

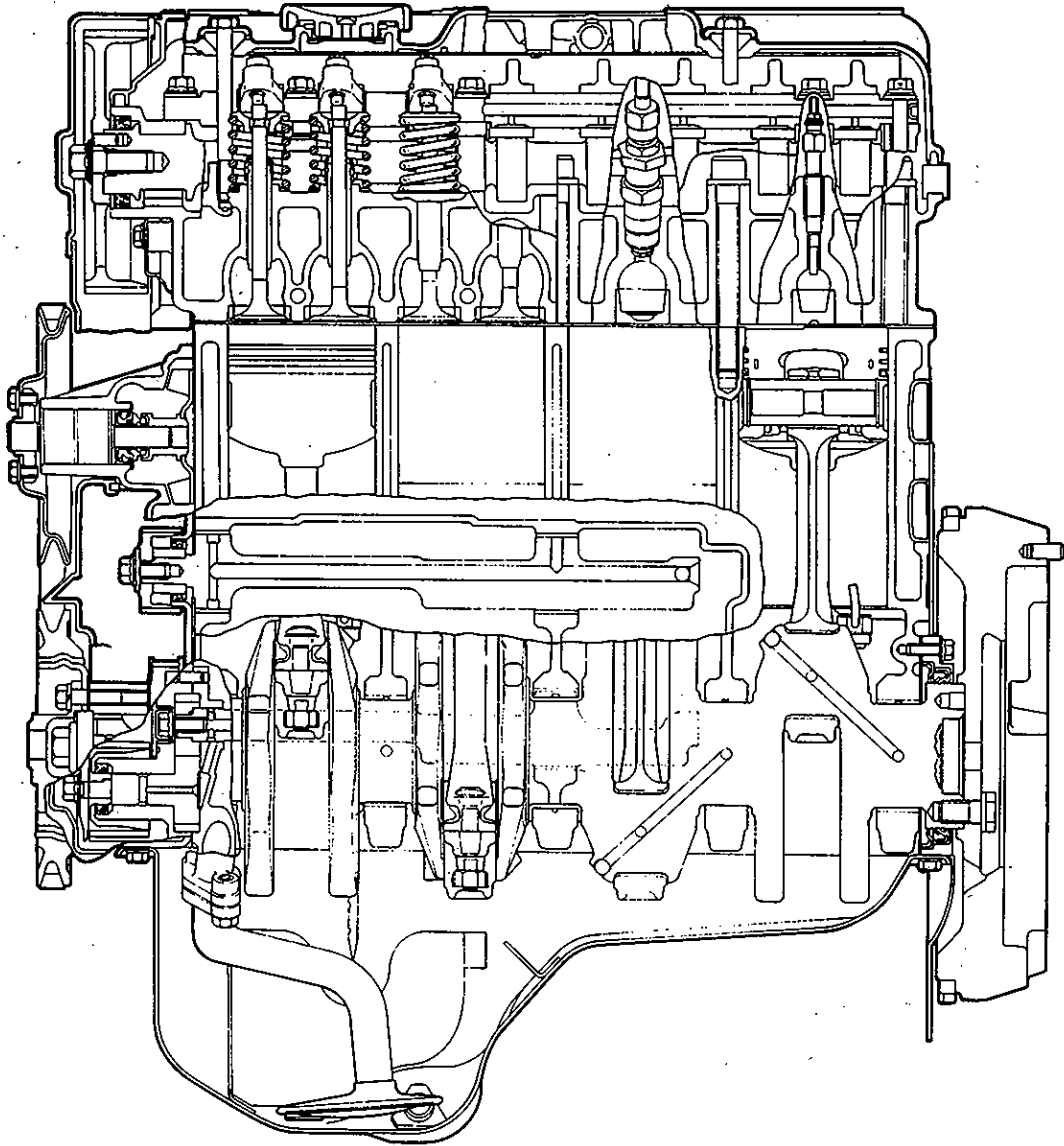
# ENGINE

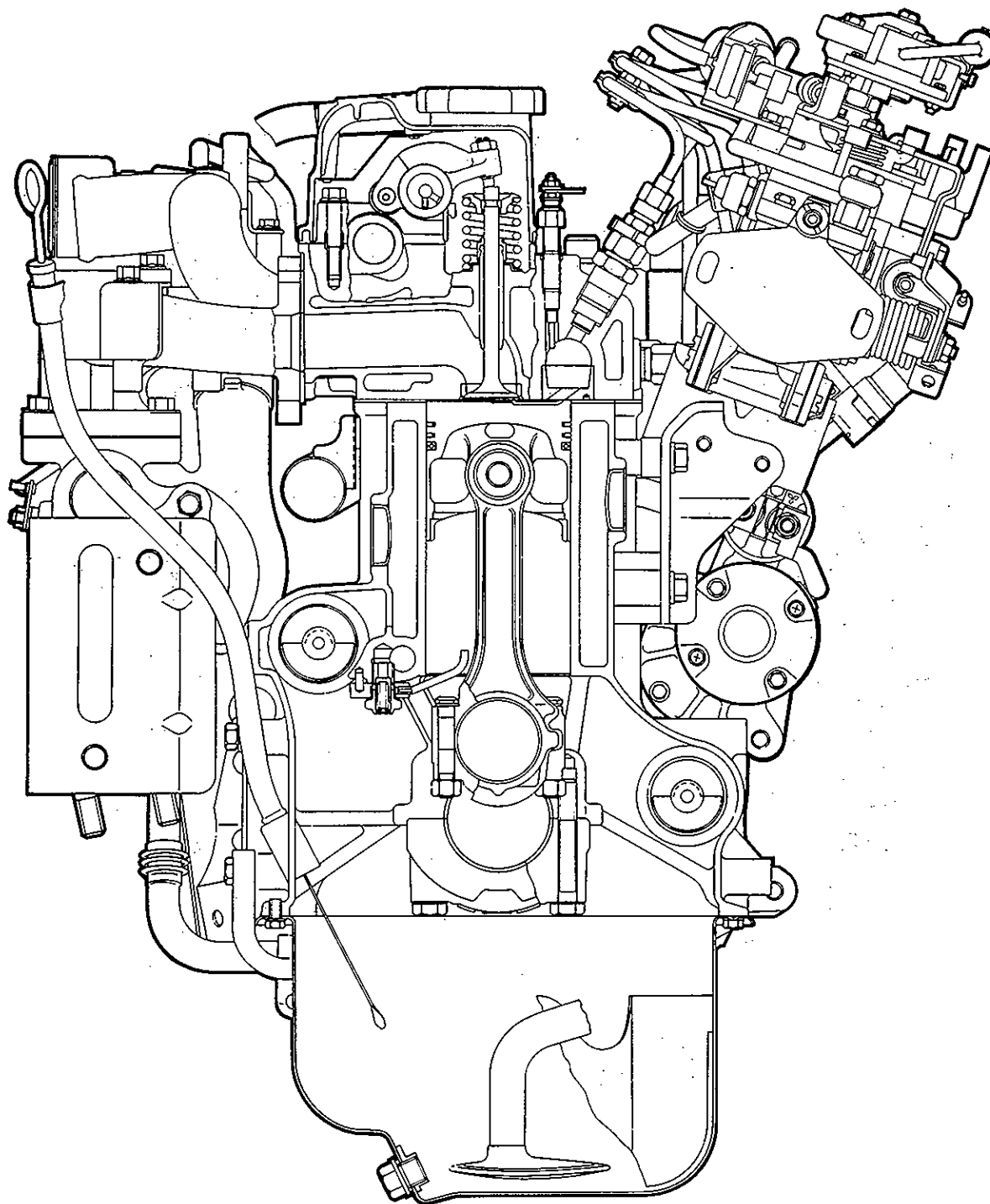
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## 4D65

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**GENERAL INFORMATION****ENGINE SECTIONAL VIEW**



DEN0698

This technical diagram illustrates the oil system of an engine. The main view shows the oil pump driven by the crankshaft, passing oil through a by-pass filter and a relief valve. The oil then travels through various passages to lubricate the cylinder walls, the rocker shaft assembly, and the camshaft. A vacuum pump and an oil pressure switch are also shown. An inset on the right provides a detailed view of the oil jet and its connection to the oil pump.

Labels in the diagram include:

- Rocker shaft
- Camshaft
- Silent shaft
- Oil pressure switch
- Vacuum pump
- By-pass filter
- Relief valve
- Oil pump
- Silent shaft
- Crankshaft
- Oil jet

PWEE9073

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## NOTES

# 1. SPECIFICATIONS

## GENERAL SPECIFICATIONS

Description	Specifications
<b>Type</b> .....	Diesel engine
<b>No. and arrangement of cylinders</b> .....	4 in-line, longitudinal
<b>Combustion chamber</b> .....	Swirl chamber
<b>Total displacement</b> .....	1,795 cc (109.5 cu.in.)
<b>Cylinder bore x stroke</b> .....	80.6 x 88.0 mm (3.173 x 3.465 in.)
<b>Compression ratio</b> .....	21.5
<b>Valve mechanism</b> .....	Single overhead camshaft
<b>Rocker arm</b> .....	Roller follower type
<b>Valve timing</b>	
Intake valve	
Open .....	20°BTDC
Close .....	48°ABDC
Exhaust valve	
Open .....	54°BBDC
Close .....	22°ATDC
<b>Lubrication system</b> .....	Pressure feed, full-flow filtration
<b>Oil pump type</b> .....	External gear type
<b>Turbocharger</b> .....	Air-cooled
<b>Cooling system</b> .....	Water-cooled, electric cooling fan
<b>Water pump type</b> .....	Centrifugal impeller type

## SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
<b>Cylinder head</b>		
Flatness of gasket surface .....	0.05 (0.0020) .....	*0.2 (0.008)
* Grinding is not allowed for correction.		
Flatness of manifold mounting surface .....	0.15 (0.0059) .....	0.3 (0.012)
Overall height .....	86.9 – 87.1 (3.421 – 3.429)	
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 .....	38.300 – 38.325 (1.5079 – 1.5089)	
0.60 .....	38.600 – 38.625 (1.5197 – 1.5207)	
Oversize rework dimensions of exhaust valve seat ring hole		
0.30 .....	34.300 – 34.325 (1.3504 – 1.3514)	
0.60 .....	34.600 – 34.625 (1.3622 – 1.3632)	
<b>Camshaft</b>		
Cam height		
Intake .....	41.83 (1.6468) .....	41.33 (1.6272)
Exhaust .....	41.83 (1.6468) .....	41.33 (1.6272)
Journal diameter .....	29.935 – 29.950 (1.1785 – 1.1791)	
Oil clearance .....	0.05 – 0.09 (0.0020 – 0.0035)	
<b>Rocker arm</b>		
I.D. ....	18.910 – 18.928 (0.7445 – 0.7452)	
Rocker arm-to-shaft clearance .....	0.01 – 0.05 (0.0004 – 0.0020)	
<b>Rocker shaft</b>		
O.D. ....	18.878 – 18.898 (0.7432 – 0.7440)	
Overall length .....	410 (16.14)	
<b>Valve</b>		
Overall length		
Intake .....	118.1 (4.650)	
Exhaust .....	117.85 (4.640)	
Stem diameter		
Intake .....	N/A: 7.960 – 7.975 (0.3134 – 0.3140) T/C & Taxi: 7.930 – 7.950 (0.3122 – 0.3130)	
Exhaust .....	7.930 – 7.950 (0.3122 – 0.3130)	
Face angle .....	45° – 45°30'	
Thickness of valve head (margin)		
Intake .....	1.5 (0.059) .....	0.7 (0.028)
Exhaust .....	1.5 (0.059) .....	0.7 (0.028)
Stem-to-guide clearance		
Intake .....	N/A: 0.03 – 0.06 (0.0012 – 0.0024) T/C & Taxi: 0.05 – 0.09 (0.0020 – 0.0035)	0.10 (0.0039)
Exhaust .....	0.05 – 0.09 (0.0020 – 0.0035)	0.15 (0.0059)

mm (in.)

	Standard	Limit
<b>Valve spring</b>		
Free height .....	49.1 (1.934) .....	48.1 (1.895)
Load/installed height .....	276 (27.6, 61)/40.4 (1.591)	
N (kg, lbs.)/mm (in.) .....		
Out-of squareness .....	2° or less .....	Max 4°
<b>Valve guide</b>		
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) over size	
Press-in temperature .....	Room temperature	
<b>Valve seat</b>		
Seat angle .....	45°	
Valve contact width .....	0.9 – 1.3 (0.035 – 0.051)	
Sinkage .....		0.2 (0.008)
Service size .....	0.30 (0.012), 0.60 (0.024) over size	
<b>Silent shaft</b>		
Journal diameter		
Right (front) .....	41.959 – 41.975 (1.6519 – 1.6526)	
(rear) .....	40.951 – 40.967 (1.6122 – 1.6129)	
Left (front) .....	18.467 – 18.480 (0.7270 – 0.7276)	
(rear) .....	40.951 – 40.967 (1.6122 – 1.6129)	
Oil clearance		
Right (front) .....	0.02 – 0.06 (0.0008 – 0.0024)	
(rear) .....	0.05 – 0.09 (0.0020 – 0.0036)	
Left (front) .....	0.02 – 0.05 (0.0008 – 0.0020)	
(rear) .....	0.05 – 0.09 (0.0020 – 0.0036)	
<b>Piston</b>		
O.D. ....	80.56 – 80.59 (3.1716 – 3.1728)	
Piston-to-cylinder clearance .....	0.03 – 0.05 (0.0012 – 0.0020)	
Ring groove width		
No. 1 ring .....	2.11 – 2.13 (0.0831 – 0.0839)	
No. 2 ring .....	N/A: 2.01 – 2.03 (0.0791 – 0.0799)	
	T/C & Taxi: 2.10 – 2.12 (0.0827 – 0.0835)	
Oil ring .....	4.01 – 4.04 (0.1579 – 0.1589)	
Service size .....	0.25 (0.010), 0.50 (0.020), 0.75 (0.030), 1.00 (0.039) over size	
<b>Piston ring</b>		
End gap		
No. 1 ring .....	0.35 – 0.50 (0.0138 – 0.0197) .....	0.8 (0.031)
No. 2 ring .....	0.25 – 0.40 (0.0098 – 0.0157) .....	0.8 (0.031)
Oil ring .....	0.25 – 0.45 (0.0098 – 0.0177) .....	0.8 (0.031)
Ring-to-ring groove clearance		
No. 1 ring .....	0.07 – 0.09 (0.0028 – 0.0035) .....	0.1 (0.004)
No. 2 ring .....	N/A: 0.02 – 0.06 (0.0008 – 0.0024) .....	0.1 (0.004)
	T/C & Taxi: 0.11 – 0.13 (0.0043 – 0.0051) ....	0.1 (0.004)
Oil ring .....	0.02 – 0.07 (0.0008 – 0.0028) .....	0.1 (0.004)
Service size .....	0.25 (0.010), 0.50 (0.020), 0.75 (0.030), 1.00 (0.039) over size	



mm (in.)

	Standard	Limit
<b>Piston pin</b>		
O.D. ....	24.994 – 25.000 (0.9840 – 0.9843)	
<b>Connecting rod</b>		
Big end center-to-small end center length .....	150 (5.91)	
Bend .....	0.03 (0.0012)	
Twist .....	0.03 (0.0012)	
Big end side clearance .....	0.10 – 0.25 (0.0039 – 0.0098)	0.4 (0.0157)
<b>Crankshaft</b>		
End play .....	0.05 – 0.18 (0.0020 – 0.0071)	0.25 (0.0098)
Journal O.D. ....	57 (2.24)	
Pin O.D. ....	45 (1.77)	
Out-of-roundness and taper of journal and pin .....	0.005 (0.0002)	
Concentricity of journal .....	0.015 (0.0006)	
Oil clearance of journal .....	0.02 – 0.05 (0.0008 – 0.0020)	0.1 (0.004)
Oil clearance of pin .....	0.02 – 0.05 (0.0008 – 0.0020)	0.1 (0.004)
Journal		
0.25 U.S. ....	56.735 – 56.750 (2.2337 – 2.2342)	
0.50 U.S. ....	56.485 – 56.500 (2.2238 – 2.2244)	
0.75 U.S. ....	56.235 – 56.250 (2.2140 – 2.2146)	
Pin		
0.25 U.S. ....	44.735 – 44.750 (1.7612 – 1.7618)	
0.50 U.S. ....	44.485 – 44.500 (1.7514 – 1.7520)	
0.75 U.S. ....	44.235 – 44.250 (1.7415 – 1.7421)	
<b>Cylinder block</b>		
Cylinder I.D. ....	80.60 – 80.63 (3.1732 – 3.1744)	
Flatness of gasket surface .....	0.05 (0.002)	*0.1 (0.004)
* Grinding is not allowed for correction.		
Overall height .....	289.95 – 290.05 (11.4153 – 11.4193)	
<b>Flywheel</b>		
Runout .....		0.13 (0.0051)
<b>Oil pump</b>		
Side clearance		
Drive gear .....	0.08 – 0.14 (0.0031 – 0.0055)	
Driven gear .....	0.06 – 0.12 (0.0024 – 0.0047)	
<b>Drive belt</b>		
Deflection .....	7 – 10 (0.28 – 0.39)	
<b>Thermostat</b>		
Identification mark "82"		
Initial opening temperature .....	82°C (179°F)	
Fully opened temperature .....	95°C (203°F)	
Lift .....	8 (0.32) or more	

## NOTE

O.D.: Outer Diameter

I.D.: Inner Diameter

U.S.: Undersize Diameter

mm (in.)

	Standard	Limit
<b>Coolant temperature gauge unit</b>		
Resistance		
Coolant temperature gauge element .....	90.5 – 117.5 $\Omega$ / 70°C (158°F)	
	21.3 – 26.3 $\Omega$ / 115 °C (239°F)	
Glow control element .....	22.3 – 27.3 k $\Omega$ / –20°C (–4°F)	
	2.92 – 3.58 k $\Omega$ / 20°C (68°F)	

**TORQUE SPECIFICATIONS**

	Nm	kgm	Torque ft.lbs.
<b>Drive belt and timing belt</b>			
Water pump pulley bolt .....	9	0.9	7
Crankshaft pulley bolt .....	25	2.5	18
Timing belt tensioner bolt .....	49	4.9	35
Tensioner spacer bolt .....	14	1.4	11
Timing belt idler bolt .....	49	4.9	35
Camshaft sprocket bolt .....	90	9.0	65
Injection pump sprocket nut .....	85	8.5	61
Crankshaft sprocket bolt .....	120	12.0	87
Oil pump sprocket nut .....	55	5.5	40
Silent shaft sprocket bolt .....	37	3.7	27
Timing belt "B" tensioner bolt .....	19	1.9	14
<b>Intake and exhaust manifolds</b>			
Intake manifold bracket "A" and "B" .....	14	1.4	10
Intake manifold "A" bolt .....	14	1.4	10
Intake manifold "B" bolt and nut .....	18	1.8	13
Heat protector bolt .....	14	1.4	10
Exhaust manifold nut			
Engine without turbocharger .....	18	1.8	13
Engine with turbocharger .....	28	2.8	20
Eye bolt .....	17	1.7	12
Intake manifold bolt and nut .....	18	1.8	13
Heat protector "A" bolt .....	15	1.5	11
Heat protector "B" and "C" mounting bolt .....	14	1.4	10
Exhaust fitting bolt and nut .....	60	6.0	43
Turbocharger bolt .....	60	6.0	43
Oil return pipe bolt .....	9	0.9	7
Relief valve .....	48	4.8	35
<b>Turbocharger</b>			
Waste gate actuator bolt .....	12	1.2	9
Coupling bolt .....	5	0.5	4

