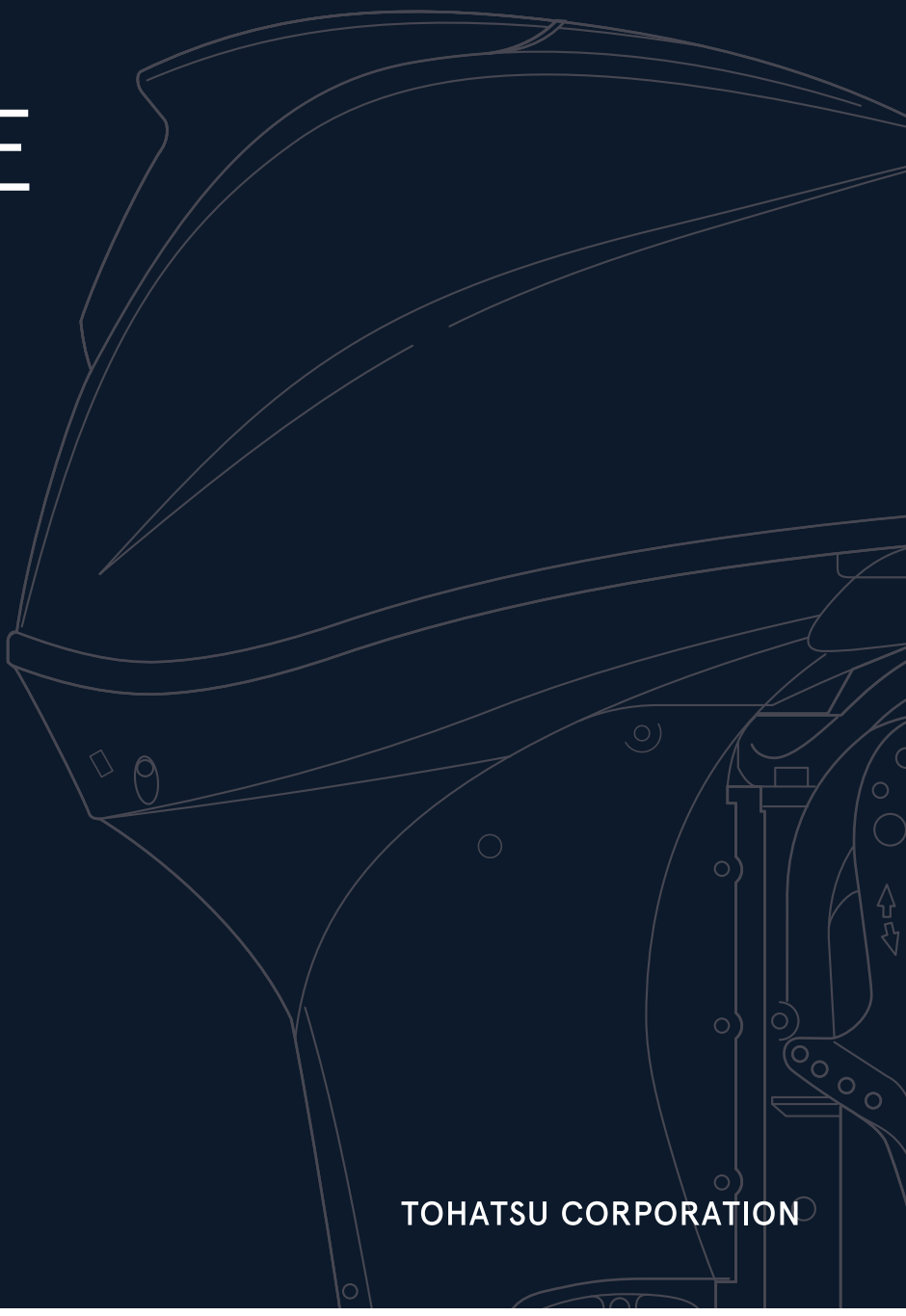
SERVICE MANUAL
Supplement

TOHATSU
Feel the Wind™

4 STROKE MFS 60A

OB No.003-21073-0 | 03-19 NB



BACKS YOU UP™

TOHATSU CORPORATION

Introduction

This manual has been prepared as a supplement for the MFS60A.

Please utilize this manual together with the service manual of our outboard motors MFS40A/MFS50A.

Contents

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Service Information

1. Tools and Instruments

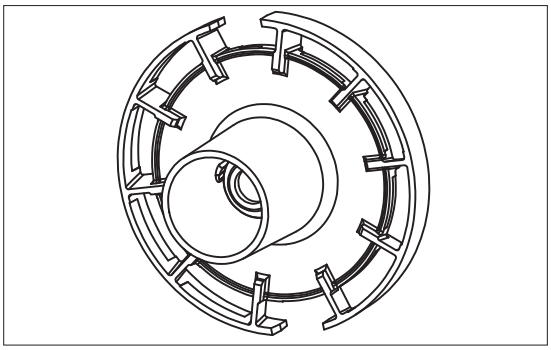
1) Test Propeller

P/N. 3UR-64110-0

Outer diameter : 236 mm

Width : 22.5 mm

Outboard motor model	Rotational speed at WOT (Wide Open Throttle) (r/min)
MFS60A	5000 - 6000



2) Measuring instruments

For the following measuring instruments, use commercially available ones.

Circuit tester	(Resistance : 1Ω, 10Ω, 10 kΩ, AC voltage : 30 to 300V, DC voltage : 30V)
Vernier calipers	(M1 type, 300 mm)
Micrometer	(minimum graduation of 0.01, outer, 0 to 25 mm, 25 to 50 mm, 50 to 75 mm)
Cylinder gauge	(4 to 6 mm, 10 to 25 mm, 25 to 30 mm, 50 to 75 mm)
Ring gauge	(ø5.5, ø17, ø42, ø70)
Dial gauge	(minimum graduation of 0.01)
Thickness gauge	(0.03 to 0.3 mm)
V block	
Surface plate	(500 mm x 500 mm)

Dial gauge magnet base or dial gauge stand

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Service Data

1. Specifications

Item	Unit	Model	
		MFS60A	
		ET (with Remote Control)	ET (with Multi Tiller Handle)

Dimensions (approx.)

Overall Length		mm (in)	with Remote Control : 783 (30.8) with Multi Tiller Handle : 1,382 (54.4)	
Overall Width		mm (in)	404 (15.9)	
Overall Height	S	mm (in)	1,257 (49.5)	
	L	mm (in)	1,390 (57.4)	
	UL	mm (in)	1,504 (59.2)	
Transom Length	S	mm (in)	405 (15.9)	
	L	mm (in)	538 (21.2)	
	UL	mm (in)	652 (25.7)	

Weight (approx.)

	L	kg (lb)	97 (214)	102 (225)
	UL	kg (lb)	100 (221)	105 (231)

Performance

Maximum Output		kW (ps)	TAC 44kW (60PS) / EU 44.1kW (60PS)
Full-throttle revolution speed range		r/min	5,000 to 6,000
Full-throttle Fuel Consumption		L (gal.)/hr	17.8 (4.70)
Idling (Neutral [N])		r/min	650/750/850/950
Trolling (Forward [F])		r/min	650/750/850/950

Power Unit

Engine Type			4 stroke	
No. of Cylinders			3	
Piston Displacement		cm^3 (cui)	866 (52.8)	
Valve System			SOHC	
Bore x Stroke		mm (in)	70 x 75 (2.76 x 2.95)	
Compression Ratio			10.5	
Shift Operation System			Remote Control	Front Shift (Manual)
Starting System			Electric Start	
Lubrication System			Wet Sump	
Cooling System			Water Cooling (Impeller System)	
Exhaust System			Through-the-prop Exhaust	
Ignition System			Battery Ignition	
Range of Ignition Angle			ATDC5° to BTDC20° (ECU timing control)	
Spark Plugs			IKR6G8 [NGK]	
Alternator Output			12V–252W, 21A	
Fuel Feed System			Electronic Fuel Injection	

Item			Unit	Model	
				MFS60A	
				ET (with Remote Control)	ET (with Multi Tiller Handle)

Fuel & Oil

Type of Fuel				Unleaded Gasoline (Research Octane Number 90 or over, Pump posted Octane Number 87 or over)
Fuel Tank Capacity			L	25
Fuel Priming System				ECU (Electronic Control Unit)
Fuel Pumping System				Mechanical (Plunger) pump + Electric System
Engine Oil	Type			4 Stroke Engine (Motor) Oil
	Grade		API	SH, SJ, SL
			SAE	10W-30, 10W-40
	Quantity		L	2.4 (when oil filter is replaced with new one)
Gear Oil	Type			Hypoid Gear Oil
	Grade	*1	API	GL-5
		*1	SAE	#80-90
	Quantity		cm^3 (US qt)	500 (0.53)

Lower Unit

Gear Shift Positions			F – N – R
Gear Ratio			2.08 (13 : 27)
Type of Gears			Spiral Bevel Gear
Clutch			Dog Clutch
Propeller Shaft Driving			Spline
Propeller Rotation Direction			Clockwise at forward (F) shift as viewed from rear
Propeller (Standard)		Marking	14P

Bracket

No. of Trim Steps		Steps	4
Trim Angle (Transom 12)	*2	Degrees	–4° to +16°
Shallow Water Drive Angle (Transom 12)	*2	Degrees	Adjustable
Max. Tilt Angle	*3	Degrees	62
Steering Angle	*4	Degrees	35+35
Max. Allowable Transom Thickness		mm (in)	31 to 70 (1.22 to 2.76)

*1 Both API and SAE requirements shall be met.
*2 Angle relative to horizon when transom angle is 12 degrees.
*3 Tilting Range
*4 Full Steering Angle Range to Starboard and Port

Item	Unit	Model	
		MFS60A	
		ET (with Remote Control)	ET (with Multi Tiller Handle)

Warning System

Over-revolution Protection			Controls engine speed to approximately 6,200 r/min or less (High Speed ESG). Warning buzzer sounds.
Engine Hydraulic Pressure Low	*1		Controls engine speed to approximately 2,800 r/min or less (Low Speed ESG). Warning buzzer sounds, and warning lamp A is lit.
Engine Cooling Water Temperature High.			Controls engine speed to approximately 2,800 r/min or less (Low Speed ESG). Warning buzzer sounds, and warning lamp B is blink.
Engine Cooling Water Temperature Abnormally High.			Controls engine speed to approximately 850 r/min (force Idling Speed). Warning buzzer sounds, and all warning lamps are blink.
Each Engine Sensor Malfunction	*1		Controls engine speed to approximately 2,800 r/min or more (Low Speed ESG). All warning lamps are blink.
Warning System Operation Check			Warning buzzers sounds for 1 second and lamp is lit for 1 second.

*1 Stop engine to cancel warning system operation.

2. Maintenance Data

	Parts Name	Item		Standard Value
Engine Parts	**Cylinder Head**	Build up of carbon in combustion chamber		
		Measure the cam journal clearance		42.000 to 42.025 mm (1.65354 to 1.65453 in)
		Distortion or damage on mating surface		Distortion Amount : 0.05 mm (0.0020 in) or less
		Corrosion on the mating surface		
		Cooling water passage clogged		
	Cylinder	Deposition in water jacket		
		Wear of bore : Use cylinder gauge to measure inner diameter.		70.00 mm (2.7559 in)
		Seizure, cylinder liner damage, or wear Taper Out-of-roundness		
		Distortion or damage on cylinder head mating surface		Distortion Amount : 0.05 mm (0.0020 in) or less
		Engine Anode		
	Piston	Outer Diameter Measure outer diameter at 12 mm (0.47 in) above lower end of piston skirt (at right angle to piston pin).		69.97 mm (2.7547 in)
		Piston Clearance		0.020 to 0.055 mm (0.00079 to 0.00217 in)
		Carbon build up on piston crown and in ring grooves		
		Scratch on the sliding surface		
		Measure side clearance between piston ring and ring groove.		Top Ring : 0.04 to 0.08 mm (0.0016 to 0.0031 in)
				Second Ring : 0.01 to 0.05 mm (0.0004 to 0.0020 in)
				Oil Ring : 0.03 to 0.13 mm (0.0012 to 0.0051 in)
		Measure piston pin hole diameter.		17.005 mm (0.66949 in)
		Clearance between piston pin and pin hole		0.002 to 0.012 mm (0.00008 to 0.00047 in)
	Piston Pin	Outer Diameter		17.000 mm (0.66929 in)
	Piston Ring	Ring End Gap	Note : Measurement of ring end gap : If ring gauge is not available, use cylinder bore top or bottom with small wear.	Ring Gage 70.000 mm (2.75591 in)
		Top Ring		Top Ring : 0.20 to 0.35 mm (0.0079 to 0.0138 in)
		Second Ring		Second Ring : 0.35 to 0.50 mm (0.0138 to 0.0197 in)
		Oil Ring		Oil Ring : 0.20 to 0.70 mm (0.0079 to 0.0276 in)
	Connecting Rod	Small End Inner Diameter		17.012 mm (0.66976 in)
		Big End Oil Clearance		0.020 to 0.045 mm (0.00079 to 0.00177 in)
		Big End Side Clearance		0.10 to 0.20 mm (0.0039 to 0.0079 in)
	Crankshaft	Crankshaft runout : Use V blocks to support crankshaft at journals of both ends.		Less than 0.05 mm (0.0020 in) at both ends and at the center.
		Crank pin outer diameter		37.99 mm (1.4957 in)
		Main journal outer diameter		39.99 mm (1.5744 in)
		Metal bearing oil clearance		0.020 to 0.041 mm (0.0008 to 0.0016 in)
		Crankshaft side clearance		0.05 to 0.15 mm (0.0020 to 0.0059 in)

Functional Limit	Action To Be taken
	Clean to remove.
42.050 mm (1.65551 in)	Replace if more than specified limit.
0.1 mm (0.004 in)	Correct. (Use water proof sand paper of #240 to 400 on the surface plate to level. Use #600 to finish.)
	Correct if possible, or replace.
	Clean to remove.
	Clean to remove.
70.06 mm (2.7583 in)	Replace if more than specified limit.
0.08 mm (0.0031 in) 0.06 mm (0.0024 in)	Replace if severely damaged on the piston sliding surface, which cannot be repaired with sand paper of No. 400 to 600, or damaged over specified limit.
0.1 mm (0.004 in)	Correct. (Use water proof sand paper of #240 to 400 on the surface plate to level. Use #600 to finish.)
	Replace if severely consumed.
69.90 mm (2.7520 in)	Replace if less than specified limit.
0.150 mm (0.00591 in)	Replace if more than specified limit.
	Clean to remove.
	Correct if possible (with #400 to 600 water proof sand paper), or replace.
Top Ring : 0.10 mm (0.0039 in)	Replace if more than specified limit. Replace oil ring when top ring or second ring is replaced.
Second Ring : 0.07 mm (0.0028 in)	
Oil Ring : 0.15 mm (0.0059 in)	
17.012 mm (0.66976 in)	Replace if more than specified limit.
0.040 mm (0.00157 in)	
16.970 mm (0.66811 in)	Replace if less than specified limit.
Top Ring : 0.55 mm (0.0217 in)	Replace if the gap is over specified limit only if cylinder inner wear is less than specified limit. Replace oil ring when top ring or second ring is replaced.
Second Ring : 0.70 mm (0.0276 in)	
Oil Ring : 1.00 mm (0.0394 in)	
17.040 mm (0.6709 in)	Replace if more than specified limit.
0.060 mm (0.00236 in)	Replace if more than specified limit.
0.30 mm (0.0118 in)	Replace if more than specified limit.
0.05 mm (0.0020 in)	Replace if more than specified limit.
37.97 mm (1.4949 in)	Replace if less than specified limit.
39.97 mm (1.5736 in)	Replace if less than specified limit.
0.060 mm (0.00236 in)	Replace if more than specified limit.
0.50 mm (0.0197 in)	Replace if more than specified limit.

	Parts Name	Item		Standard Value
Engine Parts	**Intake Valve**	Valve Clearance	IN	0.20 to 0.25 mm (0.008 to 0.010 in)
	Exhaust Valve		EX	0.30 to 0.35 mm (0.012 to 0.014 in)
		Valve Stem Outer Diameter	IN	5.48 mm (0.2157 in)
			EX	5.46 mm (0.2150 in)
		Valve Guide Inner Diameter	IN	5.51 mm (0.2169 in)
			EX	5.51 mm (0.2169 in)
		Clearance between valve guide	IN	0.008 to 0.040 mm (0.00031 to 0.00157 in)
		and valve stem	EX	0.025 to 0.057 mm (0.00098 to 0.00224 in)
		Width of contact with valve seat	IN	1.4 mm (0.06 in)
			EX	1.4 mm (0.06 in)
	Valve Spring	Free Length		38.7 mm (1.52 in)
	Cam Shaft	Cam Height (Both IN and EX)		35.70 mm (1.4055 in)
		Journal Outer Diameter		#1: 41.92 mm (1.6504 in)
				#2/3/4: 41.95 mm (1.6516 in)
		Clearance between cam shaft and holder		#1: 0.075 to 0.110 mm (0.00295 to 0.00433 in)
		(journal area)		#2/3/4: 0.045 to 0.080 mm (0.00177 to 0.00315 in)
	Rocker Arm &	Rocker Arm Inner Diameter		18.01 mm (0.7091 in)
	Shaft	Shaft Outer Diameter		17.99 mm (0.7083 in)
		Shaft Clearance		0.006 to 0.035 mm (0.00024 to 0.00138 in)
	Timing Belt	External Appearance		
	Engine Block	Compression Pressure (Reference) at 600 to 700r/min		1.5 MPa (218 psi) [15.3 kgf/cm^2] ± 10%
Fuel and Lubrication Parts	**Fuel Regulator**	Fuel Pressure		Atmospheric Pressure + 0.29 MPa (43 psi) [3.0 kg/cm^2] ± 10%
	Vapor Separator	Seal Ring Wear and Damage		
		Float Height		Float Height : 44 to 50 mm (1.732 to 1.969 in)
		Float Valve		Float Drop (Reference) : 30.0 mm (1.181 in)
	Oil Pump	Pump Body Inner Diameter		–
		Clearance between Outer Rotor and Body		–
		Height of Outer Rotor		–
		Clearance between sides of rotor and body		–
		Clearance between outer and inner rotors		–

Functional Limit	Action To Be taken
	Adjust into specified range.
5.46 mm (0.2150 in) 5.44 mm (0.2142 in)	Replace if less than specified limit.
5.55 mm (0.2185 in) 5.57 mm (0.2193 in)	Replace if more than specified limit.
0.070 mm (0.00276 in) 0.100 mm (0.00394 in)	Replace if more than specified limit.
2.0 mm (0.08 in) 2.0 mm (0.08 in)	Replace if more than specified limit.
37.1 mm (1.46 in)	Replace if less than specified limit.
35.34 mm (1.3913 in)	Replace if less than specified limit.
#1: 41.89 mm (1.6492 in) #2/3/4: 41.92 mm (1.6504 in)	Replace if less than specified limit.
#1: 0.150 mm (0.0059 in) #2/3/4: 0.120 mm (0.0047 in)	Replace if more than specified limit.
18.05 mm (0.7106 in)	Replace if more than specified limit.
17.94 mm (0.7063 in)	Replace if less than specified limit.
0.090 mm (0.00354 in)	Replace if more than specified limit.
Wear, Damage, Elongation	Replace if necessary.
	Check if rotating parts, sliding parts and sealing parts cause compression leakage.
	Replace if out of specified range.
Wear, Damage, Deterioration Due To Gasoline	Replace if necessary.
	Replace if out of specified range.
Wear, Deterioration, Damage	Replace if necessary.
40.8 mm (1.606 in)	Replace if more than specified limit.
0.25 mm (0.0098 in)	Replace if more than specified limit.
14.96 mm (0.5890 in)	Replace if less than specified limit.
0.11 mm (0.0043 in) (Including oil pump cover wear)	Replace if more than specified limit.
0.16 mm (0.0063 in)	Replace if more than specified limit.

	Parts Name	Item		Standard Value
Electric Parts	**Magneto**	Ignition Timing	(at 850 r/min)	ATDC 5°±5°
		Spark Performance (Use genuine spark tester.)	(at 500 r/min)	10 mm (0.4 in) or over
		Alternator Output	(at 4,000 r/min)	12 V 252 W
		Alternator Resistance	Between Yellow and Yellow (at 20°C)	0.28 to 0.42Ω
	Crank Position Sensor (CPS, Pulser Coil)	Resistance Between Terminals	Between Red/White and Black (at 20°C)	148 to 222Ω
		Encoder Ring (Flywheel) Clearance		0.7 to 0.9 mm (0.028 to 0.035 in)
	Ignition Coil	Primary Coil Resistance	Between Black/White and Black (at 20°C)	2.72 to 3.68 Ω
		Secondary Coil Resistance	(Between High Tension Cable and Black) (at 20°C)	15.6 to 23.4 kΩ
		[KΩRange]	Between Plug Cap and Black	19.4 to 29.6 kΩ
	Plug Cap	Resistance Between Terminals [kΩRange]		3.0 to 7.0 kΩ
	Spark Plugs	Plug Type		IKR6G8 (NGK)
		Spark Gap		0.7 to 0.8 mm (0.028 to 0.032 in)
	Fuel Injector	Resistance Between Terminals		11.40 to 12.66Ω
	Throttle Position Sensor	Resistance Between Terminals[kΩRange]	Between Blue and Black	Less than 5 kΩ
	ISC Valve	Resistance Between Terminals		27 to 33Ω "Refer to 8-24 page"
	MAT (Manifold Temperature) Sensor	Resistance Between Terminals[kΩRange]	(at 25°C)	1.8 to 2.2 kΩ
	Engine Temperature Sensor	Resistance Between Terminals[kΩRange]	(at 5°C)	4.24 to 4.86 kΩ
			(at 25°C)	1.90 to 2.10 kΩ
			(at 100°C)	0.166 to 0.204 kΩ
	Rectifier	Resistance Between Terminals		"Refer to 8-34 page"
	Starter Motor	Battery		12 V-100 AH to 12 V-120 AH
		Output		12 V 1.4 kW
		Clutch		Overrunning Clutch
		Brush Length		16.0 mm (0.63 in)
		Commutator Undercut		0.5 to 0.8 mm (0.020 to 0.032 in)
		Commutator Outer Diameter		29.0 mm (1.142 in)
	Fuse	Capacity		20 A x 2, 30 A x 1

Functional Limit	Action To Be taken
10 mm (0.4 in)	Replace if less than specified value.
	Replace if out of specified range.
	Replace if out of specified range. Adjust to specified range.
	Replace if out of specified range.
	Replace if out of specified range.
	Clean to remove carbon build up and dirt. Adjust with side electrode. Replace if electrodes are severely worn.
1.0 mm (0.039 in)	
	Replace if out of specified range.
	Replace throttle body ass'y if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range.
12.0 mm (0.472 in)	Replace if less than specified value.
0.2 mm (0.008 in)	Replace if less than specified value.
28.0 mm (1.102 in)	Replace if less than specified value.
Burn out	

	Parts Name	Item		Standard Value
Coolong System Parts	**Thermostat**	Valve Operation Starting Temperature (Submerged)		60°C ± 1.5°C (140 ± 3°F)
		Valve Full Open Temperature (Submerged)		75°C (167°F)
		Valve Full Open Lift (Submerged)		3.0 mm (0.12 in) or more
	Pump Impeller	Wear, Crack		
	Pump Case (Liner)	Wear		
	Guide Plate	Wear		
Lower Unit Parts	**Anode**	Gear Case Anode Consumption		
	Clutch Spring	Free Length		66 to 70 mm (2.60 to 2.76 in)
	Propeller Shaft	Bearing Wear and Damage		
		Oil Seal Wear		
		Propeller Shaft Runout		
	Bevel Gears	Pinion Gear (B Gear) Height		0.60 to 0.64 mm (0.0236 to 0.0252 in)
		Backrush between forward gear and pinion (A and B gears) "Refer to Chapter 6."		0.31 to 0.62 mm (0.0122 to 0.0244 in)
		Reverse Gear (C Gear) Washer Thickness		3.0 mm (0.118 in)
	Propeller	Wear, Bend, Crack, Break		
	Drive Shaft	Spline (Upper) Base Tangent Length, 3 Gears		7.9 mm (0.311 in)
		Bearing Damage		
		Oil Seal Wear and Damage		
		Drive Shaft Runout		
Power Tilt Parts	**Oil Pump**	Type		Gear Pump
		Oil Capacity		325 cm^3 (11.0 fl.oz.)
		Recommended Oil		ATF (DEXRON III)
	PTT Motor	Voltage		DC 12V
		Continuous Run		60 seconds or less
		Output		250 W
		Direction of Revolution		Forward, Reverse
		Circuit Breaker	Type	Bimetal
			ON/Reset Time	40 sec or more (36 A)/30 sec or less [25°C (77°F)]
		Brush Length		9.75 mm (0.384 in)
		Commutator	Outer Diameter	22.0 mm (0.866 in)
			Depth of Undercut	1.8 mm (0.071 in)
	Tilt Cylinder	Piston Diameter		32.0 mm (1.260 in)
		Tilt Rod Diameter		16.0 mm (0.630 in)
		Stroke		101.0 mm (3.976 in)
	PTT Switch			Paddle Rocker Switch (3A)
				Toggle Switch (20A)
Other Parts	**Oil Seals**	Damage, Wear		

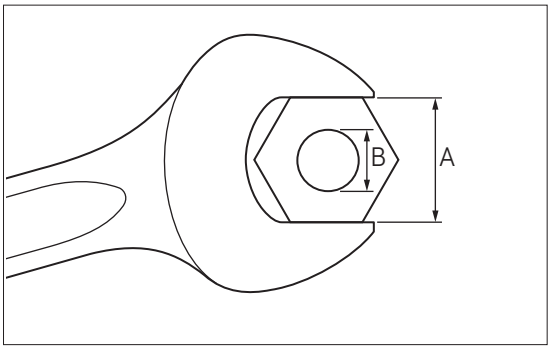
Functional Limit	Action To Be taken
Any opening under ambient temperature	Replace if out of specified range.
75°C (167°F) because thermostat operation is delayed. Measure valve open lift after 5 minutes.	
3.0 mm (0.12 in)	Replace if less than specified limit.
Wear, crack or damage on tips and upper and lower surface lips	Replace pump case liner and guide plate as a set.
	Replace if severely worn
	Replace if severely worn
	Replace if severely worn
	Replace if necessary.
0.4 mm (0.015 in)	Replace if more than specified limit.
0.05 mm (0.0020 in)	Replace if more than specified limit.
0.60 to 0.64 mm (0.0236 to 0.0252 in)	Adjust, or replace.
	Adjust, or replace.
2.85 mm (0.112 in)	Replace if less than specified limit.
Severe Damage	Replace if out of specified range
7.5 mm (0.295 in)	Replace if less than specified limit.
	Replace if necessary.
0.4 mm (0.015 in)	Replace if necessary.
0.5 mm (0.020 in)	Replace if more than specified limit.
5.0 mm (0.236 in)	Replace if less than specified limit.
20.4 mm (0.803 in)	Replace if less than specified limit.
1.0 mm (0.039 in)	Replace if less than specified limit.
Lip deteriorated, degraded or damaged, or tightening margin reduced to 0.5 mm (0.020 in) due to wear	Replace if out of specified range.

3. Tightening Torque Data

	Fastened Components	Wrench A	Screw B x Pitch	Type of Fastener	Tightening Torque N•m		
					N•m	lb•ft	kg•m
Engine	Cylinder Head (Cylinder Block and Cylinder Head)	14	M10 x 1.25	Bolt	① First Tightening Torque :		
					30	22	3
					② Final Tightening Torque :		
					60	44	6
		12	M8 x 1.25	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
	Spark Plug	16	M12 x 1.25	Special	18	13	1.8
	Tappet Lock Nut	10	M6 x 0.75	Nut	7	5	0.7
	Rocker Shaft	12	M8 x 1.25	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
	Thrust Bolt	10	M6 x 1.0	Bolt	9	7	0.9
	Anode Plug	10	M16 x 1.5	Special	18	13	1.8
	Anode	—	M5 x 0.8	Screw	2	1.4	0.2
	Oil Filter Bolt	—	M20 x 1.5	Special	30	22	3
	Oil Pump	10	M6 x 1.0	Bolt	8	6	0.8
	Oil Filter	—	M20 x 1.5	Special	Tighten to 3/4 turn from temporary (270°)		
					18	13	1.8
	Crankcase (Cylinder Block to Crankcase)	12	M8 x 1.25	Bolt	① First Tightening Torque :		
					12	9	1.2
					② Final Tightening Torque :		
					24	18	2.4
		10	M6 x 1.0	Bolt	① First Tightening Torque :		
					6	4.5	0.6
					② Final Tightening Torque :		
					11.5	8.5	1.15
	Connecting Rod	10	M8 x 0.75	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
	Flywheel	30	M20 x 1.25	Bolt	150	110	15
	Timing Pulley	50	M39 x 1.5	Bolt	120	88	12
	Cam Shaft Pulley	17	M10 x 1.25	Bolt	27	20	2.7
	Oil Pressure Switch	—	PT1/8	Special	8	6	0.8
	Power Unit	13	M8 x 1.25	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
Clamp Bracket		24	7/8-14UNF-2A	Nylon Nut	24	18	2.4
PTT	Manual Valve	—	M12	Special	1.8	1.4	0.18
Drive Shaft Housing	Engine Base Rubber Mount Upper (Center only)	13	M8 x 1.25	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
	Engine Base Main Body (Exhaust passage side)	13	M8 x 1.25	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
	Engine Base Main Body (Rear 2 part)	13	M8 x 1.25	Bolt	① First Tightening Torque :		
					15	11	1.5
					② Final Tightening Torque :		
					30	22	3
	Oil Drain	16	M14 x 1.5	Bolt	24	18	2.4
	Rubber Mount (Upper)	14	M10 x 1.25	Bolt, Nut	27	20	2.7
	Rubber Mount (Lower)	17	M12 x 1.25	---	40	29	4

	Fastened Components	Wrench A	Screw B x Pitch	Type of Fastener	Tightening Torque N•m		
					N•m	lb•ft	kg•m
Gear Case	Pinion Gear (B Gear)	17	M12 x 1.0	Nut	50	37	5
	Propeller	21	M16 x 1.5	Nut	35	26	3.5
Top Cowl	Tilt Handle	10	M6 x 1.0	Nylon Nut	2	1.4	0.2

	Fastened Components	Wrench A	Screw B x Pitch	Type of Fastener	Tightening Torque N•m		
					N•m	lb•ft	kg•m
Standard Tightening Torque	M4	—	M4 x 0.7	Bolt, Nut	1.5	1.1	0.15
	M5	—	M5 x 0.8	Bolt, Nut	3	2.2	0.3
	M6	—	M6 x 1.0	Bolt, Nut	6	5	0.6
	M8	—	M8 x 1.25	Bolt, Nut	13	10	1.3
	M10	—	M10 x 1.25	Bolt, Nut	27	20	2.7
	M4	—	M4 x 0.7	Screw	1.5	1.1	0.15
	M5	—	M5 x 0.8	Screw	2.5	1.8	0.25
	M6	—	M6 x 1.0	Screw	3.5	2.5	0.35
	M8	—	M8 x 1.25	Screw	4.5	3.3	0.5



3

Maintenance

1. Inspection Schedule

	Description	Inspection intervals				Inspection procedure	Remarks
		First 20 hours of 1 month	Every 50 hours of 3 months	Every 100 hours of 6 months	Every 200 hours of 1 year		
Fuel System	Fuel filter	❍	❍			Check and clean or Replace if necessary.	
	Piping/Hoses	❍	❍			Check and clean or Replace if necessary.	
	Fuel tank	❍	❍			Clean	
Ignition	Spark plug	❍		❍		Remove carbon deposits or Replace if necessary.	0.7 to 0.8 mm (0.028 to 0.032 in)
Starting System	Starter motor			❍		Check for salt deposits and the battery cable condition.	
	Battery	❍	❍			Check installation, fluid quantity, gravity.	
Engine	Engine oil	Replace		Replace		Replace	Oil filter replaced : 2.4 L (2.5 US qt.) Oil filter not replaced : 2.2 L (2.3 US qt.)
	Oil filter	Replace			Replace	Replace every 200 hrs or 1 year.	Replace oil filter cartridge.
	Compression pressure				❍	Check every 200 hrs or 1 year.	
	Combustion chamber					Clean every 200 hrs or 2 years.	Include valve lapping if necessary.
	Valve clearance	❍		❍		Check and adjust	IN: 0.20 to 0.25 mm (0.008 to 0.010 in) EX: 0.30 to 0.35 mm (0.012 to 0.014 in)
	Timing belt			❍		Check and Replace if necessary.	
	Thermostat			❍		Check and Replace if necessary.	
Lower Unit	Propeller	❍	❍			Check for bent blades, damage, wear.	
	Gear oil	Replace	❍	Replace		Change or replenish-oil and check for water leaks.	Hypoid gear oil (GL5, SAE#80-90) 500 ml
	Water pump		❍		Replace	Check for wear or damage. Replace every 1year.	
Power trim & tilt		❍		❍		Check & replenish oil, manually operate.	
Warning system			❍			Check function	
Bolts and Nuts		❍	❍			Retighten	
Sliding and Rotating Parts. Grease Nipples		❍	❍			Apply and pump in grease.	
Anode				❍		Check for corrosion and deformation.	Replace if necessary.
Control System	Shift cable/ Throttle cable		❍			Check for operation and damage.	

