

ENGINE

4D68

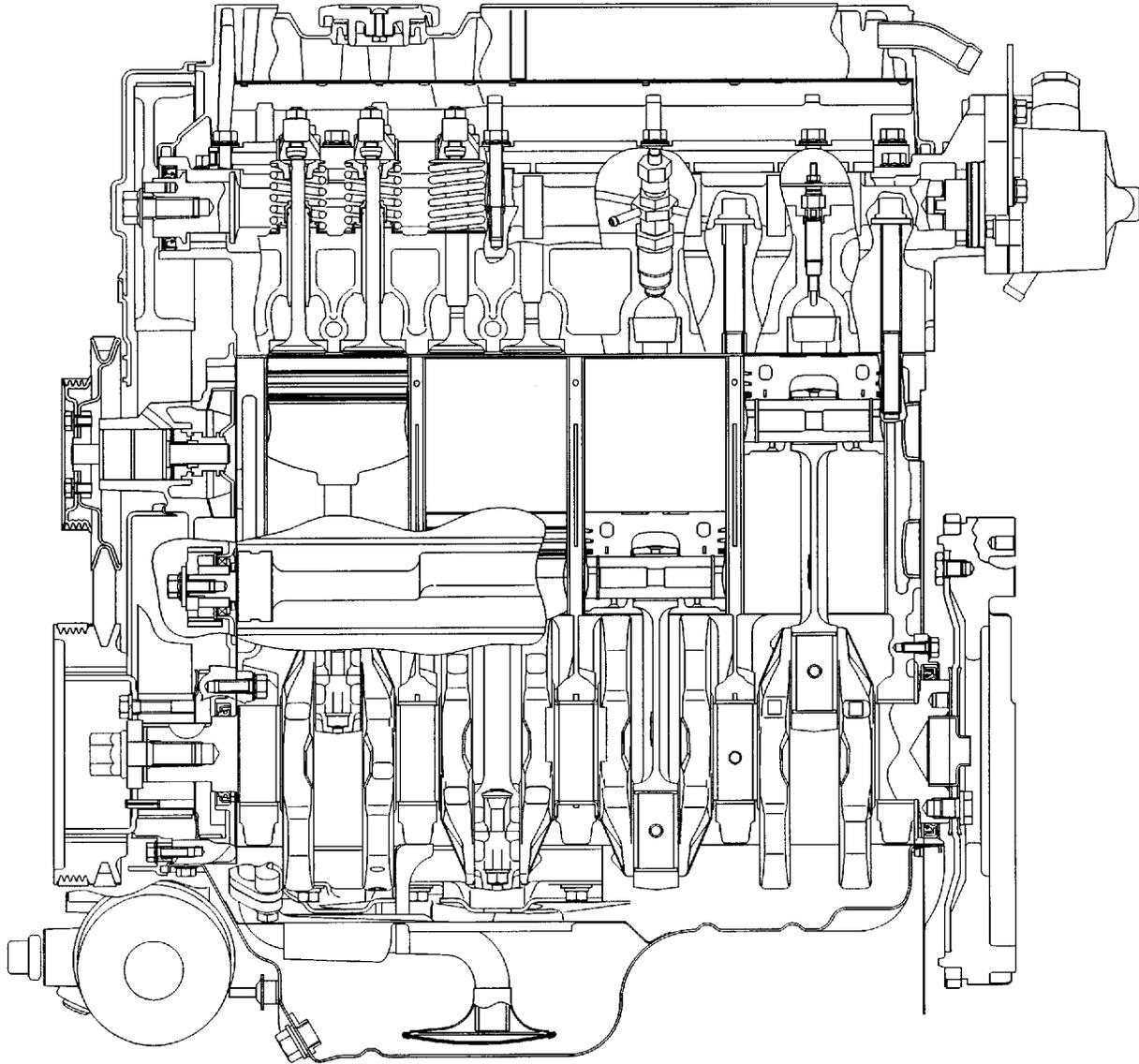
CONTENTS

GENERAL INFORMATION	11A-0-3
1. SPECIFICATIONS	11A-1-1
SERVICE SPECIFICATIONS	11A-1-1
REWORK DIMENSIONS	11A-1-3
TORQUE SPECIFICATIONS	11A-1-4
NEW TIGHTENING METHOD - BY USE OF BOLTS TO BE TIGHTENED IN PLASTIC AREA	11A-1-7
SEALANT	11A-1-7
FORM-IN-PLACE GASKET	11A-1-8
2. SPECIAL TOOLS	11A-2-1
3. DRIVE BELT AND GLOW PLUG	11A-3-1
4. TIMING BELT	11A-4-1
5. GLOW PLUG, FUEL INJECTION PUMP AND INJECTION NOZZLE	11A-5-1
6. INTAKE AND EXHAUST MANIFOLDS	11A-6-1
7. WATER PUMP, THERMOSTAT, HOSE AND PIPES	11A-7-1
8. ROCKER ARMS, ROCKER SHAFT AND CAMSHAFT ...	11A-8-1
9. CYLINDER HEAD, VALVES AND VALVE SPRINGS	11A-9-1
10. FRONT CASE, COUNTERBALANCE SHAFTS AND OIL PAN	11A-10-1
11. PISTONS AND CONNECTING RODS	11A-11-1
12. CRANKSHAFT, CYLINDER BLOCK AND FLYWHEEL ...	11A-12-1

NOTES

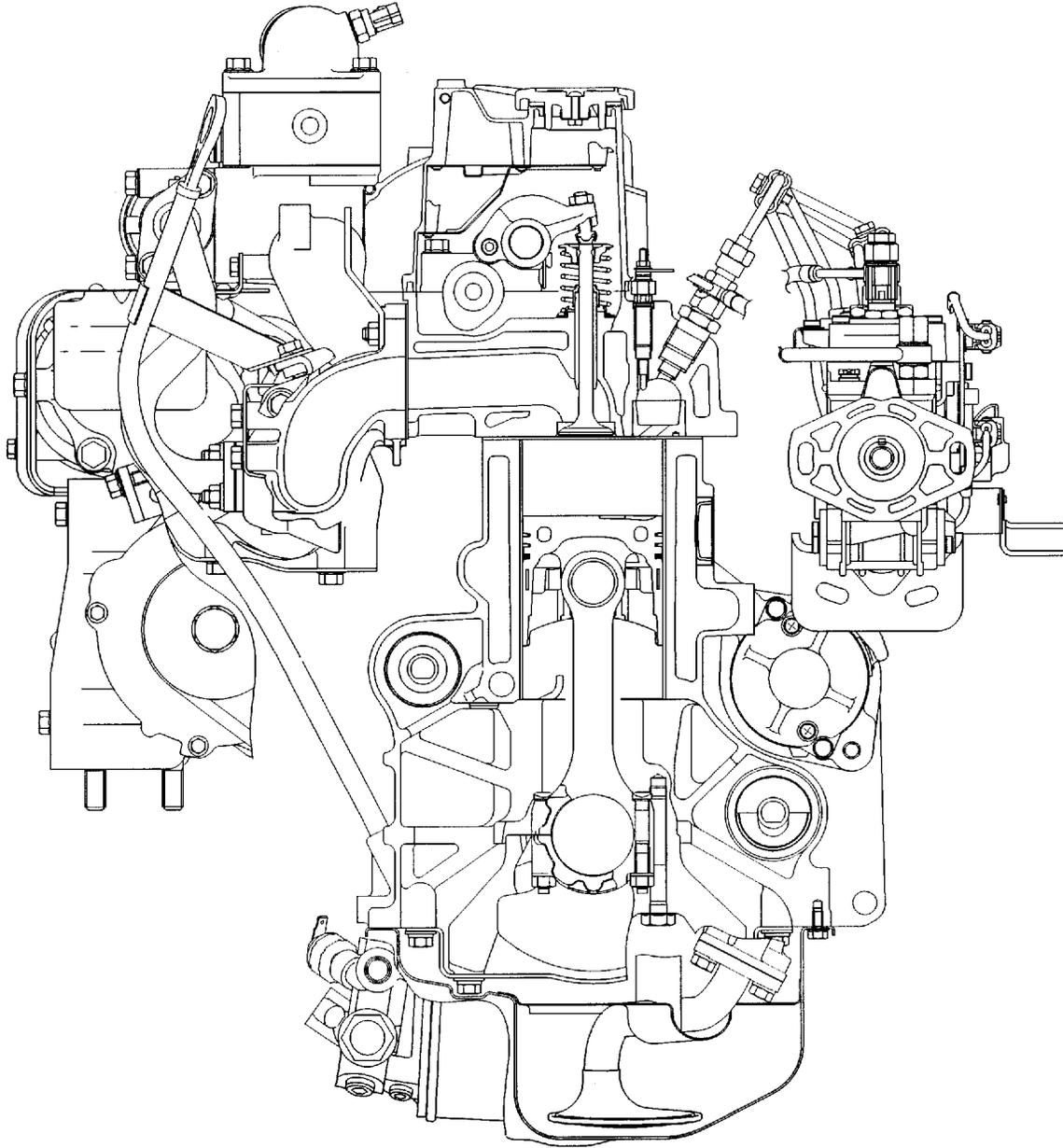
GENERAL INFORMATION

SECTIONAL VIEW OF ENGINE



DEN0883

SECTIONAL VIEW OF ENGINE



DEN0884

GENERAL SPECIFICATIONS

Descriptions		Specifications	
Type		Diesel engine	
Number of cylinders		4 in-line	
Combustion chamber		Swirl chamber	
Total displacement dm ³		1.998	
Cylinder bore mm		82.7	
Piston stroke mm		93	
Compression ratio		22.4	
Valve timing	Intake valve	Opens (BTDC)	20°
		Closes (ABDC)	48°
	Exhaust valve	Opens (BBDC)	54°
		Closes (ATDC)	22°
Lubrication system		Pressure feed, full-flow filtration	
Oil pump type		External gear type	
Cooling system		Water-cooled	
Water pump type		Centrifugal impeller type	
EGR type		Single type	
Fuel system		Electronic control distributor-type injection pump	
Supercharging		Turbocharger	
Rocker arm		Roller type	
Adjusting screw		Elephant foot type	
Oil lever sensor		Provided	

1. SPECIFICATIONS

SERVICE SPECIFICATIONS

Item		Standard value	Limit
Drive belt and glow plug			
Glow plug resistance Ω		0.5	-
Timing belt			
Timing belt deflection mm		4.0-5.0	-
Timing belt "B" deflection mm		5.0-7.0	-
Rocker arms, rocker shaft and camshaft			
Camshaft cam height mm	Intake	41.90	41.40
	Exhaust	41.96	41.46
Valve clearance (on cold engine) mm	Intake	0.25	-
	Exhaust	0.35	-
Camshaft journal O.D. mm		30.0	-
Cylinder head, valves and valve springs			
Cylinder head gasket surface flatness mm		Within 0.03	0.2
Cylinder head overall height mm		86.9-87.1	-
Valve overall length mm	Intake	114.05	113.55
	Exhaust	113.80	113.30
Thickness of valve head (margin) mm		1.5	0.7
Valve stem O.D. mm		6.0	-
Valve face angle		45° - 45.5°	-
Valve stem to guide clearance mm		0.05-0.09	0.15
Valve spring free length mm		49.1	48.1
Valve load/installed height N/mm		240/37.9	-
Valve spring out-of-squareness		2° or less	Max. 4°
Valve seat valve contact width mm		0.9-1.3	-
Valve stem projection mm		43.45	43.95
Valve guide I.D. mm		8.0	-
Valve guide projection from cylinder head upper surface mm		15	-
Cylinder head bolt shank length mm		-	119.7
Front case, counterbalance shafts and oil pan			
Oil cooler by-pass valve dimension (L) [Normal temperature] mm		34.5	-

Item		Standard value	Limit
Oil cooler by-pass valve dimension (L) [by-pass hole closing temperature (97 - 103°C or more)] mm		40.0	-
Oil pump side clearance	Drive gear	0.08 - 0.14	-
	Driven gear	0.06 - 0.12	-
Pistons and connecting rods			
Piston O.D. mm		82.7	-
Piston ring to piston ring groove clearance mm	No. 1	0.05 - 0.07	0.15
	No. 2	0.05 - 0.07	0.15
Piston ring end gap mm	No. 1	0.20 - 0.32	0.8
	No. 2	0.35 - 0.50	0.8
	Oil ring	0.10 - 0.30	0.8
Piston pin O.D. mm		25.0	-
Crankshaft pin oil clearance mm		0.02 - 0.05	0.1
Connecting rod big end side clearance mm		0.10 - 0.25	0.4
Connecting rod bushing I.D. mm		25.015 - 25.025	-
Connecting rod bushing bend (Parallelism between big end center line and small end center line) mm		0.05	-
Connecting rod bushing twist (Deflection between big end center line and small end center line) mm		0.1	-
Crankshaft, cylinder block and flywheel			
Crankshaft end play mm		0.05 - 0.18	0.25
Crankshaft journal O.D. mm		57.0	-
Crankshaft pin O.D. mm		45.0	-
Crankshaft journal oil clearance mm		0.02 - 0.04	0.1
Cylinder block gasket surface flatness mm		0.05	0.1
Cylinder block overall height mm		235	-
Cylinder bore I.D. mm		82.70 - 82.73	-
Cylinder conicity mm		0.01	-
Piston to cylinder clearance mm		0.03 - 0.05	-
Cylinder sleeve press-fitting force N		2,200 or more	-
Piston projection mm		0.823	-

REWORK DIMENSIONS

Item		Standard value	Limit
Cylinder head, valves and valve springs			
Cylinder head oversize valve guide hole (both intake and exhaust) mm	0.05 O.S.	13.050 - 13.068	-
	0.25 O.S.	13.250 - 13.268	-
	0.50 O.S.	13.500 - 13.518	-
Cylinder head oversize intake valve seat ring hole mm	0.3 O.S.	38.300 - 38.325	-
	0.6 O.S.	38.600 - 38.625	-
Cylinder head oversize exhaust valve seat ring hole mm	0.3 O.S.	34.300 - 34.325	-
	0.6 O.S.	34.600 - 34.625	-

NOTE

O.D.: Outer diameter

I.D.: Inner diameter

O.S.: Oversize diameter

TORQUE SPECIFICATIONS

Items		Nm
Drive belt and glow plug		
Oil level gauge guide bolt		13
Pulley bolt (for power steering pump drive)		9
Alternator brace bolt		23
Lock bolt		23
Adjusting bolt		10
Alternator pivot nut		44
Crankshaft pulley bolt		25
Glow plug		18
Glow plug nut		1.8
Timing belt		
Timing belt cover	Flange bolt	11
	Washer bolt	9
Crankshaft position sensor bolt		9
Timing belt tensioner bolt		48
Tensioner spring bolt		13
Timing belt idler pulley bolt		48
Camshaft sprocket bolt		88
Injection pump sprocket flange bolt		9
Injection pump sprocket nut		83
Crankshaft bolt		118
Oil pump sprocket nut		54
Tensioner "B" bolt		18
Counterbalance shaft sprocket bolt		45
Timing belt rear cover bolt		11
Engine support bracket bolt and nut		49
Glow plug, fuel injection pump and injection nozzle		
Injection pipe		29
Injection pipe clamp bolt		5
Fuel pipe bolt		13
Engine hanger bolt		18
Fuel injection pump bolt		23
Fuel injection pump nut		18
Fuel injection pump stay bolt		35
Fuel return pipe nut		29

Items	Nm	
Injection nozzle	54	
Fuel injection pump bracket nut	23	
Intake and exhaust manifold		
Air temperature sensor	14	
Air intake fitting bolt	17	
EGR valve bolt	24	
EGR pipe bolt and nut	17	
Turbocharger heat protector bolt	M8	13
	M6	11
Exhaust fitting heat protector bolt	13	
Water pipe "A" and "B" eye bolt	30	
Water pipe "A" and "B" bolt	10	
Oil pipe eye bolt	16	
Exhaust fitting bolt and nut	59	
Oil return pipe bolt	9	
Heat protector front and rear bolt	13	
Turbocharger assembly bolt	59	
Exhaust manifold bolt and nut	29	
Alternator brace stay bolt	23	
Intake manifold bolt and nut	17	
Water pump, thermostat, hose and pipe		
Oil pipe eye bolt	16	
Oil return pipe eye bolt	17	
Oil return pipe bolt	9	
Engine coolant temperature sensor	35	
Engine coolant temperature gauge unit	11	
Cover bolt	19	
Water pump bolt	13	
Water inlet pipe bolt	12	
Vacuum pump bolt	22	
Water inlet fitting bolt	23	
Water outlet fitting bolt	12	
Thermostat housing bolt	23	
Rocker arms, rocker shaft and camshaft		
Rocker cover bolt	6	
Rocker shaft bolt	29	

Items		Nm
Adjusting nut		15
Camshaft bearing cap bolt	M8 × 25, M8 × 40	20
	M8 × 55	29
Cylinder head, valves and valve springs		
Cylinder head bolt		90 ↓ Fully loosen ↓ 40 + 90° + 90°
Front case, counterbalance shafts and oil pan		
Drain plug		39
Oil level sensor bolt		9
Oil pan bolt		7
Oil screen bolt		19
Oil cooler by-pass valve		54
Oil pressure switch		10
Relief plug		44
Oil filter bracket bolt		18
Plug		23
Flange bolt		36
Front case bolt		24
Oil pump cover	Bolt	16
	Screw	10
Pistons and connection rods		
Connecting rod cap nut		20 ↓ +90° - 100°
Crankshaft, cylinder block and flywheel		
Flywheel bolt		132
Rear plate bolt		11
Oil seal case bolt		11
Bearing cap bolt		25 ↓ +90° - 100°
Check valve		15

NEW TIGHTENING METHOD - BY USE OF BOLTS TO BE TIGHTENED IN PLASTIC AREA

A new type of bolts, to be tightened in plastic area, is currently used some parts of the engine. The tightening method for the bolts is different from the conventional one. Be sure to observe the method described in the text when tightening the bolts.

Service limits are provided for the bolts. Make sure that the service limits described in the text are strictly observed.

- Areas where the bolts are in use:
 - (1) Cylinder head bolts
 - (2) Main bearing cap bolts
 - (3) Connecting rod cap bolts
- Tightening method
After tightening the bolts to the specified torque, tighten them another 90° or 180° (twice 90°). The tightening method varies on different areas. Observe the tightening method described in the text.

SEALANT

Items	Specified sealant	Quantity
Thermostat housing	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Engine coolant temperature gauge unit	3M Nut Locking Part No. 4171 or equivalent	As required
Oil pressure switch	3M ATD Part No. 8660 or equivalent	As required
Water outlet fitting	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Oil pan	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Oil seal case	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Cover	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Camshaft bearing cap	3M ATD Part No. 8660 or equivalent	As required

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.

The FIPG used in the engine is a room temperature vulcanization (RTV) type and is supplied in a 100-gram tube (Part No. MD970389 or MD997110). Since the RTV hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas. The FIPG, Part No. MD970389, can be used for sealing both engine oil and coolant, while Part No. 997110 can only be used for engine oil sealing.

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 and thin 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. For removal of the oil pan, the special tool "Oil Pan Remover" (MD998727) is available. Be sure to use the special tool to remove the oil pan.

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 remained in the bolt holes.

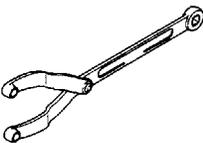
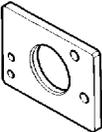
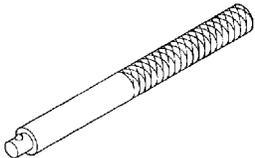
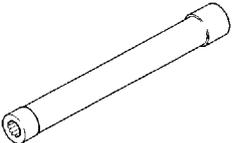
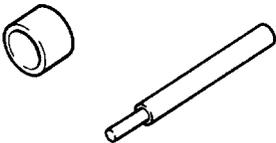
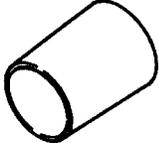
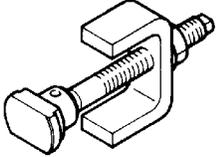
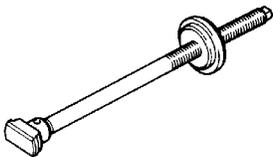
Form-In-Place Gasket Application

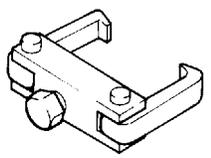
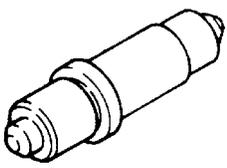
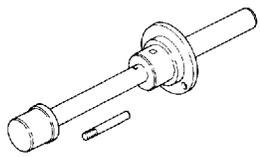
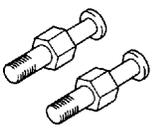
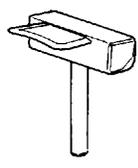
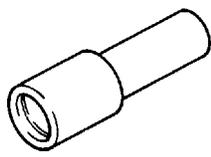
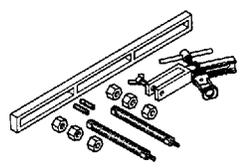
When assembling parts with the FIPG, you must observe some precautions, but the procedure is very simple as in the case of a conventional pre-cut gasket.

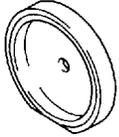
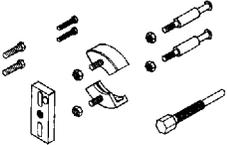
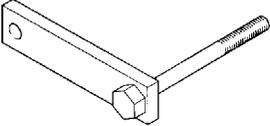
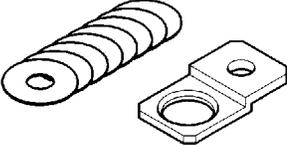
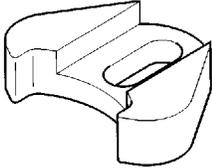
Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only. In addition, do not apply any oil or water to the sealing locations or start the engine until a sufficient amount of time (about one hour) has passed after installation is completed.

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

2. SPECIAL TOOLS

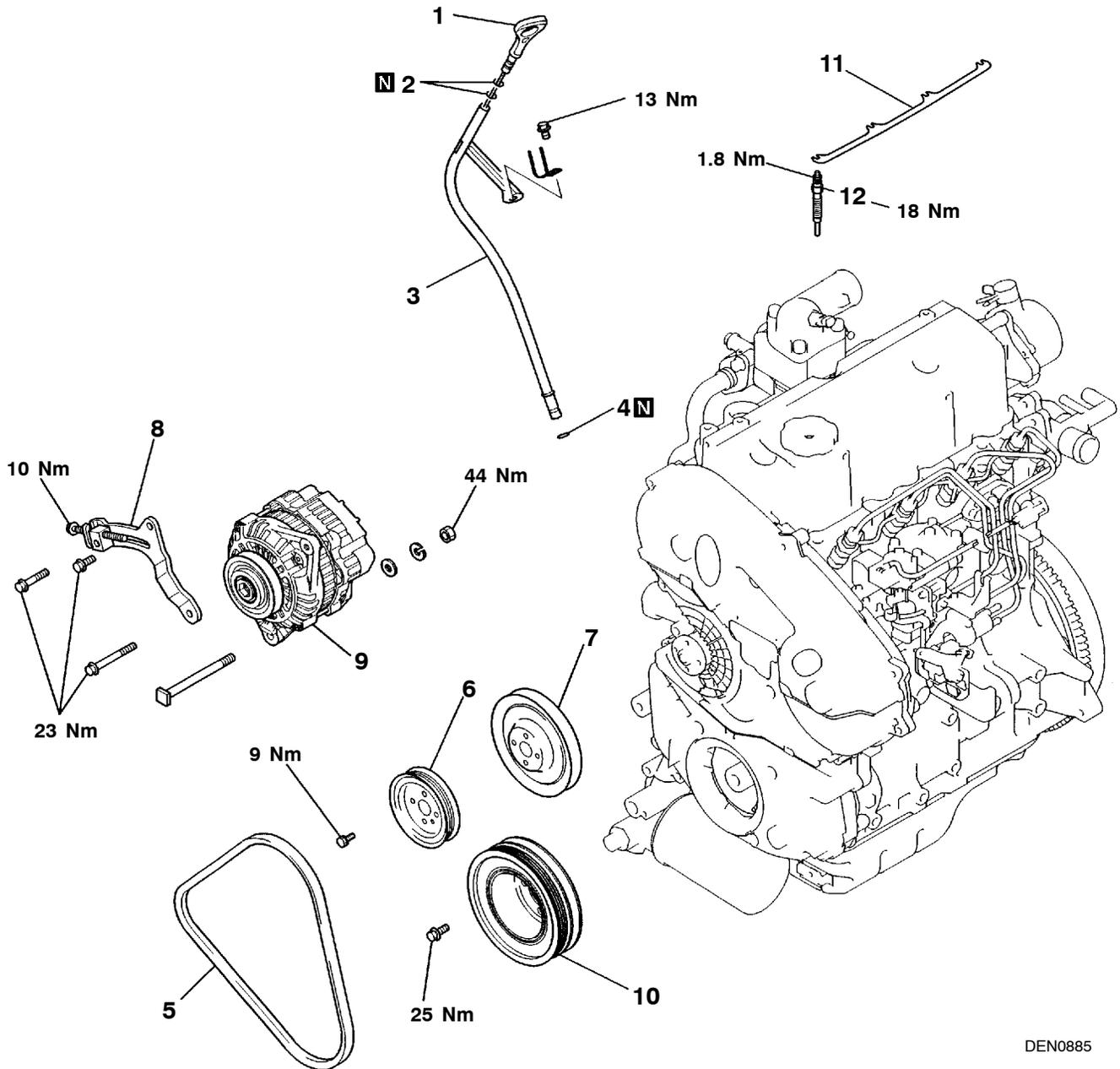
Tool	Number	Name	Use
	MB990767	End yoke holder	Holding camshaft sprocket or fuel injection pump when loosening or tightening bolts. Use with MD998719
	MB991603	Bearing installer stopper	A guide for removal and installation of counterbalance shaft left rear bearing
	MD990938	Handle	Installation of crankshaft rear oil seal (Use with MD998776)
	MB991654	Cylinder head bolt wrench	Tightening and loosening of cylinder head bolt
	MD998115	Valve guide installer	Removal and installation of valve guide
	MD998162	Plug wrench	Removal and installation of front case cap plug (Use with MD998783)
	MD998285	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal
	MD998371	Silent shaft bearing puller	Removal of counterbalance shaft front bearing
	MD998372	Silent shaft bearing puller	Removal of counterbalance shaft rear bearing

Tool	Number	Name	Use
	MD998375	Crankshaft front oil seal installer	Installation of crankshaft front oil seal
	MD998388	Injection pump sprocket puller	Removal of injection pump sprocket
	MD998702	Connecting-rod small-end bushing replacement tool	Replacement of connecting-rod small-end bushing
	MD998705	Silent shaft bearing installer	Installation of counterbalance shaft bearing
	MD998713	Camshaft oil seal installer	Installation of camshaft oil seal
	MD998719	Pulley holder pin (2)	Use with MB990767
	MD998727	Oil pan sealer cutter	Removal of oil pan
	MD998729	Valve stem seal installer	Installation of valve stem seal
	MD998772	Valve spring compressor	Compression of valve spring

Tool	Number	Name	Use
	MD998776	Crankshaft rear oil seal installer	Installation of crankshaft rear oil seal (Use with MB990938)
	MD998778	Crankshaft sprocket puller	Removal of crankshaft sprocket
	MD998781	Flywheel stopper	Holding of flywheel and drive plate
	MD998783	Plug wrench retainer	Removal and installation of front case cap plug (Use with MD998162)
	MD998785	Sprocket stopper	Holding of counterbalance shaft sprocket

3. DRIVE BELT AND GLOW PLUG

REMOVAL AND INSTALLATION



DEN0885

Removal steps

1. Oil level gauge
2. O-ring
3. Oil level gauge guide
4. O-ring
5. Drive belt (V-type)
6. Pulley (for power steering pump drive)

7. Water pump pulley
8. Alternator brace
9. Alternator
10. Crankshaft pulley
11. Glow plug plate
12. Glow plug



REMOVAL SERVICE POINTS**◀A▶ GLOW PLUG REMOVAL**

- (1) When removing the glow plug, you may loosen using a tool up to the point where one or more threads are left in engagement. Beyond this point, loosen with fingers.

