

## Section 6

# ENGINE



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## BEFORE YOU BEGIN SERVICING

Before performing any service procedures within this section, read the following safety information and review the *Safety* section on page 3-1.

 <b>WARNING</b>	
	
<p><b>ALWAYS</b> wear <b>SAFETY GLASSES</b> while servicing the engine to prevent possible eye injury.</p>	
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 <b>WARNING</b>	
	
<p><b>ENTANGLEMENT HAZARD!</b></p> <ul style="list-style-type: none"> <li>• <b>ALWAYS</b> stop the engine before you begin to service it.</li> <li>• <b>NEVER</b> leave the key in the key switch when you are servicing the engine. Someone may accidentally start the engine and not realize you are servicing it.</li> <li>• Failure to comply could result in death or serious injury.</li> </ul>	
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 <b>WARNING</b>	
	
<p><b>FUME / BURN HAZARD!</b></p> <ul style="list-style-type: none"> <li>• <b>ALWAYS</b> read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants and sealant removers.</li> <li>• Failure to comply could result in death or serious injury.</li> </ul>	
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 <b>CAUTION</b>	
	
<p><b>FLYING OBJECT HAZARD!</b></p> <ul style="list-style-type: none"> <li>• <b>ALWAYS</b> wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.</li> <li>• Failure to comply may result in minor or moderate injury.</li> </ul>	
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## CAUTION

- **ALWAYS** use only the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and / or shorten engine life.
- **ALWAYS** prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap / dipstick and the surrounding area before you remove the cap.
- **NEVER** mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- **NEVER** overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

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## INTRODUCTION

This section of the *Service Manual* describes the disassembly, inspection, and reassembly of the engine.

## SPECIFICATIONS

Note: All dimensions given are for standard original components. Oversize pistons and piston rings, as well as undersize bearings, are available and may have been installed some time during the life of the engine. Add the oversize or subtract the undersize from the standard dimension to measure these replacement parts. Refer to the parts catalog for the available sizes.

### Cylinder Head Assembly

#### Valve Clearance

Inspection Item	Standard	Limit	Reference Page
All Models - Intake / Exhaust	0.006 ± 0.002 in. (0.15 ± 0.05 mm)	-	See <i>Measuring and Adjusting Valve Clearance</i> on page 6-39.

#### Cylinder Head

Inspection Item				Standard	Limit	Reference Page
Combustion Surface Distortion (Flatness)				0.0020 in. (0.05 mm) or less	0.0059 in. (0.15 mm)	See <i>Cylinder Head Distortion</i> on page 6-30.
Valve Recession - All Models				0.016 - 0.032 in. (0.4 - 0.8 mm)	0.039 in. (1.0 mm)	See <i>Valve Recession</i> on page 6-28.
Valve Seat	Width	L48V	Intake / Exhaust	0.1003 in. (2.55 mm)	-	See <i>Valve Face and Valve Seat</i> on page 6-27.
		L70V, L100V	Intake / Exhaust	0.0551 in. (1.4 mm)	-	
	Angle	All	Intake / Exhaust	90°	-	

#### Intake / Exhaust Valve Seat

Inspection Item			Standard	Limit	Reference Page	
Seat Angle - All Models		Intake / Exhaust	90°	-	See <i>Valve Face and Valve Seat</i> on page 6-27.	
Seat Width	L48V		Intake / Exhaust	0.100 in. (2.55 mm)		-
	L70V, L100V		Intake / Exhaust	0.055 in. (1.40 mm)		-

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## Intake / Exhaust Valves, Guides and Seals

Inspection item		Standard	Limit	Reference Page
L48V	Intake	Guide Inside Diameter	0.2165 - 0.2171 in. (5.500 - 5.515 mm)	0.220 in. (5.58 mm)
		Valve Stem Outside Diameter	0.1757 - 0.1761 in. (5.465 - 5.475 mm)	0.213 in. (5.40 mm)
	Exhaust	Guide Inside Diameter	0.2165 - 0.2171 in. (5.500 - 5.515 mm)	0.220 in. (5.58 mm)
		Valve Stem Outside Diameter	0.1755 - 0.1761 in. (5.460 - 5.475 mm)	0.213 in. (5.40 mm)
	Seal	Installed Height	0.374 in. (9.5 mm)	-
L70V	Intake	Guide Inside Diameter	0.2362 - 0.2368 in. (6.000 - 6.015 mm)	0.239 in. (6.08 mm)
		Valve Stem Outside Diameter	0.2346 - 0.2352 in. (5.960 - 5.975 mm)	0.232 in. (5.90 mm)
	Exhaust	Guide Inside Diameter	0.2362 - 0.2368 in. (6.000 - 6.015 mm)	0.239 in. (6.08 mm)
		Valve Stem Outside Diameter	0.2342 - 0.2346 in. (5.950 - 5.960 mm)	0.232 in. (5.90 mm)
	Seal	Installed Height	0.334 in. (8.5 mm)	-
L100V	Intake	Guide Inside Diameter	0.2756 - 0.2762 in. (7.000 - 7.015 mm)	0.279 in. (7.08 mm)
		Valve Stem Outside Diameter	0.2740 - 0.2746 in. (6.960 - 6.975 mm)	0.272 in. (6.90 mm)
	Exhaust	Guide Inside Diameter	0.2756 - 0.2762 in. (7.000 - 7.015 mm)	0.279 in. (7.08 mm)
		Valve Stem Outside Diameter	0.2734 - 0.2740 in. (6.945 - 6.96 mm)	0.272 in. (6.90 mm)
	Seal	Installed Height	0.531 in. (13.5 mm)	-