	Nm	kgm	Torque ft.lbs.
<b>Water pump, thermostat, hose and pipe</b>			
Water pump bolt			
M8 x 20, M8 x 30 .....	14	1.4	10
M8 x 65 .....	24	2.4	17
Water outlet fitting bolt .....	19	1.9	14
Thermostat case bolt .....	14	1.4	10
Coolant temperature gauge unit .....	35	3.5	25
Alternator brace bolt .....	14	1.4	10
Alternator support nut .....	23	2.3	17
<b>Rocker arm, rocker shaft and camshaft</b>			
Rocker cover bolt .....	6	0.6	4
Rocker shaft bolt .....	30	3.0	22
Camshaft bearing cap bolt .....	20	2.0	14
Rocker arm adjusting screw nut .....	15	1.5	11
<b>Cylinder head, valves and valve spring</b>			
Cylinder head bolt .....	110	11.0	80
<b>Front case, silent shaft and oil pan</b>			
Oil drain plug .....	40	4.0	29
Oil pan bolt .....	7	0.7	5
Oil screen bolt .....	19	1.9	14
Plug .....	24	2.4	17
Left silent shaft flange bolt .....	37	3.7	27
Oil filter bracket bolt .....	19	1.9	14
Front case bolt			
8 mm diameter bolt .....	24	2.4	17
10 mm diameter bolt .....	31	3.1	22
Check valve .....	33	3.3	24
Oil cooler by-pass valve .....	55	5.5	40
Relief plug .....	45	4.5	33
Oil pressure switch .....	10	1.0	7
Oil pump cover bolt .....	17	1.7	12
<b>Piston and connecting rod</b>			
Connecting rod cap nut .....	52	5.2	38
<b>Crankshaft, flywheel and drive plate</b>			
Flywheel bolt .....	135	13.5	98
Drive plate bolt .....	135	13.5	98
Oil seal case bolt .....	11	1.1	8
Bearing cap bolt .....	68	6.8	49
<b>Cylinder block</b>			
Front roll stopper bracket bolt .....	65	6.5	47
Front engine support bracket bolt .....	60	6.0	40
Left engine support bracket bolt .....	36	3.6	26
Rear roll stopper bracket bolt .....	120	12.0	87

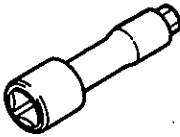
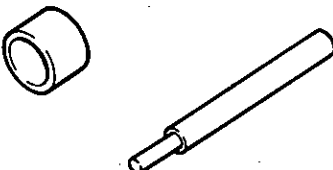
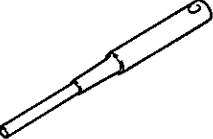




**SEALANT**

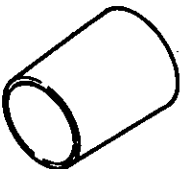

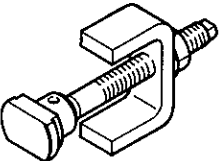
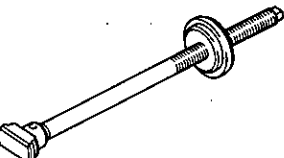
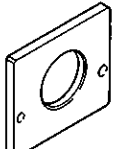

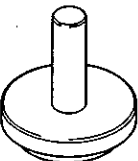
	Specified sealant	Quantity
Semi-circular packing .....	3M ATD Part No. 8660 or equivalent .....	As required
Oil pan gasket .....	MITSUBISHI GENUINE Part No. MD997110 .....	As required
	or equivalent	
Oil pressure switch .....	3M ATD Part No. 8660 or equivalent .....	As required
Coolant temperature gauge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

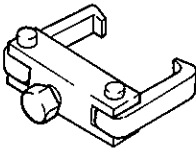
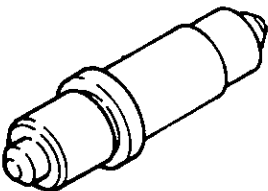
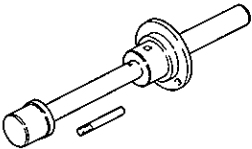
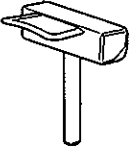
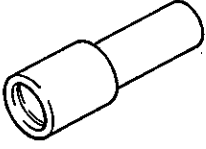
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## NOTES

## 2. SPECIAL TOOLS

Tool	Number	Name	Use
	MD998051	Cylinder head bolt wrench	Removal and installation of cylinder head bolts
	MD998115	Valve guide installer	Removal and installation of valve guide
	MD998148	Valve seat cutter pilot	Correction of valve seat
	MD998158 (intake) MD998159 (exhaust)	Valve seat cutter 45°	Correction of valve seat
	MD998162	Plug wrench	Removal and installation of front case cap plug
	MD998165	Valve seat cutter 65°	Correction of valve seat
	MD998173 (exhaust) MD998175 (intake)	Valve seat cutter 30°	Correction of valve seat

Tool	Number	Name	Use
	MD998285	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal
	MD998364	Camshaft oil seal installer	Installation of camshaft oil seal
	MD998371	Silent shaft bearing puller	Removal of silent shaft front bearing
	MD998372	Silent shaft bearing puller	Removal of silent shaft rear bearing
	MD998374	Bearing installer stopper	A guide for removal and installation of silent shaft left rear bearing
	MD998375	Crankshaft front oil seal installer	Installation of crankshaft front oil seal
	MD998376	Crankshaft rear oil seal installer	Installation of crankshaft rear oil seal

Tool	Number	Name	Use
	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 silent shaft bearing
	MD998727	Oil pan sealer cutter	Removal of oil pan
	MD998729	Valve stem seal installer	Installation of valve stem seal

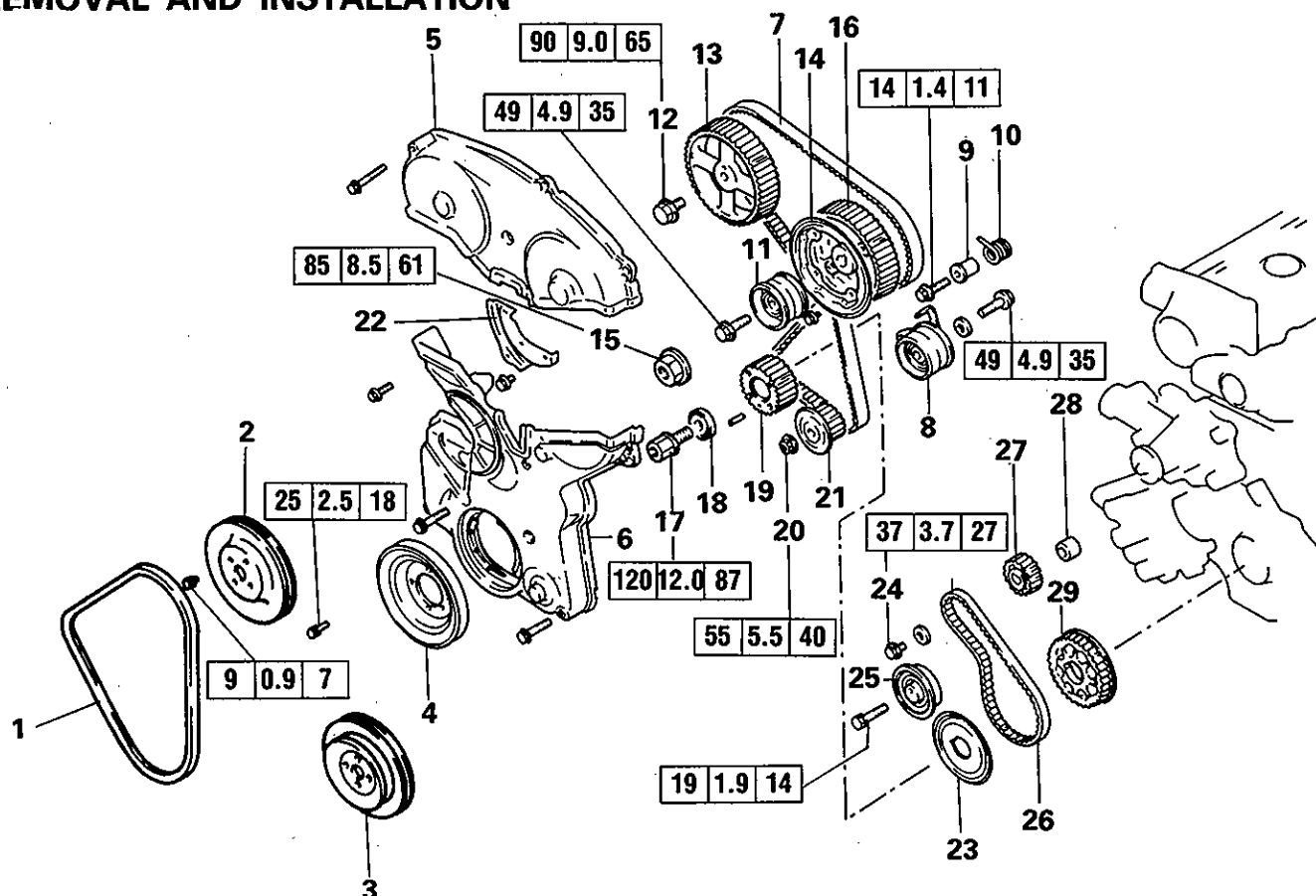


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## NOTES

## 3. DRIVE BELT AND TIMING BELT

## REMOVAL AND INSTALLATION

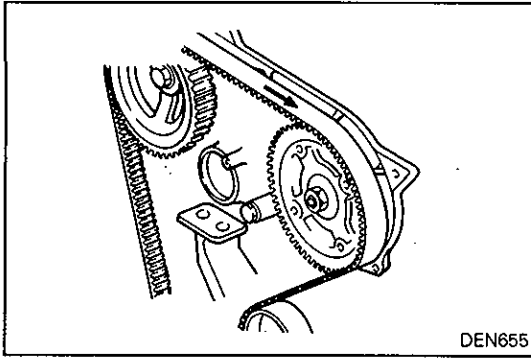


## Removal steps

1. Drive belt (V type belt)
2. Water pump pulley
3. Water pump pulley (with power steering pump drive pulley)
4. Crankshaft pulley
5. Timing belt upper cover
6. Timing belt lower cover
7. Timing belt
8. Timing belt tensioner
9. Tensioner spacer
10. Tensioner spring
11. Timing belt idler
12. Camshaft sprocket bolt
13. Camshaft sprocket
14. Flange
15. Injection pump sprocket nut
16. Injection pump sprocket
17. Bolt
18. Special washer
19. Crankshaft sprocket
20. Flange nut
21. Oil pump sprocket
22. Cover
23. Flange
24. Bolt
25. Tensioner "B"
26. Timing belt "B"
27. Silent shaft sprocket
28. Spacer
29. Crankshaft sprocket "B"