2. Inspection Items

1) Inspection and Adjustment of Valve Clearance

- Perform inspection and adjustment of valve clearances when engine is cold.
- No.1 piston is to be at top dead center of compression stroke(make sure both valves are closed).

1. Remove flywheel cover, spark plug, cylinder head cover, ignition coil connector and harness.

2. Rotate flywheel clockwise to bring "● I" mark of cam shaft pulley ① to "▲" mark ⓐ of cylinder head.

3. Check and adjust No. 1 cylinder's intake and exhaust valve clearances.
   - Insert thickness gauge in the gap between valve end ② and adjust screw ③.
   - Loosen lock nut ④.
   - Turn adjust screw ③ to adjust valve clearance.
   - Tighten lock nut ④.
   - Check valve clearance again.

Valve Clearance :
Intake valve : 0.20 - 0.25 mm (0.008 - 0.010 in) ⓑ
Exhaust valve : 0.30 - 0.35 mm (0.012 - 0.014 in) ⓒ

- When loosening or tightening lock nut, tighten adjust screw by using valve clearance driver.
- Be sure to use torque wrench.

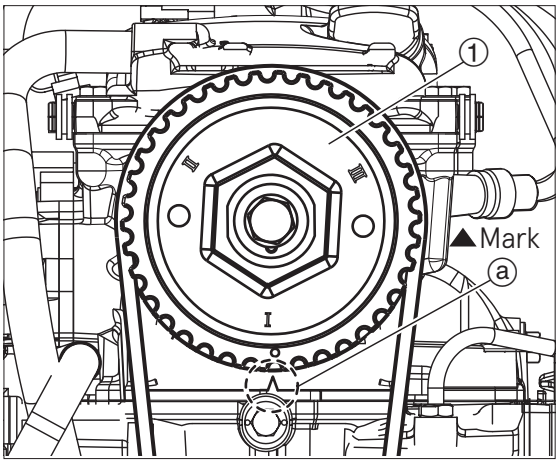
Lock nut :
7 N·m (5 lb·ft) [0.7 kgf·m]

Valve Clearance Driver ⑤ :
P/N. 3AC-99071-0
Torque Wrench ⑥ :
P/N. 3AC-99070-0

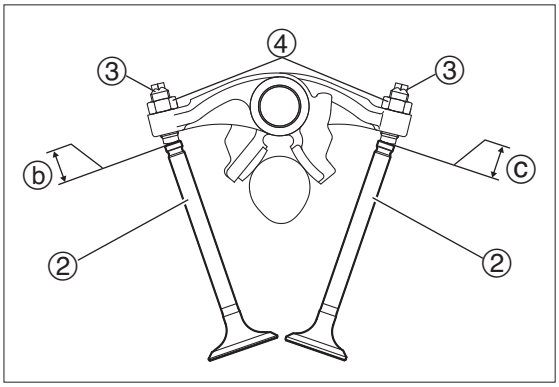
4. Rotate flywheel clockwise to bring "Ⅲ" mark of cam shaft pulley ① to "▲" mark ⓐ of cylinder head.

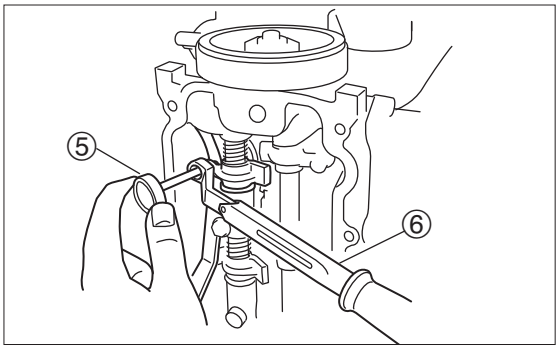
5. Check and adjust No. 3 cylinder's intake and exhaust valve clearances in the same procedure as No. 1 cylinder.

6. Check and adjust No. 2 cylinder's valve clearances in the same procedure as No. 1 cylinder.



① Cam Shaft Pulley





⑤ Valve Clearance Driver (Concave Tip, Square, Width Between Two Opposing Sides : 3 mm)
⑥ Torque Wrench (10 mm tip wrench)

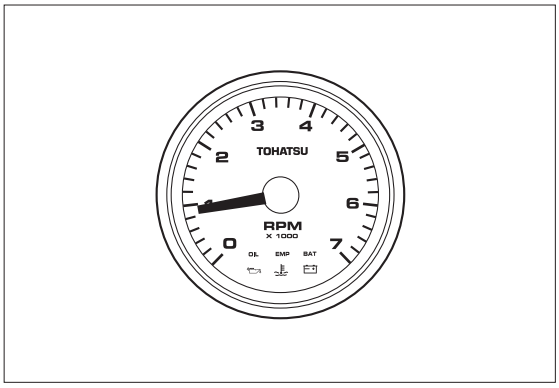
2) Inspection of Idle Speed

1. Start engine and run for 5 minutes to warm up.

2. Check idle speed to use tachometer or diagnostic program.

Tachometer :
P/N. 3GF-72647-1

Idle Speed :
850-± 30 r/min



3) Inspection of Ignition Timing

Adjusting system : Automatic control, requiring no manual adjustment.

Run engine and use timing light to check ignition timing.

9 timing marks are found on the side of flywheel (TDC0°, ATDC5°, 10°, BTDC5°, 10°, 15°, 20°, 25°, 30°), and ignition timing is read with mark on the center of starter case window.

Outboard Model	Range of Ignition Angle	Engine Starting	Idling	Accelerating
MFS60A	ATDC 5° - BTDC 20°	TDC 0°	ATDC 5°±5°	BTDC 20°

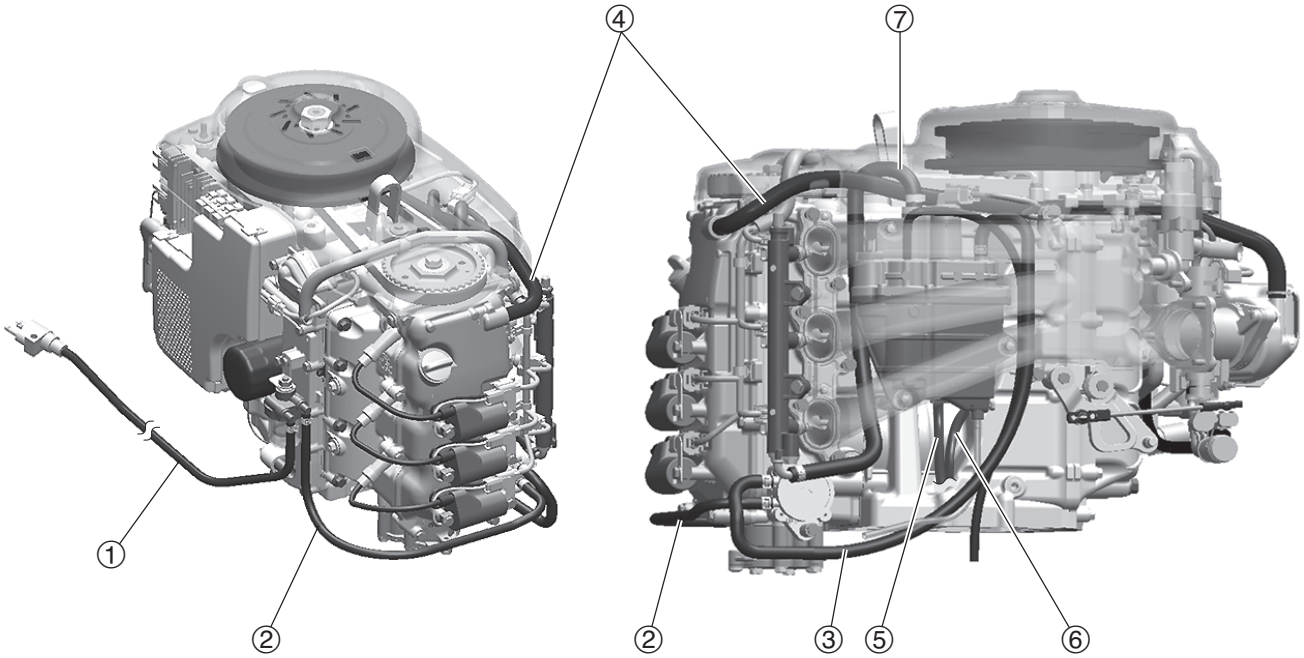
4

Fuel System (Fuel Injection)

1. Piping Arrangement Diagram
Fuel Hose, Vent Hose, Breather Hose, Cooling Water Hose

Rear Section

Port Side

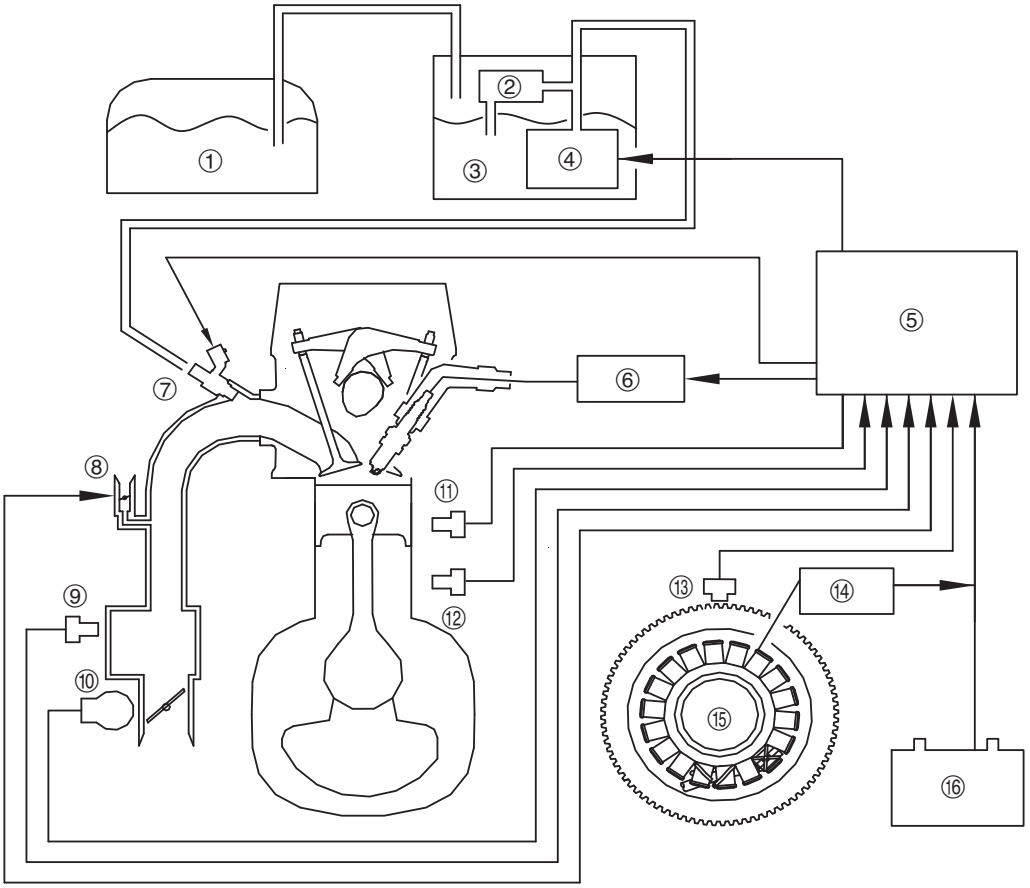


Ref. No.	Description
①	Fuel Hose (Fuel Connector to Fuel Filter)
②	Fuel Hose (Fuel Filter to Fuel Pump)
③	Fuel Hose (Fuel Pump to Vapor Separator)
④	Breather Hose (Cylinder Head to Intake Silencer
⑤	Cooling Water Hose (Engine Base to Fuel Cooler)
⑥	Cooling Water Hose (Fuel Cooler to Cooling Water Check Port)
⑦	High Pressure Fuel Hose (Vapor Separator to Fuel Rail)

2. Ignition System

For ignition system, battery ignition system is adopted, and ECU's electronic ignition timing control system controls the timing to the most suitable state according to current operating conditions.

As engine is started, electric current is generated in the alternator and to charge the battery. Which is input to ECU's regulator to feed power needed for operations of ignition coil, fuel injector and fuel feed pump (FFP).



① Fuel Tank
② Fuel Regulator
③ Vapor Separator
④ Fuel Feed Pump (FFP)
⑤ ECU
⑥ Ignition Coil
⑦ Fuel Injector
⑧ ISC Valve
⑨ MAP/MAT Sensor
⑩ TPS
⑪ Engine TEMP. Sensor
⑫ Oil Pressure Switch
⑬ Pulser Coil
⑭ Rectifier
⑮ Alternator
⑯ Battery

(1) Configuration of Ignition System

Ignition system consists mainly of the following components.

(1) Sensors and switches that transmit engine operating states to ECU.

(2) ECU that performs electronic control.

(3) Ignition coils and spark plugs that operate in accordance with control by ECU.

The following 6 components are included in the sensors and switches of (1).

· Pulser coil	Crank position (Crank Position Sensor)
· Throttle Position Sensor (TPS)	Throttle opening angle
· Water Temperature Sensor	Temperature of ENGINE (Crankcase)
· MAP (Manifold Air Pressure) Sensor	Vacuum pressure of intake air
· MAT (Manifold Air Temperature) Sensor	Temperature of intake air
· Oil Pressure Switch	Reduction of hydraulic pressure

* Integrated MAP (Manifold Pressure) Sensor and MAT (Manifold Temperature) Sensor

(2) Ignition Control

ECU's microcomputer is programmed with ignition timings best suited to engine's operating conditions. ECU obtains information about engine operating state such as revolution speed, throttle opening, manifold pressure (air intake vacuum pressure) and cooling water temperature based on the signals from the abovementioned sensors to generate ignition timing signal at the most suitable timings.

1) Ignition Timing Controls

Controls of ignition timing is classified into two controls, which are correction of ignition timing during normal operation and fixing of ignition timing (at engine starting and when an abnormality has occurred). In either case, ECU corrects ignition time or fixes it to the base.

- Basically, ignition timing is determined on engine revolution speed and manifold pressure (intake air vacuum pressure).
- Signals that are used for correction of ignition timing includes cooling water temperature, manifold intake air temperature, change of pressure at acceleration/deceleration under atmospheric pressure, and engine revolution speed.
- Ignition timing is fixed to the base at acceleration, deceleration, when high speed ESG is on, low speed ESG is on, or when hydraulic pressure is reduced.

2) Ignition and Combustion Orders

No. of Ignitions : Once per revolution per cylinder (around the end of compression and exhaust strokes)
Ignition Order : #1 → #2 → #3 → #1 → #2 → #3 → #1 (every 120 degrees of crank angle)
Combustion Order : #1 → #3 → #2 → #1 (every 240 degrees of crank angle)

3) Ignition Timing

Ignition timing is set as described below.

Model	Range of Ignition Angle	Engine Starting	Idling	Accelerating
MFS60A	ATDC 5° to BTDC 20°	TDC 0°	ATDC 5°±5°	BTDC 20°

4) Operations

- At Engine Starting and During Warm-up
  The engine is started, the ignition timing is fixed to the TDC.
  The input signal and the engine temperature, manifold intake air temperature, engine speed and atmospheric pressure, on the basis of the programs stored in the ECU, the microcomputer determines the ignition timing after starting.

- During idling and low speed running
  When ECU receives manifold pressure (intake air vacuum pressure) signal and input signal from pulser coil (engine revolution speed signal), it controls ignition timing so that idling and low speed revolution speeds stabilize.

- During normal operation
  Microcomputer determines ignition timing in accordance with ECU's program by using cooling water temperature, manifold intake air temperature, atmospheric pressure and engine revolution speed as input signals. The maximum timing during normal operation is BTDC 25°.

- During acceleration/Deceleration
  When engine revolution speed changes much and is reduced below (or exceed) a setting value, ECU determines that engine is accelerating (or decelerating), and microcomputer determines the ignition timing based on the program installed in ECU.

- At engine over-revolution
  When engine revolution speed exceeds the maximum allowable value (6,200r/min), ECU stops feeding of fuel to control the revolution based on pulser coil signals. This is the state that engine high speed ESG is "ON".

- Engine low speed ESG is "ON".
  When any of the following state has been detected, engine revolution speed is controlled to 2,800r/min to prevent or reduce engine damage. This is the state that engine low speed ESG is "ON".
  - Engine is overheating. : Engine temperature sensor detects 100° or higher.
  - Engine hydraulic pressure is low. : Oil pressure switch ON (24.5 kPa (3.6 PSi) [0.25 kg/cm^2] or less) is detected for 5 seconds or longer.

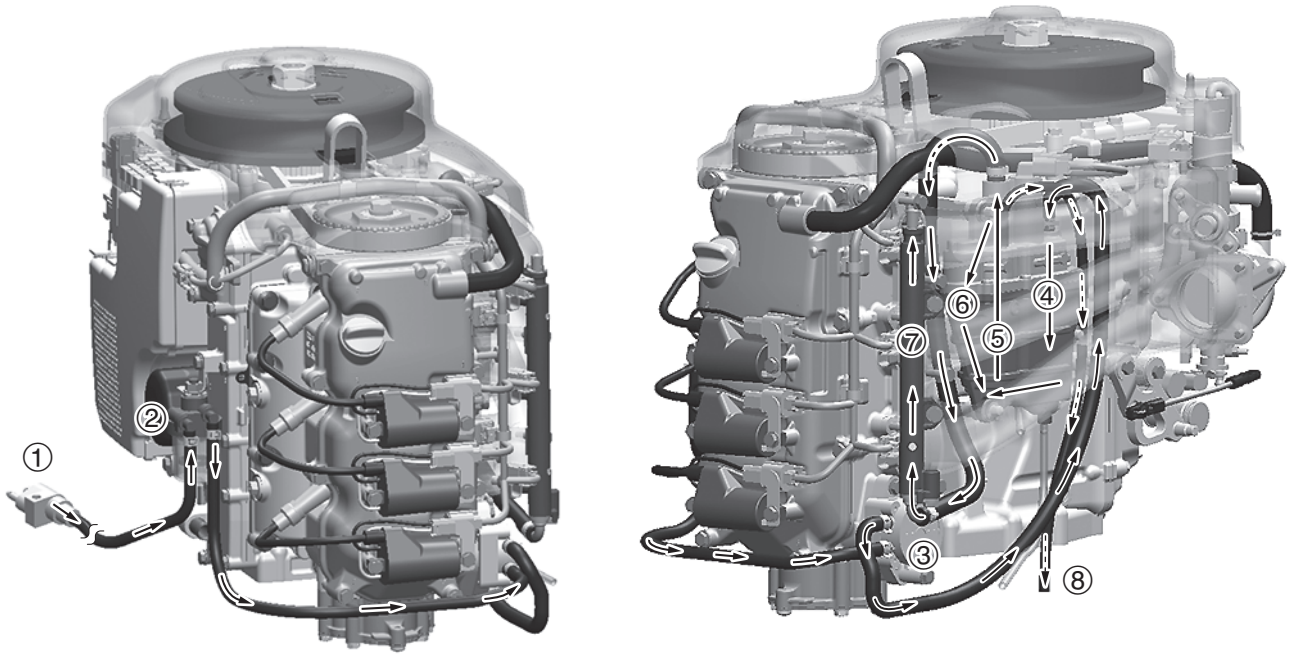
(3) Fuel Feed System

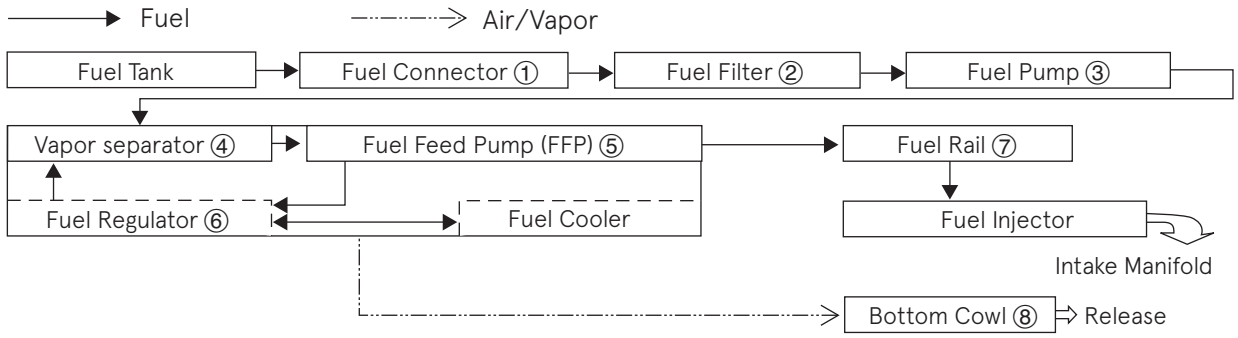
Fuel pump ③ (low pressure mechanical type) draws fuel from fuel tank, and feed it to fuel feed pump ⑤ (FFP) located in the vapor separator ④ through fuel connector ① and fuel filter ②.

Highly pressurized fuel, fed into fuel rail ⑦ and fuel injector, and then, injected into intake manifold.

Excessive fuel that is not used by fuel injector passes through fuel regulator ⑥, and circulated in the vapor separator ④ to keep fuel pressure constant.

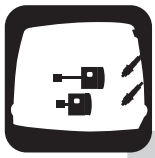
Stabilization of fuel pressure is performed by fuel regulator that is built into the vapor separator.





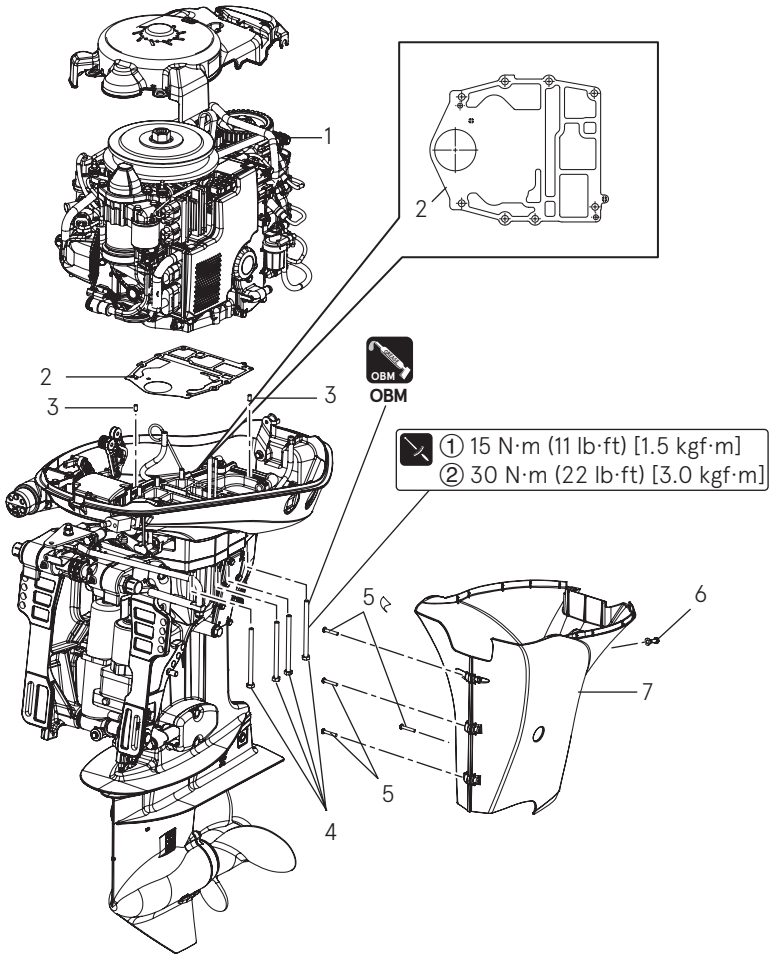
5

Power Unit



1. Parts Layout

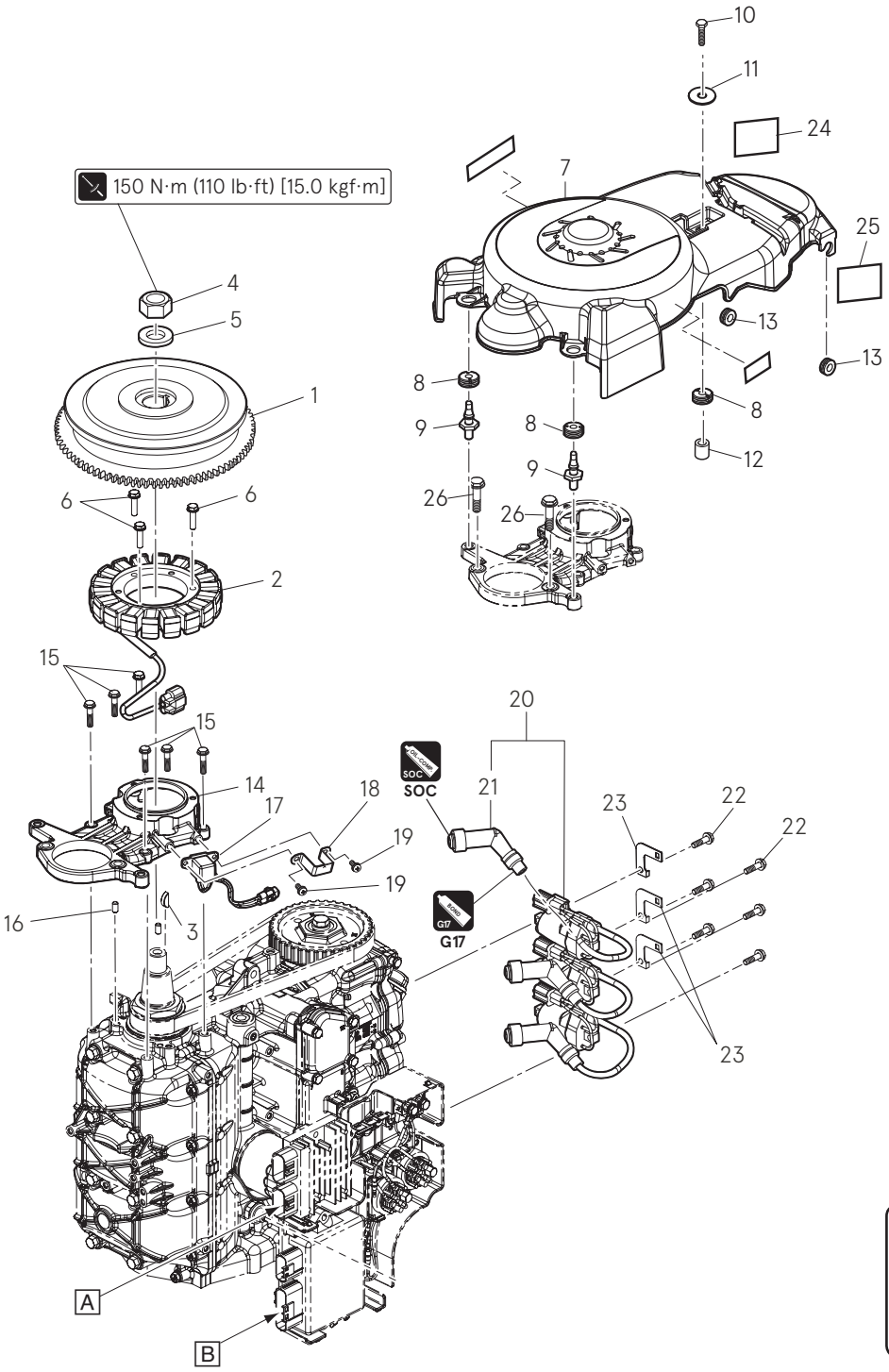
Engine



Ref. No.	Description	Q'ty	Remarks
1	Power Unit	1	
2	Engine Base Gasket	1	**Do not reuse.**
3	Dowel Pin	2	
4	Bolt	8	M8 L=115mm
5	Tapping Screw	4	
6	Bolt	1	M6 L=16mm
7	Apron	1	

Magneto

P/L Fig. 7



G17

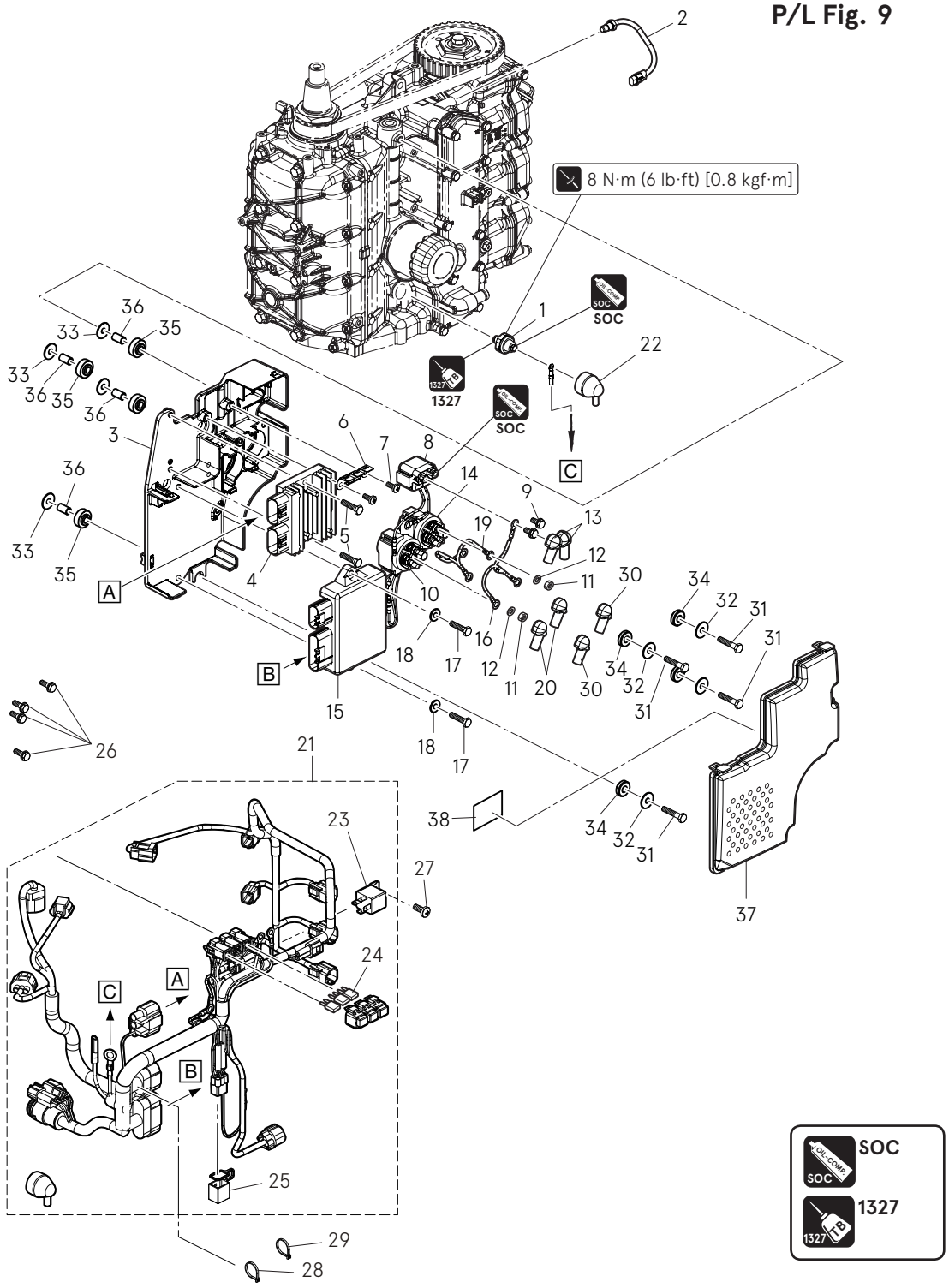
SOC

Ref. No.	Description	Q'ty	Remarks
1	Flywheel W/Gear	1	
2	Alternator Ass'y	1	
3	Key 19-7-5	1	
4	Nut 20-p1.25	1	M20
5	Washer 20.5-37-5	1	M20
6	Bolt	3	M6 L=25mm
7	Ring Gear Cover	1	
8	Grommet 16-2.5	3	
9	Hook	2	
10	Bolt	1	M6 L=20mm
11	Washer 6-16-1.5	1	M6
12	Collar 6.2-9-7.4	1	
13	Grommet 13-2	2	
14	Coil Bracket	1	