*See Valves and Valve Guides on page 6-28 and Reassembly of Intake / Exhaust Valves on page 6-31.*

## Push Rod

Inspection Item		Standard	Limit	Reference Page
Push Rod Length	L48V	5.110 - 5.126 in. (129.8 - 130.2 mm)	-	-
	L70V	6.390 - 6.406 in. (162.3 - 162.7 mm)	-	-
	L100V	7.748 - 7.764 in. (196.8 - 197.2 mm)	-	-
Push Rod Bend	All Models	Less than: 0.002 in. (0.05 mm)	0.012 in. (0.3 mm)	<i>See Push Rod Bend on page 6-30.</i>

**Valve Spring**

Inspection Item		Standard	Limit	Reference Page
L48V	Free Length	1.102 in. (28.0 mm)	1.043 in. (26.5 mm)	<i>See Valve Springs on page 6-28.</i>
	Inclination	Less than: 0.295 in. (0.75 mm)	-	
	Spring Tension / mm	2.5 - 3.1 lbf (11.2 - 13.7 N, 1.14 - 1.40 kgf)	-	
L70V	Free Length	1.299 in. (33.0 mm)	1.240 in. (31.5 mm)	
	Inclination	Less than: 0.0236 (1.16 mm)	-	
	Spring Tension / mm	2.8 - 3.4 lbf (12.5 - 15.2 N, 1.27 - 1.55 kgf)	-	
L100V	Free Length	1.575 in. (42.0 mm)	1.551 in. (39.5 mm)	
	Inclination	Less than: 0.039 in. (1.0 mm)	-	
	Spring Tension (Measured compressed at minimum of 8 mm.)	4.0 - 5.5 lbf (17.7 - 24.6 N, 1.8 - 2.51 kgf)	-	

**Rocker Arm and Shaft**

Inspection Item		Standard	Limit	Reference Page
L48V, L70V	Shaft Hole Diameter	0.4730 - 0.4737 in. (12.016 - 12.034 mm)	0.47638 in. (12.10 mm)	<i>See Rocker Arms and Push Rods on page 6-29.</i>
	Shaft Outside Diameter	0.4720 - 0.4724 in. (11.989 - 12.0 mm)	0.4685 in. (11.90 mm)	
L100V	Shaft Hole Diameter	0.5918 - 0.5923 in. (15.032 - 15.045 mm)	0.59449 in. (15.10 mm)	
	Shaft Outside Diameter	0.5901 - 0.5905 in. (15.989 - 15.0 mm)	0.58661 in. (14.90 mm)	

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## Crankshaft, Balancer Shaft, Piston and Connecting Rod

### Crankshaft

Inspection Item			Standard	Limit	Reference Page	
Connecting Rod Journal	L48V	Outside Diameter	1.1797 - 1.1803 in. (29.965 - 29.982 mm)	1.1771 in. (29.90 mm)		
		Oil Clearance	0.0001 - 0.0020 in. (0.004 - 0.053 mm)	-		
	L70V	Outside Diameter	1.4159 - 1.4166 in. (35.965 - 35.982 mm)	1.4133 in. (35.90 mm)		
		Oil Clearance	0.0001 - 0.0020 in. (0.004 - 0.053 mm)	-		
	L100V	Outside Diameter	1.5734 - 1.5740 in. (39.965 - 39.982 mm)	1.5708 in. (39.90 mm)		
		Oil Clearance	0.0007 - 0.0030 in. (0.018 - 0.077 mm)	-		
Main Bearing Journal	L48V	Crankcase Cover End	Journal Outside Diameter	1.1811 - 1.1817 in. (30.002 - 30.015 mm)	1.1776 in. (29.91 mm)	See Crankshaft on page 6-48.
			Oil Clearance	0.001 - 0.002 in. (0.025 - 0.058 mm)	0.0067 in. (0.17 mm)	
		Flywheel End	Journal Outside Diameter	1.1811 - 1.1817 in. (30.002 - 30.015 mm)	-	
			Ball Bearing Inside Diameter	1.1807 - 1.1811 in. (29.990 - 30.000 mm)	-	
			Interference Fit	0.0001 - 0.001 in. (0.002 - 0.025 mm)	-	
		L70V	Crankcase Cover End	Journal Outside Diameter	1.3782 - 1.3787 in. (35.007 - 35.018 mm)	
	Oil Clearance			0.001 - 0.002 in. (0.025 - 0.058 mm)	0.0067 in. (0.17 mm)	
	Flywheel End		Journal Outside Diameter	1.3782 - 1.3787 in. (35.007 - 35.018 mm)	-	
			Ball Bearing Inside Diameter	1.3774 - 1.3779 in. (34.988 - 35.000 mm)	-	
			Interference Fit	0.00028 - 0.0012 in. (0.007 - 0.030 mm)	-	
	L100V		Crankcase Cover End	Journal Outside Diameter	1.575 - 1.5755 in. (40.007 - 40.018 mm)	
		Oil Clearance		0.001 - 0.0022 in. (0.025 - 0.056 mm)	0.0067 in. (0.17 mm)	
		Flywheel End	Journal Outside Diameter	1.575 - 1.5755 in. (40.007 - 40.018 mm)	-	
			Ball Bearing Inside Diameter	1.5743 - 1.5747 in. (39.988 - 40.000 mm)	-	
			Interference Fit	0.00028 - 0.0012 in. (0.007 - 0.030 mm)	-	