## Installation step

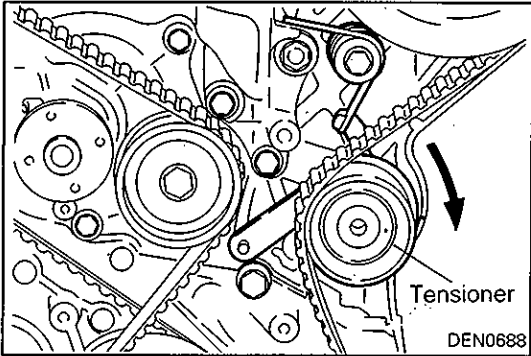
29. Crankshaft sprocket "B"
- ➡A➡ 28. Spacer
- ➡A➡ 27. Silent shaft sprocket
- ➡B➡ 25. Tensioner "B"
- ➡B➡ 26. Timing belt "B"
- ➡C➡ 24. Bolt
- ➡C➡ 23. Flange
- ➡C➡ 22. Cover
- ➡D➡ 21. Oil pump sprocket
- ➡D➡ 20. Flange nut
- ➡C➡ 19. Crankshaft sprocket
- ➡C➡ 18. Special washer
- ➡C➡ 17. Bolt
- ➡C➡ 16. Injection pump sprocket
- ➡C➡ 15. Injection pump sprocket nut
- ➡C➡ 14. Flange
- ➡C➡ 13. Camshaft sprocket
- ➡C➡ 12. Camshaft sprocket bolt
- ➡C➡ 11. Timing belt idler
- ➡C➡ 10. Tensioner spring
- ➡C➡ 9. Tensioner spacer
- ➡E➡ 8. Timing belt tensioner
- ➡F➡ 7. Timing belt
- ➡F➡ 6. Timing belt lower cover
- ➡F➡ 5. Timing belt upper cover
- ➡F➡ 4. Crankshaft pulley
- ➡F➡ 3. Water pump pulley (with power steering pump drive pulley)
- ➡F➡ 2. Water pump pulley
- ➡G➡ 1. Drive belt (V type 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) With the timing belt tensioner pushed down, tighten the tensioner mounting bolt temporarily to hold the tensioner in place.
- (3) Remove the timing belt.

#### NOTE

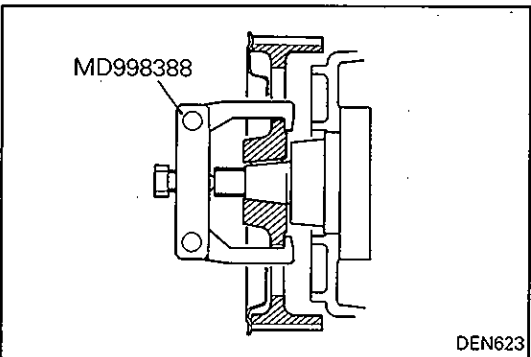
- (1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
- (2) If there is oil or water on any part, check front case oil seals, camshaft oil seal and water pump for leaks.

### ◊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.**

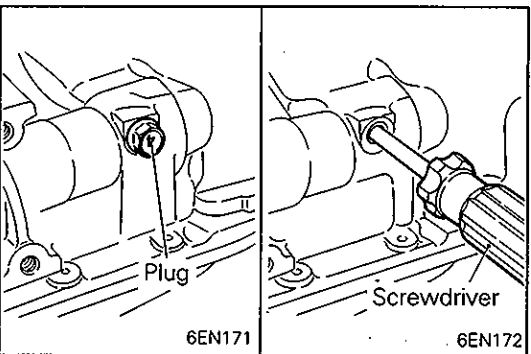


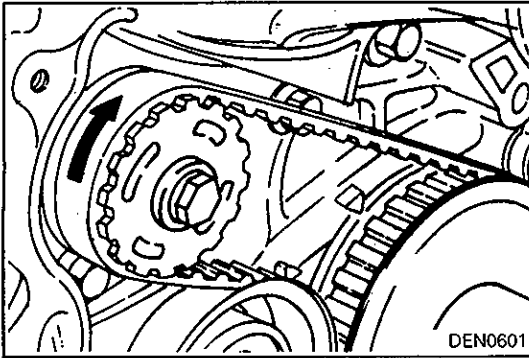
### ◊C◊ REMOVAL OF FLANGE NUT

- (1) Before loosening the oil pump sprocket nut (flange nut), remove the timing belt and then the plug at the left side of cylinder block and insert a Phillips screwdriver [shank diameter 8 mm (0.31 in.)] through the plug hole to keep the left silent 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 cogs of belt.**





### ◊D◊ 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

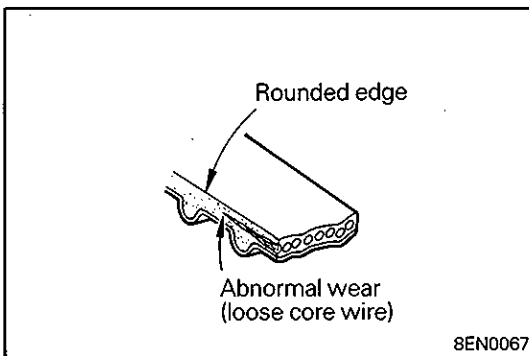
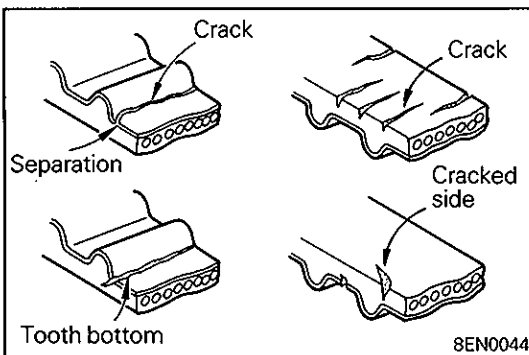
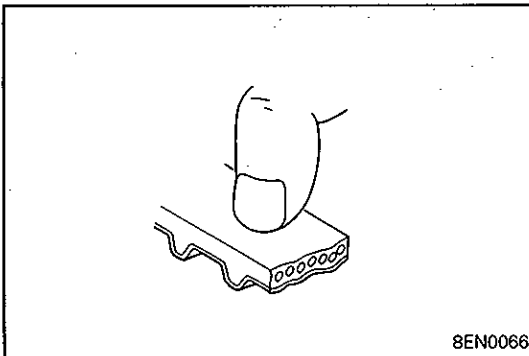
- (1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
- (2) If there is oil or water on any part, check front case oil seals, camshaft oil seal and water pump for leaks.

## INSPECTION

### TIMING BELTS

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

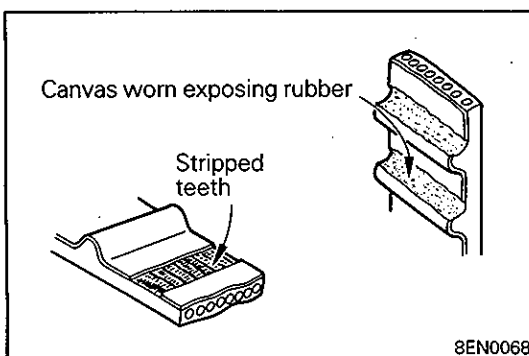
- (1) Hardened back surface rubber  
Glossy, non-elastic, and so hard that no mark is produced even when scratched by fingernails.
- (2) Cracked back surface rubber
- (3) Cracked or separated canvas
- (4) Cracked tooth bottom
- (5) Cracked side



- (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

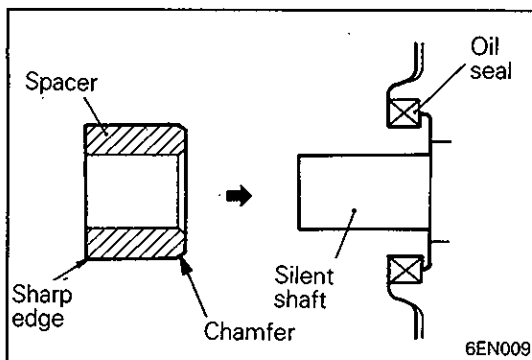
#### Initial stage:

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

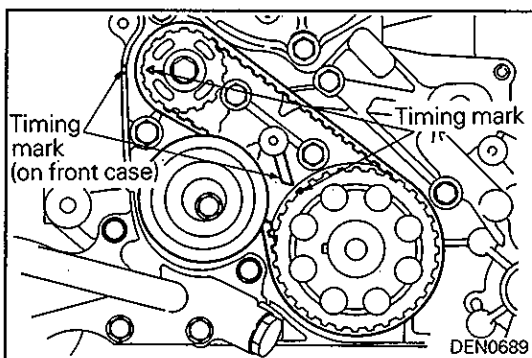
#### Final stage:

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

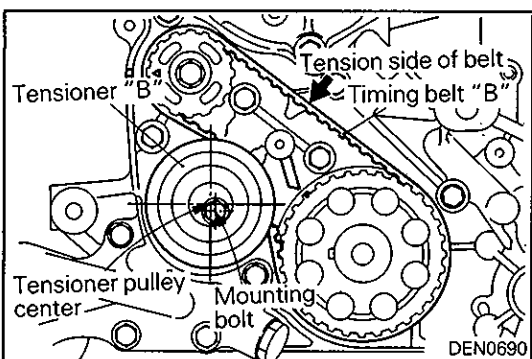
- (8) Missing tooth

**SERVICE POINTS OF INSTALLATION****◆A◆ INSTALLATION OF SPACER**

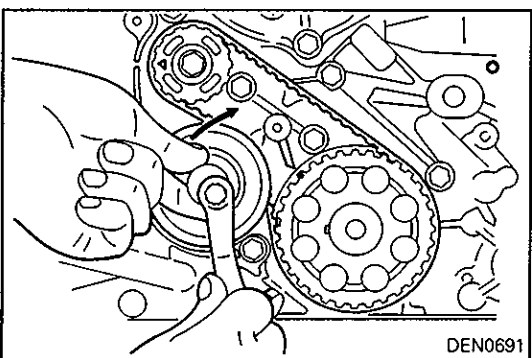
- (1) Install the spacer with the chamfered end forward the oil seal.

**◆B◆ INSTALLATION OF TIMING BELT "B"**

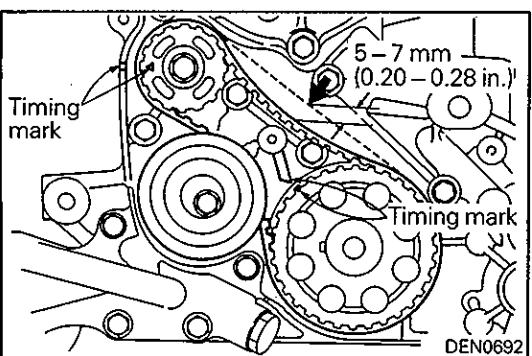
- (1) Align timing marks on the crankshaft sprocket "B" and silent shaft sprocket with the marks on the front case respectively.
- (2) Install the timing belt "B" on the crankshaft sprocket "B" and silent shaft sprocket. There should be no slack on the tension side.



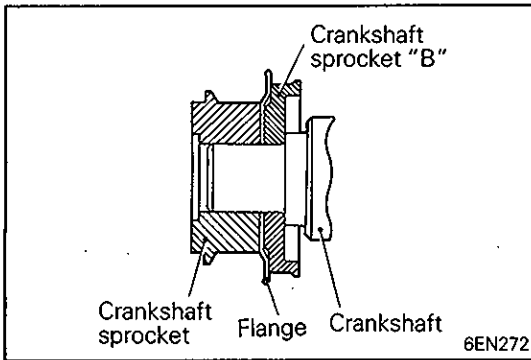
- (3) Make sure that the pulley center and the bolt center are located as shown in the illustration.



- (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 timing belt. In this condition, tighten bolt to secure tensioner "B". When bolt is tightened, use care to prevent shaft from turning together. If shaft is turned together, belt will be overtensioned.

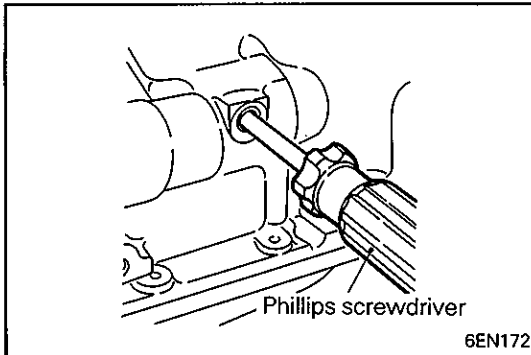


- (5) Check to ensure that timing marks on sprockets and front case are in alignment.
- (6) Press with index finger the center of span on tension side of timing belt "B". The bolt must deflect 5 to 7 mm (0.20 to 0.28 in.)



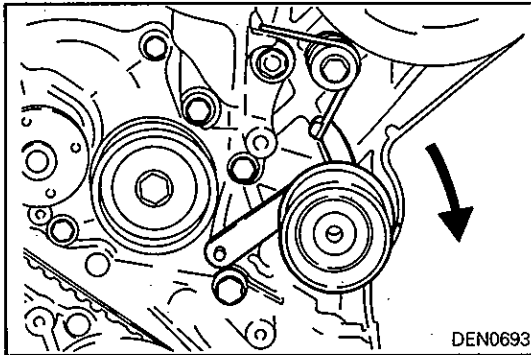
#### ◆C◆ INSTALLATION OF FLANGE AND CRANKSHAFT SPROCKET

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



#### ◆D◆ INSTALLATION OF FLANGE NUT

- (1) Before tightening the flange nut, block the silent shaft in the same way as when it was loosened.

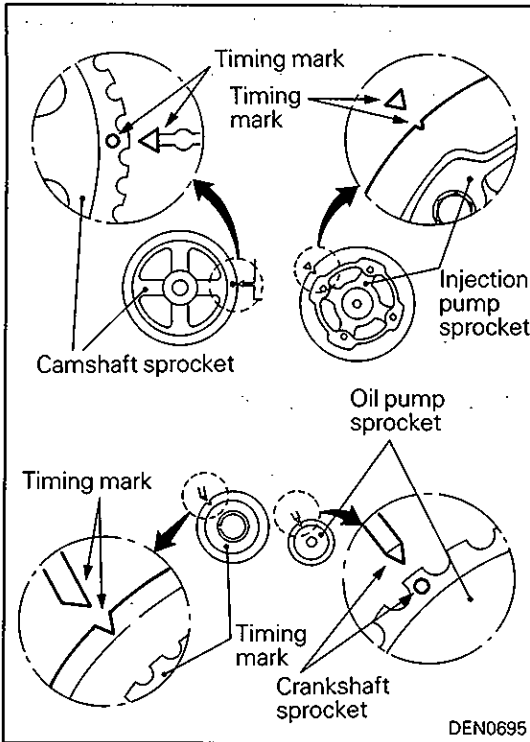


#### ◆E◆ INSTALLATION OF TIMING BELT TENSIONER

- (1) Hook the tensioner spring ends to the engine support bracket projection and tensioner bracket.
- (2) With the timing belt tensioner pushed down, temporarily tighten the tensioner mounting bolt to hold the tensioner in place.

#### ◆F◆ INSTALLATION OF TIMING BELT

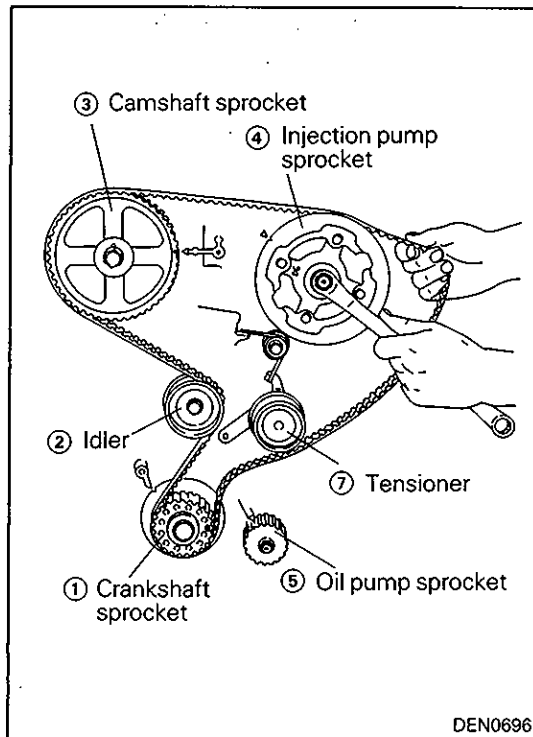
- (1) Temporarily fix the tensioner at the most lower position in the injection pump bracket slot.
- (2) Remove the glow plugs. Refer to Group 16 for their removing procedure.



- (3) Turn the crankshaft to bring the No. 1 piston at the top dead center on compression stroke.
- (4) 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.



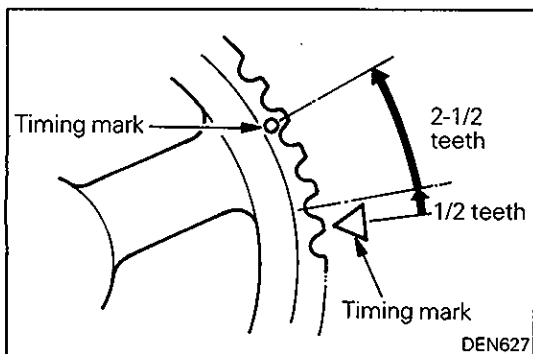
- (5) Install the timing belt on the sprockets in the following sequence while taking care so that the belt is not slack between sprockets or between sprocket and pulley.

- 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 camshaft sprocket to remove the slackness of the belt on idler side.
- ⑦ Timing belt tensioner

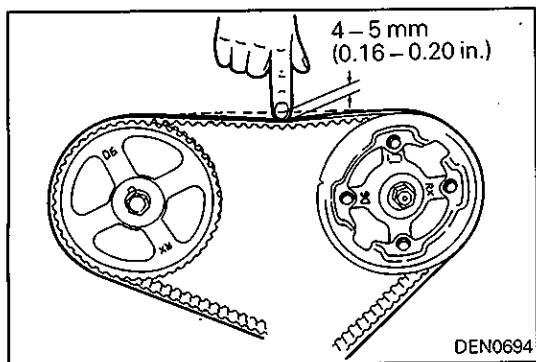
**NOTE**

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 on 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 timing marks.