Ref. No.	Description	Q'ty	Remarks
15	Bolt	6	M6 L=25mm
16	Dowel Pin 6-12	2	Cylinder Blok-Coil Braket
17	Pulsar Coil	1	
18	Pulsar Coil Guard	1	
19	Screw	2	
20	Ignition Coil W/R-cap	3	
21	Plug Cap W/Resistance	3	
22	Bolt	6	M6 L=20mm
23	Stay	3	
24-1	Caution Decal (B)	1	
24-2	Caution Decal (B)	1	
25	Fuse Decal	1	
26	Bolt	2	M8 L=30mm

Electric Parts

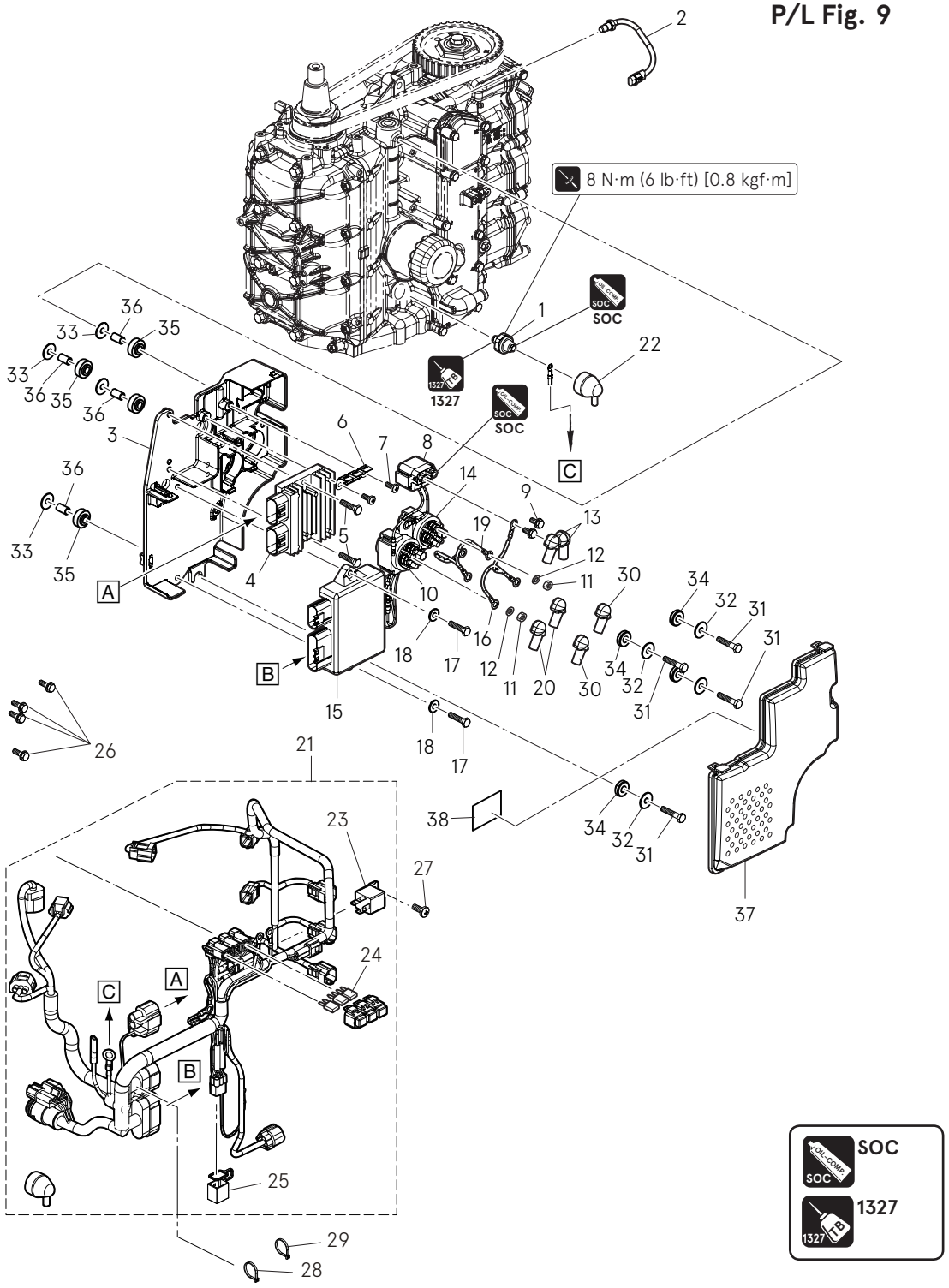
P/L Fig. 9



Ref. No.	Description	Q'ty	Remarks
1	Oil Pressure Switch	1	
2	Engine Temp Sensor	1	
3	Bracket	1	Electric Bracket
4	Rectifier Complete	1	
5	Bolt	2	M6 L=25mm
6	Fuse Holder Bracket	1	
7	Screw	2	M5 L=12mm
8	Starter Solenoid	1	
9	Bolt	2	M6 L=8mm
10	PTT Solenoid Switch (A)	1	Up 4 Side (Sb) for PTT Model
11	Nut	3	M6

Ref. No.	Description	Q'ty	Remarks
12	Spring Washer	3	M6
13	Terminal Cap 8-13-28	2	Red for Gas Assist Model
14	PTT Solenoid Switch (B)	1	Down Side (P) for PTT Model
15-1	ECU Ass'y	1	50ps EU
15-2	ECU Ass'y	1	40ps EU
15-3	ECU Ass'y	1	50ps STD
15-4	ECU Ass'y	1	40ps STD
16	Solenoid Switch Cord (A)	1	Red for PTT Model
17	Bolt	2	M6 L=20mm
18	Washer 6-16-1.5	2	M6
19	Solenoid Switch Cord (B)	1	Black for PTT Model

P/L Fig. 9

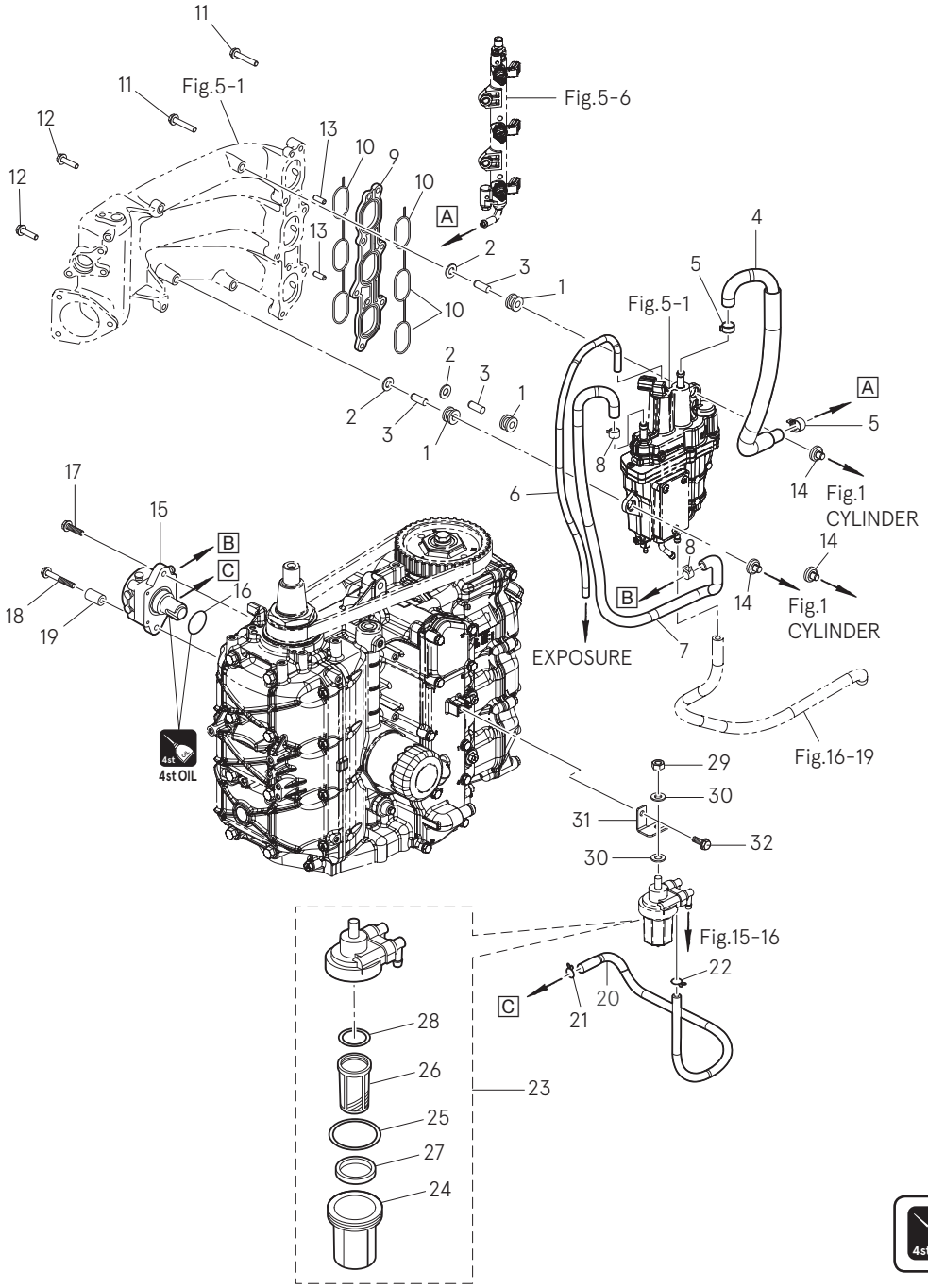


Ref. No.	Description	Q'ty	Remarks
20	Terminal Cap 8-13-28	6	Red for PTT Model
21	Cord Ass'y	1	
22	Grommet	1	
23	Relay	1	
24-1	Fuse 30A	1	
24-2	Fuse 20A	2	
25	Cable Terminal Plug	1	
26	Bolt	4	M6 L=12mm
27	Screw	1	M5 L=12mm
28	Band 104	1	Do not reuse.

Ref. No.	Description	Q'ty	Remarks
29	Band 203	1	Do not reuse.
30	Terminal Cap 8-13-28	2	Black for PTT Model
31	Bolt	4	M6 L=30mm
32	Washer 6-16-1.5	4	Inside M6
33	Washer 6.5-21-1	4	Outside M6
34	Mount 8.5-14-2.5	4	Inside
35	Rubber Mount 8.5-14-2.5	4	Outside
36	Spacer 6.2-9-15.7	4	
37	Cover	1	
38	Wiring Diagram Decal	1	

Fuel system

P/L Fig. 6

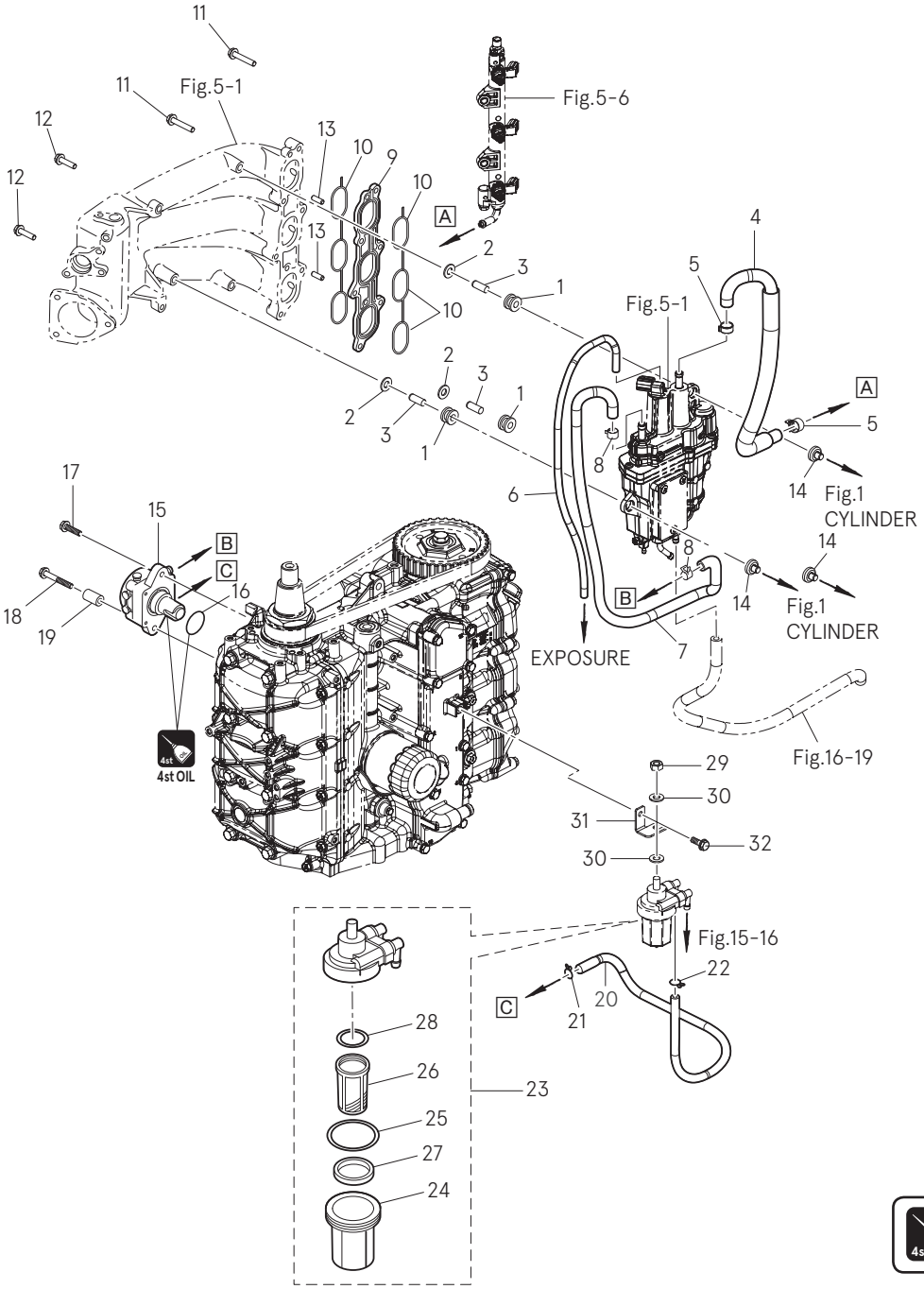


4st OIL

Ref. No.	Description	Q'ty	Remarks
1	Rubber Mount	3	
2	Washer	3	M8
3	Pin ø8-22	3	
4	Fuel Hose W/Protector	1	V/Separator-Fuel Rail EPA-KRI-15G
5	Clamp ø16.8	2	
6	Fuel Hose 4-9	1	V/Separator-Exposure
7-1	Fuel Hose W/Protector ø12	1	Fuel Pump-V/Separator USA EPA-KRI-15G
7-2	Fuel Hose W/Protector ø12	1	Fuel Pump-V/Separator STD
8	Clip ø11.3	2	
9	Insulator	1	
10	O-ring	2	Do not reuse.
11	Bolt	6	M6 L=35mm

Ref. No.	Description	Q'ty	Remarks
12	Bolt	2	M6 L=25mm
13	Dowel Pin 6-16	2	Intake Manifold Vapor Separator Assy
14	Bushing	3	
15	Fuel Pump Ass'y	1	
16	O-ring 3.5-25.7	1	Do not reuse.
17	Bolt	1	M6 L=25mm
18	Bolt	1	M6 L=45mm
19	Spacer 6.2-13-22	1	
20-1	Low Permeation Hose L=445	1	Fuel Filter-Fuel Pump USA EPA-KRI-15G L=445mm
20-2	Fuel Hose 5-10 L=445	1	Fuel Filter-Fuel Pump STD L=445mm
21	Clip ø11.3	1	

P/L Fig. 6

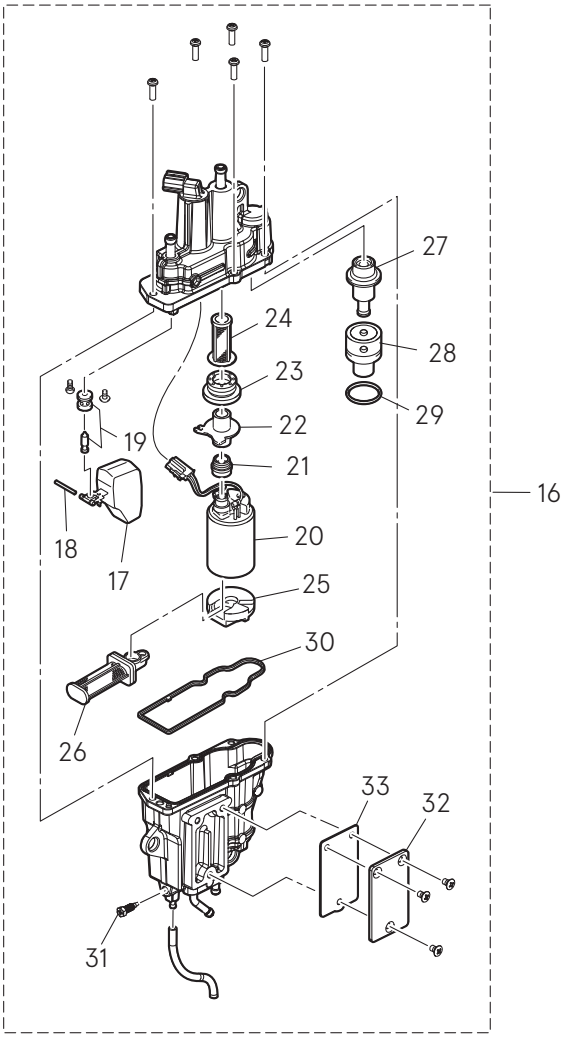


Ref. No.	Description	Q'ty	Remarks
22	Clip ø9.4	1	
23	Fuel Filter Ass'y	1	
24	Cup	1	
25	O-ring	1	**Do not reuse.**
26	Filter	1	
27	Float	1	
28	O-ring	1	**Do not reuse.**
29	Nut	1	M8
30	Washer	2	M8
31	Plate	1	
32	Bolt	1	M6 L=12mm

4st OIL

5

Vapor Separator

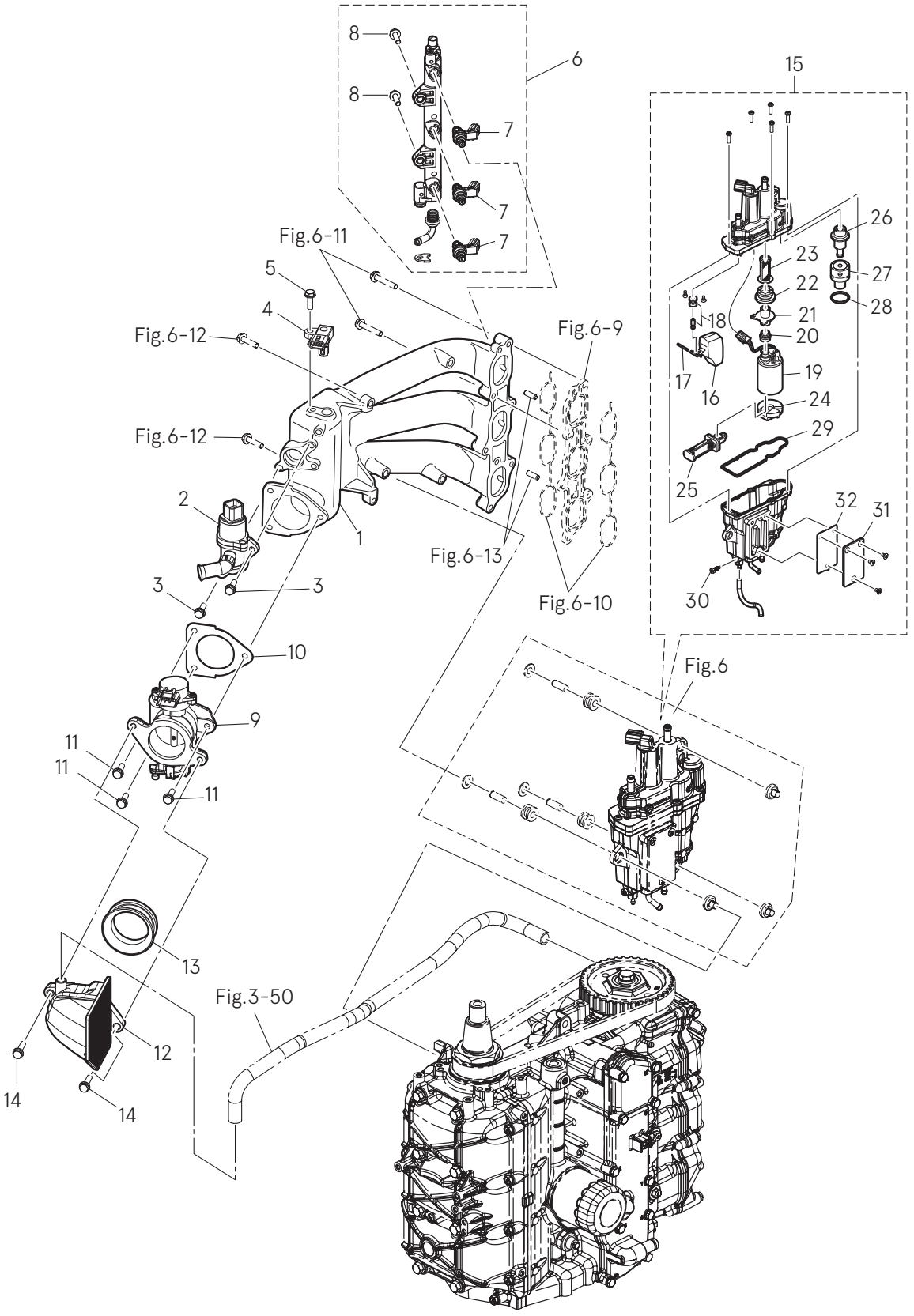


Ref. No.	Description	Q'ty	Remarks
16	Vapor Separator Ass'y	1	
17	Float	1	
18	Float Arm Pin	1	
19	Float Valve Ass'y (W/valve pin)	1	
20	Fuel Feed Pump	1	Upper
21	Grommet	1	Upper
22	Joint	1	Upper
23	Grommet	1	Upper
24	Filter (outlet)	1	Lower

Ref. No.	Description	Q'ty	Remarks
25	Grommet F.F.P. Lower	1	Lower
26	Filter (inlet)	1	
27	Fuel Regulator	1	
28	Holder	1	
29	O-Ring	1	**Do not reuse.**
30	O-Ring	1	**Do not reuse.**
31	Drain Screw	1	
32	Cover	1	
33	Seal	1	**Do not reuse.**

Intake Manifold

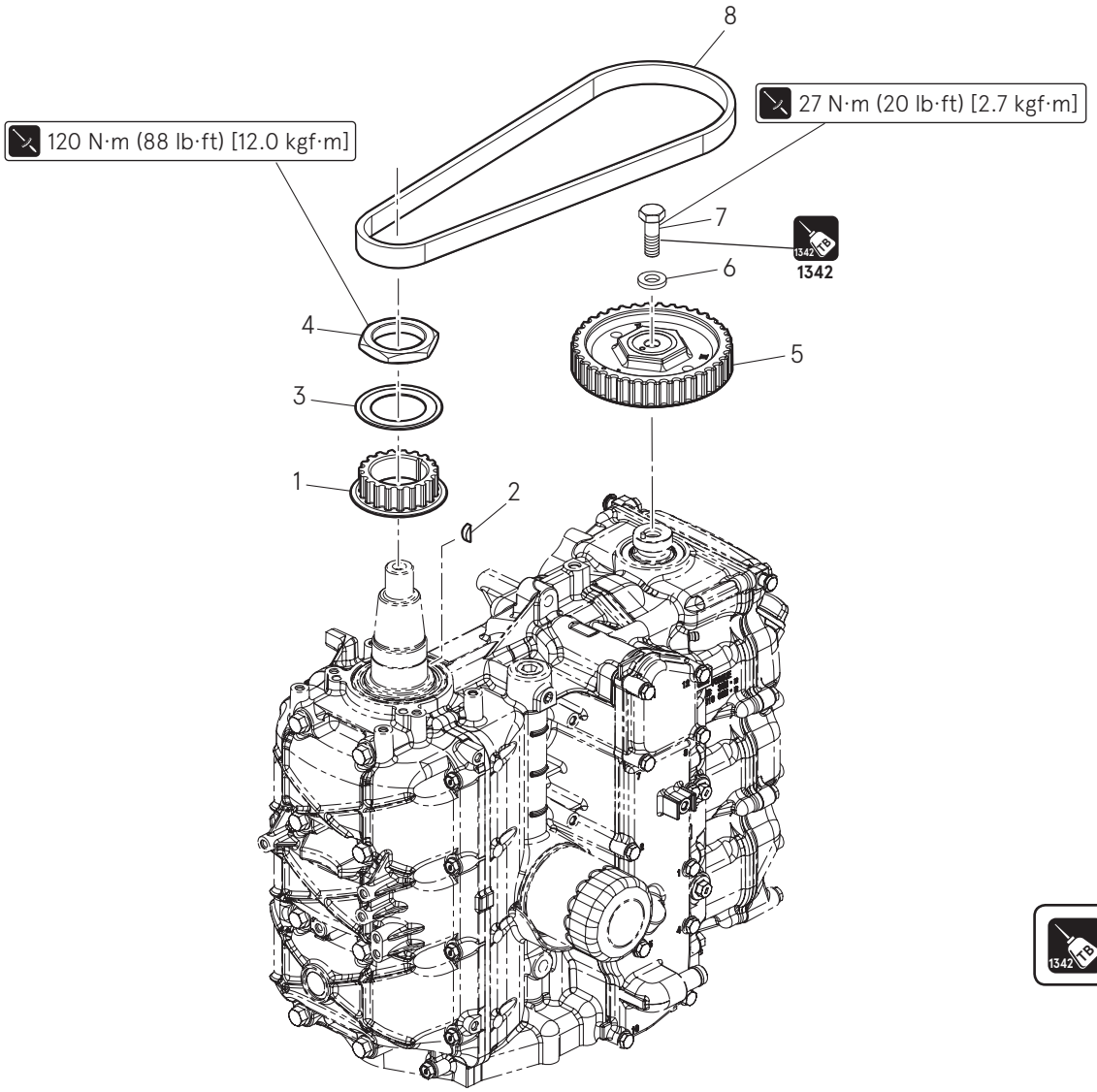
P/L Fig. 5



Ref. No.	Description	Q'ty	Remarks
1	Intake Manifold	1	
2	Isc Valve	1	Idle Speed Control Valve
3	Bolt	2	M6 L=20mm
4	MAP Sensor	1	Manifold Air Temperature & Pressure
5	Bolt	1	M6 L=20mm
6	Fuel Rail Ass'y	1	
7	Fuel Injector Ass'y	3	
8	Bolt	2	M6 L=20mm
9	Throttle Body Ass'y	1	ø45
10	Gasket	1	**Do not reuse.**
11	Bolt	3	M6 L=20mm
12	Intake Silencer Ass'y	1	
13	Gasket	1	**Do not reuse.**
14	Bolt	2	M6 L=25mm
15	Vapor Separator Ass'y	1	
16	Float	1	
17	Float Arm Pin	1	
18	Float Valve Ass'y	1	
19	Fuel Feed Pump	1	Upper
20	Grommet	1	Upper
21	Joint	1	Upper
22	Grommet	1	Upper
23	Filter (Outlet)	1	Lower
24	Grommet	1	Lower
25	Filter (Inlet)	1	
26	Fuel Regulator	1	
27	Holder	1	
28	O-ring	1	**Do not reuse.**
29	O-ring	1	**Do not reuse.**
30	Drain Screw	1	
31	Cover	1	
32	Seal	1	**Do not reuse.**

Pulley • Timing Belt

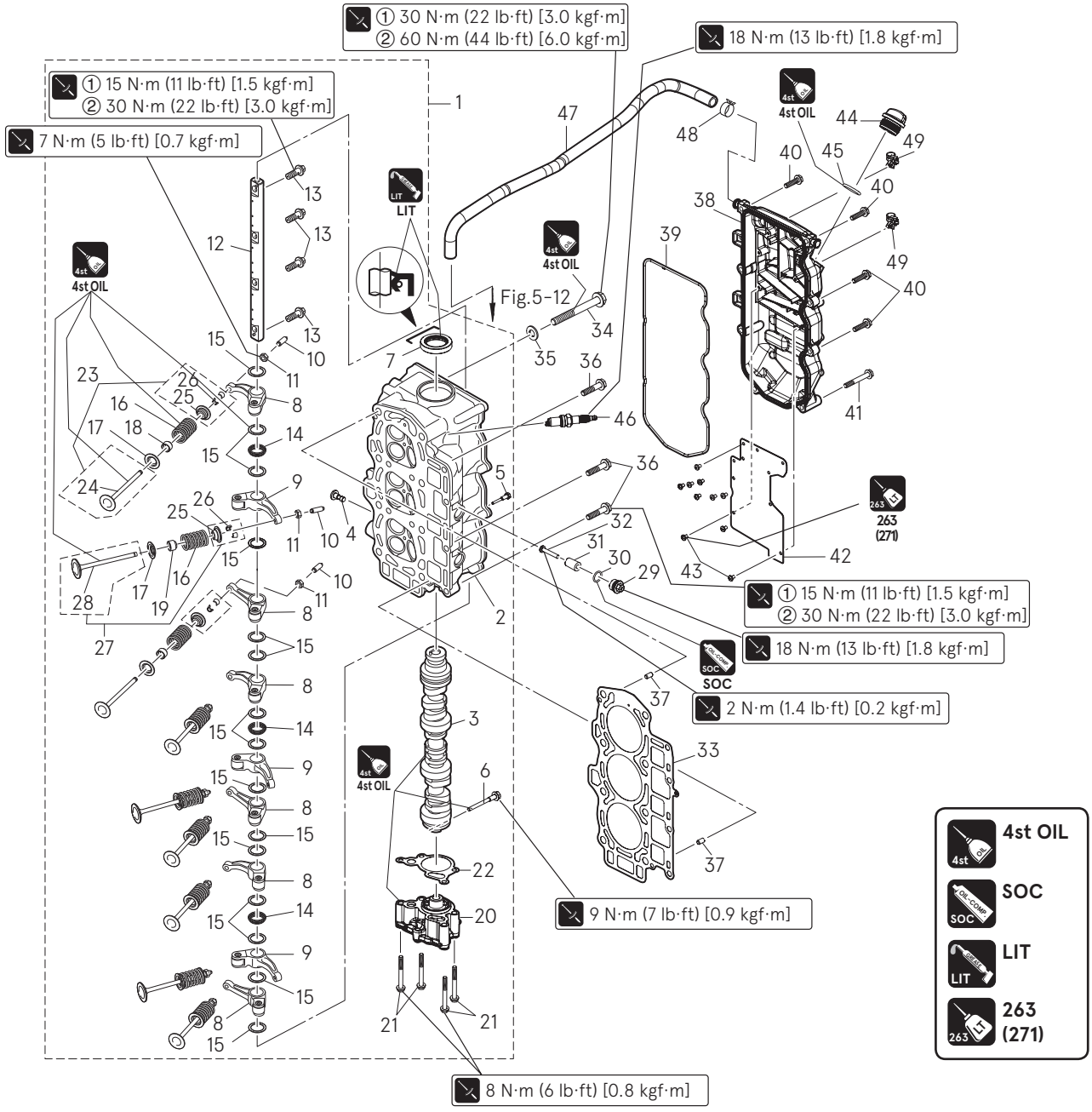
P/L Fig. 4



Ref. No.	Description	Q'ty	Remarks
1	Drive Pulley	1	Timing Pulley
2	Key t=4	1	Crankshaft
3	Belt Guide	1	
4	Nut 39-p1.5	1	M39
5	Driven Pulley	1	Camshaft Pulley
6	Washer 10.5-20-3.2	1	M10
7	Bolt 10-p1.25	1	M10 L=30mm
8	Timing Belt	1	