**Balancer Shaft**

Inspection Item		Standard	Limit	Reference Page	
Cylinder Block	L48V	Balancer Shaft Diameter	0.5899 - 0.5903 in. (14.983 - 14.994 mm)	-	<i>See Balancer Shaft on page 6-51.</i>
		Cylinder Block Bore Diameter	1.3756-1.3766 in. (34.941-34.966 mm)	-	
		Ball Bearing Inside Diameter	0.5902-0.5906 in. (14.992-15.000 mm)	-	
		Ball Bearing Outside Diameter	1.3775 - 1.3780 in. (34.989-35.000 mm)	-	
		Radial Clearance of Ball Bearing	0.00043 - 0.00098 in. (0.011 - 0.025 mm)	0.0016 in. (0.040 mm)	
Crankcase Cover	Same as Cylinder Block				
Cylinder Block	L70V	Balancer Shaft Diameter	0.6686 - 0.6691 in. (16.983 - 16.994 mm)	-	<i>See Balancer Shaft on page 6-51.</i>
		Cylinder Block Bore Diameter	1.5725 - 1.5735 in. (39.941 - 39.966 mm)	-	
		Ball Bearing Inside Diameter	0.6690 - 0.6693 in. (16.992 - 17.000 mm)	-	
		Ball Bearing Outside Diameter	1.5744 - 1.5748 in. (39.989 - 40.000 mm)	-	
		Radial Clearance of Ball Bearing	0.00043 - 0.00098 in. (0.011 - 0.025 mm)	0.0016 in. (0.040 mm)	
Crankcase Cover	Same as Cylinder Block				
Cylinder Block	L100V	Balancer Shaft Diameter	0.7867 - 0.7872 in. (19.983 - 19.994 mm)	-	<i>See Balancer Shaft on page 6-51.</i>
		Cylinder Block Bore Diameter	2.0449 - 2.0459 in. (51.941 - 51.966 mm)	-	
		Ball Bearing Inside Diameter	0.7870 - 0.7874 in. (19.990 - 20.000 mm)	-	
		Ball Bearing Outside Diameter	2.0467 - 2.0472 in. (51.987 - 52.000 mm)	-	
		Radial Clearance of Ball Bearing	0.00051 - 0.00110 in. (0.013 - 0.028 mm)	0.0016 in. (0.040 mm)	
Crankcase Cover	Same as Cylinder Block				

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## Piston

Inspection Item		Standard	Limit	Reference Page	
Piston Outside Diameter (Measure 90° to the wrist pin.)	L48V	2.7545 in. (69.965 mm)	2.7441 in. (69.700 mm)		
	L70V	3.0695 in. (77.965 mm)	3.0591 in. (77.700 mm)		
	L100V	3.3841 in. (85.955 mm)	3.3740 in. (85.700 mm)		
Piston Diameter Measurement Location (Upward from the bottom of the piston)	All Models	0.472 in. (12 mm)		<i>See Piston, Piston Rings and Wrist Pin on page 6-45.</i>	
Clearance Between Piston and Sleeve	L48V, L70V	0.0016 - 0.0024 in. (0.040 - 0.060 mm)	-		
	L100V	0.0020 - 0.0028 in. (0.050 - 0.070 mm)	-		
Wrist Pin	L48V	Hole Inside Diameter	0.7474 - 0.7478 in. (18.985 - 18.996 mm)	0.7508 in. (19.07 mm)	<i>See Piston, Piston Rings and Wrist Pin on page 6-45.</i>
		Pin Outside Diameter	0.7476 - 0.7480 in. (18.991 - 19.0 mm)	0.7448 in. (18.920 mm)	
		Oil Clearance	0.0002 - 0.0006 in. (0.005 - 0.015 mm)	-	
	L70V	Hole Inside Diameter	0.8261 - 0.8266 in. (20.983 - 20.996 mm)	0.8295 in. (21.07 mm)	
		Pin Outside Diameter	0.8264 - 0.8267 in. (20.991 - 21.000 mm)	0.8232 in. (20.91 mm)	
		Oil Clearance	0.0002 - 0.00067 in. (0.005 - 0.017 mm)	-	
	L100V	Hole Inside Diameter	0.9048 - 0.9053 in. (22.983 - 22.996 mm)	0.90830 in. (23.07 mm)	
		Pin Outside Diameter	0.9051 - 0.9055 in. (22.991 - 23.000 mm)	0.9020 in. (22.91 mm)	
		Oil Clearance	0.0002 - 0.00067 in. (0.005 - 0.017 mm)	-	