Caution

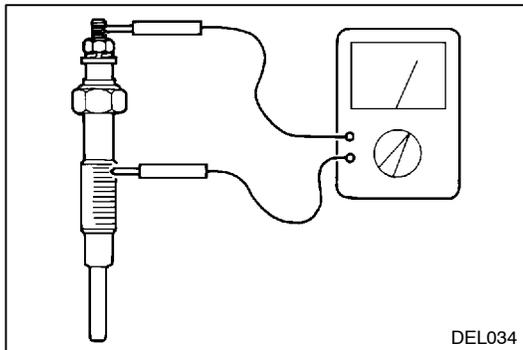
- Do not reuse a glow plug that has been dropped from a height of 10 cm or more.

INSTALLATION SERVICE POINTS**▶A◀ GLOW PLUG INSTALLATION**

- (1) When installing the glow plug, screw in one thread or more with fingers and then tighten with a tool.

Caution

- Do not reuse a glow plug that has been dropped from a height of 10 cm or more.



DEL034

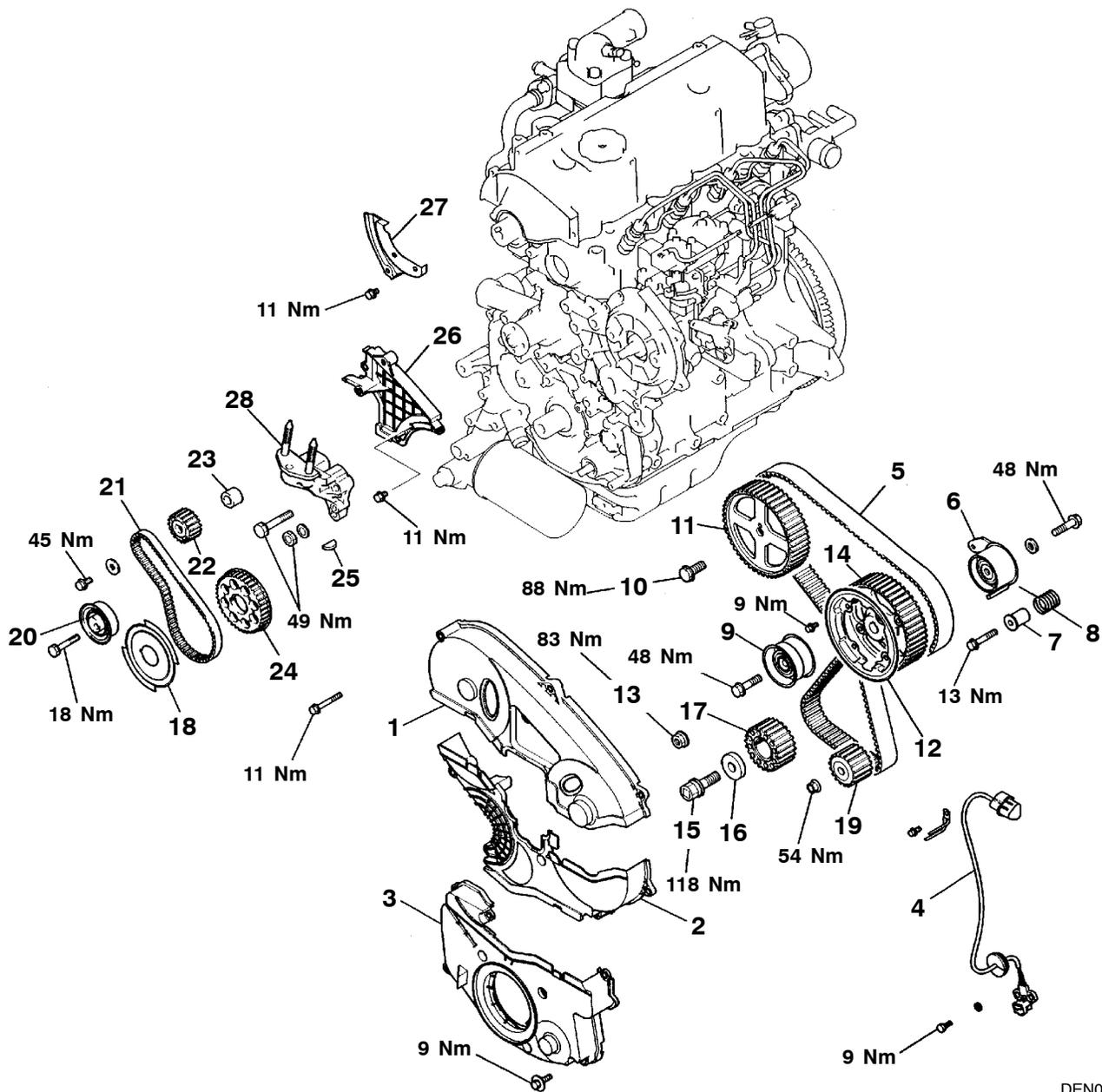
INSPECTION**GLOW PLUG**

- (1) Check the glow plugs for continuity between the terminal and the body as shown. Replace the glow plugs which show no continuity or too large a resistance.

Standard value: 0.5 Ω

4. TIMING BELT

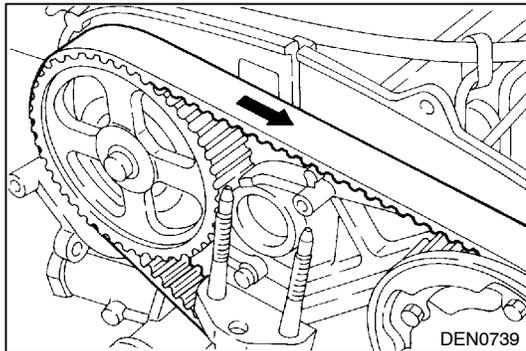
REMOVAL AND INSTALLATION



DEN0886

Removal steps

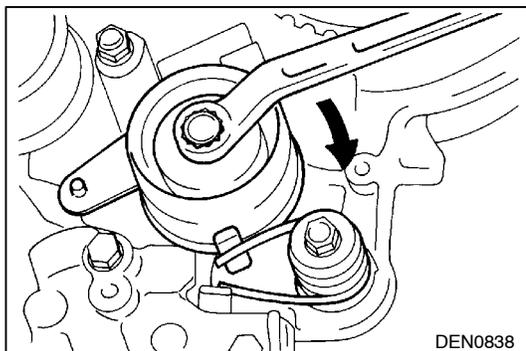
- | | | | | |
|-----|-----------------------------------|-----|-----|-----------------------------------|
| | 1. Timing belt front upper cover | | | 15. Crankshaft bolt |
| | 2. Timing belt front center cover | | | 16. Special washer |
| | 3. Timing belt front lower cover | | | 17. Crankshaft sprocket |
| | 4. Crankshaft position sensor | | | 18. Crankshaft sensing blade |
| ◀A▶ | 5. Timing belt | ▶E▶ | ▶E▶ | 19. Oil pump sprocket |
| ▶I▶ | 6. Timing belt tensioner | ▶F▶ | ▶D▶ | 20. Tensioner "B" |
| ▶H▶ | 7. Tensioner spacer | ▶G▶ | ▶C▶ | 21. Timing belt "B" |
| | 8. Tensioner spring | ▶H▶ | ▶B▶ | 22. Counterbalance shaft sprocket |
| ▶B▶ | 9. Timing belt idler pulley | ▶I▶ | ▶A▶ | 23. Spacer |
| ▶G▶ | 10. Camshaft sprocket bolt | ▶J▶ | | 24. Crankshaft sprocket "B" |
| | 11. Camshaft sprocket | | | 25. Key |
| ▶C▶ | 12. Flange | | | 26. Timing belt rear center cover |
| ▶D▶ | 13. Injection pump sprocket nut | | | 27. Timing belt rear right cover |
| | 14. Injection pump sprocket | | | 28. Engine support bracket |



REMOVAL SERVICE POINTS

◀A▶ TIMING BELT REMOVAL

- (1) Using chalk, etc., mark an arrow on the back of the timing belt to indicate the direction of rotation. This is to ensure correct installation of the belt in case it is reused.



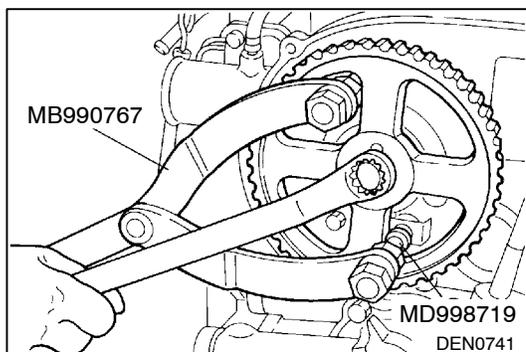
- (2) Attach a bolt to the front end face of the timing belt tensioner. Fit an offset wrench onto the bolt and turn the wrench downward as shown to tighten the tensioner mounting bolt temporarily.

Caution

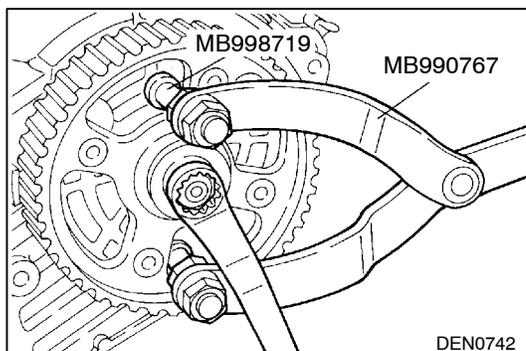
- Use such a short bolt as would not come into contact with the timing belt tensioner mounting bolt at the rear end face when it is tightened.

- (3) Remove the timing belt.

◀B▶ CAMSHAFT SPROCKET BOLT LOOSENING

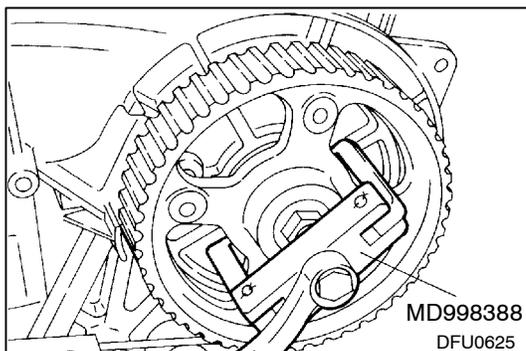


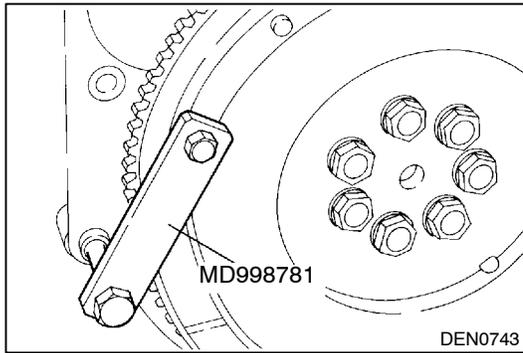
◀C▶ INJECTION PUMP SPROCKET NUT LOOSENING



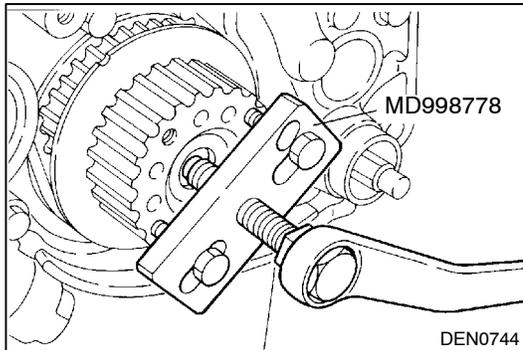
◀D▶ INJECTION PUMP SPROCKET REMOVAL

- (1) Do not strike the sprocket and drive shaft to remove these parts.

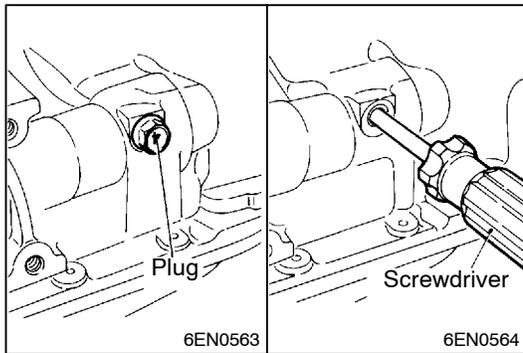




◀E▶ CRANKSHAFT BOLT LOOSENING



◀F▶ CRANKSHAFT SPROCKET REMOVAL

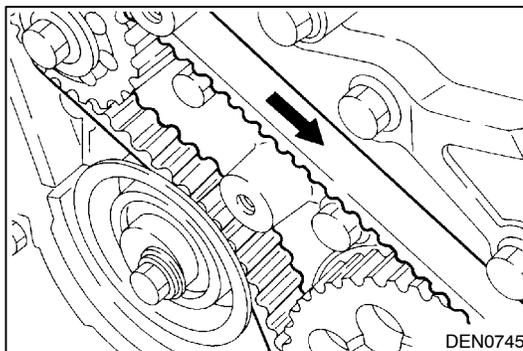


◀G▶ OIL PUMP SPROCKET REMOVAL

- (1) Before loosening the oil pump sprocket nut (flange nut), remove the timing belt and then the plug at the left side of the cylinder block and insert a Phillips screwdriver [shank diameter 8 mm] through the plug hole to keep the left counterbalance shaft in position.

Caution

- If the nut is loosened without removing the timing belt, the force produced by loosening the nut will be borne by the belt and can cause damage to the belt cogs.

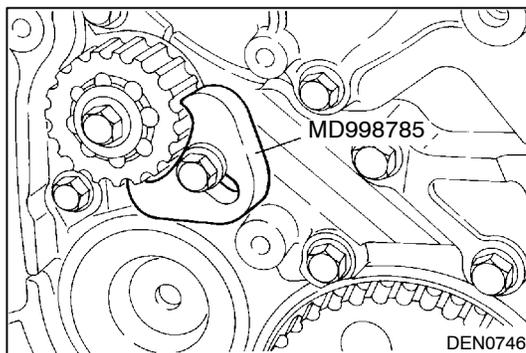


◀H▶ TIMING BELT "B" REMOVAL

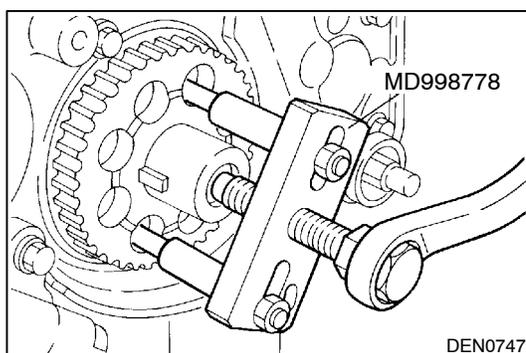
- (1) Using chalk, etc., mark an arrow on the back of the timing belt to indicate the direction of rotation. This is to ensure correct installation of the belt in case it is reused.

NOTE

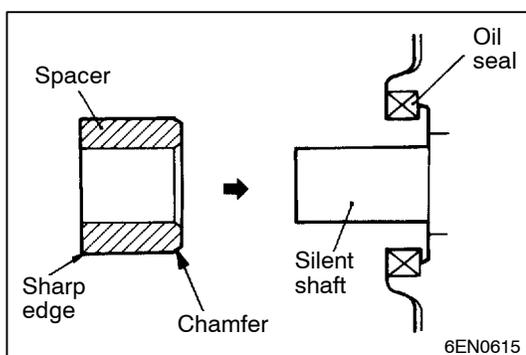
- (1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
- (2) If there is oil or water on any part, check the front case oil seals, camshaft oil seal and water pump for leaks.



◀▶ COUNTERBALANCE SHAFT SPROCKET REMOVAL



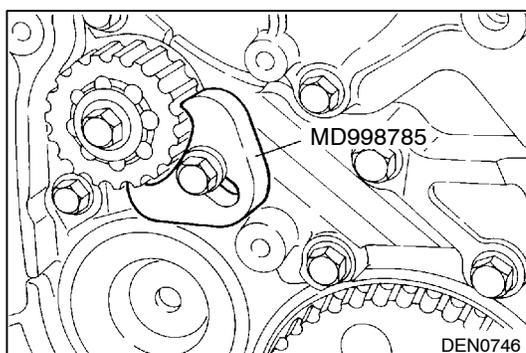
◀▶ CRANKSHAFT SPROCKET "B" REMOVAL



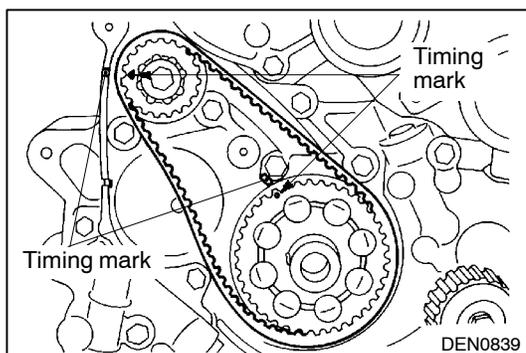
INSTALLATION SERVICE POINTS

▶▶ SPACER INSTALLATION

- (1) Install the spacer with the chamfered end toward the oil seal.

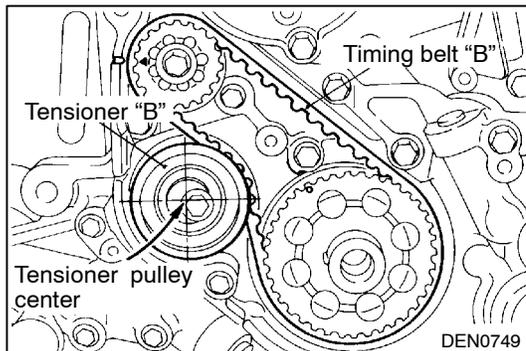


▶▶ COUNTERBALANCE SHAFT SPROCKET INSTALLATION

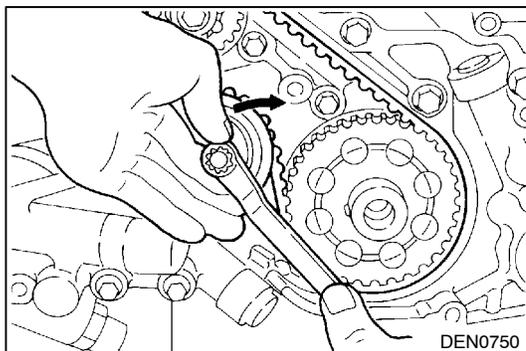


▶▶ TIMING BELT "B" INSTALLATION

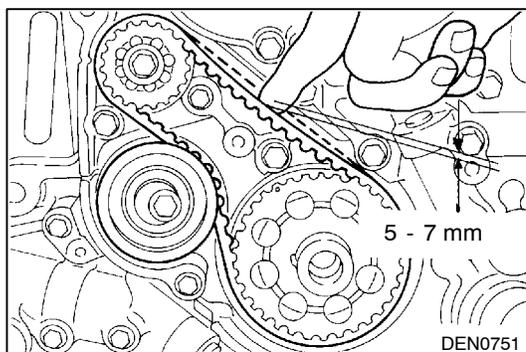
- (1) Align the timing marks on the crankshaft sprocket "B" and sprocket with the marks on the front case respectively.
- (2) Install the timing belt "B" on the crankshaft sprocket "B" and counterbalance shaft sprocket. There should be no slack on the tension side.



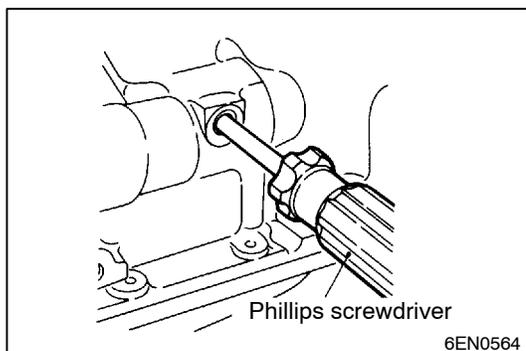
- (3) Make sure that the pulley center and the bolt center are located as shown in the illustration.



- (4) Move the tensioner "B" in the direction of arrow while lifting with a finger to give a sufficient tension to the tension side of the timing belt. In this condition, tighten the bolt to secure tensioner "B". When the bolt is tightened, use care to prevent the shaft from turning together. If the shaft is turned together, the belt will be overtensioned.

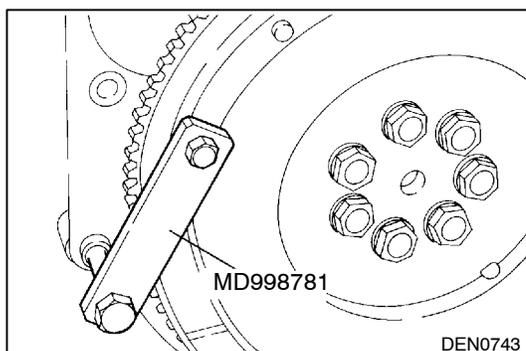


- (5) Check to ensure that the timing marks on the sprockets and the front case are in alignment.
 (6) Press with index finger the center of span on the tension side of timing belt "B". The bolt must deflect 5 to 7 mm.

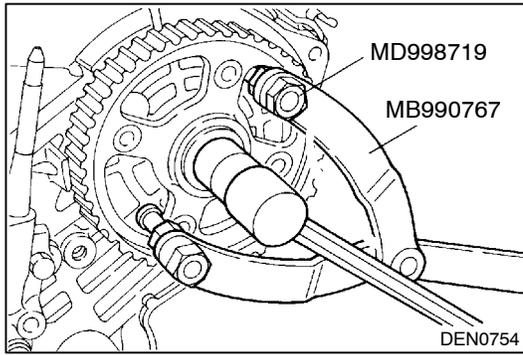


►D◄ OIL PUMP SPROCKET INSTALLATION

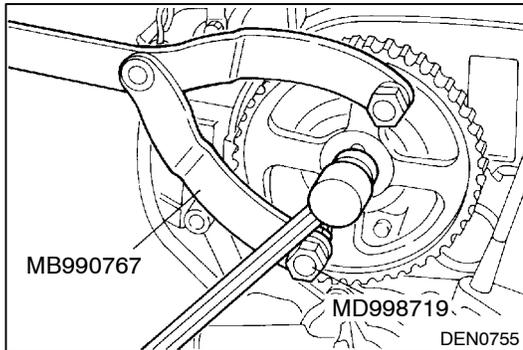
- (1) Keep the counterbalance shaft in position in the same way as when it was loosened.
 (2) Install the oil pump sprocket.
 (3) Apply a minimum quantity of engine oil to the bearing surface of the nut.
 (4) Tighten the nuts to the specified torque.



