg-m, 26.8 lb-ft)



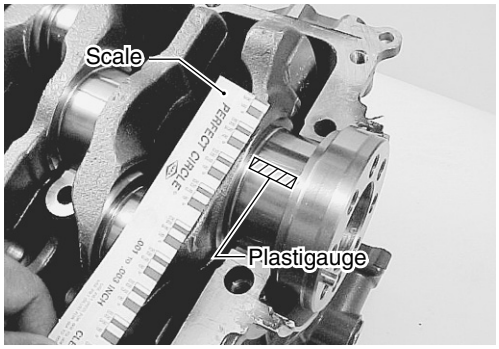
NOTE:
Crankcase must be torqued to specification in order to assure proper compression of Plastigauge and accurate reading of clearance.



(7) Remove crankcase from cylinder.
(8) Using scale on Plastigauge envelope, measure Plastigauge width at its widest point.

Crankshaft journal oil clearance
Standard: 0.030 – 0.050 mm (0.0012 – 0.0020 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 6-95.

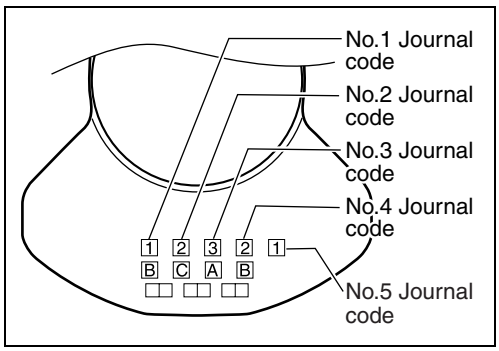
SELECTION OF MAIN BEARING

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 five (5) stamped code numerals.

The numerals (1, 2 & 3) represent the journal diameters shown below.

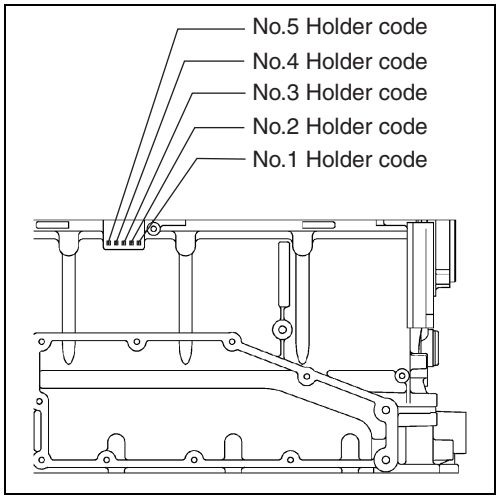


Numeral stamped	Journal diameter
1	64.994 – 65.000 mm (2.5588 – 2.5591 in)
2	64.988 – 64.994 mm (2.5586 – 2.5588 in)
3	64.982 – 64.988 mm (2.5583 – 2.5586 in)

(2) Next, check bearing holder inside diameter without bearing.

As shown in figure, the cylinder block PORT side has five (5) stamped code letters.

The letters (A, B & C) represent the bearing holder inside diameters shown below.

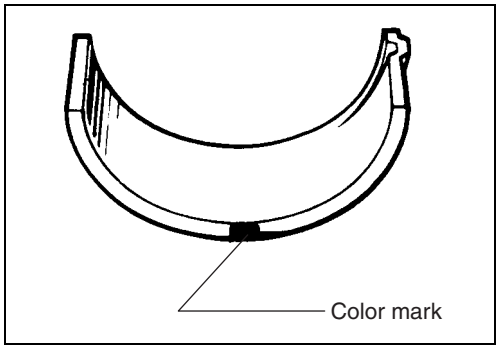


Code	Crank bearing holder inside diameter (w/o bearing)
A	70.000 – 70.006 mm (2.7559 – 2.7561 in)
B	70.006 – 70.012 mm (2.7561 – 2.7564 in)
C	70.012 – 70.018 mm (2.7564 – 2.7566 in)

(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.



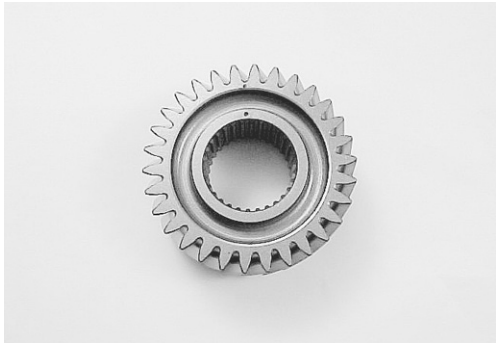
Color mark	Bearing thickness
Black	2.496 – 2.500 mm (0.0983 – 0.0984 in)
No color mark	2.499 – 2.503 mm (0.0984 – 0.0985 in)
Yellow	2.502 – 2.506 mm (0.0985 – 0.0987 in)
Blue	2.505 – 2.509 mm (0.0986 – 0.0988 in)
Pink	2.508 – 2.512 mm (0.0987 – 0.0989 in)

(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 6-93.)

CRANKSHAFT DRIVE GEAR
Inspect drive gear. Replace gear if damaged or worn.



OIL SEAL
Inspect condition. If cracked, cut or damaged, replace.



SEAL RING
Inspect seal ring.
Replace if worn, nicked, cut or other abnormal condition.

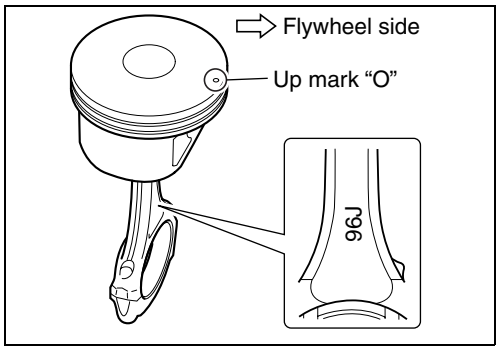


REASSEMBLY

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.

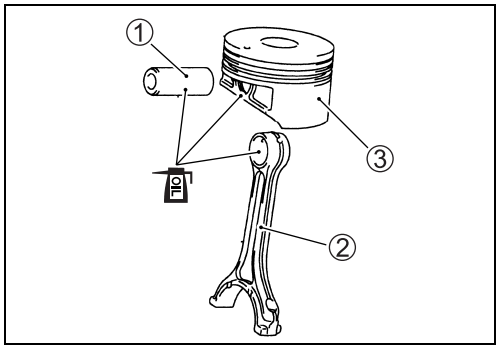


PISTON TO CONROD

Apply engine oil to piston pin ①, piston pin bore and conrod ②.
Assemble conrod ② to piston ③ as shown in figure.

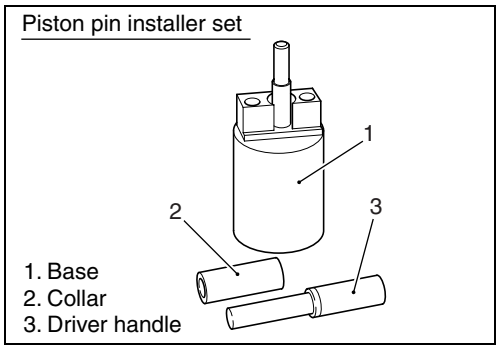
NOTE:

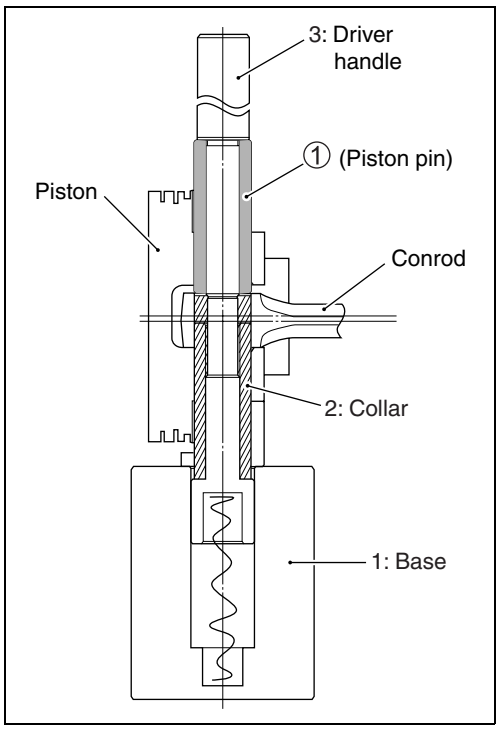
- *"96J" mark on conrod and up mark (○) on piston dome must face toward flywheel side.*

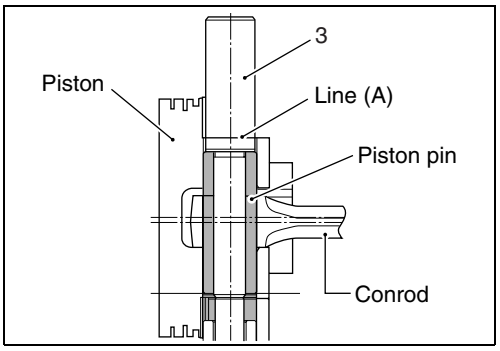


Use special tool and arbor press shown in figure.
Press fit the piston pin ① to conrod (with piston) until the line (A) on driver handle is flush with the flat surface of piston.

TOOL 09910-39610: Piston pin remover & installer



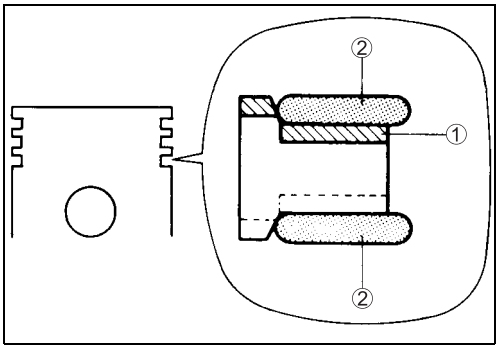




PISTON RING TO PISTON

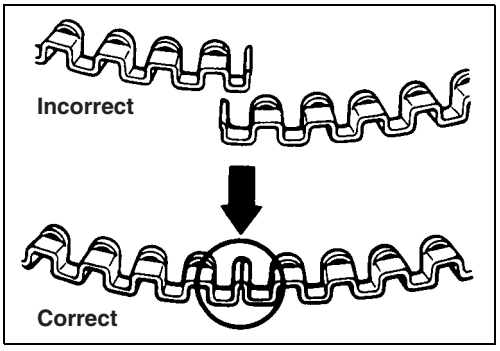
Oil ring

- 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.

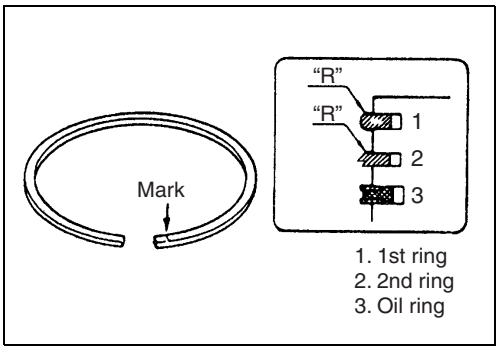


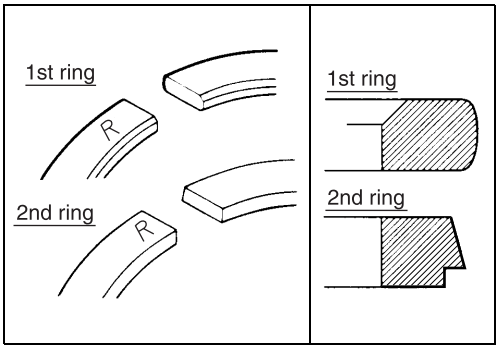
1st and 2nd piston ring

- 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.*

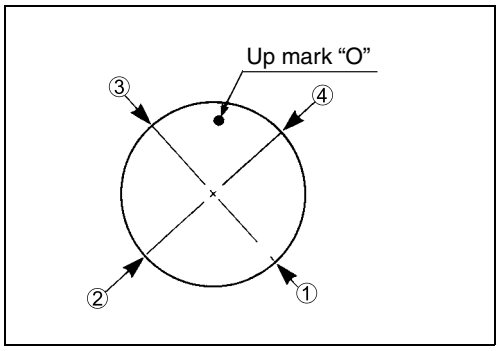




Ring gap direction

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

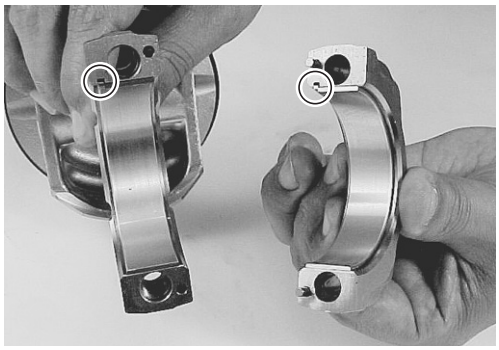
Failure to stagger piston ring gaps may result in crankcase oil dilution.

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.**



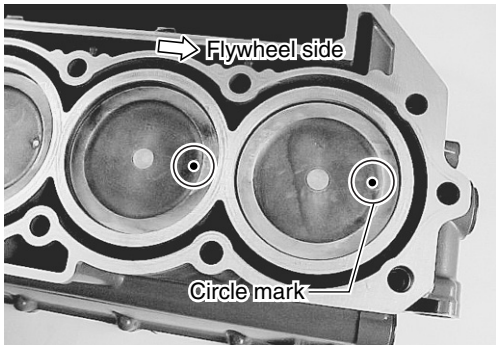
Apply engine oil to piston and cylinder walls.

Insert piston and conrod assembly into cylinder bore from cylinder head side using special tool.

TOOL 09916-77310: Piston ring compressor



NOTE:
Position the "circle" mark (○) on piston head to flywheel side.



CRANKSHAFT TO CYLINDER

Install crankshaft main bearings in cylinder and crankcase.
Apply molybdenum oil solution to bearings.

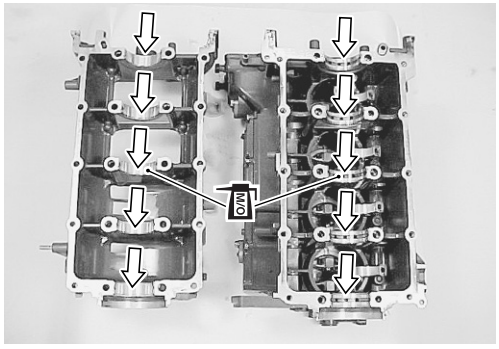
MOLYBDENUM OIL SOLUTION

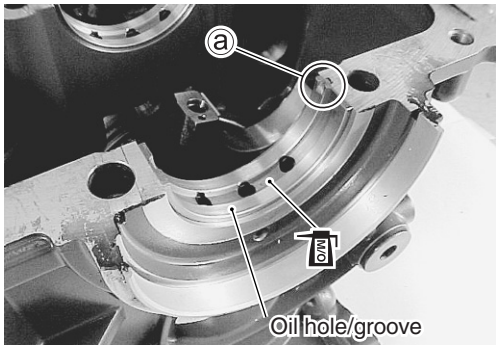
Mix equal amounts of engine oil and SUZUKI MOLY PASTE (P/no. 99000-25140) in a ratio of 1:1.

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 MOLYBDENUM OIL SOLUTION between crank bearing holder and crank main bearing.**

NOTE:
Align bearing tab ⓐ with notch in cylinder and crankcase.

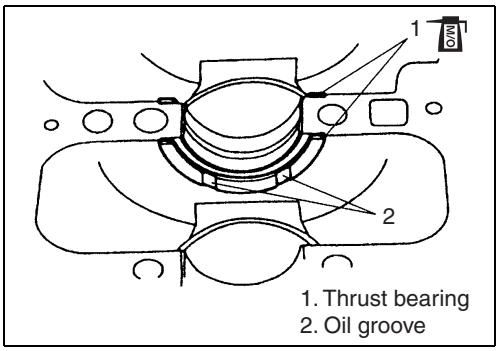




Thrust bearing

Apply molybdenum oil solution to the thrust bearing and install in cylinder block overlaping both sides of the No.4 main journal.
Oil groove on the thrust bearing must face towards crank webs.

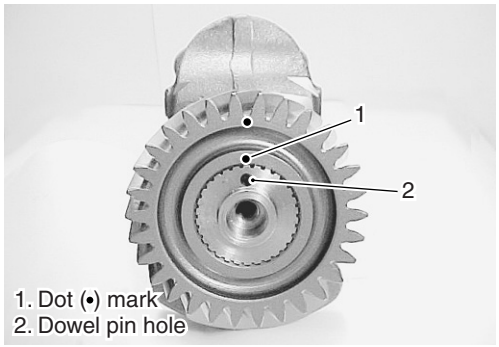
MOLYBDENUM OIL SOLUTION



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 dowel pin hole on crankshaft.



1. Dot (•) mark
2. Dowel pin hole

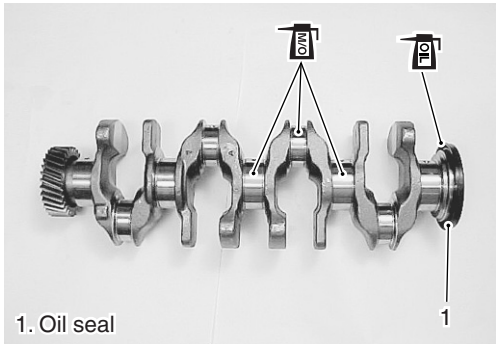
Crankshaft

Apply engine oil to upper oil seal lip.
Install upper oil seal to crankshaft.

CAUTION

Do not reuse seal removed. Be sure to use new seal.

NOTE:
Install upper oil seal with its spring/lipped side facing inward.

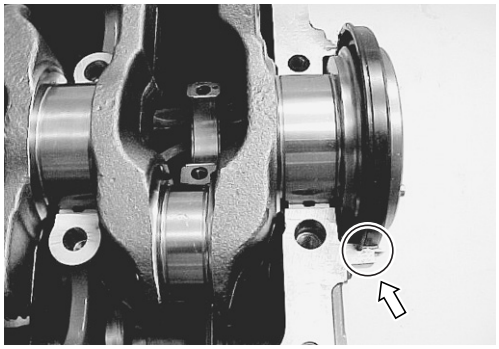


1. Oil seal

Apply molybdenum oil solution 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.

MOLYBDENUM OIL SOLUTION



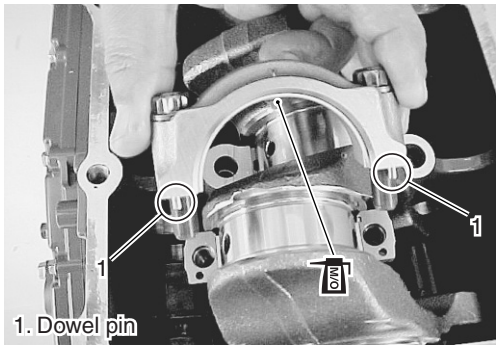
CONROD CAP

Apply molybdenum oil solution 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.

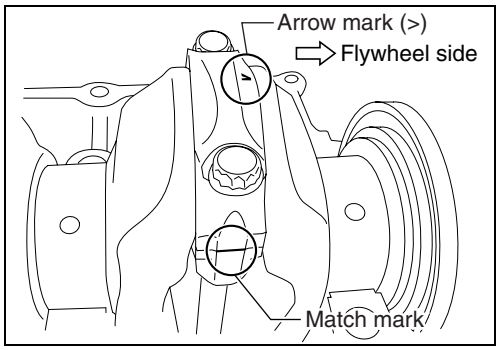
MOLYBDENUM OIL SOLUTION

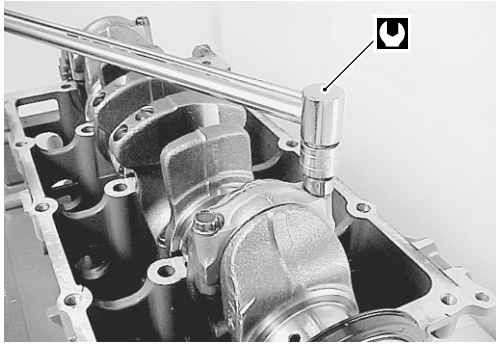


1. Dowel pin

Apply engine oil to conrod bolts.
Tighten conrod cap bolts in two steps.

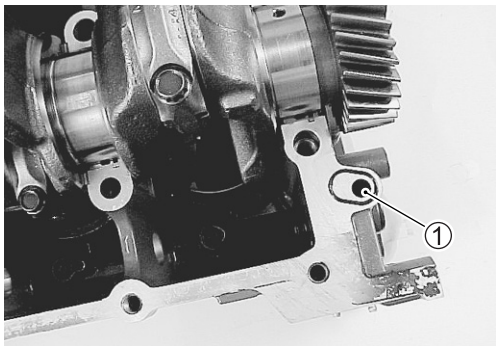
Conrod cap bolt:
1st step 31 N·m (3.1 kg-m, 22.4 lb-ft)
Final step 63 N·m (6.3 kg-m, 45.6 lb-ft)





CRANKCASE TO CYLINDER

Install the balancer gallery O-ring ①.



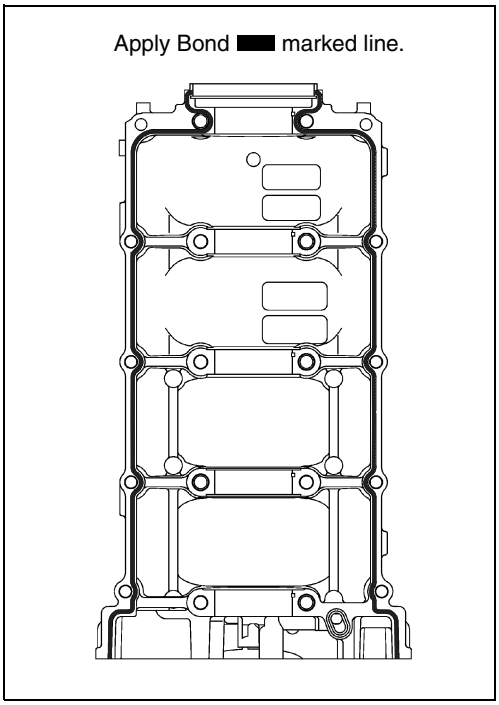
Clean mating surface of cylinder and crankcase.

Apply SUZUKI BOND to mating surface of crankcase as shown.

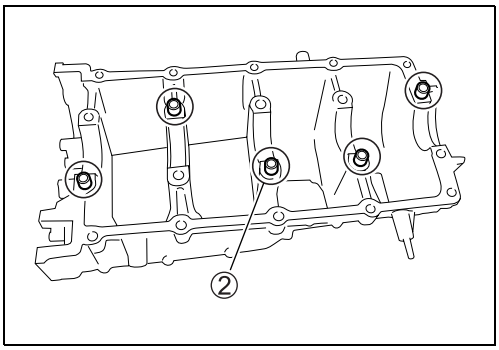
CAUTION

Apply bond to mating surface only.
Do not allow bond to contact surface of bearing.

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

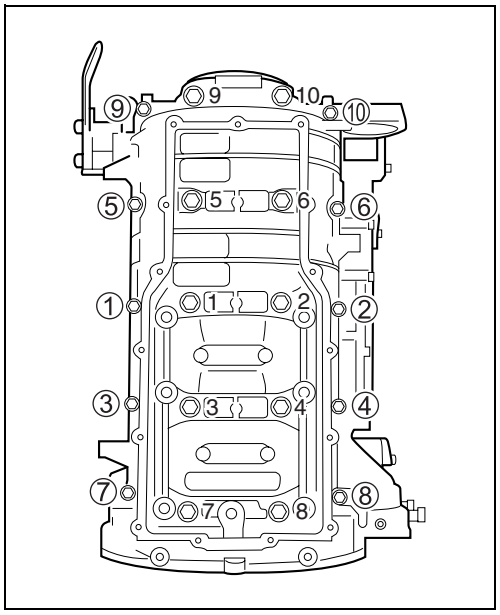


Install five (5) dowel pins ②.



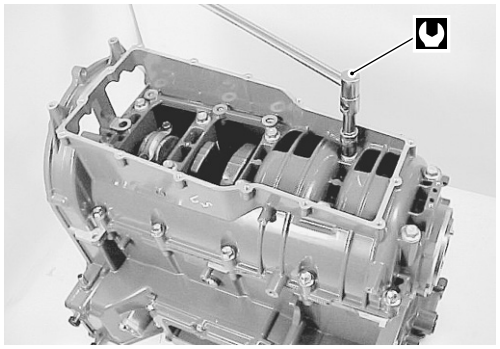
Install crankcase to cylinder.
Apply engine oil to crankcase bolts.
Tighten crankcase bolts in three (3) steps following the order indicated below.

NOTE:
Tighten 11 mm (0.433 in) thread diameter bolts first (following the order shown in figure), then tighten 10 mm (0.394 in) thread diameter bolts.



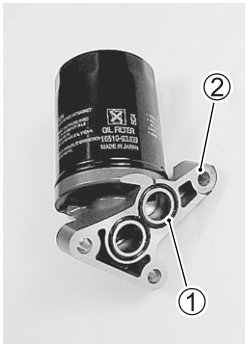
Crankcase inside bolt (11 mm thread diameter):
1st step 11 N·m (1.1 kg-m, 8.0 lb-ft)
2nd step 46 N·m (4.6 kg-m, 33.3 lb-ft)
Final step 58 N·m (5.8 kg-m, 41.9 lb-ft)

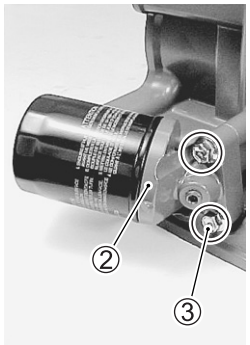
Crankcase outside bolt (10 mm thread diameter):
1st step 10 N·m (1.0 kg-m, 7.2 lb-ft)
2nd step 30 N·m (3.0 kg-m, 21.7 lb-ft)
Final step 37 N·m (3.7 kg-m, 26.8 lb-ft)



NOTE:
After tightening crankcase bolts, check to be sure that crankshaft rotates smoothly when turned by hand.

OIL FILTER HOUSING
- Install seal ring ① to oil filter housing ②.
- Install oil filter housing to cylinder block and secure with bolts ③.





COUNTER-BALANCER MECHANISM
Install counter-balancer mechanism. (See page 6-81.)

CYLINDER HEAD
Install cylinder head. (See page 6-58 to 6-61.)

TIMING CHAIN/BALANCER CHAIN
Install timing chain and balancer chain. (See page 6-37 to 6-43 or 6-50 to 6-56.)

OIL PUMP
Install oil pump assembly. (See page 6-30.)

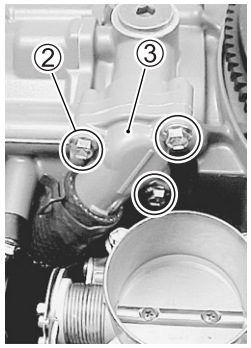
POWER UNIT
Install power unit. (See page 6-21 to 6-25.)

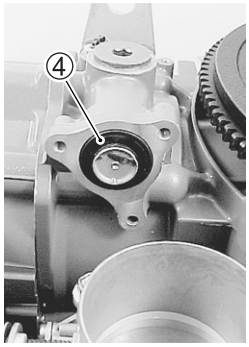
THERMOSTAT

REMOVAL

- Remove the ring gear cover and air intake silencer case. (See page 6-2.)
- Remove the flame arrester ①.
- Remove the three (3) bolts ② securing the thermostat cover ③, then remove the cover ③ and thermostat ④.







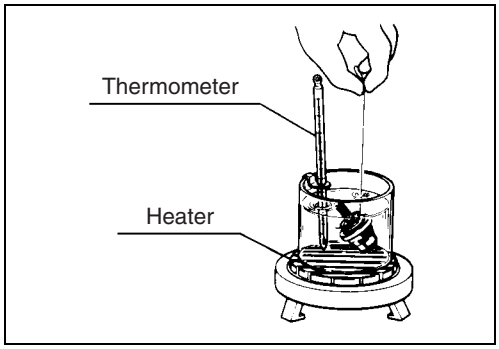
INSPECTION

- 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 – 144 °F)



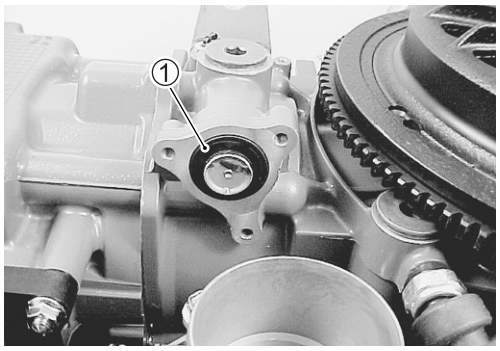
INSTALLATION

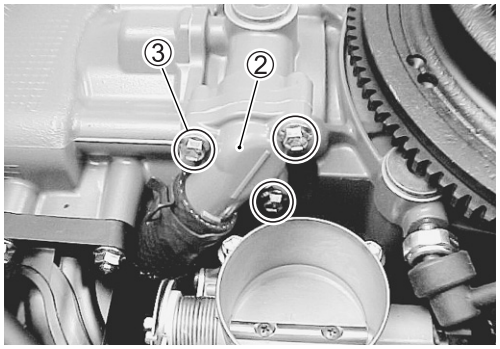
Installation is reverse order of removal with special attention to the following steps.

- Assemble thermostat ① and thermostat cover ② to cylinder block and secure with bolts ③.

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.





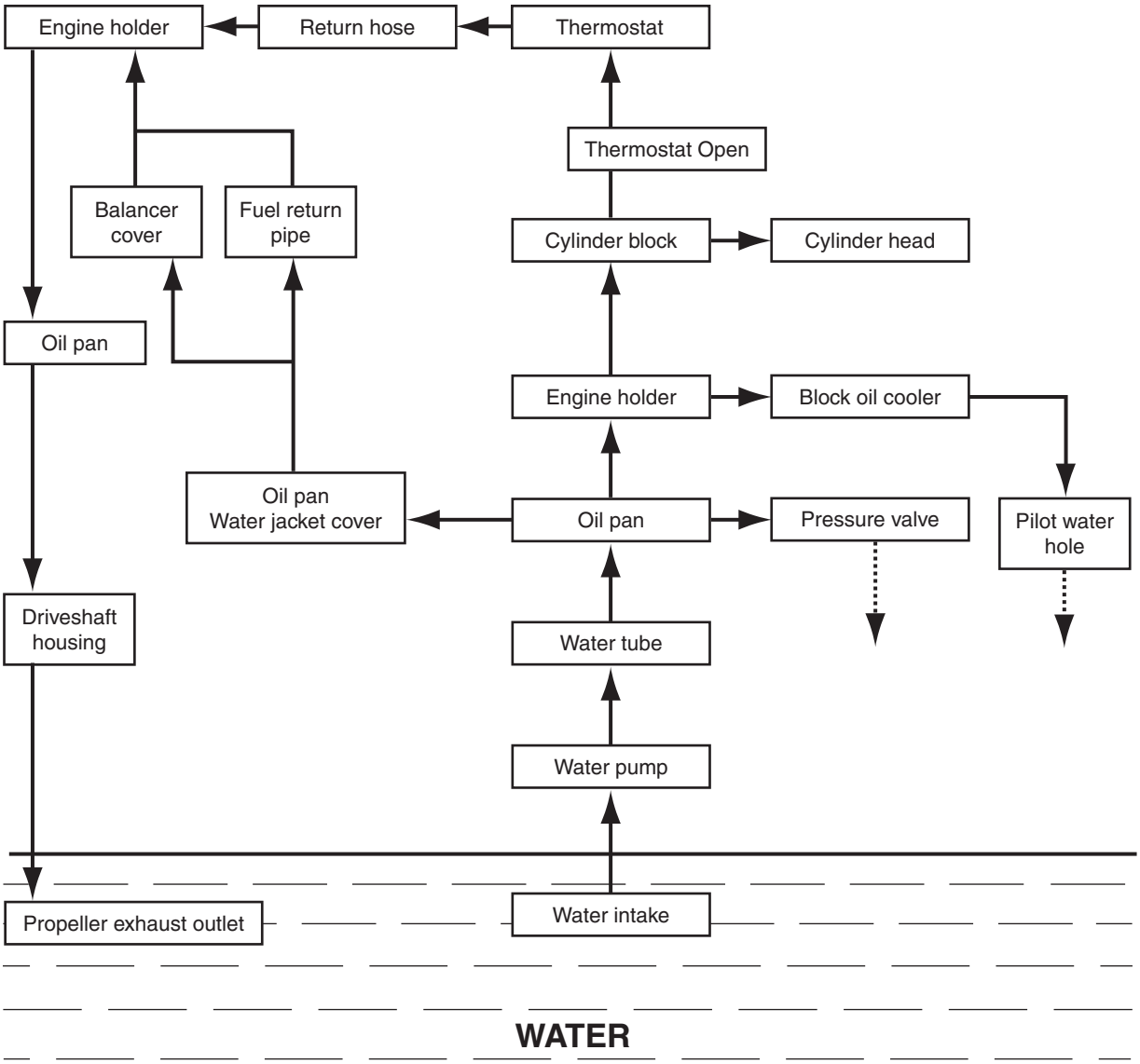
OPERATION

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 thermostat.
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 7-11
Thermostat 6-105
Water pressure valve 7-28
Cylinder head 6-63
Cylinder block 6-85



ENGINE LUBRICATION SYSTEM

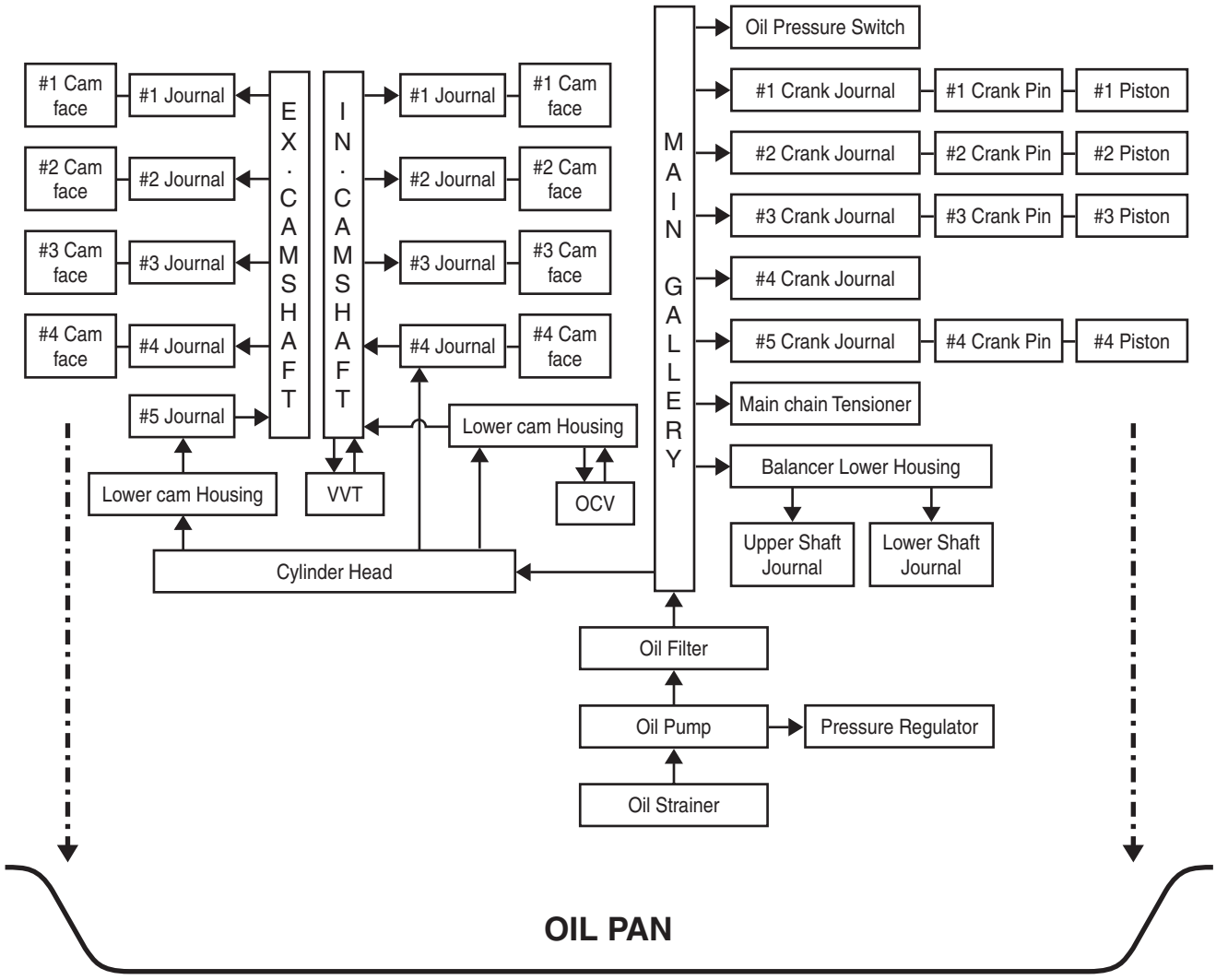
The engine lubrication system uses a camshaft-driven trochoid oil pump that pressure feeds engine oil to the engine' moving parts. The chart below shows the lubrication system oil flow.

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 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 #5.
- Lubricates crank pins #1 through #4 and all pistons and cylinder walls.
- Lubricates counter- balancer shaft journals.
- Passes through cylinder head oil passage to lubricate IN. and EX. camshaft journals and cam faces.
- Supplies pressurized engine oil to operate the VVT system.
  Oil flows to the VVT actuator through ECM controlled OCV to advance, retard or retain the intake valve timing.

ENGINE OIL LUBRICATION CHART



MID UNIT

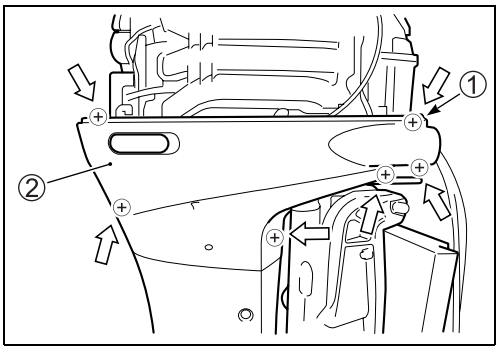
CONTENTS

ENGINE SIDE COVER 7- 2
REMOVAL 7- 2
INSTALLATION 7- 2
DRIVESHAFT HOUSING AND OIL PAN 7- 3
REMOVAL 7- 3
INSPECTION 7- 9
ASSEMBLY 7-12
SWIVEL BRACKET, STEERING BRACKET AND CLAMP BRACKET 7-19
REMOVAL 7-19
INSPECTION 7-22
REASSEMBLY 7-23
WATER PRESSURE VALVE 7-28
REMOVAL 7-28
INSPECTION 7-28
INSTALLATION 7-28

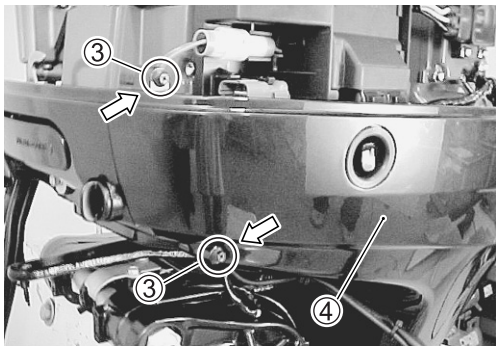
ENGINE SIDE COVER

REMOVAL

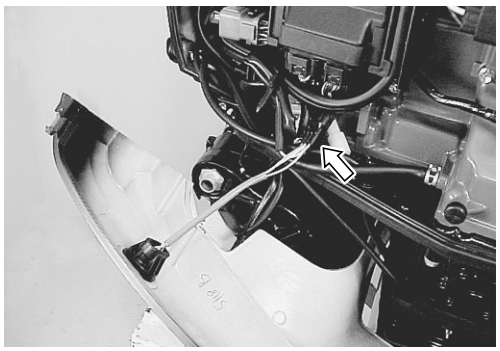
Remove six (6) screws ① and STBD side cover ②.



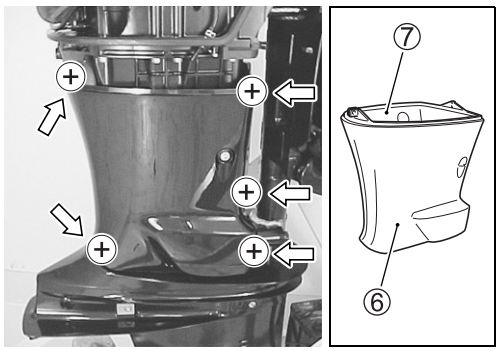
Remove two (2) screws ③ and PORT side cover ④.



Disconnect PTT switch lead connector.



Remove five (5) screws ⑤ and STBD/PORT oil pan covers ⑥/⑦.



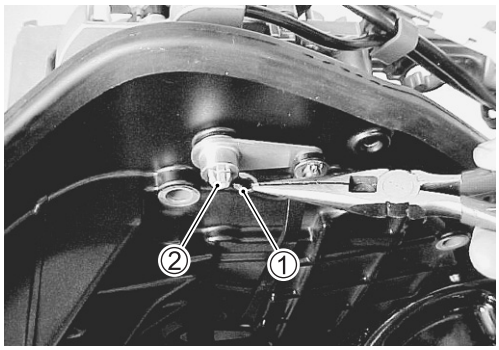
INSTALLATION

Installation is reverse order of removal.

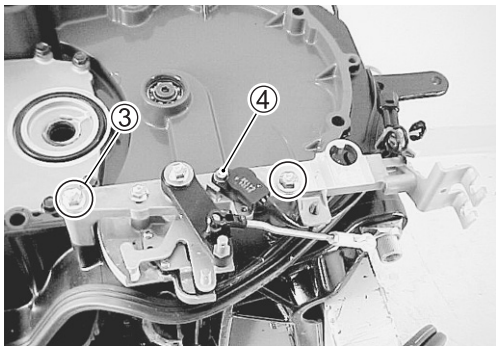
DRIVESHAFT HOUSING AND OIL PAN

REMOVAL

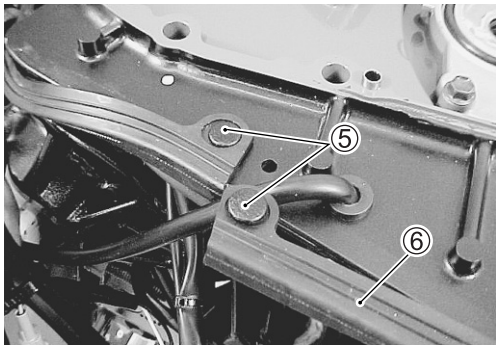
Remove power unit. (See page 6-15 to 6-20.)
Remove lower unit. (See page 9-2.)
Remove E-ring ① from clutch lever shaft ②.



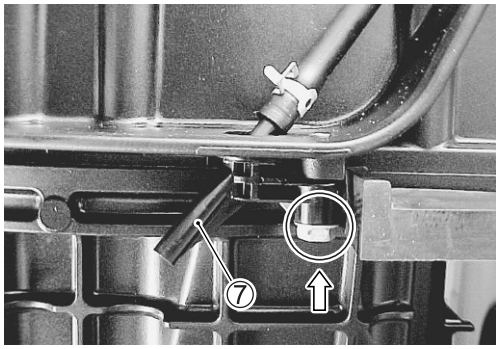
Remove two (2) bolts ③ and throttle lever holder ④.



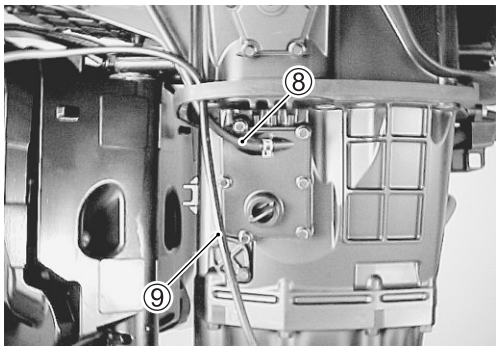
Remove pins ⑤ and side cover seal ⑥.



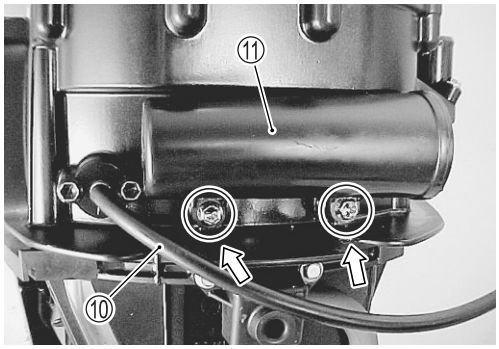
Remove bolt and pilot water tube ⑦.



Disconnect water outlet hose ⑧ from oil pan water jacket cover.
Remove speedometer pick up tube ⑨ from driveshaft housing.



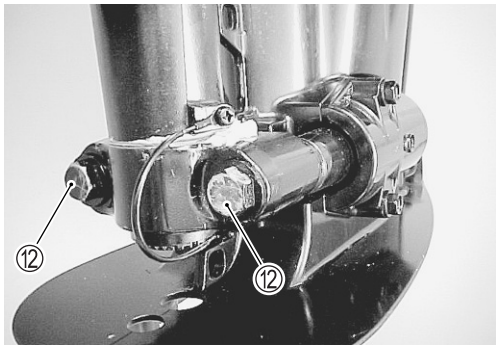
Remove water outlet hose ⑩ from engine holder.
Remove bolts and vacuum tank ⑪.

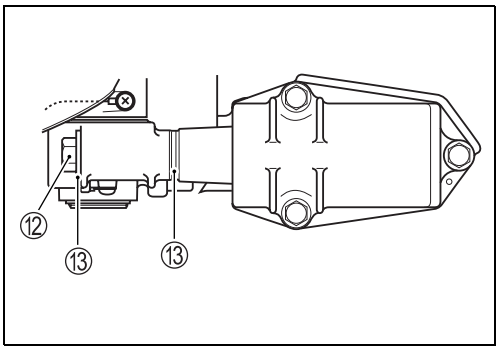


Operate the PTT motor to extend the PTT rod upward.

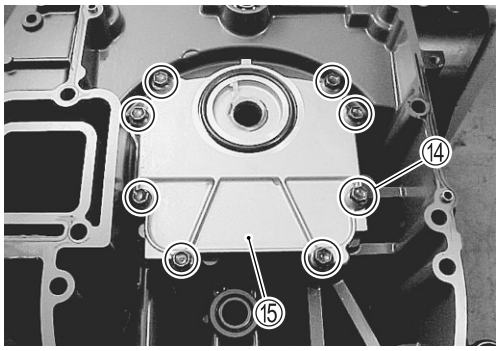
TOOL 09945-79310: PTT cable extension

Unscrew and remove STBD/PORT lower mount bolts ⑫.
Account for washers ⑬.

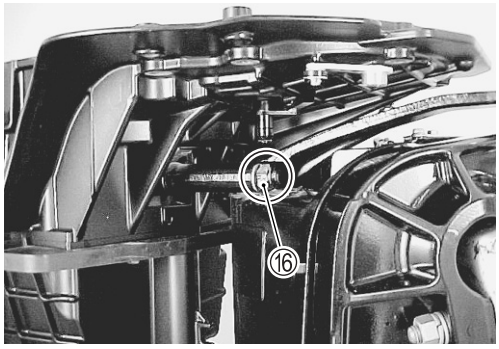




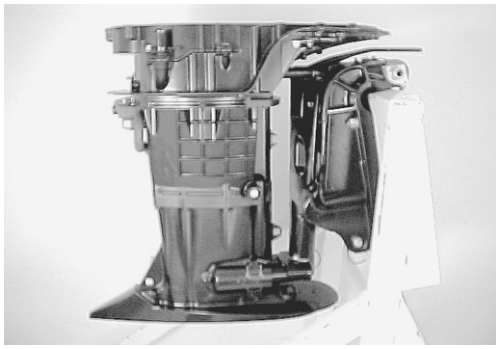
Remove eight (8) bolts ⑭ and the mount·oil seal cover ⑮.
Account for two (2) dowel pins.



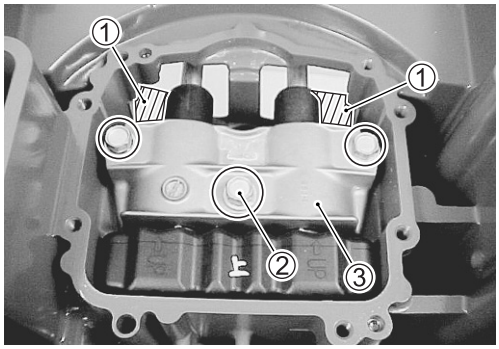
Remove STBD/PORT upper mount nuts ⑯ and washers.



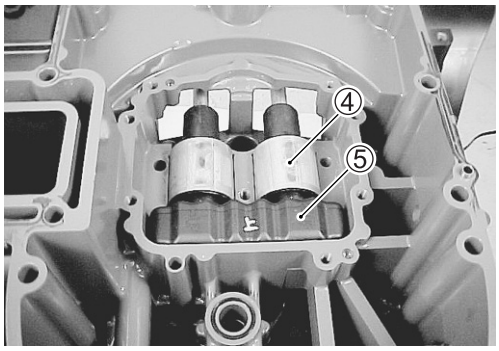
Remove driveshaft housing with oil pan.

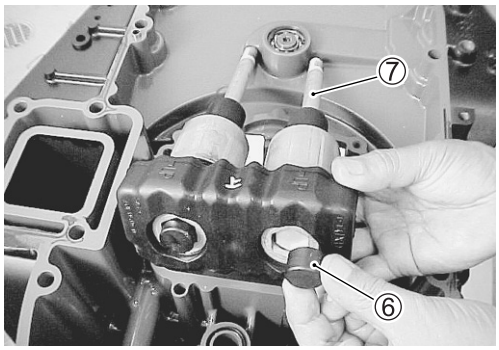


Remove the upper side mounts ①.
Remove three (3) bolts ② and upper mount cover ③.

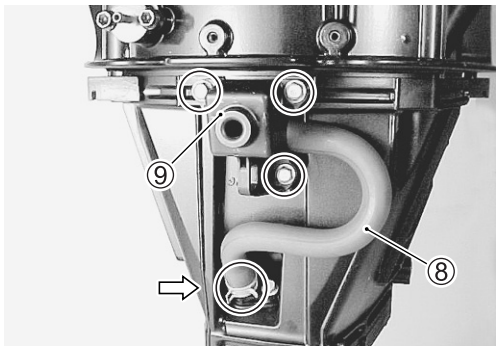


Remove upper mounts ④, thrust mount ⑤, stopper ⑥ and mount bolts ⑦.

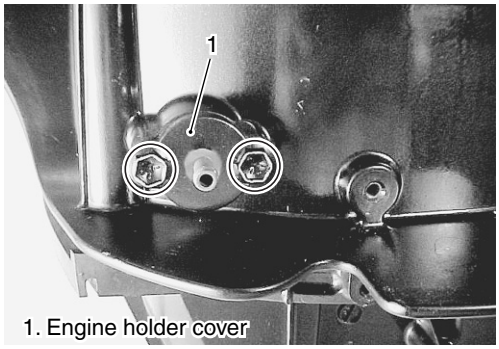




Loosen the clamp securing exhaust hose ⑧, then remove the exhaust hose from exhaust pipe.
Remove the three (3) bolts securing exhaust relief pipe ⑨, then remove exhaust relief pipe.

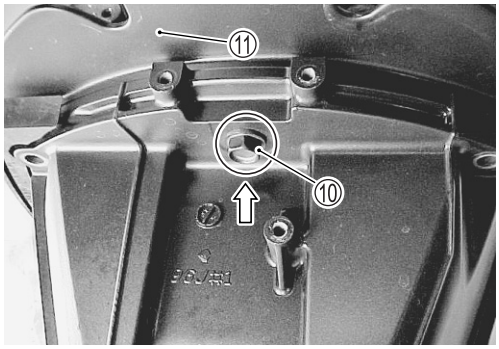


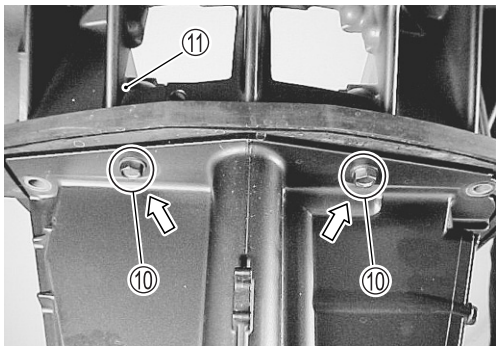
Remove two (2) bolts and engine holder cover.