Cylinder Head & Oil Pump

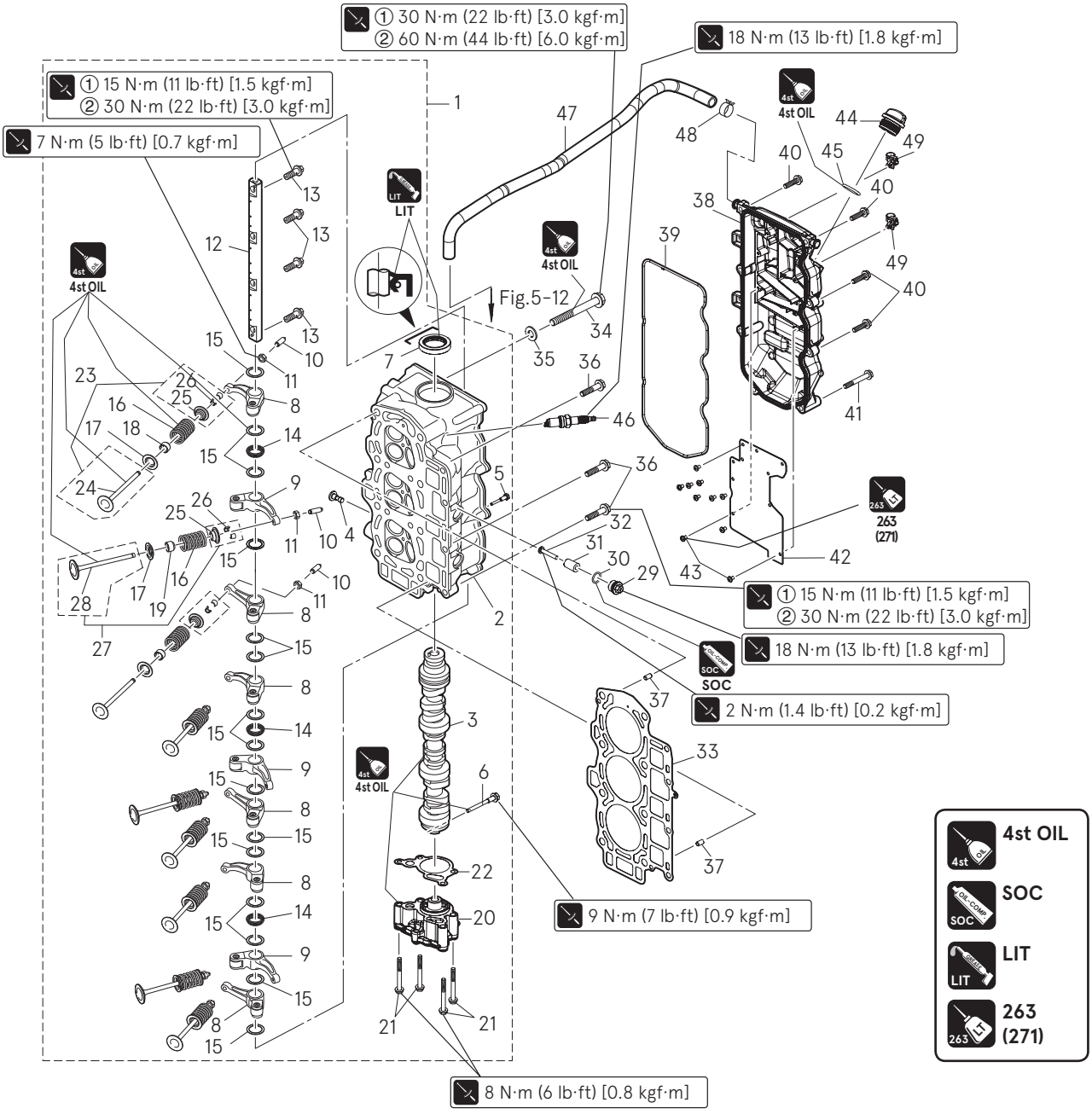
P/L Fig. 3



Ref. No.	Description	Q'ty	Remarks
1	Cylinder Head Complete	1	
2	Cylinder Head Ass'y	1	Valve Guide Valve Seat
3	Camshaft Ass'y	1	
4	Lifter	1	
5	Lifter Bolt	1	
6	Thrust Bolt	1	Camshaft
7	Oil Seal 30-45-8	1	Camshaft Upper **Do not reuse.**
8	Rocker Arm	6	
9	Rocker Arm	3	
10	Adjusting Screw	9	
11	Adjusting Nut	9	
12	Rocker Arm Shaft	1	
13	Rocker Shaft Bolt	4	
14	Rocker Shaft Spring	3	
15	Washer 16-23-0.5	15	
16	Valve Spring	9	

Ref. No.	Description	Q'ty	Remarks
17	Valve Spring Seat	9	
18	Intake Valve Stem Seal	6	Black
19	Exhaust Valve Stem Seal	3	Green
20	Oil Pump Ass'y	1	
21	Bolt	4	M6 L=50mm
22	Oil Pump Gasket	1	**Do not reuse.**
23	Intake Valve Kit	1	
24	Intake Valve ø25	6	
25	Retainer	9	
26	Cotter	18	
27	Exhaust Valve Kit	1	
28	Exhaust Valve ø28	3	
29	Anode Plug	3	
30	O-ring 1.9-13	3	**Do not reuse.**
31	Anode	3	
32	Screw	3	M5 L=30mm

P/L Fig. 3

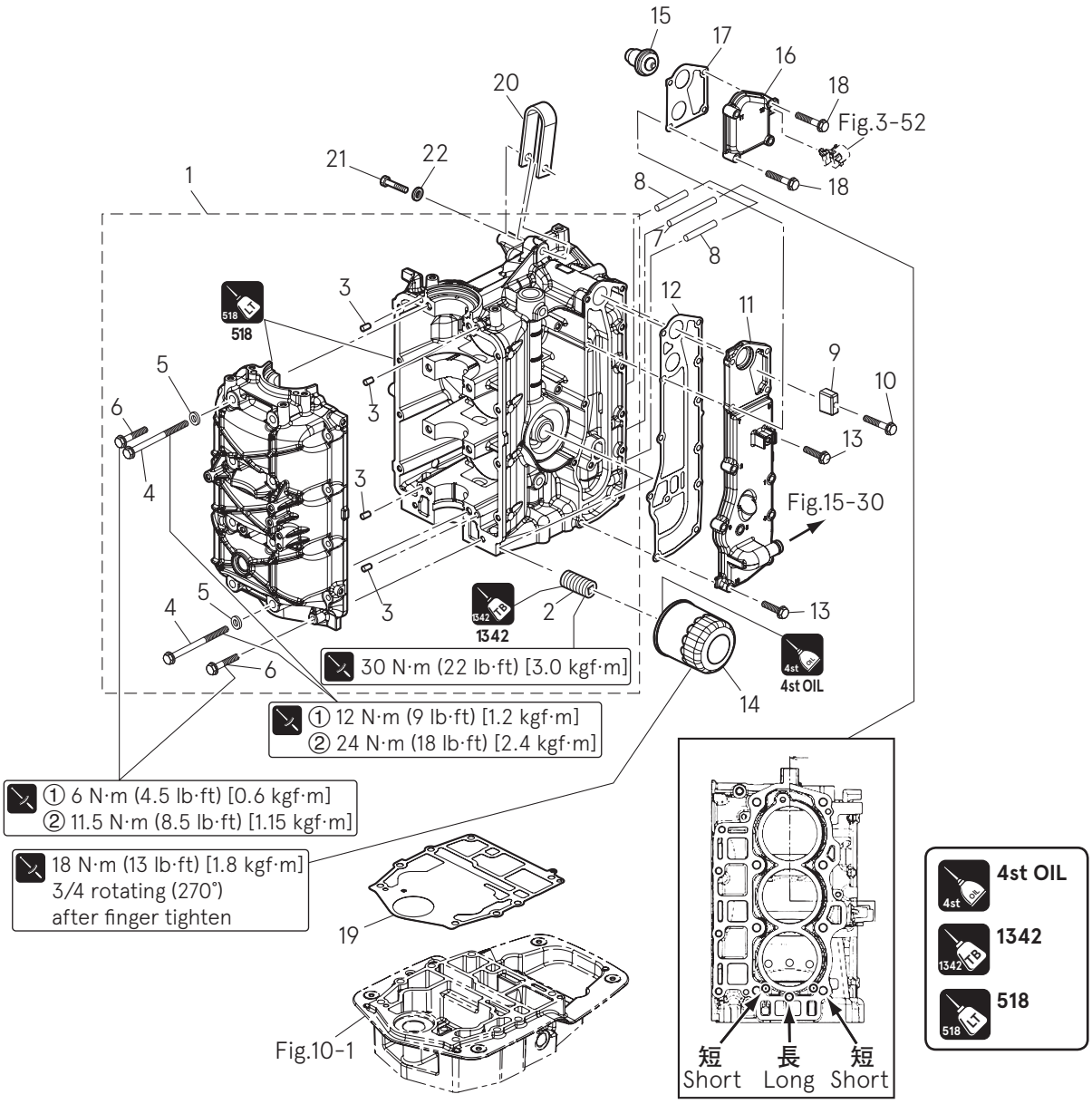


Ref. No.	Description	Q'ty	Remarks
33	Cylinder Head Gasket	1	Do not reuse.
34	Cylinder Head Bolt M10-90	8	
35	Washer	8	M10
36	Bolt 8-p1.25	4	
37	Dowel Pin 6-12	2	Cylinder Block-Cylinder Head
38	Cylinder Head Cover Ass'y	1	
39	Cylinder Head Cover Gasket	1	Do not reuse.
40	Bolt	6	M6 L=25mm
41	Bolt	2	M6 L=45mm
42	Breather Chamber Cover	1	
43	Screw	10	M4 L=6mm
44	Oil Filler Cap	1	
45	O-ring 3.1-24.4	1	Do not reuse.
46	Spark Plug (IKR6G8)	3	NGK

Ref. No.	Description	Q'ty	Remarks
47	Breather Hose	1	Cylinder Head Cover-Intake Silencer
48	Clip ø15.5	1	
49	Band	3	

Cylinder • Crankcase

P/L Fig. 1

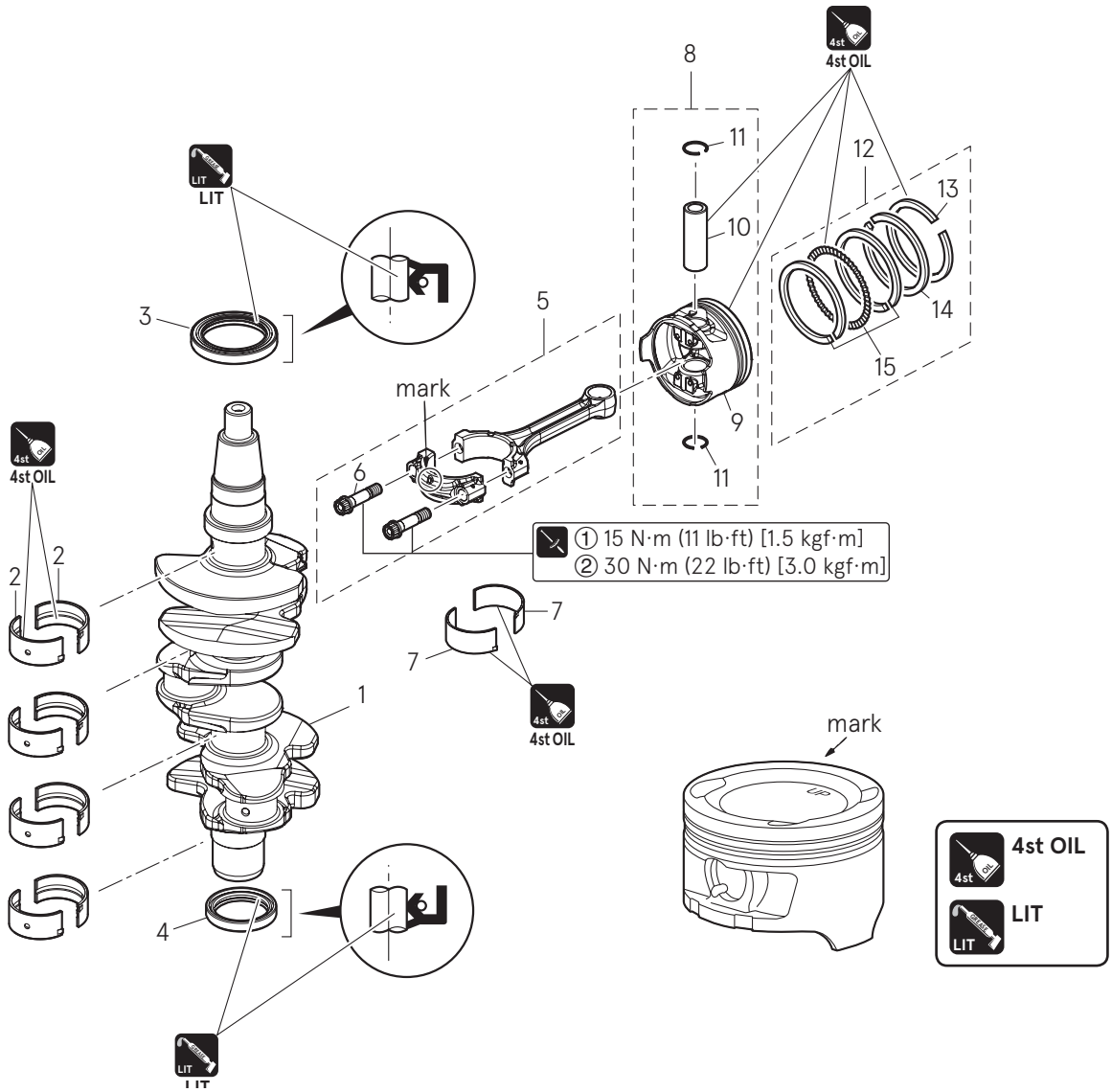


Ref. No.	Description	Q'ty	Remarks
1	Cylinder Block & Crankcase Ass'y	1	
2	Oil Filter Bolt	1	
3	Dowel Pin 6-12	4	Crankcase-Cylinder Block
4	Bolt 8-90	8	
5	Washer	8	M8
6	Bolt M6-35	10	M6 L=35mm
7	Water Jacket Insert (R) L=55	1	Long
8	Water Jacket Insert (L) L=35	2	Shot
9	Anode	1	
10	Bolt	1	M6 L=35mm
11	Exhaust Cover Ass'y	1	

Ref. No.	Description	Q'ty	Remarks
12	Exhaust Cover Gasket	1	**Do not reuse.**
13	Bolt	8	M6 L=25mm
14	Oil Filter	1	
15	Thermostat	1	Mark 60
16	Thermostat Cap	1	
17	Thermostat Cap Gasket	1	**Do not reuse.**
18	Bolt	4	M6 L=35mm
19	Engine Basement Gasket	1	**Do not reuse.**
20	Hanger	1	
21	Bolt	1	M8 L=35mm
22	Washer	1	M8

Piston & Crankshaft

P/L Fig. 2

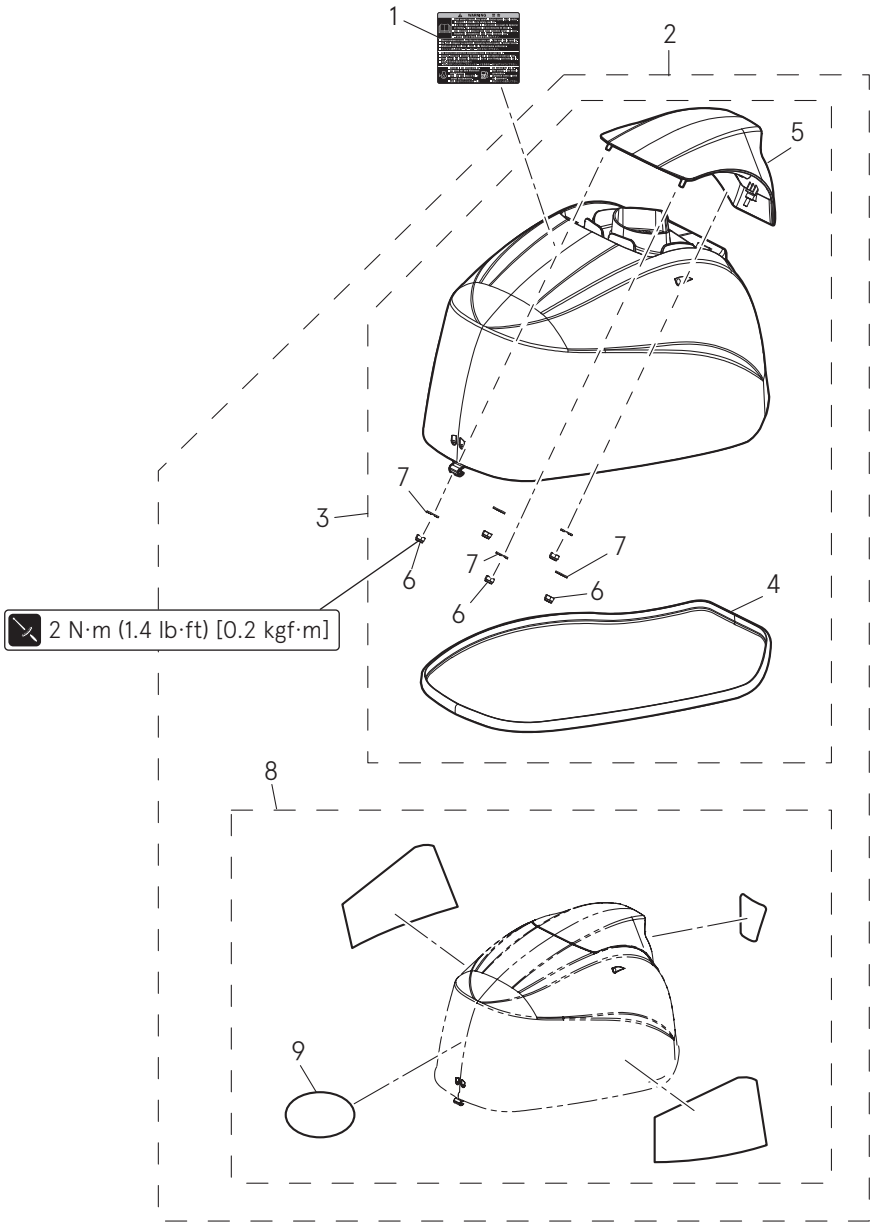


Ref. No.	Description	Q'ty	Remarks
1	Crankshaft A'ssy	1	
2-1	Plain Shaft Bearing (Brown)	A	Brown see Service Manual
2-2	Plain Shaft Bearing (Black)	A	Black see Service Manual
2-3	Plain Shaft Bearing (Blue)	A	Blue see Service Manual
3	Oil Seal 50-68-9	1	Upper **Do not reuse.**
4	Oil Seal 38-50-8	1	Lower **Do not reuse.**
5	Connecting Rod Ass'y	3	
6	Connecting Rod Bolt	2	
7-1	Big End Bearing (Brown)	A	Brown see Service Manual
7-2	Big End Bearing (Black)	A	Black see Service Manual
7-3	Big End Bearing (Blue)	A	Blue see Service Manual
8-1	Piston Repair Kit	3	STD
8-2	Piston Repair Kit (0.5 O/S)	3	OPT

Ref. No.	Description	Q'ty	Remarks
9-1	Piston	1	STD
9-2	Piston (0.5 O/S)	1	OPT
10	Piston Pin	1	
11	Piston Pin Clip	2	**Do not reuse.**
12-1	Piston Ring Set	3	STD
12-2	Piston Ring Set (0.5 O/S)	3	1st OPT
13-1	Piston Ring	1	1st STD
13-2	Piston Ring (0.5 O/S)	1	OPT
14-1	Piston Ring 2nd	1	2nd STD
14-2	Piston Ring (0.5 O/S) 2nd	1	2nd OPT
15-1	Piston Ring-oil	1	Oil STD
15-2	Piston Ring-oil (0.5 O/S)	1	Oil OPT

Top Cowl

P/L Fig. 18



Ref. No.	Description	Q'ty	Remarks
1	Caution Decal (A)	1	
2	Top Cowl Assy (Service)	1	
3	Top Cowl Sub-Ass'y	1	
4	Top Cowl Seal	1	
5	Tilt Handle Gray	1	
6	Nylon Nut 6-p1.0	5	
7	Washer 6-16-1.5	5	
8	Decal Set	1	
9	Front Decal	1	

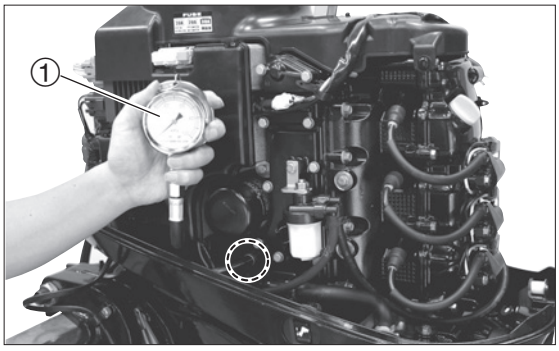
2. Inspection Items

1) Inspection of Compression Pressure

1. Refer to "Inspection of Compression Pressure" in chapter 3.

Compression Pressure (Reference) :
1.5 MPa (218 PSI) [15.3 kgf/cm²] ±10 %

2) Inspection of Oil Pressure



1. Spread rag below oil pressure switch.

2. Remove oil pressure switch and connect oil pressure gauge ① to switch hole.

Use commercially available oil pressure gauge (Thread spec : R 1/8).
Use the instrument applicable to 1 Mpa (142 PSI) [10 kgf/cm²].

3. Start engine and run 5 minutes to warm up at idling revolution speed.

4. Measure hydraulic pressure. If the pressure is below specified value, check oil pump for oil leak, and oil strainer and plunger.

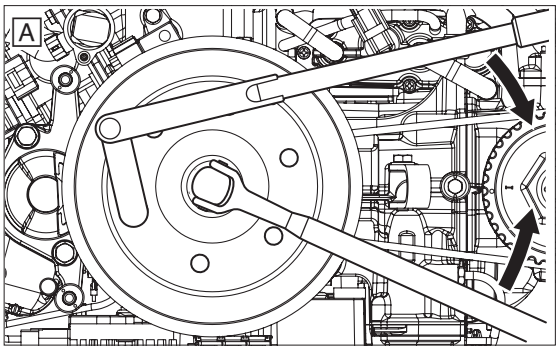
Hydraulic Pressure (Reference) : Oil Temperature 60°(140°F)
0.14 MPa (21 PSI) [1.5 kgf/cm²] or higher at 850 r/min
0.29 MPa (43 PSI) [3.0 kgf/cm²] or higher at 5750 r/min

3) Inspection of Valve Clearance

1. Refer to "Inspection of Valve Clearance" in chapter 3.

Valve Clearance (when engine is cold)
(IN) Intake valve :
0.20 – 0.25 mm (0.008 – 0.010 in)
(EX) Exhaust valve :
0.30 – 0.35 mm (0.012 – 0.014 in)

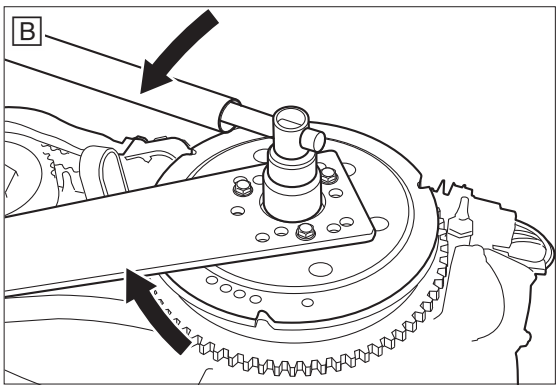
4) Removing Power Unit



1. Remove flywheel cover.

2. Loosen flywheel nut.

Loosen flywheel nut before removing power unit to make the work easier.

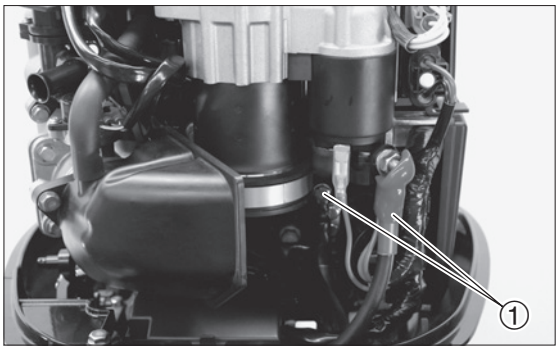


A **Flywheel Holder :**
Commercially available item
B **Flywheel puller kit :**
P/N. 3T1-72211-0

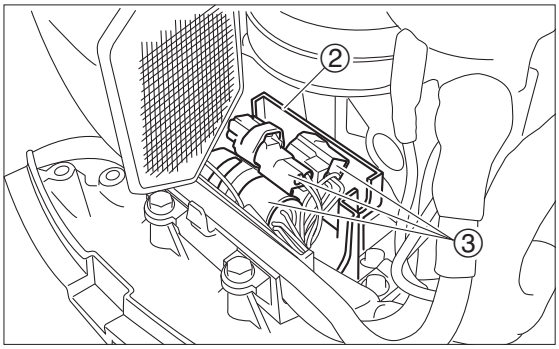
⚠ CAUTION

Apply forces to tools toward directions as shown, and perform work taking care not to allow flywheel holder to remove.

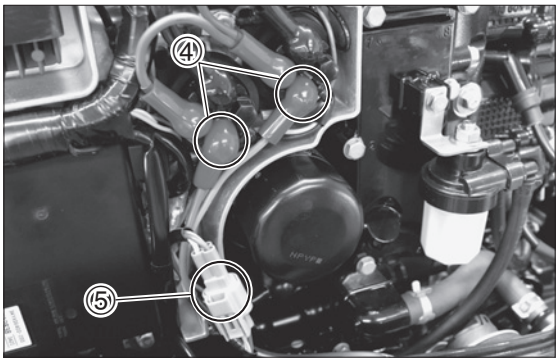
3. Disconnect battery cables ①.



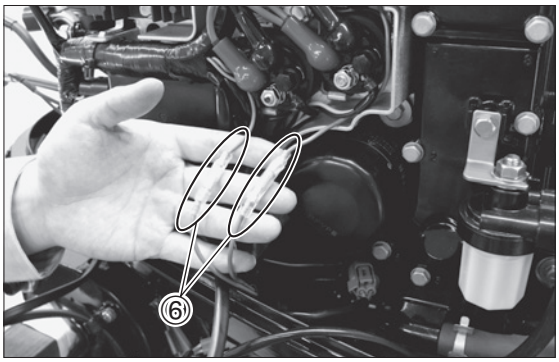
4. Open the cable terminal holder cover ② and disconnect connecters ③ (3).



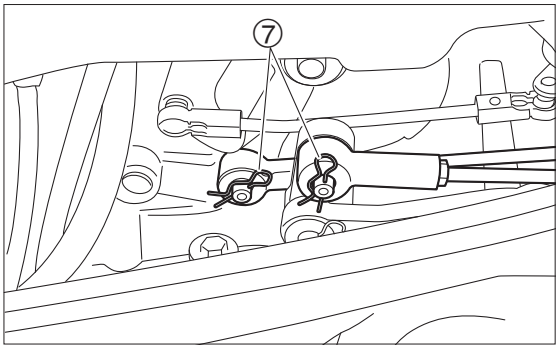
5. Remove the electrical box cover and disconnect PTT motor leads ④ and PTT switch coupler ⑤.



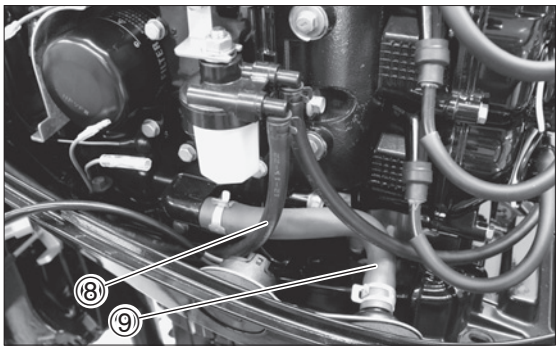
6. Disconnect neutral switch leads (green) ⑥.



7. Remove the pins ⑦ and then remove the cable joints.

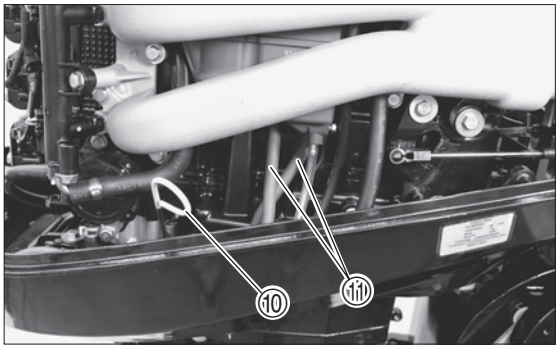


8. Disconnect the fuel hose ⑧ and flushing hose ⑨ .

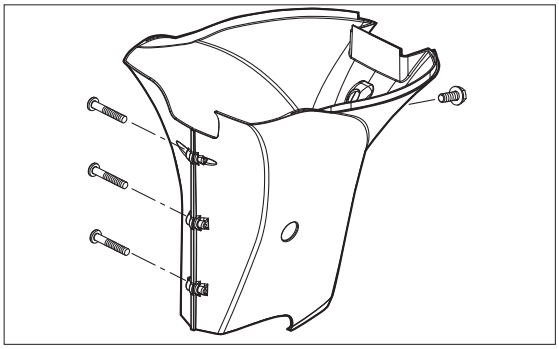


9. Remove oil level gauge ⑩.

10. Disconnect cooling water (fuel cooler) hoses ⑪.

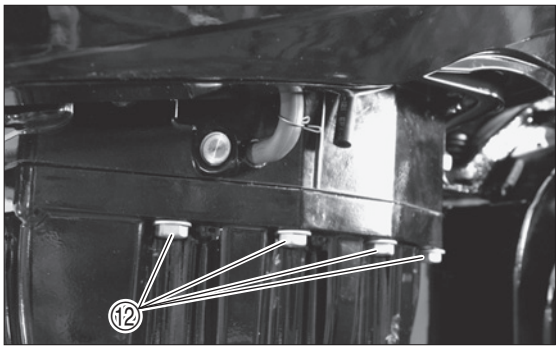


11. Remove tapping screws (L = 4 pieces. S = 3 pieces.) and bolt (one piece.), then remove apron.



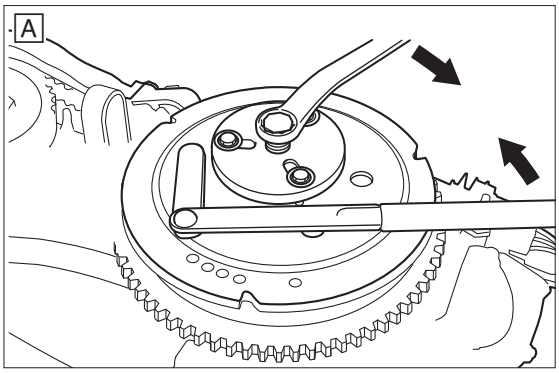
12. Remove power unit by removing bolts ⑫ (8) and then lifting it.