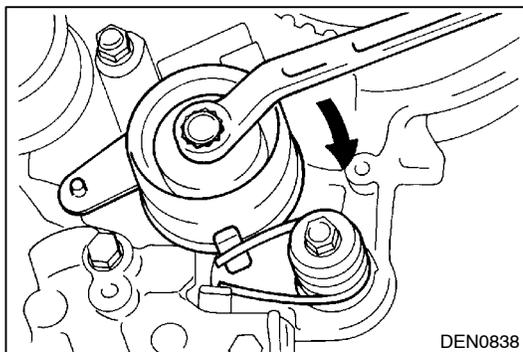
►E◄ CRANKSHAFT BOLT TIGHTENING



►F◄ INJECTION PUMP SPROCKET NUT TIGHTENING



►G◄ CAMSHAFT SPROCKET BOLT TIGHTENING

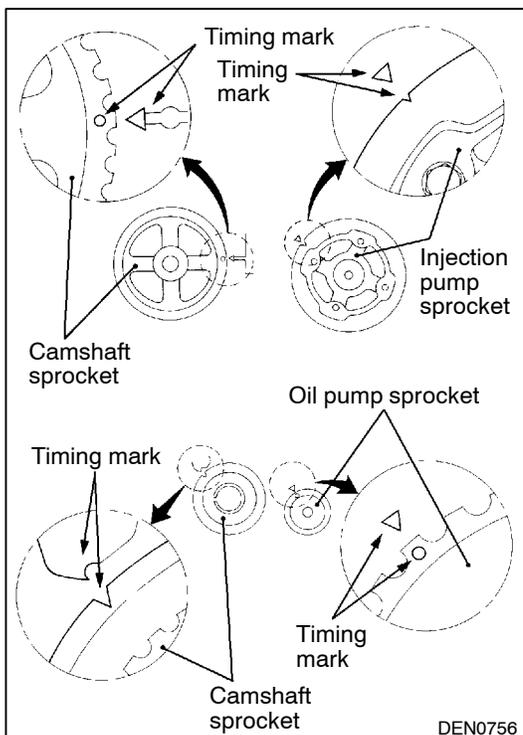


►H◄ TIMING BELT TENSIONER INSTALLATION

- (1) Set the tensioner spring ends against the tensioner bracket and the projection of the injection pump bracket.
- (2) Attach a bolt to the front end face of the timing belt tensioner. Fit an offset wrench onto the bolt and turn the wrench downward as shown to tighten the tensioner mounting bolt temporarily.

Caution

- Use such a short bolt as would not come into contact with the timing belt tensioner mounting bolt at the rear end face when it is tightened.

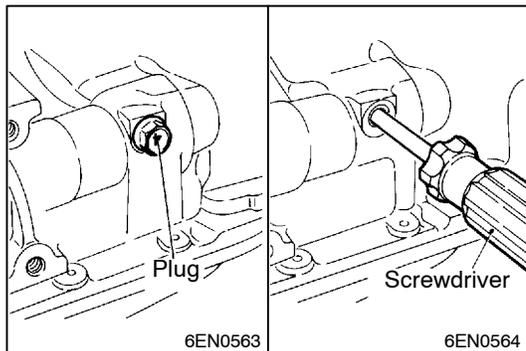


►I◄ TIMING BELT INSTALLATION

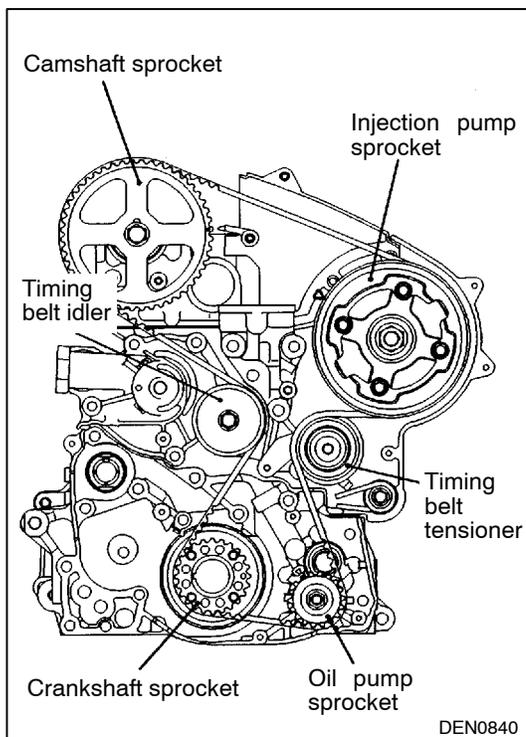
- (1) Temporarily fix the tensioner at the most lower position in the injection pump bracket slot.
- (2) Turn the crankshaft to bring the No. 1 piston at the top dead center on the compression stroke.
- (3) Align the timing marks of all sprockets with their mating marks as shown.

NOTE

If the injection pump sprocket is released, it turns about one tooth in a counterclockwise direction. Therefore, the timing mark of the injection pump sprocket should be aligned when the timing belt is installed.



- (4) Remove the plug on the cylinder block and insert a Phillips screwdriver [shank diameter 8 mm] through the hole. If it can be inserted as deep as 60 mm or more, the timing marks are correctly aligned. If the inserted depth is only 20 - 25 mm, turn the oil pump sprocket one turn and realign the timing marks. Then check to ensure that the screwdriver can be inserted 60 mm or more. Keep the screwdriver inserted until installation of the timing belt is finished.



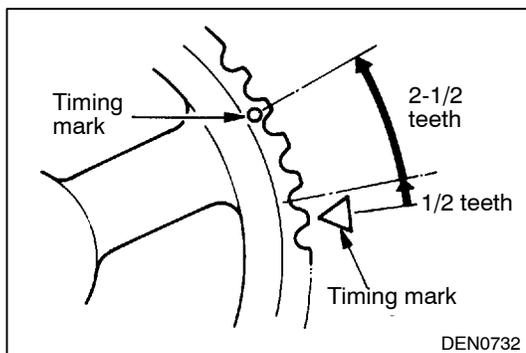
- (5) Install the timing belt on the sprockets in the following sequence while taking care so that the belt is not slack between sprockets or between sprocket and pulley.

- 1 Crankshaft sprocket
- 2 Timing belt idler
- 3 Camshaft sprocket
- 4 Injection pump sprocket
- 5 Oil pump sprocket
- 6 Turn the crankshaft in the reverse direction by 1/2 tooth of the camshaft sprocket to remove the slackness of the belt on the idler side.
- 7 Timing belt tensioner

NOTE

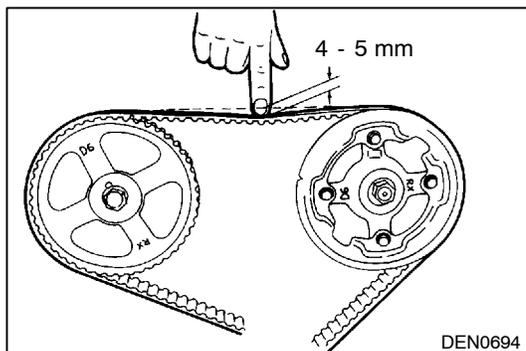
To install the timing belt on the injection pump sprocket, use an offset wrench or a similar tool and align the injection pump sprocket timing mark with the mark in the engine.

- (6) Loosen the tensioner mounting bolt 1/4 - 1/3 turn and allow the spring tension to move the tensioner against the belt.



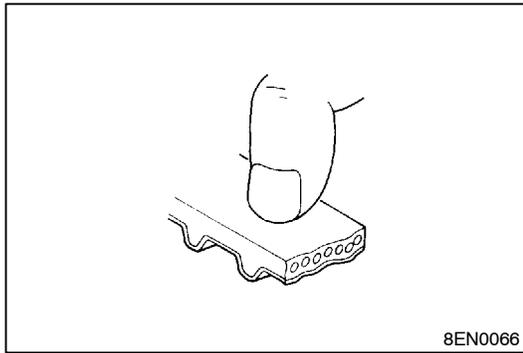
- (7) Turn the crankshaft counterclockwise by three teeth of the cam sprocket from the timing mark and hold this position. Check that the belt is in complete mesh with the sprockets.

- (8) Fix the tensioner.
 (9) Turn the crankshaft clockwise to align the timing marks.



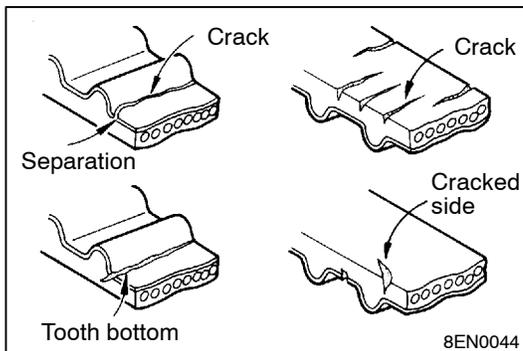
- (10) Check that the belt deflects 4 - 5 mm when its midpoint is pushed by index finger.

- (11) Check that the timing marks of all sprockets are aligned.

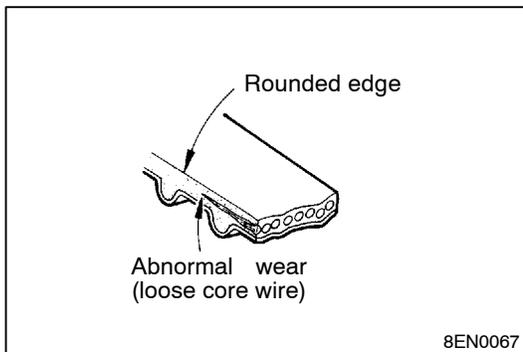
**INSPECTION****TIMING BELTS**

The timing belts must be checked closely. Should the following defects be evident, replace the belt with a new one.

- (1) Hardened back surface rubber
Glossy, non-elastic, and so hard that no mark is produced even when scratched by fingernails.



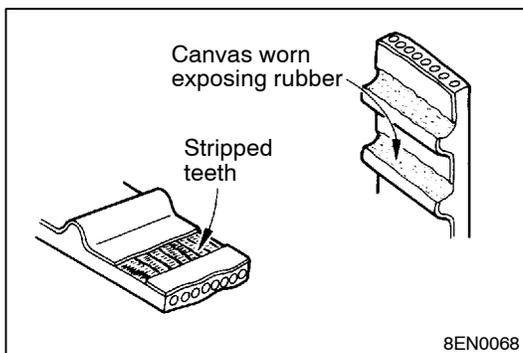
- (2) Cracked back surface rubber
- (3) Cracked or separated canvas
- (4) Cracked tooth bottom
- (5) Cracked side



- (6) Abnormal wear on side

NOTE

Normal belt should have clear-cut sides as if cut by a sharp knife.



- (7) Abnormal wear in teeth

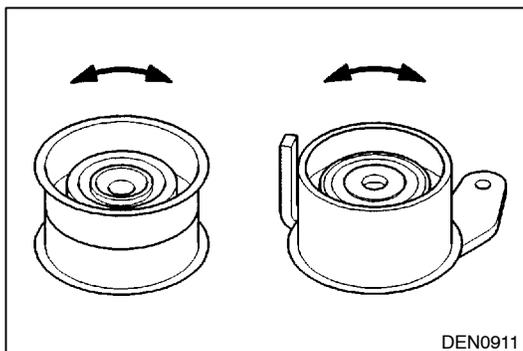
Initial stage:

Canvas on load side tooth flank worn (Fluffy canvas fibers, rubber gone and color changed to white, and unclear canvas texture)

Final stage:

Canvas on load side tooth flank worn down and rubber exposed (tooth width reduced)

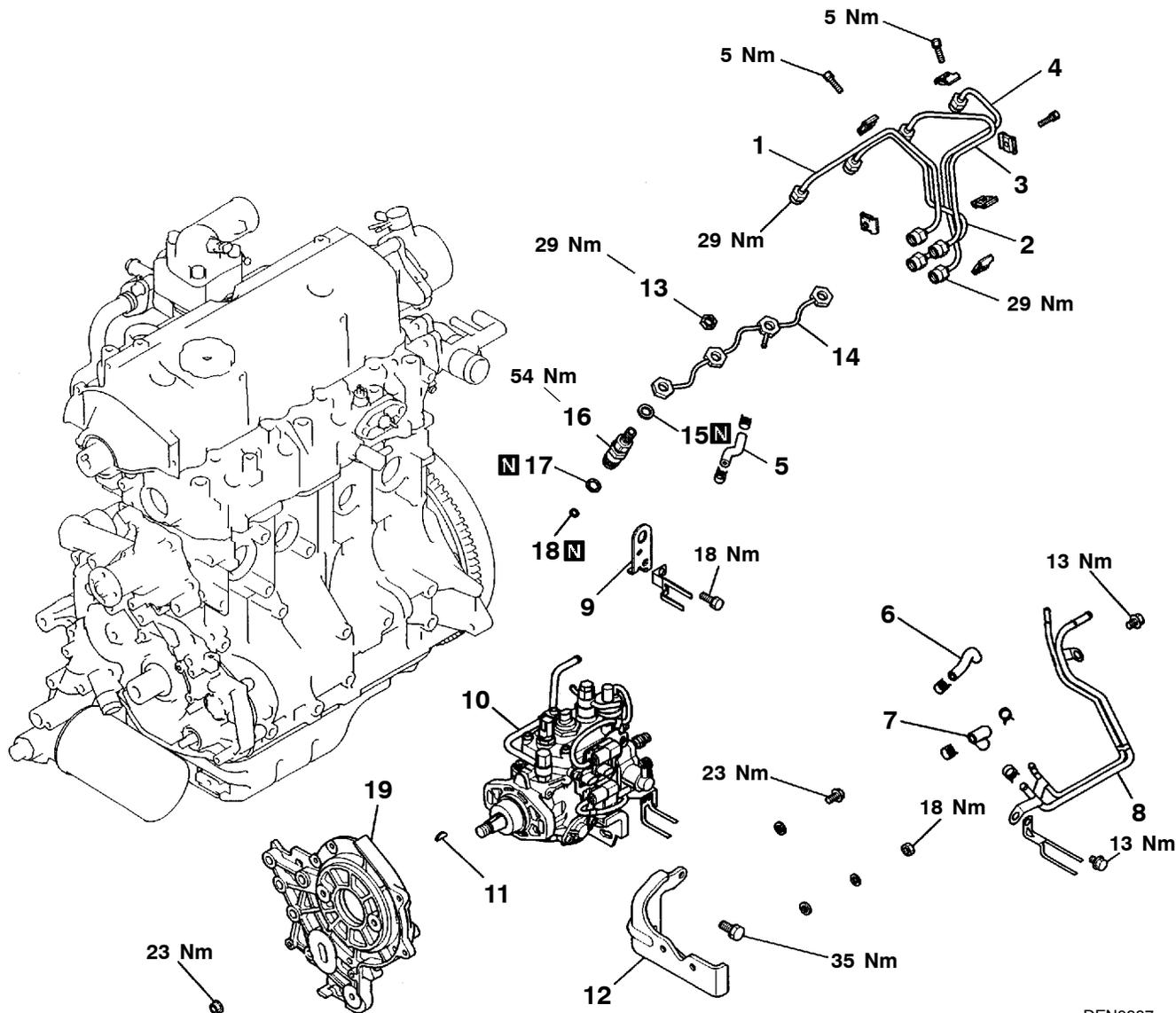
- (8) Missing tooth

**TENSIONER PULLER, IDLER PULLEY**

- (1) Check the pulley for smooth rotation, excessive play, abnormal noise. Replace it if necessary.

5. GLOW PLUG, FUEL INJECTION PUMP AND INJECTION NOZZLE

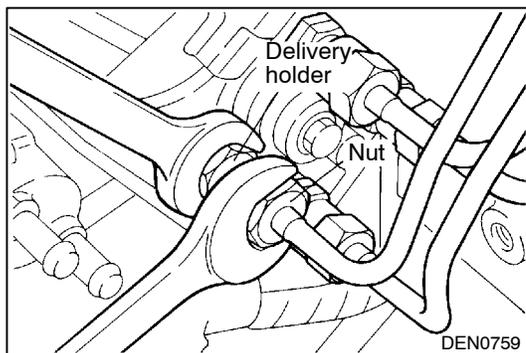
REMOVAL AND INSTALLATION



DEN0887

Removal steps

- | | | | |
|-----|-----|-------------------------|---|
| ◀A▶ | ▶D▶ | 1. Injection pipe No.1 | 11. Key |
| ◀A▶ | ▶D▶ | 2. Injection pipe No.2 | 12. Fuel injection pump stay |
| ◀A▶ | ▶D▶ | 3. Injection pipe No.3 | ▶C▶ ▶C▶ 13. Fuel return pipe nut |
| ◀A▶ | ▶D▶ | 4. Injection pipe No.4 | ▶C▶ ▶C▶ 14. Fuel return pipe |
| | | 5. Fuel hose | ▶C▶ ▶C▶ 15. Fuel return pipe gasket |
| | | 6. Fuel hose | ▶D▶ ▶B▶ 16. Injection nozzle |
| | | 7. Fuel hose | ▶D▶ ▶A▶ 17. Holder gasket |
| | | 8. Fuel pipe | ▶D▶ ▶A▶ 18. Nozzle gasket |
| | | 9. Engine hanger | ▶D▶ ▶A▶ 19. Fuel injection pump bracket |
| ◀B▶ | | 10. Fuel injection pump | |



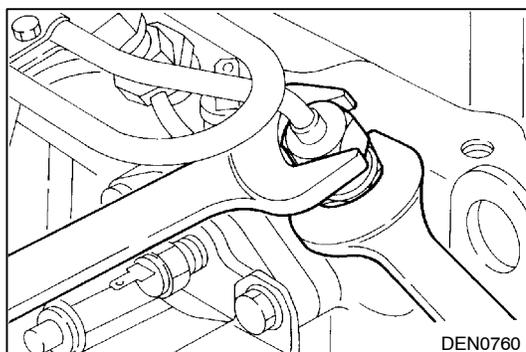
REMOVAL SERVICE POINTS

◀A▶ INJECTION PIPE REMOVAL

- (1) When loosening the union nuts on the injection pump, hold the delivery valve holder on the fuel injection pump head with a spanner to prevent it from rotating along with the union nut.

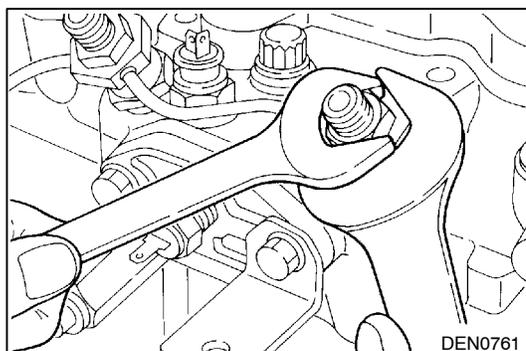
Caution

- If the injection pipe has been removed, plug the delivery valve holder to prevent foreign matter from entering the injection pump.
- (2) When loosening the union nuts on the injection nozzles, hold the hexagon nut of the fuel return pipe with a spanner to prevent it from rotating along with the union nut.



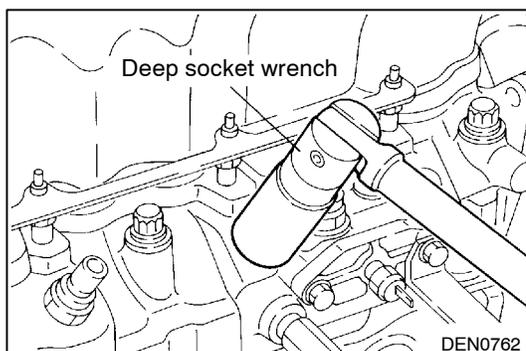
◀B▶ FUEL INJECTION PUMP REMOVAL

- (1) Do not hold the injection pump by the accelerator lever or the fast idle lever. These levers must not be removed.



◀C▶ FUEL RETURN PIPE NUT REMOVAL

- (1) When removing the fuel return pipe nut, hold the hexagon nut of the fuel return pipe with a spanner.

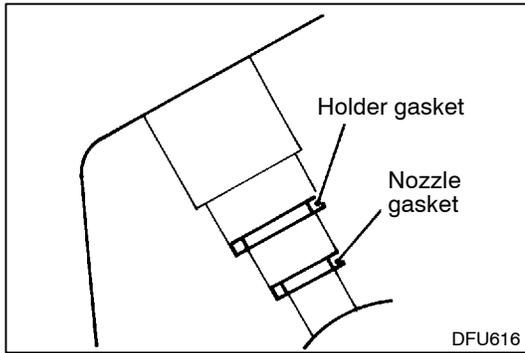


◀D▶ INJECTION NOZZLE REMOVAL

- (1) Write the cylinder number on the injection nozzle that has been removed.

Caution

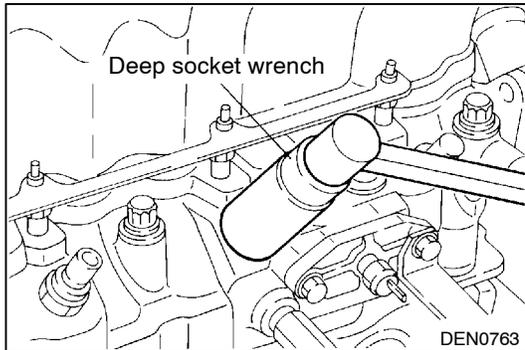
- Cover the opening with an appropriate cap to prevent entry of dust, water and foreign material into the fuel passage and combustion chamber.



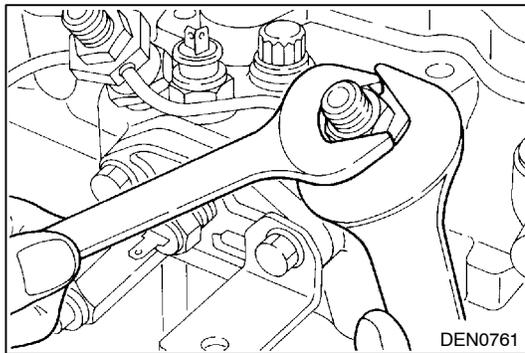
INSTALLATION SERVICE POINTS

▶A◀ NOZZLE GASKET / HOLDER GASKET INSTALLATION

- (1) Clean nozzle holder installation areas of the cylinder head.
- (2) Fit a new nozzle gasket and holder gasket into the nozzle holder hole in the cylinder head.

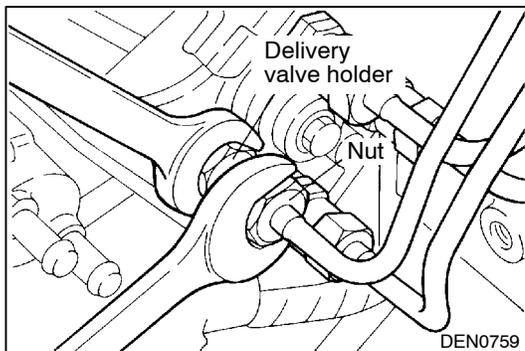


▶B◀ INJECTION NOZZLE INSTALLATION



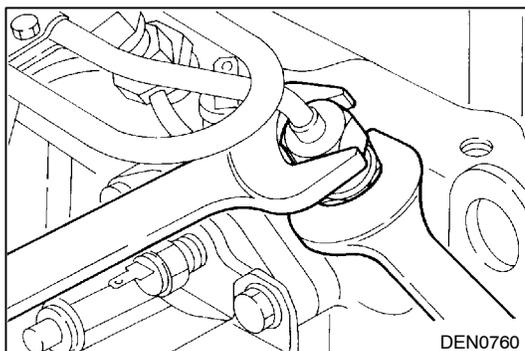
▶C◀ FUEL RETURN PIPE NUT INSTALLATION

- (1) While holding the fuel hexagon nut of the fuel return pipe with a wrench, tighten the fuel return pipe nut to the specified torque.