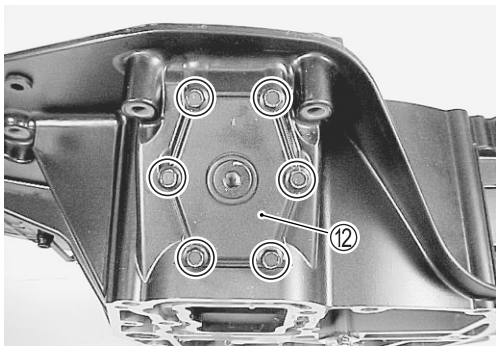
1. Engine holder cover

Remove three (3) bolts ⑩ and engine holder ⑪.

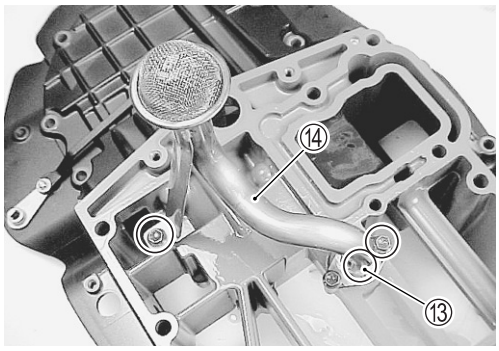




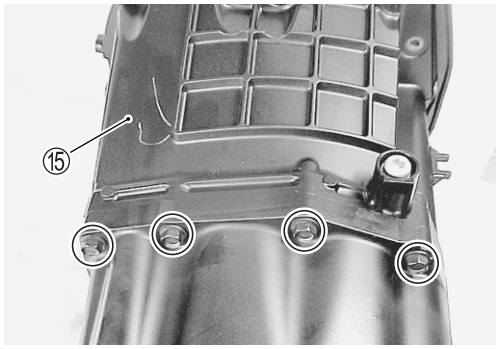
Remove six (6) bolts and water jacket cover ⑫.



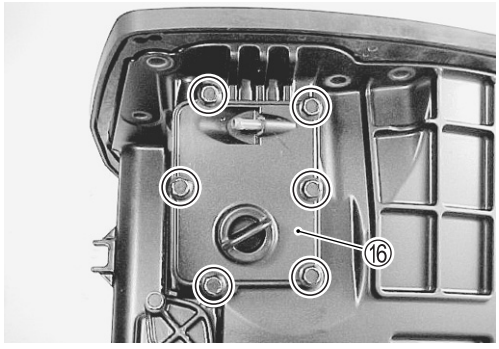
Remove three (3) bolts ⑬ and oil strainer ⑭.



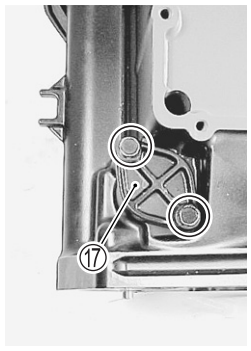
Remove eight (8) bolts, then remove oil pan ⑮.

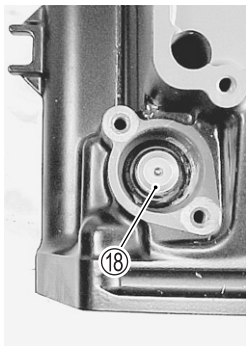


Remove six (6) bolts and oil pan water jacket cover ⑯.

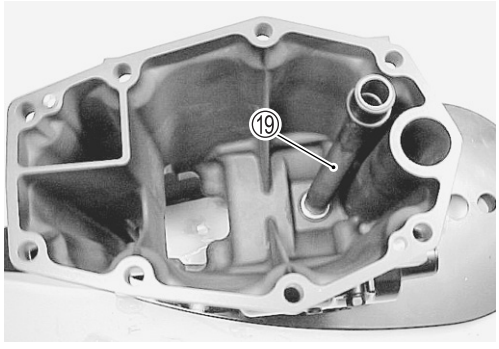


Remove bolts, water pressure valve cover ⑰ and water pressure valve ⑱.

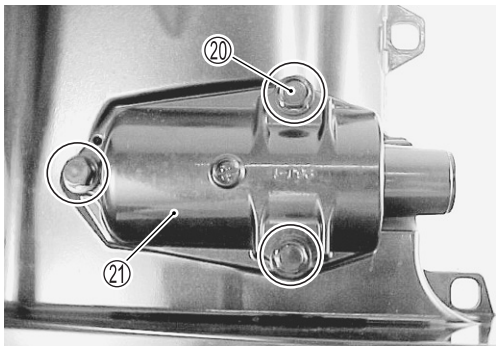




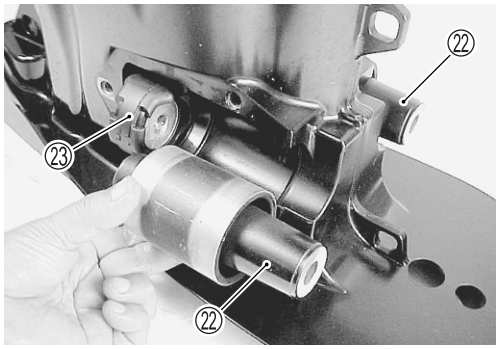
Remove water tube ⑲.



Remove bolts ⑳ and lower mount covers ㉑.



Remove lower mounts ㉒ and lower thrust mount ㉓.

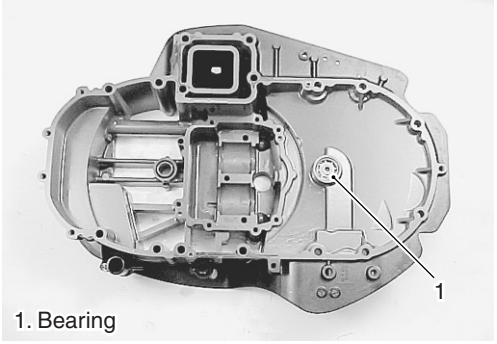


INSPECTION

NOTE:
If any component is found to be excessively worn, cracked, defective or damaged in any way, it must be replaced.

ENGINE HOLDER

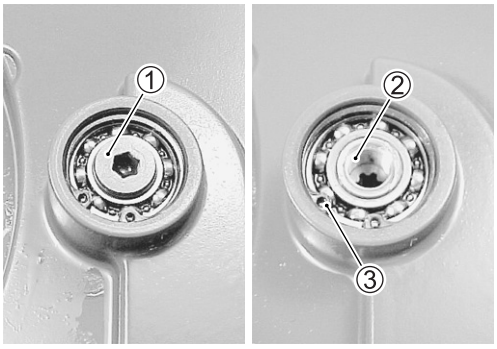
- Inspect engine holder. Replace if cracked, damaged, or other abnormal condition.
- Check water passage. If clogged or obstructed, clean water passage.
- Visually check the clutch shaft bearing. Replace if pitted, noisy, rough or other abnormal condition.
- Check clutch shaft oil seal. Replace oil seal if nicked, cut, worn or other abnormal condition.



1. Bearing

Replacing bearing and oil seal

1. Loosen and remove clutch shaft plug ①.
   Remove clutch shaft ②.
2. Remove circlip ③.

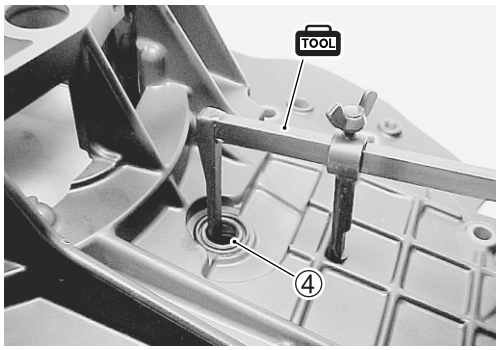


3. Extract oil seal ④ with oil seal remover.

TOOL 09913-50121: Oil seal remover

CAUTION

Do not reuse oil seal once removed.
Always use a new oil seal.

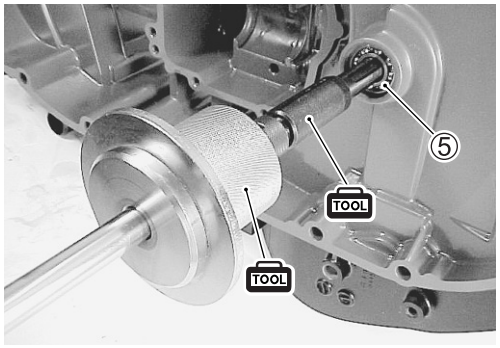


4. Remove bearing ⑤ with special tool and sliding hammer.

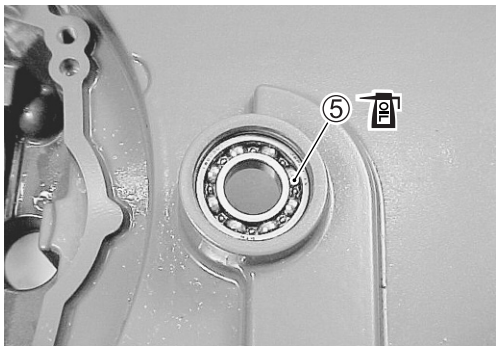
TOOL 09923-73210: Bearing remover
09930-30104: Sliding hammer

CAUTION

Do not reuse the bearing once removed.
Always use a new bearing.

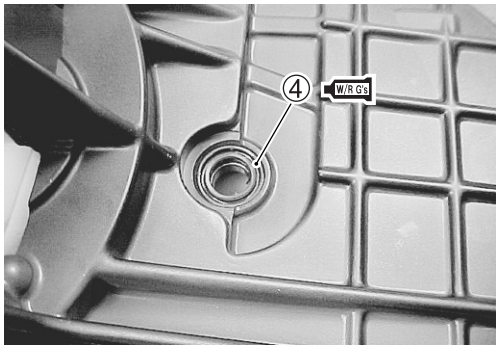


5. Apply engine oil to outer circumference of bearing ⑤.
   Install bearing into engine holder.



6. Apply Water Resistant Grease to outer circumference of oil seal ④.
   Drive oil seal into engine holder.
   The lipped portion of seal must face towards the flywheel.
   Apply Water Resistant Grease to the seal lip.

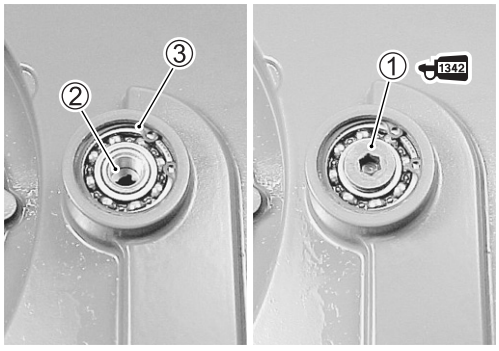
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



7. Install circlip ③.
8. Install clutch shaft ②.
   Tighten clutch shaft plug ①, pre-coated with thread lock, to specified torque.

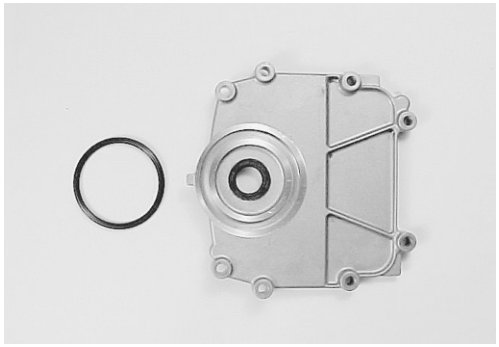
1342 99000-32050: THREAD LOCK "1342"

Clutch shaft plug: 85 N·m (8.5 kg-m, 61.5 lb-ft)

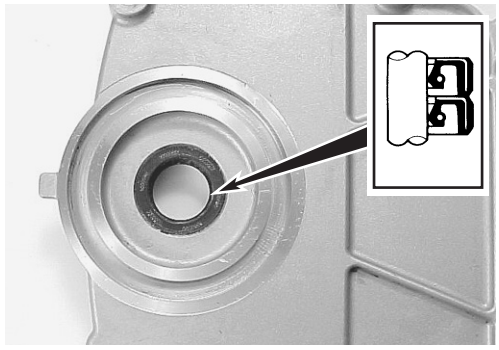


MOUNT·OIL SEAL COVER

- 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).



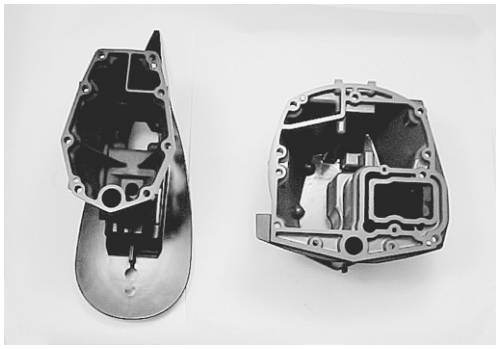
OIL STRAINER

- 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.



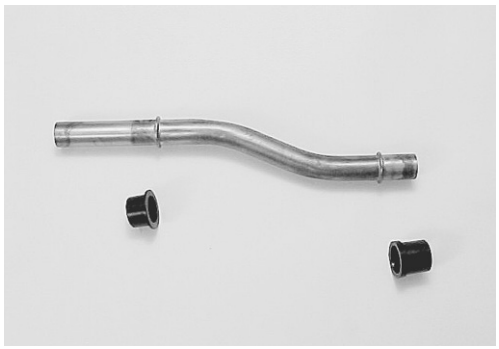
MOUNT

- 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.



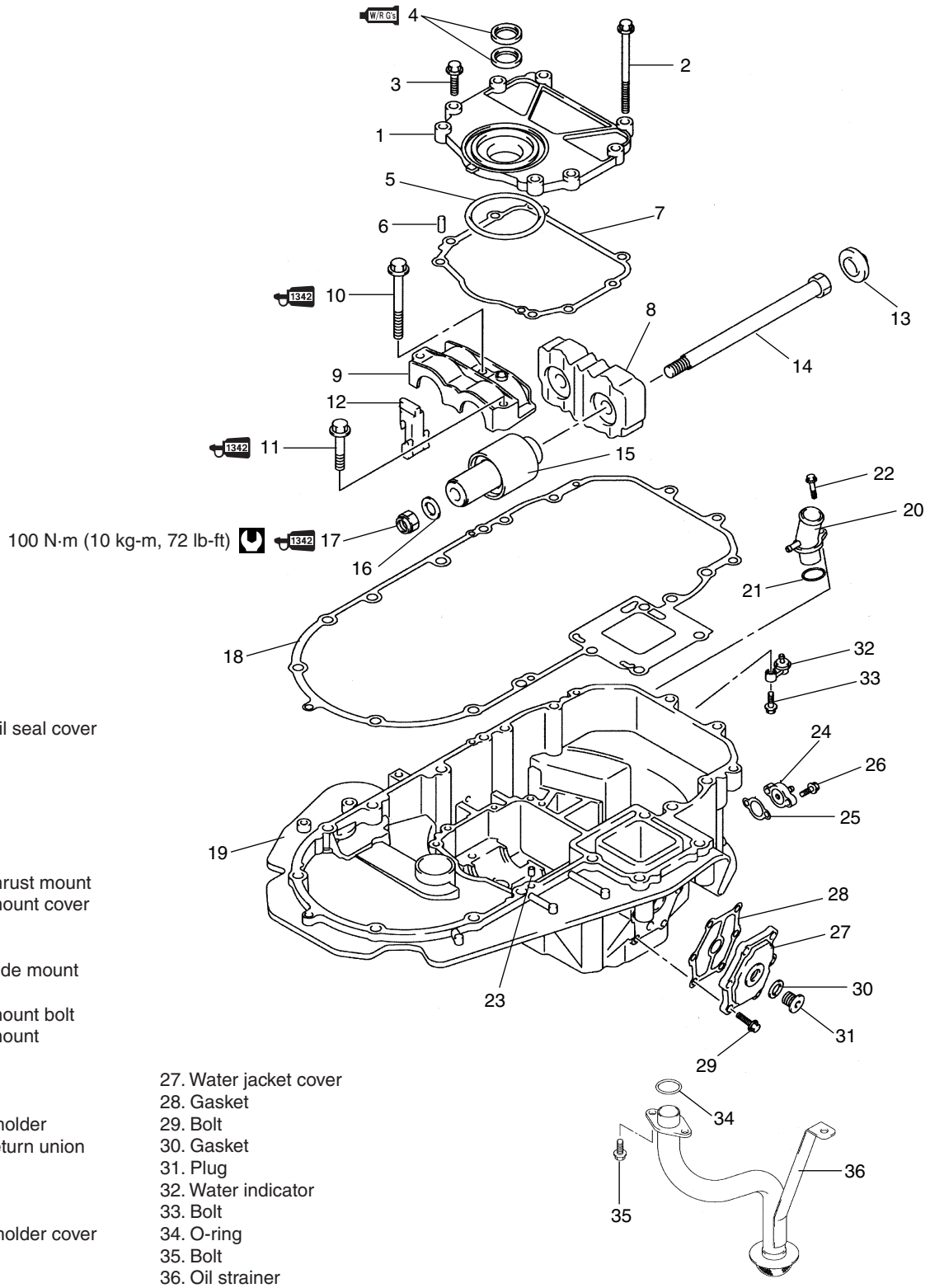
WATER TUBE

- 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.

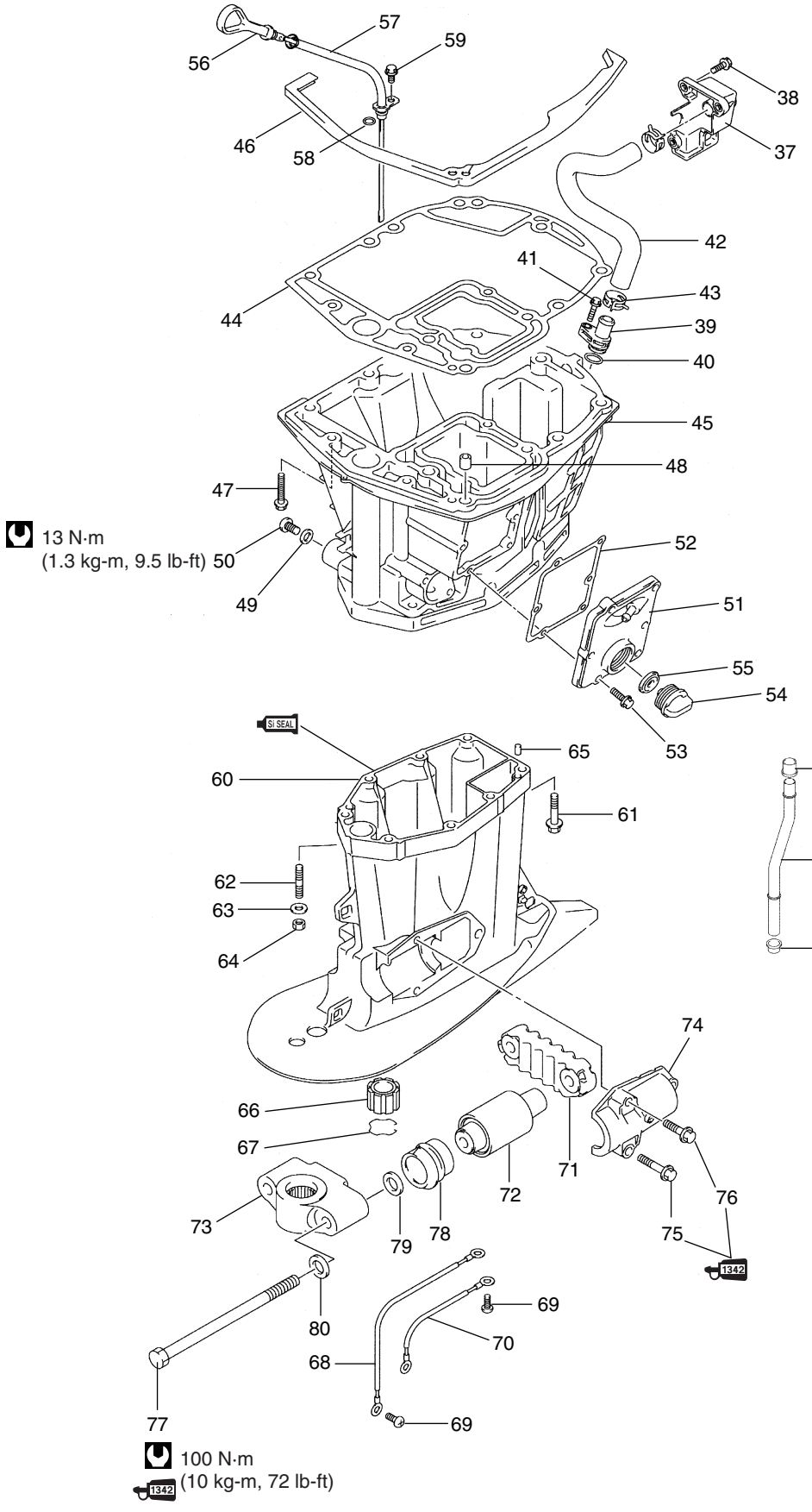


ASSEMBLY

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



1. Mount oil seal cover
2. Bolt
3. Bolt
4. Oil seal
5. O-ring
6. Pin
7. Gasket
8. Upper thrust mount
9. Upper mount cover
10. Bolt
11. Bolt
12. Upper side mount
13. Spacer
14. Upper mount bolt
15. Upper mount
16. Washer
17. Nut
18. Gasket
19. Engine holder
20. Water return union
21. O-ring
22. Bolt
23. Pin
24. Engine holder cover
25. Gasket
26. Bolt
27. Water jacket cover
28. Gasket
29. Bolt
30. Gasket
31. Plug
32. Water indicator
33. Bolt
34. O-ring
35. Bolt
36. Oil strainer



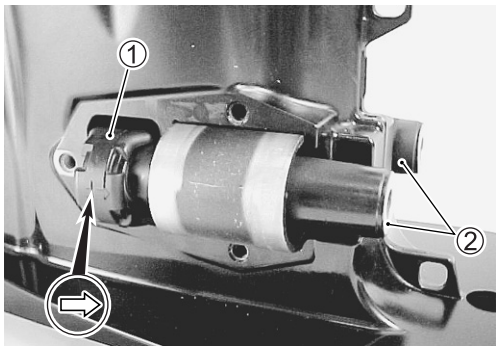
37. Exhaust release pipe
38. Bolt
39. Exhaust pipe
40. O-ring
41. Bolt
42. Hose
43. Clip
44. Gasket
45. Oil pan
46. Seal
47. Bolt
48. Pin
49. Gasket
50. Oil drain plug
51. Water jacket cover
52. Gasket
53. Bolt
54. Plug
55. Gasket
56. Oil level Gauge
57. Oil level gauge guide
58. O-ring
59. Bolt
60. Driveshaft housing
61. Bolt
62. Stud bolt
63. Washer
64. Nut
65. Pin
66. Bush (Type: X)
67. Ring
68. Lead
69. Screw
70. Lead
71. Lower thrust mount
72. Lower mount
73. Lower mount bracket
74. Lower mount cover
75. Bolt
76. Bolt
77. Lower mount bolt
78. Lower side mount
79. Washer
80. Washer
81. Bush
82. Water tube
83. Bush

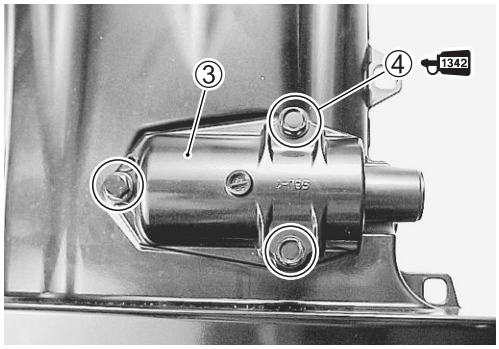
LOWER MOUNT/MOUNT COVER

- Install lower thrust mount ① with the arrow mark facing forward.
- Install lower mounts ② and lower mount cover ③.
- Tighten mount cover bolts ④, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

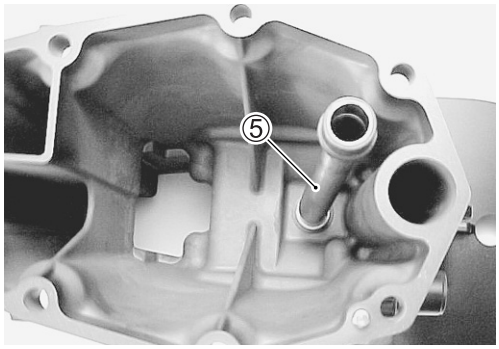
Lower mount cover bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)





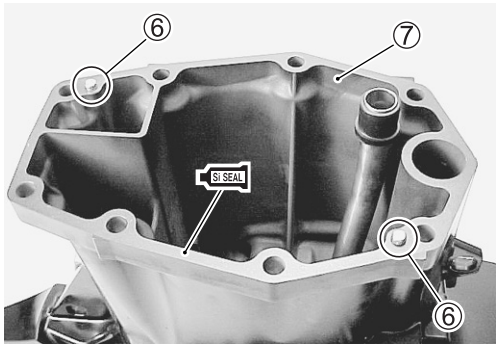
OIL PAN TO DRIVESHAFT HOUSING

- Install water tube ⑤.

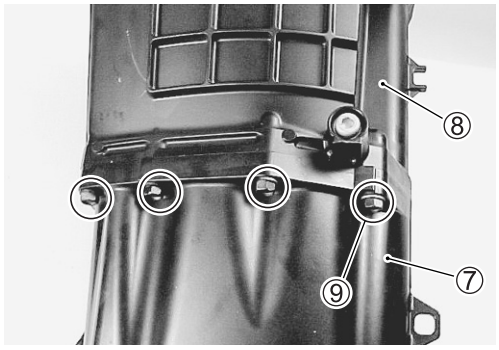


- Install two dowel pins ⑥ to driveshaft housing ⑦.
  Apply sealant to mating surfaces of driveshaft housing and oil pan.

Si SEAL 99000-31120: SUZUKI SILICONE SEAL

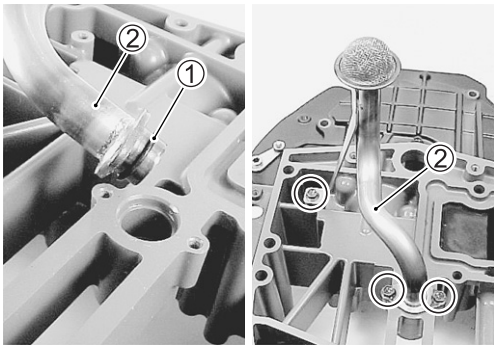


- Install oil pan ⑧ to driveshaft housing ⑦, then tighten eight (8) bolts ⑨ securely.



ENGINE HOLDER TO OIL PAN

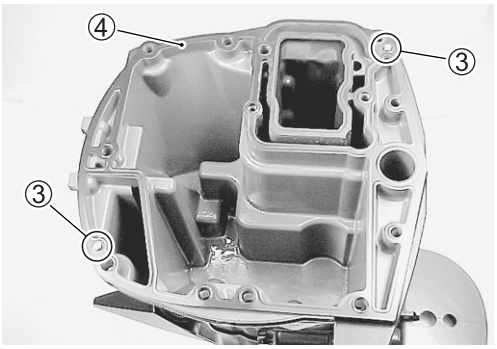
- Apply engine oil to O-ring ①, then install O-ring to oil strainer ②.
- Install oil strainer to engine holder, then tighten bolts securely.



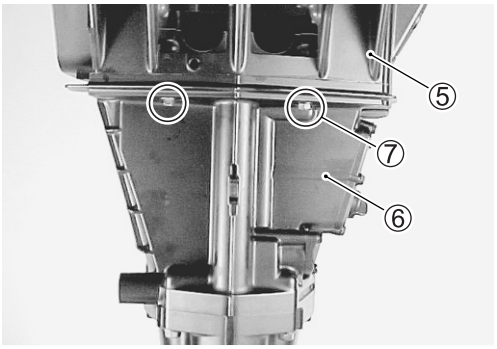
- Install two (2) dowel pins ③ and gasket ④ to oil pan.

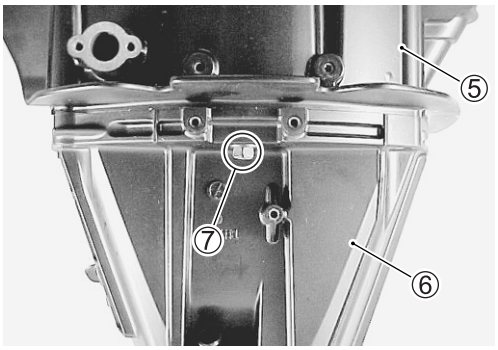
CAUTION

Do not re-use gasket. Always assemble with a new gasket.



- Install engine holder ⑤ to oil pan ⑥, then securely tighten it with engine holder bolts ⑦.





UPPER MOUNT AND MOUNT COVER

- Assemble these items in the following sequence:
  Place upper thrust mount ③ and upper mounts ② on upper mount bolts ①.
- Install spacer ④ to thrust mount.
- Place upper mount assembly and upper mount cover ⑤ into position.

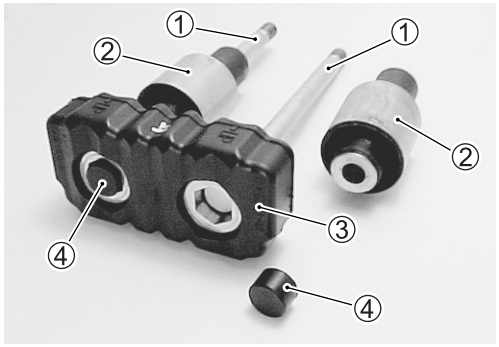
NOTE:
Install upper thrust mount with the lettered mark "UP" facing upward.

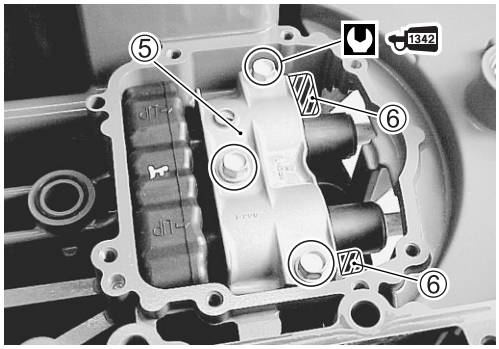
- Tighten upper mount cover bolts, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

Upper mount cover bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

- Intall the upper side mounts ⑥.



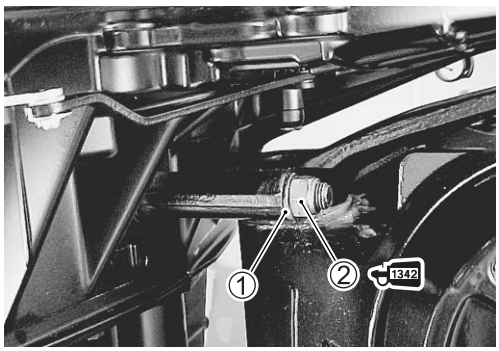


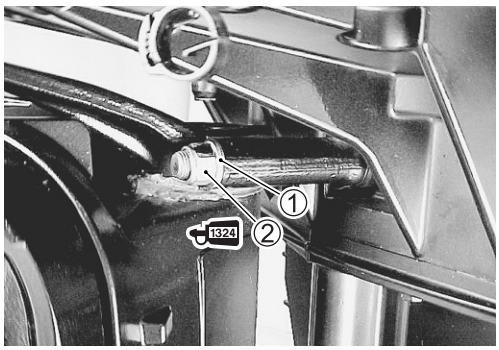
DRIVESHAFT HOUSING/OIL PAN

- 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)



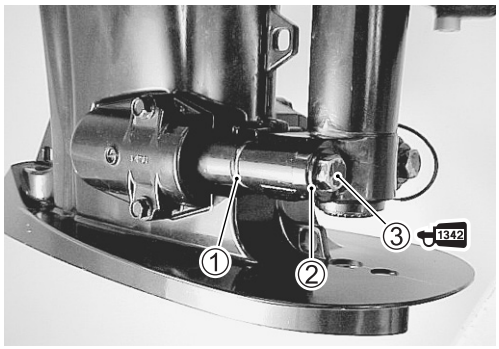


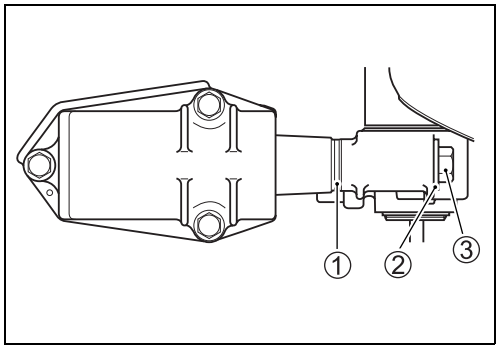
LOWER MOUNT BOLT

- Place washer ① between lower mount and lower mount bracket.
- Install washer ② and lower mount bolt ③, then tighten bolt, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

Lower mount bolt: 100 N·m (10.0 kg-m, 72.3 lb-ft)



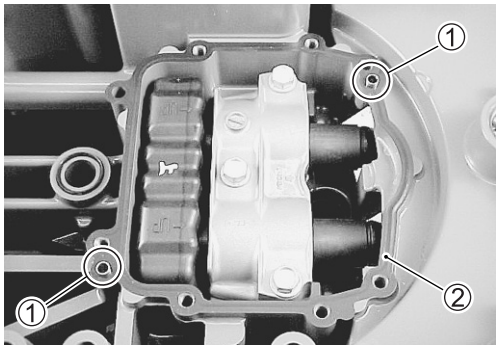


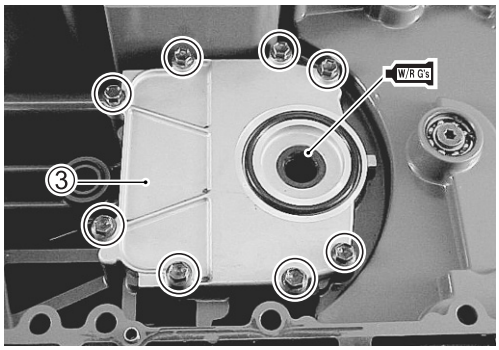
MOUNT·OIL SEAL COVER

- Apply Water Resistant Grease to oil seal.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

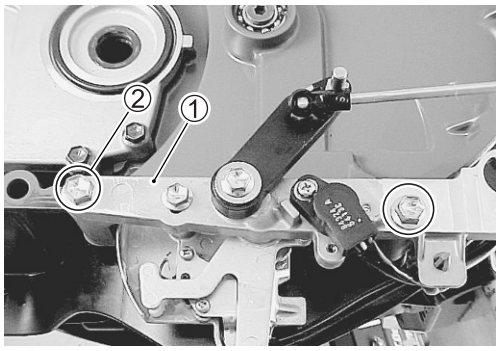
- Install dowel pins ①, gasket ② and mount·oil seal cover ③, then tighten eight (8) cover bolts securely.



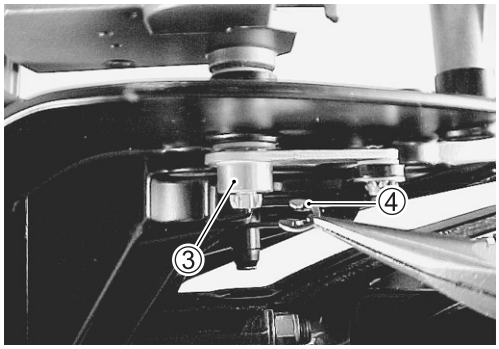


THROTTLE LEVER HOLDER

- Install throttle lever holder ① to engine holder, then tighten two (2) bolts ② securely.



- Install clutch lever shaft arm ③ and E-ring ④.



POWER UNIT

Install power unit. (See page 6-21 to 6-25.)

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, 16.5 lb-ft)

10 mm 50 N·m (5.0 kg-m, 36.0 lb-ft)

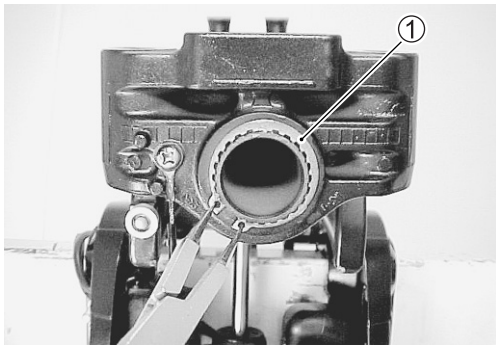
SWIVEL BRACKET, STEERING BRACKET AND CLAMP BRACKET

REMOVAL

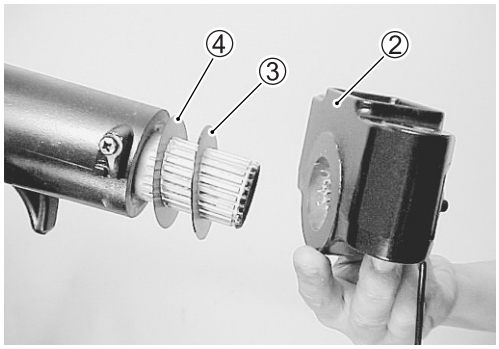
Remove driveshaft housing/oil pan.
(See page 7-3.)
Remove screw and bonding wire.



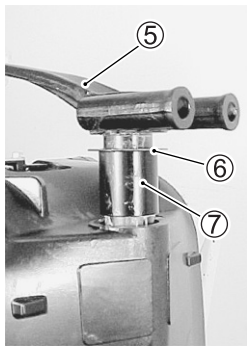
Remove circlip ①.

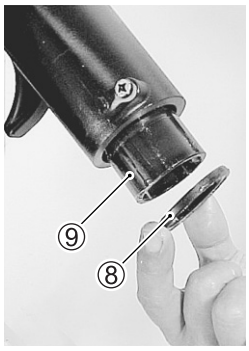


Remove lower mount bracket ②, shims ③ and washer ④ from the steering shaft.

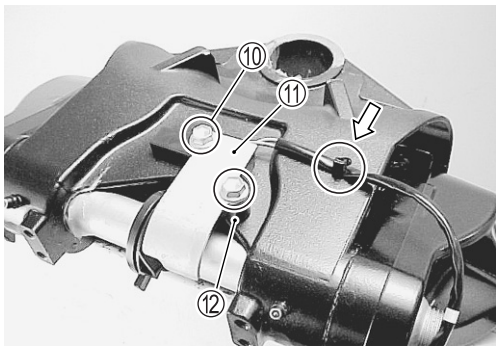


Lift steering bracket ⑤ upward to remove from swivel bracket.
Remove washer ⑥ and upper bushing ⑦.
Remove swivel bracket seal ⑧ and lower bushing ⑨.



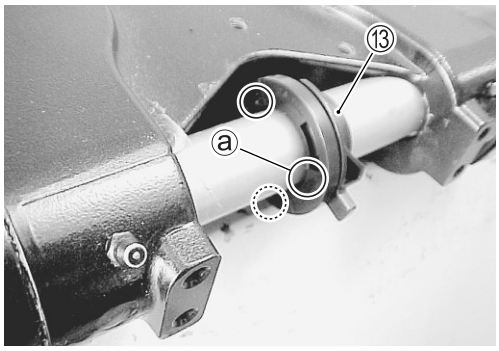


Remove two (2) bolts ⑩, switch cover ⑪ and tilt limit switch ⑫.
Cut the cable tie securing switch lead wire.



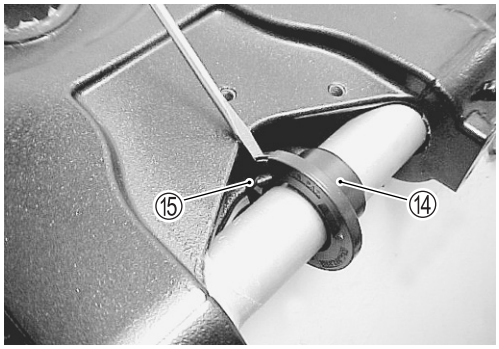
Remove tilt limit switch cam ⑬.

NOTE:
Unfasten three (3) stoppers ⓐ from the tilt limit switch cam to remove it from cam holder.

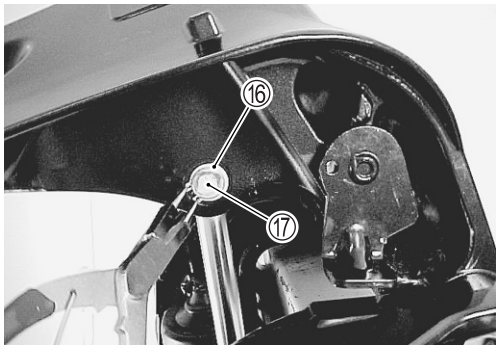


Remove upper cam holder ⑭ and lower cam holder ⑮ from clamp bracket shaft.

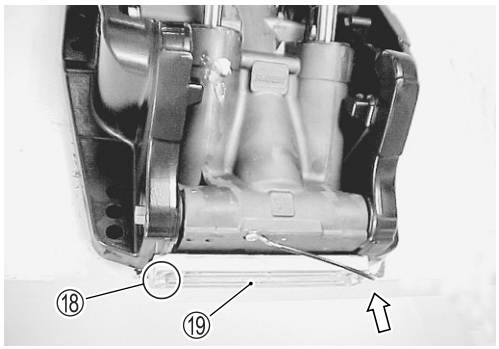
NOTE:
Use thin flat screw-driver to release the two hooks to separate the cam holder upper and lower halves.



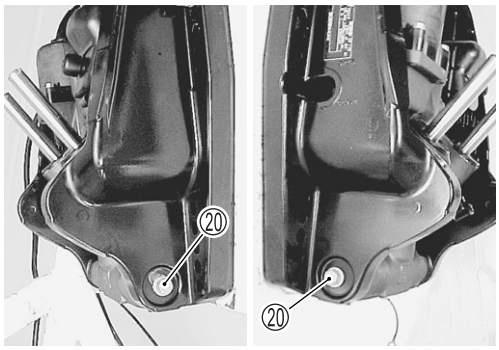
Remove circlip ⑯ and push out tilt cylinder upper rod ⑰.



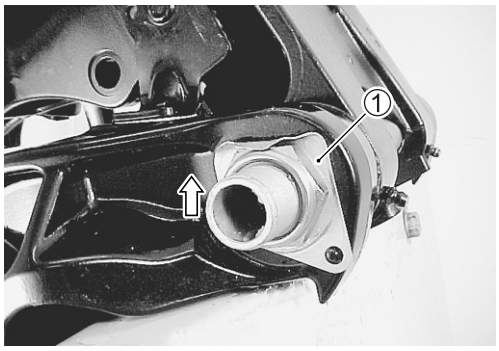
Remove bolts ⑱ and anode ⑲.



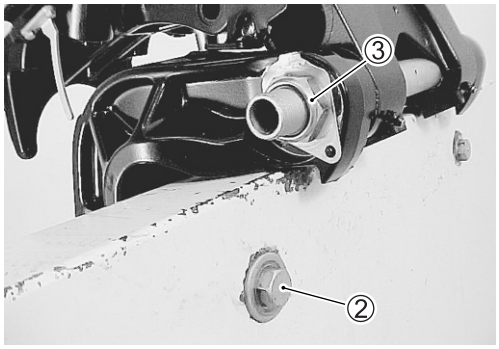
Remove bolts ⑳ securing PTT unit to the STBD and PORT clamp brackets.



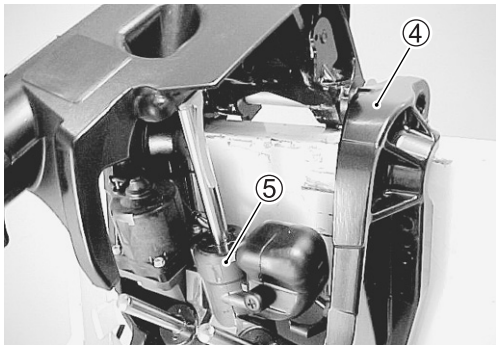
Using flat screw-driver, drive locking edge of lock washer ① to clamp bracket side.



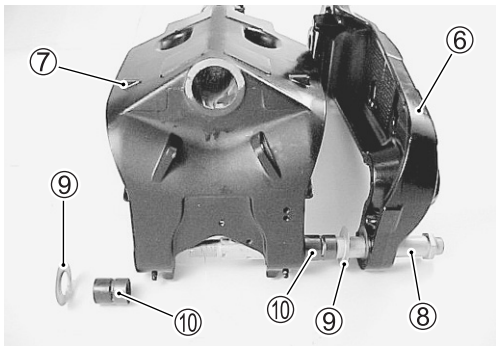
Remove the two STBD motor mounting bolts ②.
Remove the clamp bracket shaft nut ③ and washer.



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.



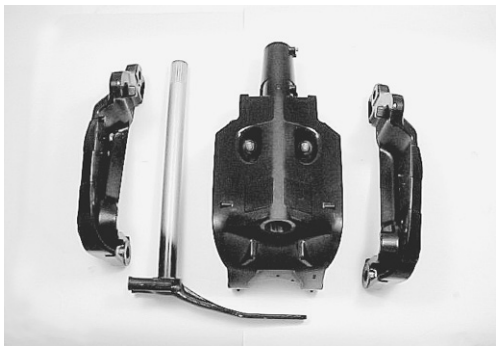
OIL SEAL
Check swivel bracket seal.
If excessive wear or other damage is found, replace seal.



CLAMP BRACKET SHAFT
Check clamp bracket shaft.
If clamp bracket shaft is bent or twisted, replace shaft.

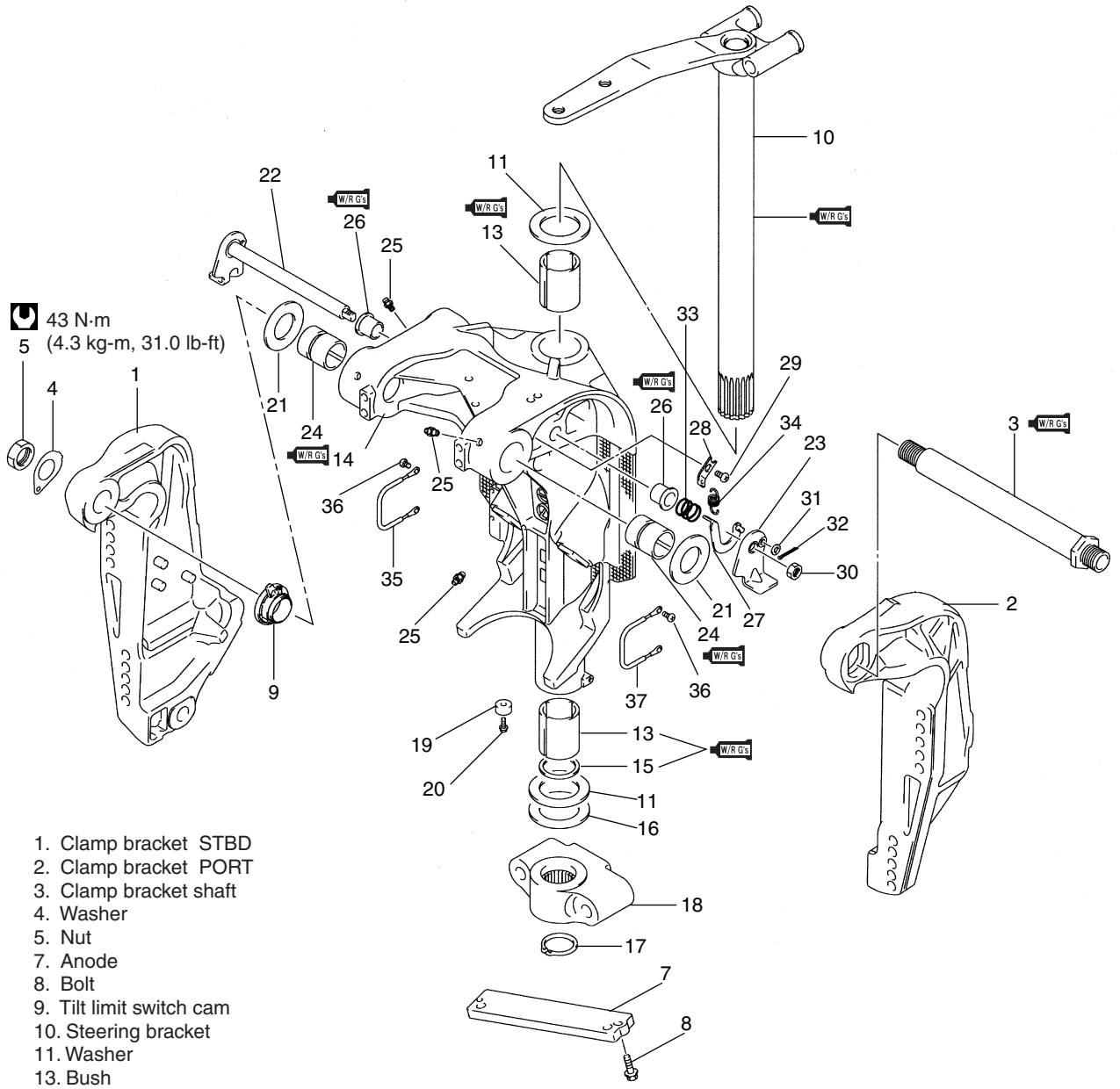


BRACKET
Check clamp brackets, steering bracket and swivel bracket.
If cracks or other damage is found, replace bracket (s).



REASSEMBLY

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



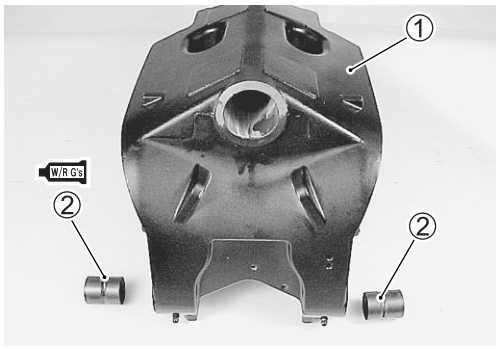
1. Clamp bracket STBD
2. Clamp bracket PORT
3. Clamp bracket shaft
4. Washer
5. Nut
7. Anode
8. Bolt
9. Tilt limit switch cam
10. Steering bracket
11. Washer
13. Bush
14. Swivel bracket
15. Seal
16. Shim
17. Circlip
18. Lower mount bracket
19. Anode
20. Bolt
21. Washer
22. Tilt lock lever
23. Tilt lock lever PORT
24. Bush
25. Grease nipple
26. Bush
27. Tilt lock lever link
28. Bracket
29. Screw
30. Nut
31. Washer
32. Pin
33. Spring
34. Spring
35. Lead
36. Screw
37. Lead

CLAMP BRACKET AND SWIVEL BRACKET

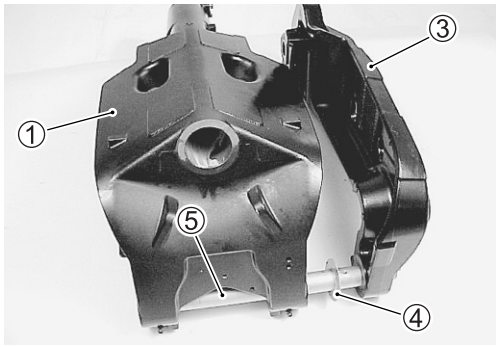
NOTE:
Before installing clamp bracket to swivel bracket, apply grease to clamp bracket shaft and bushings.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

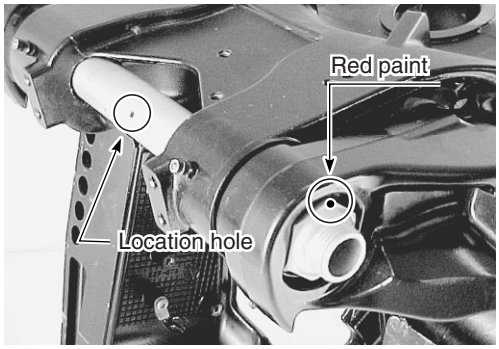
- Insert PORT and STBD bushings ② into the swivel bracket ①.



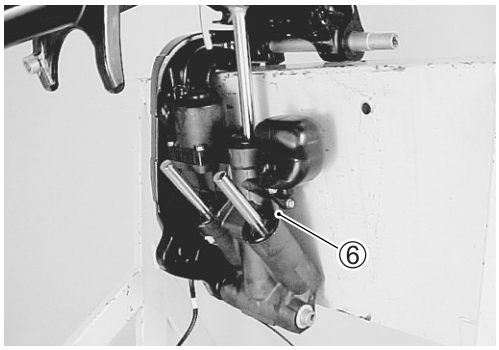
- Assemble port clamp bracket ③, washer ④, clamp bracket shaft ⑤ and swivel bracket ①.



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.



