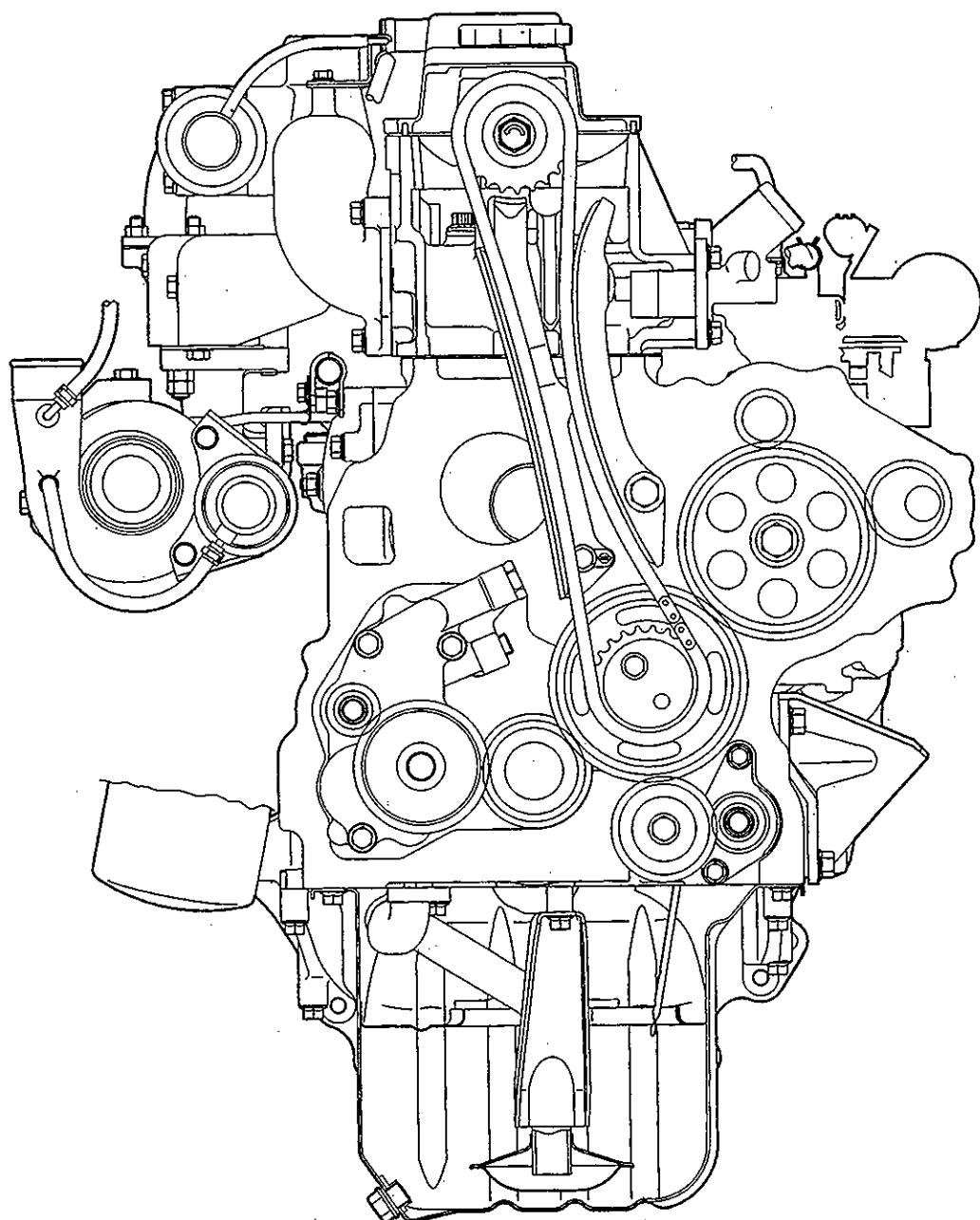


ENGINE

4M40

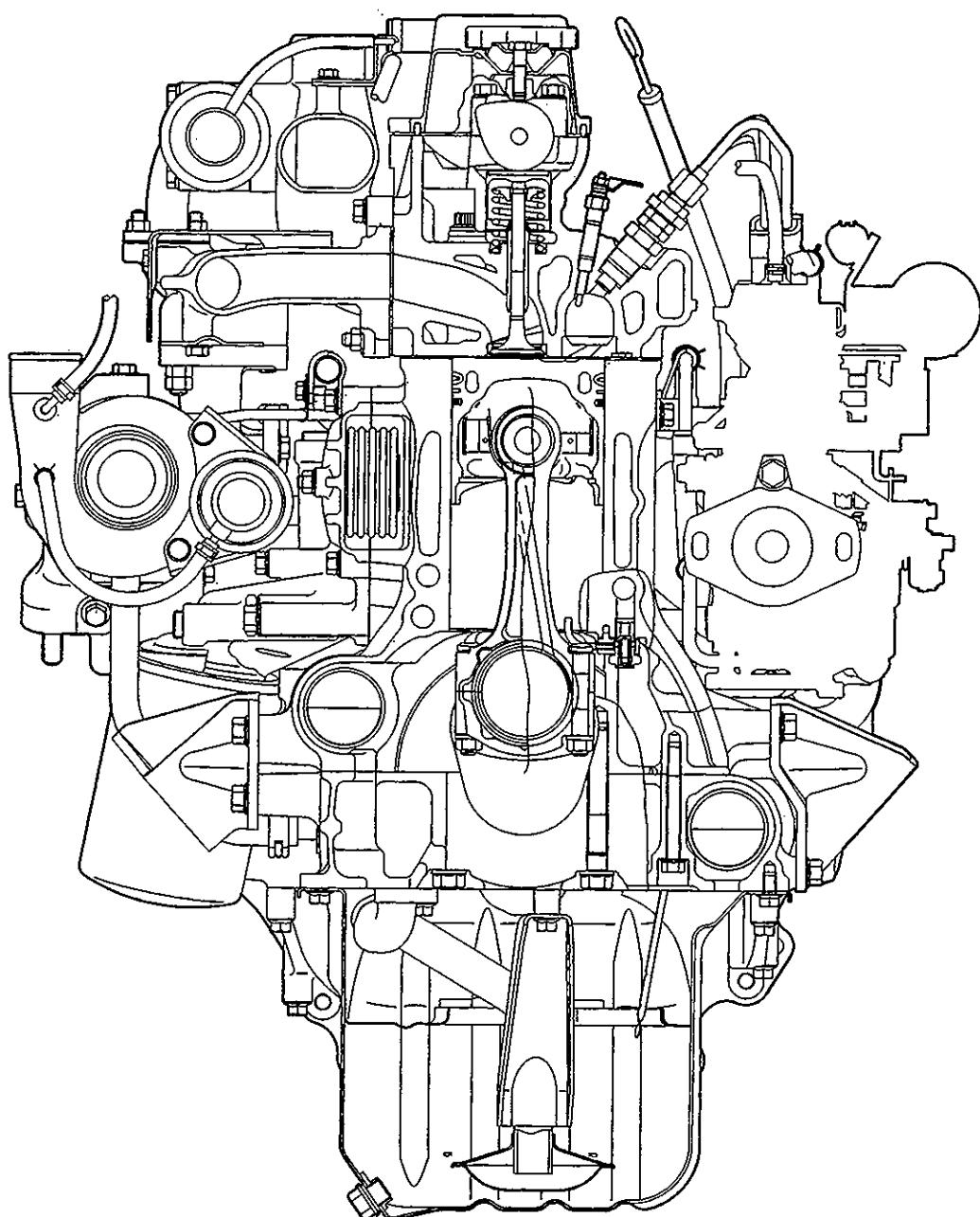
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GENERAL INFORMATION**SECTIONAL VIEW**

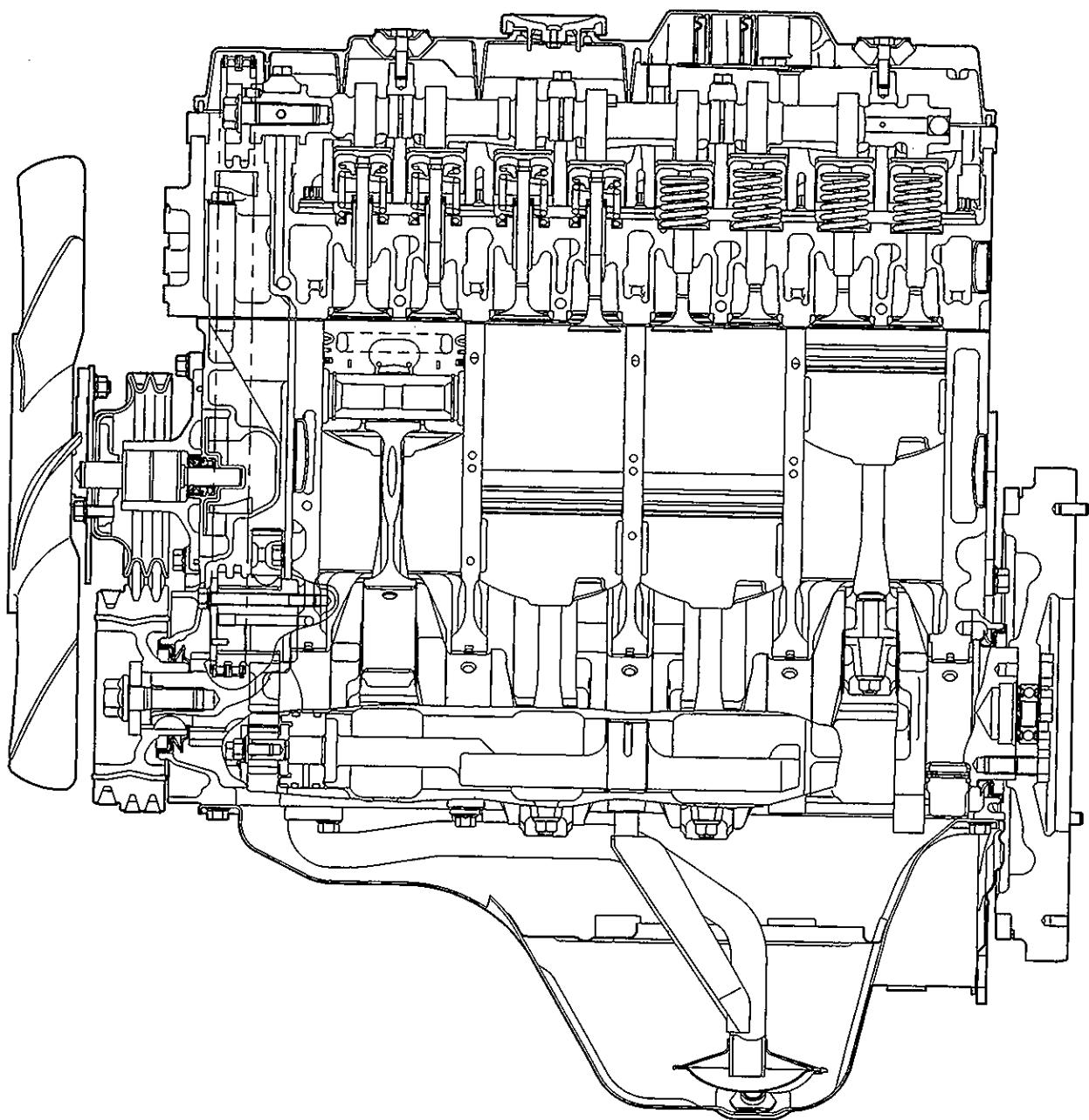
4ME0001

SECTIONAL VIEW



4ME0002

SECTIONAL VIEW



4ME0003

NOTES

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 ³ (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 19° BTDC Close 53° ABDC
Exhaust valve	Open 60° BBDC Close 16° ATDC
Supercharger	Turbo-charging type
Intercooler	Air-cooling type
Fuel supply	Distributor type fuel injection pump

SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
Glow plug		
Glow plug		
Resistance		
PAJERO	0.5 Ω* ¹ , 0.6 Ω* ²	
L200.....	1 Ω	
Turbocharger assembly		
Turbocharger		
Actuator operating pressure.....	91 (0.91)* ¹ , 96(0.97)* ²	
[when operating 1 mm (0.04 in.)]		
Turbocharger		
Cartridge assembly		
Axial play of shaft.....	0.057 – 0.103 (0.0022 – 0.0041)	
Turbine wheel back to turbine back plate	0.39 – 0.83 (0.0154 – 0.0033)	
clearance		
Camshaft and valves		
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 from 2001Model*²: From 2001Model

		mm (in.)
	Standard	Limit
Oil cooler and oil filter		
Bypass valve spring		
Valve opening pressure	390 ± 29 kPa (4 ± 0.3 kgf/cm ²)	
Regulator valve spring		
Valve opening pressure	490 ± 29 kPa (5 ± 0.3 kgf/cm ²)	
Timing gears, balance shafts		
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)
Oil pump		
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)
Fuel injection nozzle		
Fuel injection nozzle		
Fuel injection pressure (valve opening pressure)	15,000 kPa (150 kg/cm ² , 2,133 psi)	
Fuel injection pump assembly		
Fuel injection pump		
Plunger lift (fuel injection timing: 4°ATDC ^{*1} , 6°ATDC ^{*2} , 7°ATDC ^{*3} , 9°ATDC ^{*4} , 12°ATDC ^{*5})	1 ± 0.03 (0.039 ± 0.0012)	

NOTE^{*1}: PAJERO Non-turbo^{*2}: –2002 L200 Non-turbo, and 1994–1996 PAJERO Turbo for EFTA^{*3}: 2001–PAJERO Turbo without EGR^{*4}: 2002–L200 Turbo, 2003–L200 Non-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

mm (in.)

	Standard	Limit
Piston and connecting rod assembly		
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)
Piston and piston pin		
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) ^{*1} 0.4 – 0.55 (0.0157 – 0.0217) ^{*2}	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)

NOTE^{*1}: Except PAJERO 2001Model^{*2}: PAJERO 2001Model

		mm (in.)	
	Standard	Limit	
Flywheel			
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)
Hydro-Flywheel			
Play in circumferential directions	9 (0.35)	
Friction surface runout	0.75 (0.0295)	
Friction surface height	46.2 (1.819)	
Crankshaft and crankcase			
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	kNm	ft.lbs.
Cooling fan V-belt and water pump			
Cooling fan nut	10	1.0	7
Auto-cooling fan coupling nut	24	2.4	17
Water pump bolt	24	2.4	17
Water hoses and pipes			
Turbocharger water outlet pipe	26	2.6	19
Turbocharger water inlet pipe	26	2.6	19
Engine coolant temperature sensor	9	0.9	7
Coolant temperature sensor			
Coolant temperature sensor	40	4.0	29
Glow plug			
Connection plate	10* ¹ , 1.8* ²	1.0* ¹ , 0.18* ²	7* ¹ , 1.3* ²
Glow plug	18	1.8	13
Turbocharger assembly			
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
Turbocharger			
Coupling nut	4.5	0.45	3.3
Intake manifold			
Relief valve	48	4.8	35
Exhaust manifold			
Exhaust manifold bolt	30	3.0	22
Exhaust manifold nut	31	3.1	22
Rocker cover and cylinder head assembly			
Rocker cover bolt	4	0.4	3
Cam sprocket bolt	Left-hand thread 90	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
Camshaft and valve			
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
Oil cooler and oil filter			
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.	
Vacuum pump				
Oil pressure gauge unit.....	15	1.5	11	
Eyebolt (FOR L200 and FOR CHALLENGER) (PAJERO except 1998– for Europe).....	12	1.2	9	
(1998– PAJERO for Europe).....	20	2.0	14	
Timing gear case				
Crankshaft pulley bolt.....	230	23	166	
Timing gear and balance shaft				
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	
Oil Pump				
Balance shaft RH bolt	37	3.7	27	
Oil pump cover screw	10	1.0	7	
Fuel Injection nozzle				
Leak-off pipe nut	30	3.0	22	
Fuel injection nozzle assembly	55	5.5	40	
Retaining nut.....	40	4.0	29	
Fuel injection pump assembly				
Fuel injection pipe	23	2.3	17	
Fuel injection pump gear				
Fuel injection pump gear	65	6.5	47	
Piston and connecting rod assembly				
Connecting rod nut	50 + 1/4 turns	5.0 + 1/4 turns	36 + 1/4 turns	
Flywheel				
Flywheel bolt	125	12.5	90	
Drive plate				
Rubber spacer bolt.....	48	4.8	35	
Torque converter	39	3.9	28	
Drive plate bolt	135	13.5	98	
Crankshaft and crankcase				
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	
Generator				
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						
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						
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	THREEBOND TB1386D, LOCTITE 962T or equivalent
Inner surface of sealing cap press-fitting hole	
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

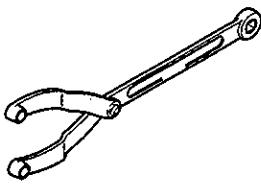
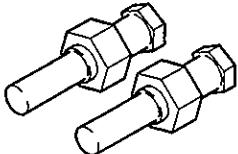
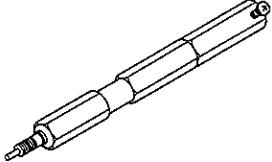
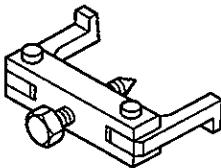
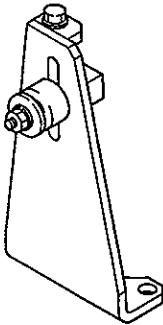
Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do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

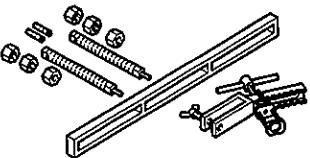
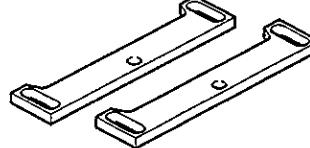
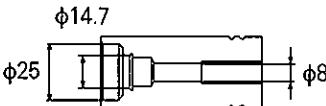
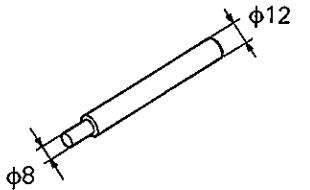
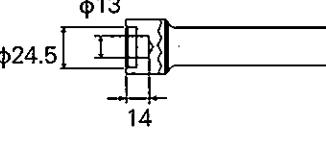
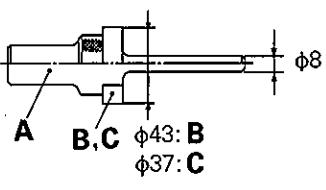
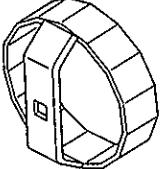
Form-In-Place Gasket Application

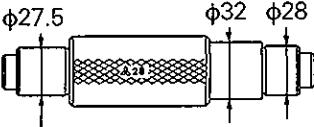
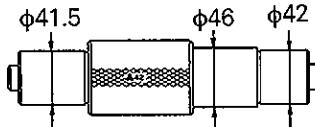
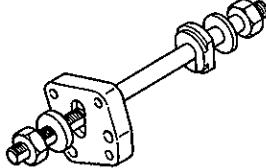
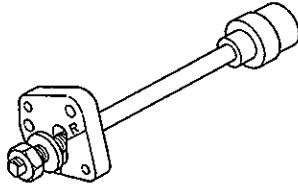
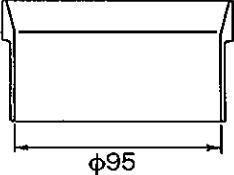
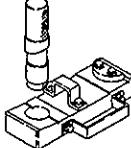
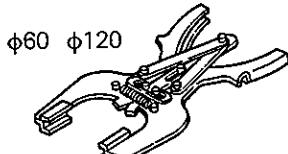
Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the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

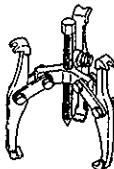
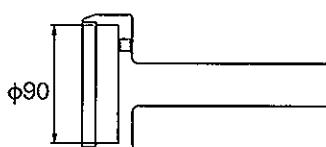
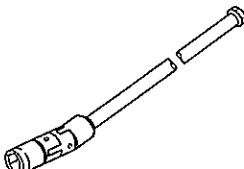
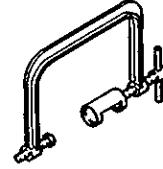
The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.

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

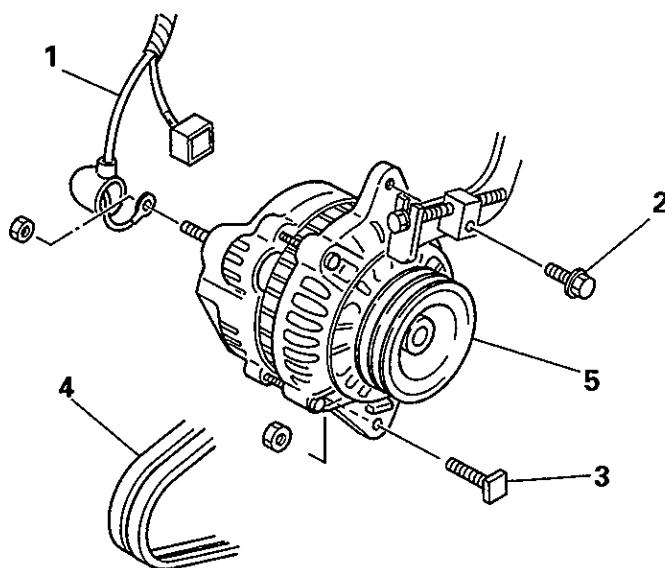
Tool	Number	Name	Use
	MD998772	Valve spring compressor	Removal and installation of valve cotter Use with MD998784
	MD998784	Valve spring compressor adapter plate	Removal and installation of valve cotter Use with MD998772
	MH062671	Valve stem seal installer	Installation of valve stem seal
	31391-10500	Valve guide remover	Removal of valve guide
	MH062686	Valve guide installer	Installation of valve guide
	31391-13100 MH062687 MH062688	A: Calking tool body B: Calking inlet C: 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

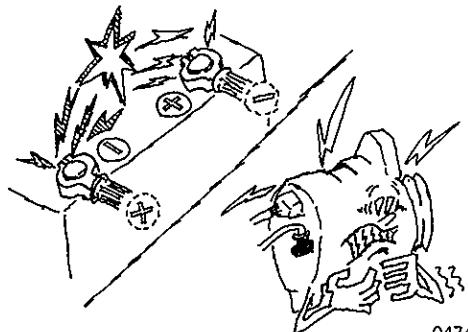
REMOVAL AND INSTALLATION



Removal steps

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

04745



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.

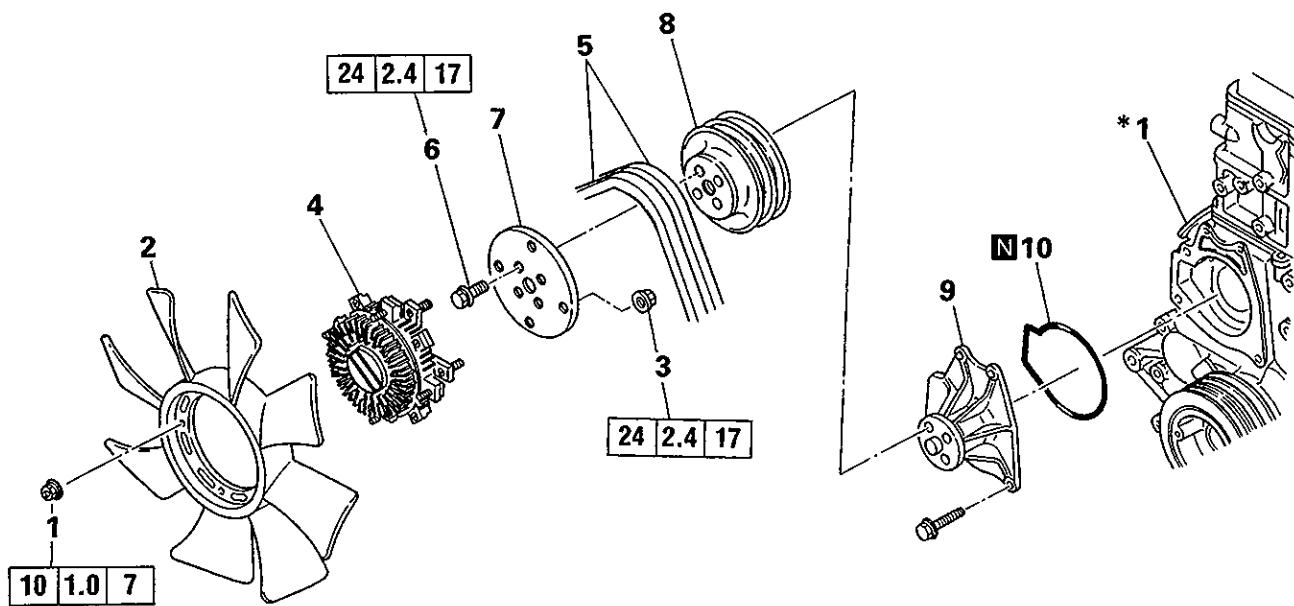
04746

NOTES

4. COOLING FAN, V-BELT AND WATER PUMP

REMOVAL AND INSTALLATION

<EXCEPT PAJERO 2001MODEL>



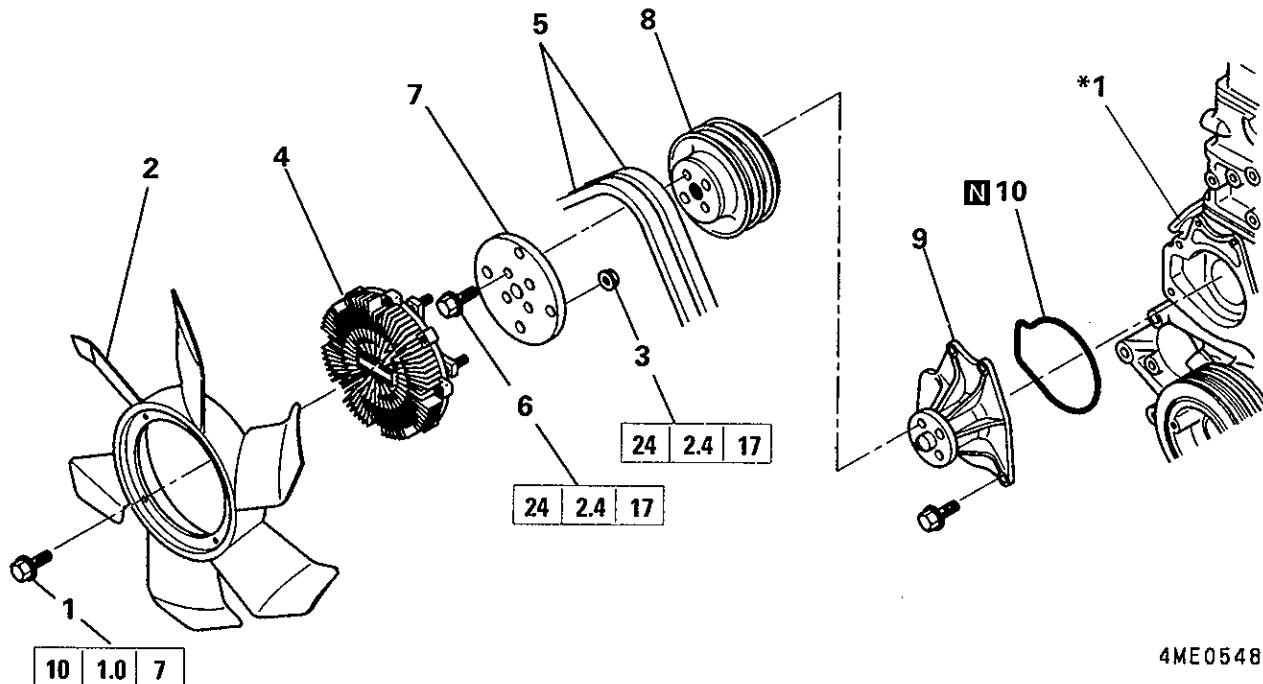
Removal steps

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

<PAJERO 2001 MODEL>



4ME0548

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

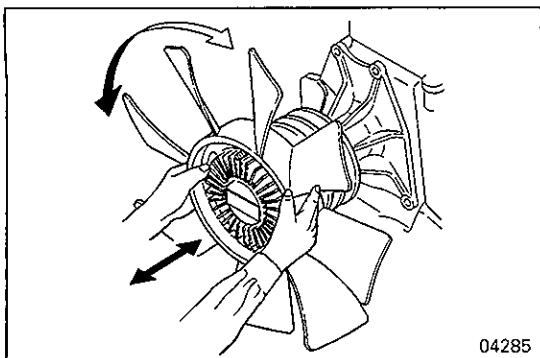
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INSPECTION

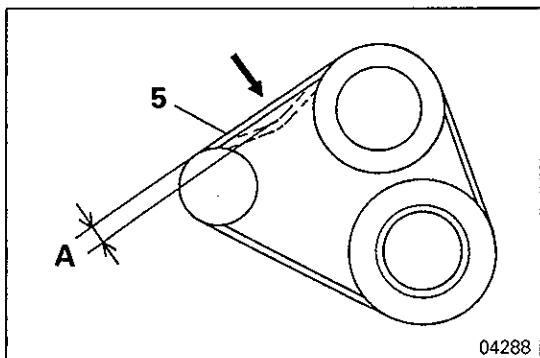
AUTO-COOLING FAN COUPLING

(1) Check the auto-cooling fan coupling 4, and replace if any of the following conditions exists:

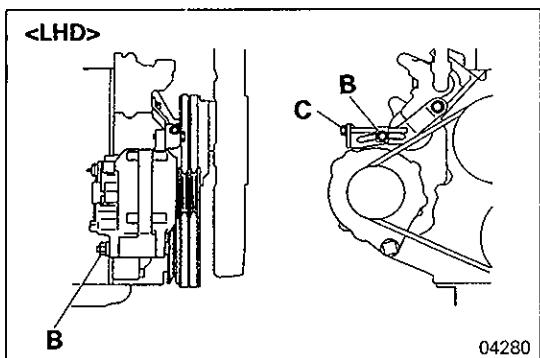
- Hydraulic fluid is leaking from the hermetically sealed housing.
- The coupling turns irregularly or produces an abnormal sound when rotated by hand due to defective inside bearing.
- The coupling has an excessive axial play when moved with the engine in a cold state.



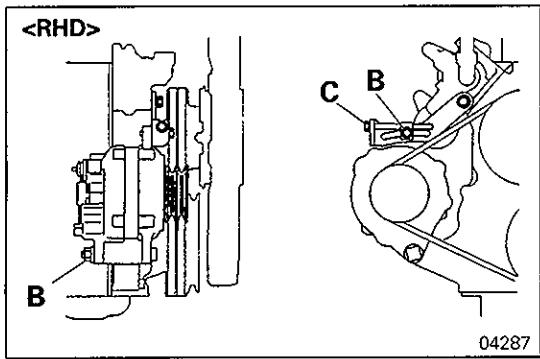
04285



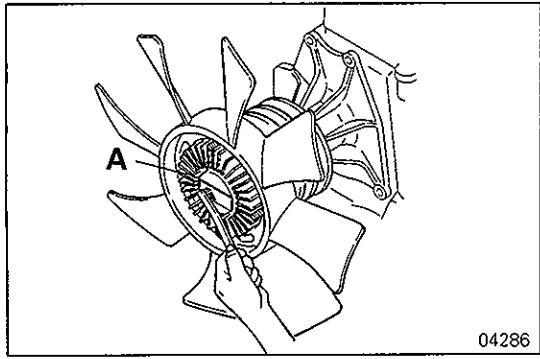
04288



04280



04287



04286

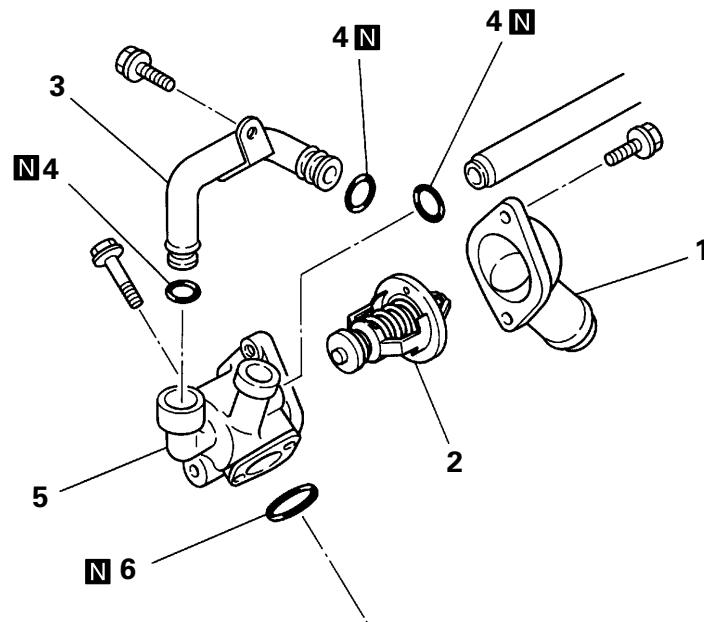
CLEANING

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

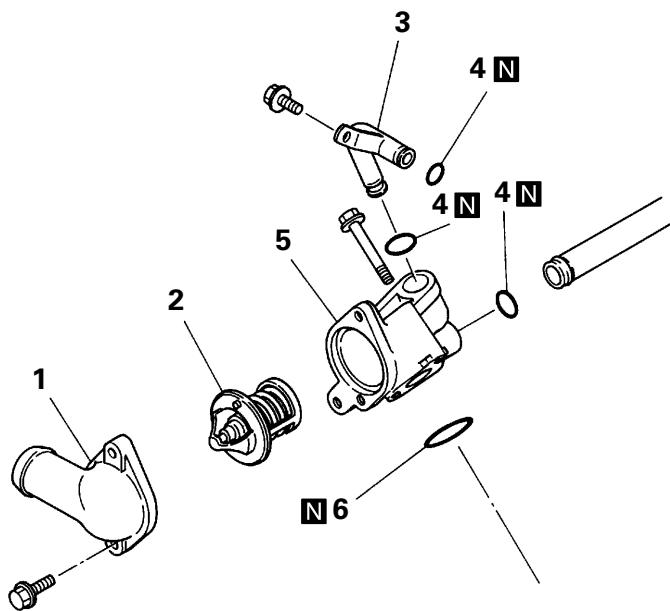
5. THERMOSTAT

REMOVAL AND INSTALLATION

<EXCEPT CHALLENGER FROM 2000MODEL, PAJERO FROM 2001MODEL, L200 FROM 2003MODEL>



<CHALLENGER FROM 2000MODEL, PAJERO FROM 2001MODEL, L200 FROM 2003MODEL>



Removal steps

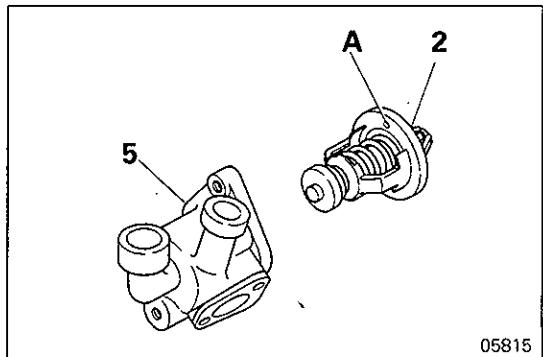
1. Thermostat cover
2. Thermostat
3. Bypass pipe
4. O-ring
5. Thermostat case
6. O-ring

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.

