

ENGINE

4D56

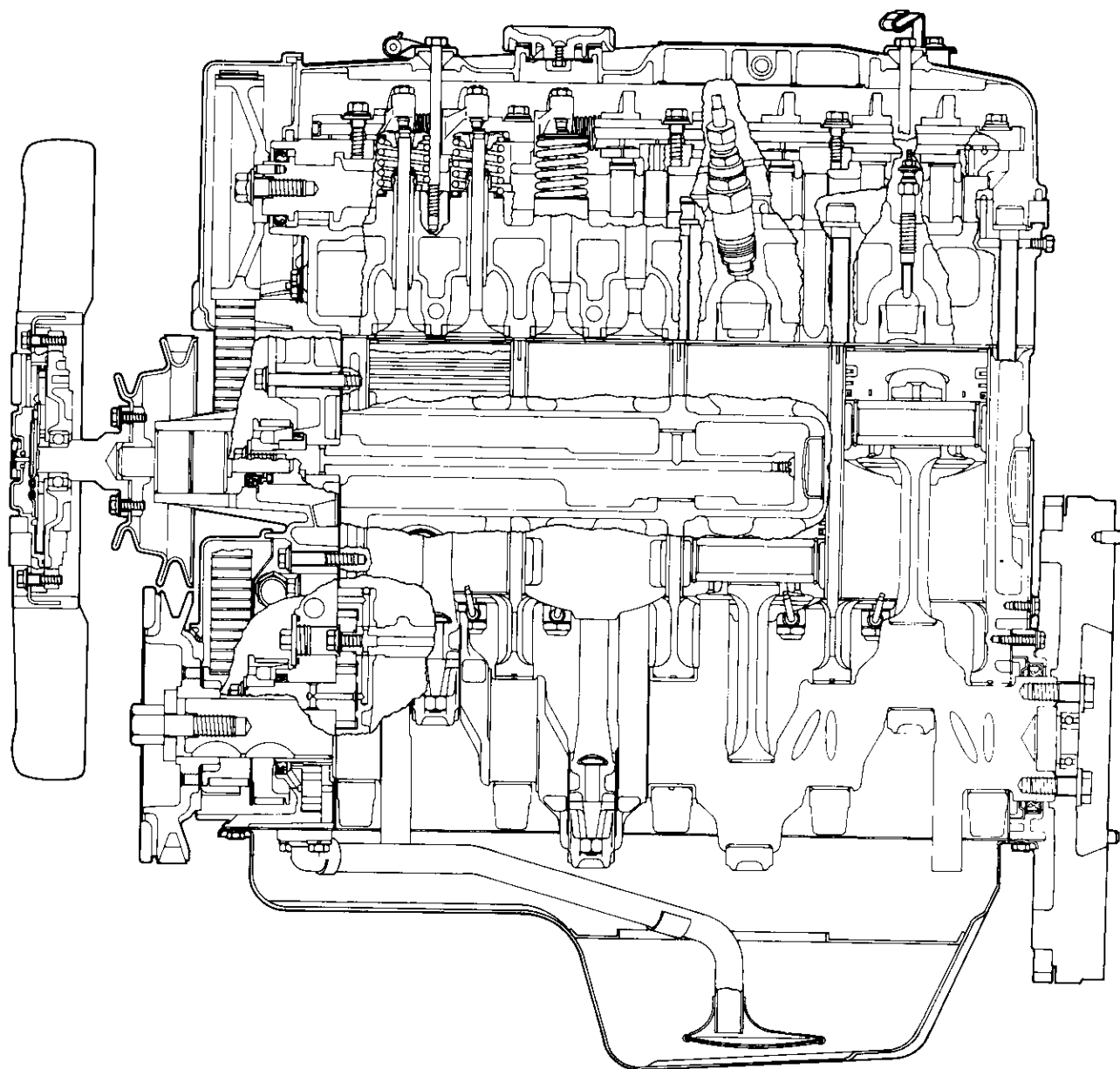
<1991 to 1993>

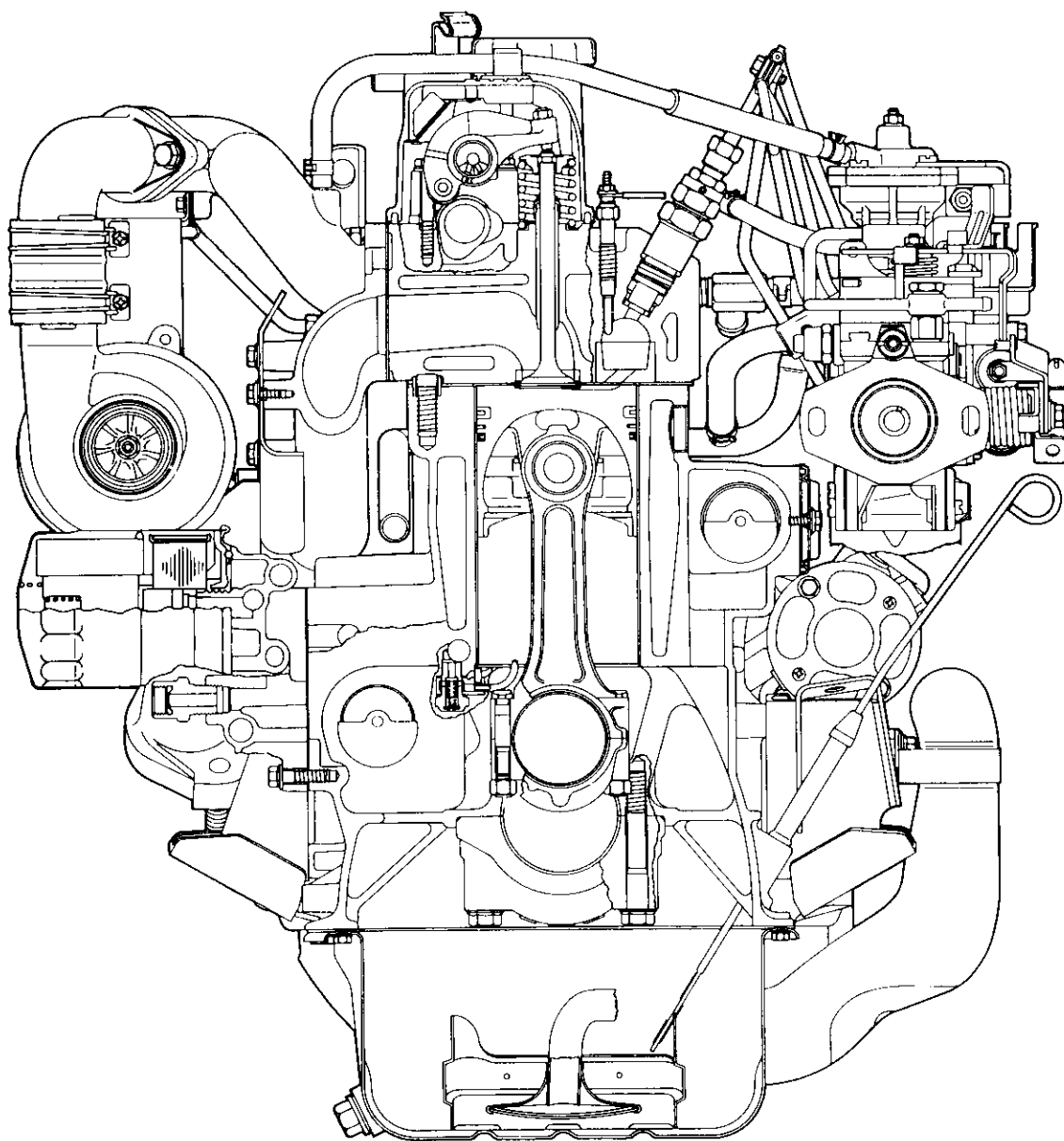
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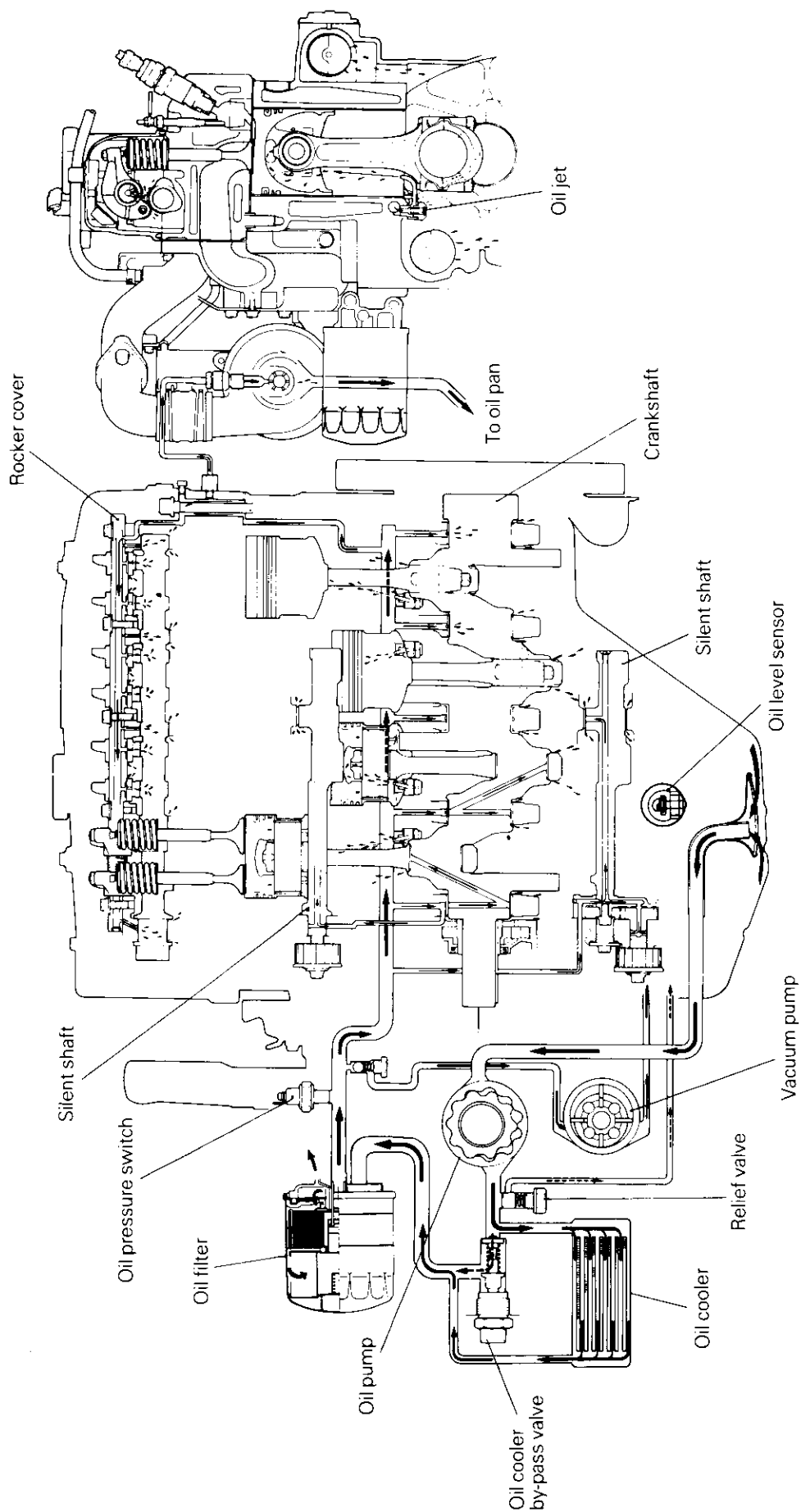
REMARKS

This manual covers the 4D56 engines of 1994 and subsequent year models. When using this manual, please note that all the pages are applicable to the above engines regardless of the indication in the headline of each page "4D56 ENGINE <1991 - 1993>" and "4D56 ENGINE <1994->".

GENERAL INFORMATION**ENGINE SECTIONAL VIEW**



LUBRICATION SYSTEM



LIST OF MAJOR CHANGES

Description of change		Applicable Engine Model	Effective Date
①	Oil pump has been changed from gear type to trochoid type.	All	From Sep. 1990

SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
Cylinder head		
Flatness of gasket surface	0.05 (0.002)	*0.2 (0.008)
* Grinding is not suitable for correction.		
Flatness of manifold mounting surface	0.15 (0.0059)	0.3 (0.012)
Overall height	94.0 – 94.1 (3.701 – 3.705)	
Oversize rework dimensions of valve guide hole (both intake and exhaust)		
0.05	13.050 – 13.068 (0.5138 – 0.5145)	
0.25	13.250 – 13.268 (0.5217 – 0.5224)	
0.50	13.500 – 13.518 (0.5315 – 0.5322)	
Oversize rework dimensions of intake valve seat ring hole		
0.30	43.300 – 43.325 (1.7047 – 1.7057)	
0.60	43.600 – 43.625 (1.7165 – 1.7175)	
Oversize rework dimensions of exhaust valve seat ring hole		
0.30	37.300 – 37.325 (1.4685 – 1.4695)	
0.60	37.600 – 37.625 (1.4803 – 1.4813)	
Camshaft		
Cam height		
Intake	36.55 (1.4390)	36.05 (1.4193)
Exhaust	36.55 (1.4390)	36.05 (1.4193)
Journal diameter	29.935 – 29.950 (1.1785 – 1.1791)	
Oil clearance	0.05 – 0.08 (0.0020 – 0.0031)	
Rocker arm		
I.D.	18.910 – 18.928 (0.7444 – 0.7452)	
Rocker arm-to-shaft clearance	0.012 – 0.050 (0.0005 – 0.0020)	
Rocker shaft		
O.D.	18.878 – 18.898 (0.7432 – 0.7440)	
Overall length	451.5 (17.78)	
Valve		
Overall length		
Intake	136.5 (5.3740)	
Exhaust	136.5 (5.3740)	
Stem diameter		
Intake	7.960 – 7.975 (0.3134 – 0.3140)	
Exhaust	7.930 – 7.950 (0.3122 – 0.3130)	
Face angle	45° – 45.5°	
Thickness of valve head (margin)		
Intake	2.0 (0.08)	1.0 (0.04)
Exhaust	2.0 (0.08)	1.0 (0.04)
Stem-to guide clearance		
Intake	0.03 – 0.06 (0.0012 – 0.0024)	0.10 (0.0039)
Exhaust	0.05 – 0.09 (0.0020 – 0.0035)	0.15 (0.0059)

mm (in.)

	Standard	Limit
Valve spring		
Free height	49.1 (1.933)	
Load/installed height	276 (27.6, 61)/40.4 (1.591)	
N (kg, lbs.)/mm (in.)		
Out-of-squareness	2° or less	Max. 4°
Valve guide		
I.D.	8.000 – 8.018 (0.3150 – 0.3157)	
O.D.	13.06 – 13.07 (0.5142 – 0.5146)	
Service size	0.05 (0.002), 0.25 (0.010), 0.50 (0.020) oversize	
Press-in temperature	Room temperature	
Valve seat		
Seat angle	45°	
Valve contact width	0.9 – 1.3 (0.035 – 0.051)	
Valve stem projection	40.95 (1.612)	41.45 (1.632)
Service size	0.3 (0.012), 0.6 (0.024) oversize	
Silent shaft		
Journal diameter		
Right (front)	18.467 – 18.480 (0.7270 – 0.7276)	
(rear)	43.009 – 43.025 (1.6933 – 1.6939)	
Left (front)	18.959 – 18.980 (0.7464 – 0.7472)	
(rear)	43.009 – 43.025 (1.6933 – 1.6939)	
Oil clearance		
Front	0.02 – 0.06 (0.0008 – 0.0024)	
Rear	0.06 – 0.10 (0.0024 – 0.0039)	
Piston		
O.D.	91.08 – 91.09 (3.5858 – 3.5862)	
	T/C 91.06 – 91.07 (3.5850 – 3.5854)	
Piston-to-cylinder clearance	0.02 – 0.04 (0.0008 – 0.0016)	
	T/C 0.04 – 0.06 (0.0016 – 0.0024)	
Ring groove width		
No. 1 ring	2.62 – 2.64 (0.1031 – 0.1039)	
	T/C 2.61 – 2.63 (0.1028 – 0.1035)	
No. 2 ring	2.04 – 2.06 (0.0803 – 0.0811)	
	T/C 2.10 – 2.12 (0.0827 – 0.0835)	
Oil ring	4.010 – 4.035 (0.1579 – 0.1589)	
Service size	0.25 (0.010), 0.50 (0.020), 0.75 (0.030), 1.00 (0.039) oversize	

mm (in.)

	Standard	Limit
Piston ring		
End gap		
No. 1 ring	0.25 – 0.40 (0.0098 – 0.0157)	0.8 (0.0315)
	T/C 0.35 – 0.50 (0.0138 – 0.020)	0.8 (0.0315)
No. 2 ring	0.25 – 0.45 (0.0098 – 0.0177)	0.8 (0.0315)
	T/C 0.25 – 0.40 (0.0098 – 0.0157)	0.8 (0.0315)
Oil ring	0.25 – 0.45 (0.0098 – 0.0177)	0.8 (0.0315)
Ring-to-ring groove clearance		
No. 1 ring	0.13 – 0.17 (0.0051 – 0.0067)	0.20 (0.0079)
	T/C 0.06 – 0.08 (0.0024 – 0.0031)	0.15 (0.0059)
No. 2 ring	0.05 – 0.09 (0.0020 – 0.0035)*	0.15 (0.0059)
	0.03 – 0.07 (0.0012 – 0.0028)	0.15 (0.0059)
	T/C 0.05 – 0.07 (0.0020 – 0.0028)	0.15 (0.0059)
Oil ring	0.02 – 0.07 (0.0008 – 0.0028)	0.10 (0.0039)
Service size	0.25 (0.010), 0.50 (0.020), 0.75 (0.030), 1.00 (0.039) oversize	
*: Pistons with ring carrier		
Piston pin		
O.D.	28.994 – 29.000 (1.1411 – 1.1417)	
Connecting rod		
Big end center-to-small end center length	157.95 – 158.05 (6.218 – 6.222)	
Bend	0.05 (0.0020)	
Twist	0.1 (0.004)	
Big end side clearance	0.10 – 0.25 (0.0039 – 0.0098)	0.40 (0.0157)
Crankshaft		
End play	0.05 – 0.18 (0.002 – 0.007)	0.25 (0.0098)
Journal O.D.	66 (2.60)	
Pin O.D.	53 (2.09)	
Out-of-roundness and taper of journal and pin	Within 0.005 (0.00020)	
Concentricity of journal	Within 0.015 (0.0006)	
Oil clearance of journal	0.02 – 0.05 (0.0008 – 0.0020)	0.10 (0.0039)
Oil clearance of pin	0.02 – 0.05 (0.0008 – 0.0020)	0.10 (0.0039)
Journal		
0.25 U.S.	65.735 – 65.750 (2.588 – 2.589)	
0.50 U.S.	65.485 – 65.500 (2.578 – 2.579)	
0.75 U.S.	65.235 – 65.250 (2.568 – 2.569)	
Pin		
0.25 U.S.	52.735 – 52.750 (2.0762 – 2.0768)	
0.50 U.S.	52.485 – 52.500 (2.0663 – 2.0670)	
0.75 U.S.	52.235 – 52.250 (2.0565 – 2.0571)	
Cylinder block		
Cylinder I.D.	91.10 – 91.13 (3.5866 – 3.5878)	
Flatness of gasket surface	0.05 (0.0020)	0.1 (0.004)
Overall height	318.45 – 318.55 (12.5374 – 12.5413)	
Flywheel		
Runout	0.13 (0.0051)	

mm (in.)

	Standard	Limit
Oil pump (Involute gear type)		
Tip clearance		
Inner gear	0.22 – 0.35 (0.0087 – 0.0138)	
Outer gear	0.12 – 0.22 (0.0047 – 0.0087)	
Side clearance	0.04 – 0.10 (0.0016 – 0.0039)	
Body clearance		
Outer gear	0.12 – 0.18 (0.0047 – 0.0071)	
Inner gear	0.03 – 0.09 (0.0012 – 0.0035)	
Oil pump (Trochoid type)		
Tip clearance	0.11 – 0.24 (0.0043 – 0.0094)	
Side clearance	0.04 – 0.10 (0.0016 – 0.0039)	
Body clearance		
Outer rotor	0.10 – 0.18 (0.0039 – 0.0071)	0.35 (0.0138)
Inner rotor	0.03 – 0.09 (0.012 – 0.035)	
Drive belt		
Deflection	10 – 13 (0.39 – 0.51)	
Thermostat		
Identification mark "76.5"		
Valve opening temperature	76.5°C (169.7°F)	
Fully opening temperature	90°C (194°F)	
Lift	8 (0.32) or more	
Identification mark "82"		
Valve opening temperature	82°C (179°F)	
Fully opening temperature	95°C (203°F)	
Lift	8 (0.32) or more	
Coolant temperature gauge unit		
Resistance		
Coolant temperature gauge element	90.5 – 117.5Ω/70°C (158°F)	
	21.3 – 26.3Ω/115°C (239°F)	
Glow control element	22.3 – 27.3kΩ/–20°C (–4°F)	
	2.92 – 3.58kΩ/20°C (68°F)	

TORQUE SPECIFICATIONS

	Nm	Torque kgm	ft.lbs.
Drive belt and timing belt			
Water pump pulley bolt	11	1.1	8
Crankshaft pulley bolt	180	18.0	130
Timing belt tensioner bolt	26	2.6	19
Timing belt tensioner spacer nut	26	2.6	19
Camshaft sprocket bolt	70	7.0	51
Injection pump sprocket nut	85	8.5	61
Silent shaft sprocket bolt and nut	37	3.7	27
Timing belt "B" tensioner spacer nut	26	2.6	19
Intake and exhaust manifolds			
Intake fitting bolt	12	1.2	9
Waste gate actuator bolt	19	1.9	14
Heat protector "A" and "B" bolt	9	0.9	7
Heat protector "C" bolt	14	1.4	10
Exhaust fitting nut	60	6.0	43
Eyebolt	17	1.7	12
Oil return pipe bolt	9	0.9	7
Turbocharger nut	60	6.0	43
Heat protector	14	1.4	10
Intake manifold bolt	18	1.8	13
Exhaust manifold nut	18	1.8	13
Turbocharger			
Coupling bolt	5	0.5	4
Water pump, thermostat, hose and pipe			
Water pump bolt			
M8 x 20, M8 x 25, M8 x 40	14	1.4	10
M8 x 70	24	2.4	17
Thermostat hosing bolt	14	1.4	10
Water inlet pipe bolt			
M8	14	1.4	10
M6	11	1.1	8
Water inlet pipe bolt			
Bolt with spring washer	12	1.2	9
Flange bolt	14	1.4	10
Coolant temperature gauge unit	35	3.5	25
Water outlet fitting bolt	12	1.2	9
Rocker arms, rocker shaft and camshaft			
Rocker cover bolt	6	0.6	4
Rocker shaft bolt	38	3.8	27
Camshaft bearing cap bolt	20	2.0	14
Rocker arm adjusting screw nut	15	1.5	11
Cylinder head, valves and valve spring			
Cylinder head bolt	118	12.0	87

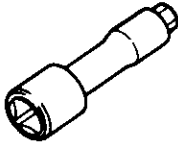
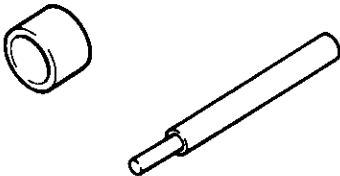
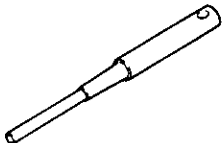
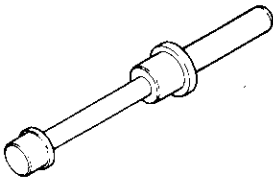
	Nm	Torque kgm	ft.lbs.
Front case, silent shaft and oil pan			
Oil filter bracket bolt	14	1.4	10
Oil drain plug	40	4.0	29
Oil lever sensor bolt	9	0.9	7
Oil pan bolt	7	0.7	5
Oil screen bolt	19	1.9	14
Front upper case bolt	14	1.4	10
Plug	24	2.4	17
Right silent shaft flange bolt	37	3.7	27
Front lower case			
M8 x 25, M8 x 65	13	1.3	9
M8 x 75 (Alternator brace bolt), M8 x 90	24	2.4	17
Check valve	33	3.3	24
Oil cooler by-pass valve	55	5.5	40
Oil pressure switch	10	1.0	7
Relief plug	38	3.8	27
Silent shaft gear cover bolt	24	2.4	17
Oil pump cover bolt	12	1.2	9
Piston and connecting rod			
Connecting rod cap nut	47	4.7	34
Crankshaft, flywheel and drive plate			
Flywheel bolt	135	13.5	98
Drive plate bolt	135	13.5	98
Oil seal case bolt	11	1.1	8
Bearing cap bolt	80	8.0	58
Cylinder block			
Cover bolt	6	0.6	4
Engine support bracket			
Head mark "7"	45	4.5	33
Head mark "8"	55	5.5	40

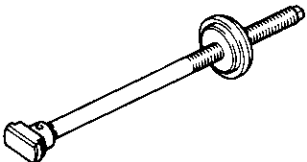
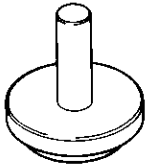
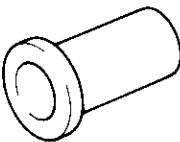
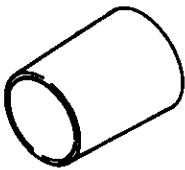
SEALANT

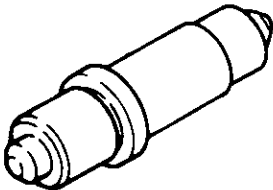
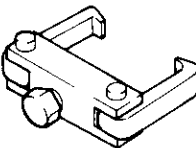
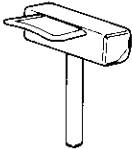
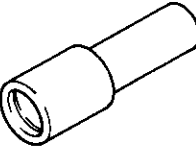
	Specified sealant	Quantity
Semi-circular packing	3M ATD Part No. 8660 or equivalent	As required
Oil pan gasket	MITSUBISHI GENUINE Part No. MD997110	As required
	or equivalent	
Oil pressure switch	3M ATD Part No. 8660 or equivalent	As required
Cooling temperature gauge unit	3M Nut Locking Part No. 4171	As required
	or equivalent	