- When lifting power unit, perform the work carefully, checking if wires and hoses are caught by other parts.
- Loosen the bolts to reverse tightening sequence.



13. Remove flywheel and key.

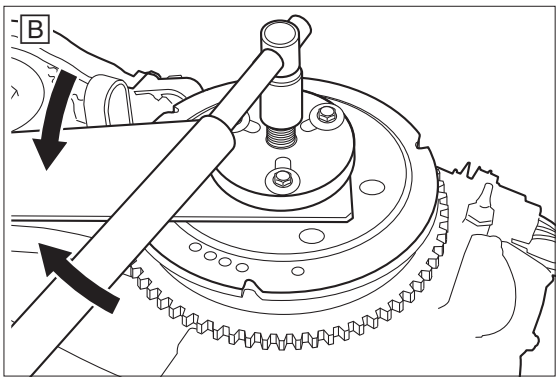
A **Flywheel Holder :**
Commercially available item
A **Flywheel Puller :**
Use puller contained in the following puller kit.
B **Flywheel Puller Kit :**
P/N. 3T1-72211-0



⚠ CAUTION

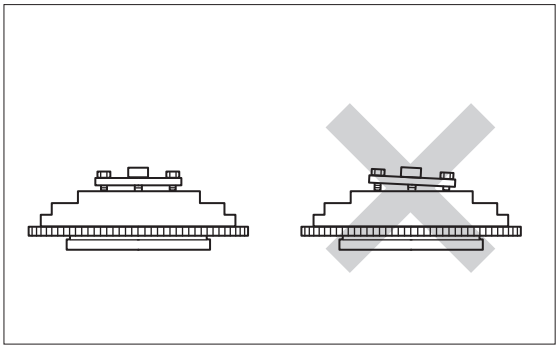
Apply forces to tools toward directions as shown, and perform work taking care not to allow flywheel holder to remove.

Screw puller onto crankshaft end until flywheel is disengaged from tapered section of crankshaft.



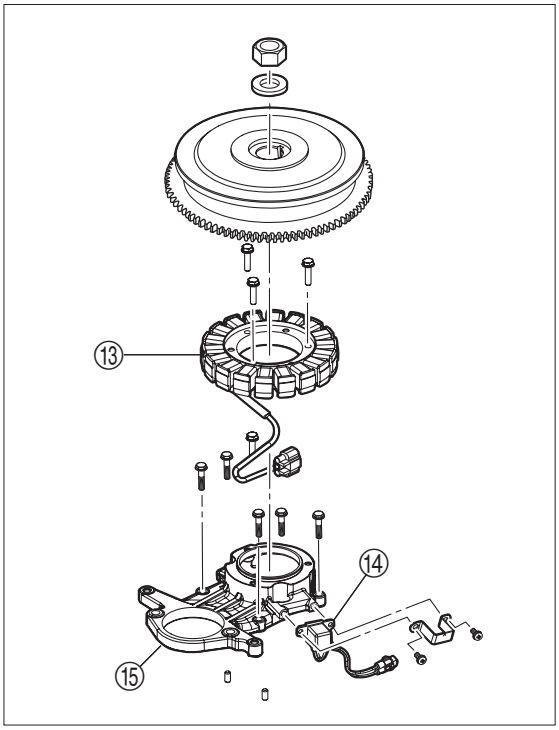
⚠ CAUTION

To prevent damages to engine and special tools, tighten flywheel puller set bolts evenly and keep flywheel puller parallel to flywheel while working.



14. Disconnect alternator ⑬ and pulser coil ⑭ .

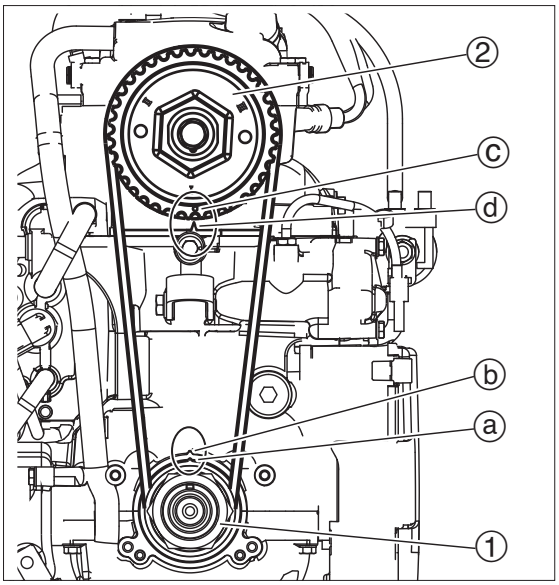
15. Remove bolts of alternator and coil bracket ⑮, and remove alternator and coil bracket.



5

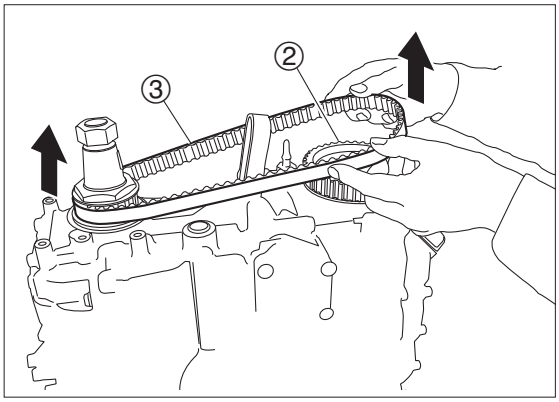
5) Removing Timing Belt and Pulley

1. Turn timing pulley ① clockwise to bring "▲" mark ⓐ of timing pulley to "▲" mark ⓑ of cylinder block, and check that "● I" mark ⓒ of cam shaft pulley ② and "▲" mark ⓓ of cylinder head are aligned with each other.



> No.1 piston is to be at top dead center of compression stroke.

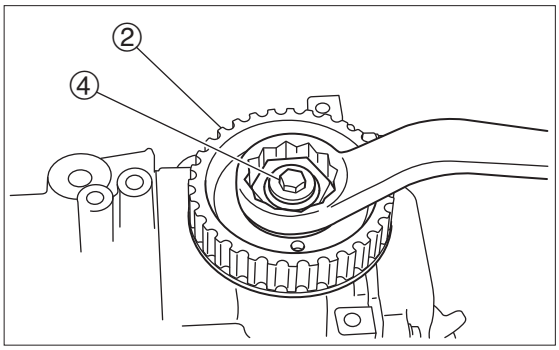
2. Remove timing belt ③ from cam shaft pulley ② side, and then, from timing pulley side.



⚠ CAUTION

Do not turn timing pulley (crank shaft) or cam shaft pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, resulting in damages to these parts.

3. Remove cam shaft pulley ② bolt ④, and then, remove cam shaft pulley ②.

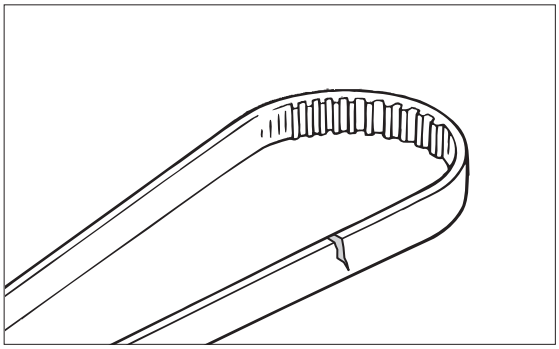


> When loosening cam shaft pulley bolt, be careful not to turn cam shaft pulley.

6) Inspection of Timing Belt

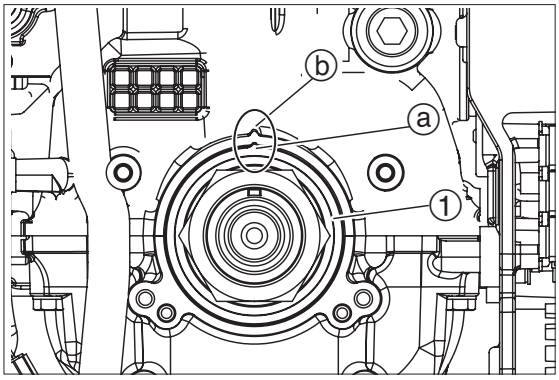
1. Check timing belt for crack, damage and wear on both faces. Replace if necessary.

2. Check timing pulley and cam shaft pulley for crack, damage and wear. Replace if necessary.



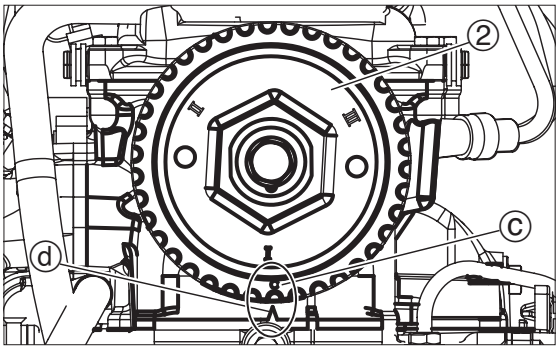
7) Installation of Pulley and Timing Belt

1. Check that "▲" mark ⓐ of timing pulley ① and "▲" mark ⓑ of cylinder block are aligned with each other.



> No.1 piston is to be at top dead center of compression stroke.

2. Install cam shaft pulley, bring "● I" mark ⓒ of cam shaft pulley ② to "▲" mark ⓓ of cylinder head, and then, tighten bolt ③ to specified torque.



Cam Shaft Pulley Bolt ③ :
27 N·m (20 lb·ft) [2.7 kgf·m]

⚠ CAUTION

Do not turn timing pulley or cam shaft pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, resulting in damages to these parts.

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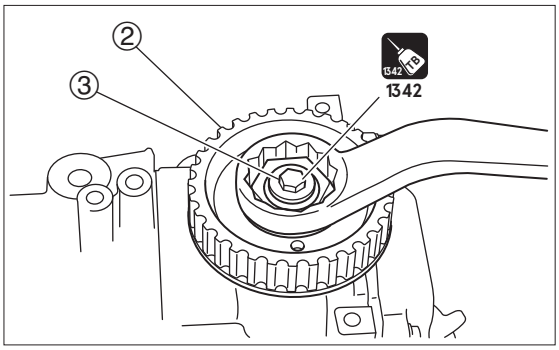
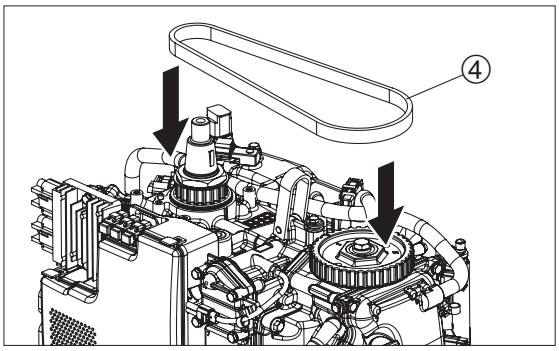


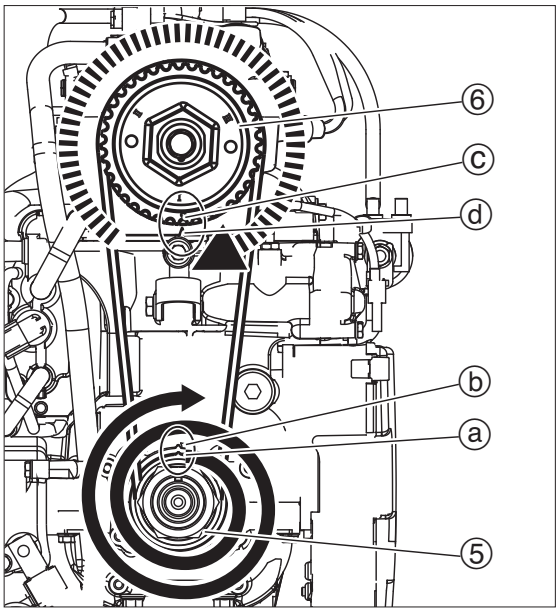
3. Attach timing belt ④ to timing pulley with its part number side facing upward, and then to cam shaft pulley.



⚠ CAUTION

- **Be careful not give damage to timing belt when installing.**
- **Do not twist timing belt, bring inside out, or bend sharp, or it may be damaged.**
- **Be careful not to allow oil or grease to adhere to timing belt.**

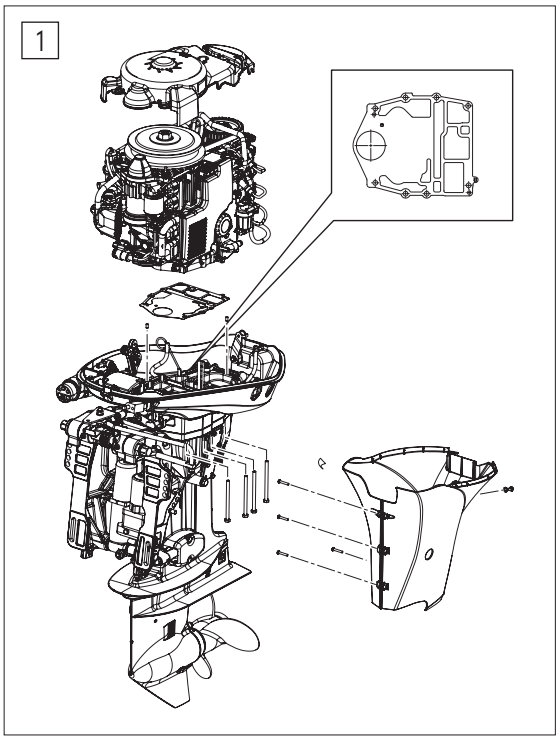
4. Turn timing pulley ⑤ clockwise twice, and check that locating marks ⓐ and ⓑ, and ⓒ and ⓓ of pulleys ⑤ and ⑥ are aligned with each other respectively.



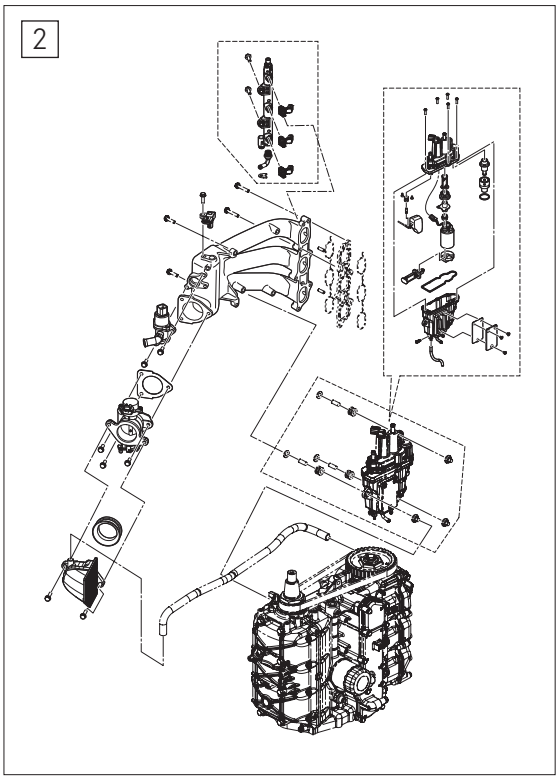
8) Removing Cylinder Head

- No.1 piston is to be at top dead center of compression stroke.
- Removal or installation of parts can be made easier when some of them are assembled together.

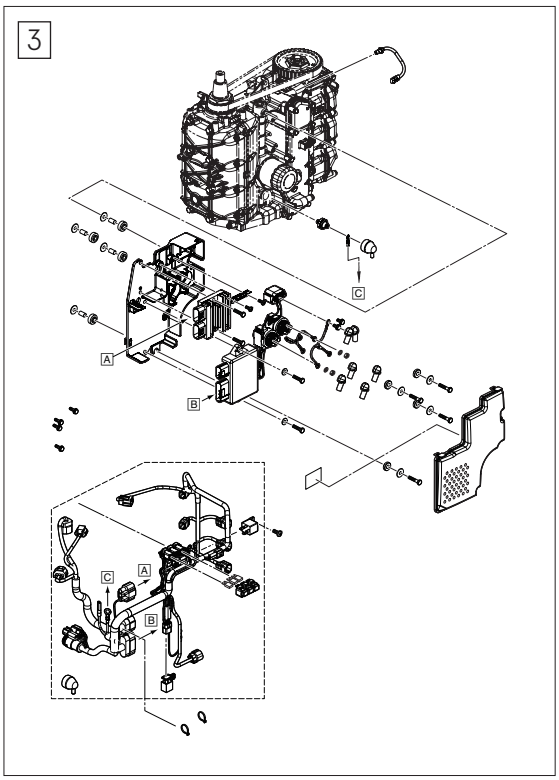
1. Remove power unit. (Refer to the section for removing power unit.)



2. Remove fuel system parts and intake manifold ass'y.



3. Remove electrical system parts from power unit.



4. Remove camshaft pulley, cylinder head cover and hose.

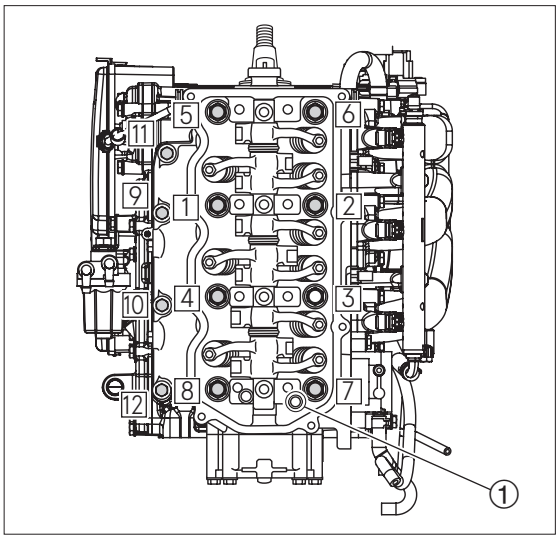
To remove, refer to the "Removing Timing Belt and Pulley" section in Chapter 5.

5. Remove cylinder head bolts in the reverse sequence of order shown, and remove cylinder head.

⚠ CAUTION

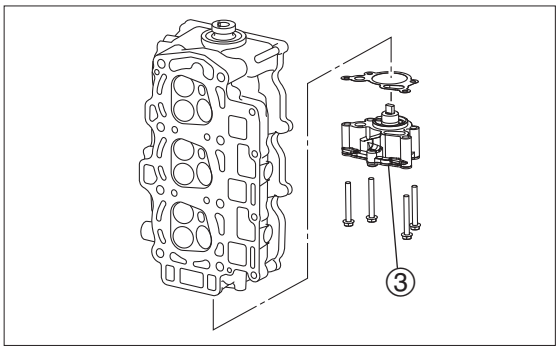
Do not scratch or give damage to mating surfaces of cylinder head and cylinder block.

To loosen "No. 7" bolt, loosen fuel pump lift bolt ①, and then remove fuel pump lift.



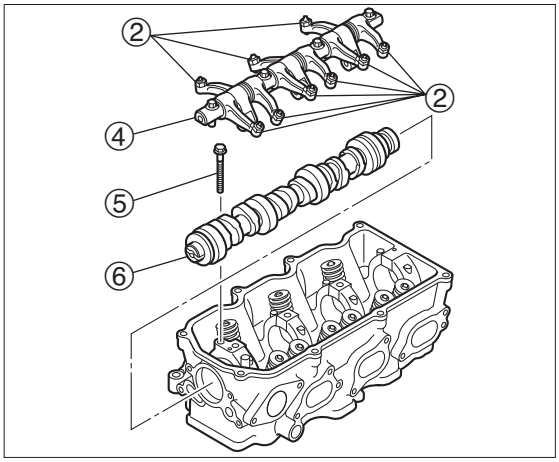
6. Loosen rocker arm lock nuts ②, and loosen adjusting screws as much as possible.

7. Remove oil pump ass'y ③.



8. Remove rocker arm shaft ass'y ④.

- The work can be made easier when cam shaft is brought to a position of low valve spring force.
- Bind with tie wrap, to remove easier.

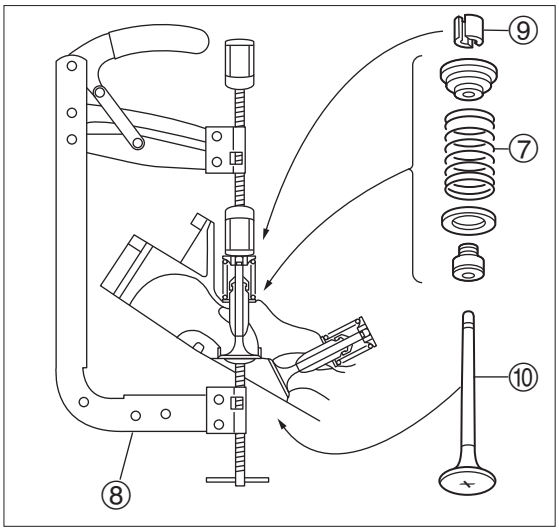


9. Remove cam shaft mounting bolt ⑤ and cam shaft ⑥.

10. Compress valve spring ⑦ by using compressor ⑧, remove cotter ⑨, and then, spring and valve ⑩.

Valves, springs and other related parts should be arranged in the order they are removed.

Valve Spring Compressor ⑧ :
Commercially available item

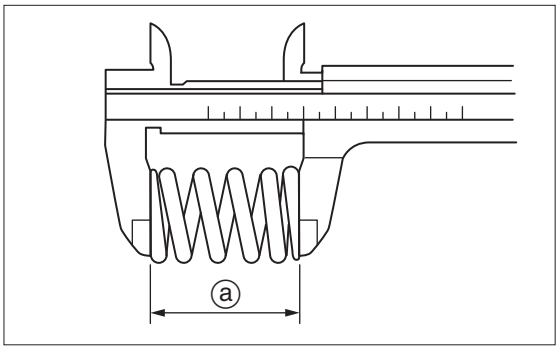


9) Inspection of Valve Spring

1. Measure valve spring free length ⓐ. Replace if the length is less than specified value.

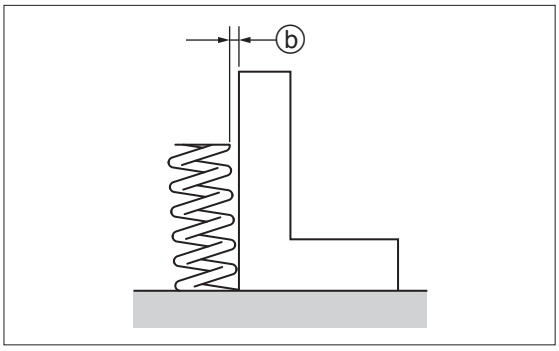
Valve Spring Free Length ⓐ : Standard Value
38.7 mm (1.52 in)

Functional Limit :
37.1 mm (1.46 in)



2. Measure valve spring inclination ⓑ. Replace if the angle is over specified value.

Valve Spring Inclination Limit ⓑ :
2.0 mm (0.08 in)



5

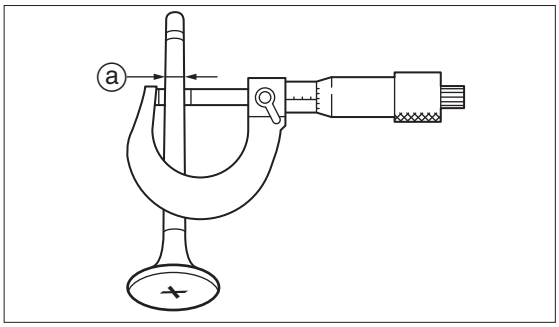
10) Inspection of Valve

1. Check valve for dent and wear on the face. Replace if necessary.

2. Measure valve stem outer diameter ⓐ. Replace if the diameter is less than specified value.

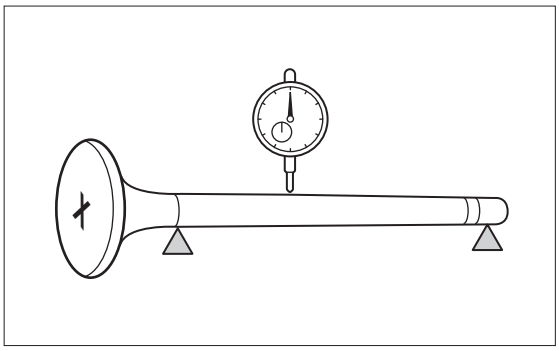
Valve Stem Outer Diameter ⓐ : Standard Value
Intake Side : 5.48 mm (0.216 in)
Exhaust Side : 5.46 mm (0.215 in)

Functional Limit :
Intake Side : 5.46 mm (0.215 in)
Exhaust Side : 5.44 mm (0.214 in)



3. Measure valve stem runout. Replace if the runout is over specified value.

Valve Stem Runout Limit :
Intake Side : 0.07 mm (0.0028 in)
Exhaust Side : 0.05 mm (0.0020 in)



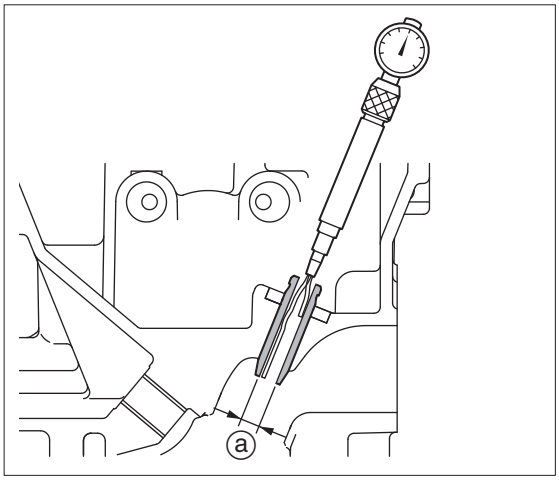
11) Inspection of Valve Guide

Before inspecting valve guide, check that valve stem outer diameter is within specified range.

1. Measure valve guide inner diameter ⓐ. Replace cylinder head if the inner diameter is over specified value.

Valve Guide Inner Diameter ⓐ : Standard Value
Intake/Exhaust Side : 5.51 mm (0.217 in)

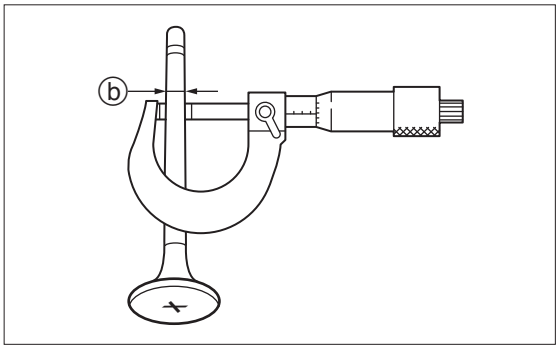
Functional Limit :
Intake Side : 5.55 mm (0.0218 in)
Exhaust Side : 5.57 mm (0.0219 in)



2. Obtain clearance between valve guide and valve stem by calculating as described below. Replace cylinder head and/or valve if the clearance is over specified value.

Clearance between Valve Guide and Valve Stem =
Valve Guide Inner Diameter ⓐ – Valve Stem Outer Diameter ⓑ :
Intake Side : 0.008 to 0.040 mm (0.00031 to 0.00157 in)
Exhaust Side : 0.025 to 0.057 mm (0.00098 to 0.00224 in)

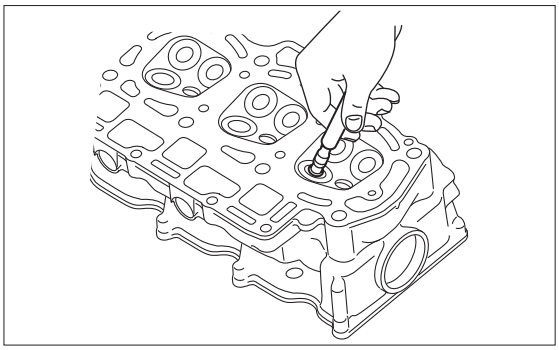
Functional Limit :
Intake Side : 0.070 mm (0.00276 in)
Exhaust Side : 0.100 mm (0.00394 in)

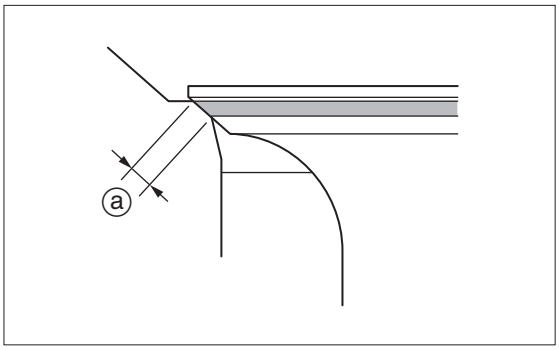


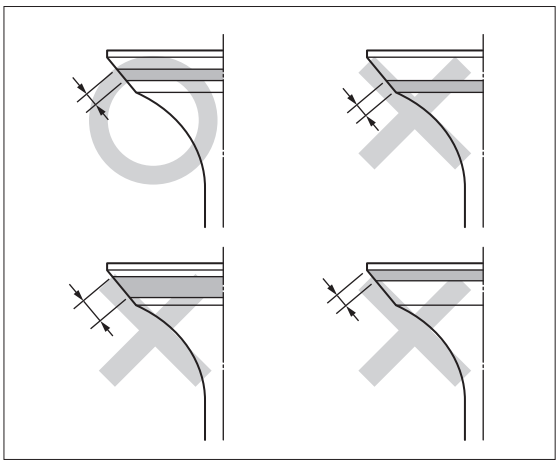
12) Inspection of Valve Seat

1. Remove carbon built up on the valve.
2. Apply thin coat of red lead on the valve seat.
3. Use valve lapper (commercially available item) as shown to push valve onto valve seat lightly.
4. Measure width of area where valve face contacted with valve seat ⓐ that can be identified with red lead adhered to valve face. Correct valve seat if contact area is above or below the center or contact area of valve seat is over specified limit.

Valve Seat Contact Width ⓐ : Standard Value Intake/Exhaust Side : 1.4 mm (0.06 in)
Functional Limit : Intake/Exhaust Side : 2.0 mm (0.08 in)

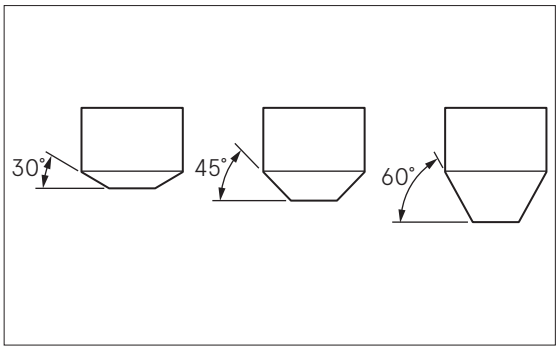






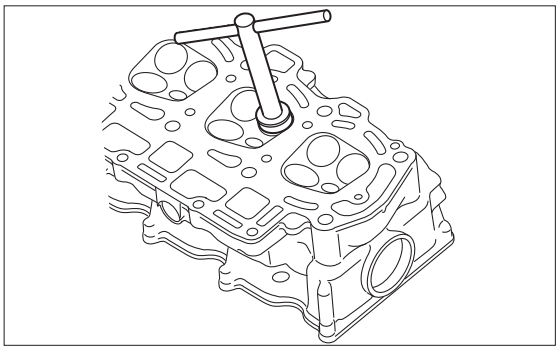
13) Correction of Valve Seat

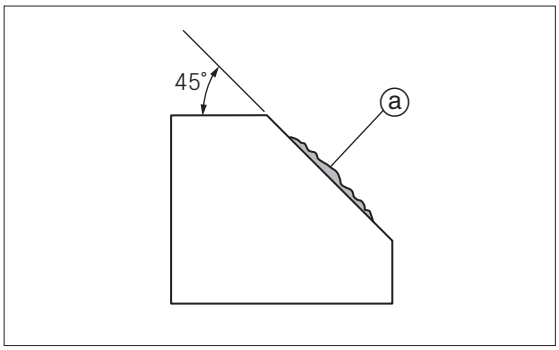
1. Use valve seat cutter (commercially available item) to correct valve seat.