## Piston Ring

Inspection Item		Standard	Limit	Reference Page	
L48V	Top Ring	Thickness	0.0578 - 0.05846 in. (1.470 - 1.485 mm)	0.0535 in. (1.36 mm)	<i>See Piston, Piston Rings and Wrist Pin on page 6-45.</i>
		Side Clearance	0.00255 - 0.00374 in. (0.065 - 0.095 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.00787 - 0.01377 in. (0.200 - 0.350 mm)	0.0394 in. (1.00 mm)	
	Second Ring	Thickness	0.0578 - 0.0586 in. (1.470 - 1.490 mm)	0.0535 in. (1.36 mm)	
		Side Clearance	0.00118 - 0.00255 in. (0.030 - 0.065 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.01181 - 0.01771 in. (0.300 - 0.450 mm)	0.0394 in. (1.00 mm)	
	Oil Ring	Thickness	0.1366 - 0.1374 in. (3.470 - 3.490 mm)	0.1322 in. (3.36 mm)	
		Side Clearance	0.00078 - 0.0026 in. (0.020 - 0.055 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0059 - 0.01377 in. (0.150 - 0.350 mm)	0.0394 in. (1.00 mm)	
L70V	Top Ring	Thickness	0.0578 - 0.0585 in. (1.470 - 1.485 mm)	0.0535 in. (1.36 mm)	
		Side Clearance	0.0025 - 0.0037 in. (0.065 - 0.095 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0079 - 0.0138 in. (0.200 - 0.350 mm)	0.0393 in. (1.0 mm)	
	Second Ring	Thickness	0.0578 - 0.0586 in. (1.470 - 1.490 mm)	0.0535 in. (1.36 mm)	
		Side Clearance	0.0012 - 0.0026 in. (0.030 - 0.065 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0118 - 0.0177 in. (0.300 - 0.450 mm)	0.0394 in. (1.0 mm)	
	Oil Ring	Thickness	0.1366 - 0.1374 in. (3.470 - 3.490 mm)	0.1322 (3.36 mm)	
		Side Clearance	0.0008 - 0.0026 in. (0.020 - 0.055 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0059 - 0.0138 in. (0.150 - 0.350 mm)	0.0394 in. (1.0 mm)	

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Inspection Item		Standard	Limit	Reference Page	
L100V	Top Ring	Thickness	0.0775 - 0.0781 in. (1.970 - 1.985 mm)	0.0732 in. (1.86 mm)	<i>See Piston, Piston Rings and Wrist Pin on page 6-45.</i>
		Side Clearance	0.0026 - 0.0037 in. (0.065 - 0.095 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0079 - 0.0138 in. (0.200 - 0.350 mm)	0.0394 in. (1.0 mm)	
	Second Ring	Thickness	0.0775 - 0.0783 in. (1.970 - 1.990 mm)	0.0732 in. (1.86 mm)	
		Side Clearance	0.0012 - 0.0026 in. (0.030 - 0.065 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0118 - 0.0177 in. (0.300 - 0.450 mm)	0.0394 in. (1.0 mm)	
	Oil Ring	Thickness	0.1562 - 0.1570 in. (3.970 - 3.990 mm)	0.1519 in. (3.86 mm)	
		Side Clearance	0.0008 - 0.0026 in. (0.020 - 0.055 mm)	0.0059 in. (0.15 mm)	
		End Gap	0.0059 - 0.0138 in. (0.150 - 0.350 mm)	0.0394 in. (1.0 mm)	

Connecting Rod

Inspection Item			Standard	Limit	Reference Page
L48V	Big End (Crankshaft)	Inside Diameter <b>See Figure 6-1 (1)</b>	1.1816 - 1.1818 in. (29.986 - 30.018 mm)	1.1846 in. (30.09 mm)	See Connecting Rod on page 6-47.
		Oil Clearance	0.00015 - 0.002 in. (0.004 - 0.053 mm)	-	
	Small End (Wrist Pin Bushing)	Inside Diameter <b>See Figure 6-1 (2)</b>	0.7490 - 0.7495 in. (19.025 - 19.038 mm)	0.7519 in. (19.10 mm)	
		Oil Clearance	0.0008 - 0.0020 in. (0.021 - 0.053 mm)	-	
L70V	Big End (Crankshaft)	Inside Diameter <b>See Figure 6-1 (1)</b>	1.4178 - 1.4180 in. (35.986 - 36.018 mm)	1.4208 in. (36.09 mm)	
		Oil Clearance	0.00015 - 0.002 in. (0.004 - 0.053 mm)	-	
	Small End (Wrist Pin Bushing)	Inside Diameter <b>See Figure 6-1 (2)</b>	0.8277 - 0.8282 in. (21.025 - 21.038 mm)	0.8307 in. (21.10 mm)	
		Oil Clearance	0.0008 - 0.0021 in. (0.021 - 0.055 mm)	-	
L100V	Big End (Crankshaft)	Inside Diameter <b>See Figure 6-1 (1)</b>	1.5748 - 1.5764 in. (40.0 - 40.042 mm)	1.5779 in. (40.08 mm)	
		Oil Clearance	0.0007 - 0.0030 in. (0.018 - 0.077 mm)	-	
	Small End (Wrist Pin Bushing)	Inside Diameter <b>See Figure 6-1 (2)</b>	0.9064 - 0.9070 in. (23.025 - 23.038 mm)	0.9094 in. (23.10 mm)	
		Oil Clearance	0.0008 - 0.0021 in. (0.021 - 0.055 mm)	-	

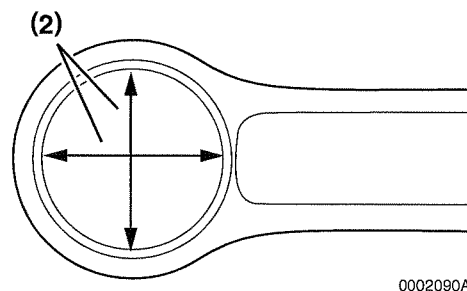
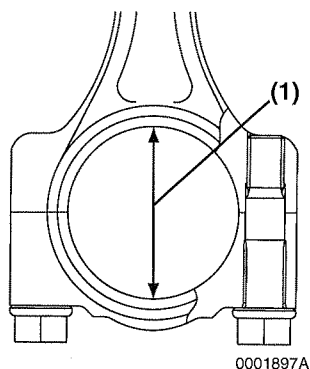