NOTES

2. SPECIAL TOOLS

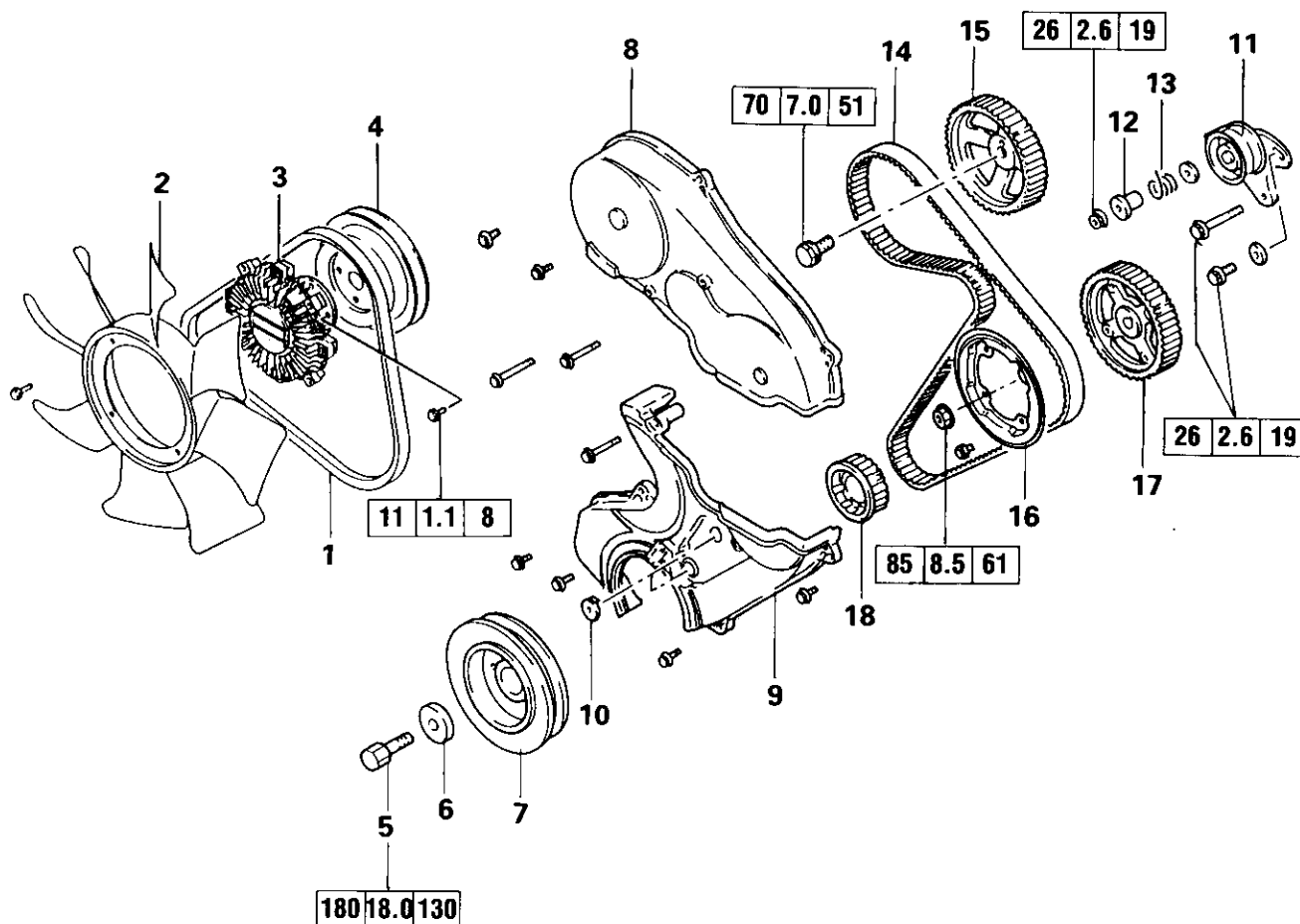
Tool	Number	Name	Use
	MD998051	Cylinder head bolt wrench	Loosening and tightening of cylinder head bolts
	MD998115	Valve guide installer	Removal and installation of valve guide
	MD998148	Valve seat cutter pilot	Correction of valve seat
	MD998158	Valve seat cutter 45°	Correction of valve seat
	MD998165	Valve seat cutter 65°	Correction of valve seat
	MD998175	Valve seat cutter 30°	Correction of valve seat
	MD998250	Silent shaft bearing installer	Installation of silent shaft rear bearing

Tool	Number	Name	Use
	MD998251	Silent shaft bearing puller	Removal of silent shaft rear bearing
	MD998376	Crankshaft rear oil seal installer	Installation of crankshaft rear oil seal
	MD998380	Bearing installer stopper	Guide for removal and installation of silent shaft right rear bearing
	MD998381	Camshaft oil seal installer	Installation of camshaft oil seal
	MD998382	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal
	MD998383	Crankshaft front oil seal installer	Installation of crankshaft front oil seal
	MD998385	Silent shaft drive gear oil seal guide	Installation of silent shaft drive oil seal

Tool	Number	Name	Use
	MD998386	Connecting-rod small-end bushing replacement tool	Replacement of connecting-rod small-end bushing
	MD998388	Injection pump sprocket puller	Removal of injection pump sprocket
	MD998727	Oil pan sealer cutter	Removal of oil pan
	MD998729	Valve stem seal installer	Installation of valve stem seal

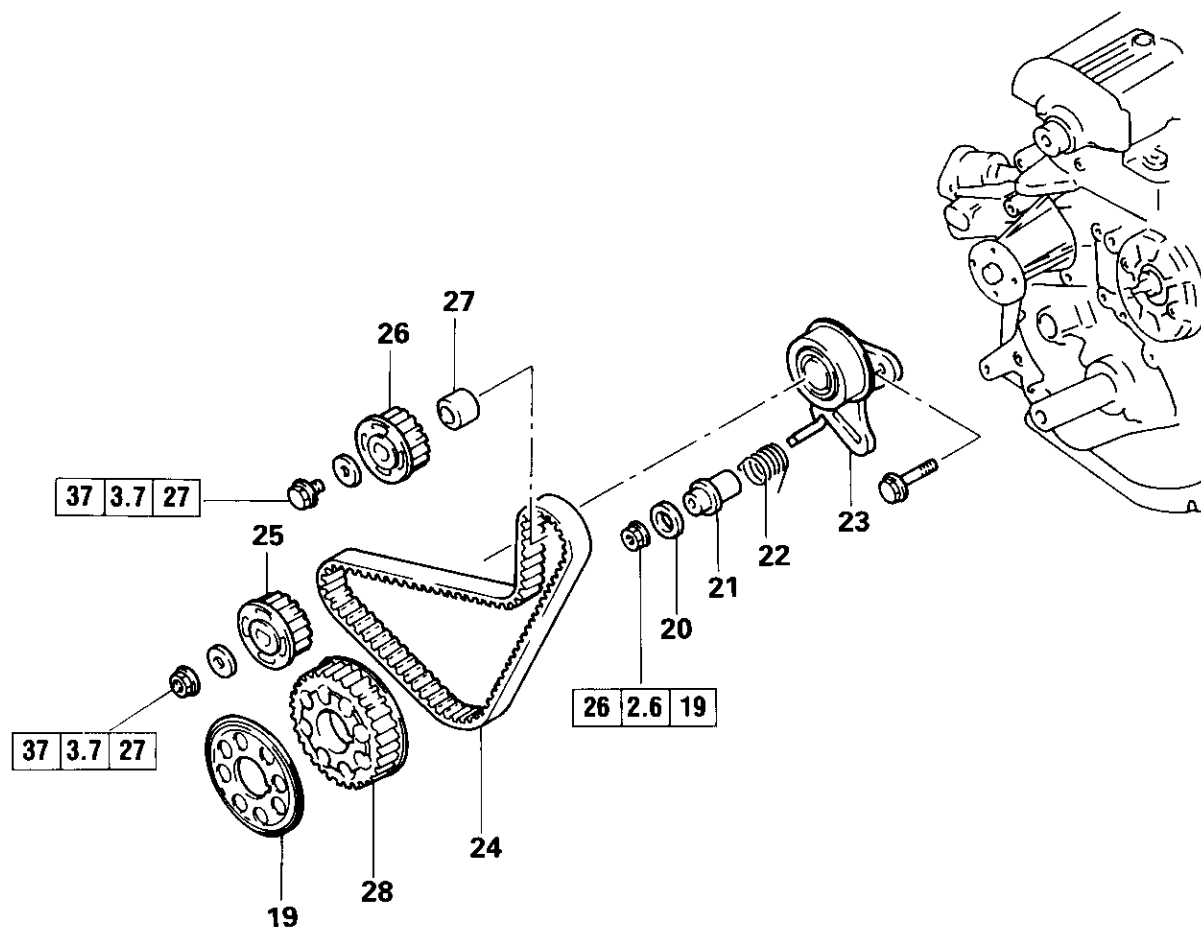
NOTES

3. DRIVE BELT AND TIMING BELT REMOVAL AND INSTALLATION



Removal steps

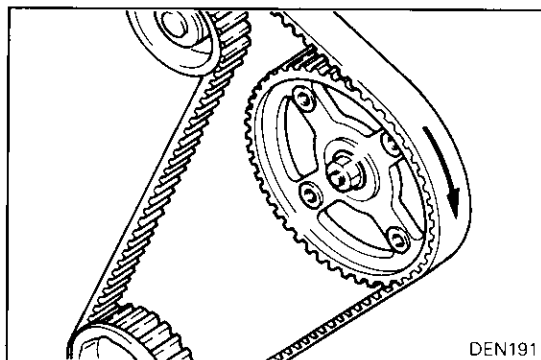
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|-----------------------------|-----|----------------------------------|
| 1. Drive belt (V type belt) | | 15. Camshaft sprocket |
| 2. Cooling fan | | 16. Flange |
| 3. Fan clutch | | 17. Injection pump sprocket |
| 4. Water pump pulley | | 18. Crankshaft sprocket |
| 5. Crankshaft pulley bolt | | 19. Flange |
| 6. Special washer | | 20. Gasket |
| 7. Crankshaft pulley | | 21. Tensioner spacer |
| 8. Timing belt upper cover | | 22. Tensioner spring |
| 9. Timing belt lower cover | | 23. Timing belt tensioner "B" |
| 10. Access cover | | 24. Timing belt "B" |
| 11. Timing belt tensioner | ◇B◇ | 25. Silent shaft sprocket, right |
| 12. Tensioner spacer | ◇C◇ | 26. Silent shaft sprocket, left |
| 13. Tensioner spring | ◇D◇ | 27. Spacer |
| 14. Timing belt | ◇D◇ | 28. Crankshaft sprocket "B" |



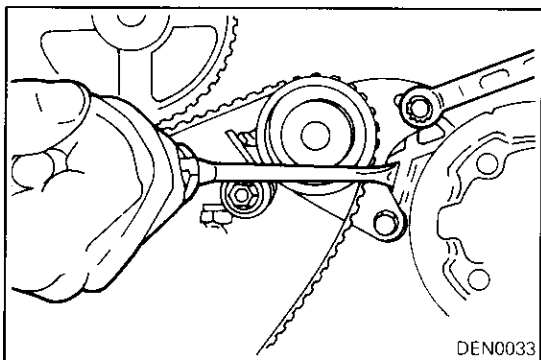
Installation steps

- ◆A◆ 28. Crankshaft sprocket "B"
- ◆B◆ 27. Spacer
- ◆C◆ 26. Silent shaft sprocket, left
- ◆C◆ 25. Silent shaft sprocket, right
- ◆D◆ 23. Timing belt tensioner "B"
- 22. Tensioner spring
- 21. Tensioner spacer
- 20. Gasket
- ◆E◆ 24. Timing belt "B"
- ◆A◆ 19. Flange
- ◆A◆ 18. Crankshaft sprocket
- 16. Flange
- 17. Injection pump sprocket
- 15. Camshaft sprocket

- ◆F◆ 11. Timing belt tensioner
- 13. Tensioner spring
- 12. Tensioner spacer
- ◆G◆ 14. Timing belt
- 10. Access cover
- 9. Timing belt lower cover
- 8. Timing belt upper cover
- 7. Crankshaft pulley
- 6. Special washer
- 5. Crankshaft pulley bolt
- 4. Water pump pulley
- 3. Fan clutch
- 2. Cooling fan
- 1. Drive belt

**SERVICE POINTS OF REMOVAL****◊A◊ REMOVAL OF TIMING BELT**

- (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) Push the timing belt tensioner toward the water pump and temporarily tighten the tensioner mounting bolt so that the tensioner cannot return.
- (3) Remove the timing belt.

NOTE

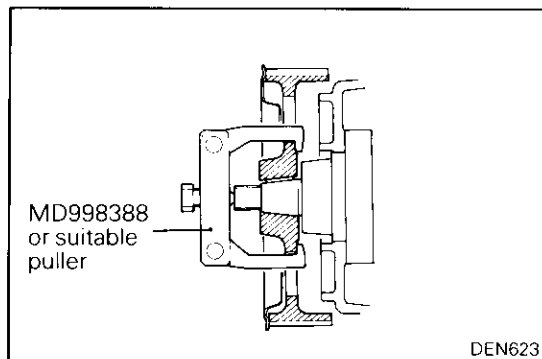
- (1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
- (2) If there is oil or water on any part, check front case oil seals, camshaft oil seal and water pump for leaks.

◊B◊ REMOVAL OF INJECTION PUMP SPROCKET

- (1) Use the special tool to remove the injection pump sprocket.

Caution

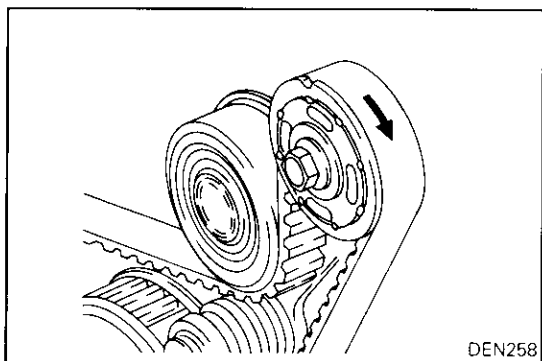
- **Never give impact to the injection pump sprocket, or a malfunction of the injection pump will result.**

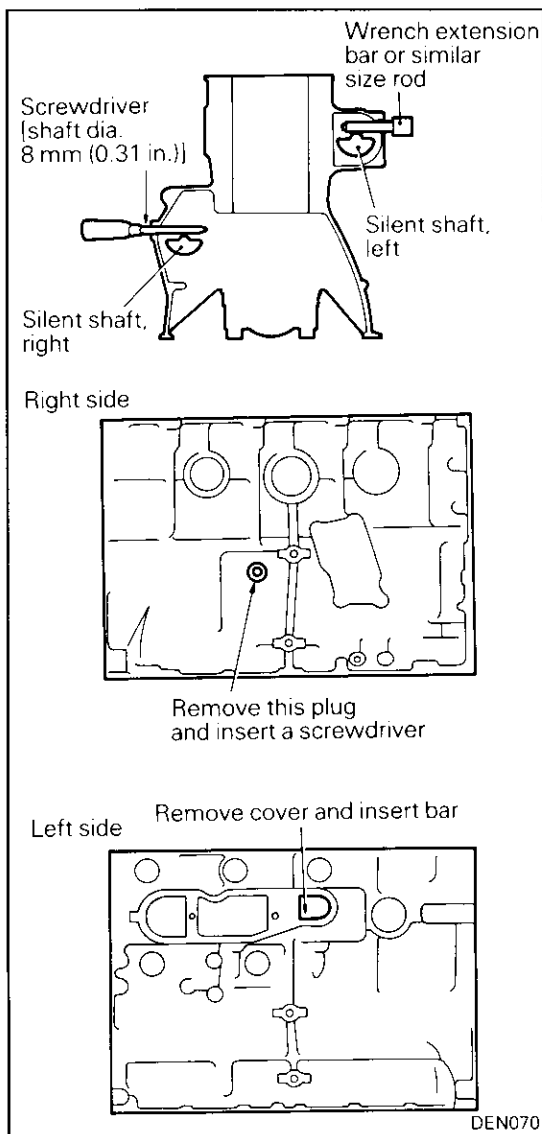
**◊C◊ REMOVAL OF TIMING BELT "B"**

- (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

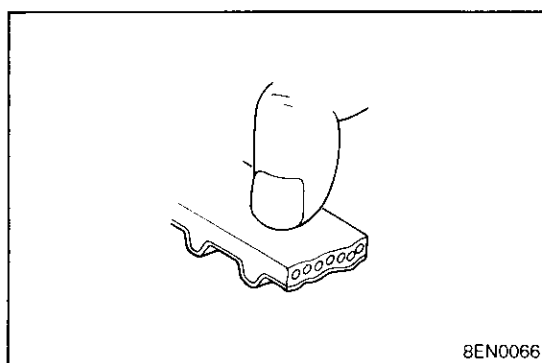
- (1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
- (2) If there is oil or water on any part, check front case oil seals, camshaft oil seal and water pump for leaks.





REMOVAL OF SILENT SHAFT SPROCKET RIGHT / LEFT

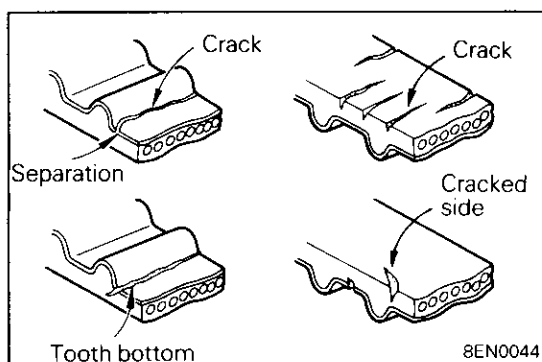
- (1) When loosening the nut and bolt for two silent shaft sprockets, be sure to lock the silent shaft as shown.



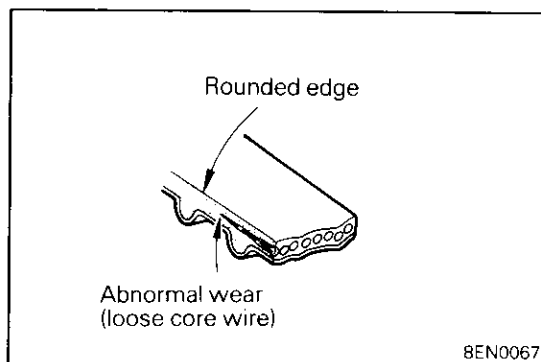
INSPECTION TIMING BELTS

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.



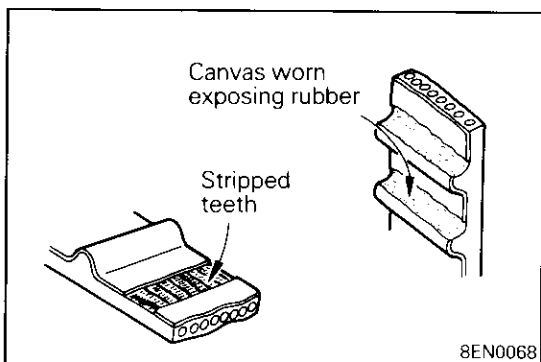
- (2) Cracked back surface rubber
- (3) Cracked or separated canvas
- (4) Cracked tooth bottom
- (5) Cracked side



(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

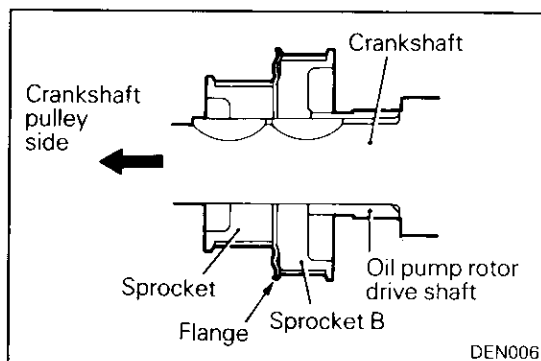
Initial stage:

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

Last stage:

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

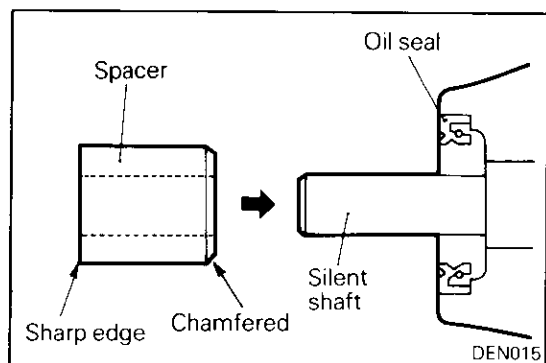
(8) Missing tooth



SERVICE POINTS OF INSTALLATION

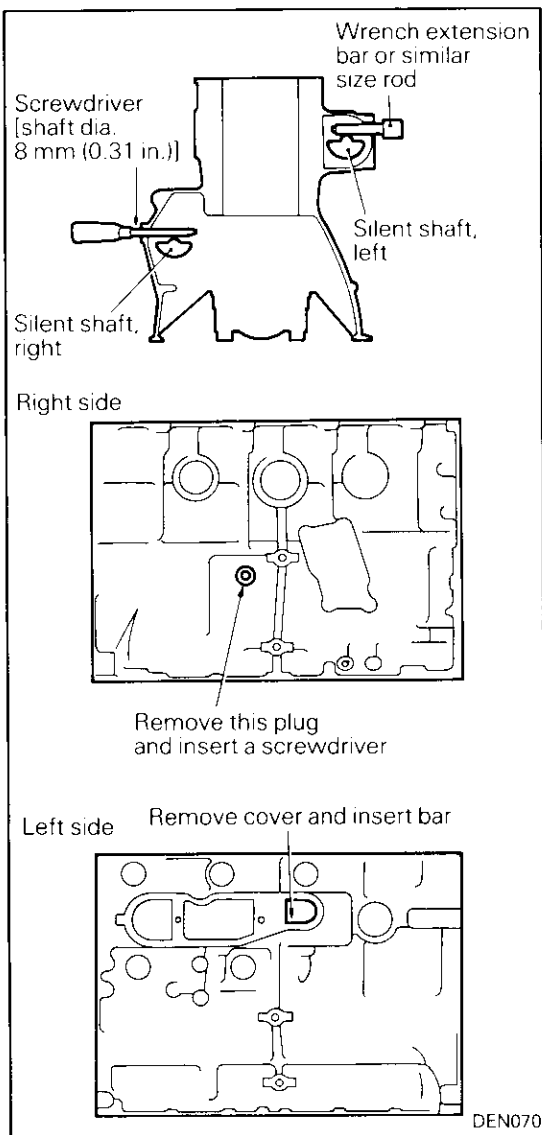
◆A◆ INSTALLATION OF CRANKSHAFT SPROCKET "B" / FLANGE / CRANKSHAFT SPROCKET

- (1) Pay special attention to direction of flange. If it is installed in wrong direction, a broken timing belt could result.



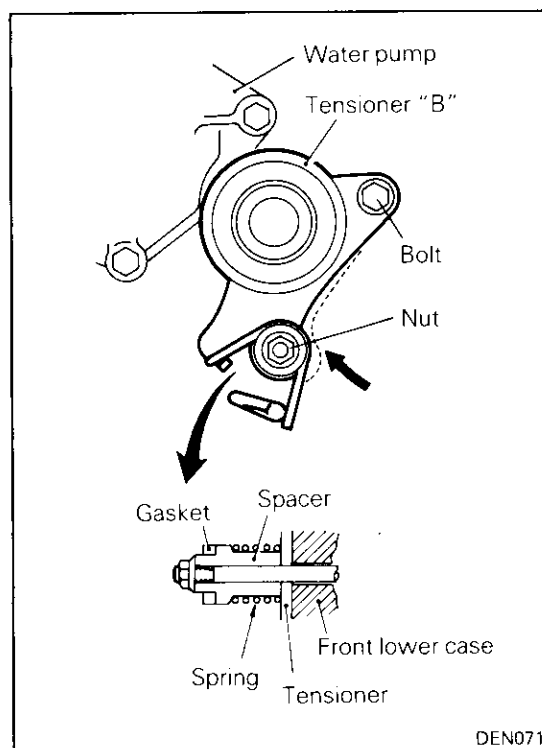
◆B◆ INSTALLATION OF SPACER

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



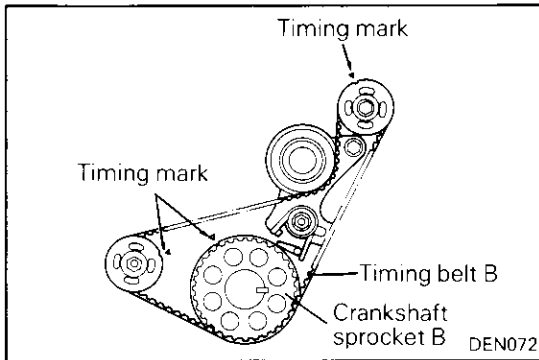
◆C◆ INSTALLATION OF SILENT SHAFT SPROCKET, RIGHT / SILENT SHAFT SPROCKET, LEFT

- (1) When tightening the nut and bolt for two silent shaft sprockets, be sure to lock the silent shaft as shown.



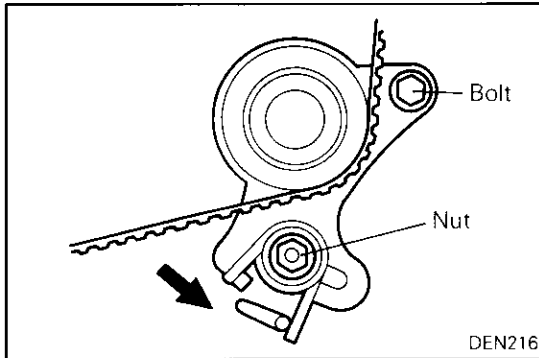
◆D◆ INSTALLATION OF TIMING BELT TENSIONER "B"

- (1) Move tensioner "B" toward water pump and tighten mounting nut and bolt.



◆E◆ INSTALLATION OF TIMING BELT "B"

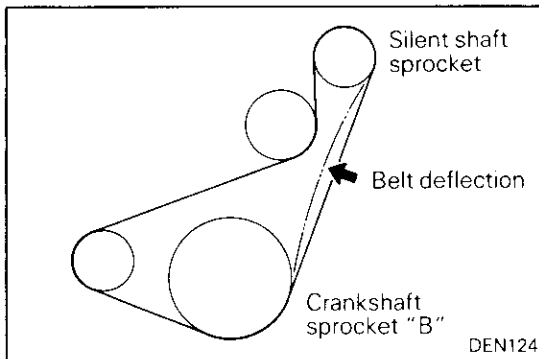
- (1) Align timing marks on the crankshaft sprocket "B", and silent shaft sprockets with their timing marks.
- (2) Install timing belt "B" onto sprockets and ensure that its tension side is not slack.



- (3) Loosen tensioner "B" mounting bolt and nut, one to two turns.
- (4) Tighten the tensioner "B" attaching nut.
- (5) Tighten the tensioner "B" attaching bolt.

NOTE

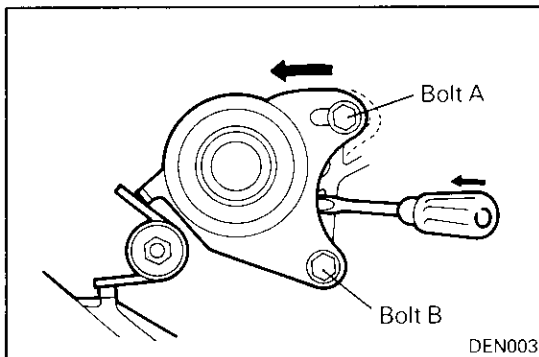
If the bolt is tightened first, the tension "B" should be turned together, resulting in reduced timing belt "B" tension.