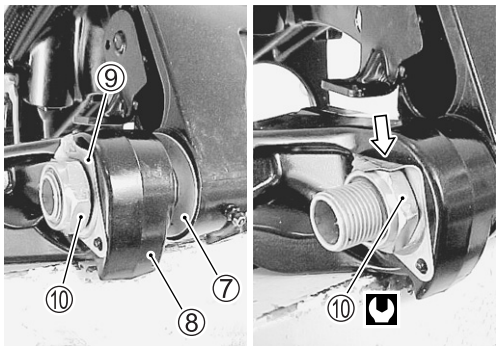
- Install PTT unit assembly ⑥.
  (For PTT unit assembly installation, see page 8-17 to 8-18.)



- 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)

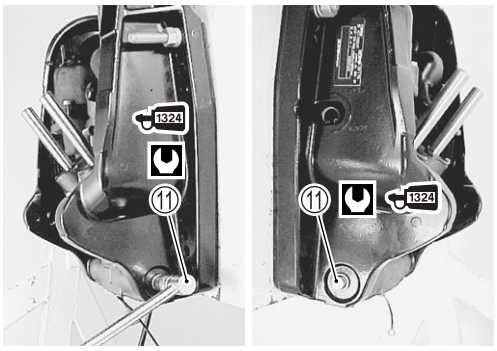
- After tightening clamp bracket shaft nut to specified torque, bend lock washer edge toward nut to secure nut.



- Tighten two (2) PTT unit retaining bolts ⑪, pre-coated with thread lock, to specified torque.

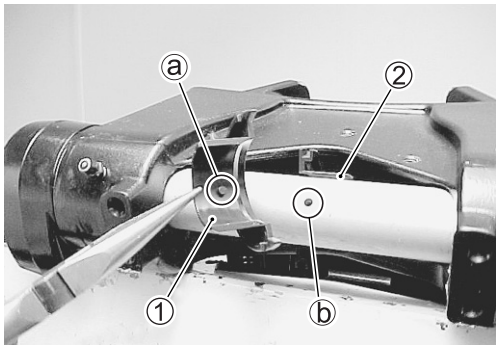
1342 99000-32050: THREAD LOCK "1342"

PTT retaining bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

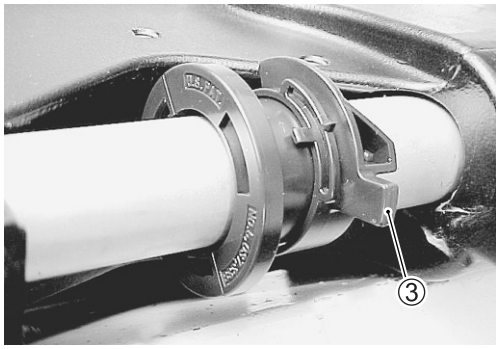


TILT LIMIT DEVICE

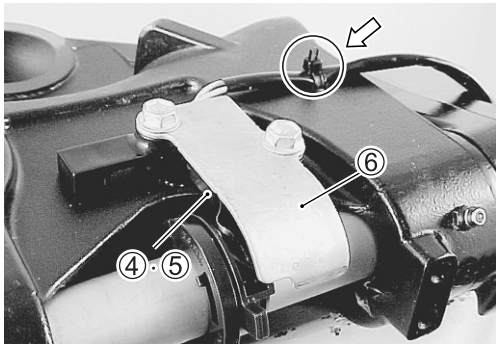
- Install the lower cam holder ① engaging its locating pin ⓐ with the clamp bracket shaft hole ⓑ, then install the upper cam holder ②.



- Install tilt limit switch cam ③.



- Install tilt limit switch ④, switch holder ⑤ and switch cover ⑥, then secure with bolts.
- Secure switch lead wire with cable tie.



STEERING BRACKET

- Apply Water Resistant Grease to steering bracket shaft.

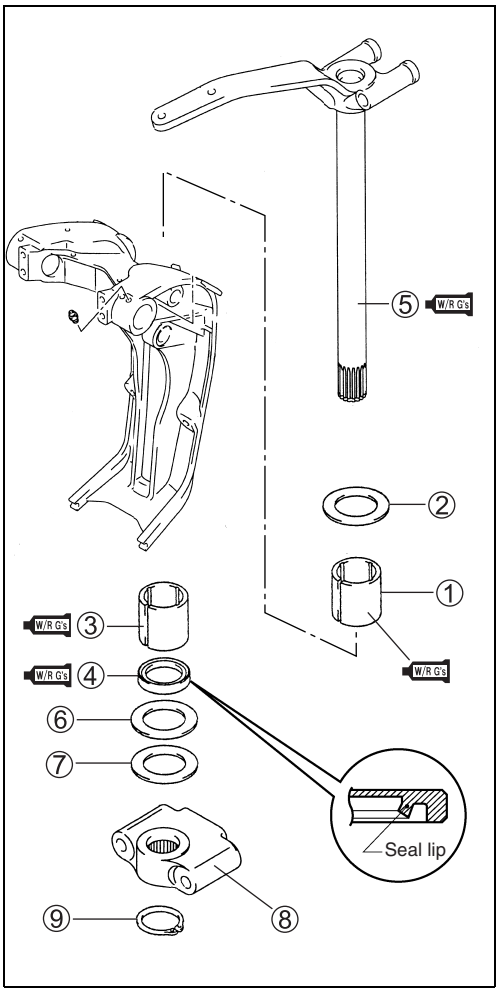
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

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.

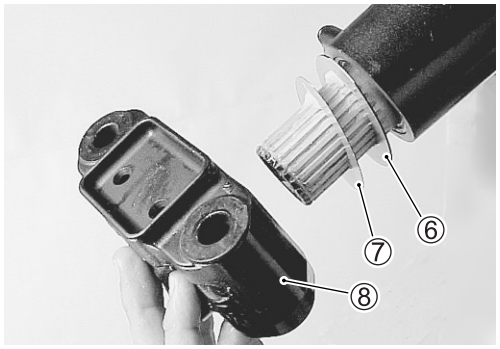
NOTE:
Install seal ④ with lip (spring side) facing downward.

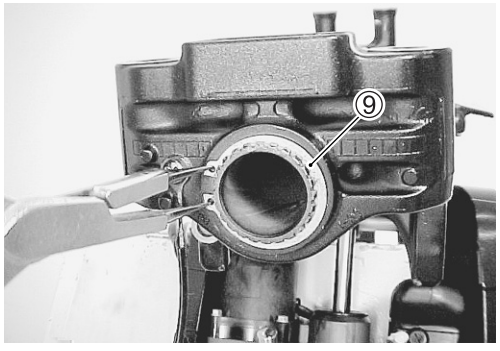
- Install steering bracket ⑤ to swivel bracket.



LOWER MOUNT BRACKET

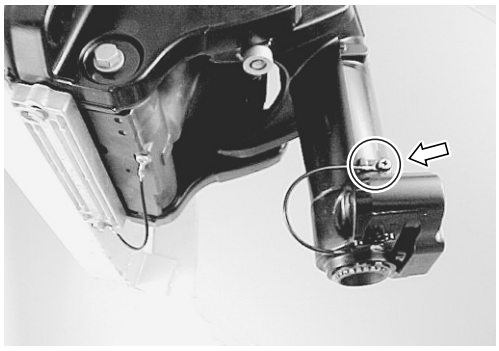
- Install washer ⑥ and shim ⑦, and then slide the lower mount bracket ⑧ upward on the splines until it contacts the shim.
- Install circlip ⑨ to retain bracket.





BONDING WIRE

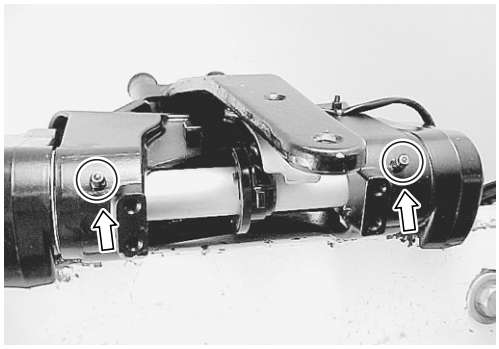
Reattach bonding wire to swivel bracket and tighten screw securely.

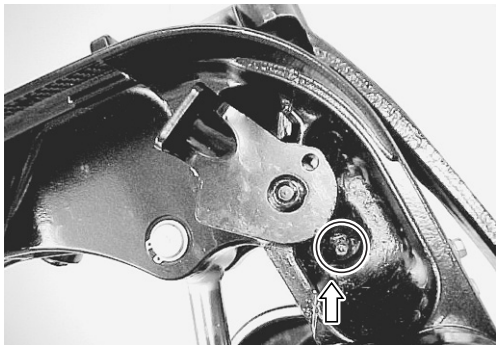


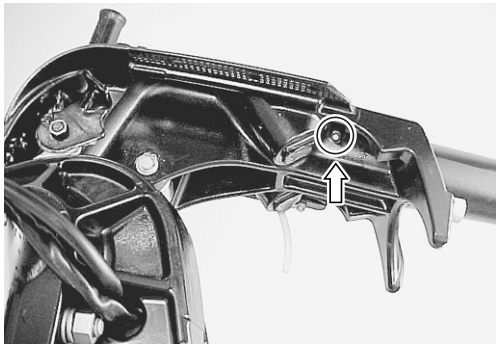
LUBRICATION

After completing reassembly of the mid unit, apply grease through each grease nipple.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



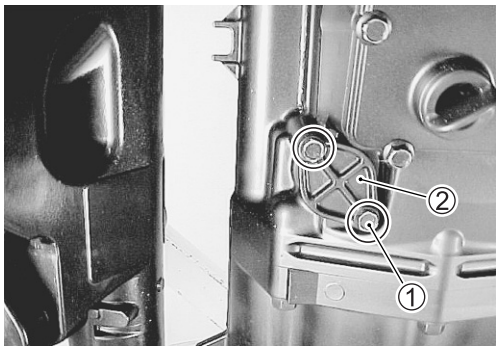


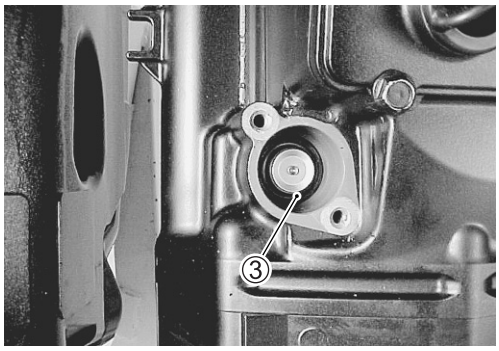


WATER PRESSURE VALVE

REMOVAL

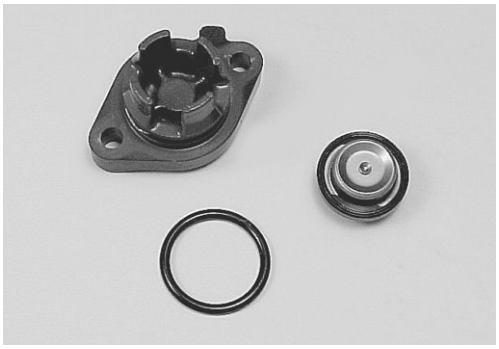
- Remove oil pan cover. (See page 7-2.)
- Remove two bolts ①, pressure valve cover ② and water pressure valve ③.





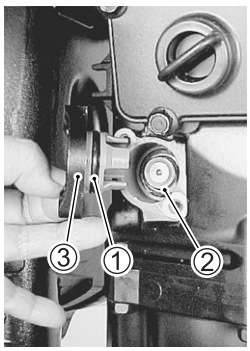
INSPECTION

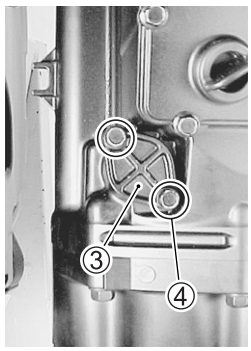
- If salt deposits, corrosion, wear or other damage is found, clean or replace.
- Inspect O-ring. Replace if nicked, cut or torn.



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

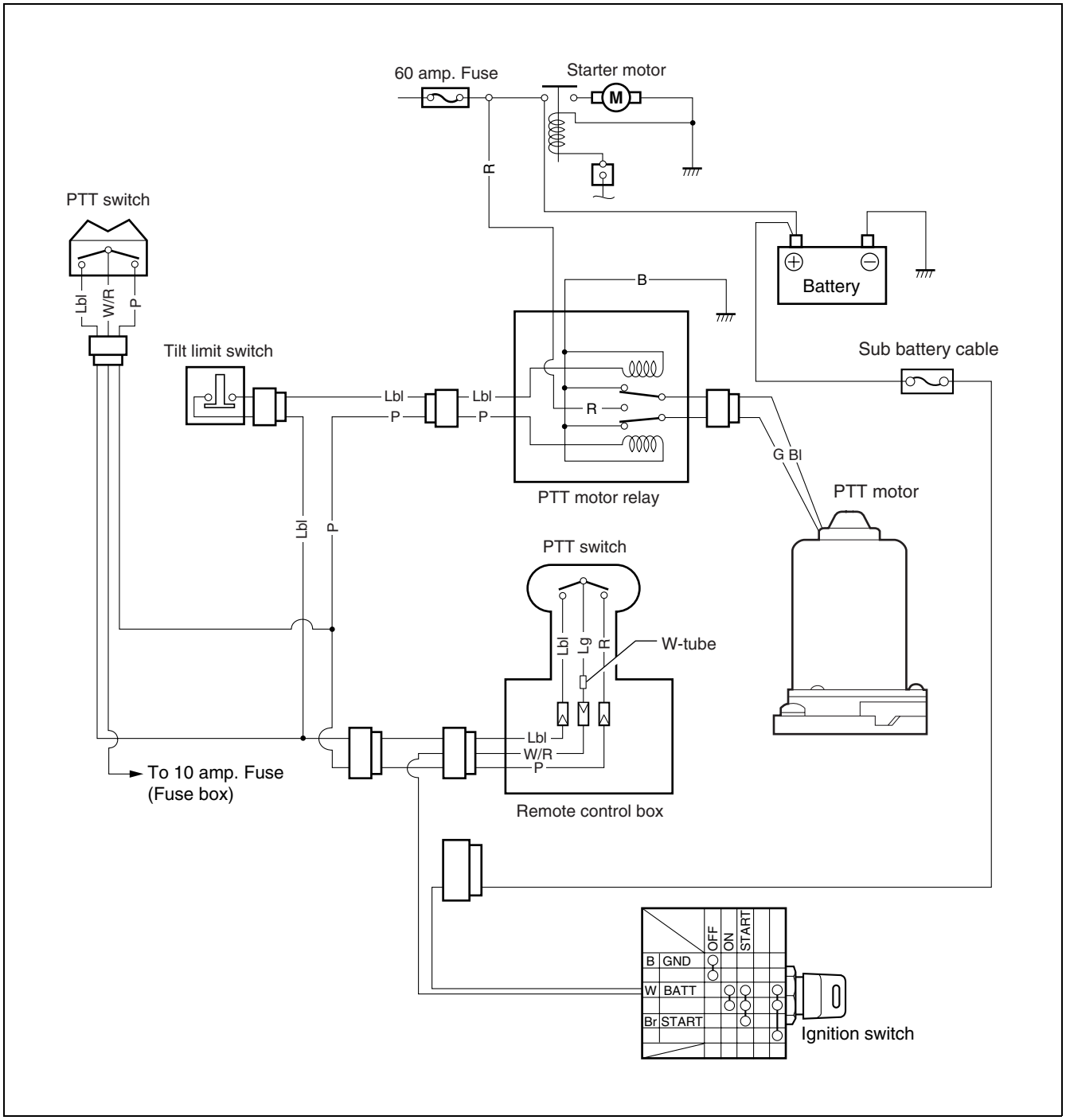
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SYSTEM WIRING DIAGRAM

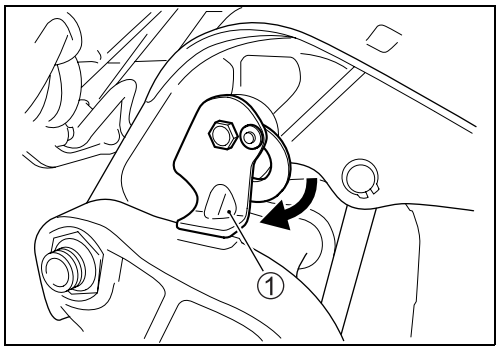


SERVICE PROCEDURE

OIL LEVEL

To check the PTT oil level:

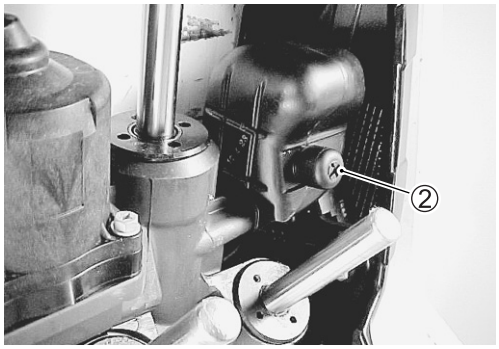
1. Raised the engine to a full-tilt position.
2. Lower the manual tilt lock lever ①.



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:

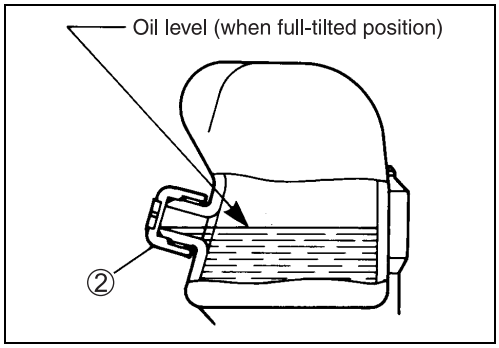
Dexron Ⅲ automatic transmission fluid or equivalent



CAUTION

To ensure consistent pump operation, do not mix different types of oil.

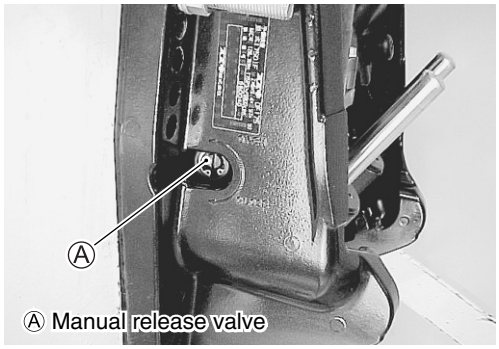
6. Reinstall oil filler plug.



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)

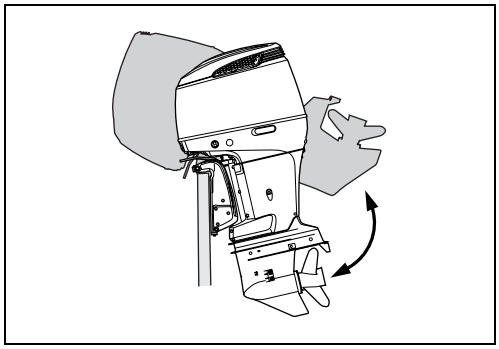


CAUTION

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.



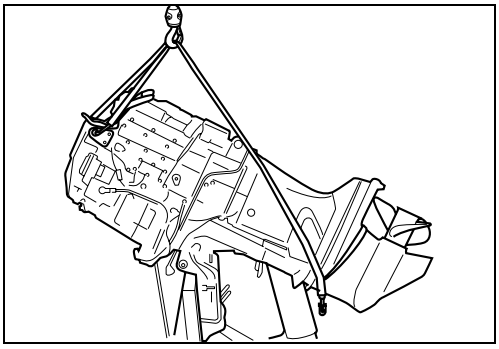
POWER TRIM AND TILT UNIT

REMOVAL

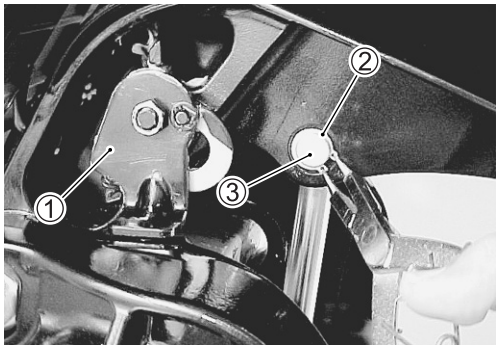
Remove side cover. (See page 7-2.)
Raise the engine to the full tilt position and lower the manual tilt lock levers ①.

⚠ WARNING

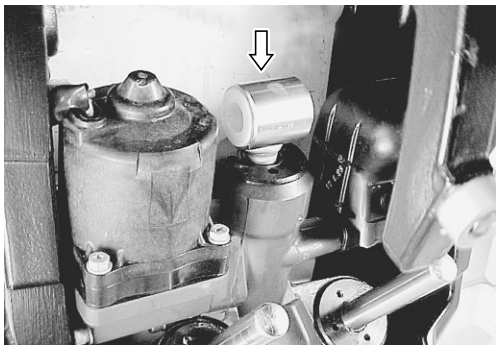
During the following procedures, the engine must be firmly secured and its weight fully supported. (See right.)



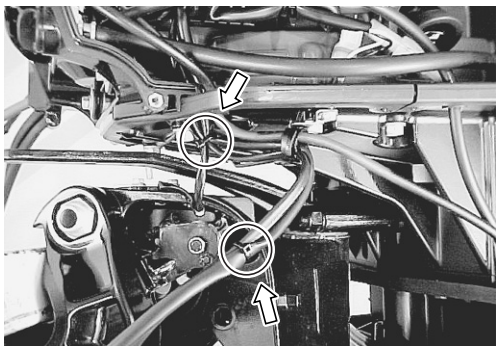
Remove the tilt rod snap ring ② and push tilt cylinder upper shaft pin ③ out.



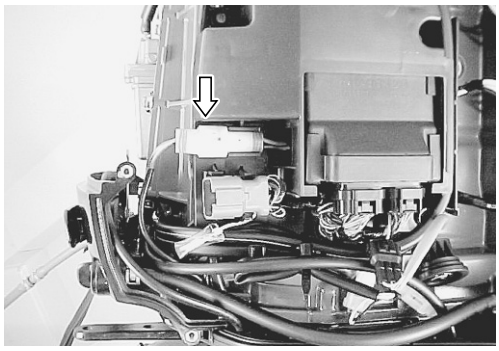
Lower tilt rod to full down position and disconnect the battery cable.



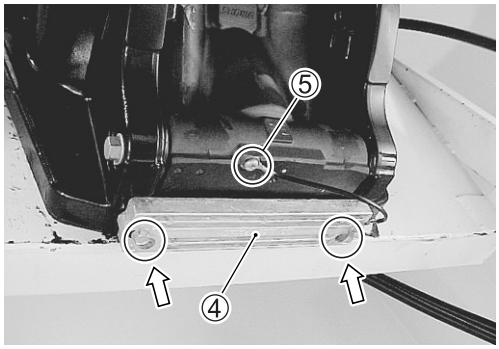
Cut the cable ties binding PTT motor cable and trim sender lead wire.



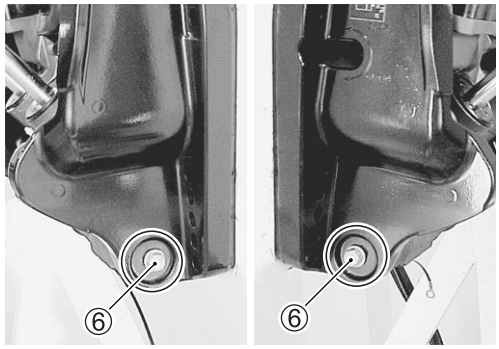
Disconnect the PTT motor cable wire connector from the PTT relay.
Remove the PTT motor cable from engine lower cover.



Remove two (2) bolts and anode ④.
Remove the screw ⑤ securing bonding wire.

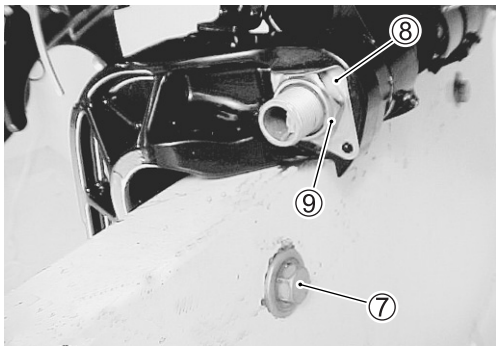


Remove the two (2) bolts ⑥ securing PTT cylinder lower shaft to STBD/PORT clamp bracket.

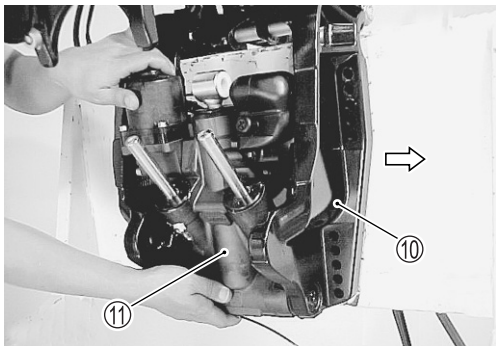


Remove two STBD motor mounting bolts ⑦.
Using flat screw driver, drive locking edge of lock washer ⑧ to clamp bracket side.
Loosen the clamp bracket shaft nut ⑨.

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.

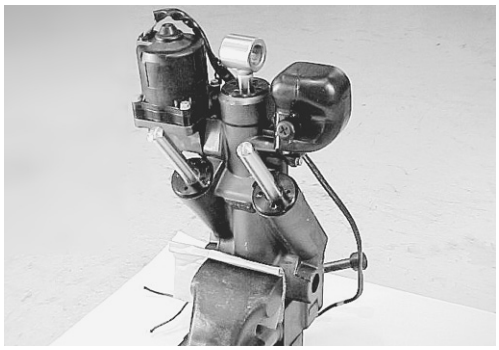


DISASSEMBLY

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.

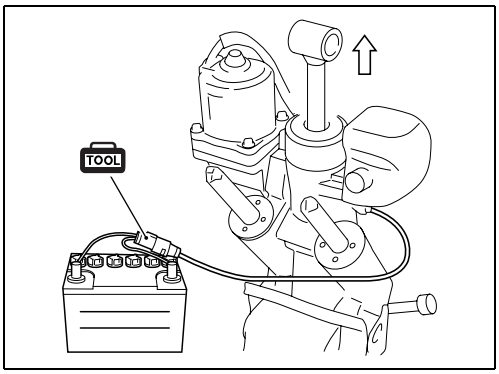
NOTE:
To prevent damage to the PTT cylinder use wood blocks, vise jaw protectors, etc., between the vise jaws and PTT components before tightening vise.



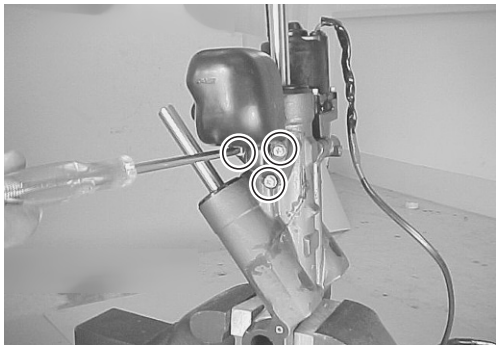
Connect the PTT cable extension to PTT motor cable connector.

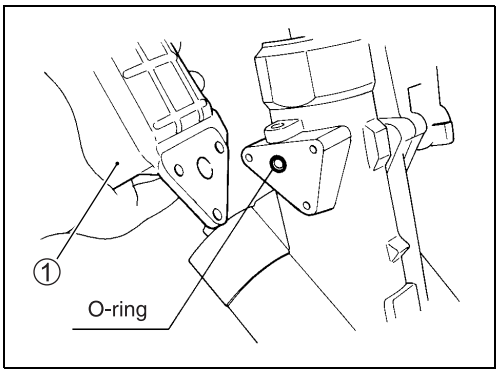
TOOL 09945-79310: PTT cable extension

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)
Unscrew the filler plug and drain PTT oil into suitable container.

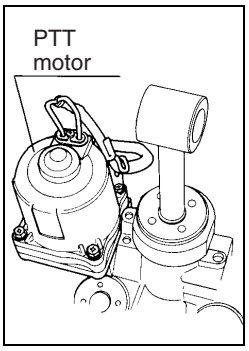


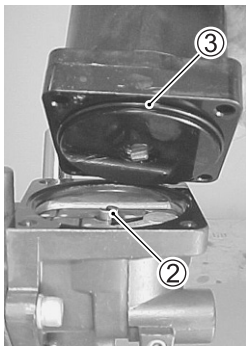
Remove the three (3) screws securing reservoir ①, then detach the reservoir from cylinder body.
Note the position of O-ring and remove it.



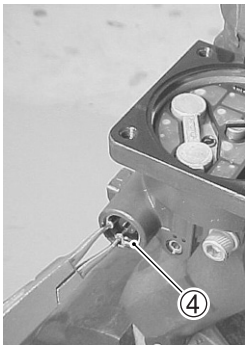


Remove the PTT motor assembly. (See page 8-13.)
Note the position of drive joint ② and O-ring ③, before removing them.



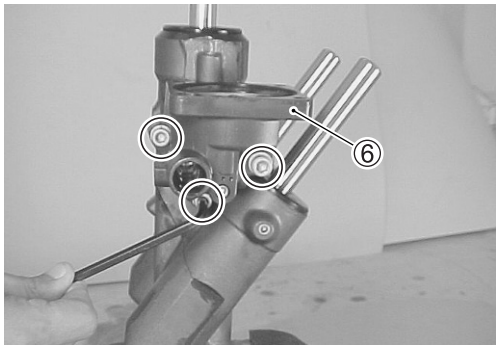


Remove the manual release valve snap ring ④, then unscrew the manual release valve ⑤.

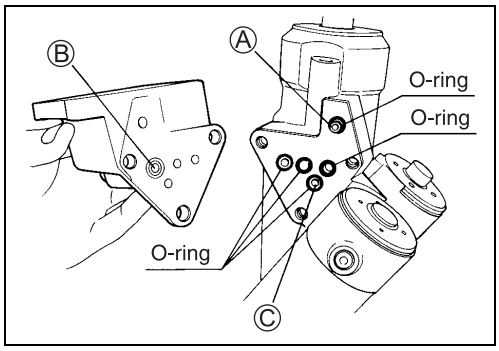




Remove the three (3) screws securing the PTT pump case ⑥, then detach the PTT pump case from PTT cylinder body.
Note the position of O-rings and orifices collars, before removing them.

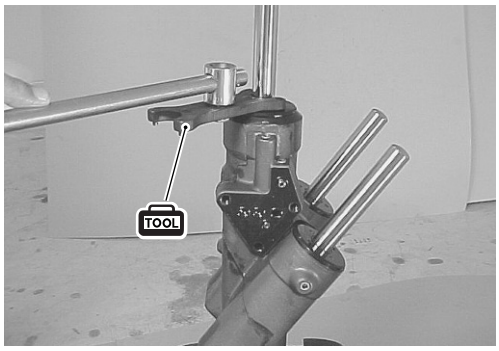


Ⓐ: Orifice collar (with ball valve)
Ⓑ: Orifice collar (with filter and ball valve)
Ⓒ: Orifice collar

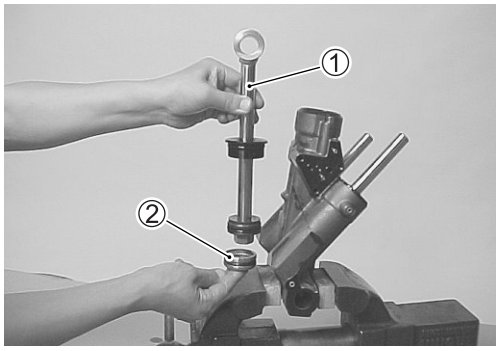


Using special tool, unscrew the PTT cylinder head.

TOOL 09944-09420: PTT cylinder cap tool



Pull the tilt rod/piston assembly ① out of the cylinder body.
Remove the free piston ② from the cylinder body.

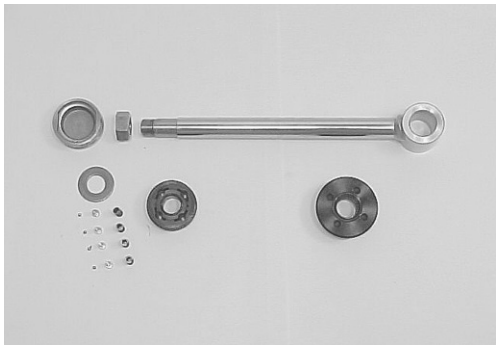


Disassembly of tilt rod/piston assembly
Unscrew the piston retaining nut from the bottom of the tilt rod and remove the washer.
Carefully retain and account for four shock valves, each composed of spring, rod and ball.



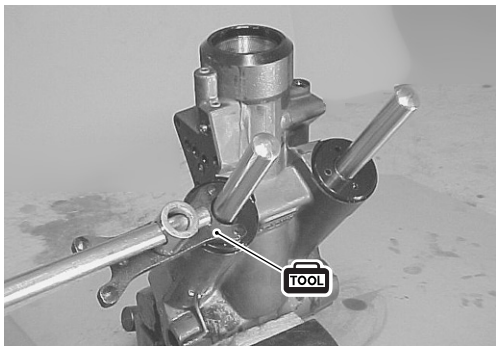


Remove the piston assembly and PTT cylinder head from the tilt rod by sliding them down and off the rod end.

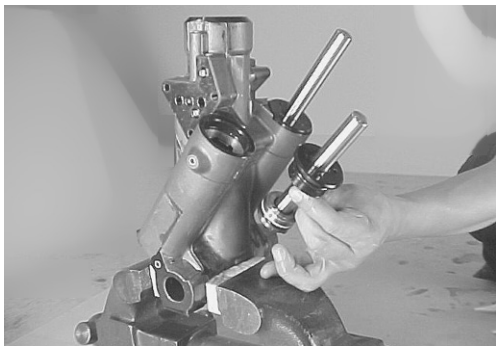


Disassembly of trim rod/piston assembly
Using special tool, unscrew the trim cylinder head.

09944-09420: PTT cylinder cap tool



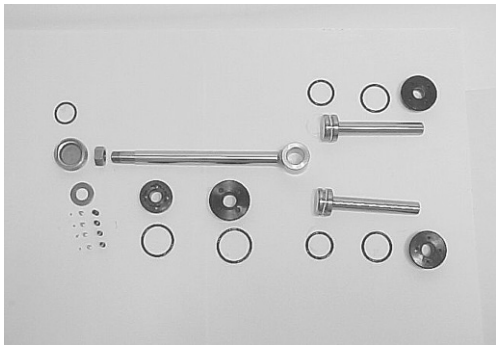
Pull the trim rod/piston assembly out of the trim cylinder.



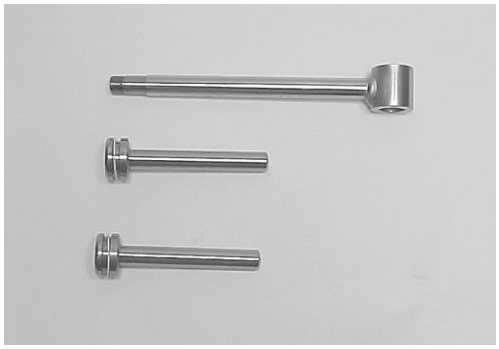
CLEANING AND INSPECTING

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.



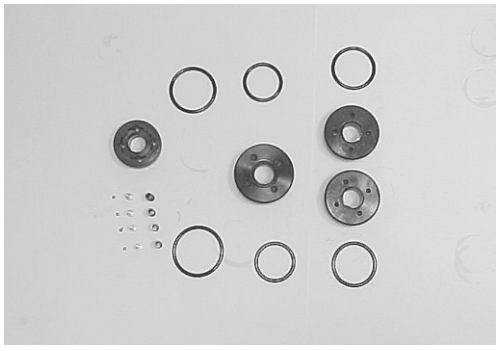
Inspect tilt rod and trim rod, replace if damaged or bent.
Inspect the surface of tilt rod and trim rod for scores, grooves or roughness.
Slight roughness may be removed with fine emery paper.
A badly scored or grooved rod must be replaced.



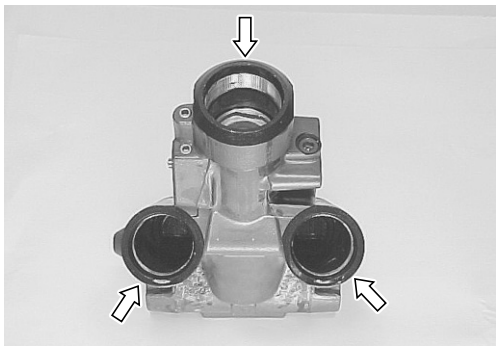
Inspect the PTT cap seal and O-ring.
Replace if cuts, nicks, or excessive wear is found.

NOTE:
It is recommended that the O-ring always be replaced once the tilt/trim cylinder has been disassembled.

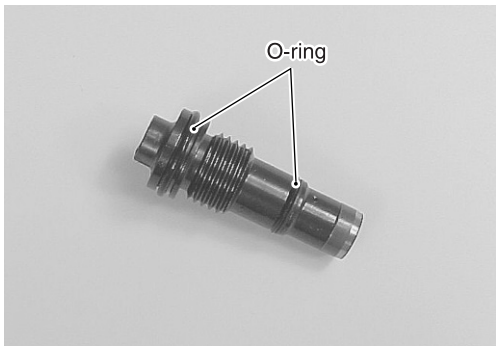
Inspect the shock valves (spring, rod and ball).
Replace if there are any signs of rust or pitting.



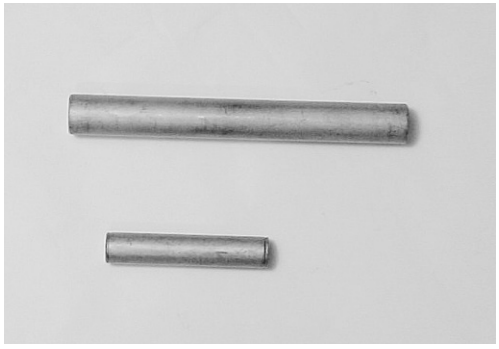
Inspect the cylinder bore for evidence of a rough or grooved surface.
Light honing may rectify slight surface roughness or scarring, but a deeply scarred surface will require replacement of the tilt cylinder.



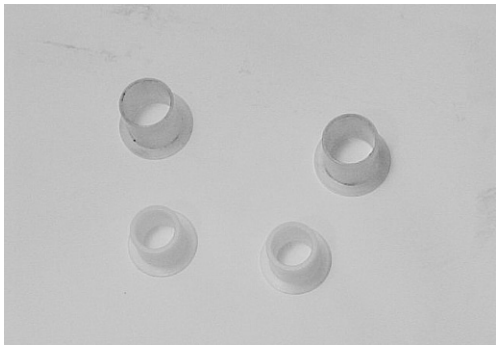
Inspect manual release valve for damage.
Inspect manual release valve O-ring.
Replace if nicked or cut.



Inspect lower rod.
If 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

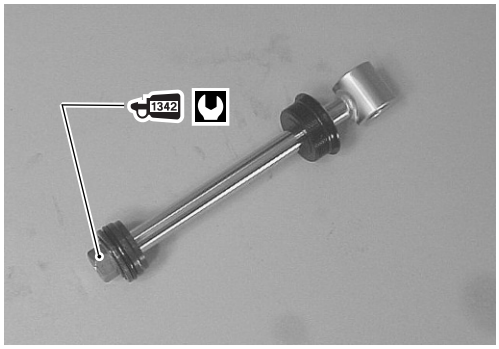
- **Do not reuse O-rings after removal, always use new O-rings.**
- **Lubricate all components and O-rings with PTT fluid before assembly.**
- **Do not reuse PTT fluid, always refill with new fluid.**

TILT 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.

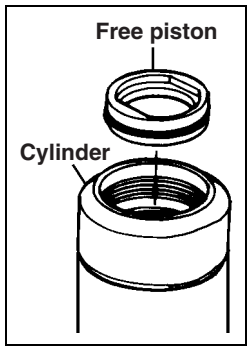
1342 99000-32050: THREAD LOCK “1342”

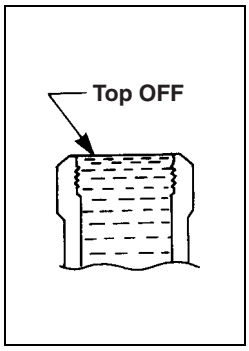
Piston retaining nut: 100 N·m (10 kg-m, 72 lb-ft)



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.

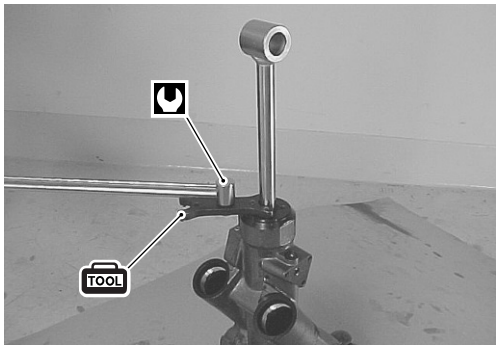




Tighten the cylinder head to specified torque using special tool.

Tilt cylinder head: 160 N·m (16 kg-m, 115.7 lb-ft)

09944-09420: PTT cylinder cap tool

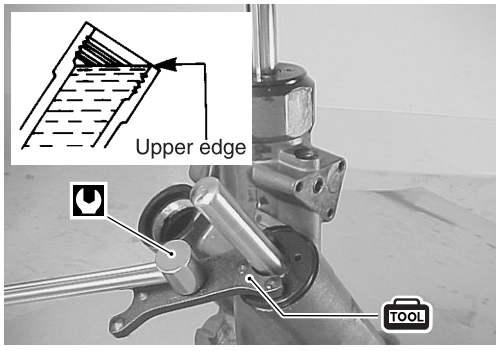


TRIM ROD

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: 78 N·m (7.8 kg-m, 56.4 lb-ft)

09944-09420: PTT cylinder cap tool



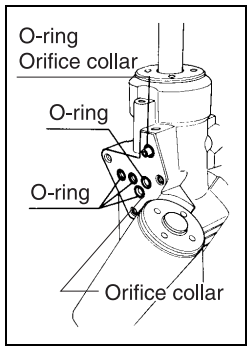
PTT PUMP CASE

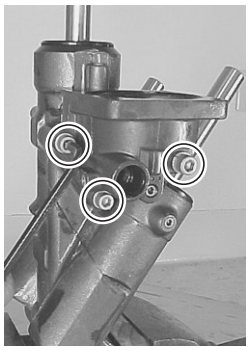
Install five (5) O-rings and orifice collars to PTT cylinder body.

NOTE:
Lubricate O-rings with PTT fluid before installing PTT cylinder body.

Install PTT pump case, then tighten three (3) screws to specified torque.

PTT pump case screw: 3.5 N·m (0.35 kg-m, 2.5 lb-ft)

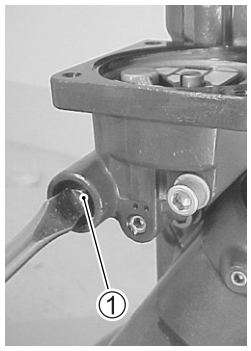


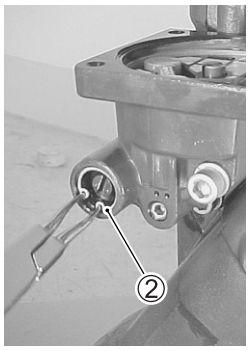


MANUAL RELEASE VALVE

Oil and install the manual release valve ①.
Tighten the valve to specified torque.
Install snap ring ②.

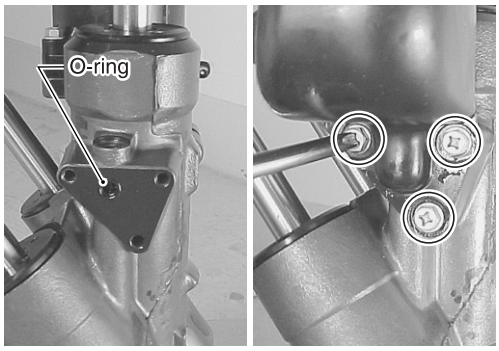
Manual release valve: 3.5 N·m (0.36 kg-m, 2.6 lb-ft)





PTT MOTOR

See the PTT motor installation section on page 8-16.



RESERVOIR

Install O-ring and reservoir, then tighten bolts to specified torque.

Pour recommended PTT fluid into reservoir until specified level.

Reservoir bolt: 5 N·m (0.5 kg-m, 3.5 lb-ft)

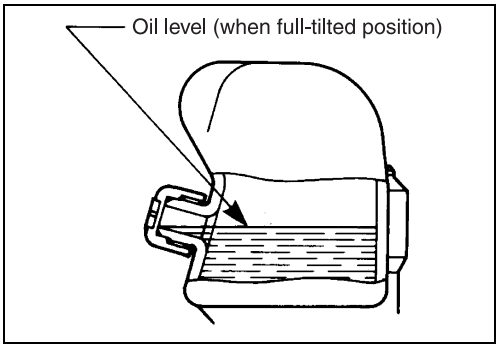
AIR BLEEDING

(Air bleeding on unit as alone)

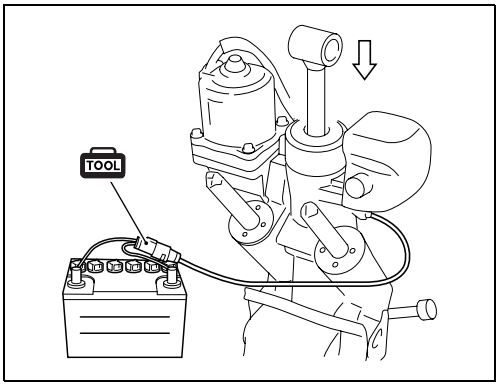
Before installing the PTT unit on the outboard motor, use the following procedure to bleed air from the system.

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.

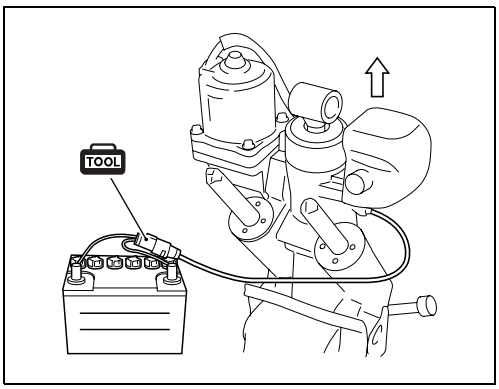
09945-79310: PTT cable extension



5. Connect the two extension cable lead wires (G to pos./Bl 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 (Bl to pos./G 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:

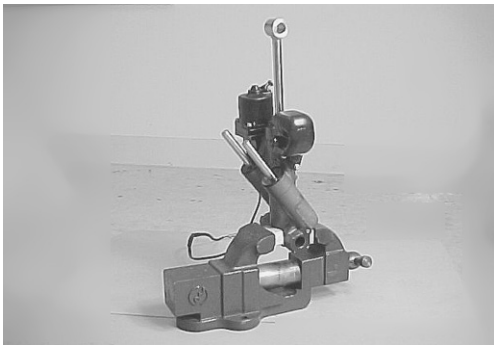
Repeat the air bleeding procedure after the PTT unit has been installed on the outboard motor.

(For air bleeding, see page 8-3.)

PTT MOTOR

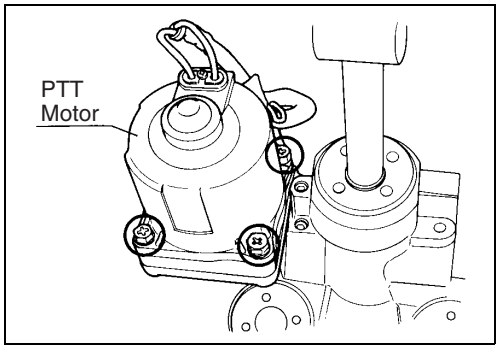
REMOVAL

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.



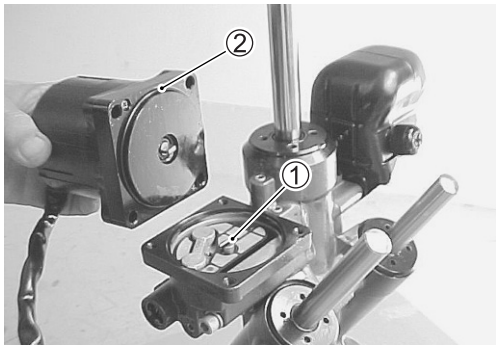
Place the lower of the PTT unit in a vise.
Tighten the vise only enough to secure the PTT unit, DO NOT OVER TIGHTEN.

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.



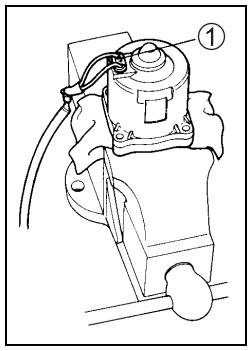
Remove the four (4) screws securing the PTT motor to the PTT pump case.

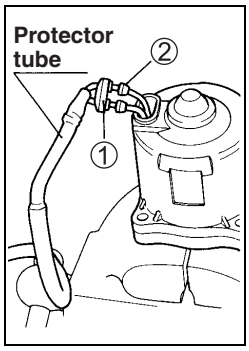
Detach the PTT motor from PTT pump case.
Note the position of drive joint ① and O-ring ② and remove them.



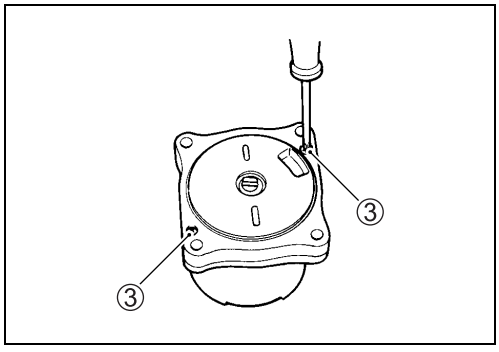
PTT MOTOR DISASSEMBLY

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.



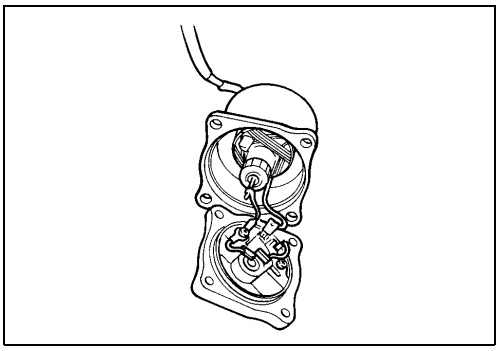


Remove the two (2) screws ③ securing the field case to the brush holder.

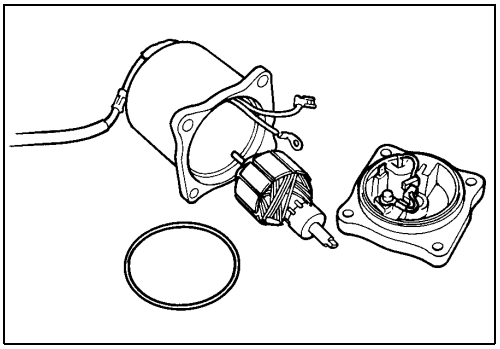


Slide the field case upward and away from the brush holder.

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.



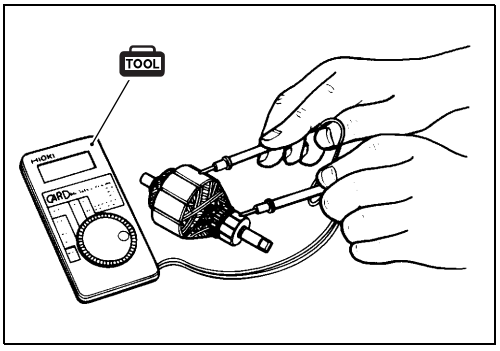
INSPECTION

Armature and commutator

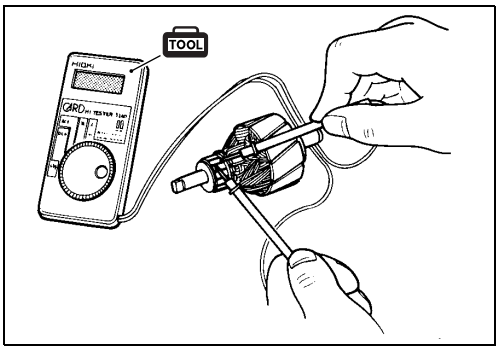
Check for continuity between the commutator and the armature core/shaft.
Replace armature if continuity is indicated.

09930-99320: Digital tester

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.



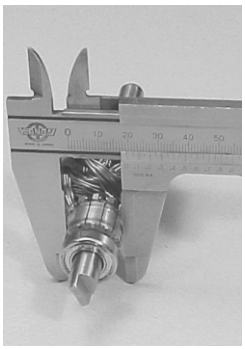
Measure commutator outside diameter.

09900-20101: Vernier calipers

Commutator outside diameter:

Standard	**22.0 mm (0.87 in)**
Service limit	**21.0 mm (0.83 in)**

If measurement exceeds service limit, replace armature.