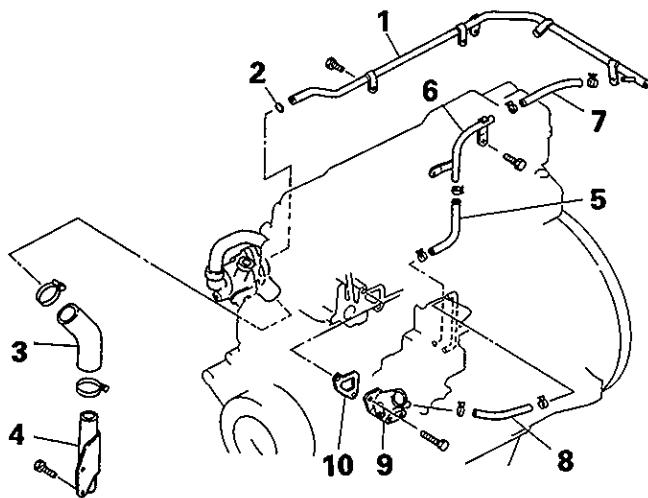


B THERMOSTAT

- (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

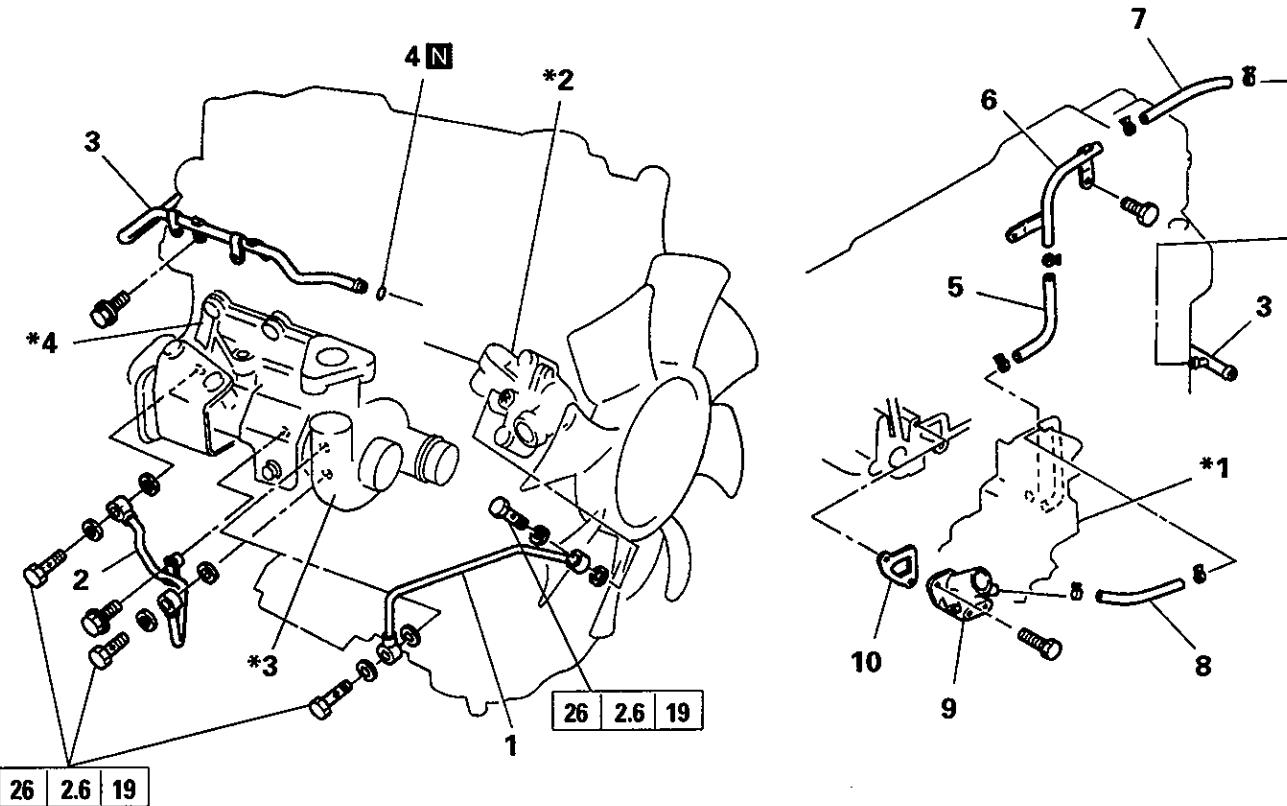
►A[●] 1. Heater return pipe
 2. O-ring
 3. Water inlet hose
 4. Water inlet pipe
 5. Water hose <with W-CSD>
 6. Water pipe <with W-CSD>
 7. Water hose <with W-CSD>
 8. Water hose <with W-CSD>
 9. Water outlet pipe
 10. Gasket

NOTE

W-CSD: Wax type cold start device

04291

REMOVAL AND INSTALLATION (FOR CHALLENGER)



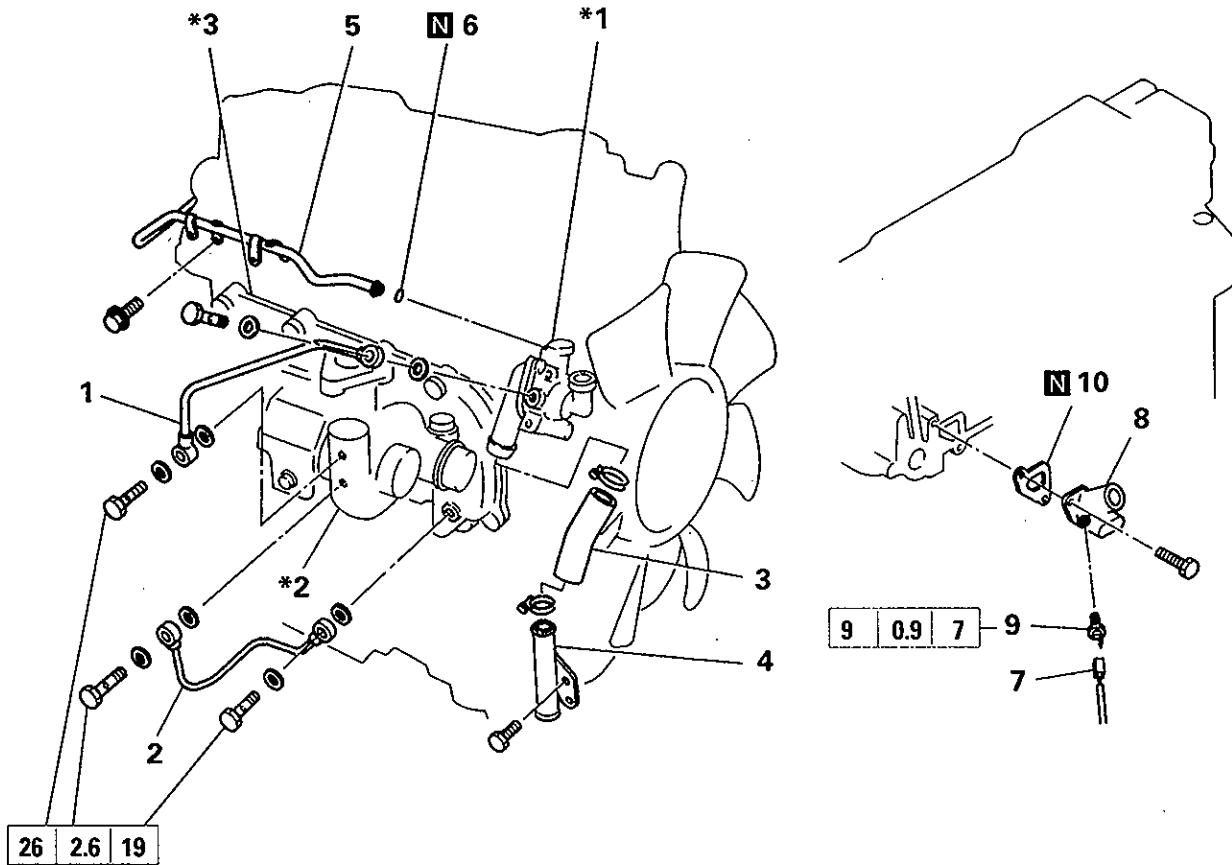
Removal steps

- 1. Turbocharger water outlet pipe
- 2. Turbocharger water inlet pipe
- 3. Heater return pipe
- 4. O-ring
- 5. Water hose
- 6. Water pipe
- 7. Water hose
- 8. Water hose
- 9. Water outlet pipe
- 10. Gasket

*1: Injection pump assembly
 *2: Thermostat assembly (See page 11A-5-1.)
 *3: Turbocharger assembly (See page 11A-9-2.)
 *4: Oil cooler assembly (See page 11A-15-1.)

4ME0069

REMOVAL AND INSTALLATION (1998– PAJERO for Europe)



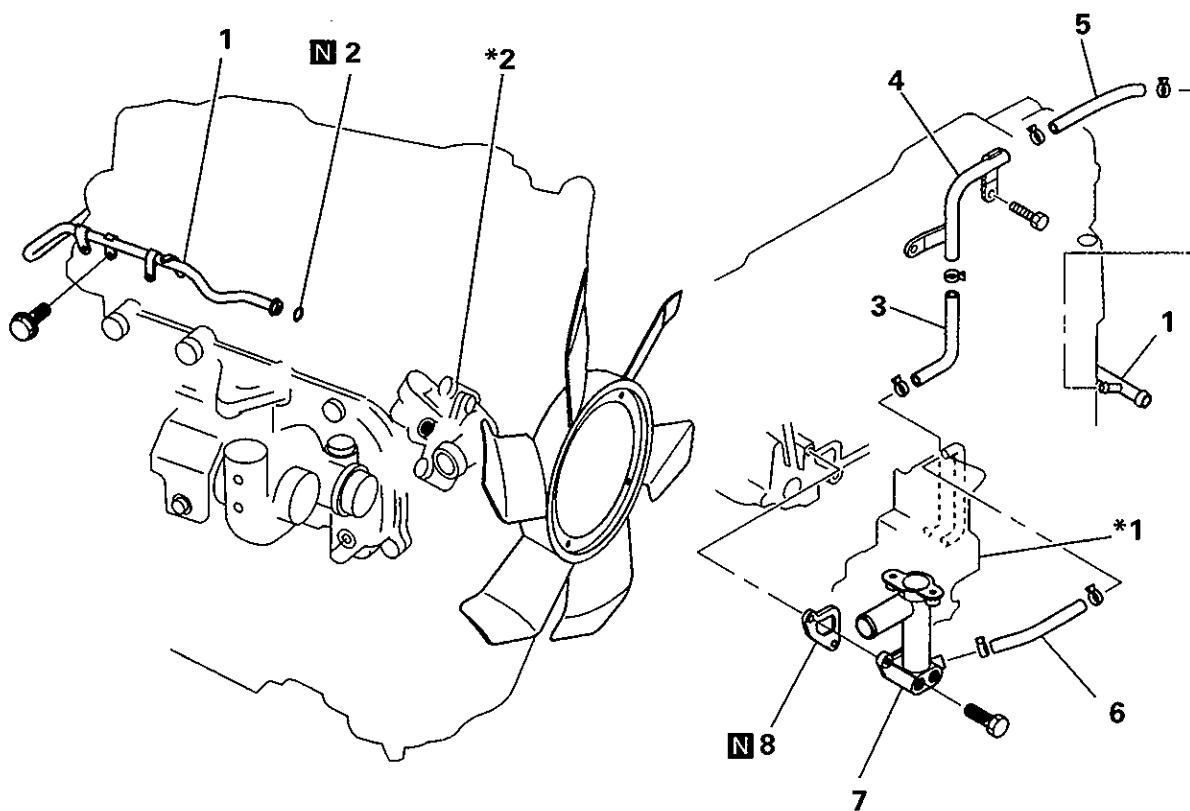
Removal steps

- 1. Turbocharger water outlet pipe
- 2. Turbocharger water inlet pipe
- 3. Water inlet hose
- 4. Water inlet pipe
- 5. Heater return pipe
- 6. O-ring
- 7. Harness
- 8. Water outlet pipe
- 9. Engine coolant temperature sensor
- 10. Gasket

*1: Thermostat case (See page 11A-5-1.)
 *2: Turbocharger assembly (See page 11A-9-3.)
 *3: Oil cooler assembly (See page 11A-15-1.)

4ME0066

REMOVAL AND INSTALLATION (2001– PAJERO)



4ME0545

Removal steps

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

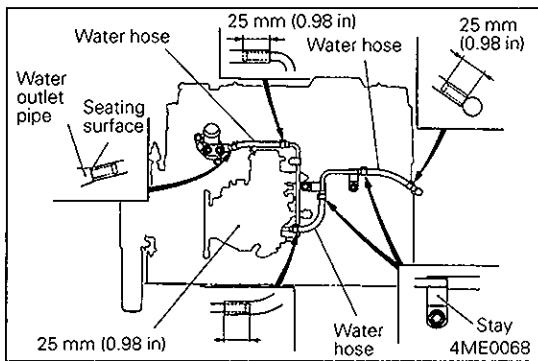
- 7. Water outlet pipe
- 8. Gasket

*1: Injection pump assembly
 *2: Thermostat case (See page 11A-5-1.)

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INSTALLATION SERVICE POINT**►A◄ O-RING****Caution**

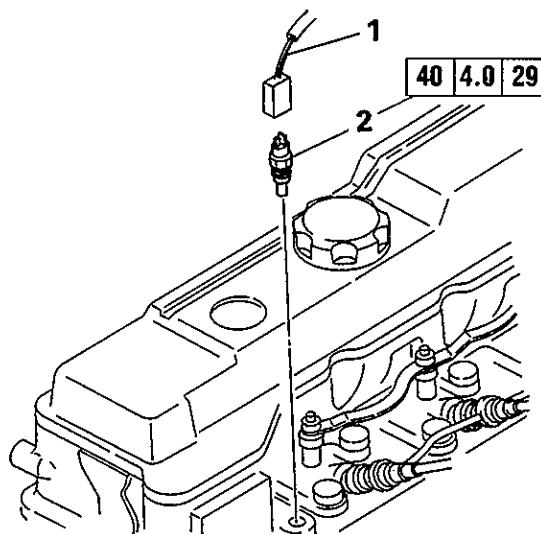
- Engine oil swells O-rings. When installing the O-ring, be sure that it is free of engine oil.

**►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

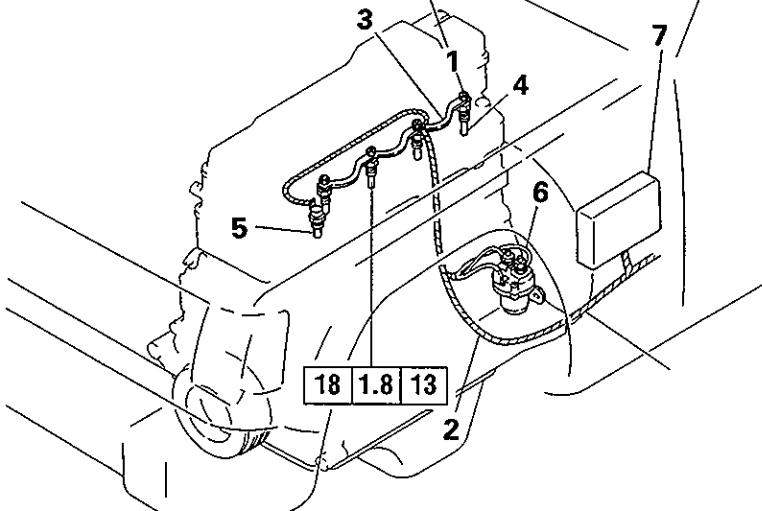
NOTES

8. GLOW PLUG

REMOVAL AND INSTALLATION

<PAJERO 2001MODEL> 1.8 | 0.18 | 1.3

<EXCEPT PAJERO 2001MODEL> 10 | 1.0 | 7



Removal steps

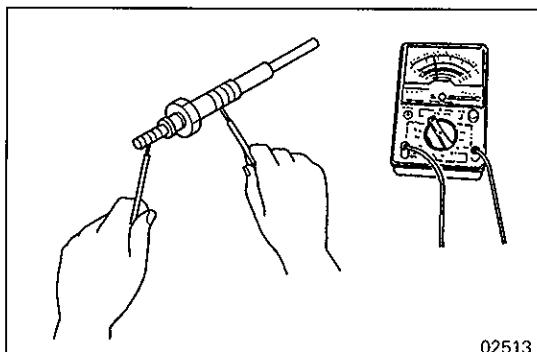
- 1. Nut
- 2. Glow plug wiring harness
- 3. Connection plate
- 4. Glow plug
- 5. Coolant temperature sensor
(See page 11A-7-1.)
- 6. Glow relay
- 7. Glow and EGR ECU (with EGR)
Glow ECU (without EGR)

04832

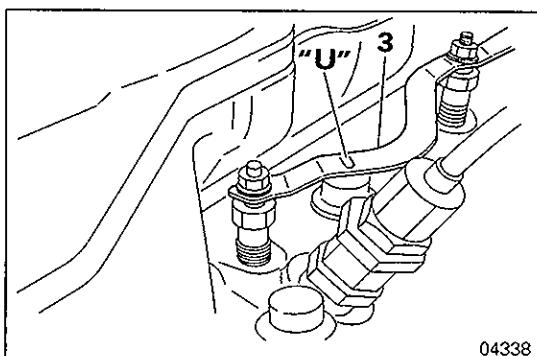
INSPECTION

GLOW PLUG

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



02513



04338

INSTALLATION SERVICE POINT

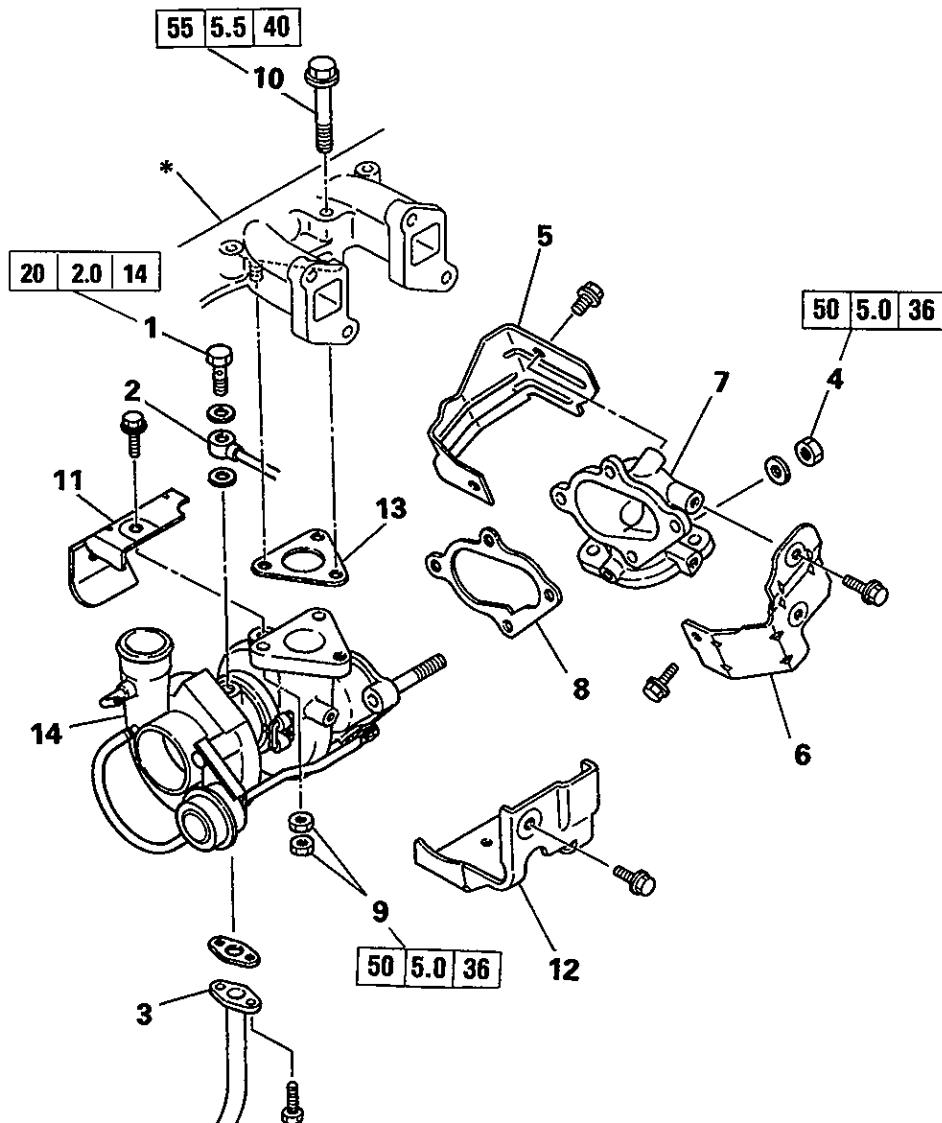
► CONNECTION PLATE INSTALLATION

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

NOTES

9. TURBOCHARGER ASSEMBLY

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

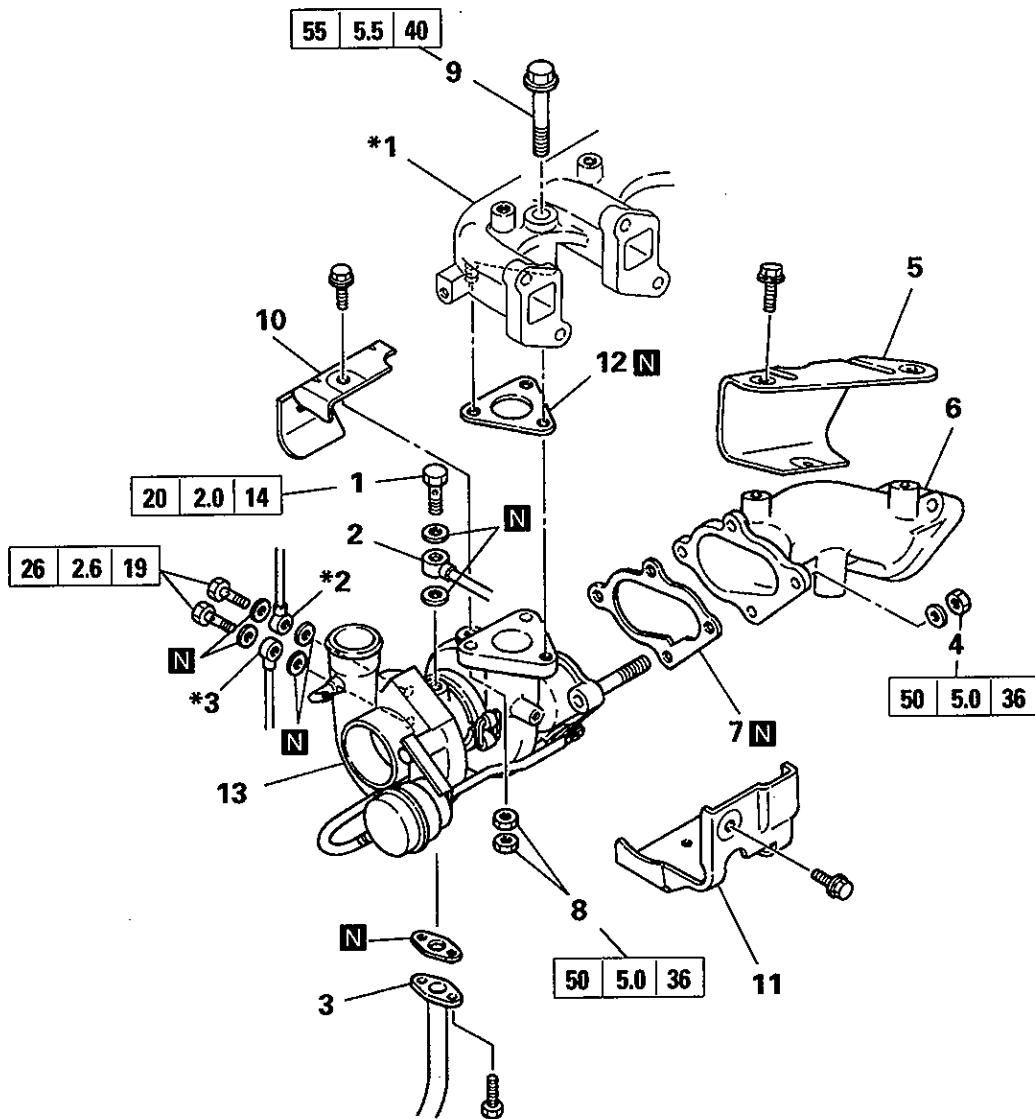


Removal steps

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 (See page 11A-10-1.)

*: Exhaust manifold

REMOVAL AND INSTALLATION (FOR CHALLENGER)



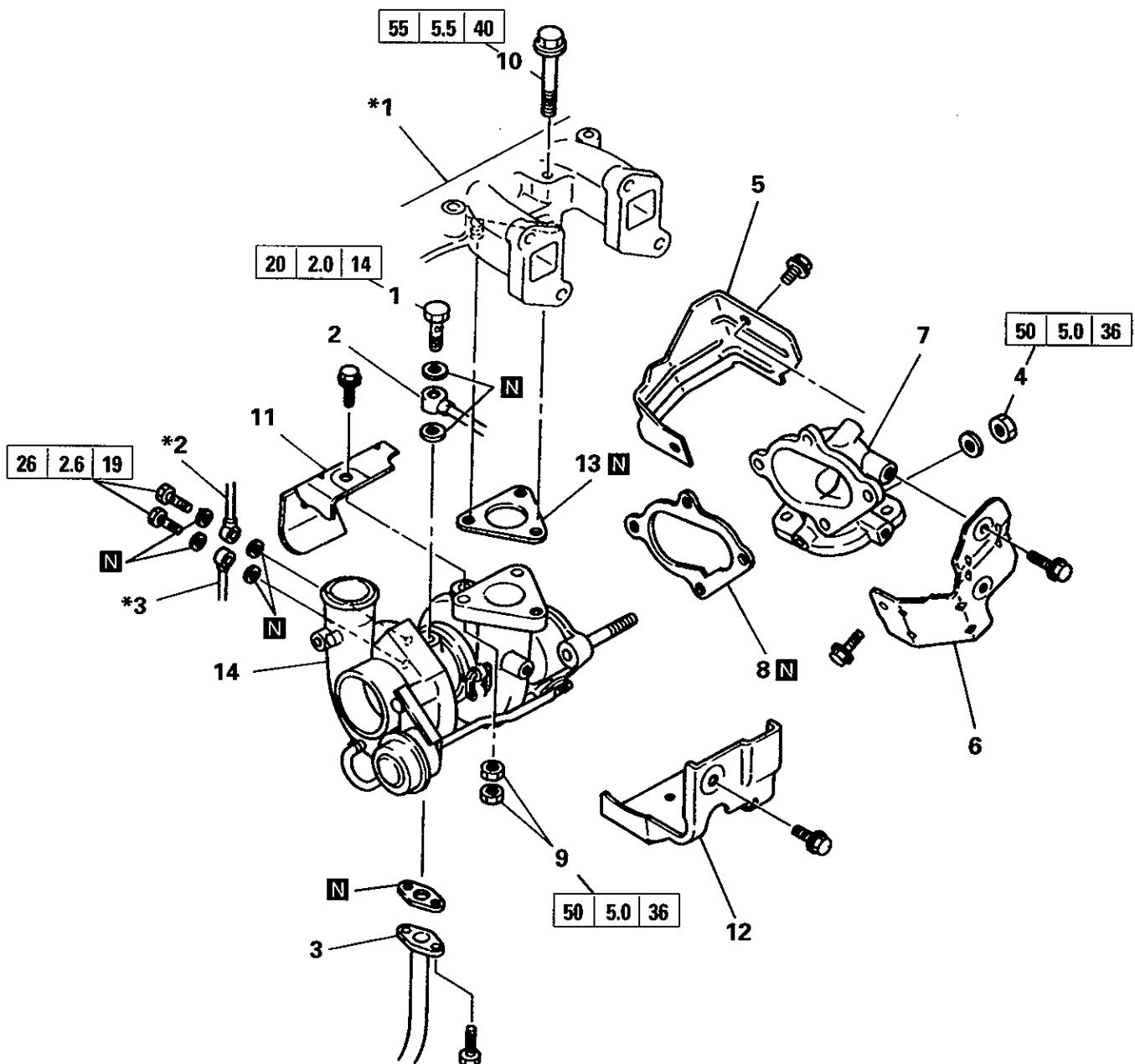
Removal steps

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

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

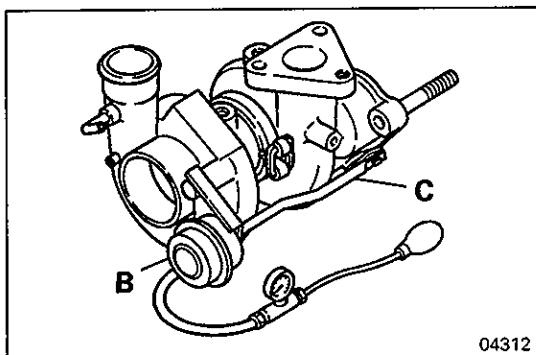
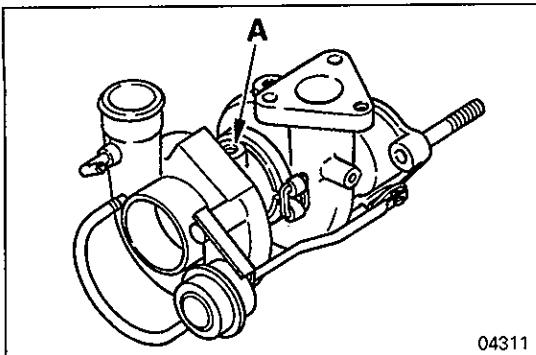
*1: Exhaust manifold
 *2: Turbocharger water outlet pipe (See page 11A-6-2.)
 *3: Turbocharger water inlet pipe (See page 11A-6-2.)

REMOVAL AND INSTALLATION (1998– PAJERO for Europe)



Removal steps

1. Eyebolt	10. Bolt
2. Oil feed pipe	11. Insulator B
3. Oil return pipe	12. Insulator A
4. Nut	13. Gasket
5. Coupler insulator	14. Turbocharger assembly (See page 11A-10-1.)
6. Insulator	*1: Exhaust manifold
7. Coupler	*2: Turbocharger water outlet pipe (See page 11A-6-3.)
8. Gasket	*3: Turbocharger water inlet pipe (See page 11A-6-3.)
9. Nut	



INSTALLATION SERVICE POINT

◆ A TURBOCHARGER ASSEMBLY INSTALLATION

- 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.

- 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.)].

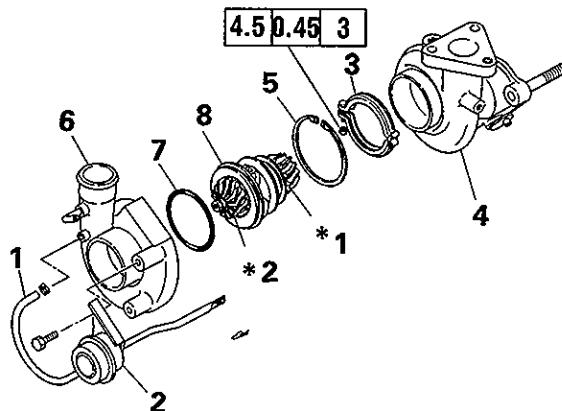
If the reading deviates from the specified standard value, replace the actuator. (See page 11A-1-2.)

Caution

- Do not load the actuator **B** with any more pressure than 117 kPa (1.17 kg/cm², 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
- 3. Coupling
- 4. Turbine housing
- 5. Snap ring
- 6. Compressor cover
- 7. O-ring
- 8. Cartridge assembly

*1: Turbine wheel

*2: Compressor wheel

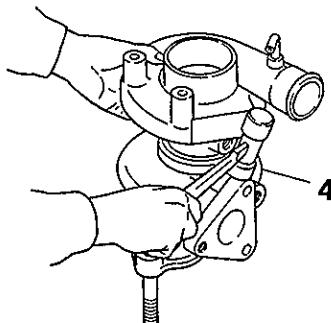
04313

DISASSEMBLY SERVICE POINTS

Ⓐ 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.

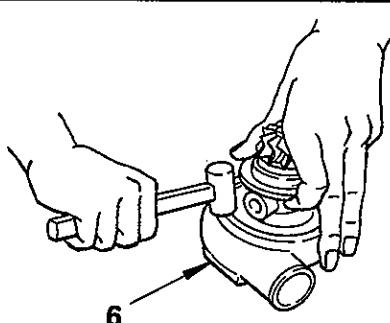


04315

Ⓑ 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.

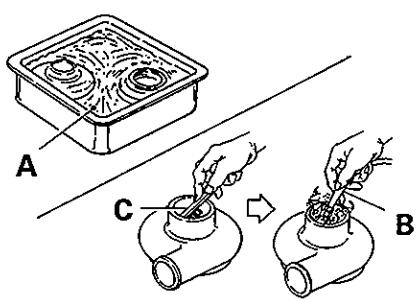


01533

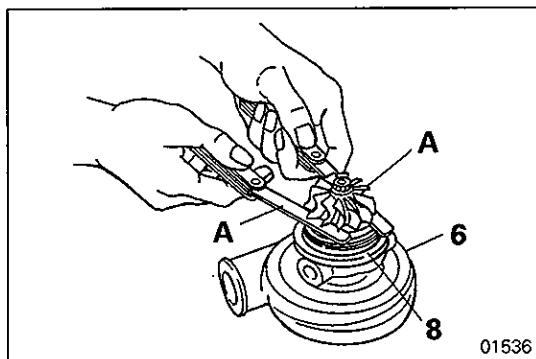
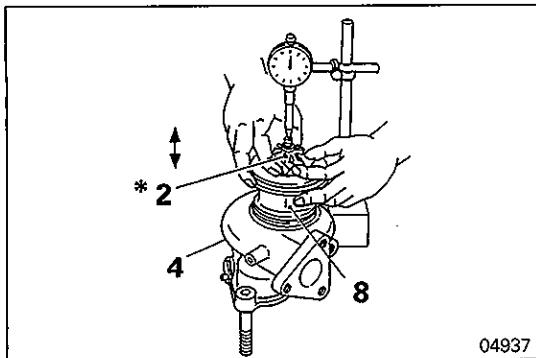
CLEANING

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

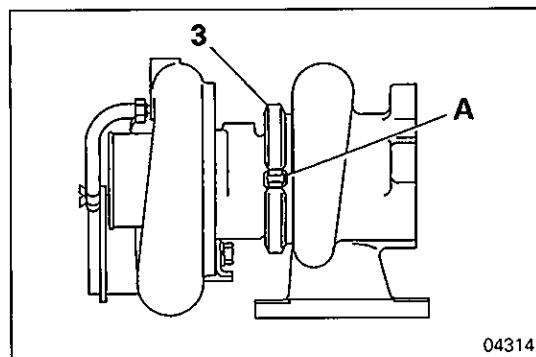
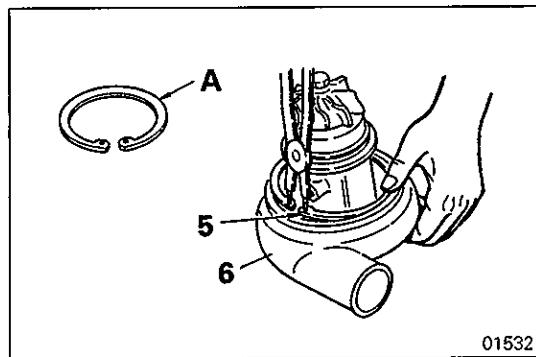
(1) Install the snap ring **5** in the compressor cover **6** with the tapered surface **A** facing upward.

Caution

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

►C COUPLING INSTALLATION

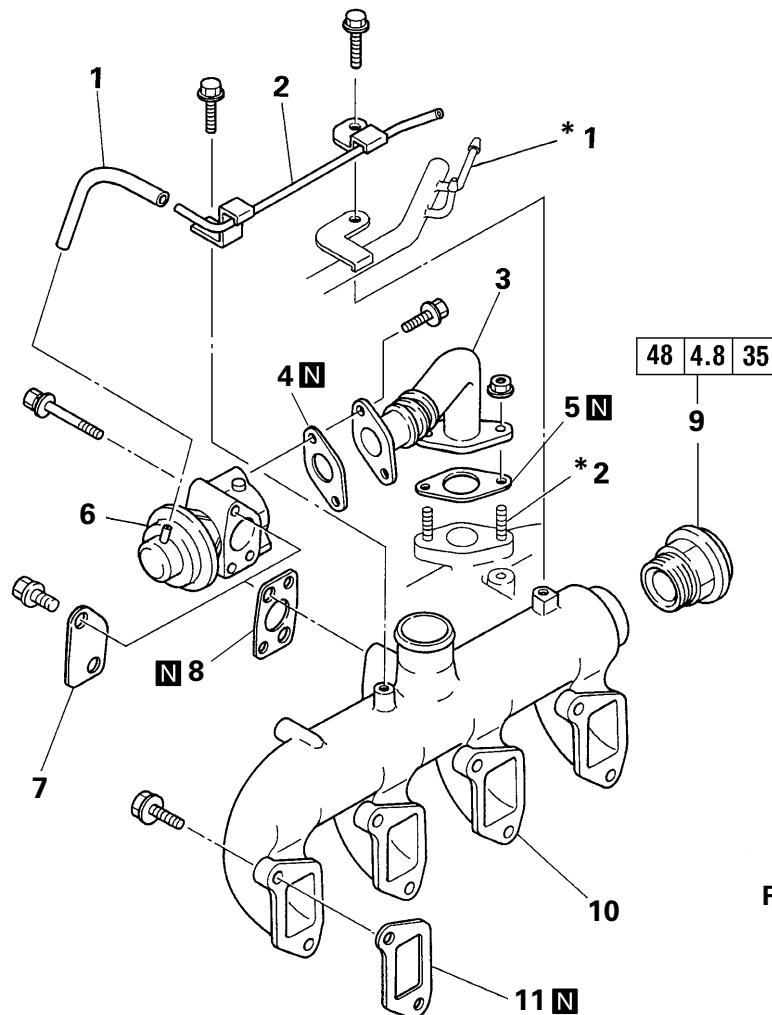
(1) Install the coupling **3** with the clip side **A** positioned as shown.