- (6) Ensure that the deflection is specified when the belt is pushed by the index finger at the position indicated by an arrow.

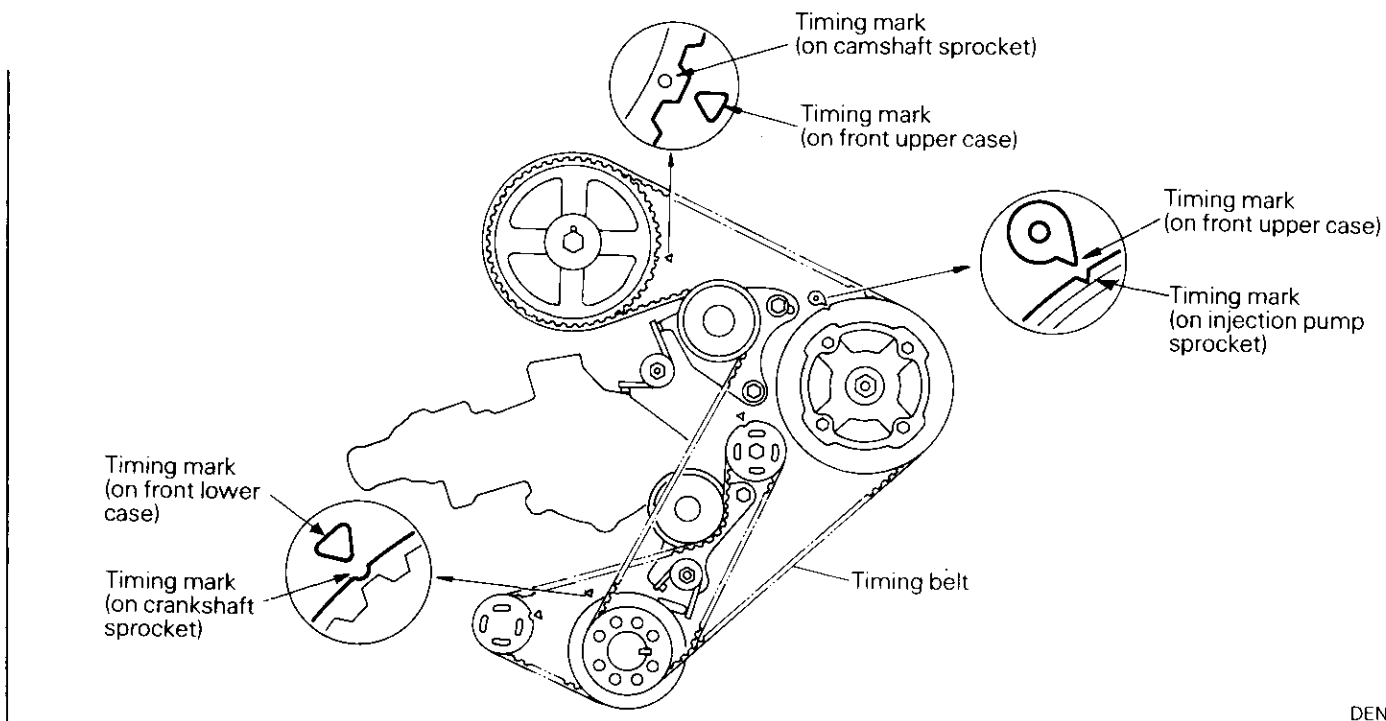
Belt deflection:

4 – 5 mm (0.157 – 0.197 in.)



◆F◆ INSTALLATION OF TIMING BELT TENSIONER

- (1) Move tensioner toward water pump and tighten mounting bolts.



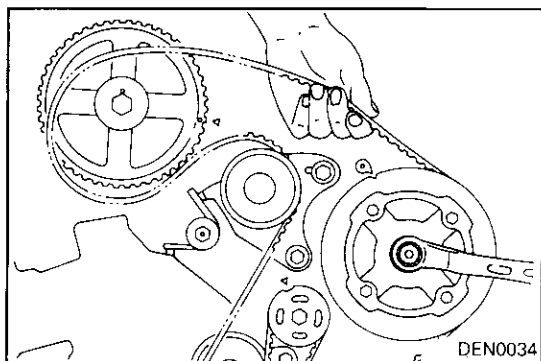
DEN002

◆G◆ INSTALLATION OF TIMING BELT

- (1) Align the timing marks on the three sprockets with their mating marks.

NOTE:

If the injection pump sprocket is freed, the timing mark on it will move back counterclockwise by about one tooth. Therefore, align the mark while engaging the timing belt.

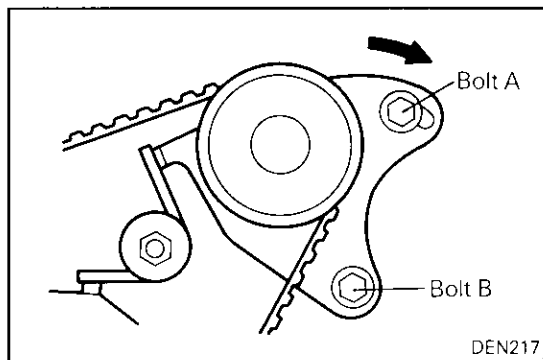


- (2) Install the timing belt over the crankshaft sprocket.
- (3) Align the timing mark on the injection pump sprocket and while holding the sprocket to prevent rotation, install the timing belt.

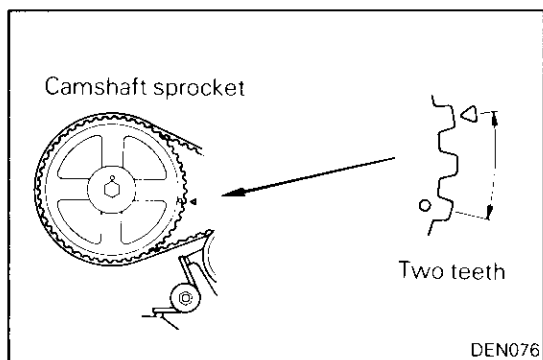
NOTE:

Make sure that the timing belt does not become loose on the tension side.

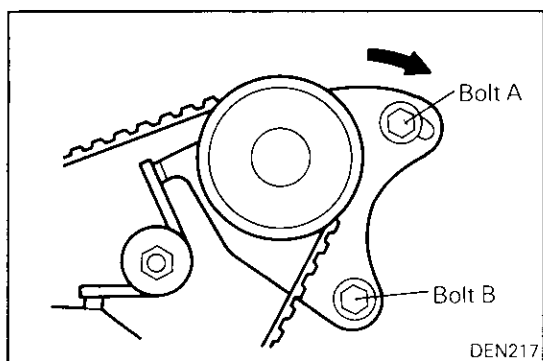
- (4) Install the timing belt over the tensioner pulley.
- (5) While tensioning the timing belt on the tension side, install the timing belt over the camshaft sprocket.
- (6) Check if all timing marks are aligned correctly.



- (7) Back off tensioner bolt "A", that have previously been secured to the water pump side, one to two turns to give tension to the belt using tensioner spring tension.



- (8) Confirm that the timing belt is correctly engaged with three sprockets.
- (9) Turn crankshaft clockwise by the two teeth of the camshaft sprocket and keep the position.

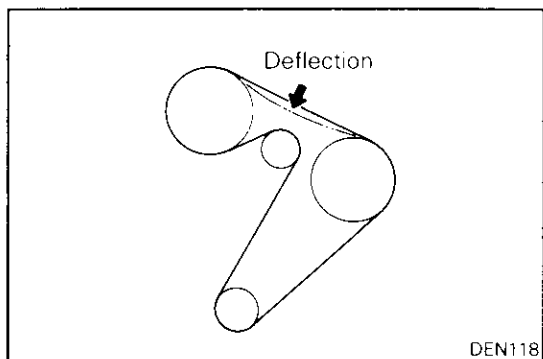


- (10) Tighten the bolt "A".

- (11) Tighten the bolt "B".

NOTE

If the bolt "B" is tightened first, the tensioner should be turned together, causing an undue tension to be applied to the timing belt.



- (12) Turn the crankshaft in the direction of backward rotation to line up timing marks. In this condition, ensure that the deflection is specified when the center of belt is pushed by the index finger.

Belt deflection:

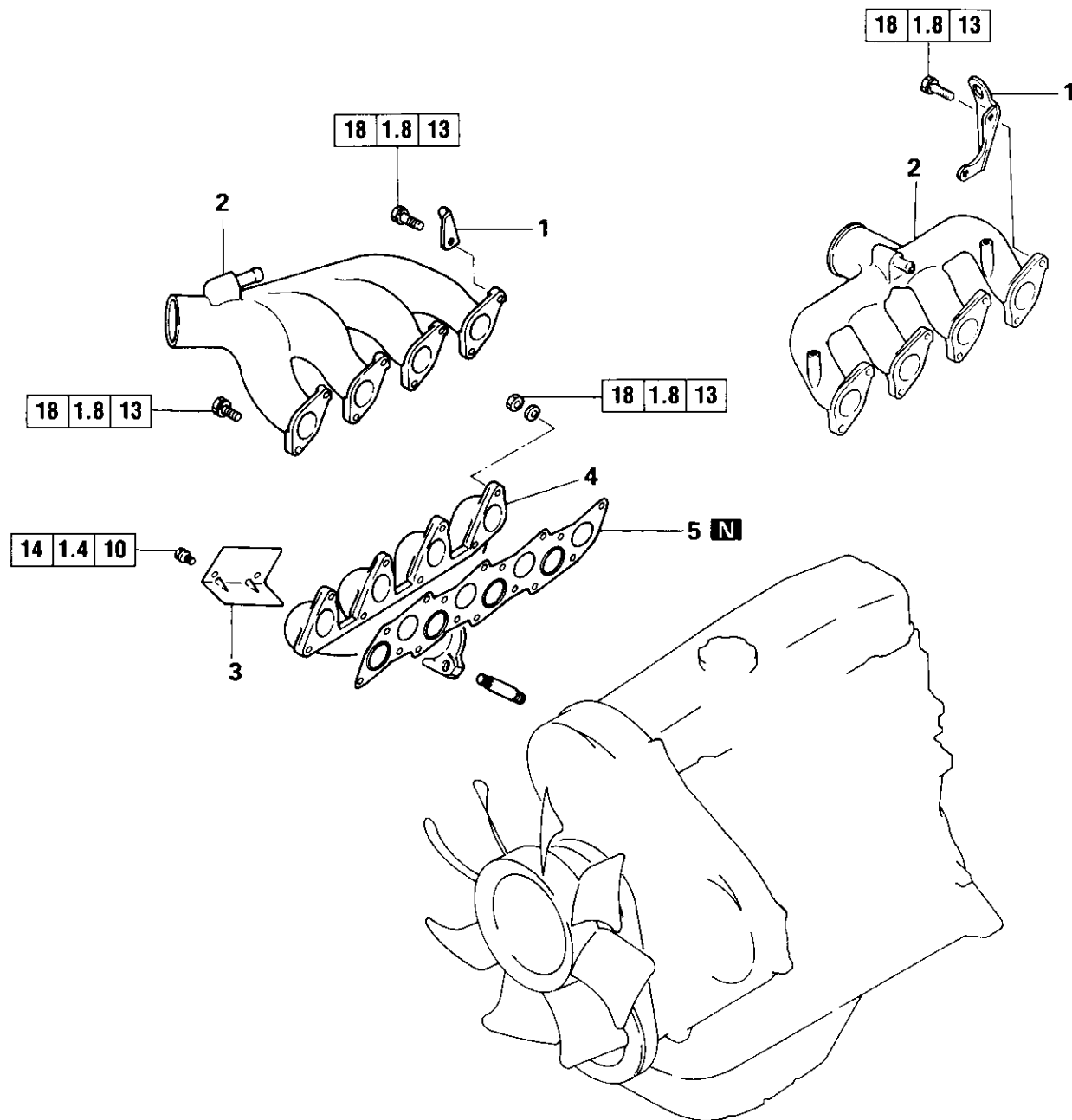
4 – 5 mm (0.157 – 0.197 in.)

NOTES

4. INTAKE AND EXHAUST MANIFOLDS

REMOVAL AND INSTALLATION

<Engine without turbocharger>



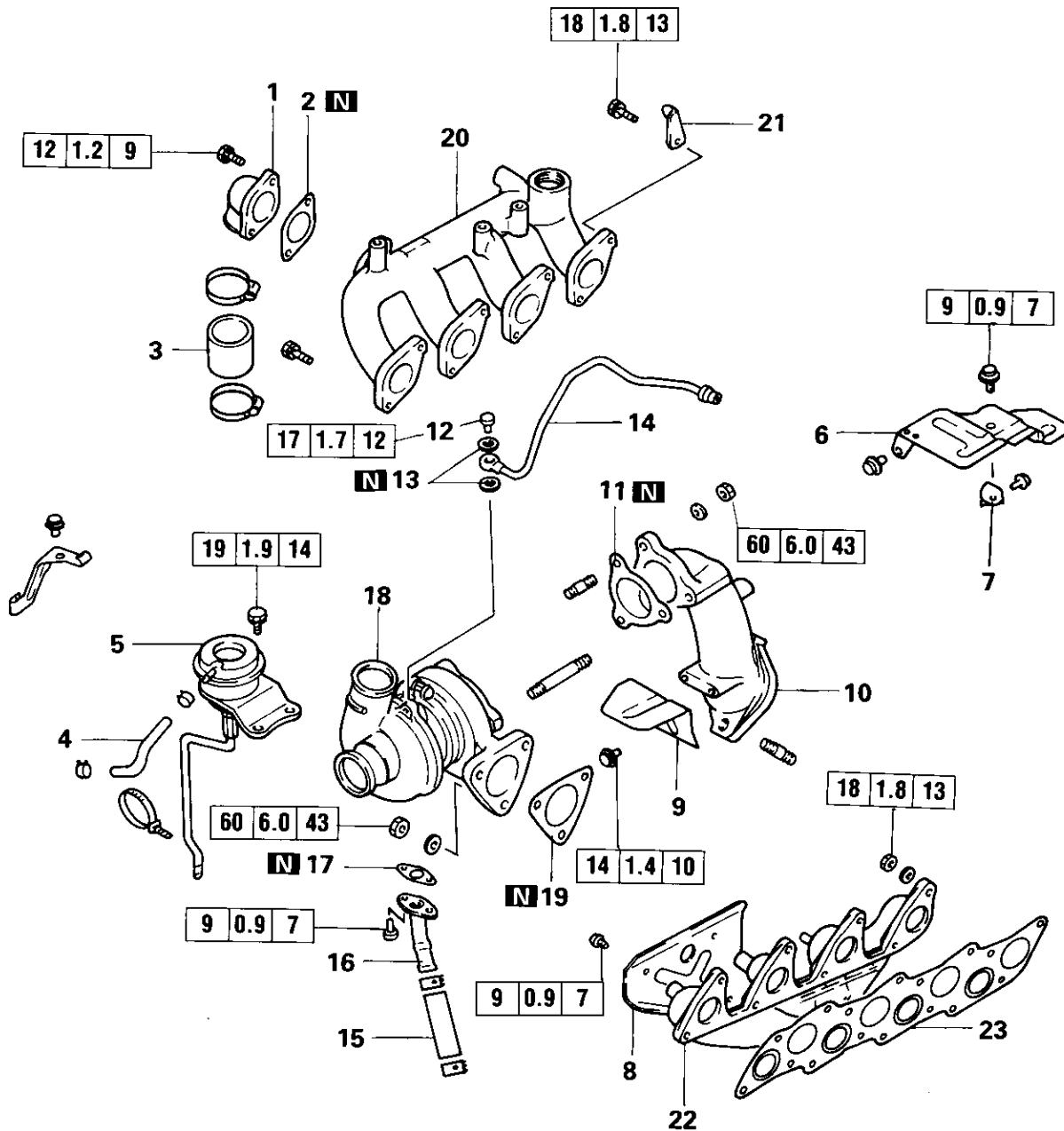
Removal steps

1. Engine hanger
2. Intake manifold
3. Heat protector
4. Exhaust manifold
5. Exhaust manifold gasket

INTAKE AND EXHAUST MANIFOLDS

REMOVAL AND INSTALLATION

<Engine with turbocharger>



Removal steps

- | | |
|----------------------------|-----------------------------|
| 1. Intake fitting | 13. Gasket |
| 2. Intake fitting gasket | 14. Oil pipe |
| 3. Air hose | 15. Oil hose |
| 4. Boost hose | 16. Oil return pipe |
| 5. Waste gate actuator | 17. Gasket |
| 6. Heat protector "A" | 18. Turbocharger assembly |
| 7. Stay | 19. Gasket |
| 8. Heat protector "B" | 20. Intake manifold |
| 9. Heat protector "C" | 21. Engine hanger |
| 10. Exhaust fitting | 22. Exhaust manifold |
| 11. Exhaust fitting gasket | 23. Exhaust manifold gasket |
| 12. Eyebolt | |

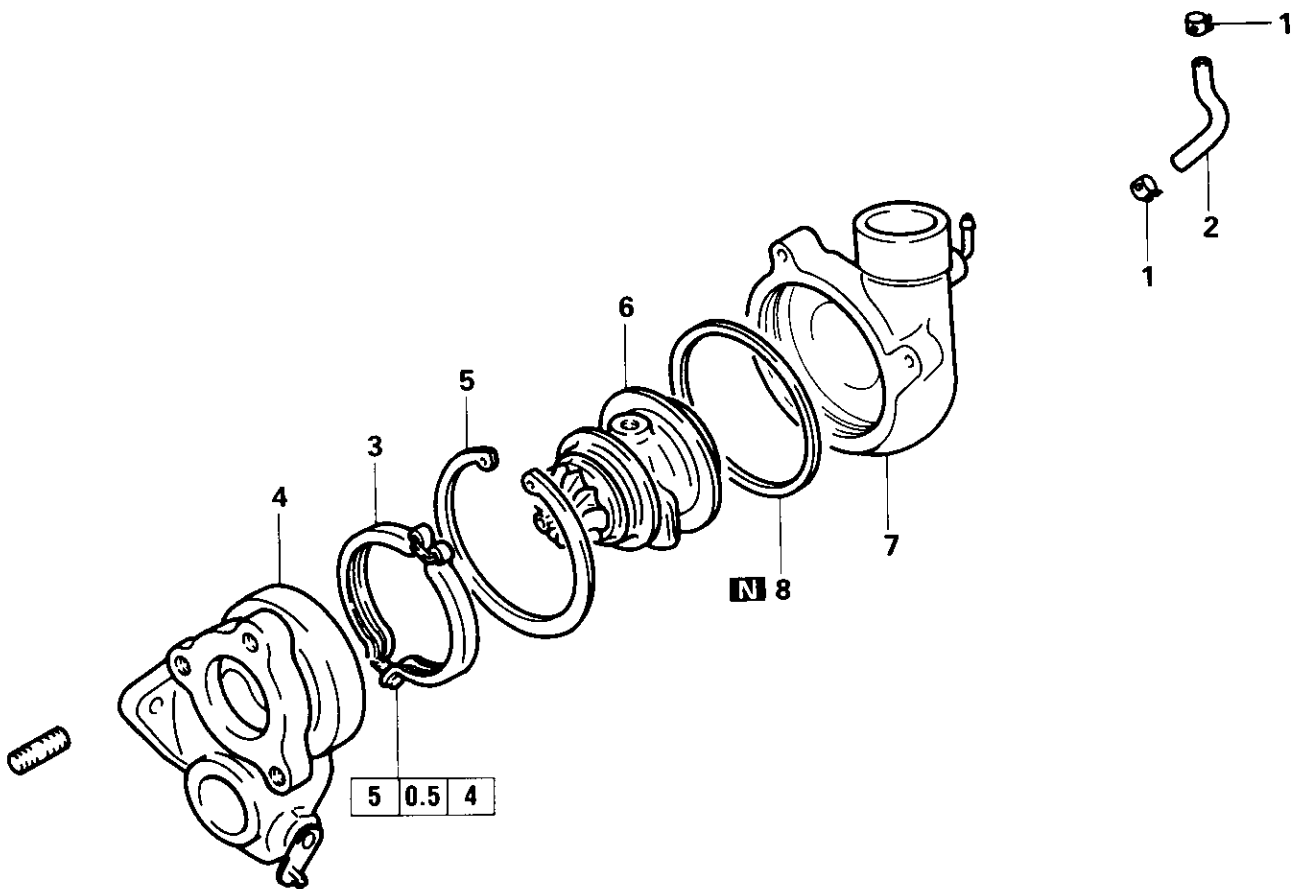
SERVICE POINT OF INSTALLATION**◆A◆ EYEBOLT**

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

NOTES

5. TURBOCHARGER

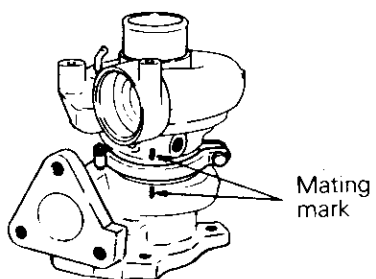
DISASSEMBLY AND REASSEMBLY



Disassembly steps

1. Hose clip
2. Hose
3. Coupling
4. Turbine housing
5. Snap ring
6. Turbine wheel assembly
7. Compressor cover
8. O-ring

DIN024



3IN044

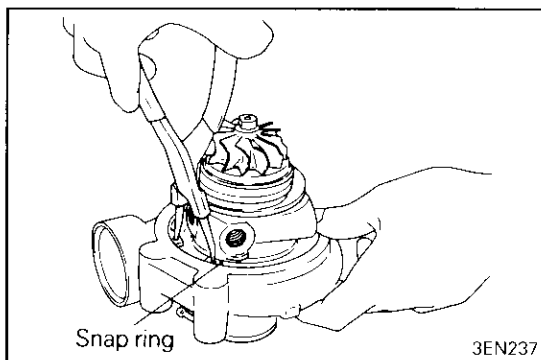
SERVICE POINTS OF DISASSEMBLY

REMOVAL OF TURBINE HOUSING

- (1) Before disassembly, put mating marks on adequate locations of the turbine housing, compressor cover and turbine wheel assembly, noting their relative position so as to ensure correct reassembly.

Caution

- When disassembling, use care not to cause damage to the compressor wheel and turbine wheel blades.

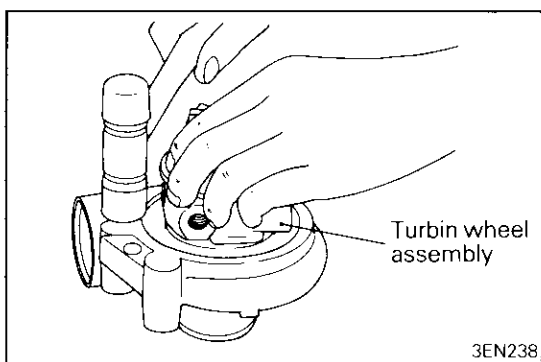


◀B▶ REMOVAL OF SNAP RING

- (1) Lay the unit with the compressor cover side facing down and using snap ring pliers, remove the compressor cover attaching snap ring.

Caution

- When removing the snap ring, hold it with fingers to prevent it from springing away.

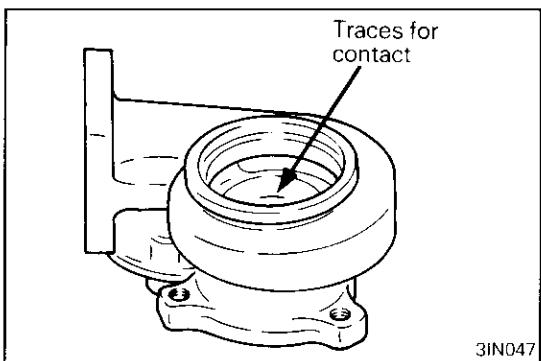


◀C▶ REMOVAL OF TURBINE WHEEL ASSEMBLY

- (1) Remove the turbine wheel assembly, striking the circumference of the compressor cover with a plastic hammer.
The turbine wheel assembly may be a little hard to remove due to an O-ring put on the outer circumference.

CLEANING

- (1) Use a clean cleaning oil commercially available. Do not use corrosive cleaning oils as they could cause damage to some parts.
- (2) Use a plastic scraper or hard brush to clean aluminum parts.



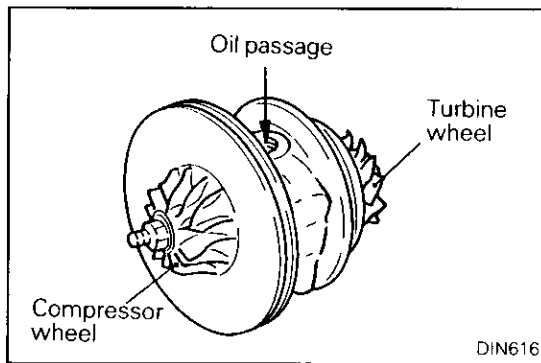
INSPECTION

TURBINE HOUSING

- (1) Check the housing for traces of contact with the turbine wheel, cracks due to overheating, pitching, deformation and other damage. Replace with a new turbine housing if cracked.
- (2) Operate the waste gate valve lever manually to check that the gate can be opened and closed smoothly.

COMPRESSOR COVER

- (1) Check the compressor cover for traces of contact with the compressor wheel and other damage.

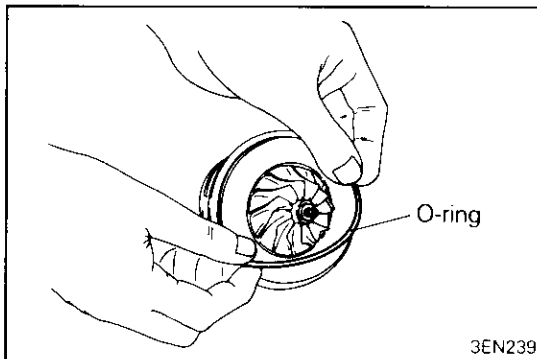


TURBINE WHEEL ASSEMBLY

- (1) Check the turbine and compressor wheel blades for bend, burr, damage, corrosion and traces of contact on the back side and replace if defective.
- (2) Check the oil passage of the turbine wheel assembly for deposit and clogging.
- (3) Check the turbine wheel and compressor wheel for light and smooth turning.

OIL PIPE / OIL RETURN PIPE

- (1) Correct or replace the oil pipe and oil return pipe if clogged, collapsed, deformed or otherwise damaged.



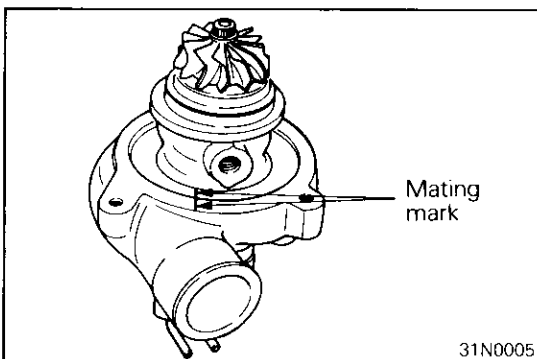
SERVICE POINTS OF REASSEMBLY

◆A◆ INSTALLATION OF O-RING

- (1) Apply a light coat of engine oil to a new O-ring and fit in the turbine wheel assembly groove.