▶D◀ INJECTION PIPE INSTALLATION

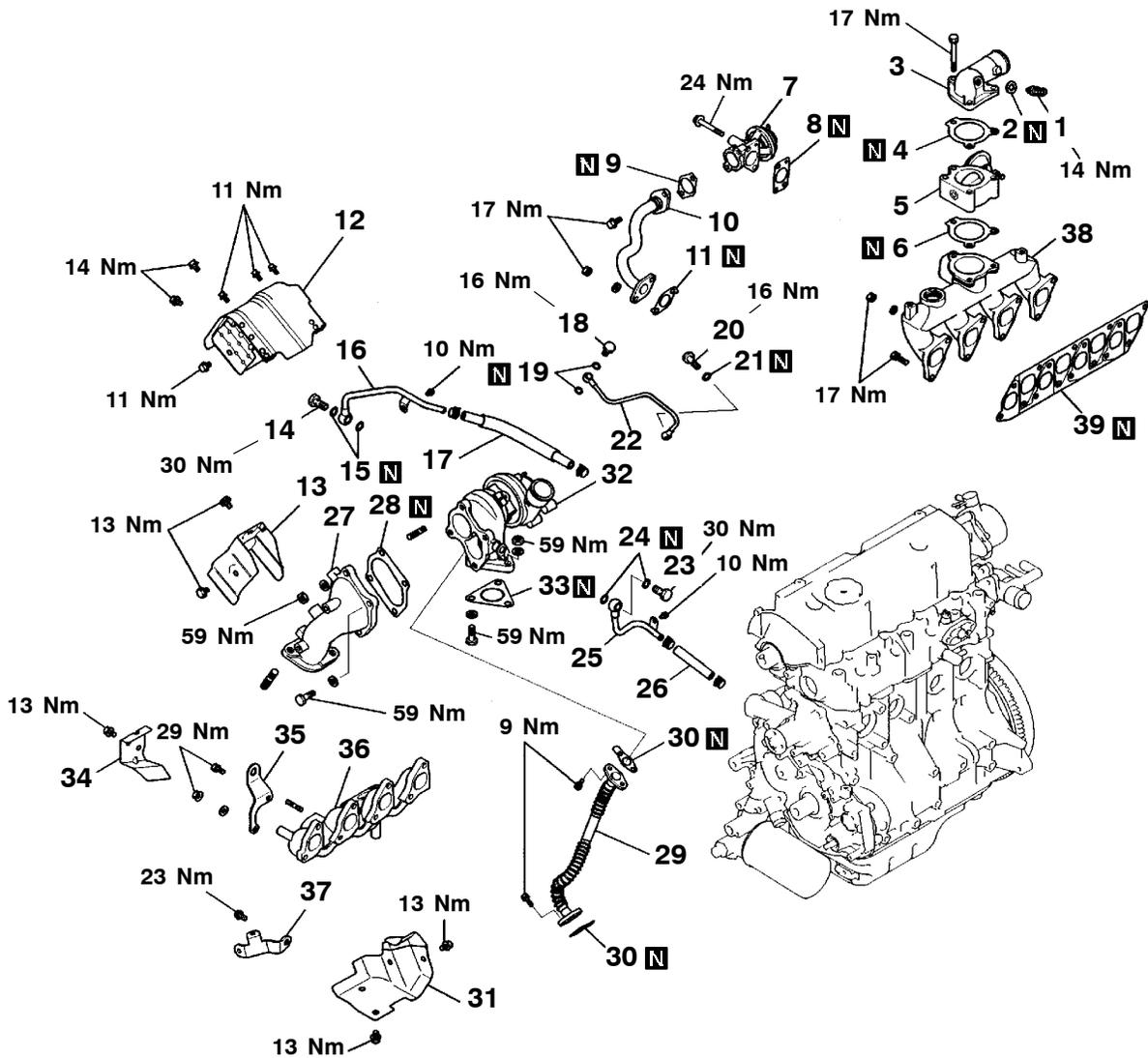
- (1) When tightening the injection pipe nuts, hold the delivery valve holder with a spanner in order to prevent it from rotating along with the nut.



- (2) When tightening the injection pipe nuts, hold the hexagon nut of the return pipe with a spanner in order to prevent it from rotating along with the nut.

6. INTAKE AND EXHAUST MANIFOLDS

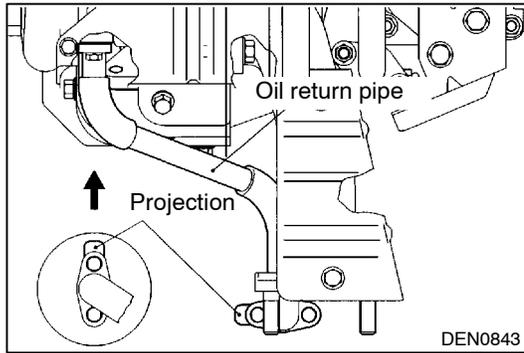
REMOVAL AND INSTALLATION



DEN0888

Removal steps

- | | | |
|-----|------------------------------------|--|
| | 1. Air temperature sensor | 21. Gasket |
| | 2. Air temperature sensor gasket | 22. Oil pipe |
| | 3. Air intake fitting | 23. Eyebolt |
| | 4. Intake fitting gasket | 24. Gasket |
| | 5. Throttle body | 25. Water pipe "B" |
| | 6. Intake fitting gasket | 26. Water hose |
| | 7. EGR valve | 27. Exhaust fitting |
| | 8. EGR valve gasket | 28. Exhaust fitting gasket |
| | 9. EGR pipe gasket | 29. Oil return pipe |
| | 10. EGR pipe | ▶A◀ 30. Oil return pipe gasket |
| ▶C◀ | 11. EGR pipe gasket | 31. Heat protector, rear |
| | 12. Turbocharger heat protector | 32. Turbocharger assembly |
| | 13. Exhaust fitting heat protector | 33. Turbocharger gasket |
| | 14. Eyebolt | 34. Heat protector, front |
| | 15. Gasket | 35. Engine hanger |
| | 16. Water pipe "A" | 36. Exhaust manifold stay |
| | 17. Water hose | 37. Alternator brace stay |
| ▶B◀ | 18. Eyebolt | 38. Intake manifold |
| | 19. Gasket | 39. Intake and exhaust manifold gasket |
| ▶B◀ | 20. Eyebolt | |



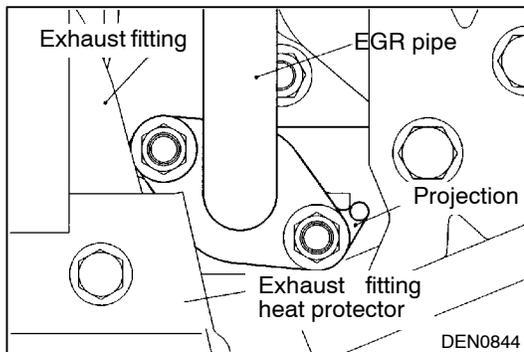
INSTALLATION SERVICE POINTS

▶A◀ OIL RETURN PIPE GASKET INSTALLATION

- (1) Install the oil return pipe gasket in such a way that its projection is located at the illustrated position.

▶B◀ EYEBOLT INSTALLATION

- (1) Before installing the oil pipe eyebolt (at top of the turbocharger), fill the turbocharger with clean engine oil.

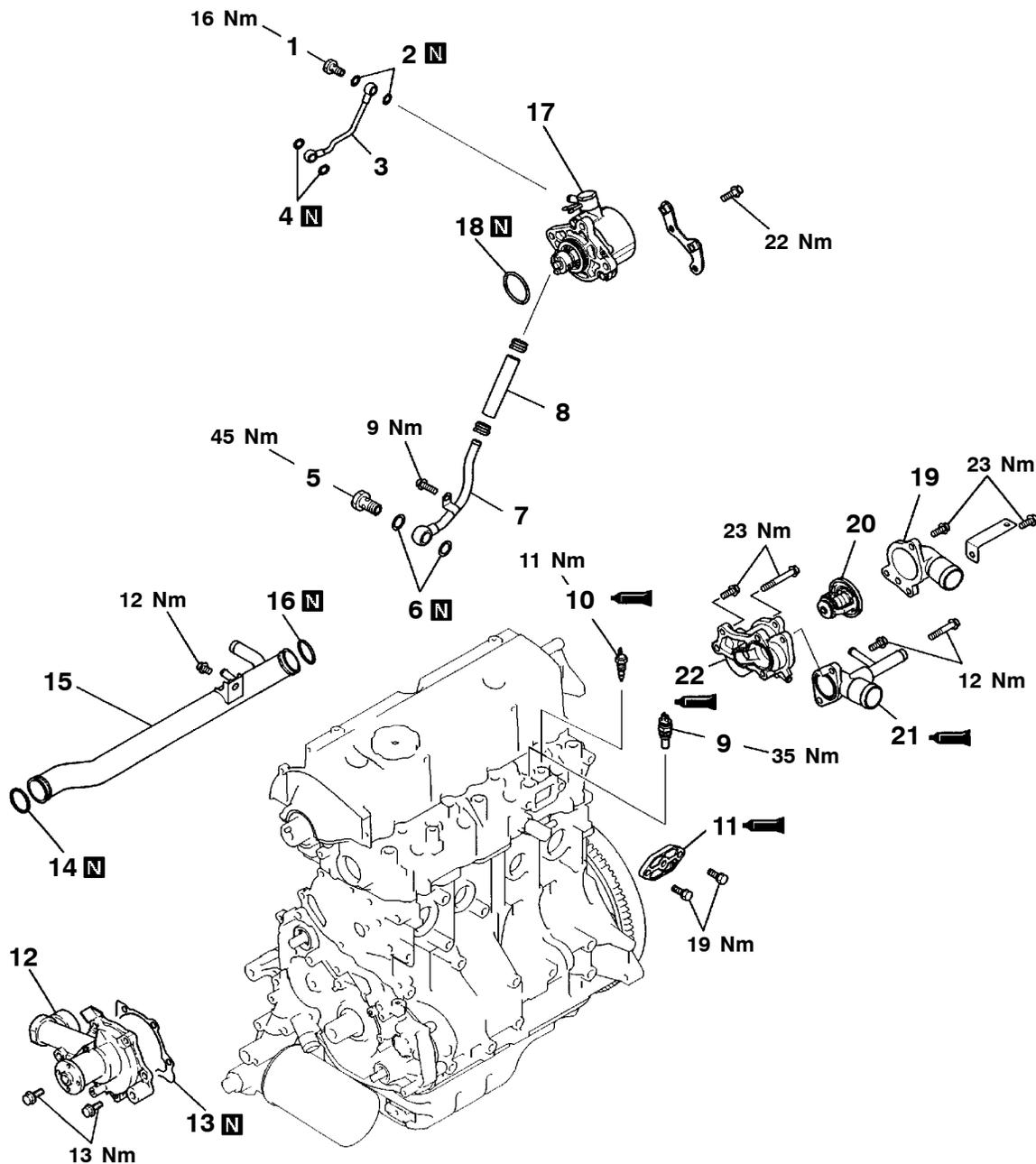


▶C◀ EGR PIPE GASKET INSTALLATION

- (1) Install the EGR pipe gasket in such a way that its projection is located at the illustrated position.

7. WATER PUMP, THERMOSTAT, HOSE AND PIPES

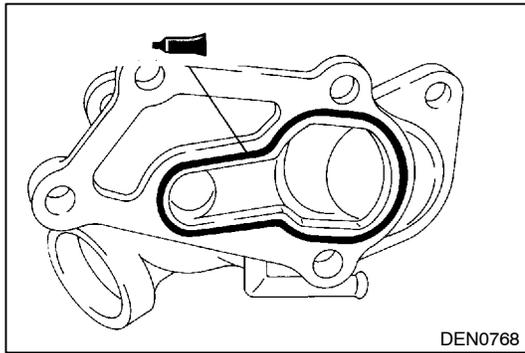
REMOVAL AND INSTALLATION



DEN0889

Removal steps

- | | |
|---|------------------------------|
| 1. Eyebolt | 12. Water pump |
| 2. Gasket | 13. Water pump gasket |
| 3. Oil pipe | >D< 14. O-ring |
| 4. Gasket | >D< 15. Water inlet pipe |
| 5. Eyebolt | >D< 16. O-ring |
| 6. Gasket | 17. Vacuum pump |
| 7. Oil return pipe | 18. O-ring |
| 8. Oil return hose | 19. Water inlet fitting |
| 9. Engine coolant temperature sensor | >C< 20. Thermostat |
| >F< 10. Engine coolant temperature gauge unit | >B< 21. Water outlet fitting |
| >E< 11. Cover | >A< 22. Thermostat housing |



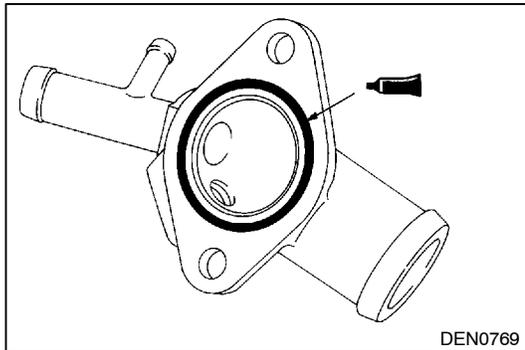
INSTALLATION SERVICE POINTS

▶A◀ THERMOSTAT HOUSING INSTALLATION

- (1) Apply a 3 mm bead of form-in-place gasket (FIPG) to the mounting surface.

Specified sealant:

Mitsubishi Genuine Part No. MD970389 or equivalent.

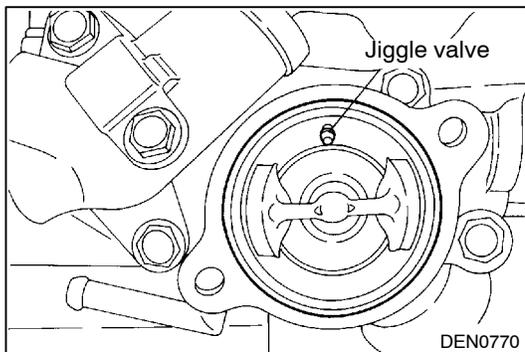


▶B◀ WATER OUTLET FITTING INSTALLATION

- (1) Apply a 3 mm bead of form-in-place gasket (FIPG) to the mounting surface.

Specified sealant:

Mitsubishi Genuine Part No. MD970389 or equivalent.



▶C◀ THERMOSTAT INSTALLATION

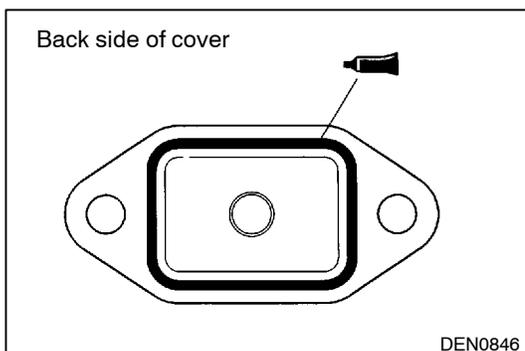
- (1) Install the thermostat with the jiggle valve up as shown in the illustration.

▶D◀ WATER INLET PIPE / O-RING INSTALLATION

- (1) Wet the O-ring (with water) to facilitate assembly.

Caution

- Keep the O-ring free of oil or grease.
- Secure the water pipe after the thermostat housing has been installed.

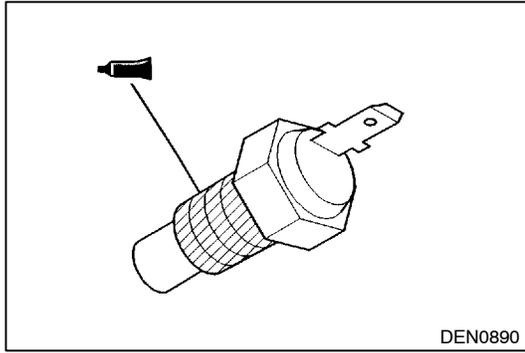


▶E◀ COVER INSTALLATION

- (1) Apply a 3 mm bead of form-in-place gasket (FIPG) to the mounting surface.

Specified sealant:

Mitsubishi Genuine Part No. MD970389 or equivalent.



**►F◄ ENGINE COOLANT TEMPERATURE GAUGE UNIT
INSTALLATION**

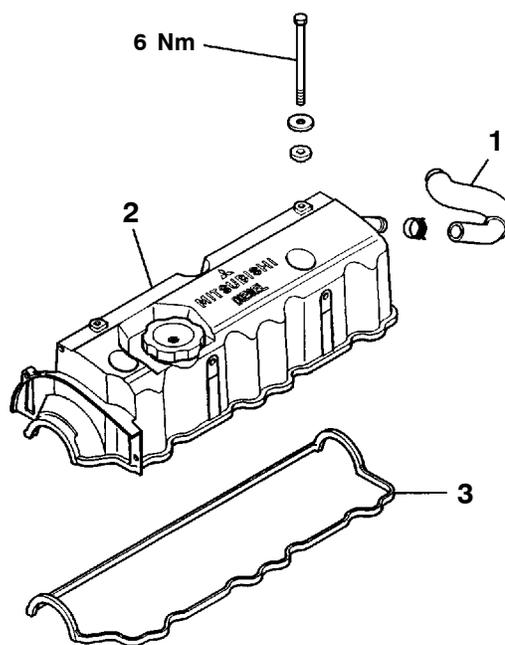
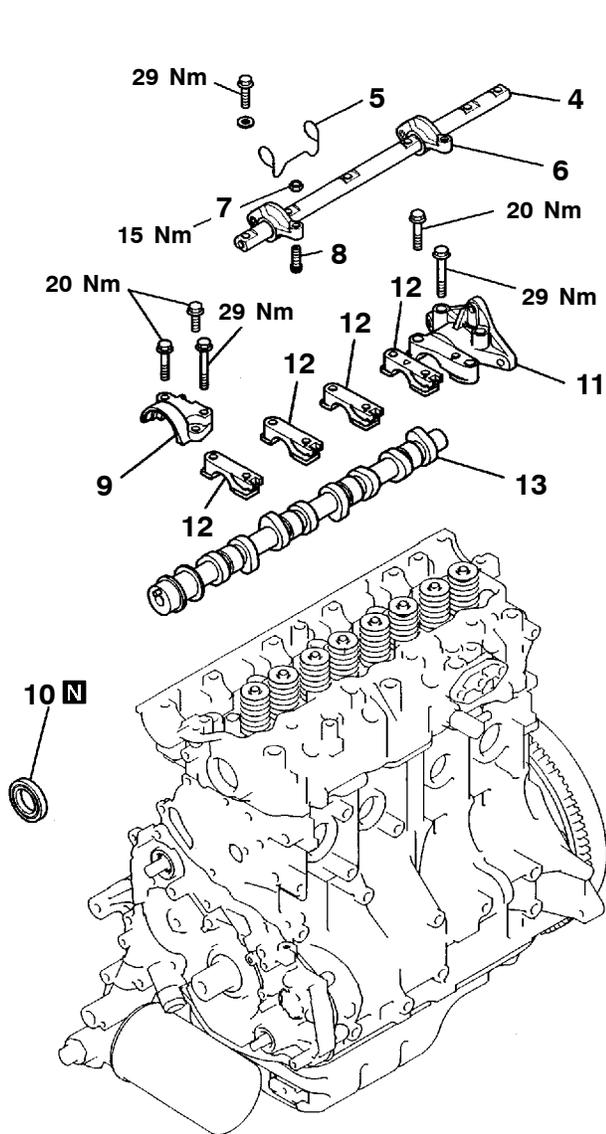
- (1) If the water temperature sensor is to be reused, apply the specified sealant to its thread.

Specified sealant:

3M Nut Locking Part No. 4171 or equivalent.

8. ROCKER ARMS, ROCKER SHAFT AND CAMSHAFT

REMOVAL AND INSTALLATION



Apply engine oil to all moving parts before installation.

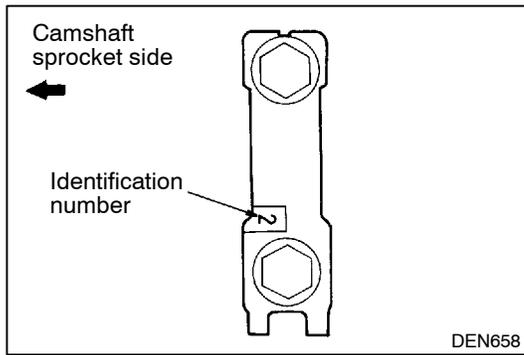
DEN0891

Removal steps

1. Breather hose
2. Rocker cover
3. Rocker cover gasket
4. Rocker shaft
5. Rocker shaft spring
6. Rocker arm
7. Adjusting nut
8. Rocker arm adjusting screw
9. Front camshaft bearing cap
10. Camshaft front oil seal
11. Rear camshaft bearing cap
12. Camshaft bearing cap
13. Camshaft

Installation steps

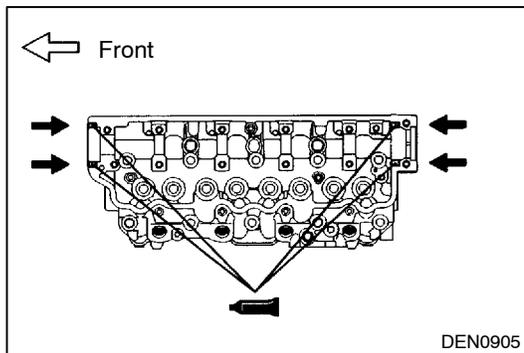
13. Camshaft
- ▶A◀ 12. Camshaft bearing cap
- ▶B◀ 11. Rear camshaft bearing cap
- ▶B◀ 9. Front camshaft bearing cap
- ▶C◀ 8. Rocker arm adjusting screw
7. Nut
6. Rocker arm
- ▶D◀ 5. Rocker shaft spring
4. Rocker shaft
- ▶E◀ 10. Camshaft oil seal
3. Rocker cover gasket
2. Rocker cover
1. Breather hose



INSTALLATION SERVICE POINTS

▶A◀ CAMSHAFT BEARING CAP INSTALLATION

- (1) Install the bearing caps in the designated position confirming the identification numbers stamped on the cap front. The No.5 cap has no identification number stamped.

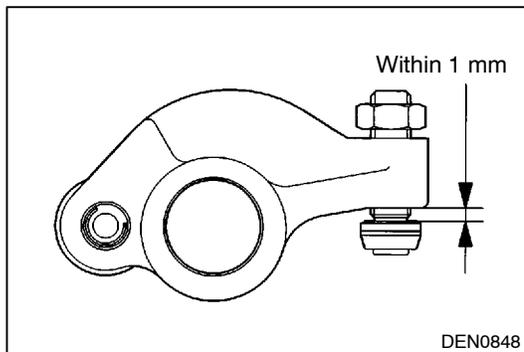


▶B◀ FRONT, REAR CAMSHAFT BEARING CAP INSTALLATION

- (1) Apply sealant to the locations shown in the illustrations.

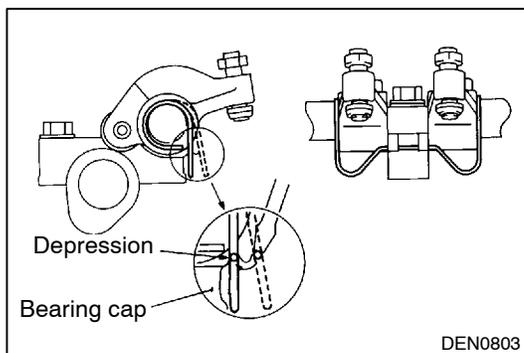
Specified sealant:

3M ATD Part No. 8660 or equivalent



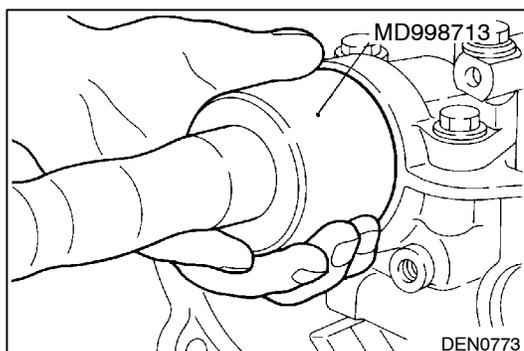
▶C◀ ROCKER ARM ADJUSTING SCREW INSTALLATION

- (1) Do not screw the adjusting screw so far that its flange may come into contact with the rocker arm. Leave some distance (within 1 mm) between them.



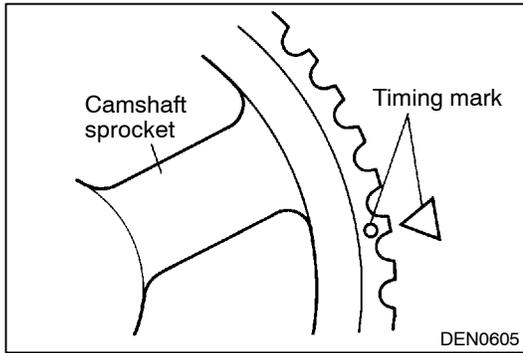
▶D◀ ROCKER SHAFT SPRING INSTALLATION

- (1) Hook the rocker shaft spring to the depression of the bearing cap.



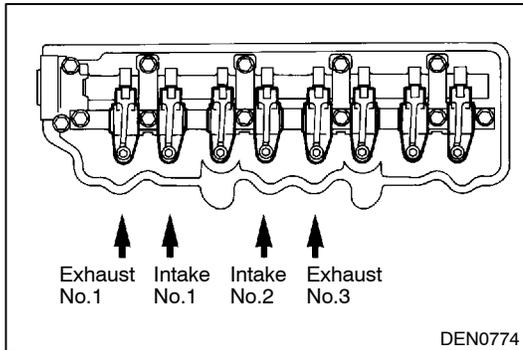
▶E◀ CAMSHAFT OIL SEAL INSTALLATION

- (1) Using the special tool, install a new camshaft oil seal into the front bearing cap.

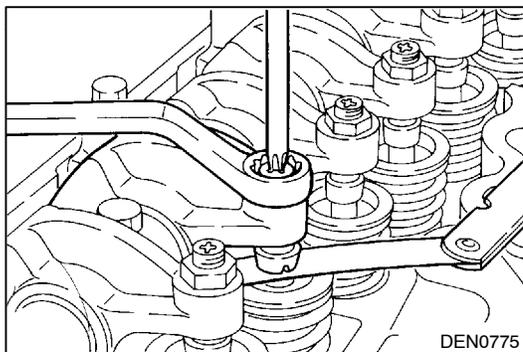


VALVE CLEARANCE ADJUSTMENT

(1) Turn the crankshaft clockwise and align the timing mark on camshaft sprocket with that on the injection pump bracket.



