

# ENGINE

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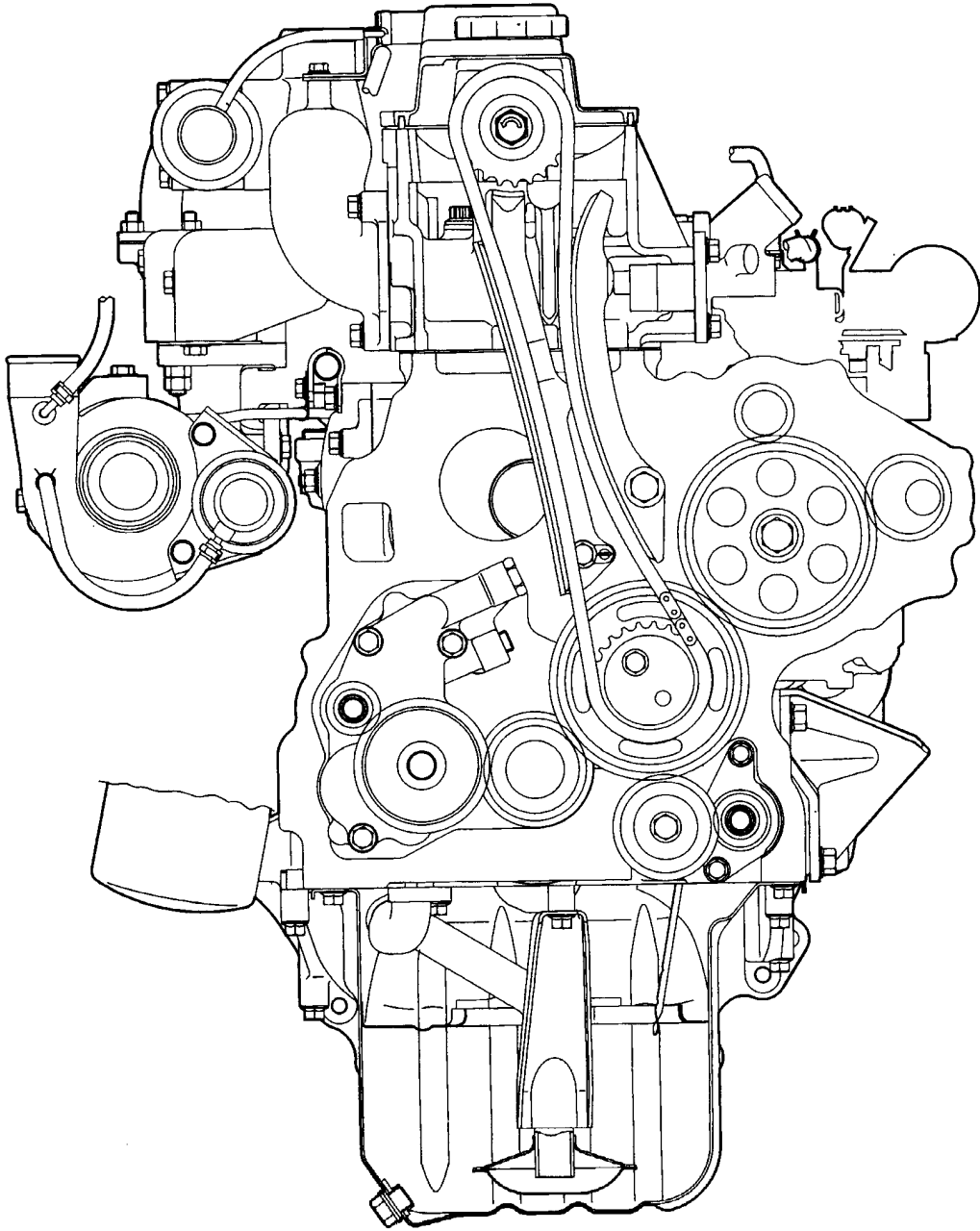
# 4M40

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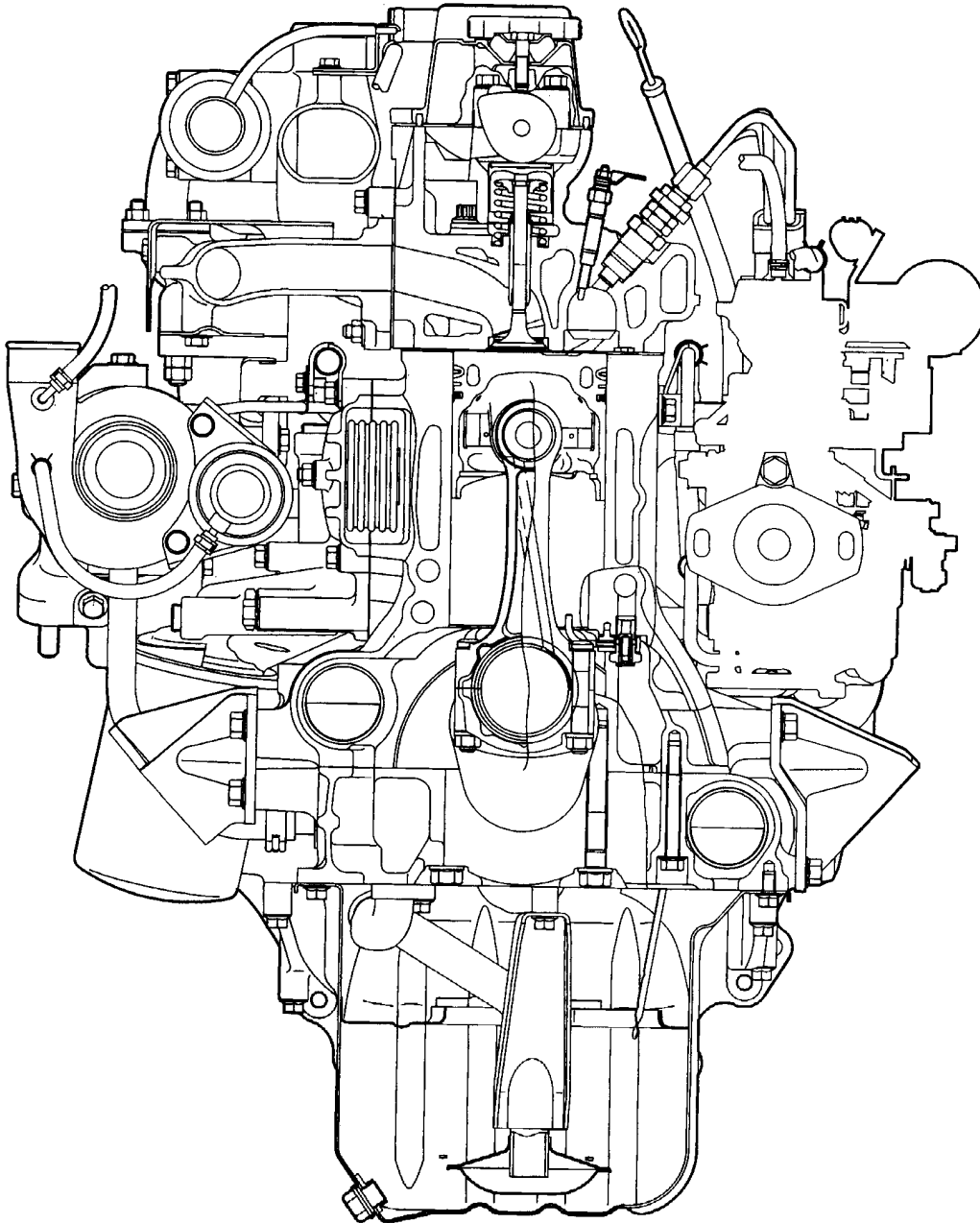
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**GENERAL INFORMATION**

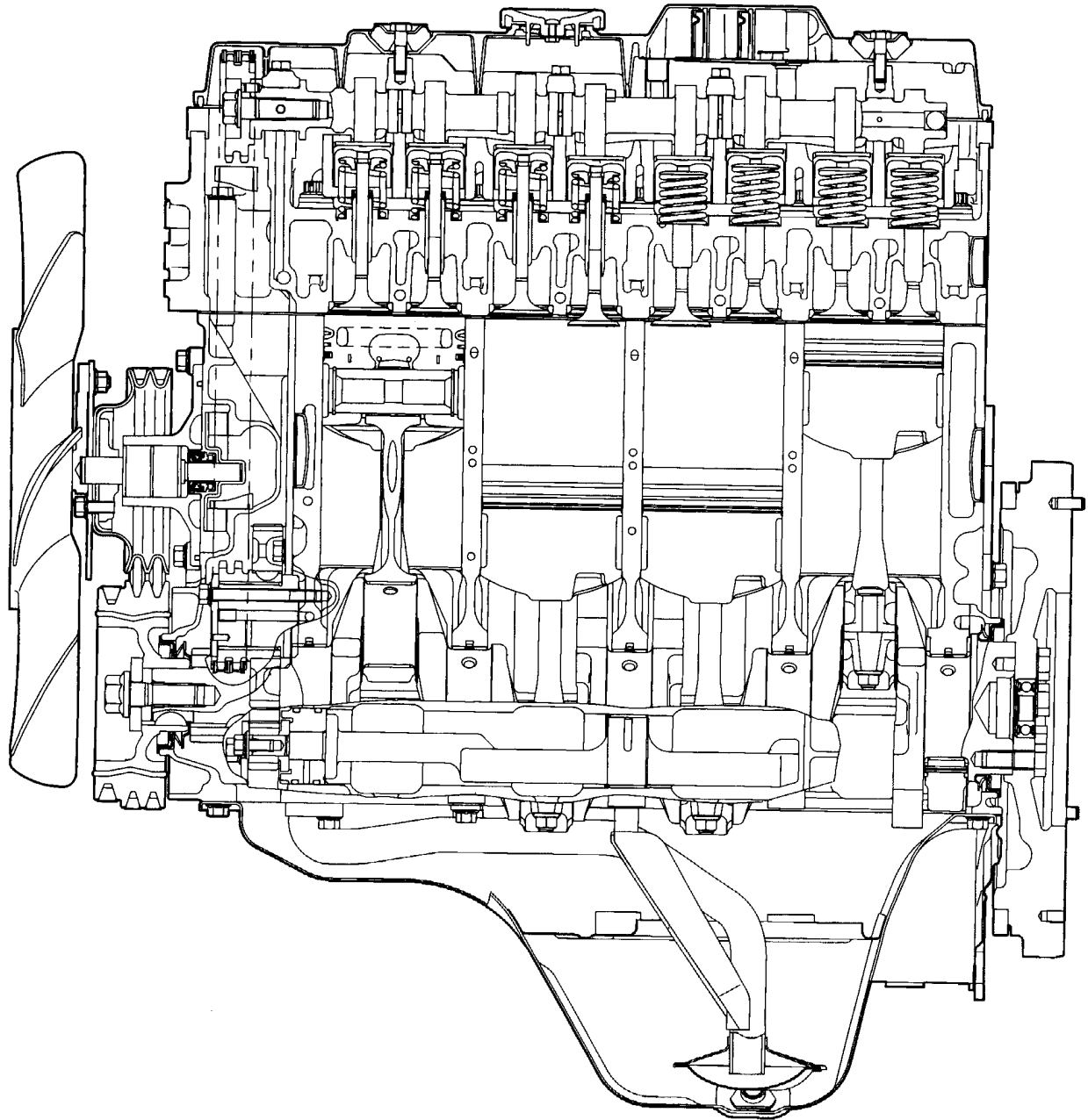
**SECTIONAL VIEW**



SECTIONAL VIEW



SECTIONAL VIEW



4ME0003

# 1. SPECIFICATIONS

## GENERAL SPECIFICATIONS

Description	Specifications
Type .....	Diesel engine
No. and arrangement of cylinders .....	4 in-line, longitudinal
Combustion chamber .....	Swirl chamber
Total displacement .....	2,835 cm <sup>3</sup> (173.0 cu.in.)
Cylinder bore x stroke .....	95 x 100 mm (3.740 x 3.937 in.)
Compression ratio .....	21
Valve mechanism .....	Single overhead camshaft
Valve timing	
Intake valve .....	Open .....
Intake valve .....	Close .....
Exhaust valve .....	Open .....
Exhaust valve .....	Close .....
Supercharger .....	Turbo-charging type
Intercooler .....	Air-cooling type
Fuel supply .....	Distributor type fuel injection pump

## SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
<b>Glow plug</b>		
Glow plug		
Resistance		
PAJERO .....	0.5 Ω*1, 0.6 Ω*2	
L200 .....	1 Ω	
<b>Turbocharger assembly</b>		
Turbocharger		
Actuator operating pressure..... [when operating 1 mm (0.04 in.)]	91 (0.91)*1, 96(0.97)*2	
<b>Turbocharger</b>		
Cartridge assembly		
Axial play of shaft .....	0.057 – 0.103 (0.0022 – 0.0041)	
Turbine wheel back to turbine back plate clearance	0.39 – 0.83 (0.0154 – 0.0033)	
<b>Camshaft and valves</b>		
Camshaft		
End play .....	0.10 – 0.18 (0.0039 – 0.0071)	0.3 (0.012)
Valve clearance (when cold)		
Intake .....	0.2 (0.008)	
Exhaust .....	0.3 (0.012)	
Difference between cam height and base circle diameter		
Intake		
PAJERO .....	9.89 (0.3894)	9.39 (0.3697)
L200, PAJERO 2001MODEL .....	9.29 (0.3657)	8.79 (0.3461)
Exhaust .....	10.19 (0.4012)	9.64 (0.3795)
Clearance between valve lifter O.D. and cylinder head	0.03 – 0.07 (0.0012 – 0.0028)	0.10 (0.0039)
Valve spring		
Free height .....	48.8 (1.921)	47.8 (1.882)
Load [installed height: 38.67 (1.52)] .....	280 N (28.0 kg, 63 lbs.)	238 N (23.8 kg, 53 lbs.)
Out-of-squareness .....	Less than 2°	4°
Valve		
Stem diameter		
Intake .....	7.96 – 7.97 (0.3134 – 0.3138)	7.85 (0.3091)
Exhaust .....	7.93 – 7.95 (0.3122 – 0.3130)	7.85 (0.3091)
Sinkage from cylinder head bottom		
Intake .....	0.75 – 1.25 (0.0295 – 0.0492)	1.5 (0.0591)
Exhaust .....	0.95 – 1.45 (0.0374 – 0.0571)	1.7 (0.0669)
Margin .....	1 (0.04)	0.8 (0.0315)
Valve seat angle .....	45° ± 15'	
Stem-to-guide clearance		
Intake .....	0.03 – 0.05 (0.0012 – 0.0020)	0.10 (0.0039)
Exhaust .....	0.05 – 0.08 (0.0020 – 0.0031)	0.15 (0.0059)
Valve seat		
Seat width .....	2 (0.08)	2.8 (0.110)
Cylinder head		
Bottom surface distortion .....	Less than 0.05 (0.0020)	0.2 (0.0078)

## NOTE

\*1: Except 2001Model

\*2: 2001Model

	Standard	Limit
<b>Oil cooler and oil filter</b>		
Bypass valve spring		
Valve opening pressure .....	390 ± 29 kPa (4 ± 0.3 kgf/cm <sup>2</sup> )	
Regulator valve spring		
Valve opening pressure .....	490 ± 29 kPa (5 ± 0.3 kgf/cm <sup>2</sup> )	
<b>Timing gears, balance shafts</b>		
Timing chain elongation .....	16.5 (0.643) .....	9 (0.36)
Tension lever		
Tension lever-to-tension lever shaft clearance .....	0.06 – 0.18 (0.0024 – 0.0071) .....	0.3 (0.012)
Balance shaft		
Balance shaft-to-balance shaft bush clearance .....	0.06 – 0.11 (0.0024 – 0.0043) .....	0.16 (0.0063)
Idler gear bush LH		
Idler gear bush LH-to-idler shaft A clearance .....	0.02 – 0.05 (0.0008 – 0.0020) .....	0.1 (0.004)
Idler sprocket bush		
Idler sprocket bush-to-idler shaft clearance .....	0.02 – 0.06 (0.0008 – 0.0024) .....	0.1 (0.004)
Backlash between gears		
Balance shaft gear RH and oil pump gear .....	0.04 – 0.19 (0.0016 – 0.0075) .....	0.3 (0.012)
Oil pump gear and crankshaft gear .....	0.04 – 0.18 (0.0016 – 0.0071) .....	0.3 (0.012)
Crankshaft gear and idler gear/sprocket assembly .....	0.04 – 0.18 (0.0016 – 0.0071) .....	0.3 (0.012)
Idler gear and idler gear LH assembly .....	0.04 – 0.19 (0.0016 – 0.0075) .....	0.3 (0.012)
Idler gear LH and balance shaft gear LH .....	0.04 – 0.22 (0.0016 – 0.0087) .....	0.4 (0.016)
Idler gear and injection pump gear .....	0.04 – 0.21 (0.0016 – 0.0083) .....	0.4 (0.016)
End play		
Balance shaft .....	0.09 – 0.24 (0.0035 – 0.0094) .....	0.3 (0.012)
Idler gear/sprocket assembly .....	0.05 – 0.20 (0.0020 – 0.0079) .....	0.3 (0.012)
Idler gear LH assembly .....	0.05 – 0.20 (0.0020 – 0.0079) .....	0.3 (0.012)
<b>Oil pump</b>		
Oil pump		
Shaft-to-oil pump case and cover clearance .....	0.03 – 0.05 (0.0012 – 0.0020) .....	0.15 (0.0059)
Difference between gear height and oil pump case depth .....	0.05 – 0.10 (0.0020 – 0.0039) .....	0.15 (0.0059)
Gear tooth crest-to-oil pump case clearance .....	0.15 – 0.26 (0.0059 – 0.0102) .....	0.27 (0.0106)
<b>Fuel injection nozzle</b>		
Fuel injection nozzle		
Fuel injection pressure (valve opening pressure) .....	15,000 kPa (150 kg/cm <sup>2</sup> , 2,133 psi)	
<b>Fuel injection pump assembly</b>		
Fuel injection pump		
Plunger lift (fuel injection timing: 4°ATDC* <sup>1</sup> , 6°ATDC* <sup>2</sup> , 7°ATDC* <sup>3</sup> , 9°ATDC* <sup>4</sup> , 12°ATDC* <sup>5</sup> ) .....	1 ± 0.03 (0.039 ± 0.0012)	

**NOTE**

\*1: PAJERO Non-turbo

\*2: L200 Non-turbo, and 1994–1996 PAJERO Turbo for EFTA

\*3: 2001–PAJERO Turbo without EGR

\*4: L200 Turbo, CHALLENGER, 1997–2000 PAJERO Turbo for Hong Kong, 1998–2000 PAJERO Turbo for Germany, 1999–2000 PAJERO Turbo for EC, 2001–PAJERO Turbo with EGR

\*5: –1997 PAJERO Turbo for Germany, –1998 PAJERO Turbo for EC, 1998–2000 PAJERO Turbo for South-Africa, –2000 PAJERO Turbo for General Export

	Standard	Limit
<b>Piston and connecting rod assembly</b>		
Piston		
Protrusion		
Non-turbo .....	0.55 – 0.77 (0.0217 – 0.0303)	
Turbo .....	0.45 – 0.67 (0.0177 – 0.0264)	
Connecting rod assembly		
End play .....	0.15 – 0.45 (0.0059 – 0.0177)	0.6 (0.024)
Connecting rod bearing		
Oil clearance .....	0.03 – 0.05 (0.012 – 0.0020)	0.1 (0.004)
Free span .....		58.8 max.
Upper crankcase		
Cylinder I.D. ....	95.00 – 95.03 (3.7401 – 3.7413)	95.25 (3.7500)
Piston and connecting rod assembly-to-upper crankcase cylinder clearance		
Non-turbo .....	0.04 – 0.05 (0.0016 – 0.0020)	0.15 (0.0059)
Turbo .....	0.07 – 0.08 (0.0028 – 0.0315)	0.15 (0.0059)
<b>Piston and piston pin</b>		
Piston pin		
Piston pin-to-connecting rod bush clearance .....	0.03 – 0.05 (0.0012 – 0.0020)	0.1 (0.004)
Piston pin-to-piston clearance .....	0.007 – 0.021 (0.0003 – 0.0008)	0.05 (0.0020)
Connecting rod		
Bend, twist .....		0.05 (0.0020)
Piston ring		
End gap		
No.1 ring .....	0.3 – 0.45 (0.0118 – 0.0177)	0.8 (0.031)
No.2 ring .....	0.3 – 0.45 (0.0118 – 0.0177)* <sup>1</sup> 0.4 – 0.55 (0.0157 – 0.0217)* <sup>2</sup>	0.8 (0.031) 0.8 (0.031)
Oil ring		
Non-turbo .....	0.3 – 0.5 (0.0118 – 0.0197)	0.8 (0.031)
Turbo .....	0.25 – 0.45 (0.0010 – 0.0177)	0.8 (0.031)
Ring-to-ring groove clearance		
No.1 ring		
Non-turbo .....	0.06 – 0.11 (0.0024 – 0.0043)	0.15 (0.0059)
Turbo .....	0.03 – 0.08 (0.0012 – 0.0031)	0.15 (0.0059)
No.2 ring		
Non-turbo .....	0.05 – 0.08 (0.0020 – 0.0031)	0.15 (0.0059)
Turbo .....	0.07 – 0.10 (0.0028 – 0.0039)	0.15 (0.0059)
Oil ring .....	0.03 – 0.06 (0.0012 – 0.0024)	0.15 (0.0059)
<b>Flywheel</b>		
Flywheel		
Friction surface runout .....		0.2 (0.008)
Friction surface distortion .....	Less than 0.05 (0.0020)	0.2 (0.008)
Friction surface height		
Non-turbo .....	16.2 (0.638)	15.2 (0.598)
Turbo .....	22.8 (0.898)	21.8 (0.858)

## NOTE

\*1: Except PAJERO 2001 Model

\*2: PAJERO 2001 Model



	Standard	Limit
mm (in.)		
<b>Crankshaft and crankcase</b>		
Crankshaft		
End play .....	0.10 – 0.28 (0.0039 – 0.0110) .....	0.4 (0.016)
Main bearing-to-crankshaft clearance		
No.1, 2, 4 and 5 bearings .....	0.04 – 0.06 (0.0016 – 0.0024) .....	0.1 (0.004)
No.3 bearing .....	0.06 – 0.08 (0.0024 – 0.0031) .....	0.1 (0.004)
Bend .....	Less than 0.02 (0.0008) .....	0.05 (0.0020)
Pin and journal		
Out-of-roundness .....	Less than 0.01 (0.0004)	
Conicity .....	Less than 0.006 (0.0002)	
Upper crankcase		
Upper surface distortion .....	Less than 0.05 (0.0020) .....	0.1 (0.004)
Main bearing		
Free span .....		73.16 max.

## TORQUE SPECIFICATION

	Torque		
	Nm	kgm	ft.lbs.
<b>Cooling fan V-belt and water pump</b>			
Cooling fan nut .....	10	1.0	7
Auto-cooling fan coupling nut .....	24	2.4	17
Water pump bolt .....	24	2.4	17
<b>Water hoses and pipes</b>			
Turbocharger water outlet pipe.....	26	2.6	19
Turbocharger water inlet pipe .....	26	2.6	19
Engine coolant temperature sensor.....	9	0.9	7
<b>Coolant temperature sensor</b>			
Coolant temperature sensor .....	40	4.0	29
<b>Glow plug</b>			
Connection plate .....	10* <sup>1</sup> , 1.8* <sup>2</sup>	1.0* <sup>1</sup> , 0.18* <sup>2</sup>	7* <sup>1</sup> , 1.3* <sup>2</sup>
Glow plug .....	18	1.8	13
<b>Turbocharger assembly</b>			
Eyebolt.....	20	2.0	14
Coupler insulator nut .....	50	5.0	36
Turbocharger nut .....	50	5.0	36
Turbocharger bolt.....	55	5.5	40
Turbocharger water outlet pipe.....	26	2.6	19
Turbocharger water inlet pipe .....	26	2.6	19
<b>Turbocharger</b>			
Coupling nut.....	4.5	0.45	3.3
<b>Intake manifold</b>			
Relief valve.....	48	4.8	35
<b>Exhaust manifold</b>			
Exhaust manifold bolt.....	30	3.0	22
Exhaust manifold nut.....	31	3.1	22
<b>Rocker cover and cylinder head assembly</b>			
Rocker cover bolt.....	4	0.4	3
Cam sprocket bolt .....	Left-hand thread	9.0	65
Cylinder head bolt			
M12 .....	50 + 1/4 turns + 1/4 turns	5.0 + 1/4 turns + 1/4 turns	36 + 1/4 turns + 1/4 turns
M8 .....	24	2.4	17
<b>Camshaft and valve</b>			
Camshaft cap bolt .....	20	2.0	14
Glow plug .....	18	1.8	13
Fuel injection nozzle .....	55	5.5	40
Water joint.....	48	4.8	35
<b>Oil cooler and oil filter</b>			
Oil cooler element nut.....	20	2.0	14
Bypass plug.....	45	4.5	33
Regulator plug .....	45	4.5	33
Turbocharger water inlet pipe .....	26	2.6	19

## NOTE

\*1: Except PAJERO 2001 Model

\*2: PAJERO 2001 Model










	Torque		
	Nm	kgm	ft.lbs.
<b>Vacuum pump</b>			
Oil pressure gauge unit.....	15	1.5	11
<b>Timing gear case</b>			
Eyebolt (FOR L200 and FOR CHALLENGER) (PAJERO except 1998– for Europe).....	12	1.2	9
(1998– PAJERO for Europe).....	20	2.0	14
<b>Timing gear and balance shaft</b>			
Crankshaft pulley bolt.....	230	23	166
<b>Timing gear and balance shaft</b>			
Tension lever bolt.....	41	4.1	30
Balance shaft gear RH bolt.....	37	3.7	27
Balance shaft gear LH bolt.....	37	3.7	27
<b>Oil Pump</b>			
Balance shaft RH bolt.....	37	3.7	27
Oil pump cover screw.....	10	1.0	7
<b>Fuel Injection nozzle</b>			
Leak-off pipe nut.....	30	3.0	22
Fuel injection nozzle assembly.....	55	5.5	40
Retaining nut.....	40	4.0	29
<b>Fuel injection pump assembly</b>			
Fuel injection pipe.....	23	2.3	17
<b>Fuel injection pump gear</b>			
Fuel injection pump gear.....	65	6.5	47
<b>Piston and connecting rod assembly</b>			
Connecting rod nut.....	50 + 1/4 turns	5.0 + 1/4 turns	36 + 1/4 turns
<b>Flywheel</b>			
Flywheel bolt.....	125	12.5	90
<b>Drive plate</b>			
Rubber spacer bolt.....	48	4.8	35
Torque converter.....	39	3.9	28
Drive plate bolt.....	135	13.5	98
<b>Crankshaft and crankcase</b>			
Rubber spacer bolt.....	48	4.8	35
Lower crankcase.....	25	2.5	18
Main bearing cap bolt.....	20 + 1/4 turns + 1/4 turns	2.0 + 1/4 turns + 1/4 turns	14 + 1/4 turns + 1/4 turns
Check valve.....	33	3.3	24
<b>Generator</b>			
Pulley nut.....	98	9.8	71

**STANDARD BOLT AND NUT TIGHTENING TORQUE TABLE**

- Fasten the parts and equipment of vehicle using the specified standard bolts and nuts. Tighten these bolts and nuts to the torques indicated below, unless otherwise specified.
- Threads and bearing surfaces must be dry.
- In case nut and bolt (or stud bolt) differ in strength, tighten them to the torque specified for the bolt.







**Hexagon head bolts and stud bolts**

Unit: Nm (kgm, ft.lbs.)

Strength Code	4T		7T		8T	
	Head Mark		Head Mark		Head Mark	
Nominal Diameter mm	  (Stud)		  (Stud)		  (Stud)	
M5	2-3 (0.2-0.3, 1.4-2.2)	-	4-6 (0.4-0.6, 2.9-4.3)	-	5-7 (0.5-0.7, 3.6-5.1)	-
M6	4-6 (0.4-0.6, 2.9-4.3)	-	7-11 (0.7-1.1, 5.1-8)	-	8-12 (0.8-1.2, 5.8-9)	-
M8	9-14 (0.9-1.4, 6.5-10)	-	17-26 (1.7-2.6, 12-19)	-	20-30 (2.0-3.0, 14-22)	-
M10	19-28 (1.9-2.8, 14-20)	18-27 (1.8-2.7, 13-20)	35-55 (3.5-5.5, 25-40)	33-50 (3.3-5.0, 24-36)	45-60 (4.5-6.0, 33-43)	43-69 (4.3-6.9, 31-50)
M12	34-50 (3.4-5.0, 25-36)	31-47 (3.1-4.7, 22-34)	70-95 (7.0-9.5, 51-69)	65-85 (6.5-8.5, 43-61)	85-110 (8.5-11, 61-80)	75-100 (7.5-10, 54-72)

**Hexagon flange bolts**

Unit: Nm (kgm, ft.lbs.)

Strength Code	4T		7T		8T	
	Head Mark		Head Mark		Head Mark	
Nominal Diameter mm	 (Stud)		 (Stud)		 (Stud)	
M6	4-6 (0.4-0.6, 2.9-4.3)	-	8-12 (0.8-1.2, 5.8-9)	-	9-14 (0.9-1.4, 6.5-10)	-
M8	10-15 (1.0-1.5, 7-11)	-	19-28 (1.9-2.8, 14-20)	-	22-33 (2.2-3.3, 16-24)	-
M10	21-31 (2.1-3.1, 15-22)	19-29 (1.9-2.9, 14-21)	21-31 (2.1-3.1, 15-22)	36-54 (3.6-5.4, 26-39)	50-65 (5.0-6.5, 36-47)	45-60 (4.5-6.0, 33-43)
M12	38-55 (3.8-5.5, 27-40)	34-52 (3.4-5.2, 25-38)	39-60 (3.9-6.0, 28-43)	70-95 (7.0-9.5, 51-69)	90-120 (9.0-12, 65-87)	85-110 (8.5-11, 61-80)

**Hexagon nuts**

Unit: Nm (kgm, ft.lbs.)

Strength Code	4T		6T	
	Head Mark			
Nominal Diameter mm	Standard Thread	Coarse Thread	Standard Thread	Coarse Thread
	M5	2-3 (0.2-0.3, 1.4-2.2)	-	4-6 (0.4-0.6, 2.9-4.3)
M6	4-6 (0.4-0.6, 2.9-4.3)	-	7-11 (0.7-1.1, 5.1-8)	-
M8	9-14 (0.9-1.4, 6.5-10)	-	17-26 (1.7-2.6, 12-19)	-
M10	19-28 (1.9-2.8, 14-20)	18-27 (1.8-2.7, 13-20)	35-55 (3.5-5.5, 25-40)	33-50 (3.3-5.0, 24-36)
M12	34-50 (3.4-5.0, 25-36)	31-47 (3.1-4.7, 22-34)	70-95 (7.0-9.5, 51-69)	65-85 (6.5-8.5, 43-61)

**Hexagon flange nuts**

Unit: Nm (kgm, ft.lbs.)

Strength Code	4T		6T	
	Head Mark			
Nominal Diameter mm	Standard Thread	Coarse Thread	Standard Thread	Coarse Thread
	M6	4-6 (0.4-0.6, 2.9-4.3)	-	8-12 (0.8-1.2, 5.8-9)
M8	10-15 (1.0-1.5, 5.7-11)	-	19-28 (1.9-2.8, 14-20)	-
M10	21-31 (2.1-3.1, 15-22)	19-29 (1.9-2.9, 14-21)	21-31 (2.1-3.1, 15-22)	36-54 (3.6-5.4, 26-39)
M12	38-55 (3.8-5.5, 27-40)	34-52 (3.4-5.2, 25-38)	39-60 (3.9-6.0, 28-43)	70-95 (7.0-9.5, 51-69)

**Tightening torques for ordinary flare nuts**

Unit: Nm (kgm, ft.lbs.)

Pipe diameter mm	φ4.76	φ6.35	φ8	φ10	φ12	φ15
Tightening torque	17 (1.7, 12)	26 (2.6, 19)	40 (4.0, 29)	60 (6.0, 43)	90 (9.0, 65)	100 (10.0, 72)

**SEALANT**

Location	Specified sealant
Front and rear packing contact surfaces of rocket cover gasket	3M ATD Part No.8660 or equivalent
Circumferential surface of packing (front and rear)	
Mating surfaces of front plate to cylinder head gasket and to oil pan	
Oil pressure gauge unit	
Oil pressure switch	
Inner surface of sealing cap press-fitting hole	THREEBOND TB1386D, LOCTITE 962T or equivalent
Mating surface of oil pan to crankcase	MD970389 or equivalent
Mating surface of timing gear case to front plate	

**FORM-IN-PLACE GASKET**

The engine has several areas where the form-in-place gasket (FIPG) is in use. To ensure that the gasket fully serves its purpose, it is necessary to observe some precautions when applying the gasket. Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of the fluid feed line. To eliminate the possibility of leaks from a joint, therefore, it is absolutely necessary to apply the gasket evenly without a break, while observing the correct bead size.

Since the FIPG used in the engine hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas.

**Disassembly**

The parts assembled with the FIPG can be easily disassembled without use of a special method. In some cases, however, the sealant between the joined surfaces may have to be broken by lightly striking with a mallet or similar tool. A flat gasket scraper may be lightly hammered in between the joined surfaces. In this case, however, care must be taken to prevent damage to the joined surfaces. The special tool Oil Pan Remover (MD998727) is available for this purpose.

**Surface Preparation**


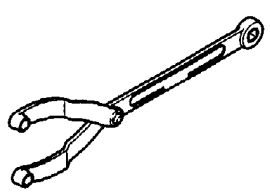
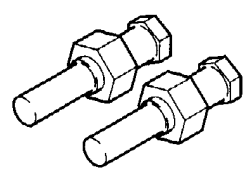
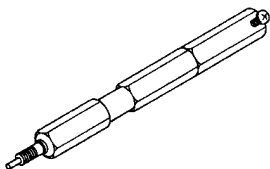
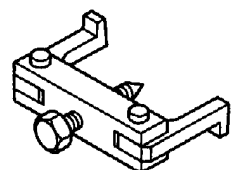
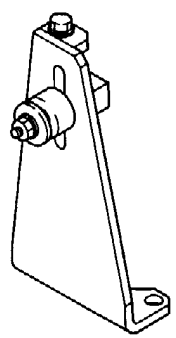
Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do not forget to remove the old sealant remaining in the bolt holes.

**Form-In-Place Gasket Application**

Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only.

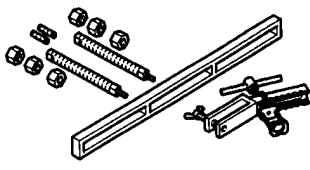
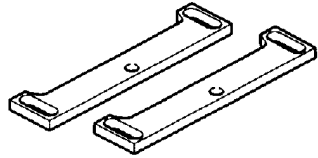
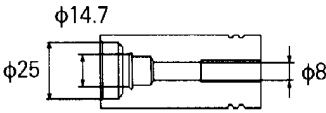
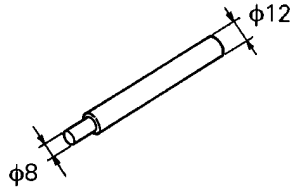
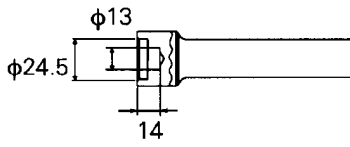
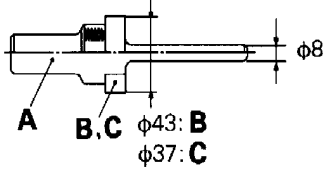
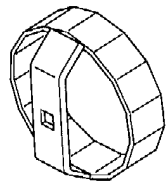
The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.

## 2. SPECIAL TOOLS

Tool	Number	Name	Use
	105789-0010 (Zexel)	Nozzle cleaning tool	Cleaning fuel injection nozzle assembly
	MB990767	Front hub and flange yoke holder	Cranking engine and locking Use with MD998754
	MD998754	Crankshaft pulley holder pin	Cranking engine and locking Use with MB990767
	MH063302	Measuring device	Checking and adjusting fuel injection timing
	MH062464	Gear puller	Removal of fuel injection pump gear
	MH062381	Cam sprocket holder kit	Holding cam sprocket

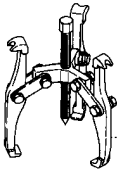
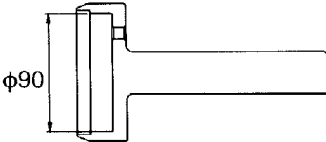
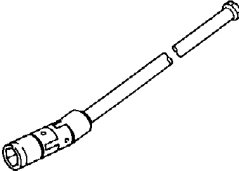
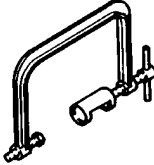
# 11A-2-2

## 4M4 ENGINE – Special Tools

Tool	Number	Name	Use
	MD998772	Valve spring compressor	Removal and installation of valve cotter Use with MD998784
	MD998784	Valve spring compressor adapter plate	Removal and installation of valve cotter Use with MD998772
	MH062671	Valve stem seal installer	Installation of valve stem seal
	31391-10500	Valve guide remover	Removal of valve guide
	MH062686	Valve guide installer	Installation of valve guide
	31391-13100 MH062687 MH062688	<b>A:</b> Calking tool body <b>B:</b> Calking inlet <b>C:</b> Calking exhaust	Installation of valve seat
	MH061590	Oil filter wrench	Replacement of oil filter

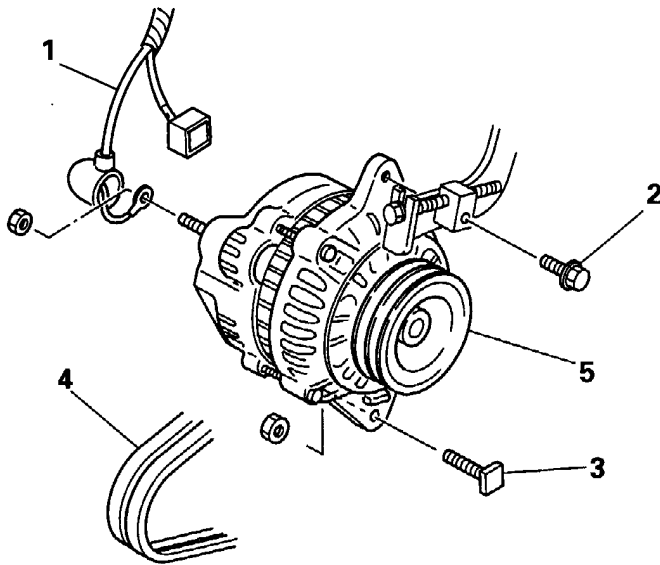


Tool	Number	Name	Use
	MH062463	Idler gear bush puller	Removal and installation of idler gear bush
	MH062462	Idler sprocket bush puller	Removal and installation of idler sprocket bush
	MH062490	Balance shaft bush remover	Removal of balance shaft bush
	MH062717	Balance shaft bush installer	Press-fitting balance shaft bush
	MH062226	Piston guide	Installation of piston and connecting rod assembly
	MH062455	Connecting rod bush puller kit	Removal and installation of connecting rod bush
	MH060014	Piston ring tool	Removal and installation of piston rings

Tool	Number	Name	Use
	MH062469	Gear puller	Removal of crankshaft gear
	MH062670	Rear oil seal slinger installer	Installation of rear oil seal slinger
	MH063300	Universal extension	Checking and adjusting fuel injection timing
	MD999597	Valve spring compressor	Compressing valve spring

### 3. GENERATOR ASSEMBLY

#### REMOVAL AND INSTALLATION

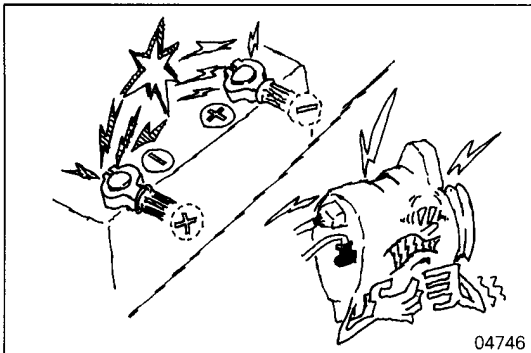


#### Removal steps

1. Wiring harness
2. Adjusting bolt
3. Bolt
4. V-belt (See page 11A-4-1.)

◆A◆ 5. Generator

04745



04746

#### REMOVAL SERVICE POINTS

##### ◆A◆ GENERATOR INSPECTION

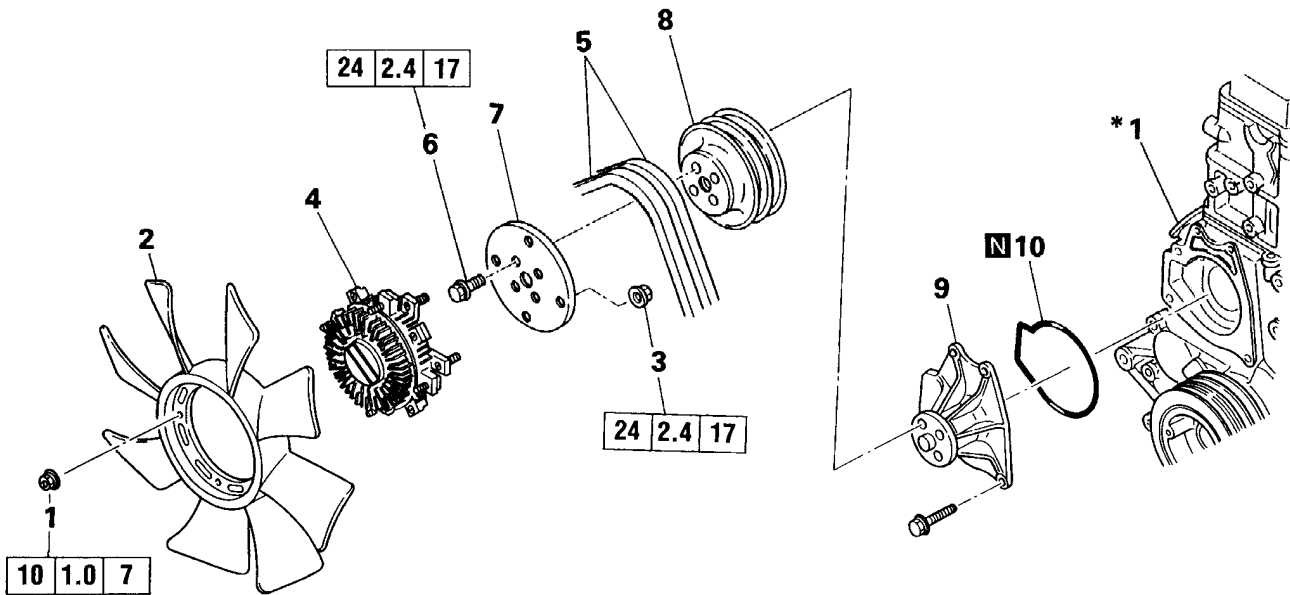
##### (1) Caution in Handling Generator

The following caution should be taken when servicing the generator **5**.

Be sure to connect the generator **5** to the battery correctly. Reversed polarity causes an excessive current to flow from the battery to the generator **5**, damaging the diodes and voltage regulator.

## 4. COOLING FAN, V-BELT AND WATER PUMP REMOVAL AND INSTALLATION

<EXCEPT PAJERO 2001MODEL>



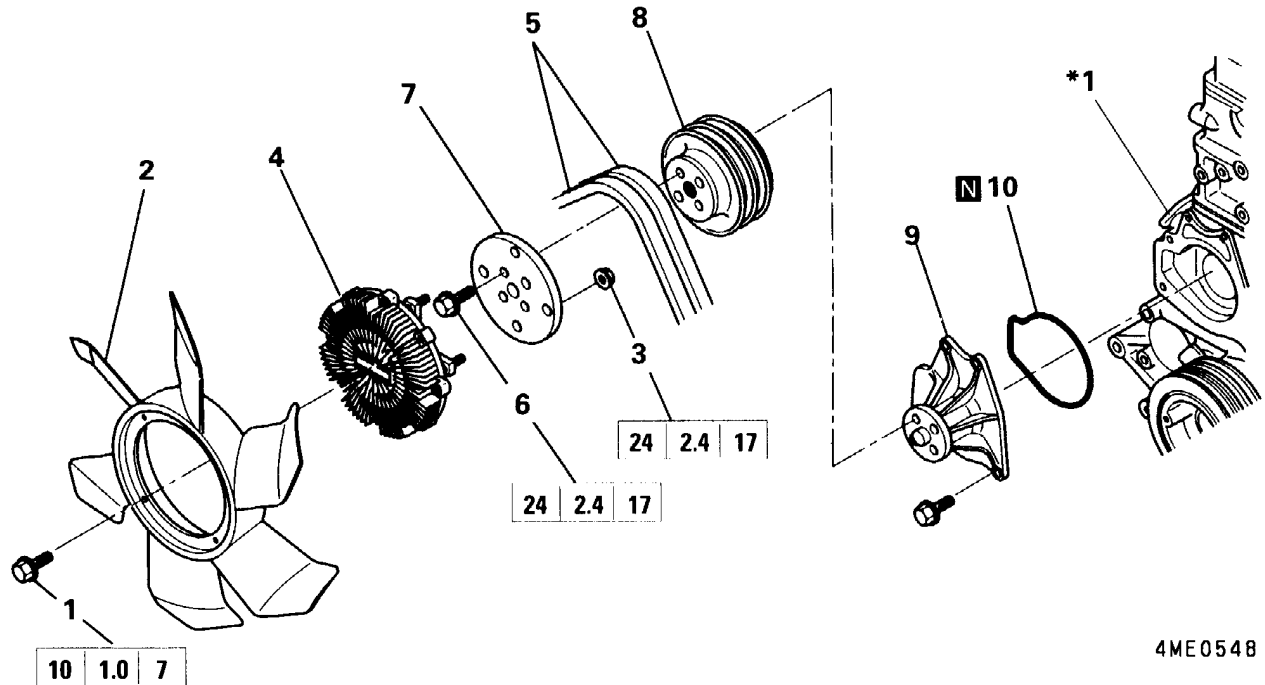
### Removal steps

1. Nut
2. Cooling fan
3. Nut <RHD>
4. Auto-cooling fan coupling
5. V-belt
6. Bolt <RHD>
7. Coupling plate <RHD>
8. Water pump pulley
9. Water pump assembly
10. O-ring

\*1: Timing gear case

## REMOVAL AND INSTALLATION

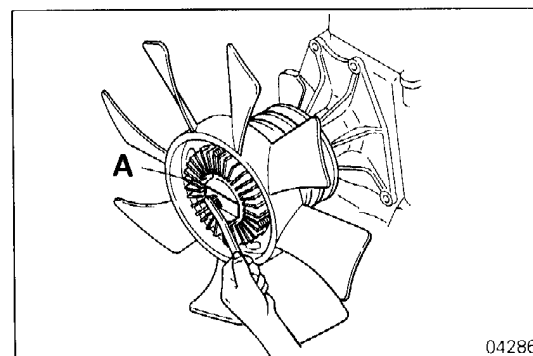
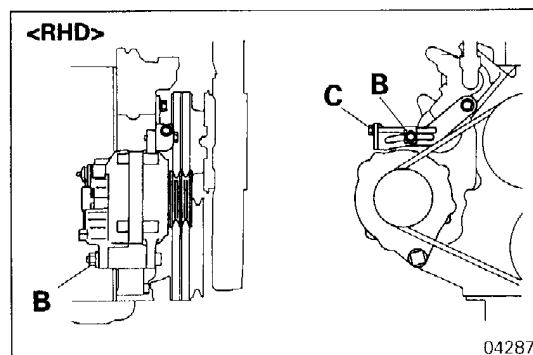
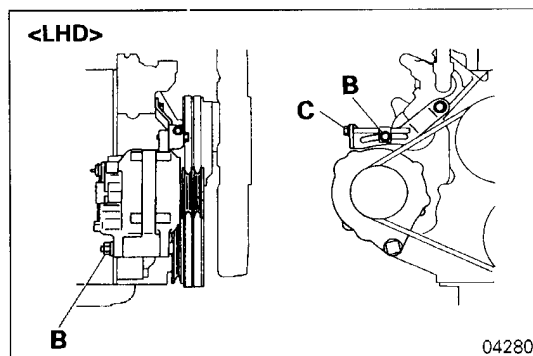
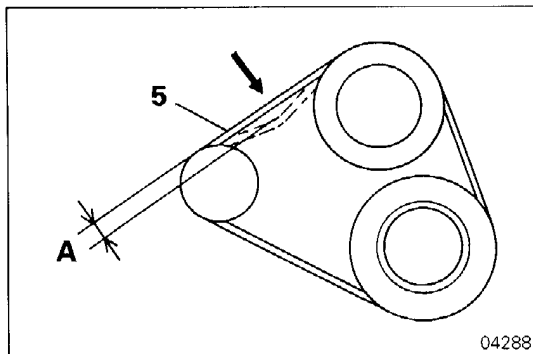
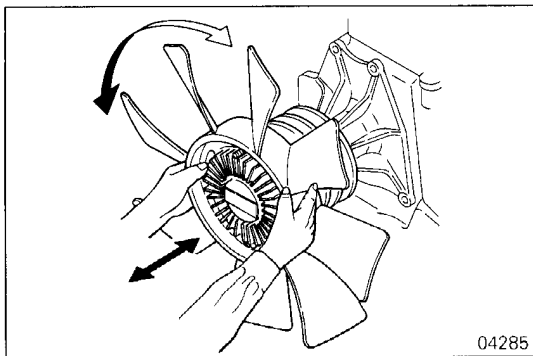
&lt;PAJERO 2001 MODEL&gt;

**Removal steps**

1. Bolt
2. Cooling fan
3. Nut
4. Auto-cooling fan coupling
5. V-belt
6. Bolt
7. Coupling plate
8. Water pump pulley
9. Water pump assembly
10. O-ring

\*1:Timing gear case

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## INSPECTION

### AUTO-COOLING FAN COUPLING

- (1) Check the auto-cooling fan coupling **4**, and replace if any of the following conditions exists:
  - (a) Hydraulic fluid is leaking from the hermetically sealed housing.
  - (b) The coupling turns irregularly or produces an abnormal sound when rotated by hand due to defective inside bearing.
  - (c) The coupling has an excessive axial play when moved with the engine in a cold state.