Ensure that the mica (insulator) between commutator segments is undercut to specified depth.

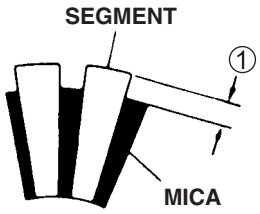
Commutator undercut:
Standard 1.6 – 1.9 mm (0.06 – 0.07 in)
Service limit 1.0 mm (0.04 in)

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 glasses when using compressed air.



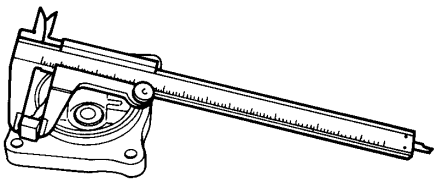
① **Commutator undercut**

Brushes
Check the length of each brush.

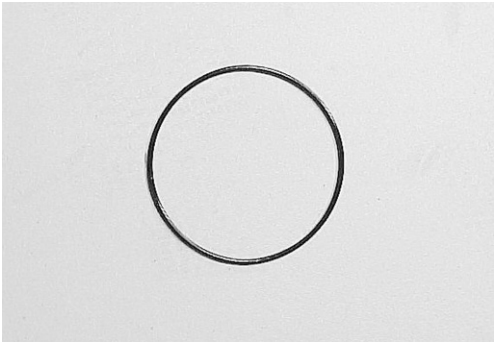
TOOL 09900-20101: Vernier calipers

Brush length:
Standard 9.8 mm (0.39 in)
Service limit 5.5 mm (0.22 in)

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

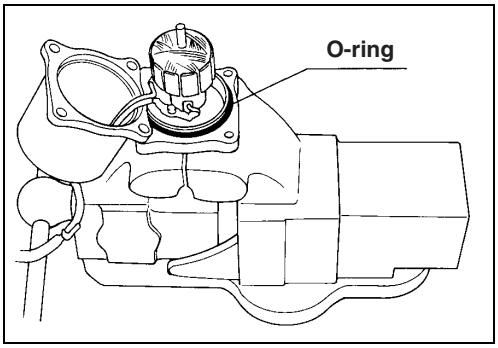


O-Ring
Inspect the O-ring between the PTT motor and PTT pump case. Replace if cuts, nicks or tears are found.

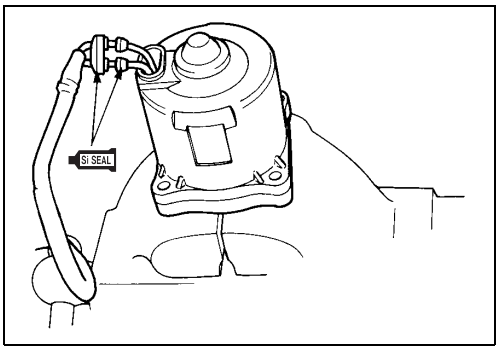


ASSEMBLY
Assembly is reverse of disassembly with special attention to following steps.

- 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.



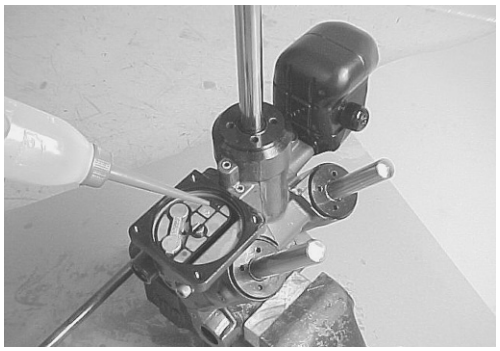
- Apply silicone seal to PTT motor cable holder and grommets and install cable holder screw.



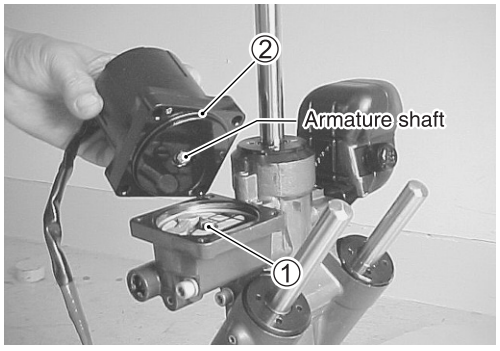
PTT MOTOR INSTALLATION

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 pump case. If level is low, add recommended PTT fluid until level with mating surface of PTT motor.



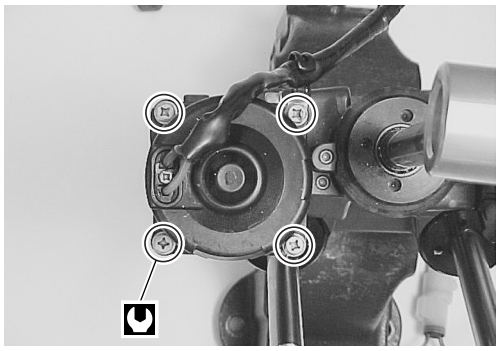
- Ensure that the faces of the PTT motor and pump unit are free of dirt or debris.
  When attaching the PTT motor to the PTT pump case, ensure that the tip of armature shaft fits firmly into the drive joint ①.



- Tighten the four (4) screws to specified torque.

PTT motor screw: 5 N·m (0.5 kg-m, 3.6 lb-ft)

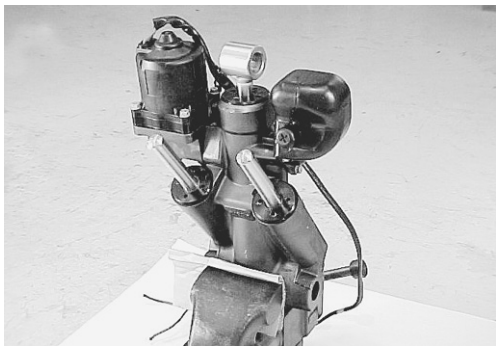
- Pour recommended PTT fluid into reservoir until specified level.
- Perform the air bleeding procedure.
  For air bleeding, see page 8-12.



INSTALLATION

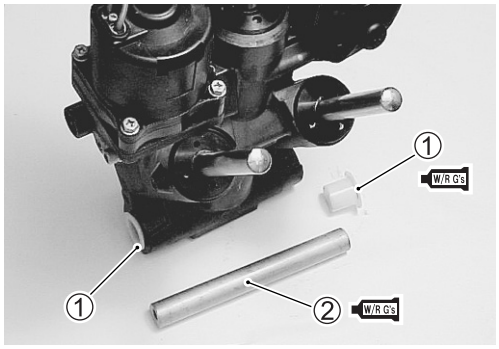
Installation is reverse order of removal with special attention to the following steps.

Lower tilt rod to full down position.



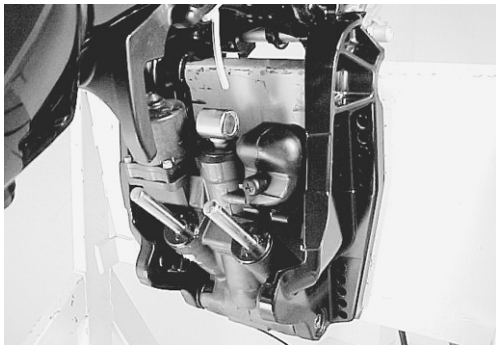
Apply Water Resistant Grease to the tilt cylinder lower shaft and lower shaft bushes.
Install bushes ① and cylinder lower shaft ② to PTT unit.

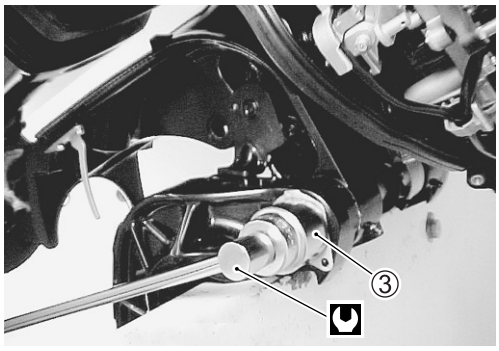
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



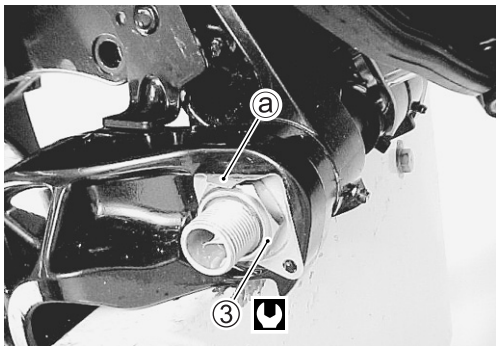
Place the PTT unit in position between the clamp brackets.
Tighten the clamp bracket shaft nut ③ to specified torque.

Clamp bracket shaft nut: 43 N·m (4.3 kg-m , 31.0 lb-ft)





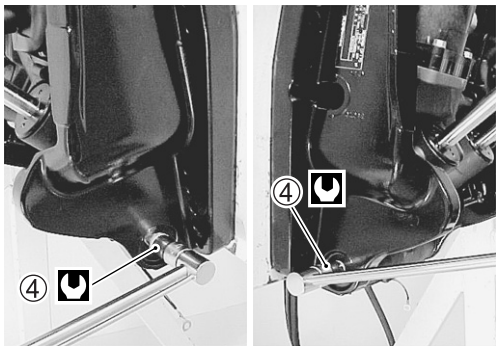
NOTE:
After tightening clamp bracket shaft nut ③ with specific torque, bend lock washer edge ⓐ toward nut for locking.



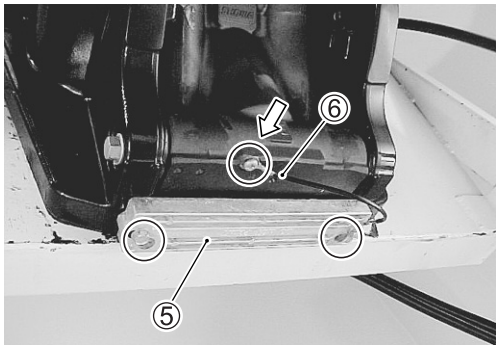
Tighten two (2) PTT cylinder lower shaft bolts ④, pre-coated with thread lock, to specified torque.

1342 99000-32050: THREAD LOCK "1342"

PTT unit retaining bolt: 50 N·m (5.0 kg-m, 36.0 lb-ft)

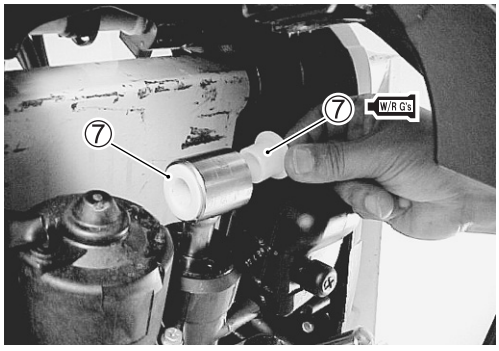


Install anode ⑤, then tighten bolts securely.
Install bonding wire ⑥, then tighten screw securely.



Apply Water Resistant Grease to tilt rod upper bushes ⑦, 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.

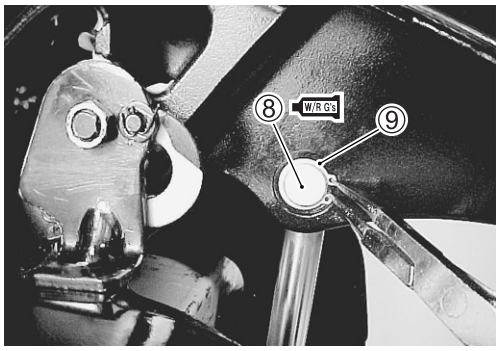
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



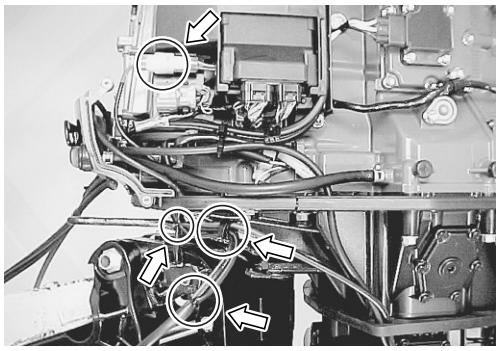
Apply Water Resistant Grease to the PTT rod upper shaft ⑧, then insert the shaft through the swivel bracket and tilt rod.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Secure the upper shaft with the snap ring ⑨.



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 11-4 to 11-10.)



PTT MOTOR RELAY

INSPECTION

1. Disconnect battery cable from battery.
   Remove the electric parts holder. (See page 4-30.)
2. Disconnect all cables/lead wires from PTT relay.
3. Check resistance between each two (2) lead wires.

09930-99320: Digital tester

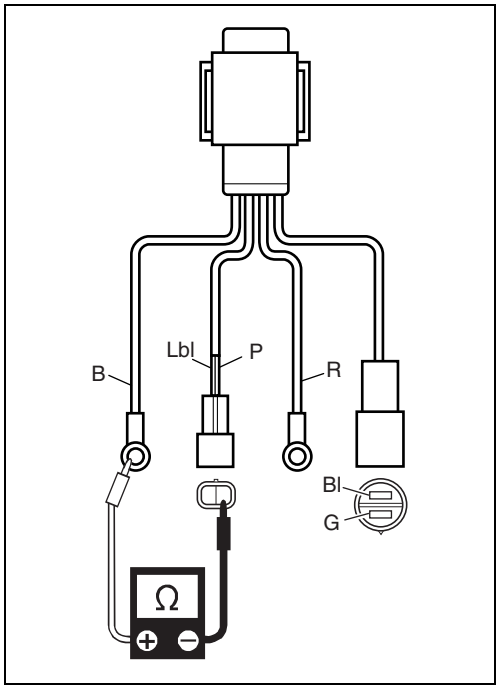
Tester range: Ω (Resistance)

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

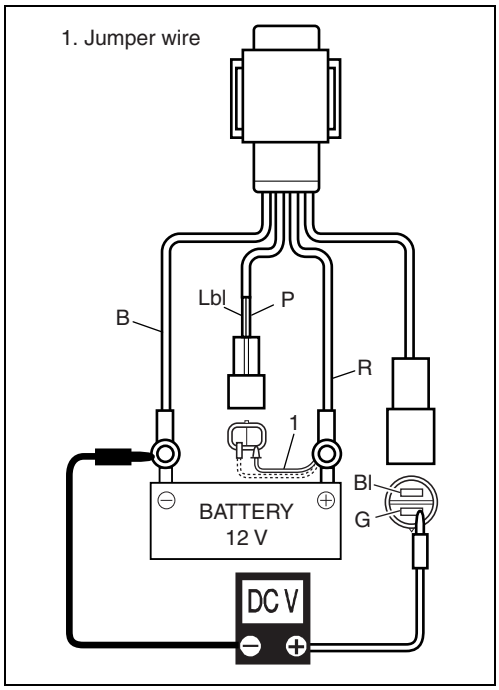
Tester range: DCV

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.



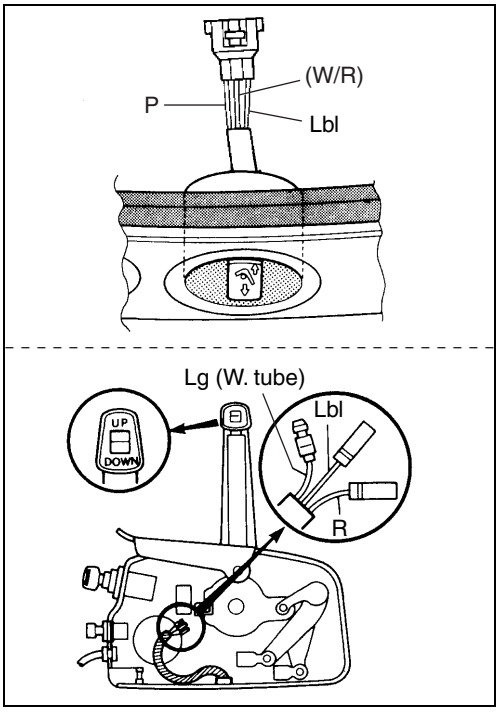
PTT SWITCH

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

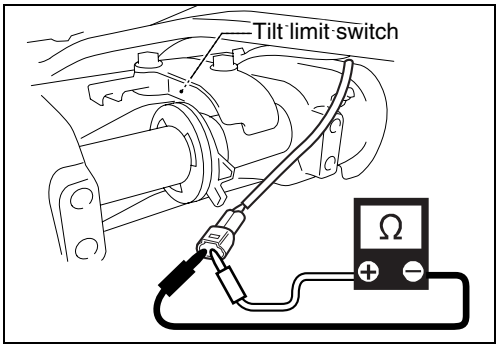
Test continuity between wires.

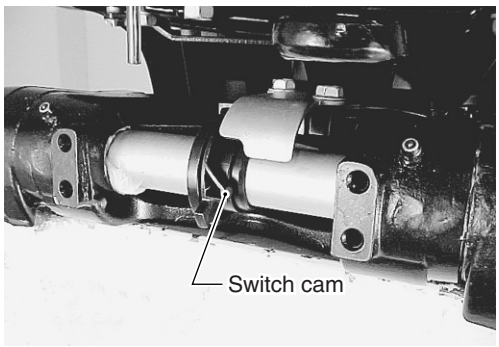
If found defective, replace switch.

09930-99320: Digital tester

Tester range: (Continuity)

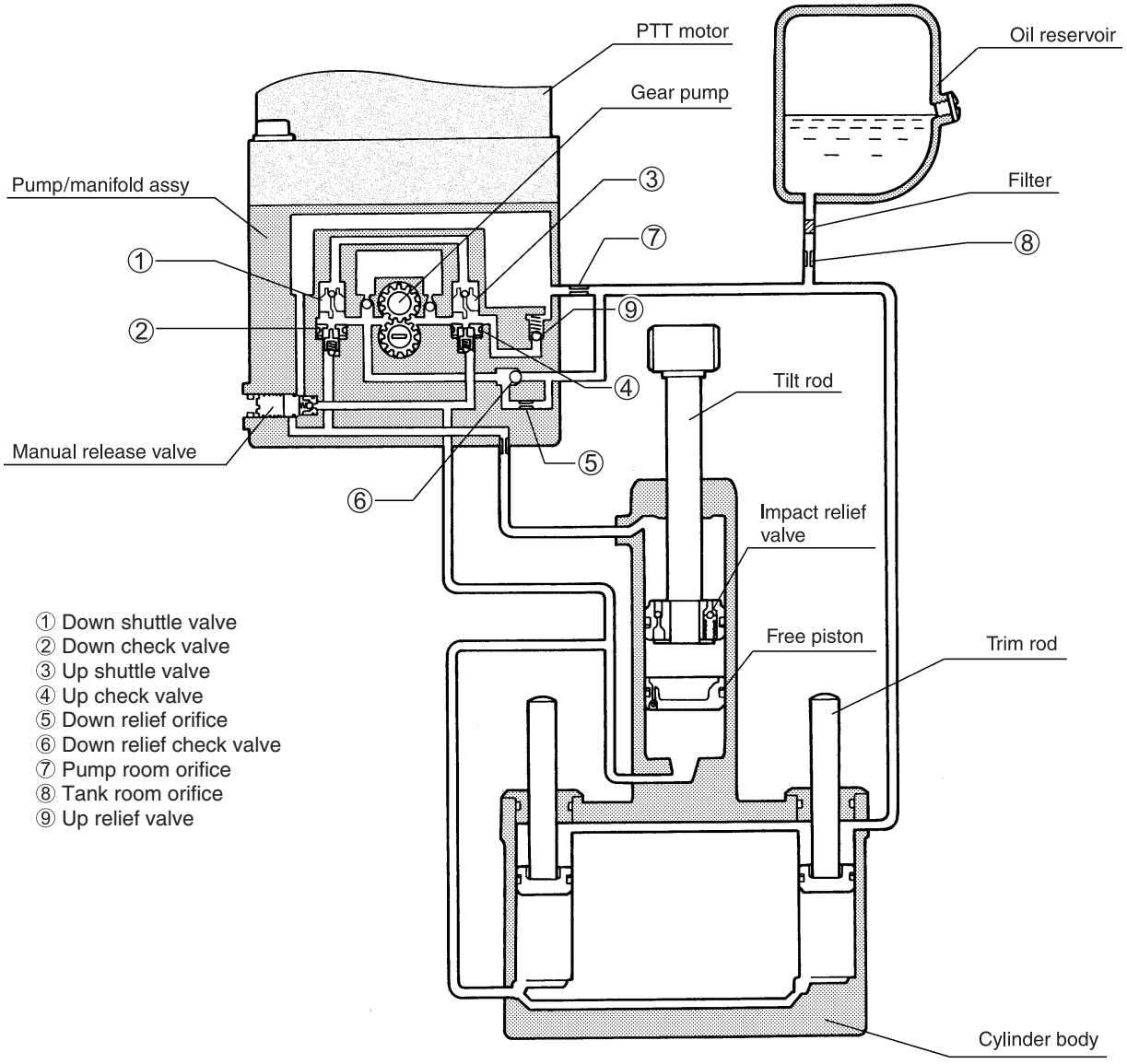
Push the switch actuator plate. (Full tilt up position)	No continuity
Release the switch actuator plate. (Except for full tilt up position)	Continuity





OPERATION

COMPONENT PARTS



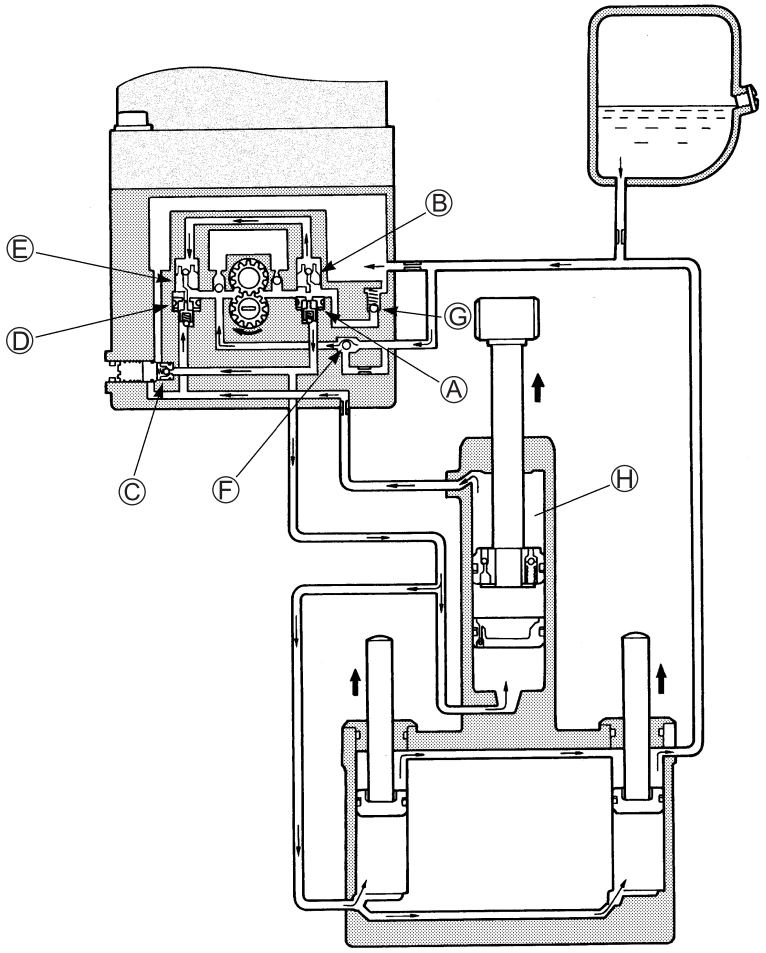
* When the manual valve is to be opened, turn the manual release valve to the left about two turns.
* When the oil level of the system should be checked, inspect the reservoir by placing the motor in the maximum tilt up position.

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.

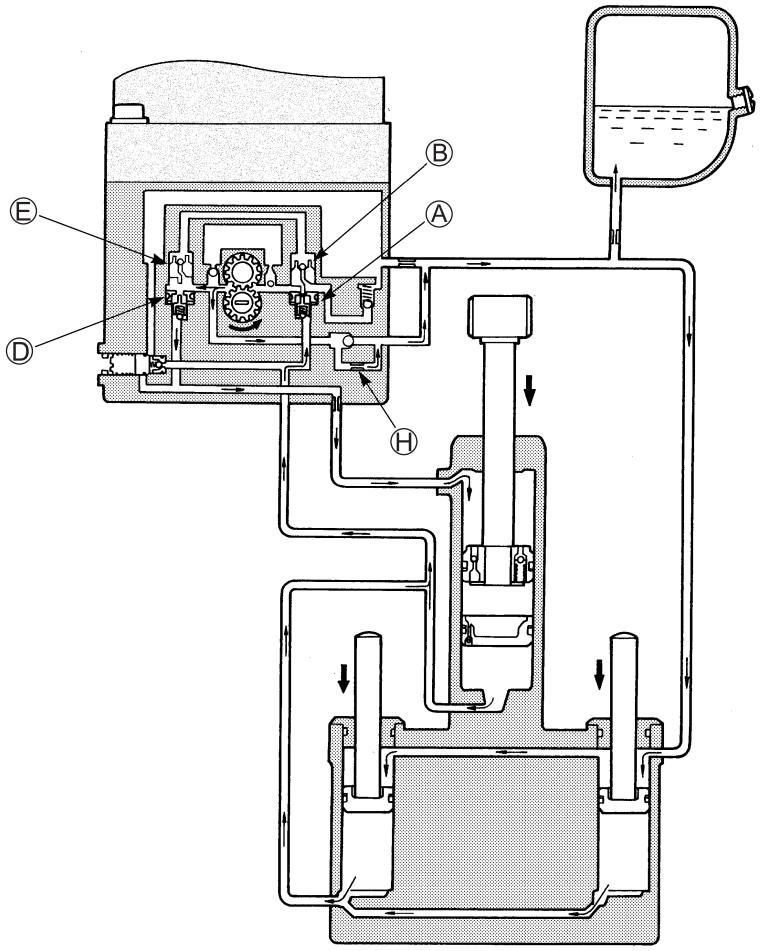
TRIM & TILT UP

(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 pump through “Down” check valve Ⓓ.
(5) Any oil in the area above both trim cylinder pistons will be returned to the reservoir.
(6) Oil will then flow from the reservoir to the 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, this pressure forces the trim pistons downward and oil from the reservoir is then able to enter the area above both trim rod pistons.
(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 orifice Ⓗ.
(7) Throughout trim operation range, oil will be discharged from the bottom of all three cylinders and the pump will only supply oil to the tilt cylinder. Excess oil is then vented to the reservoir through the “Down” relief orifice Ⓗ.
(8) To prevent damage from excessive oil pressure when all three rods are fully retraced, this pressure is relieved through the “Down” relief orifice Ⓗ.

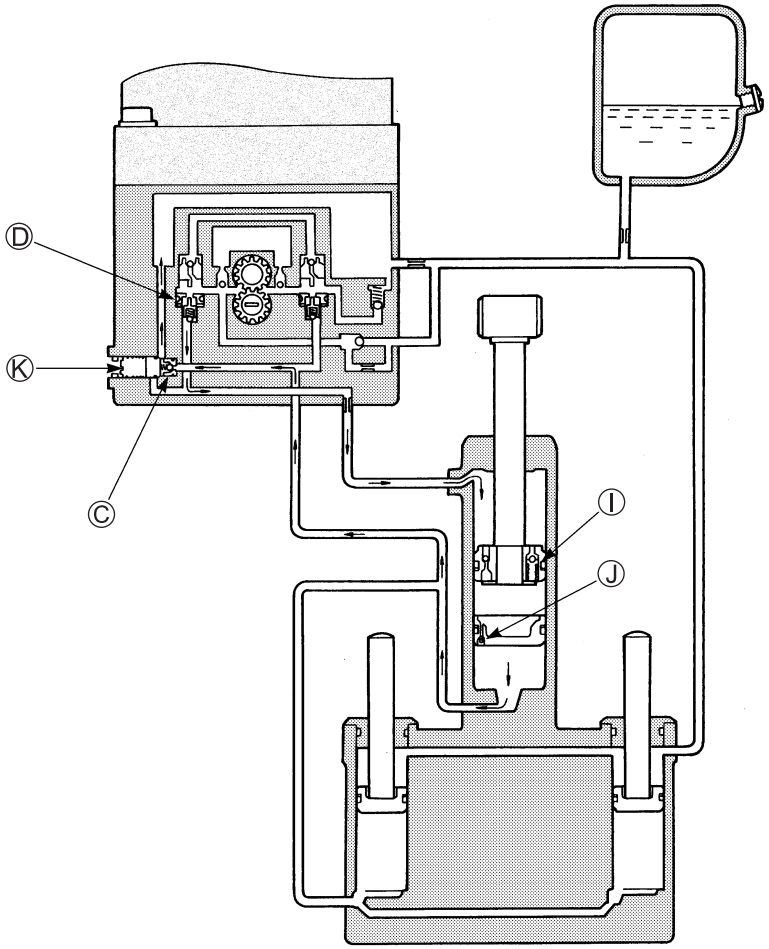


TILT SYSTEM PRESSURE RELIEF

(1) If engine speed exceeds approx. 1 500 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 Ⓒ.

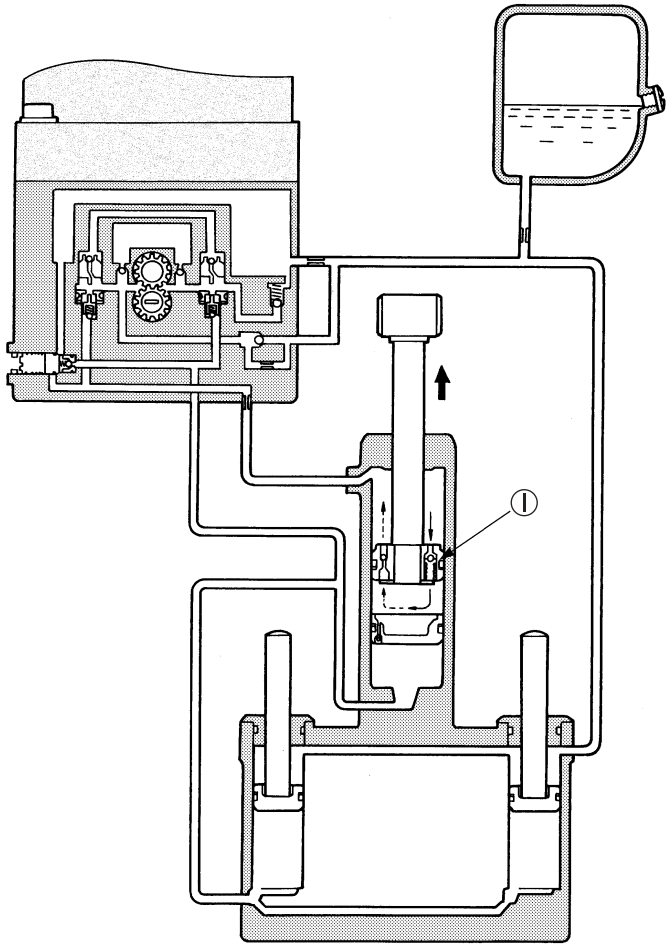


SHOCK ABSORBER CIRCUIT

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 ① 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.

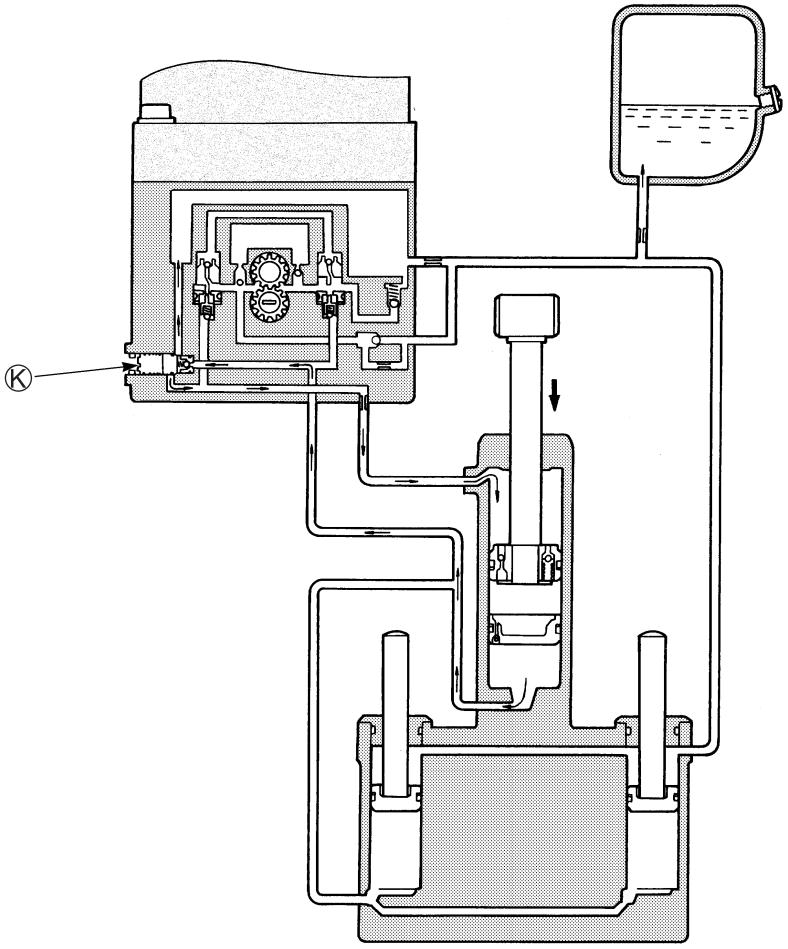
(2) When the moment of impact has passed, the PTT DOWN switch must be activated to return the engine to within the normal trim range. When the switch is pressed, the oil between the piston and free piston will be directed to the cylinder upper chamber via the return valve below the tilt piston.



MANUAL RELEASE CIRCUIT (DOWN MODE)

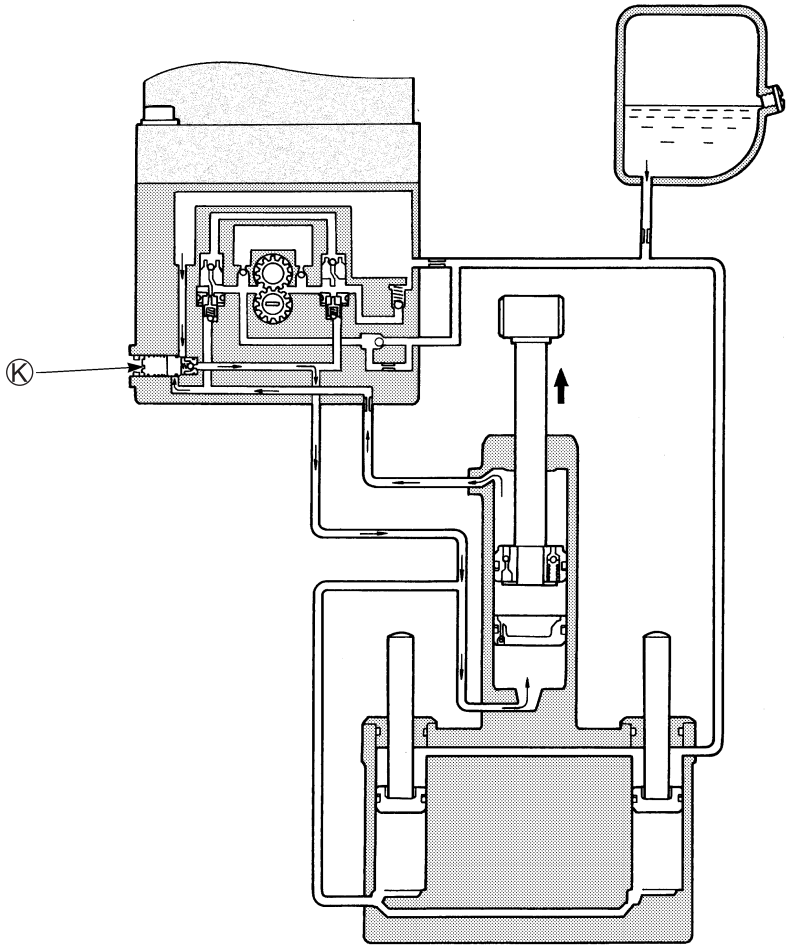
(1) By opening the manual release valve Ⓚ, the engine can be lowered manually to a running position. Oil underneath the trim and tilt pistons will be directed through this valve into the area above the tilt rod piston.

(2) The volume of oil flowing from under the trim rod pistons 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]

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DRIVESHAFT 9-12
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TRIM TAB 9-25
LOWER UNIT GEARS- SHIMMING AND ADJUSTMENT 9-26

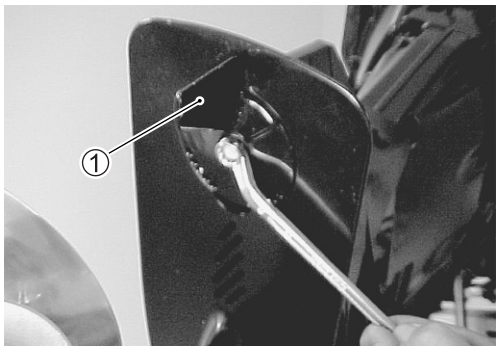
9

REMOVAL & DISASSEMBLY

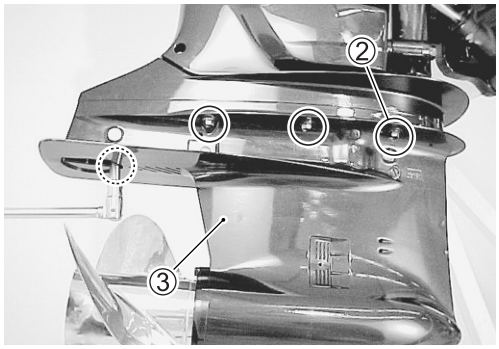
⚠ WARNING

Always disconnect the battery cable, before removing lower unit.

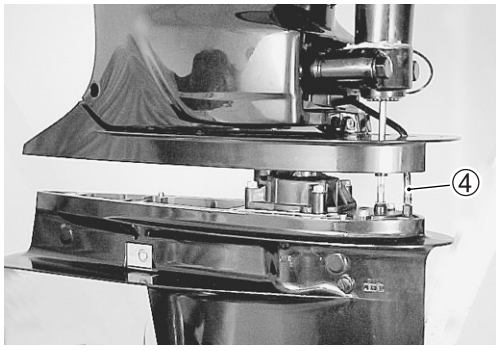
Shift to “NEUTRAL” position.
Remove bolt and trim tab ①.



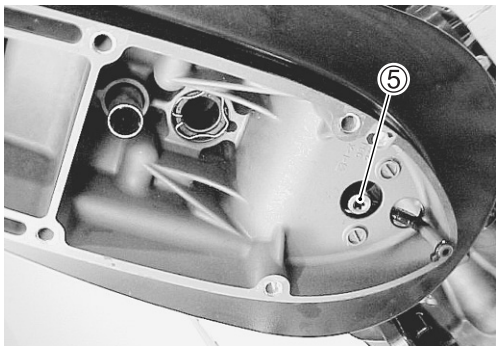
Remove seven (7) bolts ② and separate gearcase ③ from driveshaft housing.



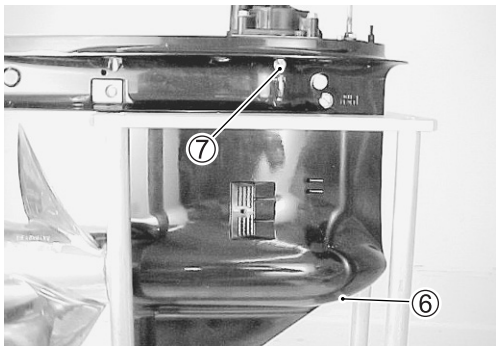
NOTE:
Before gearcase is removed completely, disconnect speedometer pick up tube ④ from gearcase.



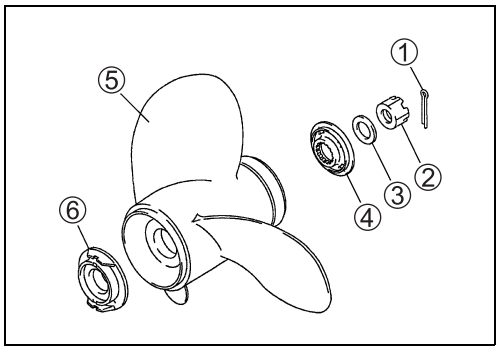
Remove clutch rod ⑤ from clutch shaft (if necessary).



Place a drain pan under oil drain plug.
Remove oil drain plug ⑥ first then air vent plug ⑦ and allow gear oil to drain.
Inspect oil for water, contaminates or metal.

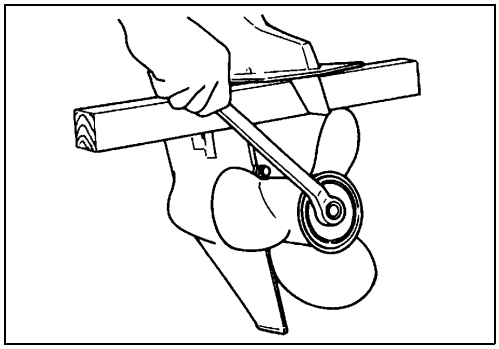


Remove cotter pin ① from propeller nut and remove propeller nut ②.
Remove washer ③, spacer ④, propeller ⑤ and stopper ⑥ from the propeller shaft.

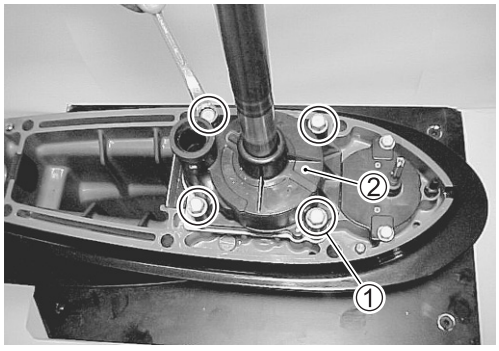


⚠ WARNING

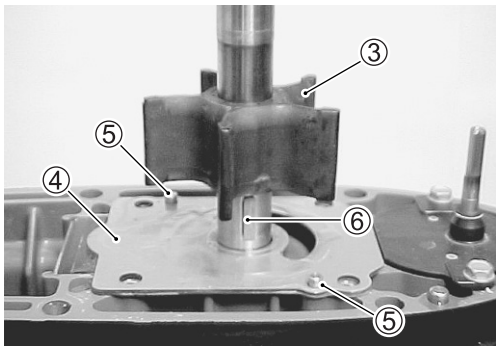
To prevent injury from propeller blades, wear gloves and place a block of wood between the anti-cavitation plate and the propeller blade tips to lock the propeller in place before attempting to remove propeller nut.



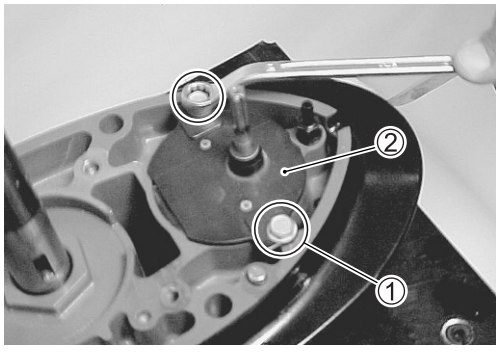
Loosen four (4) bolts ①, then remove water pump case ②.



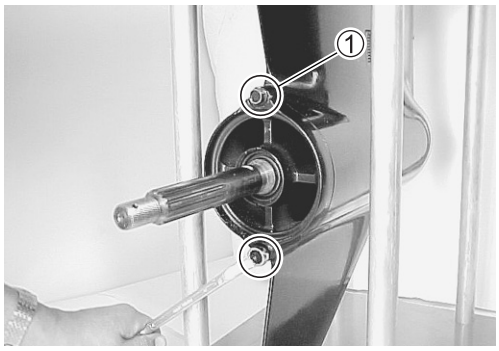
Remove impeller ③, impeller key ⑥, pump under plate ④ and dowel pins ⑤.
Keep impeller key ⑥ for reuse and discard the plate gasket.



Remove two (2) bolts ① and shift rod guide housing assembly ②.

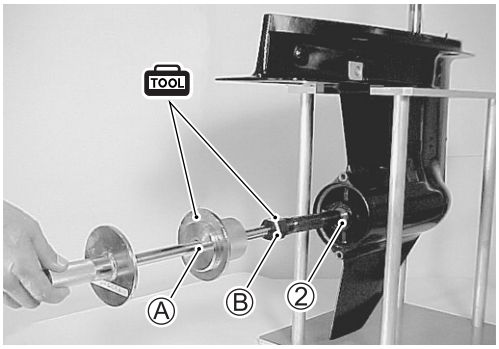


Remove two (2) bolts ① securing the propeller shaft bearing housing to the gearcase.



Using special tools, pull out the propeller shaft bearing housing. Remove the propeller shaft and bearing housing assembly ②.

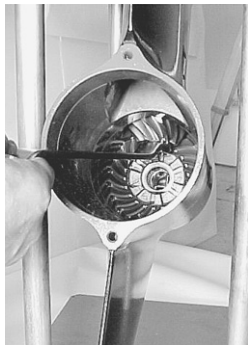
TOOL **09930-30104: Ⓐ Sliding hammer**
09930-30161: Ⓑ Propeller shaft remover

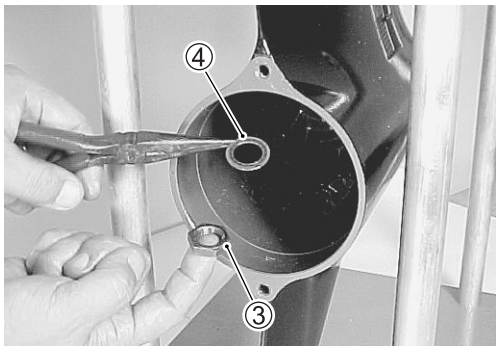


Hold the pinion nut securely, then fit special tool to the driveshaft and loosen the pinion nut.
Remove pinion nut ③ and washer ④.

TOOL **09921-29410: Driveshaft holder**

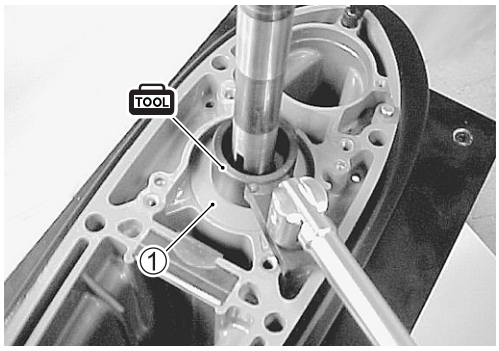




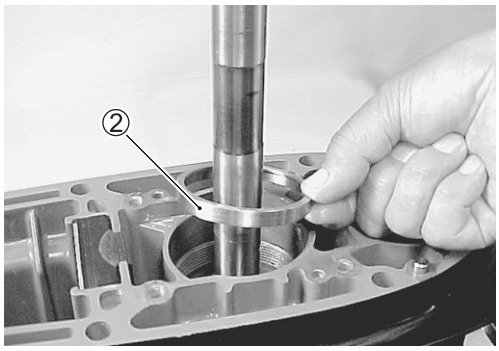


Use special tool to unscrew driveshaft oil seal housing ①, then remove oil seal housing from drive shaft.

TOOL **09926-29310: Driveshaft housing remover**

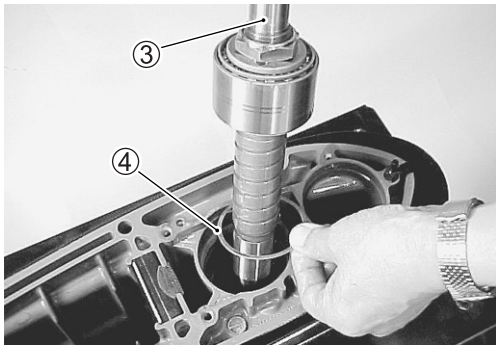


Remove driveshaft bearing spacer ②.

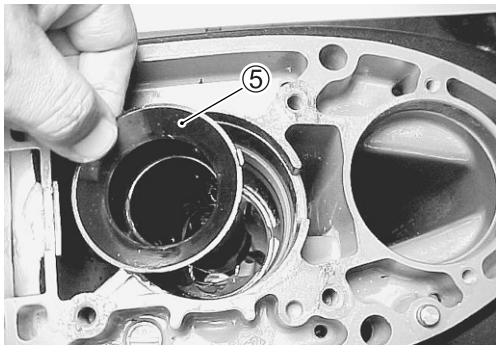


Slowly lift out driveshaft assembly ③.
Remove the pinion shim ④.

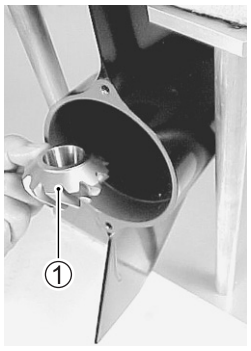
NOTE:
The driveshaft pinion gear bearing contains 22 loose roller bearings. Account for all roller bearings on disassembly.

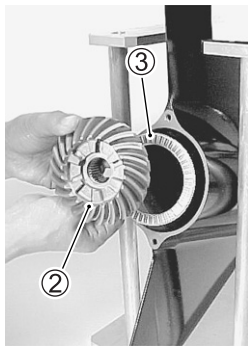


Remove the driveshaft collar ⑤.

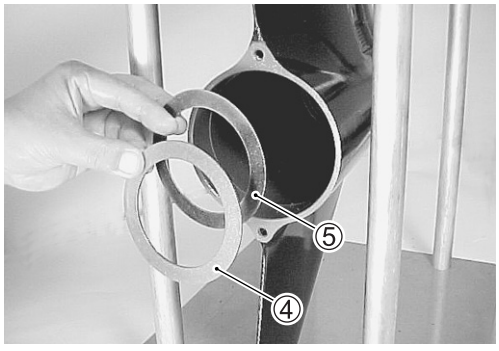


Remove the pinion gear ①.
Remove the forward gear ② and thrust bearing ③.



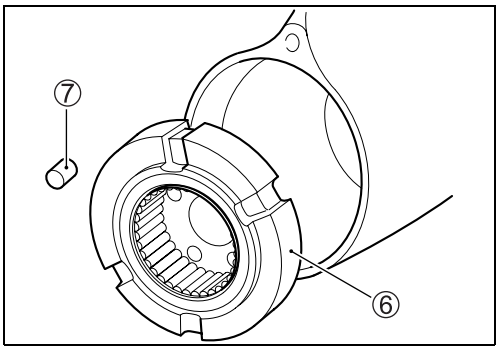


Remove the bearing thrust washer ④ and back-up shim ⑤.

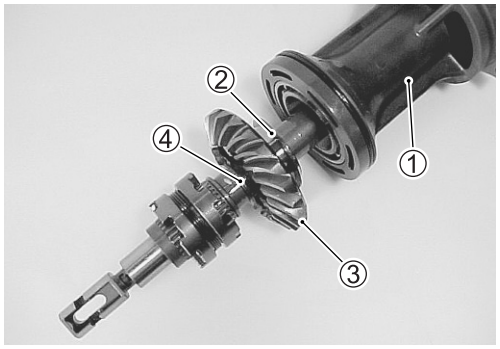


Remove the forward gear bearing housing ⑥.
Account for dowel pin ⑦.

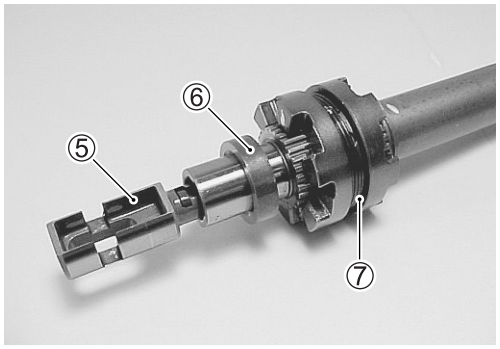
NOTE:
The forward gear radial bearing contains 35 loose roller bearing. Account for all roller bearings on disassembly.



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.

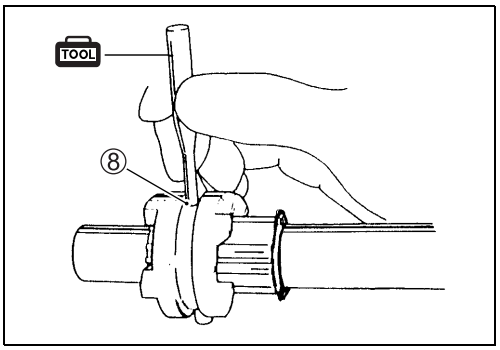


To disassemble propeller shaft components, refer to following:
(a) Remove horizontal slider ⑤ and forward gear thrust washer ⑥.
(b) Remove spring ⑦ from clutch dog shifter.