Figure 6-1

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## Camshaft and Tappet

### Camshaft

Inspection Item		Standard	Limit	Reference Page	
End Play - All Models		0.002 - 0.011 in. (0.040 - 0.280 mm)	0.018 in. (0.45 mm)	See Camshaft and Tappet on page 6-50.	
Cylinder Block - All Models	Camshaft Journal Outside Diameter	0.5905 - 0.5909 in. (4.989 - 15.000 mm)	0.5874 in. (14.920 mm)		
	Needle Bearing Inside Diameter	0.5911 - 0.5918 in. (15.016 - 15.034 mm)	-		
	Oil Clearance	0.0006 - 0.0017 in. (0.016 - 0.045 mm)	-		
Crankcase Cover	L48V	Camshaft Journal Outside Diameter	0.9834 - 0.9839 in. (24.980 - 24.993 mm)		0.9803 in. (24.900 mm)
		Bearing Inside Diameter	0.985 - 0.9858 in. (25.020 - 25.041 mm)		-
		Oil Clearance	0.0010 - 0.0024 in. (0.027 - 0.061 mm)		-
	L70V	Camshaft Journal Outside Diameter	1.1803 - 1.1808 in. (29.980 - 29.993 mm)		1.1771 in. (29.900 mm)
		Bearing Inside Diameter	1.1818 - 1.1827 in. (30.020 - 30.041 mm)		-
		Oil Clearance	0.0010 - 0.0024 in. (0.027 - 0.061 mm)		-
	L100V	Camshaft Journal Outside Diameter	1.3771 - 1.3776 in. (34.980 - 34.993 mm)		1.374 in. (34.900 mm)
		Bearing Inside Diameter	1.3787 - 1.3795 in. (35.020 - 35.041 mm)		-
		Oil Clearance	0.0010 - 0.0024 in. (0.027 - 0.061 mm)	-	

### Tappet

Inspection Item		Standard	Limit	Reference Page
Valves - All Models	Tappet Hole (Block) Inside Diameter	0.2755 - 0.2761 in. (7.000 - 7.015 mm)	0.2779 in. (7.06 mm)	See Camshaft and Tappet on page 6-50.
	Tappet Stem Outside Diameter	0.2740 - 0.2755 in. (6.960 - 6.980 mm)	0.2704 in. (6.87 mm)	
	Oil Clearance	0.0007 - 0.0021 in. (0.020 - 0.055 mm)	-	
Fuel Injection Pump - All Models	Tappet Hole (Block) Inside Diameter	0.9448 - 0.9461 in. (24.000 - 24.033 mm)	0.9472 in. (24.06 mm)	
	Tappet Stem Outside Diameter	0.9831 - 0.9446 in. (23.972 - 23.993 mm)	0.9405 in. (23.89 mm)	
	Oil Clearance	0.00027 - 0.0024 in. (0.007 - 0.061 mm)	-	

## Cylinder Block and Crankcase Cover

## Cylinder Block

Inspection Item		Standard	Limit	Reference Page	
Crankshaft Ball Bearing	L48V	Housing Bore Inside Diameter	2.8343 - 2.8349 in. (71.9905 - 72.0095 mm)	-	See Crankshaft on page 6-48.
		Ball Bearing Outside Diameter	2.8341 - 2.8346 in. (71.987 - 72.0 mm)	-	
		Interference Fit	0.0003 - 0.0008 in. (0.0095 - 0.0225 mm)	-	
	L70V	Housing Bore Inside Diameter	3.1488 - 3.1494 in. (79.98 - 79.996 mm)	-	
		Ball Bearing Outside Diameter	3.1490 - 3.1496 in. (79.987 - 80.0 mm)	-	
		Interference Fit	0.0003 - 0.0007 in. (0.009 - 0.020 mm)	-	
	L100V	Housing Bore Inside Diameter	3.5426 - 3.5433 in. (89.984 - 90.0 mm)	-	
		Ball Bearing Outside Diameter	3.5427 - 3.5433 in. (89.985 - 90.0 mm)	-	
		Interference Fit	0.0005 - 0.0006 in. (0.015 - 0.016 mm)	-	
Camshaft Needle Bearing Bore - All Models	Inside Diameter	0.8250 - 0.8259 in. (20.957 - 20.978 mm)	-	See Camshaft and Tappet on page 6-50.	
Cylinder Bore Inside Diameter	L48V	2.7559 - 2.7571 in. (70.000 - 70.030 mm)	2.7622 in. (70.16 mm)	See Cylinder Bore on page 6-51.	
	L70V	3.0709 - 3.0720 in. (78.000 - 78.030 mm)	3.0779 in. (78.18 mm)		
	L100V	3.3858 - 3.3870 in. (86.000 - 86.030 mm)	-		