### V-BELT

- (1) Push the V-belt **5** at its midpoint with a force of approximately 98 N (10 kg, 22 lbs.) as shown and read the amount of deflection **A**.
- (2) If the reading deviates from the specified standard value, accomplish the following adjustment.
- (3) Loosen the bolt and nut **B** holding the generator, and adjust the tension of the V-belt **5** using the adjusting bolt **C**.

#### Caution

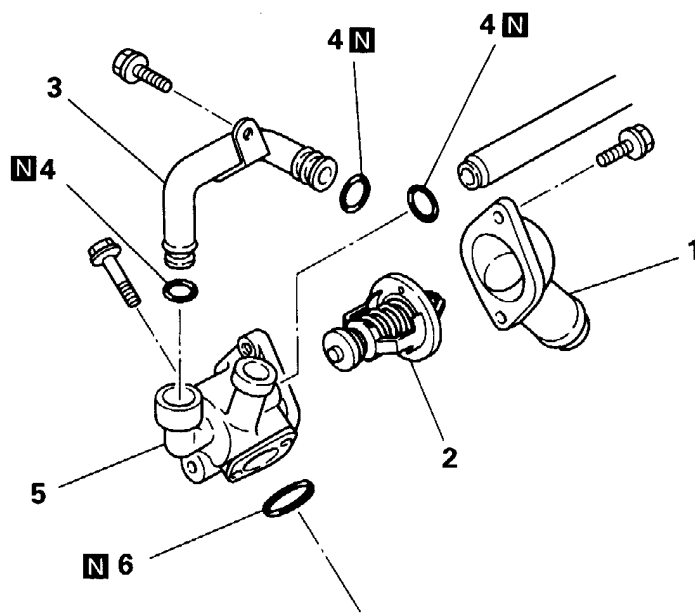
- Be sure to retighten the bolt and nut securely after the adjustment.
- Excessive tension damages not only the V-belt **5** itself but bearings elsewhere.
- Be sure to replace the V-belt **5**, when necessary, in pairs and keep it slush-free.

## CLEANING

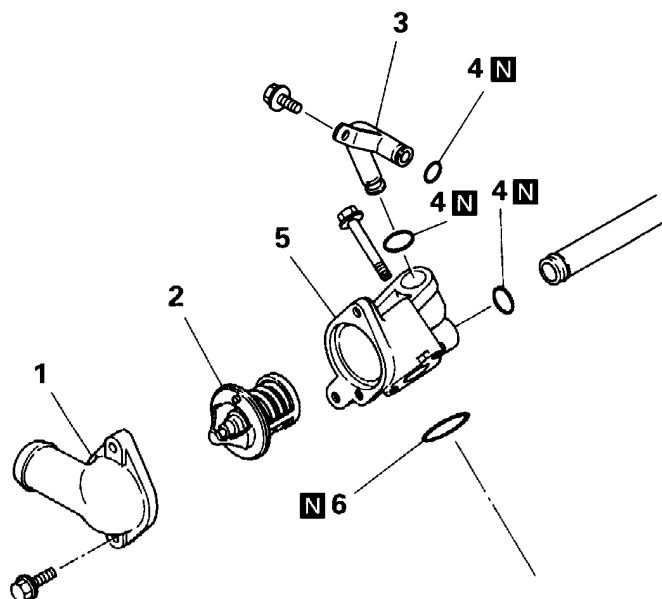
- (1) Remove foreign matters, if any, from the bimetal **A** using care not to apply unnecessary force to it.

## 5. THERMOSTAT REMOVAL AND INSTALLATION

<EXCEPT CHALLENGER 2000MODEL, PAJERO 2001MODEL>



<CHALLENGER 2000MODEL, PAJERO 2001MODEL>



### Removal steps

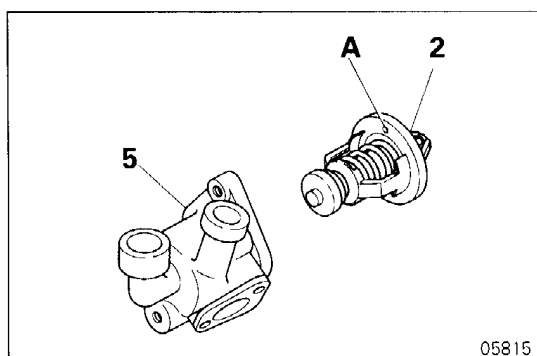
1. Thermostat cover
- ◆B◆ 2. Thermostat
- ◆A◆ 3. Bypass pipe
- ◆A◆ 4. O-ring
5. Thermostat case
- ◆A◆ 6. O-ring

4ME0367



**INSTALLATION SERVICE POINTS****▶A◀ O-RING****Caution**

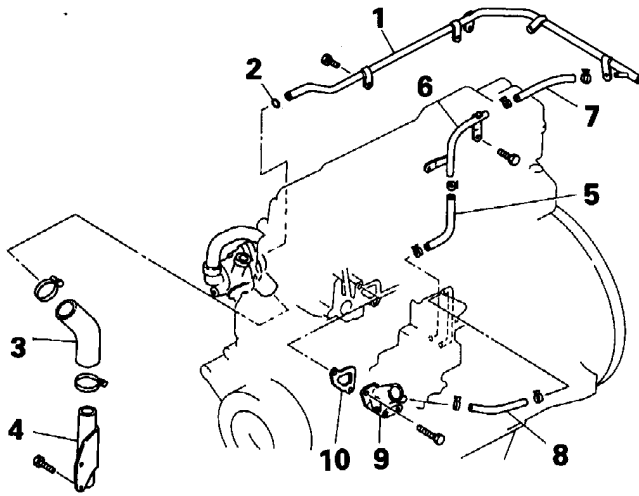
- Engine oil swells O-rings. When installing the O-rings 4 and 6, be sure that they are free of engine oil.

**▶B◀ THERMOSTAT**

- (1) Install the thermostat **2** with its jiggle valve **A** located at the uppermost position.

## 6. WATER HOSES AND PIPES

### REMOVAL AND INSTALLATION (FOR L200 and PAJERO except 1998– model for Europe)



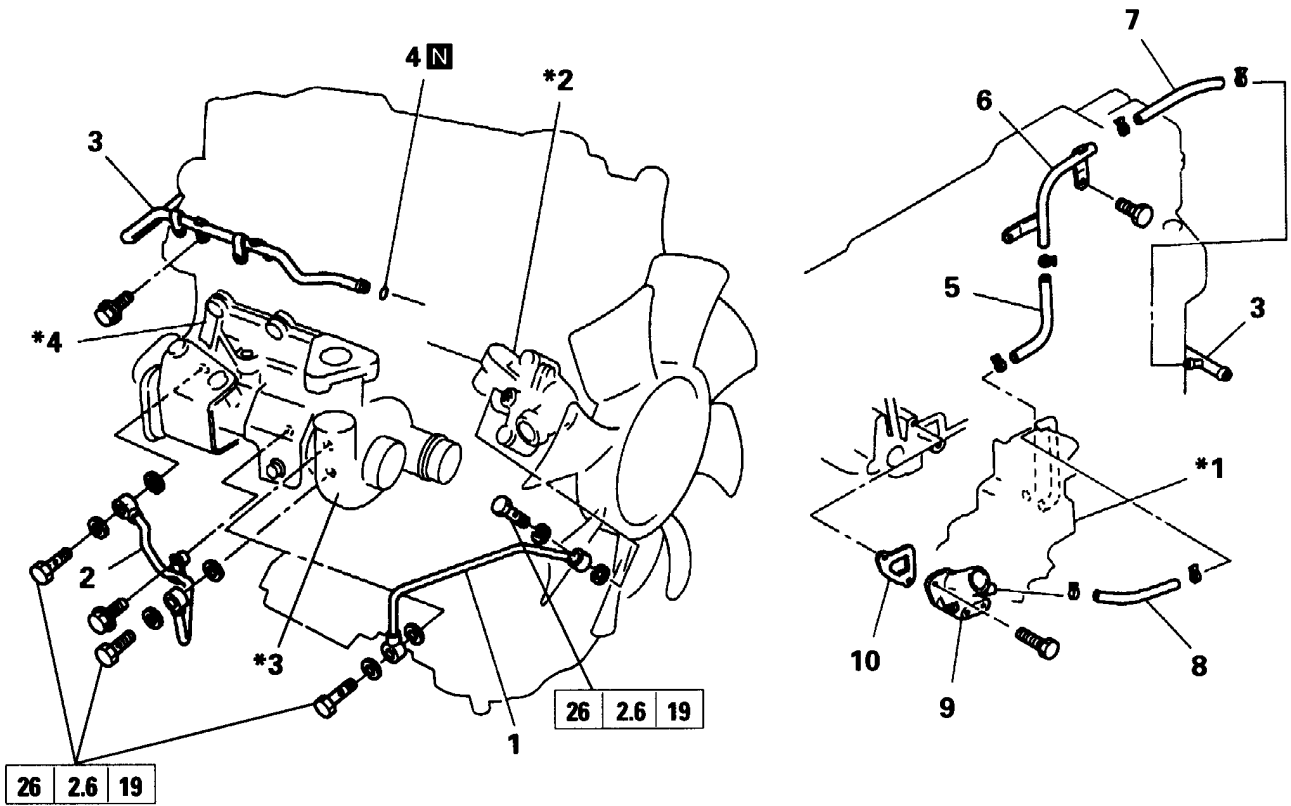
#### Removal steps

1. Heater return pipe
- ▶▶ 2. O-ring
3. Water inlet hose
4. Water inlet pipe
5. Water hose <with W-CSD>
6. Water pipe <with W-CSD>
7. Water hose <with W-CSD>
8. Water hose <with W-CSD>
9. Water outlet pipe
10. Gasket

NOTE  
W-CSD: Wax type cold start device

04291

REMOVAL AND INSTALLATION (FOR CHALLENGER)

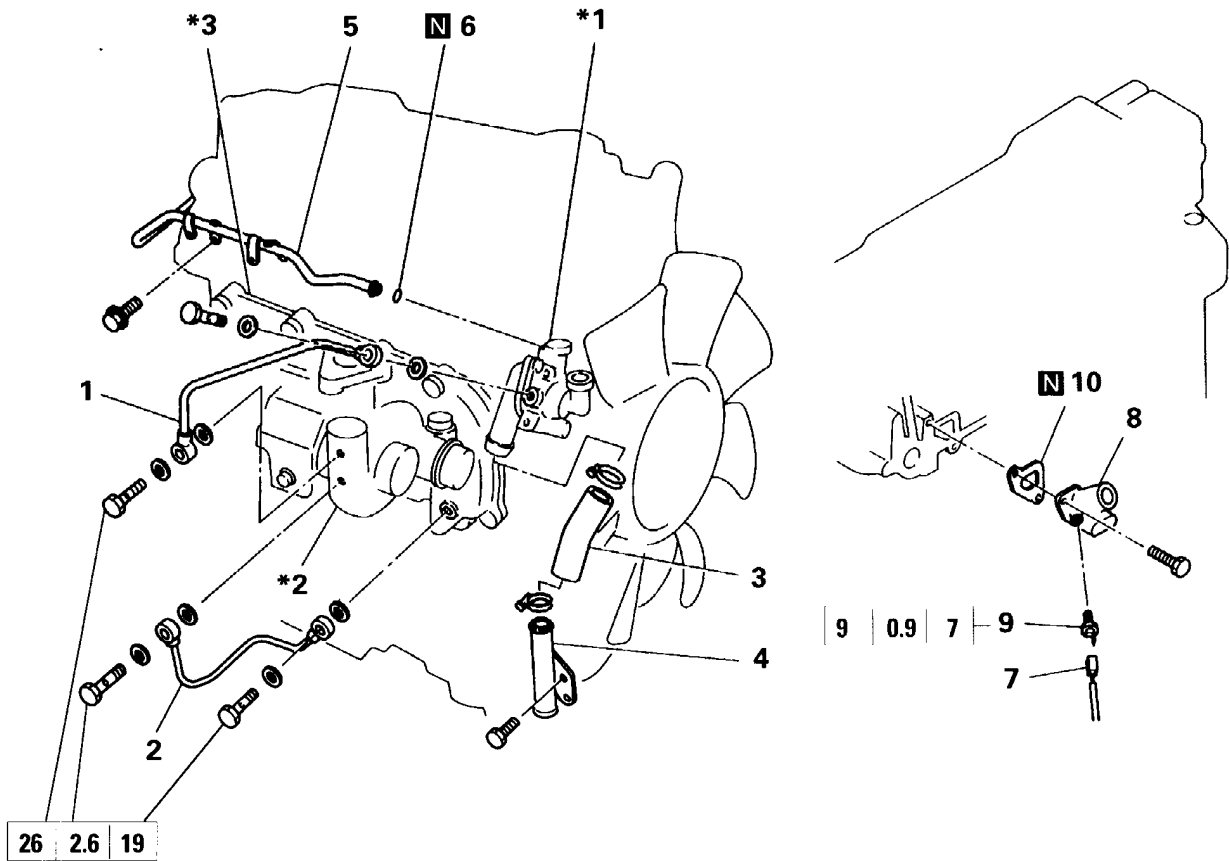


**Removal steps**

- |                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>1. Turbocharger water outlet pipe</li> <li>2. Turbocharger water inlet pipe</li> <li>3. Heater return pipe</li> <li>▶A▶ 4. O-ring</li> <li>▶B▶ 5. Water hose</li> <li>▶B▶ 6. Water pipe</li> <li>▶B▶ 7. Water hose</li> </ul> | <ul style="list-style-type: none"> <li>▶B▶ 8. Water hose</li> <li>9. Water outlet pipe</li> <li>10. Gasket</li> <li>*1: Injection pump assembly</li> <li>*2: Thermostat assembly (See page 11A-5-1.)</li> <li>*3: Turbocharger assembly (See page 11A-9-2.)</li> <li>*4: Oil cooler assembly (See page 11A-15-1.)</li> </ul> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

4ME0069

REMOVAL AND INSTALLATION (1998- PAJERO for Europe)

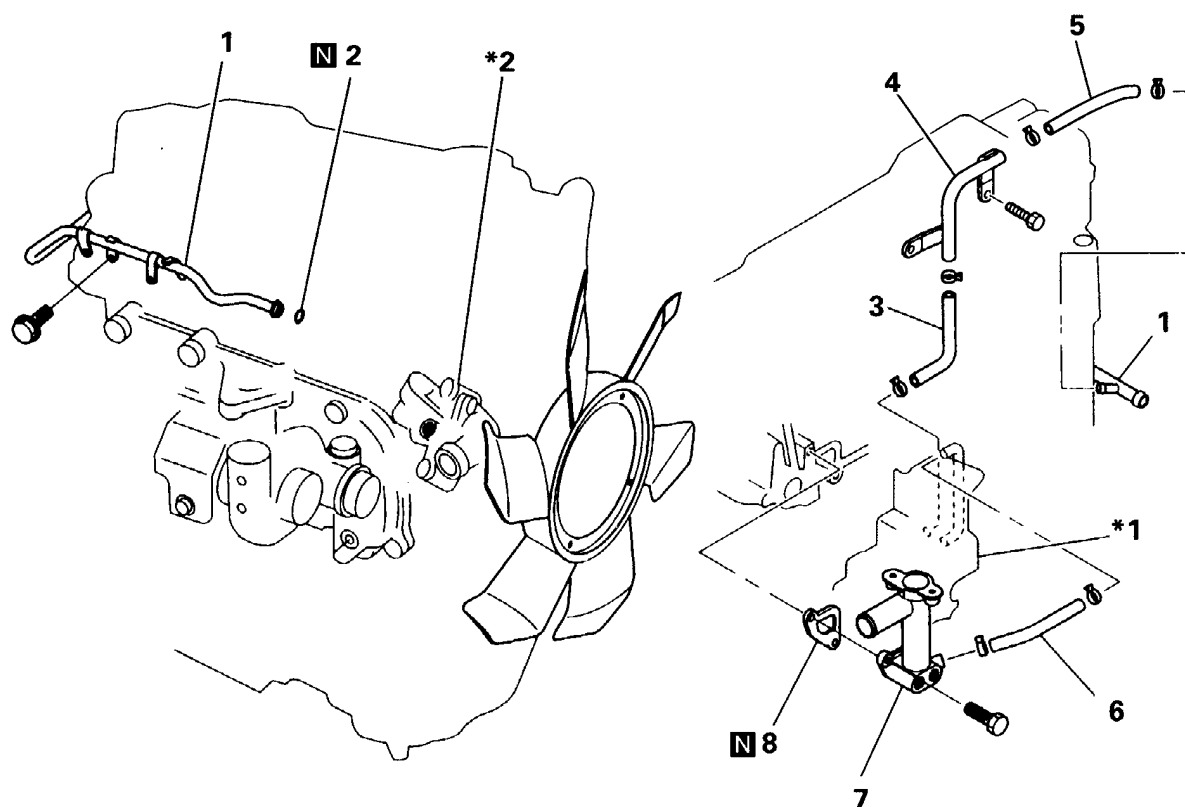


**Removal steps**

- |                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>1. Turbocharger water outlet pipe</li> <li>2. Turbocharger water inlet pipe</li> <li>▶B▶ 3. Water inlet hose</li> <li>4. Water inlet pipe</li> <li>5. Heater return pipe</li> <li>▶A▶ 6. O-ring</li> <li>7. Harness</li> </ul> | <ul style="list-style-type: none"> <li>8. Water outlet pipe</li> <li>9. Engine coolant temperature sensor</li> <li>10. Gasket</li> </ul> <p>*1: Thermostat case (See page 11A-5-1.)<br/>                 *2: Turbocharger assembly (See page 11A-9-3.)<br/>                 *3: Oil cooler assembly (See page 11A-15-1.)</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

4MF0066

## REMOVAL AND INSTALLATION (2001- PAJERO)



4ME0545

**Removal steps**

- 1. Heater return pipe
- ▶A▶ 2. O-ring
- ▶B▶ 3. Water hose
- ▶B▶ 4. Water pipe
- ▶B▶ 5. Water hose
- ▶B▶ 6. Water hose

- 7. Water outlet pipe
- 8. Gasket

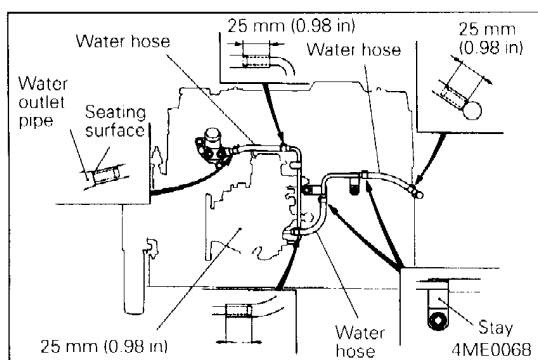
\*1: Injection pump assembly

\*2: Thermostat case (See page 11A-5-1.)

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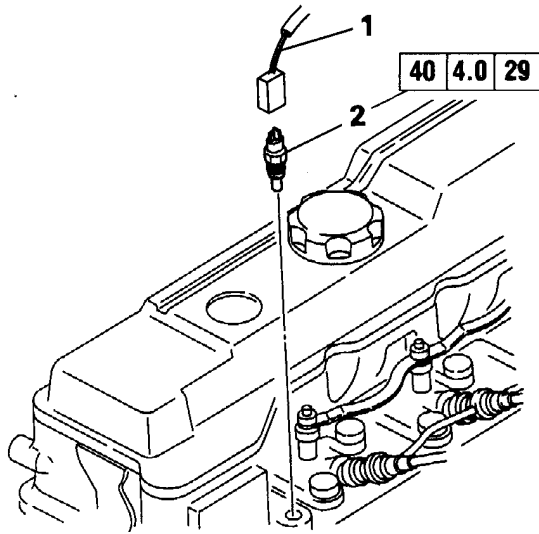
**INSTALLATION SERVICE POINT****◆A◆ O-RING****Caution**

- Engine oil swells O-rings. When installing the O-ring, be sure that it is free of engine oil.

**◆B◆ WATER HOSE INSTALLATION**

- (1) Install the water hoses as follows; first slide one end of each hose over the pipe until the overlap length is as shown in the illustration, then fit the other end firmly until it comes into contact with the stay or the seating surface of the pipe.

## 7. COOLANT TEMPERATURE SENSOR REMOVAL AND INSTALLATION



### Removal steps

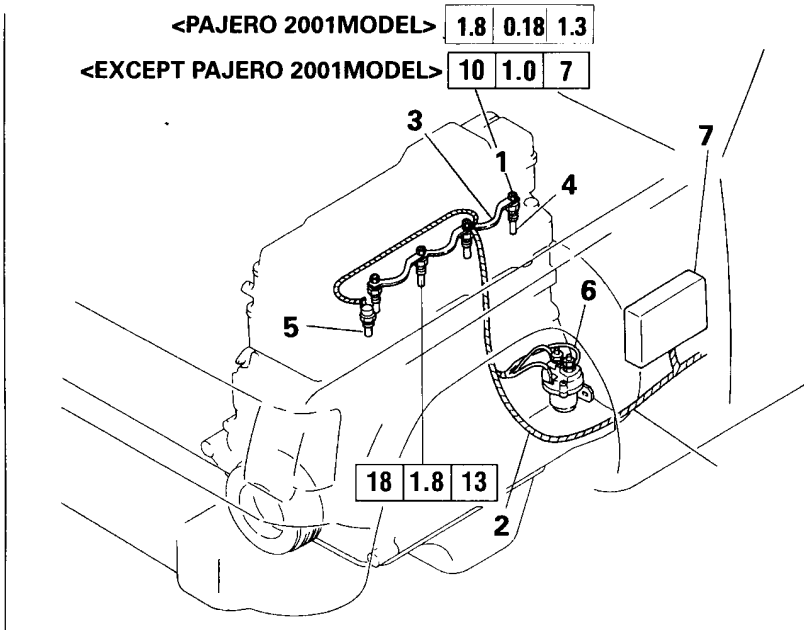
1. Wiring harness
2. Coolant temperature sensor

04292



## 8. GLOW PLUG

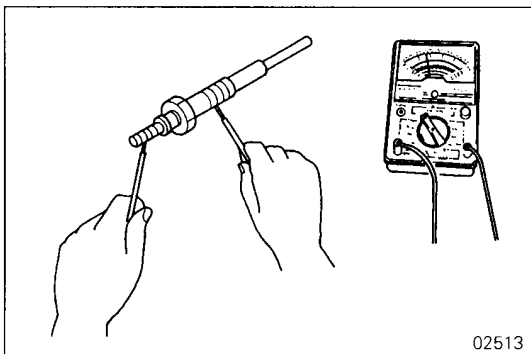
### REMOVAL AND INSTALLATION



#### Removal steps

1. Nut
2. Glow plug wiring harness
3. Connection plate
- ◆A◆ 4. Glow plug
5. Coolant temperature sensor (See page 11A-7-1.)
6. Glow relay
7. Glow and EGR ECU (with EGR)  
Glow ECU (without EGR)

04832

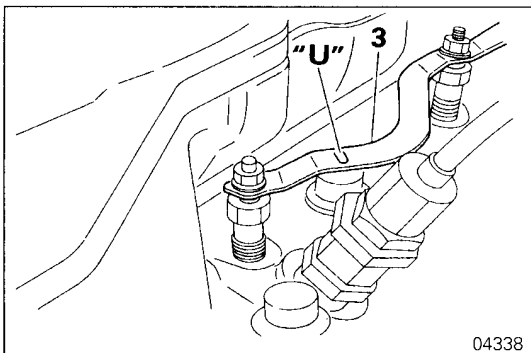


02513

### INSPECTION

#### GLOW PLUG

- (1) Measure resistance of the glow plug **4**. Replace the glow plug if the reading deviates from the specified standard value.



04338

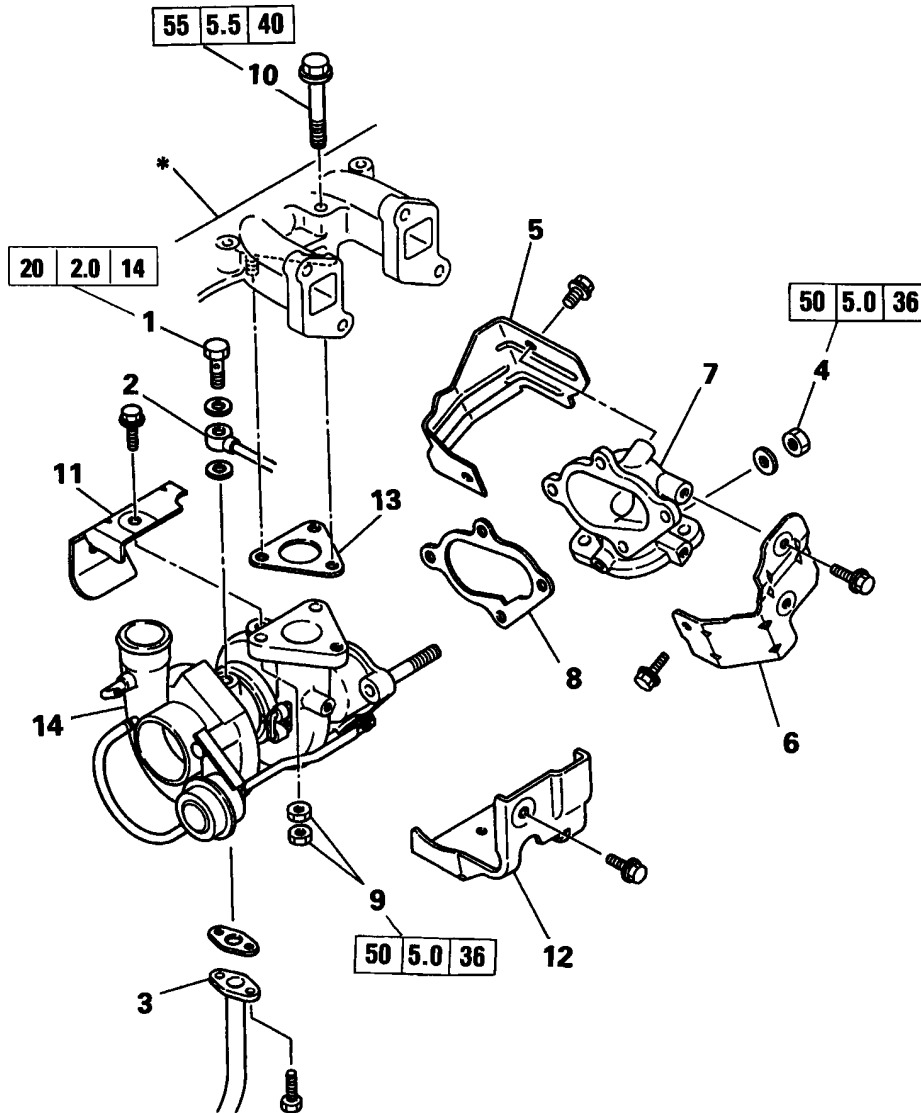
### INSTALLATION SERVICE POINT

#### ◆A◆ CONNECTION PLATE INSTALLATION

- (1) Install the connection plate **3** with "U" or "H" mark facing upward.

## 9. TURBOCHARGER ASSEMBLY

REMOVAL AND INSTALLATION (Except CHALLENGER and 1998– PAJERO for Europe)



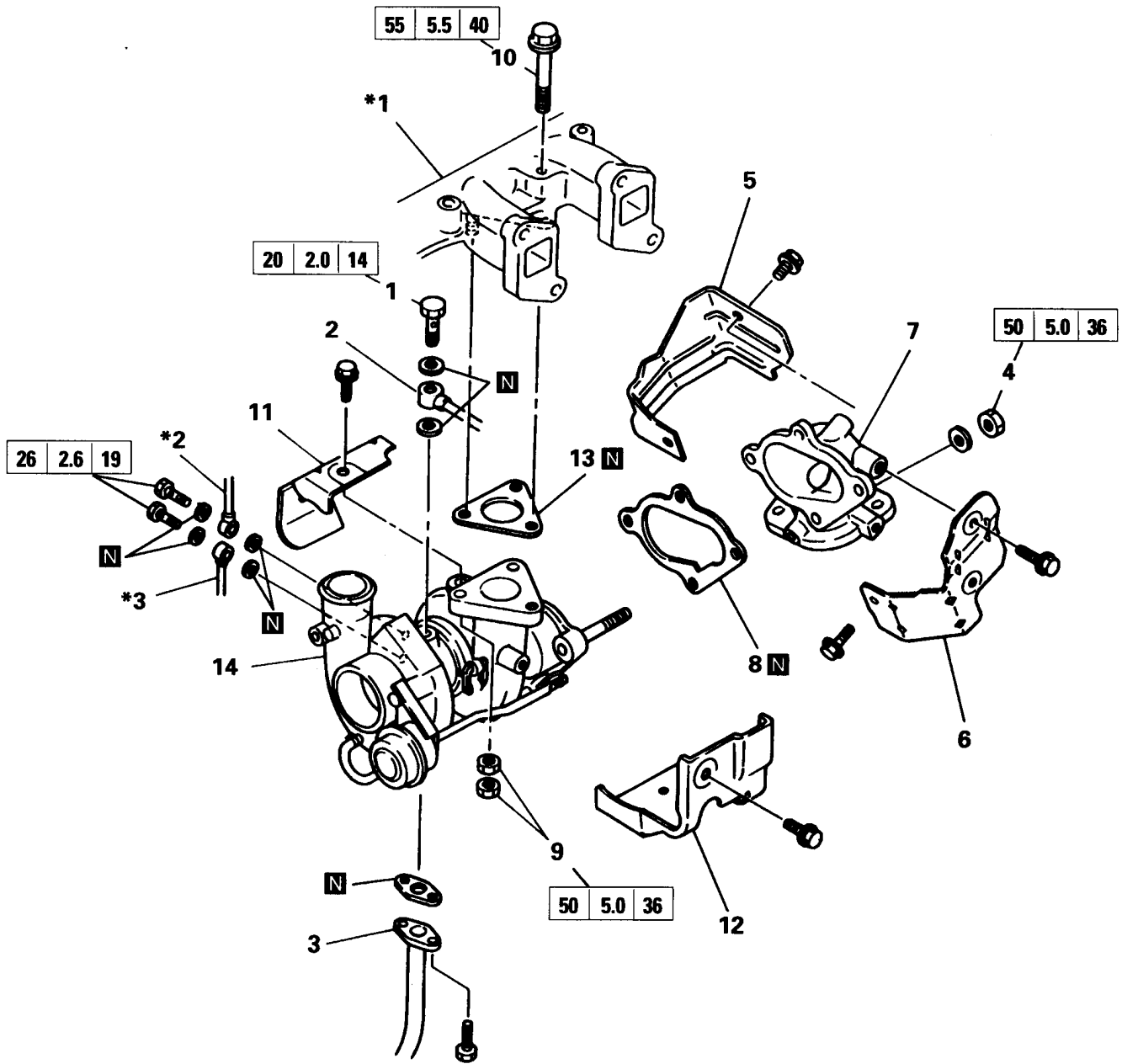
### Removal steps

- |                      |                                                       |
|----------------------|-------------------------------------------------------|
| 1. Eyebolt           | 8. Gasket                                             |
| 2. Oil feed pipe     | 9. Nut                                                |
| 3. Oil return pipe   | 10. Bolt                                              |
| 4. Nut               | 11. Insulator B                                       |
| 5. Coupler insulator | 12. Insulator A                                       |
| 6. Insulator         | 13. Gasket                                            |
| 7. Coupler           | ▶▶▶ 14. Turbocharger assembly<br>(See page 11A-10-1.) |

\*: Exhaust manifold



REMOVAL AND INSTALLATION (1998- PAJERO for Europe)

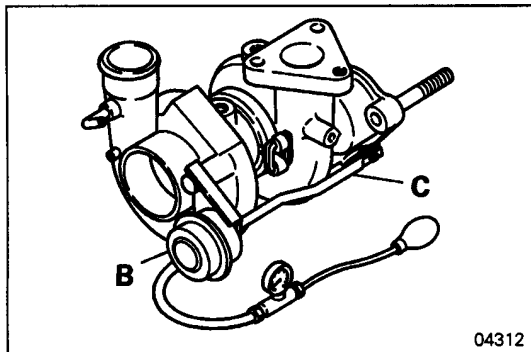
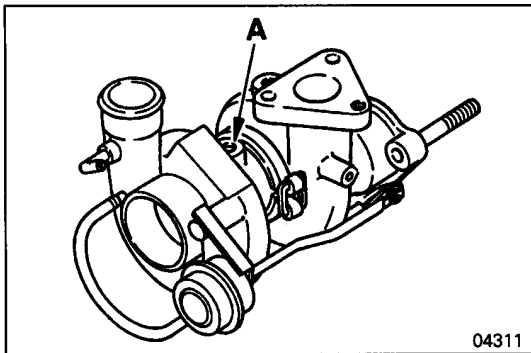


**Removal steps**

- 1. Eyebolt
- 2. Oil feed pipe
- 3. Oil return pipe
- 4. Nut
- 5. Coupler insulator
- 6. Insulator
- 7. Coupler
- 8. Gasket
- 9. Nut

- 10. Bolt
- 11. Insulator B
- 12. Insulator A
- 13. Gasket
- ▶▶ 14. Turbocharger assembly (See page 11A-10-1.)

- \*1: Exhaust manifold
- \*2: Turbocharger water outlet pipe (See page 11A-6-3.)
- \*3: Turbocharger water inlet pipe (See page 11A-6-3.)



## INSTALLATION SERVICE POINT

### ▶A◀ TURBOCHARGER ASSEMBLY INSTALLATION

(1) Prior to installing the turbocharger assembly **14**, pour engine oil into it through the oil inlet hole **A** to lubricate its component parts for smooth movement.

(2) Using a tester, apply pressure to the actuator **B** and read the pressure at which the rod **C** begins to move [approximately 1 mm (0.04 in.)].

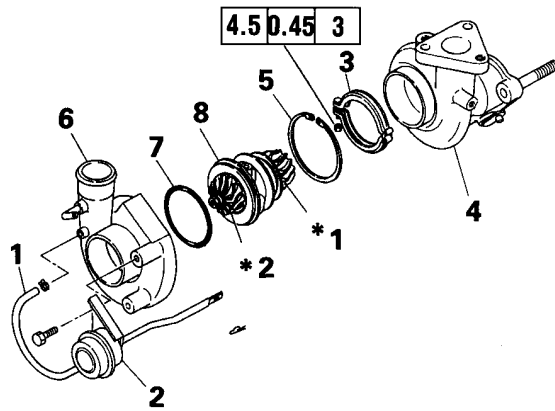
If the reading deviates from the specified standard value, replace the actuator. (See page 11A-1-2.)

#### Caution

- Do not load the actuator **B** with any more pressure than 117 kPa (1.17 kg/cm<sup>2</sup>, 16.6 psi) nor carry the turbocharger by holding the rod **C**, or the diaphragm may be damaged.

# 10. TURBOCHARGER

## DISASSEMBLY AND REASSEMBLY

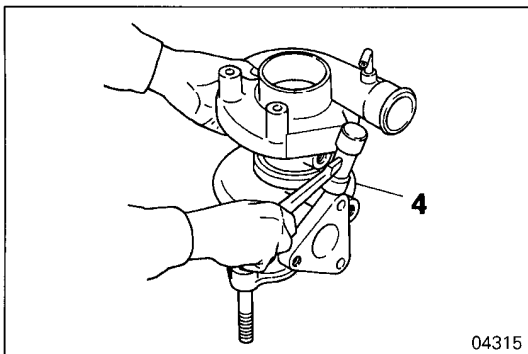


### Disassembly steps

- 1. Hose
- 2. Actuator
- ↔C↔ 3. Coupling
- ↔A↔ 4. Turbine housing
- ↔B↔ 5. Snap ring
- ↔B↔ 6. Compressor cover
- ↔A↔ 7. O-ring
- 8. Cartridge assembly

\*1: Turbine wheel  
\*2: Compressor wheel

04313



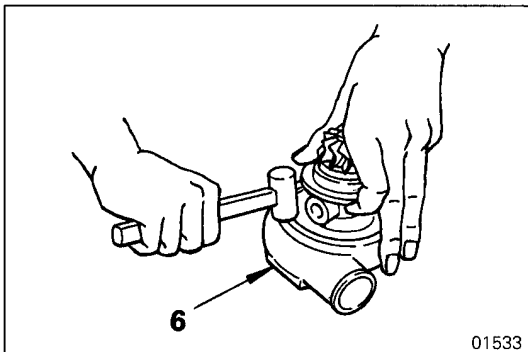
### DISASSEMBLY SERVICE POINTS

#### ↔A↔ TURBINE HOUSING REMOVAL

##### Caution

- Tap all over the circumferential surface of the turbine housing 4 with a rubber hammer or any other similar tool, using care not to damage it.
- The turbine wheel blades are easy to bend. Use care so that they do not contact the turbine housing 4.

04315

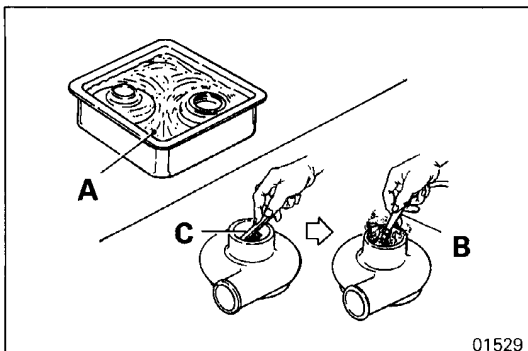


#### ↔B↔ COMPRESSOR COVER REMOVAL

##### Caution

- Tap all over the circumferential surface of the compressor cover 6 with a rubber hammer or any other similar tool, using care not to damage it.
- The compressor wheel blades are easy to bend. Use care so that they do not contact the compressor cover 6.

01533

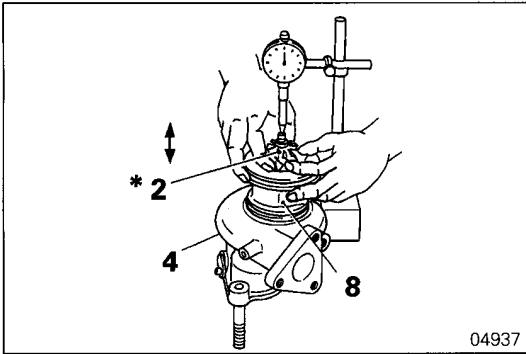


### CLEANING

#### TURBINE HOUSING / COMPRESSOR COVER

- (1) Prior to cleaning, visually check the disassembled parts for evidences of burns, abrasions or other flaws because they may become unrecognizable after washing. Replace if necessary.
- (2) Immerse the disassembled parts in the nonflammable solvent **A** (DAI-CLEANER T-30 from Daido Chemical Industry Co., Ltd.). Remove them from the solvent and blow compressed air **B** against them. Scrape off foreign matters, if any, using a plastic scraper **C** before the immersion.

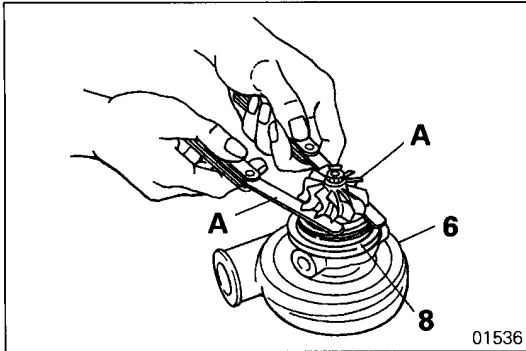
01529



## INSPECTION

### CARTRIDGE ASSEMBLY INSPECTION

- (1) Axial play of the shaft  
Install the cartridge assembly **8** temporarily in the turbine housing **4**, and measure the axial play of the shaft by moving the compressor wheel **\*2** in the axial direction. If the reading deviates from the specified standard value, replace the cartridge assembly **8**.



- (2) Turbine wheel back to turbine back plate clearance  
Install the cartridge assembly **8** temporarily in the compressor cover **6**, and read the clearance using a feeler gauge **A**. If the measurement deviates from the specified standard value, replace the cartridge assembly **8**.

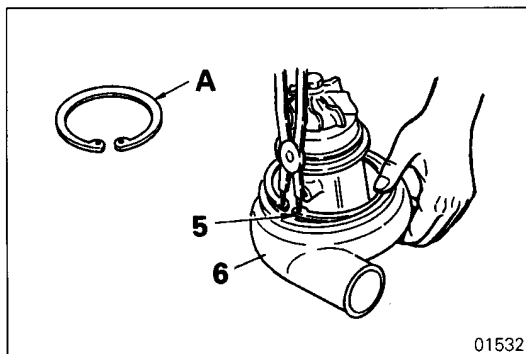
#### Caution

- **Be sure to measure the clearance at the blade tips using two feeler gauges.**

## REASSEMBLY SERVICE POINTS

### ◆A◆ O-RING INSTALLATION

- (1) Apply a thin coat of engine oil evenly to the entire circumferential surface of O-ring before installing it.

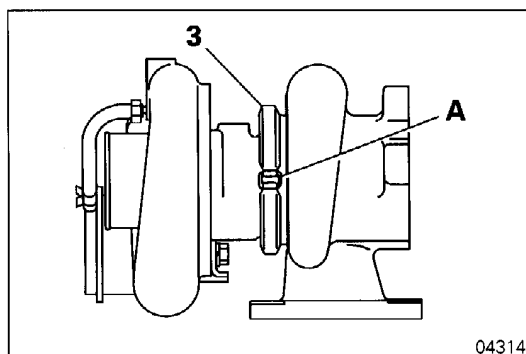


### ◆B◆ SNAP RING INSTALLATION

- (1) Install the snap ring **5** in the compressor cover **6** with the tapered surface **A** facing upward.

#### Caution

- **Hold the snap ring 5 with one hand not to let it bounce out.**



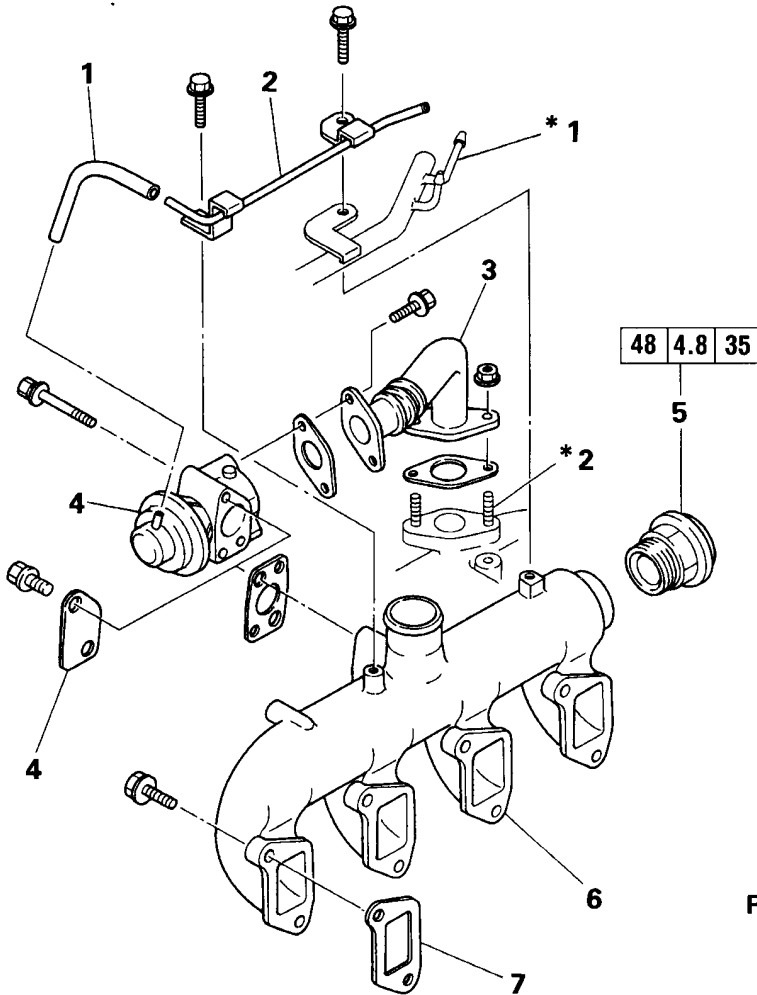
### ◆C◆ COUPLING INSTALLATION

- (1) Install the coupling **3** with the clip side **A** positioned as shown.