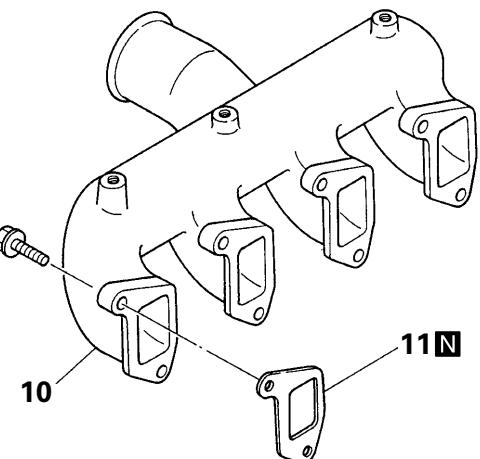
11. INTAKE MANIFOLD REMOVAL AND INSTALLATION

<Turbo: EXCEPT PAJERO 2001MODEL>

<Non-turbo>



04317



04316

Removal steps

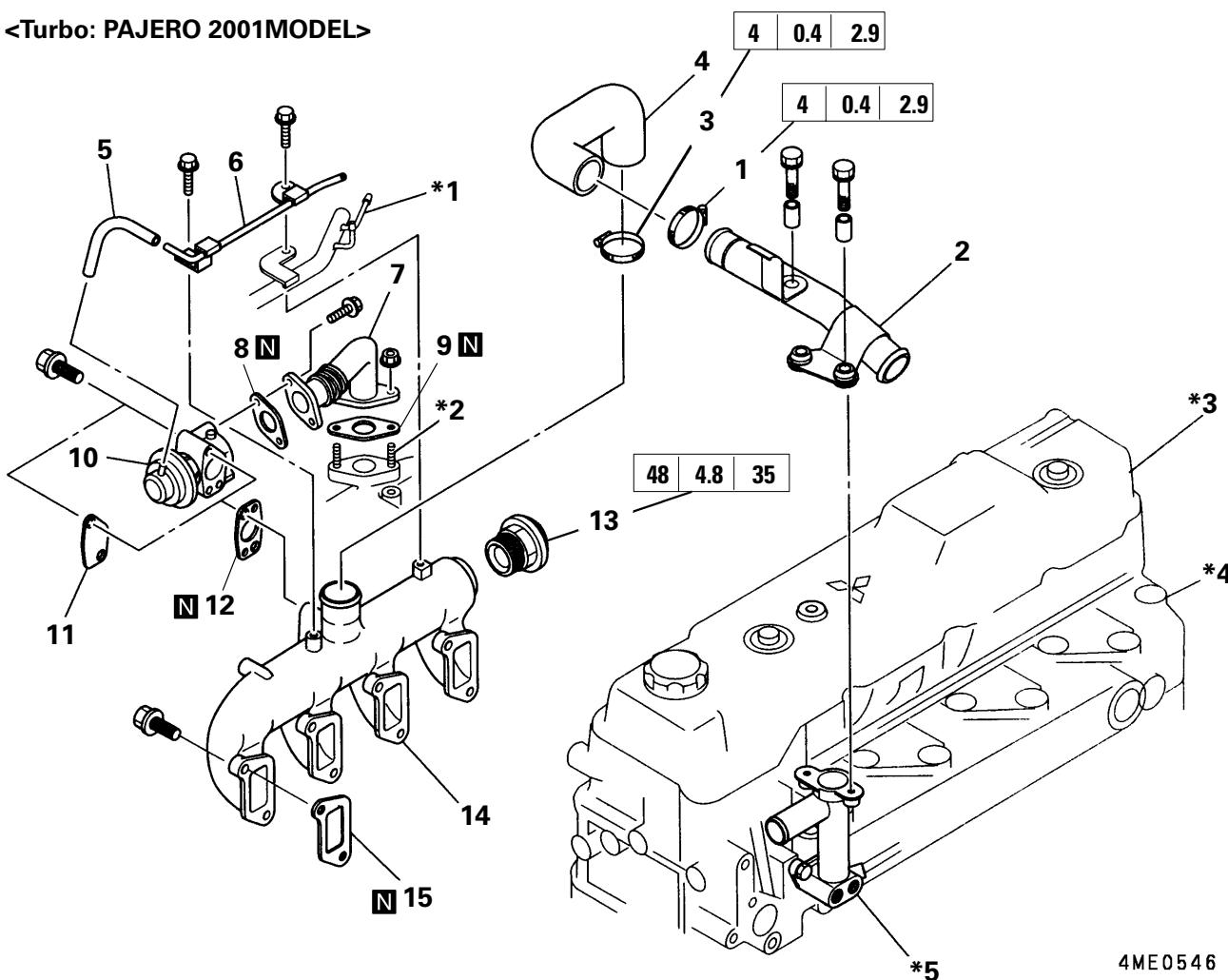
1. Vacuum hose <with EGR>
2. Vacuum pipe <with EGR>
3. EGR pipe <with EGR>
4. Gasket
5. Gasket
6. EGR valve <with EGR>
7. Cover <without EGR>
8. Gasket
9. Relief valve
10. Intake manifold
11. Gasket

*1. Vacuum pipe

*2. Exhaust manifold

REMOVAL AND INSTALLATION

<Turbo: PAJERO 2001MODEL>



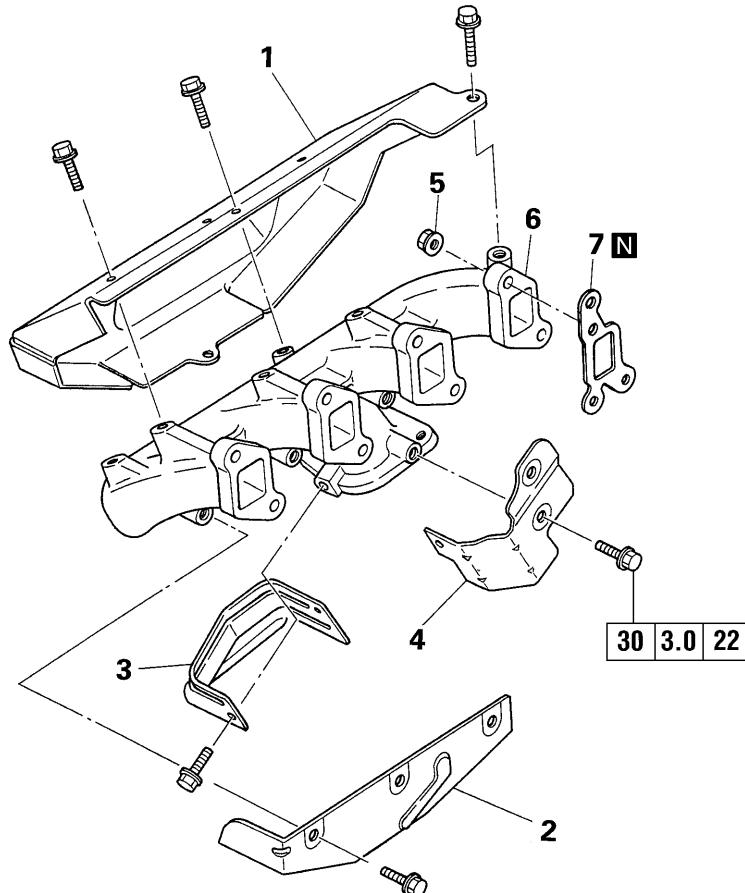
Removal steps

1. Clamp	12. Gasket
2. Air inlet pipe	13. Relief valve
3. Clamp	14. Intake manifold
4. Air inlet hose	15. Gasket
5. Vacuum hose <with EGR>	*1. Vacuum pipe
6. Vacuum pipe <with EGR>	*2. Exhaust manifold
7. EGR pipe <with EGR>	*3. Rocker cover
8. Gasket <with EGR>	*4. Cylinder head
9. Gasket <with EGR>	*5. Water outlet pipe
10. EGR valve <with EGR>	
11. Cover <without EGR>	

NOTES

12. EXHAUST MANIFOLD

REMOVAL AND INSTALLATION <NON-TURBO FOR PAJERO>

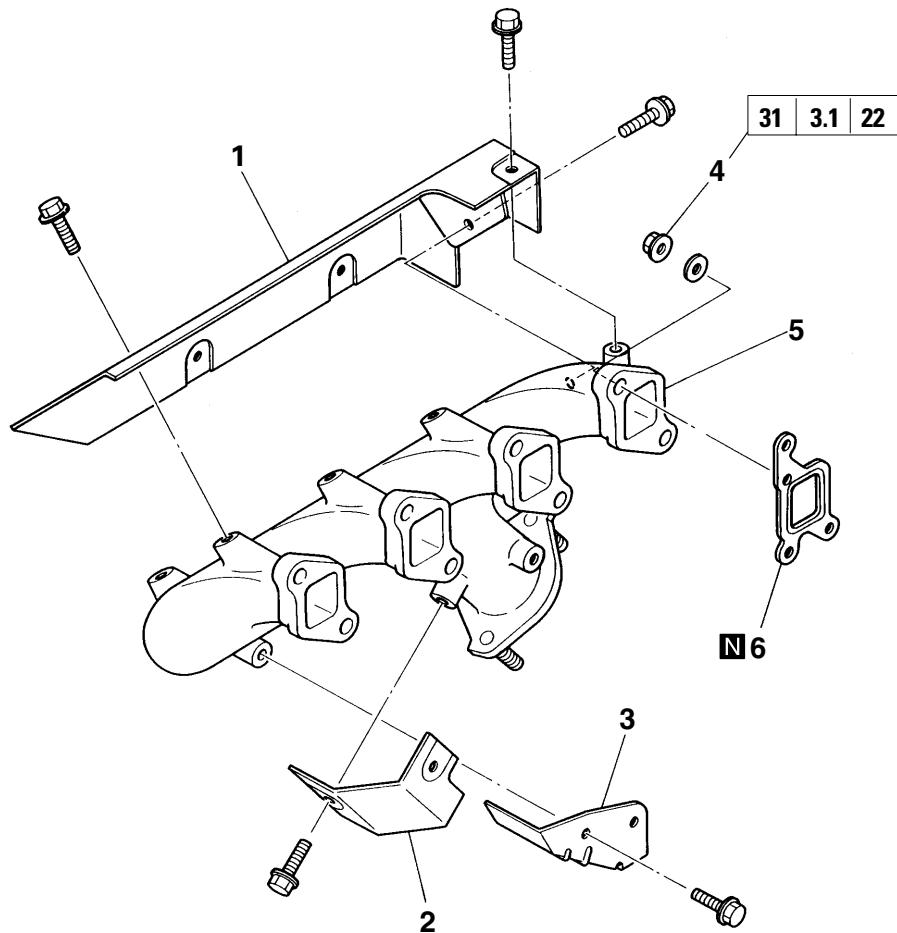


Removal steps

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

04323

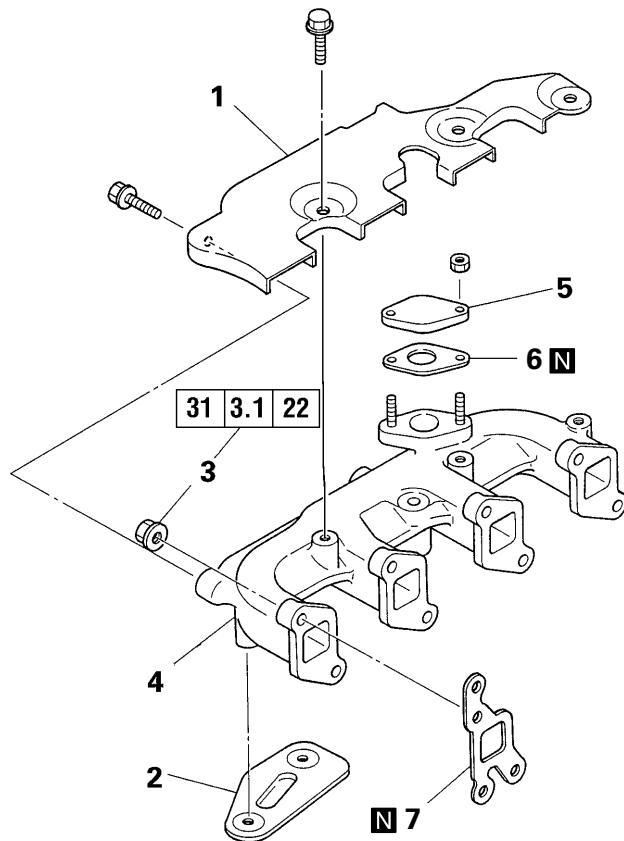
REMOVAL AND INSTALLATION <NON-TURBO FOR L200>

**Removal steps**

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

13349

REMOVAL AND INSTALLATION <FOR PAJERO TURBO>

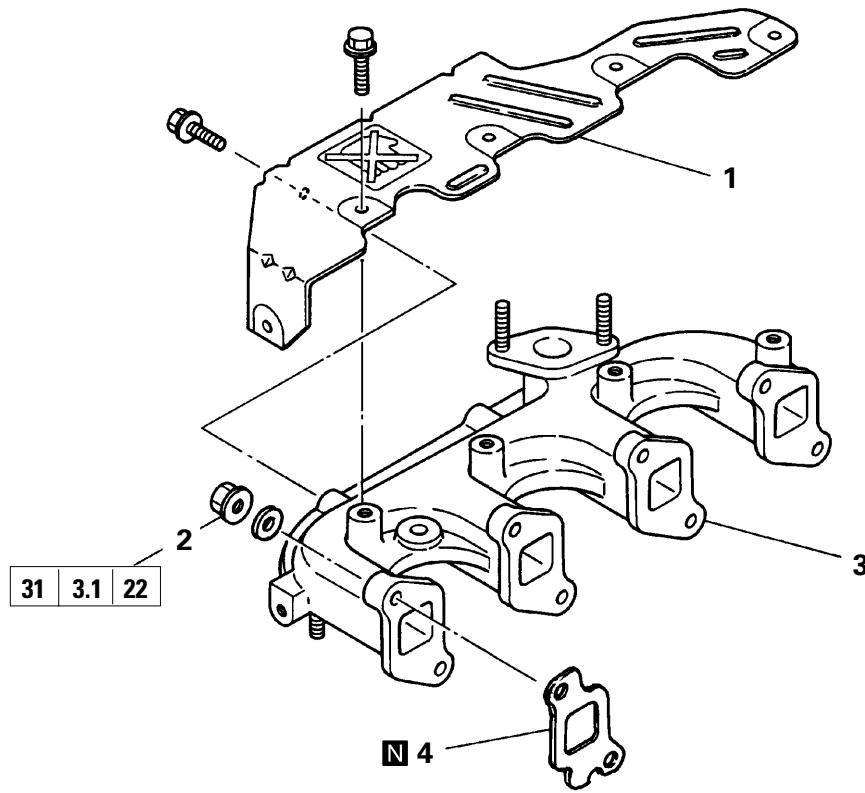


Removal steps

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

04324

REMOVAL AND INSTALLATION <FOR CHALLENGER, L200 TURBO>

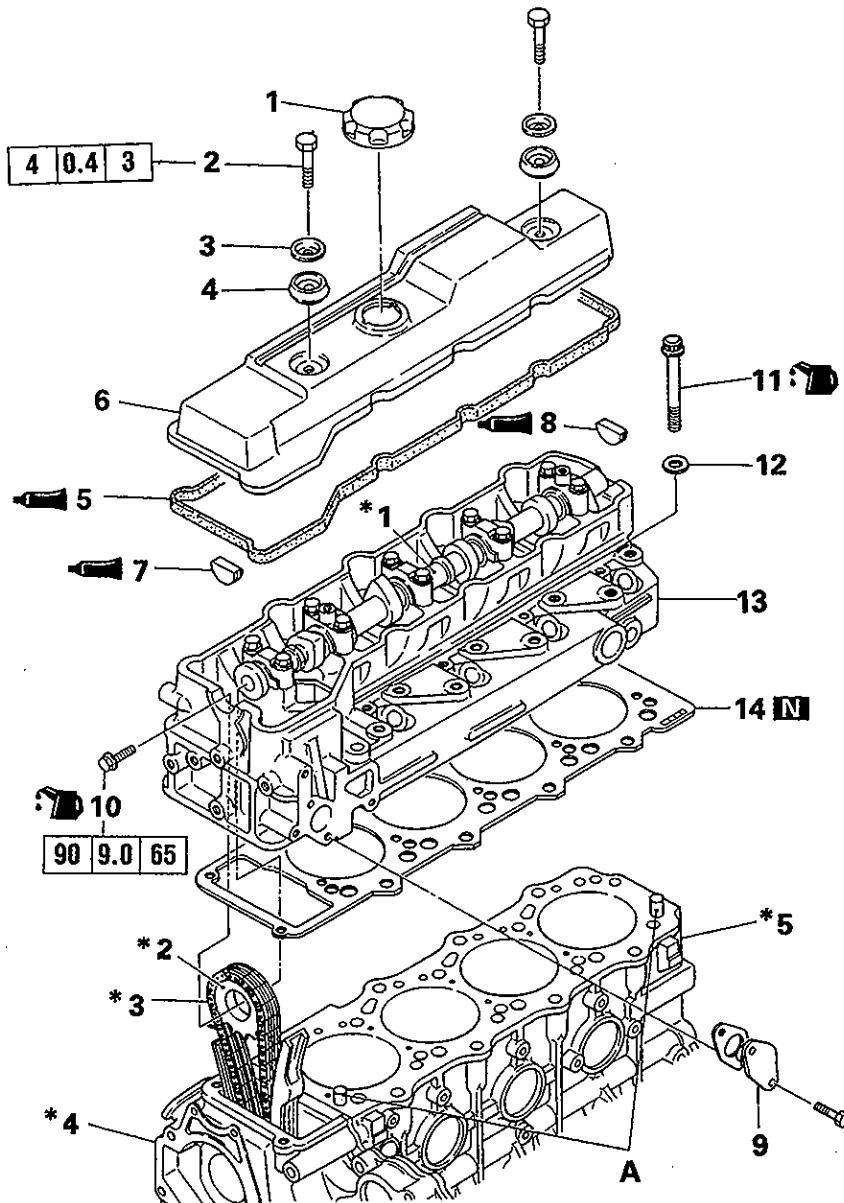
**Removal steps**

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
- 5. Rocker cover gasket
- 6. Rocker cover
- 7. Front packing
- 8. Rear packing
- 9. Tensioner
- 10. Bolt

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

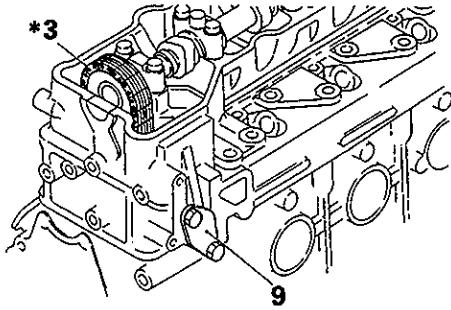
*5: Crankcase assembly (See page 11A-28-1.)

A: Dowel pin

REMOVAL SERVICE POINTS

①A 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.



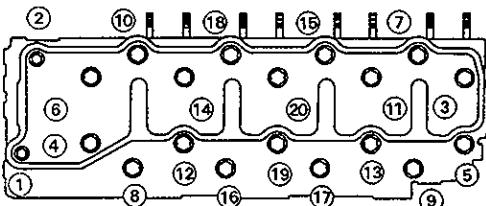
03762

(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.



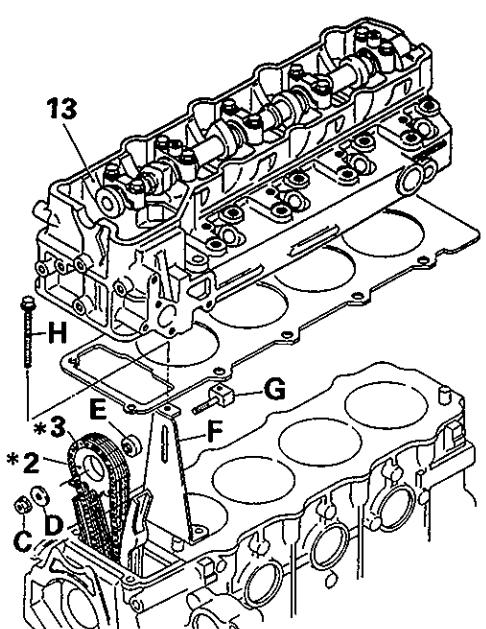
03767

(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

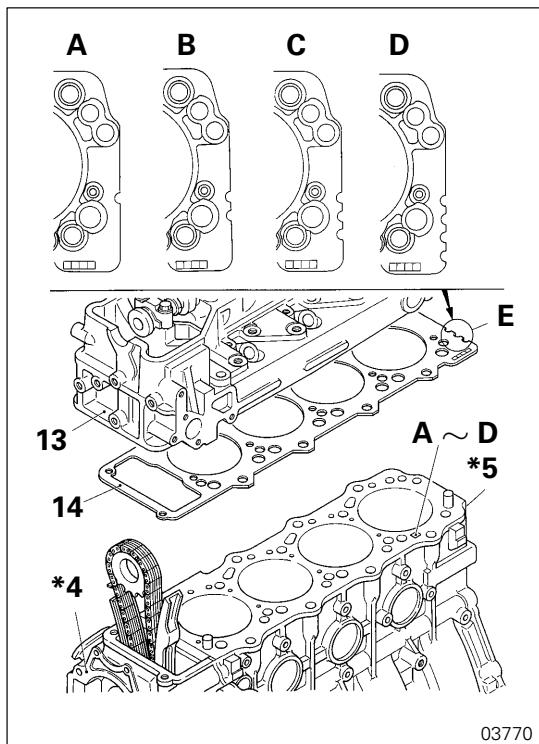


03768

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

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.

With turbocharger

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

Without turbocharger

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

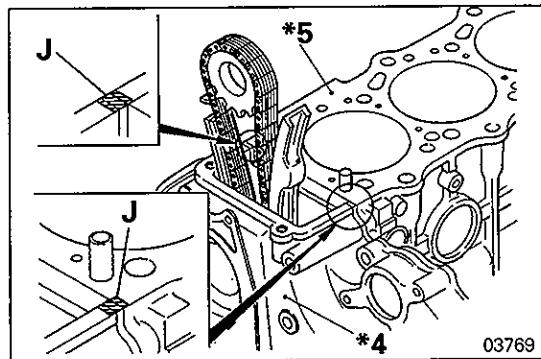
When only the gasket is to be replaced, check the identification mark stamped on the top of the crankcase assembly ***5** and choose the one with the same classification mark.

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**.
- (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.

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.

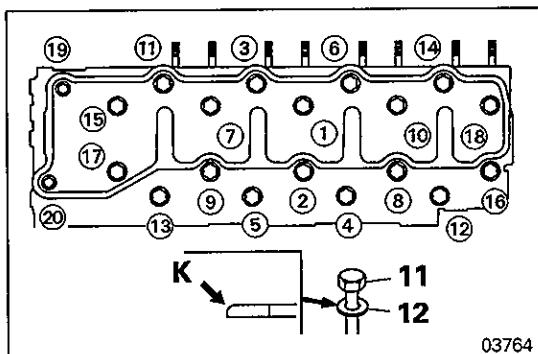
- (5) Tighten the cylinder head bolts **11**, M12 bolts of ① through ⑯ and M8 bolts of ⑯ and ⑰, in the sequence of the following steps:

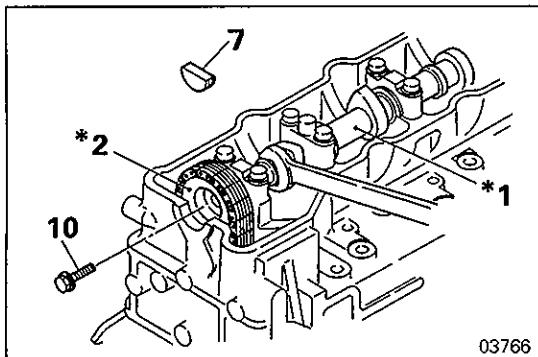
Tightening bolts ① – ⑯

- (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°).

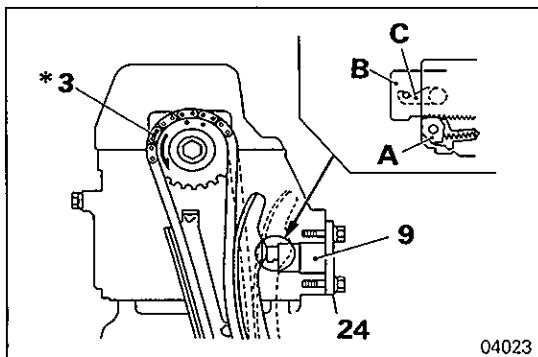
Tightening bolts ⑯ and ⑰

After the tightening of the bolts ① through ⑯ is finished, tighten the bolts ⑯ and ⑰ 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.

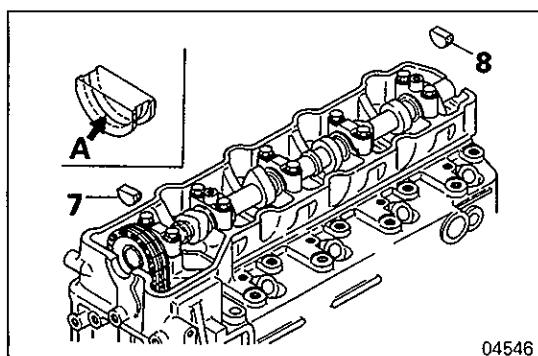


◆C◆ TENSIONER INSTALLATION

- (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.

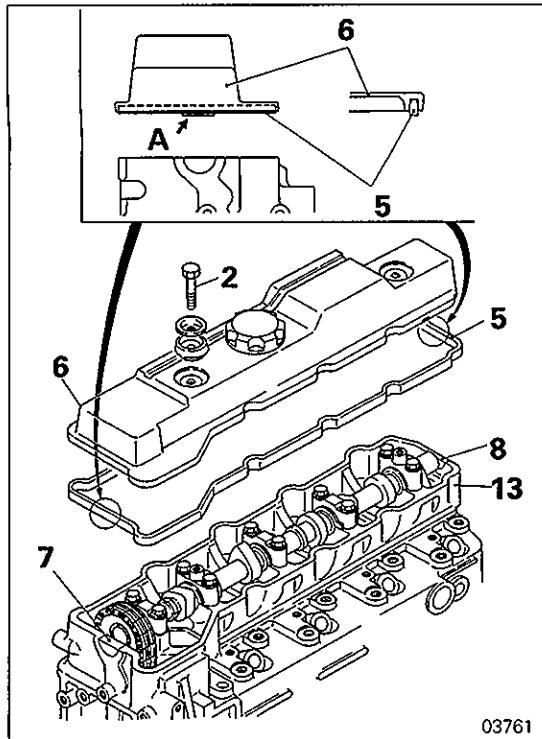


◆D◆ FRONT PACKING/REAR PACKING INSTALLATION

- (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 ± 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.



► E4 ROCKER COVER GASKET

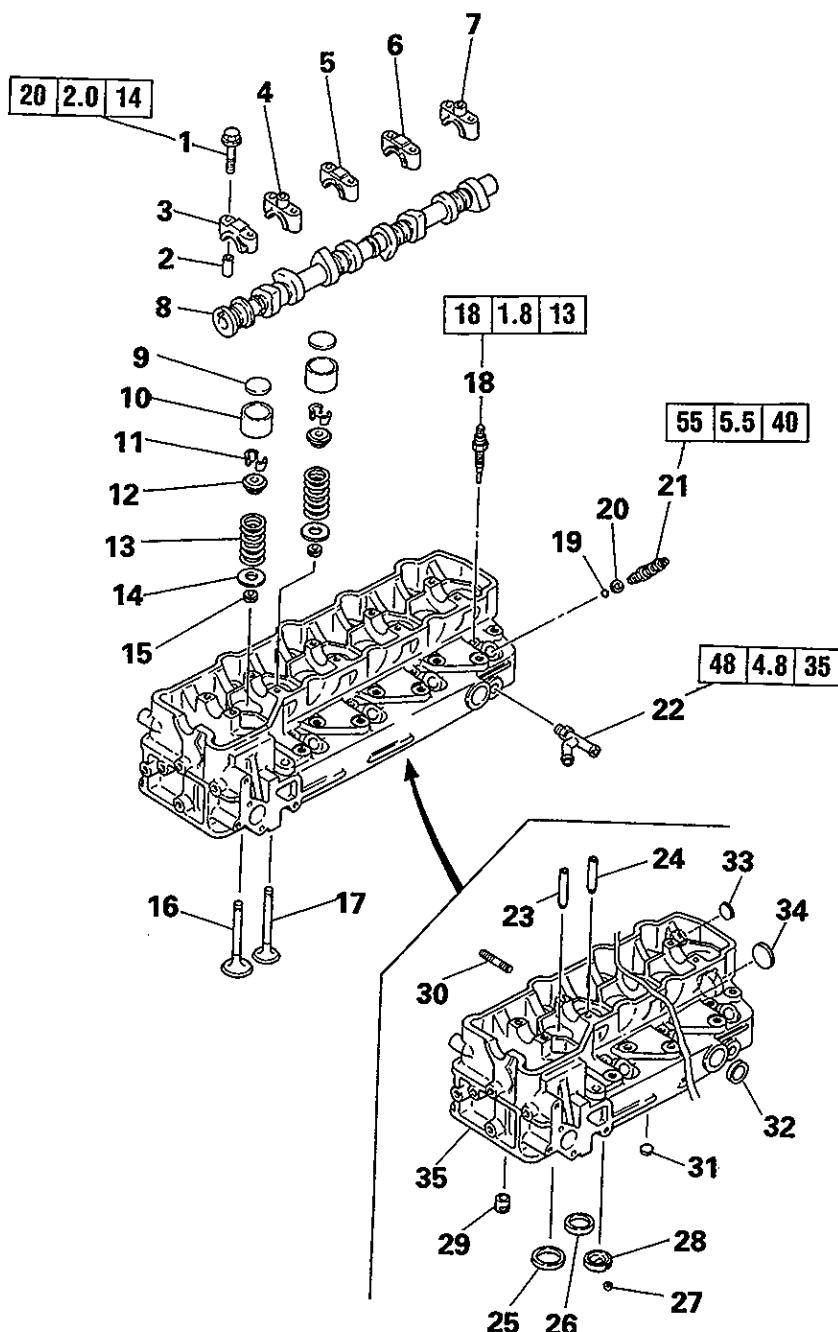
- (1) Install the rocker cover gasket **5** in the groove of the rocker cover **6** in the direction shown in the illustration.
- (2) Apply sealant to the rocker cover gasket **5** at the position **A** shown in the illustration. The sealant must be so applied that it can seal the front packing **7** 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 dose 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



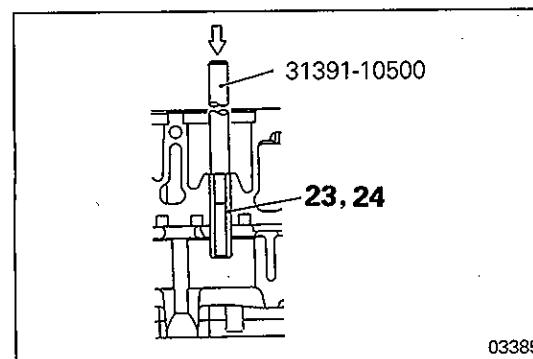
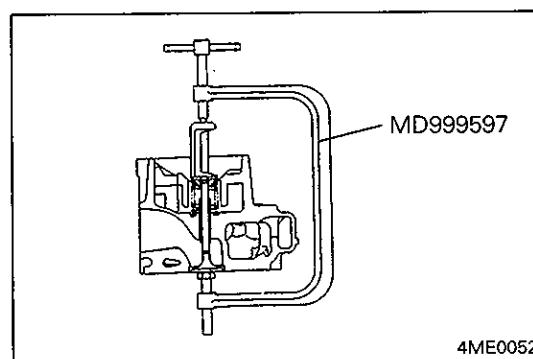
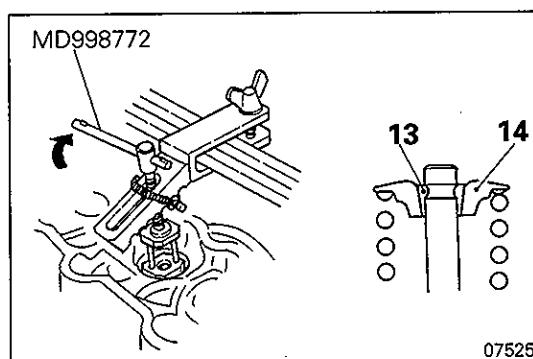
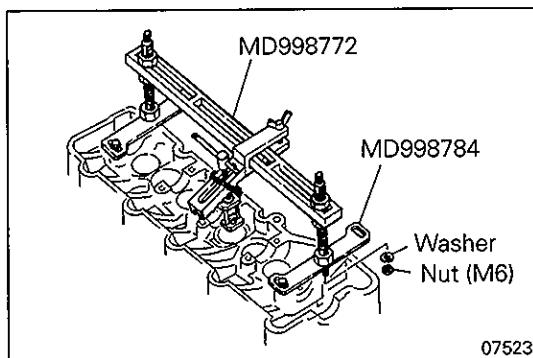
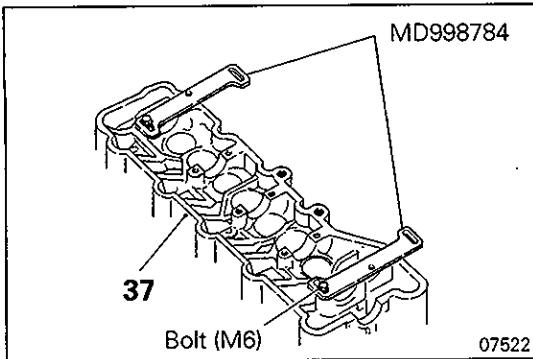
Lubricate all internal parts with engine oil during reassembly.

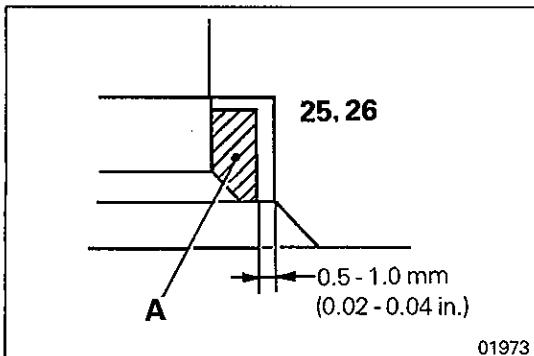
Removal steps

1. Bolt
2. Knock bush
3. No.1 camshaft cap
4. No.2 camshaft cap
5. No.3 camshaft cap
6. No.4 camshaft cap
7. No.5 camshaft cap
8. Camshaft
9. Lifter shim
10. Valve lifter
11. Valve cotter
12. Upper retainer
13. Valve spring
14. Lower retainer
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.)
22. Water joint
23. Inlet valve guide
24. Exhaust valve guide
25. Inlet valve seat
26. Exhaust valve seat
27. Tablet
28. Combustion jet
29. Water director
30. Stud
31. Sealing cap
32. Sealing cap
33. Sealing cap
34. Sealing cap
35. Cylinder head

REMOVAL SERVICE POINTS**Ⓐ A Ⓛ VALVE COTTER REMOVAL**

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

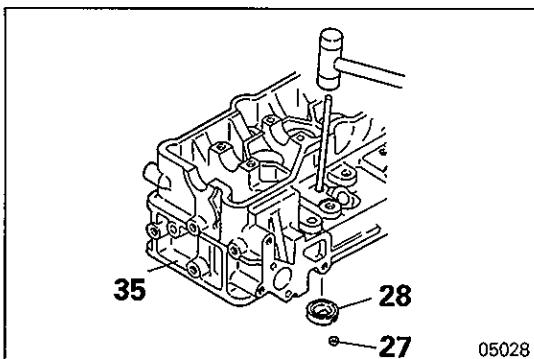
**Ⓑ B Ⓛ VALVE GUIDE REMOVAL**



⌚C⌚ VALVE SEAT REMOVAL

- 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

- Warm the cylinder head **35** to increase the clearance between it and the combustion jet **28**.
- 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

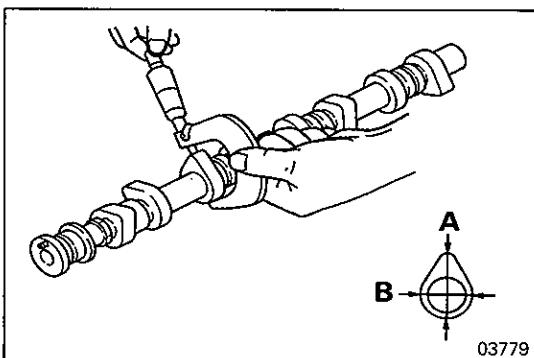
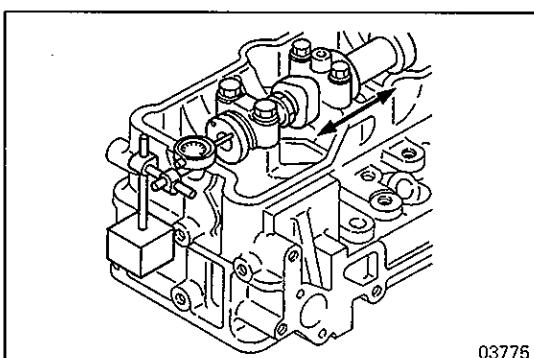
- Being made of ceramic, the combustion jet **28** is susceptible to a shock. Do not hit it too hard, or it may be damaged.

INSPECTION

CAMSHAFT

End Play

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

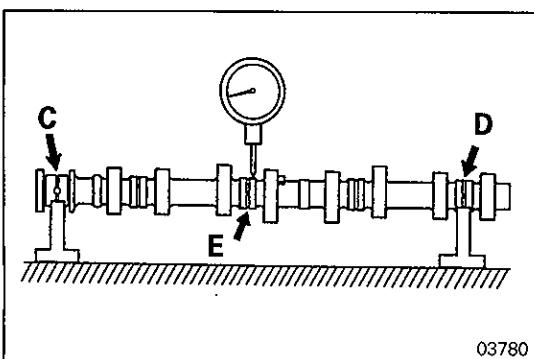


Difference between Cam Height and Base Circle Diameter

- If the specified service limit is exceeded, replace the cam shaft **8**.

A: Cam height

B: Base circle diameter



Bend

- 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

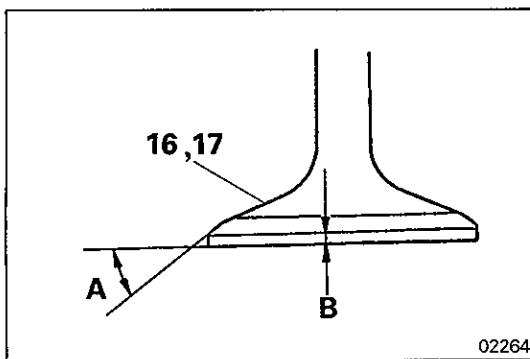
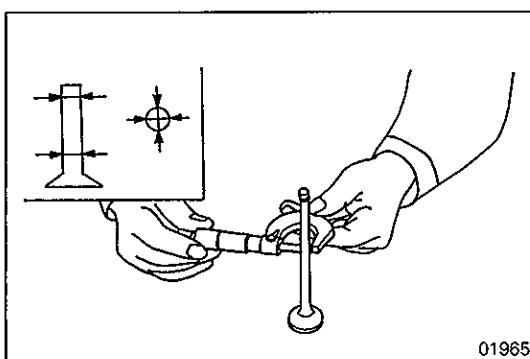
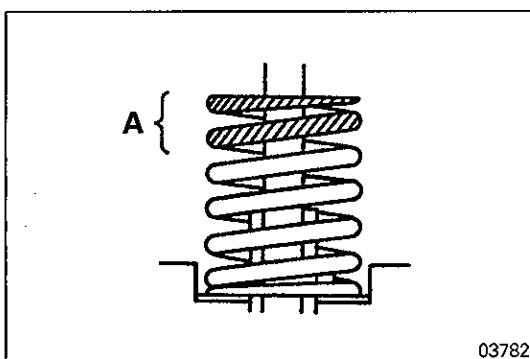
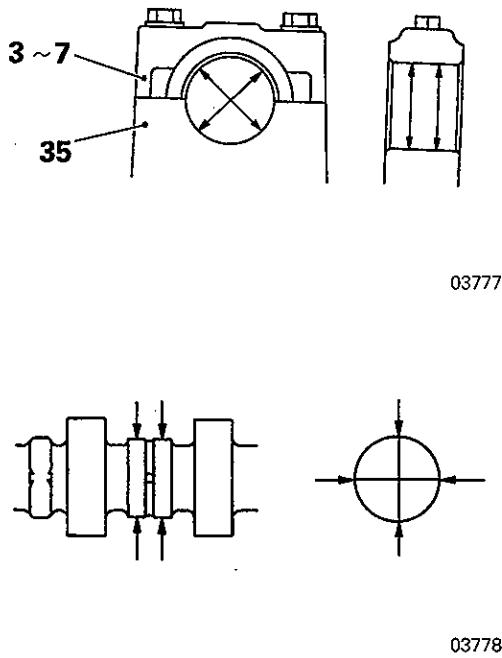
The actual shaft bend is a half of what the dial gauge reads when the camshaft **8** is given one turn.