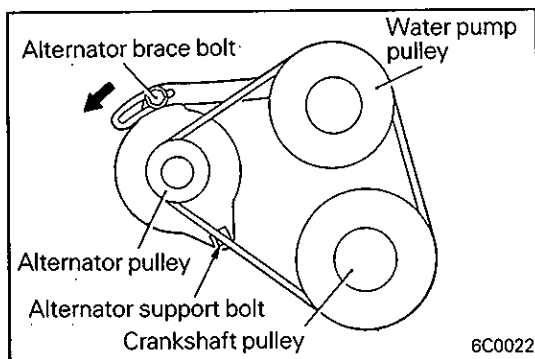


(10) Check that the belt deflects 4 – 5 mm (0.16 – 0.20 in.) when its midpoint is pushed by an index finger.

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

(12) Install the glow plugs (4 pcs.).

Refer to GROUP 16.

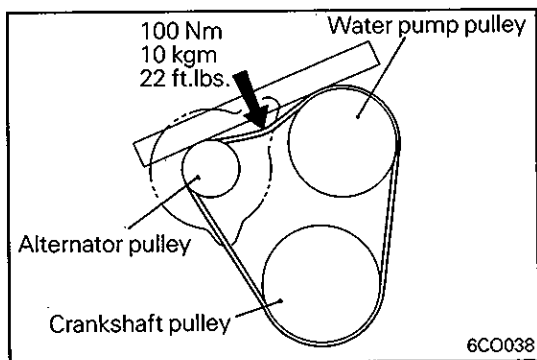


#### ADJUSTMENT OF DRIVE BELT TENSION

- (1) Loosen the nut for alternator support bolt.
- (2) Loosen alternator brace bolt.
- (3) Move the alternator to give greater tension to the belt so that the specified deflection is obtained.

**Standard value: 7.0 – 10.0 mm (0.28 – 0.39 in.)**

- (4) Tighten alternator brace bolt.
- (5) Tighten nut for alternator support bolt.





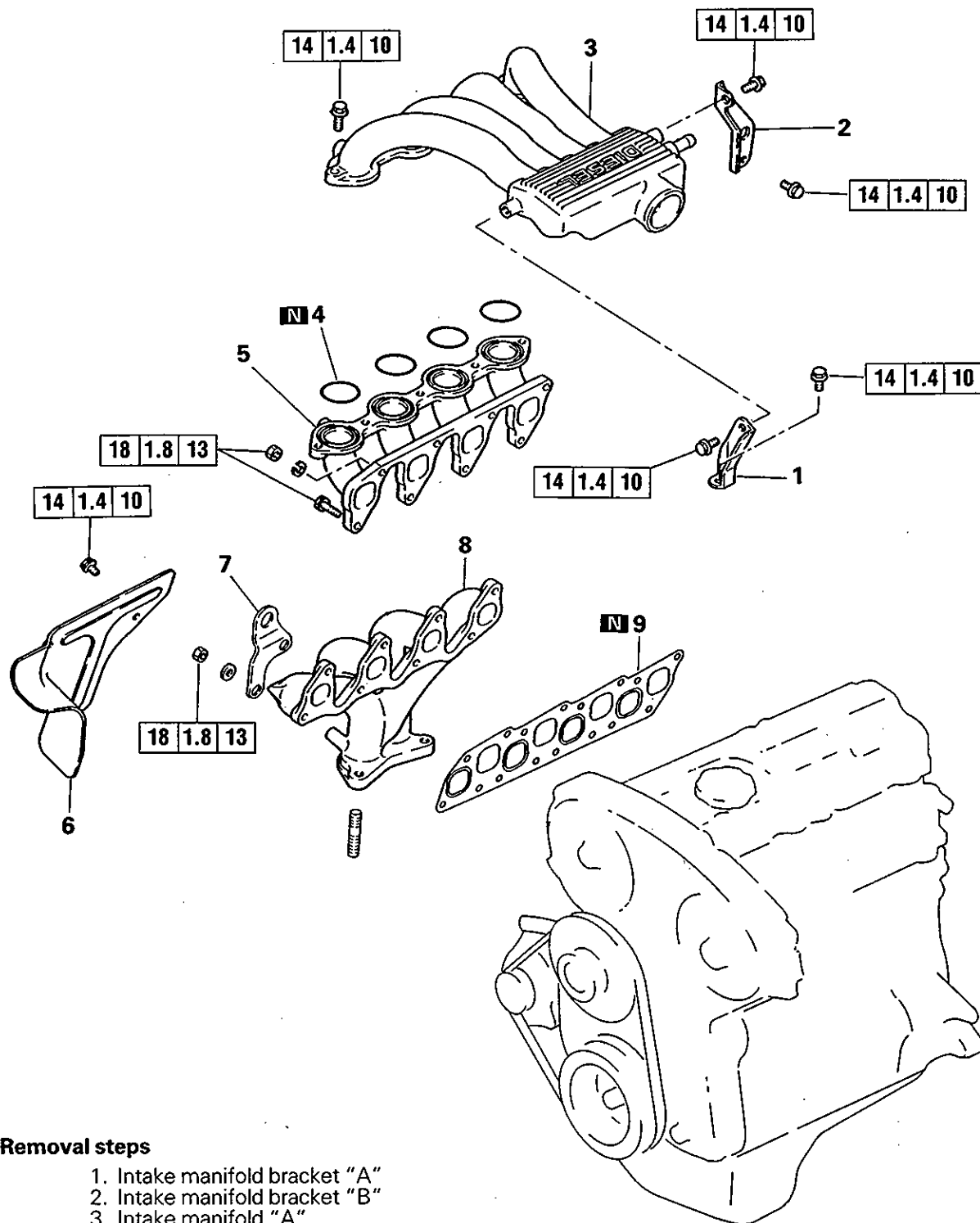
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**NOTES**

## 4. INTAKE AND EXHAUST MANIFOLDS

### REMOVAL AND INSTALLATION

<Engine without turbocharger>

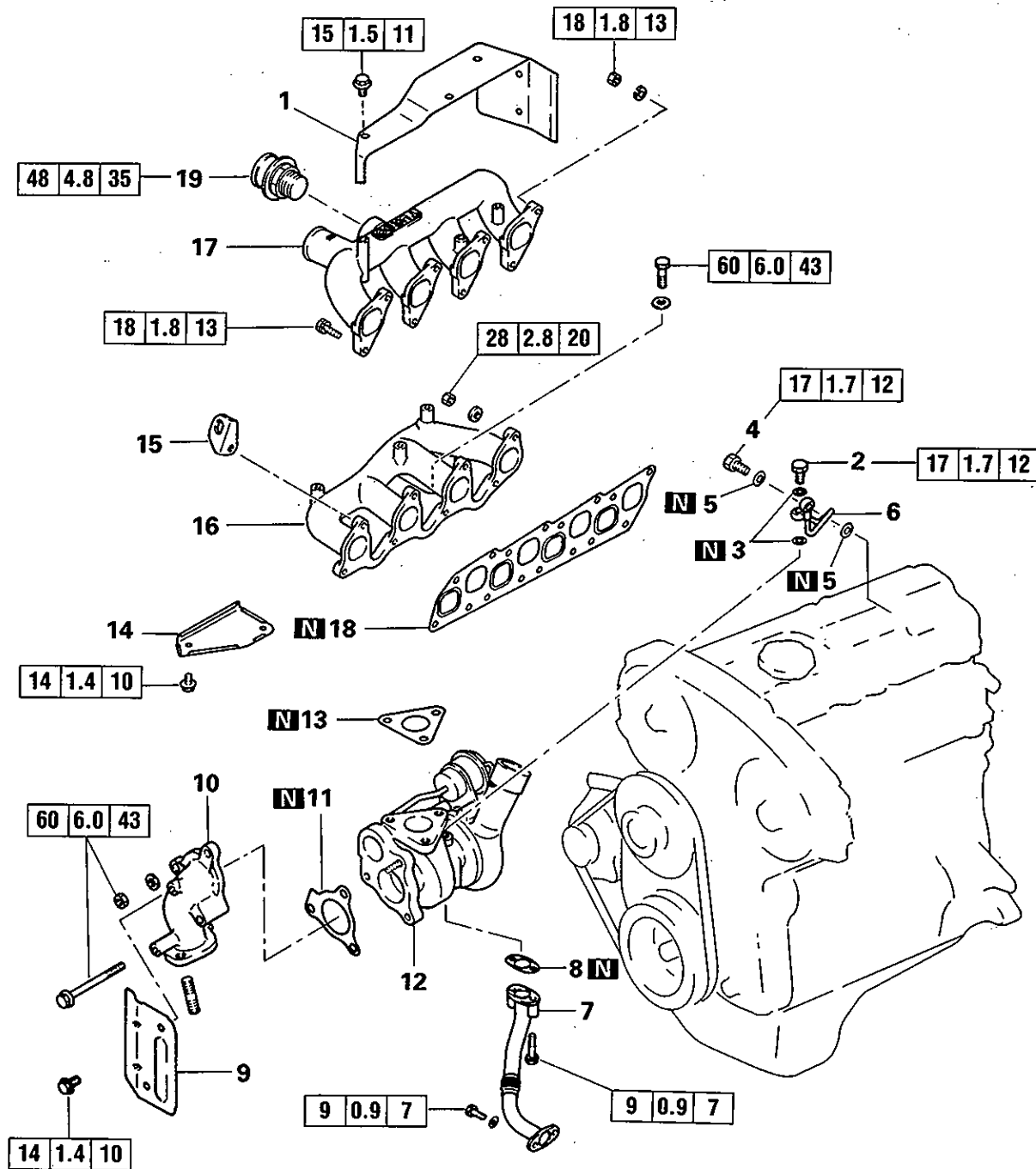


#### Removal steps

1. Intake manifold bracket "A"
2. Intake manifold bracket "B"
3. Intake manifold "A"
4. O-ring
5. Intake manifold "B"
6. Heat protector
7. Engine hanger
8. Exhaust manifold
9. Exhaust manifold gasket