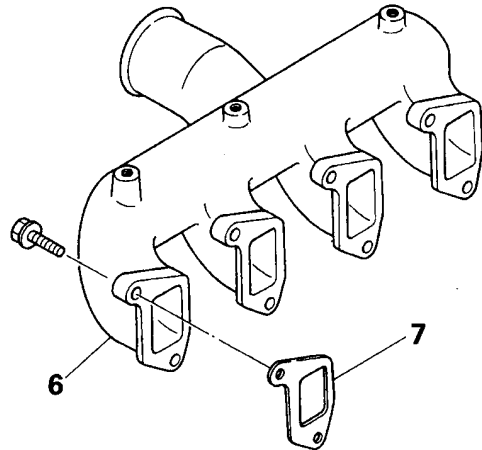
# 11. INTAKE MANIFOLD REMOVAL AND INSTALLATION

<Turbo: EXCEPT PAJERO 2001MODEL>

<Non-turbo>



04317



04316

### Removal steps

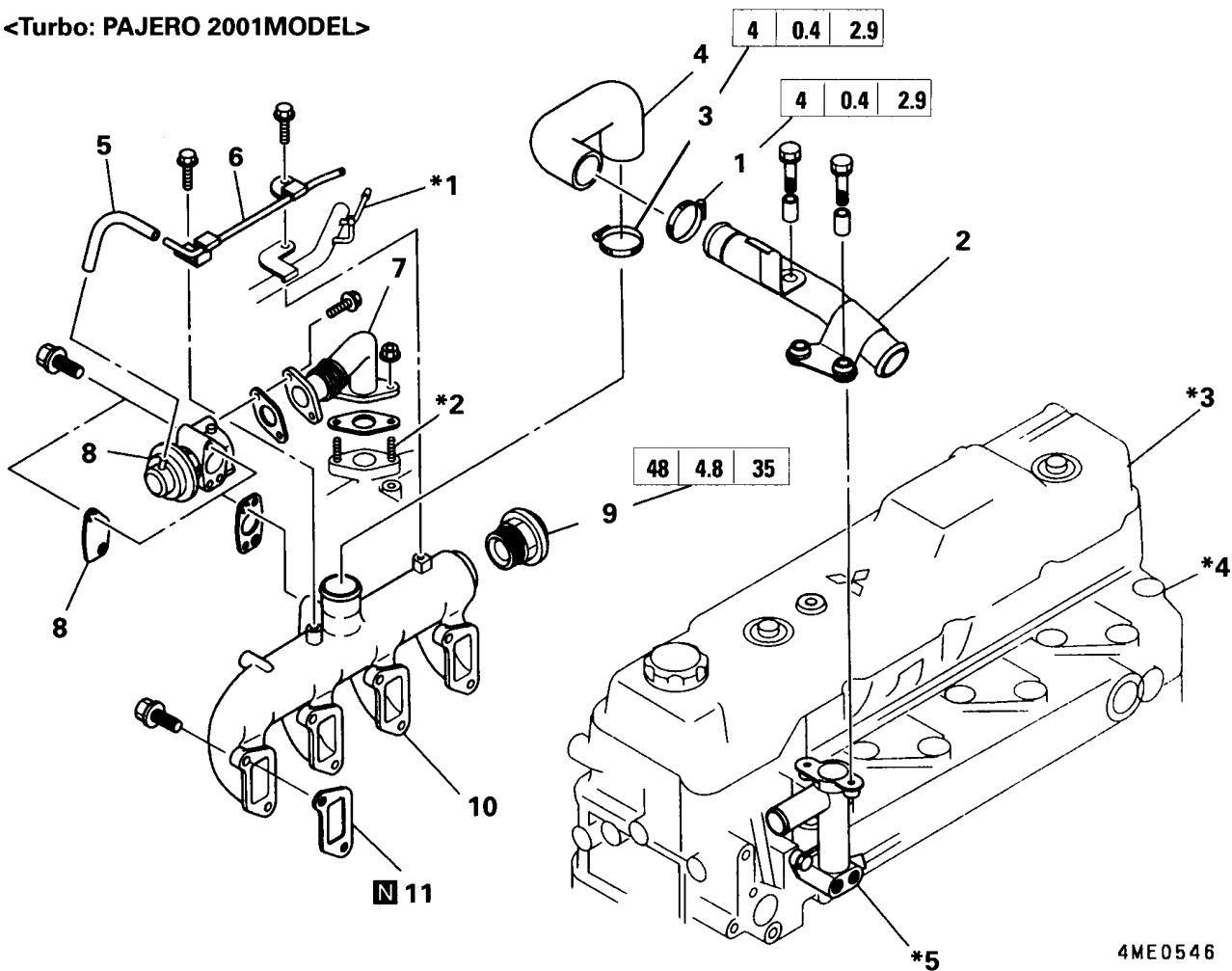
1. Vacuum hose <with EGR>
2. Vacuum pipe <with EGR>
3. EGR pipe <with EGR>
4. EGR valve <with EGR>  
Cover <without EGR>
5. Relief valve
6. Intake manifold
7. Gasket

- \*1. Vacuum pipe
- \*2. Exhaust manifold



REMOVAL AND INSTALLATION

<Turbo: PAJERO 2001MODEL>



Removal steps

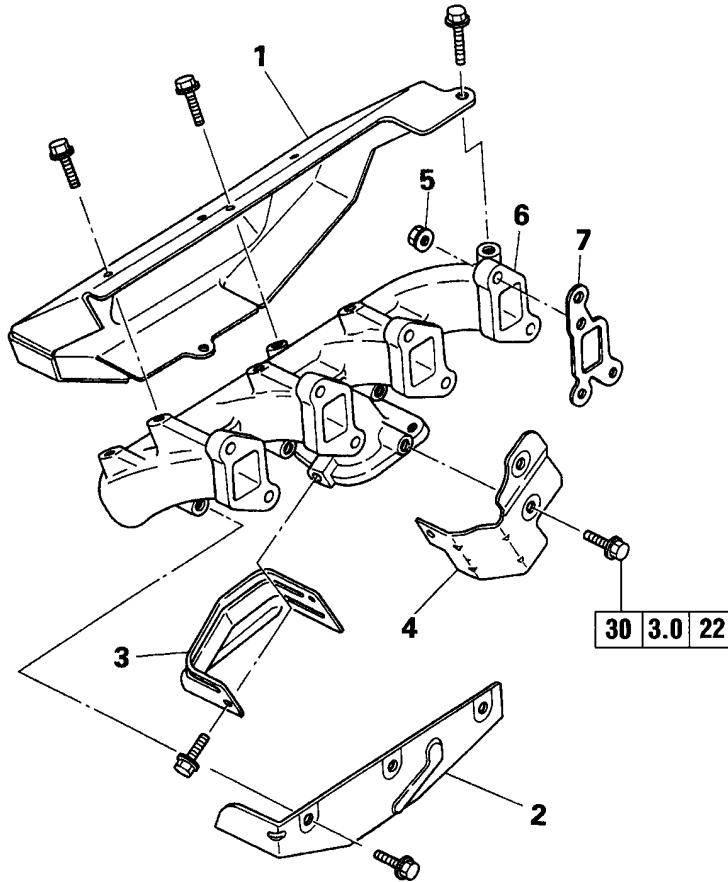
- 1. Clamp
- 2. Air inlet pipe
- 3. Clamp
- 4. Air inlet hose
- 5. Vacuum hose <with EGR>
- 6. Vacuum pipe <with EGR>
- 7. EGR pipe <with EGR>
- 8. EGR valve <with EGR>  
Cover <without EGR>

- 9. Relief valve
- 10. Intake manifold
- 11. Gasket

- \*1. Vacuum pipe
- \*2. Exhaust manifold
- \*3. Rocker cover
- \*4. Cylinder head
- \*5. Water outlet pipe

## 12. EXHAUST MANIFOLD

### REMOVAL AND INSTALLATION <NON-TURBO FOR PAJERO>

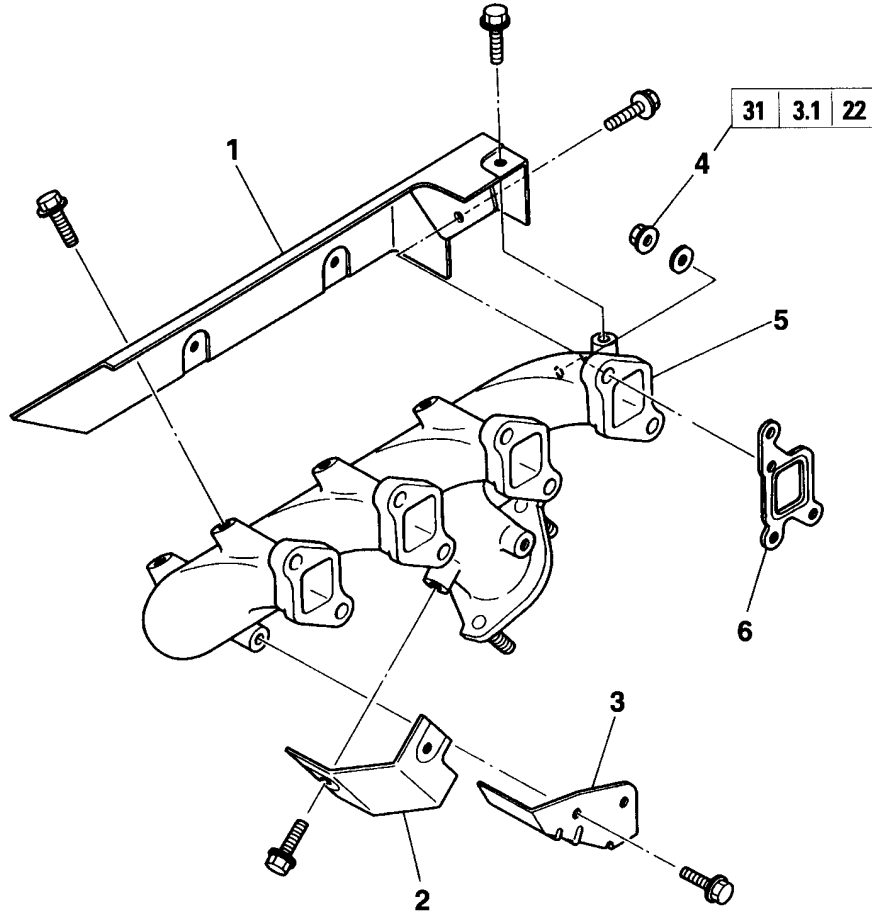


#### Removal steps

1. Insulator A
2. Insulator B
3. Insulator C
4. Insulator
5. Nut
6. Exhaust manifold
7. Gasket

04323

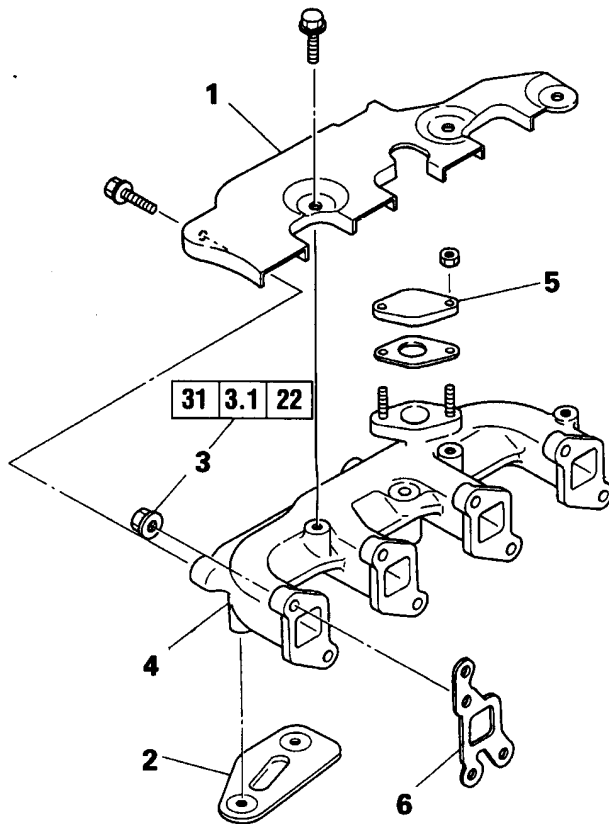
## REMOVAL AND INSTALLATION &lt;NON-TURBO FOR L200&gt;

**Removal steps**

1. Insulator A
2. Insulator B
3. Insulator
4. Nut
5. Exhaust manifold
6. Gasket

13349

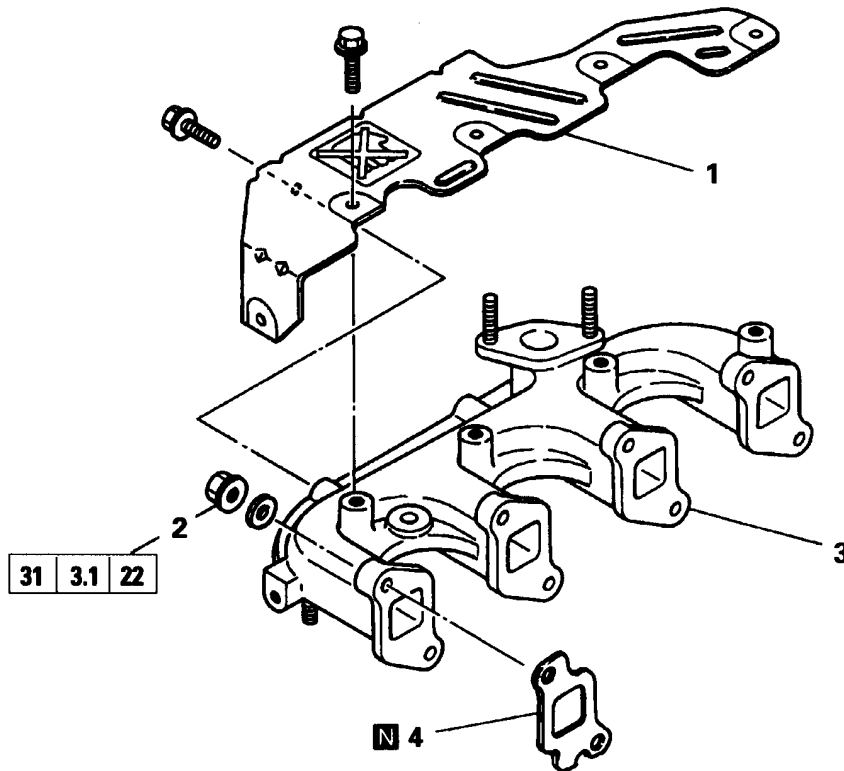
## REMOVAL AND INSTALLATION &lt;FOR PAJERO TURBO&gt;

**Removal steps**

1. Insulator
2. Insulator A
3. Nut
4. Exhaust manifold
5. Cover <without EGR>
6. Gasket

04324

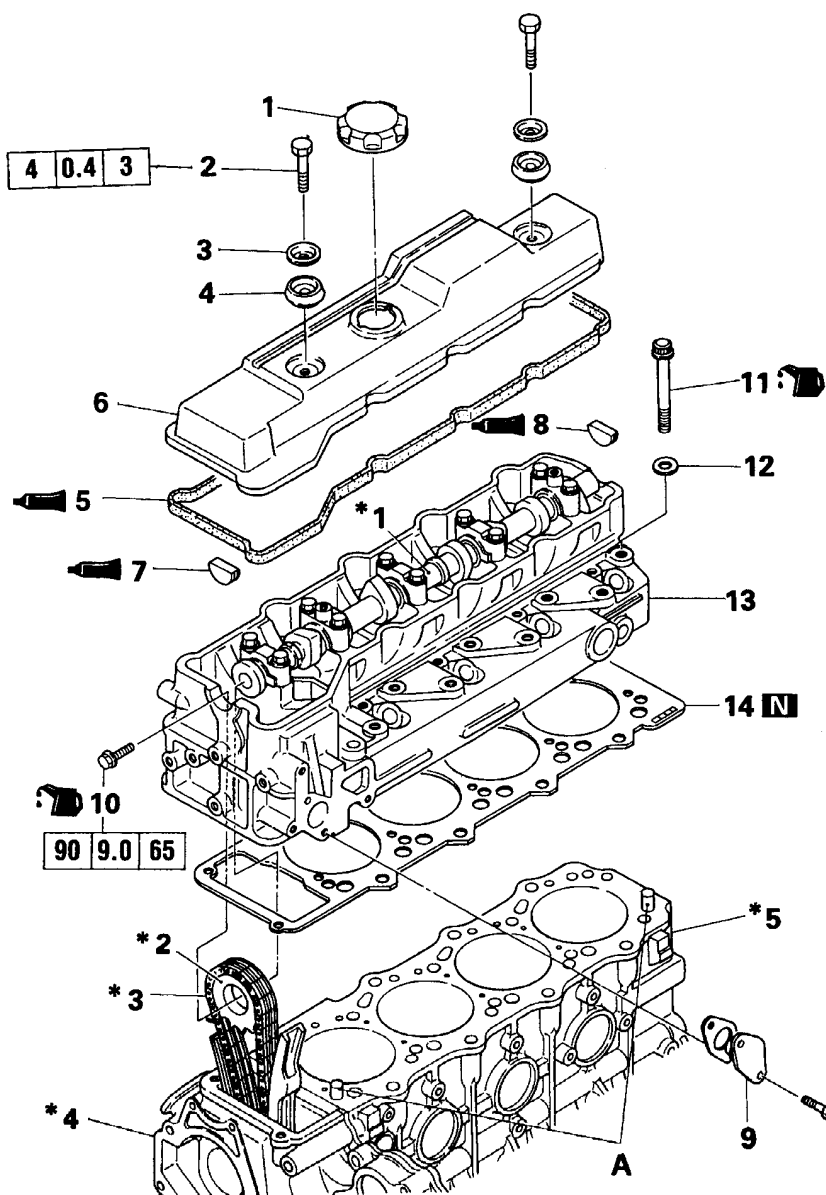
## REMOVAL AND INSTALLATION &lt;FOR CHALLENGER TURBO&gt;

**Removal steps**

1. Insulator
2. Nut
3. Exhaust manifold
4. Gasket

4ME0094

## 13. ROCKER COVER AND CYLINDER HEAD ASSEMBLY REMOVAL AND INSTALLATION



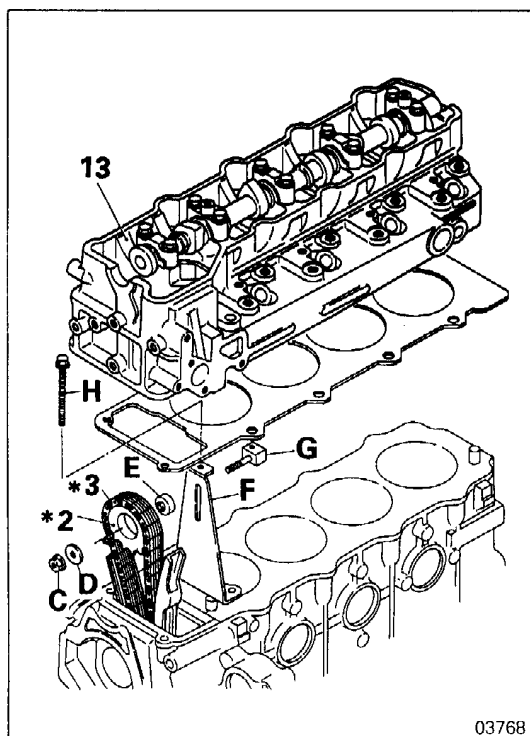
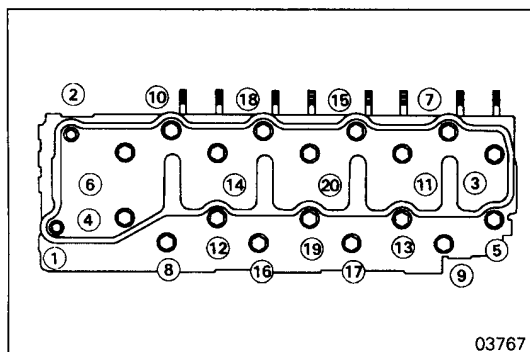
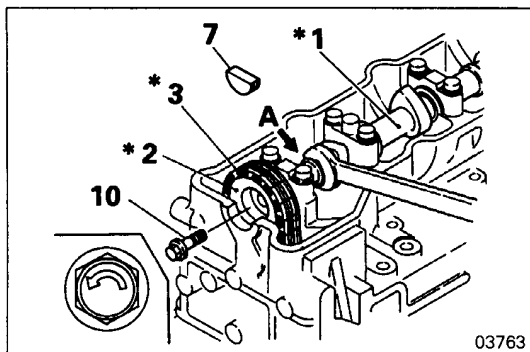
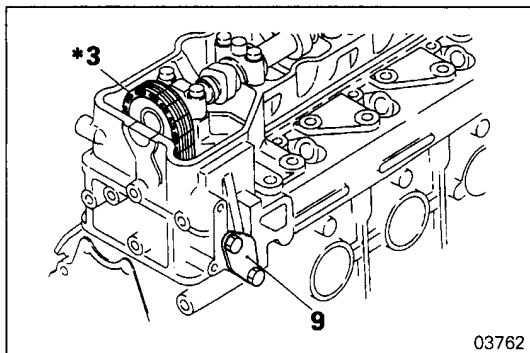
### Removal steps

1. Oil filler cap
2. Bolt
3. Plate
4. Rubber cushion
- ↗E↖ 5. Rocker cover gasket
6. Rocker cover
- ↗D↖ 7. Front packing
- ↗D↖ 8. Rear packing
- ↗C↖ 9. Tensioner
10. Bolt

11. Cylinder head bolt
12. Washer
- ↖A↗ ↗B↖ 13. Cylinder head assembly (See page 11A-14-1.)
- ↖B↗ ↗A↖ 14. Cylinder head gasket

- \*1: Camshaft (See page 11A-14-1.)
- \*2: Cam sprocket (See page 11A-19-1.)
- \*3: Timing chain (See page 11A-19-1.)
- \*4: Timing gear case assembly (See page 11A-18-1.)
- \*5: Crankcase assembly (See page 11A-28-1.)
- A: Dowel pin

03760



## REMOVAL SERVICE POINTS

### ◊A◊ CYLINDER HEAD ASSEMBLY REMOVAL

- (1) Loosen (or remove) the tensioner **9** and relieve the tension of the timing chain **\*3** before removing the cylinder head assembly.

- (2) Remove the front packing **7**. Remove the bolt **10** and separate the camshaft **\*1** from the cam sprocket **\*2**.

#### Caution

- When removing the bolt **10**, hold the camshaft **\*1** at the hexagonal section **A** to prevent it from turning together. Do not utilize the timing chain **\*3** for this purpose.
  - The bolt **10** is inversely threaded. The arrow marked on its head shows the tightening direction. To remove it, turn it in the reverse direction.
  - The cam sprocket **\*2** and timing chain **\*3** require to be positioned relatively to each other. Do not separate them unless absolutely necessary.
- (3) Loosen the cylinder head bolts **11** stepwise in the sequence of the numbers shown, then remove them.

- (4) Lift up the cylinder head assembly **13** straight and remove, while keeping the cam sprocket **\*2** in engagement with the timing chain **\*3**.

- (5) After the cylinder head assembly **13** is removed, hold the cam sprocket **\*2** with the special tool to keep the timing chain **\*3** on it.

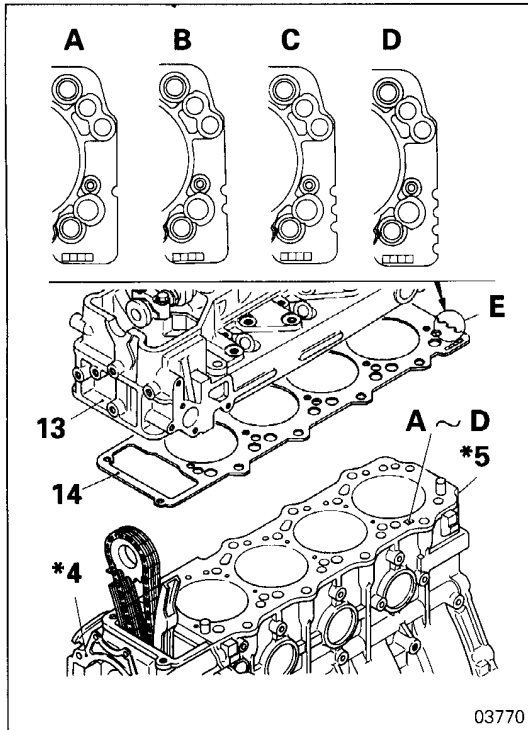
Component Parts of the Special Tool MH062392 – Cam Sprocket Holder Kit

- C: Nut
- D: Washer
- E: Spacer
- F: Adjusting plate
- G: Nut
- H: Bolt

◇B◇ CYLINDER HEAD GASKET REMOVAL

Caution

- Remove the cylinder head gasket **14** using care not to scratch the cylinder head assembly **13**, crankcase assembly **\*5** and timing gear case assembly **\*4**.



INSTALLATION SERVICE POINTS

▷A◁ CYLINDER HEAD GASKET INSTALLATION

- (1) Choose a cylinder head gasket **14** having an appropriate thickness that meets the piston protrusion. The following thicknesses of gaskets are available. They are identified by the notches at an end of the gasket. Measure the piston protrusions and calculate their average, and select an appropriate gasket thickness from the following table.  
If a piston protrudes 0.03 mm larger than the average, use one-size thicker gasket.

PAJERO

Piston protrusion		Cylinder head gasket	
Average piston protrusion	Crankcase identification mark	Classification	Thickness when tightened
0.475 ± 0.028 mm (0.0187 ± 0.0011 in.)	A	A (1 notch)	1.35 ± 0.03 mm (0.0531 ± 0.0012 in.)
0.532 ± 0.028 mm (0.0209 ± 0.011 in.)	B	B (2 notches)	1.40 ± 0.03 mm (0.0551 ± 0.0012 in.)
0.589 ± 0.028 mm (0.0232 ± 0.011 in.)	C	C (3 notches)	1.45 ± 0.03 mm (0.0571 ± 0.0012 in.)
0.646 ± 0.028 mm (0.0254 ± 0.011 in.)	D	D (4 notches)	1.50 ± 0.03 mm (0.0591 ± 0.0012 in.)

L200

Piston protrusion		Cylinder head gasket	
Average piston protrusion	Crankcase identification mark	Classification	Thickness when tightened
0.575 ± 0.028 mm (0.0226 ± 0.0011 in.)	A	A (1 notch)	1.35 ± 0.03 mm (0.0531 ± 0.0012 in.)
0.632 ± 0.028 mm (0.0249 ± 0.011 in.)	B	B (2 notches)	1.40 ± 0.03 mm (0.0551 ± 0.0012 in.)
0.689 ± 0.028 mm (0.0271 ± 0.011 in.)	C	C (3 notches)	1.45 ± 0.03 mm (0.0571 ± 0.0012 in.)
0.746 ± 0.028 mm (0.0293 ± 0.011 in.)	D	D (4 notches)	1.50 ± 0.03 mm (0.0591 ± 0.0012 in.)



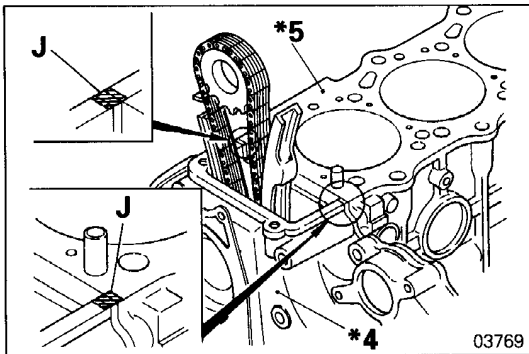
When only the gasket is to be replaced, check the identification mark stamped on the top of the crankcase assembly \*5 and choose the one with the same classification mark.

**NOTE:**

If no identification mark is stamped, select classification **C**.

**Caution**

- If a piston, connecting rod, etc. has been replaced, be sure to measure the piston protrusion as the replacement may change the piston protrusion.

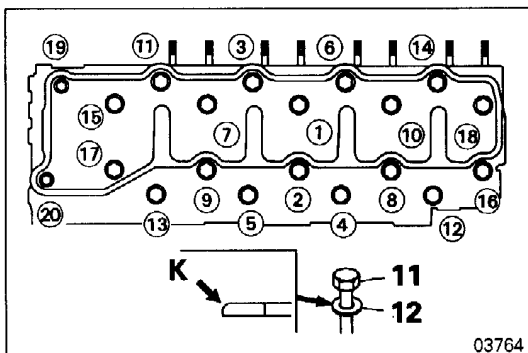


**▶B▶ CYLINDER HEAD ASSEMBLY INSTALLATION**

- (1) Choose a usable cylinder head gasket **14**.
- (2) Apply an even coat of sealant to the upper part **J** of the mating surfaces of the timing gear case assembly \*4 and crankcase assembly \*5.
- (3) Within three minutes after the application of sealant, install the cylinder head assembly **13**, with the cylinder head gasket **14** attached, to the crankcase assembly \*5.

**Caution**

- Prior to applying sealant, make sure that the surfaces to be coated are clean and free of slush and other foreign matters.
  - When installing the cylinder head assembly, be sure that sealant **J** is in place.
  - After the cylinder head assembly is installed, wait for at least one hour before starting the engine.
- (4) If the cylinder head bolts **11** were loosened or removed after installing the cylinder head assembly, be sure to replace the existing sealant with a fresh coat.



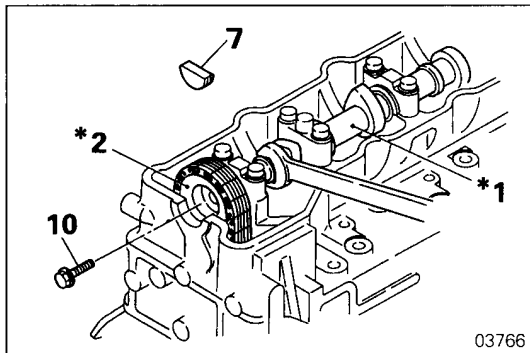
- (5) Tighten the cylinder head bolts **11**, M12 bolts of ① through ⑩ and M8 bolts of ⑱ and ⑳, in the sequence of the following steps:

Tightening bolts ① – ⑩

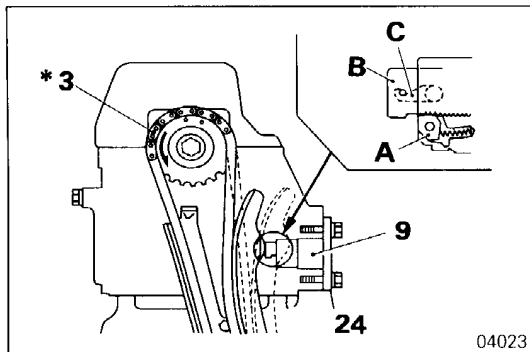
- (a) Fit the washer **12** on each cylinder head bolt **11**, with its shear droop side **K** facing in the direction shown in the illustration.
- (b) Apply a thin coat of engine oil evenly to the threaded part of each of the cylinder head bolts **11** and tighten them to 100 Nm (10 kgm, 72 ft.lbs.) in the sequence shown in the illustration.
- (c) Loosen the tightened cylinder head bolts **11** in the reverse sequence, and retighten them to 50 Nm (5 kgm, 36 ft.lbs.) in the sequence of the numbers shown.
- (d) Then, tighten the cylinder head bolts **11** further by giving them an additional 1/4 turn (90°) in the specified sequence.
- (e) Finally, give the cylinder head bolts **11** another 1/4 turn (90°).

Tightening bolts ⑱ and ⑳

After the tightening of the bolts ① through ⑩ is finished, tighten the bolts ⑱ and ⑳ to the specified torque.



- (6) Secure the cam shaft \*1 to the cam sprocket \*2 with the bolt 10. (See page 11A-13-2.)
- (7) Apply an even coat of sealant to the front packing 7, and install the packing.

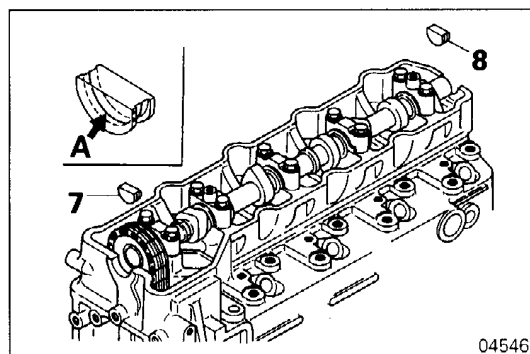


#### ⇨⇩ TENSIONER INSTALLATION

- (1) Turning the cam A, force the plunger B into the tensioner 9 by hand and lock it with the hook C. Then, install the tensioner 9.
- (2) After the tensioner 9 is installed, crank the engine in the normal (clockwise) direction.

#### Caution

- When installing the tensioner 9, be sure to force the plunger B into it, or the timing chain \*3 will be stressed excessively and may be damaged. When the engine is started, the hook C will be released automatically.
- The tensioner 9 keeps the timing chain \*3 in tension by means of the internal ratchet mechanism. Cranking the engine in reverse direction with the tensioner 9 installed, therefore, causes the plunger B to be stressed by an excessive force, which may cause damage to the cam A. Therefore, never crank the engine in reverse direction. If the engine is accidentally cranked in reverse direction, remove and reinstall the tensioner according to the correct installation procedure.

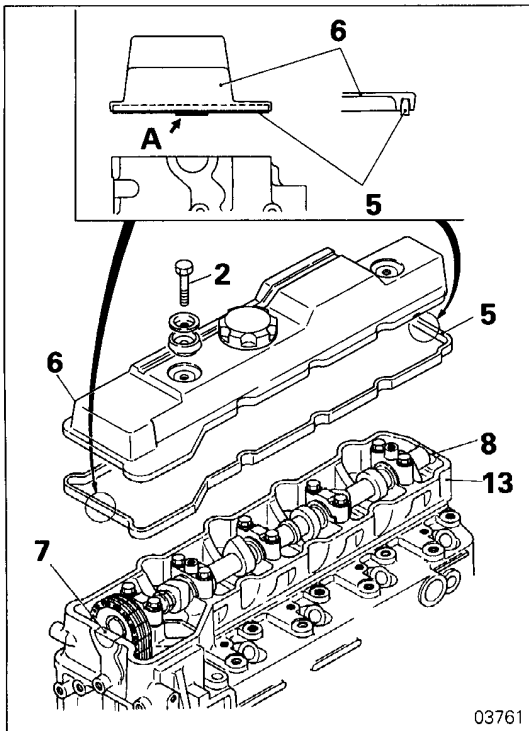


#### ⇨⇩ FRONT PACKING/REAR PACKING INSTALLATION

- (1) Apply sealant uniformly without breaks to the front packing 7 and rear packing 8 at the position A shown in the illustration. [Bead diameter:  $2 \pm 1$  mm ( $0.08 \pm 0.04$  in.)]
- (2) Install the front packing 7 and rear packing 8 within three minutes after the application of sealant.

#### Caution

- When installing the packings, use care that the surroundings are not smeared with sealant.
- Make sure that the surfaces to be coated with sealant are clean and free of slush and other foreign matters.
- After the front packing 7 and rear packing 8 are installed, wait for at least one hour before starting the engine.



### ROCKER COVER GASKET

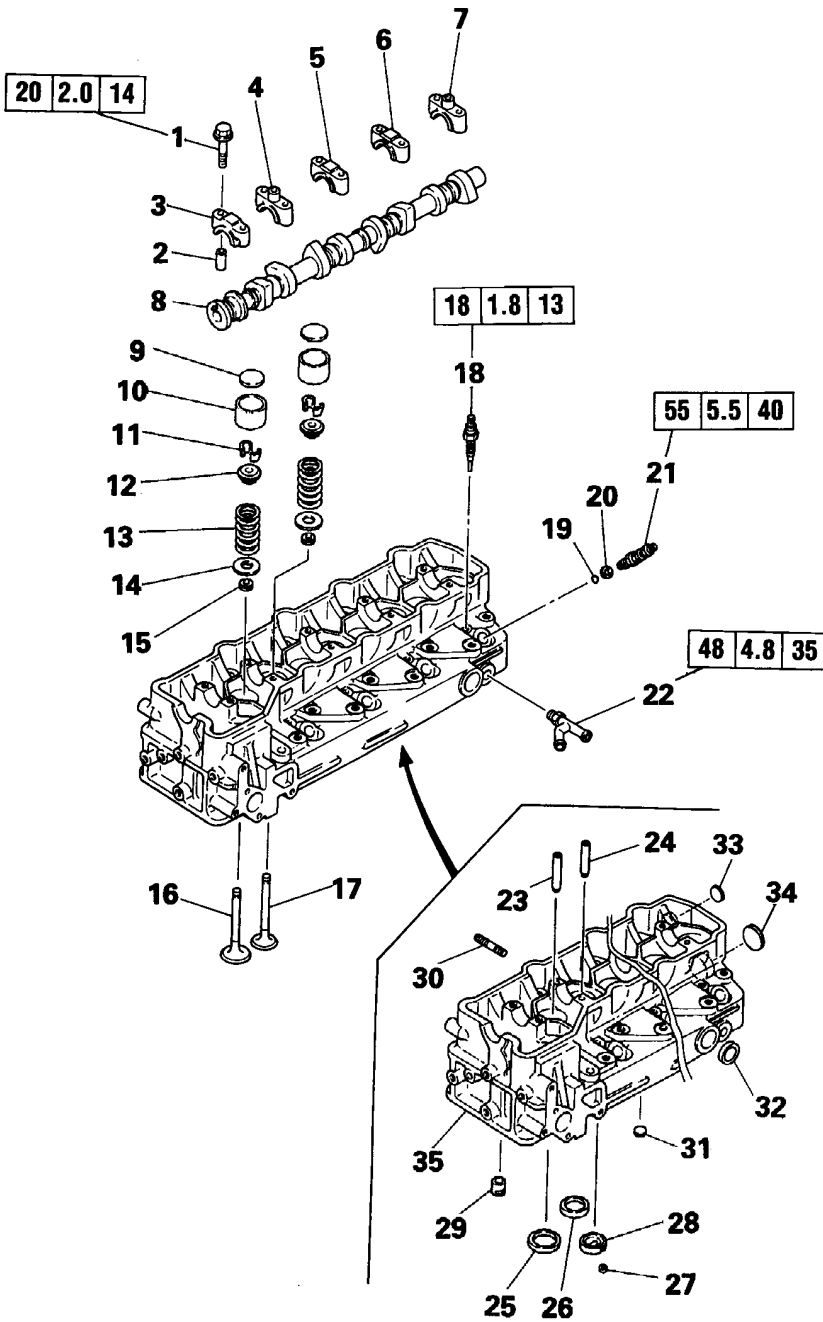
- (1) Install the rocker cover gasket **5** in the groove of the rocker cover **6** in the direction shown in the illustration.
- (2) Apply sealant to the rocker cover gasket **5** at the position **A** shown in the illustration. The sealant must be so applied that it can seal the front packing **7** and rear packing **8** on the cylinder head.
- (3) Install the rocker cover **6** to the cylinder head assembly **13** within three minutes after the application of sealant.

#### Caution

- Be sure that the surfaces to be coated with sealant are clean and free of slush and other foreign matters.
- When installing the rocker cover, take care that sealant does not smear the surroundings.
- After the rocker cover is installed, wait for at least one hour before starting the engine.
- If the bolt **2** (holding the rocker cover) was loosened or removed after installation, be sure to reinstall the rocker cover with a fresh coat of sealant.


# 14. CAMSHAFT AND VALVES

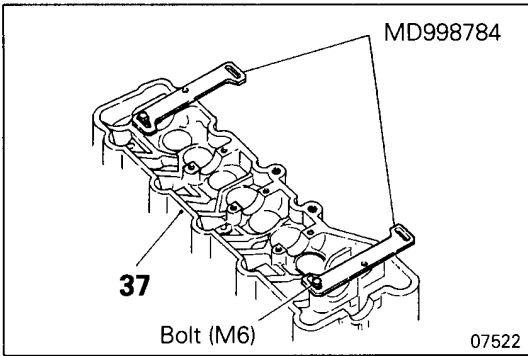
## REMOVAL AND INSTALLATION



### Removal steps

1. Bolt
2. Knock bush
- ◆L 3. No.1 camshaft cap
- ◆L 4. No.2 camshaft cap
- ◆L 5. No.3 camshaft cap
- ◆L 6. No.4 camshaft cap
- ◆L 7. No.5 camshaft cap
8. Camshaft
- ◆I 9. Lifter shim
10. Valve lifter
- ◇A◇H 11. Valve cotter
12. Upper retainer
13. Valve spring
14. Lower retainer
- ◆G 15. Valve stem seal
16. Inlet valve
17. Exhaust valve
18. Glow plug (See page 11A-8-1.)
19. Gasket
20. Gasket holder
21. Injection nozzle (See page 11A-21-1.)
- ◆E 22. Water joint
- ◇B◇F 23. Inlet valve guide
- ◇B◇F 24. Exhaust valve guide
- ◇C◇D 25. Inlet valve seat
- ◇C◇D 26. Exhaust valve seat
- ◇D◇C 27. Tablet
- ◇D◇C 28. Combustion jet
- ◆B 29. Water director
30. Stud
- ◆A 31. Sealing cap
- ◆A 32. Sealing cap
- ◆A 33. Sealing cap
- ◆A 34. Sealing cap
35. Cylinder head

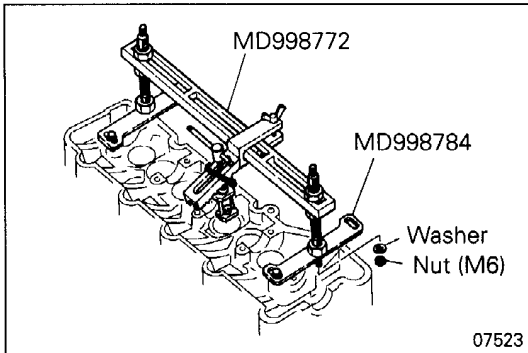
 Lubricate all internal parts with engine oil during reassembly.



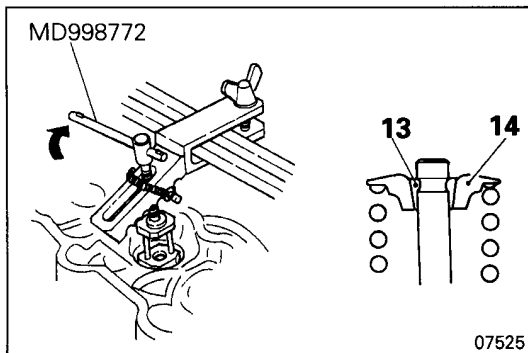
**REMOVAL SERVICE POINTS**

**◊A◊ VALVE COTTER REMOVAL**

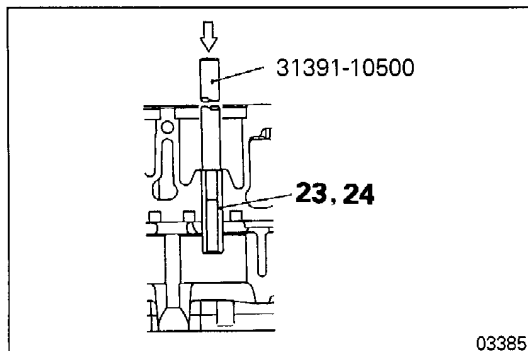
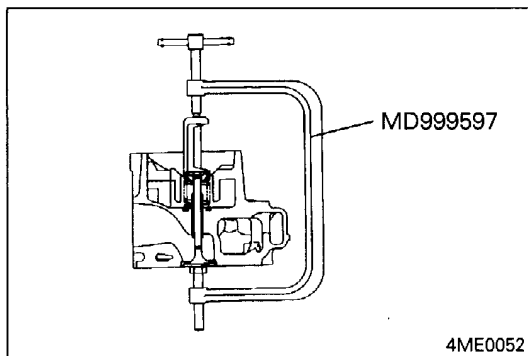
(1) Install the special tools MD998784 on the cylinder head **37** as shown in the illustration.



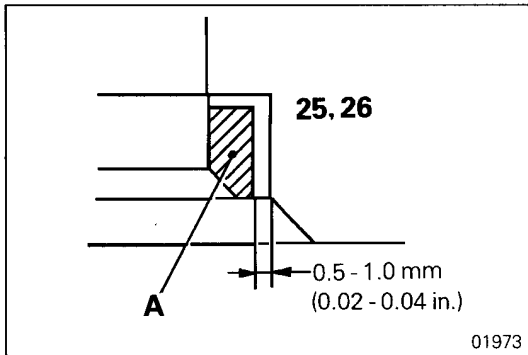
(2) Install the special tool MD998772 on the special tools MD998784.



(3) Press down the upper retainer **14** and remove the valve cotter **13**.

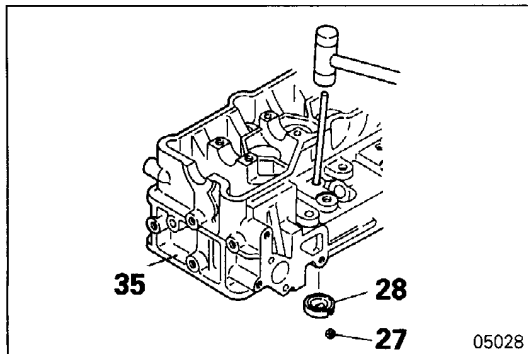


**◊B◊ VALVE GUIDE REMOVAL**



◁C▷ VALVE SEAT REMOVAL

- (1) The valve seat **25, 26** is expansion fitted. Reduce the seat thickness by removing as much material as necessary from inside the seat, and remove the seat at normal temperature.  
**A:** Remove material here.

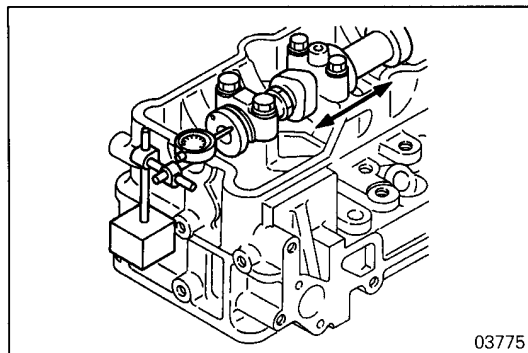


◁D▷ TABLET/COMBUSTION JET REMOVAL

- (1) Warm the cylinder head **35** to increase the clearance between it and the combustion jet **28**.
- (2) Insert a round rod in the glow plug mounting hole in the cylinder head **35**. Tapping on the rod with a hammer, remove the combustion jet **28** from the glow plug mounting hole together with the tablet **27**.