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

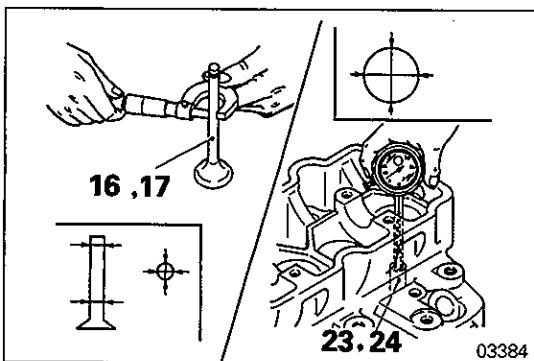
If the valve **16, 17** is new, be sure to lap it and the valve seat **25, 26** for proper seating. (See page 11A-14-5.)

Valve Seat Angle and Valve Margin

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

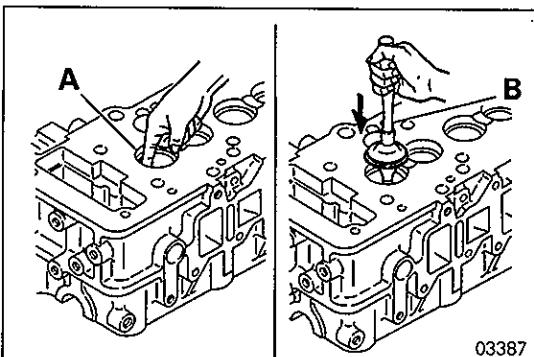
A: Valve seat angle

B: Valve margin



VALVE AND VALVE GUIDE

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



VALVE AND VALVE SEAT

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

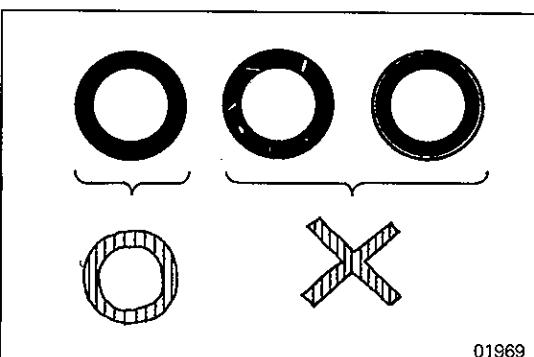
B: Valve Lapper

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.)

- 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

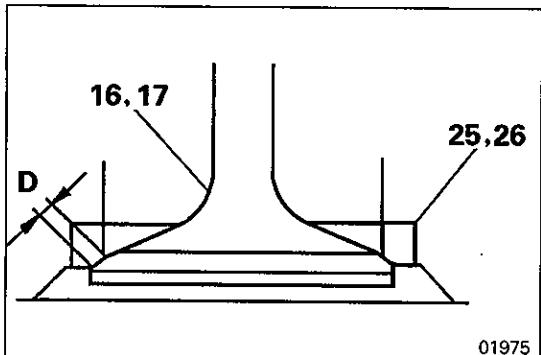
Valve Seat Width

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

D: Valve seat width

NOTE

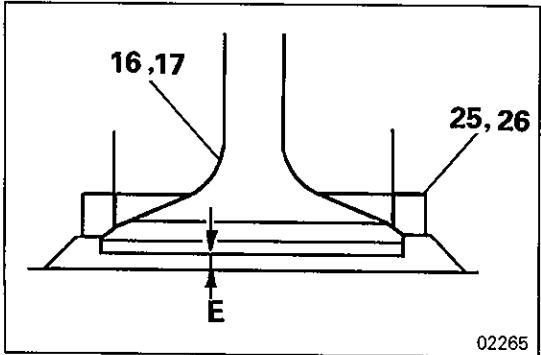
When the valve seat **25, 26** has been corrected or replaced, lap it and the valve **16, 17** for proper seating. (See page 11A-14-6.)

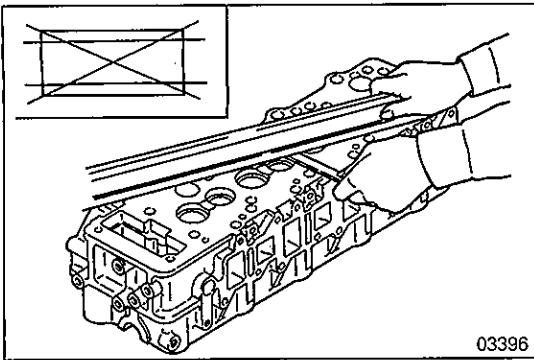


Valve Sinkage from Cylinder Head Bottom

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

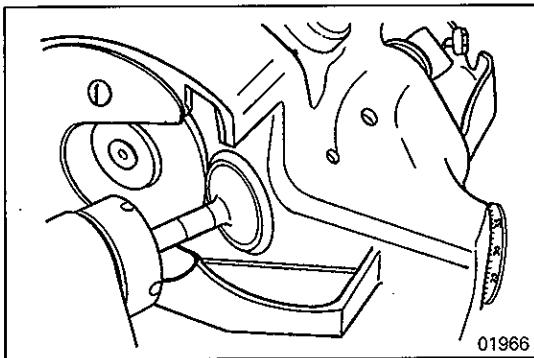
E: Valve sinkage





CYLINDER HEAD ASSEMBLY

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

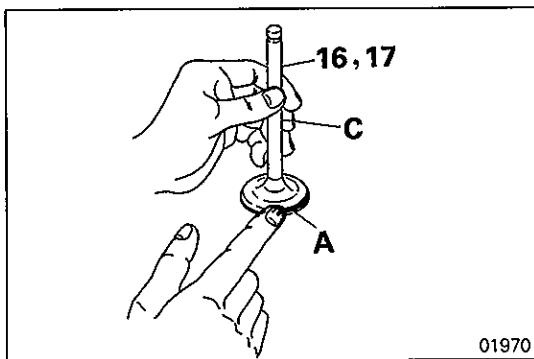


CORRECTION

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

- Lap the valve and valve seat as follows:

- 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.

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

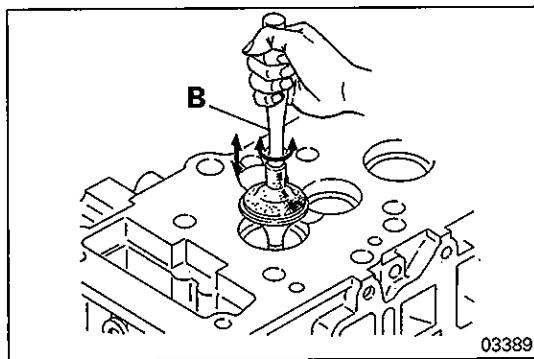
B: Valve Lapper

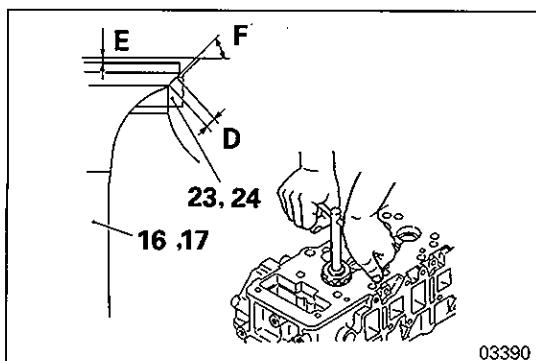
- Wash off the lapping compound in kerosene.

- Apply a thin coat of engine oil to the seating surface of the valve seat **25, 26** and oil lap.

- Check the seat contact between the valve **16, 17** and valve seat **25, 26**. (See page 11A-14-5.)

- Replace the valve seat **25, 26** if necessary.





VALVE SEAT

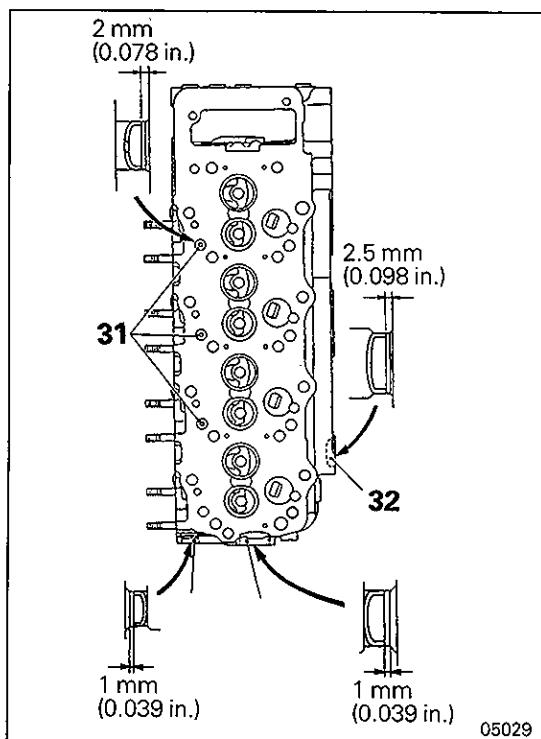
- (1) Grind the valve seat **25, 26** using a valve seat cutter or a valve seat grinder.
- (2) Polish the ground surface lightly using a #400 sandpaper held between the cutter and valve seat.
- (3) Correct the seat width of the valve **16, 17** to the specified value using a 15° or 75° cutter.

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.)



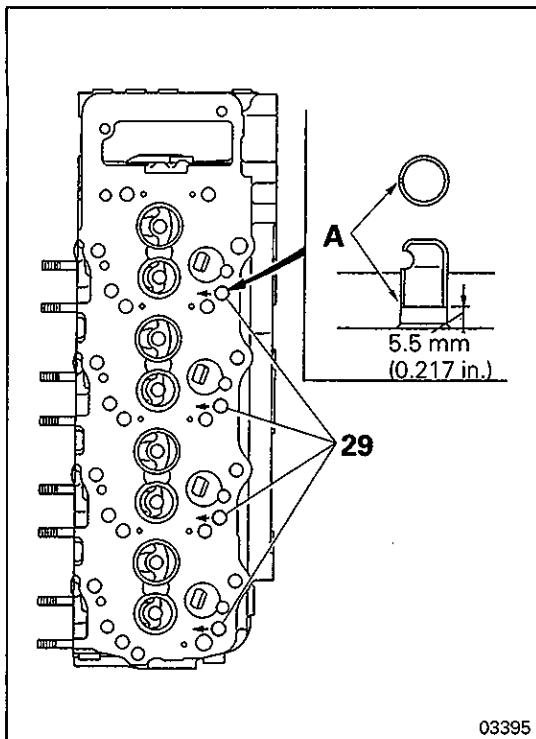
INSTALLATION SERVICE POINT

► 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.

►B4 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.



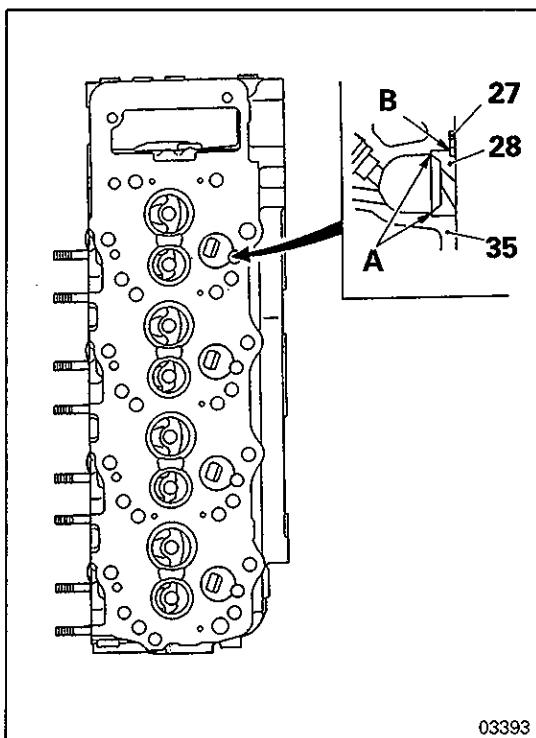
►C4 TABLET/COMBUSTION JET INSTALLATION

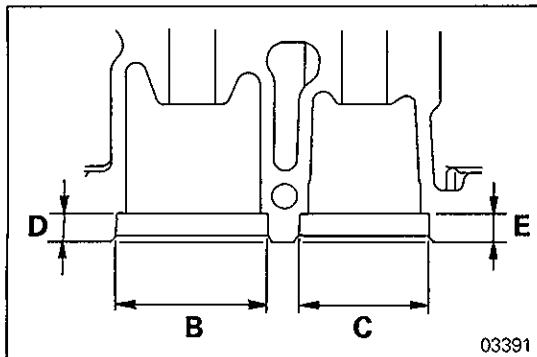
(1) Install the combustion jets **28** in such a way that the surface **A** may be brought into close contact with the combustion chamber of the cylinder head **35**.

(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

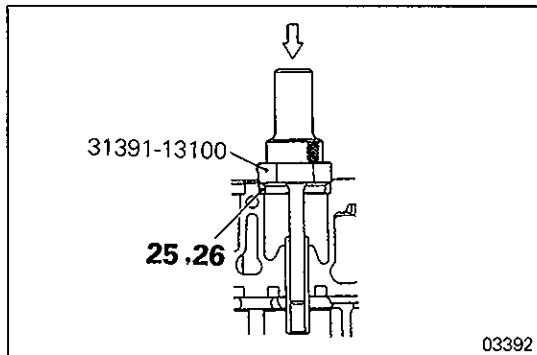
Inlet (B): $\phi 43 +0.025$ mm (1.69 $+0.00098$ in.)

Exhaust (C): $\phi 37 +0.025$ mm (1.46 $+0.00098$ in.)

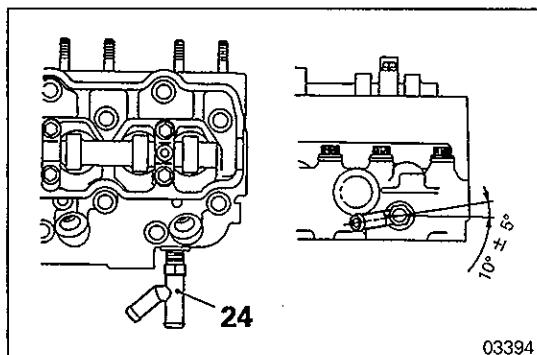
(2) Correct the dimensions **B**, **C**, **D** and **E** of valve seat mounting holes in the cylinder head to those matching the outside diameters and thicknesses of the selected oversize valve seats.

Unit: mm (in.)

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

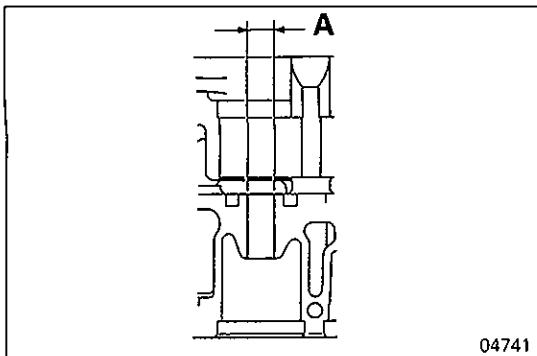


(3) Immerse the valve seats **25** and **26** in liquid nitrogen and cool enough.
 (4) Using the special tool, install the valve seats **25** and **26** in the mounting holes till they bottom the cylinder head **35** properly.
 (5) After the valve seats **25** and **26** are installed, lap them and check 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.

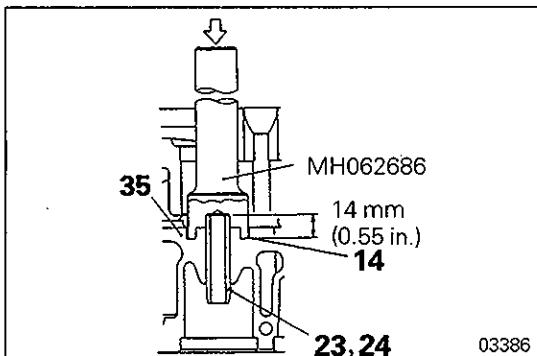
Standard value

Bore diameter (A): $13 + \frac{0.018}{0}$ mm (0.512 + 0.0007 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)
A: Valve guide mounting hole diameter in cylinder head	$\phi 13.05 + 0.018$ ($\phi 0.5138$) 0 (0)	$\phi 13.25 + 0.018$ ($\phi 0.5217$) 0 (0)	$\phi 13.50 + 0.018$ ($\phi 0.5315$) 0 (0)

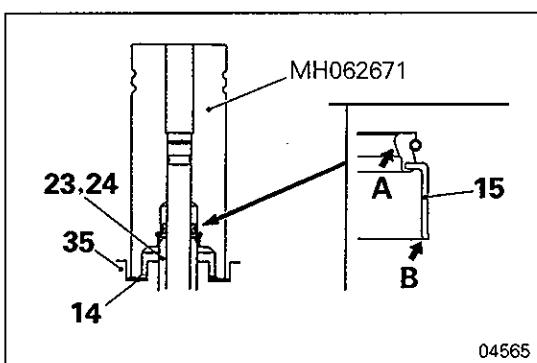


(3) After installing the lower retainers **14** to the cylinder head **35**, drive in the valve guides **23** and **24** all the way till they certainly contact the lower retainers **14** positively.

Caution

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

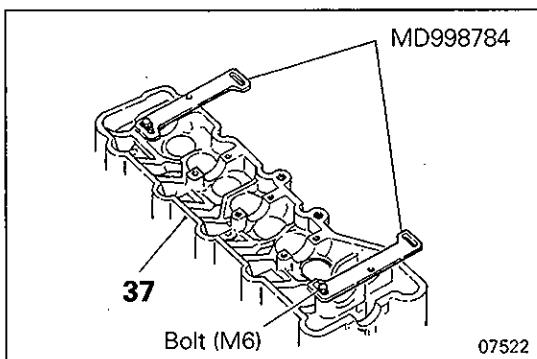
(4) The exhaust valve guide is longer than the intake valve guide. Be careful not to confuse the valve guides **23** and **24**.



►G VALVE STEM SEAL INSTALLATION

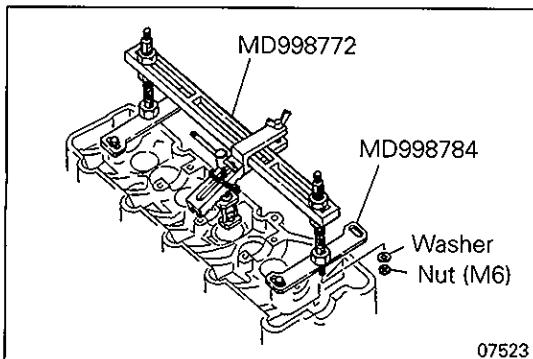
(1) Apply a thin coat of engine oil to the lip **A** of the valve stem seal **15**. Press in the valve stem seal **15** by hand as deep as its bottom **B** contacts the top surface of the valve guide **23, 24**.

(2) Slowly press the valve stem seal **15** vertically till the special tool contacts the lower retainer **14** installed in the cylinder head **35**.

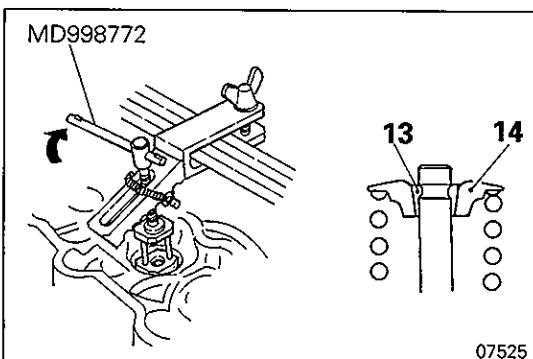


►H VALVE COTTER INSTALLATION

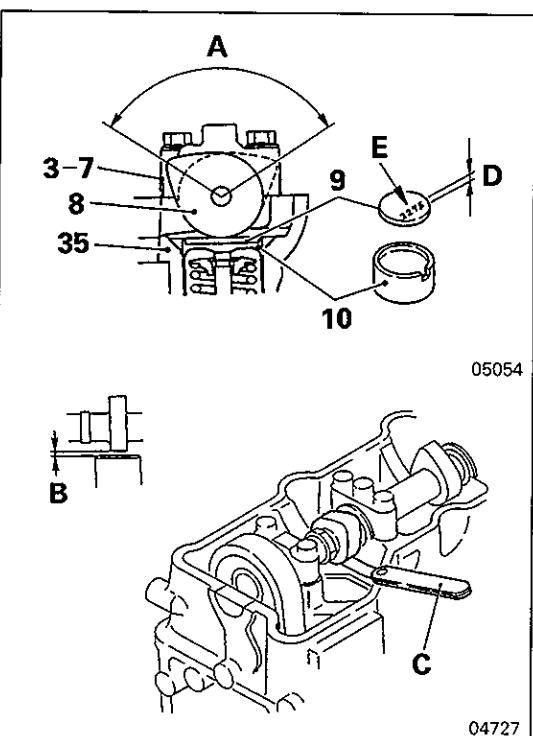
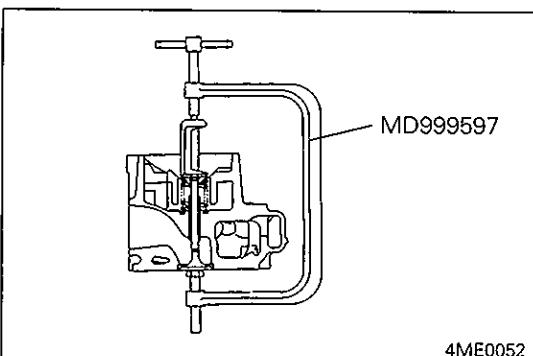
(1) Install the special tools MD998784 on the cylinder head **37** as shown in the illustration.



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



(3) Press down the upper retainer **14** and install the valve cotters **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:

- Attach an arbitrarily selected lifter shim **9** to the valve lifter **10**.
- Install the camshaft **8** in the cylinder head **35**, and attach the camshaft caps **3** through **7**.
- 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.
- 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.

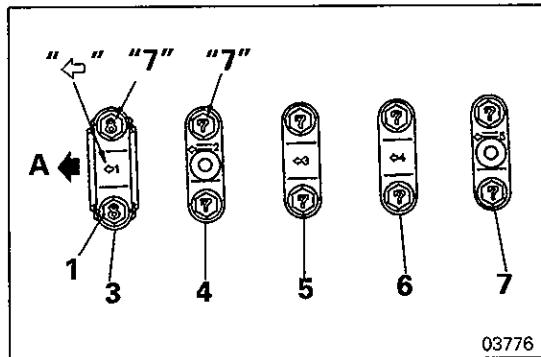
(e) Based on the readings recorded, select an appropriate lifter shim for achieving a valve clearance true to the specified standard value, and replace the lifter shim 9 with it.

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)

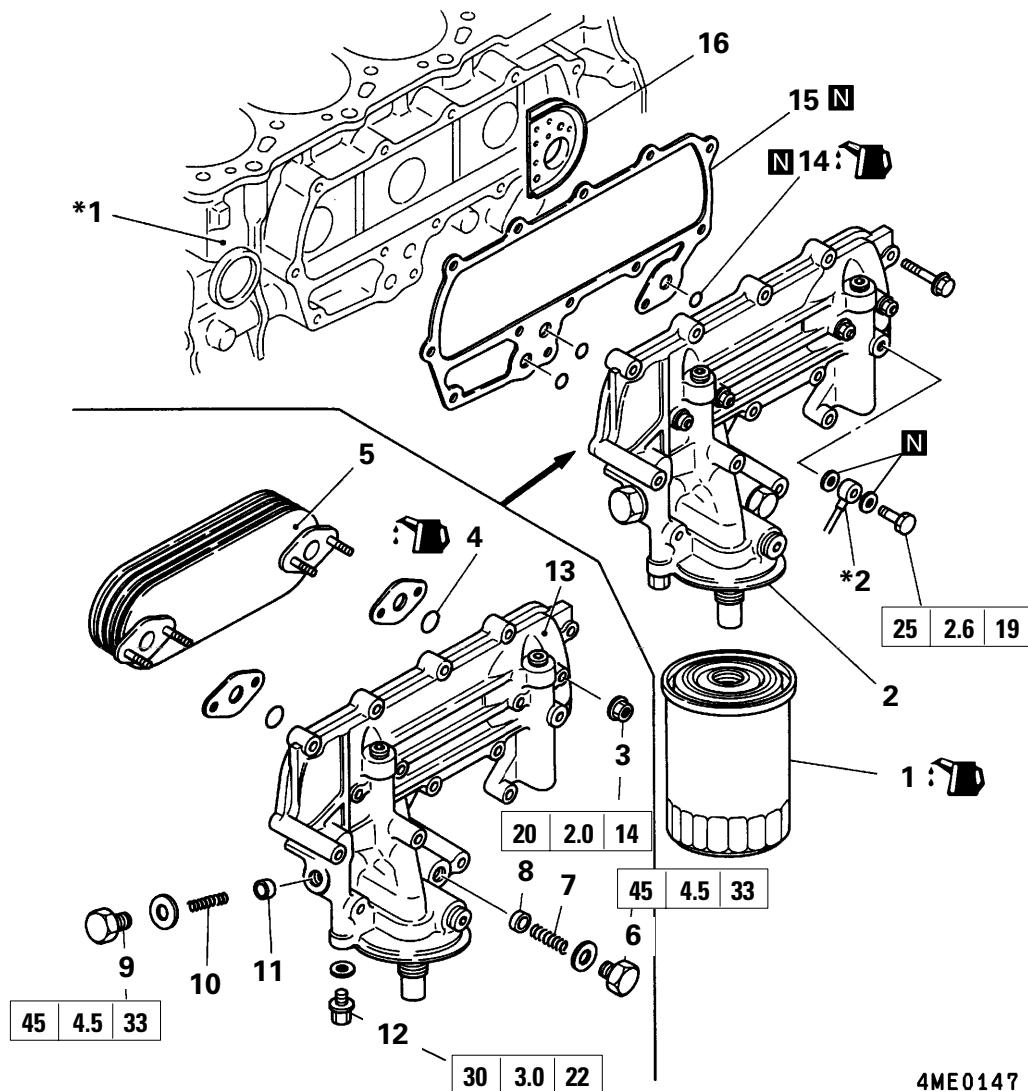


L4 CAMSHAFT CAP INSTALLATION

(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



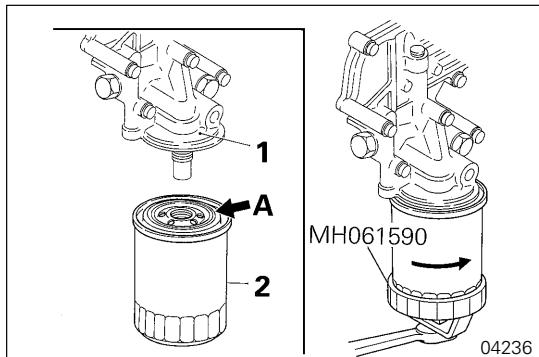
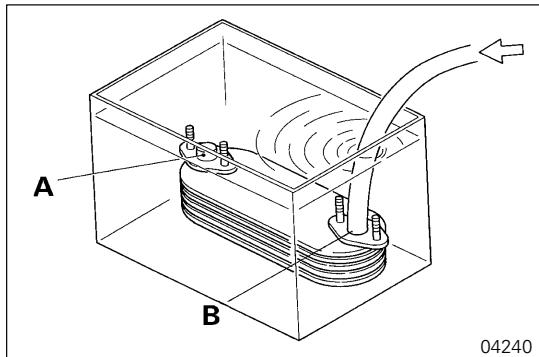
Removal steps

►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 seporate lip

*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/cm², 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.

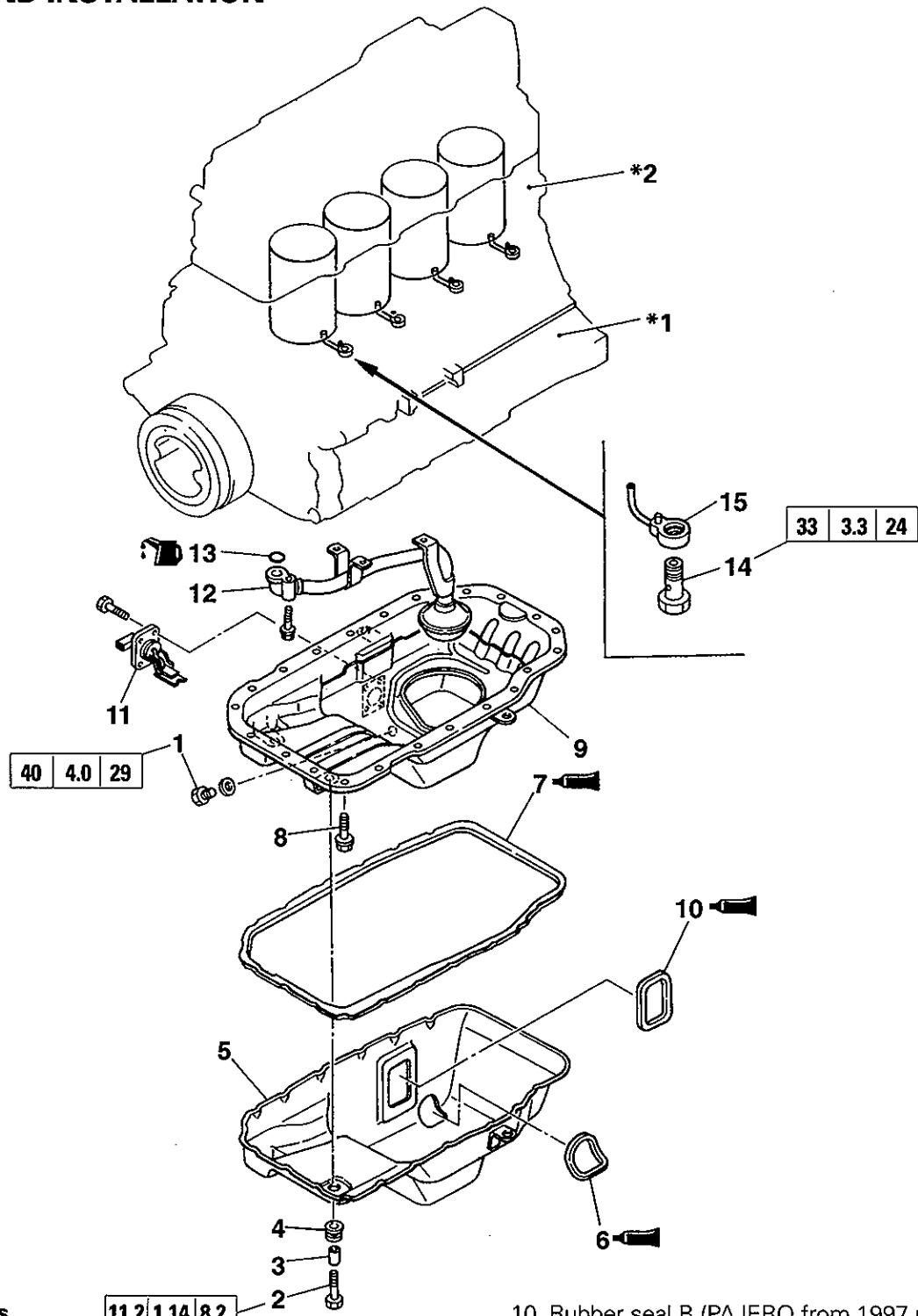
INSTALLATION SERVICE POINTS

► 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 with turbocharger) or 3/4 turn (for without turbocharger).

16. OIL PAN, OIL STRAINER AND OIL JET

REMOVAL AND INSTALLATION



Removal steps

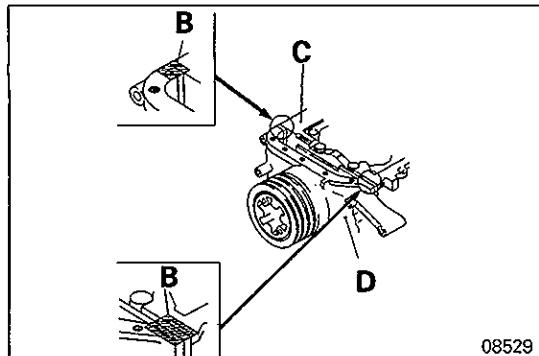
11.2 | 1.14 | 8.2

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

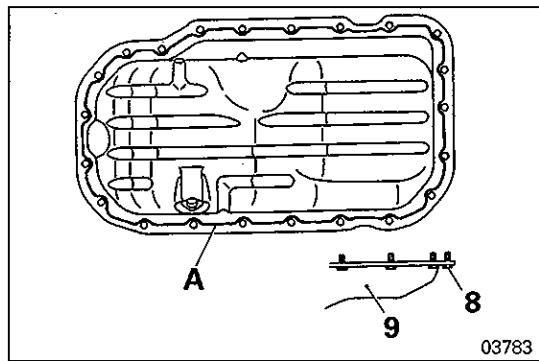
10. Rubber seal B (PAJERO from 1997 model)
11. Oil level sensor (Vehicles for Europe)
12. Oil strainer
13. O-ring
14. Check valve (See page 11A-28-1.)
15. Oil jet (See page 11A-28-1.)

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

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



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INSTALLATION SERVICE POINT

►A OIL PAN INSTALLATION

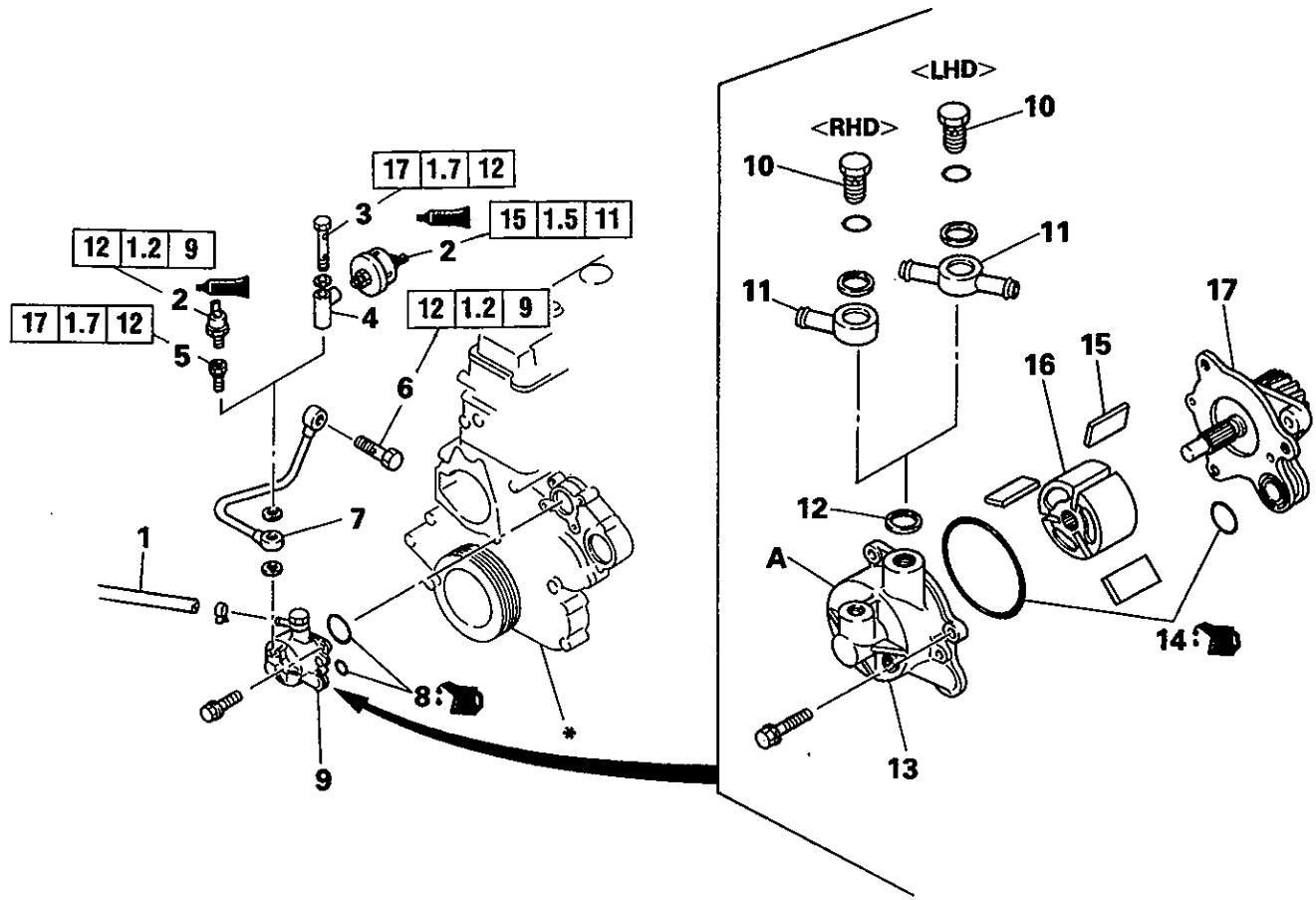
- (1) Apply sealant at the bottom **B** of the mating surface of lower crankcase **C** and timing gear case **D**.
- (2) Apply even beads of sealant **A** without skips to the circumferential mating surface of the oil pan **9** as shown. Bead diameter: $3.5 \pm 1 \text{ mm}$ ($0.14 \pm 0.04 \text{ in.}$)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

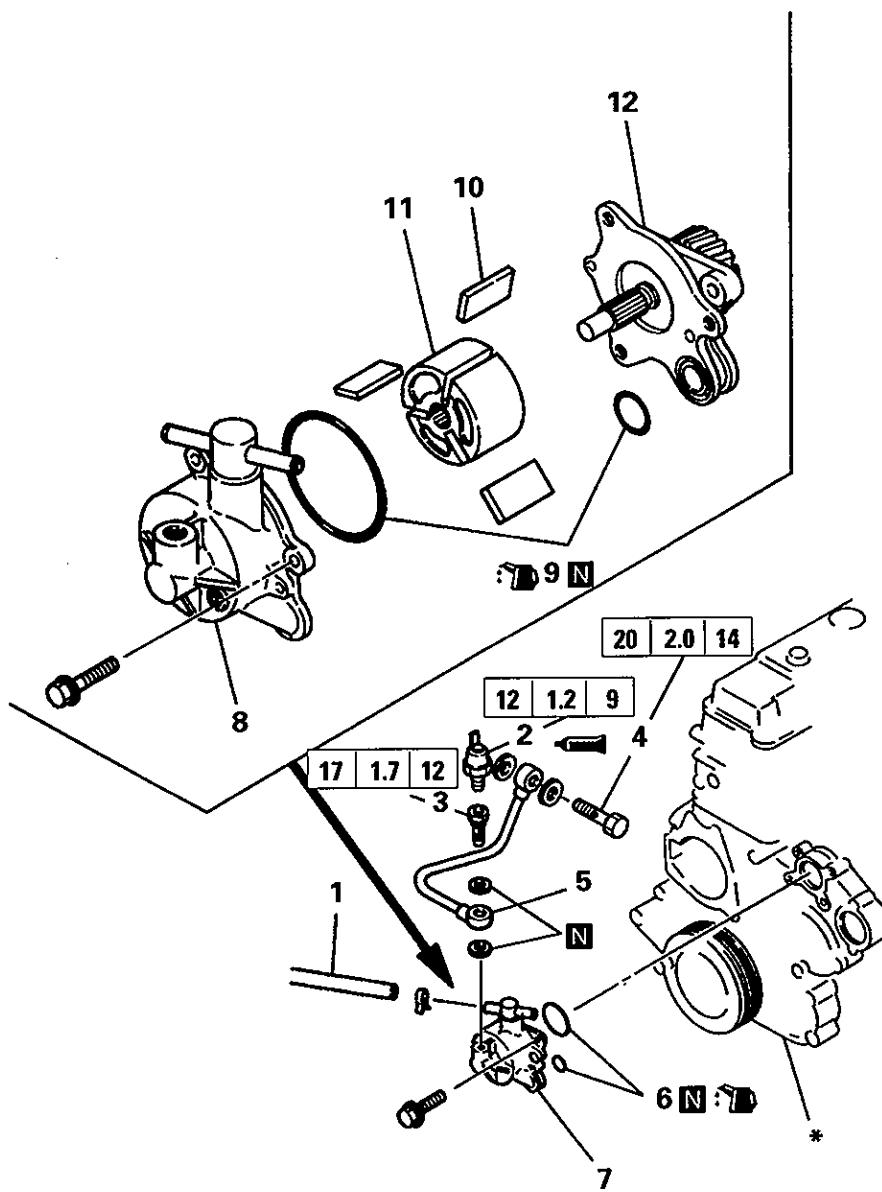
- 1. Air hose
- 2. Oil pressure switch <Except vehicles for Australia>
Oil pressure gauge unit <Vehicles for Australia>
- 3. Eyebolt <Vehicles for Australia>
- 4. Connector <Vehicles for Australia>
- 5. Connector <Except vehicles for Australia>
- 6. Eyebolt
- 7. Oil pipe
- 8. O-ring
- 9. Vacuum pump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

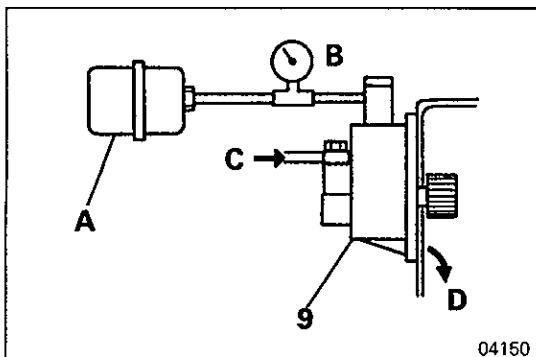
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REMOVAL AND INSTALLATION (1998– PAJERO for Europe)



Removal steps

1. Air hose	8. Cylinder assembly
2. Oil pressure switch	9. O-ring
3. Connector	10. Vane
4. Eyebolt	11. Rotor
5. Oil pipe	12. Flange assembly
6. O-ring	
7. Vacuum pump assembly	*: Timing gear case (See 11A-18-1.)