(2) Adjust the valve clearance at the points shown in the illustration.

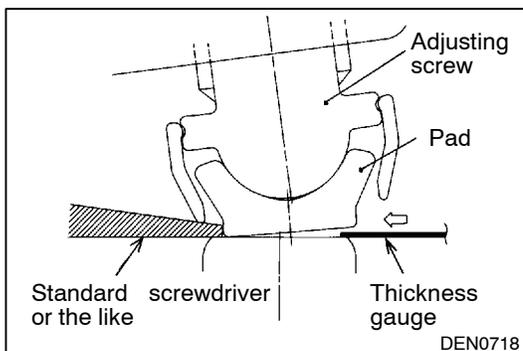


(3) Loosen the adjusting screw lock nut.

(4) Using a thickness gauge, adjust the valve clearance by turning the adjusting screw.

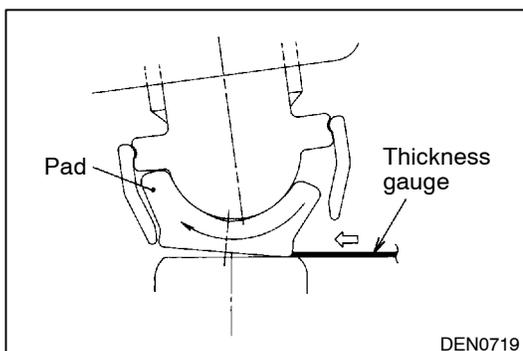
Standard value (on cold engine):

Intake	0.25 mm
Exhaust	0.35 mm



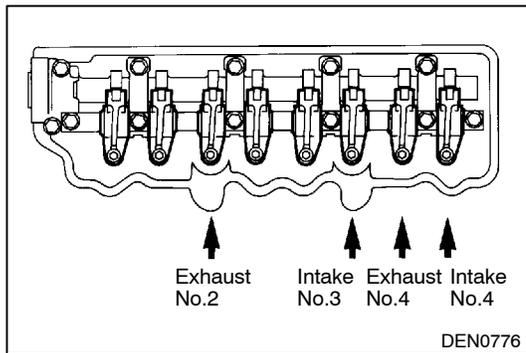
NOTE

Before insertion of a thickness gauge, provide clearance for inserting the gauge by pushing the pad with a standard screwdriver or the like from the opposite side.



If an attempt is made to insert the thickness gauge without providing the clearance for it in advance by pushing the pad with a standard screwdriver or the like, the pad will tilt as shown in the illustration, preventing insertion of the thickness gauge.

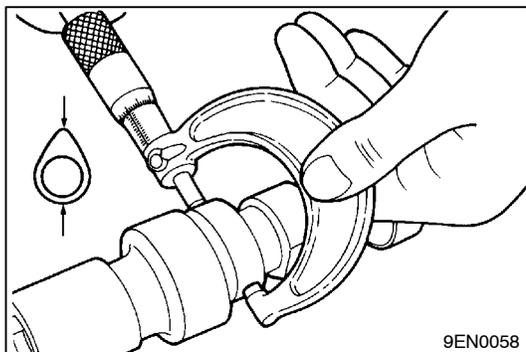
11A-8-4 4D68 ENGINE (E-W) - Rocker Arms, Rocker Shaft and Camshaft



- (5) While holding the adjusting screw with a screwdriver, tighten the lock nut.
- (6) Rotate clockwise the crankshaft one complete turn (360 degrees).
- (7) Adjust the valve clearance at the points shown in the illustration.
- (8) Repeat steps (3) to (5) to adjust the valve clearance of the remaining valves.

NOTE

With the engine mounted on vehicle, warm up the engine. Then, check for valve clearance on hot engine and adjust if necessary.



INSPECTION

CAMSHAFT

- (1) Measure the cam height.

Standard value:

Intake	41.90 mm
Exhaust	41.96 mm

Limit:

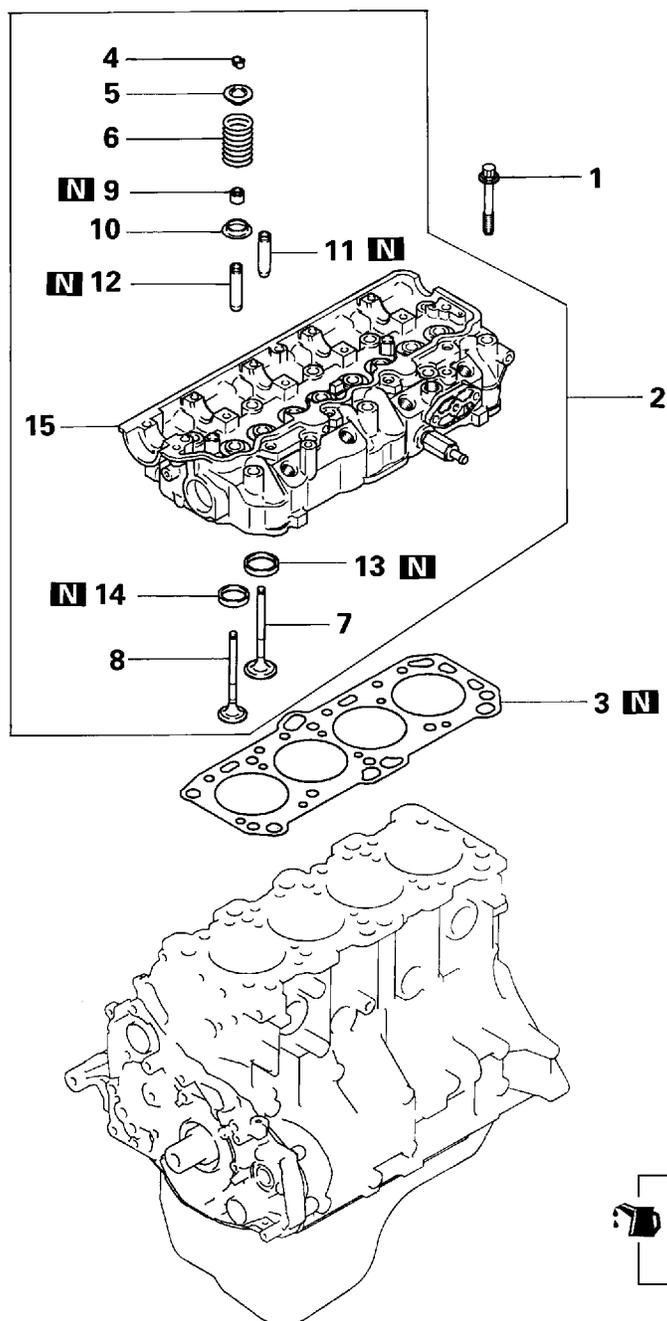
Intake	41.40 mm
Exhaust	41.46 mm

ROCKER ARM SHAFT

- (1) Check the oil holes for clogging and clean if clogged.
- (2) Check the outer circumference of the portion where the rocker arm is installed and replace if damage or seizure is evident.

9. CYLINDER HEAD, VALVES AND VALVE SPRINGS

REMOVAL AND INSTALLATION



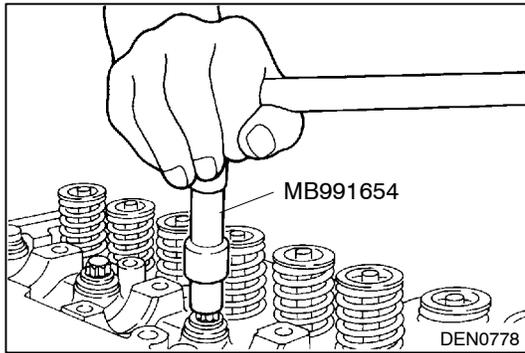
Apply engine oil to all moving parts before installation.

DEN0777

Removal steps

- ◀A▶ ▶E▶ 1. Cylinder head bolt
- ▶D▶ 2. Cylinder head assembly
- ◀B▶ ▶C▶ 3. Cylinder head gasket
- ▶B▶ 4. Valve spring retainer lock
- ▶B▶ 5. Valve spring retainer
- ▶B▶ 6. Valve spring
- ▶B▶ 7. Intake valve
- ▶B▶ 8. Exhaust valve

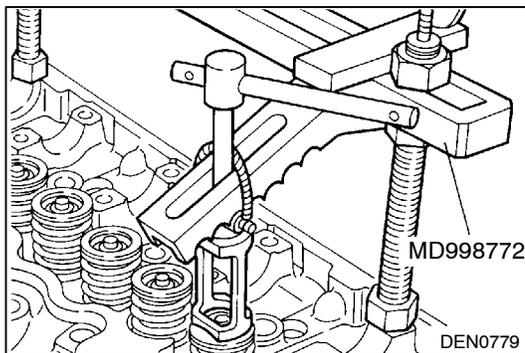
- ◀C▶ ▶A▶ 9. Valve stem seal
- ▶A▶ 10. Spring seat
- ▶A▶ 11. Intake valve guide
- ▶A▶ 12. Exhaust valve guide
- ▶A▶ 13. Intake valve seat
- ▶A▶ 14. Exhaust valve seat
- ▶A▶ 15. Cylinder head



REMOVAL SERVICE POINTS

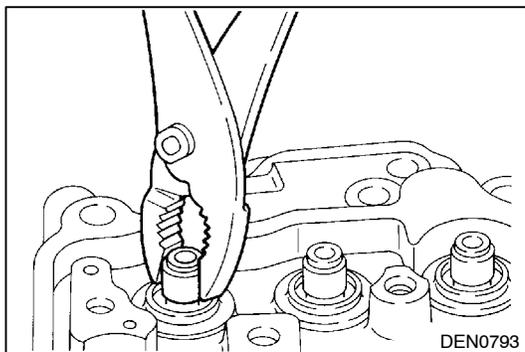
◀A▶ CYLINDER HEAD BOLT REMOVAL

- (1) Using a 12 mm - 12 points socket wrench, loosen the cylinder head bolts.



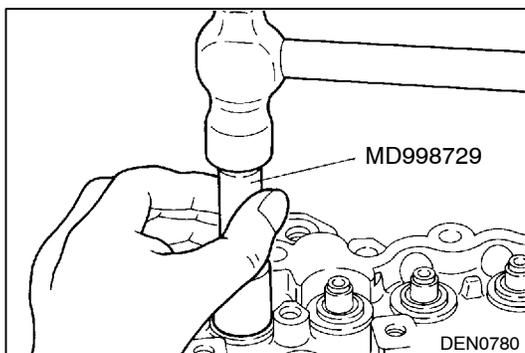
◀B▶ RETAINER LOCK REMOVAL

- (1) Store removed valves, springs and other parts, tagged to indicate their cylinder No. and location for reassembly.



◀C▶ VALVE STEM SEAL REMOVAL

- (1) Do not reuse removed stem seals.



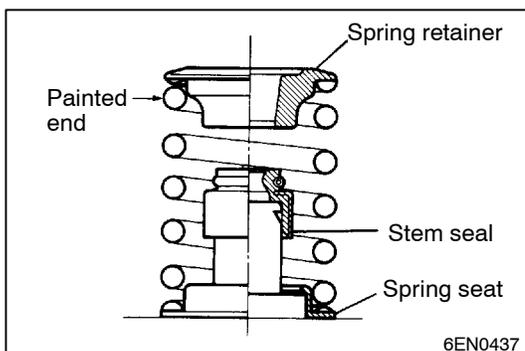
INSTALLATION SERVICE POINTS

▶A▶ VALVE STEM SEAL INSTALLATION

- (1) Install the valve spring seat.
- (2) The special tool must be used to install valve stem seals. Improper installation could result in oil leaks past the valve guide.

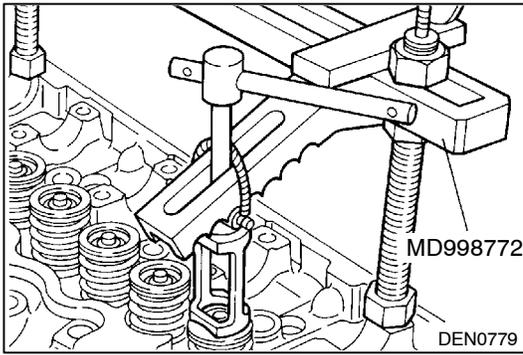
Caution

- Do not reuse removed valve stem seals.



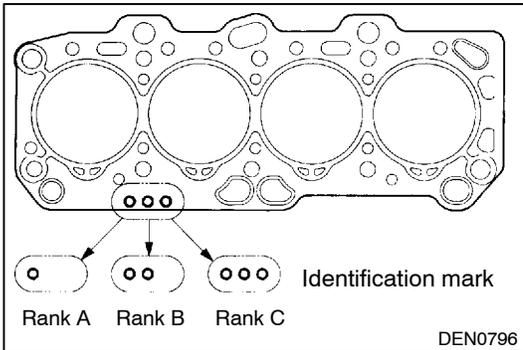
▶B▶ VALVE SPRING INSTALLATION

- (1) Direct the valve spring end with identification color toward the spring retainer.



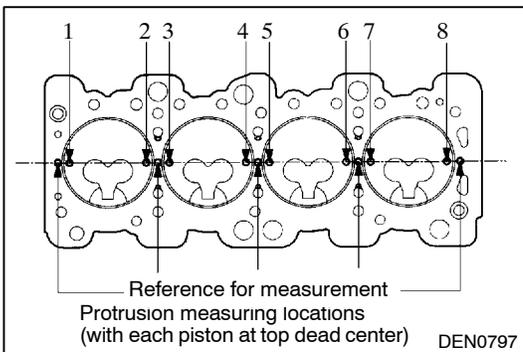
►C◄ RETAINER LOCK INSTALLATION

- (1) The valve spring, if excessively compressed, causes the bottom end of the retainer to be in contact with, and damage, the stem seal.

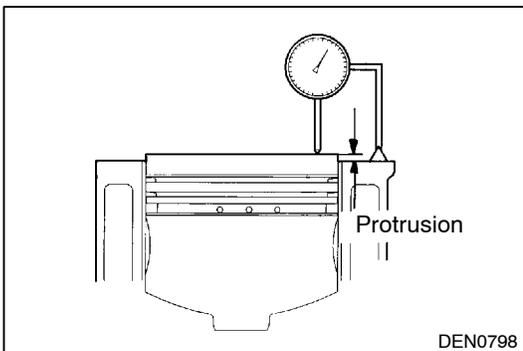


►D◄ CYLINDER HEAD GASKET INSTALLATION

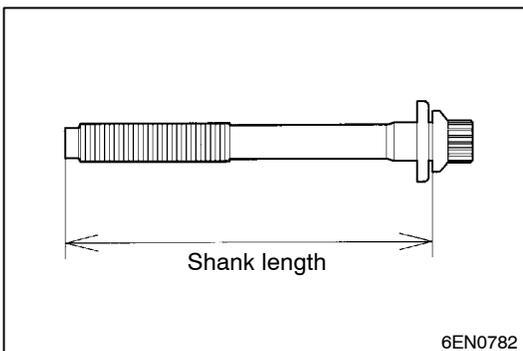
- (1) In case any of the cylinder block, piston, connecting rod and crankshaft has not been replaced, install the gasket of the same rank as before which can be identified by the mark shown in the illustration at left.



- (2) In case any of the cylinder block, piston, connecting rod and crankshaft have been replaced, reselect and install the gasket in accordance with the following procedure.
 - 1 With each piston held at the top dead center, measure its protrusion from the upper block surface at the locations shown in the illustration at left (total of eight locations). Be sure to take measurements on the crankshaft center line.
 - 2 Using the average of the eight measurements, select the gasket rank (A, B or C) in accordance with the table given below. If, however, the maximum protrusion at any one location exceeds the protrusion tolerance shown for any rank in the following table, use the gasket one rank higher than that rank.



mm			
Rank	Average value of piston protrusions	Protrusion tolerance for each rank	Thickness of selected gasket (when tightened)
A	0.641 - 0.700	0.750	1.40 ± 0.05
B	0.700 - 0.760	0.810	1.45 ± 0.05
C	0.760 - 0.823	-	1.50 ± 0.05



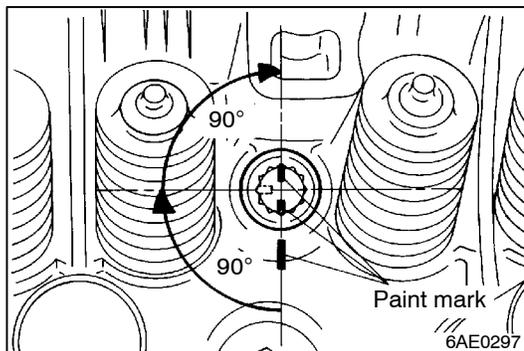
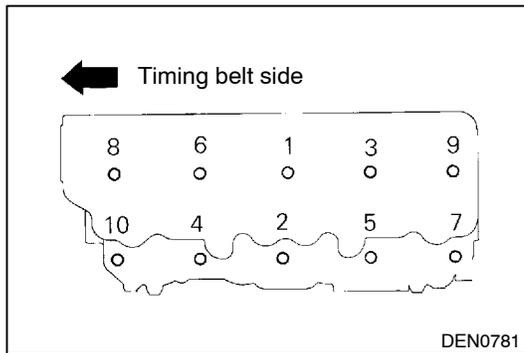
►E◄ CYLINDER HEAD BOLT INSTALLATION

- (1) When installing the cylinder head bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.

Limit: max. 119.7 mm

- (2) Apply engine oil to the bolt threads and washers.

11A-9-4 4D68 ENGINE (E-W) - Cylinder Head, Valves and Valve Springs



- (3) Using the special tool (MB991654) and according to the tightening sequence, tighten the bolts to the specified torque.

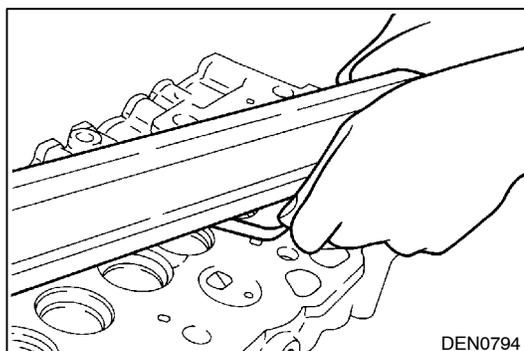
Tightening torque: 90 Nm

- (4) Loosen all bolts fully.
- (5) Retighten the loosened bolts to a torque of 40 Nm in the specified tightening sequence.

- (6) Make paint marks on the cylinder head bolt heads and cylinder head.
- (7) Give a 90° turn to the cylinder head bolts in the specified tightening sequence.
- (8) Give another 90° turn to the cylinder head bolts and make sure that the paint mark on the head of each cylinder head bolt and that on the cylinder head are on the same straight line.

Caution

- If the bolt is turned less than 90°, proper fastening performance may not be expected. When tightening the bolt, therefore, be careful to give a sufficient turn to it.
- If the bolt is overtightened, loosen the bolt completely and then retighten it by repeating the tightening procedure from step (1).



INSPECTION

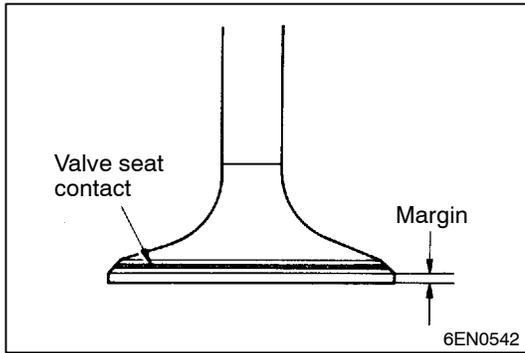
CYLINDER HEAD

- (1) Before cleaning the cylinder head, check it for water leaks, gas leaks, cracks, and other damage.
- (2) Remove all oil, water scale, sealant, and carbon. After cleaning the oil passages, blow air through them to verify that they are not blocked.
- (3) Check for distortion in the cylinder head gasket surface using a straight edge and thickness gauge. If distortion exceeds the specified limit, replace the cylinder head.

Gasket surface distortion

Standard value: 0.05 mm or less

Limit: 0.2 mm



VALVE

- (1) Check the valve face for correct contact. If incorrect, reface using a valve refacer. Valve seat contact should be maintained uniform at the center of valve face.
- (2) If the margin is smaller than the service limit, replace the valve.

Standard value: 1.5 mm

Limit: 0.7 mm

- (3) Measure the overall height of the valve. If the specified limit is exceeded, replace the valve.

Standard value:

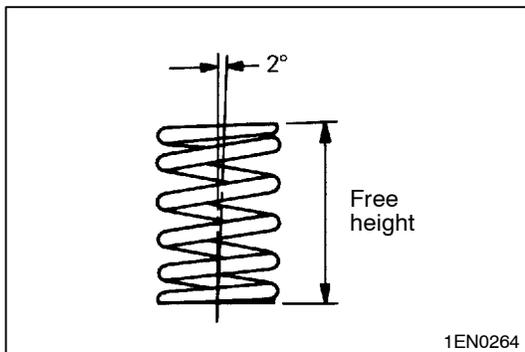
Intake 114.05 mm

Exhaust 113.80 mm

Limit:

Intake 113.55 mm

Exhaust 113.30 mm



VALVE SPRING

- (1) Measure the free height of the spring and, if it is smaller than the limit, replace.

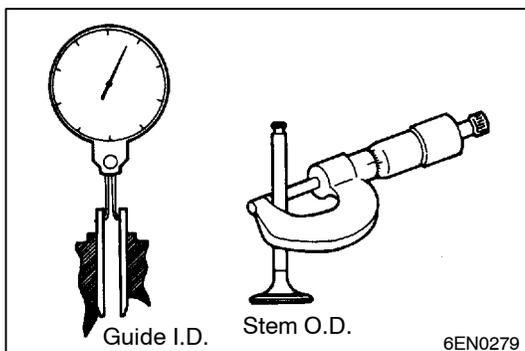
Standard value: 49.1 mm

Limit: 48.1 mm

- (2) Measure the squareness of the spring and, if the limit is exceeded, replace.

Standard value: 2° or less

Limit: Max. 4°

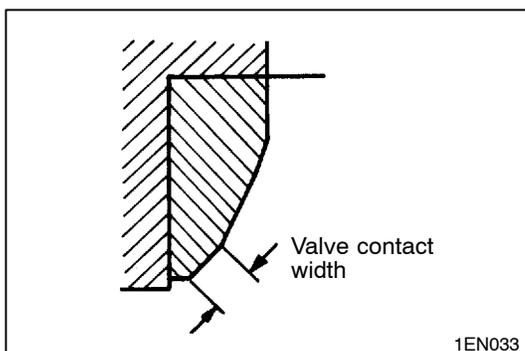


VALVE GUIDE

- (1) Measure the clearance between the valve guide and valve stem. If the limit is exceeded, replace the valve guide or valve, or both.

Standard value: 0.05 - 0.09 mm

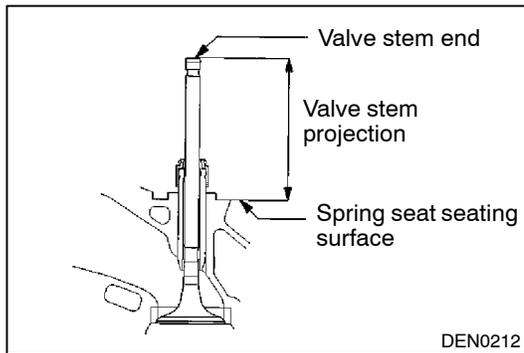
Limit: 0.15 mm



VALVE SEAT

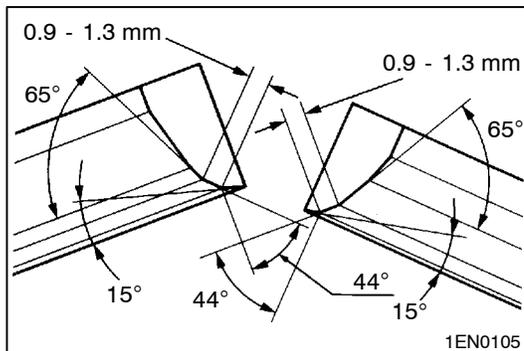
- (1) Check the valve seat for trace of overheat and contact with valve surface.

Standard value: 0.9 - 1.3 mm



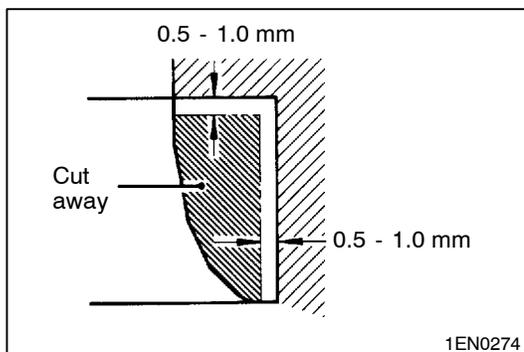
- (2) Install the valve and, while pressing the valve against the valve seat, measure the valve stem projection between the valve stem end and the valve spring seat seating surface.