**Caution**

- Being made of ceramic, the combustion jet **28** is susceptible to a shock. Do not hit it too hard, or it may be damaged.

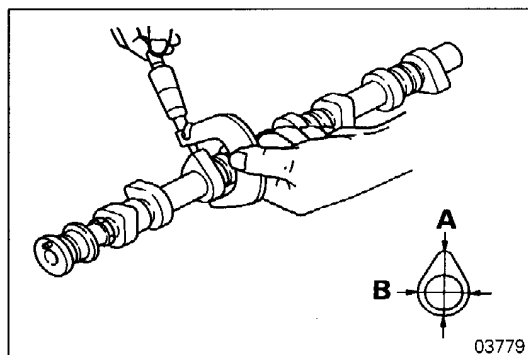


**INSPECTION**

**CAMSHAFT**

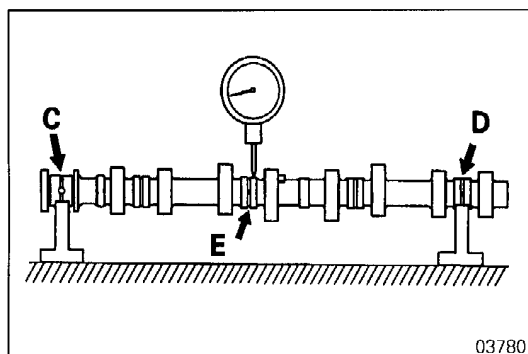
**End Play**

- (1) Measure the end play, and if the reading deviates from the specified value, replace the defective part.



**Difference between Cam Height and Base Circle Diameter**

- (1) If the specified service limit is exceeded, replace the camshaft **8**.  
**A:** Cam height  
**B:** Base circle diameter

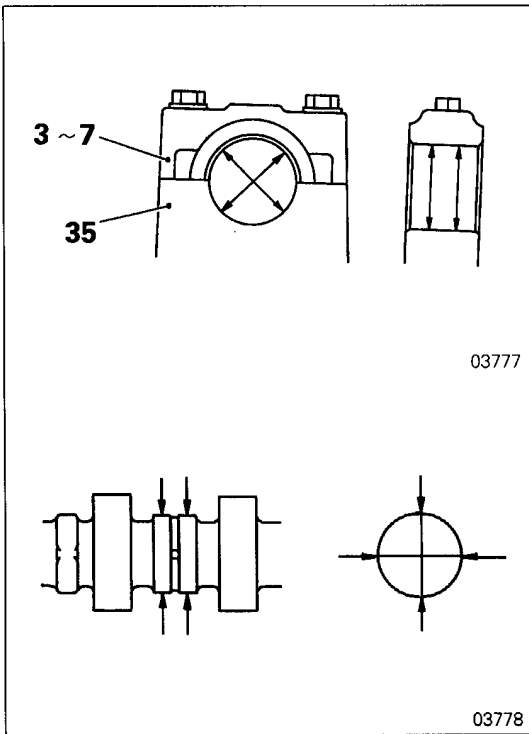


**Bend**

- (1) With the camshaft **8** supported at No.1 journal **C** and No.5 journal **D**, measure the bend at No.3 journal **E**. If the reading exceeds the specified service limit, replace the camshaft.

**NOTE**

The actual shaft bend is a half of what the dial gauge reads when the camshaft **8** is given one turn.

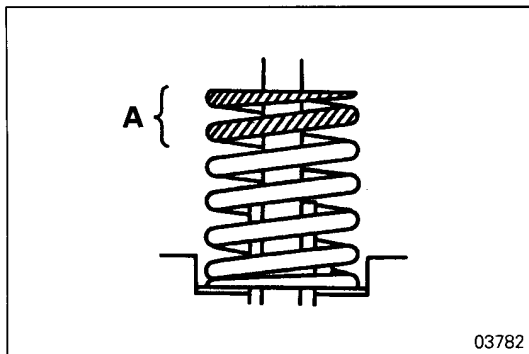


**Journal Oil Clearance**

- (1) Measure the oil clearance at each journal and if the specified service limit is exceeded, replace the defective part.

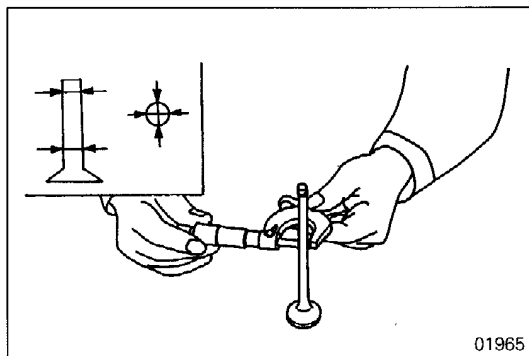
**NOTE**

Replace the camshaft caps **3** through **7** and the cylinder head **35** as an assembly if one of the caps is unusable.



**VALVE SPRING**

- (1) Install the valve spring **13** with the pink painted end **A** upward.



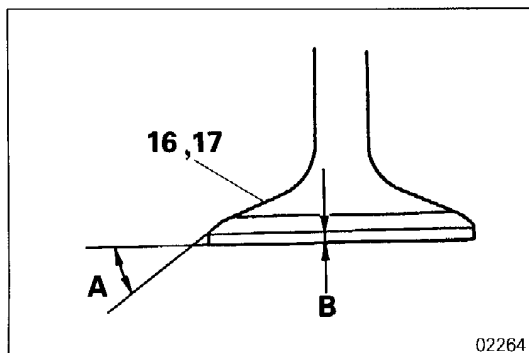
**INLET AND EXHAUST VALVES**

**Checking Stem for Wear**

- (1) If the diameter is below the specified service limit or uneven wear is recognized, replace the valve.

**NOTE**

If the valve **16, 17** is new, be sure to lap it and the valve seat **25, 26** for proper seating. (See page 11A-14-5.)

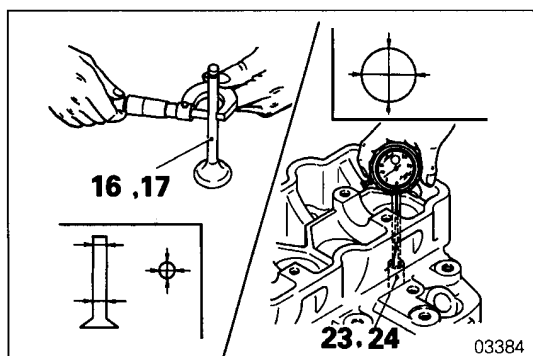


**Valve Seat Angle and Valve Margin**

- (1) If the specified service limit is exceeded by correcting the seat angle, replace the valve **16, 17**.

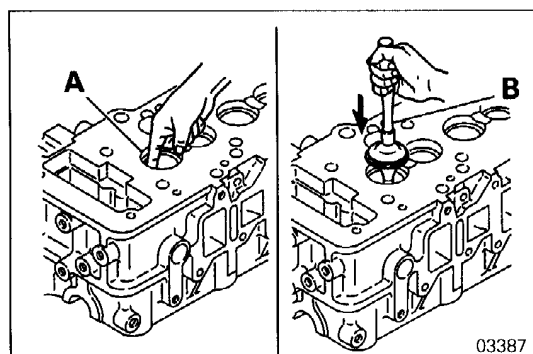
**A:** Valve seat angle

**B:** Valve margin



**VALVE AND VALVE GUIDE**

- (1) If the clearance exceeds the specified service limit, replace the defective part.



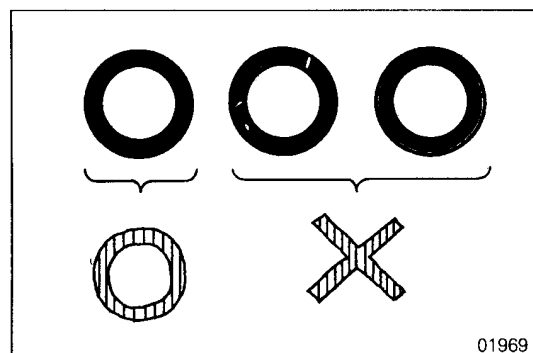
**VALVE AND VALVE SEAT**

- (1) Apply an even coat of minium to the valve seating surface **A** of the valve seat **25, 26**.
- (2) Strike the valve **16, 17** against the valve seat **25, 26** once while taking care that the valve is not rotated.

**B:** Valve Lapper

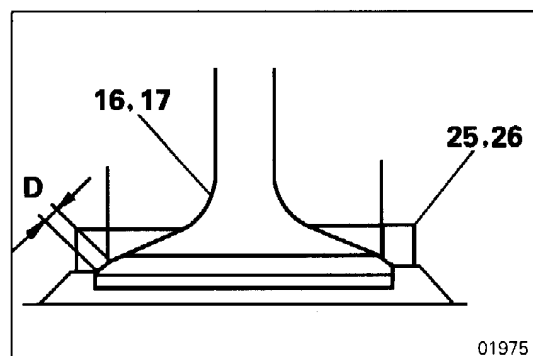
**NOTE**

Before proceeding with the contact check, examine the valve **16, 17** and valve guide **23, 24** in detail to see if they are in normal condition. (See 11A-14-5,6.)



- (3) Determine the valve seating condition from minium pattern printed on the valve **16, 17**. If any abnormal contact is found, take the following corrective action.

	Corrective action
Minor defect	Lap valve for better seating.
Major defect	Correct or replace valve and valve seat.



**VALVE SEAT**

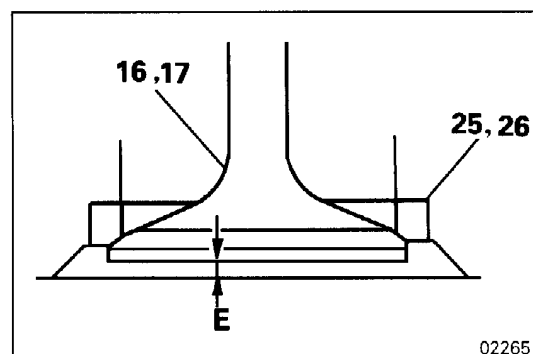
**Valve Seat Width**

- (1) If the specified service limit is exceeded, replace the valve seat **25, 26**.

**D:** Valve seat width

**NOTE**

When the valve seat **25, 26** has been corrected or replaced, lap it and the valve **16, 17** for proper seating. (See page 11A-14-6.)

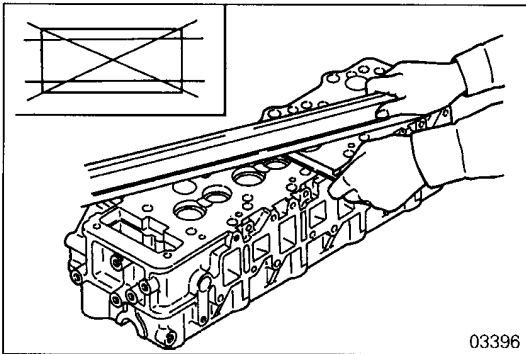


**Valve Sinkage from Cylinder Head Bottom**

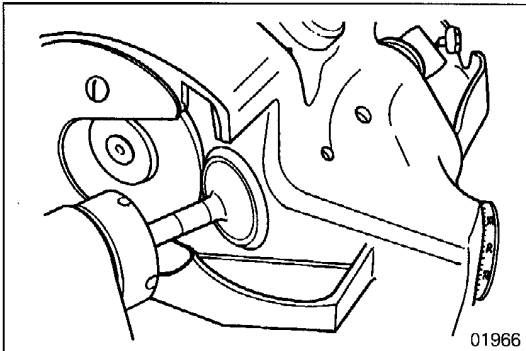
- (1) If the specified service limit is exceeded, correct or replace the defective part.

**E:** Valve sinkage

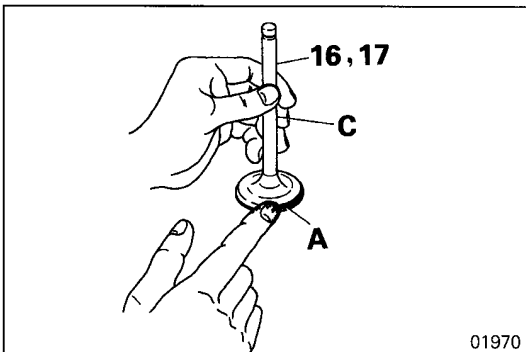


**CYLINDER HEAD ASSEMBLY**

- (1) Measure the distortion of the bottom surface of the cylinder head **35**. If the measured value exceeds the limit, replace the cylinder head.

**CORRECTION****INLET VALVE AND EXHAUST VALVE****Caution**

- The grinding should be minimum.
- If the valve margin deviates from the specified service limit after grinding, replace the valve **16, 17**.
- After grinding, lap the valve **16, 17** and valve seat **25, 26** for proper seating. (See page 11A-14-6.)

**VALVE AND VALVE SEAT**

- (1) Lap the valve and valve seat as follows:
  - (a) Apply a thin coat of lapping compound evenly to the valve seating surface of the valve seat **25, 26**.

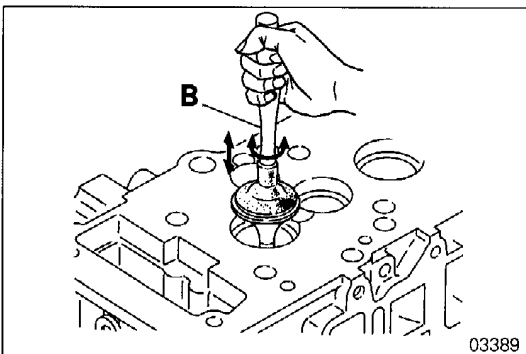
**Caution**

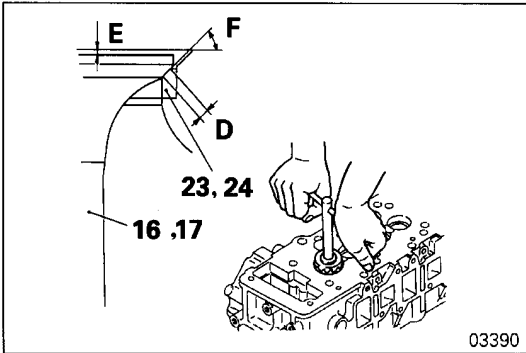
- Keep the stem **C** of the valve **16, 17** free from the lapping compound.
- Use an intermediate-mesh compound (120 – 150 meshes) first, then a fine-mesh compound (over 200 meshes).
- To achieve even application of the lapping compound, a mix with a small quantity of engine oil is recommended.

- (b) Using Valve Lapper, strike the valve **16, 17** against the valve seat **25, 26** a few times while turning little by little.

**B:** Valve Lapper

- (c) Wash off the lapping compound in kerosene.
- (d) Apply a thin coat of engine oil to the seating surface of the valve seat **25, 26** and oil lap.
- (e) Check the seat contact between the valve **16, 17** and valve seat **25, 26**. (See page 11A-14-5.)
- (f) Replace the valve seat **25, 26** if necessary.





**VALVE SEAT**

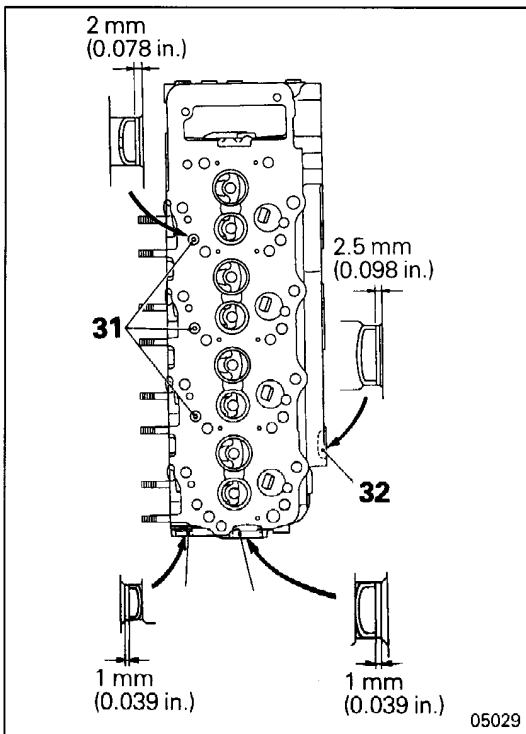
- (1) Grind the valve seat **25, 26** using a valve seat cutter or a valve seat grinder.
- (2) Polish the ground surface lightly using a #400 sandpaper held between the cutter and valve seat.
- (3) Correct the seat width of the valve **16, 17** to the specified value using a 15° or 75° cutter.

F: Valve seat angle

**Caution**

- Be sure that the sinkage **E** of the valve **16, 17** does not exceed the specified service limit as a result of the correction.

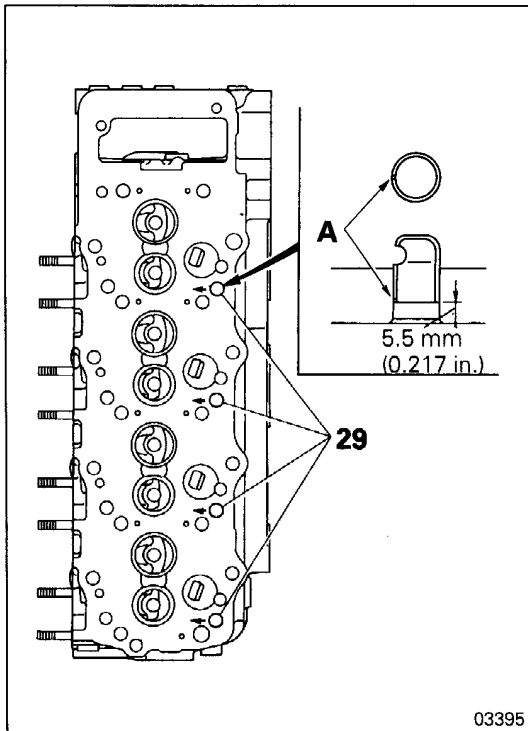
- (4) After the correction, lap the valve **16, 17** and valve seat **25, 26** for proper seating. (See page 11A-14-6.)



**INSTALLATION SERVICE POINT**

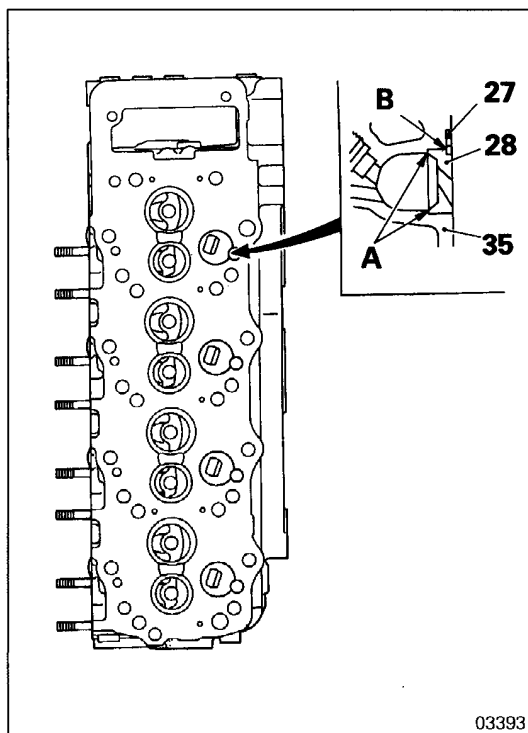
**▶A▶ SEALING CAP INSTALLATION**

- (1) Drive in the sealing caps **31** through **34** to the specified depth. By way of precaution, apply sealant to the press-fitting holes provided in the cylinder head **35** before driving the sealing caps **32** through **34** in the holes.



### ◆B◆ WATER DIRECTOR INSTALLATION

- (1) Drive in each water director **29** to the specified depth, with its notch **A** set in the direction shown in the illustration.

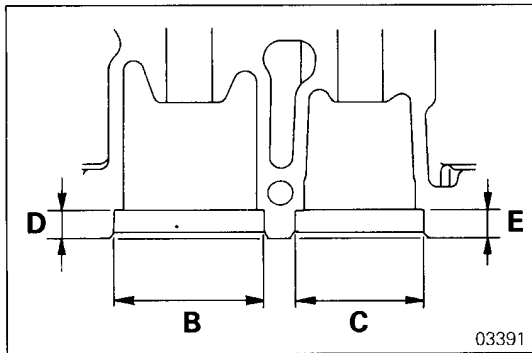


### ◆C◆ TABLET/COMBUSTION JET INSTALLATION

- (1) Install the combustion jets **28** in such a way that the surface **A** may be brought into close contact with the combustion chamber of the cylinder head **35**.
- (2) Install the tablets **27** to the combustion jets **28**. Then, press-fit them into the cylinder head **35** in such a way that the surface **B** may be brought into close contact with the combustion jet.

#### Caution

- When it becomes necessary to replace any combustion jet **28**, replace the mated tablet **27** at the same time.



**◆D◆ VALVE SEAT INSTALLATION**

- (1) Measure the valve seat mounting hole diameters **B** and **C** in the cylinder head **35**. If a measured value is out of the standard value, select an oversize valve seat from the following table.

**Standard value**

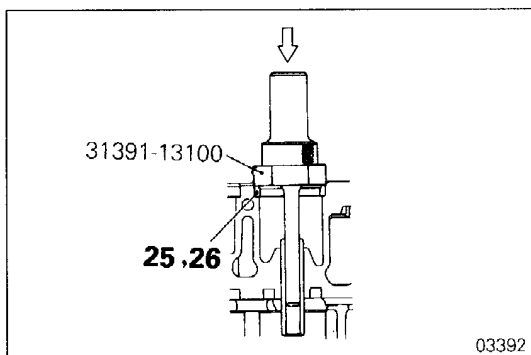
**Inlet (B):**  $\phi 43 + \begin{smallmatrix} 0.025 \\ 0 \end{smallmatrix}$  mm (  $1.69 + \begin{smallmatrix} 0.00098 \\ 0 \end{smallmatrix}$  in.)

**Exhaust (C):**  $\phi 37 + \begin{smallmatrix} 0.025 \\ 0 \end{smallmatrix}$  mm (  $1.46 + \begin{smallmatrix} 0.00098 \\ 0 \end{smallmatrix}$  in.)

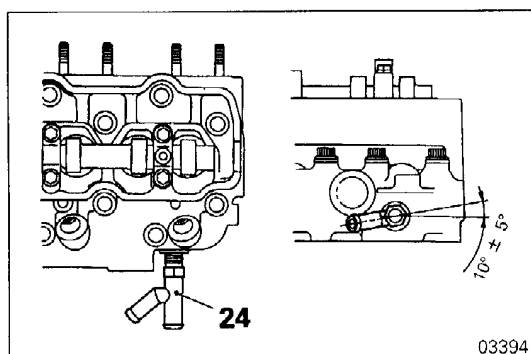
- (2) Correct the dimensions B, C, D and E of valve seat mounting holes in the cylinder head to those matching the outside diameters and thicknesses of the selected oversize valve seats.

Unit: mm (in.)

Oversize valve seat		0.30	0.60
Inlet	I.D. (B)	$\phi 43.3 + \begin{smallmatrix} 0.025 \\ 0 \end{smallmatrix}$ ( $1.705 + \begin{smallmatrix} 0.00098 \\ 0 \end{smallmatrix}$ )	$\phi 43.6 + \begin{smallmatrix} 0.025 \\ 0 \end{smallmatrix}$ ( $1.717 + \begin{smallmatrix} 0.00098 \\ 0 \end{smallmatrix}$ )
	Depth (D)	$8.2 \pm 0.1$ ( $0.323 \pm 0.004$ )	$8.5 \pm 0.1$ ( $0.335 \pm 0.004$ )
Exhaust	I.D. (C)	$\phi 37.3 + \begin{smallmatrix} 0.025 \\ 0 \end{smallmatrix}$ ( $1.469 + \begin{smallmatrix} 0.00098 \\ 0 \end{smallmatrix}$ )	$\phi 37.6 + \begin{smallmatrix} 0.025 \\ 0 \end{smallmatrix}$ ( $1.480 + \begin{smallmatrix} 0.00098 \\ 0 \end{smallmatrix}$ )
	Depth (E)	$8.3 \pm 0.1$ ( $0.327 \pm 0.004$ )	$8.6 \pm 0.1$ ( $0.339 \pm 0.004$ )

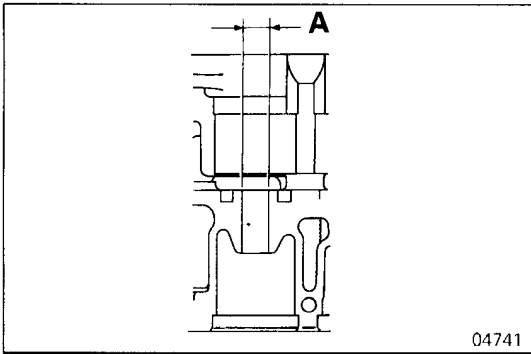


- (3) Immerse the valve seats **25** and **26** in liquid nitrogen and cool enough.
- (4) Using the special tool, install the valve seats **25** and **26** in the mounting holes till they bottom the cylinder head **35** properly.
- (5) After the valve seats **25** and **26** are installed, lap them and check the valves **16** and **17** for proper seating. (See page 11A-14-6.)



**◆E◆ WATER JOINT INSTALLATION**  
**<EXCEPT PAJERO 2001MODEL>**

- (1) To install the water joint **24**, first tighten it to the specified torque, then give an additional torque so that it may be angled as shown. The additional tightening torque should not exceed 7 Nm (0.7 kgm, 5.1 ft.lbs.) above the specified torque.



**◆F◆ VALVE GUIDE INSTALLATION**

- (1) Measure the bore diameters in the cylinder head **35** for the valve guides **23** and **24**. If a measured value is out of the standard value, select an oversize valve guide from the following table.

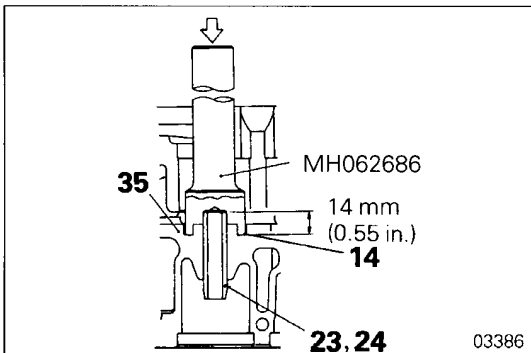
**Standard value**

**Bore diameter (A):**  $13 + \begin{smallmatrix} 0.018 \\ 0 \end{smallmatrix}$  mm ( $0.512 + \begin{smallmatrix} 0.0007 \\ 0 \end{smallmatrix}$  in.)

- (2) Correct the bore **A** to the inner diameter matching the outside diameter of the selected oversize valve guides.

Unit: mm (in.)

Oversize Valve Guide	0.05 (0.0020)	0.25 (0.0098)	0.50 (0.0197)
<b>A:</b> Valve guide mounting hole diameter in cylinder head	$\phi 13.05$ ( $\phi 0.5138$ )	$\phi 13.25$ ( $\phi 0.5217$ )	$\phi 13.50$ ( $\phi 0.5315$ )
	$+ \begin{smallmatrix} 0.018 \\ 0 \end{smallmatrix}$ ( $+ \begin{smallmatrix} 0.0007 \\ 0 \end{smallmatrix}$ )	$+ \begin{smallmatrix} 0.018 \\ 0 \end{smallmatrix}$ ( $+ \begin{smallmatrix} 0.0007 \\ 0 \end{smallmatrix}$ )	$+ \begin{smallmatrix} 0.018 \\ 0 \end{smallmatrix}$ ( $+ \begin{smallmatrix} 0.0007 \\ 0 \end{smallmatrix}$ )

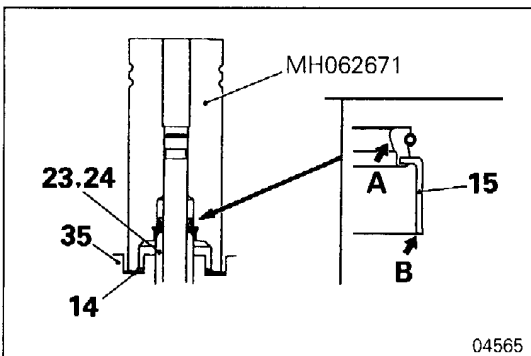


- (3) After installing the lower retainers **14** to the cylinder head **35**, drive in the valve guides **23** and **24** all the way till they certainly contact the lower retainers **14** positively.

**Caution**

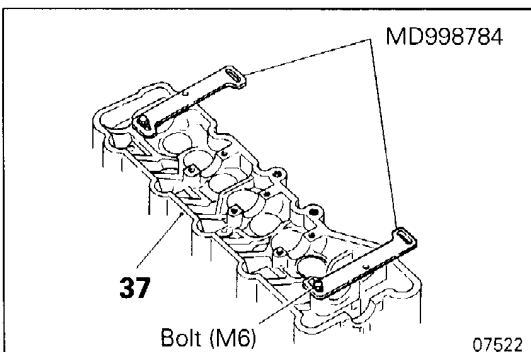
- **To install the valve guides 23 and 24 to the specified depth, be sure to use the special tool.**

- (4) The exhaust valve guide is longer than the intake valve guide. Be careful not to confuse the valve guides **23** and **24**.



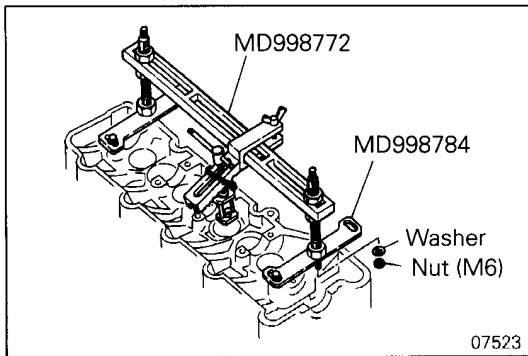
**◆G◆ VALVE STEM SEAL INSTALLATION**

- (1) Apply a thin coat of engine oil to the lip **A** of the valve stem seal **15**. Press in the valve stem seal **15** by hand as deep as its bottom **B** contacts the top surface of the valve guide **23**, **24**.
- (2) Slowly press the valve stem seal **15** vertically till the special tool contacts the lower retainer **14** installed in the cylinder head **35**.

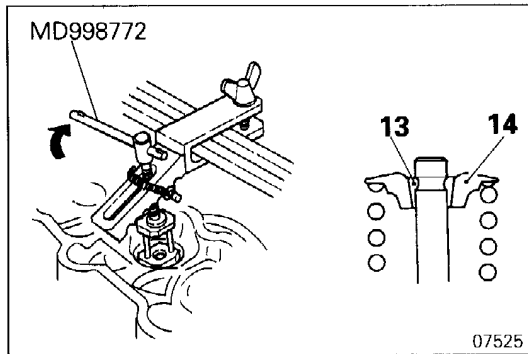


**◆H◆ VALVE COTTER INSTALLATION**

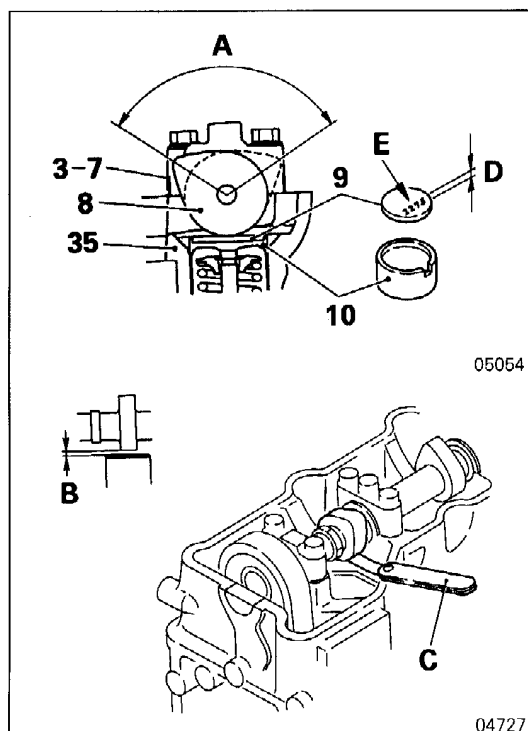
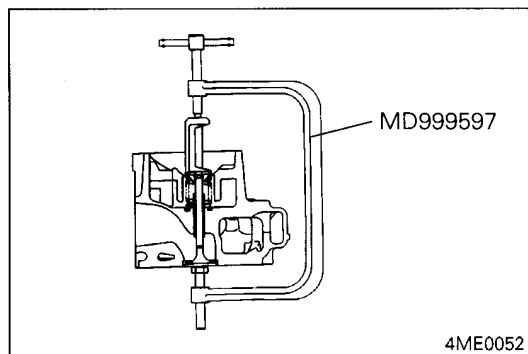
- (1) Install the special tools MD998784 on the cylinder head **37** as shown in the illustration.



(2) Install the special tool MD998772 on the special tools MD998784.



(3) Press down the upper retainer **14** and install the valve cotter **13**.



### ⇄ LIFTER SHIM INSTALLATION

(1) Select a proper thickness lifter shim that allows the valve clearance to be kept at the specified standard value and install it in the following manner:

- (a) Attach an arbitrarily selected lifter shim **9** to the valve lifter **10**.
- (b) Install the camshaft **8** in the cylinder head **35**, and attach the camshaft caps **3** through **7**.
- (c) Using a filler gauge **C**, measure the valve clearance **B** of the valves on which the respective cam lobes are located within the range **A** shown in the illustration. Record the readings.

#### Caution

- The correct measurement can be achieved only when using a feeler gauge which feels somewhat heavy to insert. No accurate measurement can be expected with a loose filler gauge.
- (d) To measure the valve clearance of the remaining valves, turn the camshaft **8**, or remove it and reinstall, in a position where their cam lobes are in the range **A**. Then, measure the valve clearance **B** in the same manner as above.

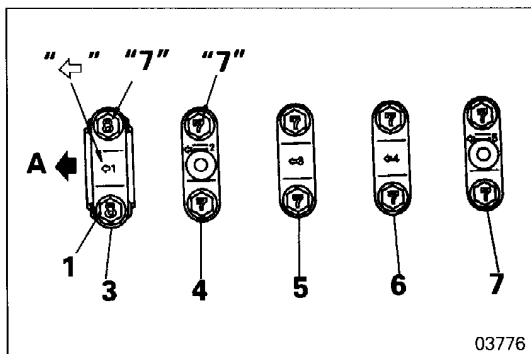
- (e) Based on the readings recorded, select an appropriate lifter shim for achieving a valve clearance true to the specified standard value, and replace the lifter shim **9** with it.

**D:** Lifter shim thickness 2.250 – 3.150 mm (0.0886 – 0.1240 in.)

Available in 37 sizes at steps of every 0.025 mm (0.0010 in.)

**E:** Stamped size mark "2275" denotes a thickness of 2.275 mm (0.0896 in.)

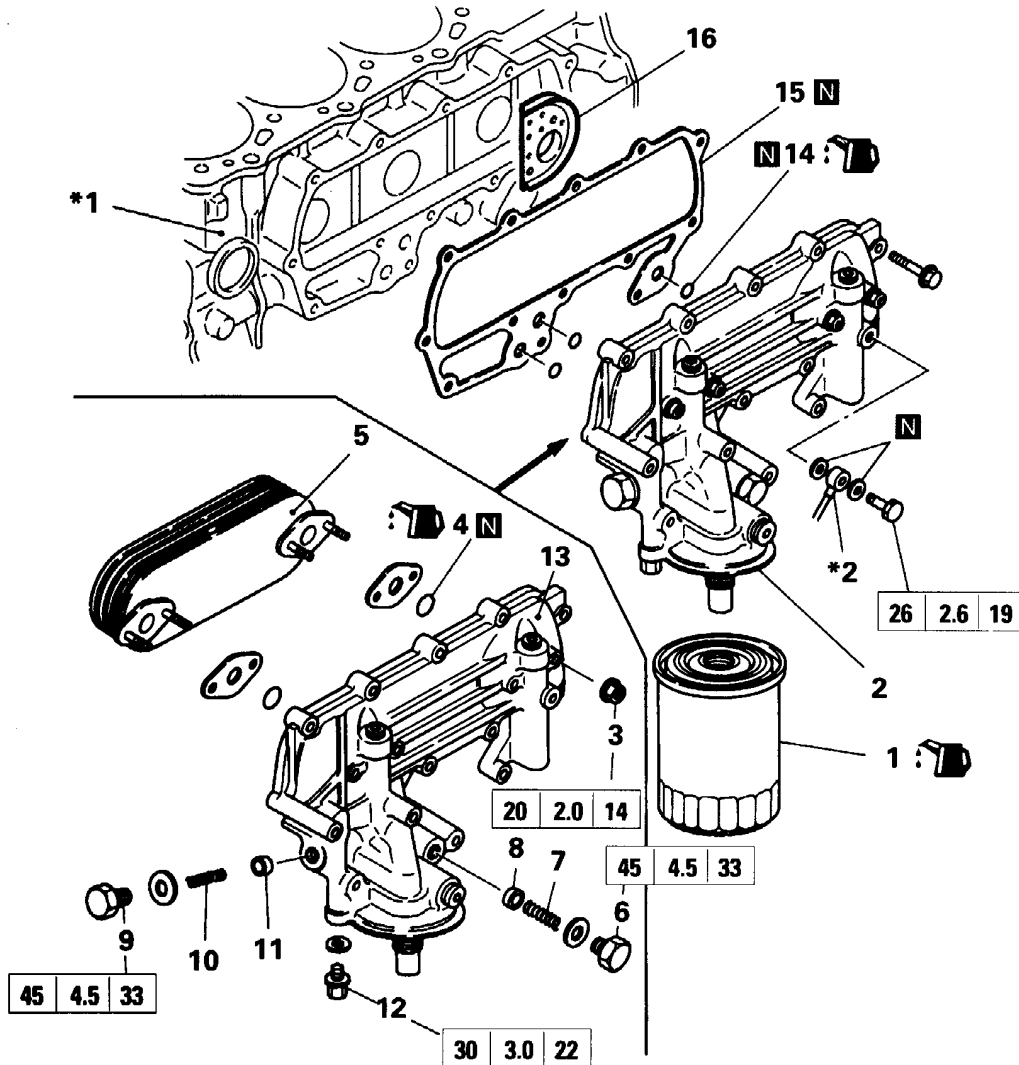
Shim thickness necessary for valve clearance adjustment: Thickness of removed shim + (gauge thickness – specified standard value)



#### ▶◀ CAMSHAFT CAP INSTALLATION

- (1) Install the camshaft caps **3** through **7** with their front marks directed forward, and tighten the bolts **1** to the specified torques.

**15. OIL COOLER AND OIL FILTER  
REMOVAL AND INSTALLATION**



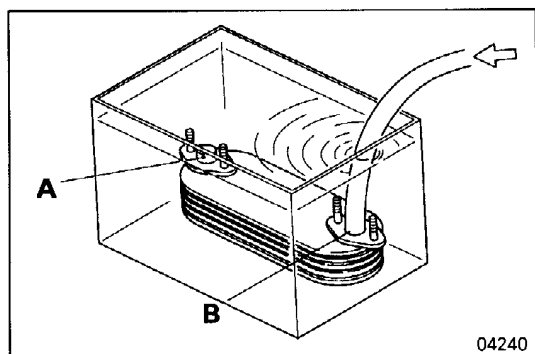
**Removal steps**

- ◆A◆ 1. Oil filter
  - 2. Oil cooler assembly
  - 3. Nut
  - 4. O-ring
  - 5. Oil cooler element
  - 6. Plug
  - 7. Bypass valve spring
  - 8. Plunger
  - 9. Plug
  - 10. Regulator valve spring
  - 11. Plunger
  - 12. Water drain plug
  - 13. Oil cooler body
  - 14. O-ring
  - 15. Gasket
  - 16. Water separate lip (CHALLENGER and 1998- PAJERO for Europe)
- \*1: Crankcase assembly  
\*2: Turbocharger water inlet pipe

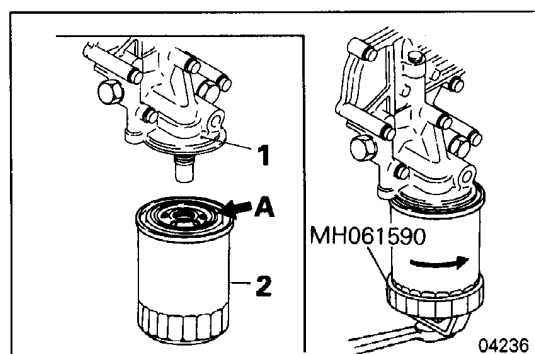


**CLEANING**

- (1) Check the oil cooler element **5** for deposited carbon and sludge in oil passage and bypass, and wash it clean in cleaning oil, if necessary.
- (2) Wash the oil cooler element **5** and the oil cooler cover **12** if they are much contaminated with scale.

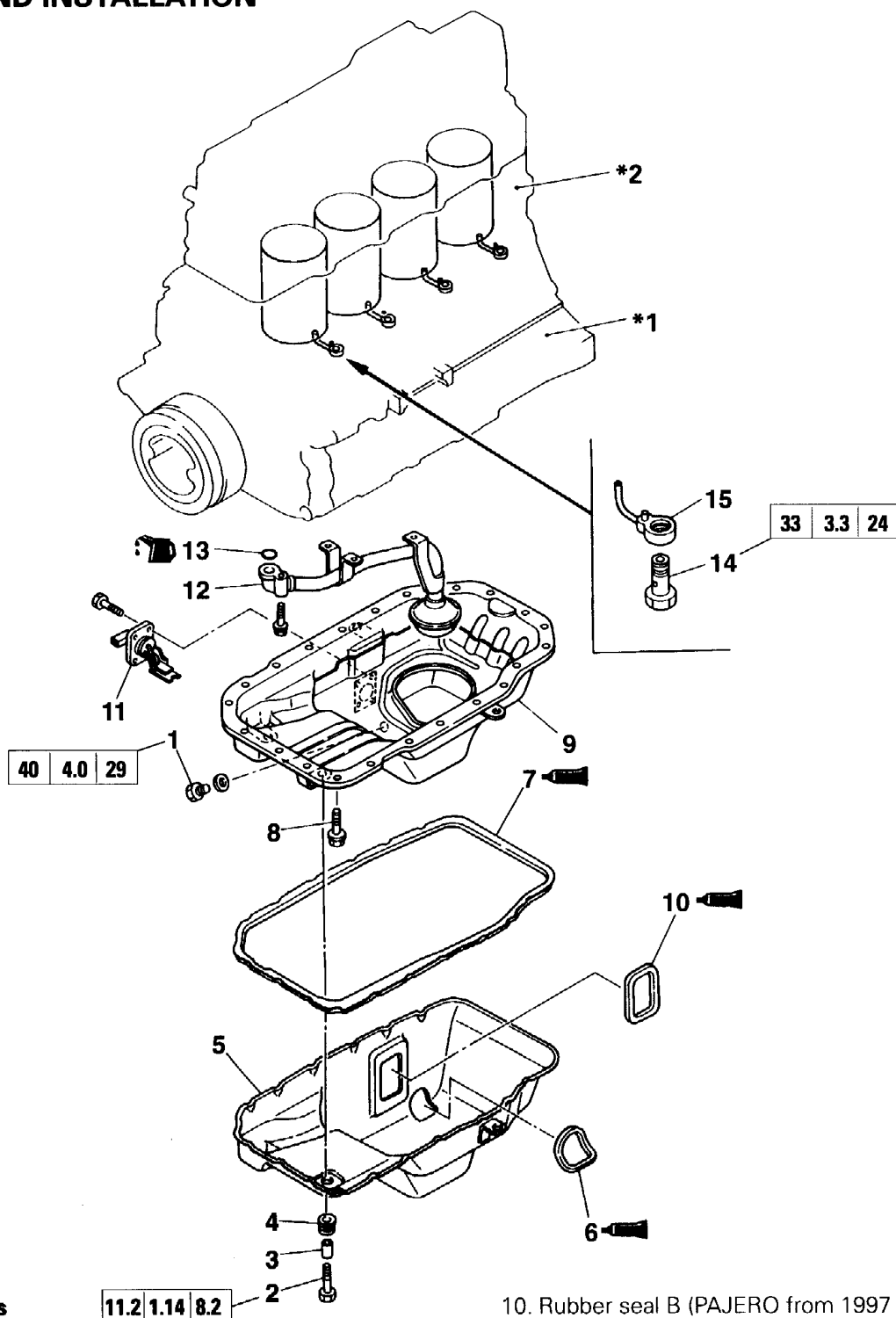
**INSPECTION****OIL COOLER ELEMENT**

- (1) Immerse the oil cooler element **5** in a water tank, with the oil outlet **A** closed. Connect a hose to the engine oil inlet **B**.
- (2) Apply an air pressure of 300 kPa (3 kg/cm<sup>2</sup>, 43 psi) into the oil cooler element **5** through the connected hose, and check for air leaks.
- (3) Replace the oil cooler element **5** if it leaks.

**INSTALLATION SERVICE POINTS****◆A◆ OIL FILTER INSTALLATION**

- (1) Clean the surface of the oil cooler body **1** which contacts the oil filter **2**.
- (2) Apply a thin coat of engine oil to the gasket **A** on the oil filter **2**.
- (3) Holding the gasket **A** in contact with the oil cooler cover **1**, tighten the cover 5/8 turn (for PAJERO) or 3/4 turn (for L200).

# 16. OIL PAN, OIL STRAINER AND OIL JET REMOVAL AND INSTALLATION

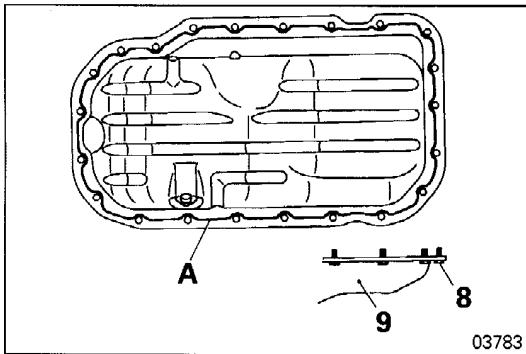
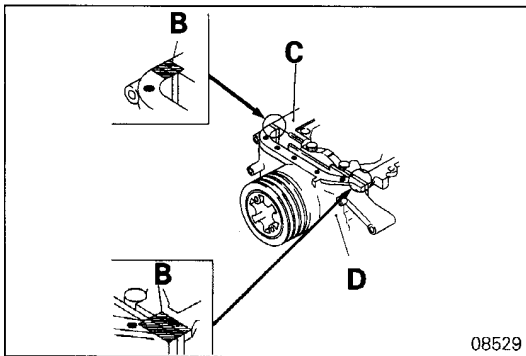


**Removal steps**

1. Drain plug
2. Bolt (PAJERO from 1997 model)
3. Collar (PAJERO from 1997 model)
4. Insulator (PAJERO from 1997 model)
5. Oil pan cover (PAJERO from 1997 model)
6. Rubber seal C (PAJERO from 1997 model)
7. Rubber seal A (PAJERO from 1997 model)
8. Bolt
9. Oil pan

10. Rubber seal B (PAJERO from 1997 model)
11. Oil level sensor (Vehicles for Europe)
12. Oil strainer
13. O-ring
14. Check valve (See page 11A-28-1.)
15. Oil jet (See page 11A-28-1.)