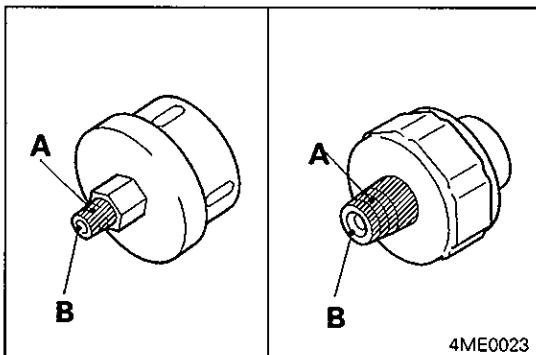
INSPECTION

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

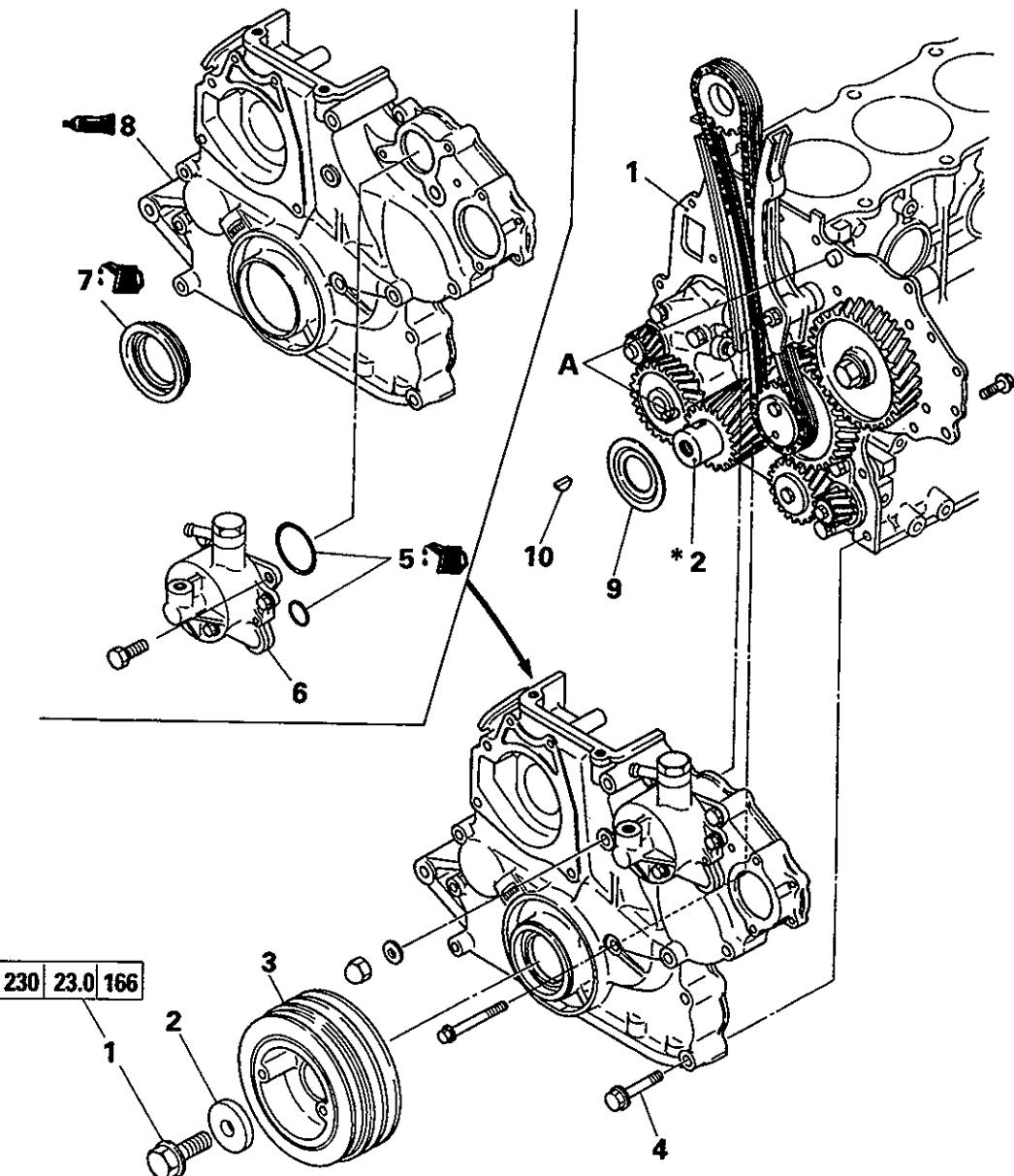
► **A** OIL PRESSURE GAUGE UNIT AND OIL PRESSURE SWITCH INSTALLATION

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

NOTES

18. TIMING GEAR CASE

REMOVAL AND INSTALLATION <FOR PAJERO>



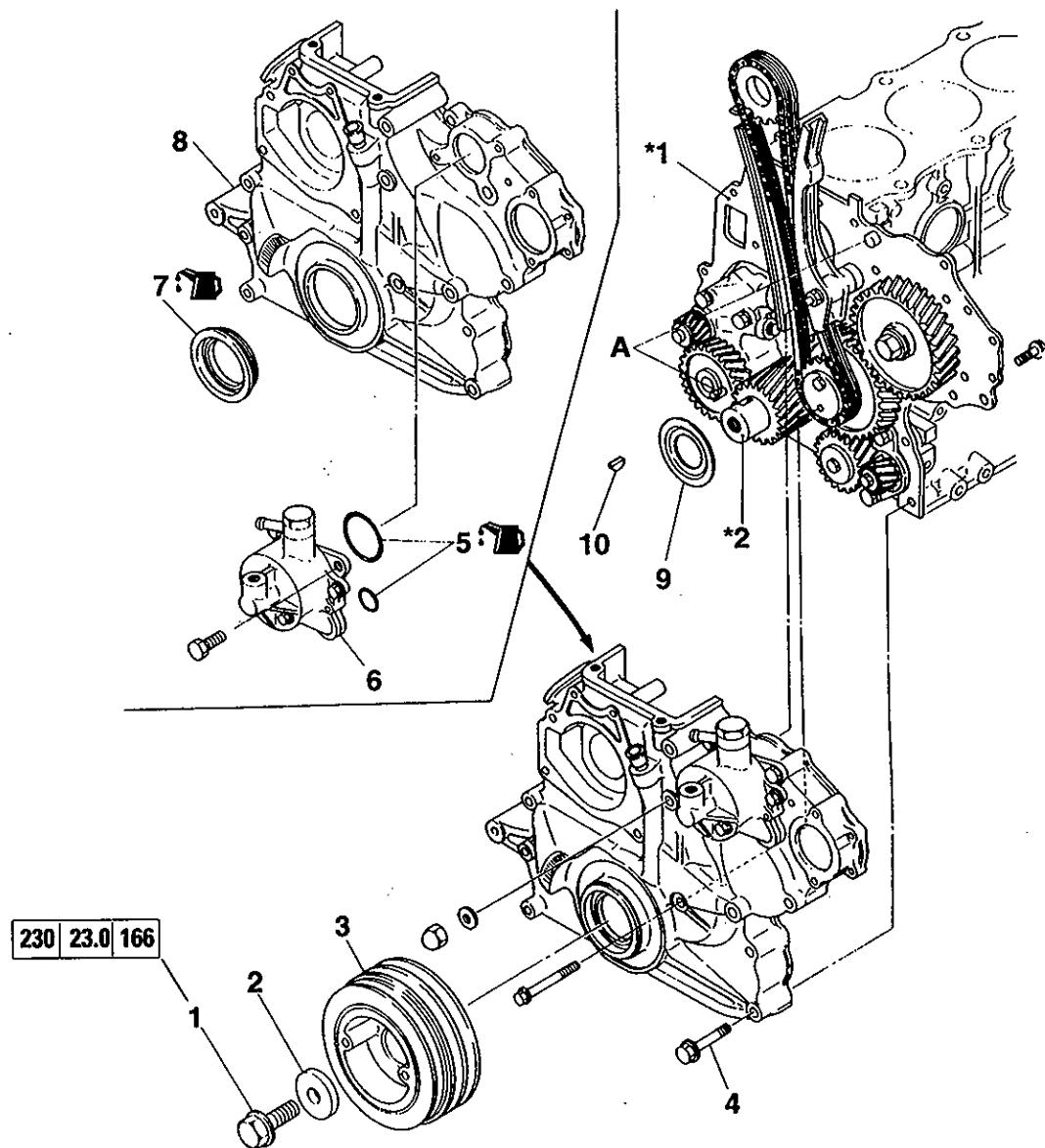
Removal steps

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

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

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

REMOVAL AND INSTALLATION <FOR L200 and CHALLENGER>



Removal steps

Ⓐ 1. Bolt
 2. Washer
 3. Crankshaft pulley
 4. Bolt
 5. O-ring
 6. Vacuum pump assembly
 (See page 11A-17-1.)
 7. Front oil seal

Ⓑ 8. Timing gear case
 9. Front oil seal slinger
 10. Key

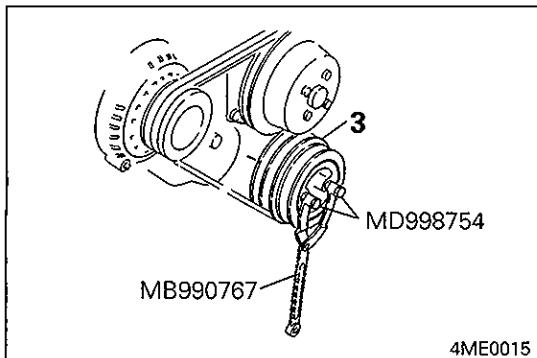
*1: Front plate (See page 11A-28-1.)

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

A: Dowel pin

NOTE

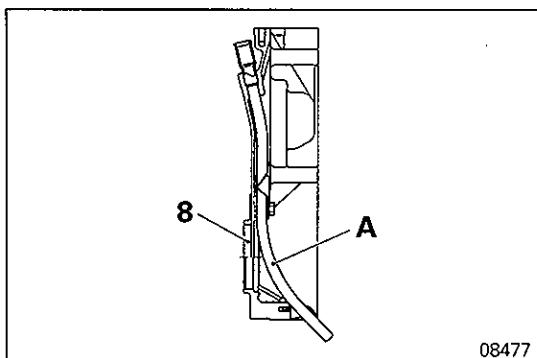
Do not remove the front oil seal unless absolutely necessary.



REMOVAL SERVICE POINTS

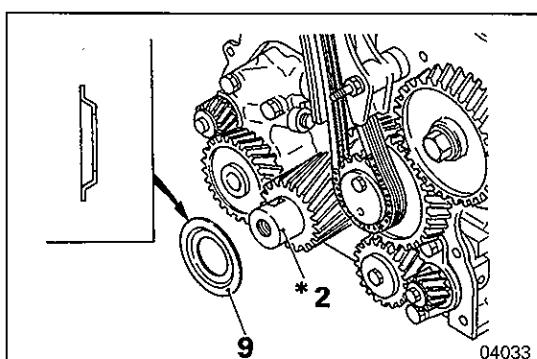
Ⓐ CRANKSHAFT CENTER BOLT REMOVAL

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



Ⓑ TIMING GEAR CASE REMOVAL <L200>

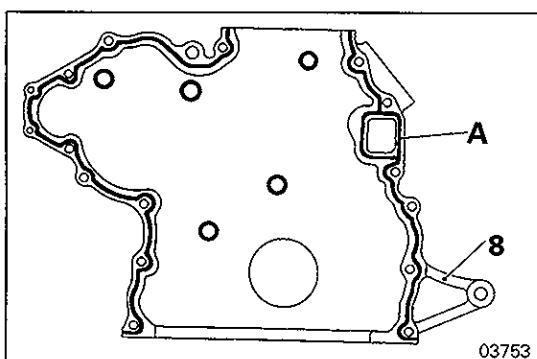
- (1) Be sure to handle the timing gear case 8 carefully as the guide pipe A protrudes from the bottom of the case.



INSTALLATION SERVICE POINTS

Ⓐ FRONT OIL SEAL SLINGER INSTALLATION

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

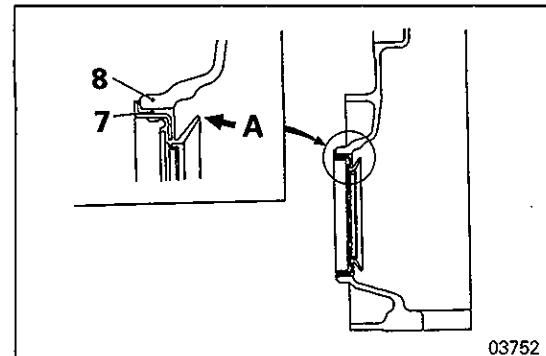


Ⓑ TIMING GEAR CASE INSTALLATION

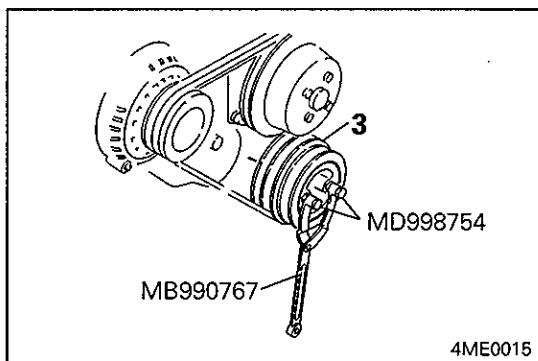
- (1) Apply an even bead of sealant A without break to the entire joint surface of the timing gear case 8 as shown. Bead diameter: 3.5 ± 1 mm (0.14 ± 0.04 in.)
- (2) Install the timing gear case 8 within 15 minutes after the application of sealant A.

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**

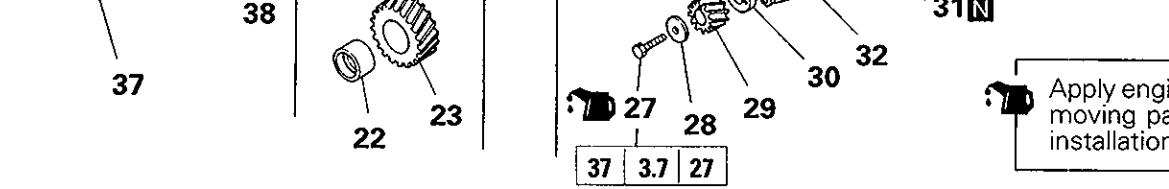
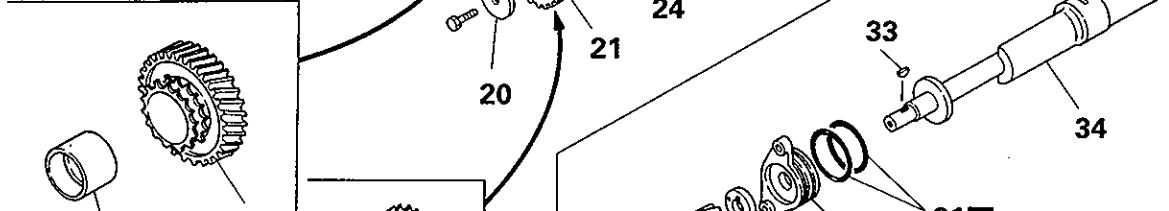
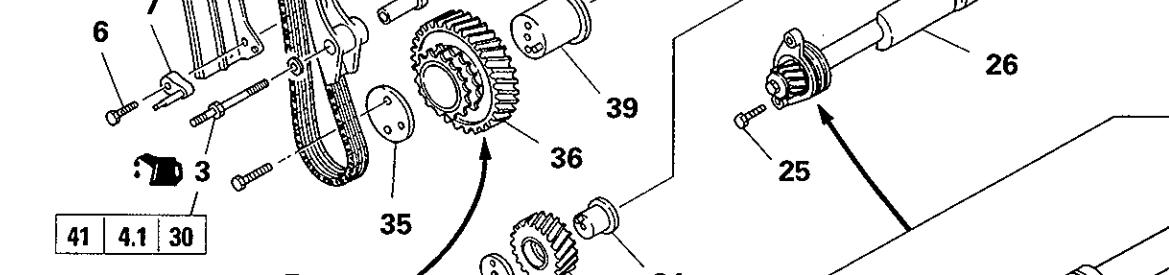
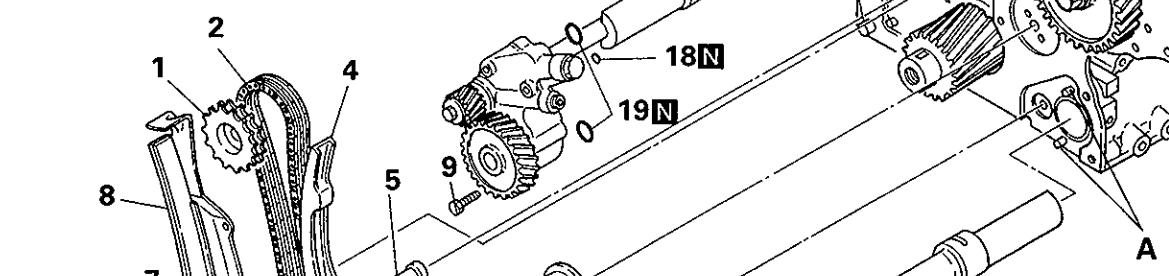
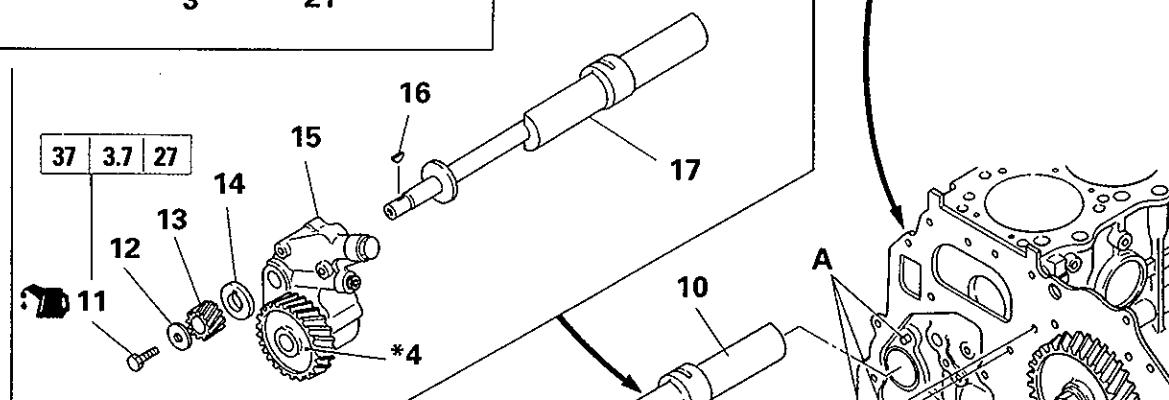
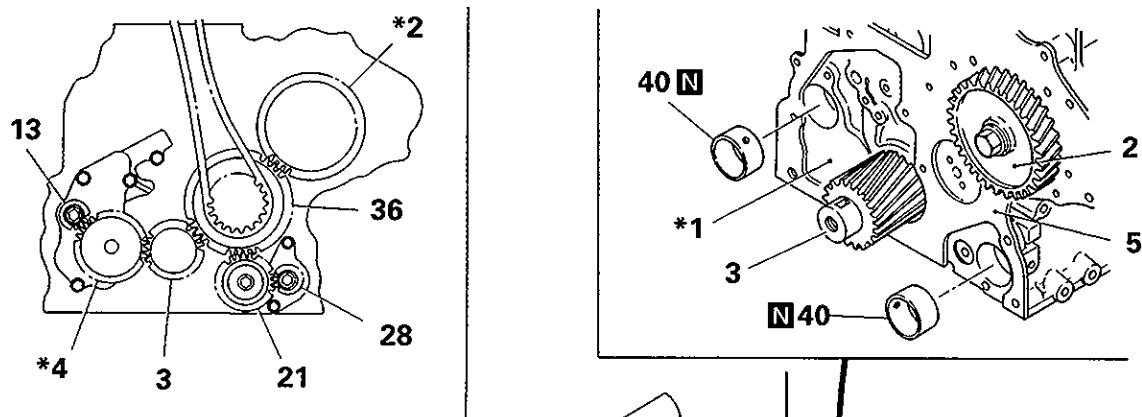
(1) Apply a thin coat of engine oil to the lip **A**, and install the front oil seal **7** to the timing gear case **8** with the lip directed as shown.

**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
2. Timing chain
3. Bolt
4. Tension lever
5. Tension lever shaft
6. Eyebolt
7. Oil jet assembly (See page 11A-16-1.)
8. Guide plate
9. Bolt
10. Balance shaft assembly RH
11. Bolt
12. Washer
13. Balance shaft gear RH
14. Thrust spacer
15. Oil pump assembly
16. Key

ⒶⒶ

17. Balance shaft RH
18. O-ring
19. O-ring
20. Idler washer A
21. Idler gear assembly LH
22. Idler gear bush LH
23. Idler gear LH
24. Idler shaft A
25. Bolt
26. Balance shaft assembly LH
27. Bolt
28. Washer
29. Balance shaft gear LH
30. Thrust spacer
31. O-ring
32. Thrust plate
33. Key

ⒷⒷ

ⒸⒸ

34. Balance shaft LH
35. Idler washer
36. Idler gear and sprocket assembly
37. Idler sprocket bush
38. Idler gear and sprocket
39. Idler shaft
40. Balance shaft bush

*1: Crankcase assembly
(See page 11A-28-1.)
*2: Injection pump gear
*3: Crankshaft gear
(See page 11A-28-1.)
*4: Oil pump gear
*5: Front plate
(See page 11A-28-1.)

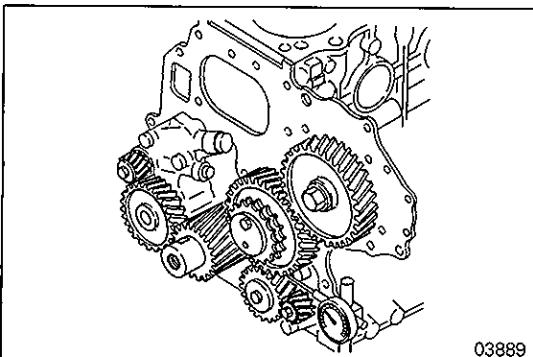
Ⓐ: Dowel pin

Installation steps

ⒶⒶ 40. Balance shaft bush
ⒷⒷ 39. Idler shaft
38. Idler gear and sprocket
ⒷⒷ 37. Idler sprocket bush
ⒸⒸ 36. Idler gear and sprocket assembly
34. Balance shaft LH
33. Key
32. Thrust plate
31. O-ring
30. Thrust spacer
29. Balance shaft gear LH
28. Washer
27. Bolt
ⒺⒺ 26. Balance shaft assembly LH
25. Bolt

24. Idler shaft A
23. Idler gear LH
ⒹⒹ 22. Idler gear bush LH
21. Idler gear assembly LH
20. Idler washer A
19. O-ring
18. O-ring
17. Balance shaft RH
16. Key
15. Oil pump assembly
14. Thrust spacer
13. Balance shaft gear RH
12. Washer
11. Bolt
ⒻⒻ 10. Balance shaft assembly RH
9. Bolt

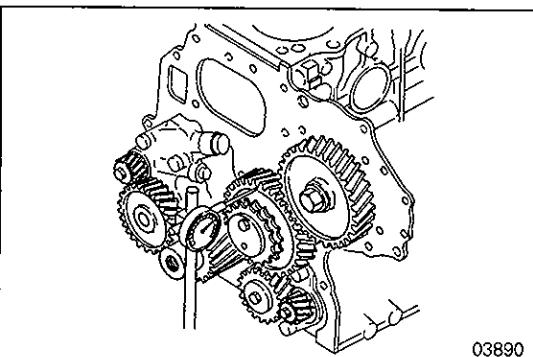
8. Guide plate
7. Oil jet assembly
6. Eyebolt
5. Tension lever shaft
4. Tension lever
3. Bolt
ⒼⒼ 2. Timing chain
1. Cam sprocket
35. Idler washer



PRE-REMOVAL INSPECTION

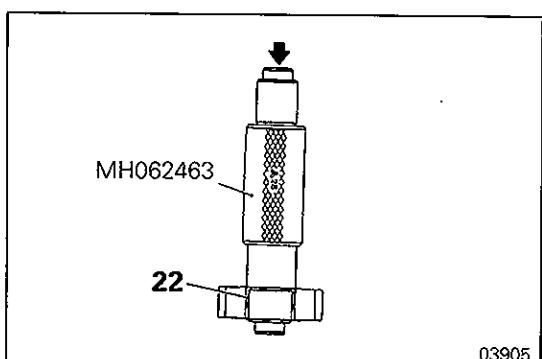
BACKLASH

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



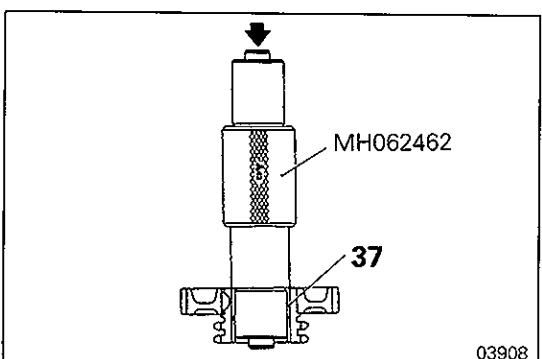
END PLAY

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

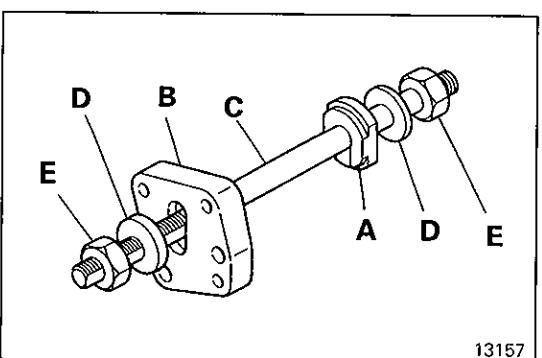


REMOVAL SERVICE POINTS

Ⓐ IDLER GEAR BUSH LH REMOVAL



Ⓑ IDLER SPROCKET BUSH REMOVAL



Ⓒ BALANCE SHAFT BUSH REMOVAL

- 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

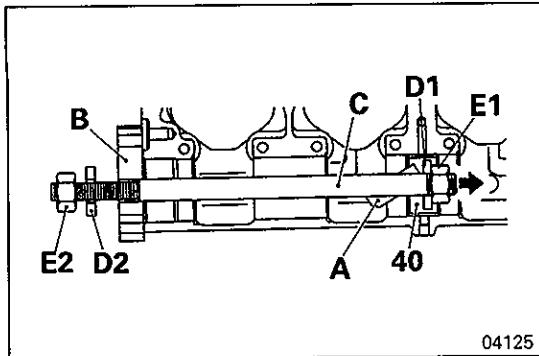
D: Washer (2 pcs)

E: Nut (2 pcs)

NOTE:

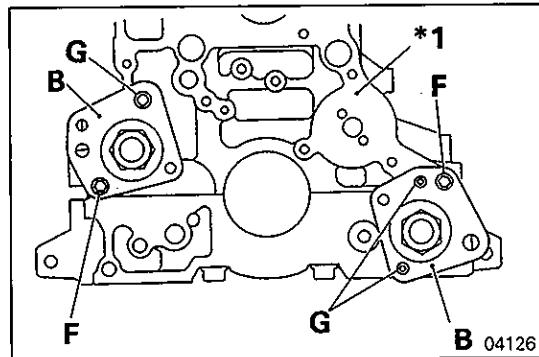
Apply engine oil to the sliding surface of plate **B** and puller **C**.

PWEE9409



04125

- (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.



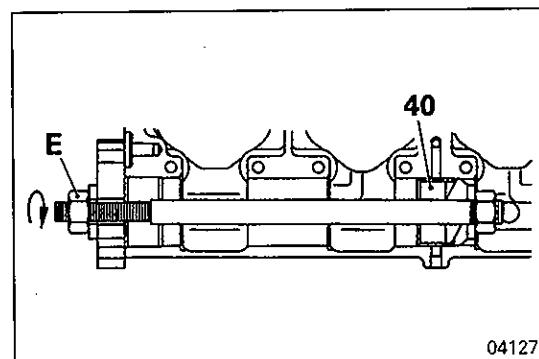
04126

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

G: Dowel pin

Caution

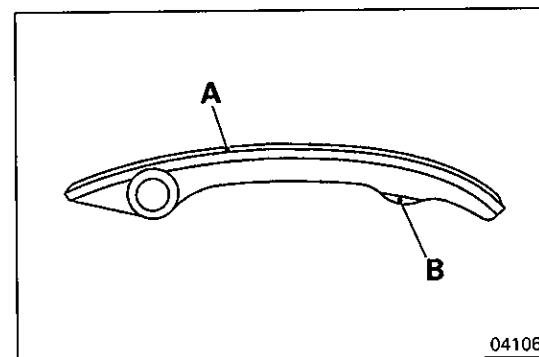
- The securing position of the plate **B** is different between when removing the left-hand and right-hand balance shaft bushes. Be sure to secure it in right places.



04127

INSPECTION TENSION LEVER

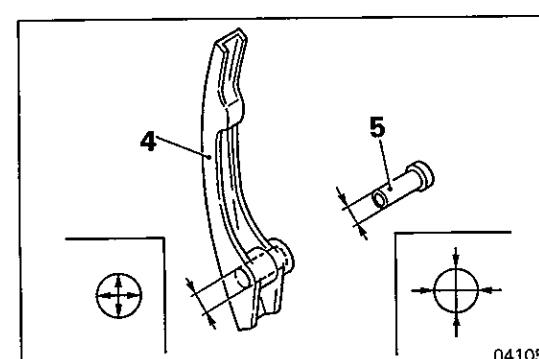
- (1) Check the tension lever **4** for evidence of cracking, flaking or other defect in the surface **A** that makes sliding contact with the timing chain and in the surface **B** that contacts the tensioner. Replace the tension lever **4** if necessary.



04106

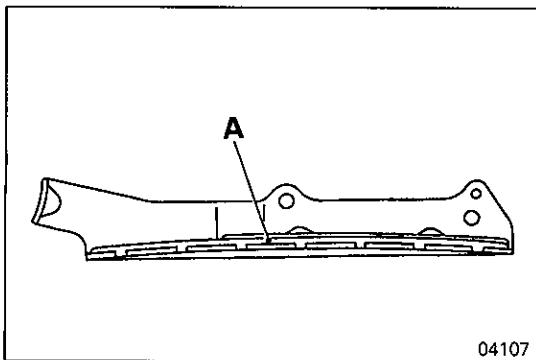
TENSION LEVER-TO-TENSION LEVER SHAFT CLEARANCE

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



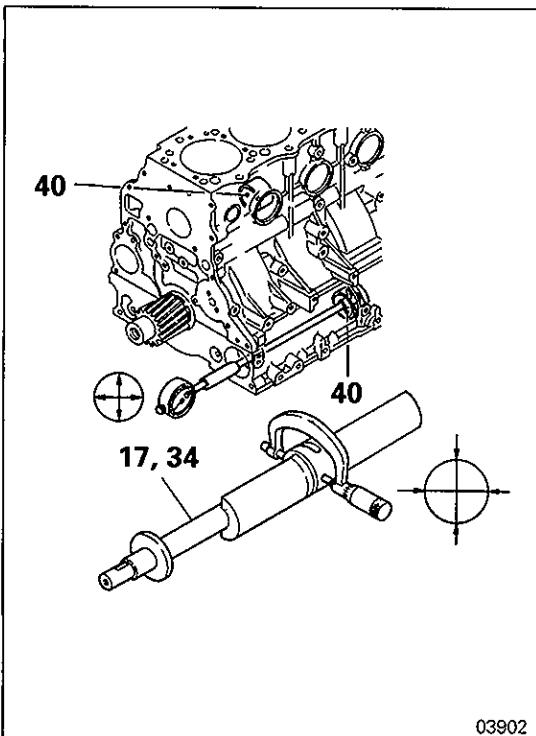
04105

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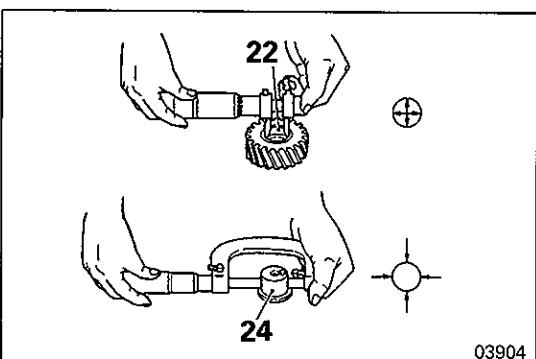
CHECKING GUIDE PLATE

- (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.



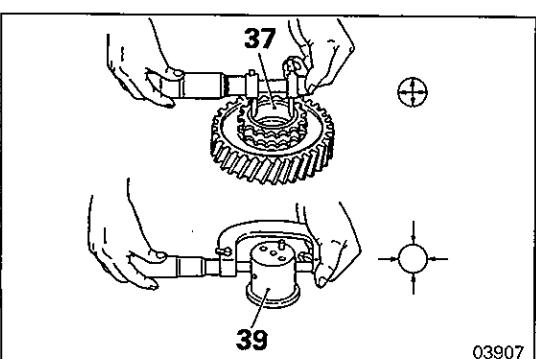
BALANCE SHAFTS RH AND LH, AND BALANCE SHAFT BUSHES

- (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

► A4 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.