Caution

- When installing the O-ring, use care not to damage it. A damaged O-ring causes oil leaks.

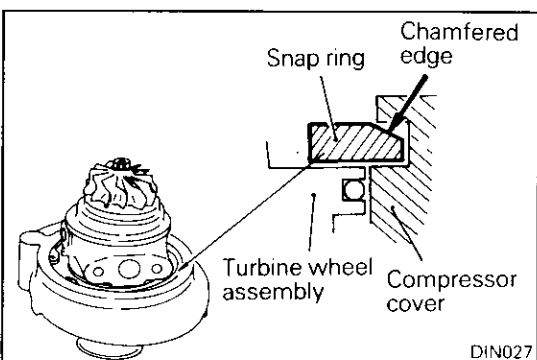


◆B◆ INSTALLATION OF TURBINE WHEEL ASSEMBLY

- (1) Assemble the turbine wheel assembly and the compressor cover together, lining up the mating marks put at the time of disassembly.

Caution

- Use care not to damage the blades of turbine wheel and compressor wheel.

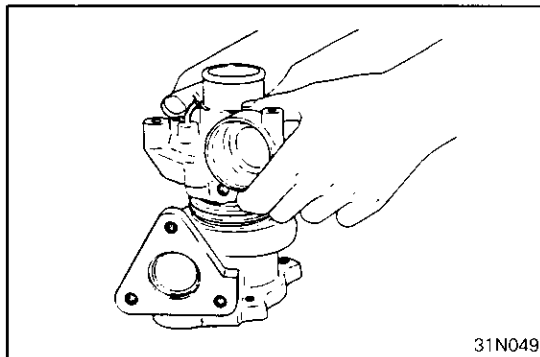


◆C◆ INSTALLATION OF SNAP RING

- (1) Lay the assembly with the compressor cover facing down and fit the snap ring.

Caution

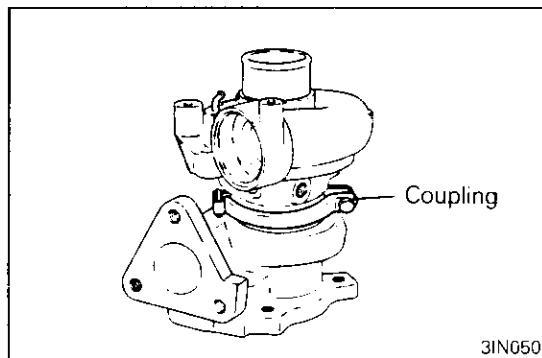
- Fit the snap ring with its chamfered side facing up.

**◆D◆ INSTALLATION OF TURBINE HOUSING**

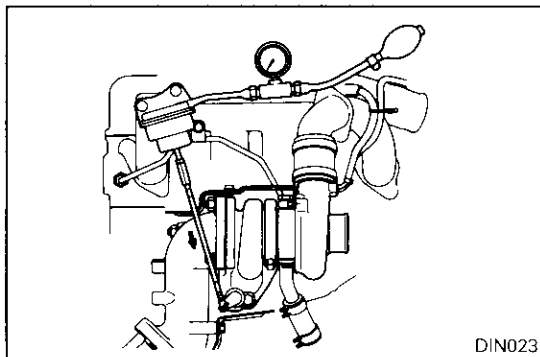
- (1) Install the compressor cover and turbine wheel assembly to the turbine housing, lining up the mating marks put at the time of disassembly.

Caution

- Use care not to damage the blades of turbine wheel.

**◆E◆ INSTALLATION OF COUPLING**

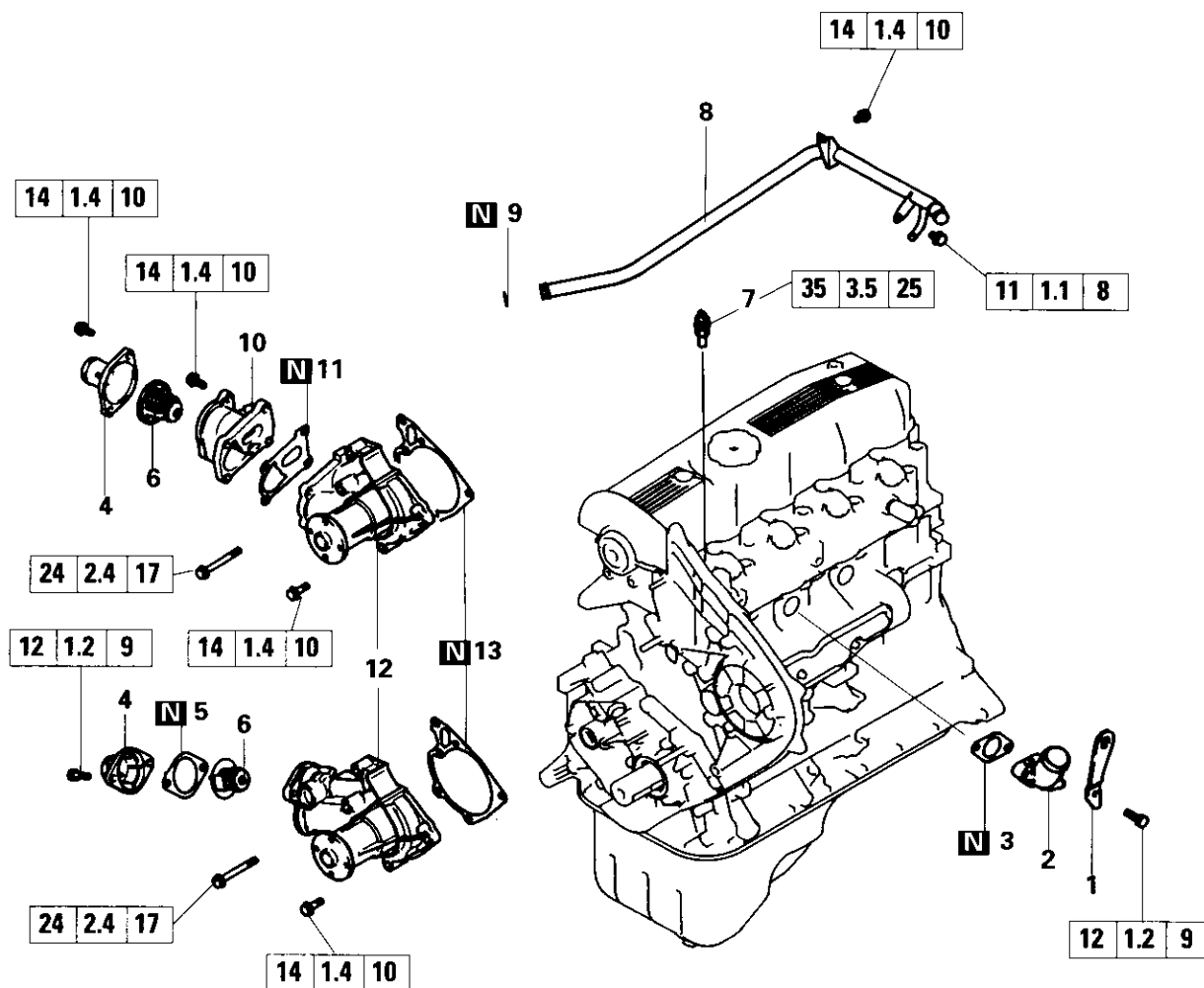
- (1) Install the coupling and tighten to specified torque.

**INSPECTION OF WASTE GATE ACTUATOR OPERATION**

- (1) Check that the rod moves when the following pressure is applied using a tester. Check as installed on the engine.

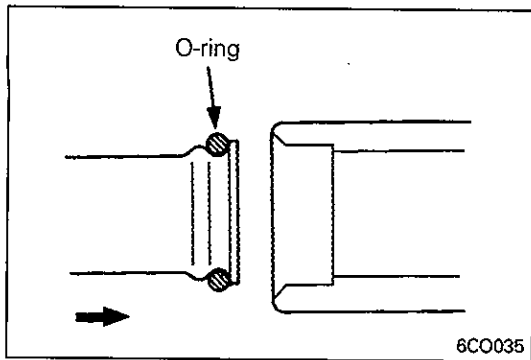
6. WATER PUMP, THERMOSTAT, HOSE AND PIPE

REMOVAL AND INSTALLATION



Removal steps

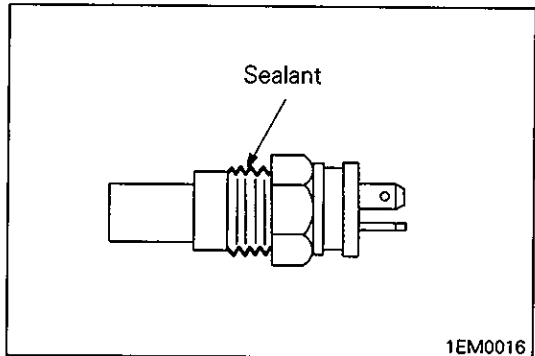
1. Engine hanger
 2. Water outlet fitting
 3. Water outlet fitting gasket
 4. Water inlet fitting
 5. Water inlet fitting gasket
 - <Except engines with turbocharger and intercooler>
 6. Thermostat
 - ▶B▶ 7. Coolant temperature gauge unit
 - ▶A▶ 8. Water inlet pipe
 - ▶A▶ 9. O-ring
 10. Thermostat hosing
 11. Thermostat hosing gasket
 12. Water pump
 13. Water pump gasket
- } Engines with turbocharger and intercooler

**SERVICE POINTS OF INSTALLATION****▶A▶ INSTALLATION OF WATER INLET PIPE / O-RING**

- (1) With the O-ring at the front end of water inlet pipe replaced with a new one, apply water to its outside surface for easier insertion into the water pump body.

NOTE:

Never apply engine oil and other lubricant to the O-ring.

**▶B▶ INSTALLATION OF WATER TEMPERATURE GAUGE UNIT**

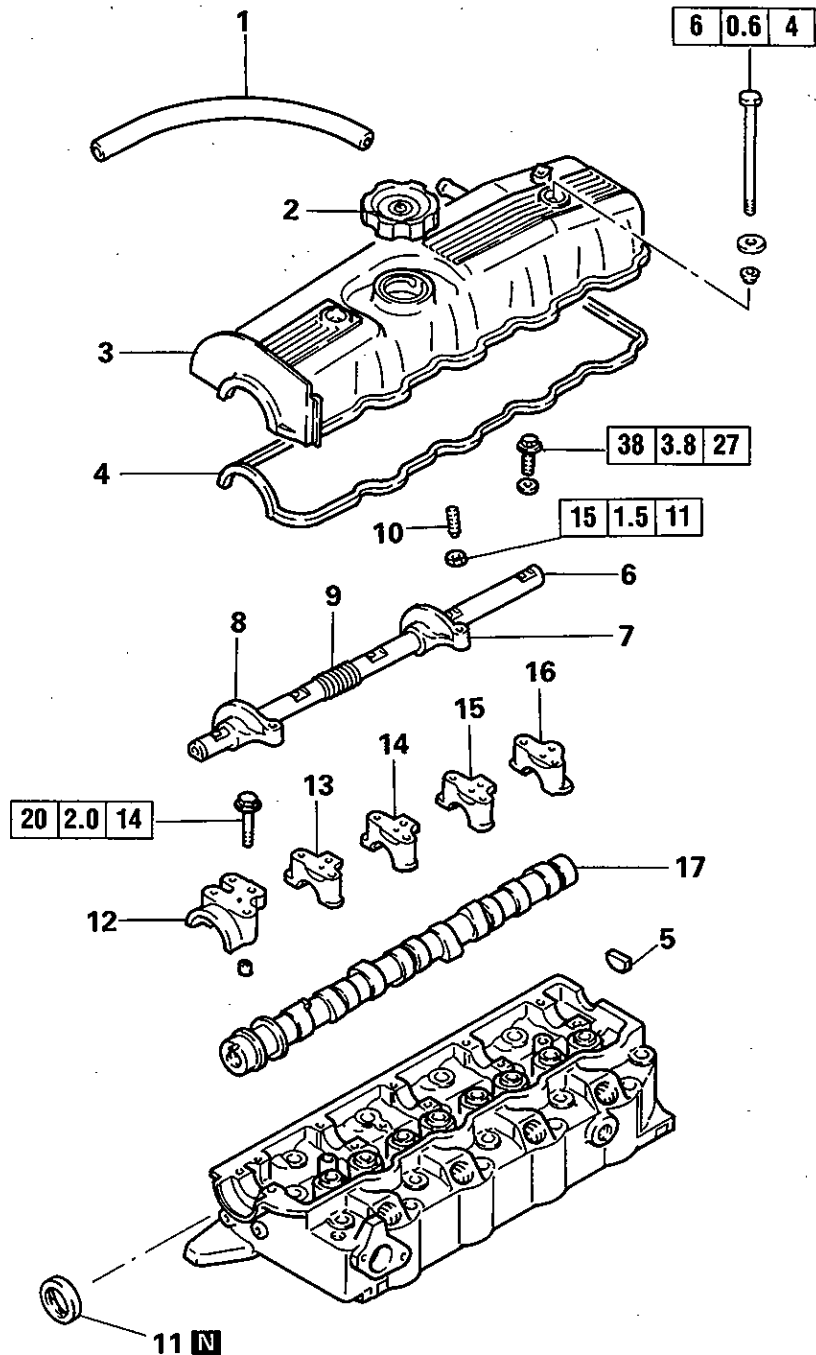
- (1) Apply sealant to threads.

Specified sealant:

3M Nut Locking Part No. 4171 or equivalent

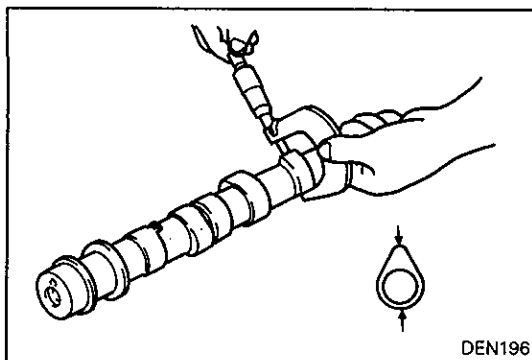
7. ROCKER ARMS, ROCKER SHAFT AND CAMSHAFT

REMOVAL AND INSTALLATION



Removal steps

1. Breather hose
2. Oil filler cap
3. Rocker cover
4. Rocker cover gasket
- ◆E◆ 5. Semi-circular packing
- ◆D◆ 6. Rocker shaft
- ◆C◆ 7. Rocker arm, intake
- ◆C◆ 8. Rocker arm, exhaust
9. Rocker shaft spring
10. Adjust screw
- ◆B◆ 11. Camshaft oil seal
- ◆A◆ 12. Camshaft bearing cap, front
- ◆A◆ 13. Camshaft bearing cap, No. 2
- ◆A◆ 14. Camshaft bearing cap, No. 3
- ◆A◆ 15. Camshaft bearing cap, No. 4
- ◆A◆ 16. Camshaft bearing cap, rear
17. Camshaft

**INSPECTION****CAMSHAFT**

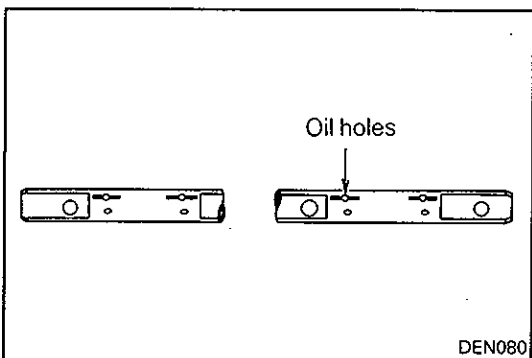
- (1) Measure the cam height.

Standard value:

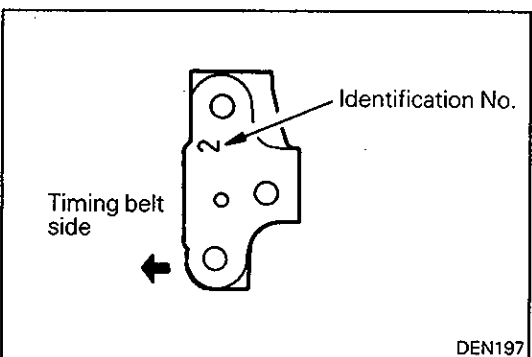
Intake and exhaust: 36.45 – 36.65 mm
(1.435 – 1.443 in.)

Limit:

Intake and exhaust: 36.05 mm (1.419 in.)

**ROCKET 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 either damage or seizure are evident.

**SERVICE POINTS OF INSTALLATION****◆A◆ INSTALLATION OF REAR CAMSHAFT BEARING CAP**

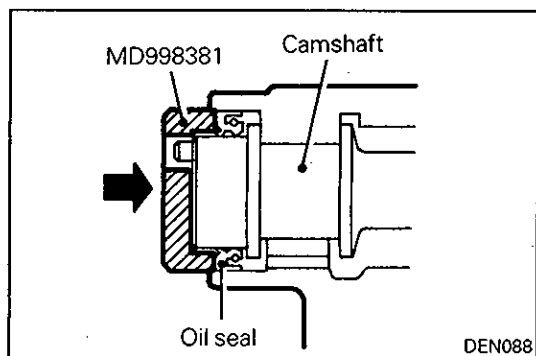
- (1) Install the bearing caps in the designated positions, confirming the identification numbers.

Bearing cap identification

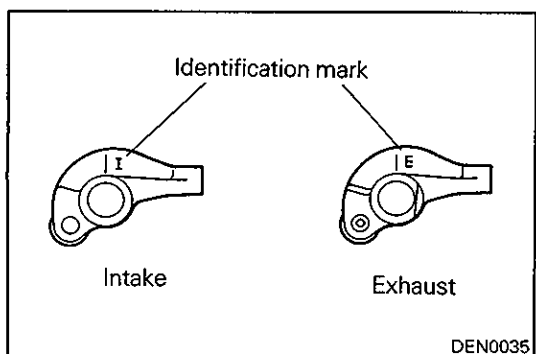
Location	1	2	3	4	5
Ident. No.	None	2	3	4	None

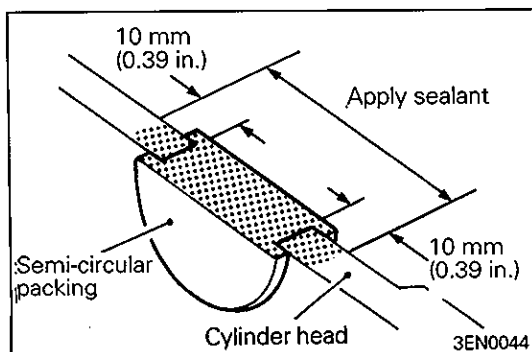
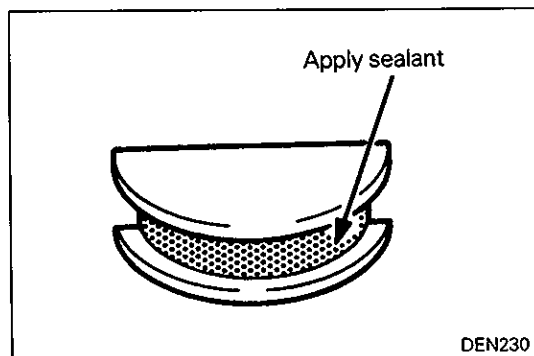
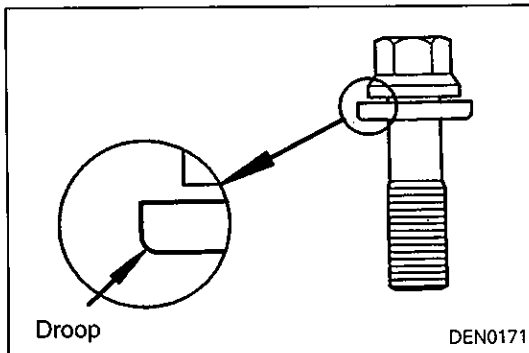
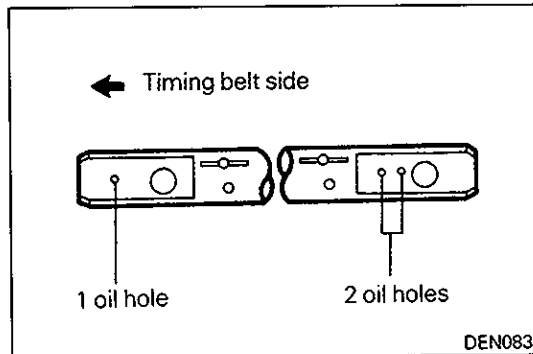
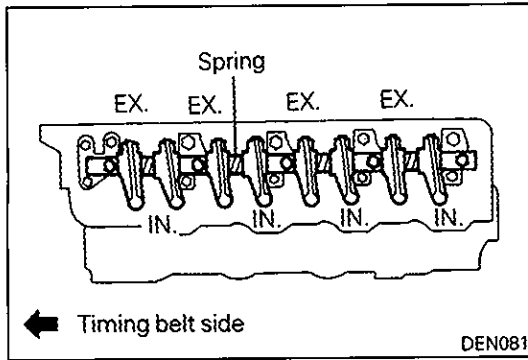
◆B◆ INSTALLATION OF CAMSHAFT OIL SEAL

- (1) Apply oil to the oil seal lips.
- (2) Using Camshaft Oil Seal Installer (special tool), press-fit a new camshaft oil seal into the front bearing cap.

**◆C◆ INSTALLATION OF ROCKER ARM EXHAUST / ROCKER ARM INTAKE**

- (1) Install in the correct position, confirming the identification marks.





◆D◆ INSTALLATION OF ROCKER SHAFT

- (1) Keep the oil hole side down.
- (2) Install the rocker shaft with its side having one oil hole facing to the front.

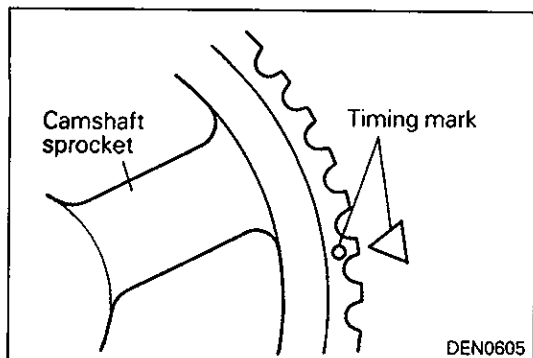
- (3) Set the washer with its shear droop toward the bolt threads.

◆E◆ INSTALLATION OF SEMI-CIRCULAR PACKING

- (1) Apply specified sealant to portions indicated in illustration.

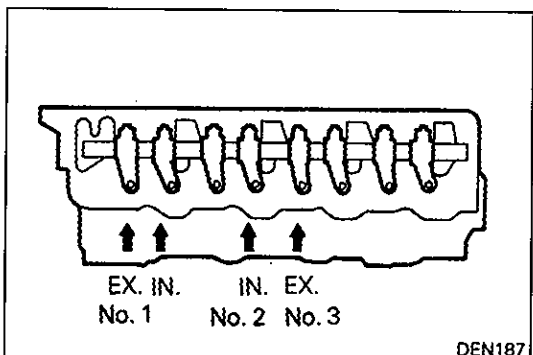
Specified sealant:

3M ATD Part No. 8660 or equivalent

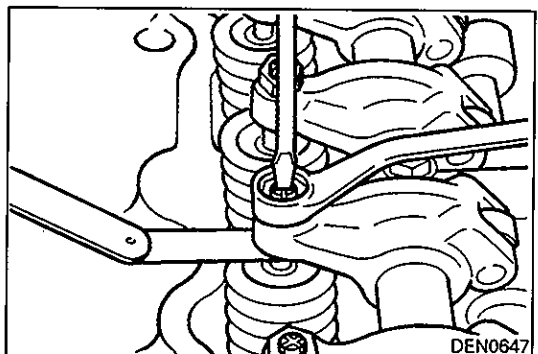


VALVE CLEARANCE ADJUSTMENT

- (1) Turn the crankshaft clockwise and align the timing mark on camshaft sprocket with its mating mark.



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



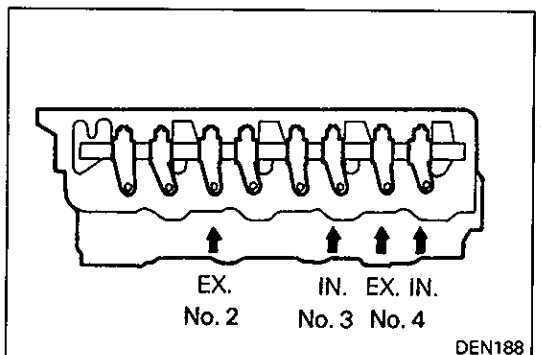
- (3) Loosen the adjusting screw lock nut.
- (4) Using a thickness gauge, adjust the valve clearance by turning the adjusting screw.

Standard value: on cold engine

0.15 mm (0.006 in.) Intake

0.15 mm (0.006 in.) Exhaust

- (5) While holding the adjusting screw with a screwdriver, tighten the lock nut.