- \*1: Lower crankcase  
(See page 11A-28-1.)
- \*2: Upper crankcase  
(See page 11A-28-1.)



## INSTALLATION SERVICE POINT

### ◆A◆ OIL PAN INSTALLATION

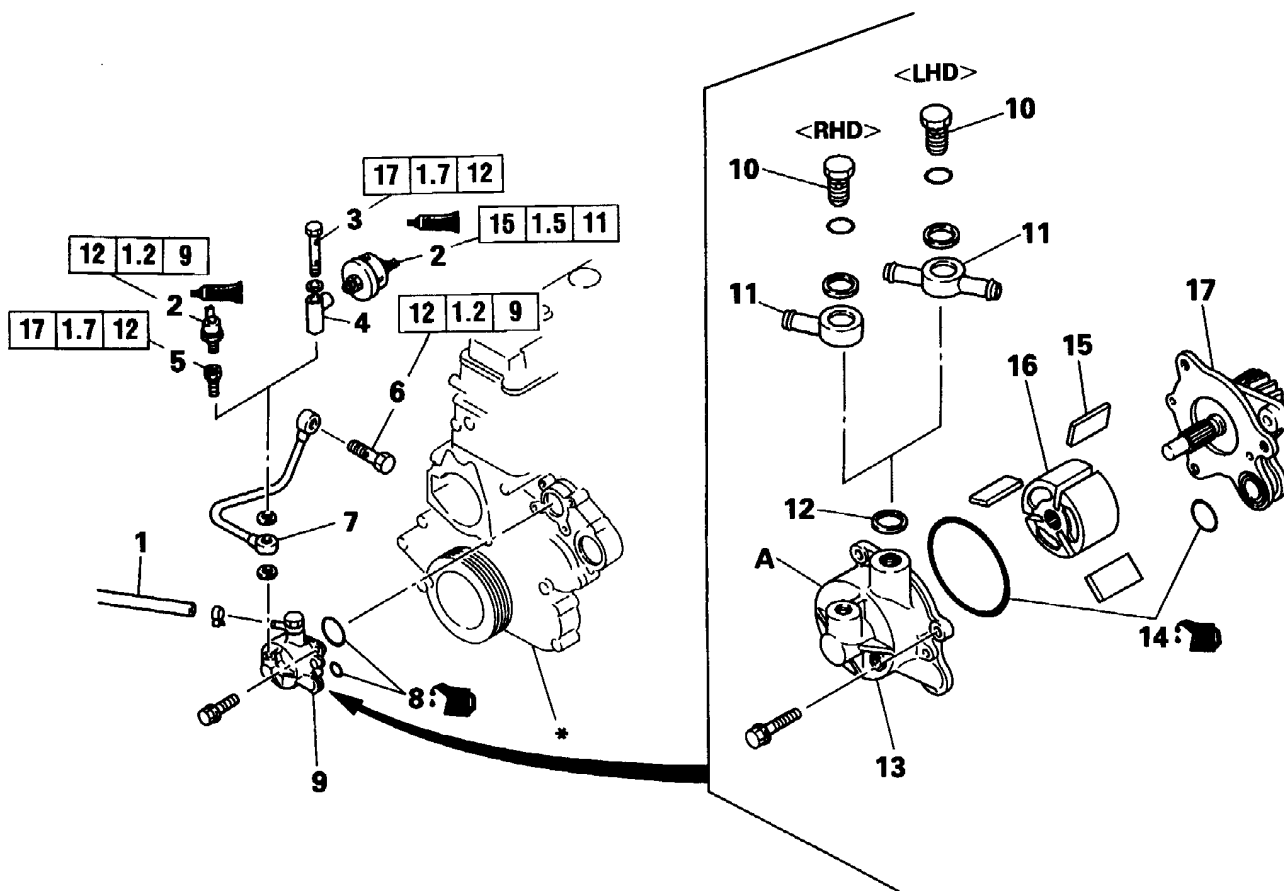
- (1) Apply sealant at the bottom **B** of the mating surface of lower crankcase **C** and timing gear case **D**.
- (2) Apply even beads of sealant **A** without skips to the circumferential mating surface of the oil pan **9** as shown. Bead diameter:  $3.5 \pm 1$  mm ( $0.14 \pm 0.04$  in.)
- (3) Install the oil pan **9** to the lower crankcase within 15 minutes after the application of sealant **A**.

### Caution

- The surface to be coated with sealant **A** must be clean and free of slush and other foreign matters.
- When installing, take care that sealant **A** does not smear other places.
- After the oil pan **9** is installed, wait for at least one hour before starting the engine.
- Remove and reinstall the oil pan **9** with fresh beads of sealant **A** whenever the bolts **8** (holding the oil pan) were loosened or removed after the installation.

## 17. VACUUM PUMP

REMOVAL AND INSTALLATION (FOR L200, CHALLENGER and PAJERO except 1998-model for Europe)



### Removal steps

1. Air hose
- ▶▶ 2. Oil pressure switch <Except vehicles for Australia>  
Oil pressure gauge unit <Vehicles for Australia>
3. Eyebolt <Vehicles for Australia>
4. Connector <Vehicles for Australia>
5. Connector <Except vehicles for Australia>
6. Eyebolt
7. Oil pipe
8. O-ring
9. Vacuum pump assembly
10. Check valve assembly

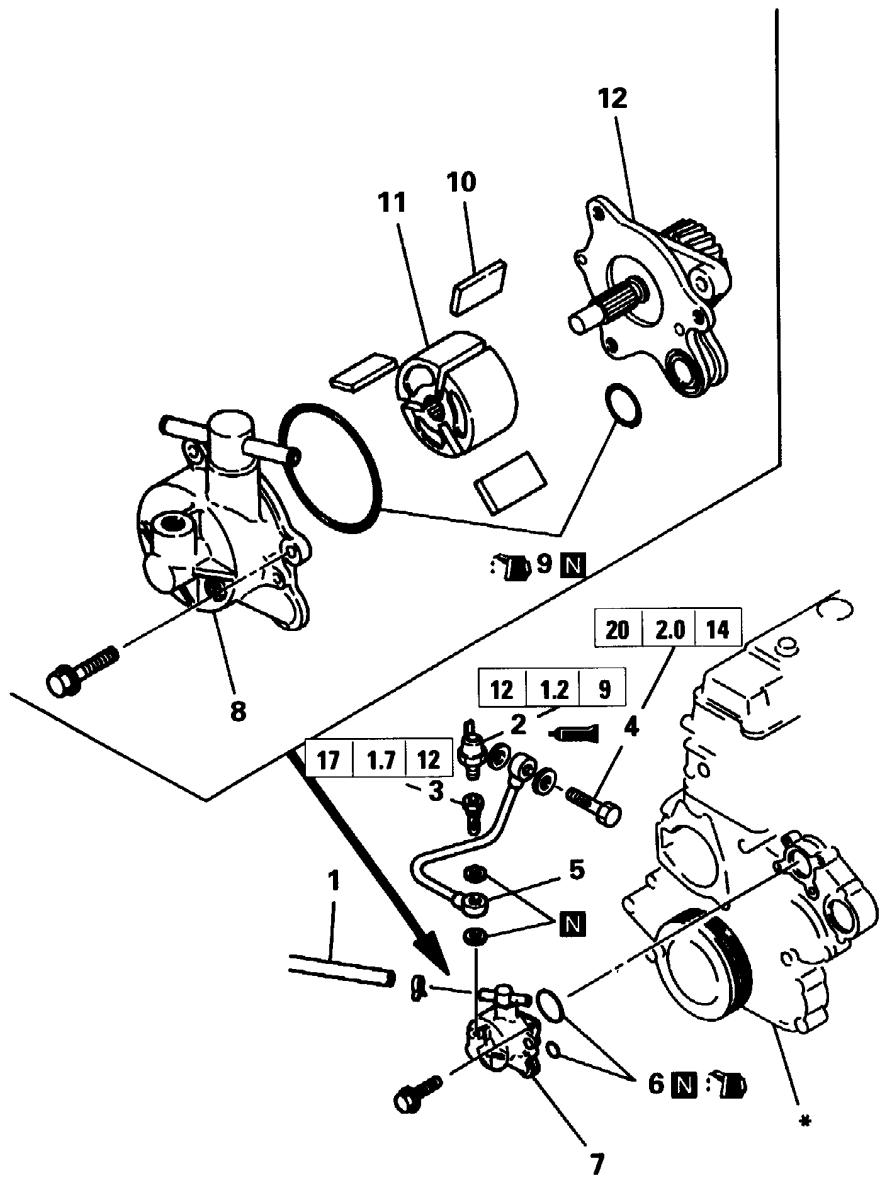
11. Joint assembly
12. Packing
13. Cylinder assembly
14. O-ring
15. Vane
16. Rotor
17. Flange assembly

\*: Timing gear case (See 11A-18-1.)

A: Dowel pin

05180

REMOVAL AND INSTALLATION (1998– PAJERO for Europe)

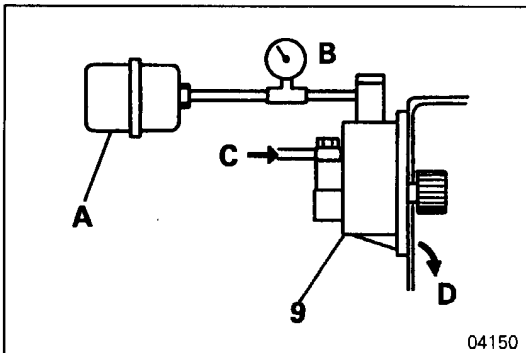


**Removal steps**

- 1. Air hose
- ▶A▶ 2. Oil pressure switch
- 3. Connector
- 4. Eyebolt
- 5. Oil pipe
- 6. O-ring
- 7. Vacuum pump assembly

- 8. Cylinder assembly
- 9. O-ring
- 10. Vane
- 11. Rotor
- 12. Flange assembly

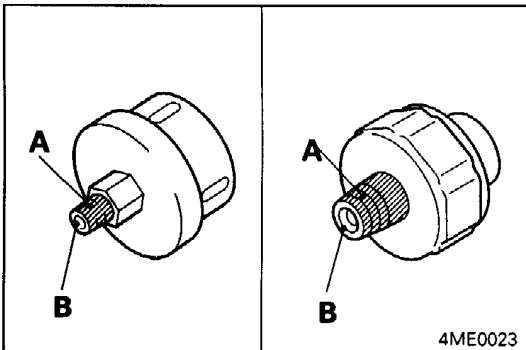
\*: Timing gear case (See 11A-18-1.)

**INSPECTION****VACUUM PUMP ASSEMBLY**

- (1) Connect a vacuum tank **A** (capacity: 10 liters) to the vacuum pump assembly **9** through a vacuum gauge **B**. Start the engine and check the vacuum pump for vacuum build-up. If the gauge reading deviates from the specified standard value, replace the vacuum pump.

**C:** Engine oil inlet

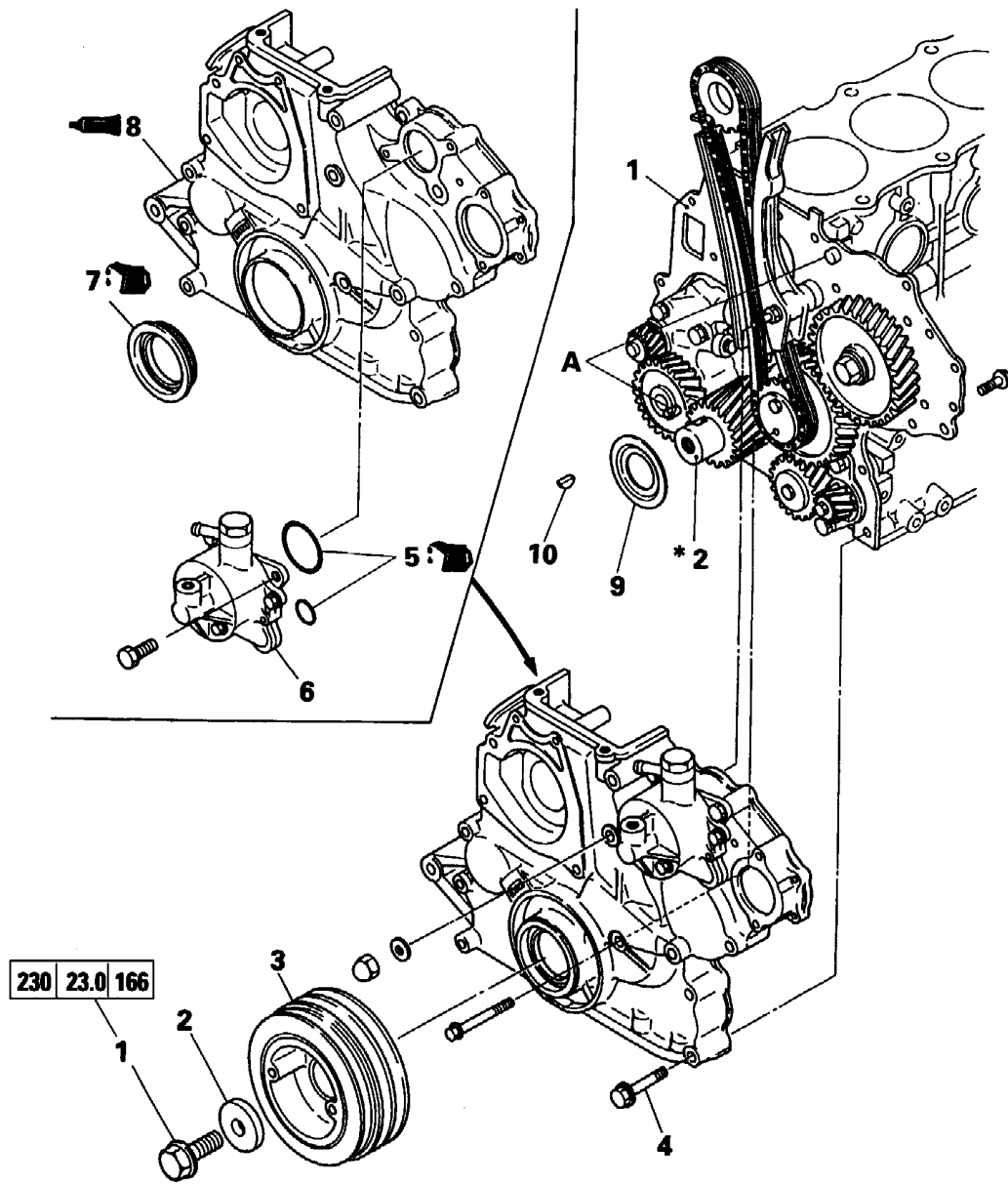
**D:** Engine oil outlet (to oil pan)

**INSTALLATION SERVICE POINT****◆A◆ OIL PRESSURE GAUGE UNIT AND OIL PRESSURE SWITCH INSTALLATION**

- (1) Apply sealant to threads **A**. Be sure to keep the end **B** free from the sealant.

# 18. TIMING GEAR CASE

## REMOVAL AND INSTALLATION <FOR PAJERO>



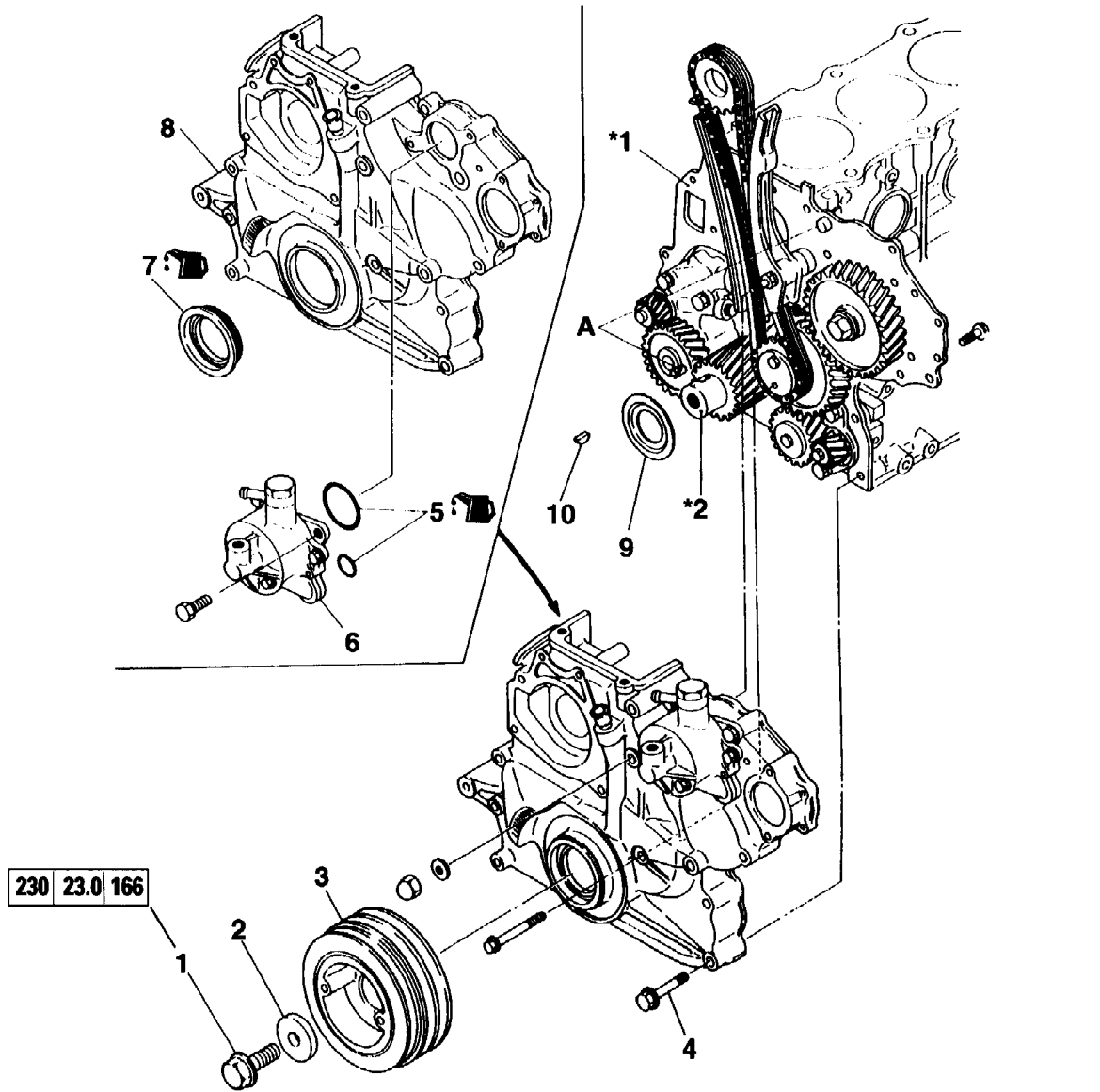
**Removal steps**

- ◀A▶▶D▶ 1. Bolt
- ▶ 2. Washer
- ▶ 3. Crankshaft pulley
- ▶ 4. Bolt
- ▶ 5. O-ring
- ▶ 6. Vacuum pump assembly  
(See page 11A-17-1.)
- ▶C▶▶ 7. Front oil seal
- ▶B▶▶ 8. Timing gear case
- ▶A▶▶ 9. Front oil seal slinger
- ▶ 10. Key

- \*1: Front plate (See page 11A-28-1.)
- \*2: Crankshaft (See page 11A-28-1.)
- A: Dowel pin

**NOTE**  
Do not remove the front oil seal unless absolutely necessary.

REMOVAL AND INSTALLATION <FOR L200 and CHALLENGER>



**Removal steps**

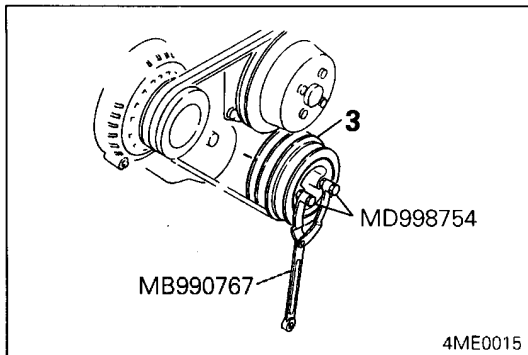
- ◁A▷▷D◁ 1. Bolt
- 2. Washer
- 3. Crankshaft pulley
- 4. Bolt
- 5. O-ring
- 6. Vacuum pump assembly  
(See page 11A-17-1.)
- ▷C◁ 7. Front oil seal
- ◁B▷▷B◁ 8. Timing gear case
- ▷A◁ 9. Front oil seal slinger
- 10. Key

- \*1: Front plate (See page 11A-28-1.)
- \*2: Crankshaft (See page 11A-28-1.)
- A: Dowel pin

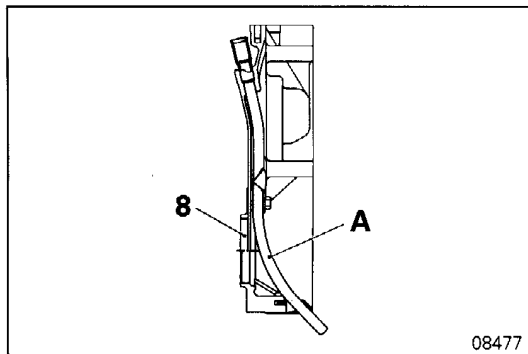
**NOTE**

Do not remove the front oil seal unless absolutely necessary.

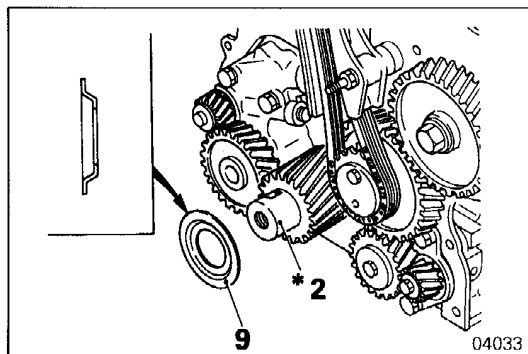


**REMOVAL SERVICE POINTS****◀A▶ CRANKSHAFT CENTER BOLT REMOVAL**

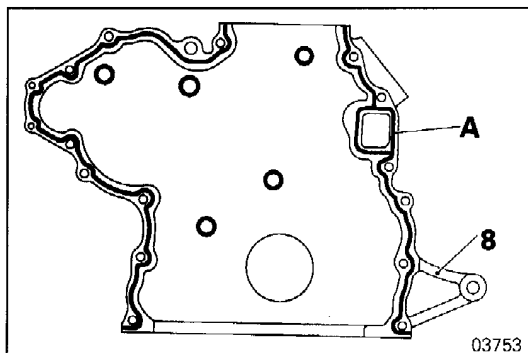
- (1) Holding the crankshaft pulley **3** with the special tool, remove the crankshaft center bolt **1**.

**◀B▶ TIMING GEAR CASE REMOVAL <L200>**

- (1) Be sure to handle the timing gear case **8** carefully as the guide pipe **A** protrudes from the bottom of the case.

**INSTALLATION SERVICE POINTS****▶A▶ FRONT OIL SEAL SLINGER INSTALLATION**

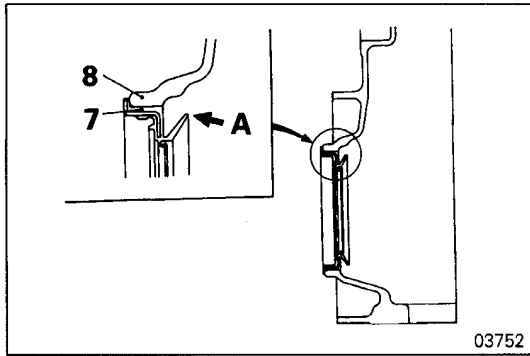
- (1) Install the front oil seal slinger **9** onto the crankshaft **\*2** in the direction shown in the illustration.

**▶B▶ TIMING GEAR CASE INSTALLATION**

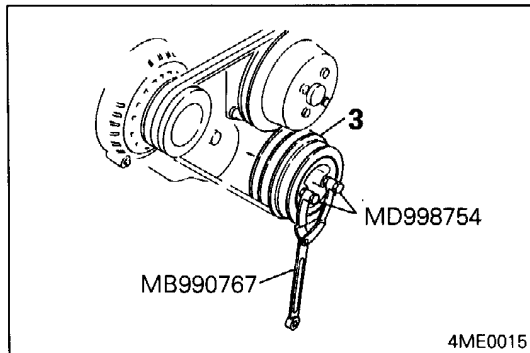
- (1) Apply an even bead of sealant **A** without break to the entire joint surface of the timing gear case **8** as shown. Bead diameter:  $3.5 \pm 1$  mm ( $0.14 \pm 0.04$  in.)
- (2) Install the timing gear case **8** within 15 minutes after the application of sealant **A**.

**Caution**

- The joint surface to be coated with sealant **A** must be clean and free of slush and other foreign matters.
- When installing, use care that the surroundings are not smeared with sealant **A**.
- After the timing gear case is installed, wait for at least one hour before starting the engine.
- Remove and reinstall the timing gear case with a fresh bead of sealant **A** whenever the bolts **4** (holding the timing gear case) were loosened or removed after installation.

**⇄C⇄ FRONT OIL SEAL INSTALLATION**

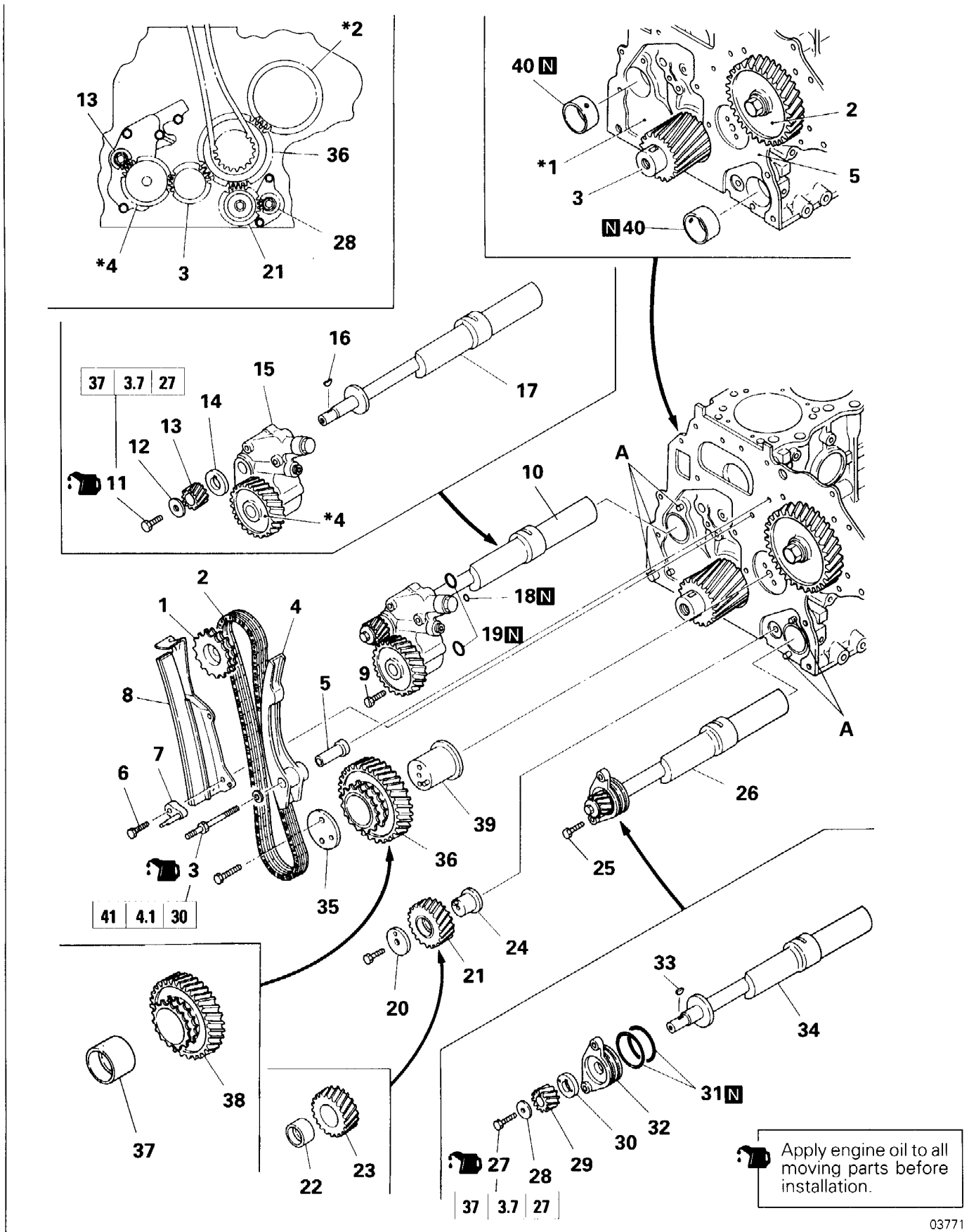
- (1) Apply a thin coat of engine oil to the lip **A**, and install the front oil seal **7** to the timing gear case **8** with the lip directed as shown.

**⇄D⇄ CRANKSHAFT CENTER BOLT INSTALLATION**

- (1) Holding the crankshaft pulley **3** with the special tool, install the crankshaft center bolt **1**.

# 19. TIMING GEAR AND BALANCE SHAFT

## REMOVAL AND INSTALLATION



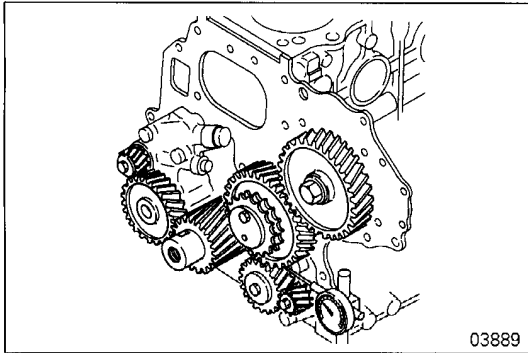
Apply engine oil to all moving parts before installation.

**Removal steps**

- |                                          |     |                               |     |                                             |
|------------------------------------------|-----|-------------------------------|-----|---------------------------------------------|
| 1. Cam sprocket                          |     | 17. Balance shaft RH          |     | 34. Balance shaft LH                        |
| 2. Timing chain                          |     | 18. O-ring                    |     | 35. Idler washer                            |
| 3. Bolt                                  |     | 19. O-ring                    |     | 36. Idler gear and sprocket assembly        |
| 4. Tension lever                         |     | 20. Idler washer A            |     | 37. Idler sprocket bush                     |
| 5. Tension lever shaft                   |     | 21. Idler gear assembly LH    | ◊B◊ | 38. Idler gear and sprocket                 |
| 6. Eyebolt                               |     | 22. Idler gear bush LH        |     | 39. Idler shaft                             |
| 7. Oil jet assembly (See page 11A-16-1.) | ◊A◊ | 23. Idler gear LH             |     | 40. Balance shaft bush                      |
| 8. Guide plate                           |     | 24. Idler shaft A             | ◊C◊ |                                             |
| 9. Bolt                                  |     | 25. Bolt                      |     |                                             |
| 10. Balance shaft assembly RH            |     | 26. Balance shaft assembly LH |     | *1: Crankcase assembly (See page 11A-28-1.) |
| 11. Bolt                                 |     | 27. Bolt                      |     | *2: Injection pump gear                     |
| 12. Washer                               |     | 28. Washer                    |     | *3: Crankshaft gear (See page 11A-28-1.)    |
| 13. Balance shaft gear RH                |     | 29. Balance shaft gear LH     |     | *4: Oil pump gear                           |
| 14. Thrust spacer                        |     | 30. Thrust spacer             |     | *5: Front plate (See page 11A-28-1.)        |
| 15. Oil pump assembly                    |     | 31. O-ring                    |     | <b>A:</b> Dowel pin                         |
| 16. Key                                  |     | 32. Thrust plate              |     |                                             |
|                                          |     | 33. Key                       |     |                                             |

**Installation steps**

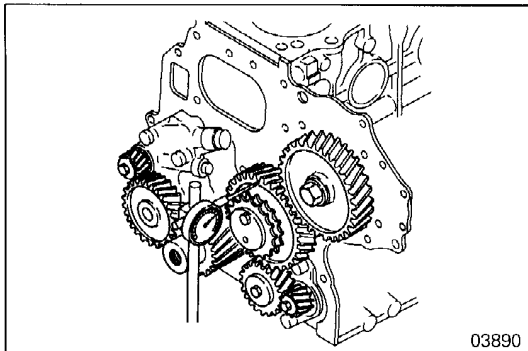
- |                                         |  |                                  |  |                        |
|-----------------------------------------|--|----------------------------------|--|------------------------|
| ◊A◊40. Balance shaft bush               |  | 24. Idler shaft A                |  | 8. Guide plate         |
| ◊C◊39. Idler shaft                      |  | 23. Idler gear LH                |  | 7. Oil jet assembly    |
| 38. Idler gear and sprocket             |  | ◊D◊22. Idler gear bush LH        |  | 6. Eyebolt             |
| ◊B◊37. Idler sprocket bush              |  | 21. Idler gear assembly LH       |  | 5. Tension lever shaft |
| ◊C◊36. Idler gear and sprocket assembly |  | 20. Idler washer A               |  | 4. Tension lever       |
| 34. Balance shaft LH                    |  | 19. O-ring                       |  | 3. Bolt                |
| 33. Key                                 |  | 18. O-ring                       |  | ◊G◊ 2. Timing chain    |
| 32. Thrust plate                        |  | 17. Balance shaft RH             |  | 1. Cam sprocket        |
| 31. O-ring                              |  | 16. Key                          |  | 35. Idler washer       |
| 30. Thrust spacer                       |  | 15. Oil pump assembly            |  |                        |
| 29. Balance shaft gear LH               |  | 14. Thrust spacer                |  |                        |
| 28. Washer                              |  | 13. Balance shaft gear RH        |  |                        |
| 27. Bolt                                |  | 12. Washer                       |  |                        |
| ◊E◊26. Balance shaft assembly LH        |  | 11. Bolt                         |  |                        |
| 25. Bolt                                |  | ◊F◊10. Balance shaft assembly RH |  |                        |
|                                         |  | 9. Bolt                          |  |                        |



**PRE-REMOVAL INSPECTION**

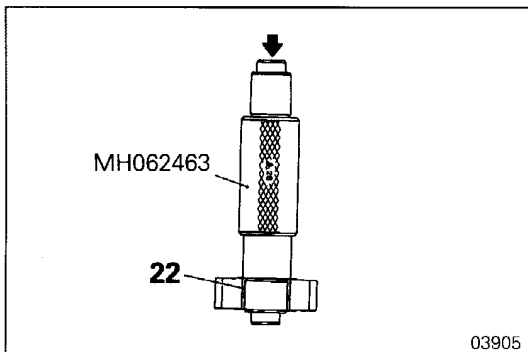
**BACKLASH**

- (1) Measure backlash between gears, pair by pair, at three or more points. If the reading exceeds the specified service limit, replace defective part.



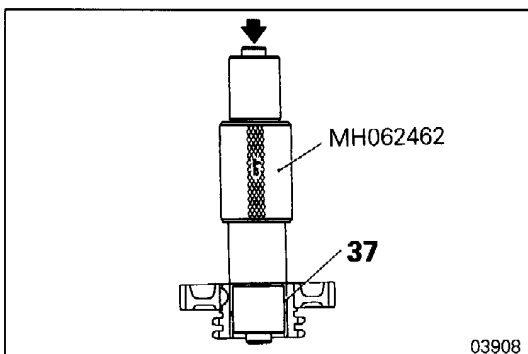
**END PLAY**

- (1) Measure end play of each gear and shaft. If the reading exceeds the specified service limit, replace defective part.

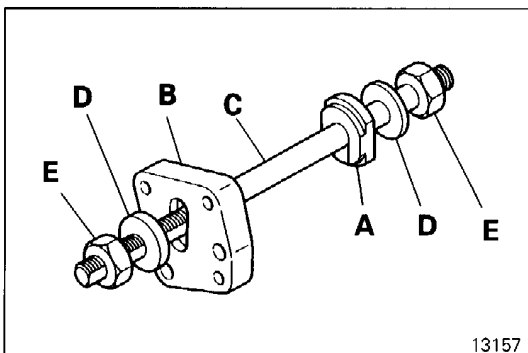


**REMOVAL SERVICE POINTS**

◊A◊ **IDLER GEAR BUSH LH REMOVAL**



◊B◊ **IDLER SPROCKET BUSH REMOVAL**



◊C◊ **BALANCE SHAFT BUSH REMOVAL**

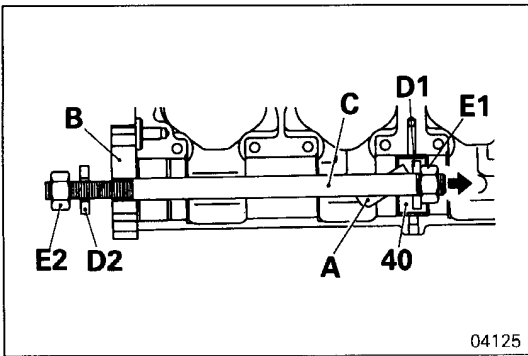
- (1) Using the special tool, remove the balance shaft bushes **40** in the following manner:

Component Parts of Special Tool MH062490 – Balance Shaft Bush Remover

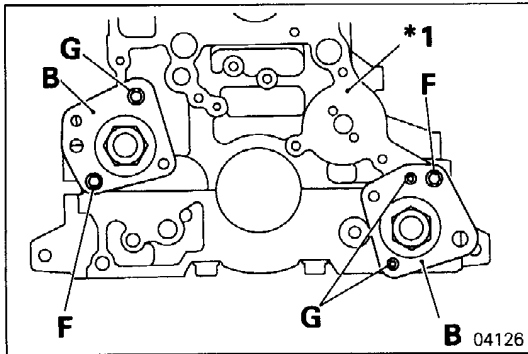
- A:** Remover
- B:** Plate
- C:** Puller
- D:** Washer (2 pcs)
- E:** Nut (2 pcs)

**NOTE:**

Apply engine oil to the sliding surface of plate **B** and puller **C**.



- (2) Set the tools as shown by passing the remover **A**, through the balance shaft bush **40** while tilting it as shown.
- (3) Pull the puller **C** to bring the washer **D1** into contact with the remover **A**. Then, turn in the nut **E2** until the plate **B** is lightly pressed by it.

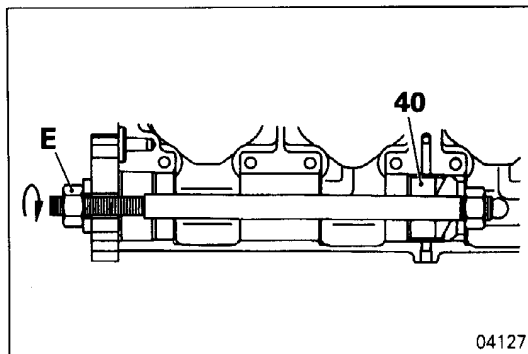


- (4) Secure the plate **B** to the crankcase **\*1** using bolt **F** [M8x1.25 mm (0.042 in.)]

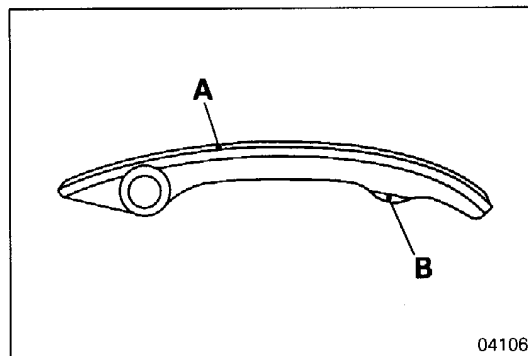
**G:** Dowel pin

**Caution**

- **The securing position of the plate B is different between when removing the left-hand and right-hand balance shaft bushes. Be sure to secure it in right places.**

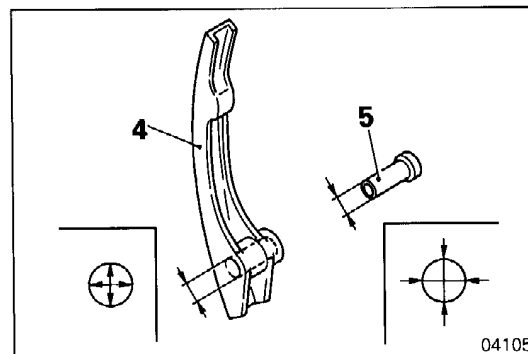


- (5) Tighten the Nut **E** further to remove the balance shaft bush **40**.



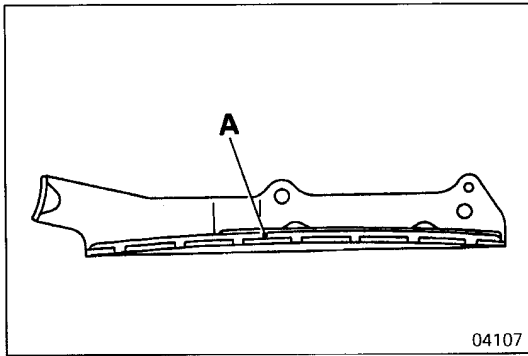
**INSPECTION**  
**TENSION LEVER**

- (1) Check the tension lever **4** for evidence of cracking, flaking or other defect in the surface **A** that makes sliding contact with the timing chain and in the surface **B** that contacts the tensioner. Replace the tension lever **4** if necessary.



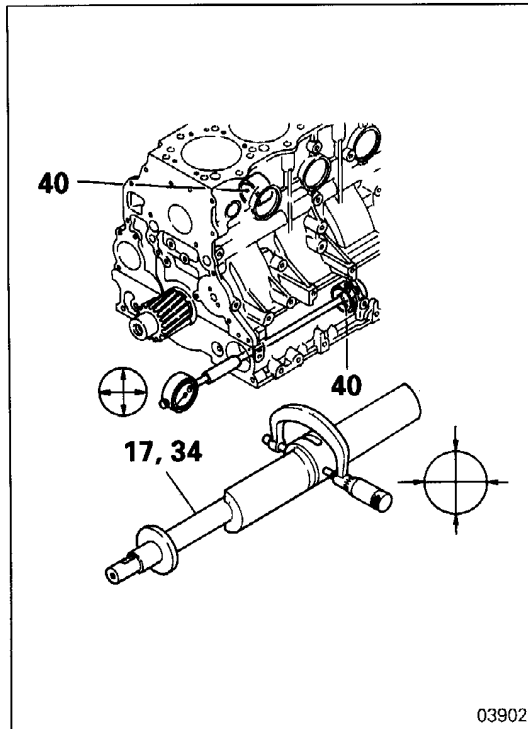
**TENSION LEVER-TO-TENSION LEVER SHAFT CLEARANCE**

- (1) Measure the tension lever-to-tension lever shaft clearance. If the reading exceeds the specified service limit, replace defective part.



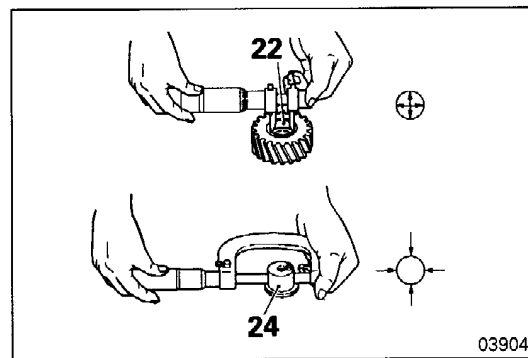
**CHECKING GUIDE PLATE**

- (1) Check the guide plate **8** for evidence of cracking, flaking or other defect in the surface **A** that makes sliding contact with the timing chain. Replace the guide plate if necessary.



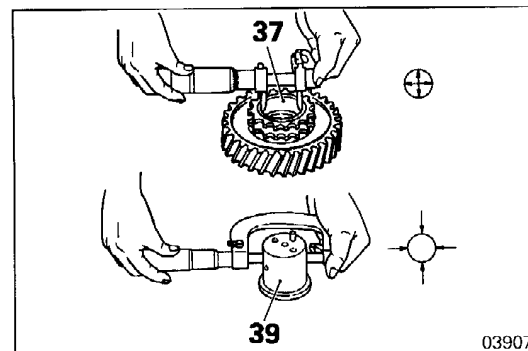
**BALANCE SHAFTS RH AND LH, AND BALANCE SHAFT BUSHES**

- (1) Measure the balance shaft-to-balance shaft bush clearance. If the reading exceeds the specified service limit, replace defective part.



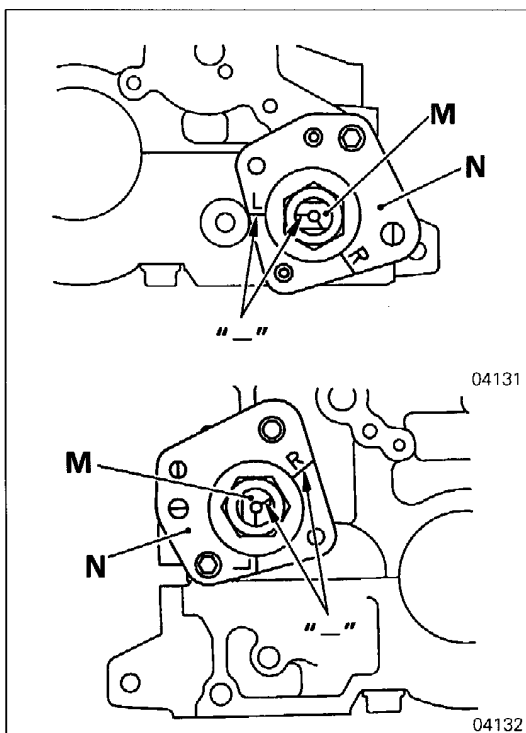
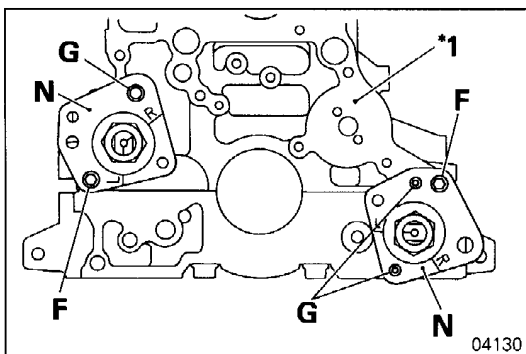
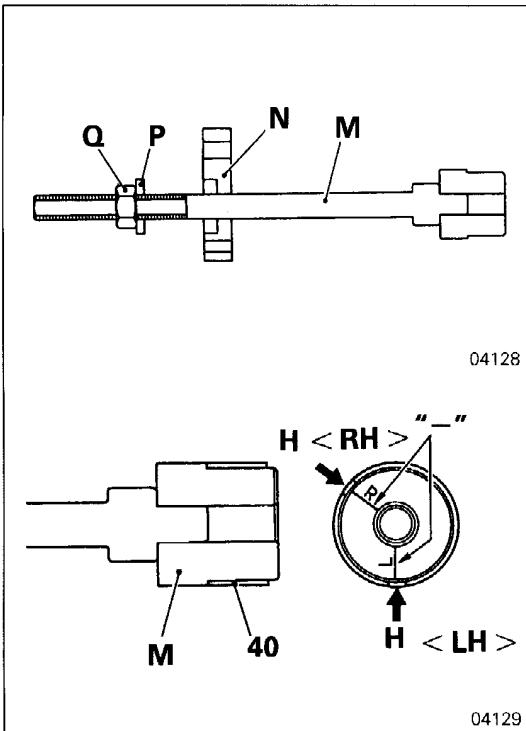
**IDLER GEAR BUSH LH AND IDLER SHAFT A**

- (1) Measure the idler shaft-to-idler gear bush clearance. If the reading exceeds the specified service limit, replace defective part.