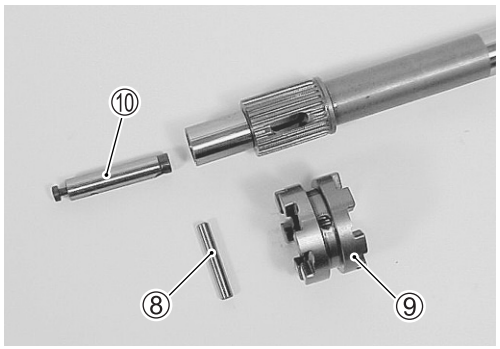


(c) Use special tool to push the dog pin ⑧ out of the clutch dog shifter.

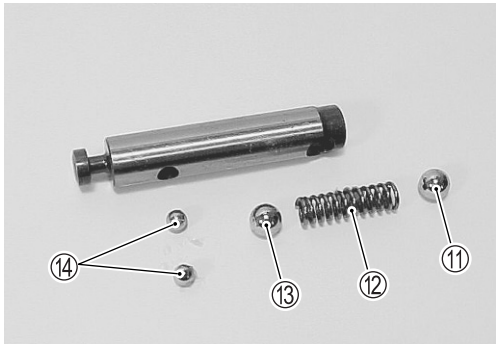
09922-89810: Shift pin remover



(d) Remove clutch dog shifter ⑨ and connector pin ⑩ from propeller shaft.



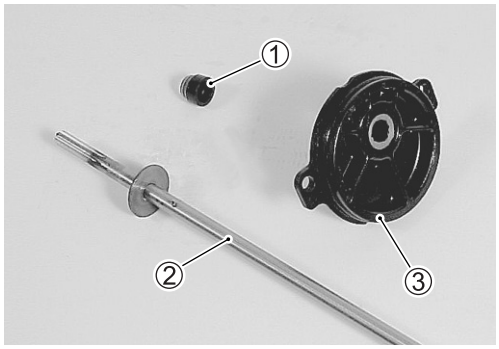
(e) Remove large detent ball ⑪, detent spring ⑫, large detent ball ⑬ and two (2) small detent balls ⑭ from connector pin.



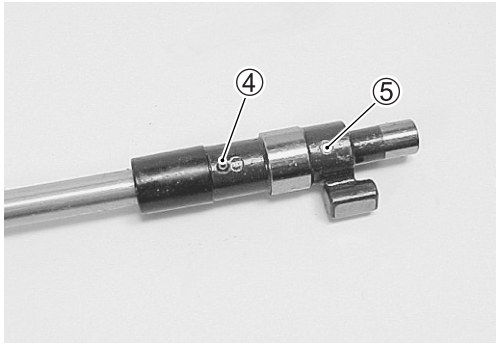
Disassembly of shift rod components

(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.

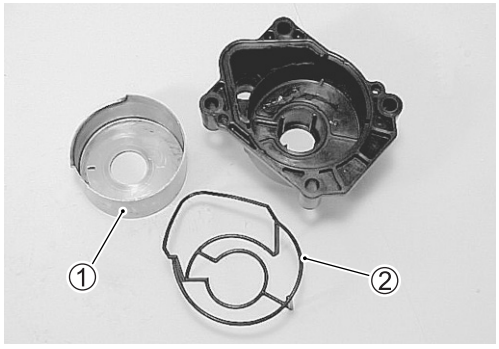


Disassembly of water pump case

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

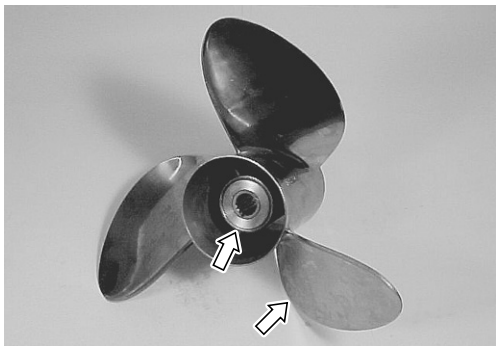
NOTE:
If any component is worn excessively, cracked, defective or damaged in any way, it must be replaced.

NOTE:
Thoroughly wash all metal components with cleaning solvent and dry with compressed air.

⚠ WARNING

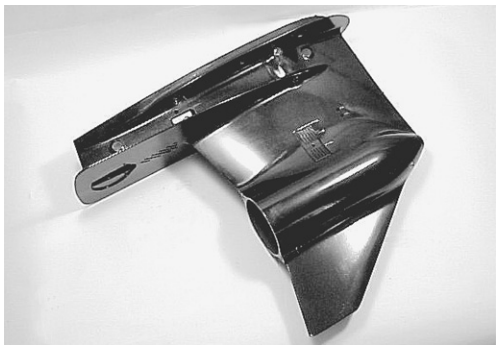
Wear safety glasses when using compressed air.

PROPELLER



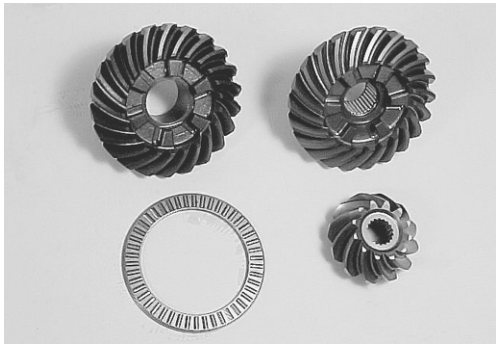
- Inspect propeller for bent, chipped or broken blades. Replace or repair propeller if in damaged condition.
- Inspect propeller bush splines. Replace or repair propeller if splines are worn or damaged.
- Inspect propeller bush for deterioration or slipping. Replace if necessary.

GEARCASE



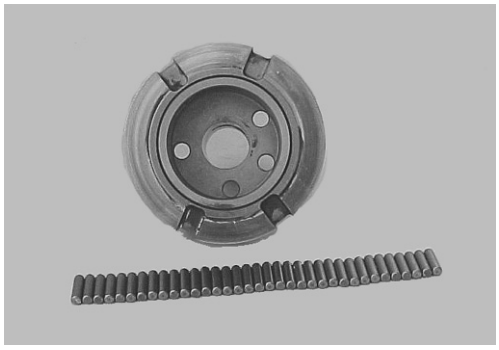
- Inspect the gearcase. Replace if cracked, damaged or other abnormal condition.
- Visually check the pinion bearing. Replace gearcase if pitted, rough or other abnormal condition.

GEARS/BEARING



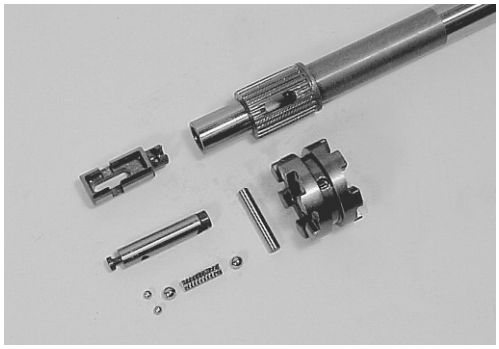
- Inspect forward, reverse and pinion gear teeth and engaging dogs.
  Replace gears if damaged, worn or other abnormal condition.
- Inspect propeller shaft forward bearing, forward gear thrust bearing.
  Replace bearing if pitted, noisy, rough or other abnormal condition.

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.

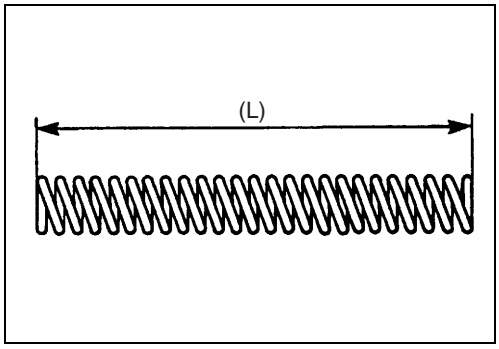
PROPELLER SHAFT COMPONENTS



- 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: 25.0 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.





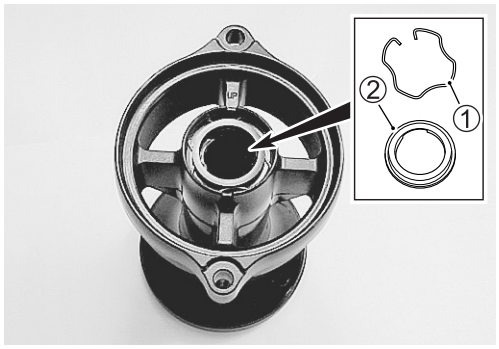
Replacing propeller shaft oil seal

1. Remove retaining ring ① and oil seal protector ②.
2. Extract seals ③ with oil seal remover.

TOOL 09913-50121: Oil seal remover

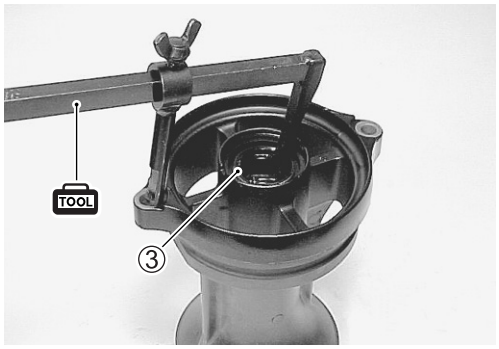
CAUTION

Do not reuse oil seal once removed.
Always use new oil seal.

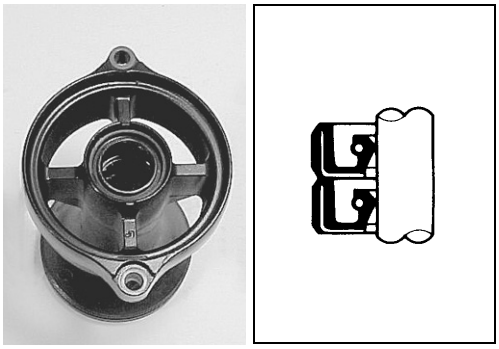


3. Apply Water Resistant Grease to the inner circumference of the housing.
4. Using an oil seal installer, drive the two oil seals (one at a time) into the propeller shaft bearing housing.
   The lipped portion of the seal must face towards the propeller.
   Apply Water Resistant Grease to the seal lips.

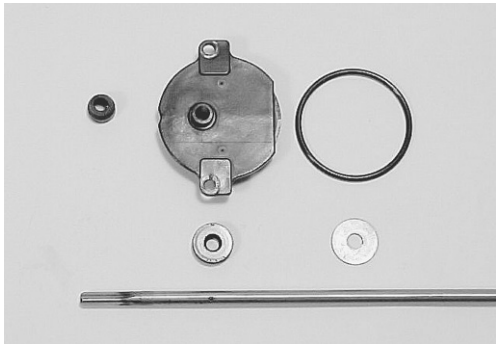
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



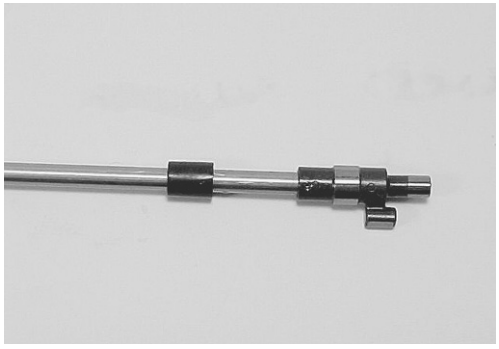
5. Install the oil seal protector and retaining ring.



SHIFT ROD GUIDE HOUSING COMPONENTS

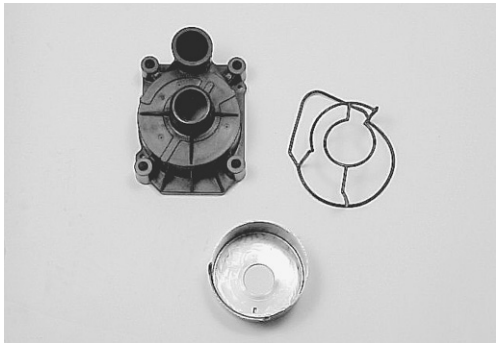


- Inspect shift rod guide housing. Replace if cracked, damaged or other abnormal condition.
- Inspect shifter yoke. Replace if wear, damaged or other abnormal condition.
- Inspect shift rod/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect O-ring. Replace if nicked, cut, torn, swollen or other abnormal condition.

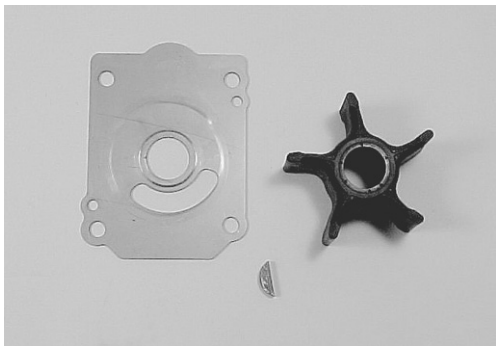


- Inspect oil seal and dust seal. Replace if nicked, cut, worn or other abnormal condition.

WATER PUMP AND RELATED ITEMS



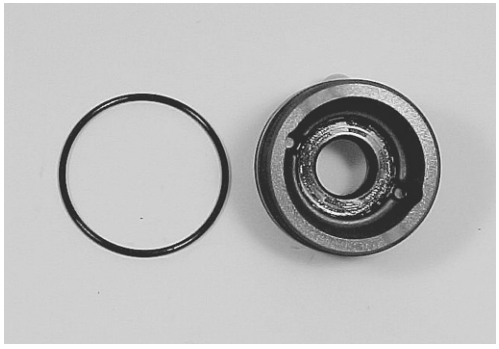
- Inspect impeller. Replace if vanes are cut, torn, worn or other abnormal condition.
- Inspect pump case. Replace if cracked, distorted or other abnormal condition.
- Inspect pump inner sleeve. Replace if worn, cracked, distorted, corroded or other abnormal condition.
- Inspect seal ring. Replace if 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.



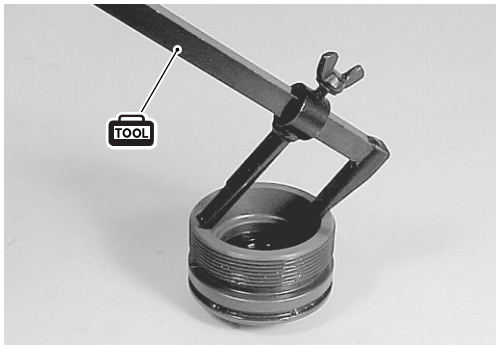
Replacing driveshaft oil seal

1. Using special tool, remove two (2) oil seals out of the driveshaft oil seal housing.

TOOL 09913-50121: Oil seal remover

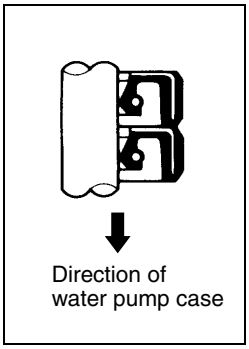
2. Apply Water Resistant Grease to inner circumference of driveshaft oil seal housing.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



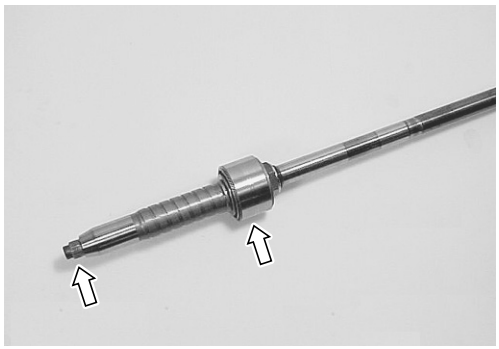
3. Grease the inner lips of oil seal. With the lips facing away from driveshaft bearing, place seal in position and drive it into the oil seal housing.

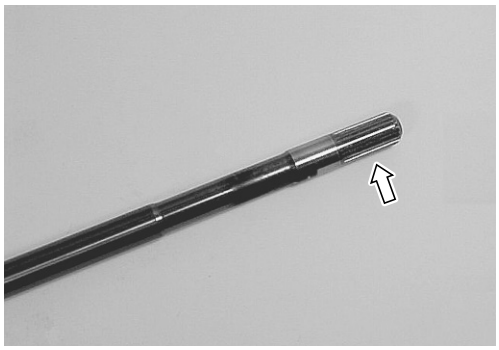




DRIVESHAFT

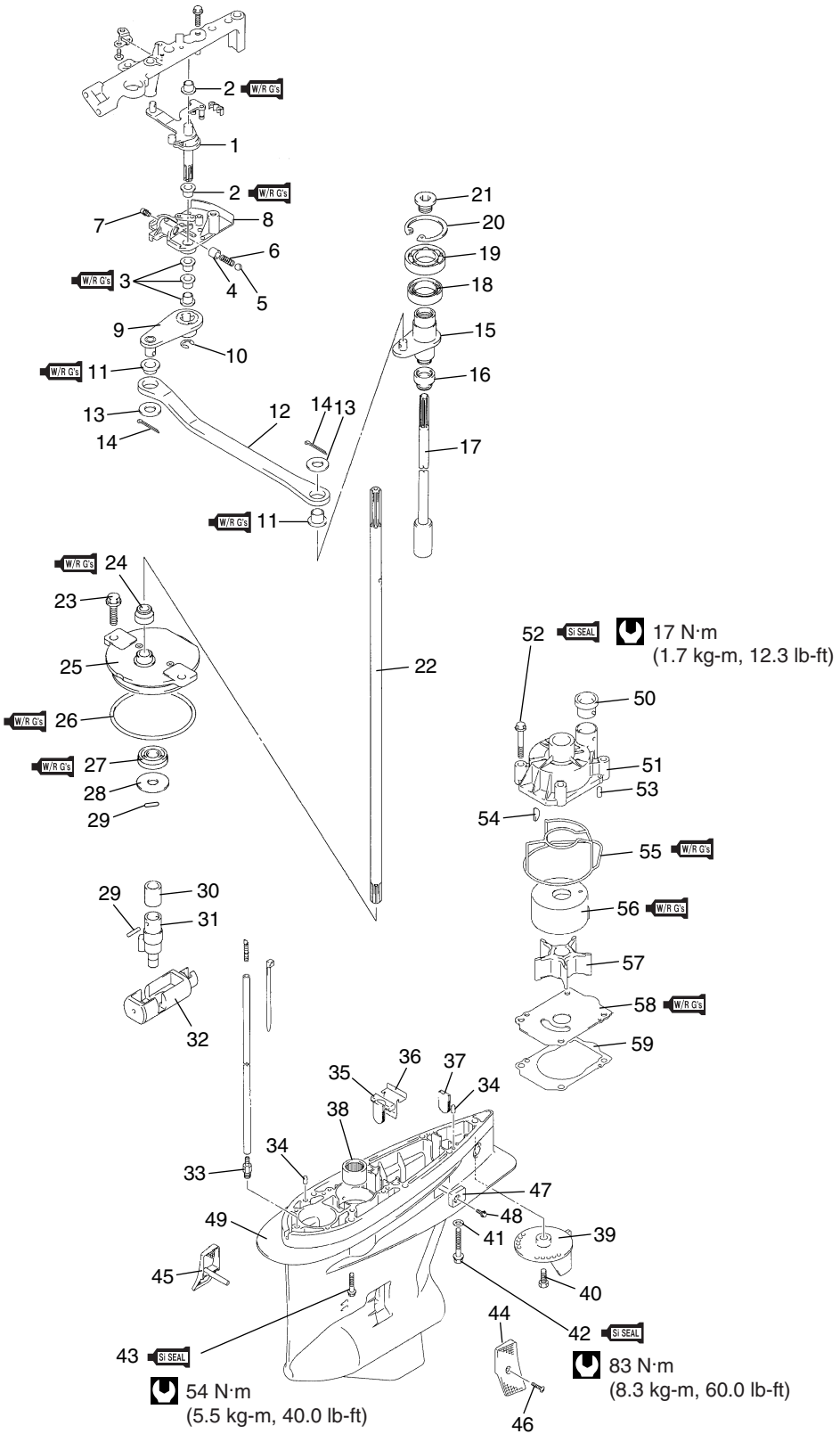
- Inspect driveshaft/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect driveshaft bearing, replace if pitted, noisy, rough or other abnormal condition.



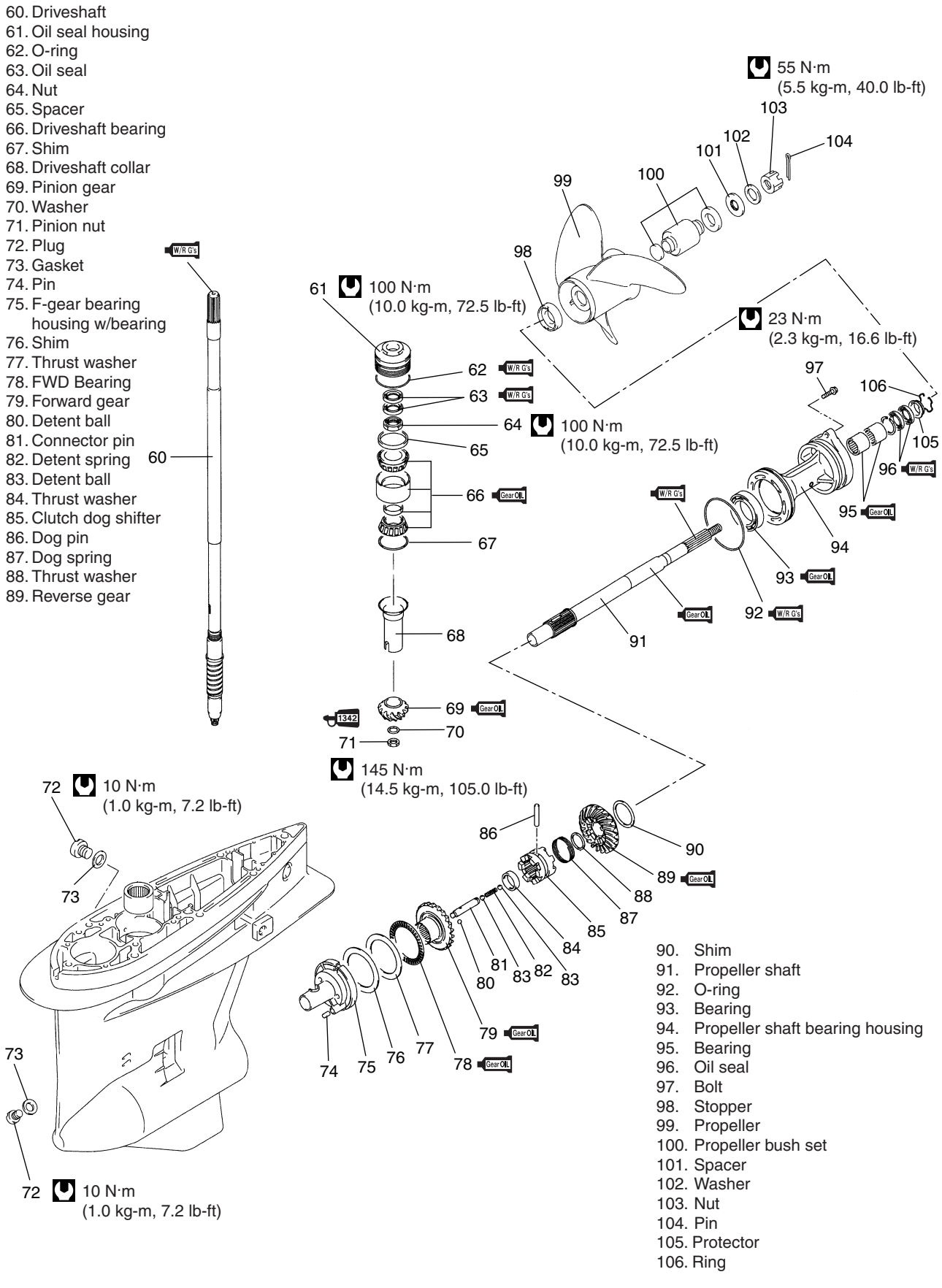


ASSEMBLY & INSTALLATION

Assembly & installation are reverse order of disassembly with special attention to the following steps.



1. Clutch lever
2. Bush
3. Bush
4. Pin
5. Ball
6. Spring
7. Grease nipple
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
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
105. Protector
106. Ring

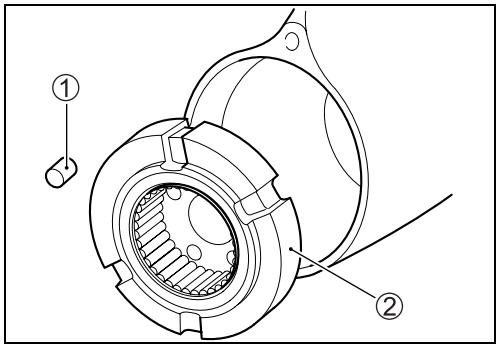
CAUTION

- **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.

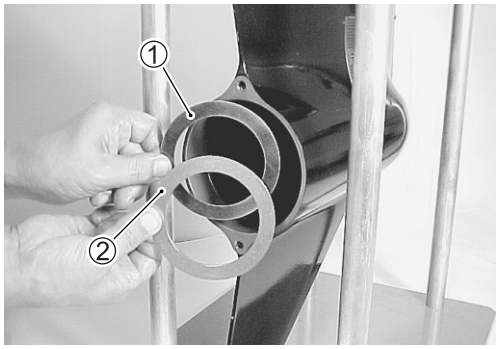
NOTE:
Before installing forward gear, check for correct amount and position of forward gear radial bearing rollers.
Use oil soluble grease to retain bearing rollers.

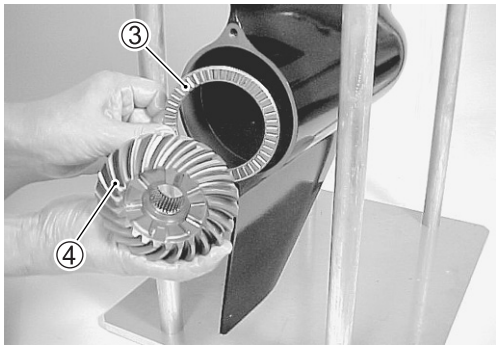


FORWARD GEAR

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**



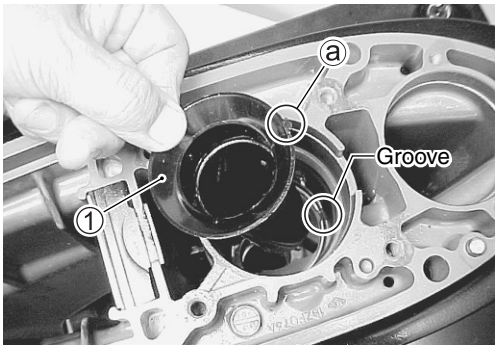


DRIVESHAFT COLLAR

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:

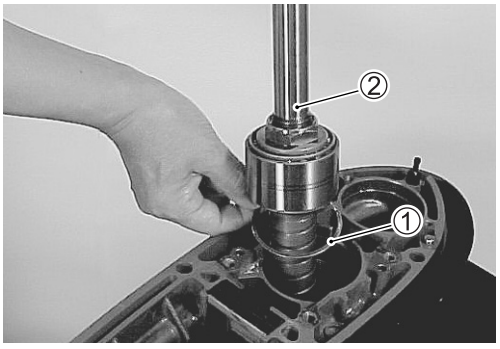
Before installing pinion gear, check for correct amount and position of pinion bearing rollers.

Use oil soluble grease to retain bearing rollers.



DRIVESHAFT

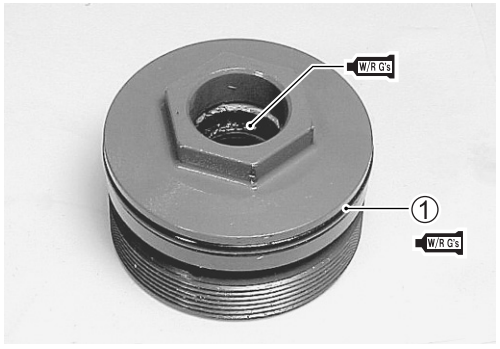
Install pinion shim ①, then lower the driveshaft assembly ② down into the gearcase until the bottom of shaft protrudes through center of pinion.



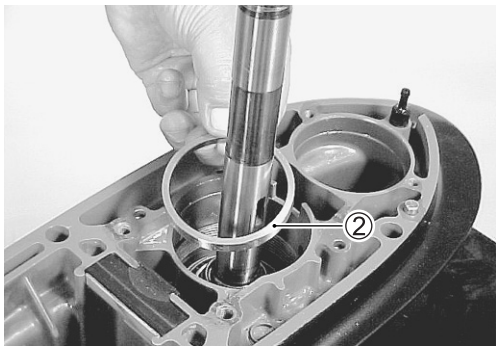
DRIVESHAFT OIL SEAL HOUSING

- 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**



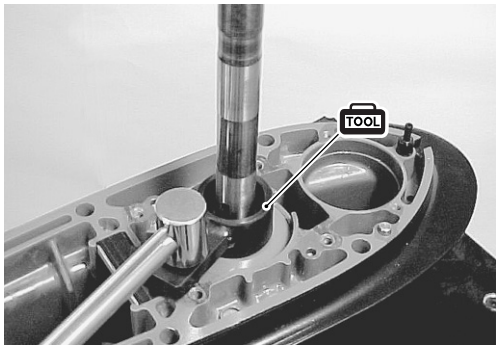
- Install driveshaft bearing spacer ②.



- Install driveshaft oil seal housing on gearcase, then tighten oil seal housing to specified torque.

Driveshaft oil seal housing: 100 N·m (10.0 kg-m, 72.5 lb-ft)

09926-29310: Driveshaft housing remover

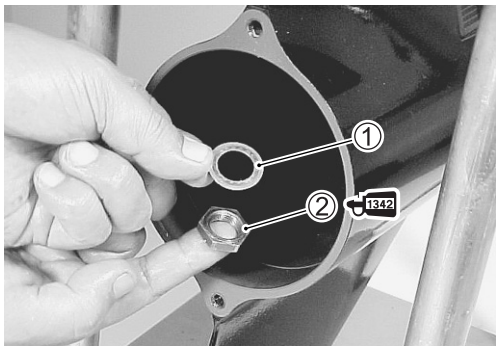


PINION NUT

- Apply THREAD LOCK "1342" to the threads of pinion nut ② before threading it onto driveshaft.

1342 99000-32050: THREAD LOCK "1342"

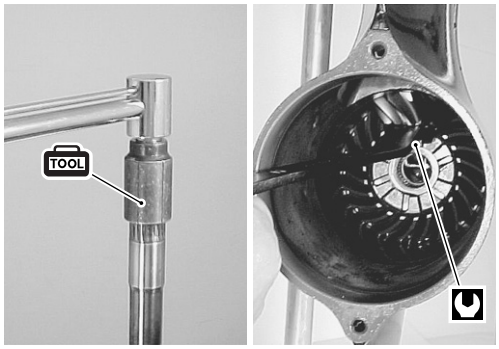
NOTE:
It is recommended the original pinion nut be used for the purposes of shimming during repair. A new pinion nut should be used on final assembly.



- Install washer ①, pinion nut ②, then tighten nut to specified torque.

Pinion nut: 145 N·m (14.5 kg-m, 105.0 lb-ft)

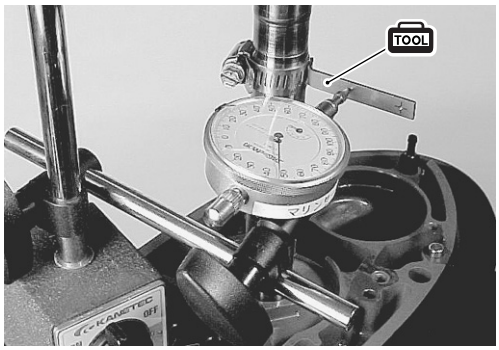
09921-29410: Driveshaft holder



CHECKING GEAR BACKLASH

Before installing reverse gear, gear backlash should checked. (See the "GEARS-SHIMMING AND ADJUSTMENT/Adjusting gear backlash" section on page 9-27.)

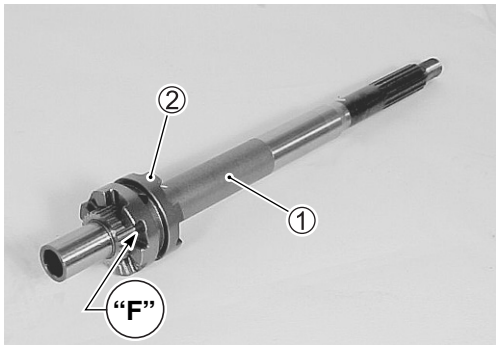
09952-09310: Backlash indicator tool



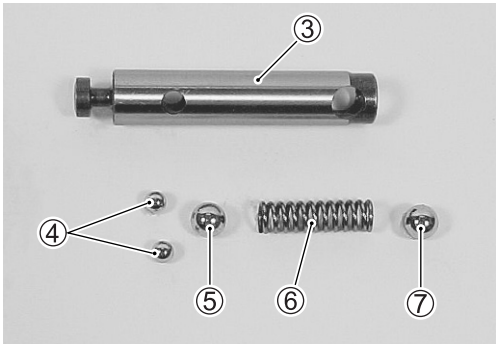
PROPELLER SHAFT

- Slide the clutch dog shifter ② onto the propeller shaft ①.

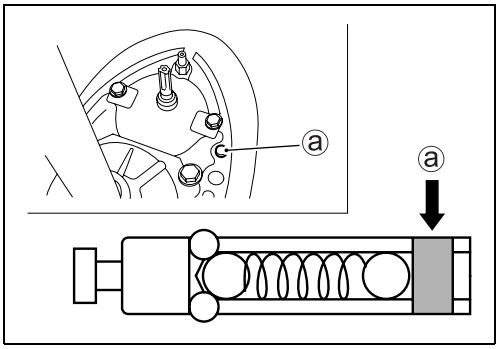
NOTE:
The side of the clutch dog shifter marked with the letter "F" must face towards forward gear.



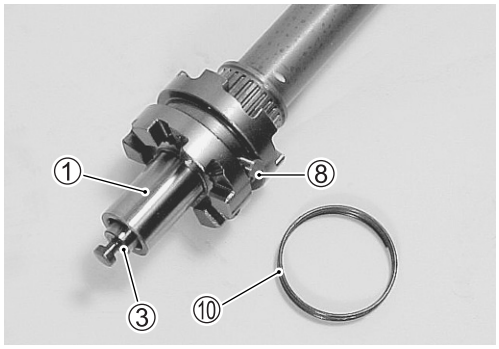
- Insert two (2) small detent balls ④, large detent ball ⑤, detent spring ⑥ and large detent ball ⑦ into connector pin ③.
  Then depress detent ball ⑦ and temporarily insert stopper pin ⓐ into dog pin hole of connector pin, as shown in right figure.



NOTE:
Temporarily insert a gearcase dowel pin ⓐ into the connector pin to prevent the detent ball from falling out.



- Insert the connector pin ③ (with 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.

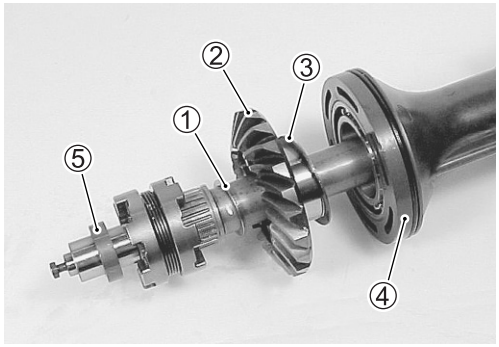


PROPELLER SHAFT/BEARING HOUSING

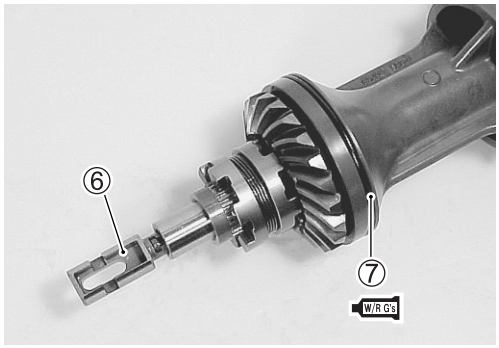
- Assemble the propeller shaft in the following sequence: forward thrust washer ⑤, reverse thrust washer ①, reverse gear ②, reverse gear back-up shim ③ and propeller shaft housing ④.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Gear OIL 99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL



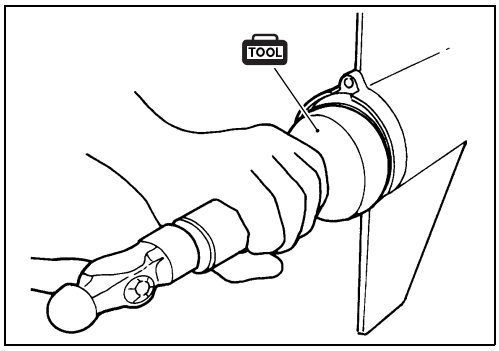
- Assemble horizontal slider ⑥ to connector pin.
- Apply Water Resistant Grease to bearing housing O-ring ⑦.



NOTE:
Before installing propeller shaft/bearing housing assembly, move shifter dog to bring horizontal slider to the neutral position.

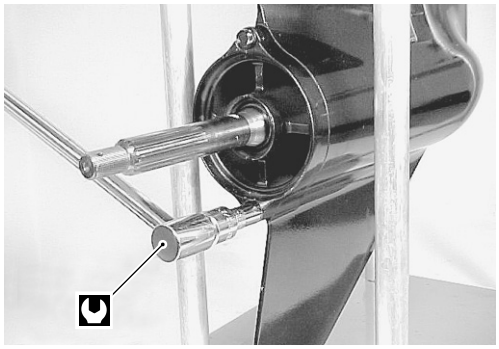
- Using special tools, install the propeller shaft and housing assembly in the gear case.

TOOL 09922-59410: Propeller shaft housing installer
09922-59420: Housing installer handle



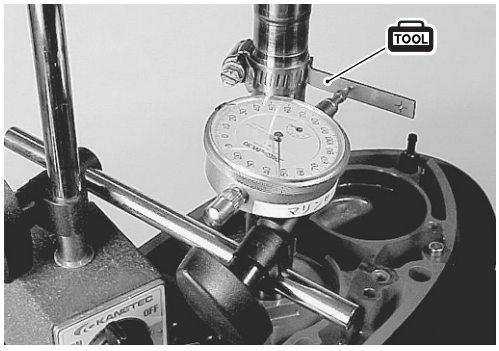
- When the housing is fully seated, tighten both retaining bolts to the specified torque.

Bearing housing bolt: 23 N·m (2.3 kg-m, 16.6 lb-ft)

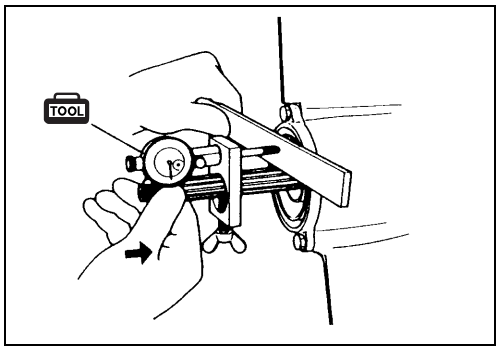


RECHECKING GEAR BACKLASH
Recheck the gear backlash.
This should not be less than previously checked.
If less, reduce the number/thickness of reverse gear back-up shims.
(See the “GEARS-SHIMMING AND ADJUSTMENT/RECHECKING GEAR BACKLASH” section on page 9-30.)

TOOL 09952-09310: Backlash indicator tool

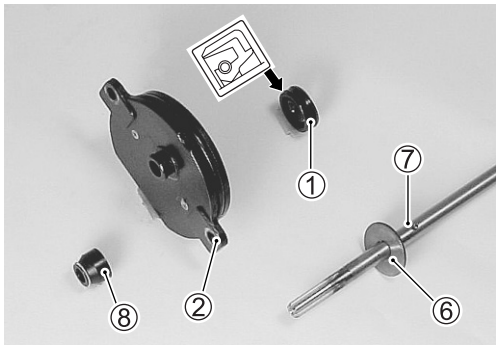


CHECKING PROPELLER SHAFT THRUST PLAY
See the “GEARS-SHIMMING AND ADJUSTMENT/CHECKING PROPELLER SHAFT THRUST PLAY” section on page 9-31.

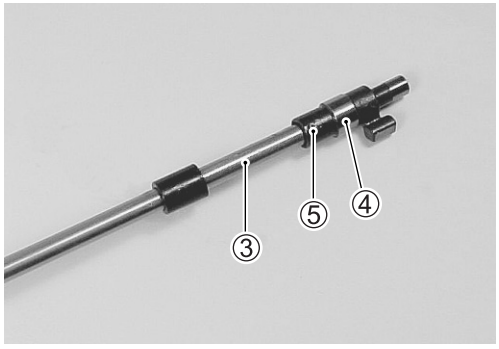


SHIFT ROD GUIDE HOUSING
- Using an oil seal installer, drive the oil seal ① into the shift rod guide housing ②.
  The lipped portion of oil seal must face towards the driveshaft housing.

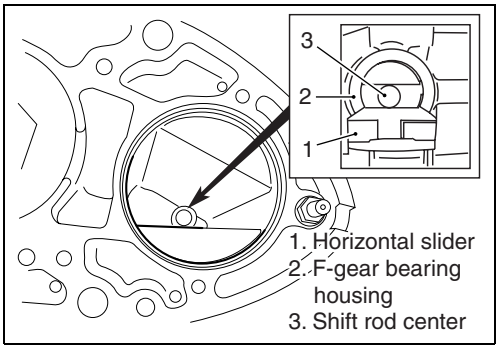
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



- 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.



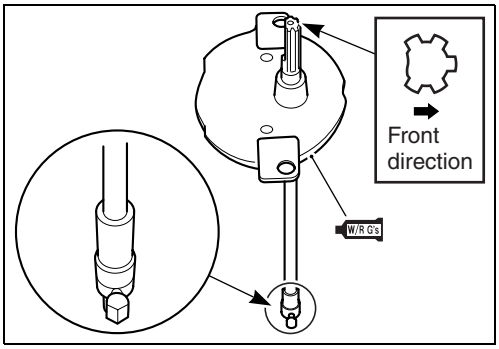
NOTE:
Be sure the horizontal slider is in the neutral position before installing the shift unit (shift rod guide housing assembly.).



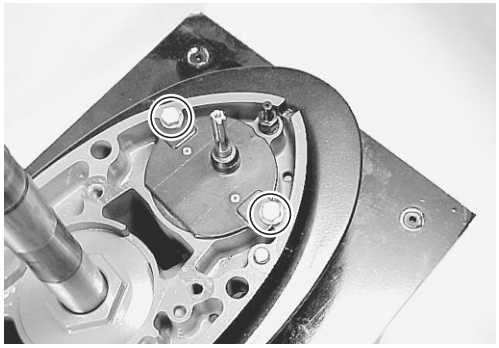
- Apply Water Resistant Grease to the shift rod guide housing O-ring.

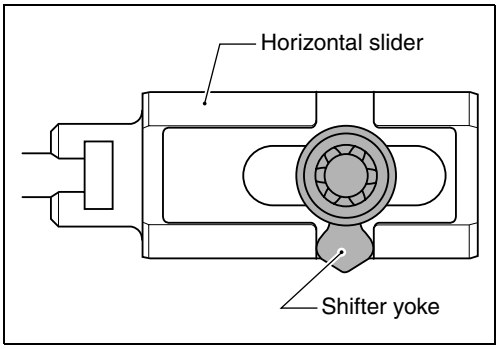
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

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.

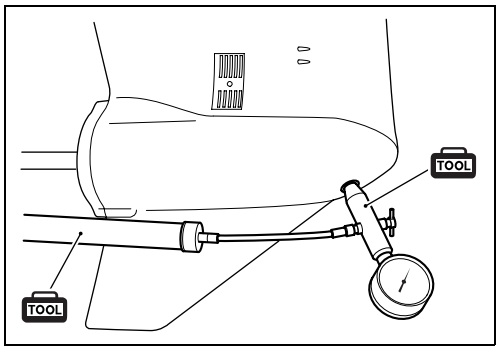




LEAKAGE CHECK

Check for leakage of oil seal and O-ring when applying specified pressure inside of the gearcase.

09950-69512: 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)

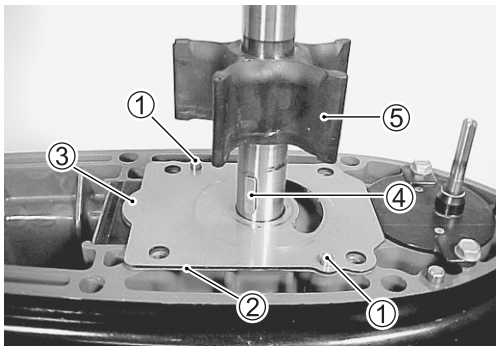
CAUTION

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)

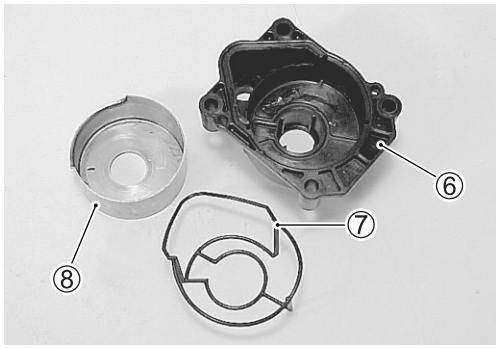
- Place the dowel pins ①, under panel gasket ② and under panel ③ into position.
- Insert the key ④ in the driveshaft and slide the impeller ⑤ onto driveshaft, ensuring that key and keyway are aligned.



- Place the seal ring ⑦ into groove of the pump case ⑥, then install inner sleeve ⑧ to pump case.

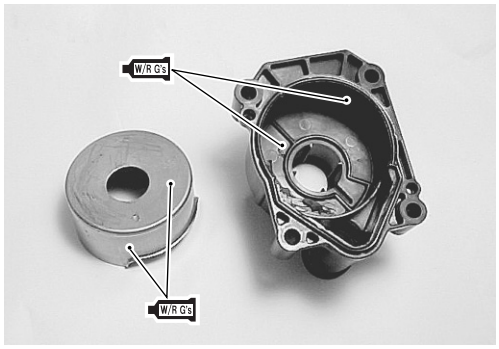
CAUTION

Do not re-use seal ring once removed.
Always use new ring.



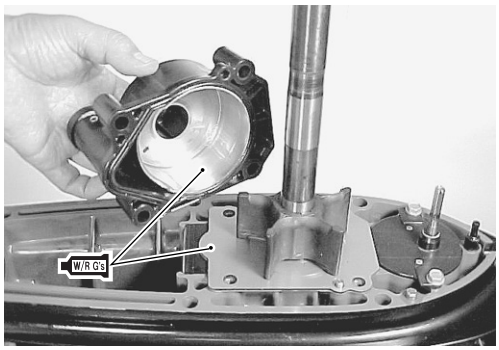
NOTE:
Before installing pump inner sleeve, apply water resistant grease lightly between inner sleeve and pump case mating surfaces.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



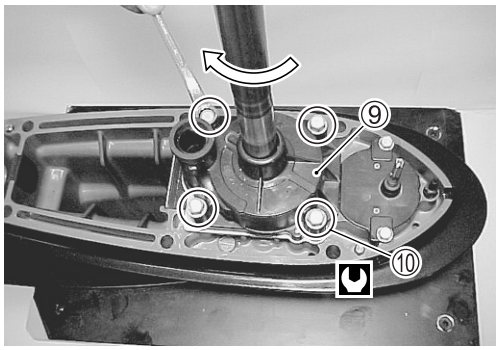
NOTE:
Before installing water pump case assembly, apply Water Resistant Grease lightly on pump case inner sleeve and under panel for initial lubrication.

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, 12.3 lb-ft)



PROPELLER INSTALLATION

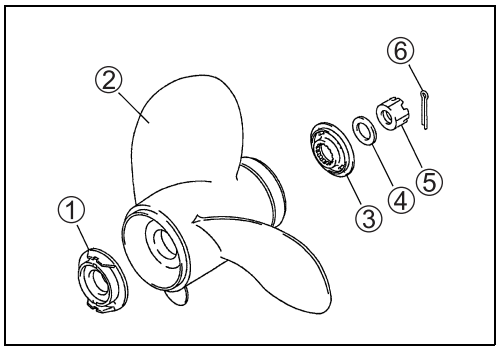
Install propeller stopper ① onto propeller shaft, then slide on the propeller ②.

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

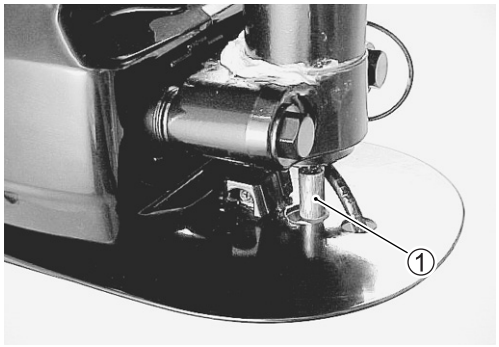
Propeller nut: 55 N·m (5.5 kg-m, 40.0 lb-ft)



LOWER UNIT INSTALLATION

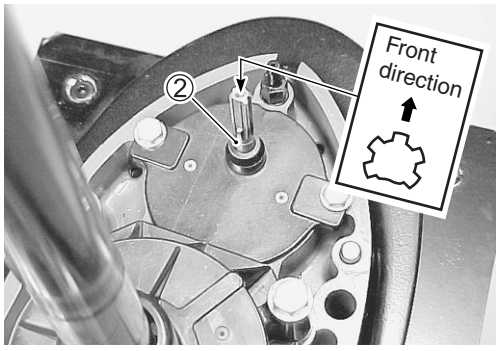
- Apply Water Resistant Grease to clutch rod splines, then install clutch rod ① by aligning clutch rod splines with splines in clutch shaft.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

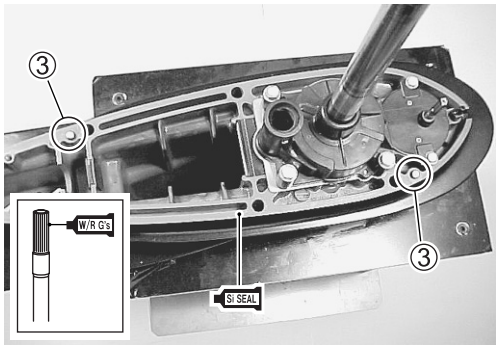


- Ensure that shift rod ② is at neutral position.

NOTE:
Before installing lower unit assembly, bring shift to neutral position by turning shift rod right or left.

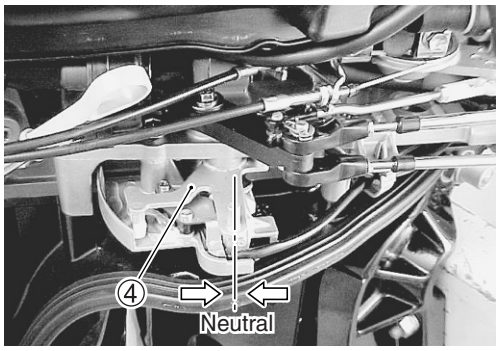


- Insert two (2) dowel pins ③.
- Apply Water Resistant Grease to driveshaft and shift rod splines.
- Apply a light coating of SUZUKI SILICONE SEAL to mating surfaces of gearcase and driveshaft housing.



• Set the clutch control lever ④ at Neutral position, then slide the lower unit ⑤ 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.



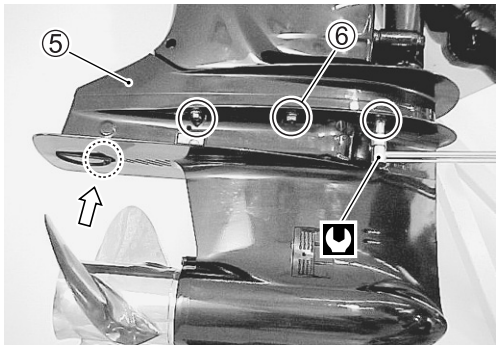
• Apply SUZUKI SILICONE SEAL to seven (7) gearcase bolts ⑥ and tighten them to specified torque.

Gearcase bolt: 10 mm 55 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

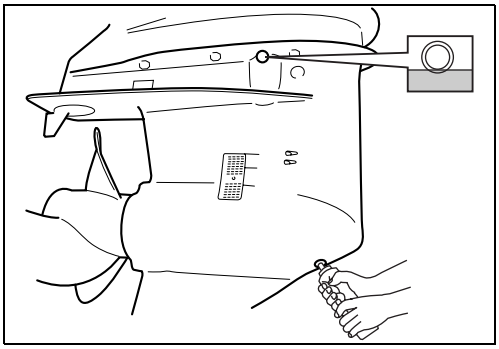
• Shift the clutch control lever to Forward and Reverse position from Neutral position to check proper gear engagement.