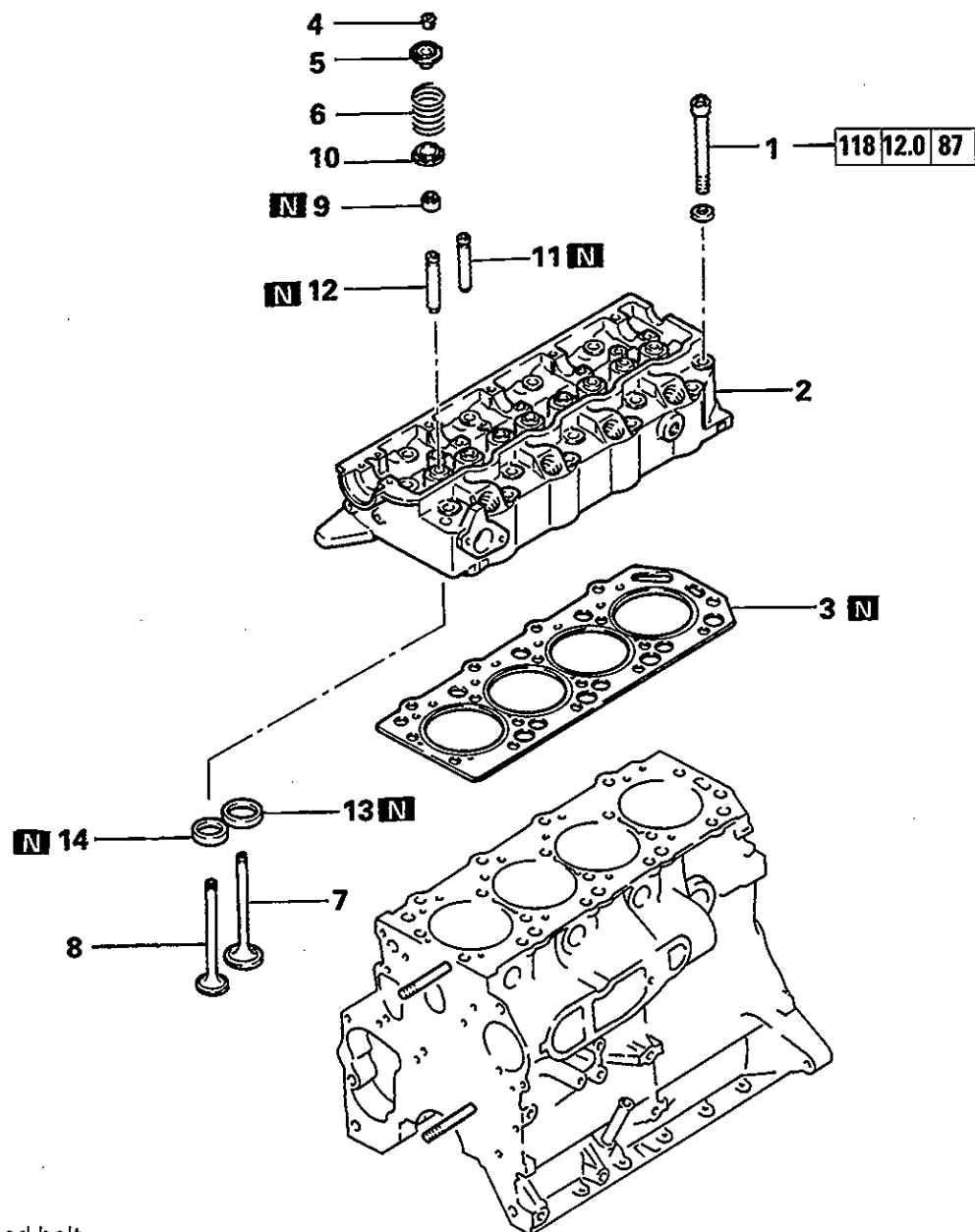
- (6) Rotate clockwise the crankshaft one complete turn (360 degree).
- (7) Adjust the valve clearance at points shown in the illustration.
- (8) Repeat steps (3) to (5) to adjust the valve clearance of remaining valves.

NOTE

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

8. CYLINDER HEAD, VALVES AND VALVE SPRING

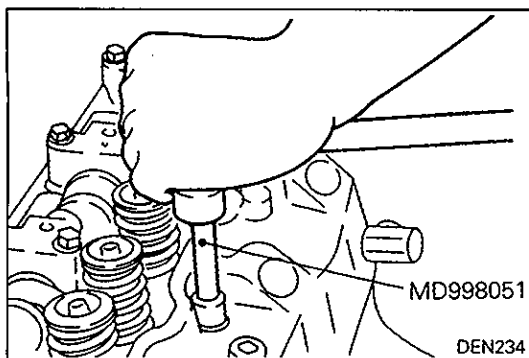
REMOVAL AND INSTALLATION



Removal steps

- ◀A▶ ▶C▶ 1. Cylinder head bolt
- 2. Cylinder head
- 3. Cylinder head gasket
- 4. Valve spring retainer lock
- 5. Valve spring retainer
- ▶B▶ 6. Valve spring
- 7. Intake valve
- 8. Exhaust valve
- ▶A▶ 9. Valve stem seal
- 10. Spring seat
- 11. Intake valve guide
- 12. Exhaust valve guide
- 13. Intake valve seat
- 14. Exhaust valve seat

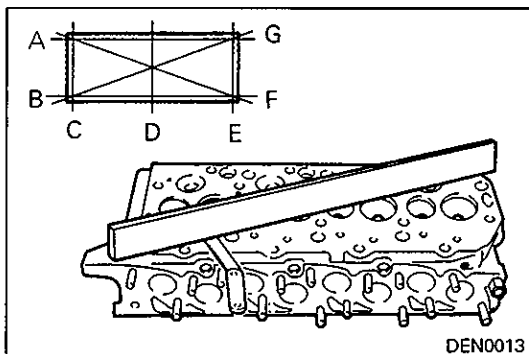
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SERVICE POINT OF REMOVAL

◇A◇ REMOVAL OF CYLINDER HEAD BOLTS

- (1) Using the special tool, loosen the cylinder head bolts.



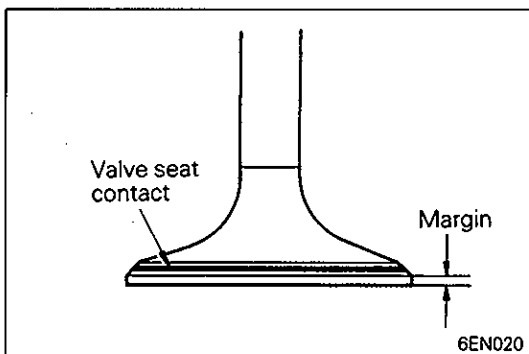
INSPECTION

CYLINDER HEAD

- (1) Check the cylinder head gasket surface for flatness by using a straightedge in the directions of A through G shown in illustration.

Standard value: 0.05 mm (0.0020 in.)

Limit: 0.2 mm (0.008 in.)

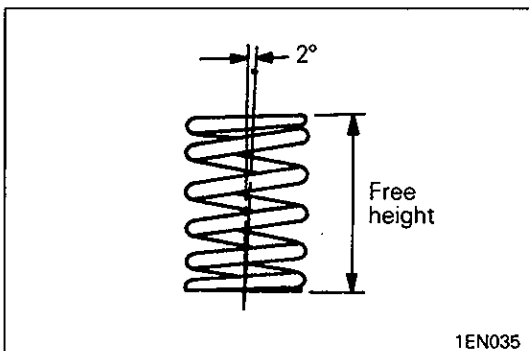


VALVE

- (1) Check the valve face for correct contact. If incorrect, reface using 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: 2.0 mm (0.80 in.)

Limit: 1.0 mm (0.040 in.)



VALVE SPRING

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

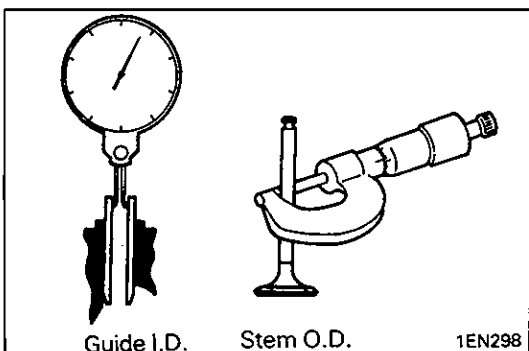
Standard value: 49.1 mm (1.9331 in.)

Limit: 48.1 mm (1.8937 in.)

- (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:

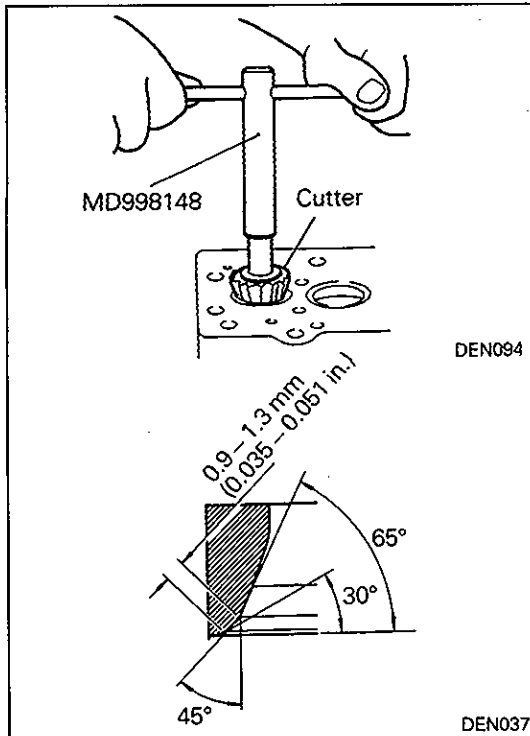
0.03 - 0.06 mm (0.0012 - 0.0024 in.)Intake

0.05 - 0.09 mm (0.0020 - 0.0035 in.)Exhaust

Limit:

0.10 mm (0.0039 in.)Intake

0.15 mm (0.0059 in.)Exhaust

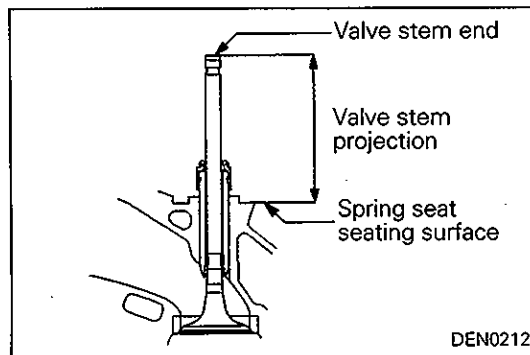
**VALVE SEAT RECONDITIONING PROCEDURE**

- (1) Before connecting the valve seat, check for clearance between the valve guide and valve and, if necessary, replace the valve guide.
- (2) Using the special tool or seat grinder, correct to obtain the specified seat width and angle.

Available Valve Seat Cutter Types

Cutter angle	Tool number
	Intake/exhaust
45°	MD998158
65°	MD998165
30°	MD998175

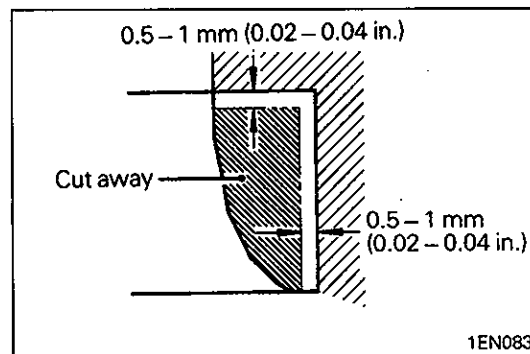
- (3) After correction, valve and valve seat should be lapped with a lapping compound.



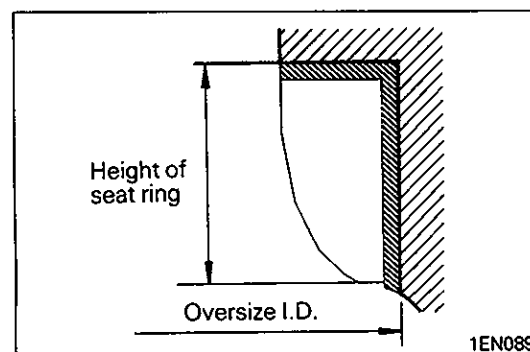
- (4) Install the valve and, while pressing the valve against the valve seat, measure the valve stem projection between the valve stem end and the valve spring seat seating surface.

Standard value: 40.95 mm (1.612 in.)

Limit: 41.45 mm (1.632 in.)

**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) Rebore the valve seat hole in cylinder head to the oversize valve seat diameter.

Intake valve seat hole diameter

0.30 O.S.: 43.300 – 43.325 mm (1.7047 – 1.7057 in.)

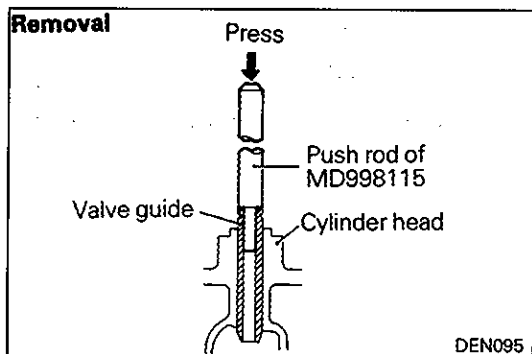
0.60 O.S.: 43.600 – 43.625 mm (1.7165 – 1.7175 in.)

Exhaust valve seat hole diameter

0.30 O.S.: 37.300 – 37.325 mm (1.4685 – 1.4695 in.)

0.60 O.S.: 37.600 – 37.625 mm (1.4803 – 1.4813 in.)

- (3) Before fitting the valve seat, either heat the cylinder head up to approximately 250°C (482°F) or cool the valve seat using cooling spray to prevent the cylinder head bore from galling.
- (4) Using 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 cylinder head gasket surface.
- (2) Rebore valve guide hole to the new oversize valve guide outside diameter.

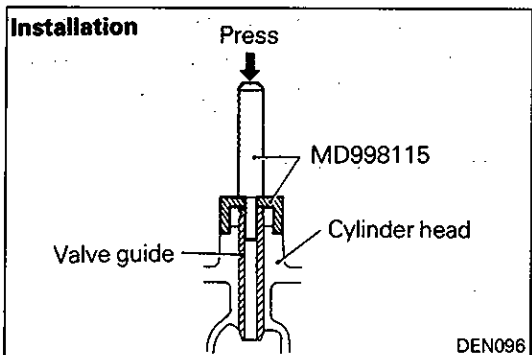
Valve guide hole diameter:

0.05 O.S.:	13.050 – 13.068 mm (0.5138 – 0.5145 in.)
0.25 O.S.:	13.250 – 13.268 mm (0.5217 – 0.5224 in.)
0.50 O.S.:	13.500 – 13.518 mm (0.5315 – 0.5322 in.)

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.



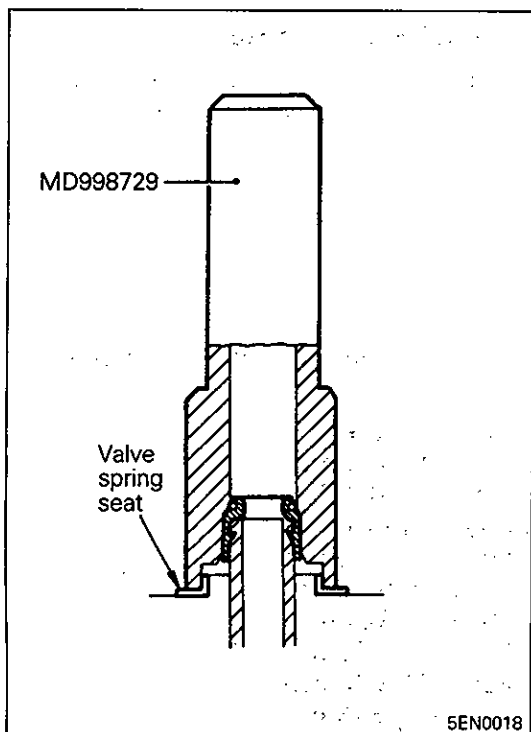
SERVICE POINTS OF INSTALLATION

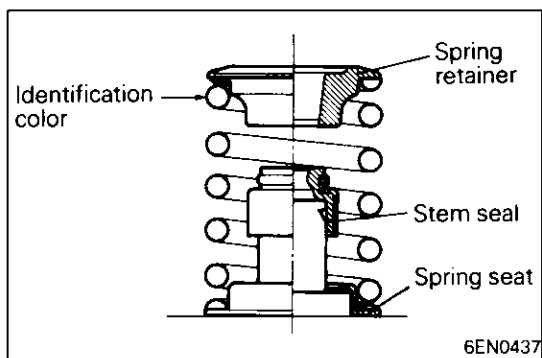
▶A▶ INSTALLATION OF VALVE STEM SEAL

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

NOTE

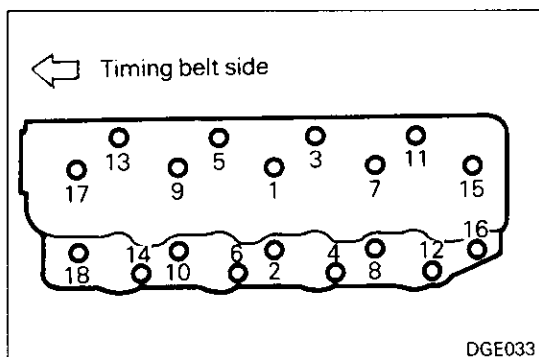
The valve stem seal cannot be reused.





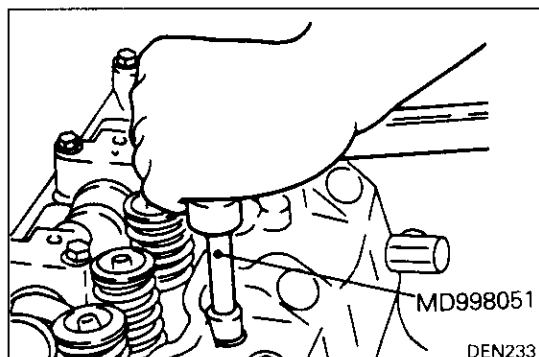
◆B◆ INSTALLATION OF VALVE SPRING

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



◆C◆ INSTALLATION OF CYLINDER HEAD BOLT

- (1) Using the special tool and torque wrench, tighten bolts in the shown sequence.

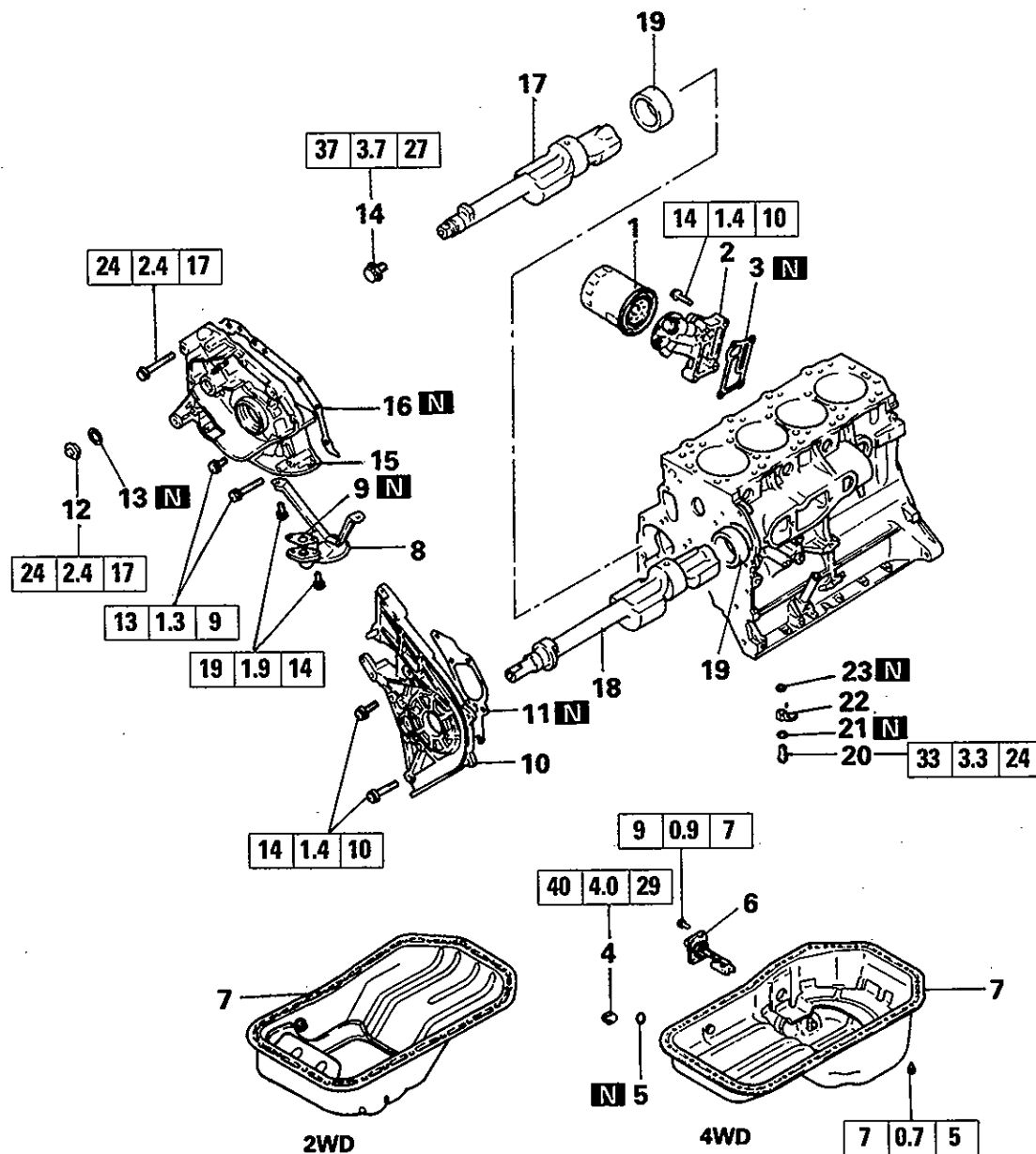


- (2) Repeat the tightening sequence several times, and tighten the bolts to specification in the final sequence.

NOTES

9. FRONT CASE, SILENT SHAFT AND OIL PAN

REMOVAL AND INSTALLATION

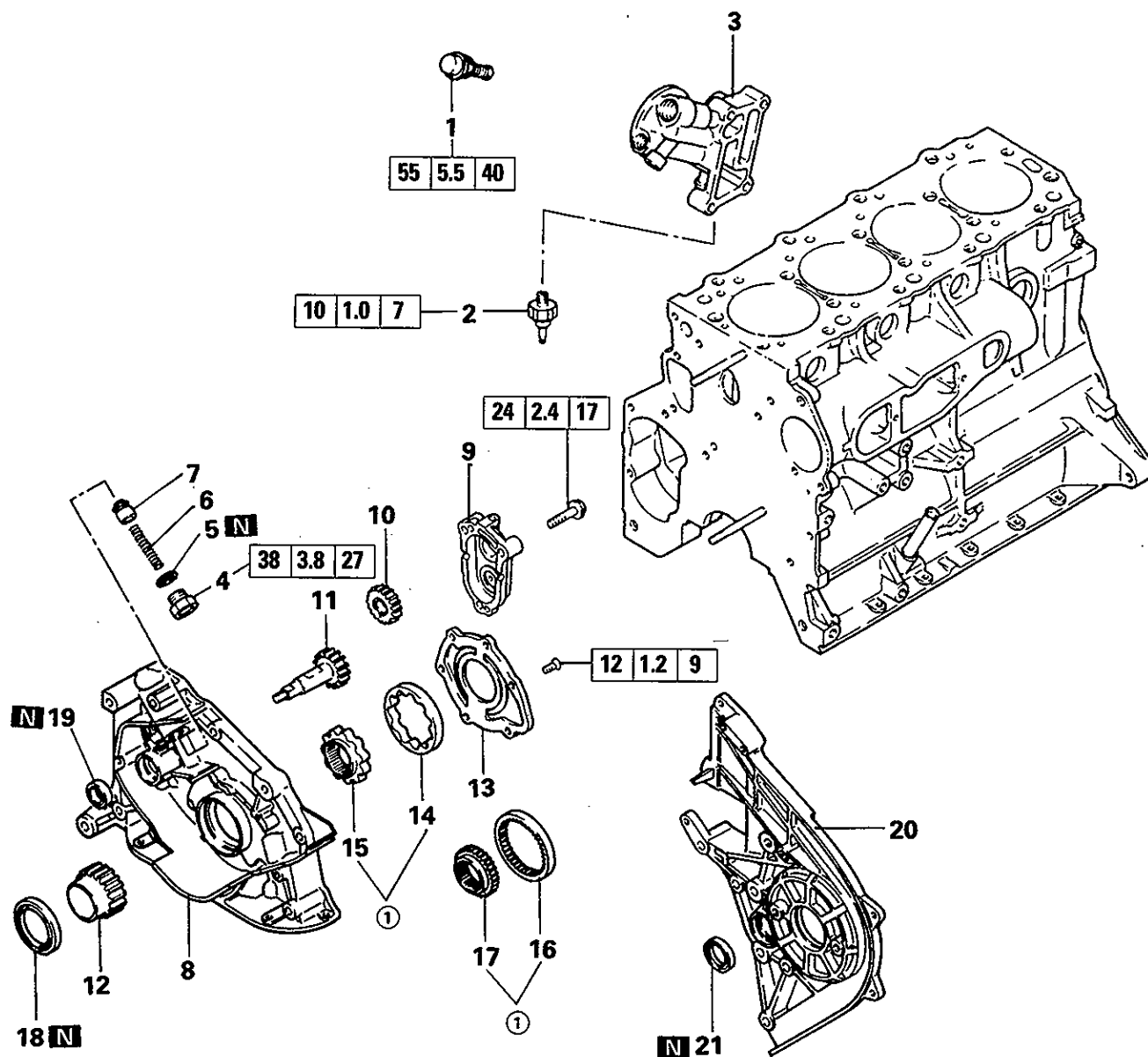


Removal steps

- | | | | |
|---------|------------------------------|---------|-----------------------------|
| ◆K◆ | 1. Oil filter | ◆B◆ ◆H◆ | 13. O-ring |
| | 2. Oil filter bracket | | 14. Flange bolt |
| | 3. Oil filter bracket gasket | | 15. Front lower case |
| | 4. Oil drain plug | | 16. Front lower case gasket |
| ◆J◆ | 5. Oil drain plug gasket | | 17. Silent shaft, right |
| | 6. Oil level sensor | | 18. Silent shaft, left |
| ◆A◆ ◆I◆ | 7. Oil pan | ◆C◆ ◆G◆ | 19. Silent shaft bearing |
| | 8. Oil screen | | 20. Check valve |
| | 9. Oil screen gasket | ◆F◆ | 21. Gasket |
| | 10. Front upper case | | 22. Oil jet |
| | 11. Front upper case gasket | | 23. Gasket |
| | 12. Plug cap | | |

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DISASSEMBLY AND REASSEMBLY



Disassembly steps

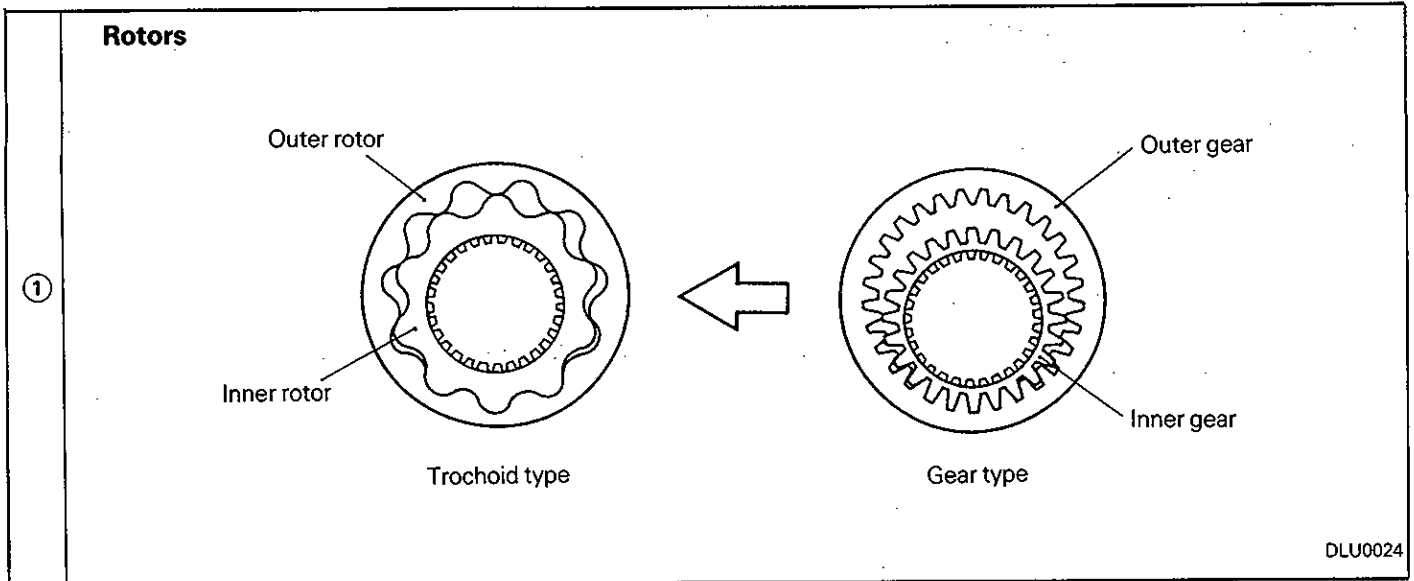
1. Oil cooler by-pass valve
- ↗E 2. Oil pressure switch
3. Oil filter gasket
4. Plug
5. Gasket
6. Relief spring
7. Relief plunger
8. Front lower case
9. Silent shaft gear cover
- ↗D 10. Silent shaft driven gear
- ↗D 11. Silent shaft drive gear
12. Oil pump gear drive shaft

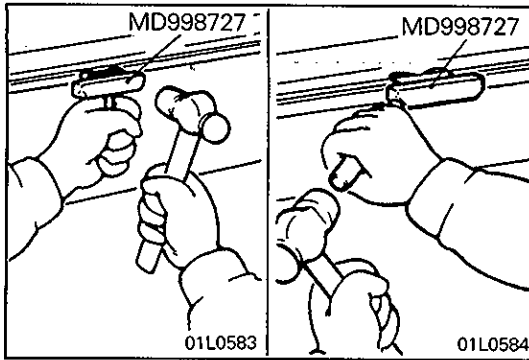
13. Oil pump cover
- ↗D ↗C 14. Outer rotor } Trochoid type
- ↗D ↗C 15. Inner rotor }
- ↗D ↗C 16. Outer gear } Gear type
- ↗D ↗C 17. Inner gear }
- ↗B 18. Crankshaft front oil seal
- ↗A 19. Oil seal
20. Front upper case
21. Oil seal

NOTE

①: See "Details of change" table.