Standard value: 43.45 mm
Limit: 43.95 mm



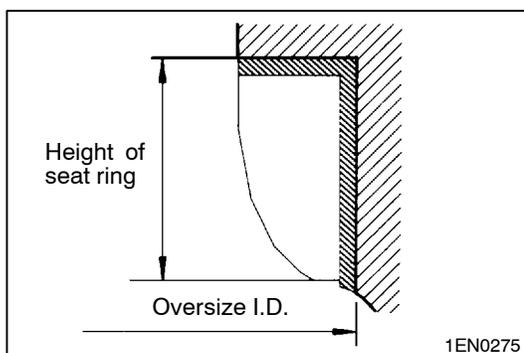
VALVE SEAT RECONDITIONING PROCEDURE

- (1) Before correcting the valve seat, check the clearance between the valve guide and valve. If necessary, replace the valve guide.
- (2) Using the appropriate special tool or seat grinder, correct the valve seat to achieve the specified seat width and angle.
- (3) After correcting the valve seat, lap the valve and valve seat using lapping compound. Then, check the valve stem projection (refer to 5. VALVE SEAT in INSPECTION).



VALVE SEAT REPLACEMENT PROCEDURE

- (1) Cut the valve seat to be replaced from the inside to thin the wall thickness. Then, remove the valve seat.



- (2) Rebores the valve seat hole in the cylinder head to a selected oversize valve seat diameter.

Intake valve seat hole diameter

0.30 O.S.: 38.300 - 38.325 mm

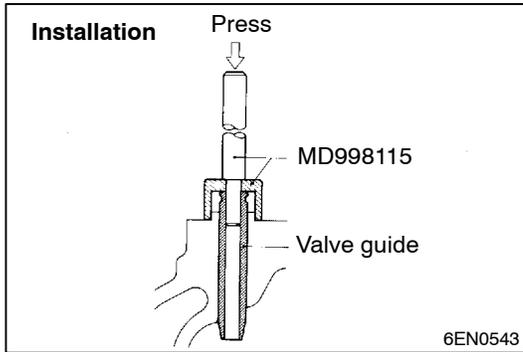
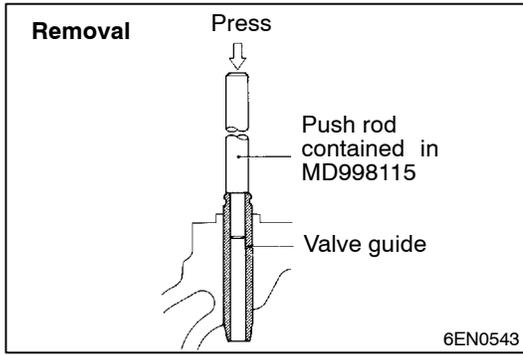
0.60 O.S.: 38.600 - 38.625 mm

Exhaust valve seat hole diameter

0.30 O.S.: 34.300 - 34.325 mm

0.60 O.S.: 34.600 - 34.625 mm

- (3) Before fitting the valve seat, either heat the cylinder head up to approximately 250°C or cool the valve seat using cooling spray, to prevent the cylinder head bore from galling.
- (4) Using a valve seat cutter, correct the valve seat to the specified width and angle.
 See "VALVE SEAT RECONDITIONING PROCEDURE".



VALVE GUIDE REPLACEMENT PROCEDURE

- (1) Using the special tool and a press, remove the valve guide toward the cylinder head gasket surface.
- (2) Rebore the valve guide hole to the new oversize valve guide outside diameter.

Valve guide hole diameter

0.05 O.S.: 13.050 - 13.068 mm

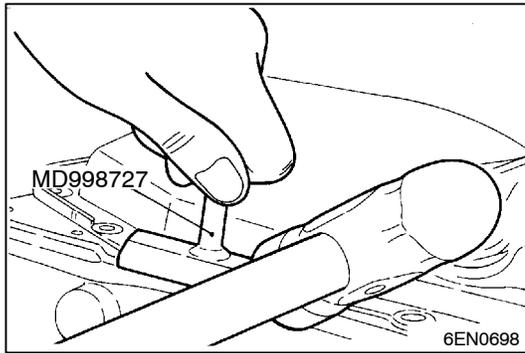
0.25 O.S.: 13.250 - 13.268 mm

0.50 O.S.: 13.500 - 13.518 mm

NOTE

Do not install a valve guide of the same size again.

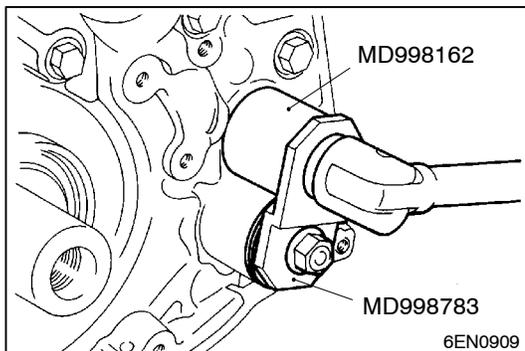
- (3) Using the special tool, press-fit the valve guide, working from the cylinder head top surface.
- (4) After installing valve guides, insert new valves in them to check for sliding condition.
- (5) When valve guides have been replaced, check for valve contact and correct valve seats as necessary.



REMOVAL SERVICE POINTS

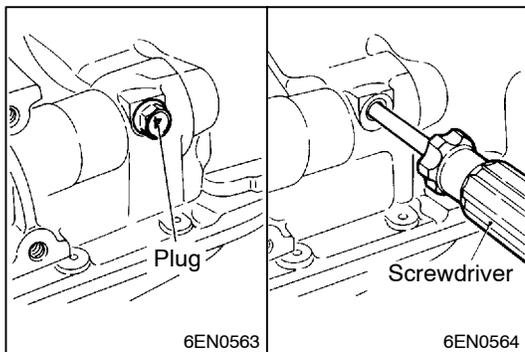
◀A▶ OIL PAN REMOVAL

- (1) Knock the special tool deeply between the oil pan and the cylinder block.
- (2) Hitting the side of the special tool, slide the special tool along the oil pan to remove it.



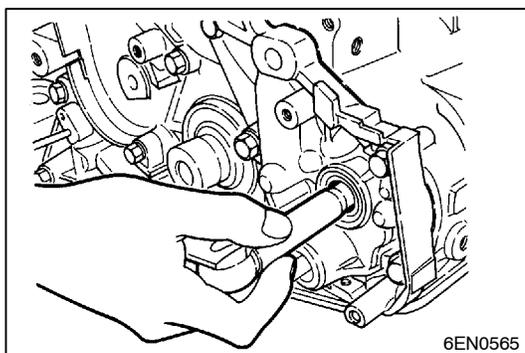
◀B▶ PLUG REMOVAL

- (1) If the plug is too hard to loosen, tap on the plug several times with a plastic hammer, then remove it using the special tool.

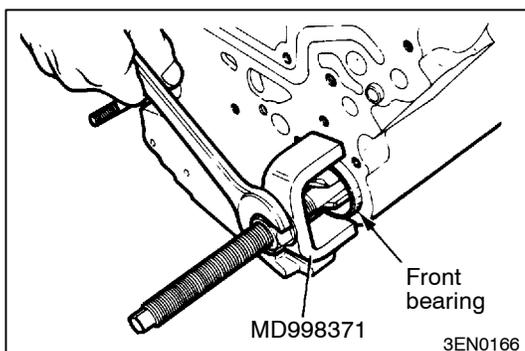


◀C▶ FLANGE BOLT REMOVAL

- (1) When loosening the oil pump driven gear flange bolt, first insert a Phillips screwdriver [shank diameter 8 mm] into the plug hole on the left side of the cylinder block to block the silent shaft.



- (2) Loosen the flange bolt.

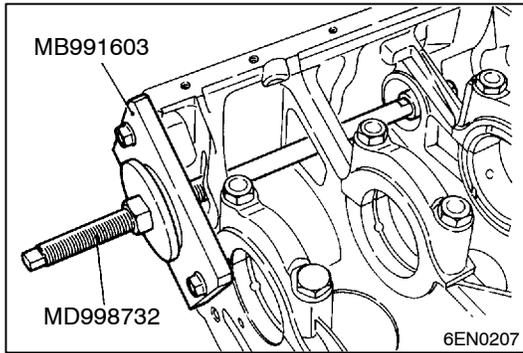


◀D▶ COUNTERBALANCE SHAFT FRONT BEARING REMOVAL

- (1) Using the special tool, remove the front bearing from the cylinder block.

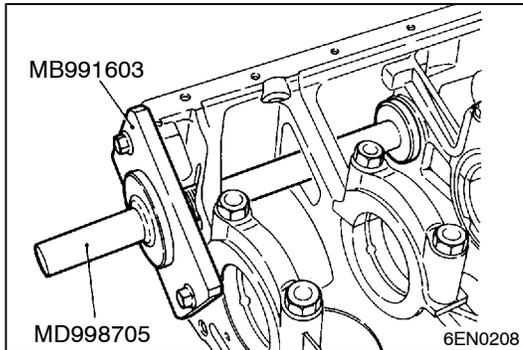
NOTE

Be sure to remove the front bearing first. If it has not been removed, the Rear Bearing Puller cannot be used.



◀E▶ RIGHT COUNTERBALANCE SHAFT REAR BEARING / LEFT COUNTERBALANCE SHAFT REAR BEARING REMOVAL

- (1) Using the special tool, remove two rear bearings from the cylinder block.
- (2) To remove the left rear bearing, install the special tool, Silent Shaft Bearing Installer Stopper, to the front of the cylinder block, then remove the bearing using the special tool, Silent Shaft Bearing Puller.



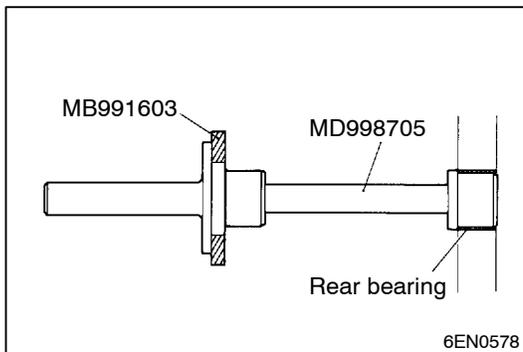
INSTALLATION SERVICE POINTS

▶A◀ LEFT COUNTERBALANCE SHAFT REAR BEARING INSTALLATION

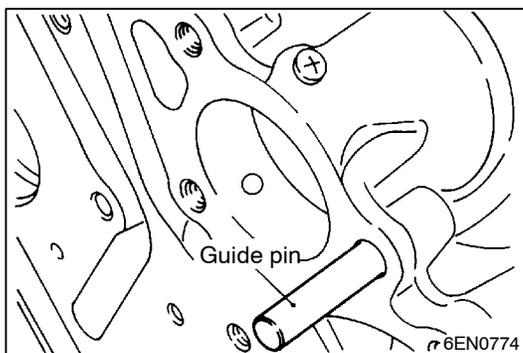
- (1) Install the special tool in the cylinder block.
- (2) Apply engine oil to the rear bearing outer circumference and bearing hole in the cylinder block.

NOTE

The left side bearing is provided with no oil hole.

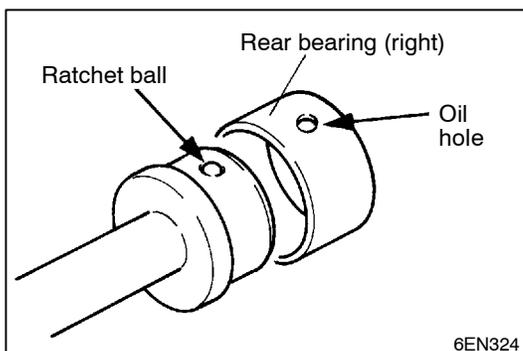


- (3) Using the special tool, install the bearing.

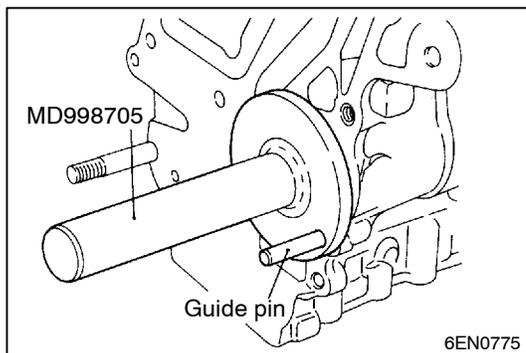


▶B◀ RIGHT COUNTERBALANCE SHAFT REAR BEARING INSTALLATION

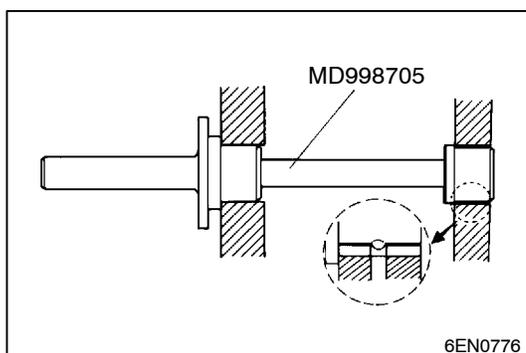
- (1) Install the guide pin of the special tool to the threaded hole of the cylinder block as illustrated.



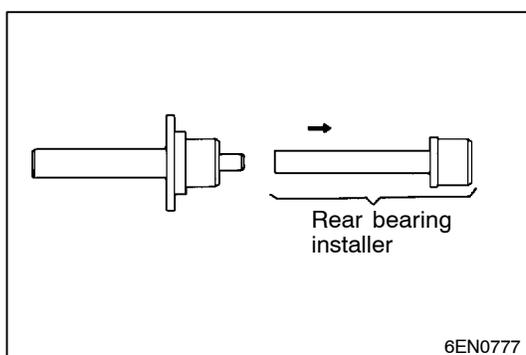
- (2) Install the bearing to the special tool, aligning the ratchet ball of the special tool with the oil hole of the rear bearing.
- (3) Apply engine oil to the outer circumference of the bearing and to the bearing hole of the cylinder block.



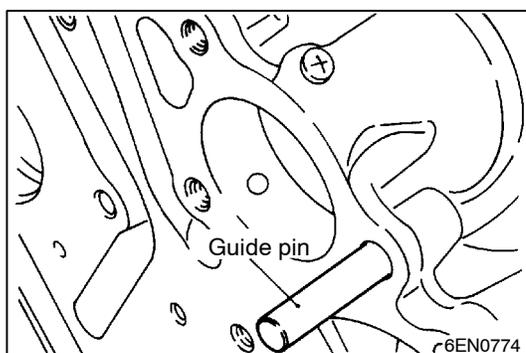
- (4) Insert the installer aligning with the guide pin and install the bearing.



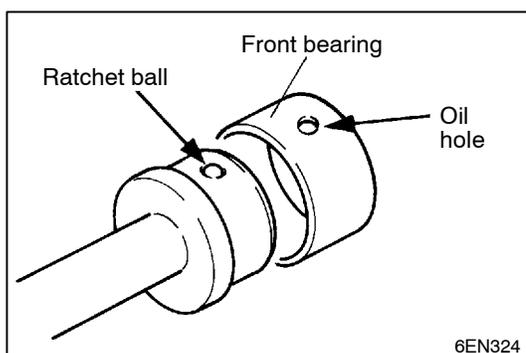
▶◀ COUNTERBALANCE SHAFT FRONT BEARING INSTALLATION



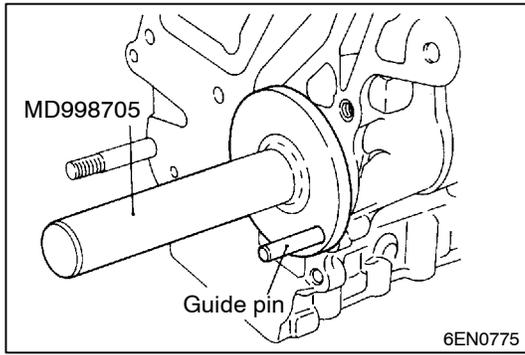
- (1) Remove the rear bearing installing portion from the special tool.



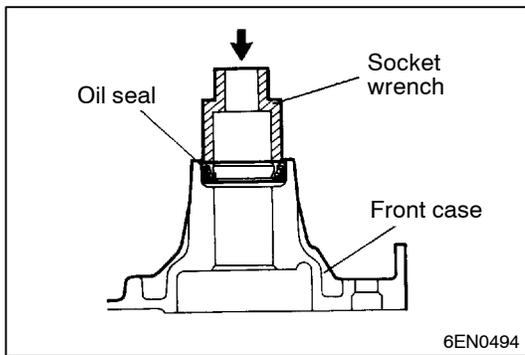
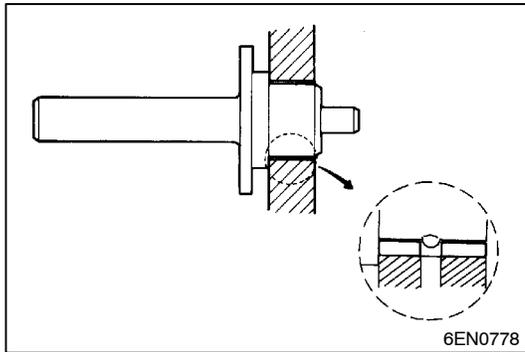
- (2) Install the guide pin of the special tool to the threaded hole of the cylinder block as illustrated.



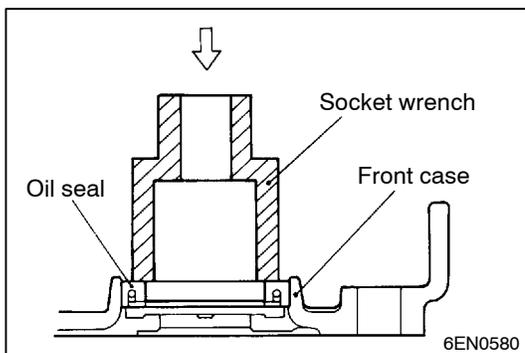
- (3) Install the bearing to the special tool, aligning the ratchet ball of the special tool with the oil hole of the front bearing.
- (4) Apply engine oil to the outer circumference of the bearing and to the bearing hole of the cylinder block.



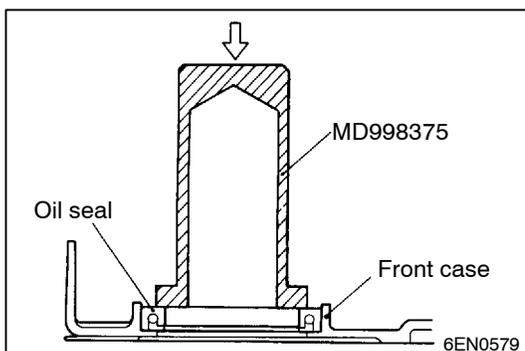
- (5) Insert the installer aligning with the guide pin and install the bearing.



►D◄ OIL PUMP OIL SEAL INSTALLATION

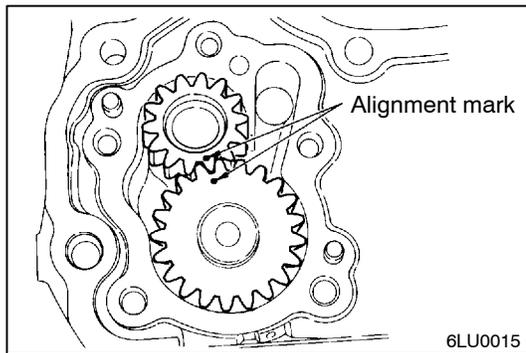


►E◄ COUNTERBALANCE SHAFT OIL SEAL INSTALLATION



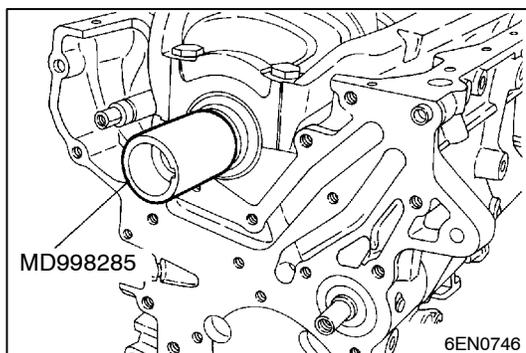
►F◄ CRANKSHAFT FRONT OIL SEAL INSTALLATION

- (1) Using the special tool, install the crankshaft front oil seal into the front case.



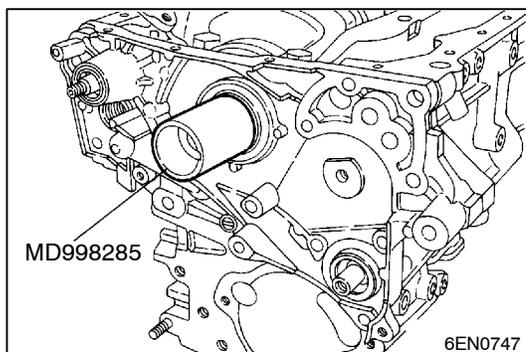
▶◀ OIL PUMP DRIVEN GEAR / OIL PUMP DRIVE GEAR INSTALLATION

- (1) Apply engine oil amply to the gears and line up the alignment marks.

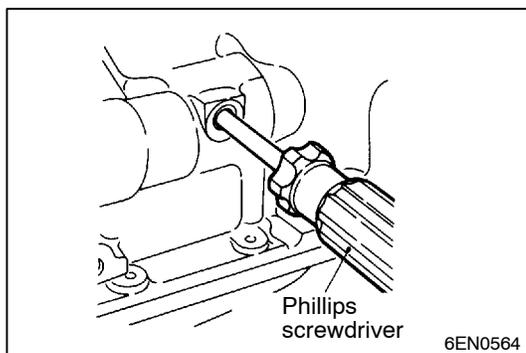


▶◀ FRONT CASE INSTALLATION

- (1) Install the special tool at the front end of the crankshaft and apply a thin coat of engine oil to the outer circumference. In case an oil seal has been installed to the front case, be sure to use the guide.

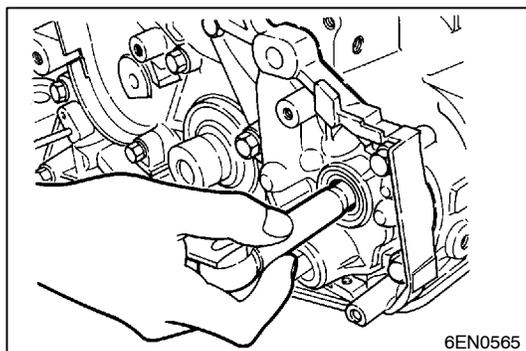


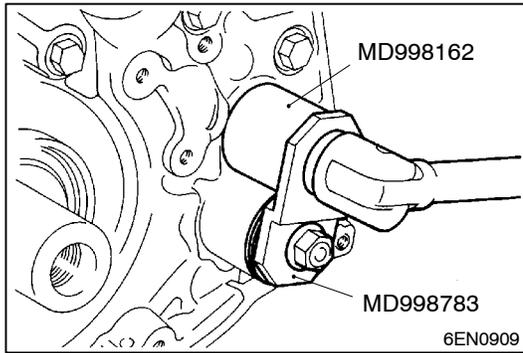
- (2) Install the front case assembly via a new front case gasket and temporarily tighten the flange bolts (other than those for tightening the filter bracket.)
- (3) Install the oil filter bracket via the oil filter bracket gasket and temporarily tighten four bolts with washers.
- (4) Tighten the front case bolts to the specified torque.



▶◀ FLANGE BOLT INSTALLATION

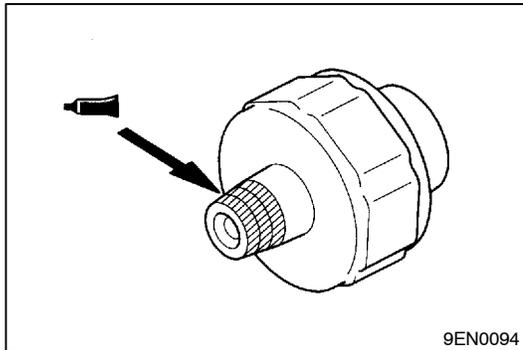
- (1) Insert a Phillips screwdriver [shank diameter 8 mm] into the plug hole on the left side of the cylinder block to block the counterbalance shaft then tighten the flange bolt.





▶J◀ PLUG INSTALLATION

- (1) Fit a new O-ring in the front case.
- (2) Tighten the plug to the specified torque using the special tool.

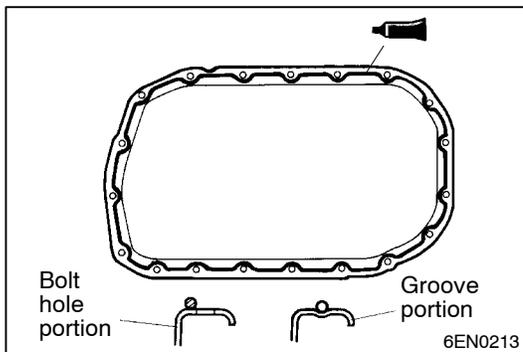


▶K◀ OIL PRESSURE SWITCH INSTALLATION

Specified sealant: 3M ATD Part No. 8660 or equivalent

Caution

- Keep the end of the thread portion clear or sealant.
- Avoid an overtightening.