**IDLER SPROCKET BUSH AND IDLER SHAFT**

- (1) Measure the idler shaft-to-idler sprocket bush clearance. If the reading exceeds the specified service limit, replace defective part.



## INSTALLATION SERVICE POINTS

### ◆A◆ BALANCE SHAFT BUSH INSTALLATION

- (1) Using the special tool, install the balance shaft bushes **40** in the following manner:

Component Parts of Special Tool MH062717 – Balance Shaft Bush Installer

**M:** Installer

**N:** Plate

**P:** Washer

**Q:** Nut

#### Caution

- Apply engine oil to the sliding surfaces of the installer **M** and plate **N**.

- (2) Install the balance shaft bush **40** onto the installer **M** with its oil hole **H** in line with the alignment mark “-” on the installer. Align the oil hole of the left-hand bush with the “L” side “-” mark and that of the right-hand bush with the “R” side mark.

#### Caution

- To keep the oil hole **H** of the balance shaft bush **40** in position on the installer **M**, install the bush with the chassis grease applied on the inner surface of it.

- (3) Secure the plate **N** to the crankcase **\*1** using bolt **F** [M8 x 1.25 mm (0.0492 in.)] as shown.

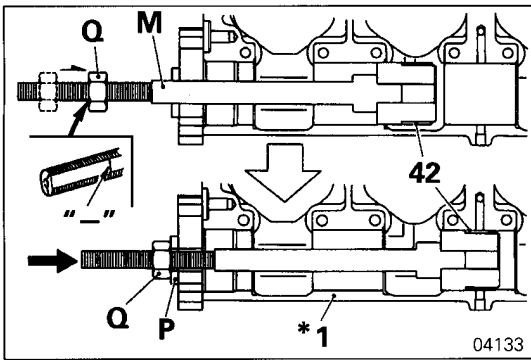
**G:** Dowel pin

#### Caution

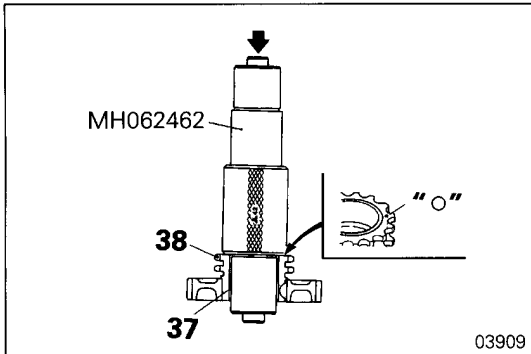
- Note that the securing position of the plate **N** is different between the left-hand balance shaft bush and the right-hand bush.
- Prior to securing the plate **N**, check that the installer **M** is correctly positioned with respect to the balance shaft bush **40**.

- (4) Line up the alignment marks “-” on the installer **M** and the plate **N**.



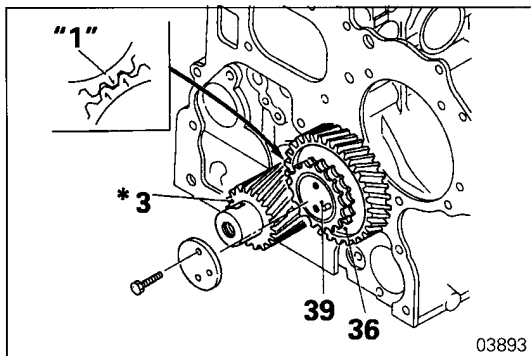


- (5) Set the drive-in depth for the balance shaft bush **40** by turning the nut **Q** until it reaches the alignment mark “-” on the installer **M**.
- (6) Press-fit the balance shaft bush **40** in the crankcase **\*1** by driving in the installer **M** until the nut **Q** completely contacts the washer **P**.
- (7) Check that the oil hole **H** in the balance shaft bush **40** is in exact alignment with the oil passage in the crankcase.



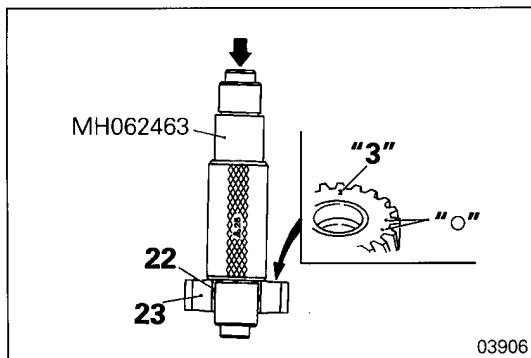
**▶B◀ IDLER SPROCKET BUSH INSTALLATION**

- (1) Press-fit the idler sprocket bush **37** into the idler gear and sprocket **38** from the side showing the match mark “o”.



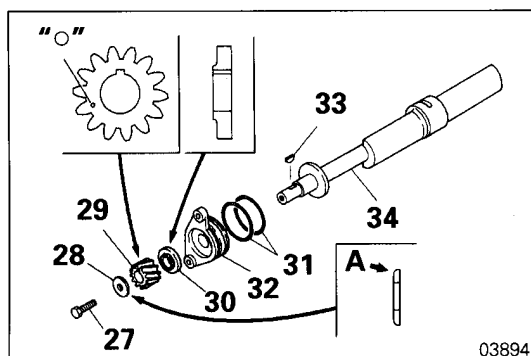
**▶C◀ INSTALLING IDLER GEAR AND SPROCKET ASSEMBLY TO IDLER SHAFT**

- (1) Install the idler gear and sprocket assembly **36** onto the idler shaft **39** while aligning the mark “1” with that on the crankshaft gear **\*3**.



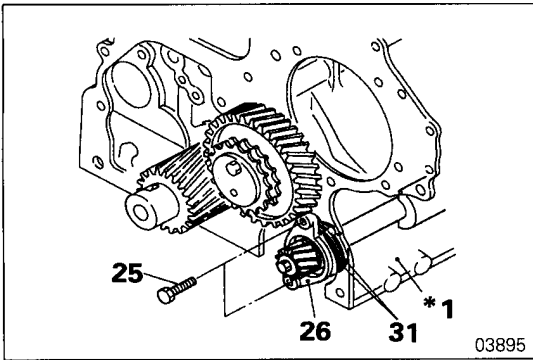
**▶D◀ IDLER GEAR BUSH LH INSTALLATION**

- (1) Press-fit the idler gear bush LH **22** into the idler gear LH **23** from the side showing the match marks “3” and “o”.



**▶E◀ BALANCE SHAFT LH ASSEMBLY INSTALLATION**

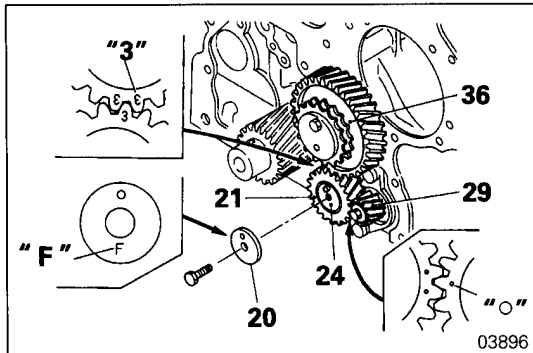
- (1) Install the balance shaft LH assembly **26** as follows:
  - (a) Assemble the parts shown in the illustration to the balance shaft LH **34** and secure them by tightening the bolt **27** to the specified torque.  
Be sure that the washer **28** and thrust spacer **30** face in correct direction as shown. Install the balance shaft gear LH **29** with the side showing the match mark “o” outward.  
**A:** Shear droop side



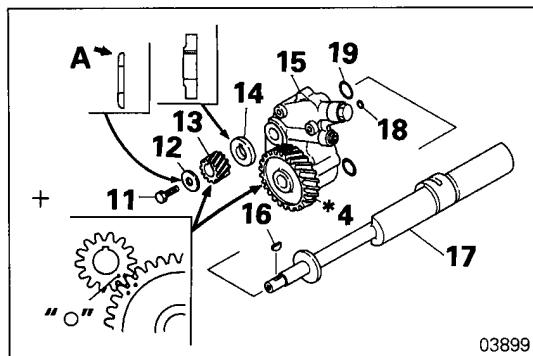
- (b) Insert the completed balance shaft LH assembly **16** into the crankcase assembly **\*1**, set it in position with the dowel pin on the crankcase assembly and secure it with bolts **25**.

#### Caution

- Do not rotate the balance shaft LH assembly **26** during insertion into the crankcase assembly **\*1**. This may cause the O-ring **31** to be slipped out of place.
- Insert the balance shaft LH assembly **26** using care not to damage the inner surface of the balance shaft bush **40** in the crankcase.



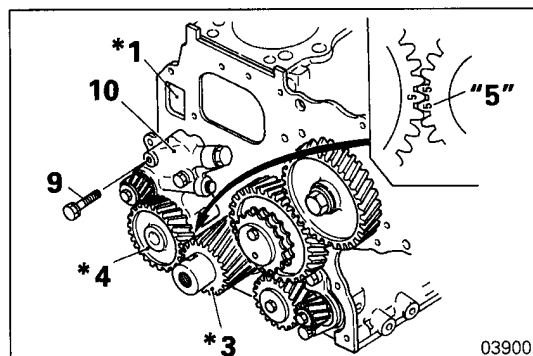
- (c) Install the idler gear LH assembly **21** onto the idler shaft **24**. At this time, be sure to align the match marks **"3"** and **"o"** on the idler gear with the corresponding match marks on the idler gear and sprocket assembly **36** and the balance shaft gear LH **29**.
- (d) Then, install the idler washer **20** to the idler gear LH assembly with its front mark **"F"** facing outward.



#### ▶F◀ BALANCE SHAFT RH ASSEMBLY INSTALLATION

- (1) Install the balance shaft RH assembly **10** as follows:
- (a) Assemble the parts shown in the illustration to the balance shaft RH **17** and secure by tightening the bolt **11** to the specified torque. Be sure to install the washer **12** and thrust spacer **14** in the direction shown in the illustration, and install the balance shaft gear RH **13** with its mating mark **"o"** aligned with the mating mark **"6"** on the oil pump gear **\*4**.

**A:** Shear droop side

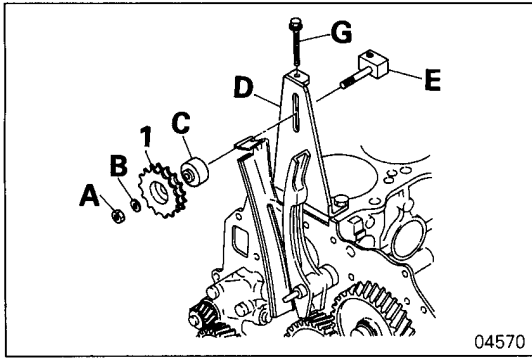


- (b) Insert the completed balance shaft RH assembly **10** into the crankcase assembly while aligning the mating marks **"5"** on the oil pump gear **\*4** and the crankshaft gear **\*3**, and set the shaft assembly in position with the dowel pin on the crankcase assembly **\*1** and secure it with bolts **9**.

#### Caution

- Insert the balance shaft RH assembly **10** using care not to damage the inner surface of the balance shaft bush **40** in the crankcase.

- (c) After the timing gears are installed in position, check that all the rotary parts smoothly rotate.

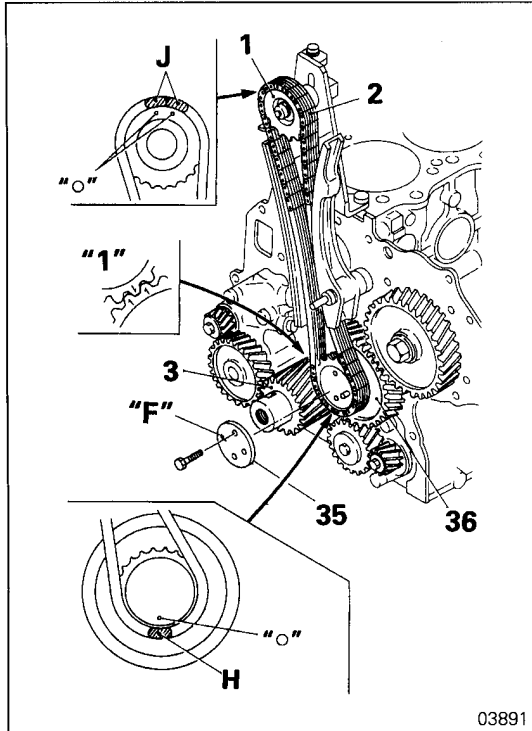


**⚡G⚡ TIMING CHAIN INSTALLATION**

(1) Hold the cam sprocket **1** using the special tool.

Component Parts of Special Tool MH062381 – Cam Sprocket Holder Kit

- A:** Nut
- B:** Washer
- C:** Spacer
- D:** Adjusting plate
- E:** Nut
- G:** Bolt



(2) Check that the match mark "**1**" on the idler gear and sprocket assembly **36** is in alignment with that on the crankshaft gear **\*3**.

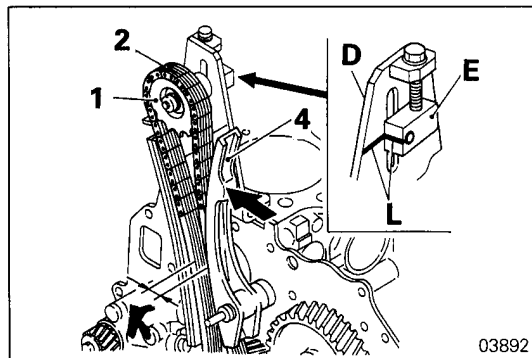
(3) Align the match mark "**0**" on the idler gear and sprocket assembly **36** with the mark link plate **H** of the timing chain **2**.

**NOTE**

The timing chain **2** has the match mark provided at two places: one bright white link plate **H** at one place and a pair of bright white link plates **J** at the other.

(4) Place the timing chain **2** around the cam sprocket **1** while aligning the timing mark "**0**" on the cam sprocket **1** with the mark link plate **J** on the timing chain **2**.

(5) Attach the idler washer **35** with the front mark "**F**" facing outward.

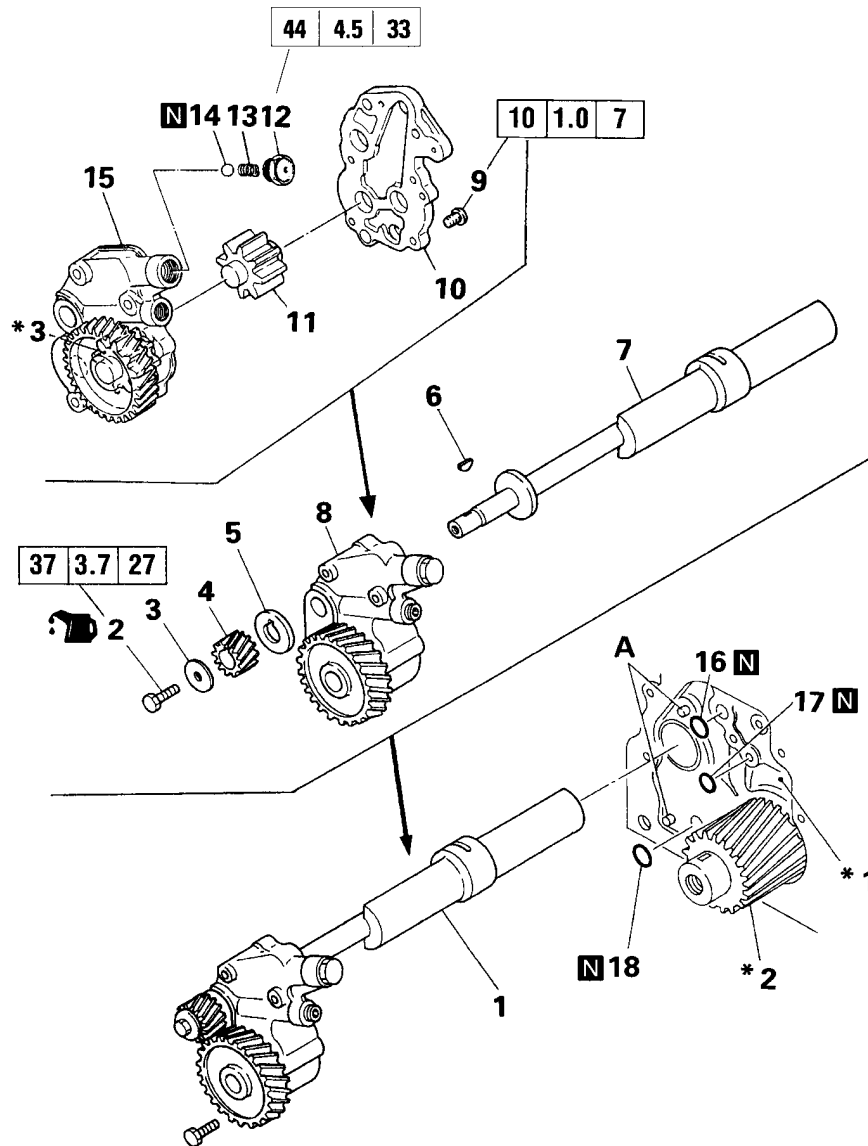


(6) With the stamped lines **L** on the adjusting plate **D** and nut **E** in alignment, set the cam sprocket **1** in the normal operating position. Push the tension lever **4** by hand to take up the slack of the timing chain **2**.

(7) Measure the clearance **K** of the timing chain **2** stretched. If the reading deviates the specified standard limit, replace the timing chain.

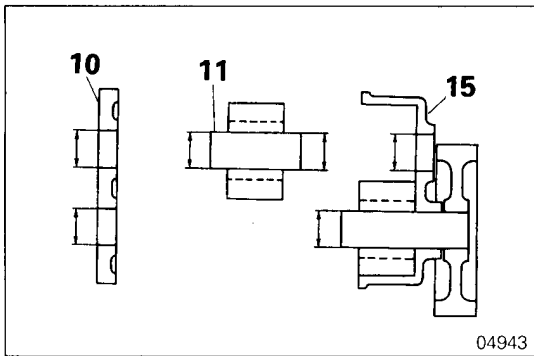
## 20. OIL PUMP

### DISASSEMBLY AND REASSEMBLY

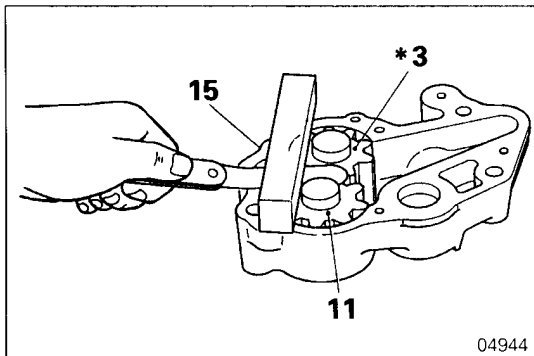


#### Removal steps

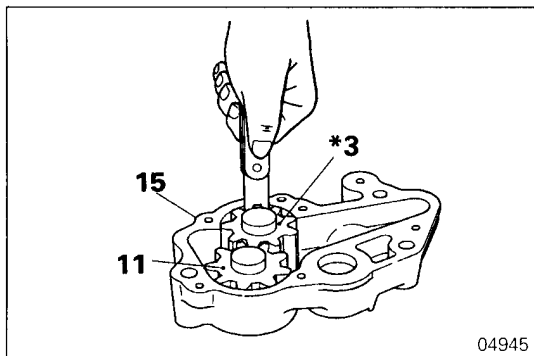
- |                              |                                    |
|------------------------------|------------------------------------|
| 1. Balance shaft RH assembly | 13. Relief valve spring            |
| 2. Bolt                      | 14. Steel ball                     |
| 3. Washer                    | 15. Gear and body assembly         |
| 4. Balance shaft gear RH     | 16. O-ring                         |
| 5. Thrust spacer             | 17. O-ring                         |
| 6. Key                       | 18. O-ring                         |
| 7. Balance shaft RH          |                                    |
| 8. Oil pump assembly         | *1: Crankcase (See page 11A-28-1.) |
| 9. Screw                     | *2: Crankshaft gear                |
| 10. Oil pump cover           | *3: Drive gear                     |
| 11. Driven gear assembly     | A: Locating pin                    |
| 12. Plug                     |                                    |

**INSPECTION****OIL PUMP**

- (1) Shaft to Oil Pump Case and Cover Clearances  
In either case, if the measurement exceeds the specified service limit, replace oil pump assembly.



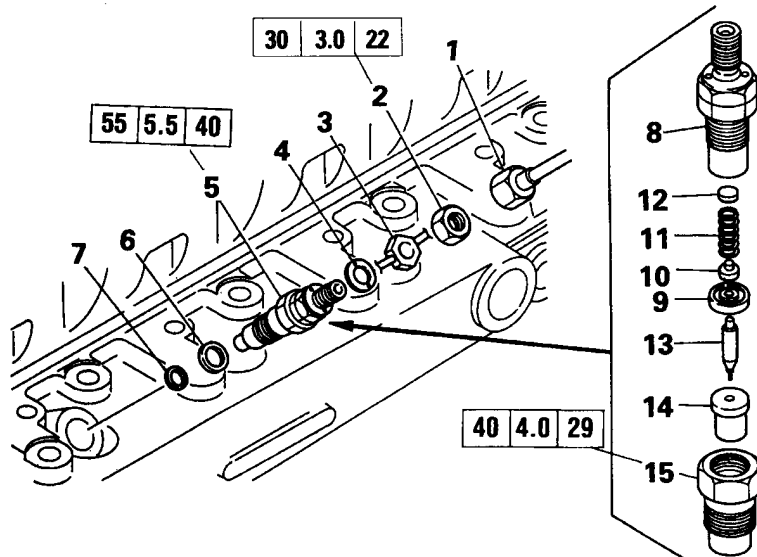
- (2) Difference between Gear Height and Oil Pump Case Depth  
If the difference exceeds the specified service limit, replace defective part.



- (3) Gear Tooth Crest-to-Oil Case Clearance  
If the clearance exceeds the specified service limit, replace defective part.

## 21. FUEL INJECTION NOZZLE

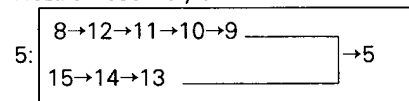
### REMOVAL AND INSTALLATION



#### Removal steps

1. Fuel injection pipe
2. Nut
3. Leak-off pipe
4. leak-off pipe gasket
5. Fuel injection nozzle assembly
6. Nozzle holder gasket
7. Nozzle gasket
8. Body
9. Spacer
10. Push rod
11. Spring
12. Adjusting shim
13. Needle valve
14. Nozzle tip
15. Retaining nut

Part Assembly Sequence for Fuel Injection Nozzle Assembly 5.



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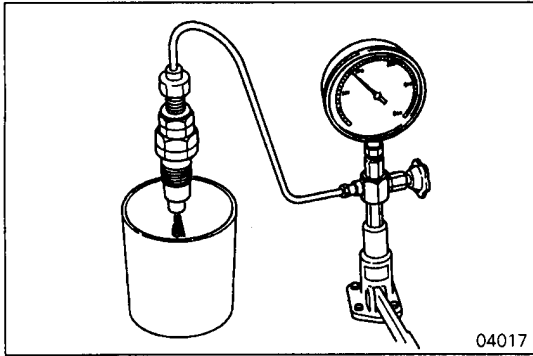
### INSPECTION

#### FUEL INJECTION NOZZLE ASSEMBLY

- (1) Install the nozzle tester to the fuel injection nozzle assembly 5 and perform the following checks:

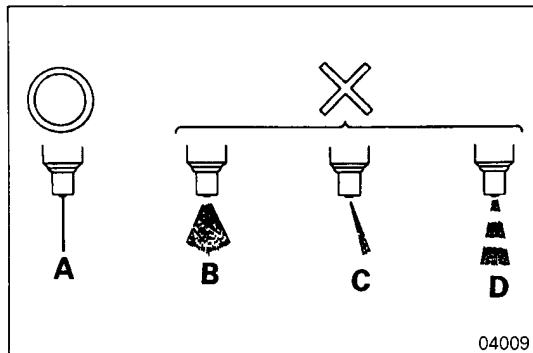
#### Caution

- Prior to proceeding with the checks, bleed air from the fuel injection nozzle by pumping the nozzle tester lever two or three times.



### Valve Opening Pressure Check

- (1) Operate the nozzle tester lever at 1 to 2 seconds per stroke. Read the pressure when, after a gradual increase, the pointer deflects rapidly.
- (2) If the reading deviates from the specified standard value, disassemble the fuel injection nozzle, clean and reassemble. Then, make necessary pressure adjustment using adjusting shims **12**.
- (3) A shim thickness of 0.1 mm (0.04 in.) changes the valve opening pressure by 1,177 – 2,157 kPa (12 – 22 kg/cm<sup>2</sup>, 171 – 313 psi). [The shim thickness necessary to change the pressure by 100 kPa (1 kg/cm<sup>2</sup>, 142 psi) is between 0.0045 mm (0.00018 in.) and 0.0083 mm (0.00033 in.).]
- (4) If the reading still deviates after the adjustment, replace the fuel injection nozzle assembly **5**.

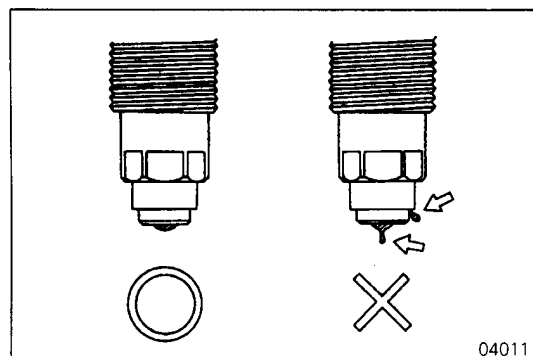


### Check Spray Pattern

- (1) Inject fuel continuously by pumping the nozzle tester lever quickly (1 to 2 seconds per stroke).
  - A:** The spray is a straight and fine streak with a spray angle of approx. 0° <Non-turbo> or 10° <Turbo>. (Acceptable)
  - B:** The angle of spray is too wide. (Unacceptable)
  - C:** The spray is out of the axial line. (Unacceptable)
  - D:** The spray breaks. (Unacceptable)
- (2) Disassemble, clean and recheck the fuel injection nozzle assembly if necessary. If the problem still remains after another check, replace the fuel injection nozzle assembly.
- (3) Check that the fuel injection nozzle does not dribble after injection.

### Caution

- **Keep away from the fuel jet.**

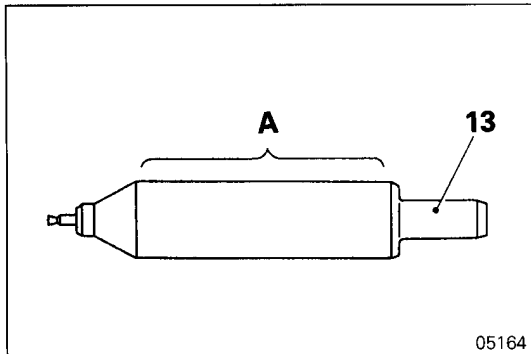


### Oil Tightness Check

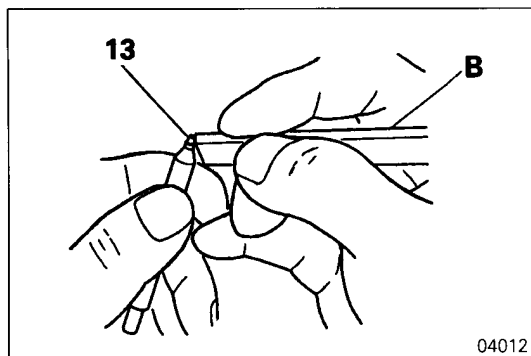
- (1) Slowly increase the nozzle internal pressure and maintain it at the specified test pressure of 12,749 – 13,729 kPa (130 – 140 kg/cm<sup>2</sup>, 1,849 – 1,991 psi). In this condition, check that the fuel injection nozzle does not start dribbling within 10 seconds.
- (2) If the dribbling begins in less than 10 seconds, disassemble, clean and recheck the fuel injection nozzle assembly **5**. If the problem still remains after another check, replace the fuel injection nozzle assembly.

**REMOVAL SERVICE POINTS****◁A▷ FUEL INJECTION NOZZLE ASSEMBLY REMOVAL****Caution**

- Remove deposited carbon from the fuel injection nozzle assembly 5 before disassembling, reassembling and adjusting it. Prior to disassembly, check the fuel injection nozzle for abnormal injection pressure, abnormal spray and fuel leaks. If it is found in order, do not disassemble the fuel injection nozzle assembly.

**◁B▷ NEEDLE VALVE / NOZZLE TIP REMOVAL****Caution**

- Be sure not to touch the sliding contact surface A of the needle valve 13.
- Be sure not to change the original combination of the needle valve 13 and nozzle tip 14 removed.

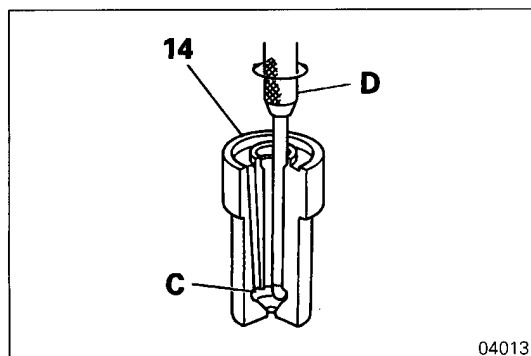
**CLEANING****NEEDLE VALVE / NOZZLE TIP**

- (1) Wash the needle valve 13 and nozzle tip 14 removed in clean kerosene (cleaning oil) and remove deposited carbon from them in the following manners using the specified special tools.

- (a) Remove carbon deposited on the tip of the needle valve 13 using the special tool Cleaning Bar B.

**Caution**

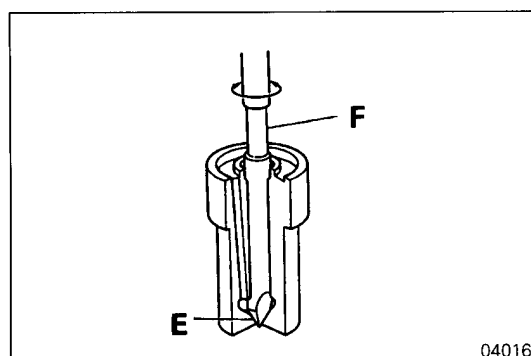
- For cleaning, never use a wire brush or any other hard metal tool.
- (b) Remove carbon accumulated in the oil pit C of the nozzle tip 14 using the Cleaning Scraper D.



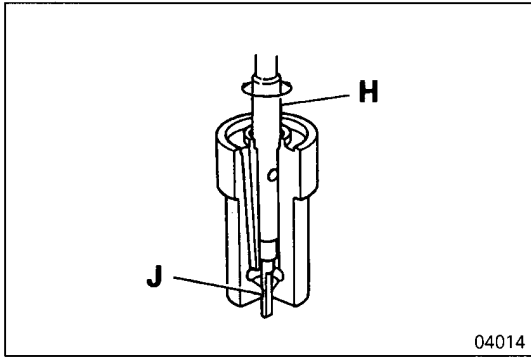
- (c) Clean the seat E of the nozzle tip 14 using the special tool Cleaning Scraper F.

**Caution**

- Use sufficient care not to damage the seat surface.
- (d) To remove baked carbon, use the Fuso Carbon Remover.

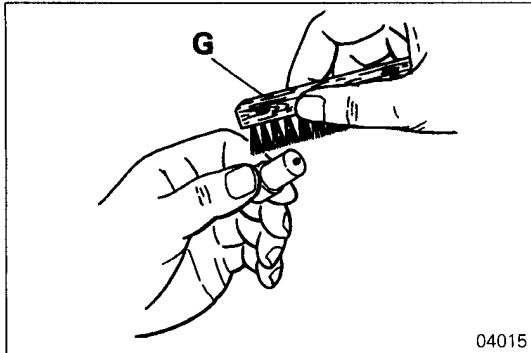




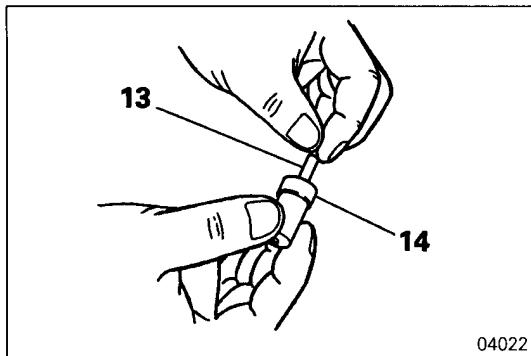


- (e) Remove carbon deposited in the nozzle hole area of the nozzle tip **14** by turning the special tool Needle Cleaner **H** that runs through the nozzle hole **J**.

**Cleaning needle diameter: Less than 1.0 mm (0.04 in.)**



- (f) Remove carbon deposited on the external surface of the nozzle tip **14** using the special tool Wire Brush **G**.



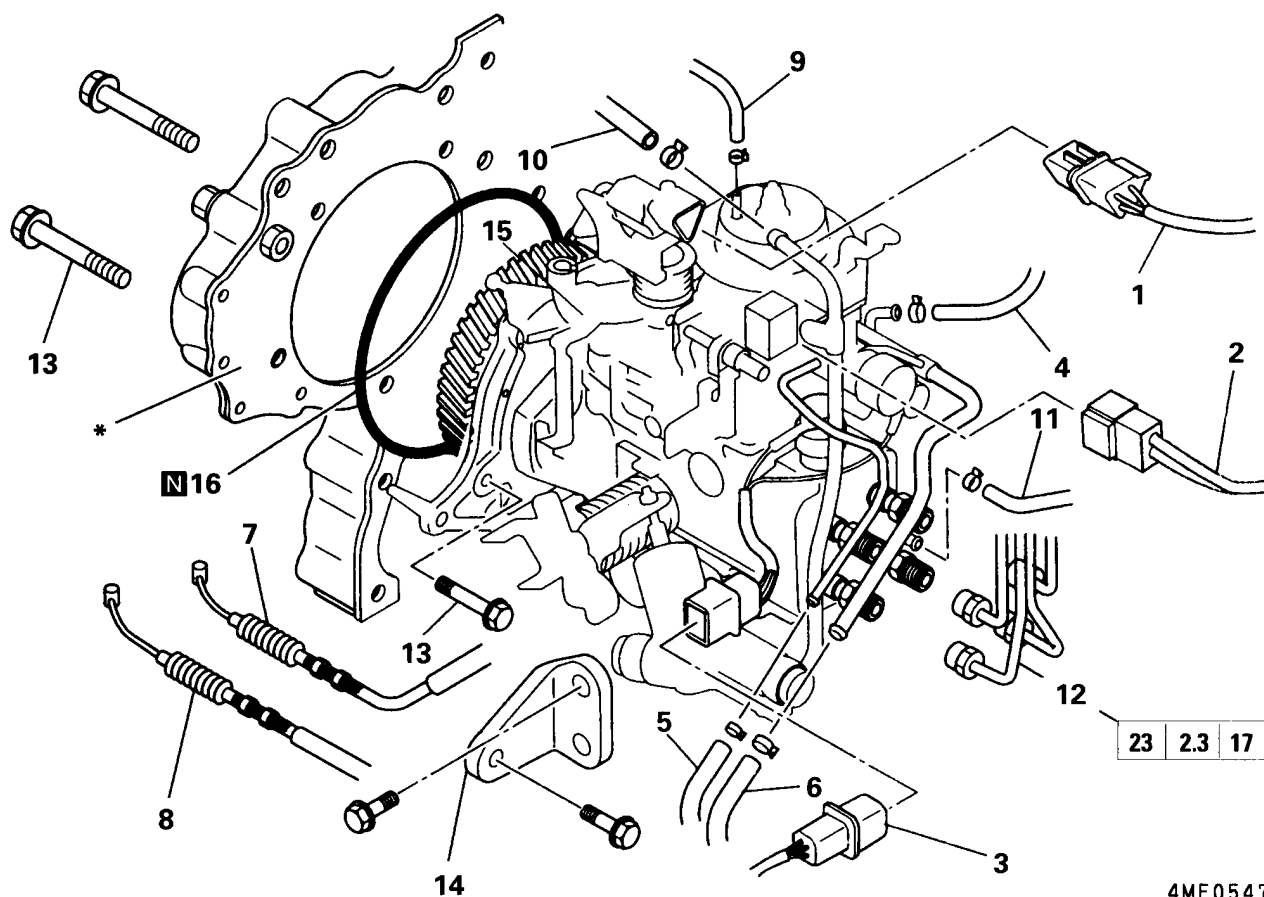
## INSPECTION

### NEEDLE VALVE / NOZZLE TIP

- (1) Wash the needle valve **13** and nozzle tip **14** clean in clean kerosene (cleaning oil) prior to reassembly.
- (2) Pull out the needle valve **13** to approximately one third of its length, let go of it and see if it slides down by gravity. (Repeat this procedure a few times after turning the needle valve each time.)
- (3) If the needle valve **13** fails to slide down by itself, wash it again and give it another check. Replace the needle valve **13** and nozzle tip **14** as a set.

## 22. FUEL INJECTION PUMP ASSEMBLY

### REMOVAL AND INSTALLATION

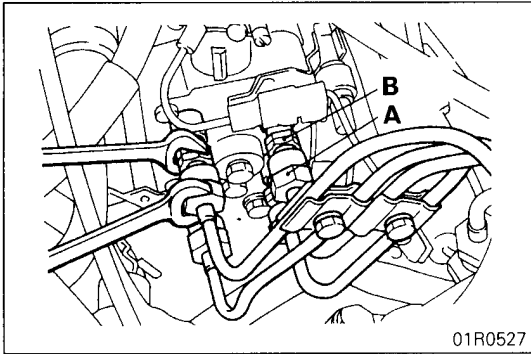


4ME0547

#### Removal steps

1. Wiring harness
2. Wiring harness  
<PAJERO 2001MODEL for Australia>
3. Wiring harness
4. Fuel leak-off hose
5. Fuel return hose
6. Fuel feed hose
7. Accelerator cable
8. Throttle cable
9. Boost hose <Turbo>
10. Water hose <with W-CSD>
11. Water hose <with W-CSD>
- ◀A▶▶C▶ 12. Fuel injection pipe
13. Bolt
14. Stay
- ▶B▶ 15. Fuel injection pump assembly
- ▶A▶ 16. O-ring
- \*: Front plate

NOTE  
W-CSD: Wax type cold start device



## REMOVAL SERVICE POINT

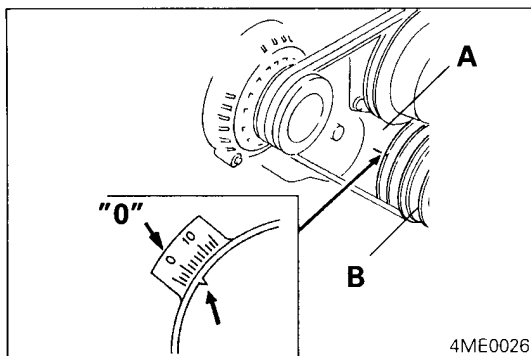
### ◊A◊ FUEL INJECTION PIPE REMOVAL

- (1) Loosen the union nut **A** of the fuel injection pipe while locking the delivery valve holder **B** to prevent it from rotating together.

## INSTALLATION SERVICE POINTS

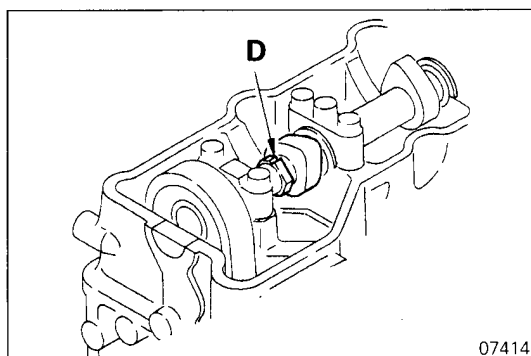
### ▶A▶ O-RING INSTALLATION

- (1) Apply a thin coat of engine oil evenly to the entire circumferential surface of O-ring before installing it.



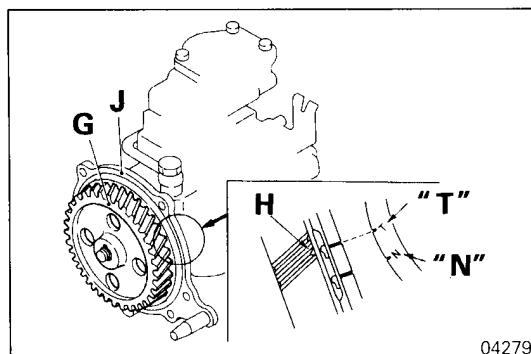
### ▶B▶ FUEL INJECTION PUMP ASSEMBLY INSTALLATION

- (1) Crank up the engine with the specified special tool to place the No.1 piston at the TDC on the compression stroke. Align the notch in the crankshaft pulley **B** with the timing mark "**0**" on the timing gear case **A**.

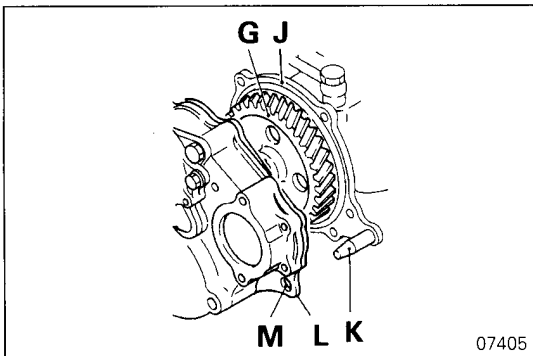


### Caution

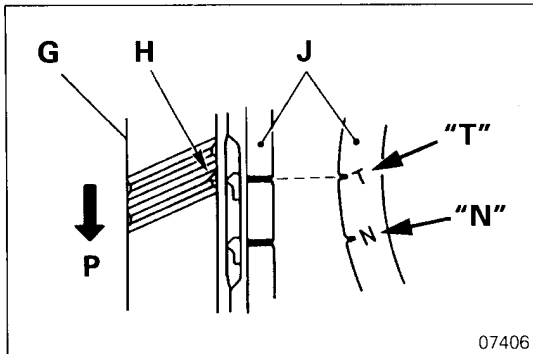
- If the dent **D** on the hexagonal section of the camshaft faces upward, the No. 1 piston is at the TDC on the compression stroke. If not, rotate the crankshaft one more turn in normal direction.
- Never rotate the crankshaft in reverse direction. It may cause damage to the timing chain tensioner. If the crankshaft is accidentally rotated in reverse direction, remove and reinstall the tensioner according to the correct installation procedure.



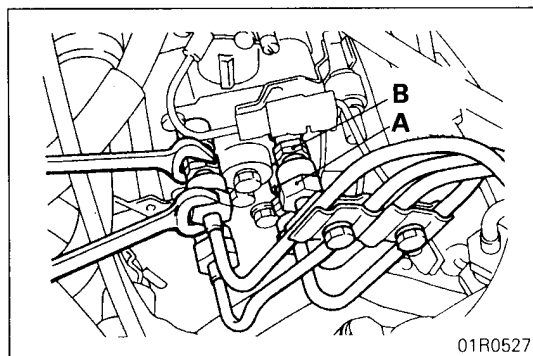
- (2) Align the notch **H** on the injection pump gear **G** with the mating mark "**N**" <Non-turbo> or "**T**" <Turbo> on the flange plate **J**.



- (3) Align the guide bar **K** of the flange plate **J** with the guide hole **M** of the front plate **L** and insert the front plate just before the injection pump gear **G** meshes with the idler gear.

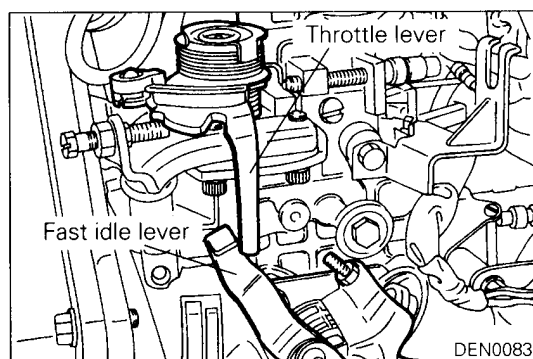


- (4) Confirm that the notch **H** on the injection pump gear **G** is aligned with the mating mark "**N**" <Non-turbo> or "**T**" <Turbo> on the flange plate **J**. Then install the front plate on the injection pump assembly. While meshing the gears, the notch **H** on the gear should move in the direction **P**.



**⇄ FUEL INJECTION PIPE INSTALLATION**

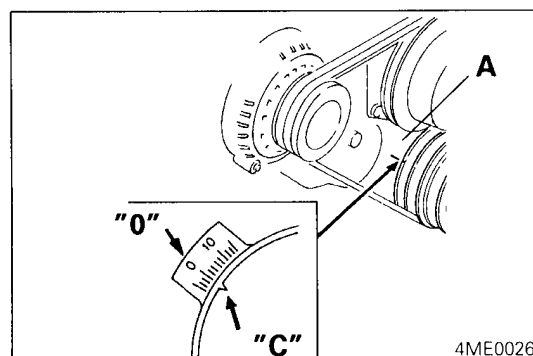
- (1) Tighten the union nut **A** of the fuel injection pipe while locking the delivery valve holder **B** to prevent it from rotating together.