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



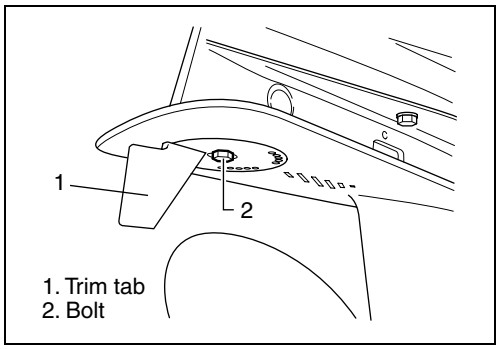
TRIM TAB

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:

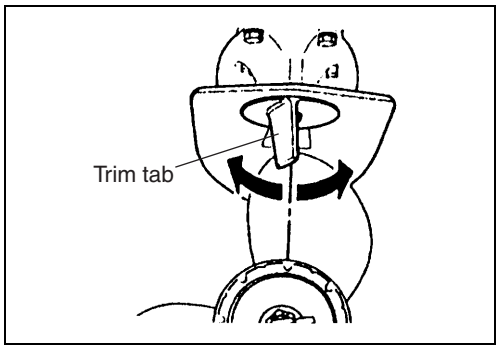
Adjusting

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.



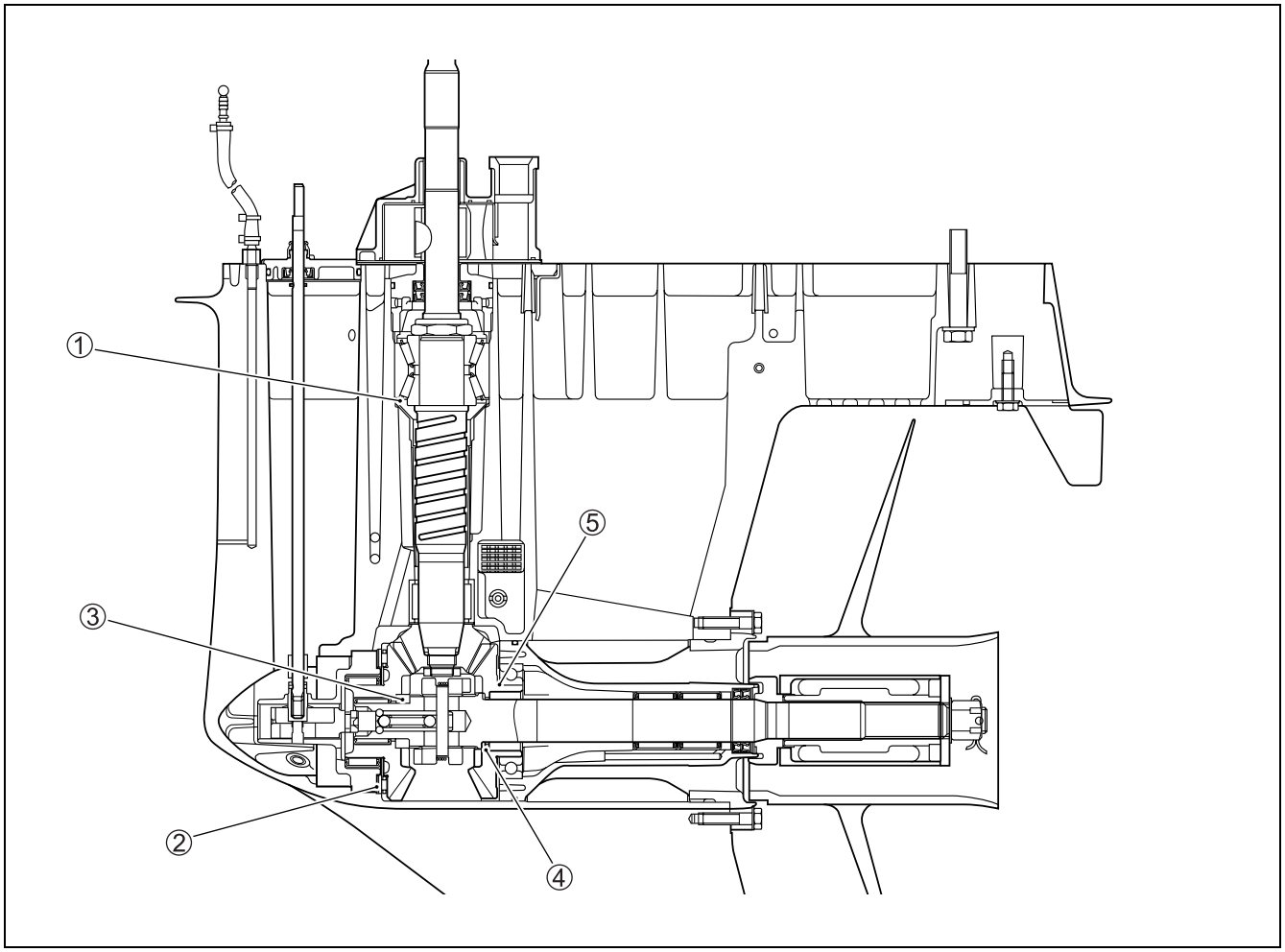
With a properly adjusted trim tab, steering should be neutral and there should be no tendency for the steering to be pulled to either port or starboard.

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

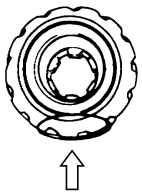


FORWARD GEAR/PINION GEAR

Follow the procedure below to adjust forward gear/pinion gear.

Step to prior to adjustment

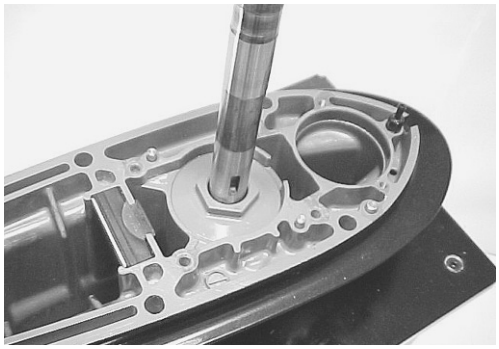
1. Install standard pinion gear back-up shim thickness modified according to ± design specification mark on gear.



± 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.

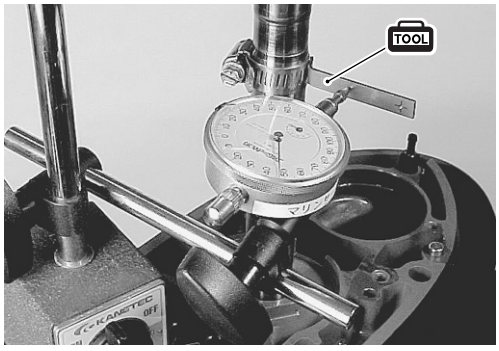
Pinion nut: 145 N·m (14.5 kg-m, 105.0 lb-ft)



Adjusting gear backlash

(a) Assemble special tool to driveshaft as shown in figure.

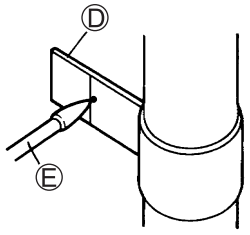
09900-20602: Dial gauge
09900-20701: Magnetic stand
09952-09310: Backlash indicator tool



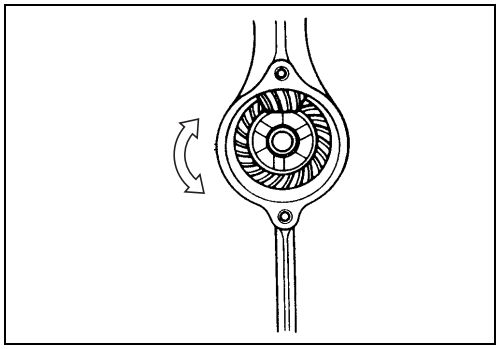
(b) Push forward gear inward and hold it by hand, align dial gauge pointer at 90 ° to the mark on the backlash indicator tool and read backlash on dial gauge by lightly moving driveshaft clockwise and counterclockwise by hand.

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)

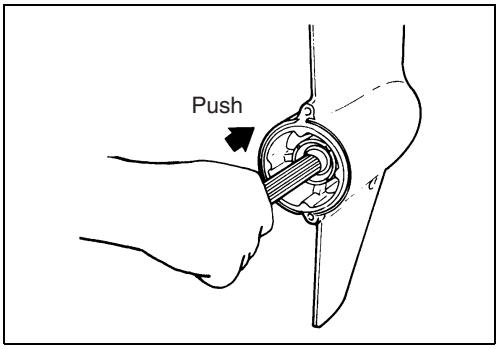
Check tooth contact pattern using the following procedure:

1. To assess tooth contact, apply a light coat of Prussian Blue on the convex surface of forward gear.

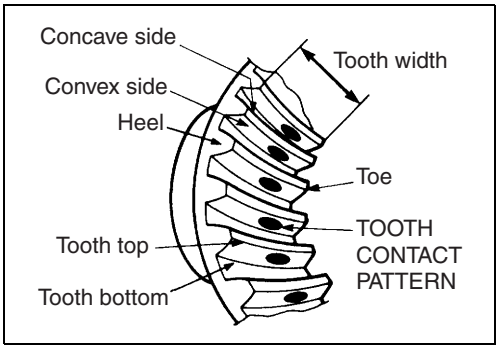


2. Install propeller shaft and housing assembly (minus reverse gear and internal components).
3. Push propeller shaft inward and hold in position.
4. Using driveshaft holder tool, rotate the driveshaft 5 – 6 times.

TOOL 09921-29410: Driveshaft holder



5. Carefully pull out propeller shaft and housing to check tooth contact pattern.



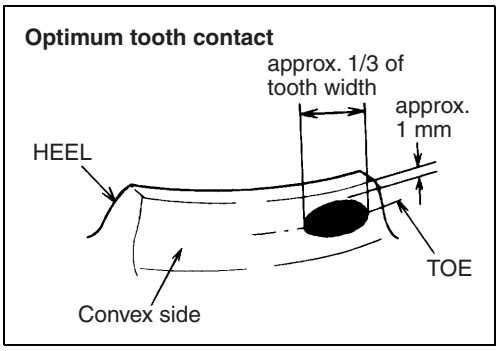
Optimum tooth contact

The optimum tooth contact is shown at right.

A shim adjustment may be necessary to obtain this contact pattern.

CAUTION

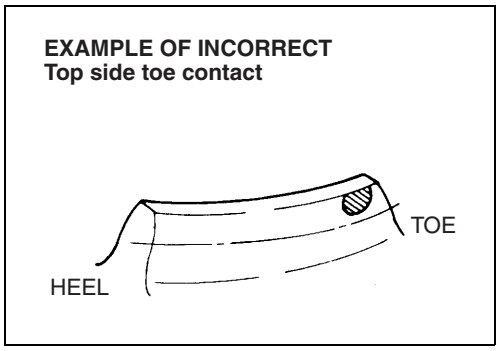
Gear backlash should be checked when increasing or decreasing shim thickness to adjust tooth contact.



Example (1)
Incorrect topside toe contact:
Correction measures:
- Decrease thickness of forward gear shim.
- Slightly decrease pinion gear shim thickness.

CAUTION

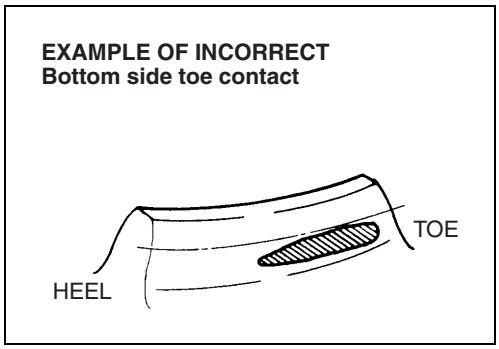
Do not set tooth contact in this position (top side toe contact). Damage and chipping of forward and pinion gear may result.



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.

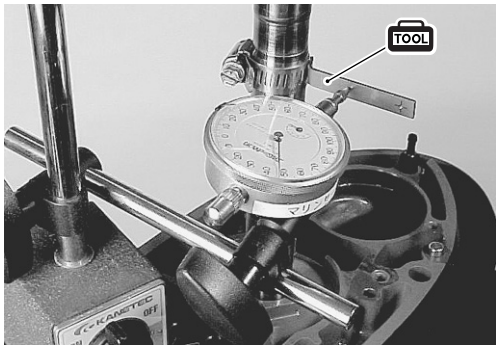
TOOL **09900-20602: Dial gauge**
09900-20701: Magnetic stand
09952-09310: Backlash indicator tool

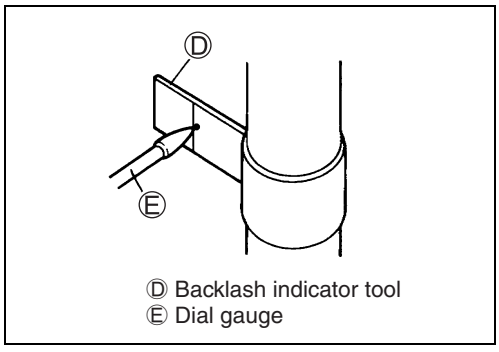
(b) Push the forward gear inward and fix it by hand, then read backlash on dial graduation by lightly moving driveshaft clockwise and counterclockwise by hand.

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.





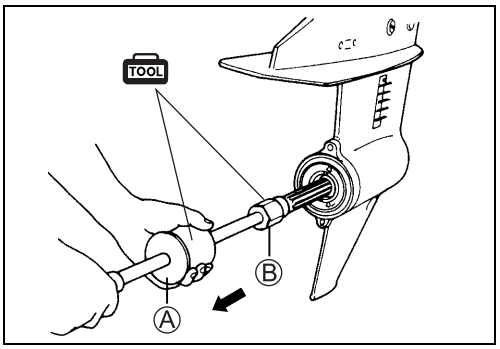
Ⓓ Backlash indicator tool
Ⓔ Dial gauge

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.

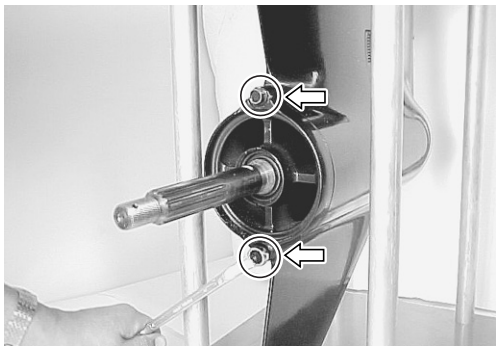
TOOL **09930-30161: Propeller shaft remover – Ⓑ**
09930-30104: Sliding hammer – Ⓐ



3. Assemble special tool in the following sequence.

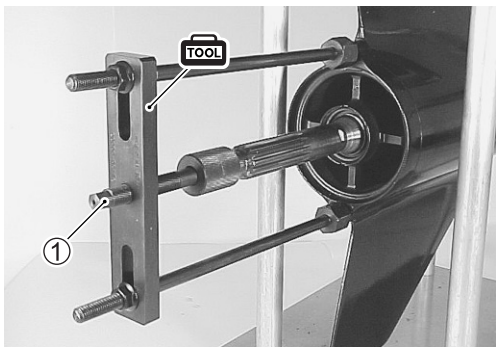
TOOL **09951-99310: Gear holder**

(a) Remove two (2) bearing housing retaining bolts, then screw long bolts of special tool to secure the bearing housing.



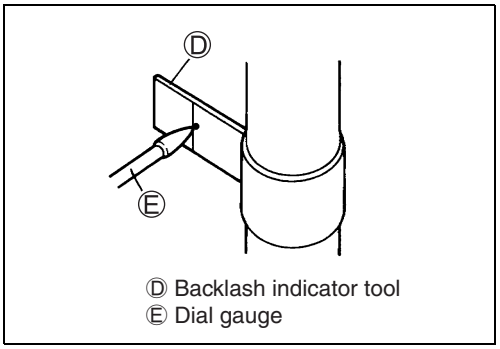
(b) Install the special tool and then attach it to the propeller shaft as shown.

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 **09900-20602: Dial gauge**
09900-20701: Magnetic stand
09952-09310: Backlash indicator tool



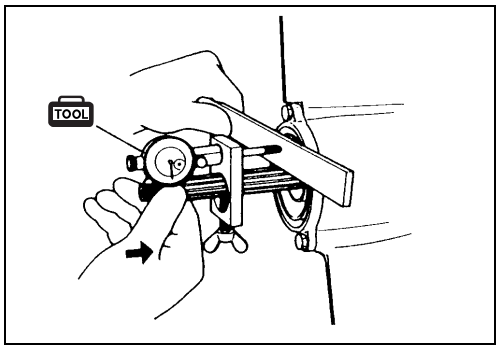
Ⓓ Backlash indicator tool
Ⓔ Dial gauge

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). (See 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]

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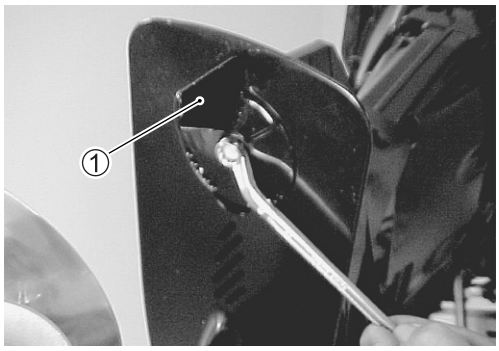
10

REMOVAL & DISASSEMBLY

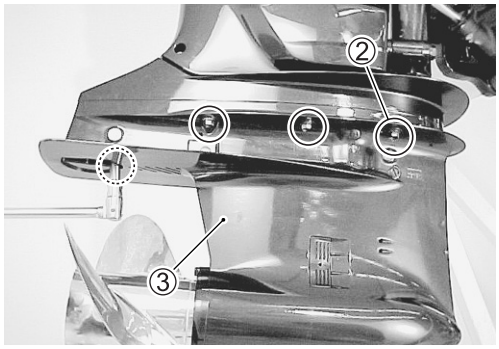
⚠ WARNING

Always disconnect the battery cable, before removing lower unit.

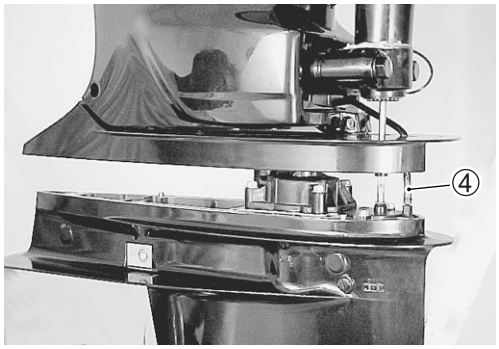
Shift to “NEUTRAL” position.
Remove bolt and trim tab ①.



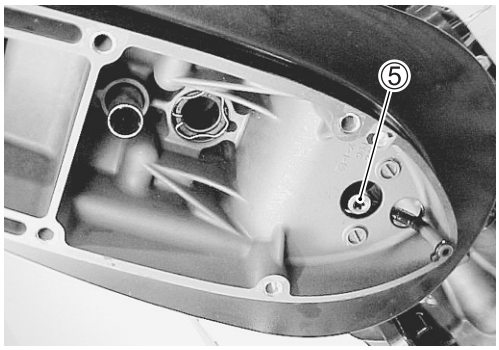
Remove seven (7) bolts ② and separate gearcase ③ from driveshaft housing.



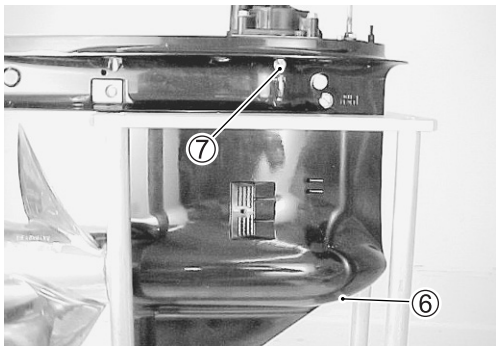
NOTE:
Before gearcase is removed completely, disconnect speedometer pick up tube ④ from gearcase.



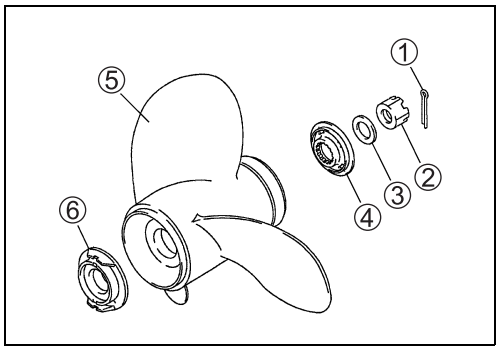
Remove clutch rod ⑤ from clutch shaft (if necessary).



Place a drain pan under oil drain plug.
Remove oil drain plug ⑥ first then air vent plug ⑦ and allow gear oil to drain.
Inspect oil for water, contaminates or metal.

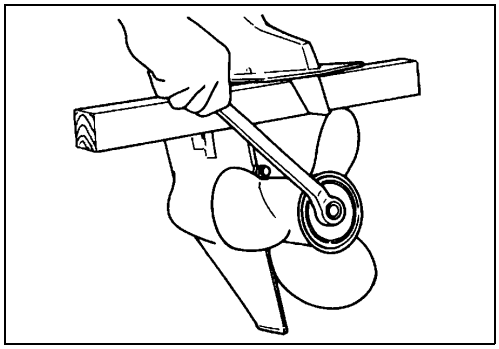


Remove cotter pin ① from propeller nut and remove propeller nut ②.
Remove washer ③, spacer ④, propeller ⑤ and stopper ⑥ from the propeller shaft.

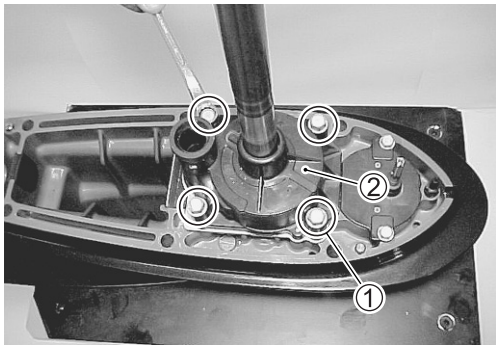


⚠ WARNING

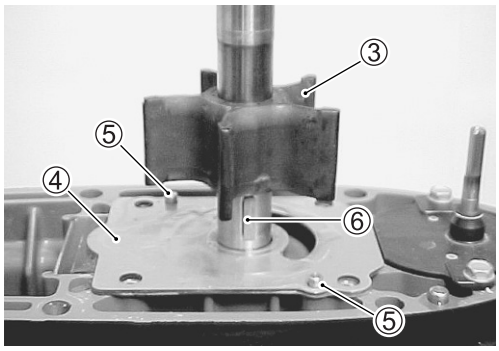
To prevent injury from propeller blades, wear gloves and place a block of wood between the anti-cavitation plate and the propeller blade tips to lock the propeller in place before attempting to remove propeller nut.



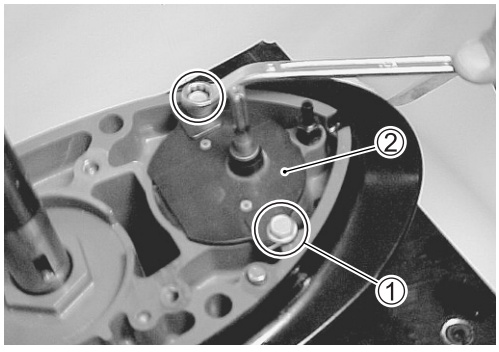
Loosen four (4) bolts ①, then remove water pump case ②.



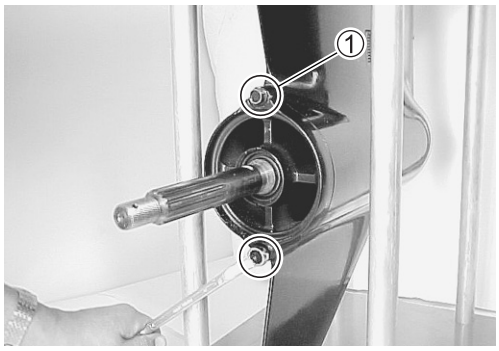
Remove impeller ③, impeller key ⑥, pump under plate ④ and dowel pins ⑤.
Keep impeller key ⑥ for reuse and discard the plate gasket.



Remove two (2) bolts ① and shift rod guide housing assembly ②.

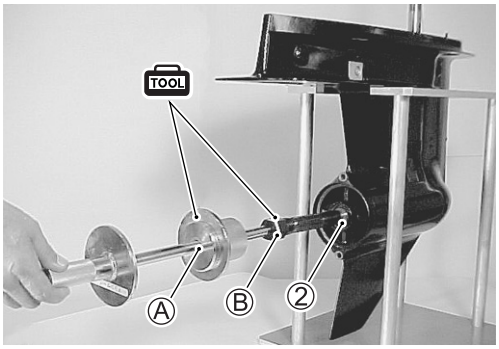


Remove two (2) bolts ① securing the propeller shaft bearing housing to the gearcase.



Using special tools, pull out the propeller shaft bearing housing. Remove the propeller shaft and bearing housing assembly ②.

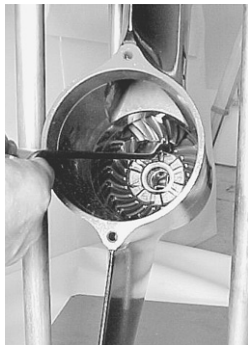
TOOL **09930-30104: Ⓐ Sliding hammer**
09930-30161: Ⓑ Propeller shaft remover

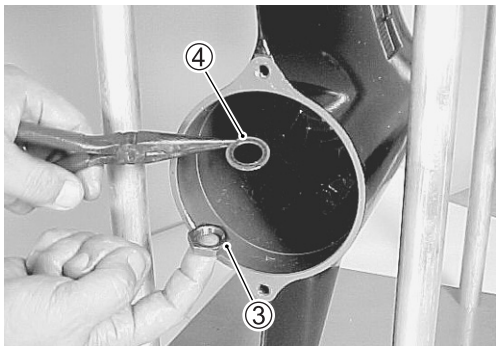


Hold the pinion nut securely, then fit special tool to the driveshaft and loosen the pinion nut.
Remove pinion nut ③ and washer ④.

TOOL **09921-29410: Driveshaft holder**

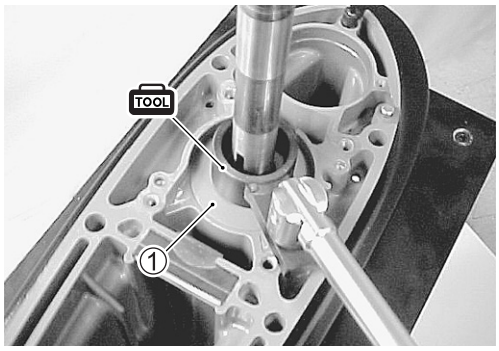




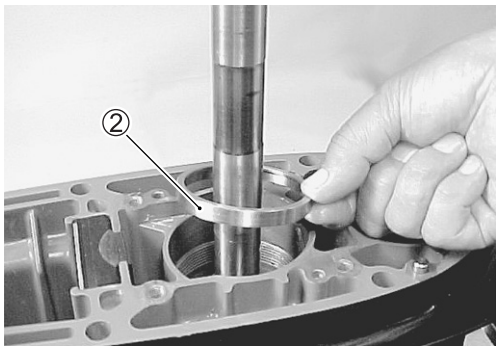


Use special tool to unscrew driveshaft oil seal housing ①, then remove oil seal housing from drive shaft.

TOOL **09926-29310: Driveshaft housing remover**

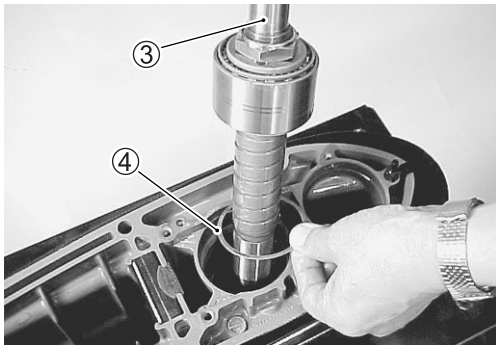


Remove driveshaft bearing spacer ②.

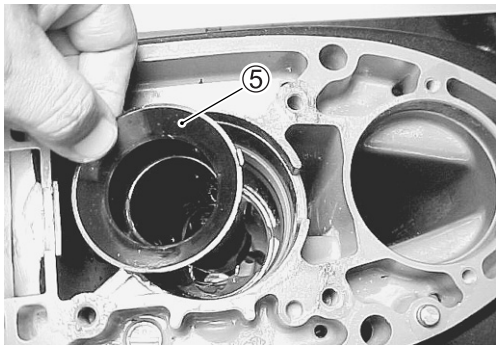


Slowly lift out driveshaft assembly ③.
Remove the pinion shim ④.

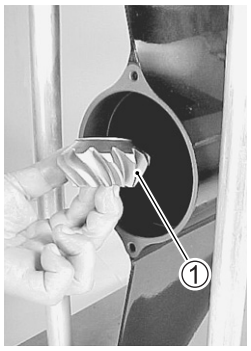
NOTE:
The driveshaft pinion gear bearing contains 22 loose roller bearings. Account for all roller bearings on disassembly.

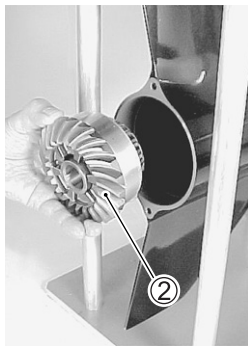


Remove the driveshaft collar ⑤.

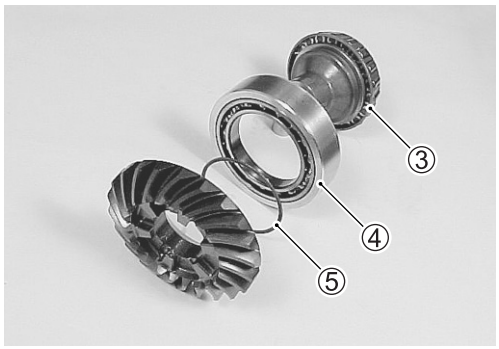


Remove the pinion gear ①.
Remove the reverse gear ② (with reverse gear bearing housing and thrust bearing).



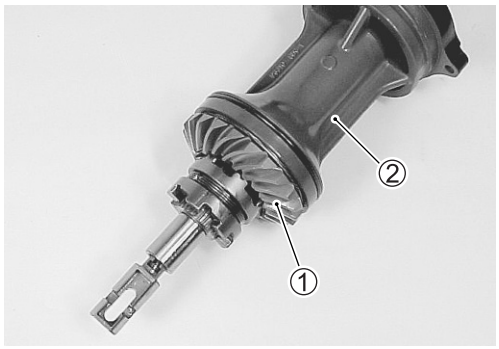


Remove the thrust bearing ③, reverse gear bearing housing ④ and back-up shim ⑤ from reverse gear.

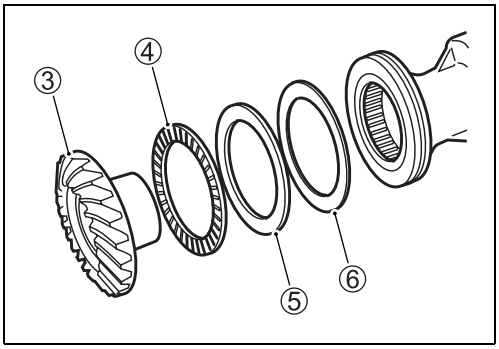


Disassembly of propeller shaft components

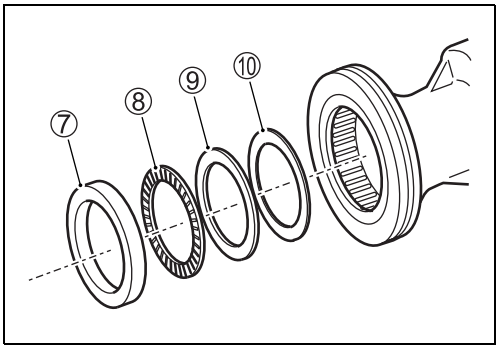
Slide propeller shaft away from forward gear ① and bearing housing assembly ②.



Remove the forward gear ③, forward gear thrust bearing ④, forward gear thrust washer ⑤, forward gear back-up shim ⑥.



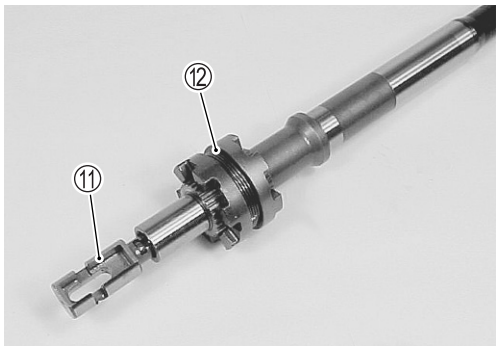
Remove the propeller shaft thrust washer ⑦, propeller shaft thrust bearing ⑧, bearing washer ⑨ and shim ⑩ from propeller shaft bearing housing.



To disassemble propeller shaft components, refer to following:

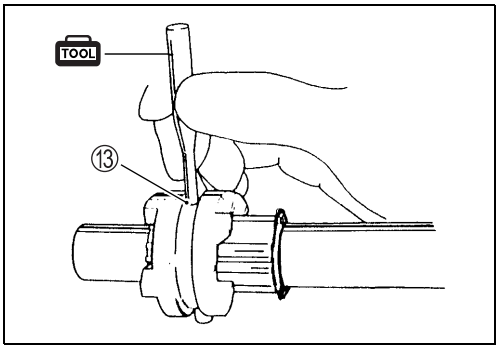
(a) Remove horizontal slider ⑪.

(b) Remove spring ⑫ from clutch dog shifter.

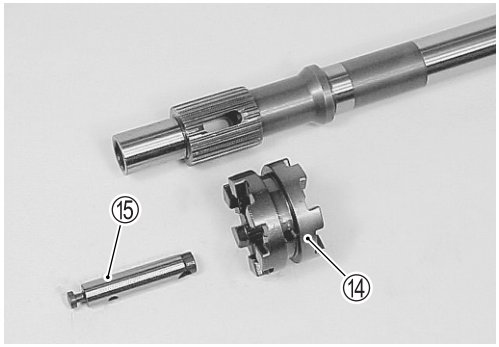


(c) Use special tool to push the dog pin ⑬ out of the clutch dog shifter.

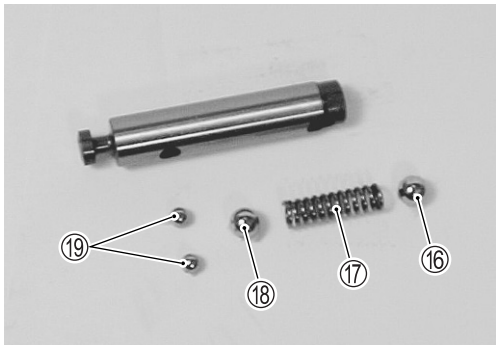
TOOL 09922-89810: Shift pin remover



(d) Remove clutch dog shifter ⑭ and connector pin ⑮ from propeller shaft.

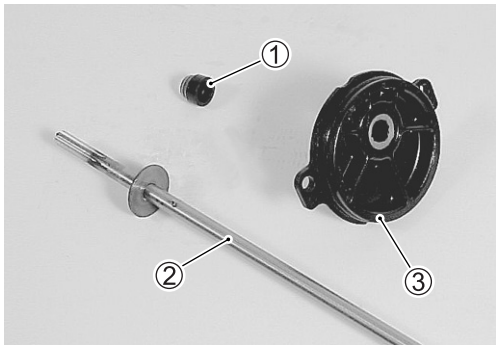


(e) Remove large detent ball ⑯, detent spring ⑰, large detent ball ⑱ and two (2) small detent balls ⑲ from connector pin.

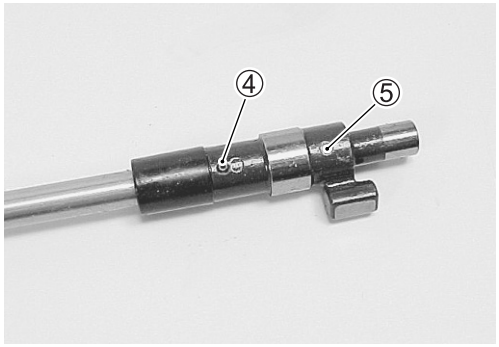


Disassembly of shift rod components

(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.

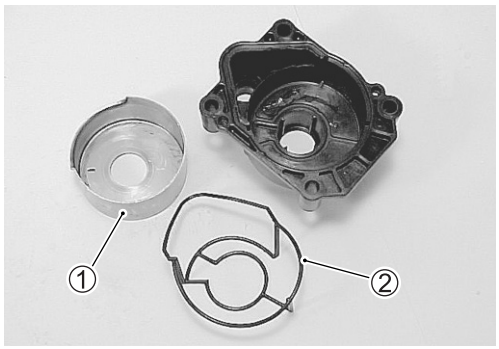


Disassembly of water pump case

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.

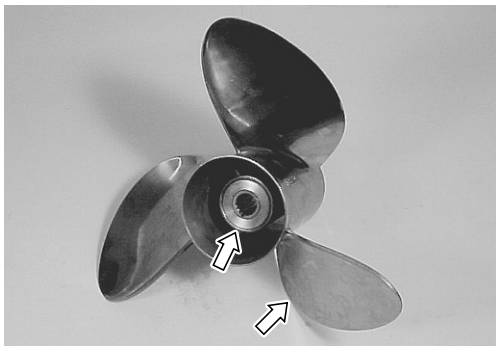
NOTE:
Thoroughly wash all metal components with cleaning solvent and dry with compressed air.

⚠ WARNING

Wear safety glasses when using compressed air.

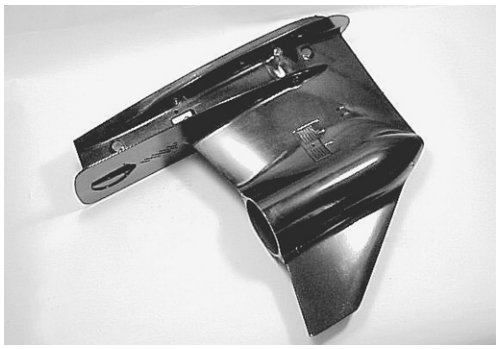
PROPELLER

- 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.



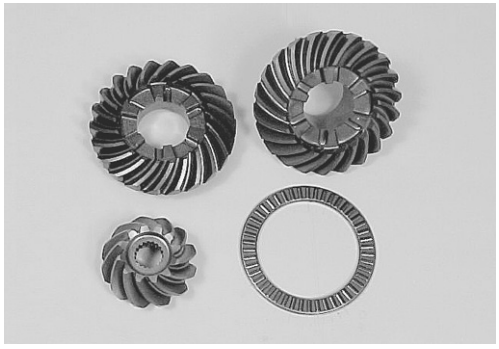
GEARCASE

- 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



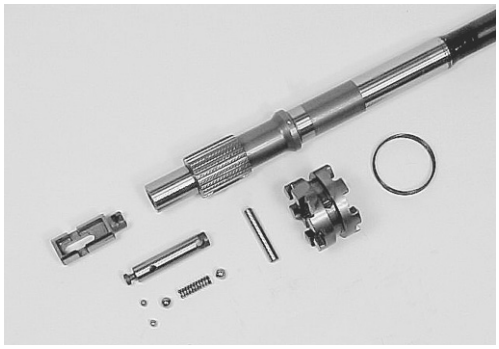
- Inspect forward, reverse and pinion gear teeth and engaging dogs.
  Replace gears if damaged, worn or other abnormal condition.
- Inspect forward gear thrust bearing.
  Replace bearing if pitted, noisy, rough or other abnormal condition.

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.

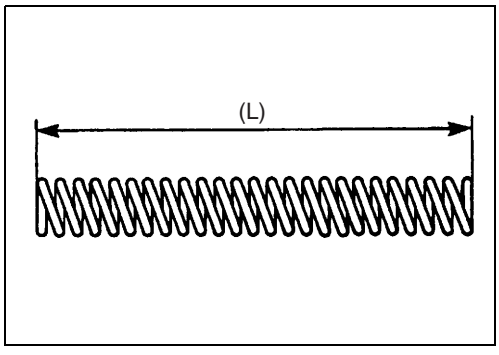
PROPELLER SHAFT COMPONENTS



- 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.

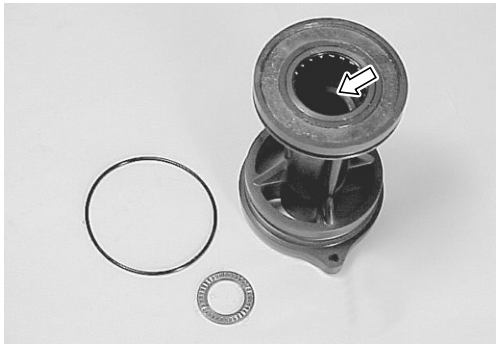


- Check detent spring by measuring its free length. If free length is not within specifications, replace detent spring.

  Detent spring free length (L)
  Standard: 27.8 mm (1.09 in)
  Service limit: 25.0 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.





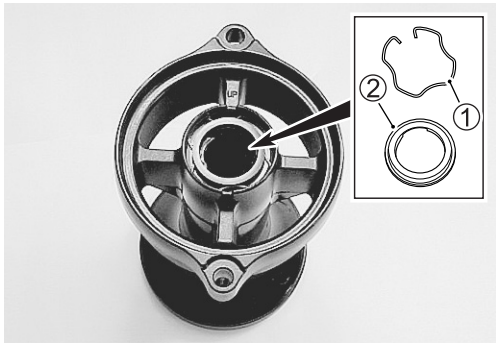
Replacing propeller shaft oil seal

1. Remove retaining ring ① and oil seal protector ②.
2. Extract seals ③ with oil seal remover.

TOOL 09913-50121: Oil seal remover

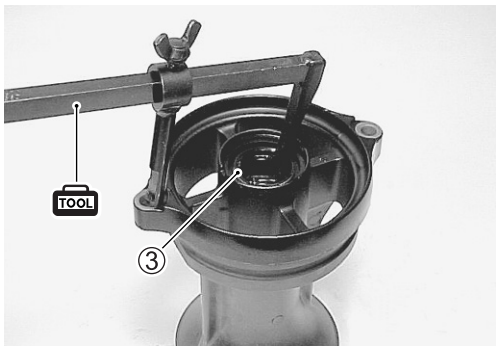
CAUTION

Do not reuse oil seal once removed.
Always use new oil seal.

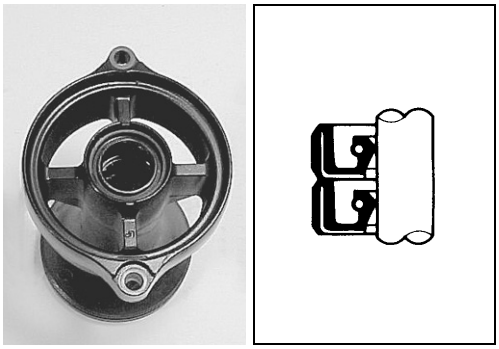


3. Apply Water Resistant Grease to the inner circumference of the housing.
4. Using an oil seal installer, drive the two oil seals (one at a time) into the propeller shaft bearing housing.
   The lipped portion of the seal must face towards the propeller.
   Apply Water Resistant Grease to the seal lips.

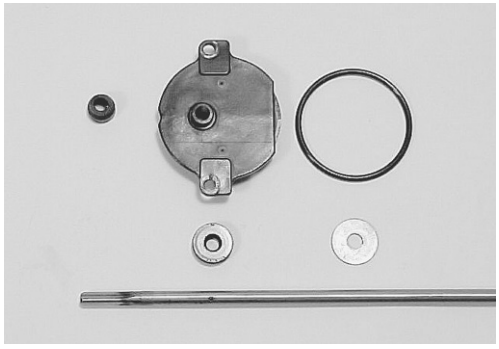
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



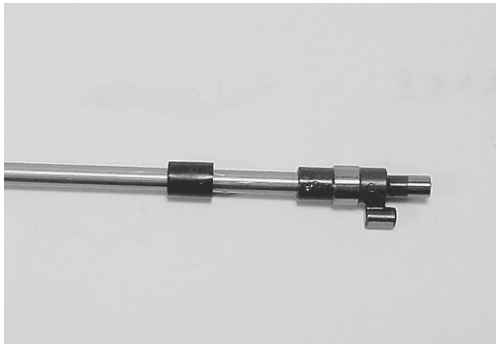
5. Install the oil seal protector and retaining ring.



SHIFT ROD GUIDE HOUSING COMPONENTS

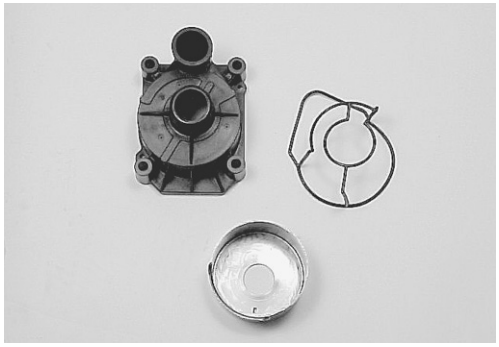


- Inspect shift rod guide housing. Replace if cracked, damaged or other abnormal condition.
- Inspect shifter yoke. Replace if wear, damaged or other abnormal condition.
- Inspect shift rod/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect O-ring. Replace if nicked, cut, torn, swollen or other abnormal condition.

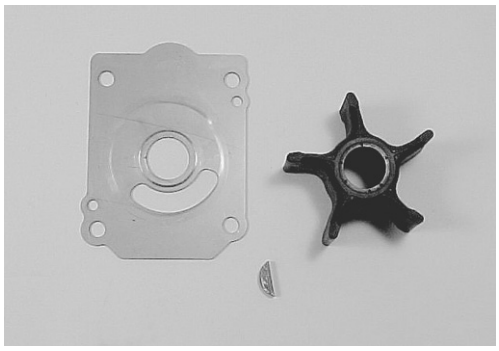


- Inspect oil seal and dust seal. Replace if nicked, cut, worn or other abnormal condition.

WATER PUMP AND RELATED ITEMS

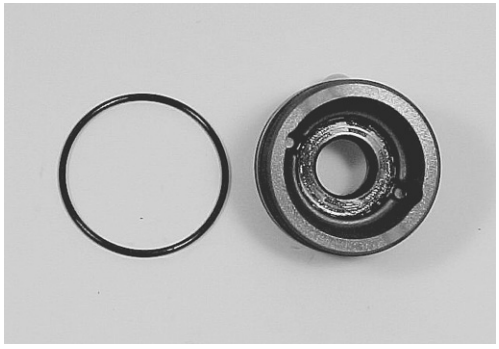


- Inspect impeller. Replace if vanes are cut, torn, worn or other abnormal condition.
- Inspect pump case. Replace if cracked, distorted or other abnormal condition.
- Inspect pump inner sleeve. Replace if worn, cracked, distorted, corroded or other abnormal condition.
- Inspect seal ring. Replace if nicked, cut, torn, swollen or other abnormal condition.



- Inspect under panel. Replace if cracked, distorted, corroded or other abnormal condition.

DRIVESHAFT OIL SEAL HOUSING

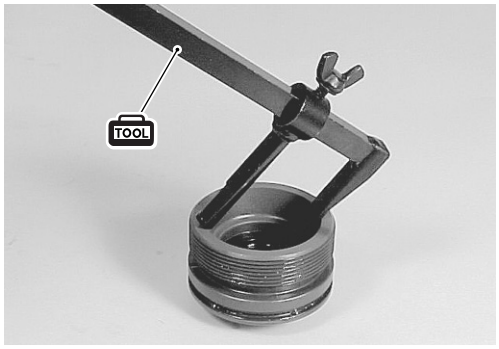


- Inspect housing. Replace if cracked, damaged or other abnormal condition.
- Check condition of oil seals. Replace if nicked, cut, worn or other abnormal condition.
- Inspect O-ring. Replace if worn, nicked, cut or other abnormal condition.

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

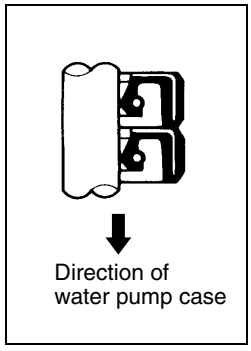


2. Apply Water Resistant Grease to inner circumference of driveshaft oil seal housing.

W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

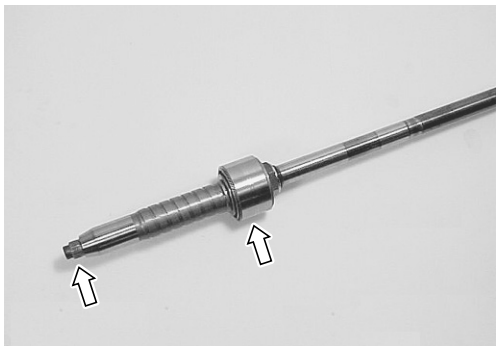
3. Grease the inner lips of oil seal. With the lips facing away from driveshaft bearing, place seal in position and drive it into the oil seal housing.

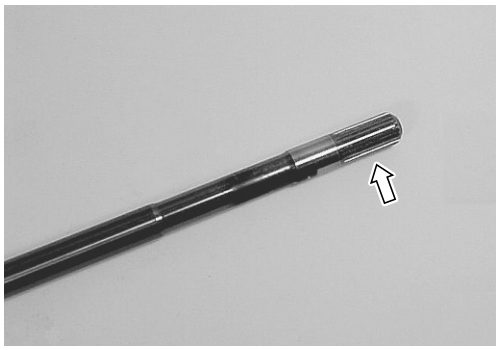




DRIVESHAFT

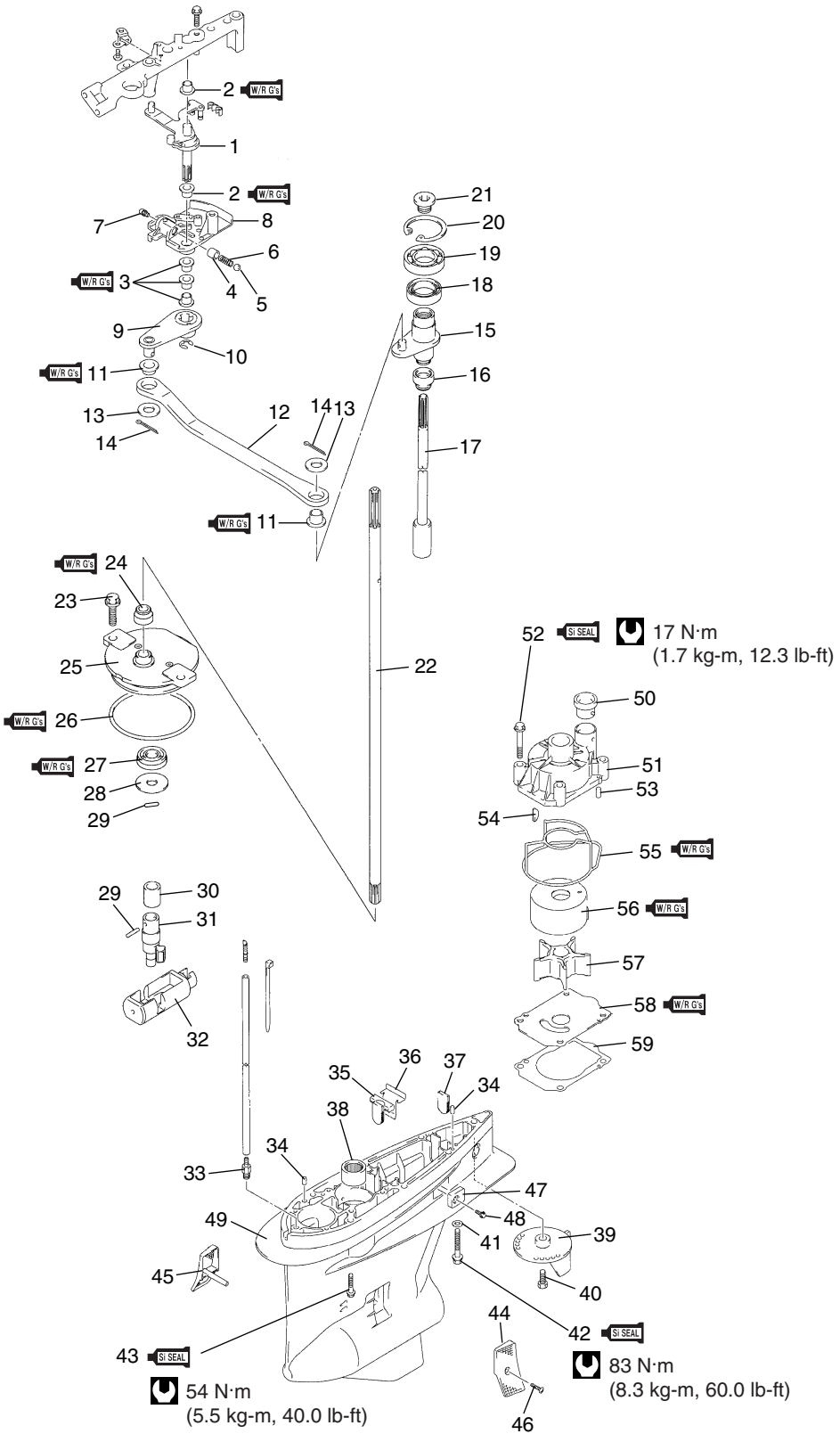
- Inspect driveshaft/splines. Replace if worn, twisted, damaged or other abnormal condition.
- Inspect driveshaft bearing, replace if pitted, noisy, rough or other abnormal condition.