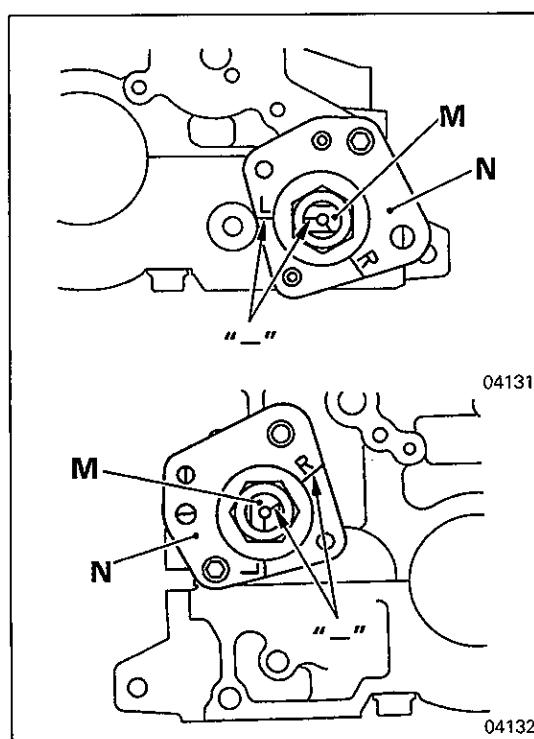
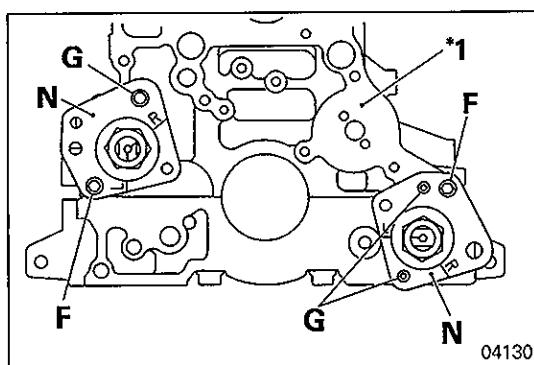
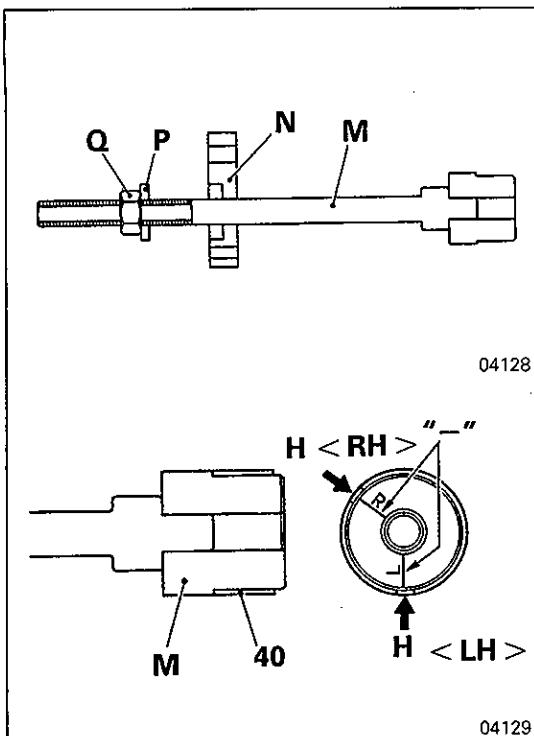
(3) Secure the plate **N** to the crankcase ***1** using bolt **F** [M8 x 1.25 mm (0.0492 in.)] as shown.

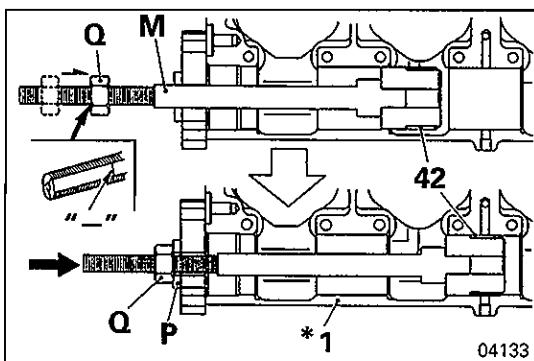
G: Dowel pin

Caution

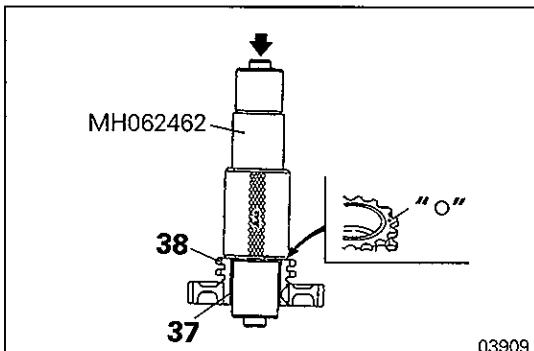
- Note that the securing position of the plate **N** is different between the left-hand balance shaft bush and the right-hand bush.
- Prior to securing the plate **N**, check that the installer **M** is correctly positioned with respect to the balance shaft bush **40**.

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



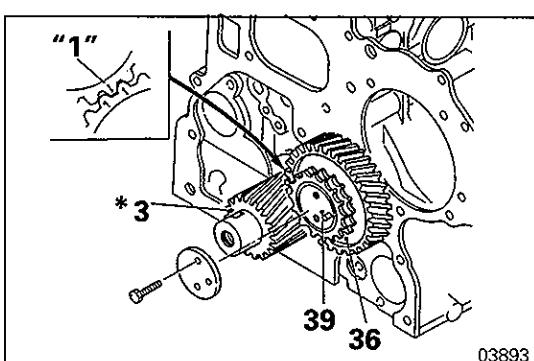


- (5) Set the drive-in depth for the balance shaft bush **40** by turning the nut **Q** until it reaches the alignment mark “-” on the installer **M**.
- (6) Press-fit the balance shaft bush **40** in the crankcase ***1** by driving in the installer **M** until the nut **Q** completely contacts the washer **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.



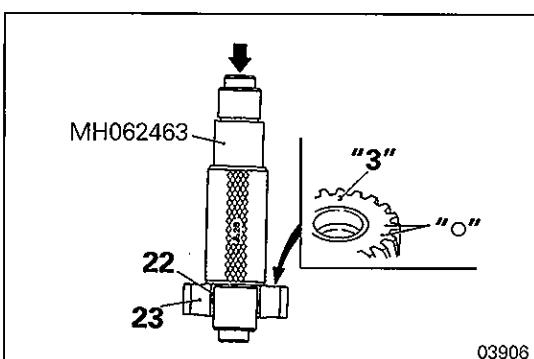
►B IDLER SPROCKET BUSH INSTALLATION

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



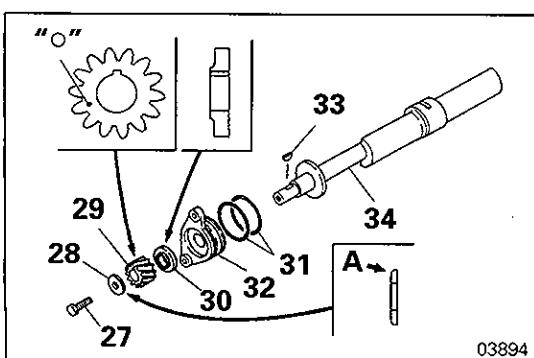
►C INSTALLING IDLER GEAR AND SPROCKET ASSEMBLY TO IDLER SHAFT

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

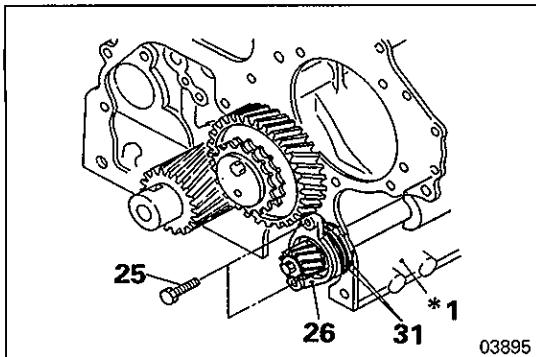


►E BALANCE SHAFT LH ASSEMBLY INSTALLATION

- (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.

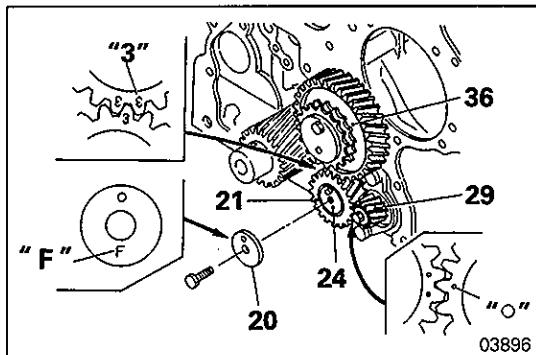
A: Shear droop side



(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**.

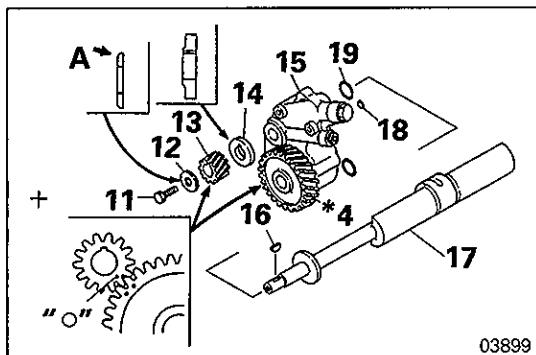
Caution

- **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.**

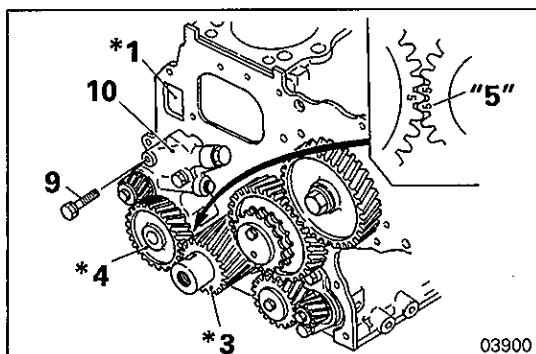


(c) Install the idler gear LH assembly **21** onto the idler shaft **24**. At this time, be sure to align the match marks **"3"** and **"O"** on the idler gear with the corresponding match marks on the idler gear and sprocket assembly **36** and the balance shaft gear LH **29**.

(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**.

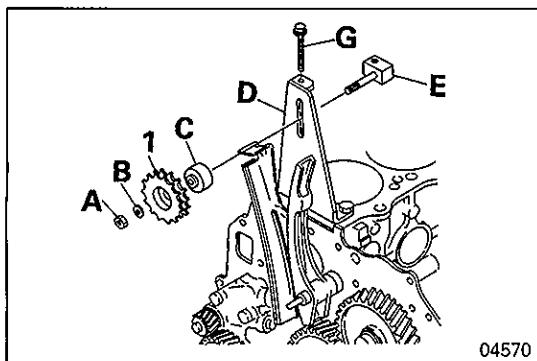
A: Shear droop side

(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.

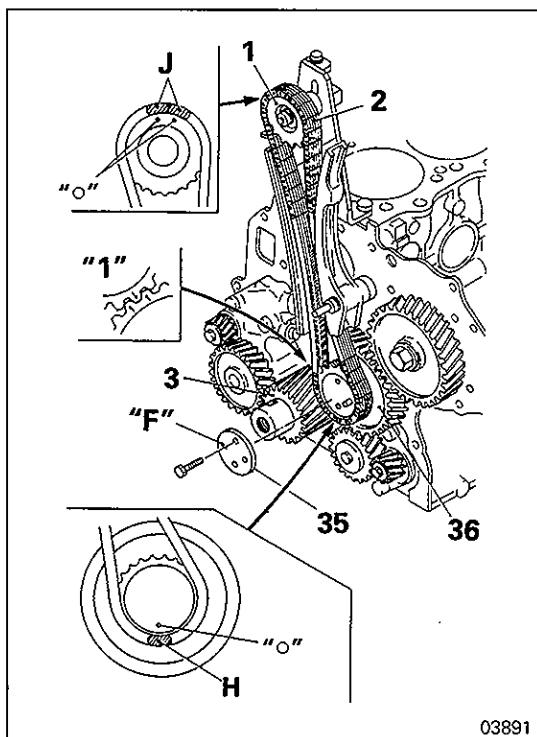


►G TIMING CHAIN INSTALLATION

- (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



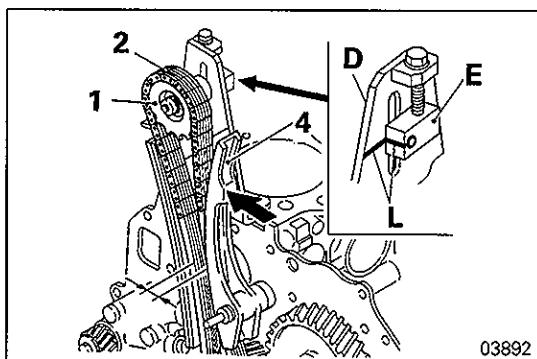
- (2) Check that the match mark “**1**” on the idler gear and sprocket assembly **36** is in alignment with that on the crankshaft gear ***3**.

- (3) Align the match mark “**o**” 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 “**o**” 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.



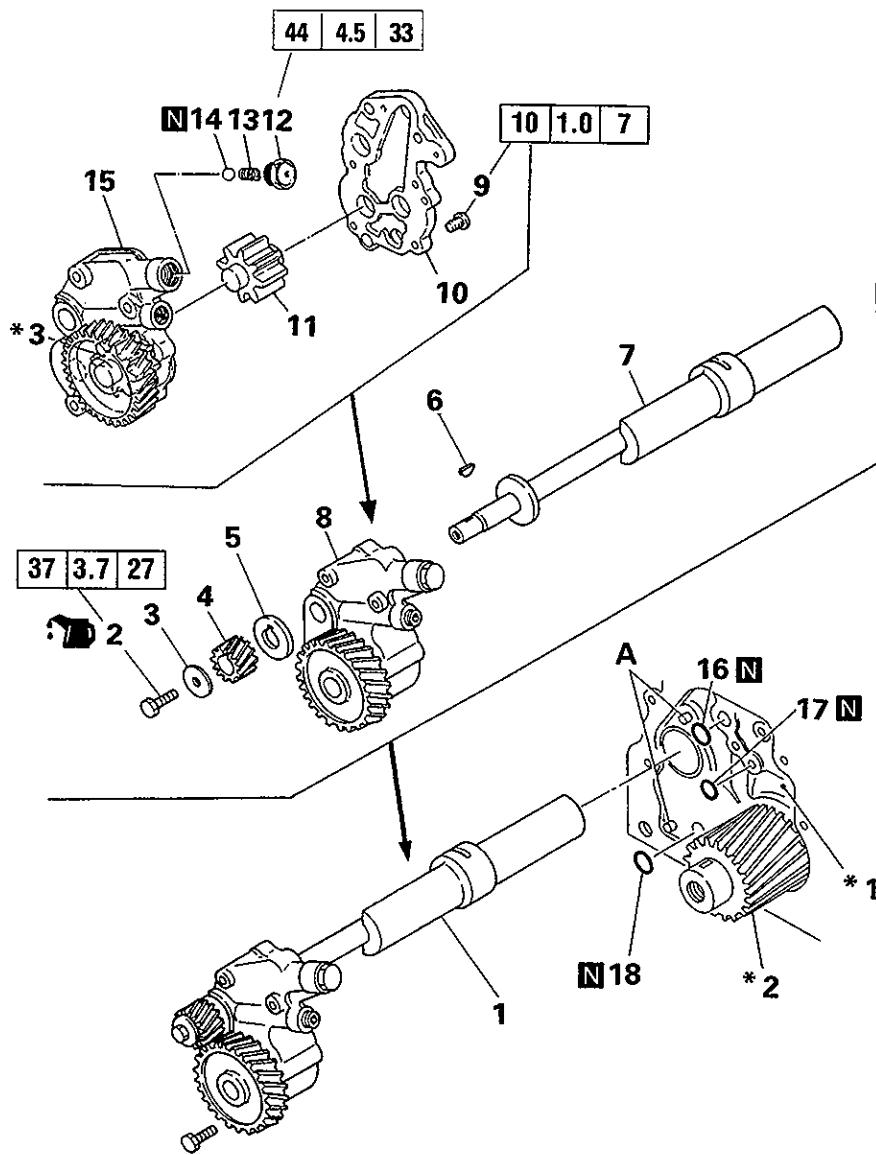
- (6) With the stamped lines **L** on the adjusting plate **D** and nut **E** in alignment, set the cam sprocket **1** in the normal operating position. Push the tension lever **4** by hand to take up the slack of the timing chain **2**.

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

NOTES

20. OIL PUMP

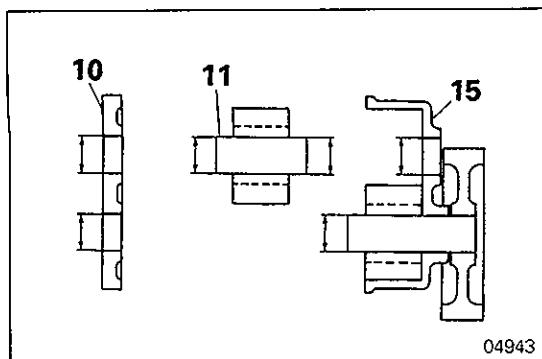
DISASSEMBLY AND REASSEMBLY



Removal steps

1. Balance shaft RH assembly
2. Bolt
3. Washer
4. Balance shaft gear RH
5. Thrust spacer
6. Key
7. Balance shaft RH
8. Oil pump assembly
9. Screw
10. Oil pump cover
11. Driven gear assembly
12. Plug
13. Relief valve spring
14. Steel ball
15. Gear and body assembly
16. O-ring
17. O-ring
18. O-ring

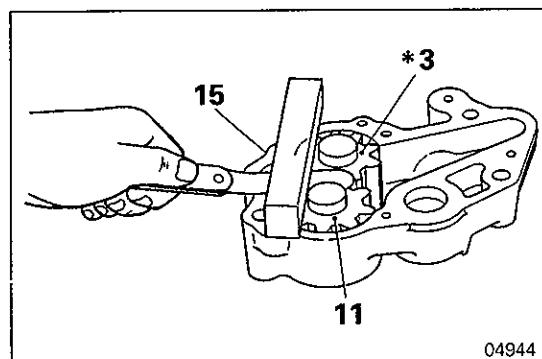
*1: Crankcase (See page 11A-28-1.)
 *2: Crankshaft gear
 *3: Drive gear
 A: Locating pin



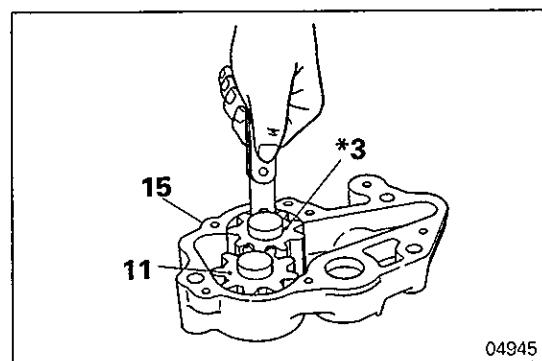
INSPECTION

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.



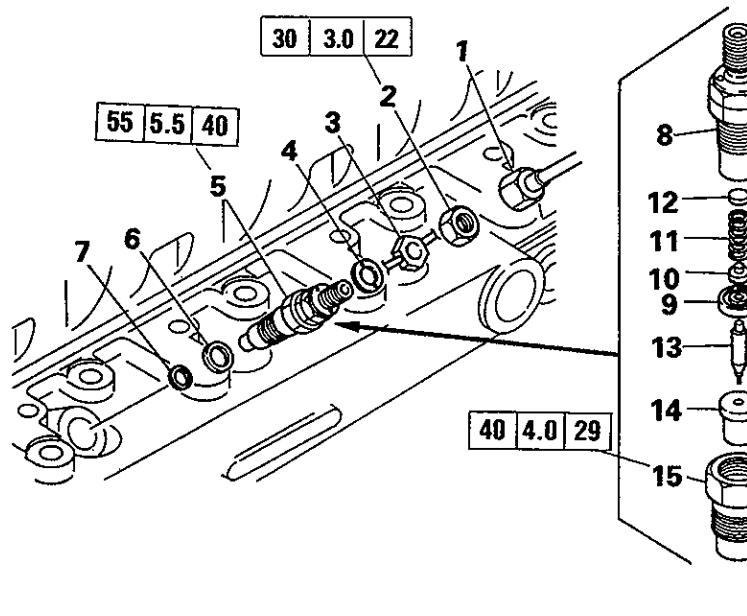
(2) Difference between Gear Height and Oil Pump Case Depth
If the difference exceeds the specified service limit, replace defective part.



(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.

8→12→11→10→9	→5
5:	15→14→13

04008

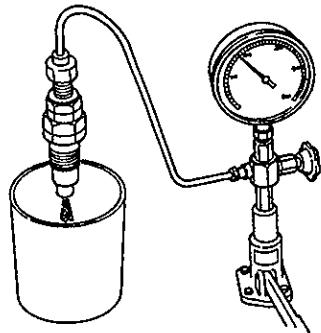
INSPECTION

FUEL INJECTION NOZZLE ASSEMBLY

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

Caution

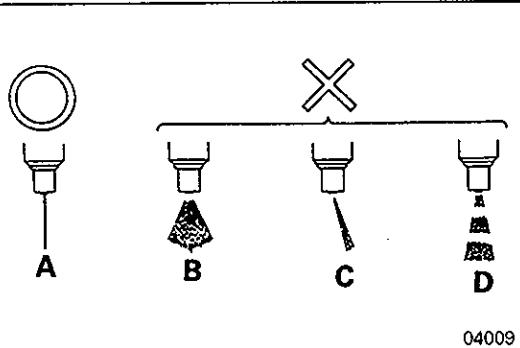
- **Prior to proceeding with the checks, bleed air from the fuel injection nozzle by pumping the nozzle tester lever two or three times.**



04017

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/cm², 171 – 313 psi). [The shim thickness necessary to change the pressure by 100 kPa (1 kg/cm², 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**.



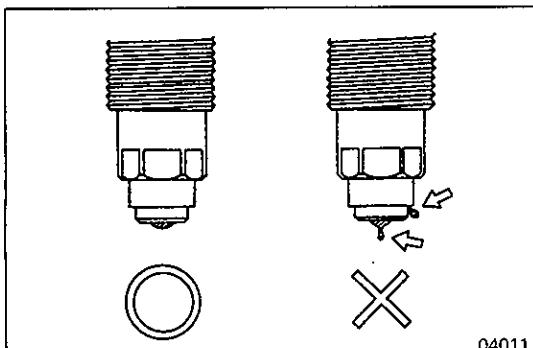
04009

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.



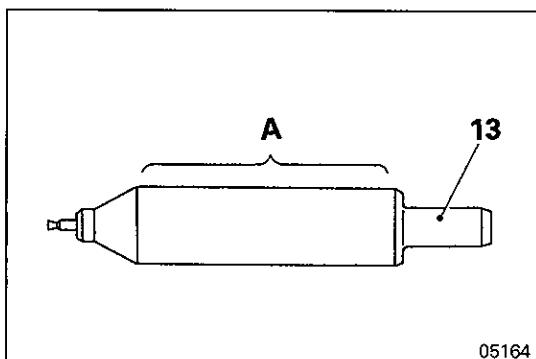
04011

Oil Tightness Check

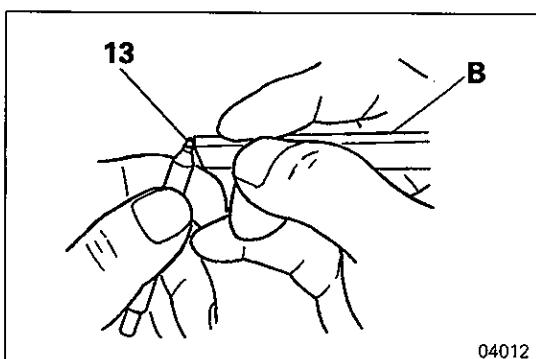
- (1) Slowly increase the nozzle internal pressure and maintain it at the specified test pressure of 12,749 – 13,729 kPa (130 – 140 kg/cm², 1,849 – 1,991 psi). In this condition, check that the fuel injection nozzle does not start dribbling within 10 seconds.
- (2) If the dribbling begins in less than 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**Ⓐ 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.

**Ⓑ 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**

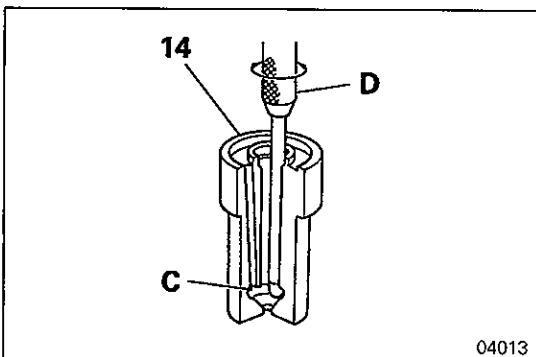
- (1) Wash the needle valve 13 and nozzle tip 14 removed in clean kerosene (cleaning oil) and remove deposited carbon from them in the following manners using the specified special tools.

- (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.

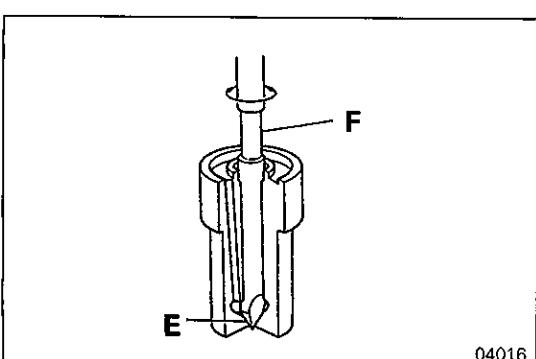


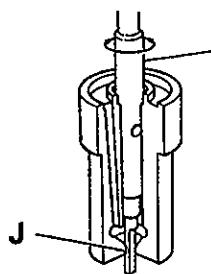
- (c) Clean the seat E of the nozzle tip 14 using the special tool Cleaning Scraper F.

Caution

- Use sufficient care not to damage the seat surface.

- (d) To remove baked carbon, use the Fuso Carbon Remover.

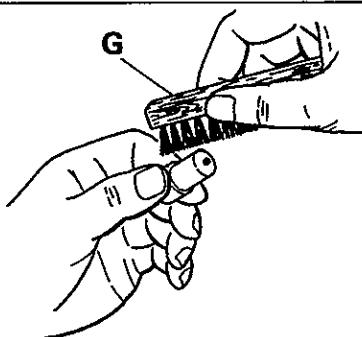




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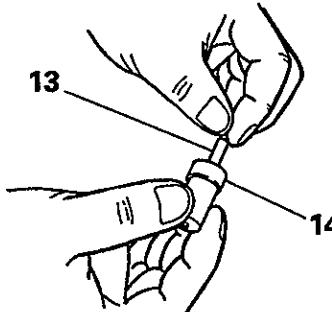
(e) Remove carbon deposited in the nozzle hole area of the nozzle tip **14** by turning the special tool Needle Cleaner **H** that runs through the nozzle hole **J**.

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



04015

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



04022

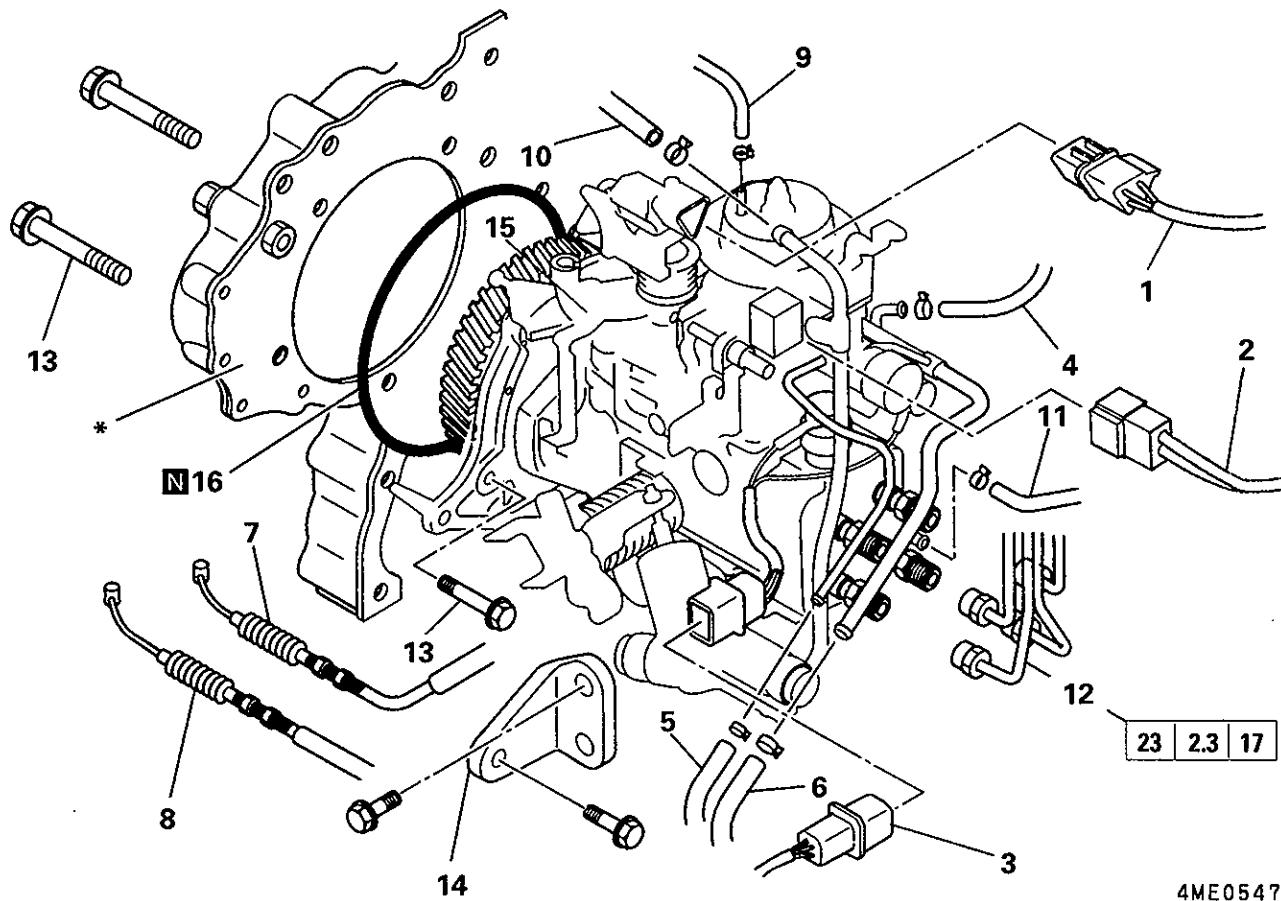
INSPECTION

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



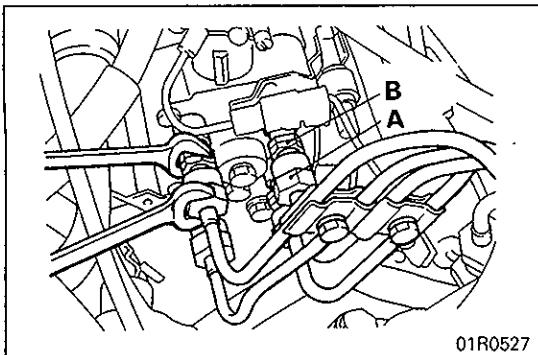
4ME0547

Removal steps

1. Wiring harness
2. Wiring harness
<PAJERO 2001 MODEL 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>
12. Fuel injection pipe
13. Bolt
14. Stay
15. Fuel injection pump assembly
16. O-ring

*: Front plate

NOTE
W-CSD: Wax type cold start device



REMOVAL SERVICE POINT

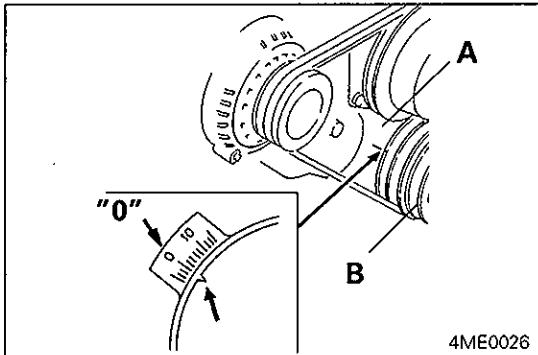
►A► FUEL INJECTION PIPE REMOVAL

- (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.

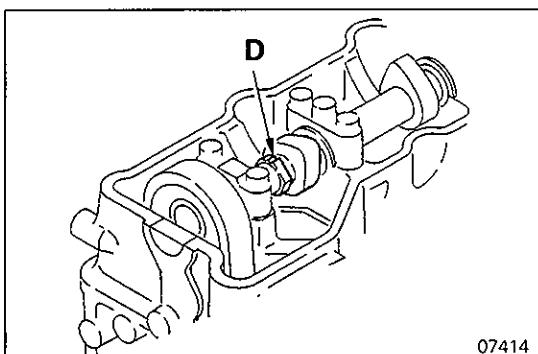


►B◄ FUEL INJECTION PUMP ASSEMBLY INSTALLATION

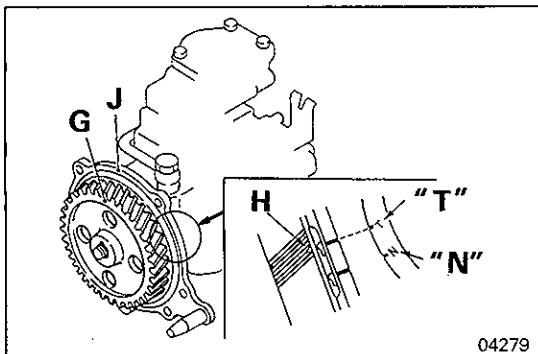
- (1) Crank up the engine with the specified special tool to place the No.1 piston at the TDC on the compression stroke. Align the notch in the crankshaft pulley **B** with the timing mark "0" on the timing gear case **A**.

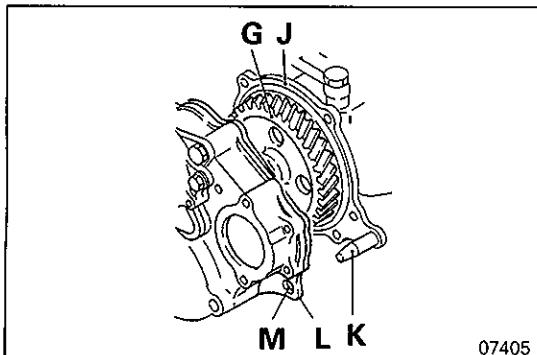
Caution

- If the dent **D** on the hexagonal section of the cam-shaft 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.

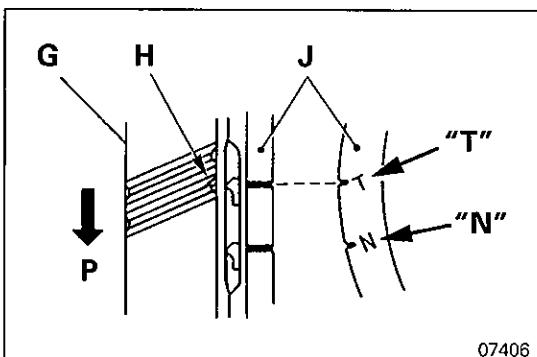


- (2) Align the notch **H** on the injection pump gear **G** with the mating mark "N" <Non-turbo> or "T" <Turbo> on the flange plate **J**.

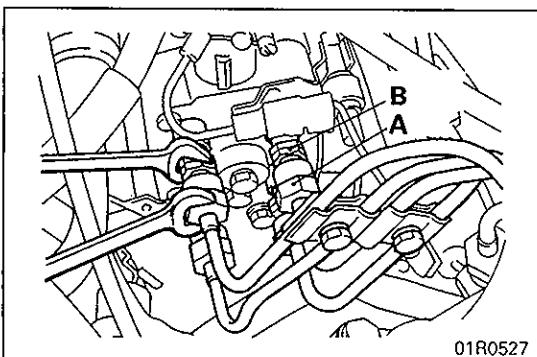




(3) Align the guide bar **K** of the flange plate **J** with the guide hole **M** of the front plate **L** and insert the front plate just before the injection pump gear **G** meshes with the idler gear.

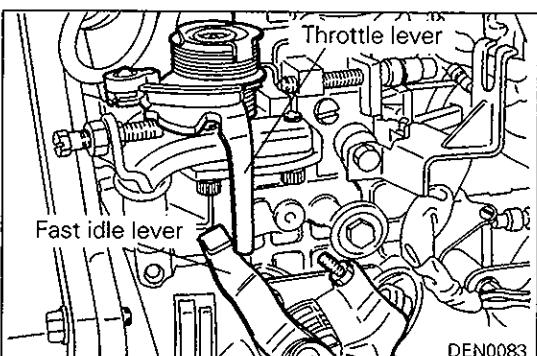


(4) Confirm that the notch **H** on the injection pump gear **G** is aligned with the mating mark "**N**" <Non-turbo> or "**T**" <Turbo> on the flange plate **J**. Then install the front plate on the injection pump assembly. While meshing the gears, the notch **H** on the gear should move in the direction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



►C FUEL INJECTION PIPE INSTALLATION

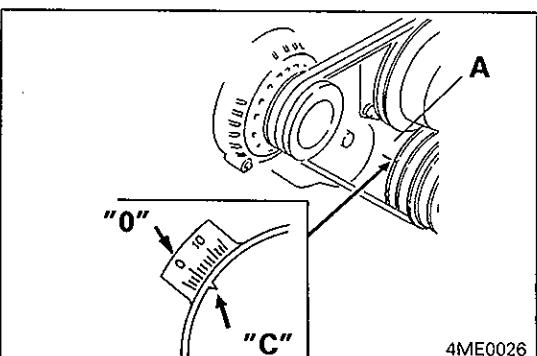
(1) Tighten the union nut **A** of the fuel injection pipe while locking the delivery valve holder **B** to prevent it from rotating together.