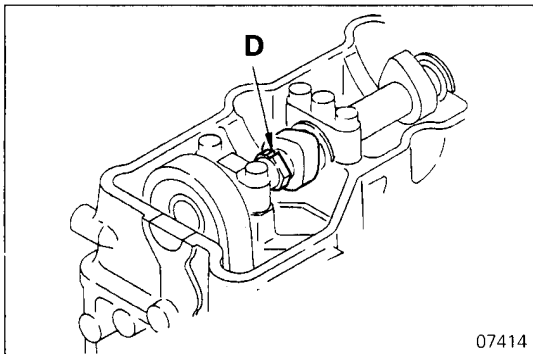
**FUEL INJECTION TIMING CHECK AND ADJUSTMENT**

**CHECKING**

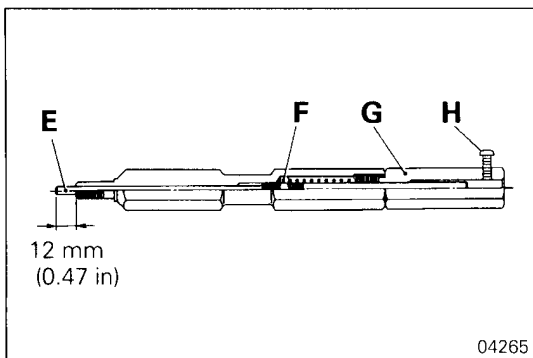
- (1) Warm up the engine and then check that the fast idle lever is separated from the throttle lever.  
 (2) Remove all the glow plugs.



- (3) Crank up the engine to place No.1 piston at the TDC on the compression stroke. Align the notch **C** in the crankshaft with the timing mark "**0**" on the timing gear case **A**.

**Caution**

- If the dent **D** on the hexagonal section of the camshaft faces upward, the No. 1 piston is at the TDC on the compression stroke. If not, rotate the crankshaft one more turn in normal direction.
- Never rotate the crankshaft in reverse direction. It may cause damage to the timing chain tensioner. If the crankshaft is accidentally rotated in reverse direction, remove and reinstall the tensioner according to the correct installation procedure.



- (4) Make sure that the push rod **E** of the special tool protrudes 12 mm (0.47 in) from the end of the tool body.

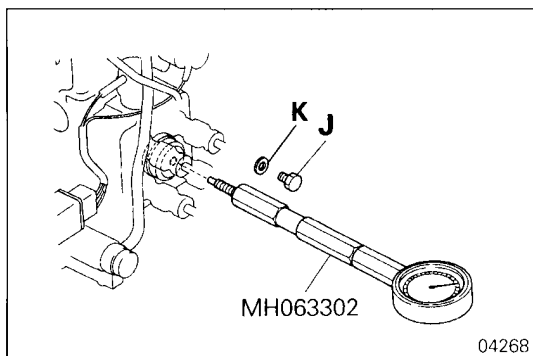
**NOTE**

Projection of the push rod can be adjusted by the nut **F** in the tool body.

- (5) Install a dial indicator (small) to the holder **G**.  
 (6) Secure the dial indicator with the screw **H** at the position where the probe of the indicator contacts the push rod and the pointer starts moving.

**NOTE**

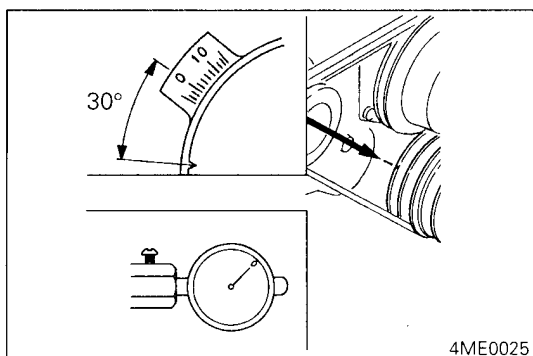
Be sure to keep the pointer deflection within 0.5 mm (0.020 in).



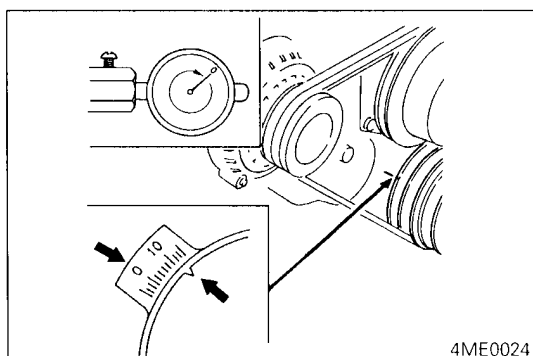
- (7) Remove the head plug **J** and gasket **K** from the fuel injection pump and install the special tool in that place.  
 (8) Screw in the special tool up to the position where the pointer of the dial gauge starts moving.

**NOTE**

If the above position is difficult to fix, stop screwing within one turn from the start of the pointer deflection.



- (9) Turn the crankshaft clockwise again till No. 1 piston is set 30° before TDC on the compression stroke.  
 (10) Zero the dial gauge.  
 (11) Turn the crankshaft a little (2 to 3°) clockwise and counter-clockwise and check that the dial gauge still reads "0".



- (12) Set No.1 cylinder piston to the fuel injection timing by turning the crankshaft clockwise. At this point, read the dial gauge to measure the valve lift.

**Fuel injection timing:**

**4° ATDC: PAJERO Non-turbo**

**6° ATDC: L200 Non-turbo, and 1994–1996 PAJERO Turbo for EFTA**

**7° ATDC: 2001–PAJERO Turbo without EGR**

**9° ATDC: L200 Turbo, CHALLENGER, 1997–2000 PAJERO Turbo for Hong Kong, 1998–2000 PAJERO Turbo for Germany, 1999–2000 PAJERO Turbo for EC, 2001–PAJERO Turbo with EGR**

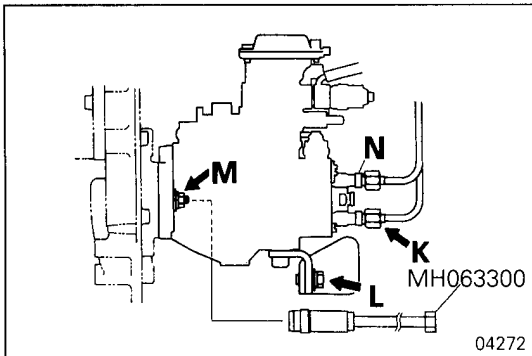
12° ATDC: –1997 PAJERO Turbo for Germany, –1998 PAJERO Turbo for EC, 1998–2000 PAJERO Turbo for South-Africa, –2000 PAJERO Turbo for General Export

Plunger lift:  $1 \pm 0.03$  mm ( $0.039 \pm 0.0012$  in.)

**NOTE**

The timing mark scale is graduated 2° apart.

- (13) If the reading deviates from the specified standard value, make necessary adjustment as follows:



**ADJUSTMENT**

- (1) Loosen the injection pipe union nut **K** as well as the bolt **L** and nut **M** holding the fuel injection pump in this order.

**K:** Fuel injection pipe union nut (4 places)

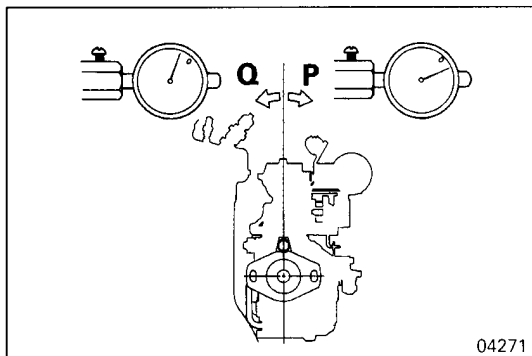
**L:** Bolt (1 place)

**M:** Nut (2 places)

Use the special tool to loosen the nut **L** on the crankcase side.

**Caution**

- When loosening the union nuts **K**, lock the delivery valve holder with a wrench to prevent it from turning together.
- Do not remove the union nuts **K**, bolt **L** and nuts **M**. Just loosen.

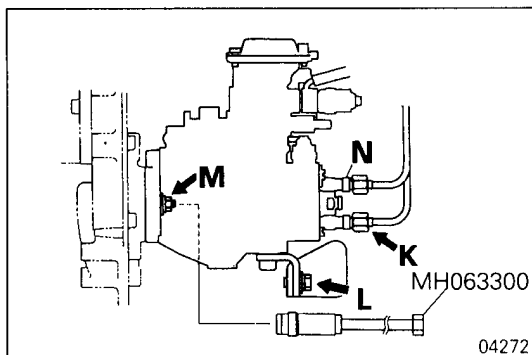


- (2) Adjust the fuel injection timing by tilting the fuel injection pump assembly right or left till the dial gauge reads the specified value.

**P:** In case the reading exceeds the specified standard value.

**Q:** In case the reading is below the specified standard value.

- (3) After the adjustment, check again to see if the dial gauge indicates the specified plunger lift.



- (4) Retighten the nuts and bolt in the order of **M**, **L** and **K**.

**M:** Nut (2 places)

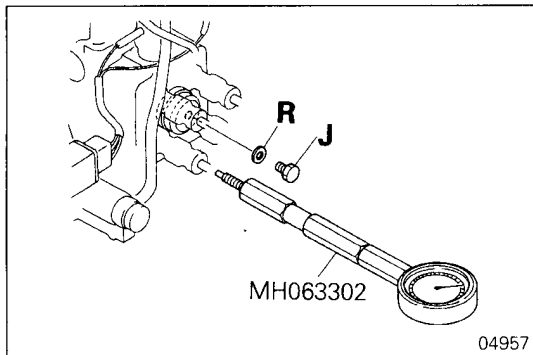
**L:** Bolt (1 place)

**K:** Fuel injection pipe union nut (4 places)

**T = 23 Nm (2.3 kgm, 17 ft.lbs.)**

**Caution**

- When torquing the union nuts **K**, lock the delivery valve holder with a wrench to prevent it from turning together.

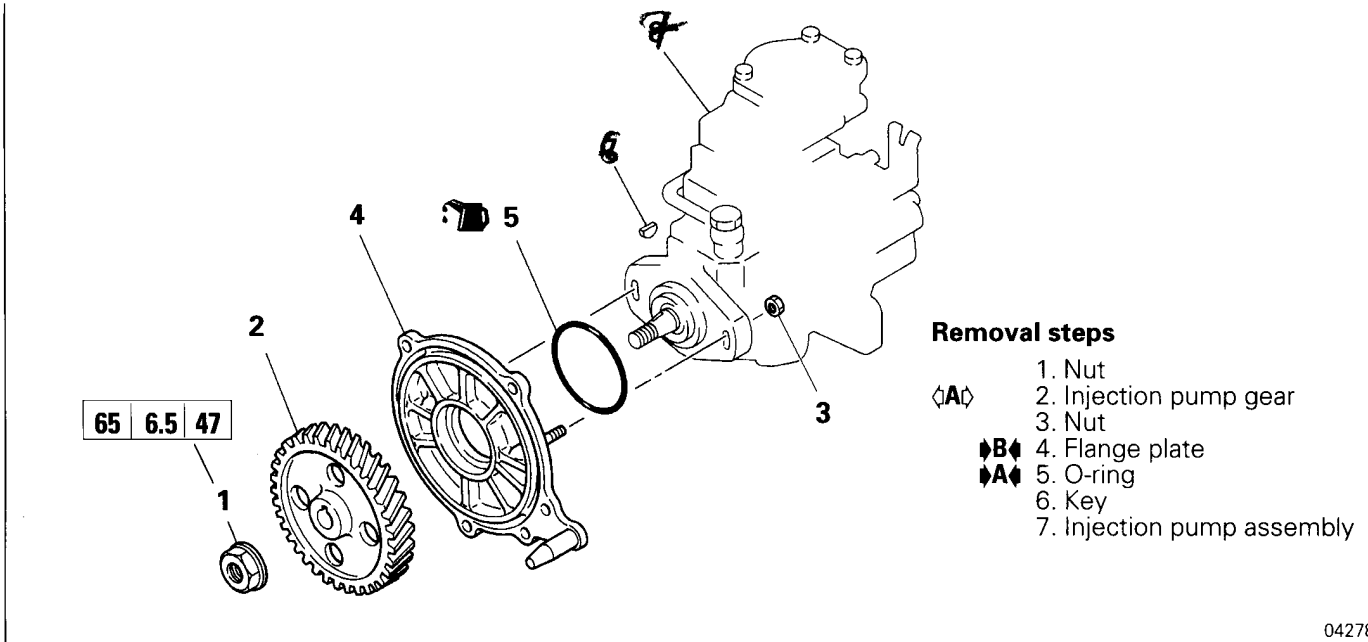


- (5) Remove the special tool.
- (6) Replace the gasket **R** with a new one, and tighten the head plug **J** to the specified torque.

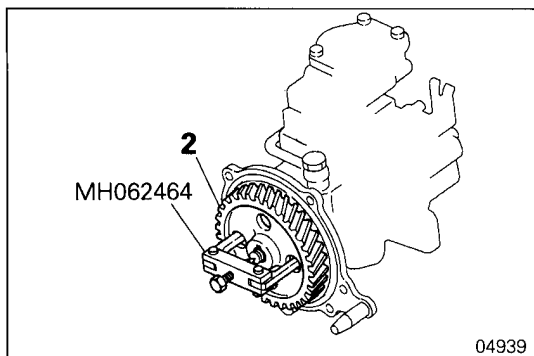
**T = 17 Nm (1.7 kgm, 12 ft.lbs.)**

## 23. FUEL INJECTION PUMP GEAR

### REMOVAL AND INSTALLATION



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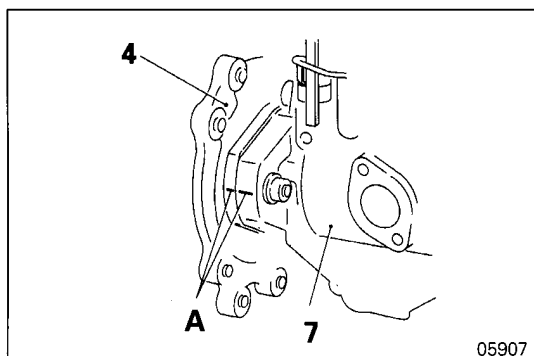


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### INSTALLATION SERVICE POINT

#### ◆A◆ O-RING INSTALLATION

- (1) Apply a thin coat of engine oil evenly to the entire circumferential surface of O-ring before installing it.

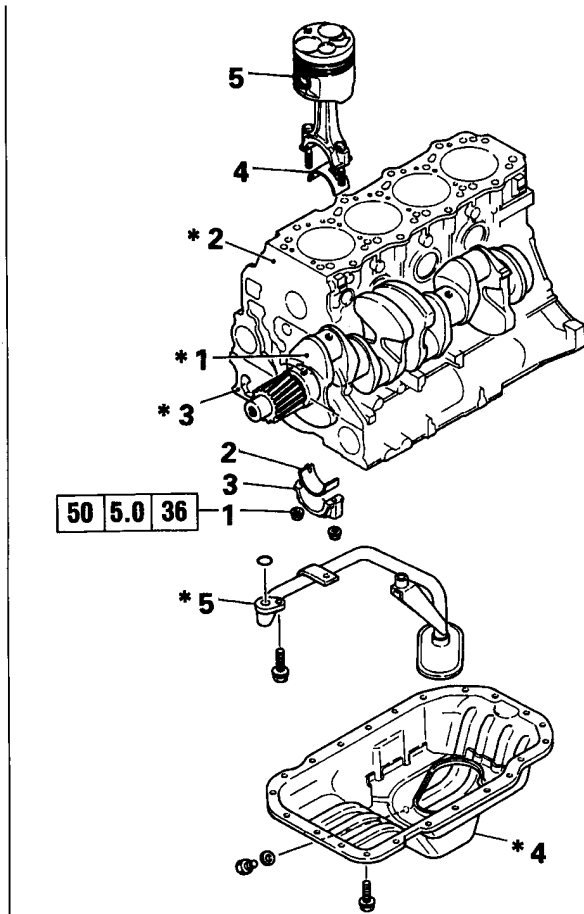


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## 24. PISTON AND CONNECTING ROD ASSEMBLY

### REMOVAL AND INSTALLATION



#### Removal steps

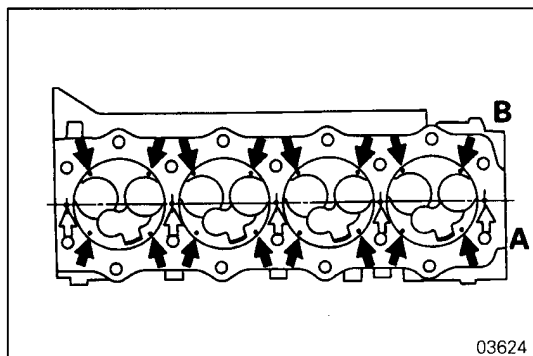
1. Nut
- ▶A▶ 2. Lower connecting rod bearing
3. Connecting rod cap
- ▶A▶ 4. Upper connecting rod bearing
- ▶B▶ 5. Piston and connecting rod assembly (See page 11A-25-1.)

- \*1: Crankshaft assembly (See page 11A-28-1.)  
 \*2: Upper crankcase assembly (See page 11A-28-1.)  
 \*3: Lower crankcase assembly (See page 11A-28-1.)  
 \*4: Oil pan (See page 11A-16-1.)  
 \*5: Oil strainer (See page 11A-16-1.)

#### Caution

**Nut 1 (holding the connecting rod cap) is installed by the special plastic-area-tightening method. Do not remove it unless absolutely necessary.**

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## INSPECTION

### PISTON AND CONNECTING ROD ASSEMBLY

#### Piston Protrusion from Crankcase Top

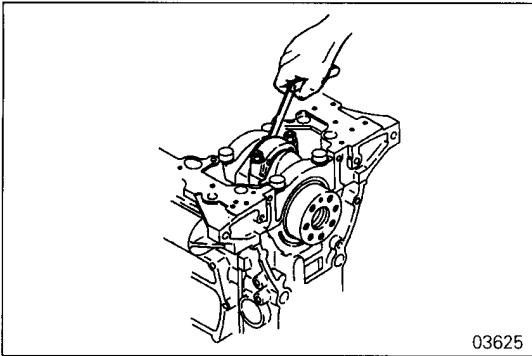
#### Caution

- **Do not fail to check piston protrusions. The engine performance are directly influenced by them.**

- (1) Position each piston at the TDC.
- (2) Check for piston protrusions of each cylinder. There are five reference points **A** on the upper crankcase assembly \*2. For each cylinder, measure the piston protrusion at the specified 4 points using the closest reference point as zero level. Average the 4-point readings.

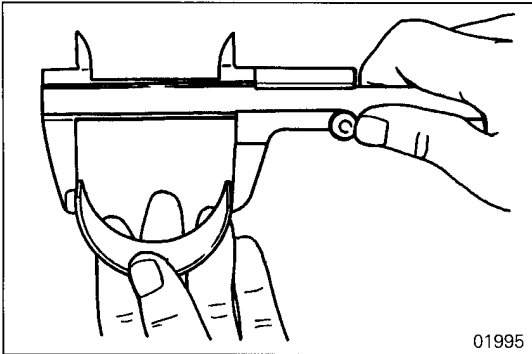
**B:** Measuring point (16 in total)

- (3) If the average deviates the specified standard value, measure clearance at each section of piston, connecting rod and crankshaft.



### Connecting Rod End Play

- (1) Measure end play of each connecting rod.
- (2) If the measurement exceeds the specified service limit, replace defective part.



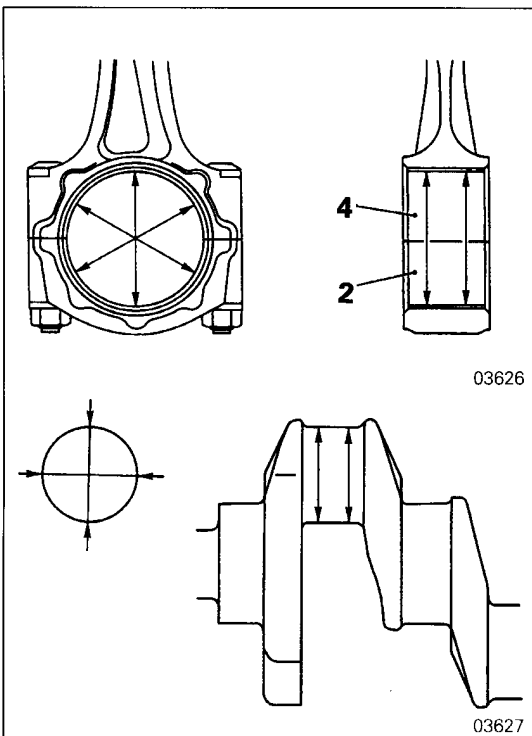
### CONNECTING ROD BEARING

#### Caution

- Be sure not to use the connecting rod bearings **2** and **4** expanded forcibly.
- When either one of the connecting rod bearings **2** and **4** is replaced, replace both in pairs.

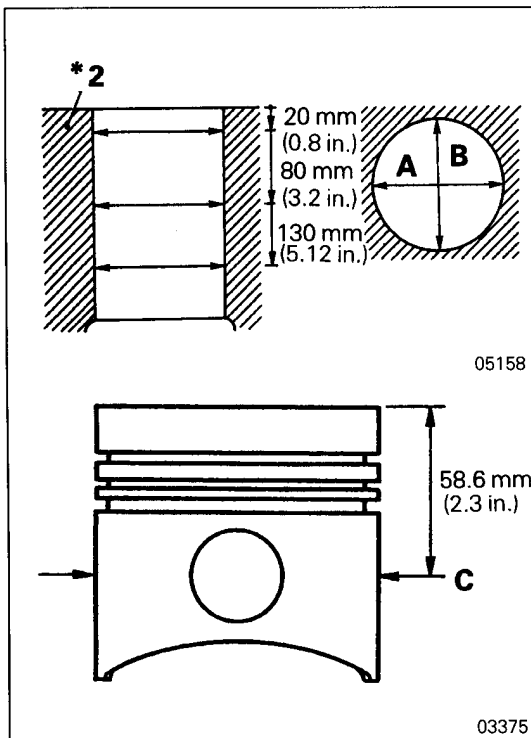
#### Free Span

- (1) Measure free span of the connecting rod bearings **2** and **4**. If the reading is less than the specified service limit, replace both in pairs.



### Connecting Rod Bearing-to-Crankshaft Clearance (Oil Clearance)

- (1) If the reading exceeds the specified service limit, replace defective part.



### PISTON AND CONNECTING ROD ASSEMBLY AND UPPER CRANK CASE ASSEMBLY

- (1) If the upper crankcase assembly \*2 includes a cylinder with any I.D. measurement exceeding the service limit, proceed to the following:

Non-turbo engine

Rebore and hone all cylinders to an oversize I.D. and replace the pistons and piston rings accordingly.

Turbo engine

Replace the upper crankcase assembly \*2.

**A:** Cylinder I.D. measuring position (axial direction of crankshaft)

**B:** Cylinder I.D. measuring position (At right angle with crankshaft)

**C:** Piston O.D. measuring position

- (2) In any upper crankcase assembly \*2 cylinder, if the piston-to-cylinder clearance is not within the service limit range although the cylinder I.D. measurements conform to the specification, proceed to the following:

Non-turbo engine

Rebore and hone all cylinders to an oversize I.D. and replace the pistons and piston rings accordingly.

Turbo engine

Replace the piston.

### CYLINDER BORING

- Select an oversize piston O.D. appropriate to the largest I.D. cylinder in the crankcase.
- There are four piston oversize dimensions available: 0.25 mm, 0.50 mm, 0.75 mm and 1.00 mm. Based on the piston O.D. selected from them, determine a bore size to which the cylinders are rebored so that the specified piston-to-cylinder clearance will be ensured.
- Use the following formula when determining the cylinder reboring dimension.

Cylinder reboring dimension = Piston O.D. + Piston-to-cylinder clearance\* – Honing allowance\*\*

\*Piston-to-cylinder clearance: 0.04–0.05 mm (0.0016–0.0020 in.)

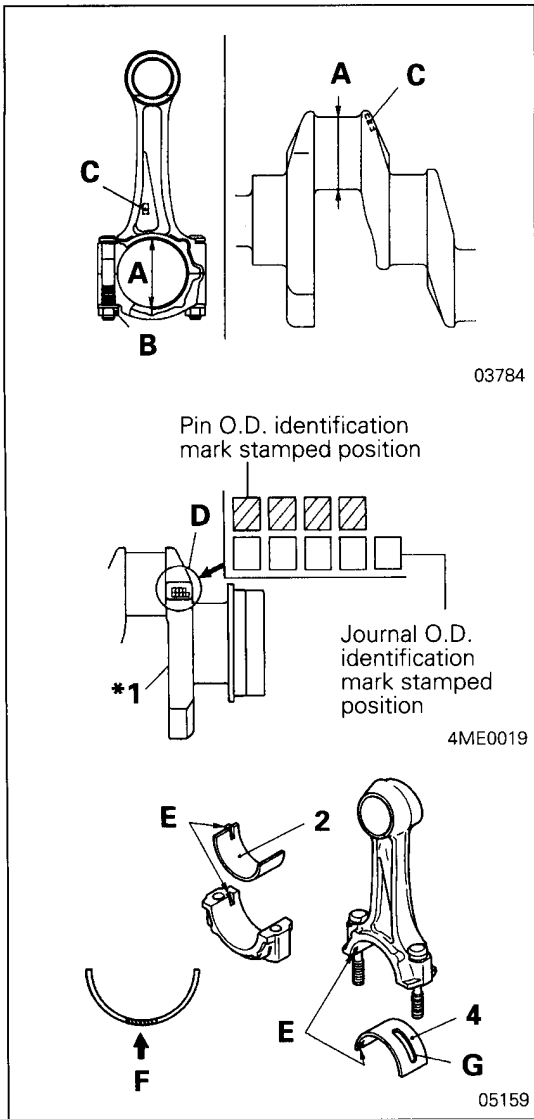
\*\*Honing allowance: 0.02 mm (0.0008 in.)

- Bore all cylinders to the dimension obtained and then hone them to the final size.

### Caution

- Bore the cylinders in the order of No. 2 → No. 4 → No. 1 → No. 3 to avoid deformation of the crankcase due to heat generated during boring.**
- When honing cylinders, make sure that the resulting bore dimension is equal to the total of piston O.D. and piston-to-cylinder clearance. In addition, hone them to the following specifications:**
  - Honed surface roughness: 2–4 μm
  - Crosshatch pattern angle: 15–25°
  - Squareness of cylinder bore: 0.05 mm (0.020 in.)
- Recheck the piston-to-cylinder clearance after honing.**

**Standard clearance: 0.04–0.05 mm (0.0016–0.020 in.)**



### INSTALLATION SERVICE POINTS

#### ◆A◆ CONNECTING ROD BEARING INSTALLATION

(1) The connecting rod bearings **2** and **4** must have a proper plate thickness that matches the difference between the big end I.D. of the connecting rod and the pin O.D. of the crankshaft.

(a) Measure the big end I.D. of the connecting rod (with bearings removed) and the pin O.D. of the crankshaft.

**A:** Measuring point

Connecting rod: One point in vertical direction

Crankshaft: One point in any direction

#### Caution

- **Tighten the nuts B by specified procedure before measuring the connecting rod big end I.D. (Refer to 11A-24-5.)**

- **For the service parts, the above dimensions can be identified by the identification colors on the connecting rod and crankshaft.**

**C:** Identification color position

**The pin O.D. of the crankshaft is also indicated by the identification marks "1" or "2" stamped at the position shown in the illustration.**

(b) Select appropriate thicknesses of the connecting rod bearings **2** and **4** from the following table and install them while locating the lugs **E** in position.

**F:** Identification color position (side)

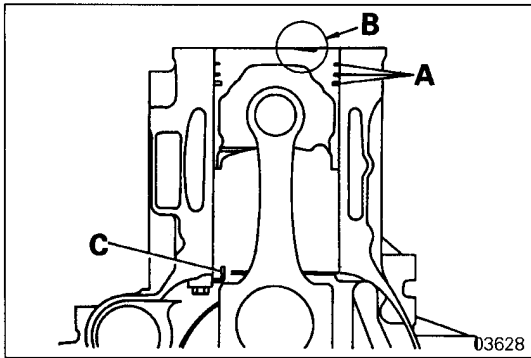
The connecting rod bearings also have the identification colors.

#### Caution

- **When installing the bearings 2 and 4, be sure to set the upper bearing with oil hole G and lower bearing without oil hole in their correct positions.**

Unit: mm (in.)

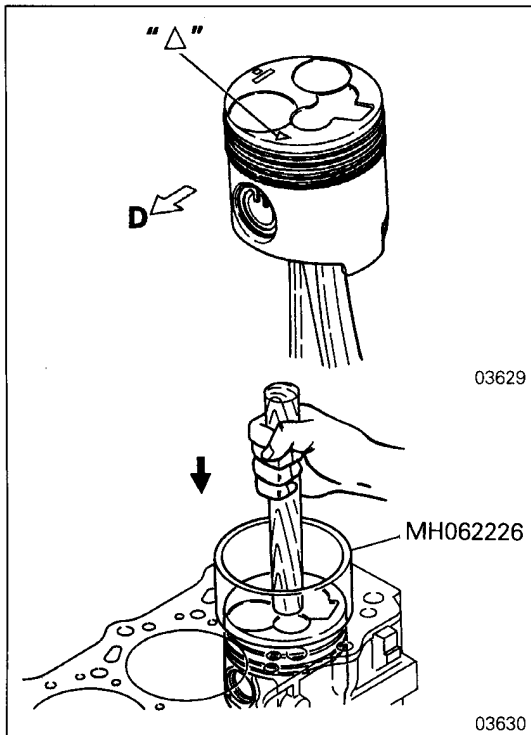
Crankshaft		Connecting rod		Connecting rod bearing		
Identification color (Identification mark)	Pin O.D.	Identification color	Big end I.D.	Identification color	Plate thickness	Oil clearance
None (1)	54 (2.13) -0.012 (-0.0005) -0.0200 (-0.008)	Blue	58 (2.28) +0.019 (+0.0007) +0.010 (+0.0004)	None	2 (0.08) -0.004 (-0.0002) -0.008 (-0.0003)	0.030 — 0.055 (0.0012 — 0.0022)
		None	58 (2.28) 0 (0)	Blue	2 (0.08) -0.008 (-0.0003) -0.012 (-0.0005)	0.028 — 0.054 (0.0011 — 0.0021)
Blue (2)	54 (2.13) -0.020 (-0.0008) -0.029 (-0.0011)	Blue	58 (2.28) +0.019 (+0.0007) +0.010 (+0.0004)	Yellow	2 (0.08) 0 (0) -0.004 (-0.0002)	0.030 — 0.056 (0.0012 — 0.0022)
		None	58 (2.28) 0 (0)	None	2 (0.08) -0.004 (-0.0002) -0.008 (-0.0003)	0.028 — 0.055 (0.0011 — 0.0022)



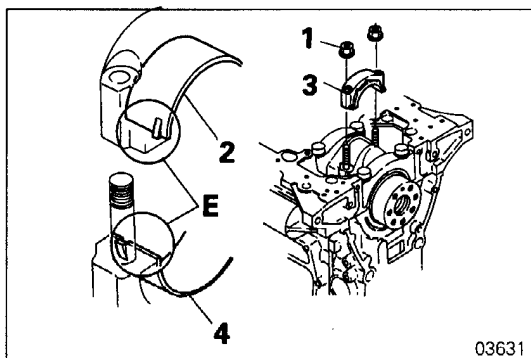
## ▶B◀ PISTON AND CONNECTING ROD ASSEMBLY INSTALLATION

### Caution

- Be sure that the end gap of all the piston rings **A** is in position. Location of piston ring end gap: (See page 11A-25-2)
- Be careful not to damage the piston head (combustion chamber) **B**.
- Be careful not to hit the connecting rod against the oil jet **C**.



- (1) Install the piston with the front mark "Δ" facing towards the engine front **D**.



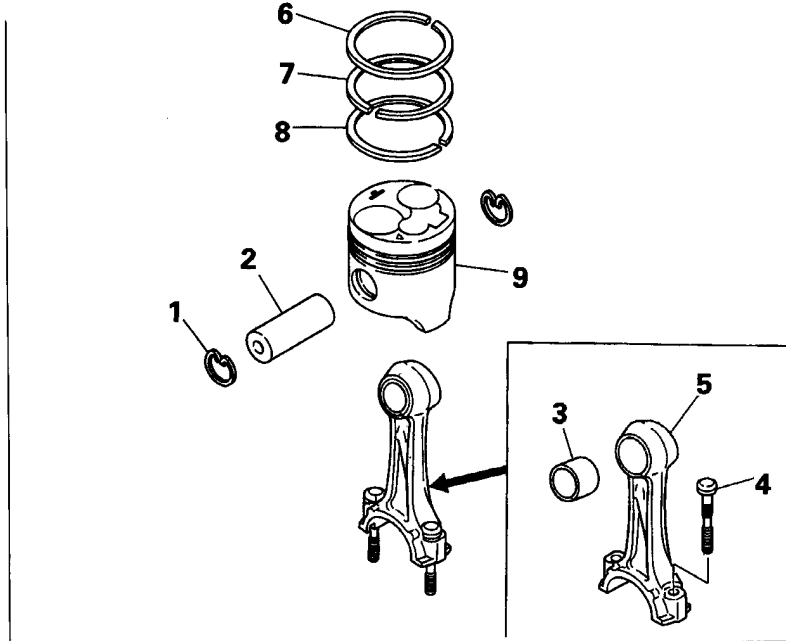
- (2) Insert the piston and connecting rod assembly. Apply a thin coat of engine oil to the threaded part of the connecting rod bolt. Install the connecting rod cap **3** with the lugs **E** of the upper and lower connecting rod bearings **4** and **2** at the same side.
- (3) Tighten the nuts **1** alternately in the following manner.
  - Tighten the nuts **1** to 30 Nm (3 kgm, 20 ft.lbs.) first.
  - Then, torque them further to 50 Nm (5 kgm, 36 ft.lbs.).
  - Give them a  $45^\circ \pm 5^\circ$  clockwise turn to tighten additionally.
  - Finally, give them another  $45^\circ \pm 5^\circ$  turn.

### Caution

- After all the connecting rod caps **3** are installed, check the following:  
**Connecting rod end play** (See page 11A-24-1.)  
**Piston protrusion** (See page 11A-24-1.)

## 25. PISTON AND PISTON PIN

### REMOVAL AND INSTALLATION



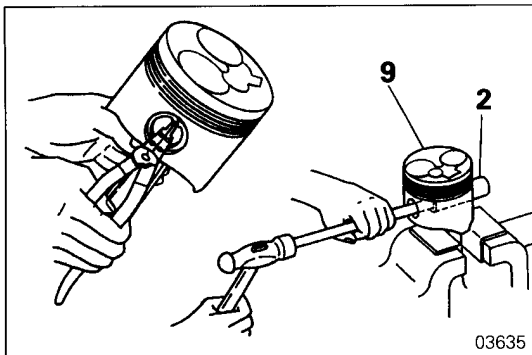
#### Removal steps

- 1. Snap ring
- ◁A▷ ▷D◁ 2. Piston pin
- ◁C▷ ▷A◁ 3. Connecting rod bush
- ▷C◁ 4. Connecting rod bolt
- ◁B▷ ▷B◁ 5. Connecting rod
- ◁B▷ ▷B◁ 6. 1st compression ring
- ◁B▷ ▷B◁ 7. 2nd compression ring
- 8. Oil ring
- 9. Piston

#### Caution

**Do not remove the connecting rod bolt 4 unless absolutely necessary.**

03633

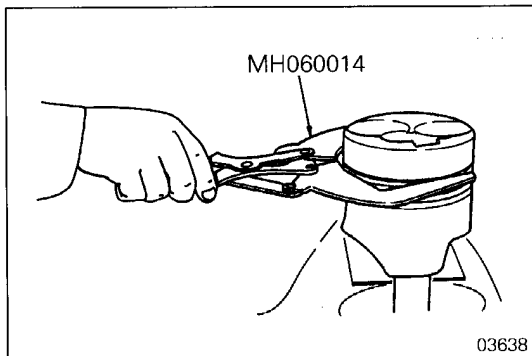


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### REMOVAL SERVICE POINTS

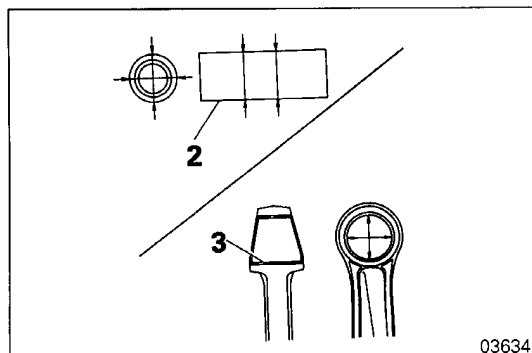
#### ◁A▷ PISTON PIN REMOVAL

- (1) Remove the piston pin 2 using an appropriate push-out bar.
- (2) If the piston pin 2 is hard to remove, warm the piston 9 over a heater or in hot water before removal.



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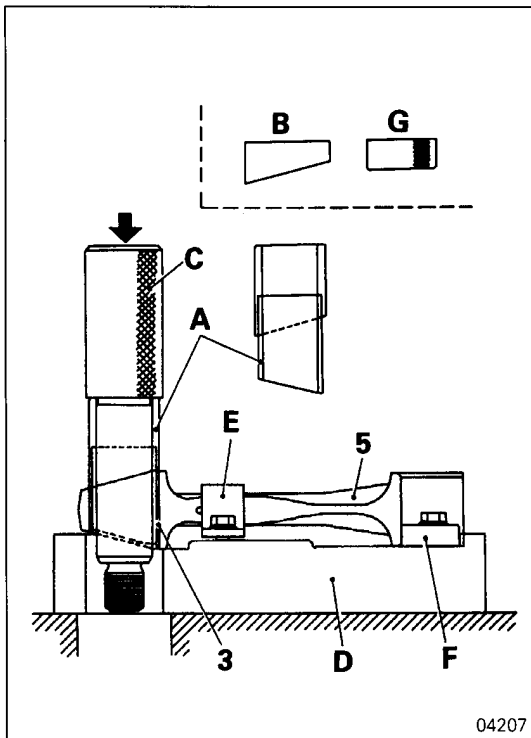
#### ◁B▷ COMPRESSION RING REMOVAL



03634

#### ◁C▷ CONNECTING ROD BUSH REMOVAL

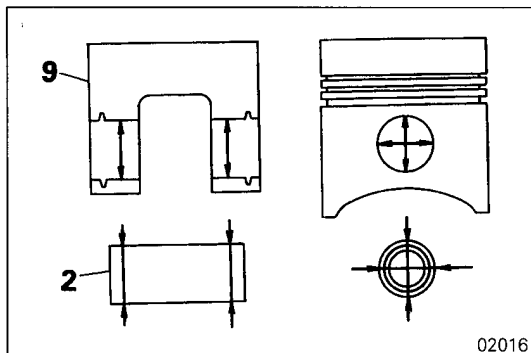
- (1) Measure the piston pin-to-bush clearance. If the clearance exceeds the specified service limit, replace defective part.



- (2) Use the special tool to replace the connecting rod bush **3**.  
Component Parts of Special Tool MH062455 – Connecting Rod Bush Puller Kit

**A:** Collar    **B:** Collar    **C:** Puller    **D:** Base  
**E:** Bracket    **F:** Plate    **G:** Nut

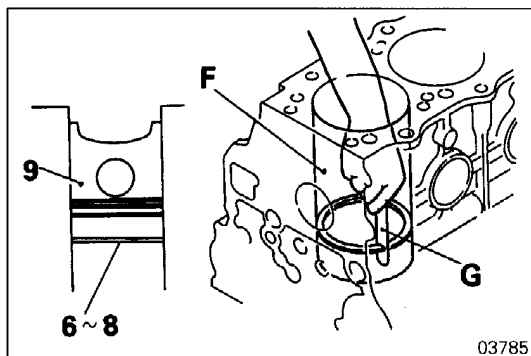
- (3) Remove the upper connecting bearing beforehand, if attached, from the big end of the connecting rod **5**.  
(4) Secure the connecting rod **5** to the base **D** with the bracket **E** and plate **F**.  
(5) Attach the collar **A** onto the puller **C** as shown, and remove the connecting rod bush **3** slowly under a press ram load of approximately 50,000 N (5,000 kg, 11,300 lbs.).



## INSPECTION

### PISTON PIN / CONNECTING ROD / PISTON

- (1) Measure the clearance between the piston pin **2** and piston **9**. If the clearance exceeds the specified service limit, replace defective part.

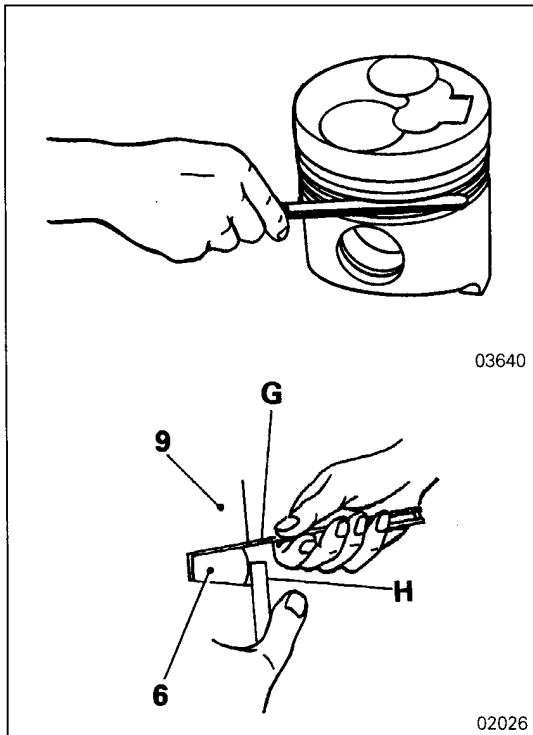


### PISTON RING END GAP

- (1) Place the piston rings **6-8** in the cylinder bore **F** of the crankcase using the piston **9**.  
(2) Holding the piston rings **6-8** in this state, measure their end gap using a feeler gauge **G**. If the reading exceeds the specified service limit, replace the piston ring.

#### Caution

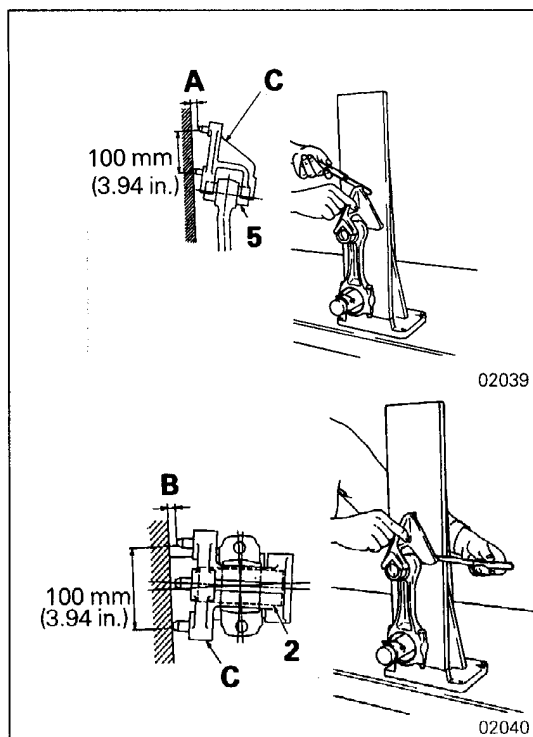
- In order to insert the piston rings **6-8** level in the cylinder bore **F** of the crankcase, be sure to use the piston **9**.
- The piston rings **6-8** must be placed at the less-wearing bottom part of the crankcase cylinder bore **F**.
- Replace the piston rings **6-8** in a complete set.

**PISTON RING TO PISTON RING GROOVE CLEARANCE**

- (1) If the specified service limit is exceeded, replace defective part.
- (2) The first compression ring **6** is a full keystone ring. Press it against the piston **9** with a straightedge **H** and measure the side clearance using a feeler gauge **G**.

**Caution**

- Remove deposited carbon from all the piston ring grooves in the piston **9** before measurements. Make side clearance measurements over the entire ring groove.
- Replace the piston rings **6 – 8** in a complete set.

**CONNECTING ROD BEND AND TWIST**

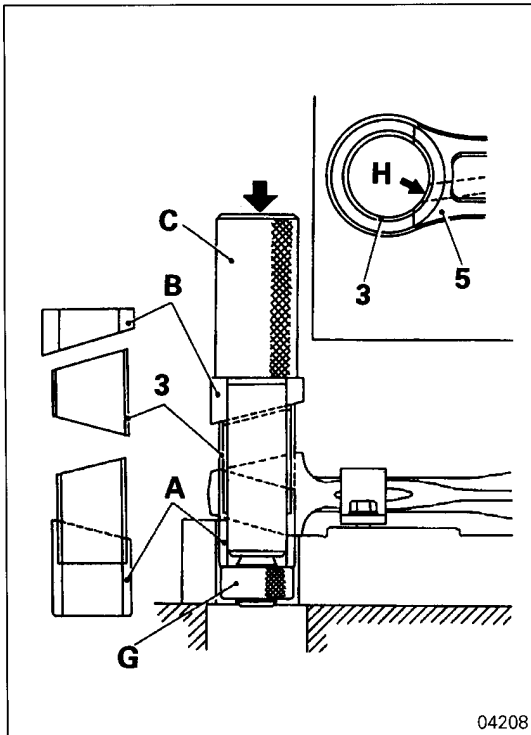
- (1) Install the connecting rod bush **3** and piston pin **2** into the connecting rod **5**.
- (2) Measure the bend **A** and twist **B** of the connecting rod **5**. If the readings exceed the specified service limits, replace the connecting rod.

**C:** Connecting rod aligner (measuring device)

**Caution**

- Install the connecting rod **5** to the connecting rod aligner **C** with the upper and lower connecting rod bearings attached.
- Tighten the connecting rod cap by specified procedure. (See page 11A-24-1.)





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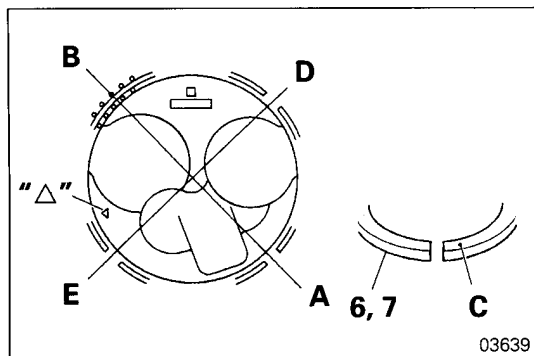
## INSTALLATION SERVICE POINTS

### ◆A◆ CONNECTING ROD BUSH INSTALLATION

- (1) Apply a thin coat of engine oil to the peripheral surface of the connecting rod bush **3** and the bush mounting hole in the connecting rod **5**.
- (2) Set the collar **B**, connecting rod bush **3** and collar **A** and the puller **C** in the connecting rod as shown and secure them with the nut **G**.
- (3) Bring the oil holes in alignment at **H** and press-fit the connecting rod bush **3** into the connecting rod **5** slowly under a press ram load of approximately 50,000 N (5,000 kg, 11,300 lbs.).
- (4) After press-fitted, ream the connecting rod bush **3** up to the specified bush-to-piston pin clearance.

#### Caution

- After reaming, insert the piston pin **2** in the bush **3** and check to see that it smoothly moves without play.