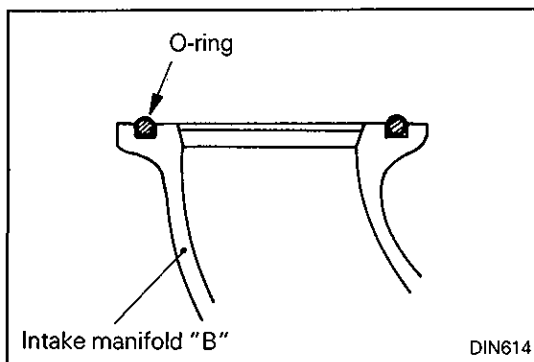
## REMOVAL AND INSTALLATION

&lt;Engine with turbocharger&gt;



## Removal steps

- |                       |                           |
|-----------------------|---------------------------|
| 1. Heat protector "A" | 11. Gasket                |
| 2. Eyebolt            | 12. Turbocharger assembly |
| 3. Gasket             | 13. Gasket                |
| 4. Eyebolt            | 14. Heat protector "B"    |
| 5. Gasket             | 15. Engine hanger         |
| 6. Oil pipe           | 16. Exhaust manifold      |
| 7. Oil return pipe    | 17. Intake manifold       |
| 8. Gasket             | 18. Manifold gasket       |
| 9. Heat protector "C" | 19. Relief valve          |
| 10. Exhaust fitting   |                           |

**SERVICE POINTS OF INSTALLATION****◆A◆ O-RING**

- (1) When installing the intake manifold "A", be sure to fit four O-rings in the intake manifold "B".

**◆B◆ EYEBOLT**

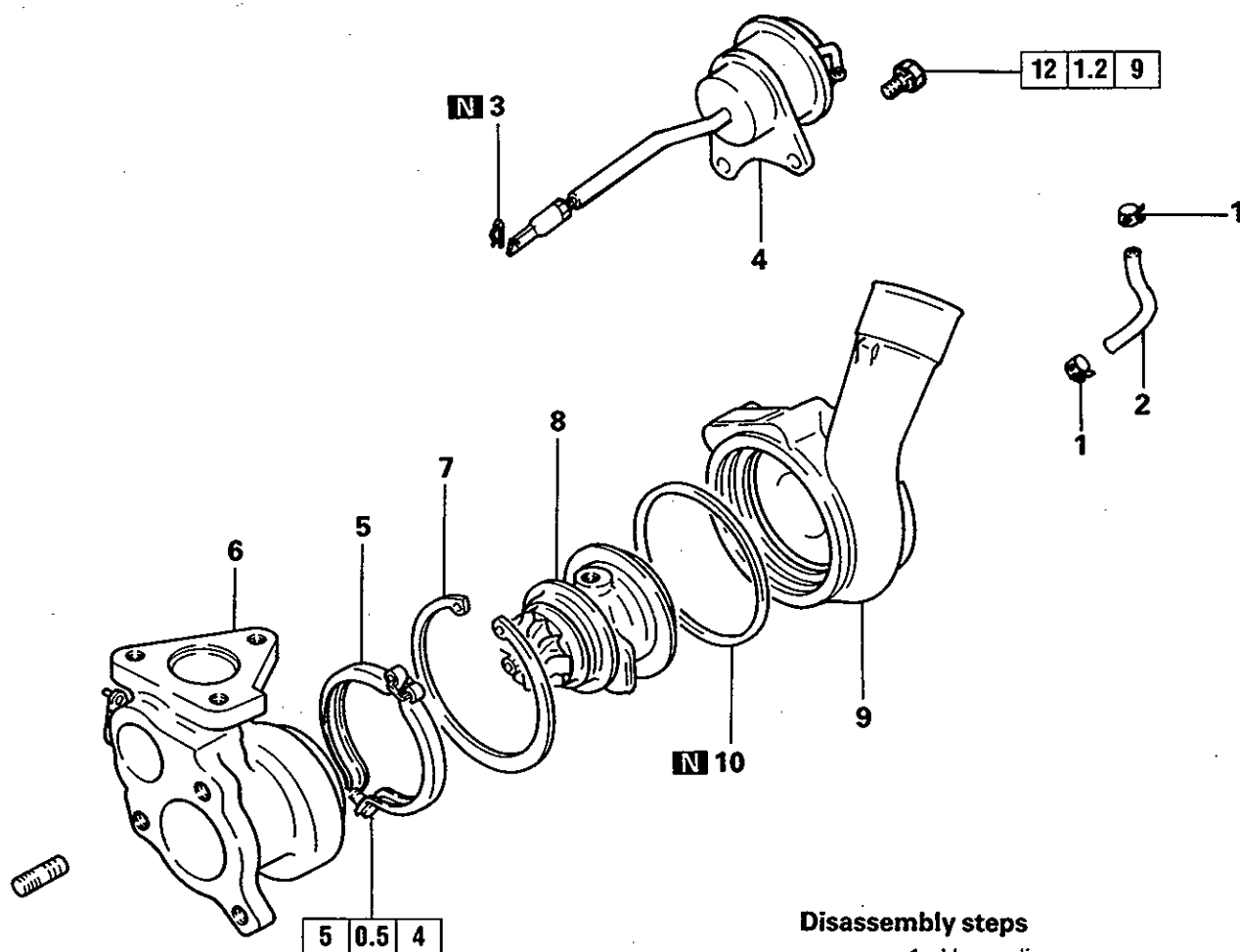
- (1) Before installing the oil pipe eyebolt (at top of the turbocharger), fill the turbocharger with clean engine oil.

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## NOTES

## 5. TURBOCHARGER

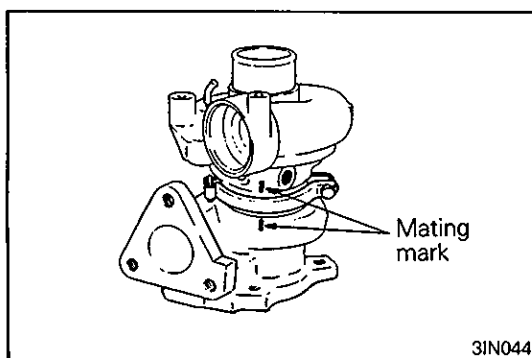
## DISASSEMBLY AND REASSEMBLY



## Disassembly steps

1. Hose clip
2. Hose
3. Snap pin
4. Waste gate actuator
5. Coupling
6. Turbine housing
7. Snap ring
8. Turbine wheel assembly
9. Compressor cover
10. O-ring

DIN615



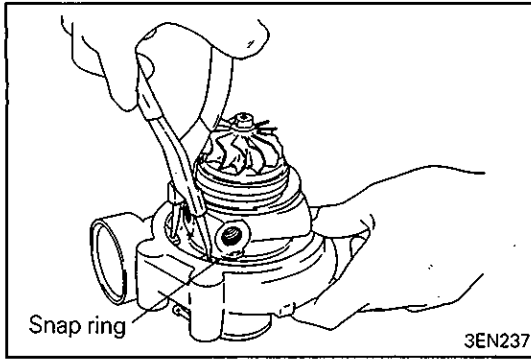
## SERVICE POINTS OF DISASSEMBLY

## ◊A◊ 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.

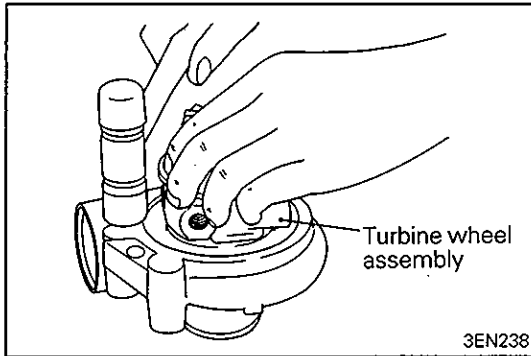


### ◁B▷ REMOVAL OF SNAP RING

- (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.

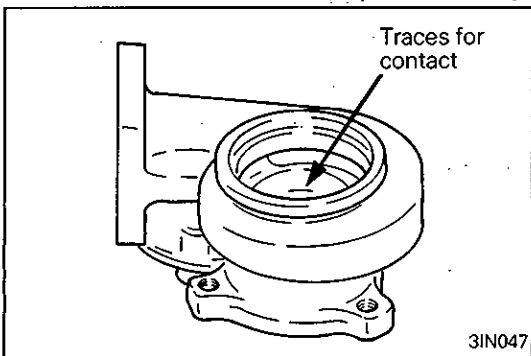


### ◁C▷ REMOVAL OF TURBINE WHEEL ASSEMBLY

- (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.