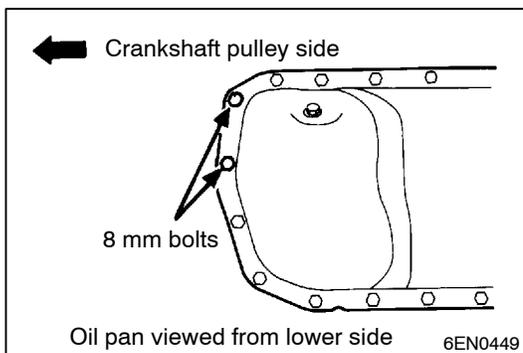
▶L◀ OIL PAN INSTALLATION

- (1) Clean both mating surface of oil pan and cylinder block.
- (2) Apply a 4 mm wide bead of sealant to the entire circumference of the oil pan flange.

Specified sealant:

MITSUBISHI GENUINE PART No. MD970389 or equivalent

- (3) The oil pan should be installed in 15 minutes after application of sealant.

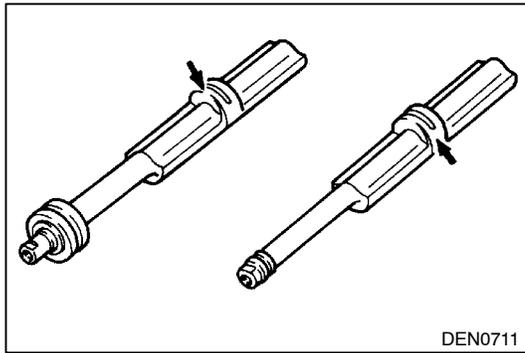


- (4) Note the difference in bolt lengths at the location shown.

INSPECTION

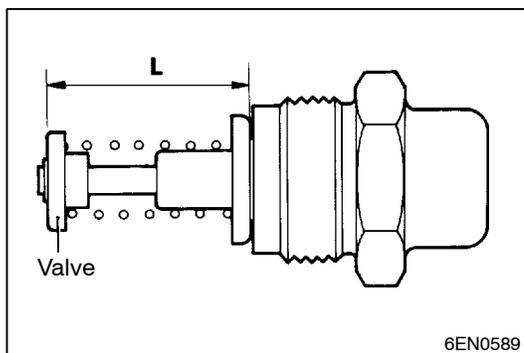
FRONT CASE

- (1) Check the oil holes for clogging and clean if necessary.
- (2) Check the left silent shaft front bearing section for wear, damage and seizure. If there is anything wrong with the section, replace the front case.
- (3) Check the front case for cracks and other damage. Replace cracked or damaged front case.



COUNTERBALANCE SHAFT

- (1) Check the oil holes for clogging.
- (2) Check the journals for seizure, damage, and contact with bearing. If there is anything wrong with the journal, replace the counterbalance shaft, bearing or front case assembly.



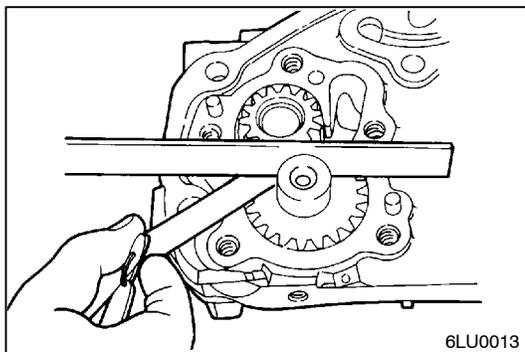
OIL COOLER BYPASS VALVE

- (1) Make sure that the valve moves smoothly.
- (2) Ensure that the dimension L measures the standard value under normal temperature and humidity.

Dimension L: 34.5 mm

- (3) The dimension must be the standard value when measured after the valve has been dipped in 100°C oil.

Dimension L: 40 mm or more



OIL PUMP

- (1) Assemble the oil pump gear to the front case and rotate it to ensure smooth rotation with no looseness.
- (2) Ensure that there is no ridge wear on the contact surface between the front case and the gear surface of the oil pump cover.
- (3) Check the side clearance.

Standard value:

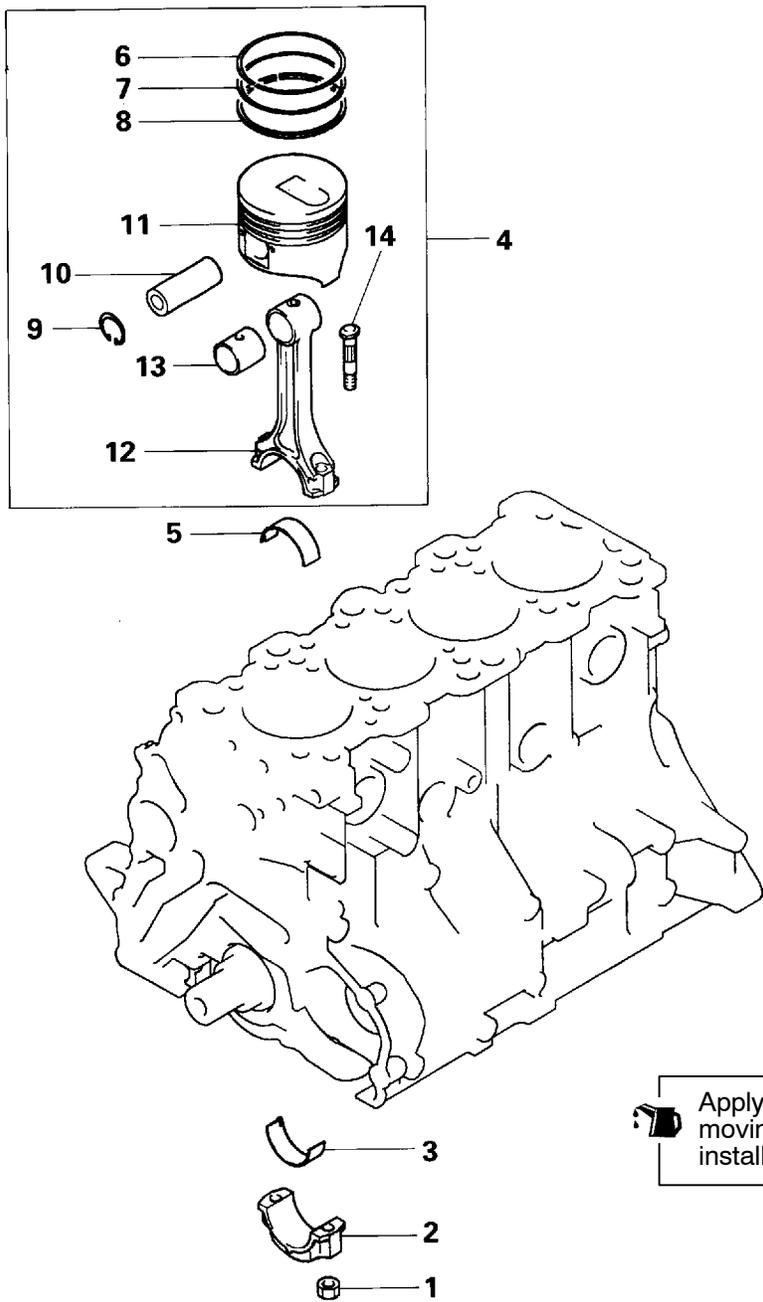
Drive gear	0.08 - 0.14 mm
Driven gear	0.06 - 0.12 mm

OIL SEAL

- (1) Check the oil seal lip for wear and damage. Replace the oil seal if necessary.
- (2) Check the oil seal lip for deterioration. Replace oil seal if necessary.

11. PISTONS AND CONNECTING RODS

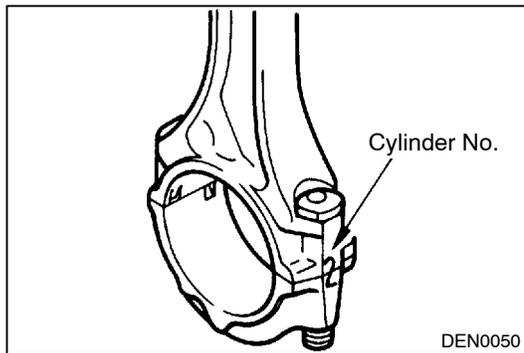
REMOVAL AND INSTALLATION



- Removal steps**
- ◀A▶ ▶F▶ 1. Connecting rod cap nut
 - ▶E▶ 2. Connecting rod cap
 - ▶C▶ 3. Connecting rod bearing
 - ▶D▶ 4. Piston and connecting rod assembly
 - ▶C▶ 5. Connecting rod bearing
 - ▶B▶ 6. Piston ring No.1
 - ▶B▶ 7. Piston ring No.2

- ▶A▶ 8. Oil ring
- ▶A▶ 9. Snap ring
- ▶A▶ 10. Piston pin
- ▶A▶ 11. Piston
- ▶A▶ 12. Connecting rod
- ▶A▶ 13. Bushing
- ▶A▶ 14. Connecting rod bolt

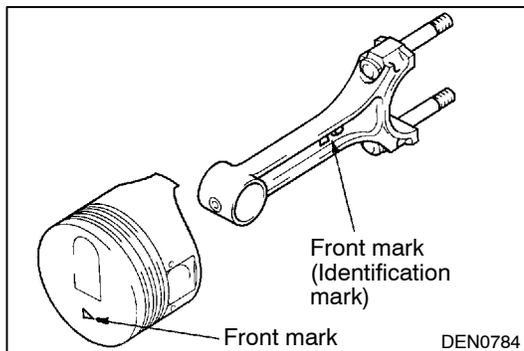
DEN0771



REMOVAL SERVICE POINTS

◀A▶ CONNECTING ROD CAP REMOVAL

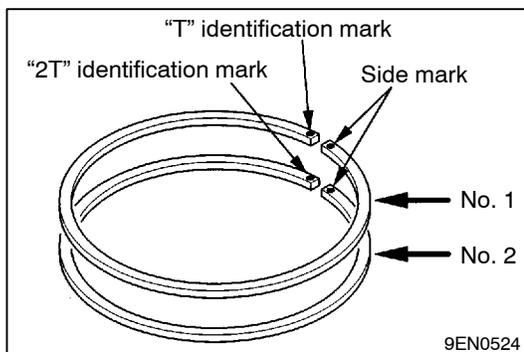
- (1) Mark the cylinder number on the side of the connecting rod big end for correct reassembly.



INSTALLATION SERVICE POINTS

▶A◀ PISTON PIN / PISTON / CONNECTING ROD INSTALLATION

- (1) Assemble the piston and connecting rod, directing the front marks in the same direction.
- (2) Insert the piston pin. The pin should be inserted by hand. Replace if there is a play.



▶B◀ PISTON RING NO. 2 / PISTON RING NO. 1 INSTALLATION

- (1) Using a ring expander, fit ring No. 2 and ring No. 1 with their identification marks facing upward (on the piston crown side).

Identification marks:

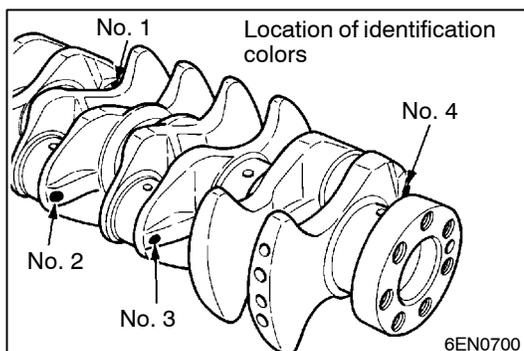
No. 1 ring: T

No. 2 ring: 2T

NOTE

Piston rings are stamped with size marks as follows:

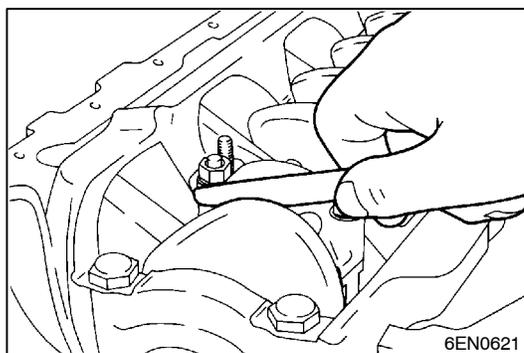
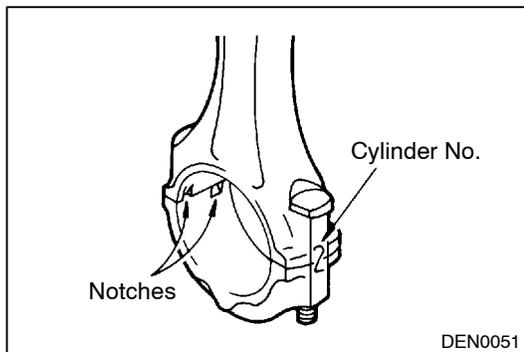
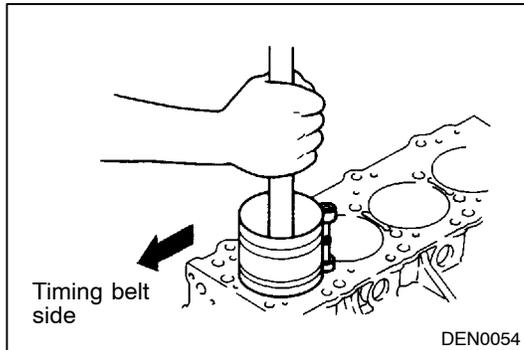
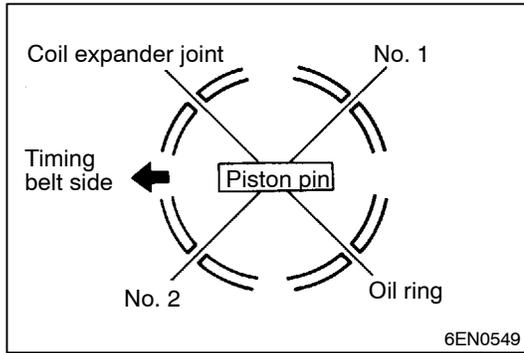
Size	Size mark
STD	None
0.50 mm O.S.	50
1.00 mm O.S.	100



▶C◀ CONNECTING ROD BEARING INSTALLATION

- (1) When the bearings are replaced, select and install them according to the identification colors on the crankshaft.

Crank pin O.D. identification color	Connecting rod bearing identification mark
Yellow	1
None	2
White	3



►D◄ PISTON AND CONNECTING ROD ASSEMBLY INSTALLATION

- (1) Liberally coat engine oil on the circumference of the piston, piston ring, and oil ring.
- (2) Arrange the piston ring and oil ring gaps as shown in the illustration.
- (3) Rotate the crankshaft so that the crank pin is on the center of the cylinder bore.
- (4) Use suitable thread protectors on the connecting rod bolts before inserting the piston and connecting rod assembly into the cylinder block. Care must be taken not to nick the crank pin.
- (5) Using a suitable piston ring compressor tool, install the piston and connecting rod assembly into the cylinder block.

Caution

- Direct the front mark (arrow) on the piston top towards the engine front (timing belt side).

►E◄ CONNECTING ROD CAP INSTALLATION

- (1) Verifying the mark made during disassembly, install the bearing cap to the connecting rod. If the connecting rod is new with no index mark, make sure that the bearing locking notches come on the same side as shown.

- (2) Make sure that the connecting rod big end side clearance meets the specification.

Standard value: 0.10 - 0.25 mm

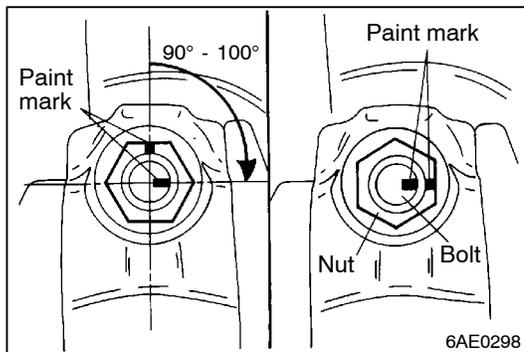
Limit: 0.4 mm

►F◄ CONNECTING ROD CAP NUT INSTALLATION

Caution

- If the cylinder head has been installed before installing the connecting rod cap nut, be sure to remove the spark plugs.

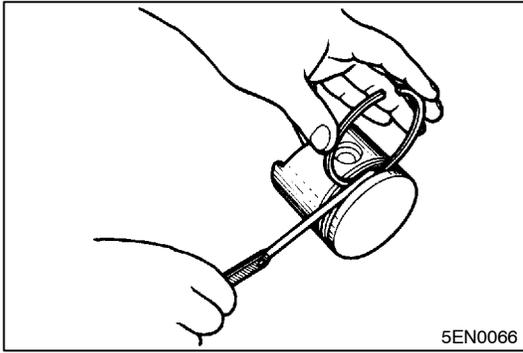
- (1) Since the connecting rod cap bolts and nuts are torqued using the plastic area tightening method, the bolts should be examined BEFORE reuse. If the bolt threads are "necked down", the bolt should be replaced.
Necking can be checked by running a nut with fingers to the full length of the bolt threads. If the nut does not run down smoothly, the bolt should be replaced.
- (2) Before installation of each nut, apply engine oil to the thread portion and bearing surface of the nut.
- (3) Install each nut to the bolt and tighten it with fingers. Then tighten the nuts alternately to install the cap properly.
- (4) Tighten the nuts to a torque of 20 Nm.



- (5) Make a paint mark on the head of each nut.
- (6) Make a paint mark on the bolt end at the position 90° to 100° from the paint mark made on the nut in the direction of tightening the nut.
- (7) Give a 90° to 100° turn to the nut and make sure that the paint mark on the nut and that on the bolt are in alignment.

Caution

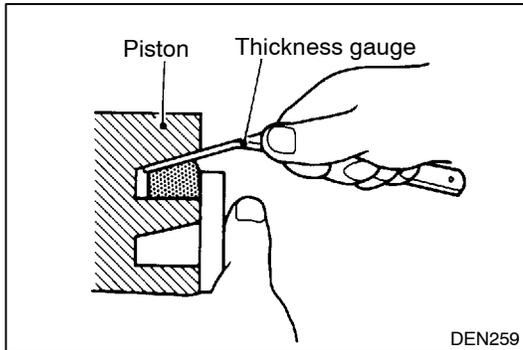
- If the nut is turned less than 90°, proper fastening performance may not be expected. When tightening the nut, therefore, be careful to give a sufficient turn to it.
- If the nut is overtightened (exceeding 100°), loosen the nut completely and then retighten it by repeating the tightening procedure from step (1).



INSPECTION

PISTON RING

- (1) Check for side clearance.
If the limit is exceeded, replace the ring or piston, or both.



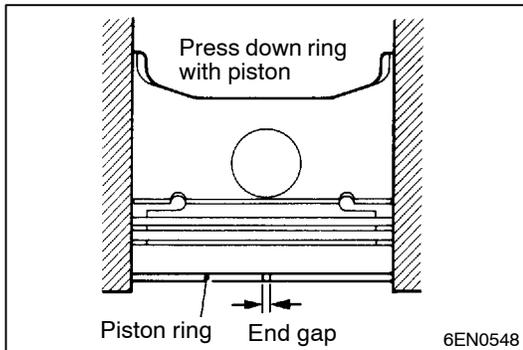
- (2) In the case of semi-keystone type piston rings, check the ring to ring groove clearance as illustrated.

Standard value:

No. 1	0.05 - 0.07 mm
No. 2	0.05 - 0.07 mm

Limit:

No. 1	0.15 mm
No. 2	0.15 mm

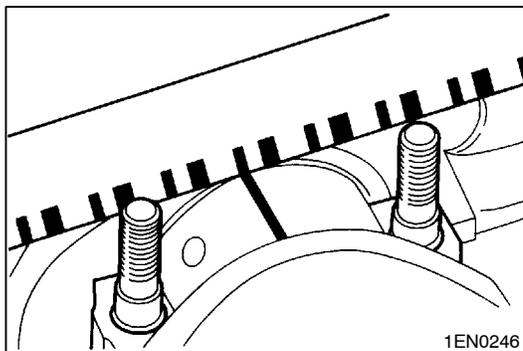


- (3) Insert the piston ring into the cylinder bore. Force it down with a piston, its crown being in contact with the ring, to correctly position it at right angles to the cylinder wall. Then, measure the end gap with a thickness gauge. If the end gap is excessively, replace the piston ring.

Standard value:

No. 1	0.20 - 0.32 mm
No. 2	0.35 - 0.50 mm
Oil	0.10 - 0.30 mm

Limit: 0.8 mm

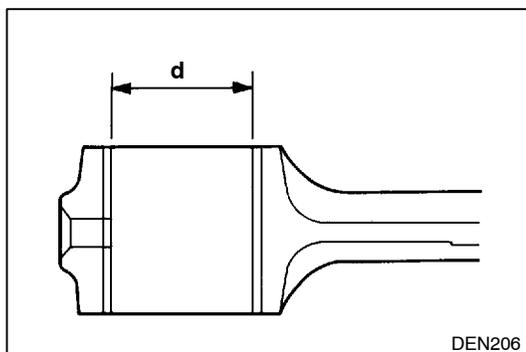
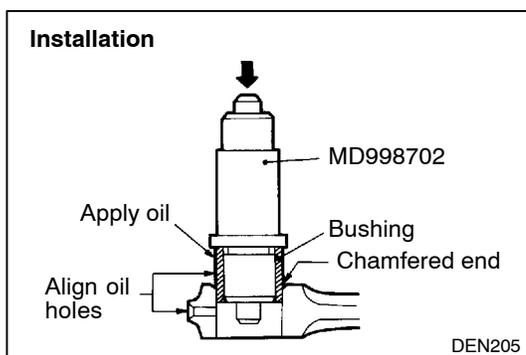
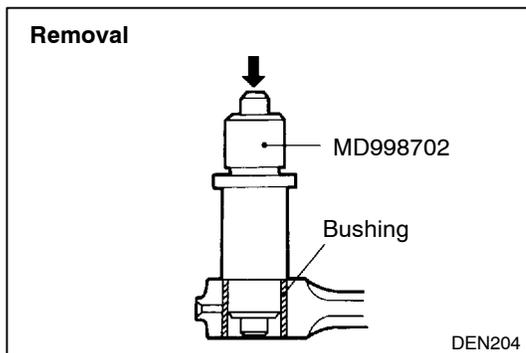


CRANKSHAFT PIN OIL CLEARANCE (PLASTIC GAUGE METHOD)

- (1) Remove oil from the crankshaft pin and the connecting rod bearing.
- (2) Cut the plastic gauge to the same length as the width of the bearing and place it on the crankshaft pin in parallel with its axis.
- (3) Install the connecting rod cap carefully and tighten the bolts to the specified torque.
- (4) Carefully remove the connecting rod cap.
- (5) Measure the width of the plastic gauge at its widest part by using scale printed on the plastic gauge package.

Standard value: 0.02 - 0.05 mm

Limit: 0.1 mm



CONNECTING ROD BUSHING REPLACEMENT

(1) Using the special tool, remove the bushing.

(2) Using the special tool, install the bushing, aligning the oil hole of the bushing with the oil hole at the small end of the connecting rod.

(3) Finish the bushing I.D. to the standard value.

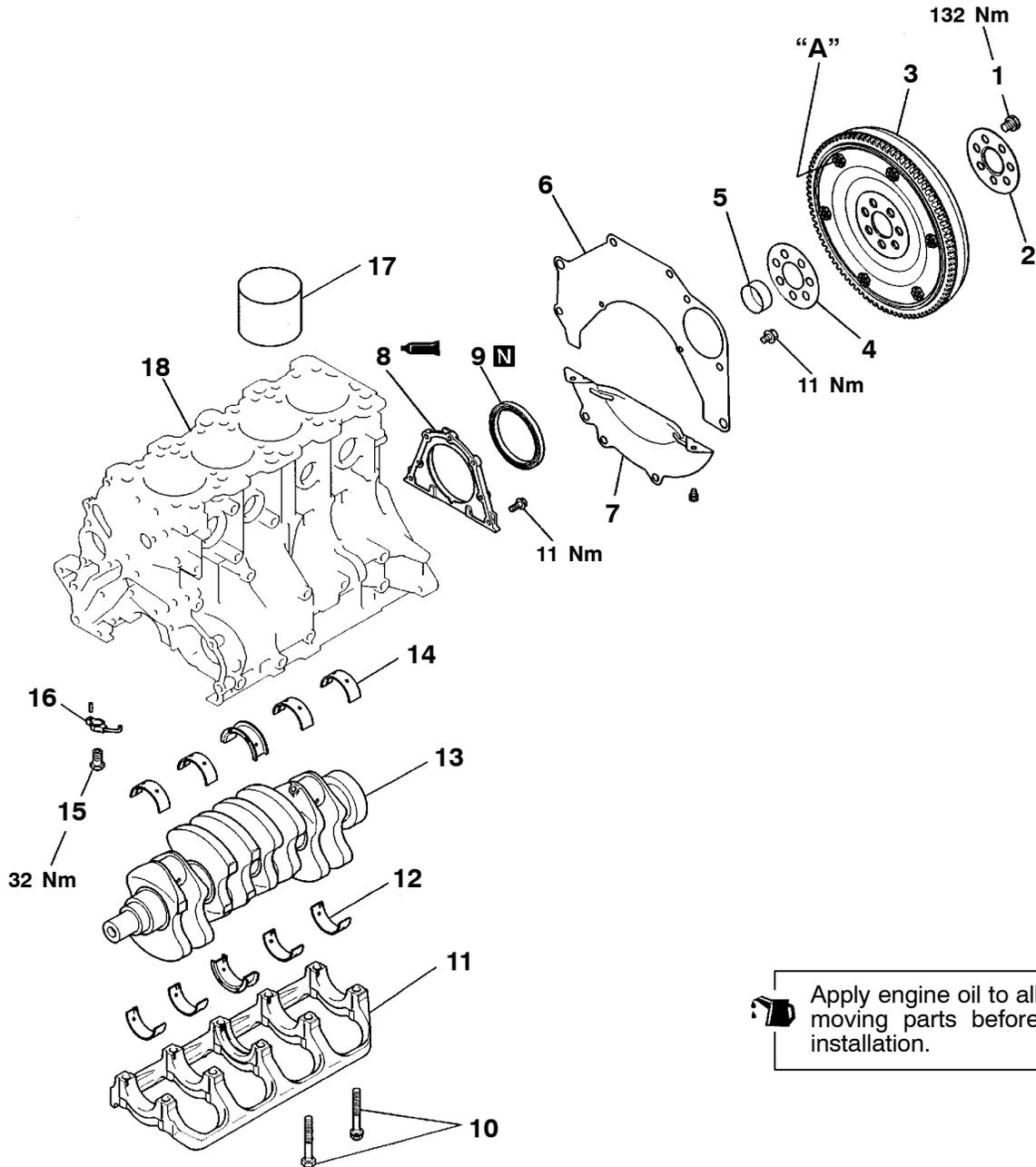
Bushing I.D. (d) standard value:

25.015 - 25.025 mm

Bend (Parallelism between big end center line and small end center line): 0.05 mm

Twist (Deflection between big end center line and small end center line): 0.1 mm

12. CRANKSHAFT, CYLINDER BLOCK AND FLYWHEEL REMOVAL AND INSTALLATION



Apply engine oil to all moving parts before installation.