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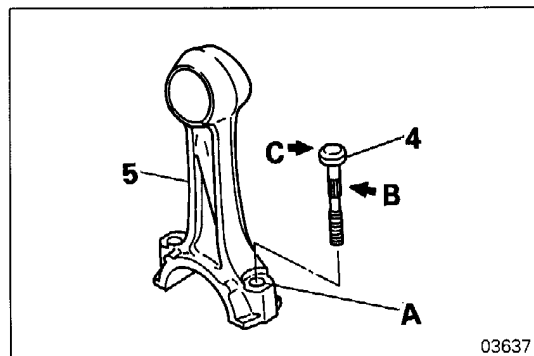
### ◆B◆ PISTON RING INSTALLATION

- (1) Install the oil ring **8** with its end gaps positioned at **A** and the butting end of the expander spring positioned at **B** shown in the illustration.
- (2) Install the compression rings **6** and **7** with their manufacturer's marks **C** near the end gaps facing upward.
- (3) Set the end gaps of the compression rings **6** and **7** to the positions shown in the illustration.

**D:** End gap of the 1st compression ring

**E:** End gap of the 2nd compression ring

Δ: Front mark of piston

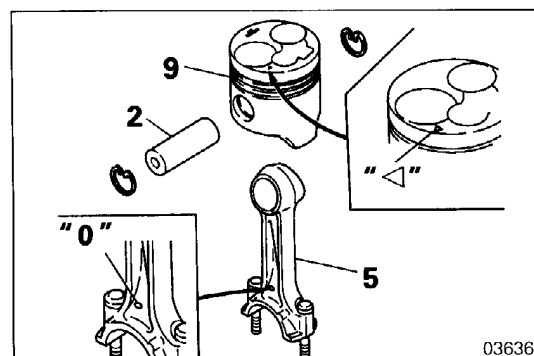


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### ◆C◆ CONNECTING ROD BOLT INSTALLATION

- (1) Check that the bolt hole **A** in the connecting rod **5** is free of damage, burrs, etc.
- (2) Apply a thin coat of engine oil to the connecting bolt **4** at the point **B**, and install it in the connecting rod **5** with the notch **C** in the head inward.

**C:** Nick in bolt head



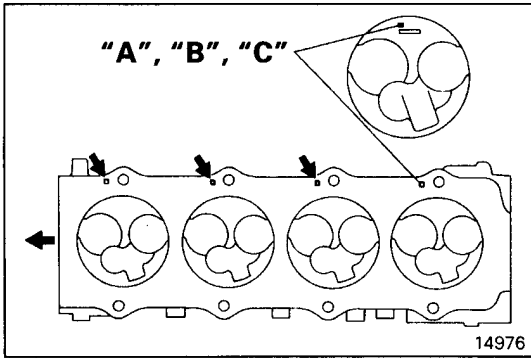
03636

### ◆D◆ PISTON PIN INSTALLATION

- (1) Apply a thin coat of engine oil to the piston pin **2** prior to installation. Assemble the connecting rod **5** and the piston **9** with the mark **"O"** and the front mark **"Δ"** facing in the directions shown, and insert the piston pin.
- (2) If the piston pin **2** is hard to insert, warm the piston **9** by a piston heater or in hot water.

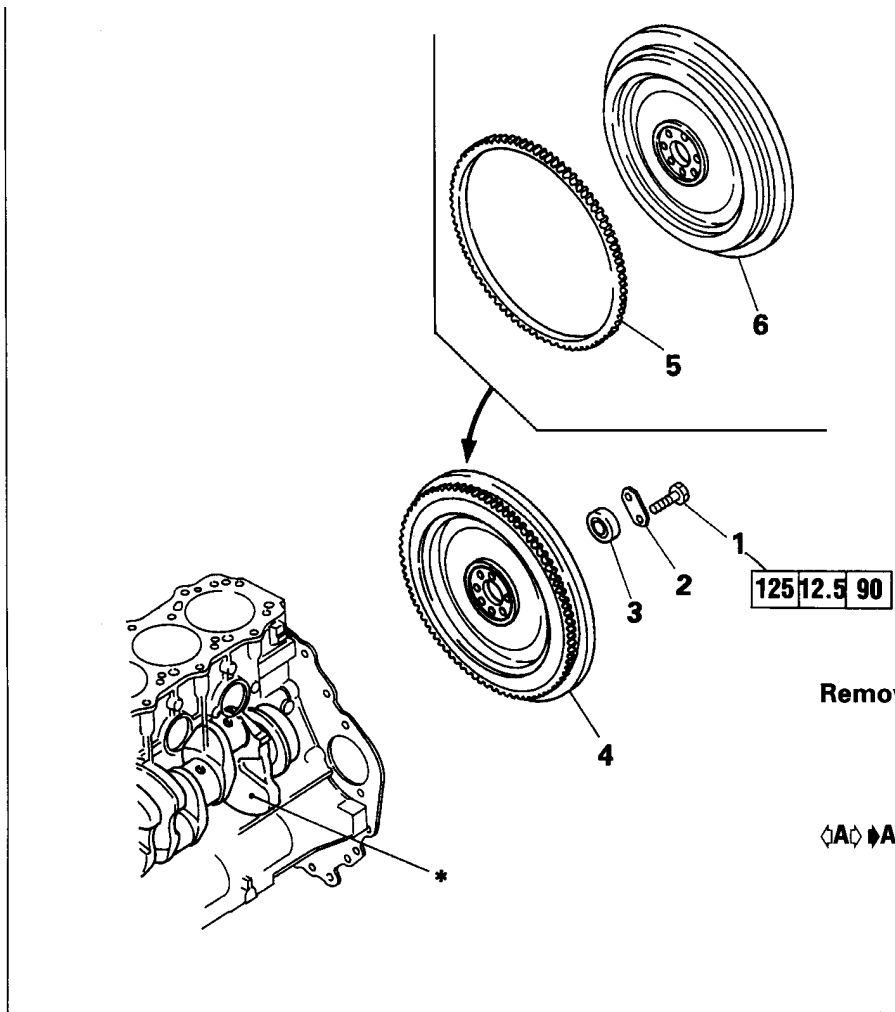
#### Caution

- Check that the piston moves smoothly without excessive play.

**PISTON SELECTION**

- (1) Select pistons that bear the same size marks (**A**, **B** or **C**) as the cylinder size marks stamped on the crankcase.

## 26. FLYWHEEL REMOVAL AND INSTALLATION



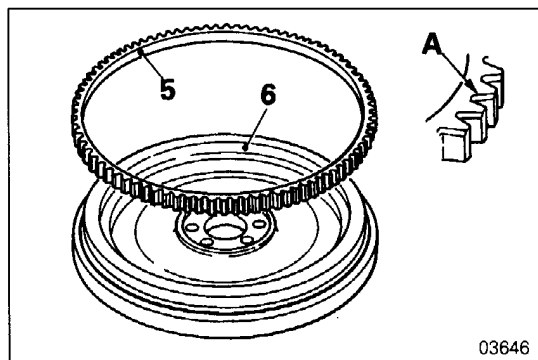
### Removal steps

1. Bolt
2. Plate
3. Bearing
4. Flywheel assembly
5. Ring gear
6. Flywheel

◁A▷▷A◁

\*: Crankshaft assembly (See page 11A-28-1.)

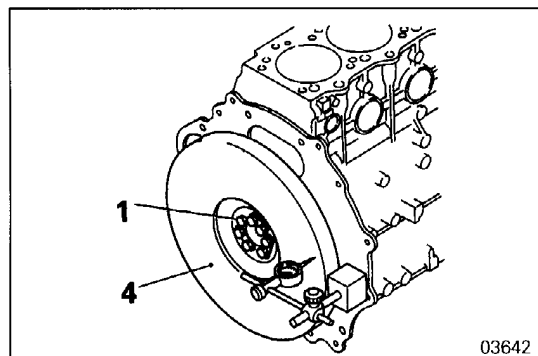
05179



### REMOVAL SERVICE POINTS

#### ◁A▷ RING GEAR REMOVAL

- (1) Check the ring gear **5** for damage and abnormal wear, and replace if necessary.
- (2) Heat the ring gear **5** evenly with an acetylene torch or the like, and remove it by evenly tapping on its periphery.

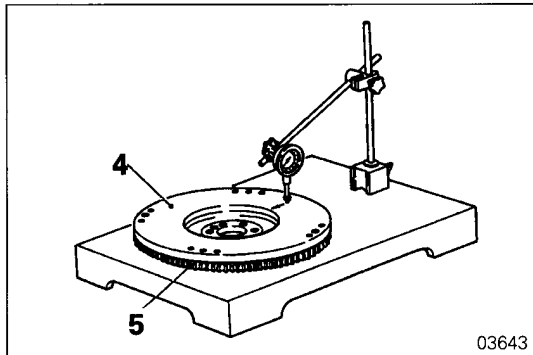


### INSPECTION

#### FLYWHEEL ASSEMBLY

##### Runout

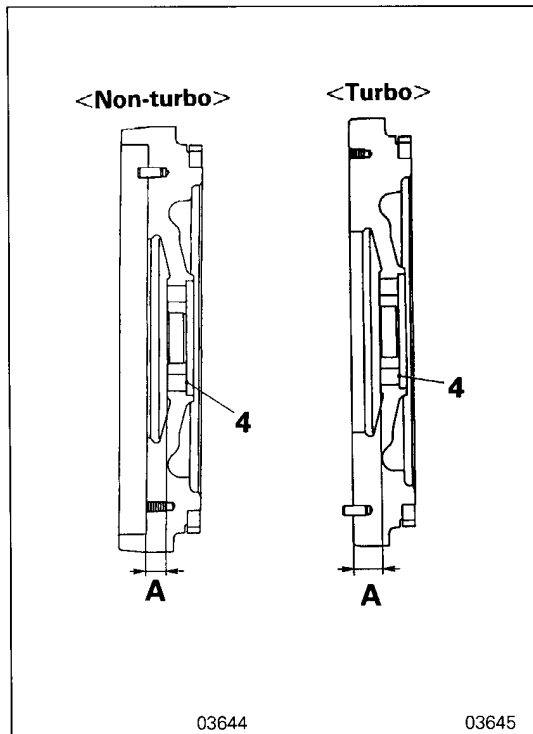
- (1) If the runout exceeds the specified service limit, check the flywheel assembly **4** for loosened bolt **1** and defects in the joint surface to the crankshaft\*. Repair or replace, if necessary.

**Friction Surface Distortion**

- (1) If the reading exceeds the specified service limit, repair or replace the flywheel assembly **4**.

**Caution**

- If the ring gear **5** is found faulty, replace it before the distortion measurement.

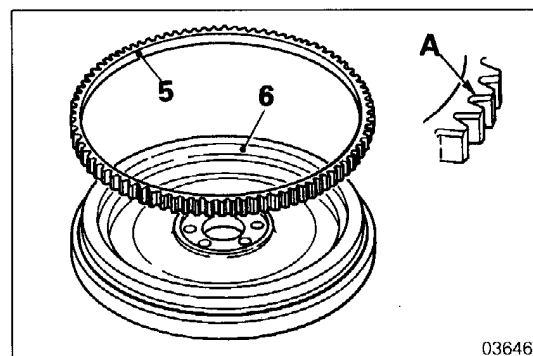
**Friction Surface Height**

- (1) If the measurement is less than the specified serviced limit, replace the flywheel assembly **4**.

**A:** Friction surface height

**Redressing****Caution**

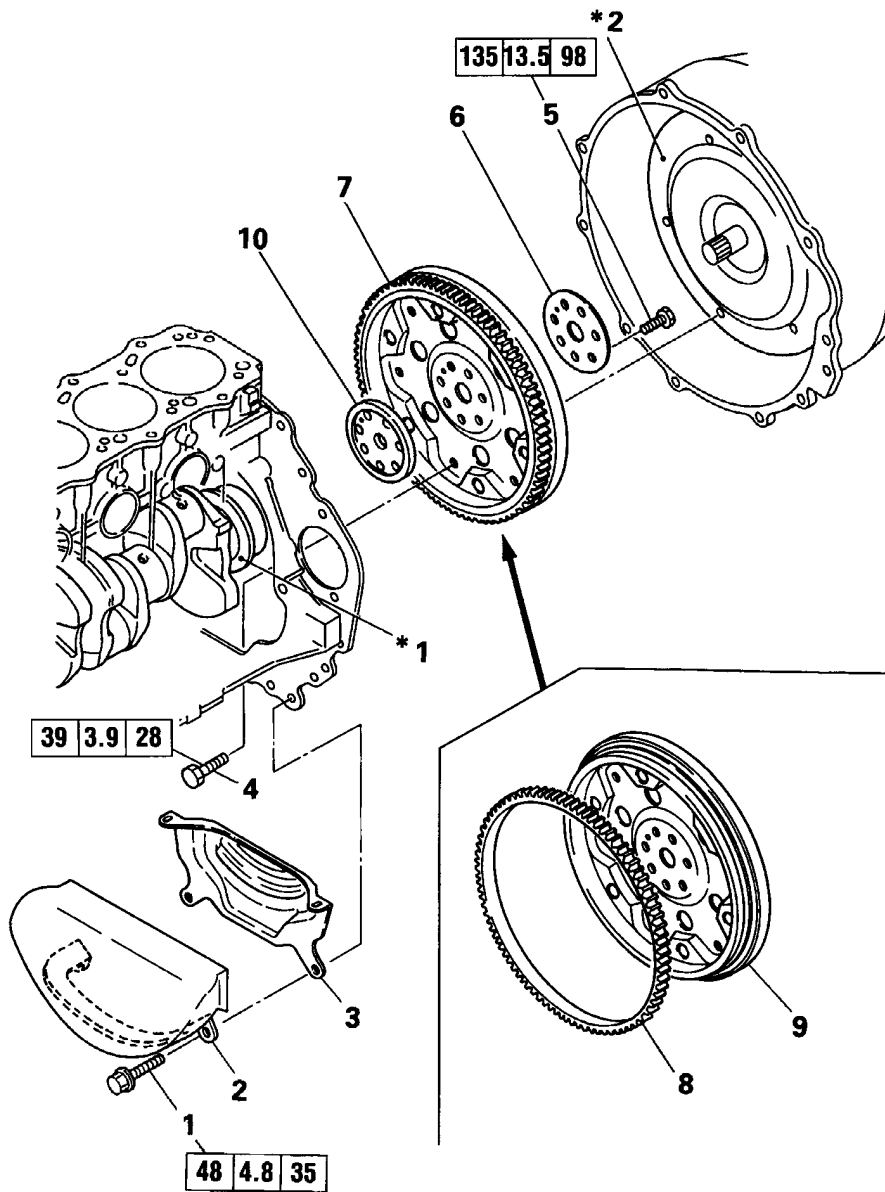
- Redress the friction surface, when necessary, so that it is parallel to the surface **B** within a tolerance of 0.1 mm (0.04 in.) and its height **A** is not below the specified service limit.

**INSTALLATION SERVICE POINTS****◆A◆ RING GEAR INSTALLATION**

- (1) Heat the ring gear **5** at approximately 100°C (212°F) with an acetylene torch or the like for three minutes.
- (2) Install the ring gear **5** over the flywheel **6** with the unchamfered side of the tooth crests inward.

**A:** Chamfered side of tooth crest

**27. DRIVE PLATE  
REMOVAL AND INSTALLATION**



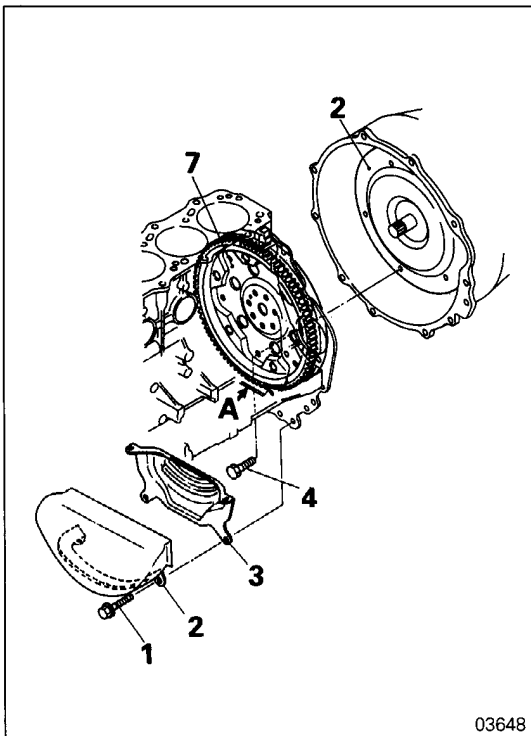
**Removal steps**

1. Bolt
2. Rubber spacer
3. Dust cover
4. Bolt
5. Bolt
6. Adaptor plate

- ↔A↔ ↔B↔ 7. Drive plate assembly
- ↔B↔ ↔A↔ 8. Ring gear
- 9. Drive plate
- 10. Crankshaft adaptor

\*1: Crankshaft assembly (See page 11A-28-1.)

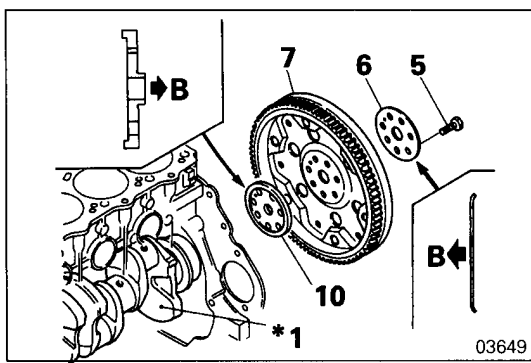
\*2: Torque converter

**REMOVAL SERVICE POINTS****◇A◇ DRIVE PLATE ASSEMBLY REMOVAL**

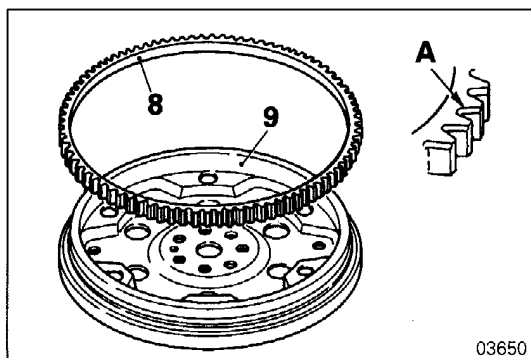
- (1) Remove the dust cover **3** and rubber spacer **2** from the rear plate.
- (2) Remove the bolts **4** (6 places) through work opening **A** and separate the drive plate assembly **7** from the torque converter **\*2**.
- (3) Turn the crankshaft and remove the remaining bolts **4**.

**Caution**

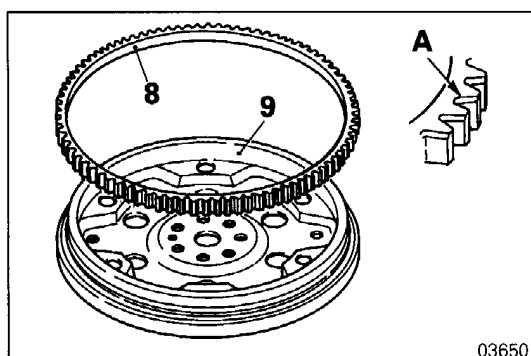
- **Never rotate the crankshaft in reverse direction. It may cause damage to the timing chain tensioner. If the crankshaft is accidentally rotated in reverse direction, remove and reinstall the tensioner according to the correct installation procedure.**



- (4) Remove the bolts **5** and detach the drive plate assembly **7** from the crankshaft assembly **\*1**.

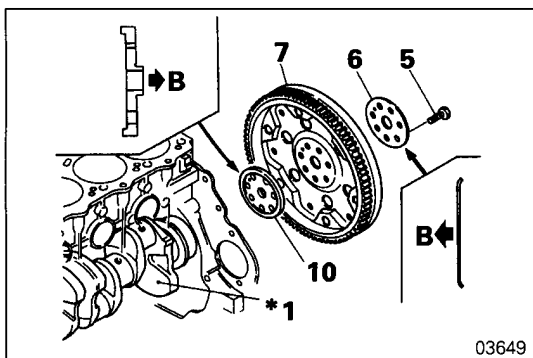
**◇B◇ RING GEAR REMOVAL**

- (1) Check the ring gear **8** for damage and abnormal wear, and replace if necessary.
- (2) Heat the ring gear **8** evenly with an acetylene torch or the like, and remove it by tapping on its periphery evenly.

**INSTALLATION SERVICE POINTS****▷A◁ RING GEAR INSTALLATION**

- (1) Heat the ring gear **8** evenly at approximately 100°C (212°F) with an acetylene torch or the like for three minutes.
- (2) Install the ring gear **8** over the drive plate **9** with the unchamfered side of the tooth crests inward.

**A:** Chamfered side of tooth crest

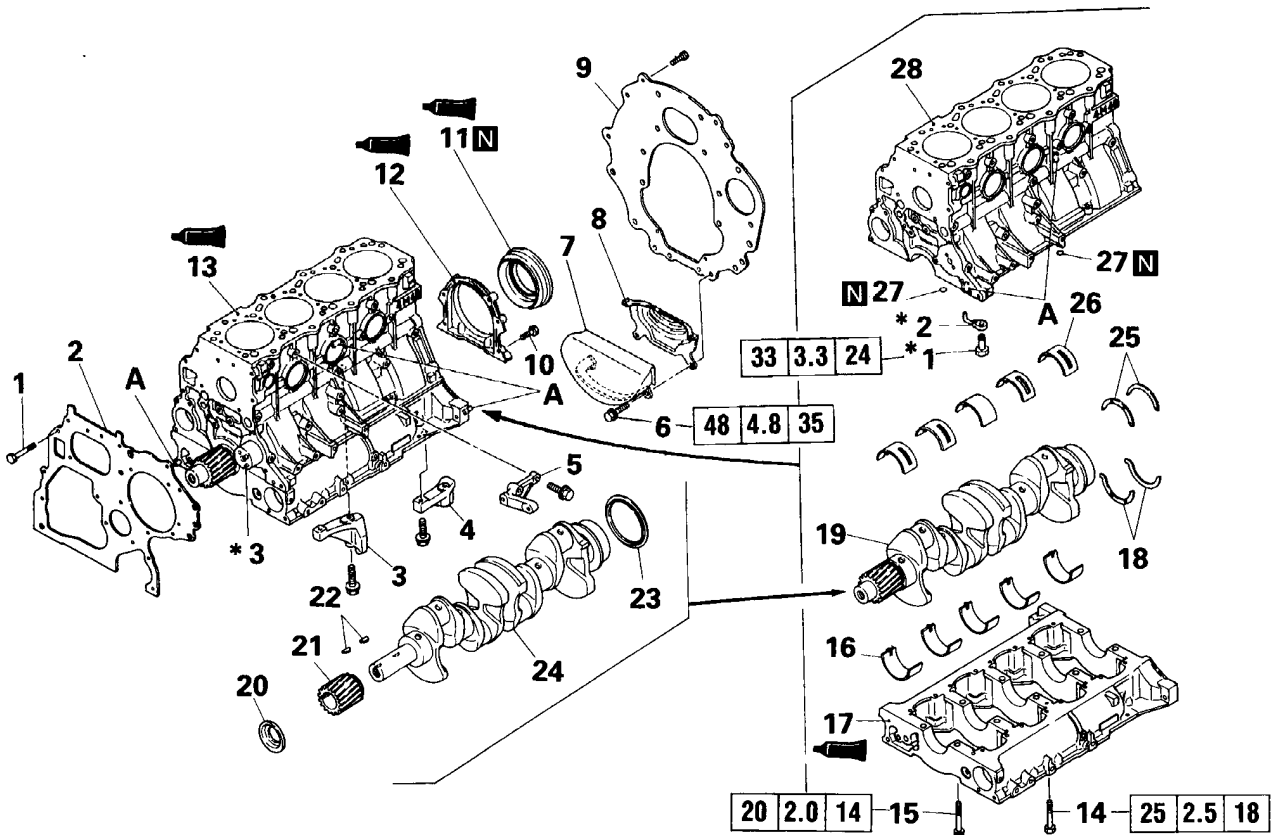
**▶B◀ DRIVE PLATE ASSEMBLY INSTALLATION**


- (1) Attach the adaptor plate **6** and the crankshaft adaptor **10** to the drive plate assembly, facing in the directions **B** shown.

**B:** Drive plate side

## 28. CRANKSHAFT AND CRANKCASE

### REMOVAL AND INSTALLATION



 Apply engine oil to all moving parts before installation.

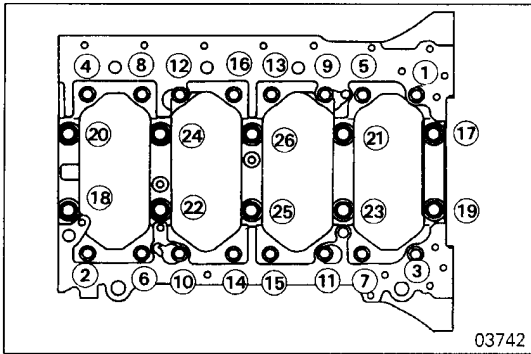
#### Removal steps

- 1. Bolt
- ◆G◆ 2. Front plate
- 3. Stiffener
- 4. Stiffener RH
- 5. Stiffener LH
- 6. Bolt
- 7. Rubber spacer
- 8. Dust cover
- 9. Rear plate
- 10. Bolt
- ◆H◆ 11. Rear oil seal
- ◆H◆ 12. Rear oil seal case
- 13. Crankcase assembly
- ◇A◇ ◆F◆ 14. Bolt
- ◇A◇ ◆F◆ 15. Main bearing cap bolt
- ◆D◆ 16. Lower main bearing

- ◆E◆ 17. Lower crankcase
- ◆C◆ 18. Lower thrust plate
- 19. Crankshaft assembly
- 20. Front oil seal slinger
- ◇B◇ ◆B◆ 21. Crankshaft gear
- 22. Key
- ◆A◆ 23. Rear oil seal slinger
- 24. Crankshaft
- ◆C◆ 25. Upper thrust plate
- ◆D◆ 26. Upper main bearing
- 27. O-ring
- 28. Upper crankcase

- \*1: Check valve (See page 11A-16-1.)
- \*2: Oil jet (See page 11A-16-1.)
- \*3: Idler shaft (See page 11A-19-1.)
- A: Dowel pin





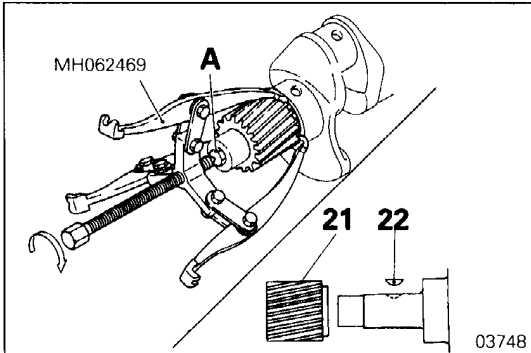
## REMOVAL SERVICE POINTS

### ◊A◊ BOLT / MAIN BEARING CAP BOLT REMOVAL

① – ⑯: Bolt **14**

⑰ – ⑳: Main bearing cap bolt **15**

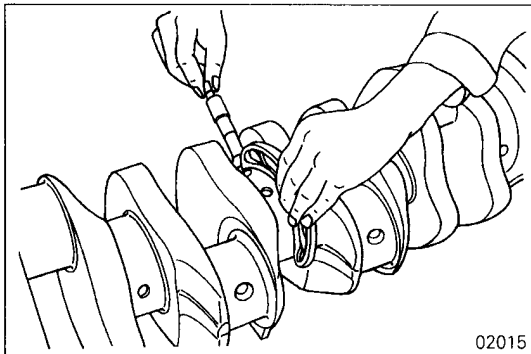
- (1) Gradually loosen the bolts **14** in the sequence of numbers ① – ⑯ shown in the illustration.
- (2) Then, gradually loosen the main bearing cap bolts **15** in the sequence of numbers ⑰ – ⑳ shown, and remove.



### ◊B◊ CRANKSHAFT GEAR REMOVAL

#### Caution

- Before attaching the special tool, install a protective bolt **A** [M16 x 1.5 mm (0.06 in.); 30 mm (1.18 in.) long] to the crankshaft end so that the crankshaft will not be damaged by the special tool.
- Do not tap on the crankshaft gear **21** to remove it.

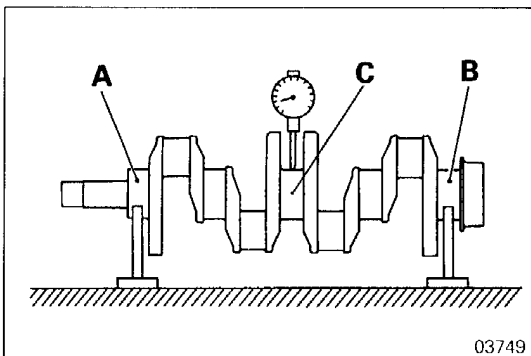


## INSPECTION

### CRANKSHAFT

#### Out-of-Roundness and Conicity of Crankshaft Journal and Pin

- (1) If the measured value exceeds the limit, replace the crankshaft.

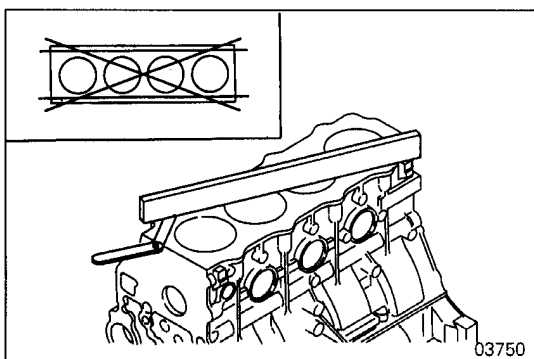


#### Bend

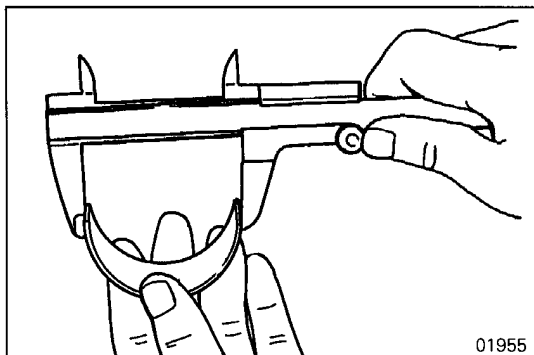
- (1) To measure the bend of the crankshaft **24**, support it at No. 1 journal **A** and No. 5 journal **B** and read the runout at No. 3 journal **C**. If the reading exceeds the specified service limit, replace the crankshaft.

#### NOTE

The bend of the crankshaft **24** is a half of the dial gauge reading obtained when the crankshaft is rotated one turn.

**UPPER CRANKCASE TOP DISTORTION**

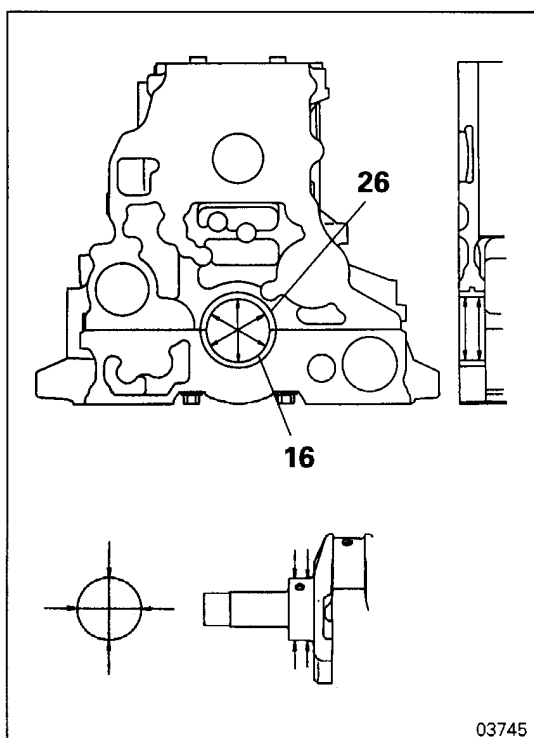
- (1) If the measured value exceeds the limit, replace the upper crankcase.

**MAIN BEARING****Caution**

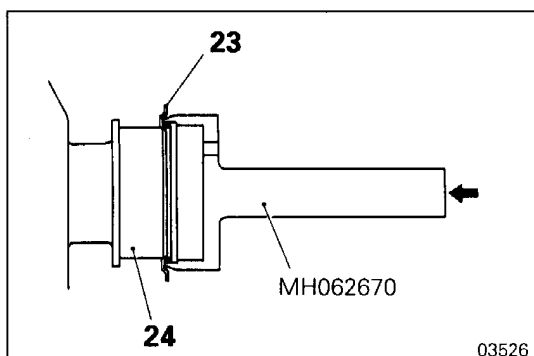
- Be sure not to use the main bearings **16** and **26** expanded forcibly.
- When either the main bearing **16** or **26** is defective, replace them in pairs.

**Free Span**

- (1) Measure the free span of each of the main bearings **16** and **26**. If the reading for either bearing or both exceeds the specified service limit, replace them in pairs.

**Main Bearing-to-Crankshaft Clearance**

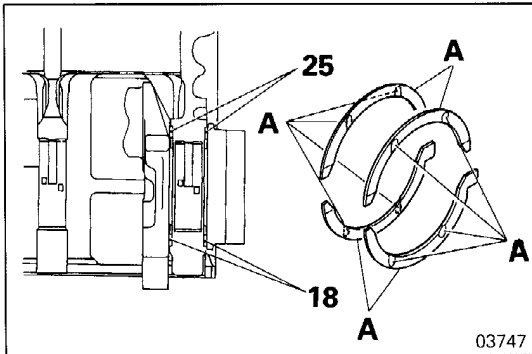
- (1) If the reading is less than the specified service limit, replace defective part.

**INSTALLATION SERVICE POINTS****◆A◆ REAR OIL SEAL SLINGER INSTALLATION**

- (1) Drive the rear oil seal slinger **23** onto the crankshaft **24** using the special tool until it completely contacts the rear end of the crankshaft.

▶B◀ **CRANKSHAFT GEAR INSTALLATION**

- (1) Before installing, heat the crankshaft gear **21** to approximately 100°C (212°F) with a piston heater or the like.

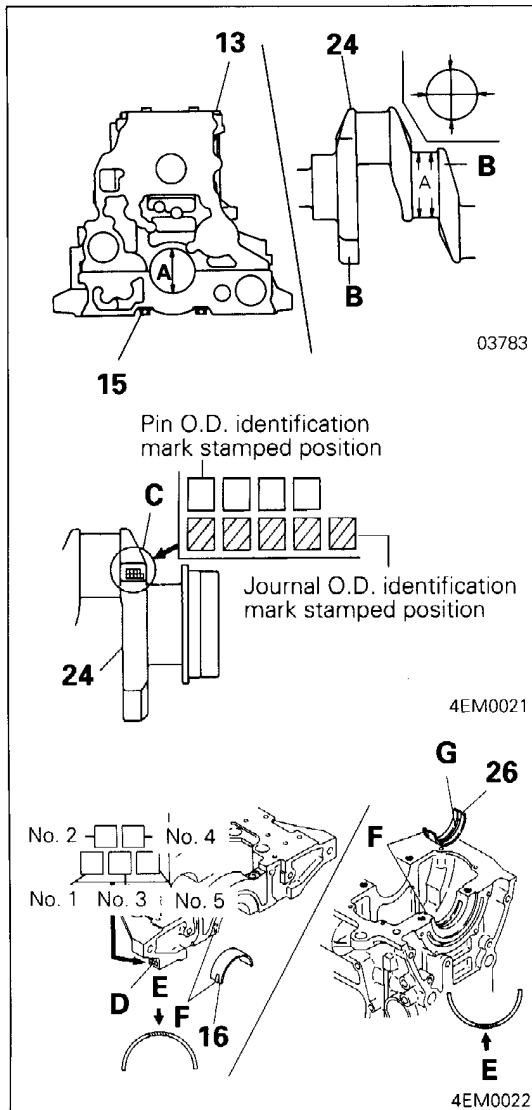


▶C◀ **THRUST PLATE INSTALLATION**

- (1) Install the thrust plates **18** and **25** to the crankshaft assembly **19** at No.5 journal only.

**Caution**

- Install the thrust plates **18** and **25** with the oil groove **A** oriented outward.
- If the oversize thrust plates are to be used, be sure to use the same size of upper thrust plate **25** and lower thrust plate **18** at one side. However, using the same size of upper (or lower) thrust bearings on both sides is not necessary.



▶D◀ **MAIN BEARING INSTALLATION**

- (1) The main bearings **16** and **25** must have a proper plate thickness that matches the difference between the bearing mounting hole I.D. of the crankcase assembly **13** and the journal O.D. of the crankshaft **24**.

- (a) Measure the bearing mounting hole I.D. of the crankcase assembly **13** and the journal O.D. of the crankshaft **24**.

**A:** Measuring point (One point in vertical direction for crankcase)

**Caution**

- Tighten the main bearing cap bolts **15** by specified procedure before measuring the bearing mounting hole I.D. of the crankcase assembly **13**. (Refer to 11A-28-1.)
- For the service parts, the above dimensions can be identified by the identification colors or identification marks on the crankcase and crankshaft.

**B:** Identification color position

**C:** Identification mark position

**D:** Identification mark position (rear right of the crankcase)

- (b) Select an appropriate thickness of the main bearings **16** and **26** from the following table.

**E:** Identification color position (side)

**F:** Lug

**G:** Oil hole

**Caution**

- The main bearing **16** and **26** must be installed in the specified direction. The main bearings for No. 3 journal are different in thickness from the others.
- The upper main bearing **26** for No. 3 journal is different in shape from the others.

Unit: mm (in.)

Crankshaft		Crankcase			Main bearing		
Identification color (Identification mark)	Journal O.D.	Size mark	Bearing mounting hole I.D.	Identification color (L/U)	Journal No.	Plate Thickness	Oil Clearance
None (1)	68 (2.68) -0.022 (-0.0009) -0.030 (-0.0012)	A	72 (2.83) +0.019 (0.0007) +0.010 (0.0004)	Black/ Black	No. 1,2,4,5	2 (0.08) -0.004 (-0.0002) -0.008 (-0.0003)	0.040 – 0.065 (0.0016 – 0.0026)
					No. 3	2 (0.08) -0.014 (-0.0006) -0.018 (-0.0007)	0.060 – 0.085 (0.0024 – 0.0033)
		B	72 (2.83) +0.010 (+0.0004) +0 (+0)	Blue/Blue	No. 1,2,4,5	2 (0.08) -0.008 (-0.0003) -0.012 (-0.0005)	0.038 – 0.064 (0.0015 – 0.0025)
					No. 3	2 (0.08) -0.018 (-0.0007) -0.022 (-0.0009)	0.058 – 0.084 (0.0023 – 0.0033)
Blue (2)	68 (2.68) -0.030 (-0.0012) -0.039 (-0.0015)	A	72 (2.83) +0.019 (0.0007) +0.010 (0.0004)	Yellow/ Yellow	No. 1,2,4,5	2 (0.08) -0 (-0) -0.004 (-0.0002)	0.040 – 0.066 (0.0016 – 0.0026)
					No. 3	2 (0.08) -0.010 (-0.0004) -0.014 (-0.0006)	0.060 – 0.086 (0.0024 – 0.0034)
		B	72 (2.83) +0.010 (+0.0004) +0 (+0)	Black/ Black	No. 1,2,4,5	2 (0.08) -0.004 (-0.0002) -0.008 (-0.0003)	0.038 – 0.065 (0.0015 – 0.0026)
					No. 3	2 (0.08) -0.014 (-0.0006) -0.018 (-0.0007)	0.058 – 0.085 (0.0023 – 0.0033)

L: Lower main bearing U: Upper main bearing

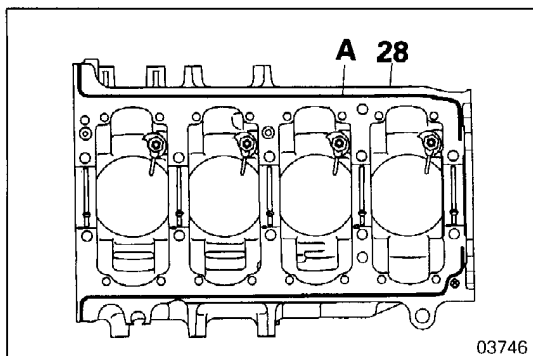
**⇨E⇩ LOWER CRANKCASE INSTALLATION**

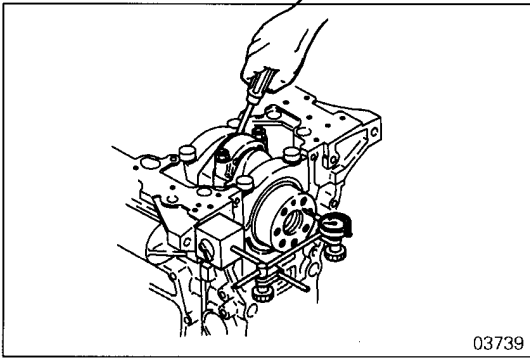
- Apply an even bead of sealant **A** to the illustrated position of the upper crankcase **28**. [Bead diameter: 2 ± 1 mm (0.08 ± 0.04 in.)]
- Install the lower crankcase **17** to the upper crankcase **28** within 15 minutes after the application of sealant **A**.

**Caution**

- Be sure that the surface to be coated with sealant **A** is clean and free of slush and other foreign matters.
- When installing the lower crankcase, be sure that sealant **A** does not smear the surroundings.
- After the lower crankcase is installed, wait for at least one hour before starting the engine.
- Remove and reinstall the lower crankcase with fresh bead of sealant **A** whenever the main bearing cap bolts **15** were loosened or removed after the installation.

- After installing the lower crankcase **17**, verify the following:  
Smooth rotation of the crankshaft assembly **19**  
End play of the crankshaft assembly **19** within specified service limit (See page 11A-28-5.)





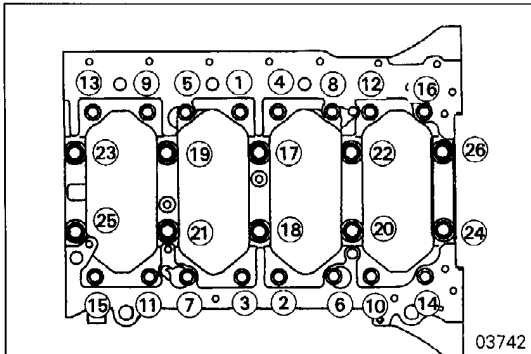
### END PLAY OF CRANKSHAFT

- (1) If the end play exceeds the specified service limit, replace the thrust plates **18** and **25** with oversize thrust plates.

#### Thrust plate installation:

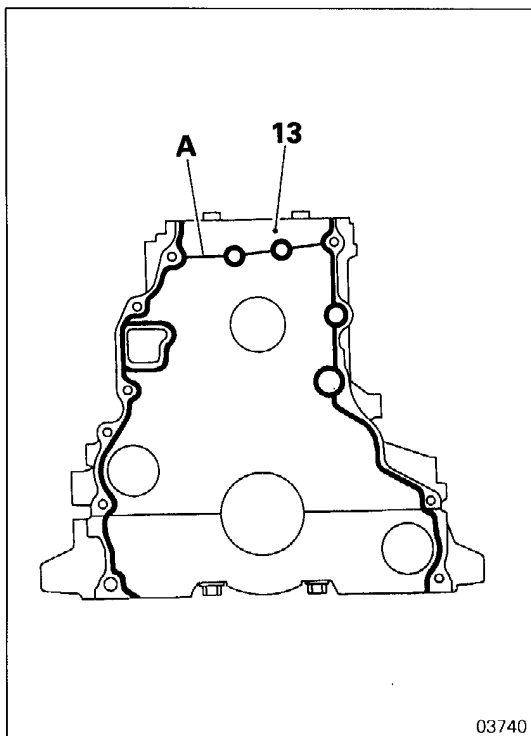
<Available oversizes>

+0.15 mm (+0.0059 in.), +0.30 mm (+0.0118 in.), +0.45 mm (+0.0177 in.)



### ◆F◆ BOLT / MAIN CAP BOLT INSTALLATION

- (1) Apply a thin coat of engine oil to the main bearing cap bolts **15**, and tighten them to 20 Nm (2 kgm, 14 ft.lbs.) in the sequence of numbers **17** – **26** shown in the illustration.
- (2) Then, tighten the bolts 1/4 turn (90 deg.) in the sequence of numbers shown.
- (3) Give them an additional 1/4 turn (90 deg.) in the same way as above.
- (4) After the main bearing cap bolts **15** are all tightened, tighten the bolts **14** to the specified torque in the sequence of numbers **1** – **16** shown in the illustration.

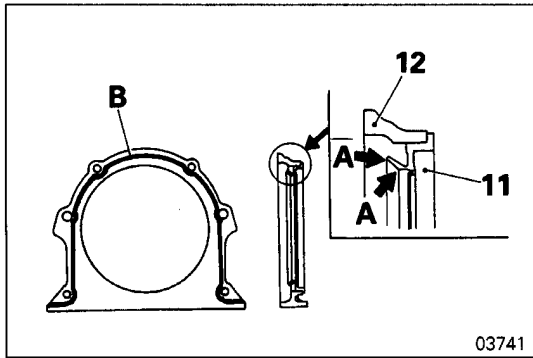


### ◆G◆ FRONT PLATE INSTALLATION

- (1) Apply an even bead of sealant **A** without break to the crankcase assembly **13** where indicated in the illustration. [Bead diameter:  $2 \pm 1$  mm ( $0.08 \pm 0.04$  in.)]
- (2) Install the front plate **2** to the crankcase assembly **13** within 15 minutes after the application of sealant **A**.

#### Caution

- Be sure that the surface to be coated with sealant **A** is clean and free of slush and other foreign matters.
- When installing the front plate, use care that the surroundings are not smeared with sealant **A**.
- After the front plate is installed, wait for at least one hour before starting the engine.
- The bolt **1** that holds the front plate **2** is also used to secure the timing gear case. Attach the front plate **2** with a temporary bolt until the timing gear case is installed.



### REAR OIL SEAL AND REAR OIL SEAL CASE INSTALLATION

- (1) Apply a thin coat of engine oil to the lip **A**, and install the oil seal **11** to the rear oil seal case **12**.
- (2) Apply an even bead of sealant **B** to the illustrated position of the rear oil seal **12**. [Bead diameter:  $3 \pm 1$  mm ( $0.12 \pm 0.04$  in.)]
- (3) Install the rear oil seal case **12** to the crankcase assembly **13** within three minutes after the application of sealant **B**.

#### Caution

- Be sure that the surface to be coated with sealant **B** is clean and free of slush and other foreign matters.
- When installing the rear oil seal case, use care that the surroundings are not smeared with sealant **B**.
- After the rear oil seal case is installed, wait for at least one hour before starting the engine.
- Remove and reinstall the rear oil seal case with fresh bead of sealant **B** whenever the bolt **10** (holding the rear oil seal case **12**) was loosened or removed after the installation.