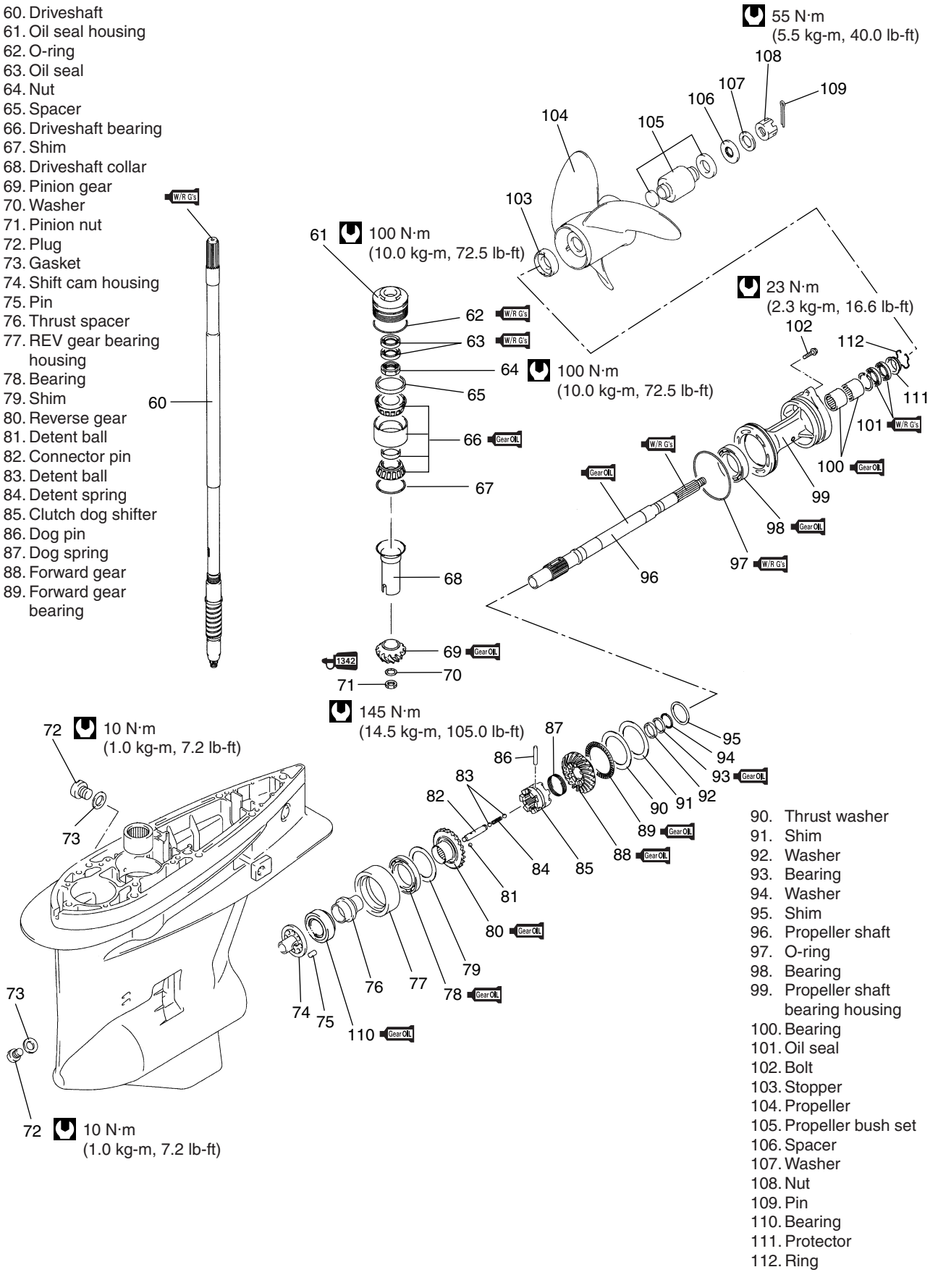


ASSEMBLY & INSTALLATION

Assembly & installation are reverse order of disassembly with special attention to the following steps.



1. Clutch lever
2. Bush
3. Bush
4. Pin
5. Ball
6. Spring
7. Grease nipple
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
110. Bearing
111. Protector
112. Ring

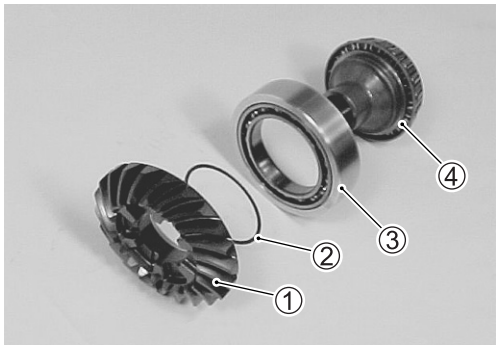
CAUTION

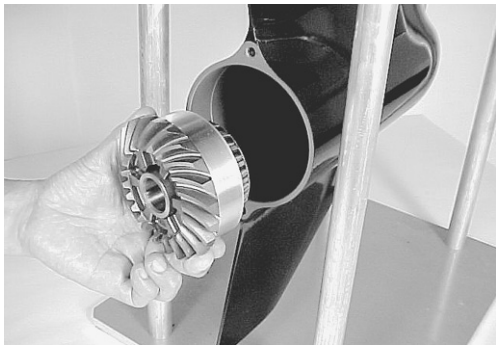
- **Make sure that all parts used in assembly are clean and lubricated.**
- **It is recommended that all seals, gaskets and O-rings be replaced with new on assembly.**
- **After assembly, check parts for tightness and smoothness of operation.**
- **Before final assembly, be absolutely certain that all 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**



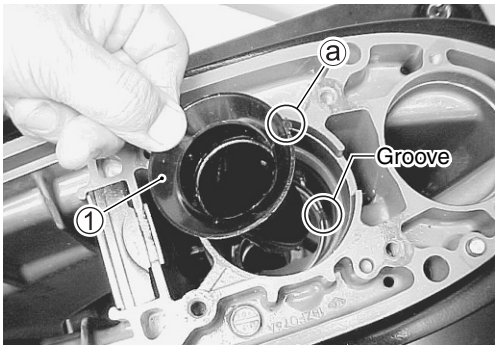


DRIVESHAFT COLLAR

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:

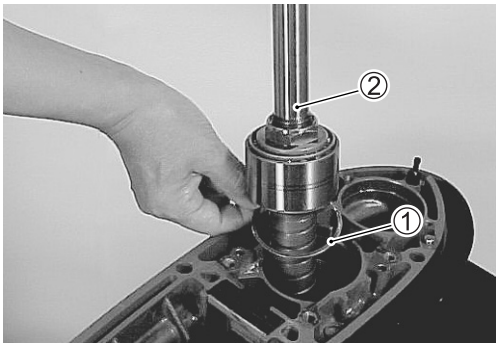
Before installing pinion gear, check for correct amount and position of pinion bearing rollers.

Use oil soluble grease to retain bearing rollers.



DRIVESHAFT

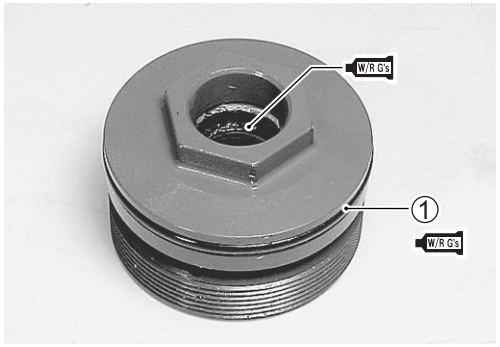
Install pinion shim ①, then lower the driveshaft assembly ② down into the gearcase until the bottom of shaft protrudes through center of pinion.



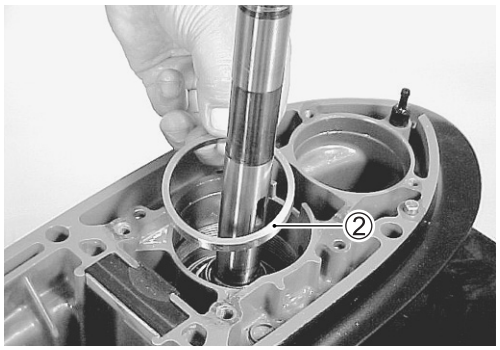
DRIVESHAFT OIL SEAL HOUSING

- 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



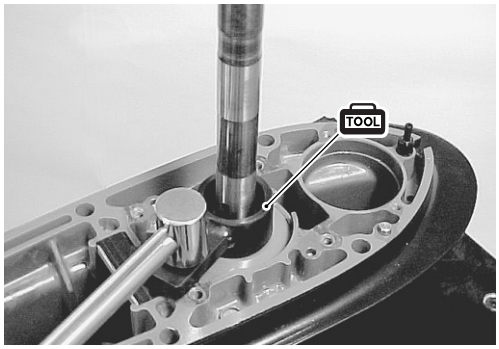
- Install driveshaft bearing spacer ②.



- Install driveshaft oil seal housing on gearcase, then tighten oil seal housing to specified torque.

Driveshaft oil seal housing: 100 N·m (10.0 kg-m, 72.5 lb-ft)

TOOL 09926-29310: Driveshaft housing remover

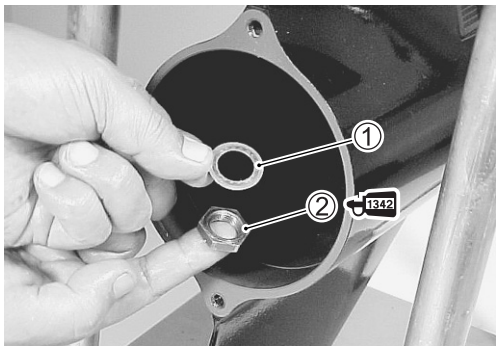


PINION NUT

- Apply THREAD LOCK "1342" to the threads of pinion nut ② before threading it onto driveshaft.

1342 99000-32050: THREAD LOCK "1342"

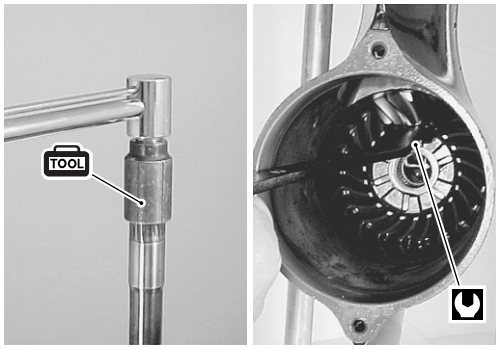
NOTE:
It is recommended the original pinion nut be used for the purposes of shimming during repair. A new pinion nut should be used on final assembly.



- Install washer ①, pinion nut ②, then tighten nut to specified torque.

Pinion nut: 145 N·m (14.5 kg-m, 105.0 lb-ft)

TOOL 09921-29410: Driveshaft holder



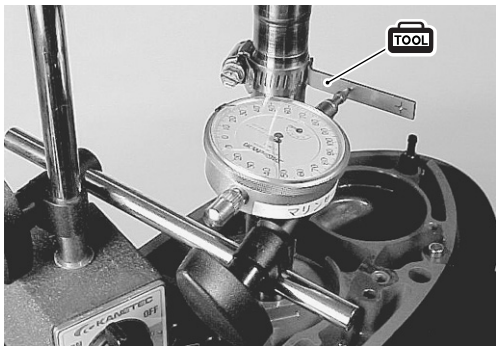
CHECKING GEAR BACKLASH

Before installing forward gear, gear backlash should checked.

Gear backlash: Approx. 0.6 – 0.8 mm (0.024 – 0.031 in)

(See the "GEARS-SHIMMING AND ADJUSTMENT/ADJUSTING GEAR BACKLASH" section on page 10-27.)

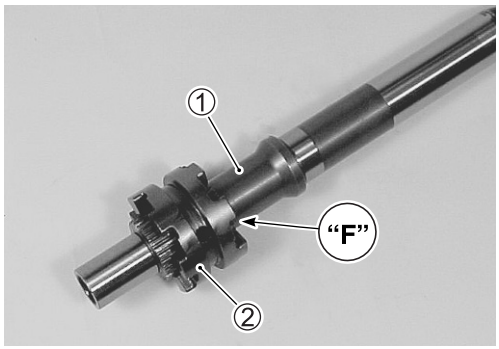
TOOL 09952-09310: Backlash indicator tool



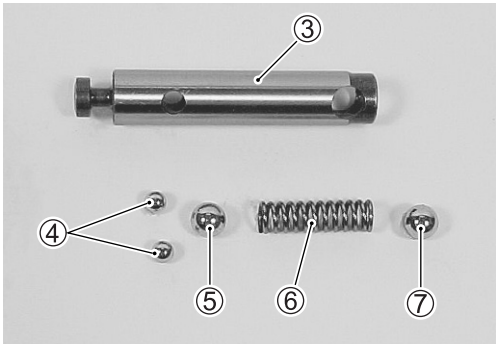
PROPELLER SHAFT

- Slide the clutch dog shifter ② onto the propeller shaft ①.

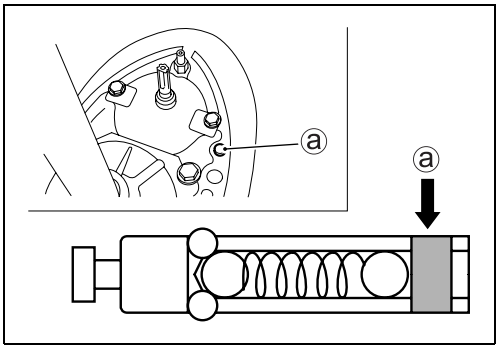
NOTE:
The side of the clutch dog shifter marked with the letter "F" must face towards forward gear.



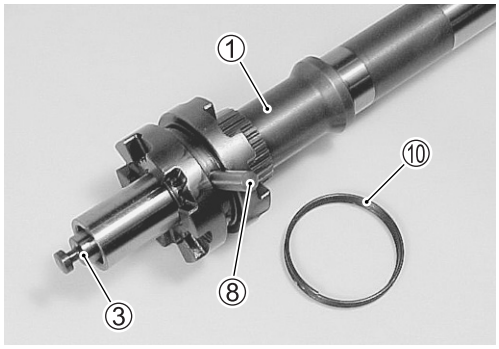
- Insert two (2) small detent balls ④, large detent ball ⑤, detent spring ⑥ and large detent ball ⑦ into connector pin ③. Then depress detent ball ⑦ and temporarily insert stopper pin ⓐ into dog pin hole of connector pin, as shown in right figure.



NOTE:
Temporarily insert a gearcase dowel pin ⓐ into the connector pin to prevent the detent ball from falling out.



- Insert the connector pin ③ (with 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:

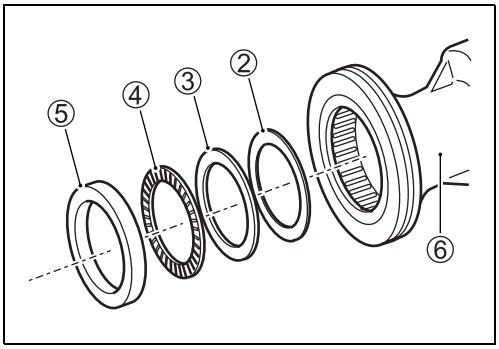
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE

Gear OIL 99000-22540: SUZUKI OUTBOARD MOTOR GEAR OIL

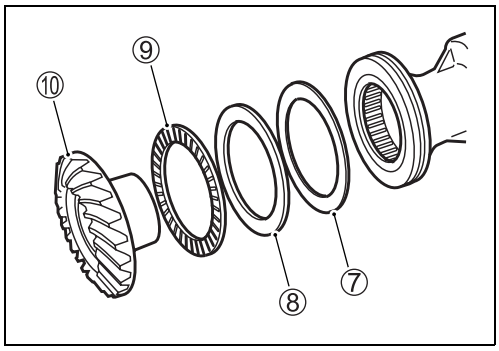
(a) Apply Water Resistant Grease to O-ring ①, then install the O-ring into the groove on the propeller shaft bearing housing.



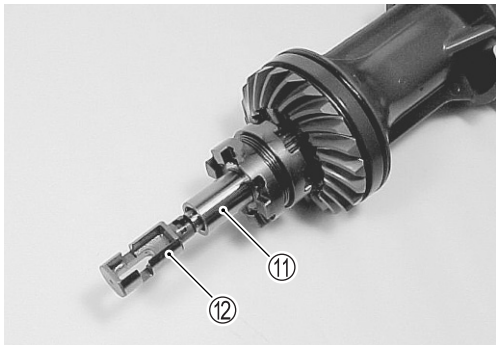
(b) Install shim ②, bearing washer ③, propeller shaft thrust bearing ④, propeller shaft thrust washer ⑤ into propeller shaft bearing housing ⑥.



(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.

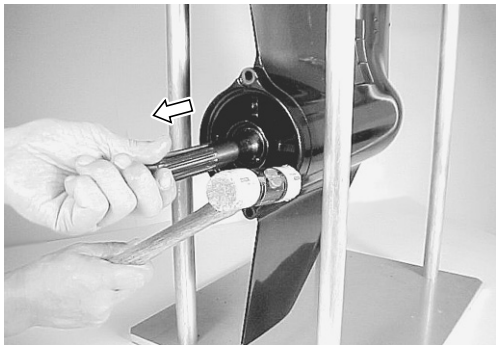


(d) Slide propeller shaft ⑪ into forward gear and propeller shaft bearing housing.
(e) Assemble horizontal slider ⑫ to connector pin.



NOTE:
Before installing propeller shaft/bearing housing assembly, move shifter dog to bring horizontal slider to the neutral position.

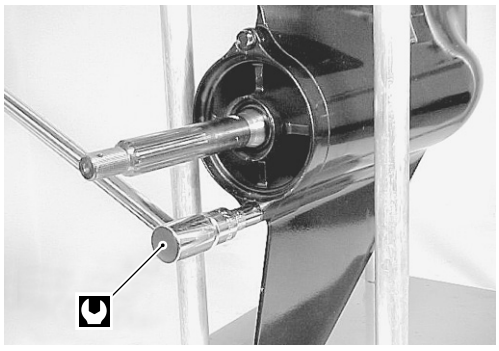
- To hold the correct bearing position, pull propeller shaft backward and then install propeller shaft and housing assembly in the gearcase.



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)

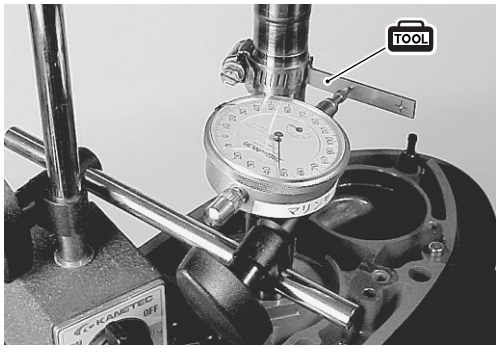


RECHECKING GEAR BACKLASH
Recheck the forward gear backlash.

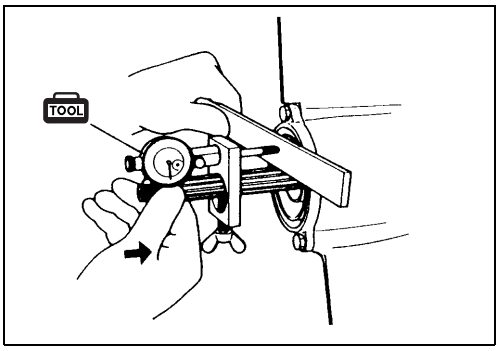
Gear backlash: Approx 0.3 – 0.5 mm (0.012 – 0.020 in)

(See the "GEARS-SHIMMING AND ADJUSTMENT/ADJUSTING GEAR BACKLASH" section on page 10-28.)

09951-09310: Gear adjust spring set
09952-09310: Backlash indicator tool



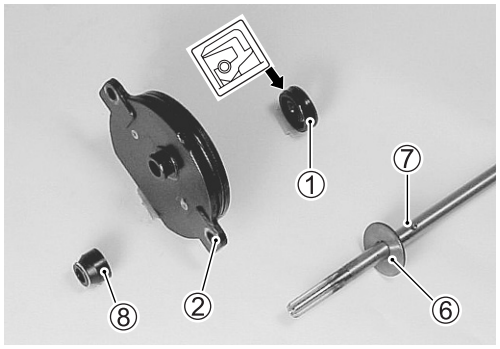
CHECKING PROPELLER SHAFT THRUST PLAY
See the “GEARS-SHIMMING AND ADJUSTMENT/CHECKING PROPELLER SHAFT THRUST PLAY” section on page 10-31.



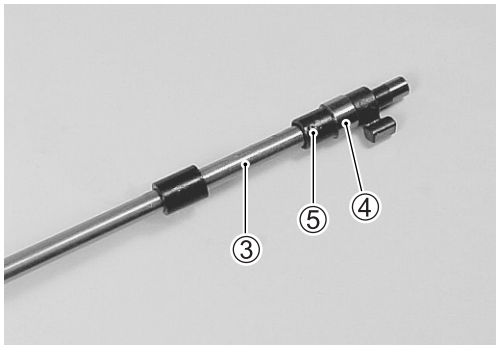
SHIFT ROD GUIDE HOUSING

- 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.

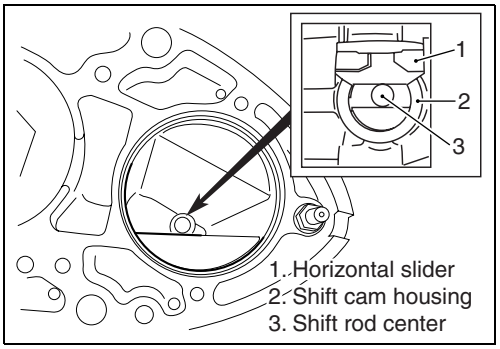
W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



- 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.).

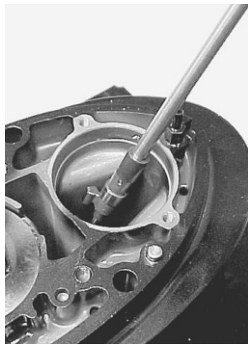


- Apply Water Resistant Grease to the shift rod guide housing O-ring.

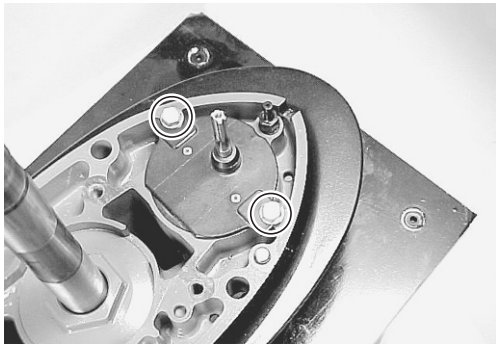
W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**

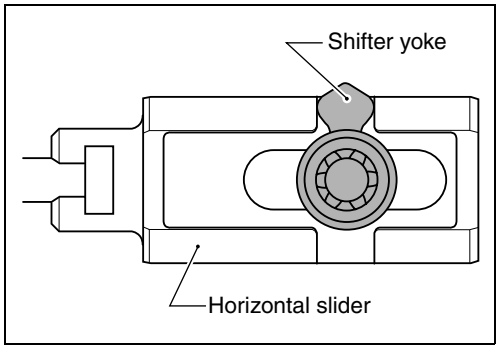
NOTE:
Before installing shift rod guide housing assembly, bring shifter yoke to neutral position by turning shift rod right or left.





- 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.

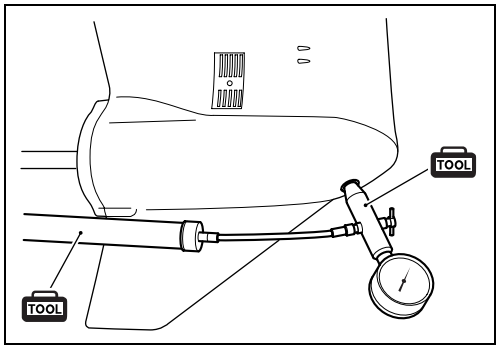




LEAKAGE CHECK

Check for leakage of oil seal and O-ring when applying specified pressure inside of the gearcase.

TOOL 09950-69512: 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)

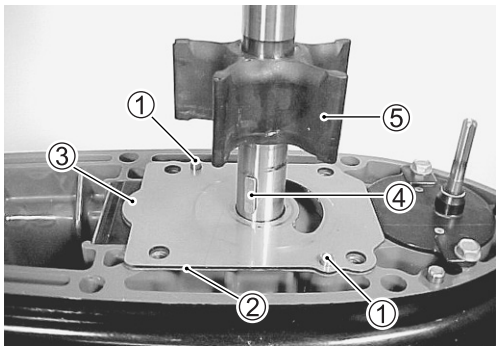
CAUTION

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)

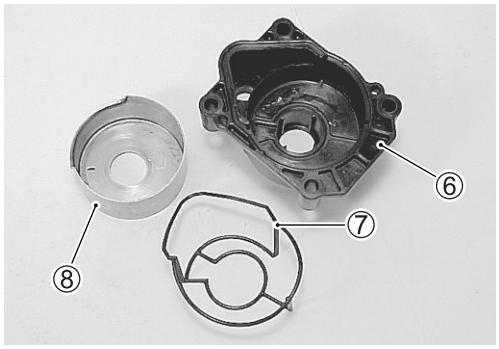
- Place the dowel pins ①, under panel gasket ② and under panel ③ into position.
- Insert the key ④ in the driveshaft and slide the impeller ⑤ onto driveshaft, ensuring that key and keyway are aligned.



- Place the seal ring ⑦ into groove of the pump case ⑥, then install inner sleeve ⑧ to pump case.

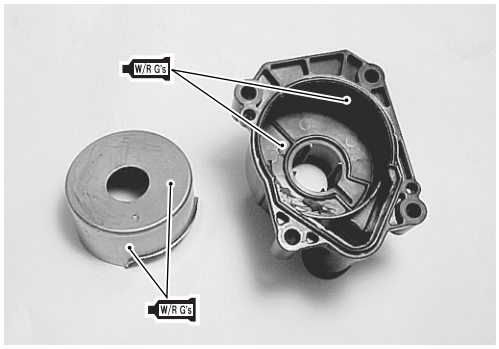
CAUTION

Do not re-use seal ring once removed.
Always use new ring.



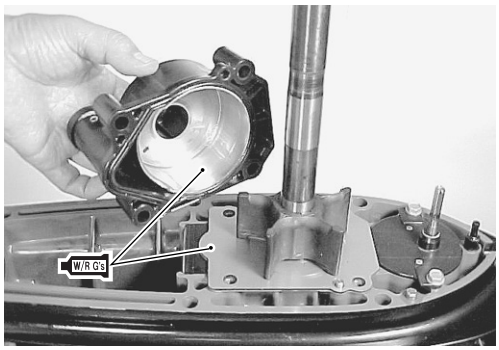
NOTE:
Before installing pump inner sleeve, apply water resistant grease lightly between inner sleeve and pump case mating surfaces.

W/R G's **99000-25160: SUZUKI WATER RESISTANT GREASE**



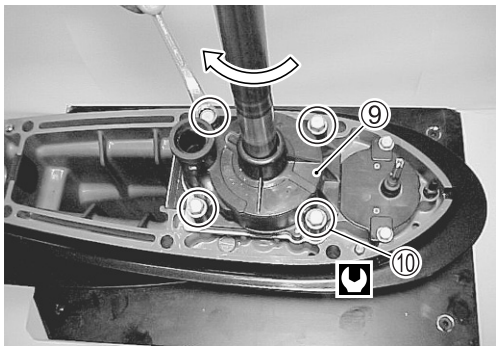
NOTE:
Before installing water pump case assembly, apply Water Resistant Grease lightly on pump case inner sleeve and under panel for initial lubrication.

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, 12.3 lb-ft)



PROPELLER INSTALLATION

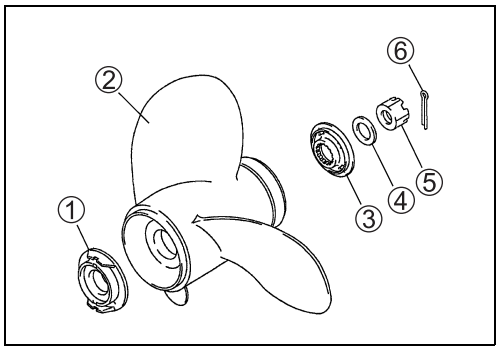
Install propeller stopper ① onto propeller shaft, then slide on the propeller ②.

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

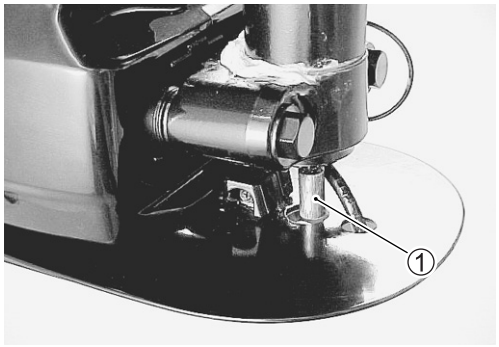
Propeller nut: 55 N·m (5.5 kg-m, 40.0 lb-ft)



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.

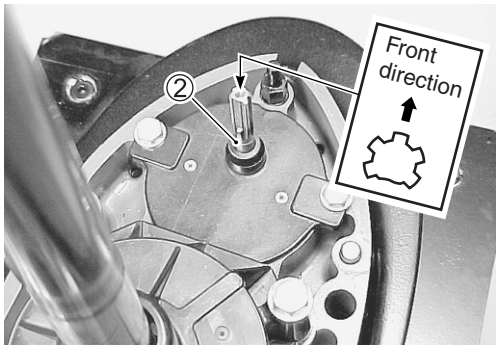
W/R G's 99000-25160: SUZUKI WATER RESISTANT GREASE



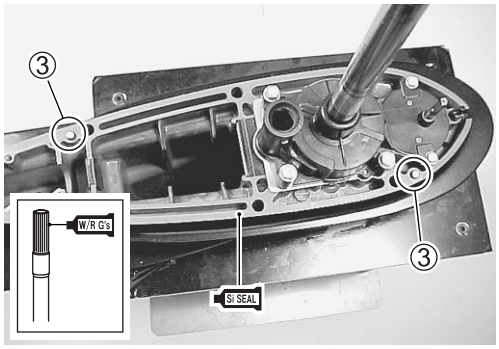
- Ensure that shift rod ② is at neutral position.

NOTE:

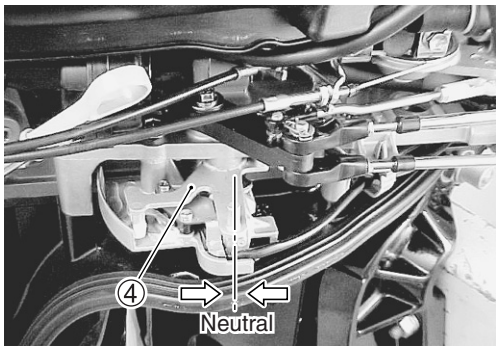
Before installing lower unit assembly, bring shift to neutral position by turning shift rod right or left.



- 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.



• Set the clutch control lever ④ at Neutral position, then slide the lower unit ⑤ into place, ensuring that the top of driveshaft engages properly with driven gear shaft and that water tube locates in water pump case outlet.



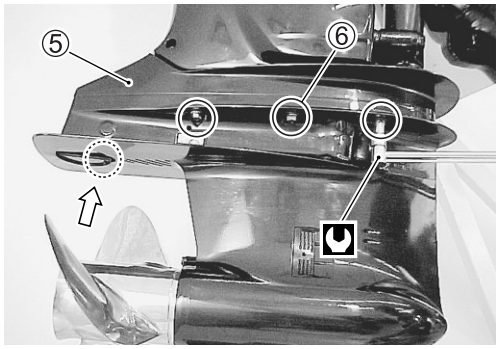
NOTE:
In order for shift rod and clutch rod splines to be aligned correctly, clutch rod may need to be turned slightly right or left.

• Apply SUZUKI SILICONE SEAL to seven (7) gearcase bolts ⑥ and tighten them to specified torque.

Gearcase bolt: 10 mm 55 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

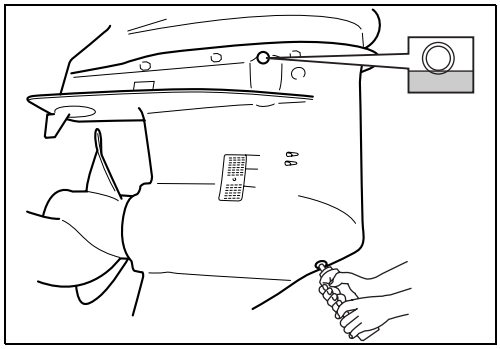


• Shift the clutch control lever to Forward and Reverse position from Neutral position to check proper gear engagement.

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



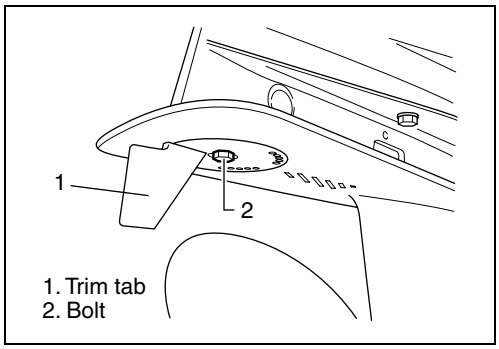
TRIM TAB

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:

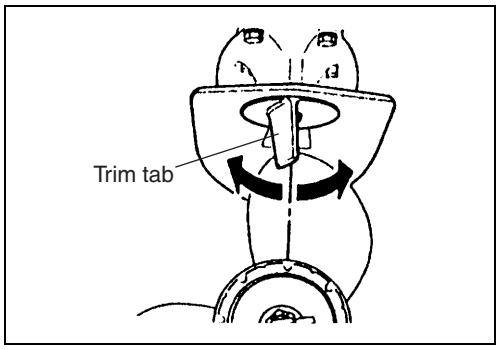
Adjusting

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.

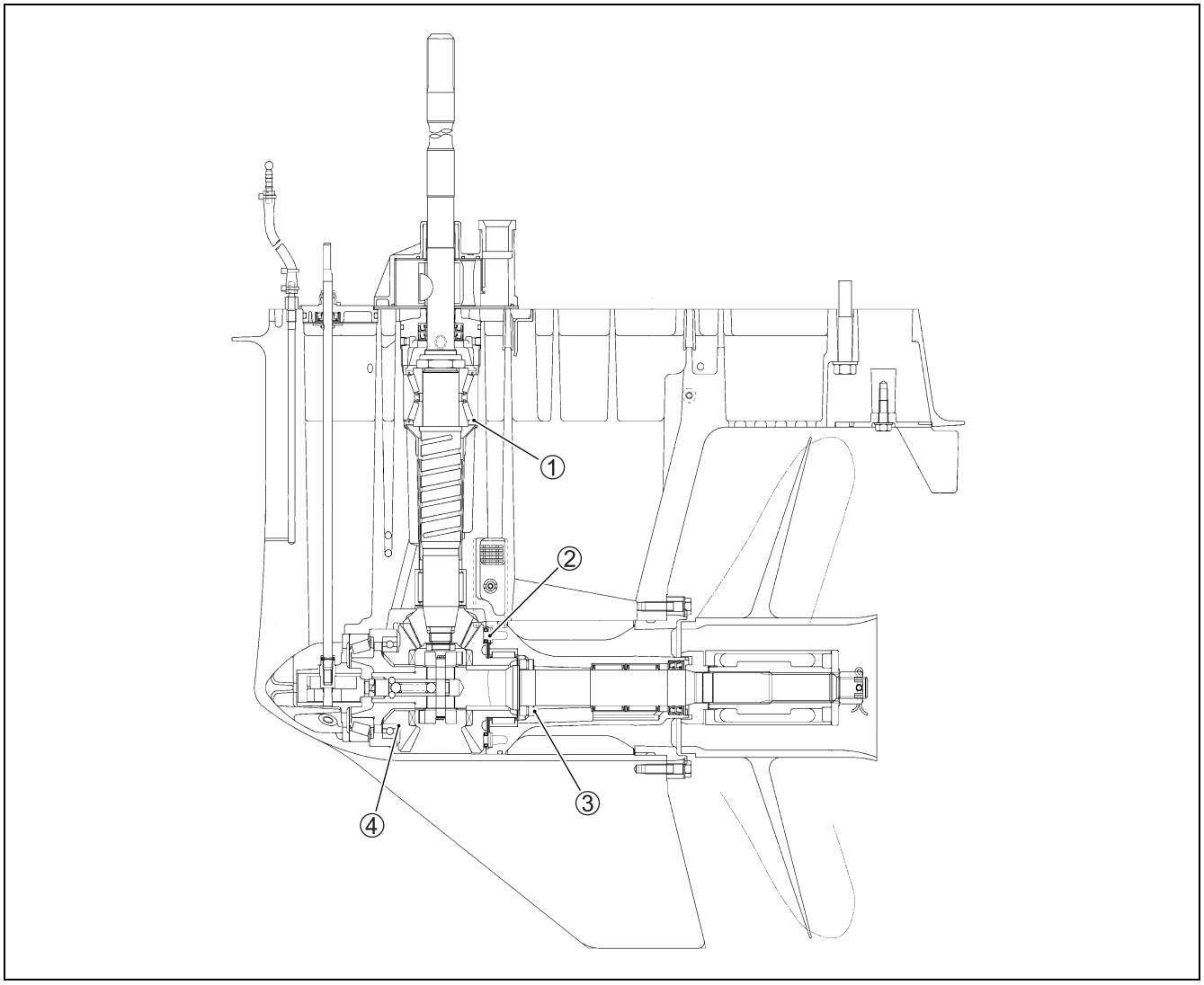
LOWER UNIT GEARS- SHIMMING AND ADJUSTMENT

(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	1.0
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

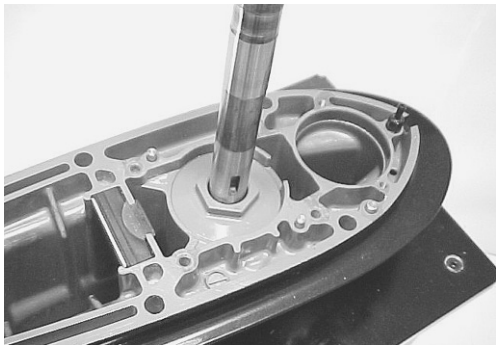
1. Install standard pinion gear back-up shim thickness modified according to ± design specification mark on gear.



± 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.

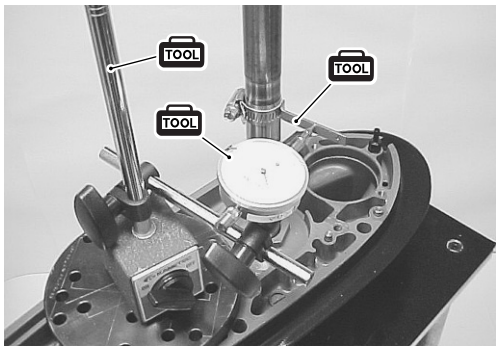
Pinion nut: 145 N·m (14.5 kg-m, 105.0 lb-ft)



ADJUSTING GEAR BACKLASH

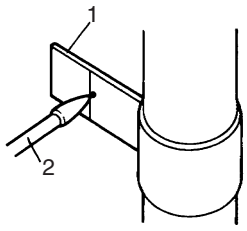
(a) Assemble special tool to driveshaft as shown in figure.

09900-20602: 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)

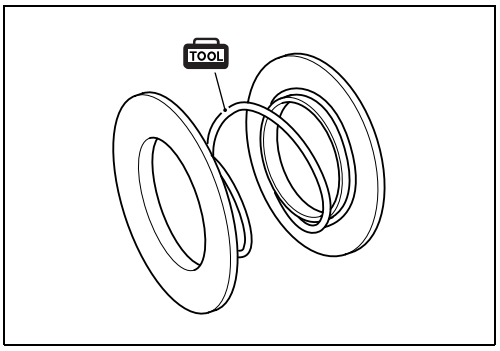


1. Backlash indicator tool
2. Dial gauge

- 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.

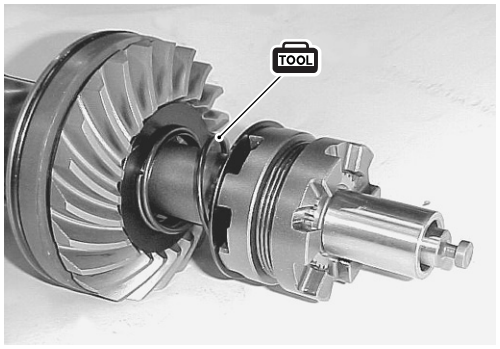


Adjusting gear backlash

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: 145 N·m (14.5 kg-m, 105.0 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.

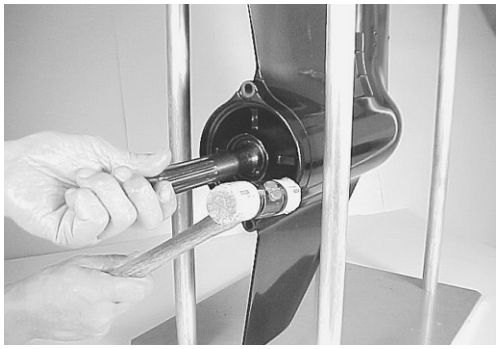


NOTE:

- *Before installing special tool, move shifter dog to reverse position.*
- *Use longer spring (free length: 42.3 mm, 1.67 in) in the gear adjust spring set to adjust the forward gear backlash.*

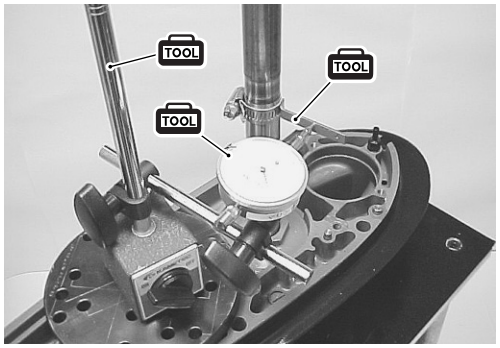
TOOL 09951-09310: Gear adjust spring set

4. Install forward gear and propeller shaft housing assembly into gearcase, then tighten both bearing housing retaining bolts to specified torque.



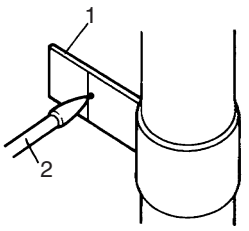
5. Assemble special tool to driveshaft as shown in figure.

TOOL 09900-20602: 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.

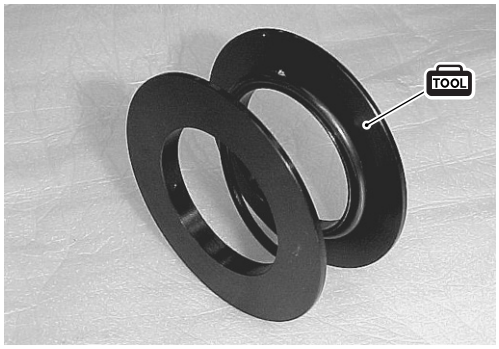
Checking and adjusting tooth contact pattern (Pinion and Forward gear)

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.

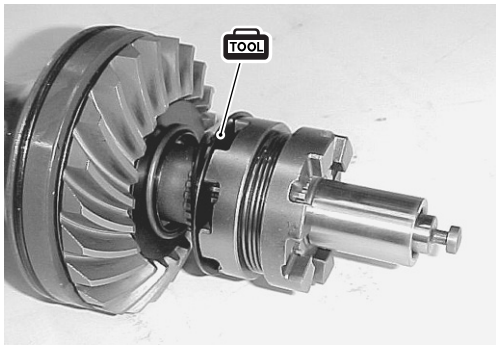
NOTE:

- *Use shorter spring (free length: 23.8 mm, 0.94 in) in the gear adjust spring set and install it between forward gear and clutch dog to check the tooth contact pattern.*
- *Before installing special tool, move shifter dog to reverse position.*



TOOL 09951-09310: Gear adjust spring set

2. Install forward gear and propeller shaft housing assembly into gearcase, then tighten both bearing housing retaining bolts to specified torque.

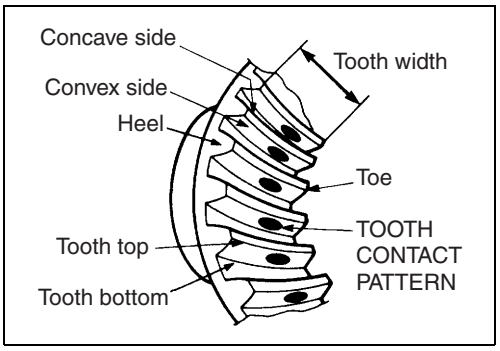


3. Using driveshaft holder tool, rotate the driveshaft 5 – 6 times.

TOOL 09921-29410: Driveshaft holder



4. Carefully pull out propeller shaft and housing to check tooth contact pattern.



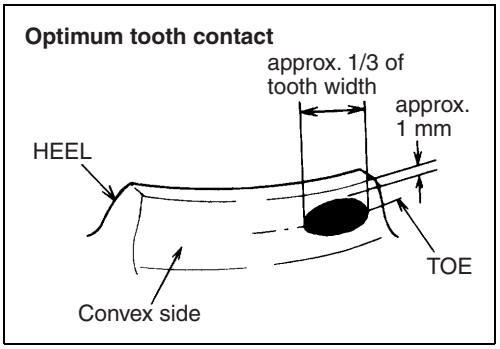
Optimum tooth contact

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)

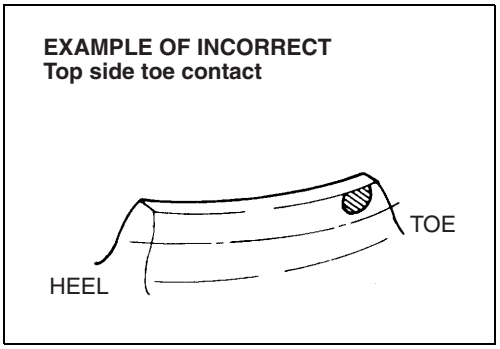
Incorrect topside toe contact:

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)

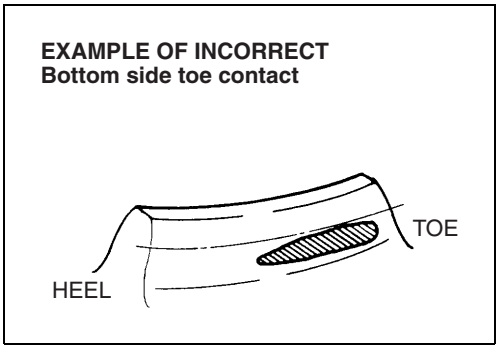
Incorrect bottom side toe contact:

Correction measures:

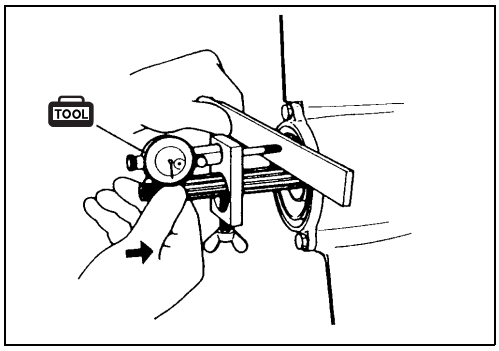
- Increase thickness of forward gear shim.
- Slightly increase pinion gear shim thickness.

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.