DEN0893

Removal steps

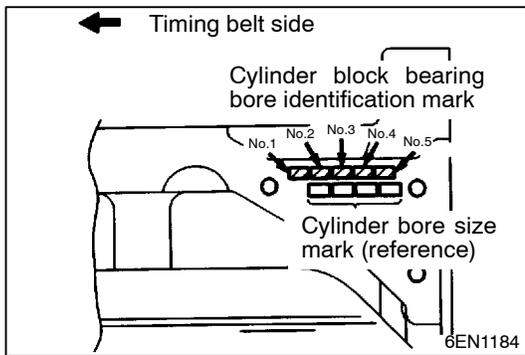
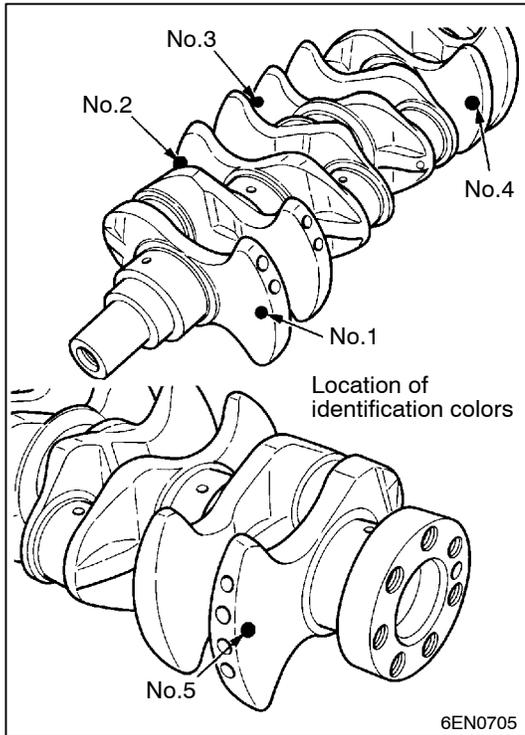
1. Flywheel bolt
2. Adapter plate
3. Flexible flywheel
4. Adapter plate
5. Crankshaft bush
6. Rear plate
7. Bell housing cover
8. Oil seal case
9. Oil seal
10. Bearing cap bolt
11. Bearing cap
12. Crankshaft bearing, lower
13. Crankshaft
14. Crankshaft bearing, upper

15. Check valve
16. Oil jet
17. Cylinder sleeve
18. Cylinder block

Caution

On the flexible wheel equipped engines, do not remove any of the bolts "A" of the flywheel shown in the illustration.

The balance of the flexible flywheel is adjusted in an assembled condition. Removing the bolt, therefore, can cause the flexible flywheel to be out of balance, giving damage to the flywheel.



INSTALLATION SERVICE POINTS

▶A◀ CRANKSHAFT BEARING INSTALLATION

When the bearing needs replacing, select and install a proper bearing by the following procedure.

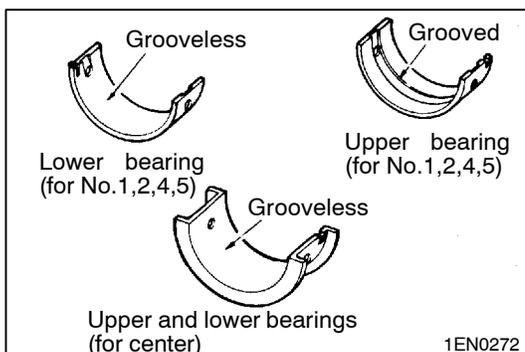
- (1) Measure the crankshaft journal diameter and confirm its classification from the following table. In the case of a crankshaft supplied as a service part, identification colors of its journals are painted at the positions shown in the illustration.
- (2) The cylinder block bearing bore diameter identification marks are stamped at the position shown in the illustration from front to rear beginning at No. 1.

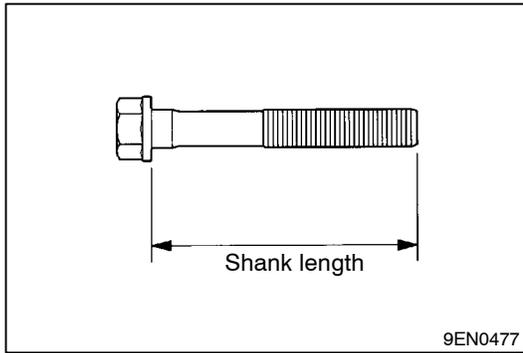
Crankshaft journal			O.D. mm	Cylinder block bearing bore diameter identification mark	Bearing identification mark (for service part)
Classification	Identification color				
	Production part	Service part			
1	None	Yellow	56.994 - 57.000	0	1
				1	2
				2	3
2	None	None	56.988 - 56.994	0	2
				1	3
				2	4
3	None	White	56.982 - 56.988	0	3
				1	4
				2	5

- (3) Select a proper bearing from the above table on the basis of the identification data confirmed under items (1) and (2).

[Example]

1. If the measured value of a crankshaft journal outer diameter is 57.000 mm, the journal is classified as "1" in the table. In case the crankshaft is also replaced by a spare part, check the identification colors of the journals painted on the new crankshaft. If the color is yellow, for example, the journal is classified as "1".
2. Next, check the cylinder block bearing hole identification mark stamped on the cylinder block. If it is "0", read the "Bearing identification mark" column to find the identification mark of the bearing to be used. In this case, it is "1".
- (3) Install the bearings having an oil groove to the cylinder block. Install the grooveless bearing with thrust flanges in the center bearing bore in the cylinder block.
- (4) Install the bearings having no oil groove to the bearing caps.

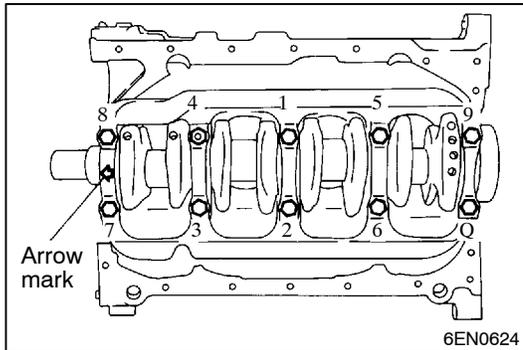




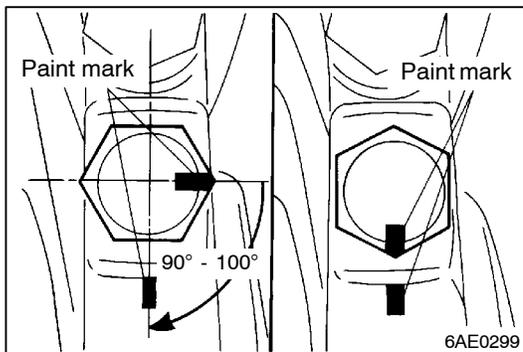
►B◄ **BEARING CAP / BEARING CAP BOLT INSTALLATION**

- (1) Install the bearing caps so that their arrows are directed to the timing belt side.
- (2) Before installing the bearing cap bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.

Limit: 71.1 mm



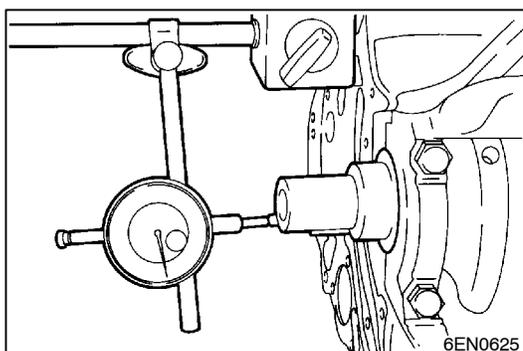
- (3) Apply engine oil to the threaded portion and bearing surface of the bolt.
- (4) Tighten the bolts to 25 Nm in the specified tightening sequence.



- (5) Make a paint mark on the head of each bolt.
- (6) Make a paint mark on the bearing cap at the position 90° to 100° from the paint mark made on the bolt in the direction of tightening the bolt.
- (7) According to the specified tightening sequence, give a 90° to 100° turn to each bolt and make sure that the paint mark on the bolt and that on the cap are in alignment.

Caution

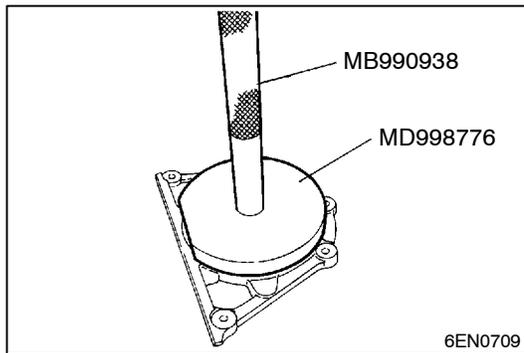
- If the bolt is turned less than 90°, proper fastening performance may not be expected. When tightening the bolt, therefore, be careful to give a sufficient turn to it.
- If the bolt is overtightened (exceeding 100°), loosen the bolt completely and then retighten it by repeating the tightening procedure from step (1).



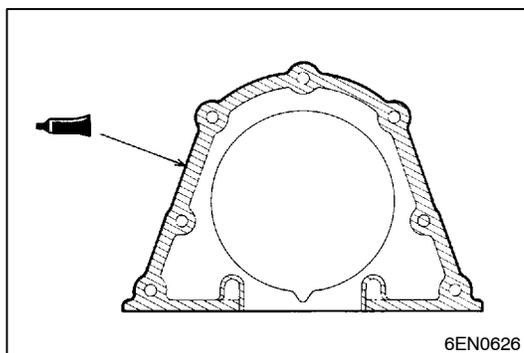
- (8) After installing the bearing caps, make sure that the crankshaft turns smoothly and the end play is correct. If the end play exceeds the limit, replace the crankshaft bearings.

Standard value: 0.05 - 0.18 mm

Limit: 0.25 mm

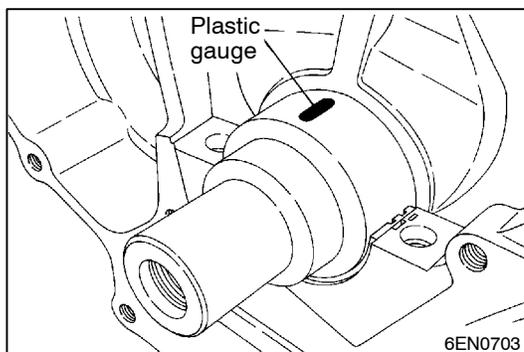


▶◀ OIL SEAL INSTALLATION



▶◀ OIL SEAL CASE INSTALLATION

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or
equivalent

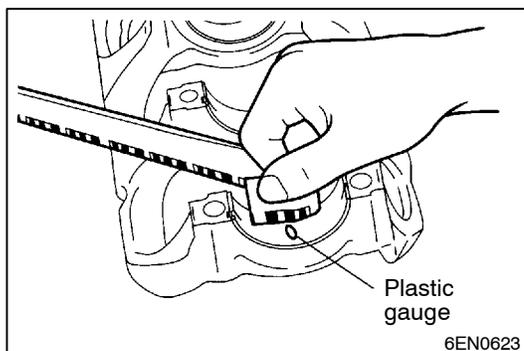


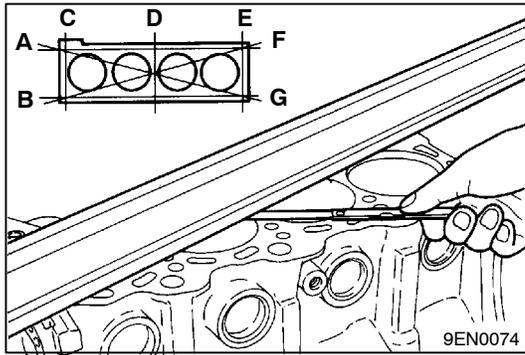
INSPECTION

CRANKSHAFT OIL CLEARANCE (PLASTIC GAUGE METHOD)

- (1) Remove oil from the crankshaft journal and the crankshaft bearing.
- (2) Install the crankshaft.
- (3) Cut the plastic gauge to the same length as the width of the bearing and place it on the journal in parallel with its axis.
- (4) Install the crankshaft bearing cap carefully and tighten the bolts to the specified torque.
- (5) Carefully remove the crankshaft bearing cap.
- (6) Measure the width of the plastic gauge at its widest part by using a scale printed on the plastic gauge package.

Standard value: 0.02 - 0.04 mm
Limit: 0.1 mm

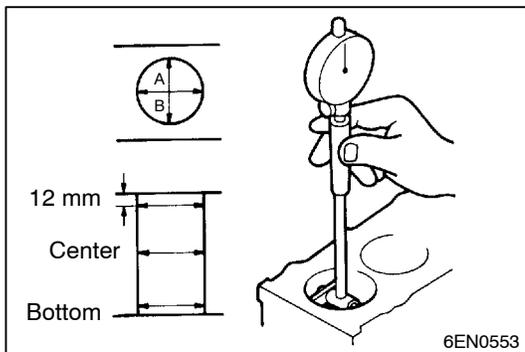




CYLINDER BLOCK

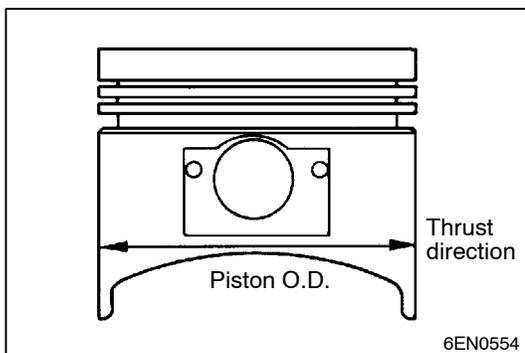
- (1) Visually check for cracks, rust, and corrosion, and inspect the cylinder block using a flaw detecting agent. Rectify defects where possible or replace the cylinder block.
- (2) Check the cylinder block's top surface for distortion using a straight edge and thickness gauge. Be sure to make measurements with the straight edge placed in the direction of A, B,.. and G as shown in the illustration. Before measurements, make sure that the top surface is free of gasket chips and other foreign material. If the distortion is excessive, replace the cylinder block.

Standard value: 0.05 mm
Limit: 0.1 mm



- (3) Check the cylinder sleeve wall for scratches and seizure. If defects are evident, replace the cylinder sleeve. Measure the cylinder sleeve inner diameter at the points shown in the illustration. If it is badly worn, replace.

Standard value: 82.70 - 82.73 mm
Conicity: 0.01 mm



BORING CYLINDER

- (1) Oversize pistons to be used should be determined on the basis of the largest bore cylinder.

Piston size identification

Size	Identification mark
0.50 mm O.S.	0.50
1.00 mm O.S.	1.00

NOTE

Size mark is stamped on the piston top.

- (2) Measure outside diameter of piston to be used. Measure it in thrust direction as shown.
- (3) Based on the measured piston O.D., calculate the boring finish dimension.

Boring finish dimension = Piston O.D. + (Clearance between piston O.D. and cylinder) - 0.02 mm (honing margin)

- (4) Bore all cylinders to the calculated boring finish dimension.

Caution

To prevent distortion that may result from temperature rise during honing, bore cylinders, in the order of No. 2, No. 4, No. 1 and No. 3.

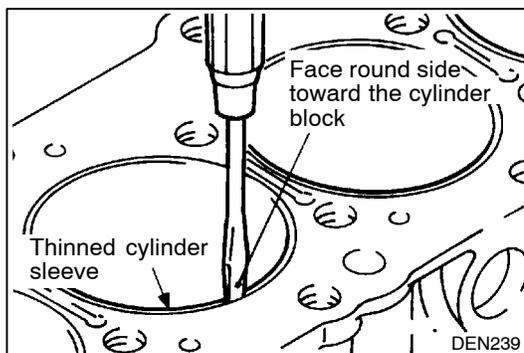
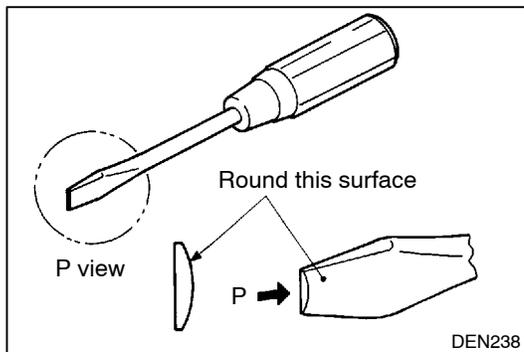
- (5) Hone to the final finish dimension (Piston O.D. + clearance between piston O.D. and cylinder.)
- (6) Check the clearance between piston and cylinder.

Clearance between piston and cylinder:

0.03 - 0.05 mm

NOTE

When boring cylinders, finish all of four cylinders to the same oversize. Do not bore only one cylinder to an oversize.

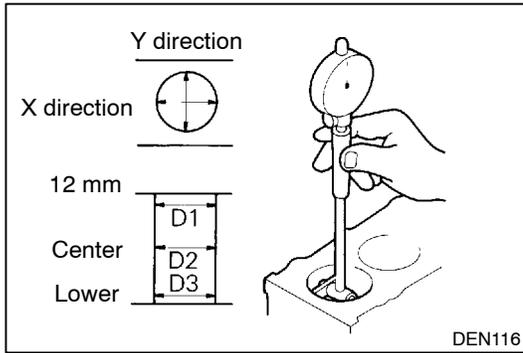


CYLINDER SLEEVE CHANGE PROCEDURES

REMOVAL

- (1) Fix the cylinder block to a boring machine and center it. Center at the lower portion of the cylinder sleeve where there is less uneven wear.
- (2) Bore to the sleeve wall thickness of about 0.5 mm.
- (3) Machine the screwdriver as illustrated and insert it between the cylinder sleeve and cylinder block. Lightly hit it to break the sleeve.

When doing so, be careful not to damage the cylinder block wall.

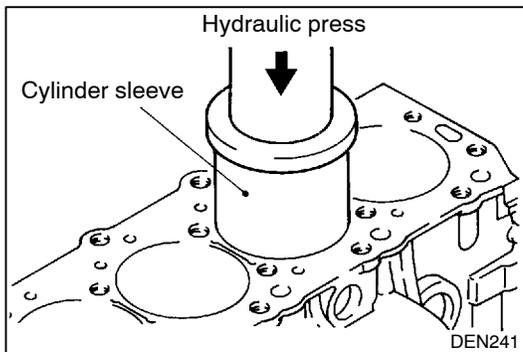


INSPECTION

- (1) After removing the cylinder sleeve, check the cylinder block sleeve hole surface.
If there is damage, insufficient interference-fit-margin or other problems, bore the cylinder block sleeve hole to an oversize.
- (2) To check the interference, measure both the cylinder sleeve O.D. and cylinder block sleeve hole I.D. at the positions D₁, D₂ and D₃ in both X and Y directions.
- (3) If the average of the differences between measured values is smaller than 0.12 mm, then bore the sleeve hole to 0.5 mm oversize and install an oversize sleeve. If the average is larger than 0.175 mm, bore the sleeve hole to the extent that the difference falls within a range of 0.12 to 0.175 mm, then install a standard cylinder sleeve.

Caution

- If one cylinder requires oversize machining, oversize it with the other cylinder sleeves removed. Machining while the sleeves remain in the other cylinders may disturb roundness.

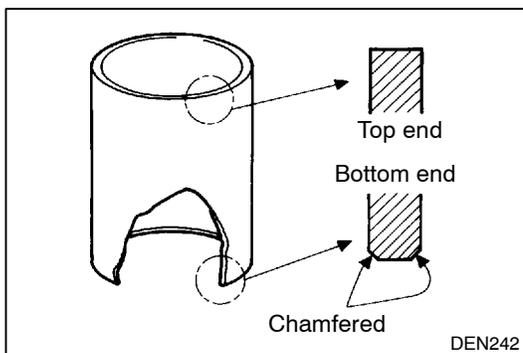


INSTALLATION

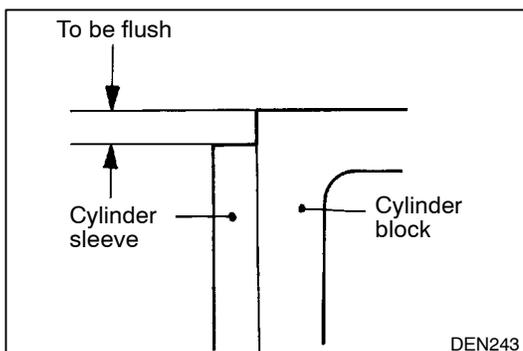
When cylinder block sleeve hole has not been bored

- (1) Amply apply press oil to the cylinder block sleeve hole and sleeve outer circumference.
- (2) Apply a disc [diameter 100 mm, thickness 20 mm or more] to the top of the sleeve and press fit using a hydraulic press.

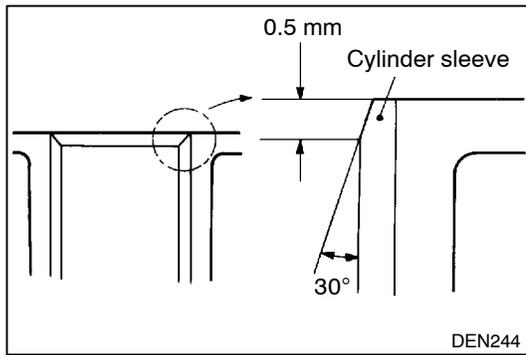
Installation load: 22,000 N or more



- (3) Install with the chamfered end first as illustrated. Continue until the sleeve upper end is flush with the block upper end.



- (4) Cut off the top end of the cylinder block in order to make the cylinder block flush with the sleeve. Cut off the minimum top end portion of the cylinder block necessary to make them flush. Do not cut off more than 0.2 mm.



- (5) Chamfer the cylinder sleeve top end as illustrated.

- (6) The service cylinder sleeve has the I.D. machined to 81.5 to 81.7 mm. After installation of the sleeve, therefore, hone the I.D. to the standard value.

Cylinder I.D.: 82.70 - 82.73 mm

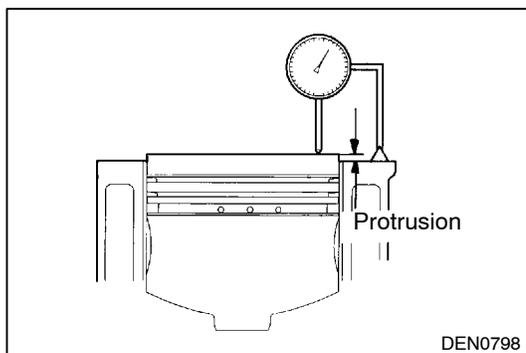
Honing finished surface roughness: 2 - 4 μ

Honing cross hatch angle: 15 - 25°

Cylinder bore squareness: 0.05 mm

When boring the cylinder block sleeve hole

- (1) Prepare a cylinder sleeve of 0.5 mm oversize (identification color: red).
- (2) Hone the cylinder block sleeve hole to 86.13 to 86.15 mm.
- (3) Install the cylinder sleeve and finish the I.D. The installation and machining procedures are the same as in the case when the block sleeve hole has not been bored.



INSPECTION AFTER ASSEMBLY

- (1) After assembling the crankshaft, piston, etc., check the piston protrusion.
If the protrusion exceeds the limit, change the piston and connecting rod in order to reduce the protrusion to within the limit.
- (2) If the protrusion still exceeds the limit after piston reassembly, replace the cylinder block.

Limit: 0.823 mm

NOTES