Details of Change

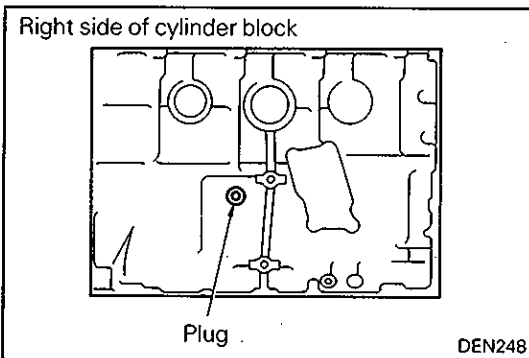


**SERVICE POINTS OF REMOVAL****◊A◊ REMOVAL OF OIL PAN**

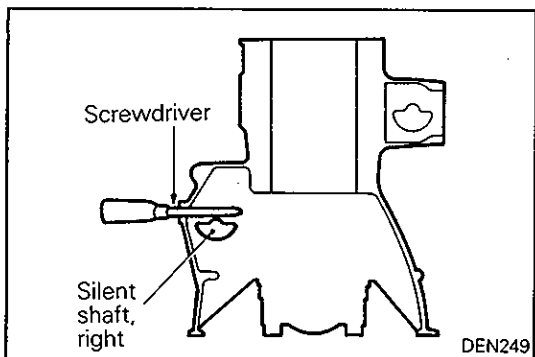
- (1) Knock the special tool deeply between the oil pan and the cylinder block.
- (2) Hitting the side of the special tool, slide the special tool along the oil pan to remove it.

◊B◊ REMOVAL OF FLANGE BOLT

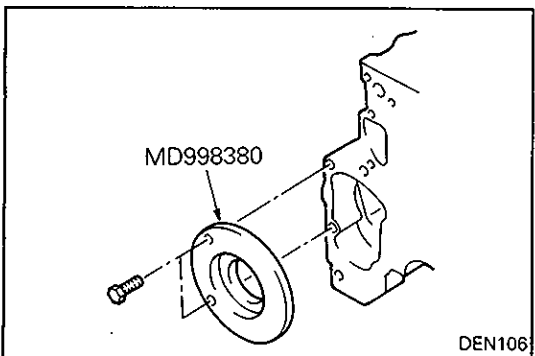
- (1) Remove the plug on the right side of cylinder block.



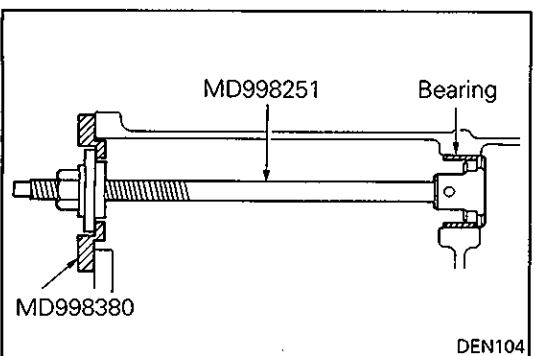
- (2) Insert a Phillips screwdriver into the plug hole to lock the silent shaft in position.
- (3) Remove the flange bolt.

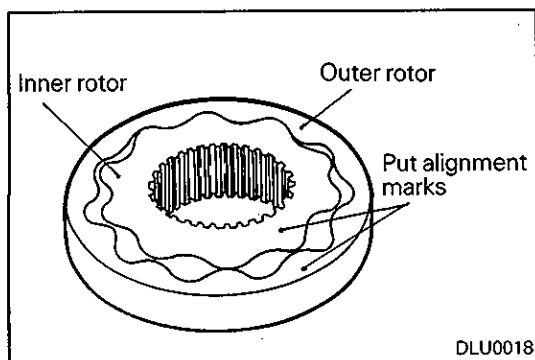
**◊C◊ REMOVAL OF SILENT SHAFT BEARING**

- (1) Install the special tool to the cylinder block. This is used to hold the special tool.



- (2) Pull out the rear bearing from the cylinder block using the special tool.





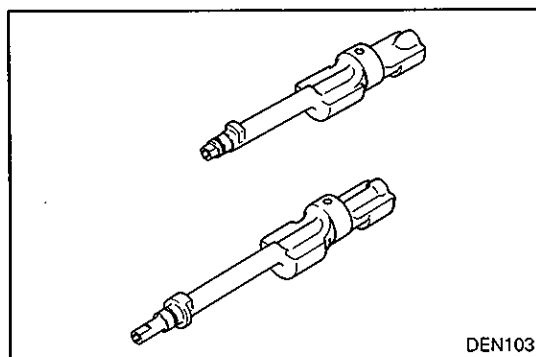
REMOVAL OF OUTER ROTOR / INNER ROTOR / OUTER GEAR / INNER GEAR

- (1) Put alignment marks on the outer and inner rotors or outer and inner gears for reference in reassembly.

INSPECTION

FRONT LOWER CASE

- (1) The front case parts must be free from damage and cracks.
- (2) Install the oil pump rotor or gear into the front case and make sure that the rotor or gear turns smoothly with no excessive play in it.
- (3) The front case and oil pump cover surfaces in contact with the pump rotor or gear side face must be free from ridge wear.



SILENT SHAFT

- (1) Check oil holes must be free from clogging.
- (2) Check journal for seizure, damage, and contact with bearing. If defects are evident, replace the silent shaft, bearing, or front case assembly.
- (3) Check the silent shaft oil clearance. If wear is excessive, replace the silent shaft bearing, silent shaft or front case assembly.

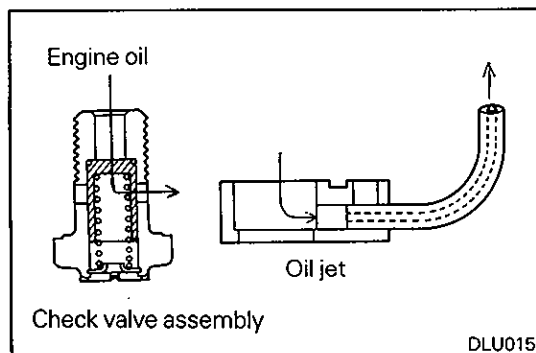
Standard value:

Front

0.02 – 0.06 mm (0.0008 – 0.0024 in.) Right

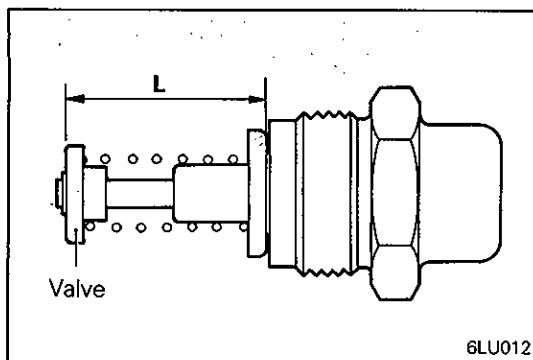
0.02 – 0.05 mm (0.008 – 0.0020 in.) Left

Rear 0.06 – 0.10 mm (0.0024 – 0.0039)



OIL JET, CHECK VALVE

- (1) Check the oil jet and check valve for clogging.
- (2) Check the oil jet for damage and deformation.

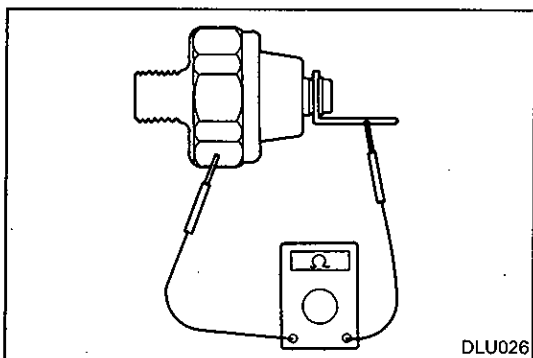
**OIL COOLER BYPASS VALVE (Models with oil cooler)**

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

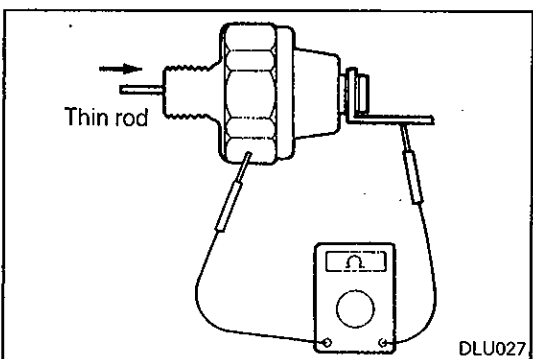
Dimension L: 34.5 mm (1.358 in.)

- (3) The dimension must be the standard value when measured after the valve has been dipped in 100°C (212°F) oil.

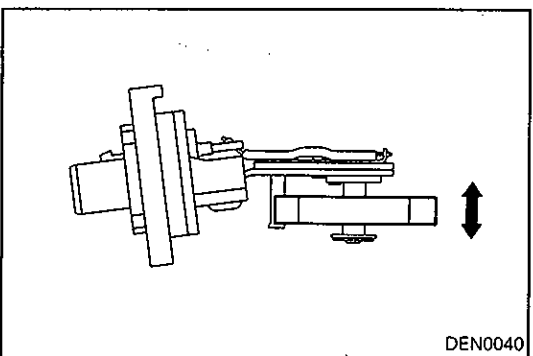
Dimension L: 40 mm (1.57 in.) or more

**OIL PRESSURE SWITCH**

- (1) Connect a tester (ohm range) between the terminal and the body of the switch to check for continuity. The switch is normal if there is continuity. If there is no continuity, replace the switch.



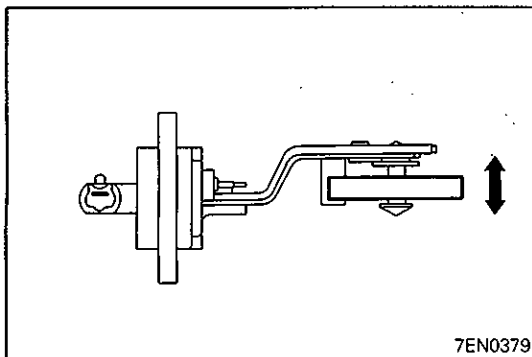
- (2) Insert a thin rod in the oil hole of the switch and push it in lightly. The switch is normal if no continuity is detected (infinite resistance on the tester). If there is continuity, replace the switch.
- (3) Apply a 0.5 kg/cm² pressure to the oil hole. The switch is normal if there is no continuity. Also check for air leaks. If any air leaks are detected, the cause may be a broken diaphragm. Replace the switch if it leaks.

**OIL LEVEL SENSOR (FOR EUROPE)**

<P05V, P05W, P15V, P25V, P25W>

- (1) Check continuity of the oil level sensor with the float moving up and down.

Float position	Switch ON/OFF
Condition when down	OFF (no continuity)
Condition when up	ON (continuity)



<V24C, V24V, V24W, V44V, V44W>

- (1) Immerse the oil level sensor and check continuity with its float positioned both up and down at oil temperatures both below 40°C (104°F) and above 80°C (176°F).

40°C (104°F)

Float position	Switch ON/OFF
Condition when down	ON (continuity)
Condition when up	ON (continuity)

80°C (176°F)

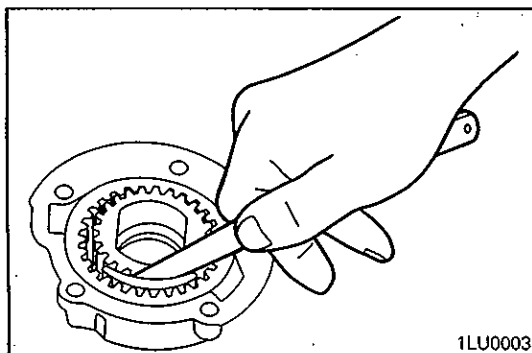
Float position	Switch ON/OFF
Condition when down	OFF (no continuity)
Condition when up	ON (continuity)

OIL FILTER BRACKET

- (1) Check the oil filter mounting surface for damage.
- (2) Check for cracks and oil leaks.

OIL PUMP – Gear type

- (1) Check the gear teeth for wear and damage.
- (2) Set the outer and inner gears in the front lower case and check that they rotate smoothly.

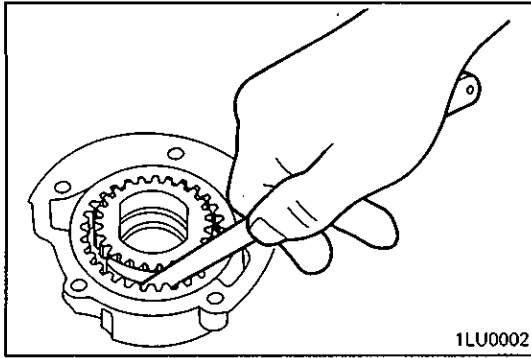


- (3) Check the inner gear tip to crescent clearance.

Standard value:

0.22 – 0.35 mm (0.0087 – 0.0138 in.)

Limit: 0.5 mm (0.020 in.)

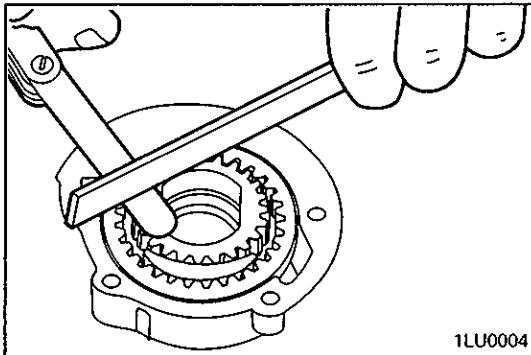


- (4) Check the outer gear tip to crescent clearance.

Standard value:

0.12 – 0.22 mm (0.0047 – 0.0087 in.)

Limit: 0.4 mm (0.016 in.)

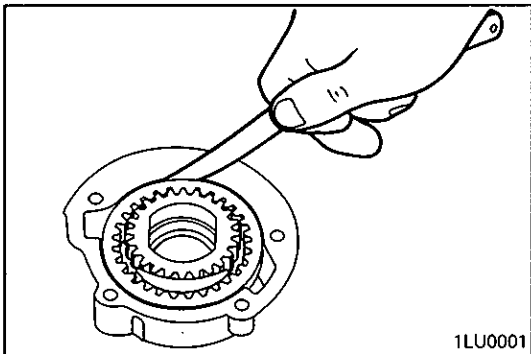


- (5) Check the inner gear and outer gear side clearance.

Standard value:

0.04 – 0.10 mm (0.0016 – 0.0039 in.)

Limit: 0.15 mm (0.006 in.)

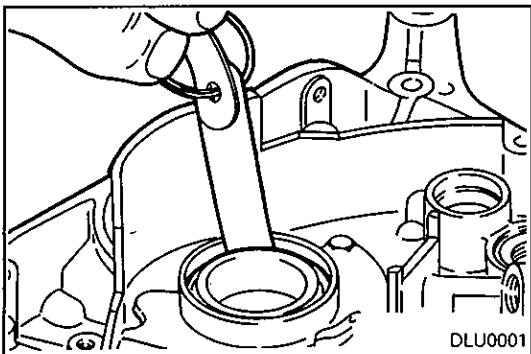


- (6) Check the outer gear outer circumference to front case clearance (body clearance)

Standard value:

0.12 – 0.18 mm (0.0047 – 0.0071 in.)

Limit: 0.3 mm (0.012 in.)



- (7) Check the inner gear outer circumference to front case clearance (body clearance).

Standard value:

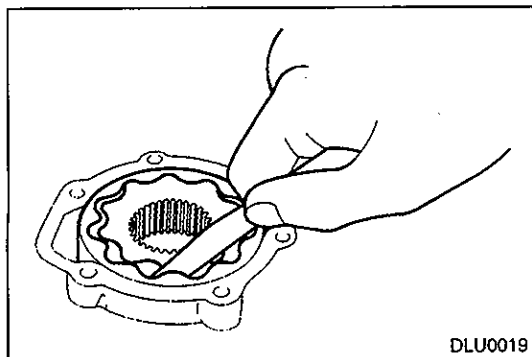
0.03 – 0.09 mm (0.0012 – 0.0035 in.)

Limit: 0.15 mm (0.006 in.)

- (8) Check the front case and oil pump cover surfaces in contact with the pump gear side face for ridge wear.

OIL PUMP – Trochoid type

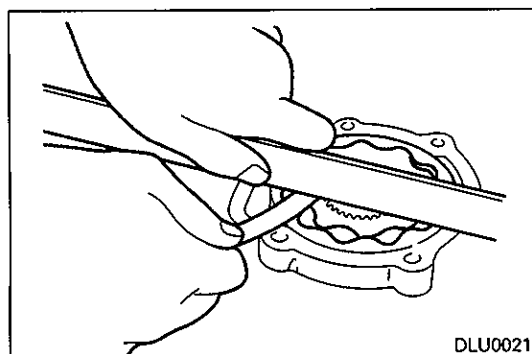
- (1) Check the rotor teeth for wear and damage.
- (2) Set the outer and inner gears in the front lower case and check that they rotate smoothly.



- (3) Check the tip clearance.

Standard value:

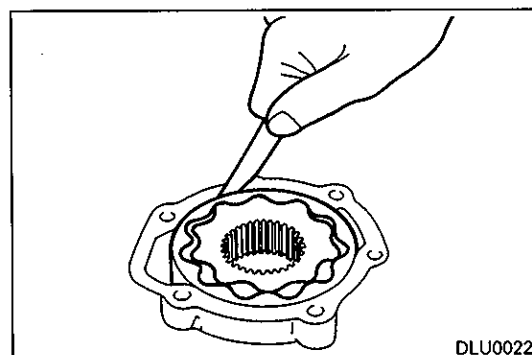
0.11 – 0.24 mm (0.0043 – 0.0094 in.)



- (4) Check the inner rotor and outer rotor side clearance.

Standard value:

0.04 – 0.10 mm (0.0016 – 0.0039 in.)

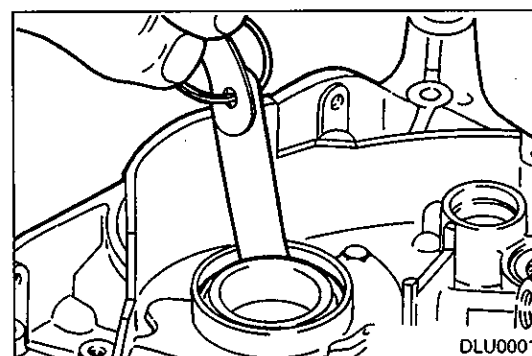


- (5) Check the outer rotor outer circumference to front case clearance (body clearance)

Standard value:

0.10 – 0.18 mm (0.0039 – 0.0071 in.)

Limit: 0.35 mm (0.0138 in.)



- (6) Check the inner rotor outer circumference to front case clearance (body clearance).

Standard value:

0.03 – 0.09 mm (0.0012 – 0.0035 in.)

- (7) Check the front case and oil pump cover surfaces in contact with the pump rotor side face for ridge wear.

RELIEF PLUNGER

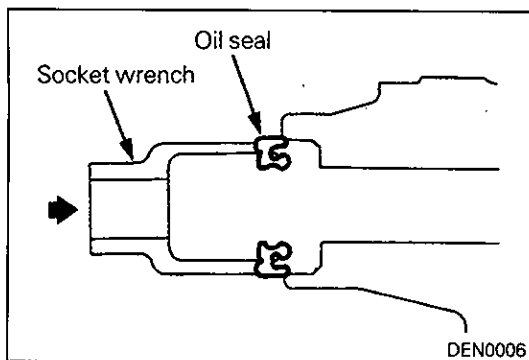
- (1) Ensure that the relief plunger slides smoothly.

RELIEF SPRING

- (1) Ensure that the relief spring is not broken.

OIL SEAL

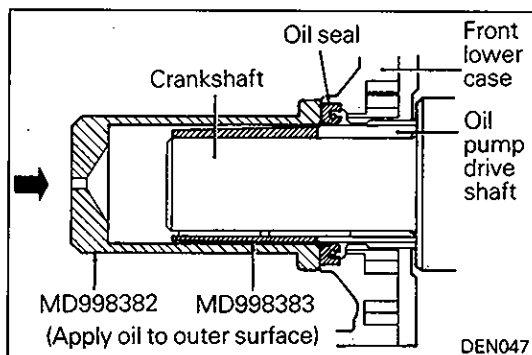
- (1) Check the oil seal lip for wear and damage. Replace oil seal if necessary.
- (2) Check the oil seal lip for deterioration. Replace oil seal if necessary.



SERVICE POINTS OF INSTALLATION

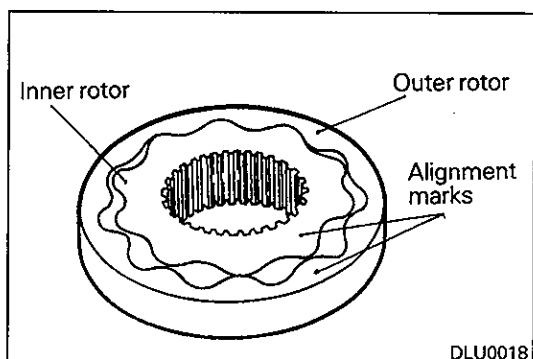
◆A◆ INSTALLATION OF OIL SEAL

- (1) Apply engine oil to the oil seal outer surface and drive in with a socket wrench.



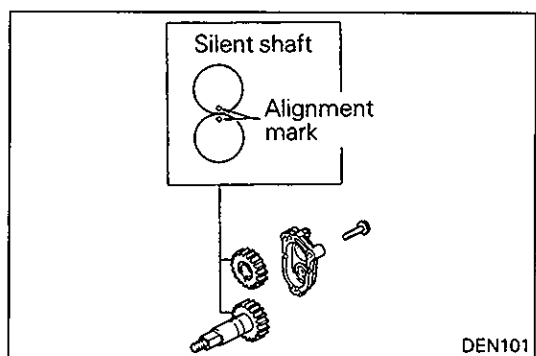
◆B◆ INSTALLATION OF CRANKSHAFT FRONT OIL SEAL

- (1) Attach the special tool to the crankshaft and apply engine oil to the outer surface of the tool.
- (2) Using the special tool, install the front oil seal into the front lower case.



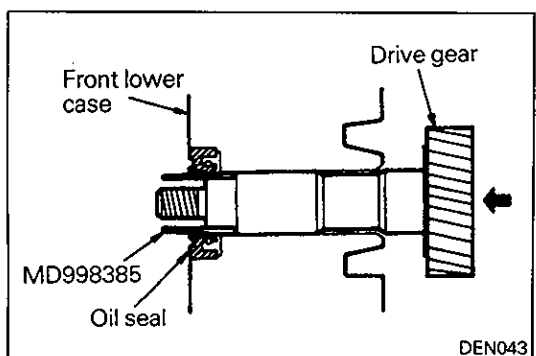
◆C◆ INSTALLATION OF INNER GEAR / OUTER GEAR / INNER ROTOR / OUTER ROTOR

- (1) Install the outer rotor (or outer gear) in the same direction as before noting the mark put at the time of removal. Apply engine oil to the entire rotor (or gear) surface.

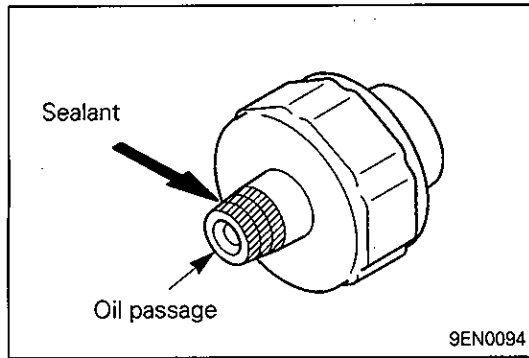


◆D◆ INSTALLATION OF SILENT SHAFT DRIVE GEAR / SILENT SHAFT DRIVEN GEAR

- (1) Install the silent shaft drive and driven gears to the front lower case. Make sure that the alignment marks are in line.



- (2) Install the special tool to the drive gear. Apply engine oil to the outer surface of the special tool and the drive gear shaft and install the drive gear as shown.