2. Turn 45 degree cutter clockwise to cut valve seat surface to make it smooth.

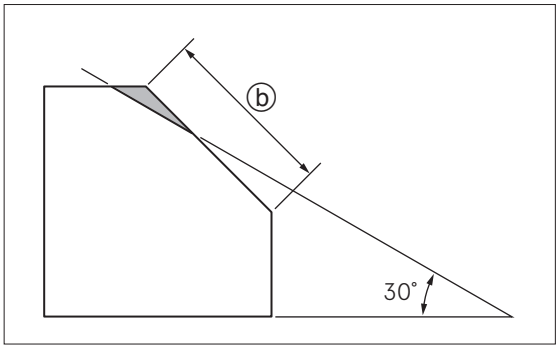
Be careful not to over-cut valve seat. Turn valve seat cutter while pushing down evenly.





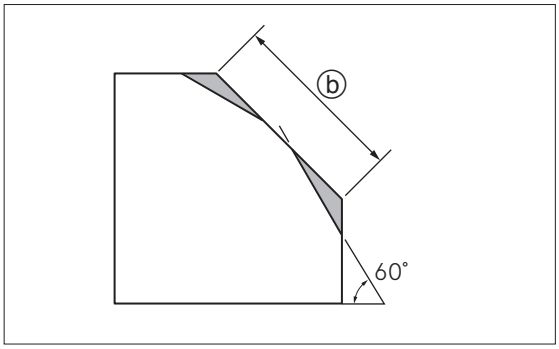
ⓐ Carbon build-up or uneven surface.

3. Use 30 degree cutter to adjust contact position of valve seat upper end.



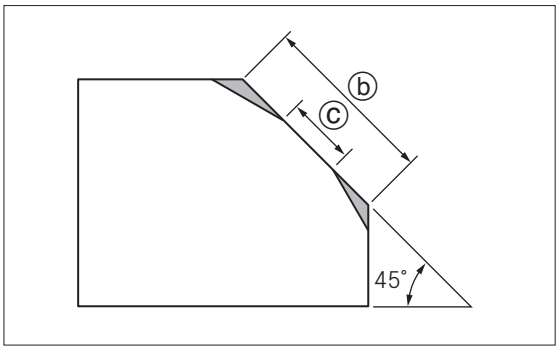
ⓑ Width before correction

4. Use 60 degree cutter to adjust contact position of valve seat lower end.



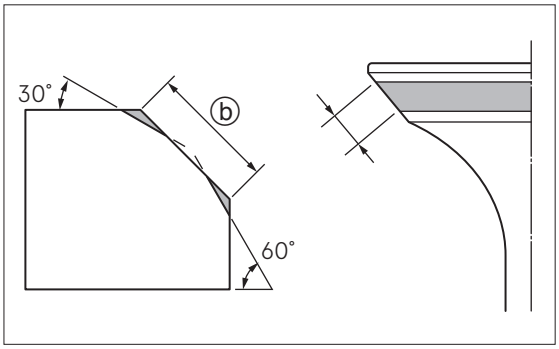
ⓑ Width before correction

5. Use 45 degree cutter to adjust contact width of valve seat ⓒ to specified value.



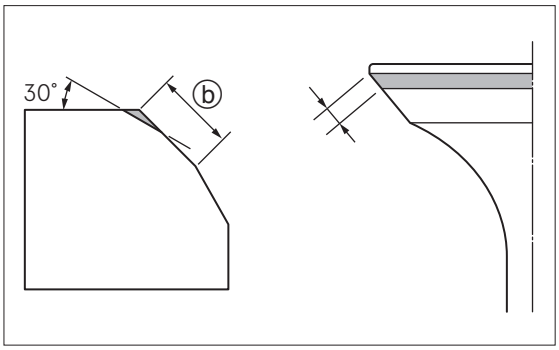
ⓑ Width before correction
ⓒ Specified width

6. Valve seat contact area is located on the center, which should be adjusted to specified value by cutting upper and lower ends by using 30 degree and 60 degree seat cutters respectively if the area is too wide.



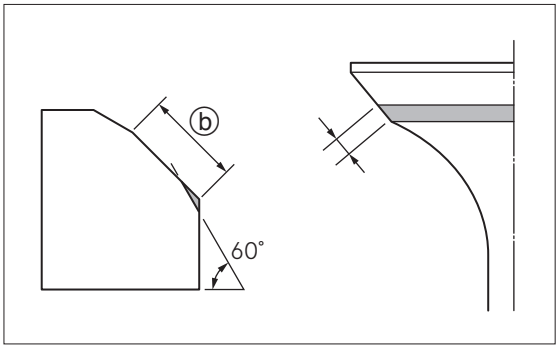
ⓑ Width before correction

7. If valve seat contact area is too narrow and is located neater to valve face upper end, use 30 degree seat cutter to cut upper end. Use 45 degree cutter to adjust contact width of valve seat to specified value.



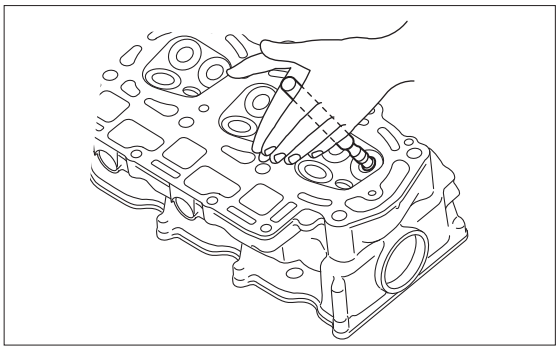
ⓑ Width before correction

8. If valve seat contact area is too narrow and is located neater to valve face lower end, use 60 degree seat cutter to cut lower end. Use 45 degree cutter to adjust contact width of valve seat to specified value.



ⓑ Width before correction

9. Apply thin coat of abrasive compound on the overall valve seat contact area, and turn valve lapper (commercially available item) while tapping valve.



⚠ CAUTION

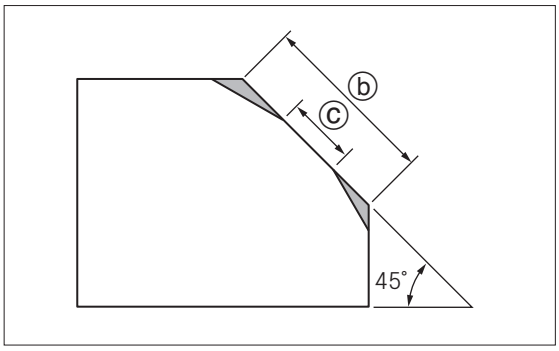
Perform the work by taking care not to allow abrasive compound to adhere to valve stem and valve guide.

- Use finer abrasive compound to finish.
- When changing abrasive compound to finer one, remove present one completely.
- After completion of lapping, wipe off the compound and then clean.

10. After ending the work, remove the compound completely from cylinder head and valve.

11. Check valve seat contact width ⓒ.

Valve Seat Contact Width ⓒ : Standard Value
1.4 mm (0.06 in)

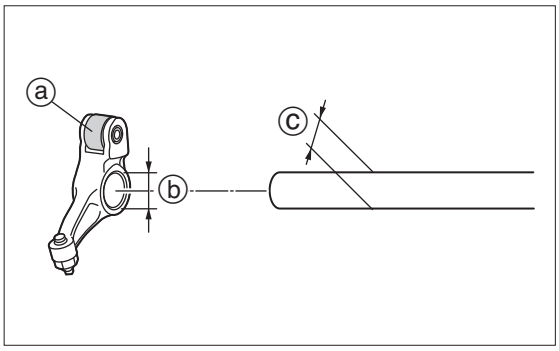


ⓑ Width before correction

14) Inspection of Rocker Arm and Rocker Arm Shaft

1. Check rocker arm, rocker arm shaft and rocker arm contact area ⓐ for wear. Replace if necessary.

2. Measure rocker arm inner diameter ⓑ and rocker arm shaft outer diameter ⓒ. Obtain oil clearance ⓓ (ⓓ = ⓑ − ⓒ). Replace if the clearance is out of specified range.



ⓓ = ⓑ − ⓒ

Rocker Arm Inner Diameter ⓑ : Standard Value
18.01 mm (0.7091 in)
Rocker Arm Shaft Outer Diameter ⓒ : Standard Value
17.99 mm (0.7083 in)
Oil Clearance Between Rocker Arm Hole and Shaft ⓓ : ⓑ − ⓒ
0.006 to 0.035 mm (0.00024 to 0.00138 in)

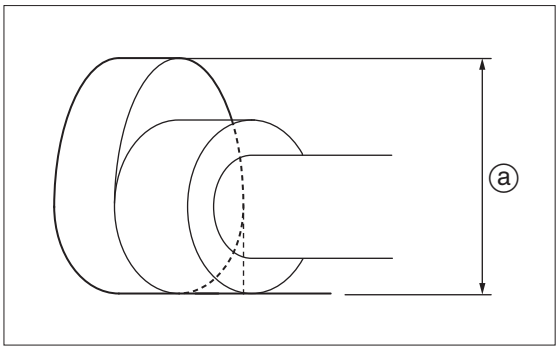
Functional Limit :
Replace if ⓑ is over 18.05 mm (0.7106 in).
Replace if ⓒ is less than 17.94 mm (0.7063 in).
Replace if ⓓ is over 0.090 mm (0.00354 in).

15) Inspection of Cam Shaft

1. Measure cam height. Replace if the height is less than specified value.

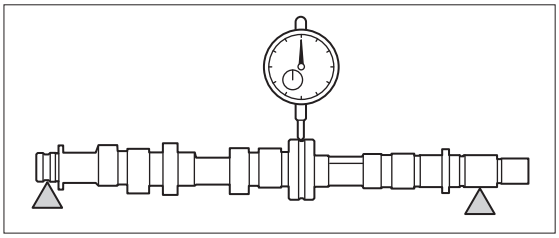
Cam Height at Both Intake and Exhaust Sides ⓐ : Standard Value
35.70 mm (1.4055 in)

Functional Limit : Cam Height at Both Intake and Exhaust Sides ⓐ
35.34 mm (1.3913 in)



2. Measure cam shaft runout. Replace if the runout is over specified value.

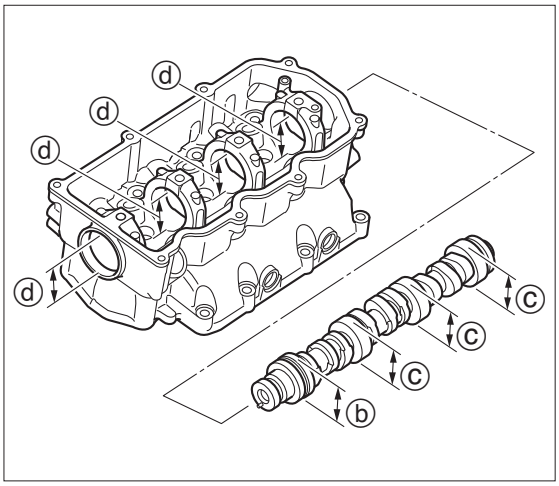
Cam Shaft Runout Limit :
0.05 mm (0.0020 in)



3. Measure cam shaft journal outer diameters ⓑ and ⓒ. Replace cam shaft or cylinder head if either of the diameters is less than specified value.

Cam Shaft Outer Diameter (pulley side bearing) ⓑ : Standard Value
41.92 mm (1.6504 in)
Cam Shaft Outer Diameter (oil pump side and center bearing) ⓒ : Standard Value
41.95 mm (1.6516 in)

Limit :
ⓑ 41.89 mm (1.6492 in)
ⓒ 41.92 mm (1.6504 in)



4. Measure cylinder head journal inner diameter ⓓ.

Cylinder head journal inner diameter ⓓ (upper): Standard Value
42.000 to 42.025 mm (1.65354 to 1.65453 in)

Functional Limit :
42.050 mm (1.65551 in)

5. Calculate the oil clearance using the cylinder head journal inner diameter ⓓ and the camshaft journal outer diameter ⓑ or ⓒ.

Oil Clearance : Standard Value
ⓓ - ⓑ 0.07 to 0.11 mm (0.0028 to 0.0043 in)
ⓓ - ⓒ 0.04 to 0.08 mm (0.0016 to 0.0031 in)

Functional Limit :
ⓓ - ⓑ 0.15 mm (0.0059 in)
ⓓ - ⓒ 0.12 mm (0.0047 in)

If oil clearance is over functional limit, replace any of cylinder head or cam shaft, or all of them as a set, and check that the clearance is within specified range.

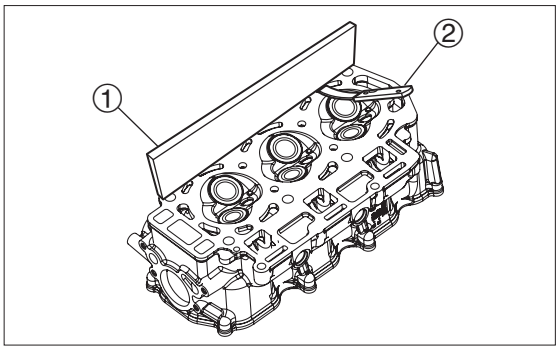
5

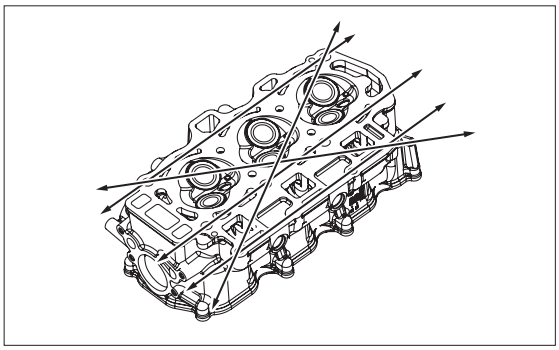
16) Inspection of Cylinder Head

1. Remove carbon build-up of combustion chamber, and check for deterioration.

2. Use straight edge ① and thickness gauge ② to check distortion of cylinder head in the directions shown. Replace if the distortion is over specified value.

Cylinder Head Distortion Amount : 0.05 mm (0.0020 in) or less
Functional Limit : 0.10 mm (0.004 in)

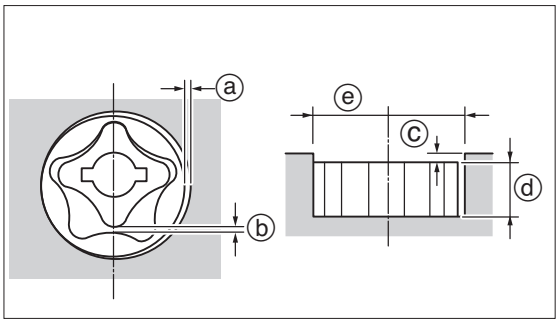


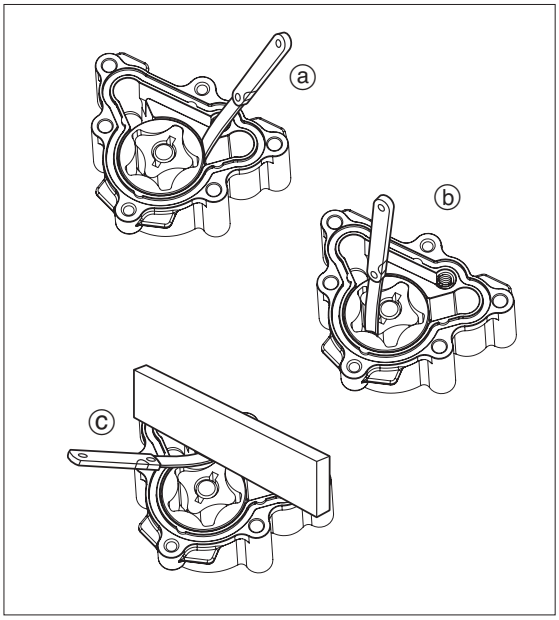


17) Inspection of Oil Pump

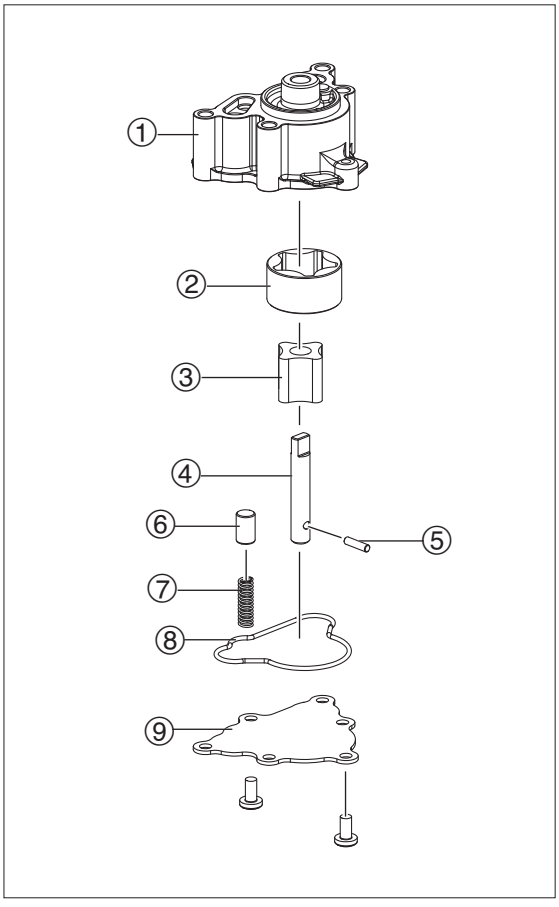
1. Use micrometer, cylinder gauge, depth gauge and thickness gauge to measure dimensions shown below. Replace oil pump if over specified value.

Functional Limit :
Clearance between Outer Rotor and Body ⓐ :
0.25 mm (0.0098 in)
Clearance between outer and inner rotors ⓑ :
0.16 mm (0.0063 in)
Clearance between sides of rotor and body ⓒ :
0.11 mm (0.0043 in) (including wear of oil pump cover)
Height of Outer Rotor ⓓ :
14.96 mm (0.5890 in)
Pump Body Inner Diameter ⓔ :
40.8 mm (1.605 in)





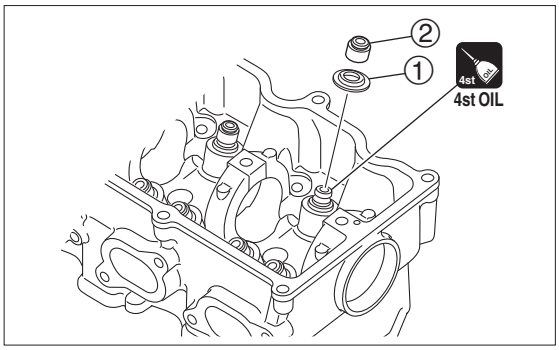
① Pump body
② Outer rotor
③ Inner rotor
④ Shaft
⑤ Pin
⑥ Plunger piston
⑦ Plunger spring
⑧ Gasket
⑨ Oil pump cover



5

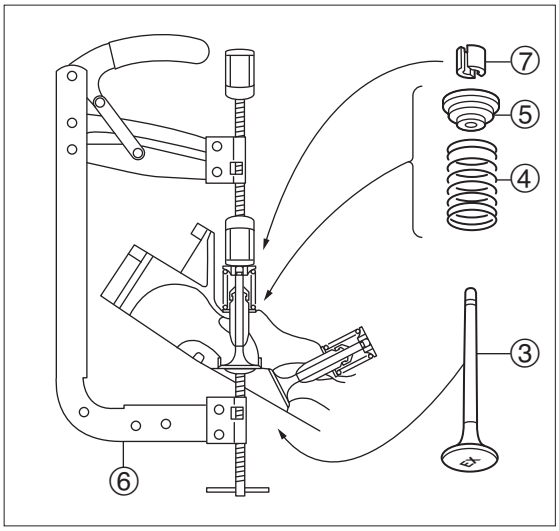
18) Installation of Valves

1. Install valve spring seat ①, and then apply oil to valve guide and attach new valve stem seal ②.



Intake Side : Black
Exhaust Side : Green

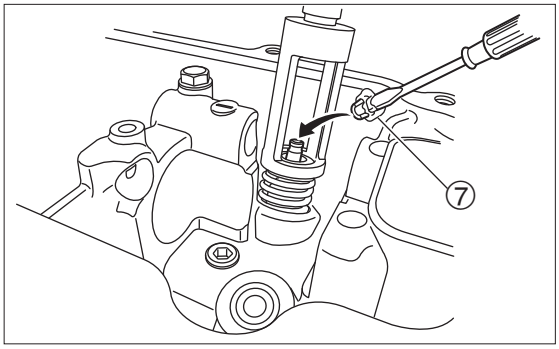
2. Install valve ③, valve spring ④ and retainer ⑤ in the order shown, and then, attach valve spring compressor ⑥.



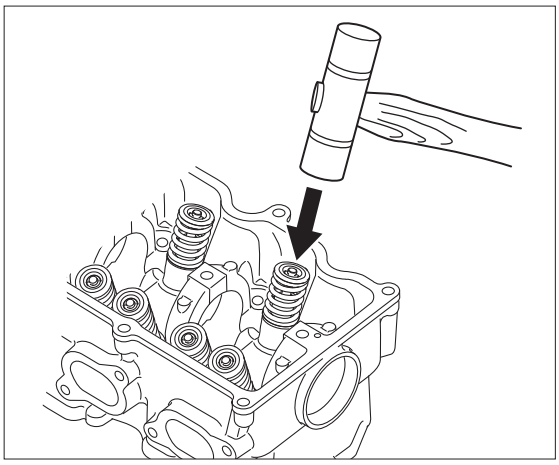
Valve Spring Compressor ⑥ :
Commercially available item

Install the valve spring so that the painted side is facing upward.

3. With valve spring ④ being compressed, use small screw driver with small amount of grease at the tip to put cotter ⑦.



4. Tap retainer ⑤ with plastic hammer to fix cotter ⑦ securely.



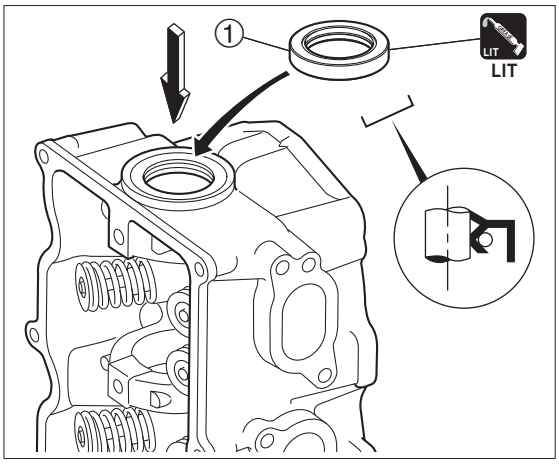
19) Installation of Cam Shaft

1. Apply engine oil to periphery of new oil seal ① and install it.

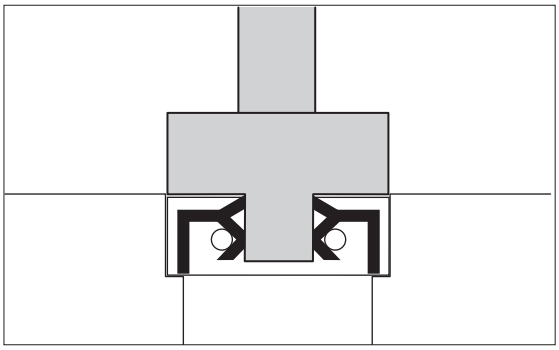
Driver Rod :
P/N. 3AC-99702-0
Oil Seal Attachment :
P/N. 3AC-99820-0

Apply grease to lip of oil seal before installing it.

LIT



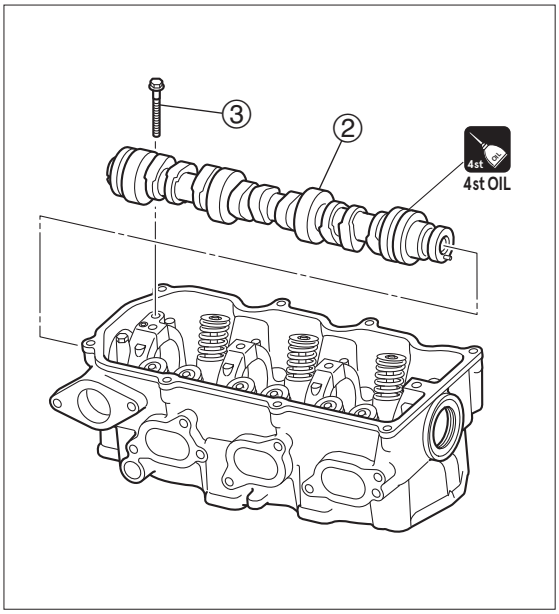
① Oil seal 50-68-9



2. Install cam shaft ② from direction shown.

3. Tighten camshaft locating bolt ③ to specified torque.

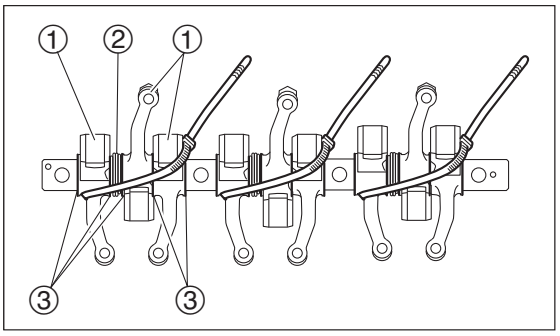
Thrust Bolt :
9 N·m (7 lb·ft) [0.9 kgf·m]



5

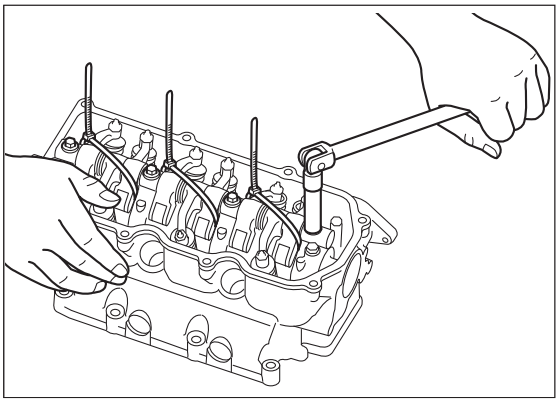
20) Installation of Rocker Arm Shaft

1. Install rocker arms ①, springs ② and, washers ③ from lower side of cylinder head while installing rocker arm shaft.



> It is easy to assemble and kept together each rocker arm with tie wraps.

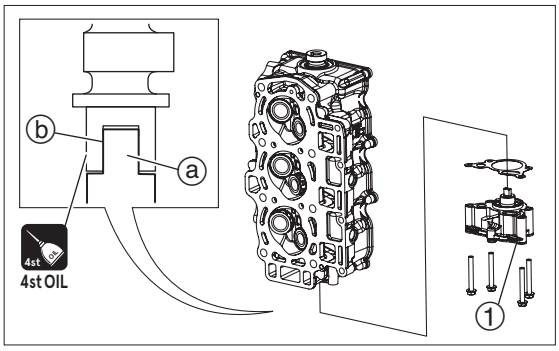
2. Tighten rocker arm shaft locating bolts in two steps to specified torque.



Rocker Arm Shaft Bolt :
First Tightening Torque : 15 N·m (11 lb·ft) [1.5 kgf·m]
Final Tightening Torque : 30 N·m (22 lb·ft) [3.0 kgf·m]

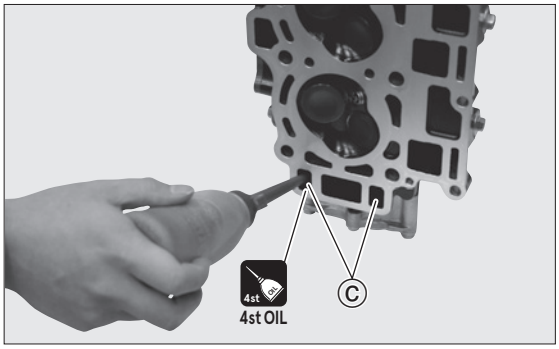
21) Installation of Oil Pump

1. Align pin of oil pump drive shaft ⓐ and cam shaft cut ⓑ with each other to install oil pump ①.

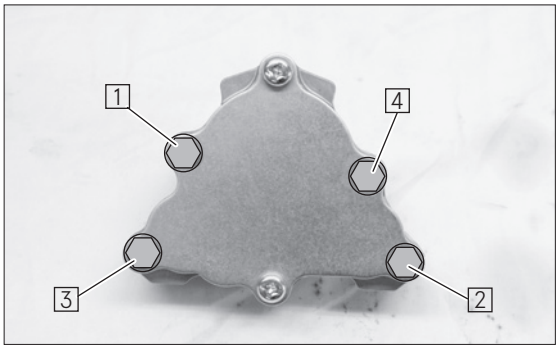


2. Apply engine oil approx. 2 ml to the oil pump from the cylinder head holes ⓒ.

3. Secure oil pump using four M6 bolts by tightening them to specified torque in the order specified below.
Bolt tightening order : 1 → 2 → 3 → 4



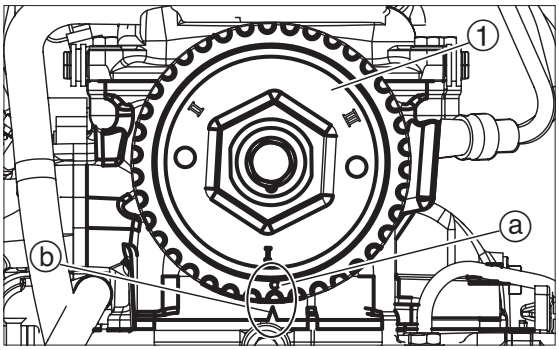
Oil Pump Bolts :
8 N·m (6 lb·ft)[0.8 kg·m]



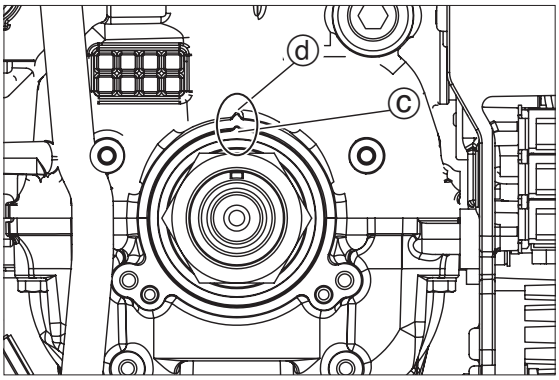
22) Installation of Cylinder Head

No.1 piston is to be at top dead center of compression stroke.

1. After installing cam shaft pulley, bring " ●I " mark ⓐ of pulley ① to "▲" mark ⓑ of cylinder head.



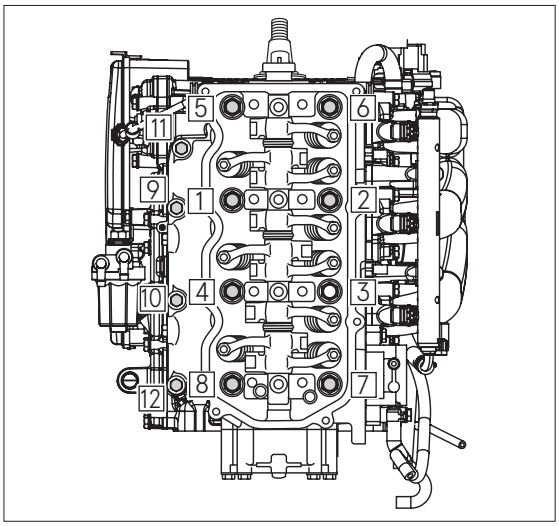
2. Check that "▲" mark ⓒ of belt guide and "▲" mark ⓓ of cylinder block are aligned with each other.