# ENGINE

## Crankcase Cover

Inspection Item		Standard	Limit	Reference Page	
Crankshaft Sleeve Bearing	L48V	Bore Diameter in Cover	1.3385 - 1.3395 in. (34.000 - 34.025 mm)	-	<i>See Bearings on page 6-49.</i>
		Bearing Outside Diameter	1.3413 - 1.3427 in. (34.070 - 34.105 mm)	-	
		Interference Fit	0.0017 - 0.0041 in. (0.045 - 0.105 mm)	-	
		Bearing Metal Inside Diameter	1.1826 - 1.1834 in. (30.040 - 30.060 mm)	1.1862 in. (30.130 mm)	
	L70V	Bore Diameter in Cover	1.5354 - 1.5364 in. (39.000 - 39.025 mm)	-	
		Bearing Outside Diameter	1.5381 - 1.5395 in. (39.070 - 39.105 mm)	-	
		Interference Fit	0.0017 - 0.0041 in. (0.045 - 0.105 mm)	-	
		Bearing Metal Inside Diameter	1.3796 - 1.3804 in. (35.043 - 35.063 mm)	1.383 in. (35.130 mm)	
	L100V	Bore Diameter in Cover	1.7322 - 1.7332 in. (44.000 - 44.025 mm)	-	
		Bearing Outside Diameter	1.7356 - 1.737 in. (44.085 - 44.120 mm)	-	
		Interference Fit	0.0023 - 0.0047 in. (0.060 - 0.120 mm)	-	
		Bearing Metal Inside Diameter	1.5764 - 1.5772 in. (40.043 - 40.063 mm)	1.5799 in. (40.130 mm)	
Camshaft Ball Bearing	L48V	Bore Diameter in Cover	2.045 - 2.0458 in. (51.945 - 51.965 mm)	-	<i>See Camshaft and Tappet on page 6-50.</i>
		Ball Bearing Outside Diameter	2.0467 - 2.0472 in. (51.987 - 52.000 mm)	-	
		Interference Fit	0.0008 - 0.0021 in. (0.022 - 0.055 mm)	-	
	L70V	Bore Diameter in Cover	2.4385 - 2.4393 in. (61.940 - 61.960 mm)	-	
		Ball Bearing Outside Diameter	2.4404 - 2.4409 in. (61.987 - 62.000 mm)	-	
		Interference Fit	0.001 - 0.0023 in. (0.027 - 0.060 mm)	-	
	L100V	Bore Diameter in Cover	2.832 - 2.8328 in. (71.935 - 71.955 mm)	-	
		Ball Bearing Outside Diameter	2.8341 - 2.8346 in. (71.987 - 72.000 mm)	-	
		Interference Fit	0.0012 - 0.0025 in. (0.032 - 0.065 mm)	-	



**Oil Pump (Trochoid Pump)**

Inspection Item		Standard	Limit	Reference Page
All Models	Outer Rotor Outside Diameter	1.1401 - 1.1409 in. (28.960 - 28.980 mm)	1.1377 in. (28.900 mm)	See <i>Installation of Crankcase Cover on page 6-65.</i>
	Oil Pump Cavity Diameter (Crankcase Cover)	1.1456 - 1.1464 in. (29.100 - 29.121 mm)	1.1488 in. (29.180 mm)	
	Outer Rotor-to-Crankcase Cover Bore Clearance	0.0047 - 0.0063 in. (0.120 - 0.161 mm)	-	
	Outer and Inner Rotor Width	0.3137 - 0.3149 in. (7.970 - 8.000 mm)	0.3110 in. (7.900 mm)	
	Oil Pump Cavity Depth (Crankcase Cover)	0.3157 - 0.3169 in. (8.020 - 8.050 mm)	0.3188 in. (8.100 mm)	
	Rotor Recess	0.0007 - 0.0031 in. (0.020 - 0.080 mm)	-	
	Inner Rotor-to-Outer Rotor Clearance	0.0000 - 0.0055 in. (0.000 - 0.140 mm)	0.0098 in. (0.25 mm)	

# ENGINE

## Special Torque Specifications

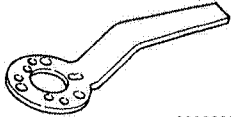
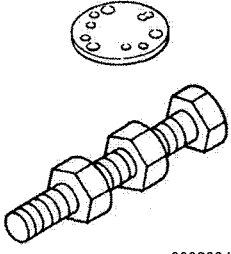
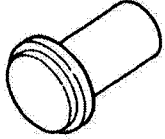
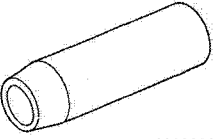

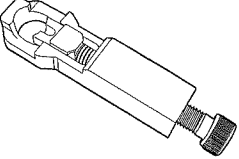
Component	Model	Thread Diameter and Pitch	Torque	Lubricating Oil Application (Thread Portion and Seat Surface)
Crankcase Cover Bolt	L48V	14-M6 x 1.0 mm	96 - 114 lb-in. (10.8 - 12.8 N·m, 1.1 - 1.3 kgf·m)	Not Applied
	L70V, L100V	13-M8 x 1.25 mm	225 - 243 lb-in. (25.5 - 27.5 N·m, 2.6 - 2.8 kgf·m)	
Stiffener Bolts on Crankcase Cover	All Models	M8 x 1.25 mm	225 - 242 lb-in. (25.5 - 27.4 N·m, 2.6 - 2.8 kgf·m)	Not Applied
Connecting Rod Nuts and Bolts	L48V, L70V	2-M7 x 1.0 mm	200 - 243 lb-in. (22.6 - 27.5 N·m, 2.3 - 2.8 kgf·m)	Applied
	L100V	2-M8 x 1.0 mm	32.5 - 36 lb-ft (44.1 - 49.0 N·m, 4.9 - 5.0 kgf·m)	
Flywheel Nut	L48V	M16 x 1.5 mm	101.5 - 108.7 lb-ft (137.3 - 147.1 N·m, 14.0 - 15.0 kgf·m)	Applied
	L70V	M16 x 1.5 mm	116 - 123.2 lb-ft (156.9 - 166.7 N·m, 16.0 - 17.0 kgf·m)	
	L100V	M18 x 1.5 mm	159 - 166 lb-ft (215.7 - 225.6 N·m, 22.0 - 23.0 kgf·m)	
Cylinder Head Nuts (Final Torque)	L48V	M8 x 1.25 mm	21.5 - 24.4 lb-ft (29.4 - 33.3 N·m, 3.0 - 3.4 kgf·m)	Applied
	L70V	M9 x 1.5 mm	34.8 - 37.8 lb-ft (47 - 51 N·m, 4.8 - 5.2 kgf·m)	
	L100V	M10 x 1.25 mm	44.0 - 46.9 lb-ft (59.8 - 63.7 N·m, 6.1 - 6.5 kgf·m)	
Valve Rocker Arm Support	L48V, L70V	M6 x 1.00 mm	88 - 106 lb-in. (10 - 12 N·m, 1.0 - 1.2 kgf·m)	Not Applied
	L100V	M8 x 1.5 mm	225 - 243 lb-in. (25.5 - 27.5 N·m, 2.6 - 2.8 kgf·m)	Not Applied