◆E◆ INSTALLATION OF OIL PRESSURE SWITCH

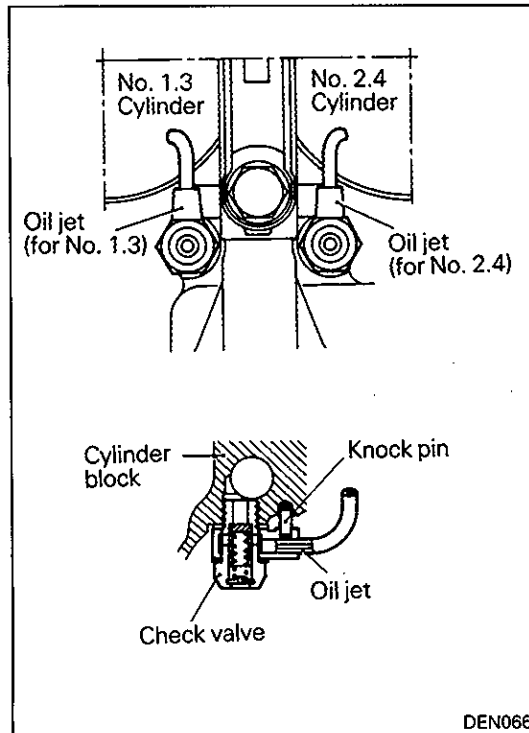
- (1) Apply sealant to the threads of the switch.

Specified sealant:

3M ATD Part No. 8660 or equivalent

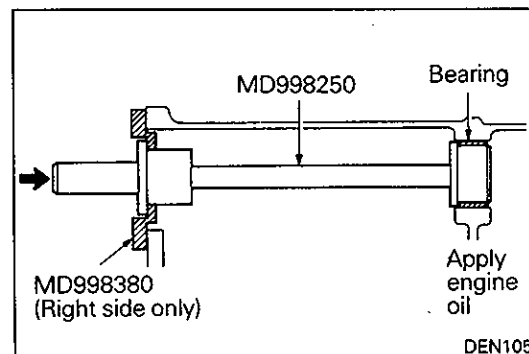
Caution

- Use care not to allow the sealant to plug the oil passage.



◆F◆ INSTALLATION OF OIL JET

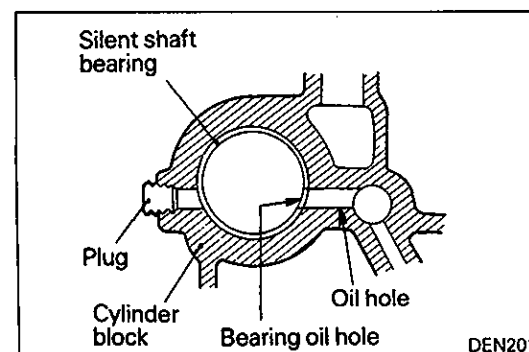
- (1) There are two types of oil jets installed: one for No. 1 and 3 and the other for No. 2 and 4. Make sure that the correct one is installed with correct direction as shown.



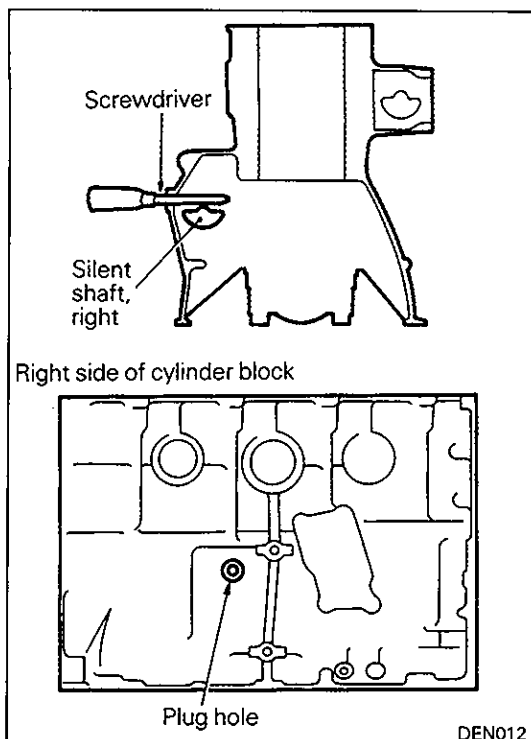
◆G◆ INSTALLATION OF SILENT SHAFT BEARING

- (1) Using the special tool, press-fit the bearing into the cylinder block.

Before press-fitting the bearing, apply an ample amount of engine oil to the bearing surfaces as well as bearing hole in the cylinder block.

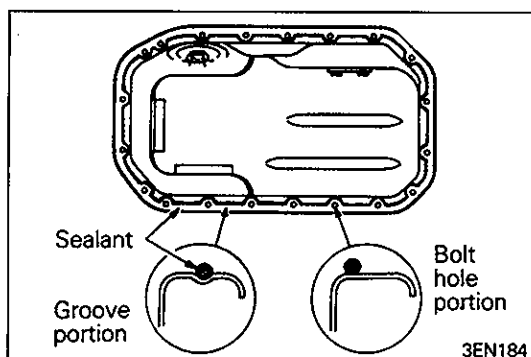


- (2) When press-fitting the right bearing into position, make sure that the oil hole in bearing is aligned with that in cylinder block.



◆H◆ INSTALLATION OF FLANGE BOLT

- (1) Insert a Phillips screwdriver into the plug hole to block the silent shaft.
- (2) Install the flange bolt and tighten to the specification.
- (3) Remove the screwdriver and install the plug.



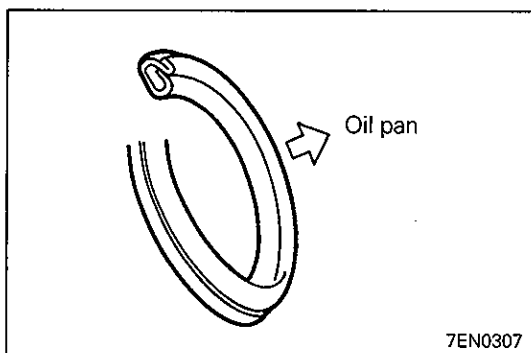
◆I◆ INSTALLATION OF OIL PAN

- (1) Clean both mating surfaces of oil pan and cylinder block.
- (2) Apply a 4 mm (0.16 in.) wide bead of sealant to the entire circumference of the oil pan flange.

Specified sealant:

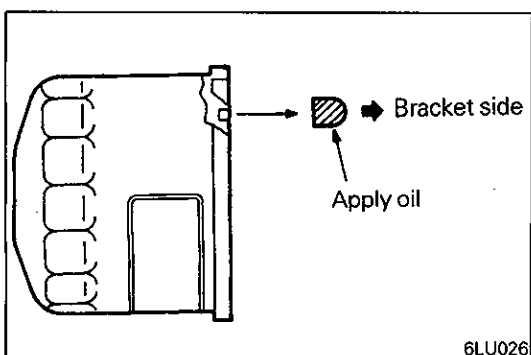
MITSUBISHI GENUINE Part No. MD997110 or equivalent

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



◆J◆ INSTALLATION OF OIL DRAIN PLUG GASKET

- (1) Replace the gasket with a new one and install it in the direction shown in the illustration.



◆K◆ INSTALLATION OF OIL FILTER

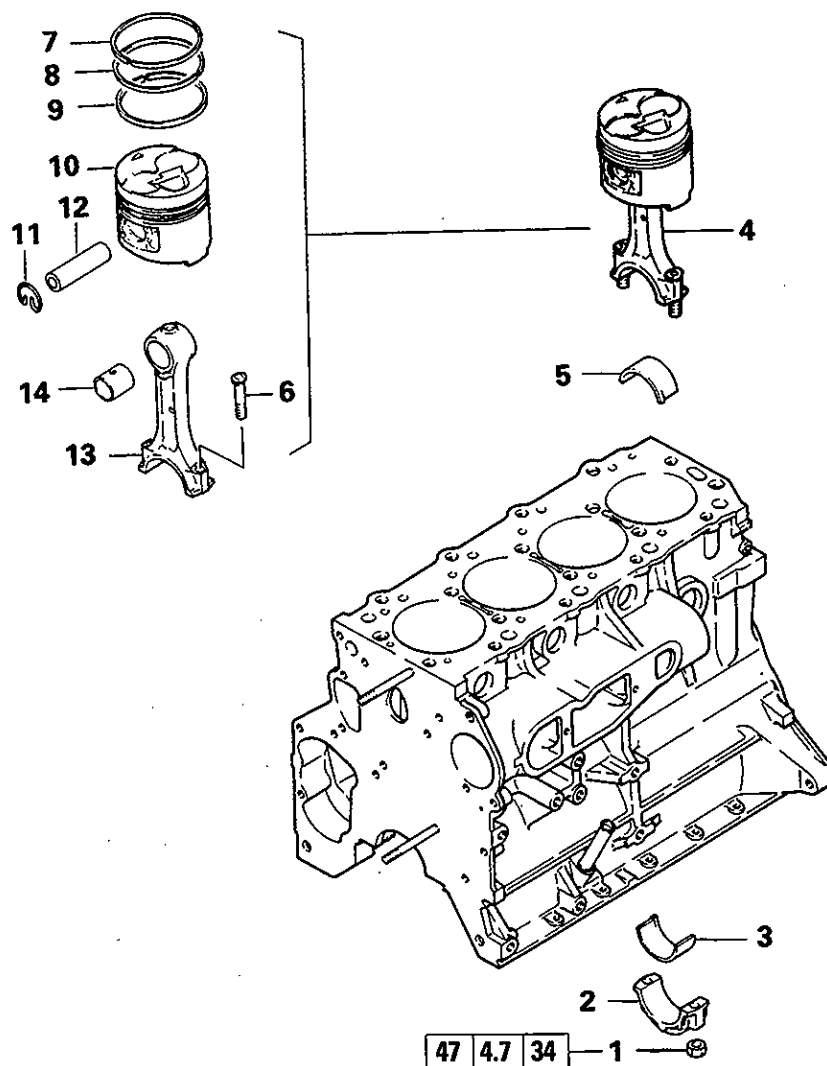
- (1) Wipe clean the mounting surface on the filter bracket. Then, apply a thin coat of engine oil to filter O-ring and tighten oil filter hand-tight.

Caution

- **Never use a wrench to tighten the oil filter.**

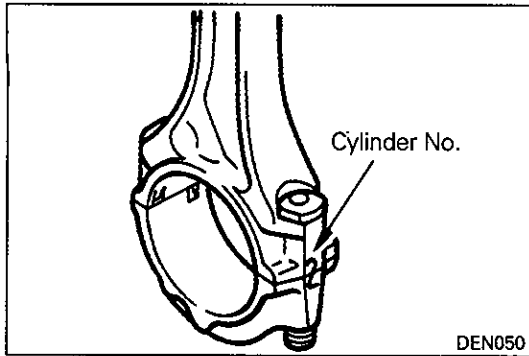
10. PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION



Removal steps

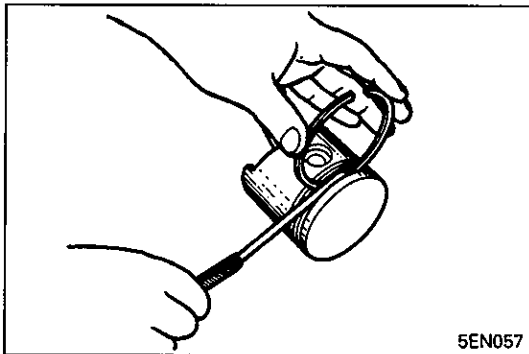
1. Nut
- ◀A▶ ▶D▶ 2. Connecting rod cap
- ▶C▶ 3. Connecting rod bearing
- ▶C▶ 4. Piston and connecting rod assembly
5. Connecting rod bearing
6. Bolt
- ▶B▶ 7. Piston ring No. 1
- ▶B▶ 8. Piston ring No. 2
- ▶B▶ 9. Oil ring
- ▶A▶ 10. Piston
- ▶A▶ 11. Snap ring
- ▶A▶ 12. Piston pin
- ▶A▶ 13. Connecting rod
14. Bushing



SERVICE POINT OF REMOVAL

◁A▷ REMOVAL OF CONNECTING ROD CAP

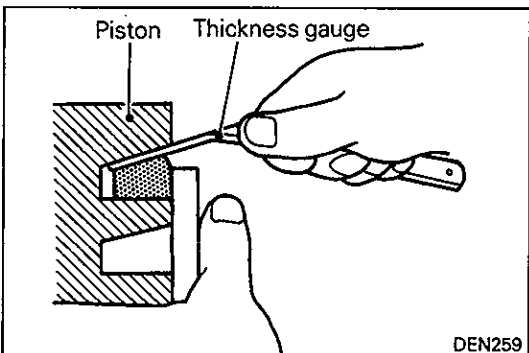
- (1) Mark the cylinder number on the side of the connecting rod big end for correct reassembly.



INSPECTION

PISTON RING

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



- (2) In case of keystone type, measure the ring to groove clearance as shown.

Without turbocharger

Standard value:

0.13 – 0.17 mm (0.0051 – 0.0067 in.)	No. 1
0.05 – 0.09 mm (0.0012 – 0.0028 in.)	No. 2*
0.03 – 0.07 mm (0.0012 – 0.0028 in.)	No. 2
0.02 – 0.07 mm (0.0008 – 0.0028 in.)	Oil

Limit:

0.20 mm (0.0079 in.)	No. 1
0.15 mm (0.0059 in.)	No. 2
0.10 mm (0.0039 in.)	Oil

*: Pistons with ring carrier

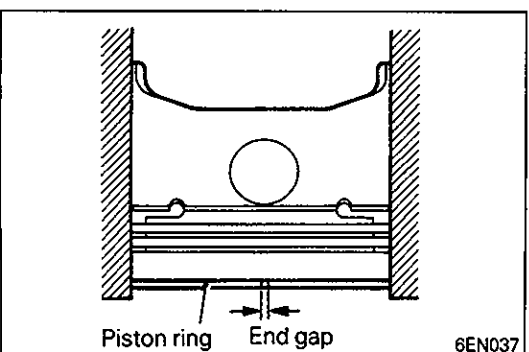
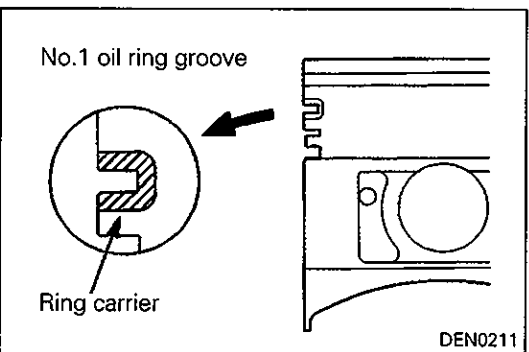
With turbocharger

Standard value:

0.06 – 0.08 mm (0.0022 – 0.0030 in.)	No. 1
0.05 – 0.07 mm (0.0020 – 0.0028 in.)	No. 2
0.02 – 0.07 mm (0.0008 – 0.0028 in.)	Oil

Limit:

0.15 mm (0.0059 in.)	No. 1
0.15 mm (0.0059 in.)	No. 2
0.10 mm (0.0039 in.)	Oil



- (3) Insert the piston ring into 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 excessive, replace piston ring.

Without turbocharger

Standard value:

0.25 – 0.40 mm (0.0098 – 0.0157 in.)	No. 1
0.25 – 0.45 mm (0.0098 – 0.0177 in.)	No. 2
0.25 – 0.45 mm (0.0098 – 0.0177 in.)	Oil

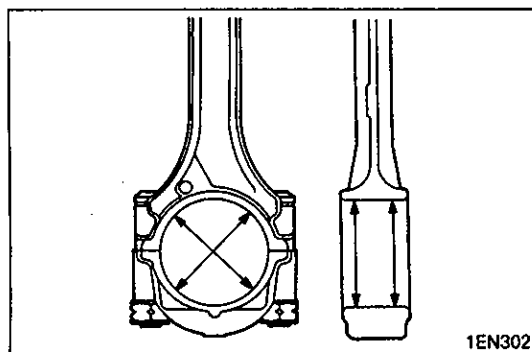
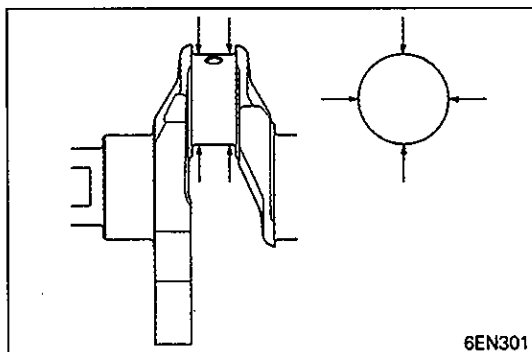
Limit: 0.8 mm (0.0315 in.)

With turbocharger**Standard value:**

0.35 – 0.50 mm (0.0138 – 0.020 in.)No. 1

0.25 – 0.40 mm (0.0098 – 0.0157 in.)No. 2

0.25 – 0.45 mm (0.0098 – 0.0177 in.)Oil

Limit: 0.8 mm (0.0315 in.)**CONNECTING ROD BEARING**

- (1) Visually check the bearing surface for uneven contact, streaks, scratches, and seizure. Replace if defects are evident. If streaks and seizure are excessive, check also the crankshaft. If damage is present on the crankshaft, replace crankshaft or regrind to undersize for reuse.

Caution

- **Do not attempt an undersize machining on crankshaft with special surface treatment. This type of crankshaft can be identified by its dull gray appearance.**

- (2) Measure the connecting rod bearing I.D. and crankshaft pin O.D. if the oil clearance exceeds the limit, replace bearing, and crankshaft if necessary.
Or, regrind the crankshaft to an undersize and replace bearing with an undersize one.

Standard value:

0.02 – 0.05 mm (0.0008 – 0.0020 in.)

Limit: 0.10 mm (0.0039 in.)**Crankshaft pin diameter:**

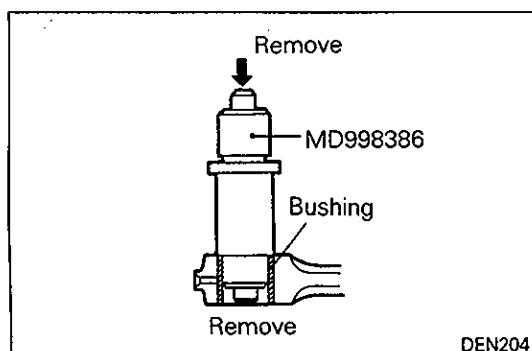
0,25 U.S. ...52.734 – 52.750 mm (2.0761 – 2.0768 in.)

0,50 U.S. ...52.484 – 52.500 mm (2.0662 – 2.0669 in.)

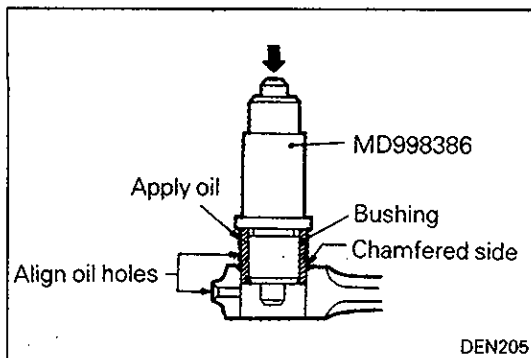
0,75 U.S. ...52.234 – 52.250 mm (2.0565 – 2.0571 in.)

NOTE

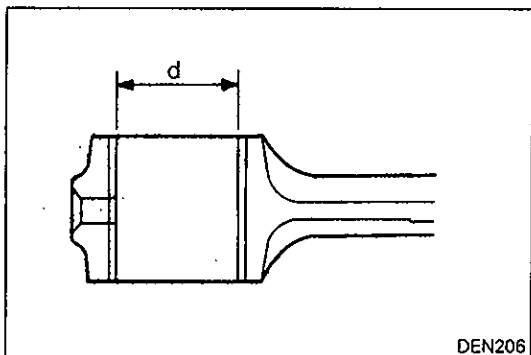
Refer to CRANKSHAFT for the measurement of oil clearance using a plastic gauge.

**CONNECTING ROD BUSHING REPLACEMENT PROCEDURE**

- (1) Using Connecting Rod Bushing Remover and Installer (special tool), remove the bushing.



- (2) Using the special tool, press-fit the bushing into position. At the time, make sure that the oil hole in the bushing is aligned with that in the connecting rod small end.



- (3) Machine the bushing I.D. to the standard value.

Bushing I.D. standard value:

29.015 - 29.025 mm (1.1423 - 1.1427 in.)

Big-to-small-end center parallelism:

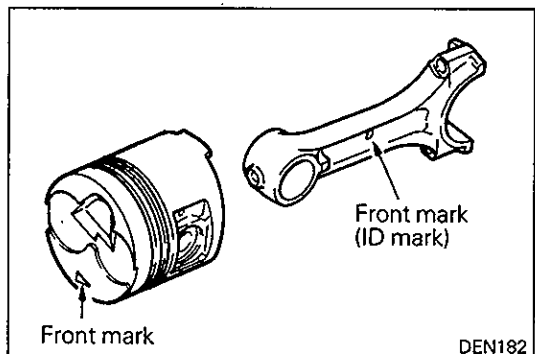
0.05 mm (0.002 in.)

Torsion: 0.1 mm (0.004 in.)

SERVICE POINTS OF INSTALLATION

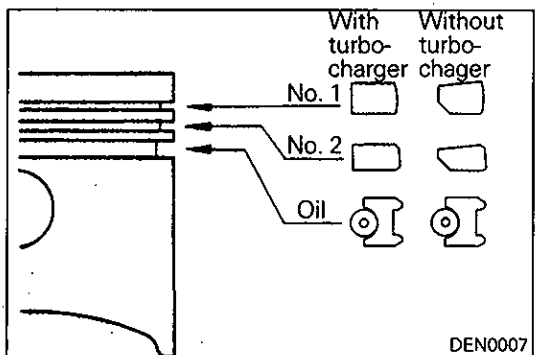
◆A◆ INSTALLATION OF CONNECTING ROD / PISTON PIN / PISTON

- (1) Mate the piston with the connecting rod.
- (2) Line up the front marks and insert the piston pin. The piston pin must be smoothly pressed by hand into position. Replace the piston pin if there is an excessive play.



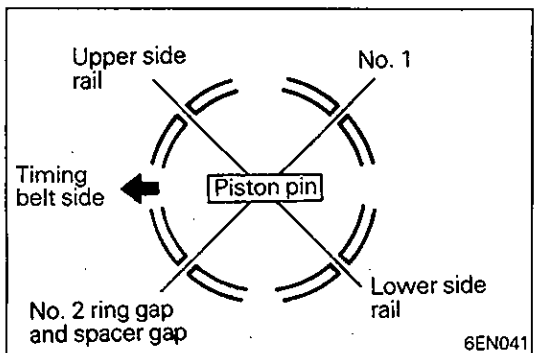
◆B◆ INSTALLATION OF PISTON RING NO. 1 / PISTON RING NO. 2 / OIL RING

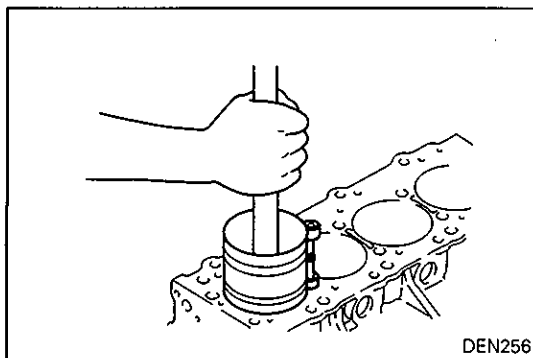
- (1) Install the oil ring expander and the oil ring in the piston.
- (2) Then, install the piston ring No. 2 followed by piston ring No. 1. Install the rings with their side having manufacturer's and size marks facing up (on the piston crown side).



◆C◆ INSTALLATION OF PISTON AND CONNECTING ROD ASSEMBLY

- (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 (side rail and spacer) as shown in the figure.
- (3) Rotate crankshaft so that crank pin is on center of cylinder bore.





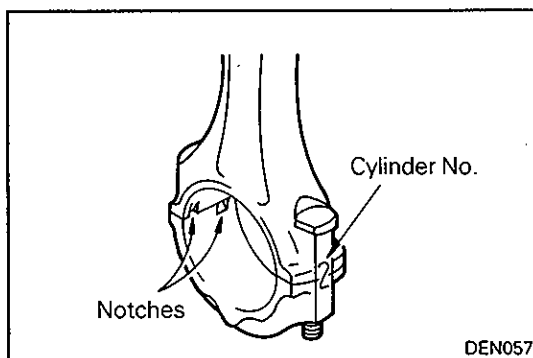
- (4) Use suitable thread protectors on connecting rod bolts before inserting piston and connecting rod assembly into cylinder block.

Care must be taken not to nick crank pin.

- (5) Using a suitable piston ring compressor tool, install piston and connecting rod assembly into cylinder block.

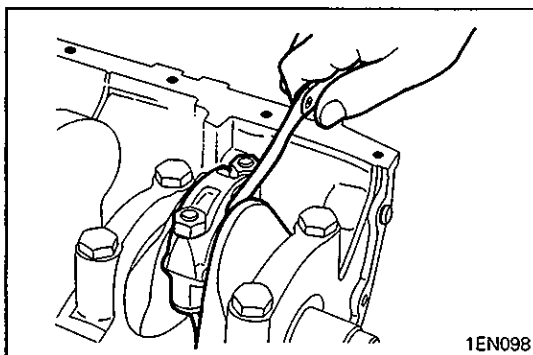
Caution

- Insert with the front mark (arrow) on the piston head directed toward the engine front (timing belt side).