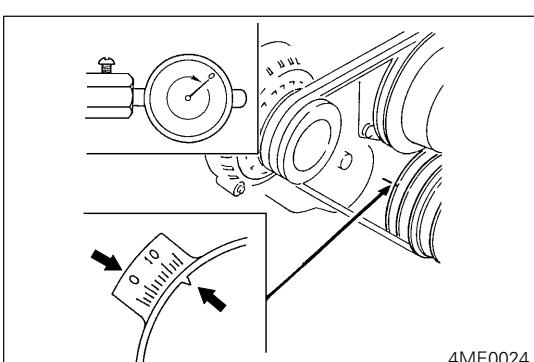
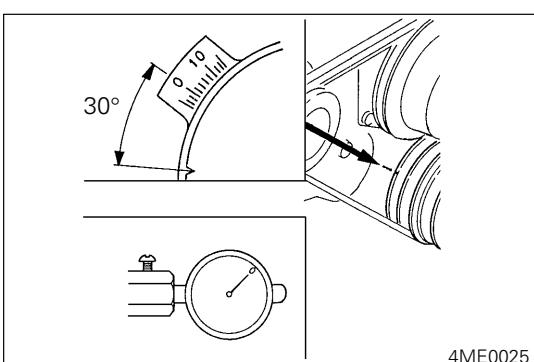
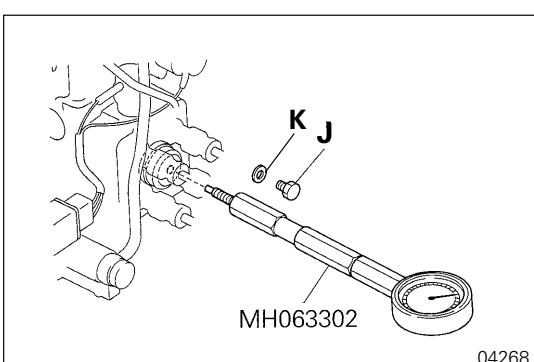
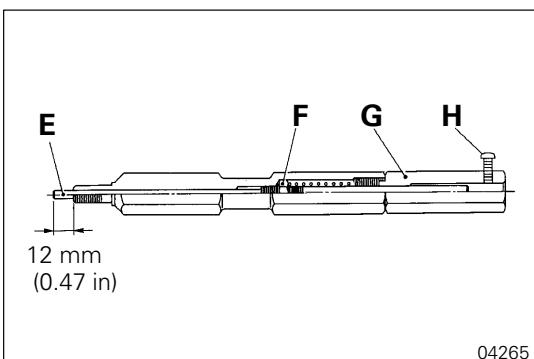
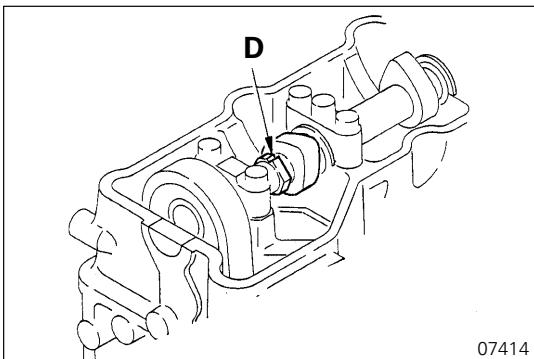
FUEL INJECTION TIMING CHECK AND ADJUSTMENT

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 cam-shaft 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: -2002 L200 Non-turbo, and 1994–1996 PAJERO Turbo for EFTA

7° ATDC: 2001–PAJERO Turbo without EGR

9° ATDC: 2002–L200 Turbo, 2003–L200 Non-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: $1 \pm 0.03 \text{ mm} (0.039 \pm 0.0012 \text{ in.})$

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)

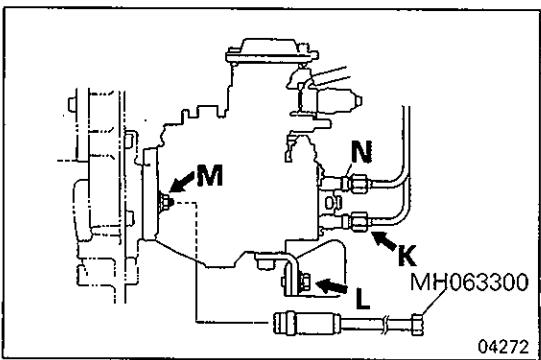
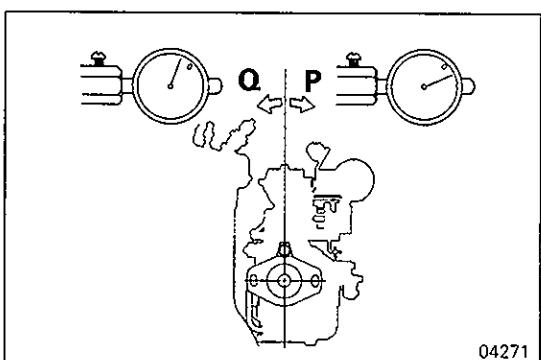
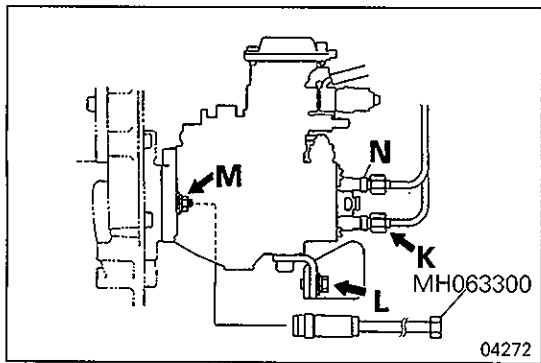
L: Bolt (1 place)

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)

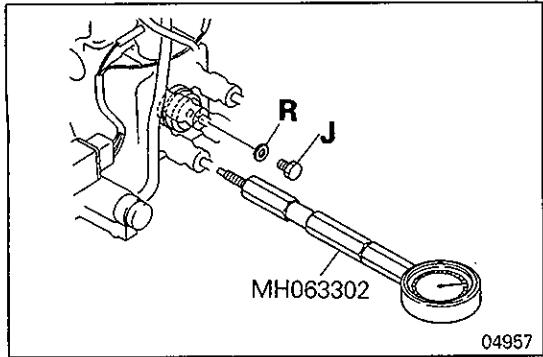
L: Bolt (1 place)

K: Fuel injection pipe union nut (4 places)

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

Caution

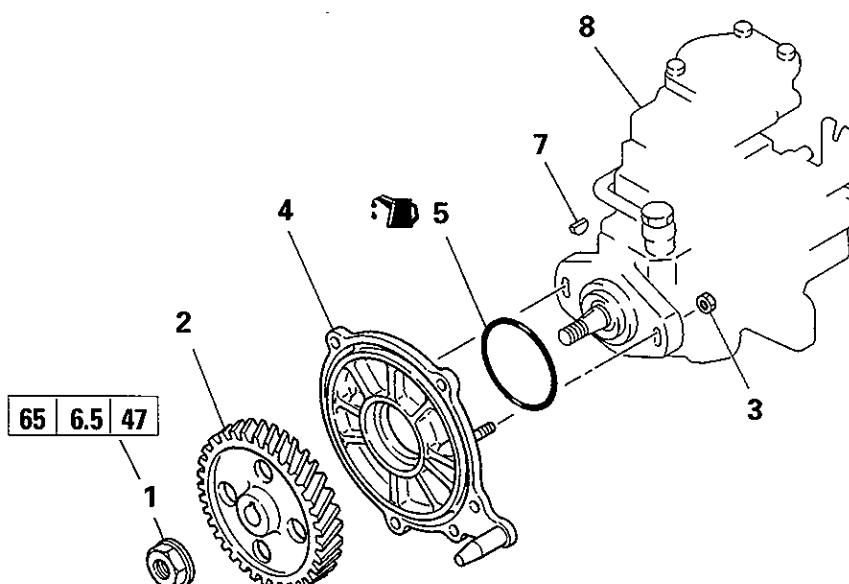
- When torquing the union nuts **K**, lock the delivery valve holder with a wrench to prevent it from turning together.



- (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



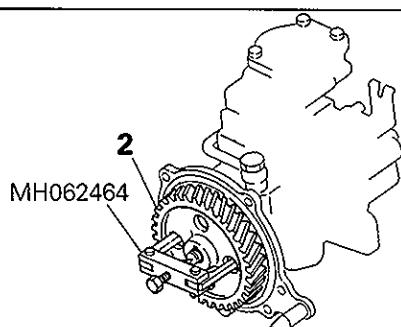
Removal steps

- Ⓐ 1. Nut
- Ⓑ 2. Injection pump gear
- Ⓐ 3. Nut
- Ⓐ 4. Flange plate
- Ⓐ 5. O-ring
- Ⓐ 6. Key
- Ⓑ 7. Injection pump assembly

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REMOVAL SERVICE POINT

Ⓐ FUEL INJECTION PUMP GEAR



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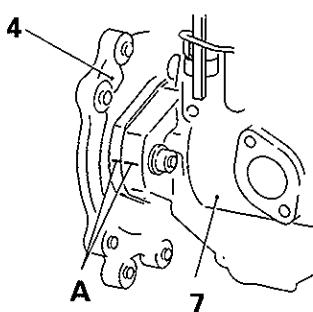
INSTALLATION SERVICE POINT

Ⓑ O-RING INSTALLATION

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

Ⓑ FLANGE PLATE INSTALLATION

- (1) Install the injection pump assembly 7 while aligning the mating marks A on the flange plate 4 and the pump assembly.

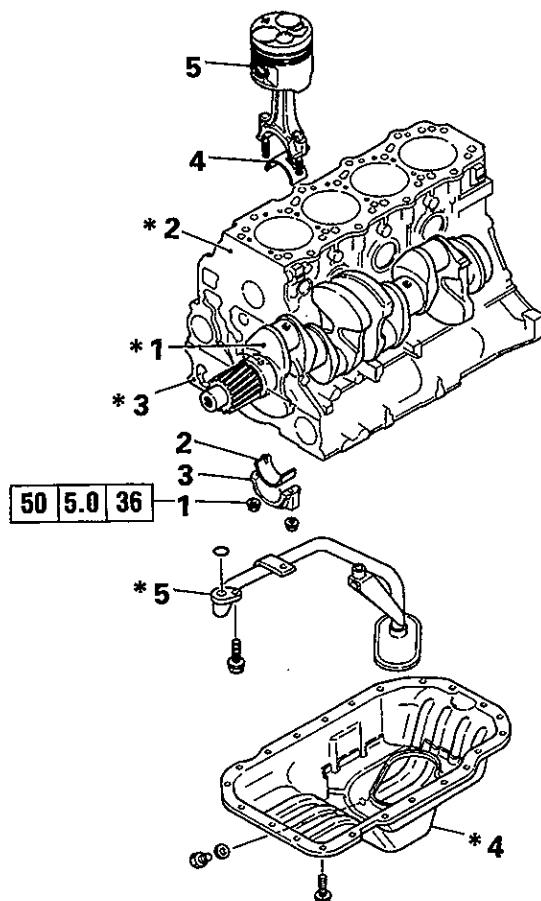


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NOTES

24. PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL AND INSTALLATION



Lubricate all internal parts with engine oil during reassembly.

Removal steps

1. Nut
2. Lower connecting rod bearing
3. Connecting rod cap
4. Upper connecting rod bearing
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

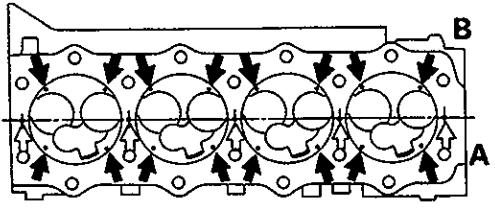
- Do not fail to check piston protrusions. The engine performance are directly influenced by them.

(1) Position each piston at the TDC.

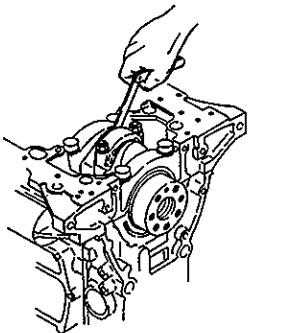
(2) Check for piston protrusions of each cylinder. There are five reference points **A** on the upper crankcase assembly *2. For each cylinder, measure the piston protrusion at the specified 4 points using the closest reference point as zero level. Average the 4-point readings.

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.



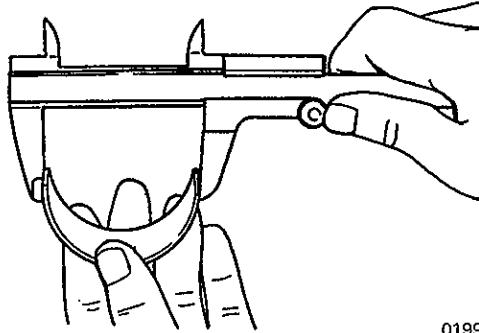
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Connecting Rod End Play

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



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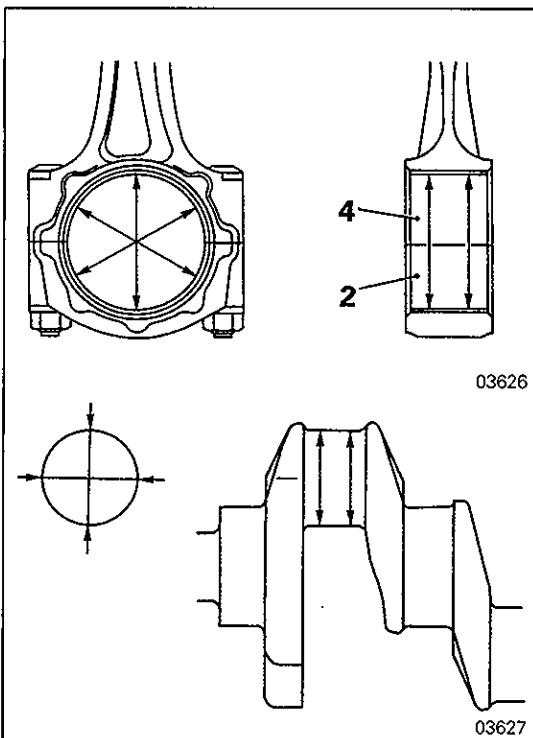
CONNECTING ROD BEARING

Caution

- Be sure not to use the connecting rod bearings 2 and 4 expanded forcedly.
- 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.

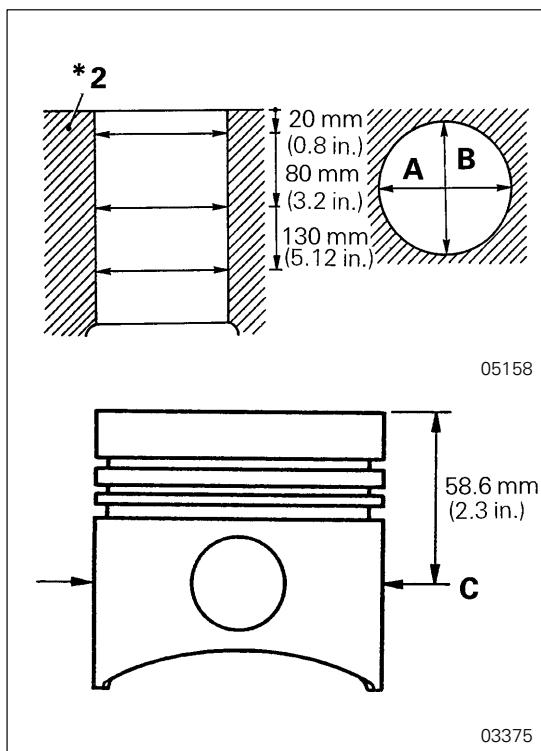


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Connecting Rod Bearing-to-Crankshaft Clearance (Oil Clearance)

- (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 crank-shaft)

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 and piston ring.

CYLINDER BORING

(1) Select an oversize piston O.D. appropriate to the largest I.D. cylinder in the crankcase.

(2) There are four piston oversize dimensions available: 0.50 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.

(3) 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:

Non-turbo engine 0.02 mm (0.0008 in.)

Turbo engine 0.05 mm (0.0020 in.)

NOTE

Use a cubic boron nitride (CBN) tip for boring cylinders of the turbo-engine.

(4) Bore all cylinders to the dimension obtained and then hone them to the final size.

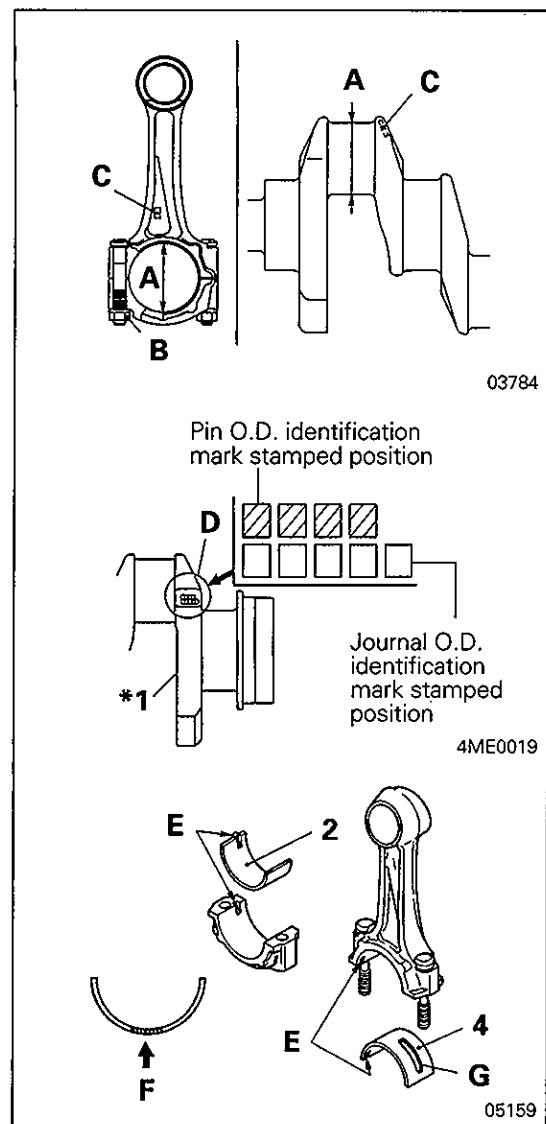
Caution

1. **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.**
2. **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.)

3. Recheck the piston-to-cylinder clearance after honing.
Standard clearance:
Non-turbo engine 0.04–0.05 mm (0.0016–0.0020 in.)
Turbo engine 0.07–0.08 mm (0.0028–0.0032 in.)

Intentionally blank



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)

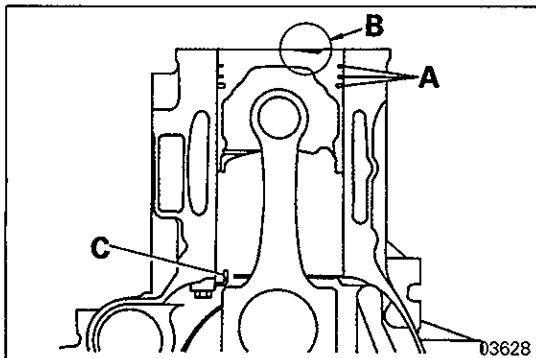
The connecting rod bearings also have the identification colors.

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.)

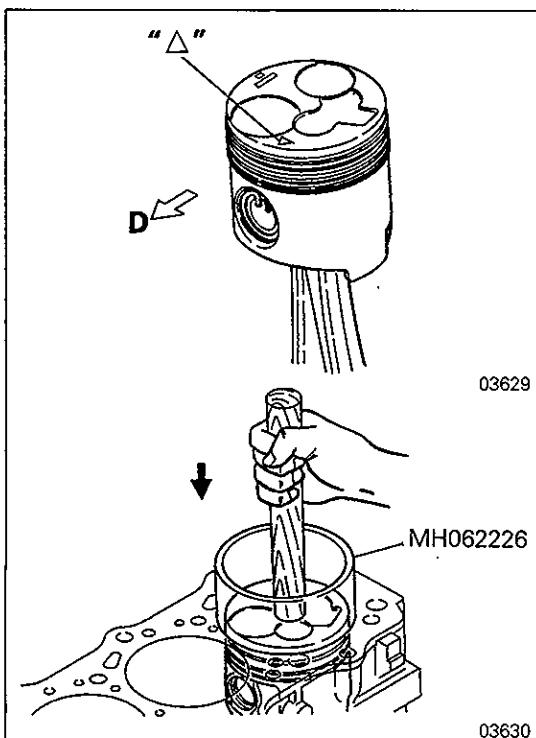
Crankshaft		Connecting rod		Connecting rod bearing		
Identification color (Identification mark)	Pin O.D.	Identification color	Big end I.D.	Identification color	Plate thickness	Oil clearance
None (1)	54 (2.13) -0.012 (-0.0005) -0.0200 (-0.008)	Blue	58 (2.28) +0.019 (+0.0007) +0.010 (+0.0004)	None	2 (0.08)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



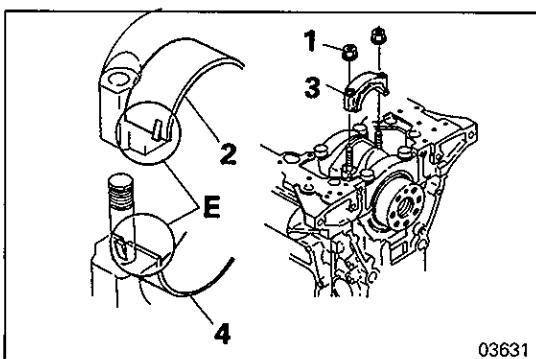
► B PISTON AND CONNECTING ROD ASSEMBLY INSTALLATION

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 "△" 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.

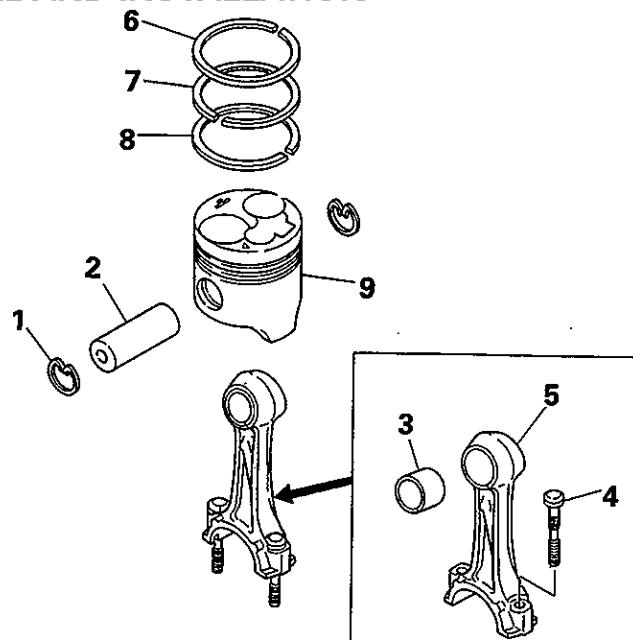
Caution

- 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.)

NOTES

25. PISTON AND PISTON PIN

REMOVAL AND INSTALLATION



Removal steps

- 1. Snap ring
- 2. Piston pin
- 3. Connecting rod bush
- 4. Connecting rod bolt
- 5. Connecting rod
- 6. 1st compression ring
- 7. 2nd compression ring
- 8. Oil ring
- 9. Piston

Caution

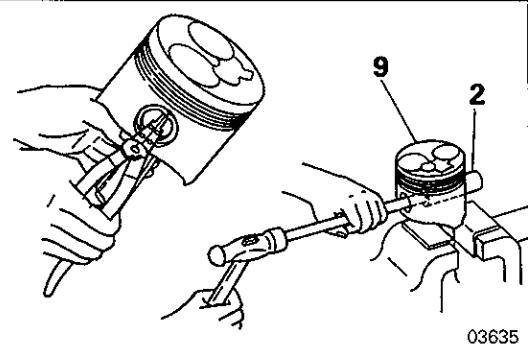
Do not remove the connecting rod bolt 4 unless absolutely necessary.

03633

REMOVAL SERVICE POINTS

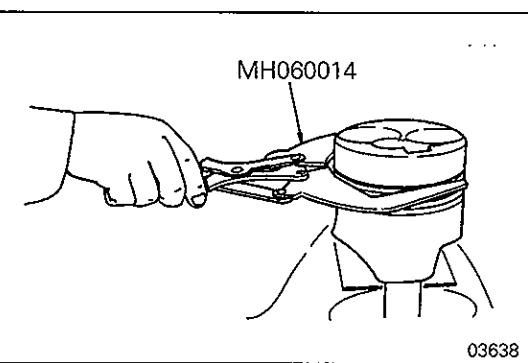
Ⓐ PISTON PIN REMOVAL

- (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.



03635

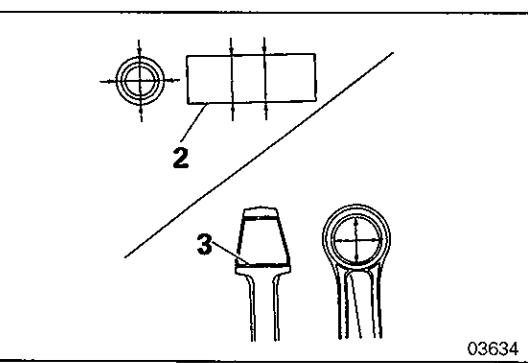
Ⓑ COMPRESSION RING REMOVAL



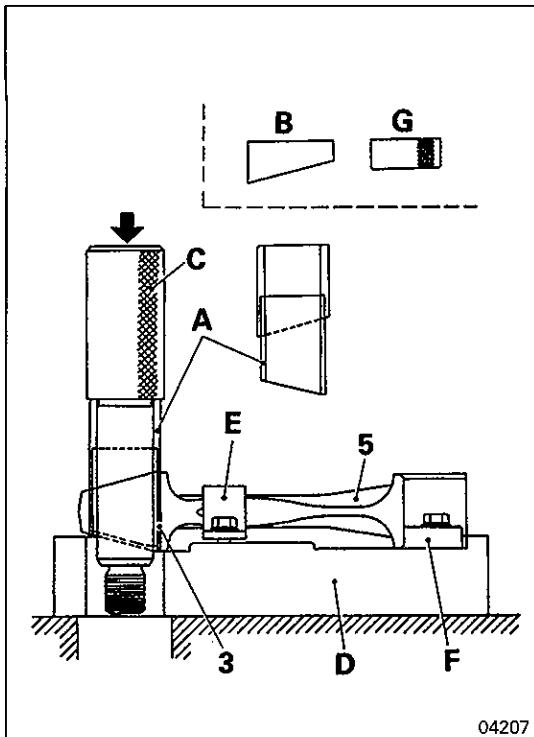
03638

Ⓒ CONNECTING ROD BUSH REMOVAL

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



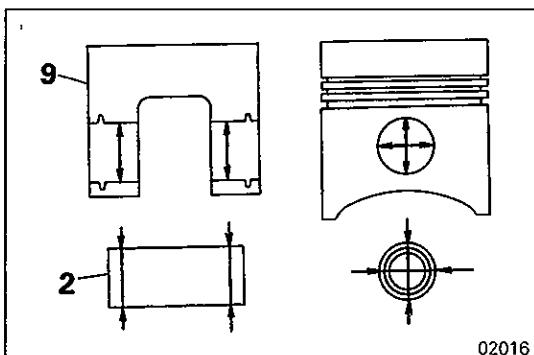
03634



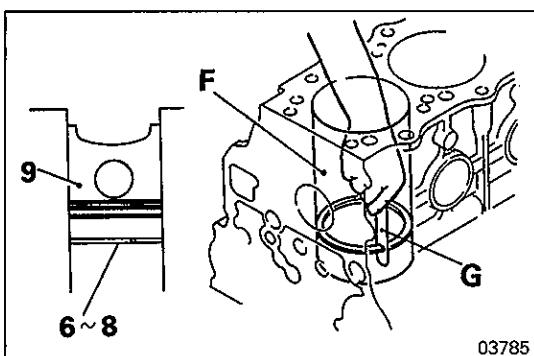
04207

- (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.).



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03785

INSPECTION

PISTON PIN / CONNECTING ROD / PISTON

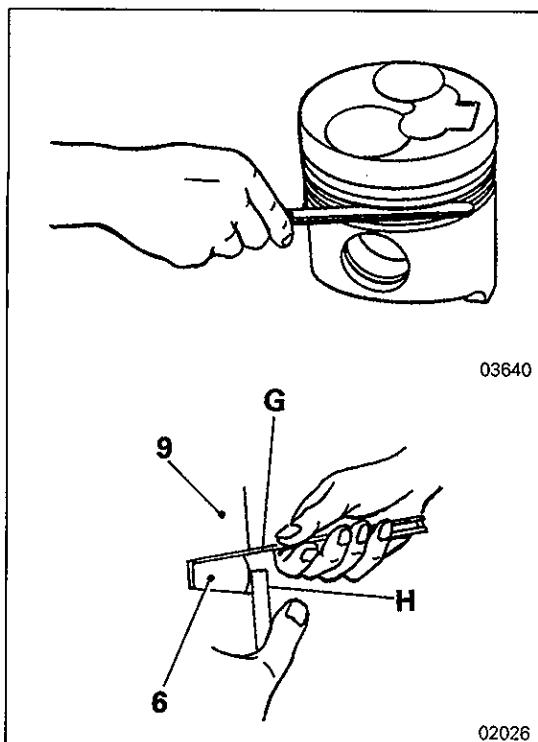
- (1) Measure the clearance between the piston pin **2** and piston **9**. If the clearance exceeds the specified service limit, replace defective part.

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.

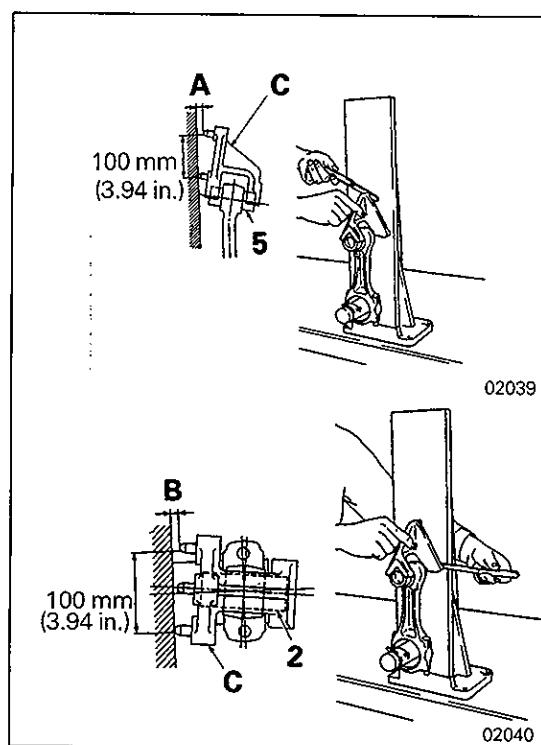


PISTON RING TO PISTON RING GROOVE CLEARANCE

- (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.



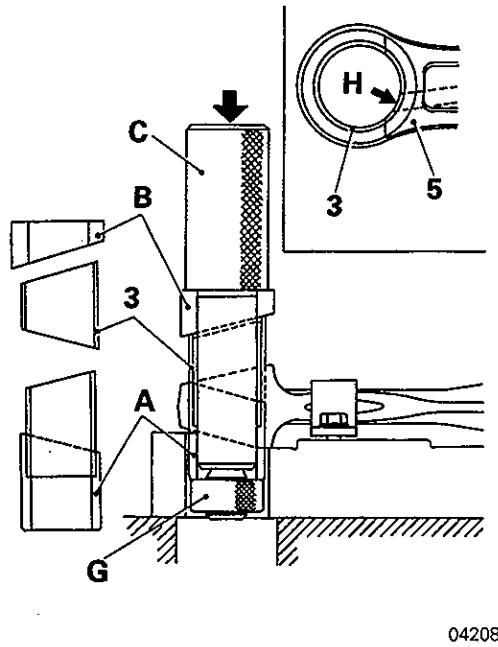
CONNECTING ROD BEND AND TWIST

- (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.)

INSTALLATION SERVICE POINTS**►A CONNECTING ROD BUSH INSTALLATION**

04208

- (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.

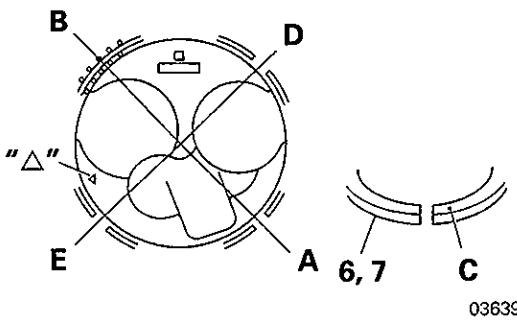
- (2) Set the collar B, connecting rod bush 3 and collar A and the puller C in the connecting rod as shown and secure them with the nut G.

- (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.

►B PISTON RING INSTALLATION

03639

- (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

△: Front mark of piston

►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

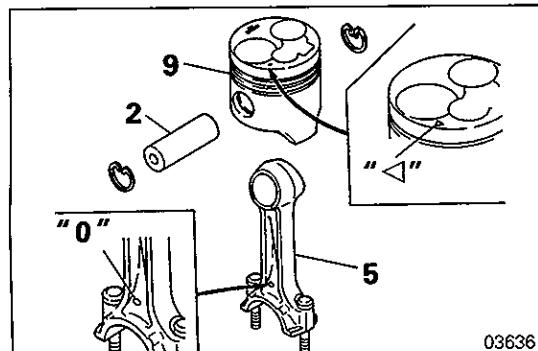
►D PISTON PIN INSTALLATION

- (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 "0" and the front mark "△" facing in the directions shown, and insert the piston pin.

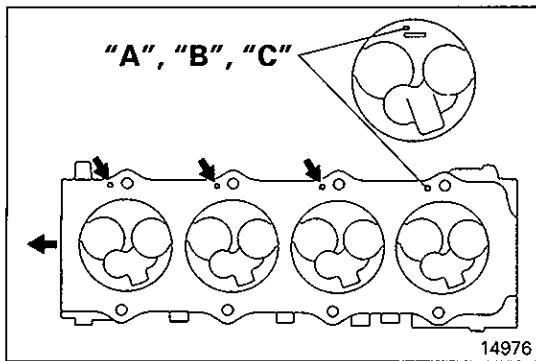
- (2) If the piston pin 2 is hard to insert, warm the piston 9 by a piston heater or in hot water.

Caution

- Check that the piston moves smoothly without excessive play.



03636



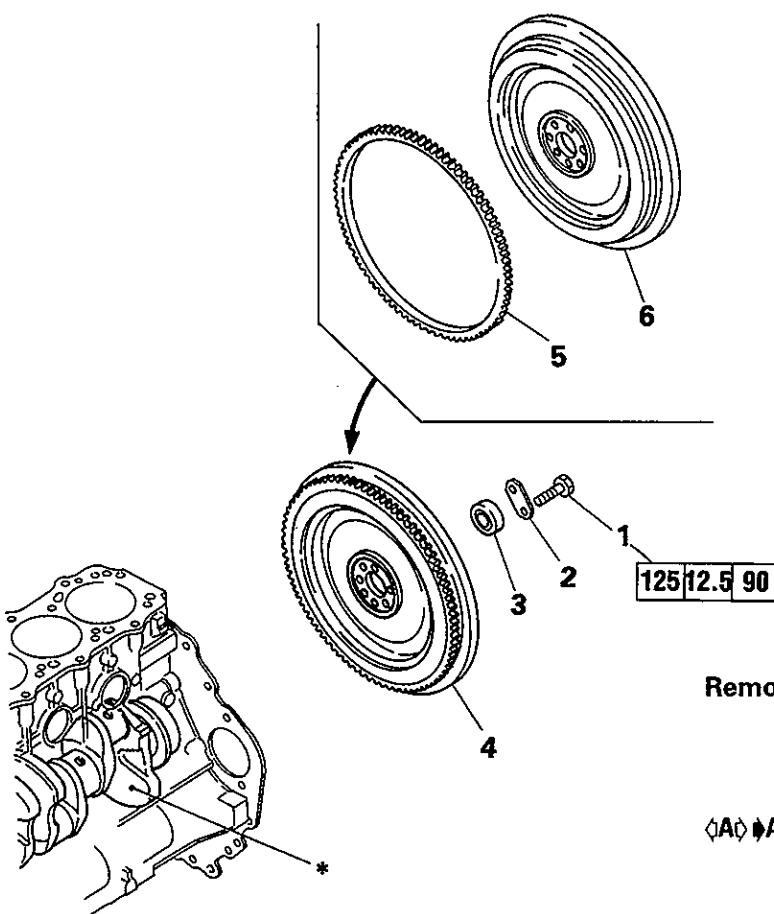
PISTON SELECTION

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

NOTES

26. FLYWHEEL

REMOVAL AND INSTALLATION

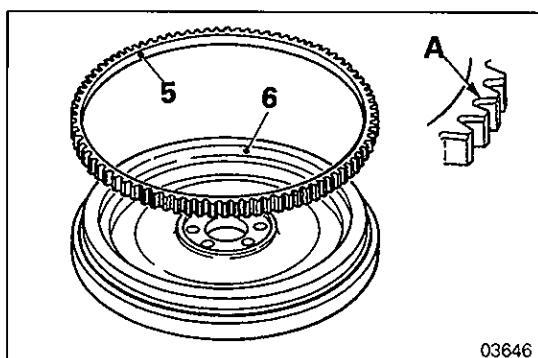


Removal steps

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

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

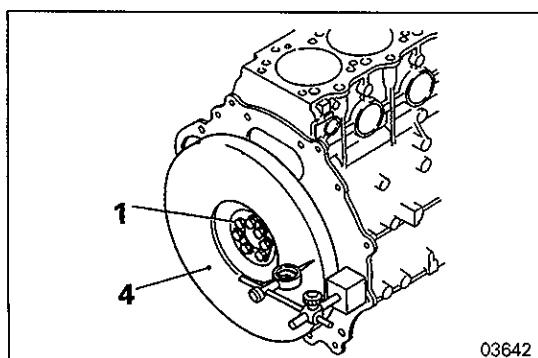
05179



REMOVAL SERVICE POINTS

Ⓐ Ⓛ RING GEAR REMOVAL

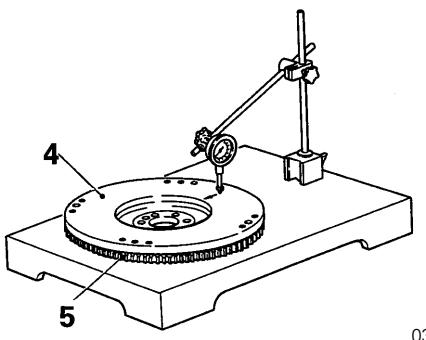
- (1) Check the ring gear **5** for damage and abnormal wear, and replace if necessary.
- (2) Heat the ring gear **5** evenly with an acetylene torch or the like, and remove it by evenly tapping on its periphery.



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.



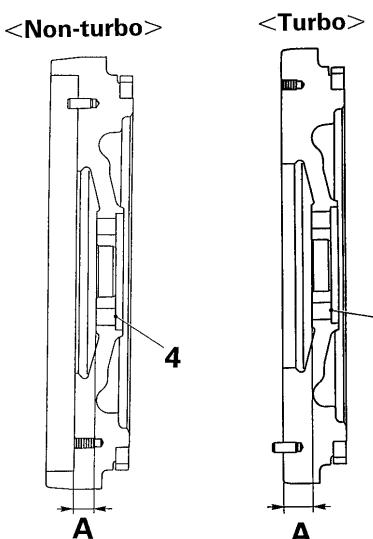
03643

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.