Component	Model	Thread Diameter and Pitch	Torque	Lubricating Oil Application (Thread Portion and Seat Surface)
Fuel Nozzle Case Nut	All Models	U-0.605-40UNS-2B	30 - 35 lb-ft (40.7 - 47.5 N·m, 4.2 - 4.8 kgf·m)	Not Applied
Fuel Pump Delivery Valve (If Equipped)		M14 x 15 mm	21.5 - 25 lb-ft (29.4 - 34.3 N·m, 3.0 - 3.5 kgf·m)	Not Applied
Fuel Injection Pump Nuts		3-M6 x 1.0 mm	87 - 104 lb-in. (9.8 - 11.8 N·m, 1.0 - 1.2 kgf·m)	Not Applied
Fuel Injection Nozzle Nuts		2-M6 x 1.0 mm	61.3 - 79 lb-in. (6.9 - 8.9 N·m, 0.7 - 0.9 kgf·m)	Not Applied
Fuel Injection Pump Inspection Window Plate Nuts		3-M6x1.0 mm	87 - 104 lb-in. (9.8 - 11.8 N·m, 1.0 - 1.2 kgf·m)	Not Applied
Fuel Limiter Mounting Nut		-	215 - 218 lb-in. (24.2 - 24.6 N·m, 2.4 - 2.5 kgf·m)	Not Applied
High Pressure Fuel Injection Line Nuts		-	19.8 - 23.5 lb-ft (26.9 - 31.9 N·m, 2.7 - 3.3 kgf·m)	Not Applied

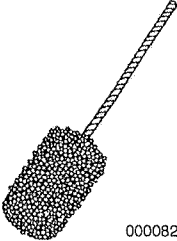
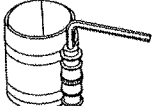
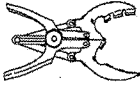

See *Tightening Torques for Standard Bolts and Nuts* on page 4-20 for standard hardware torque values.

# ENGINE

## SPECIAL SERVICE TOOLS

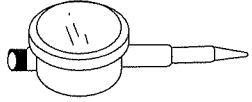
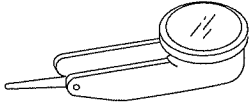
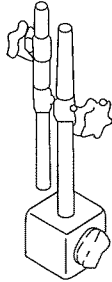
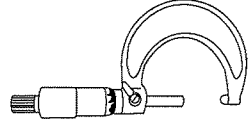
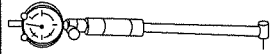

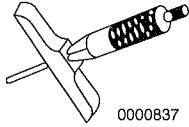
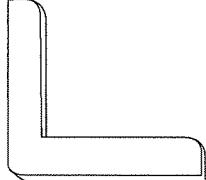
No.	Tool Name	Applicable Model and Tool Size					Illustration
1	Flywheel Holder Wrench (For Removing and Installing the Flywheel)	Yanmar Part No. 114250-92101					 0002393
2	Flywheel Puller (For Removing the Flywheel)	Yanmar Part No. 114250-92121					 0002394
		Model	Bolt	Qty. Used	Nut	Qty. Used	
		L48V, L70V	26116-060454	3	26716-060002	6	
L100V	4	8					
3	Oil Seal Installer (For Installing the Crankshaft and Camshaft Oil Seals)	Model	Cylinder Block (Crankshaft) - Yanmar Part No.	Crankcase Cover (Crankshaft and Camshaft) - Yanmar Part No.		 0002395	
		L48V	114350-92311	114250-92311			
		L70V	114350-92311	114350-92311			
		L100V	014650-92311	014650-92311			
4	Oil Seal Protector (For Installing the Crankcase Cover)	Model	Yanmar Part No.			 0002396	
		L48V	114350-92301 or 114268-92300				
		L70V	114268-92300				
		L100V	114268-92300				
5	Valve Stem Seal Installer (For Installing Valve Stem Seals to the Correct Height)	Model	Yanmar Part No.			 0002397	
		L48V	114250-92350				
		L70V	114350-92350				
		L100V	114650-92350				
6	Throttle Shaft Pin Removal Tool (L70V and L100V Models)	Yanmar Part No. 114310-92000					 0004243