◆D◆ INSTALLATION OF CONNECTING ROD CAP

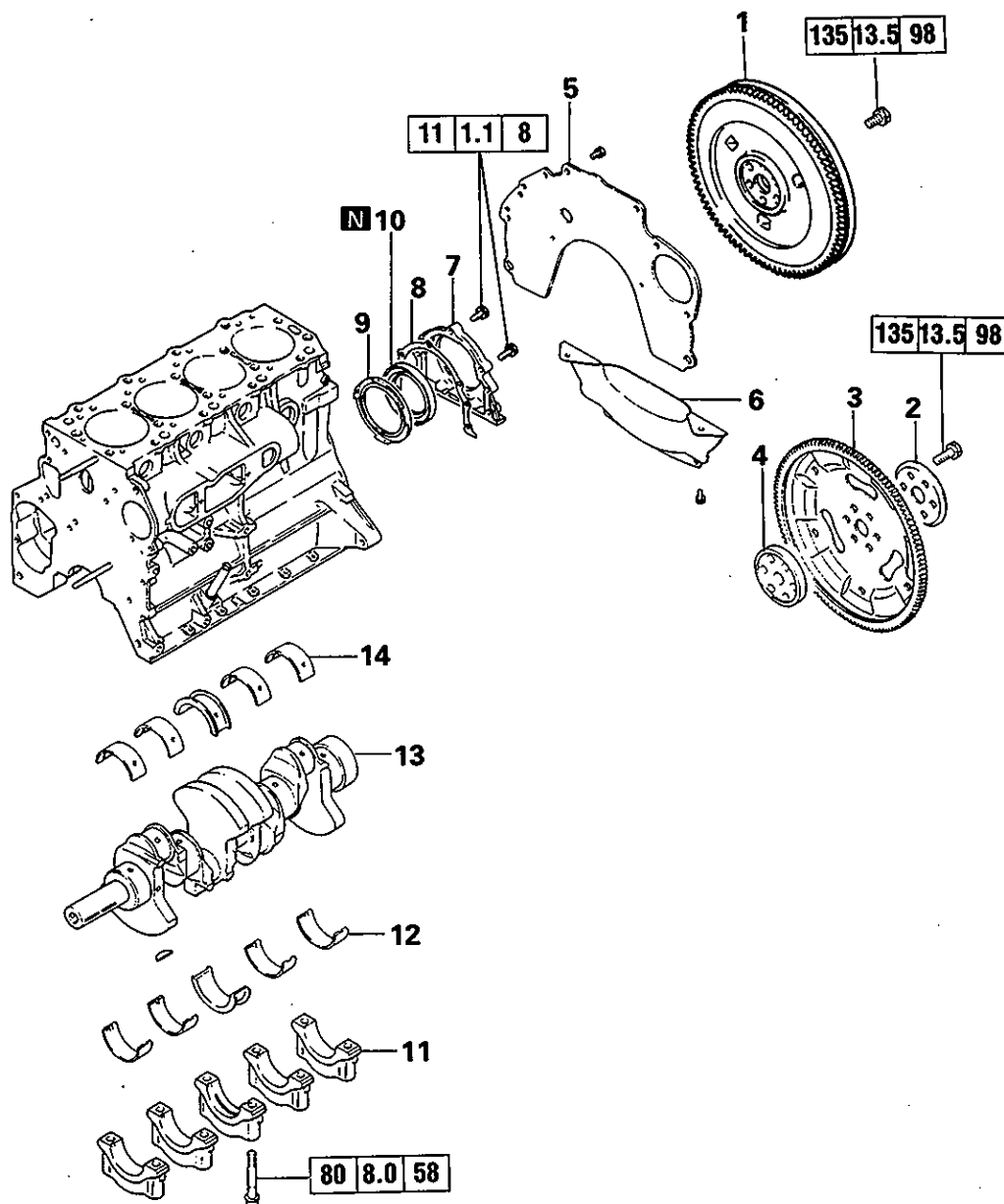
- (1) Verifying the mark made during disassembly, install the bearing cap to the connecting rod. If the connecting rod is new with no index mark, make sure that the bearing locking notches come on the same side as shown.



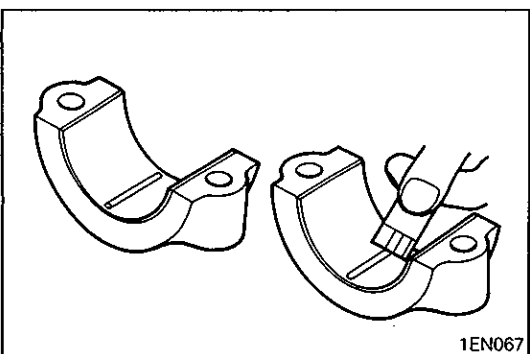
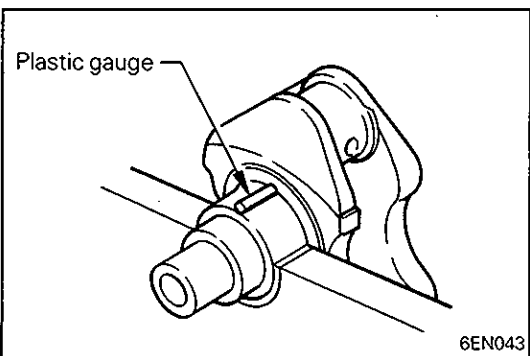
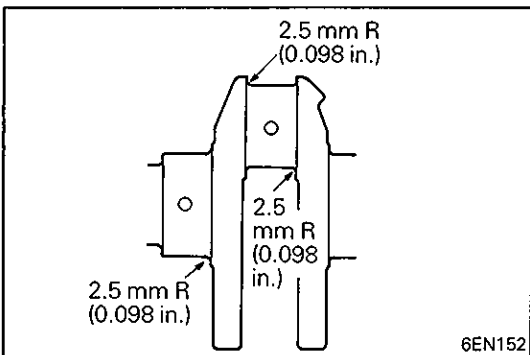
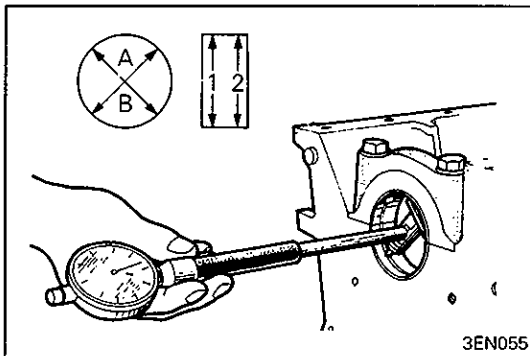
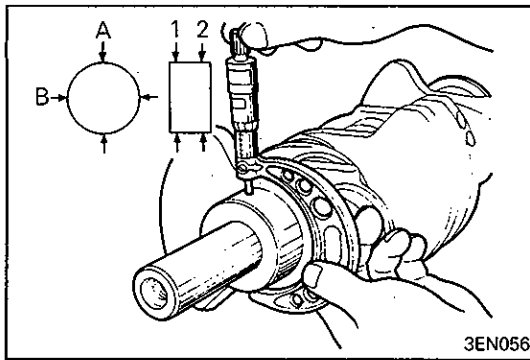
- (2) Make sure that connecting rod big end side clearance meets the specification.

Standard value: 0.10 – 0.25 mm (0.0039 – 0.0098 in.)
Limit: 0.4 mm (0.016 in.)

NOTES

11. CRANKSHAFT, FLYWHEEL AND DRIVE PLATE**REMOVAL AND INSTALLATION****Removal steps**

1. Flywheel assembly – For manual transmission
2. Adapter plate
3. Drive plate
4. Crankshaft adapter
5. Rear plate
6. Bell housing cover
7. Oil seal case
8. Gasket
9. Oil separator
10. Rear oil seal
11. Bearing cap
12. Crankshaft bearing (lower)
13. Crankshaft
14. Crankshaft bearing (upper)



INSPECTION

CRANKSHAFT

- (1) Measure the outside diameter of journal and inside diameter of crankshaft bearing. If the difference between them (oil clearance) exceeds the limit, replace the crankshaft bearing and, if necessary, crankshaft. When the crankshaft is to be reused by machining to undersize, the crankshaft bearings should be changed to undersized ones.

Standard value:

0.02 – 0.05 mm (0.0008 – 0.0020 in.)

Limit: 0.1 mm (0.0039 in.)

Caution

- Do not attempt an undersize machining on the crankshaft with special surface treatment which is used in engines with a turbocharger. This type of crankshaft can be identified by its dull gray appearance.

- (2) When the crankshaft is machined to undersize, finish the fillets of journals and pins to the specified radius.

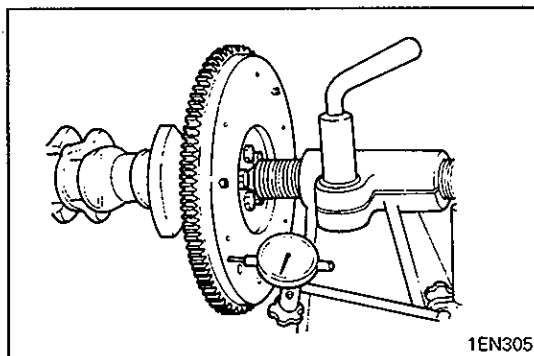
CRANKSHAFT OIL CLEARANCE (PLASTIC GAUGE METHOD)

The crankshaft oil clearance can be measured easily by using a plastic gauge, as follows:

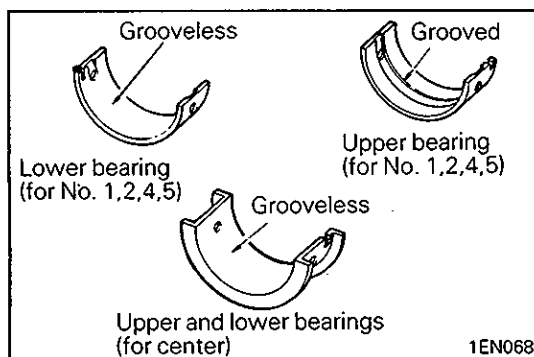
- (1) Remove oil and grease and any other foreign matters from crankshaft journal and bearing inner surface.
- (2) Install the crankshaft.
- (3) Cut the plastic gauge to the same length as the width of bearing and place it on journal in parallel with its axis.
- (4) Gently place the crankshaft bearing cap over it and tighten the bolts to the specified torque.
- (5) Remove the bolts and gently remove the crankshaft bearing cap.
- (6) Measure the width of the smashed plastic gauge at its widest section by using a scale printed on the plastic gauge bag.

CRANKSHAFT REAR OIL SEAL

- (1) Check oil seal lip for wear and damage.
- (2) Check rubber for deterioration or hardening.
- (3) Check oil seal case for cracks and damage.

**FLYWHEEL**

- (1) Check the runout of flywheel.
Limit: 0.13 mm (0.0051 in.)

**SERVICE POINTS OF INSTALLATION****◆A◆ INSTALLATION OF CRANKSHAFT BEARING (UPPER)**

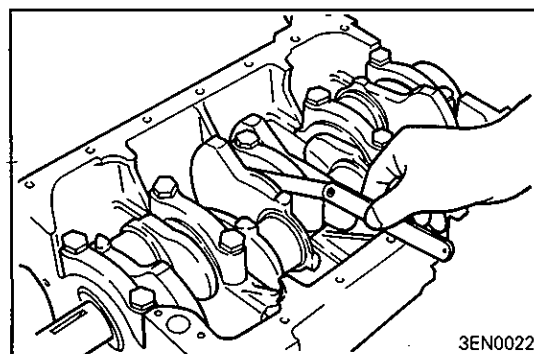
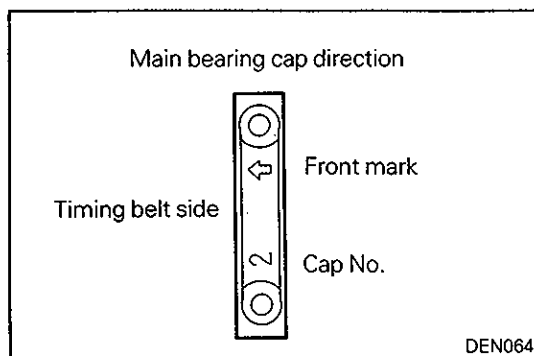
- (1) Install the upper crankshaft bearing to the cylinder block. There is an oil groove in the upper crankshaft bearing. There is no difference between upper and lower bearings for the center (with flange).

◆B◆ INSTALLATION OF CRANKSHAFT BEARING (LOWER)

- (1) Install the lower crankshaft bearing (with no oil groove; there is no difference for center) to each bearing cap and apply engine oil to bearing surfaces.

◆C◆ INSTALLATION OF BEARING CAP

- (1) Install according to the front mark and cap No.

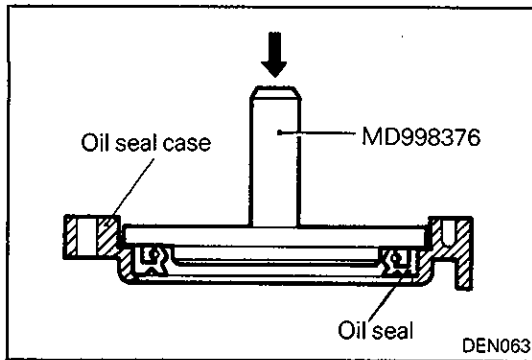
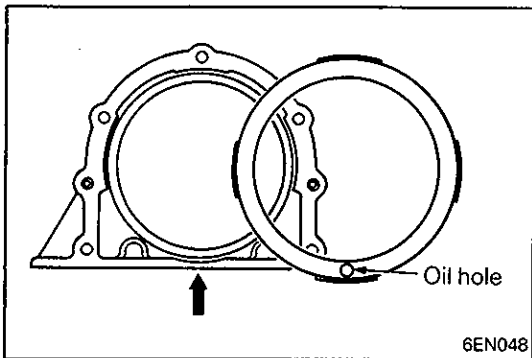


- (2) After installing the bearing caps, make sure that the crankshaft turns smoothly and the end play is correct. If the end play exceeds the limit, replace crankshaft bearings.

Standard value:

0.05 – 0.18 mm (0.0020 – 0.0071 in.)

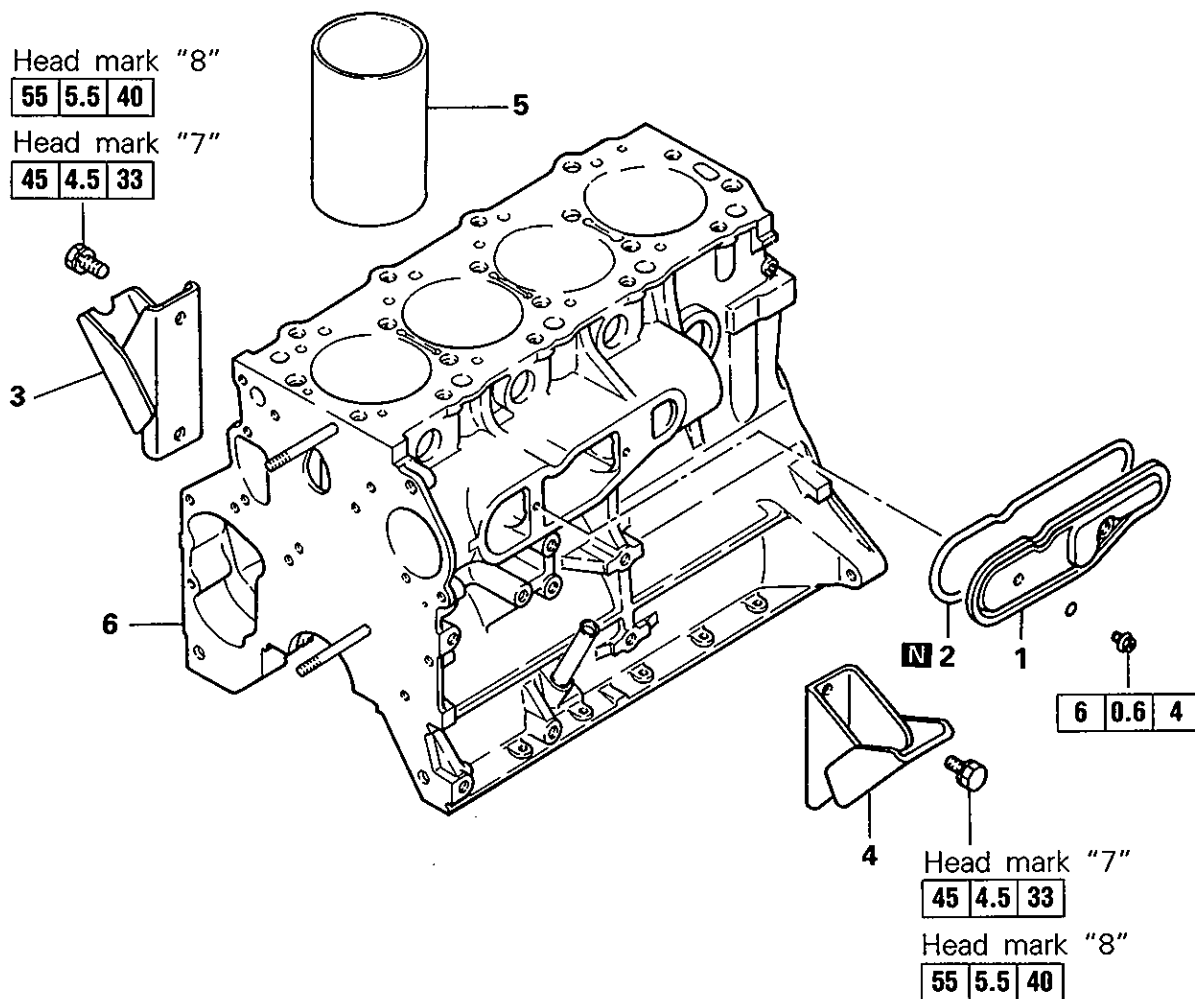
Limit: 0.25 mm (0.0098 in.)

**◆D◆ INSTALLATION OF OIL SEAL****◆E◆ INSTALLATION OF OIL SEPARATOR**

- (1) Push the oil separator into the oil seal case, with its oil hole at the case bottom (indicated by an arrow in illustration).

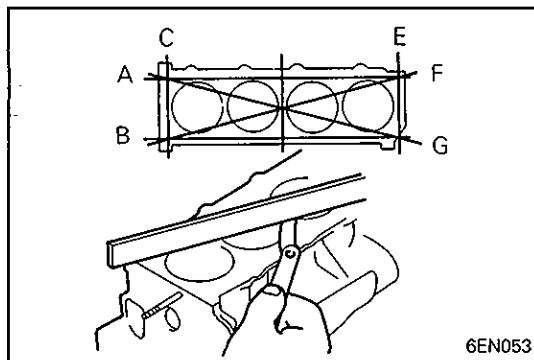
12. CYLINDER BLOCK

REMOVAL AND INSTALLATION



Removal steps

1. Cover
2. Packing
3. Engine bracket, right
4. Engine bracket, left
5. Cylinder sleeve
6. Cylinder block

**INSPECTION****CYLINDER BLOCK**

- (1) Using a straightedge and thickness gauge, check the block top surface for warpage. Make sure that the surface is free from gasket chips and other objects.

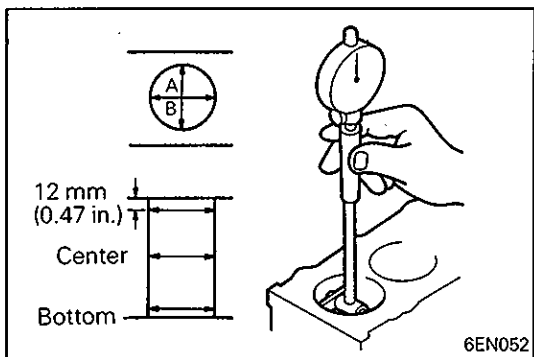
Standard value: 0.05 mm (0.0020 in.)

Limit: 0.1 mm (0.0039 in.)

- (2) If the distortion is excessive, correct within the allowable limit or replace.

Cylinder block height (when new):

318.45 – 318.55 mm (12.5374 – 12.5413 in.)

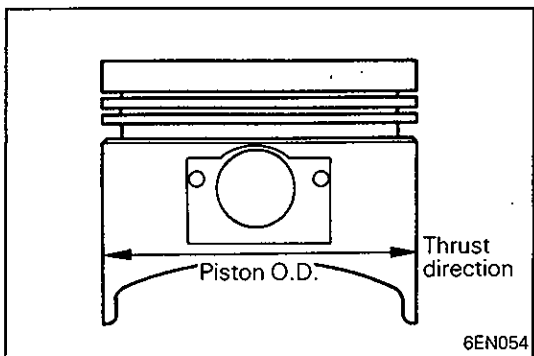


- (3) Check cylinder walls for scratches and seizure. If defects are evident, correct (bored to oversize) or replace.
- (4) Using cylinder gauge, measure the cylinder bore and cylindricity. If worn badly, correct cylinder to an oversize and replace piston and piston rings. Measurement points are shown in illustration.

Standard value:

Cylinder I.D.: 91.10 – 91.13 mm (3.5866 – 3.5878 in.)

Cylindricity: 0.015 mm (0.0006 in.)

**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
0.25 mm (0.01 in.) O.S.	0.25
0.50 mm (0.02 in.) O.S.	0.50
0.75 mm (0.03 in.) O.S.	0.75
1.00 mm (0.04 in.) O.S.	1.00

NOTE

Size mark is stamped on piston top.

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

**Boring finish dimension = Piston O.D. +
(clearance between piston O.D. and cylinder) –
0.02 mm (0.0008 in.) (honing margin)**

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

Caution

- To prevent distortion that may result from temperature rise during honing, bore cylinders, working from No. 2 to No. 4 to No. 1 to No. 3.

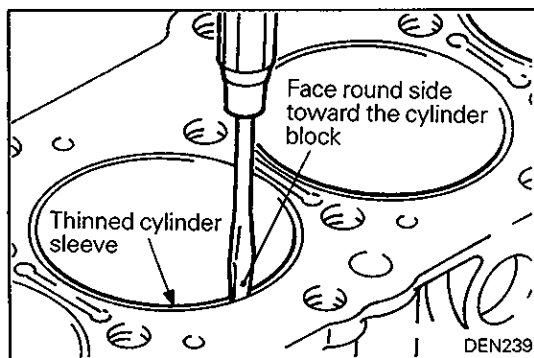
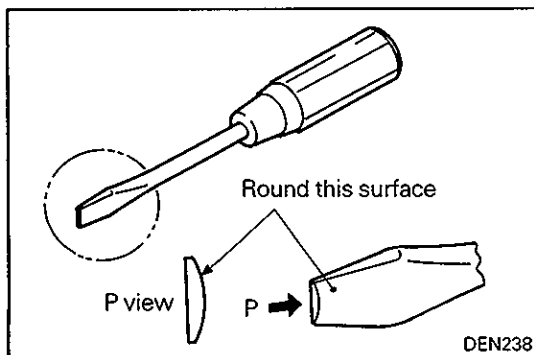
- (5) Hone to final finish dimension (piston O.D. + clearance between piston O.D. and cylinder).
 (6) Check clearance between piston and cylinder.

Clearance between piston and cylinder:

0.02 – 0.04 mm (0.00079 – 0.00157 in.)	Without turbocharger
0.04 – 0.06 mm (0.00157 – 0.00236 in.)	With turbocharger

NOTE

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



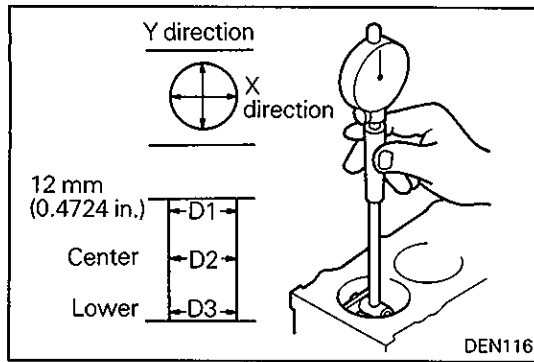
CYLINDER SLEEVE CHANGE PROCEDURES

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 (0.0197 in.).
- (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.
- (2) If there is damage, insufficient tightening allowance or other problems, bore the cylinder block sleeve hole to an oversize.

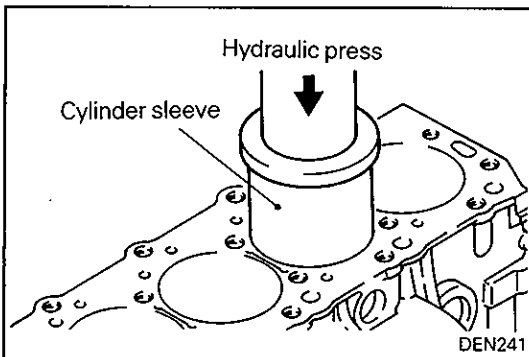


- (3) To measure the tightening allowance, measure both the cylinder sleeve O.D. and cylinder block sleeve hole I.D. at the position illustrated.

Measure D1, D2 and D3 in both X and Y directions and if the average is smaller than 0.12 mm (0.0047 in.), then bore the sleeve hole to 0.5 mm (0.0197 in.) oversize and install the oversize 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.

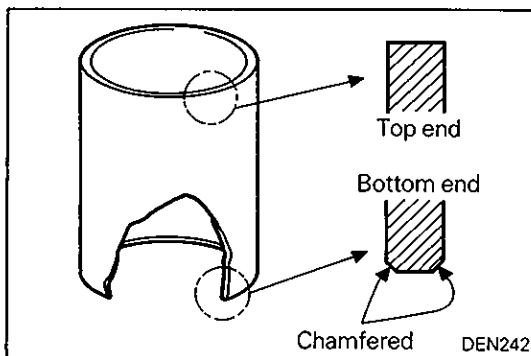


Installation

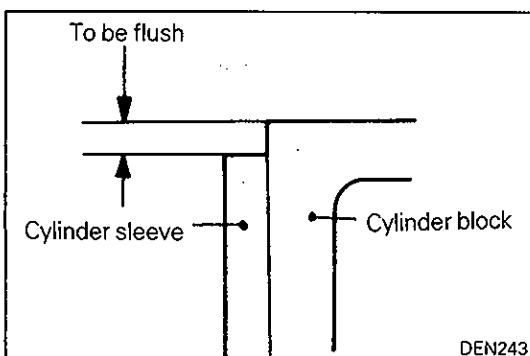
WHEN CYLINDER BLOCK SLEEVE HOLE HAS NOT BEEN BORED

- (1) Amply apply press oil to the cylinder block sleeve hole and sleeve outer circumference.
- (2) Apply a disc [diameter 100 mm (3.94 in.), thickness 20 mm (0.79 in.) or more] to the top of the sleeve and press fit using a hydraulic press.

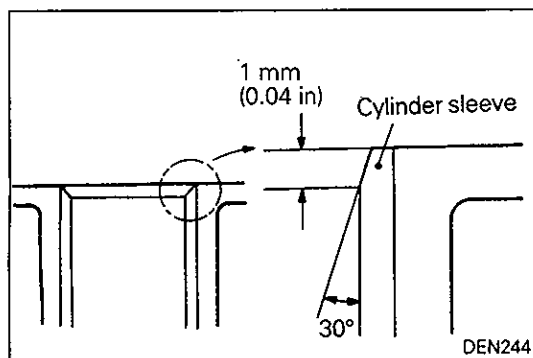
Installation load: 22,000 N (2,200 kg 4,850 lbs.) or more



- (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 (0.0079 in.).



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

- (6) The service cylinder sleeve has the I.D. machined to 89.9 to 90.1 mm (3.539 to 3.547 in.). After installation of the sleeve, therefore, hone the I.D. to the standard value.

Cylinder I.D.: 91.10 – 91.13 mm (3.5866 – 3.5878 in.)

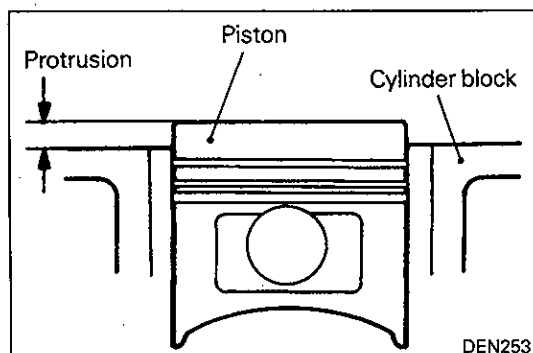
Honing finished surface roughness: 2 – 4 μ

Honing cross hatch angle: 15 – 25°

Cylinder bore squareness: 0.05 mm (0.0197 in.)

WHEN BORING THE CYLINDER BLOCK SLEEVE HOLE

- (1) Prepare a cylinder sleeve of 0.5 mm (0.0197 in.) oversize (identification color: red).
- (2) Hone the cylinder block sleeve hole to 94.025 to 94.050 mm (3.7018 to 3.7027 in.).
- (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 combination of piston, connecting rod and cylinder 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: 0.974 mm (0.0383 in.)

NOTES