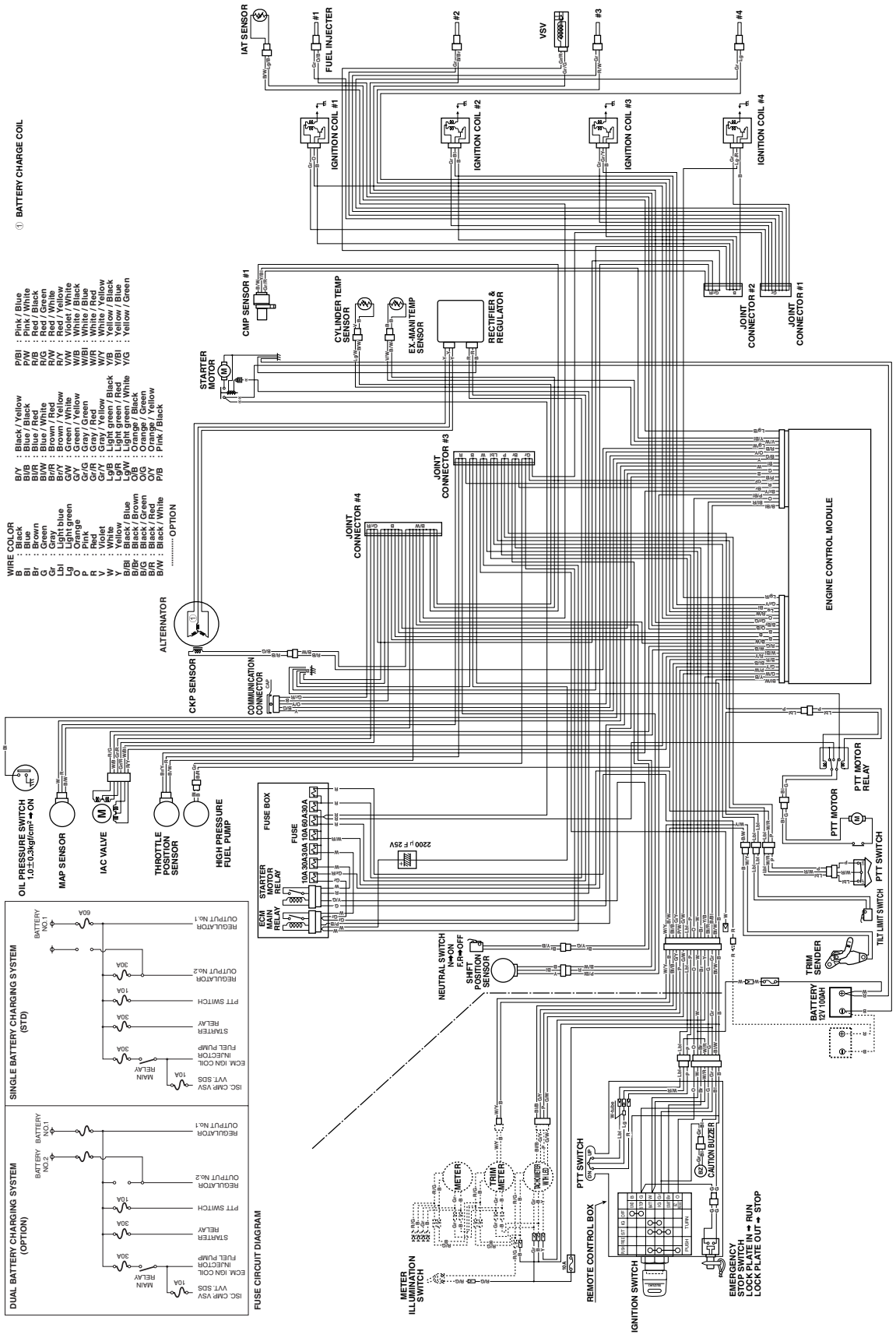
WIRE/HOSE ROUTING

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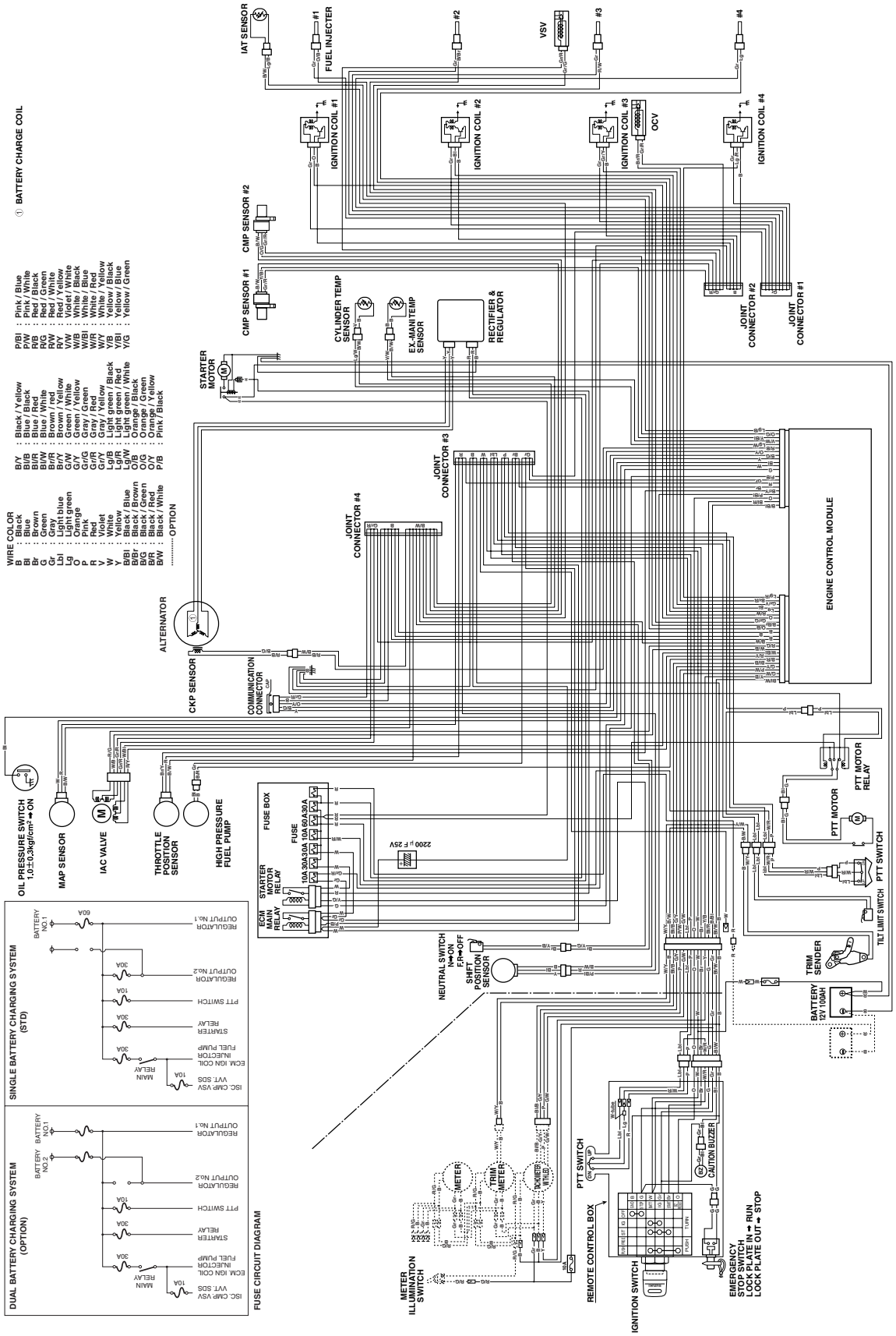
WIRING DIAGRAM 11- 2
DF150 .....11- 2
DF175 .....11- 3
WIRE ROUTING 11- 4
FUEL/WATER HOSE ROUTING 11-11
FUEL HOSE ROUTING 11-11
WATER HOSE ROUTING 11-15

WIRING DIAGRAM

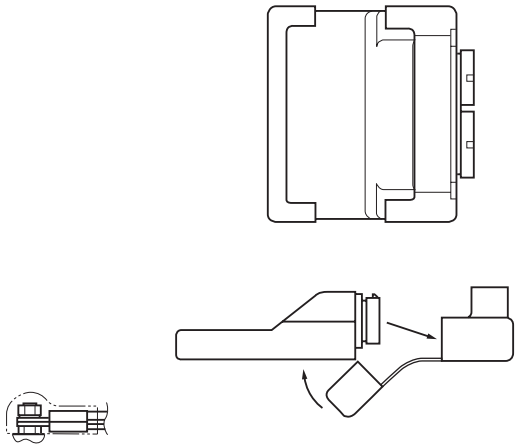
DF150

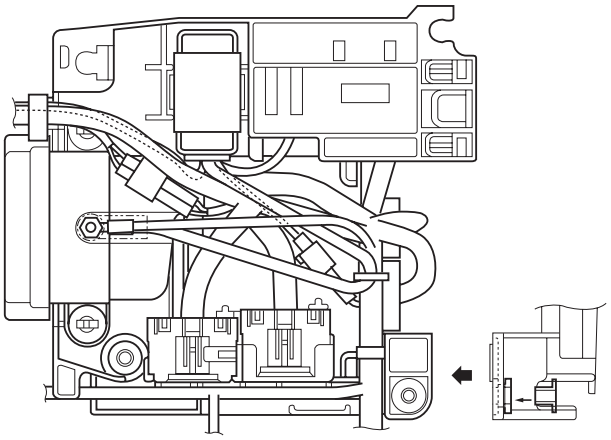


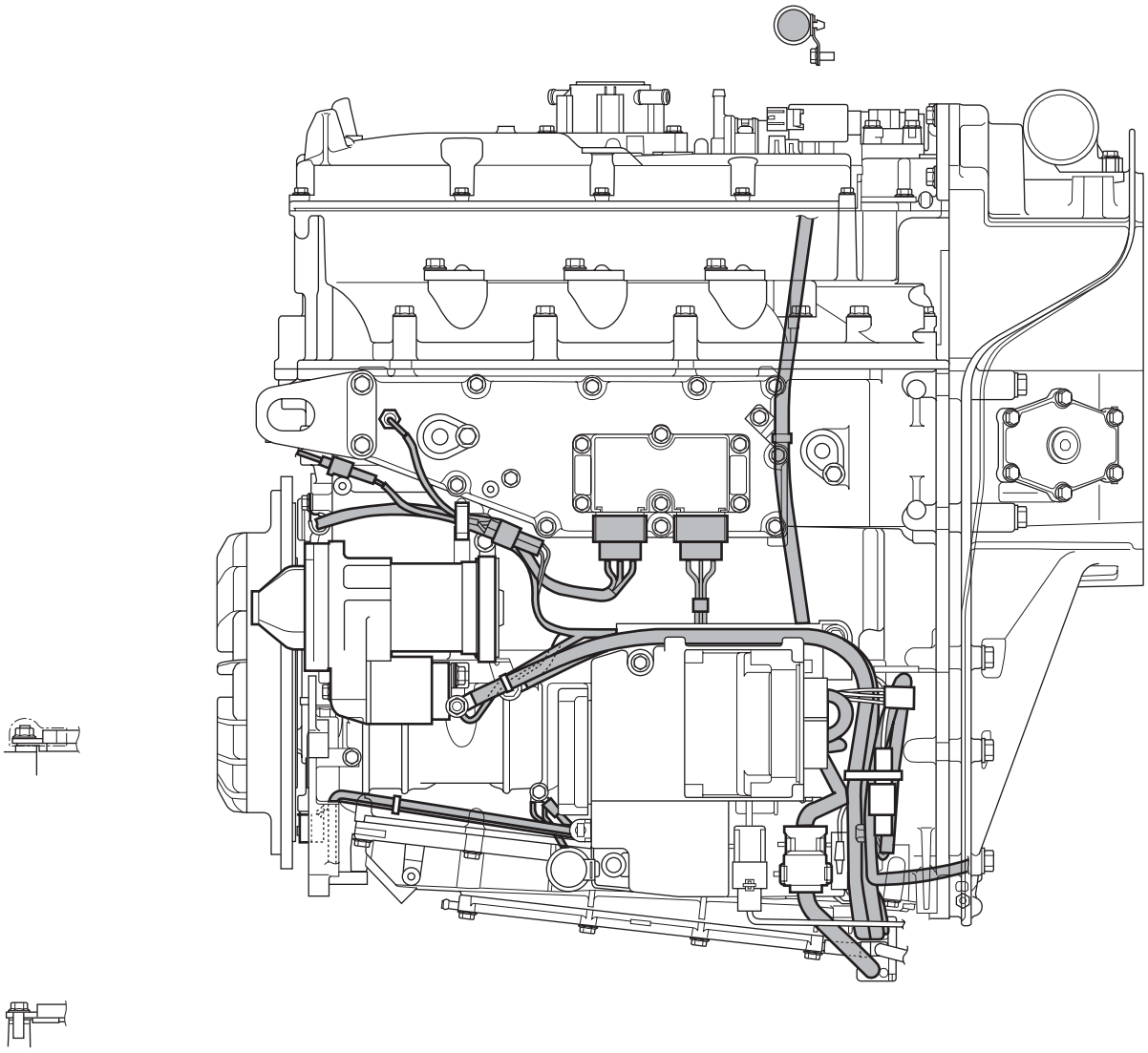
DF175

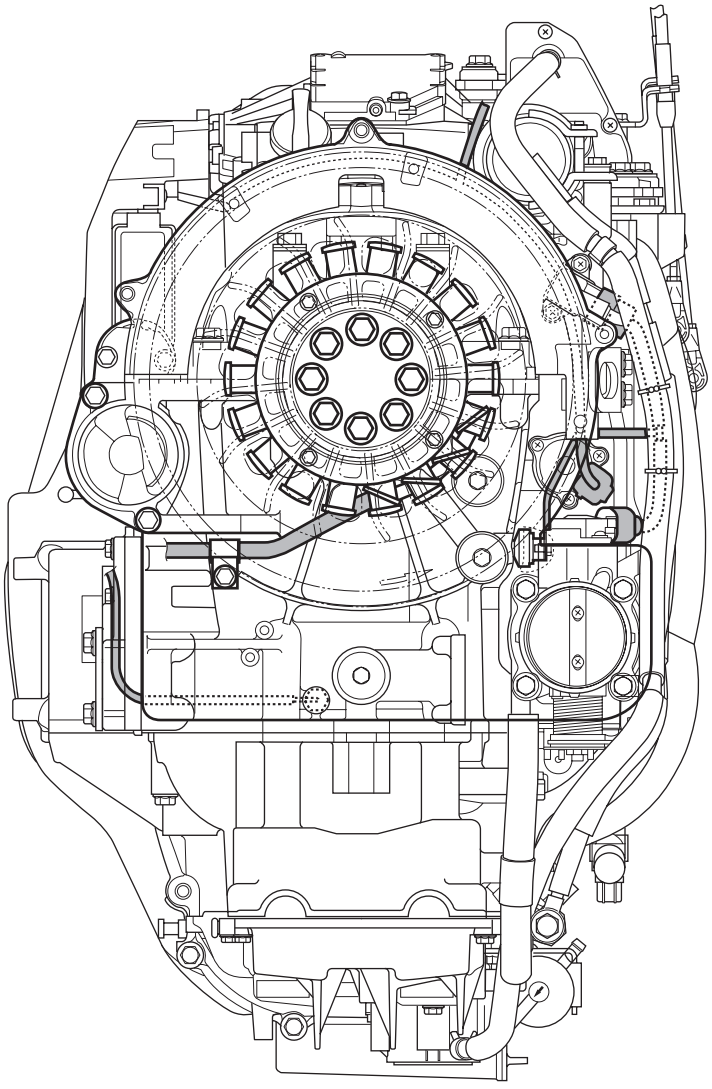

① BATTERY CHARGE COIL
WIRE COLOR
B : Black
Bl : Blue
Br : Brown
G : Green
Gr : Grey
Lbl : Light blue
Lg : Light green
O : Orange
P : Pink
R : Red
V : Violet
W : White
Y : Yellow
B/Bl : Black / Blue
B/Br : Black / Brown
B/G : Black / Green
B/R : Black / Red
B/W : Black / White
..... OPTION
B/Y : Black / Yellow
Bl/B : Blue / Black
Bl/R : Blue / Red
Bl/W : Blue / White
Br/B : Brown / Black
Br/Y : Brown / Yellow
G/W : Green / White
G/Y : Green / Yellow
Gr/G : Grey / Green
Gr/R : Gray / Red
Gr/Y : Gray / Yellow
Lg/B : Light green / Black
Lg/R : Light green / Red
Lg/W : Light green / White
O/B : Orange / Black
O/G : Orange / Green
O/Y : Orange / Yellow
P/B : Pink / Black
P/Bl : Pink / Blue
P/W : Pink / White
R/B : Red / Black
R/G : Red / Green
R/W : Red / White
R/Y : Red / Yellow
V/W : Violet / White
W/B : White / Black
W/Bl : White / Blue
W/R : White / Red
W/Y : White / Yellow
Y/B : Yellow / Black
Y/Bl : Yellow / Blue
Y/G : Yellow / Green
IAT SENSOR
#1
FUEL INJECTER
#2
VSV
#3
#4
IGNITION COIL #1
IGNITION COIL #2
IGNITION COIL #3
OCV
IGNITION COIL #4
CMP SENSOR #2
CMP SENSOR #1
CYLINDER TEMP SENSOR
EX.-MANI TEMP SENSOR
RECTIFIER & REGULATOR
JOINT CONNECTOR #2
JOINT CONNECTOR #1
STARTER MOTOR
JOINT CONNECTOR #3
JOINT CONNECTOR #4
ENGINE CONTROL MODULE
ALTERNATOR
CKP SENSOR
COMMUNICATION CONNECTOR
OIL PRESSURE SWITCH 1.0±0.3kgf/cm² ➡ ON
MAP SENSOR
IAC VALVE
THROTTLE POSITION SENSOR
HIGH PRESSURE FUEL PUMP
FUSE BOX
FUSE
10A 30A 30A 10A 60A 30A
2200 μ F 25V
STARTER MOTOR RELAY
ECM MAIN RELAY
PTT MOTOR
PTT MOTOR RELAY
PTT SWITCH
TILT LIMIT SWITCH
TRIM SENDER
BATTERY 12V 100AH
NEUTRAL SWITCH N➡ON F/R➡OFF
SHIFT POSITION SENSOR
SINGLE BATTERY CHARGING SYSTEM (STD)
BATTERY NO.1
60A
REGULATOR OUTPUT No.1
30A
REGULATOR OUTPUT No.2
10A
PTT SWITCH
30A
STARTER RELAY
30A
ECM IGN COIL INJECTOR FUEL PUMP
MAIN RELAY
10A
ISC. CMP VSV VVT. SDS
DUAL BATTERY CHARGING SYSTEM (OPTION)
BATTERY NO.1
BATTERY NO.2
REGULATOR OUTPUT No.1
REGULATOR OUTPUT No.2
10A
PTT SWITCH
30A
STARTER RELAY
30A
ECM IGN COIL INJECTOR FUEL PUMP
MAIN RELAY
10A
ISC. CMP VSV VVT. SDS
FUSE CIRCUIT DIAGRAM
METER
TRIM METER
KICKER WARNING
PTT SWITCH
REMOTE CONTROL BOX
CAUTION BUZZER
METER ILLUMINATION SWITCH
IGNITION SWITCH
EMERGENCY STOP SWITCH
LOCK PLATE IN ➡ RUN
LOCK PLATE OUT ➡ STOP

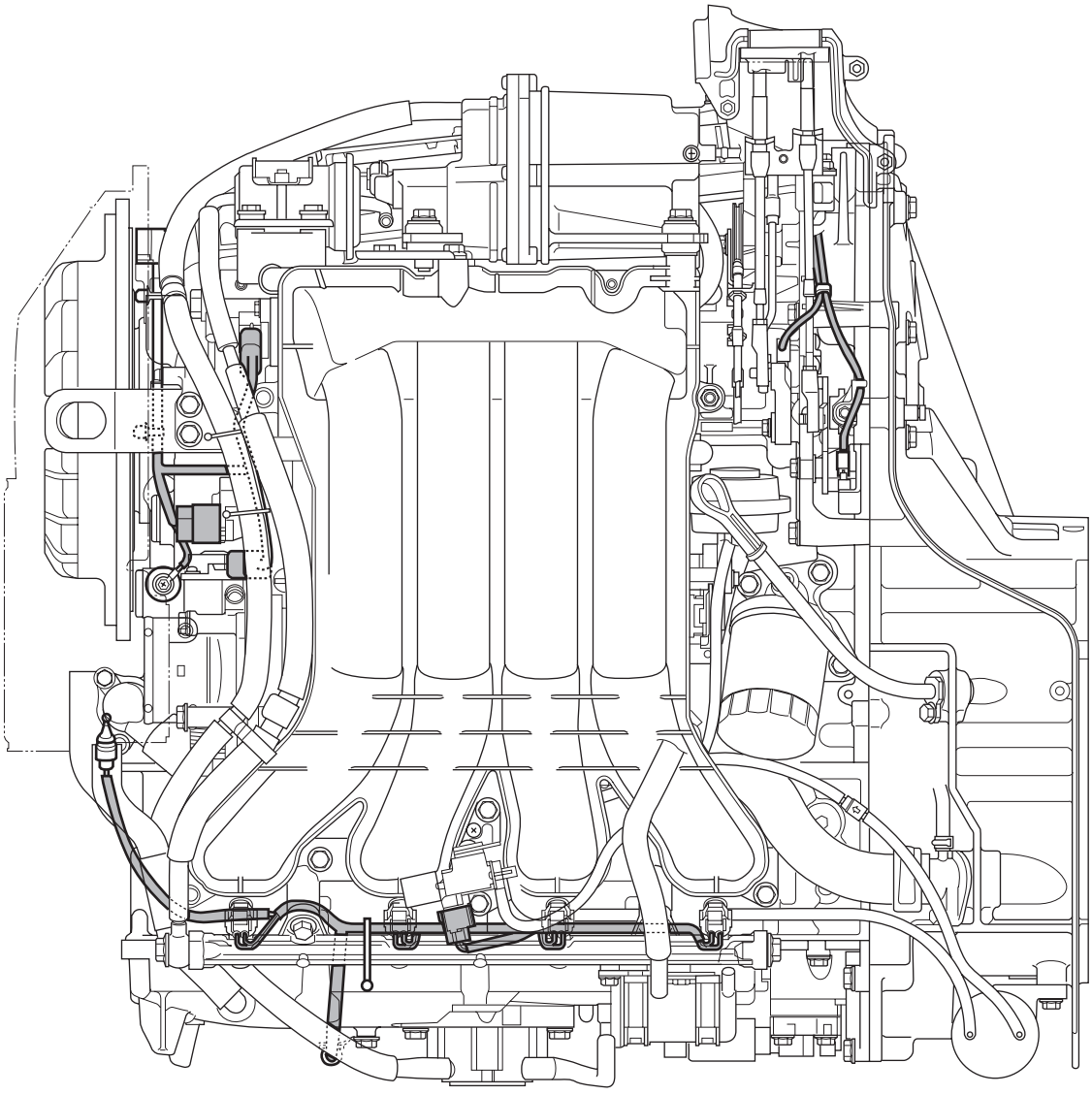
WIRE ROUTING

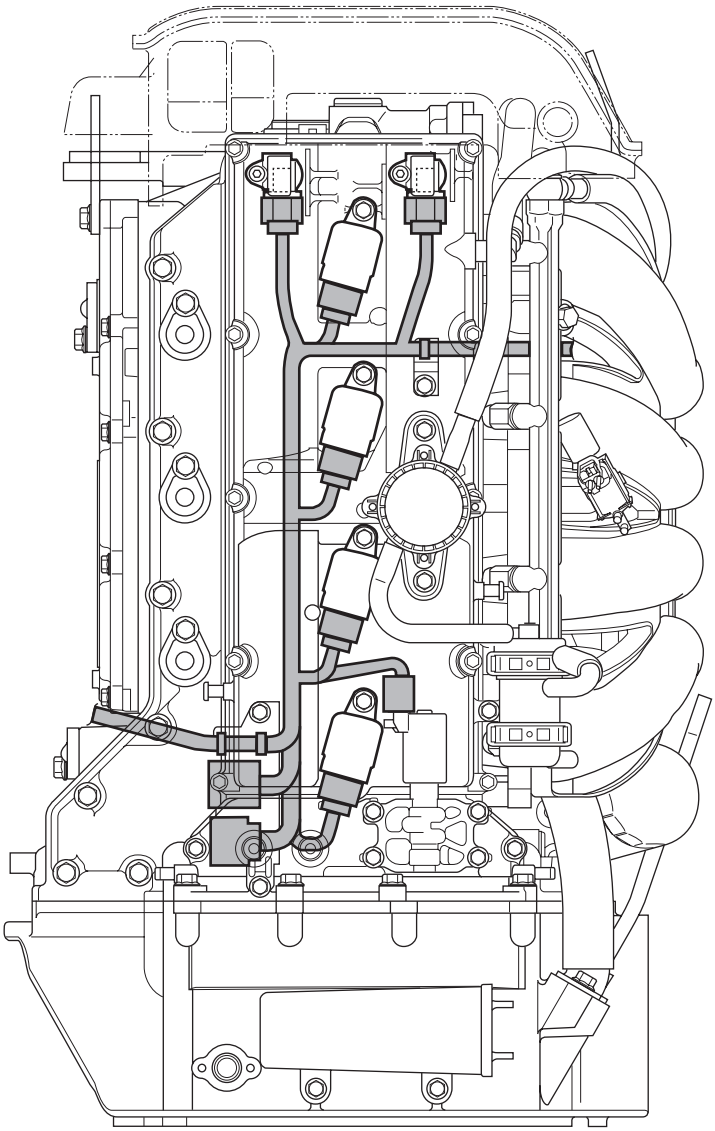


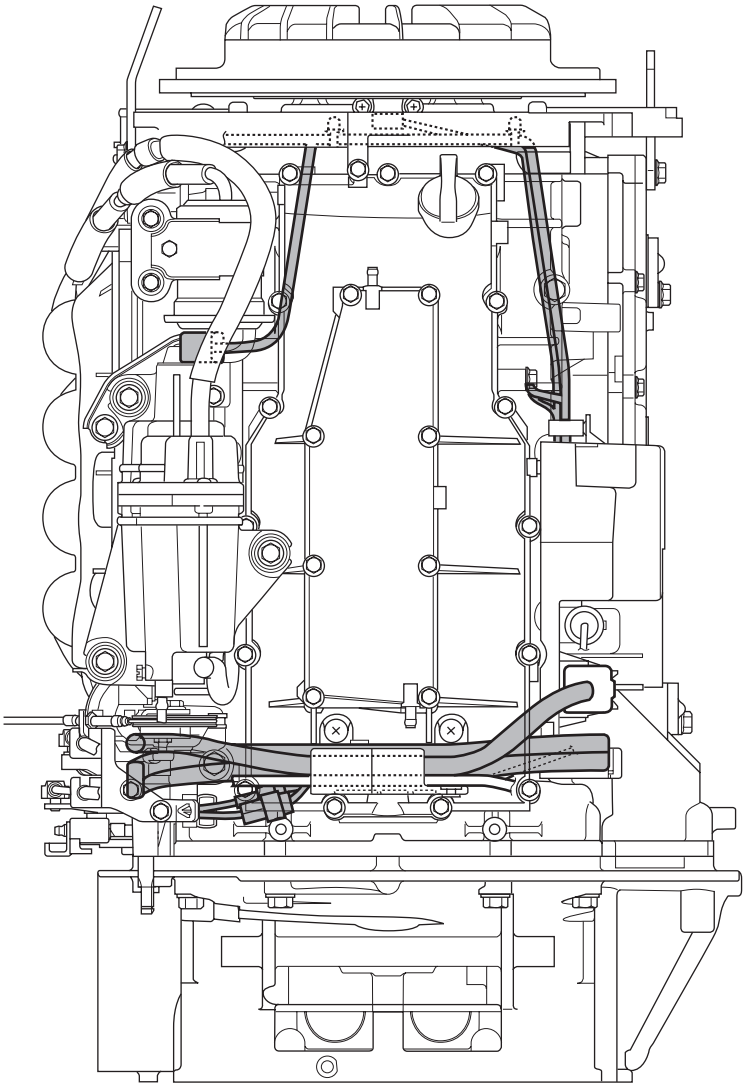


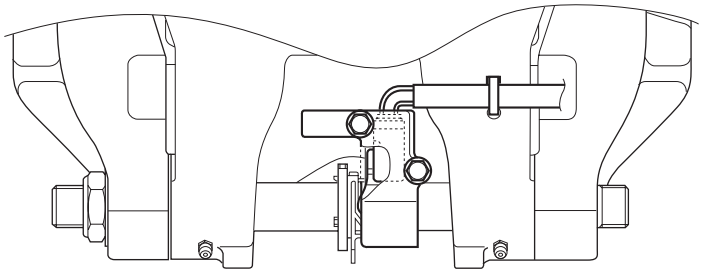


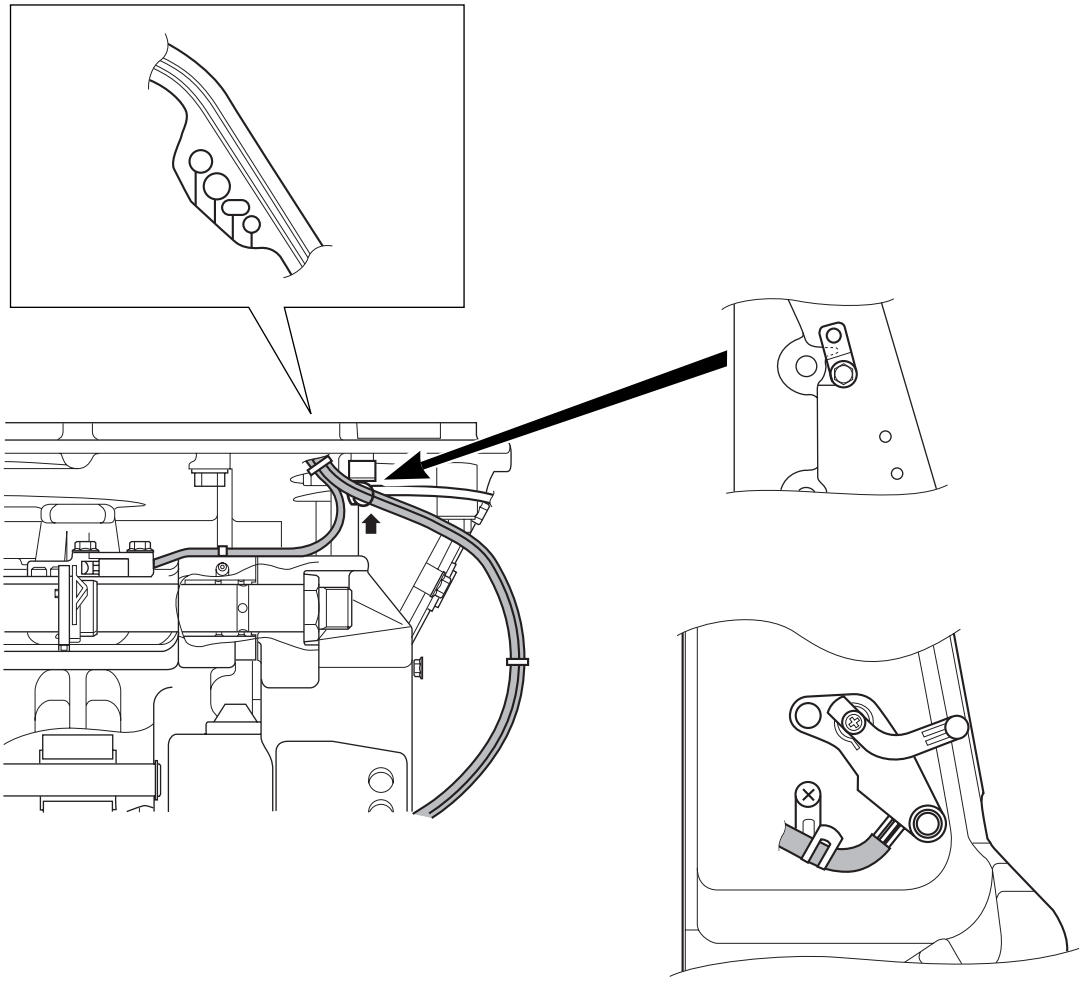










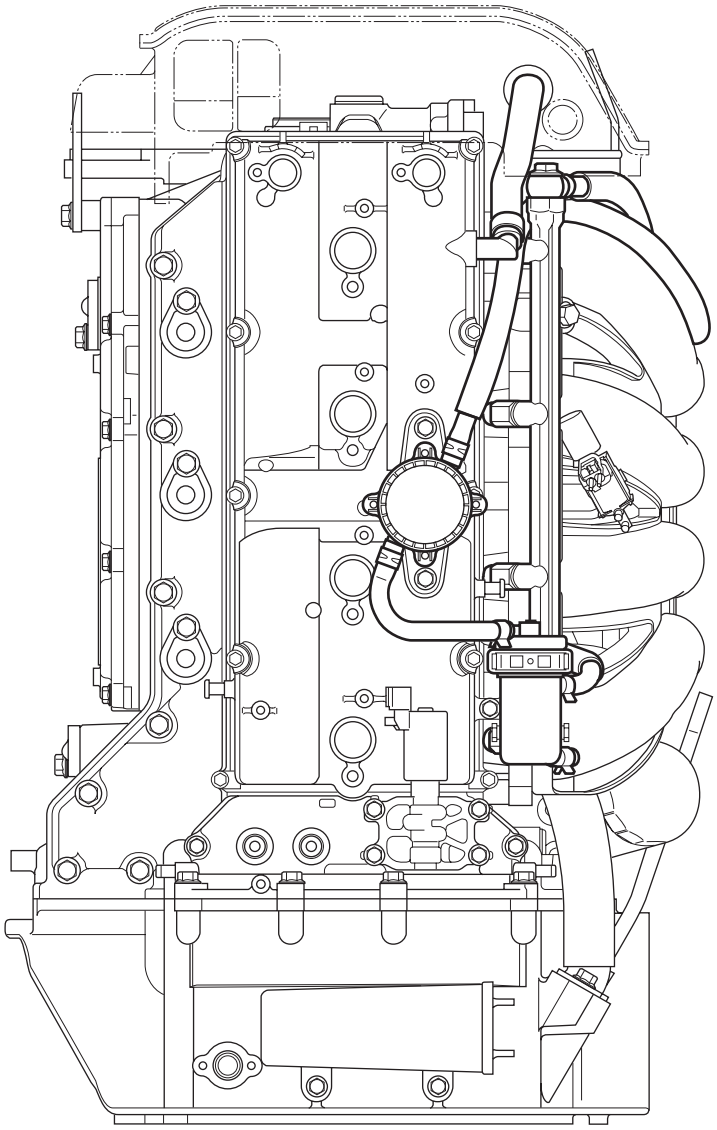


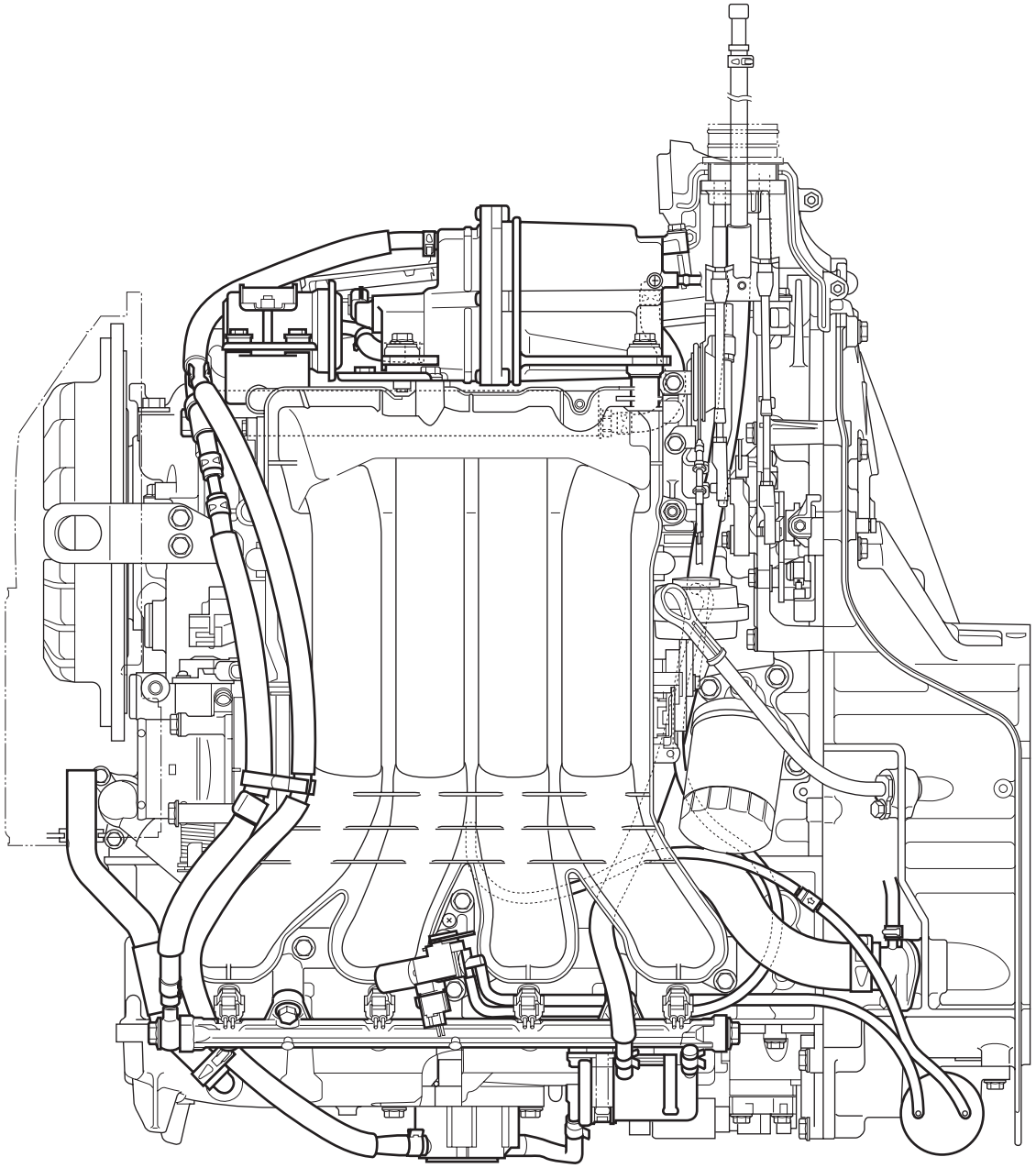
FUEL/WATER HOSE ROUTING

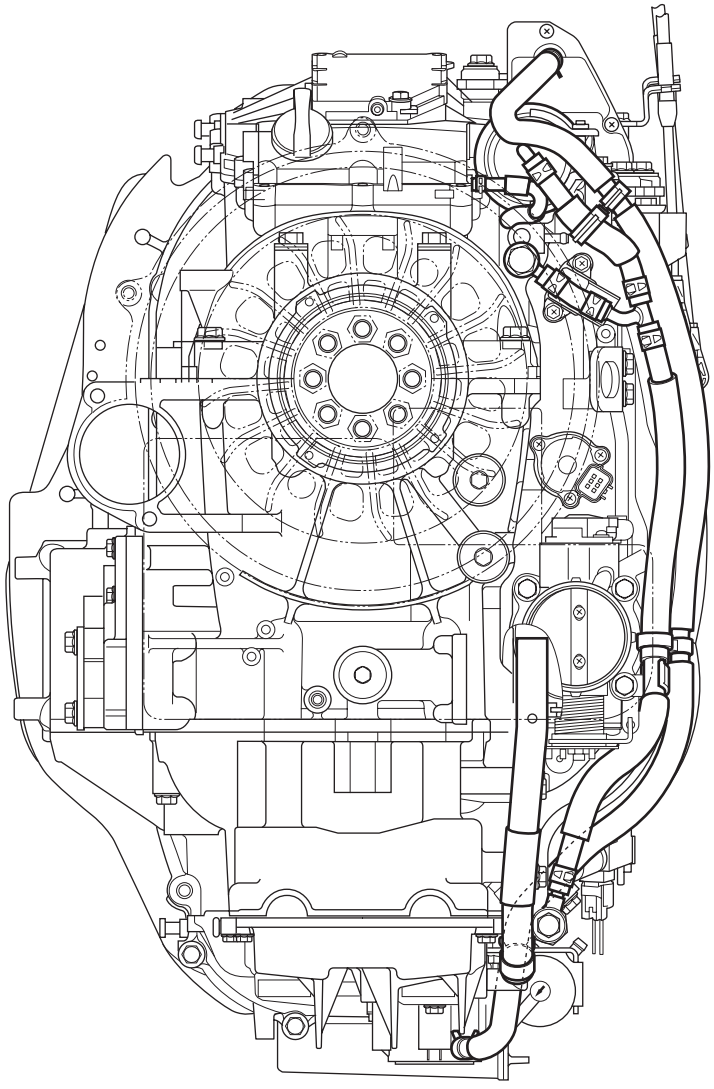
CAUTION

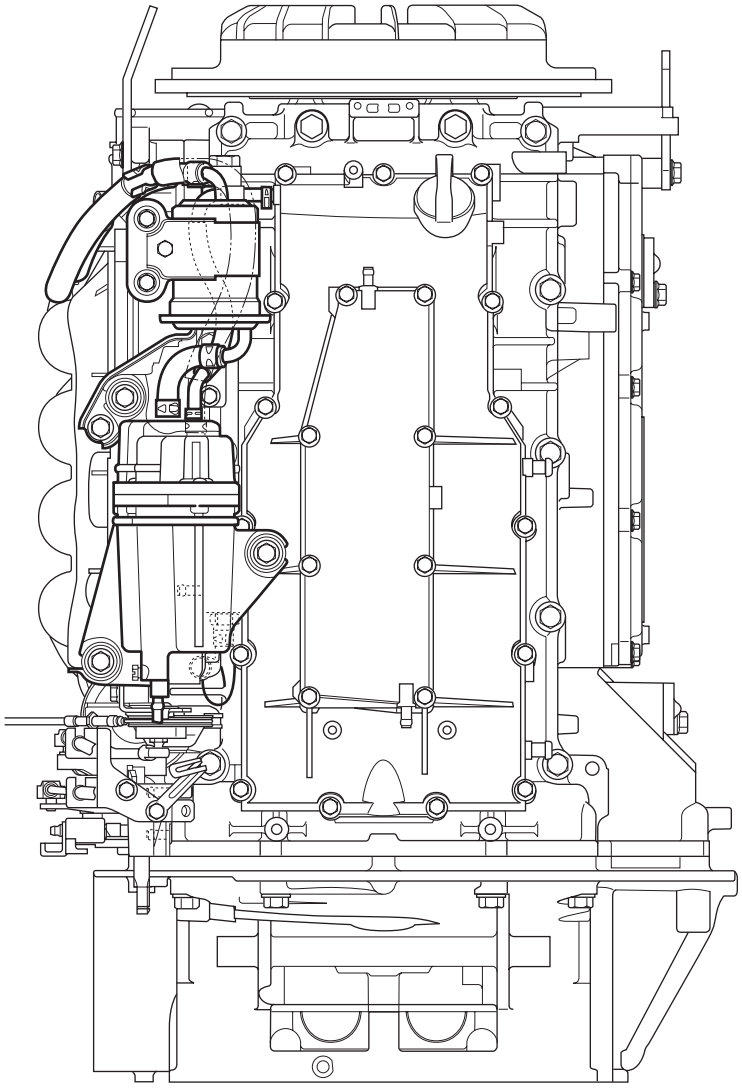
- **Do not over-bend (kink) or twist hoses when installing.**
- **When installing hose clips, position tabs to avoid contact with other parts.**
- **Check that hoses do not contact rods and levers during either engine operation or standstill.**
- **Extreme care should be taken not to cut, abrade or cause any other damage on hoses.**
- **Care should be taken not to cause hoses to be compressed excessively by any clamp when fitted.**

FUEL HOSE ROUTING

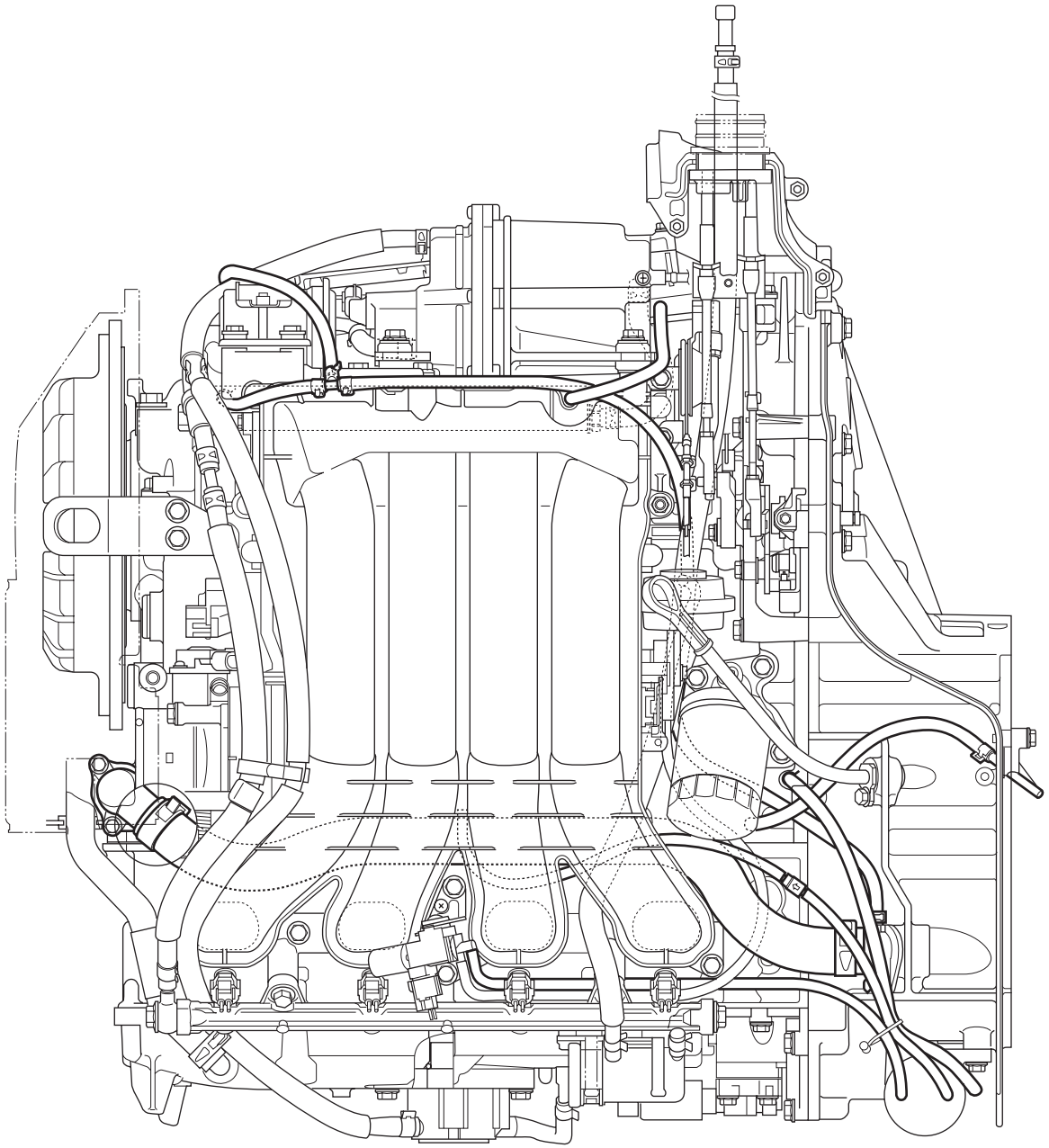


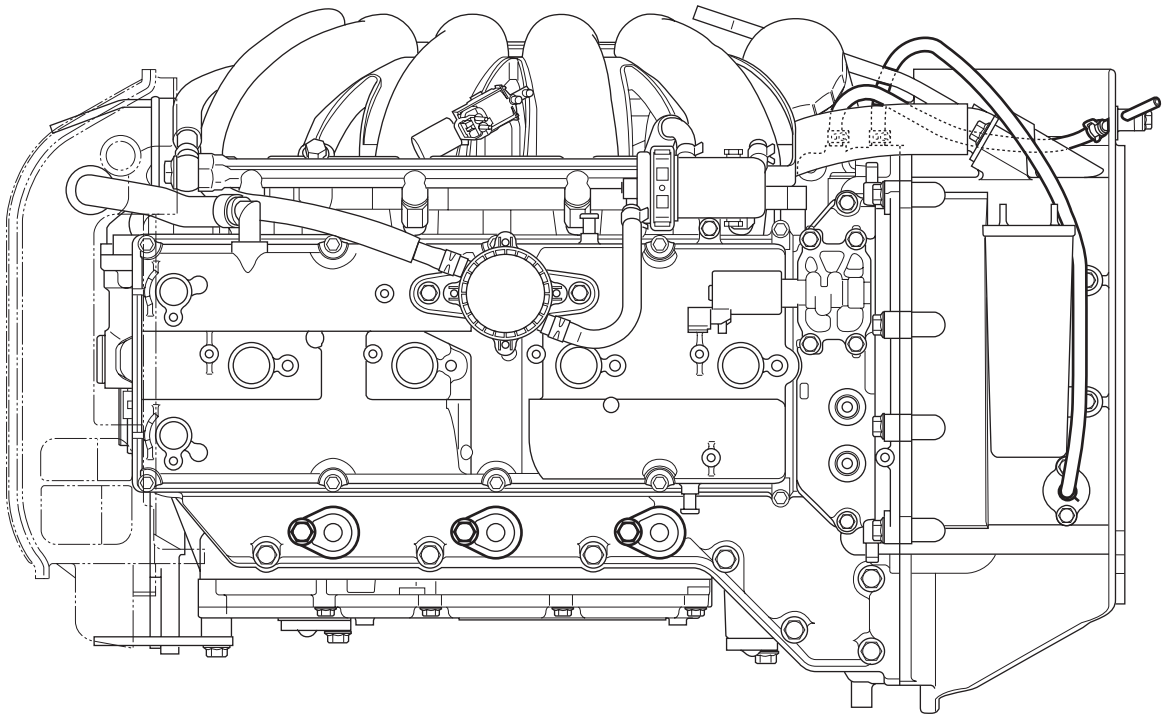


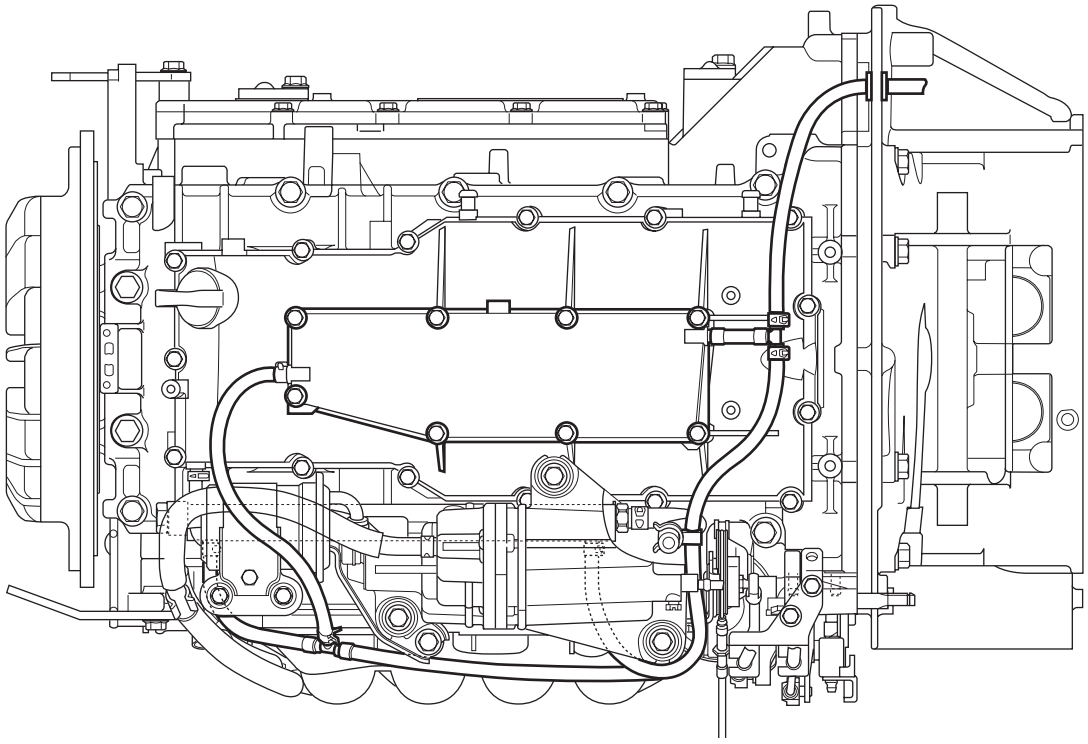


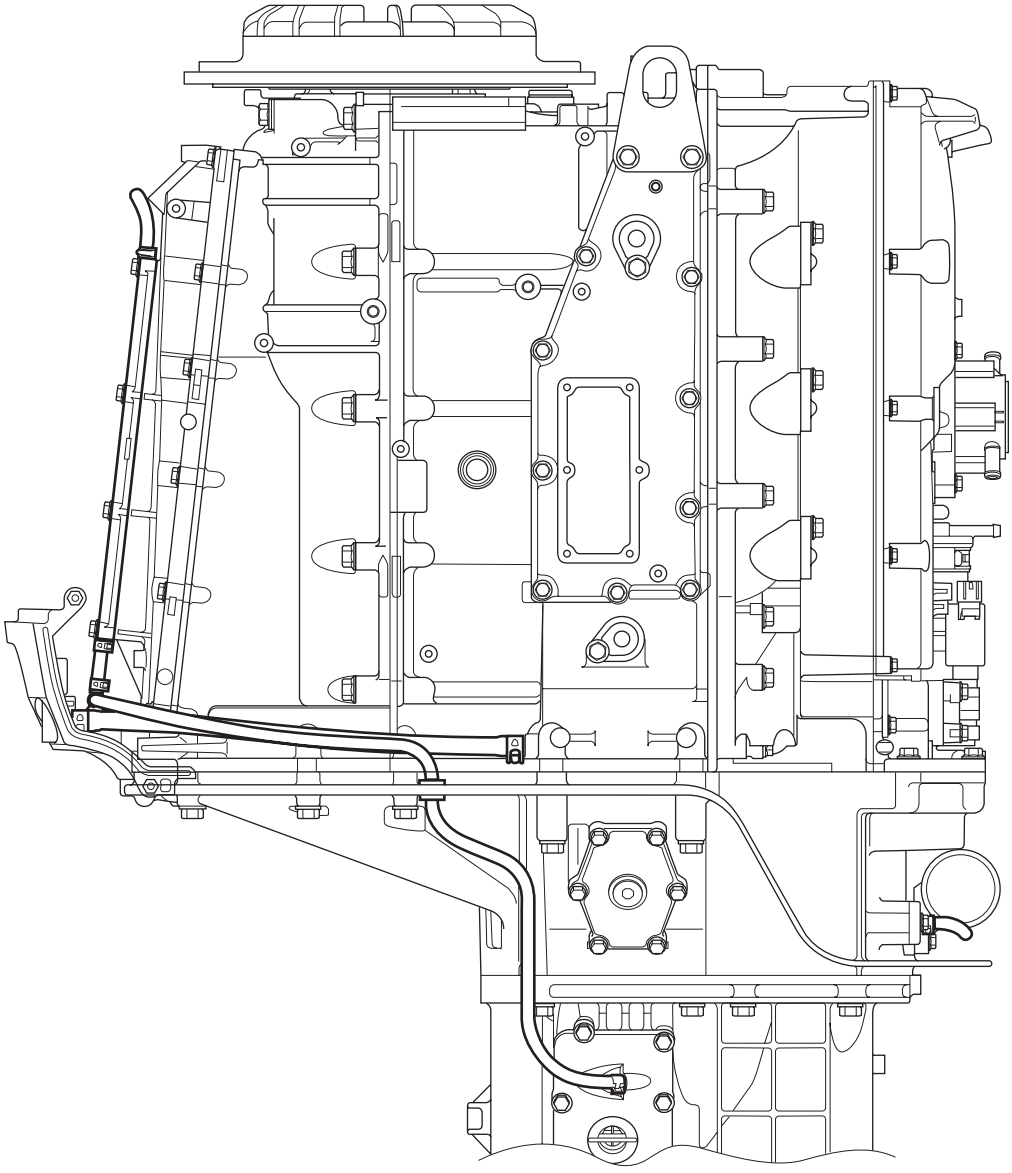


WATER HOSE ROUTING









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