3. Install cylinder head with new gasket, and tighten bolts in the order shown in two steps to specified torque.

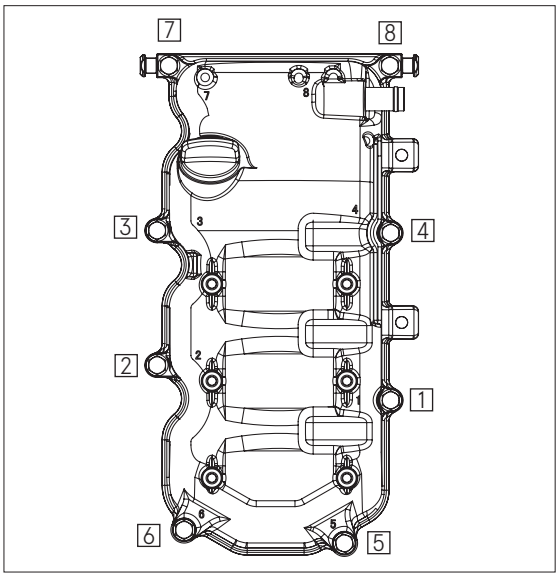
⚠ CAUTION

- **Do not reuse cylinder head gasket. Be sure to replace with new one.**
- **Do not turn timing pulley or cam shaft pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, resulting in damages to these parts.**



- First, tighten M10 bolts in two steps to specified torque. Then, tighten M8 bolts in two steps to specified torque.
- After installing cylinder head, install timing belt and check valve clearance. For the procedure, refer to relevant sections.

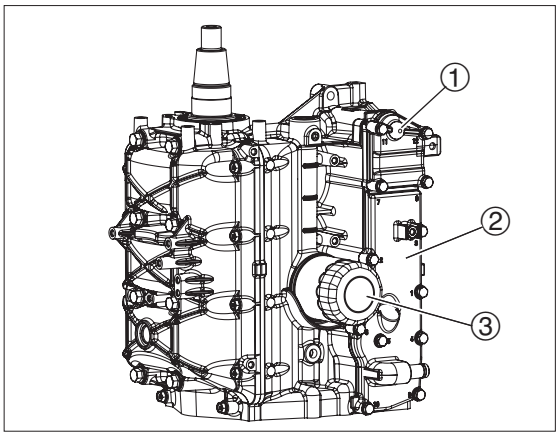
First step:
Cylinder Head Bolts (M10) 1 ~ 8
30 N·m (22 lb·ft) [3.0 kgf·m]
Cylinder Head Bolts (M8) 9 ~ 14
15 N·m (11 lb·ft) [1.5 kgf·m]
Second step:
Cylinder Head Bolts (M10) 1 ~ 8
60 N·m (44 lb·ft) [6.0 kgf·m]
Cylinder Head Bolts (M8) 9 ~ 14
30 N·m (22 lb·ft) [3.0 kgf·m]



4. Install cylinder head cover, and tighten them.

23) Disassembly of Cylinder Block

1. Remove thermostat cover bolt and the cover ① and exhaust cover ②.

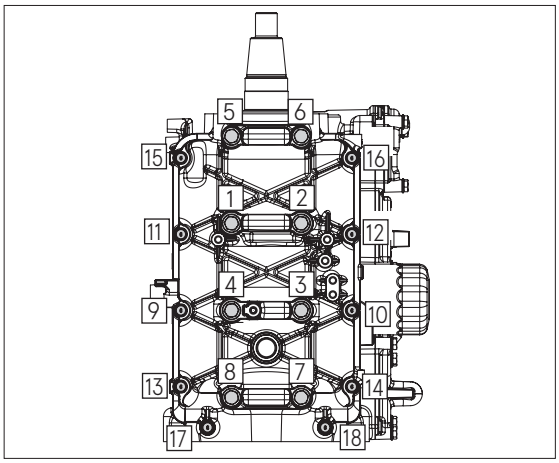


2. Remove oil filter ③.

Wipe off spilled oil completely.

Oil Filter Wrench :
P/N. 3AC-99090-0

3. Loosen crank case bolts in several steps in the reverse sequence of order shown, and remove crank case. 18 ~ 1

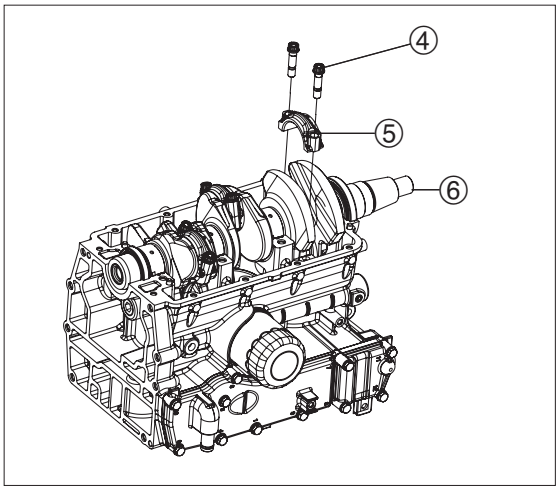


4. Remove connecting rod bolts ④ and connecting rod cap ⑤, and then, crankshaft ⑥ and oil seal.

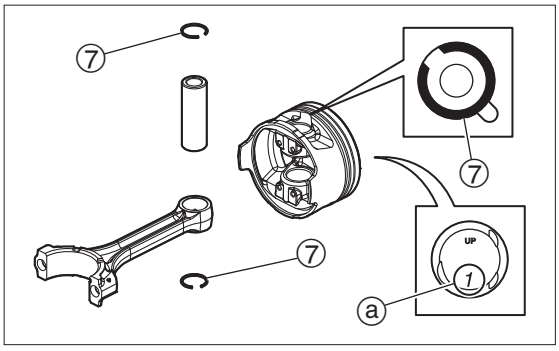
5. Remove bearings from cylinder block and crankcase.

6. Remove connecting rods and piston assemblies from cylinder block.

- Removed bearings should be arranged in the order they are removed.
- Mark individual pistons with number ⓐ corresponding to their cylinders.
- Connecting rods and caps should be arranged as pairs in the order they are removed. Removes parts should be arranged so that they can be reassembled in their original positions and orientations.
- Do not reuse piston pin clips. Be sure to replace with new ones.



7. Remove piston pin clips ⑦ and piston pin, and then, piston.



⑦ piston pin clips **Do not reuse.**

24) Removing of Drive Pulley

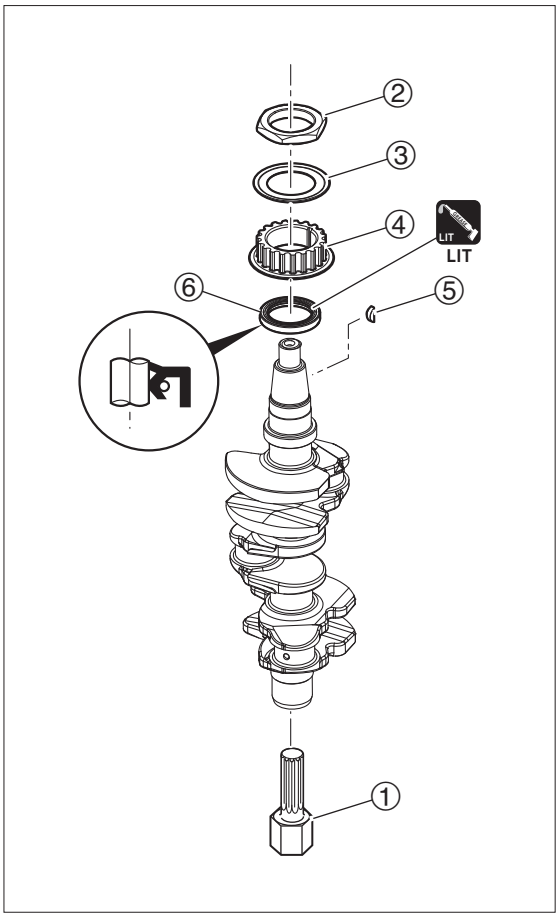
1. Secure crankshaft holder ① with vice, and then insert crankshaft.

Crankshaft Holder ① :
P/N. 3KY-72815-0

It may help to heat the nut with a small torch to be able to remove easier. Also, many front wheel drive auto sockets work well for removal/ installation drive belt pulley nuts.

2. Loosen drive pulley nut ②, use socket wrench (50 mm).

3. Remove drive pulley nut ②, belt guide ③, drive pulley ④, key ⑤ and oil seal ⑥.



25) Installing of Drive Pulley

1. Secure crankshaft holder ① with vise, and then insert crankshaft.

Crankshaft Holder ① :
P/N. 3KY-72815-0

2. Apply Lithium grease to oil seal lip and install oil seal ⑥.

3. Install key ⑤, drive pulley ④, belt guide ③ and drive pulley nut ②.

4. Tighten drive pulley nut ② to specified torque, use socket wrench (50 mm).

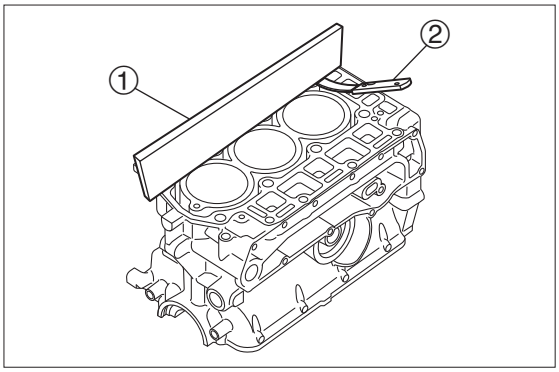
Drive Pulley Nut ② :
120 N·m (88 lb·ft)[12 kg·m]

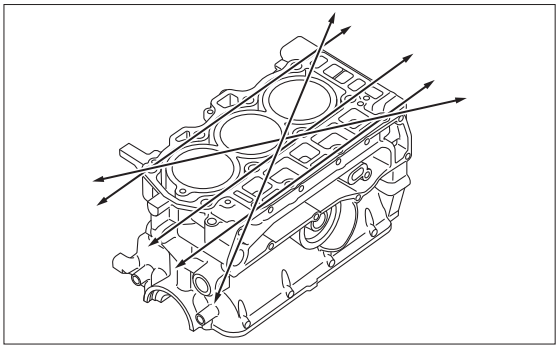
26) Inspection of Cylinder

1. Use straight edge ① and thickness gauge ② to check distortion of cylinder in the directions shown. Replace if the distortion is over specified value.

Cylinder Distortion Amount :
0.05 mm (0.0020 in) or less

Functional Limit :
0.10 mm (0.004 in)





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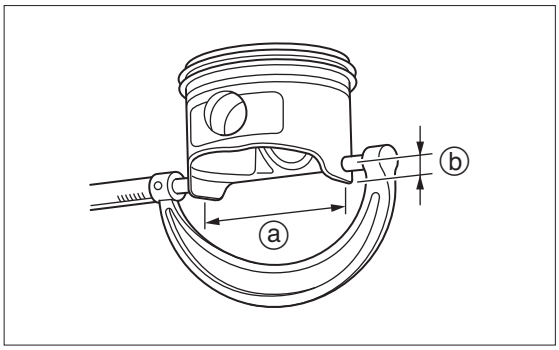
27) Inspection of Piston Outer Diameter

1. Measure piston outer diameter between points specified. Replace if the diameter is less than specified value.

Piston Outer Diameter ⓐ : Standard Value
69.97 mm (2.7547 in)
Measurement Points ⓑ :
9 mm (0.35 in) above piston skirt bottom

Functional Limit :
69.90 mm (2.7520 in)



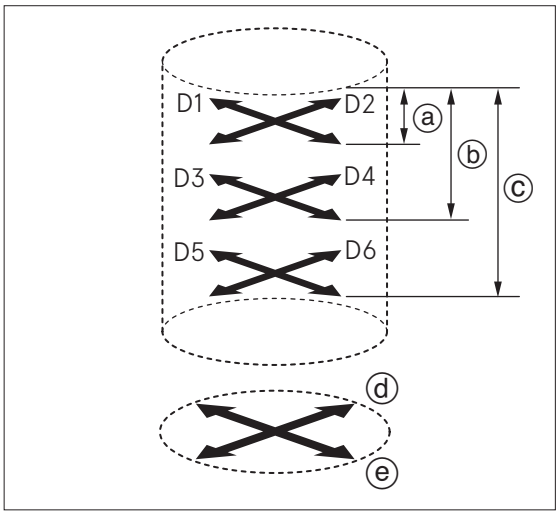
28) Inspection of Cylinder Inner Diameter

1. Measure cylinder inner diameters (D1 to D6) at ⓐ, ⓑ and ⓒ in crankshaft directions ⓓ (D1, D3 and D5 respectively), and in crank web directions ⓔ (D2, D4 and D6 respectively).

Cylinder Inner Diameters (D1 to D6) : Standard Value
70.00 mm (2.7559 in)

Functional Limit :
Replace if over 70.06 mm (2.7583 in).

Note : Measure at the maximum wear points.



ⓐ 15 mm (0.6 in)
ⓑ 35 mm (1.4 in)
ⓒ 55 mm (2.2 in)

2. Obtain taper through calculation described below. Replace cylinder block if taper is over specified value.

Taper :
D1–D5 (Measurement Point ⓐ)
D2–D6 (Measurement Point ⓒ)

Functional Limit :
0.06 mm (0.0024 in)

3. Obtain out-of-roundness through calculation described below. Replace cylinder block if out-of-roundness is over specified value.

Out-of-roundness :
D2–D1 (Direction ⓓ)
D6–D5 (Direction ⓔ)

Functional Limit :
0.06 mm (0.0024 in)

29) Inspection of Piston Clearance

1. If piston clearance is over specified limit, replace cylinder block, piston and piston rings as a set, or both.

Piston Clearance (Cylinder inside diameter – Piston outside diameter):
0.020 to 0.055 mm (0.00079 to 0.00217 in)

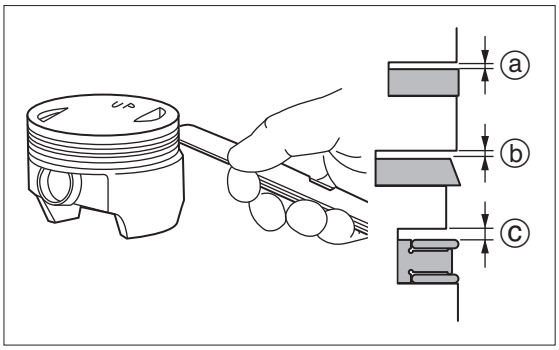
Functional Limit :
0.150 mm (0.00591 in)

30) Inspection of Piston Ring Side Clearance

1. Measure piston side clearance. Replace piston and piston rings as a set if the clearance is over specified value.

Piston Side Clearance :
Top Ring ⓐ : 0.04 to 0.08 mm (0.0016 to 0.0031 in)
Second Ring ⓑ : 0.01 to 0.05 mm (0.0004 to 0.0020 in)
Oil Ring ⓒ : 0.03 to 0.13 mm (0.0012 to 0.0051 in)

Functional Limit :
Top Ring ⓐ : 0.10 mm (0.0039 in)
Second Ring ⓑ : 0.07 mm (0.0028 in)
Oil Ring ⓒ : 0.15 mm (0.0059 in)



31) Inspection of Piston Rings

1 Push piston ring ① into ring gauge 70.000 mm (2.75591 in) parallel to top edge. Measure at the top or bottom of cylinder bore with no wear.

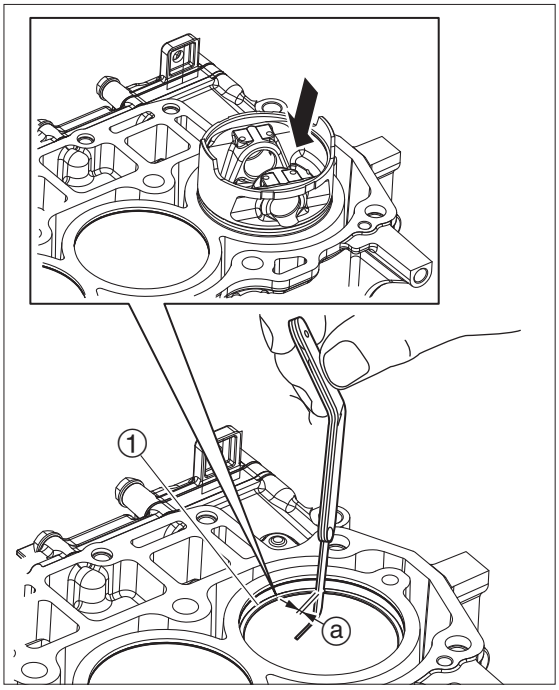
2. When ring gauge is not available, use piston crown to push piston ring ① into to cylinder.

3. Measure piston ring closed gap ⓐ. Replace if the gap is over specified value.

Piston Ring Closed Gap ⓐ :
Top Ring : 0.20 to 0.35 mm (0.0079 to 0.0138 in)
Second Ring : 0.35 to 0.50 mm (0.0138 to 0.0197 in)
Oil Ring : 0.20 to 0.70 mm (0.0079 to 0.0276 in)

Functional Limit :
Top Ring : 0.55 mm (0.0217 in)
Second Ring : 0.70 mm (0.0276 in)
Oil Ring : 1.00 mm (0.0394 in)

Replace oil ring when top ring or second ring is replaced.



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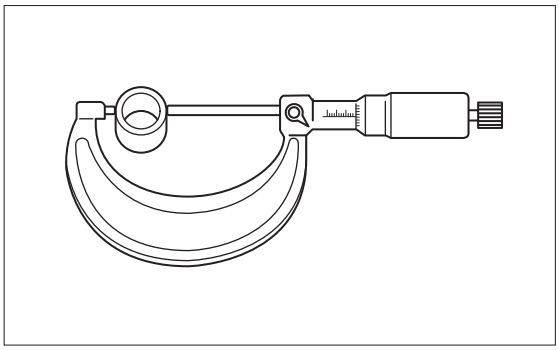
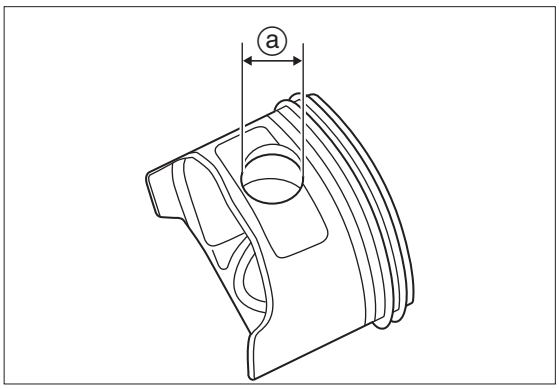
32) Inspection of Piston Pins



1. Measure piston pin outer diameter. Replace piston pin if outer diameter is less than specified value.

Piston Pin Outer Diameter : Standard Value 17.00 mm (0.6693 in)
Functional Limit : 16.970 mm (0.66811 in)



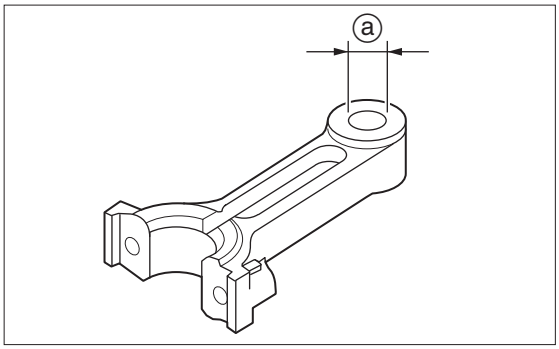
2. Measure piston pin inner diameter ⓐ. Replace piston pin if the inner diameter is over specified value.

Piston Pin Inner Diameter ⓐ : Standard Value 17.005 mm (0.66949 in)
Functional Limit : 17.012 mm (0.66976 in)

3. Obtain clearance between piston pin and pin boss. Replace piston pin or piston if the clearance is over specified value.

Clearance Between Piston Pin and Pin Boss : 0.002 to 0.012 mm (0.00008 to 0.00047 in)
Functional Limit : 0.040 mm (0.00157 in)

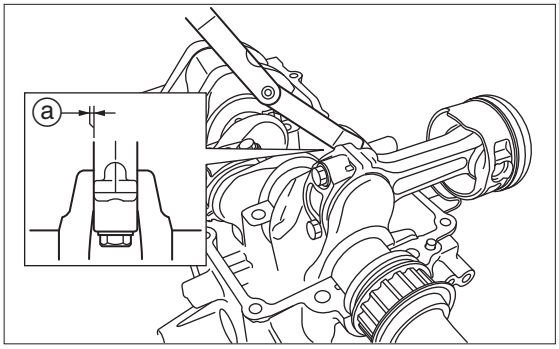
33) Inspection of Connecting Rod Small End Inner Diameter



1. Measure connecting rod small end inner diameter ⓐ. Replace connecting rod if the diameter is over specified value.

Connecting Rod Small End Inner Diameter ⓐ : Standard Value 17.012 mm (0.66976 in)
Functional Limit : 17.040 mm (0.6709 in)

34) Inspection of Connecting Rod Big End Side Clearance



1. Measure connecting rod big end side clearance ⓐ. Replace connecting rod and/or crankshaft if the clearance is over specified value.

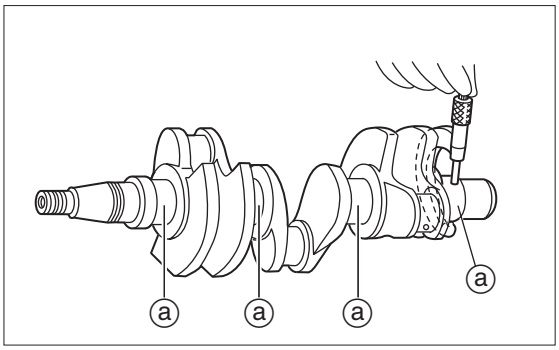
Connecting Rod Big End Side Clearance ⓐ : 0.10 to 0.20 mm (0.0039 to 0.0079 in)
Functional Limit : 0.30 mm (0.0118 in)

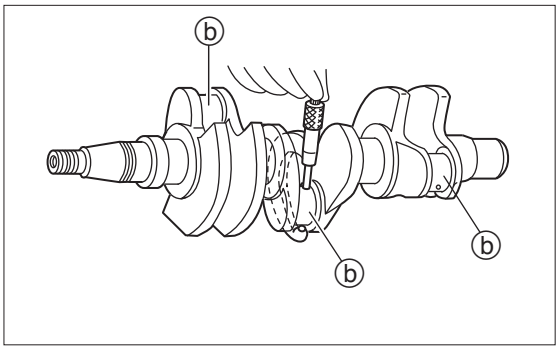
35) Inspection of Crankshaft

1. Measure crankshaft journal outer diameter ⓐ and crank pin outer diameter ⓑ. Replace crankshaft if either outer diameter is less than specified value.

Crankshaft Journal Outer Diameter ⓐ : Standard Value
39.99 mm (1.5744 in)
Crank Pin Outer Diameter ⓑ : Standard Value
37.99 mm (1.4957 in)

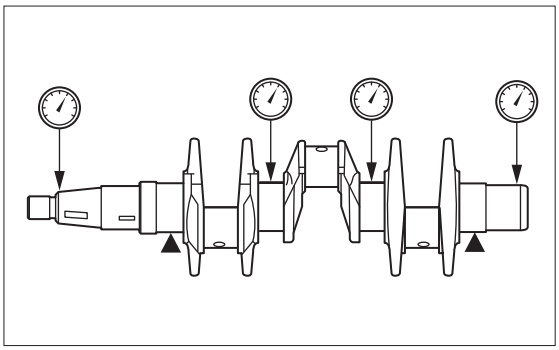
Functional Limit :
Crankshaft Journal Outer Diameter ⓐ :
Replace if ⓐ is less than 39.97 mm (1.5736 in).
Crank Pin Outer Diameter ⓑ :
Replace if ⓑ is less than 37.97 mm (1.4949 in).





2. Measure crankshaft runout. Replace crankshaft if runout is over specified value.

Crankshaft Runout Limit :
0.05 mm (0.0020 in)



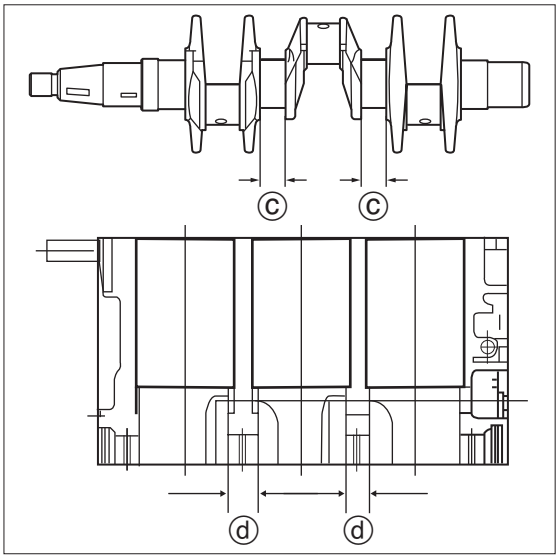
3. Side Clearance

Side Clearance :
0.05 to 0.15 mm (0.0020 to 0.0059 in)

Functional Limit :
0.50 mm (0.0197 in)

If side clearance is out of specified range, measure crank case (cylinder side) width ⓓ and crankshaft width ⓒ, and replace the part of which width is out of specified range.

Crankshaft Width ⓒ : Standard Value
24.05 to 24.10 mm (0.9468 to 0.9488 in)
Crank Case Width ⓓ : Standard Value
23.95 to 24.00 mm (0.9429 to 0.9449 in)



36) Inspection of Crank Pin (rod journal) Oil Clearance

1. Clean connecting rod and metal bearing, and then install metal bearing.

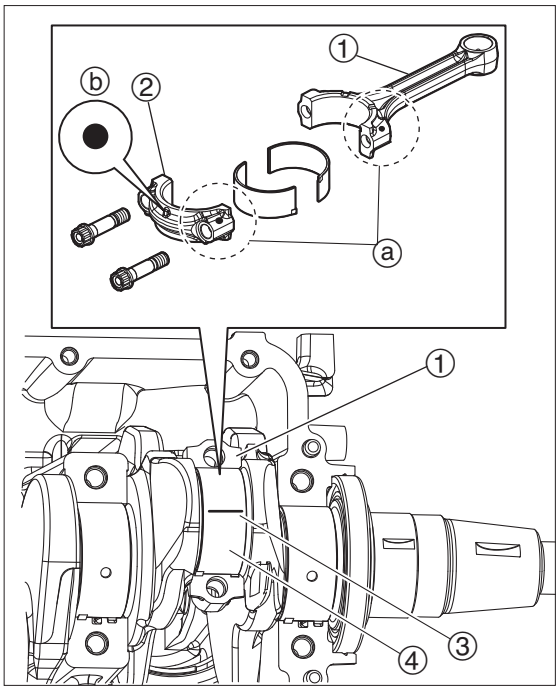
2. Place cylinder block upside down on the work bench. Install piston to connecting rod ①.

   Do not attach piston rings.

3. Install crankshaft on the cylinder block.

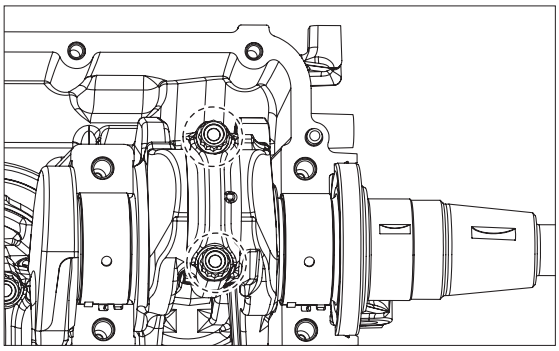
4. Place plasti-gauge ③ on each crank pin ④ parallel to crankshaft.

   Do not place plasti-gauge ③ on the oil hole of crank pin ④.



5. Install connecting rod and cap ② to crank pin ④.

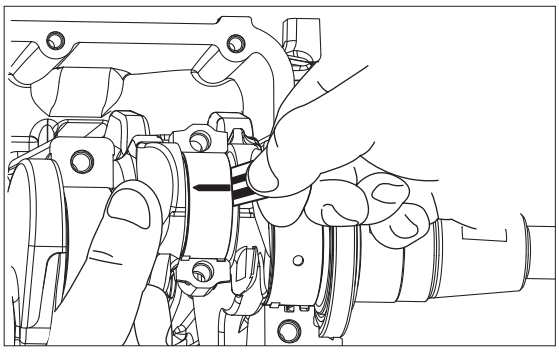
   - Be sure that individual cap is installed to their original connecting rod. (ⓐ)
   - Check that "Δ" mark ⓑ of connecting rod is directed to crankshaft flywheel side.



6. Tighten connecting rod bolts in two steps to specified torque.

   Do not move connecting rod and crankshaft until oil clearance measurement is completed.

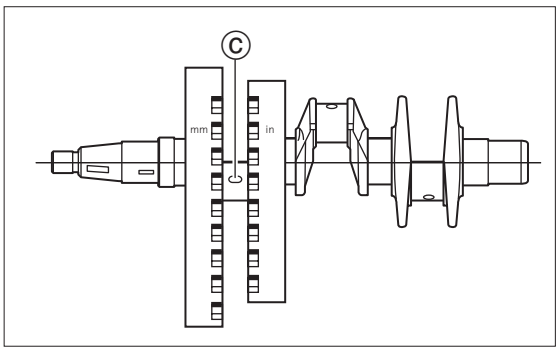
   Connecting Rod Bolts :
   First Tightening Torque : 15 N·m (11 lb·ft) [1.5 kgf·m]
   Final Tightening Torque : 30 N·m (22 lb·ft) [3.0 kgf·m]



7. Remove connecting rod cap and measure width of crushed plasti-gauge on each crank pin. Replace connecting rod or crankshaft if the width is over specified value.

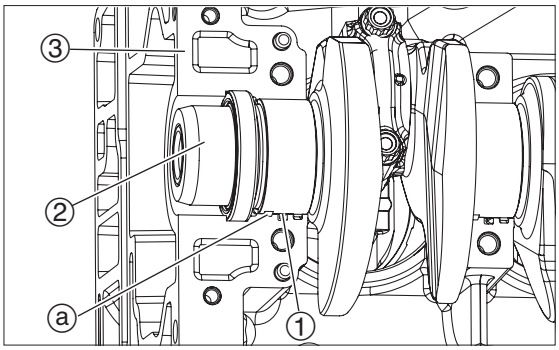
   Crank Pin Oil Clearance ⓒ :
   0.020 to 0.045 mm (0.00079 to 0.00177 in)

   Functional Limit :
   0.060 mm (0.00236 in)



ⓒ Plasti-gauge

37) Inspection of Crank Shaft Main Journal Oil Clearance

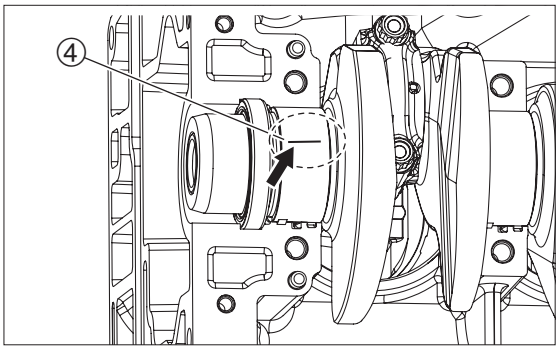


1. Clean bearings, crankshaft main journal, and bearing installation areas of crank case and cylinder block.

2. Place cylinder block on the work bench with cylinder head side facing downward.

3. Install bearing ① and crankshaft ② to cylinder block ③.

> · Be sure that individual bearings are installed to their original locations.
> · Install bearings with their projection ⓐ fit into cylinder block groove.