**Special Service Tools (Continued)**


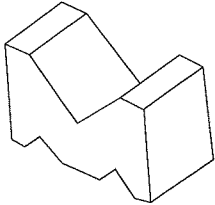
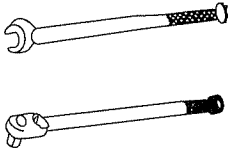
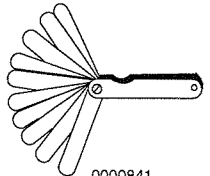
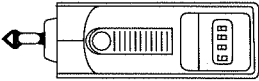
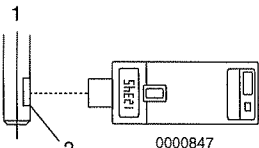
No.	Tool Name	Applicable Model and Tool Size			Illustration
		Model	Part No.	Cylinder Bore	
7	Flex-Hone (For Honing of Cylinder Bore)	L48V	129400-92400	3.071 - 3.307 in. (70 - 84 mm)	 0000823
		L70V	129400-92420	3.071 - 3.307 in. (78 - 84 mm)	
		L100V	129400-92430	3.268 - 3.740 in. (86 - 95 mm)	
8	Piston Ring Compressor (For Installing Piston)	Yanmar Part No. 95550-002476 The piston ring compressor is applicable for 2.362 - 4.921 in. (60 - 125 mm) diameter pistons			 0000824
9	Piston Ring Expander (For Removal/ Installation of Piston Rings)	Available Locally			 0000825
10	Piston Ring Groove Cleaning Tool	Available Locally			 0002897

# ENGINE

## MEASURING INSTRUMENTS

No.	Instrument Name	Application	Illustration
1	Dial Indicator (Available Locally)	Measurements of shaft bending, and strain and gap of surfaces	 0000831
2	Test Indicator (Available Locally)	Measurements of narrow or deep portions that cannot be measured by dial gauge	 0000832
3	Magnetic Stand (Available Locally)	For holding the dial gauge when measuring	 0000833
4	Micrometer (Available Locally)	For measuring the outside diameters of crankshaft, piston, piston pins, etc.	 0000834
5	Cylinder Bore Gauge (Available Locally)	For measuring the inside diameters of cylinder liners, rod metal, etc.	 0000835
6	Calipers (Available Locally)	For measuring outside diameters, depth, thickness and width	 0000836
7	Depth Micrometer (Available Locally)	For measuring amount of valve sink	 0000837
8	Square (Available Locally)	For measuring valve spring inclination and straightness of parts	 0000838

**Measuring Instruments (Continued)**

No.	Instrument Name		Application	Illustration
9	Straight Edge (Available Locally)		For measuring cylinder head distortion and straightness of parts	 <p>0003594</p>
10	V-Block (Available Locally)		For measuring shaft bend	 <p>0000839</p>
11	Torque Wrench (Available Locally)		For tightening nuts and bolts to the specified torque	 <p>0000840</p>
12	Feeler Gauge (Available Locally)		For measuring gaps between ring and ring groove, valve clearance and shaft joints during assembly	 <p>0000841</p>
13	Tachometer (Available Locally)	Contact Type	For measuring revolution by contacting the mortise in the revolving shaft	 <p>0000846</p>
		Photoelectric Type	For measuring revolution by sensing the reflecting mark on the outer periphery of the revolving shaft  1 — Revolving Shaft 2 — Reflection Mark	 <p>0000847</p>

## CYLINDER HEAD

### Removal of Cylinder Head

#### L48V Models

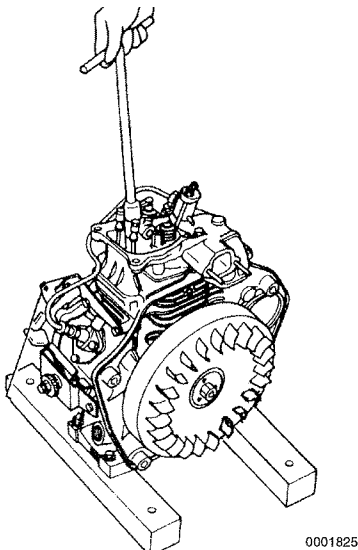
1. Remove the air cleaner assembly.
2. Remove the fuel tank and fuel tank support brackets.
3. Remove the muffler assembly.

#### L70V and L100V Models

1. Remove the cylinder head upper cooling cover.
2. Remove the cylinder head side cooling cover.
1. Remove the air cleaner assembly.
2. Remove the fuel tank and fuel tank support brackets.
3. Remove the muffler assembly.

#### All Models

1. Disconnect the external compression release linkage (if equipped) from the rocker arm cover.
2. Remove the rocker arm (valve) cover.
3. Remove the rocker arm shaft assembly **Figure 6-2**, by first removing the two bolts that secure the rocker arm shaft assembly to the cylinder head.



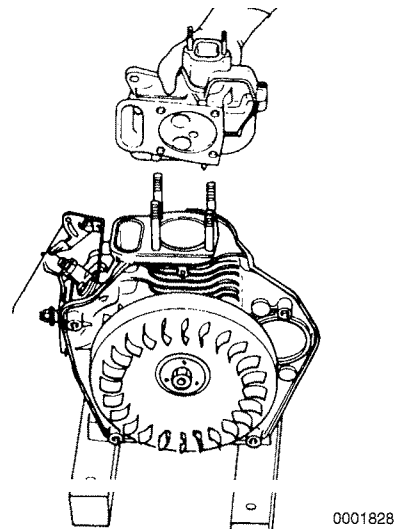
**Figure 6-2**

Note: Mark the push rods so they can be reinstalled in their original locations.

4. Remove the push rods.

Note: When loosening or tightening the high-pressure fuel line nuts, use a "line" or "flare nut" wrench to prevent rounding of the nuts.

5. Remove the high-pressure fuel injection line, fuel return line and the fuel injector. See *Removal of Fuel Injector on page 7-21*.
6. Remove the two cylinder head nuts and two bolts and remove the cylinder head **(Figure 6-3)**. Discard the cylinder head gasket. Place the cylinder head on a protected work surface to prevent damage to the combustion surface.



**Figure 6-3**