03644

03645

Friction Surface Height

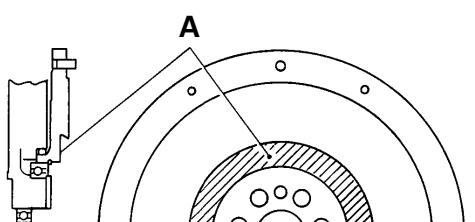
(1) If the measurement is less than the specified service limit, replace the flywheel assembly **4**.

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.



4ME0272

HYDRO-FLYWHEEL

(1) Check the color of the portion **A** on the rear surface of the flywheel and determine whether the flywheel is usable in accordance with the table below.

If it is not usable, replace the flywheel assembly **4**.

Color	Purple	Dark blue	Light blue	Gray
Judge- ment	Usable		Non-usable	

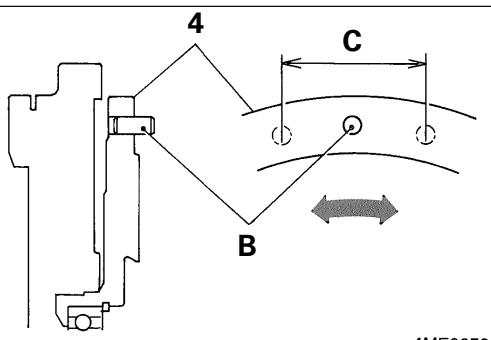
(2) Measure the play of the flywheel in circumferential directions as follows:

Measure the distance between the positions to which the knock pin moves when the flywheel is turned by hand in both directions.

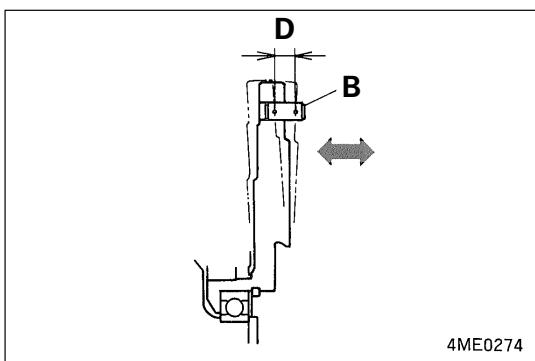
If the distance exceeds the limit, replace the flywheel assembly **4**.

B: Knock pin

C: Play in circumferential directions

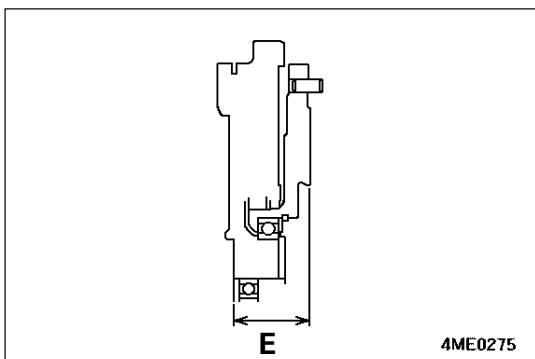


4ME0273



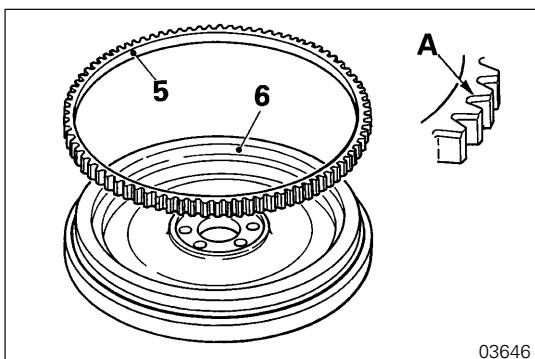
(3) Measure the runout of the flywheel on the friction surface as follows:
Push and pull on a part of the flywheel by hand in the axial directions with a light force [approximately 98N (10kg, 22lbs.)] to measure the amount of movement of the knock pin.
If the runout exceed the limit, replace the flywheel assembly **4**.

D: Friction surface runout



(4) Measure the height of the friction surface.
If the measurement is lower than the limit, replace the flywheel assembly **4**.

E: Friction surface height



INSTALLATION SERVICE POINTS

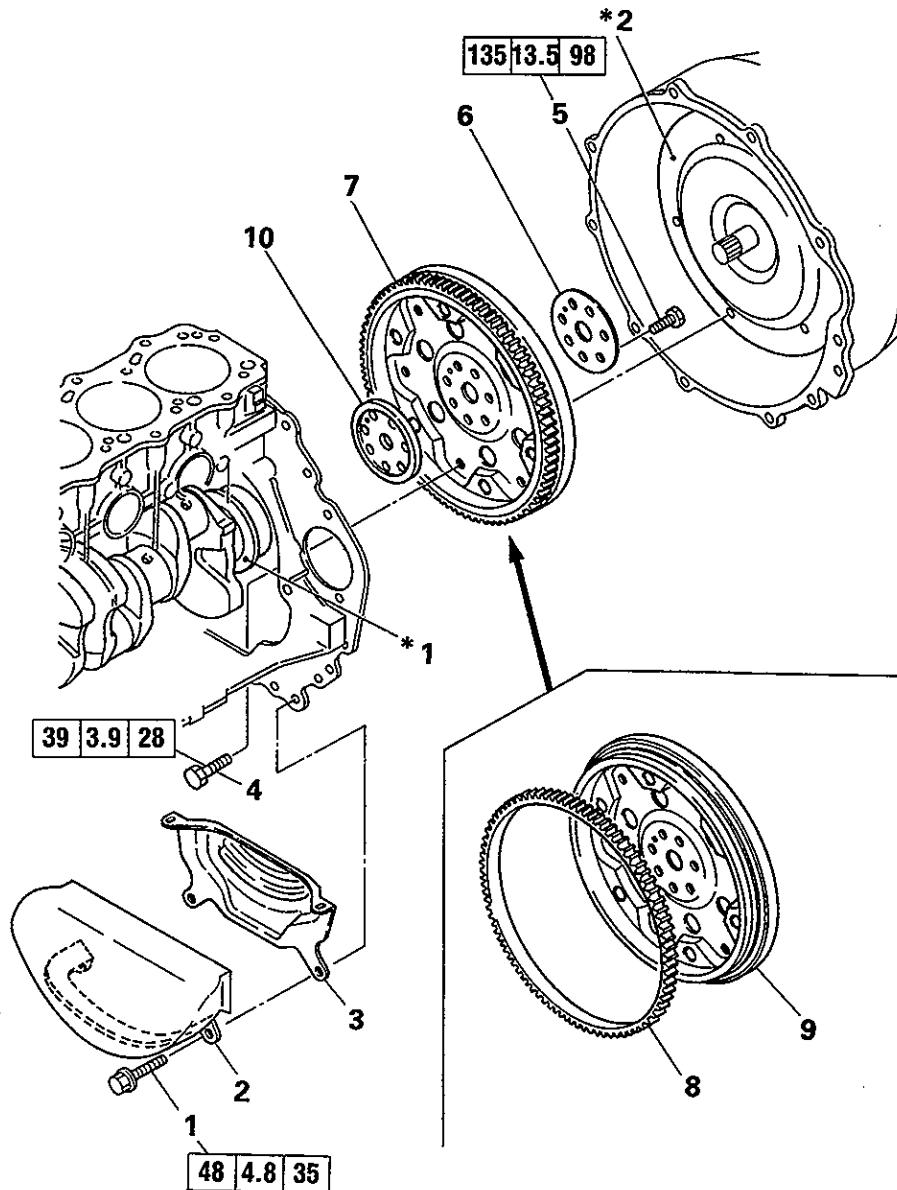
► **A** RING GEAR INSTALLATION

- (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

Ⓐ Ⓑ 7. Drive plate assembly

Ⓑ Ⓒ 8. Ring gear

9. Drive plate

10. Crankshaft adaptor

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

*2: Torque converter

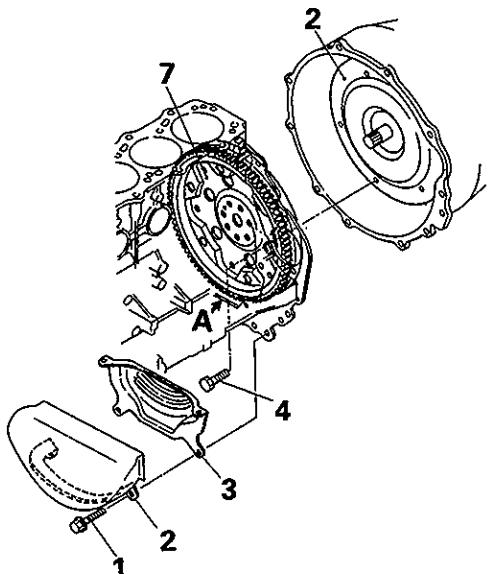
REMOVAL SERVICE POINTS

Ⓐ 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

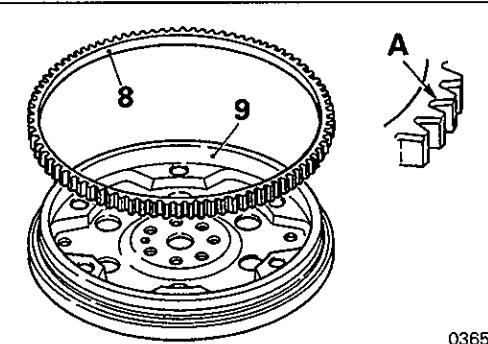
- Never rotate the crankshaft in reverse direction. It may cause damage to the timing chain tensioner. If the crankshaft is accidentally rotated in reverse direction, remove and reinstall the tensioner according to the correct installation procedure.



03648

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

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Ⓑ 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

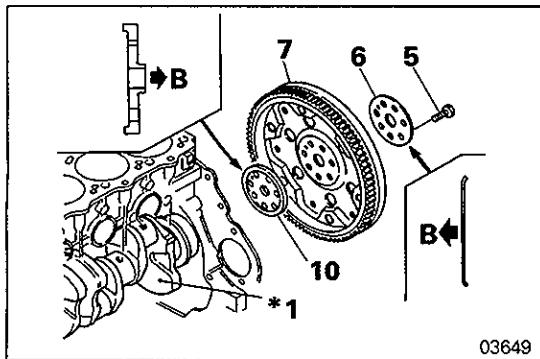
Ⓐ RING GEAR INSTALLATION

- (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

03650

PWEE9409

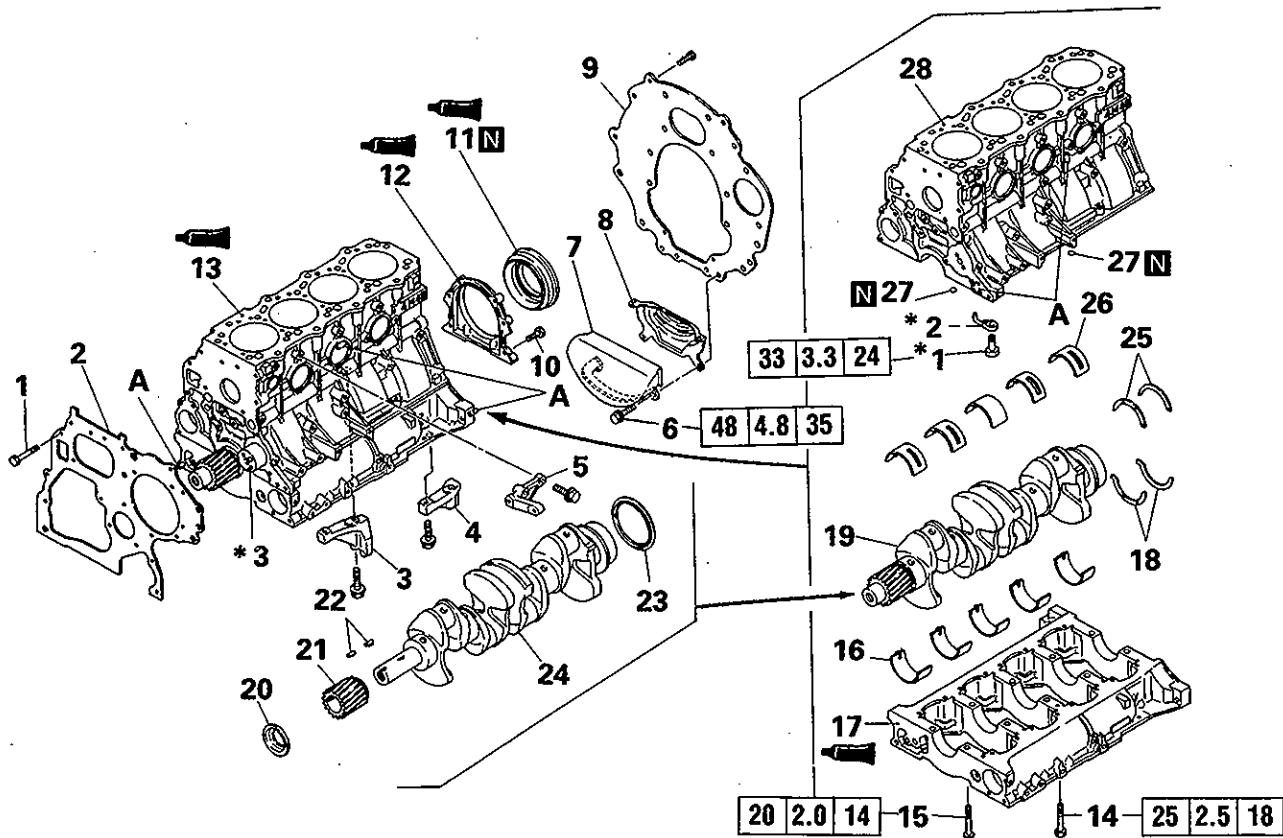


► B DRIVE PLATE ASSEMBLY INSTALLATION

- (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

NOTES

28. CRANKSHAFT AND CRANKCASE REMOVAL AND INSTALLATION



 Apply engine oil to all moving parts before installation.

Removal steps

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

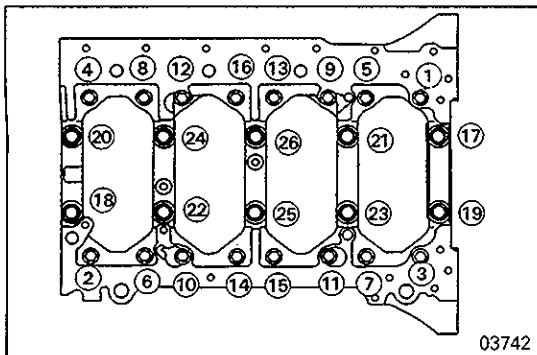
- ◆E◆17. Lower crankcase
- ◆C◆18. Lower thrust plate
- 19. Crankshaft assembly
- 20. Front oil seal slinger
- ◆B◆21. Crankshaft gear
- 22. Key
- ◆A◆23. Rear oil seal slinger
- 24. Crankshaft
- ◆C◆25. Upper thrust plate
- ◆D◆26. Upper main bearing
- 27. O-ring
- 28. Upper crankcase

*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

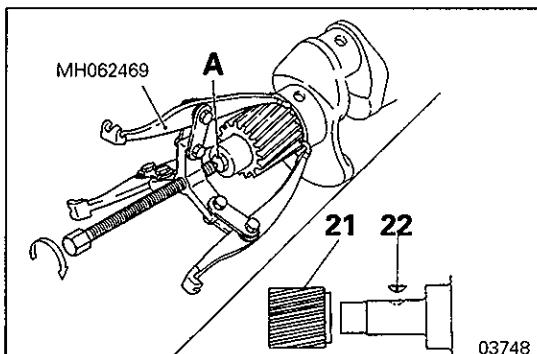
Ⓐ BOLT / MAIN BEARING CAP BOLT REMOVAL

① – ⑯: Bolt **14**

⑰ – ㉖: Main bearing cap bolt **15**

(1) Gradually loosen the bolts **14** in the sequence of numbers ① – ⑯ shown in the illustration.

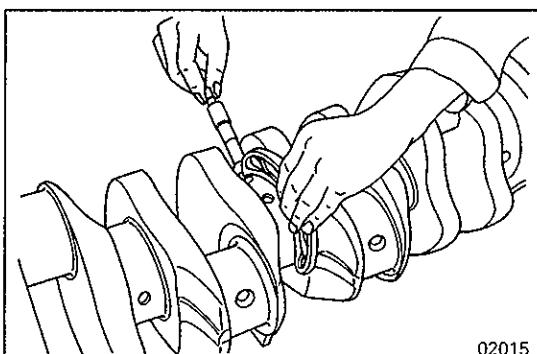
(2) Then, gradually loosen the main bearing cap bolts **15** in the sequence of numbers ⑰ – ㉖ shown, and remove.



Ⓑ 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.

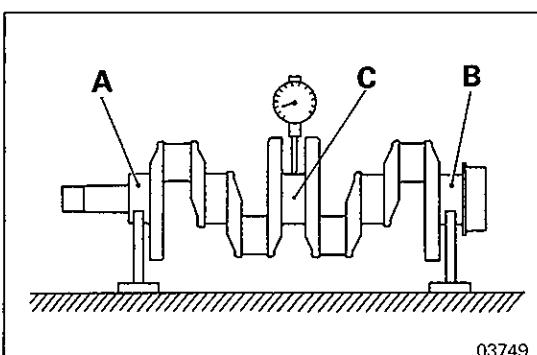


INSPECTION

CRANKSHAFT

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

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

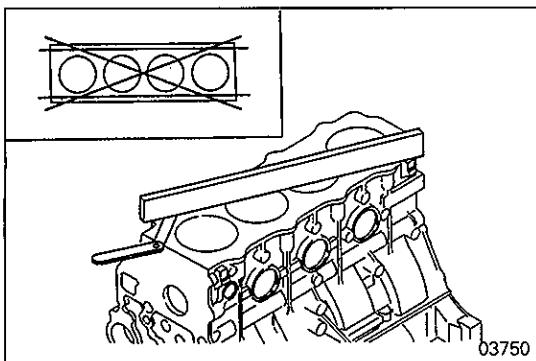


Bend

(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.

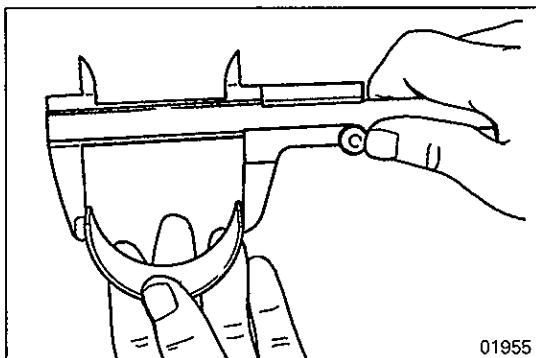
NOTE

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

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



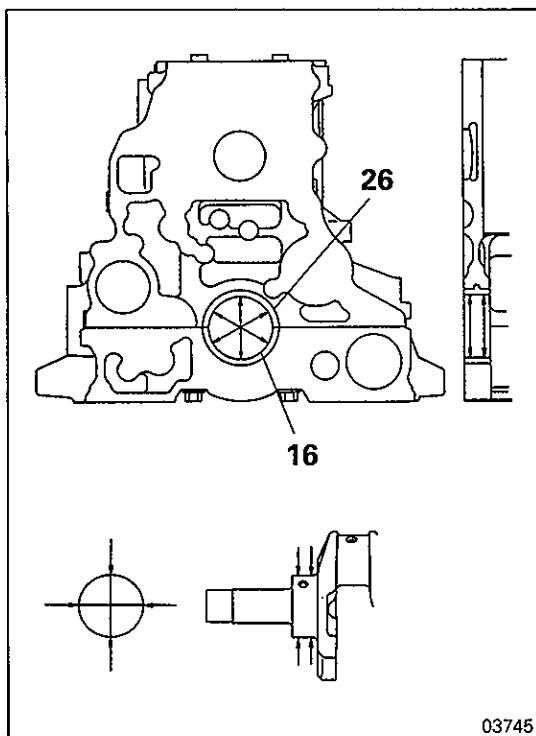
MAIN BEARING

Caution

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

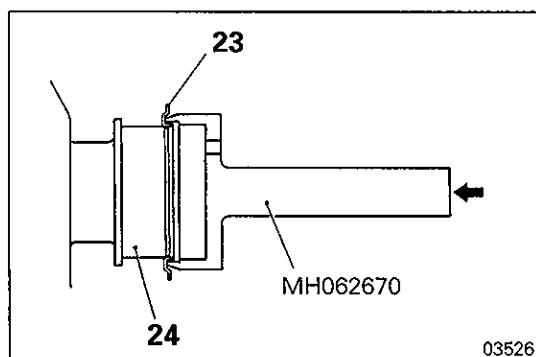
Free Span

- 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

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



INSTALLATION SERVICE POINTS

► REAR OIL SEAL SLINGER INSTALLATION

- 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.

►B4 CRANKSHAFT GEAR INSTALLATION

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

►C4 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.**

►D4 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.

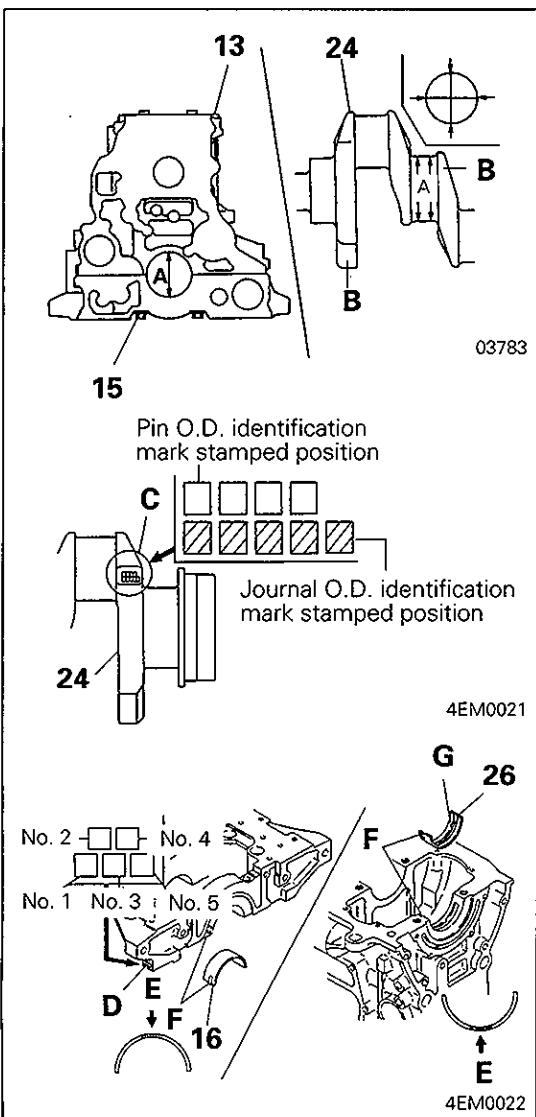
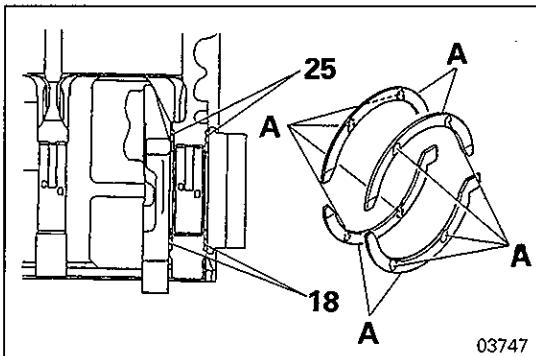
E: Identification color position (side)

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)	
	68 (2.68) -0.030 (-0.0012) -0.039 (-0.0015)	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 (-0.007) -0.022 (-0.009)	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)	
	68 (2.68) -0.030 (-0.0012) -0.039 (-0.0015)	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 (-0.006) -0.018 (-0.007)	0.058 – 0.085 (0.0023 – 0.0033)	

L: Lower main bearing U: Upper main bearing

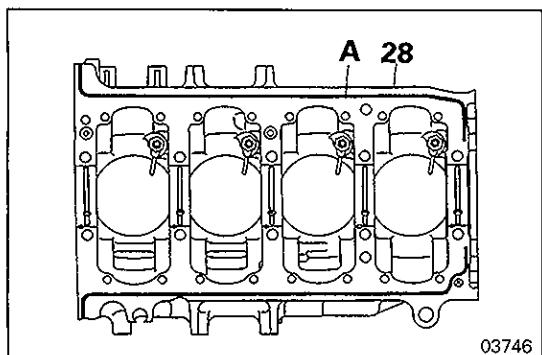
► E LOWER CRANKCASE INSTALLATION

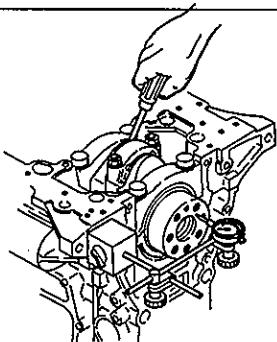
- Apply an even bead of sealant **A** to the illustrated position of the upper crankcase **28**. [Bead diameter: 2 ± 1 mm (0.08 \pm 0.04 in.)]
- Install the lower crankcase **17** to the upper crankcase **28** within 15 minutes after the application of sealant **A**.

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.)





03739

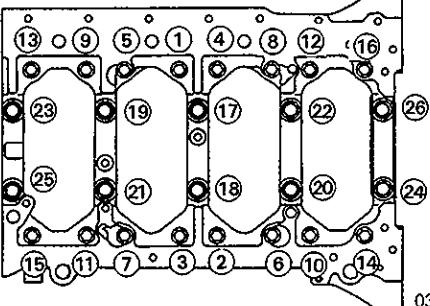
END PLAY OF CRANKSHAFT

- 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.)



03742

◆F◆ BOLT / MAIN CAP BOLT INSTALLATION

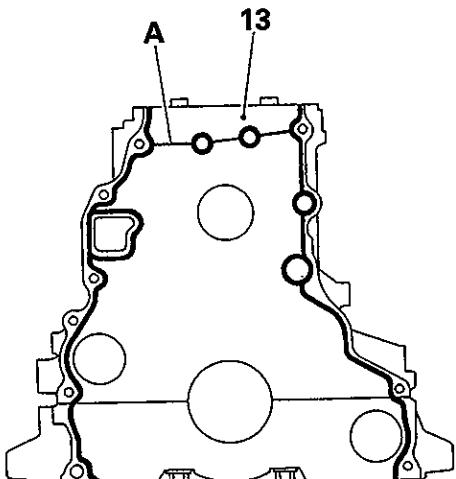
- Apply a thin coat of engine oil to the main bearing cap bolts **15**, and tighten them to 20 Nm (2 kgm, 14 ft.lbs.) in the sequence of numbers **17** – **26** shown in the illustration.
- Then, tighten the bolts 1/4 turn (90 deg.) in the sequence of numbers shown.
- Give them an additional 1/4 turn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

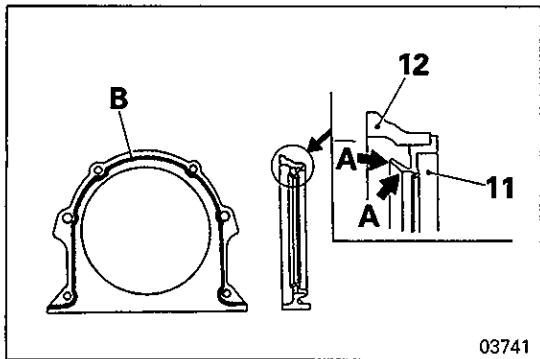
- Apply an even bead of sealant **A** without break to the crankcase assembly **13** where indicated in the illustration. [Bead diameter: 2 ± 1 mm (0.08 \pm 0.04 in.)]
- Install the front plate **2** to the crankcase assembly **13** within 15 minutes after the application of sealant **A**.

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.



03740



►H 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 ± 1 mm (0.12 ± 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.

NOTES

Service Bulletins

Click on the applicable bookmark to select the Service Bulletin.





SERVICE BULLETIN

QUALITY INFORMATION ANALYSIS

OVERSEAS SERVICE DEPT. MITSUBISHI MOTORS CORPORATION

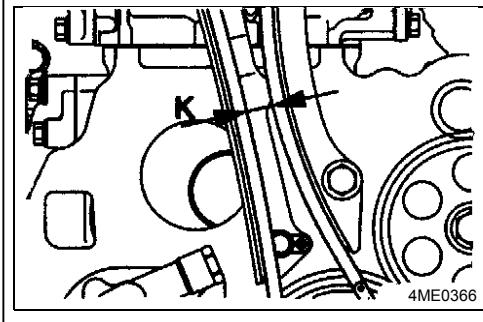
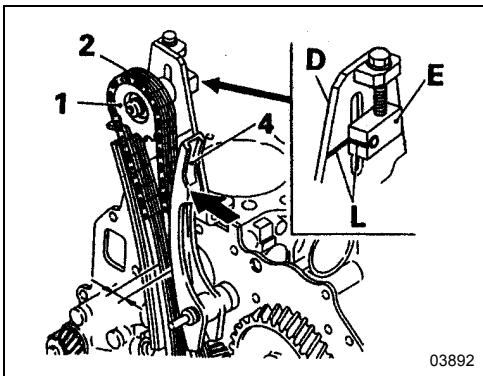
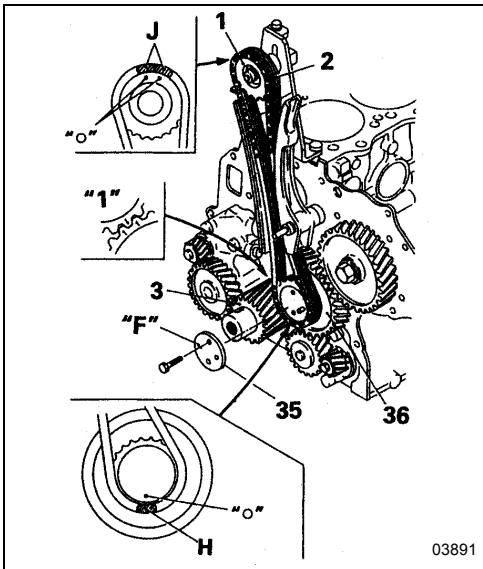
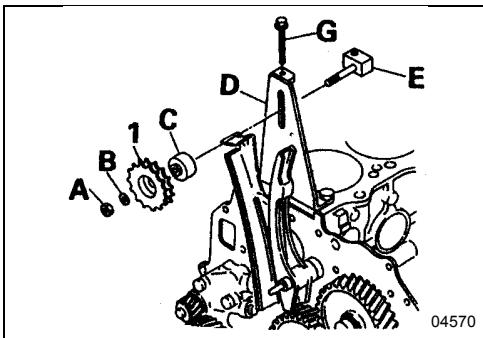
SERVICE BULLETIN		No.: MSB-99E11-505	
		Date: 1999-11-15	<Model> <M/Y>
Subject: ADDED DESCRIPTION OF TIMING CHAIN CLEARANCE MEASUREMENT			(EC,EXP) PAJERO 99-10 (V10,V20,V30,V40)
Group: ENGINE		Draft No.: 99EN531510	
CORRECTION	INTERNATIONAL CAR ADMINISTRATION OFFICE	 T.NITTA - PROJECT LEADER AFTER SALES SERVICE & CS PROMOTION	

1. Description:

Under TIMING CHAIN INSTALLATION, a description has been added of the timing chain clearance measurement.

2. Applicable Manuals:

Manual	Pub. No.	Language	Page(s)
Engine 4M4 Series	PWEE9409	(English)	11A-19-9
Workshop Manual	PWES9410	(Spanish)	
	PWEF9411	(French)	
	PWEG9412	(German)	
	PWED9413	(Dutch)	
	PWEW9414	(Swedish)	



► 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 "o" 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 "o" 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.

Standard value: 16.5 mm
 Limit: 9.0 mm

<Added>

<Added>

Measurement should be carried out at a narrow inside area of the timing chain.



SERVICE BULLETIN

QUALITY INFORMATION ANALYSIS

OVERSEAS SERVICE DEPT. MITSUBISHI MOTORS CORPORATION

SERVICE BULLETIN		No.: MSB-99E11-506REV	
		Date: 2000-12-30	<Model> (EC)PAJERO <M/Y> 94-10 (V10,20,30,40)
Subject: ADDITIONAL DESCRIPTION OF REUSE OF BOLT IN PLASTIC AREA			
Group: ENGINE		Draft No.: 99EN592316	
CORRECTION	INTERNATIONAL CAR ADMINISTRATION OFFICE	 T.NITTA - PROJECT LEADER AFTER SALES SERVICE & CS PROMOTION	

NOTE: This service Bulletin replaces the previous S/B MSB-99E11-506

1. Description:

In the following 4M4 engine Workshop Manual, a description has been added of the reuse of bolts in the plastic area in order to incorporate corrections in the Manual.

2. Applicable Manuals:

Manual	Pub. No.	Language	Page(s)
ENGINE 4M4 Series	PWEE9409	(English)	11A-13-4,
Workshop Manual	PWES9410	(Spanish)	11A-28-6
Engine & Transmission	PWEF9411	(French)	
	PWEG9412	(German)	
	PWED9413	(Dutch)	
	PWEW9414	(Swedish)	

3. Details:

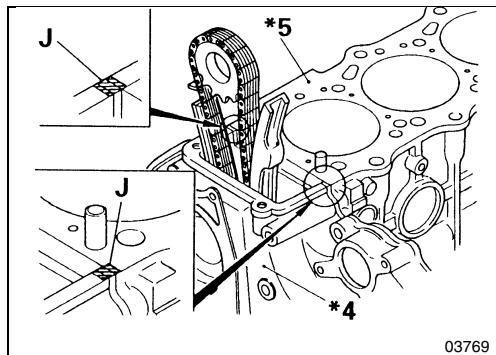
When only the gasket is to be replaced, check the identification mark stamped on the top of the crankcase assembly *5 and choose the one with the same classification mark

NOTE:

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

Caution

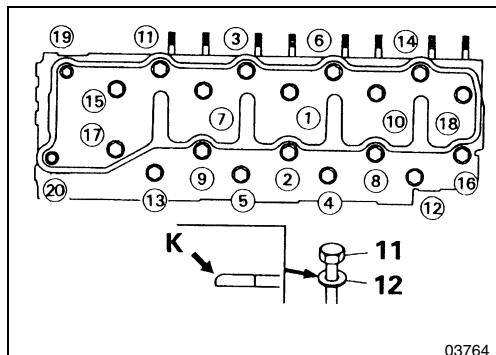
- If a piston, connecting rod, etc. has been replaced, be sure to measure the piston protrusion as the replacement may change the piston protrusion.



→ **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.

A on the following page added here.



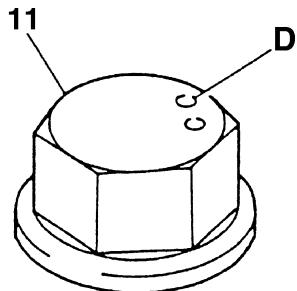
- (5) Tighten the cylinder head bolts 11, M12 bolts of ① through ⑯ and M8 bolts of ⑯ and ⑰, in the sequence of the following steps:
Tightening bolts ①-⑯
 - (a) Fit the washer 12 on each cylinder head bolt 11, with its shear drop side **K** facing in the direction shown in the illustration.
 - (b) Apply 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 direction 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 ⑯ and ⑰

After the tightening of bolts ① through ⑯ is finished, tighten the ⑯ and ⑰ to the specified torque.

B on the following page added here.

<Added> A



21229

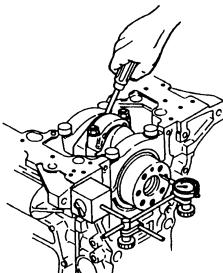
Caution

- If the cylinder head bolt 11 is to be reused, make sure that punch mark D is placed on the head of the cylinder head bolt every time the bolt is reused. The number of punch marks denotes how many times the bolt has been reused in the plastic
- If the bolt to be tightened has three punch marks on its heads, replace the bolt.

<Added> B

Caution

Because cylinder head bolts 11 are fastened by the plastic zone fastening method, do not tighten further after they have been tightened at the specified angle.



03739

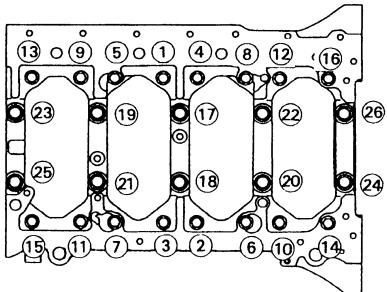
END PLAY OF CRANKSHAFT

- 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>

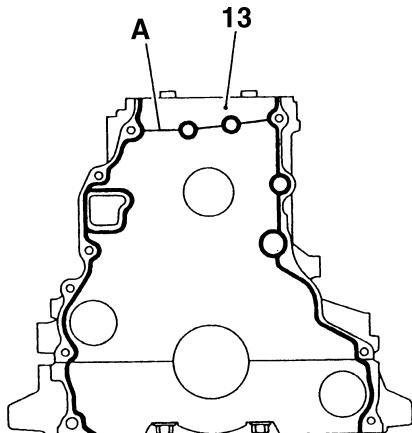
+0.15 mm (+0.0059 in.), +0.30 mm (+0.0118 in.), +0.45 mm
(+0.0177 in.)



03742

→ F ← BOLT / MAIN CAP BOLT INSTALLATION

- 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.
- Then, tighten the bolts $\frac{1}{4}$ turn (90 deg.) in the sequence of numbers shown.
- Give them an additional $\frac{1}{4}$ turn (90 deg.) in the same way as above.
- 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.



03740

→ G ← FRONT PLATE INSTALLATION

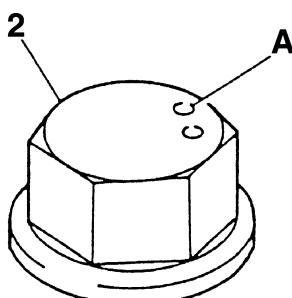
- Apply an even bead of sealant A without break to the crankcase assembly **13** where indicated in the illustration. [Bead diameter: 2 ± 1 mm (0.08 \pm 0.04 in.)]
- Install the front plate **2** to the crankcase assembly **13** within 15 minutes after the application of sealant A.

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. **<Added>**

Caution

Because main cap bolts 2 are fastened by the plastic zone fastening method, do not tighten further after they have been once tightened.



28966

Caution

- If the main cap bolts **2** are to be reused, make sure that punch mark A is placed on the head of each of the main cap bolts every time the bolts are reused. The number of punch marks denotes how many times the bolts have been reused in the plastic area.
- If the bolt to be tightened has three punch marks on its head, replace the bolt.

<Added>