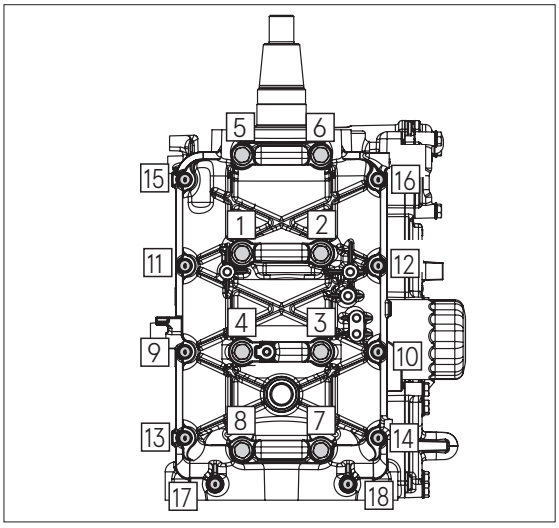
4. Place plasti-gauge ④ on each crankshaft main journal parallel to crankshaft.

> Do not place plasti-gauge on the oil hole of crankshaft main journal.

5. Install bearings to crank case.

> · Be sure that individual bearings are installed to their original locations.
> · Install bearings with their projection fit into crank case groove.

6. Install crank case to cylinder block.



7. Tighten crank case bolts in two steps to specified torque in the order shown.

> **First Tightening Torque :**
> 1 ~ 8 **: Crank Case Bolts (M8)**
> 12 N·m (9 lb·ft) [1.2 kgf·m]
> 1 ~ 8 **: Crank Case Bolts (M6)**
> 6 N·m (4.5 lb·ft) [0.6 kgf·m]
> **Final Tightening Torque :**
> 9 ~ 18 **: Crank Case Bolts (M8)**
> 24 N·m (18 lb·ft) [2.4 kgf·m]
> 9 ~ 18 **: Crank Case Bolts (M6)**
> 11.5 N·m (8.5 lb·ft) [1.15 kgf·m]

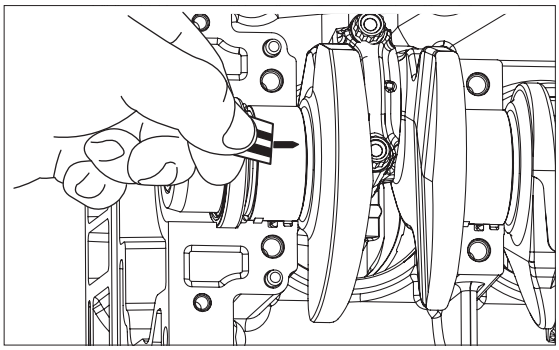
> Do not move crankshaft until oil clearance measurement is completed.

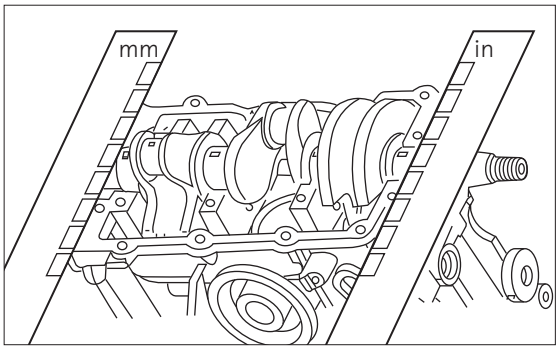
8. Loosen bolts in reverse order in several steps. Remove crank case and measure width of crushed plasti-gauge on each main journal. Replace bearing if the width is over specified value.

Crankshaft Main Journal Oil Clearance :
0.020 to 0.041 mm (0.00079 to 0.00161 in)

Functional Limit :
0.060 mm (0.00236 in)

If the clearance is less than specified value, check that inner diameter code is as shown below.





38) Selecting of Cylinder/Crankcase Metal Bearing

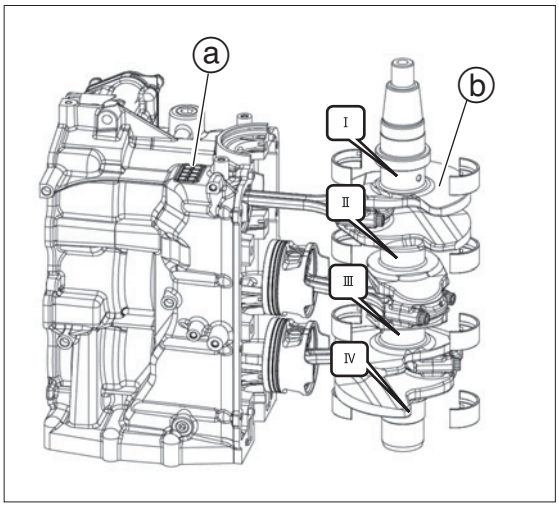
1 Check that metal bearing inner diameter code ⓐ and crankshaft journal outside diameter code ⓑ as shown below chart.

Marked on cylinder upper section with inner diameter code ⓐ that indicates inner diameter of each bearing holder. There are three types of bearing in accordance with inner diameter code.

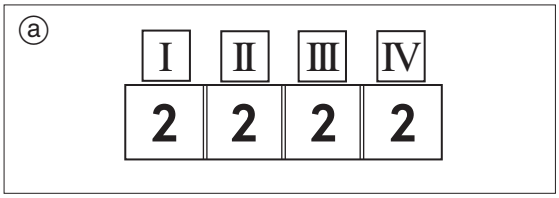
Code	Inner Diameter
1	44.000 to 44.004 mm (1.73228 to 1.73244 in)
2	44.005 to 44.009 mm (1.73248 to 1.73263 in)
3	44.010 to 44.014 mm (1.73267 to 1.73283 in)

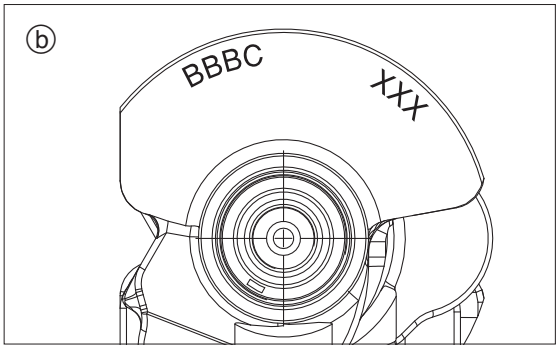
And, crankshaft is marked on its upper section with outer diameter code ⓑ that indicates outer diameter of each crankshaft journal.

Code	Outer Diameter
A	39.996 to 40.000 mm (1.57464 to 1.57480 in)
B	39.971 to 39.975 mm (1.57444 to 1.57460 in)
C	39.986 to 39.990 mm (1.57425 to 1.57441 in)



ⓐ Inner Diameter Code ⓑ Outer Diameter Code





2. Check that matching chart of crank journal metal bearing code as shown below chart, and then select crank journal metal bearing.

Code	1	2	3
A	Brown	Brown	Black
B	Brown	Black	Black
C	Black	Black	Blue

Crank journal metal bearing thickness

Parts No.	Color	Thickness
3KY-07707-0	Brown	1.996 to 2.000 mm (0.07858 to 0.07874 in)
3KY-07708-0	Black	2.000 to 2.005 mm (0.07874 to 0.07894 in)
3KY-07750-0	Blue	2.005 to 2.010 mm (0.07894 to 0.07913 in)

39) Selecting of Connecting Rod Metal Bearing

1 Check that connecting rod metal inner diameter code ⓐ and crank pin outside diameter code ⓑ as shown right illustration.

Marked on mating position of each connecting rod and connecting rod cap with inner diameter code ⓐ that indicates inner diameter. There are three types of bearing in accordance with inner diameter code.

Code	Inner Diameter
1	41.000 to 41.006 mm (1.61417 to 1.61441 in)
2	41.007 to 41.012 mm (1.61445 to 1.61464 in)
3	41.013 to 41.018 mm (1.61468 to 1.61488 in)

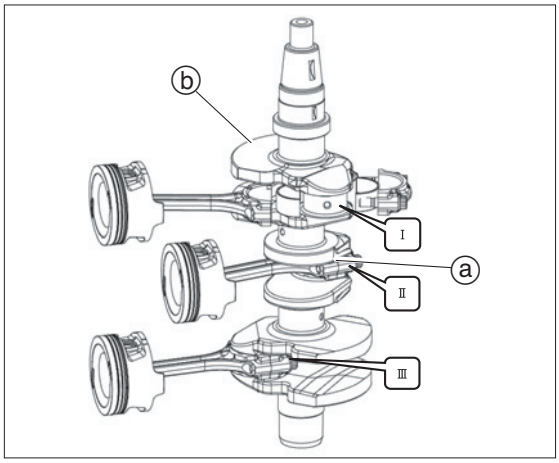
The code is not means cylinder No..

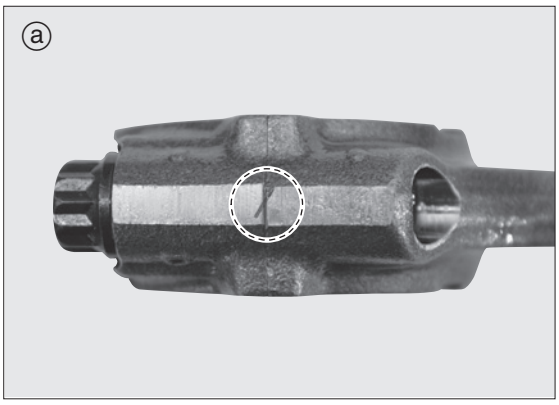
And, marked on crankshaft upper section with outer diameter code ⓑ that indicates outer diameter of each crank pin.

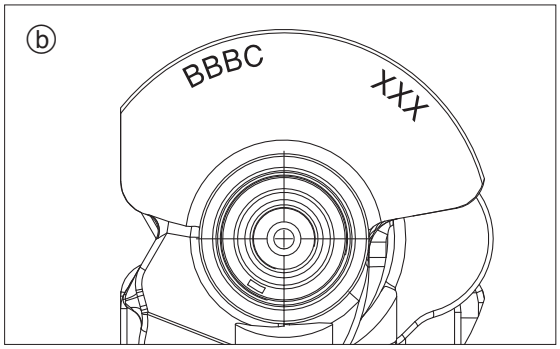
Code	Outer Diameter
X	37.996 to 38.000 mm (1.49590 to 1.49606 in)
Y	37.991 to 37.995 mm (1.49571 to 1.49586 in)
Z	37.986 to 37.790 mm (1.49551 to 1.49567 in)

2. Check that matching chart of connecting rod metal bearing code as shown below chart, and then select connecting rod metal bearing.

Code	1	2	3
X	Brown	Brown	Black
Y	Brown	Black	Black
Z	Black	Black	Blue





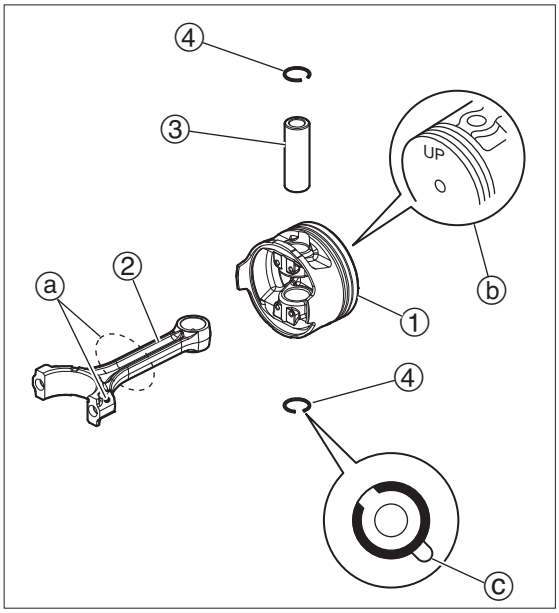


Connecting rod metal bearing thickness

Parts No.	Color	Thickness
3KY-00080-0	Brown	1.491 to 1.495 mm (0.05870 to 0.05886 in)
3KY-00081-0	Black	1.495 to 1.500 mm (0.05886 to 0.05906 in)
3KY-00082-0	Blue	1.500 to 1.505 mm (0.05906 to 0.05925 in)

40) Assembling Piston and Connecting Rod

1. Install connecting rod ②, piston pin ③, and piston pin clips ④ to piston ①.

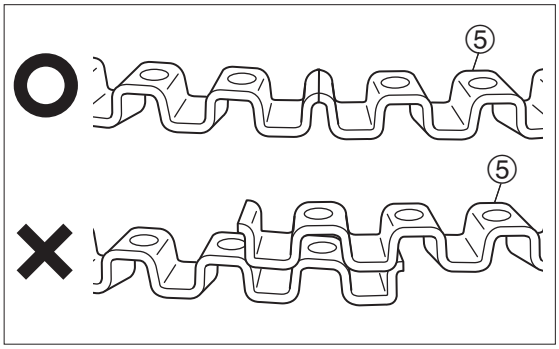


- Point "Δ" mark of connecting rod ⓐ and "UP" mark ⓑ of piston at the same direction.
- Be sure to use new piston pin clip, and place clip gap away from piston pin groove ⓒ as shown.
- Be sure that individual connecting rod cap is installed to their original connecting rod.

2. Put expander ⑤ (#4) into oil ring groove, and check that ring ends meets correctly as shown.

3. While holding expander ⑤ (#4) gap with thumb, put upper side rail (#3) into the groove so that the gap is away from gap of expander ⑤ (#4) to the left by 90 degrees.

4. In similar way, put lower side rail (#5) into the groove so that the gap is away from gap of expander ⑤ (#4) to the right by 90 degrees.

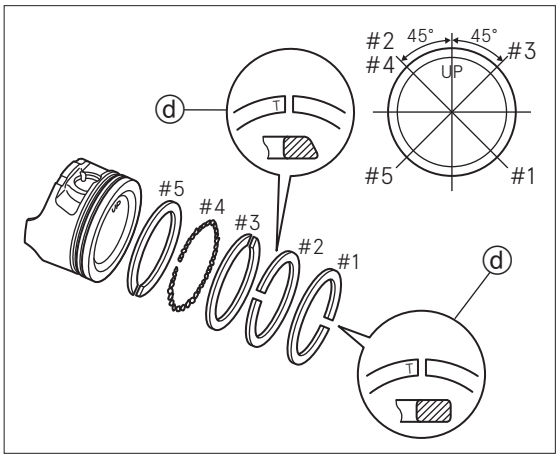


5. Install second ring (#2 taper) and top ring (#1) to piston. Install the rings so that their side with manufacturer's identification ⓓ (T) faces upward.

6. Install piston ring so that their gaps are away from each other.

⚠ CAUTION

Be careful not to scratch piston surface and damage rings.

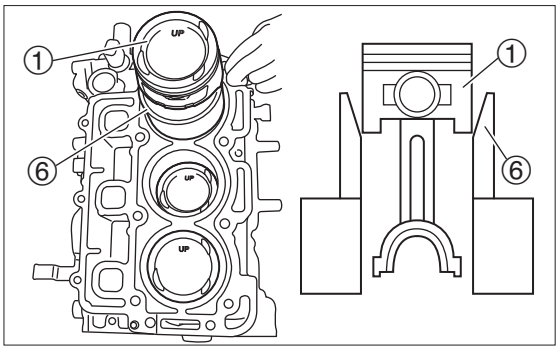


- Install piston rings so that their gaps are away also from thrust direction of piston and direction piston pin.
- After installing piston rings, check that they move smoothly.

7. Put pistons into cylinder with piston ① "UP" mark directing flywheel side and piston slider ⑥ set on the pistons.

Before installing, apply engine oil to piston peripheral surfaces, piston rings and piston sliders.

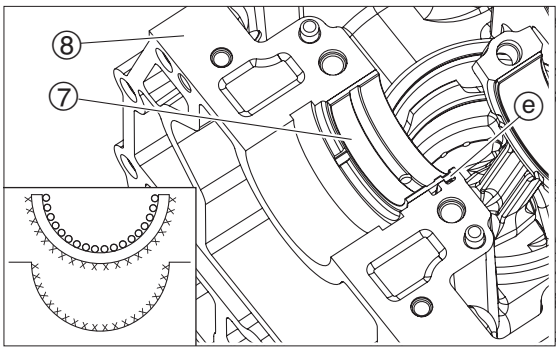
Piston Slider ⑥ :
P/N. 3KY-72871-0



8. Clean and remove grease on bearing holder of crank case (x).

9. Install bearing half ⑦ to cylinder block ⑧ and connecting rod.

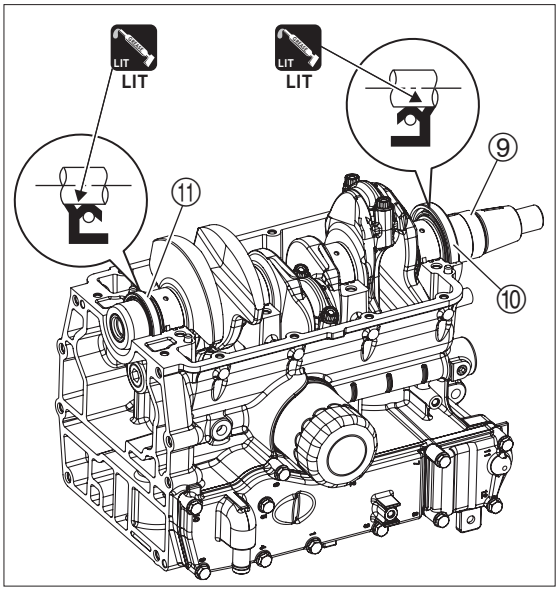
- Be sure that individual bearings are installed to their original locations.
- Install bearings with their projection ⓔ fit into cylinder block groove.



10. Apply engine oil to bearings and crankshaft (o).

11. Install crankshaft ⑨ and oil seals ⑩ and ⑪ on the cylinder block.

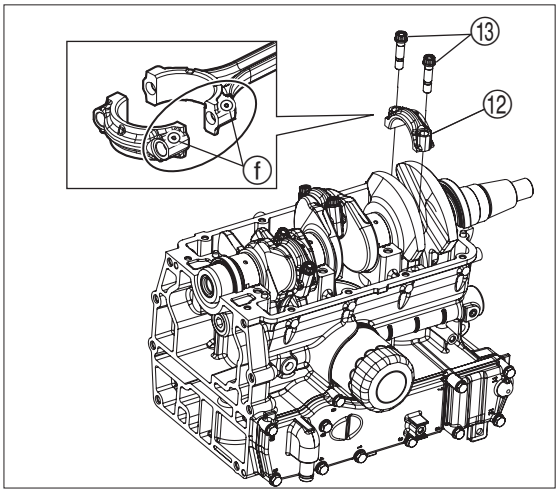
- Apply grease to lip of oil seal before installing it.
- Be sure that individual connecting rod cap is installed to their original connecting rod.



12. Attach connecting rod cap ⑫ with metal bearing to connecting rod, and tighten connecting rod bolts ⑬ in two steps to specified torque.

- Lubricate connecting rod journals and connecting rod bearings.
- Align mating marks ⓕ of connection rod cap and connecting rod with each other.

Connecting Rod Bolts ⑬ :
First Tightening Torque : 15 N·m (11 lb·ft) [1.5 kgf·m]
Final Tightening Torque : 30 N·m (22 lb·ft) [3.0 kgf·m]



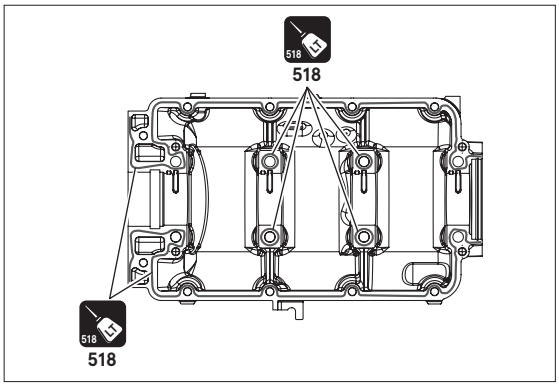
13. Install bearing half to crank case.

- Be sure that individual bearings are installed to their original locations.
- Install bearings with their projection fit into crank case groove.
- Remove grease from surface of crankcase and outside of bearing half.

14. Apply 4 stroke engine oil to bearings.

15. Apply sealing agent to mating surface of crank case (halves).

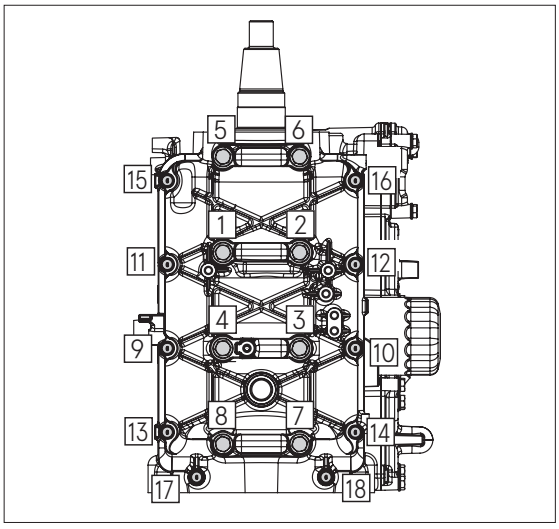
- Degrease mating surfaces of cylinder and crank case.
- Be careful not to allow sealing agent to adhere to bearing.
- Apply Loctite 518 to mating surfaces of crankcase halves, taking care that no excessive agent protrudes.
- Be sure apply Loctite 518 constantly and to be approximately 2 mm width.



16. Install crank case to cylinder block.

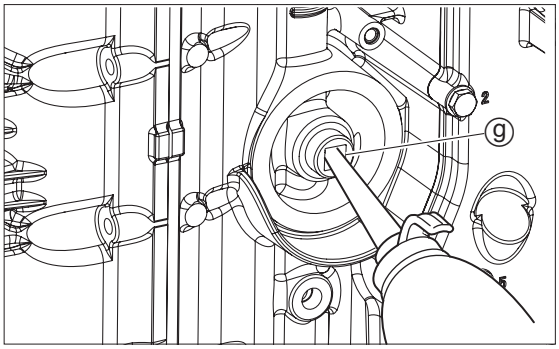
17. Tighten crank case M8 bolts, and then tighten M6 bolts to first specified torque in the order shown. Then tighten final specified torque.

First Tightening Torque :
1 ~ 8 : Crank Case Bolts (M8)
12 N·m (9 lb·ft) [1.2 kgf·m]
1 ~ 8 : Crank Case Bolts (M6)
6 N·m (4.5 lb·ft) [0.6 kgf·m]
Final Tightening Torque :
9 ~ 18 : Crank Case Bolts (M8)
24 N·m (18 lb·ft) [2.4 kgf·m]
9 ~ 18 : Crank Case Bolts (M6)
11.5 N·m (8.5 lb·ft) [1.15 kgf·m]



Make no forced assemblies. After tightening crankcase use flywheel nut to turn crankshaft to check for crankshaft rotate smoothly.

18. Put some engine oil into oil passage ⓖ of oil filter bolt before installing oil filter.

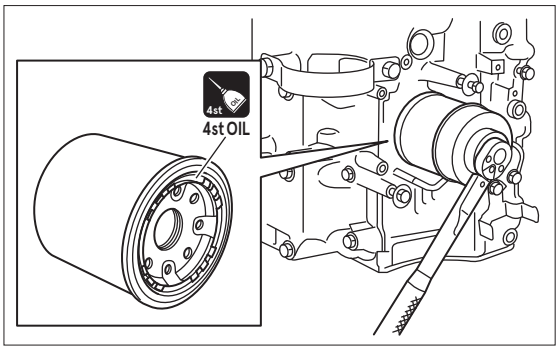


19. Install oil filter and tighten it to specified torque by using oil filter wrench.

Apply thin coat of engine oil to O-ring before installing oil filter.

Oil Filter Wrench :
P/N. 3AC-99090-0

Oil Filter :
18 N·m (13 lb·ft) [1.8 kgf·m]

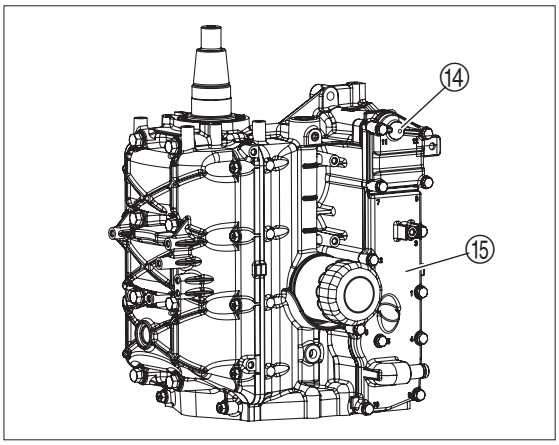


20. Install thermostat, new gasket, thermostat cover ⑭ and exhaust cover ⑮.

Exhaust cover Bolt :
6 N·m (5 lb·ft) [0.6 kgf·m]

21. Install cylinder head.

For installation procedure, refer to "Installation of Cylinder Head".



5

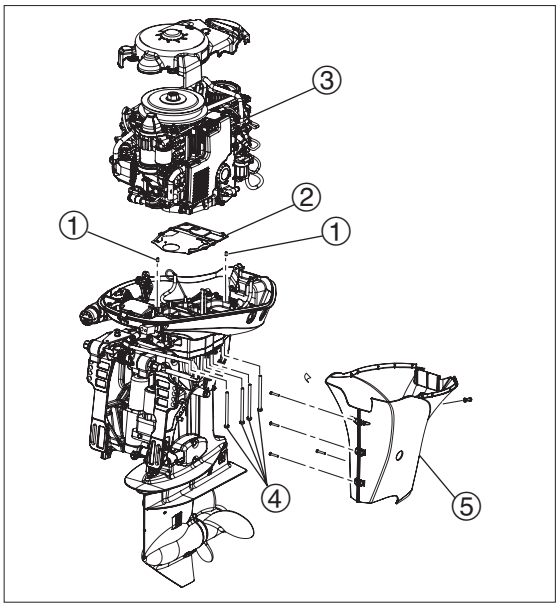
41) Installation of Power Unit

1. Clean power unit mating surface, and install dowel pin ① and gasket ②.

2. Install power unit ③, and tighten bolts ④ in two or three steps to specified torque.

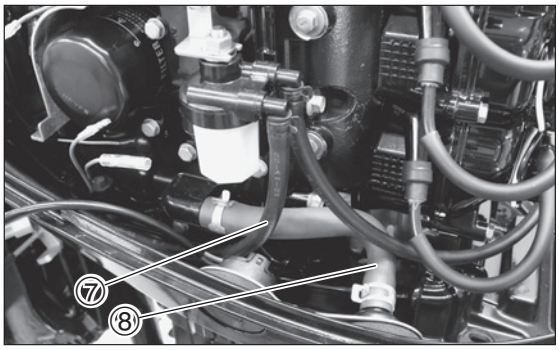
Power Unit Installation Bolt :
First Tightening Torque : 15 N·m (11 lb·ft) [1.5 kgf·m]
Final Tightening Torque : 30 N·m (22 lb·ft) [3.0 kgf·m]

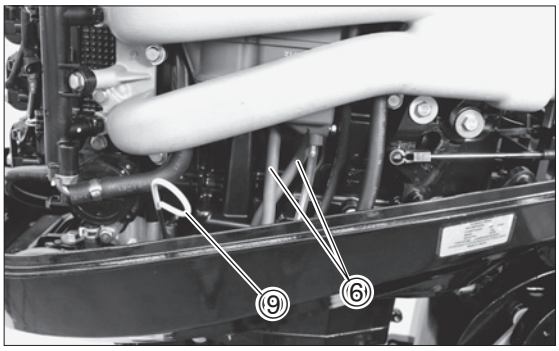
3. Install apron ⑤.



4. Reconnect cooling water (fuel cooler) hoses ⑥, fuel hose ⑦ and flushing hose ⑧.

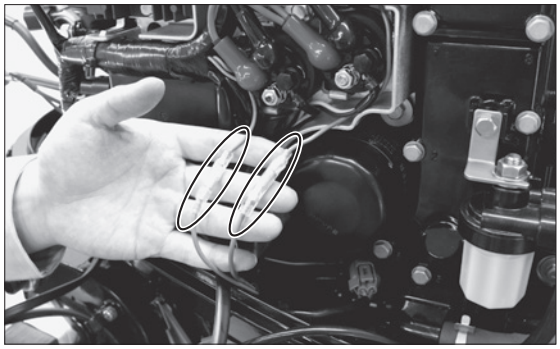
5. Install oil level gauge ⑨.





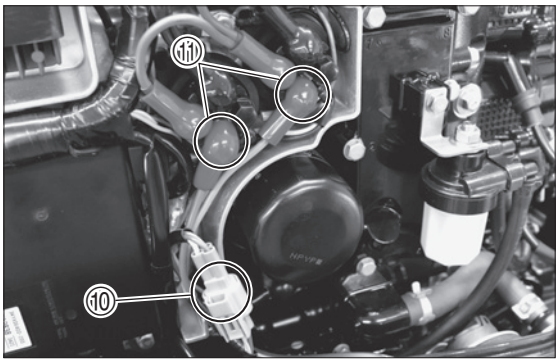
6. Apply grease to sliding parts such as links and cables and install pin to hold cable joint.

7. Connect neutral switch leads.

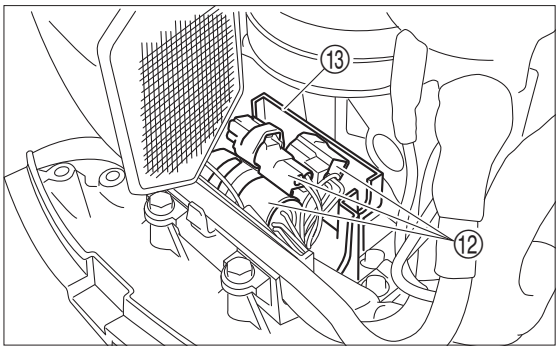


8. Install PTT switch coupler ⑩ and PTT motor leads ⑪.

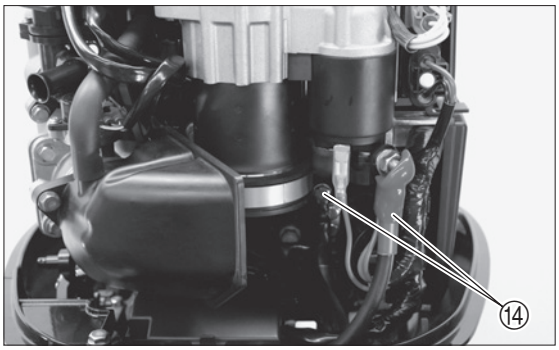
Positive Battery Cable Nut :
4 N·m (3 lb·ft) [0.4 kgf·m]
PTT Motor Lead Bolt :
4 N·m (3 lb·ft) [0.4 kgf·m]



9. Reconnect couplers ⑫ (3 pices), and then place them into cable terminal holder ⑬ and install holder cover.



10. Connect battery cables ⑭.

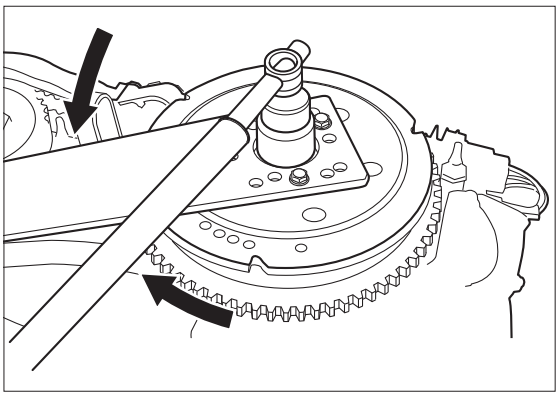


11. Install key and flywheel.

⚠ CAUTION
Apply forces to tools toward directions as shown, and perform work taking care not to allow flywheel holder to remove.

Flywheel Puller Kit :
P/N. 3T1-72211-0

Flywheel Nut :
150 N·m (108 lb·ft) [15.0 kgf·m]



12. Reinstall flywheel cover.

13. Fill with specified amount of engine oil.

Recommended Engine Oil :
4 Stroke Engine Oil
API : SH, SJ, SL
SAE : 10W-30 , 10W-40
Quantity of Engine Oil:
When oil filter is not replaced : 2.2 L
When oil filter is replaced : 2.4 L

Crank engine with lanyard removed to build oil pressure before test running the engine.

5

SERVICE MANUAL
Supplement

4 STROKE
MFS 60A

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