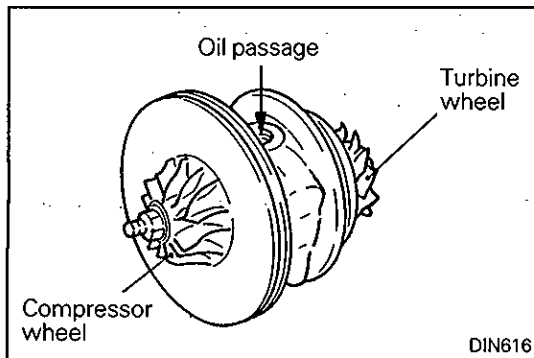
## INSPECTION

### 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

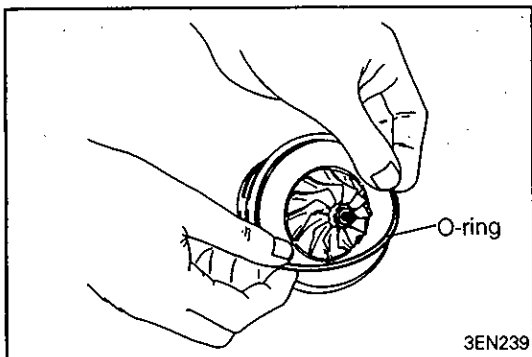
- (1) Check the compressor cover for traces of contact with the compressor wheel and other damage.

**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) In the case of water cooled type, check also the water passage for deposit and clogging.
- (4) Check the turbine wheel and compressor wheel for light and smooth turning.

**OIL PIPE / OIL RETURN PIPE**

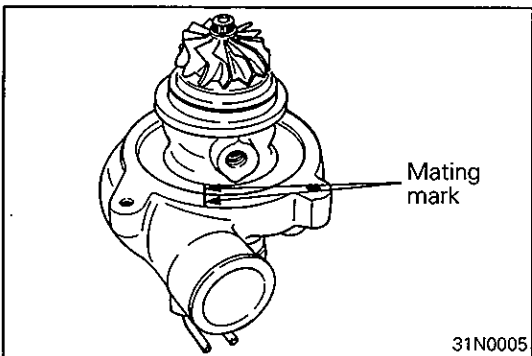
- (1) Correct or replace the oil pipe and oil return pipe if clogged, collapsed, deformed or otherwise damaged.

**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**

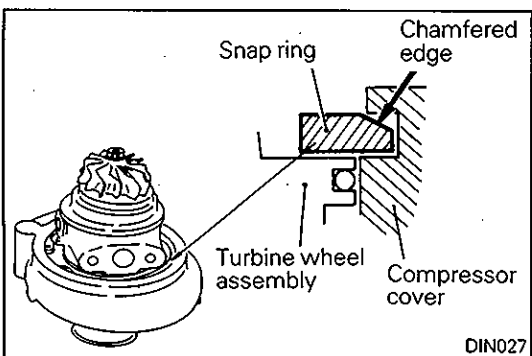
- When installing the O-ring, use care not to damage it. A damaged O-ring causes oil leaks.

**▶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.

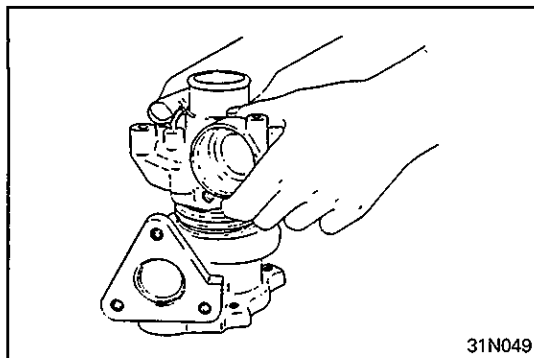
**▶C▶ INSTALLATION OF SNAP RING**

- (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.

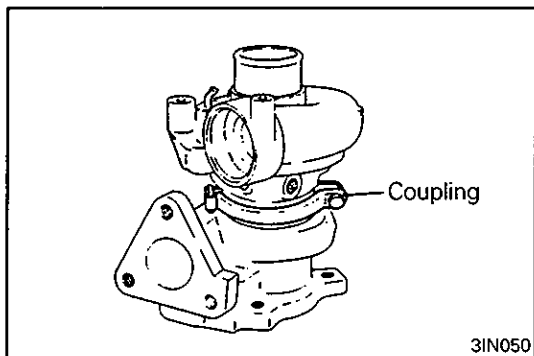


**◆D◆ INSTALLATION OF TURBINE HOUSING**

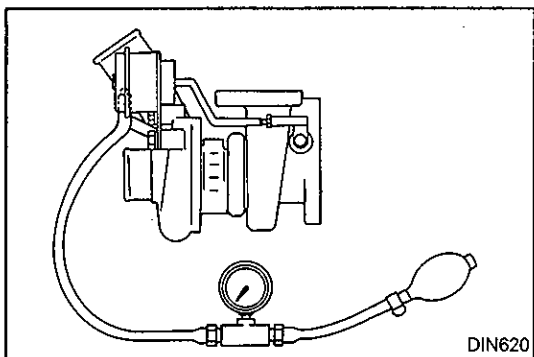
- (1) Install the compressor cover and turbine wheel assembly to the turbine housing, lining up the mating marks put at the time of disassembly.

**Caution**

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

**◆E◆ INSTALLATION OF COUPLING**

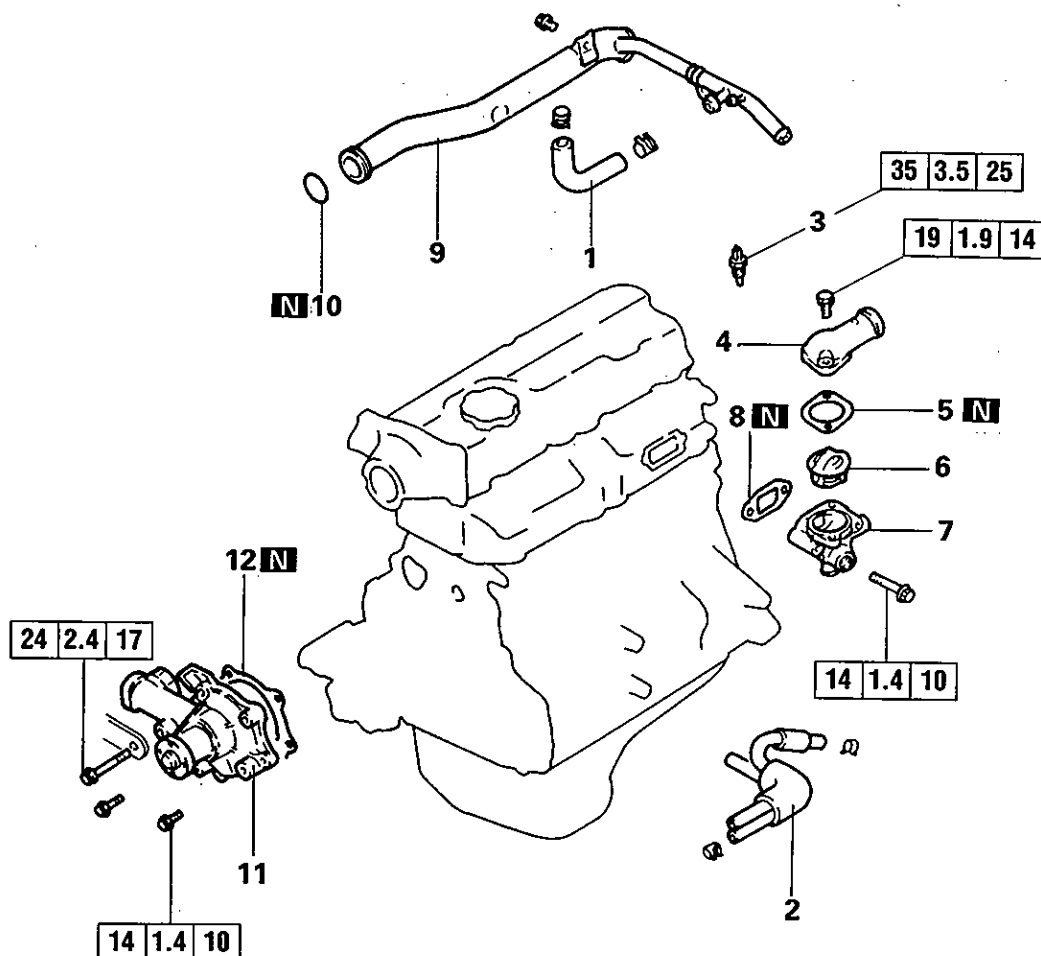
- (1) Install the coupling and tighten to specified torque.

**INSPECTION OF WASTE GATE ACTUATOR OPERATION**

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

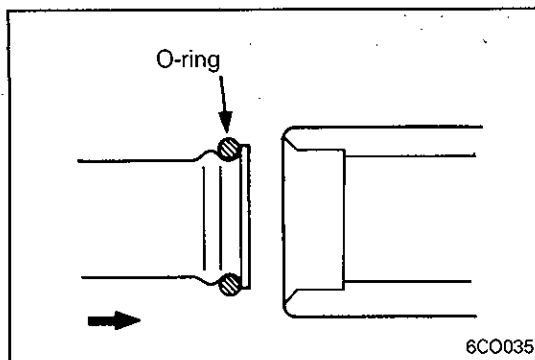
**Approx. 74.5 kPa (0.76 kg/cm<sup>2</sup>, 10.80 psi)**

## 6. WATER PUMP, THERMOSTAT, HOSE AND PIPE REMOVAL AND INSTALLATION



### Removal steps

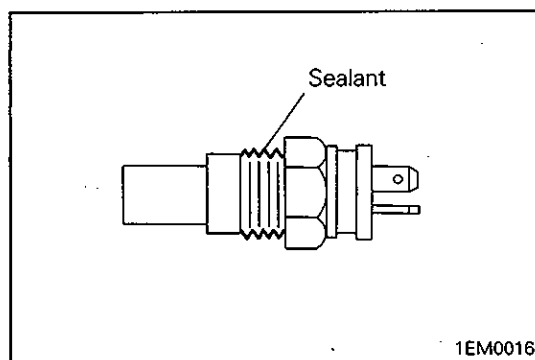
1. Water by-pass hose
2. Water hose
- ◆B◆ 3. Coolant temperature gauge unit
4. Water outlet fitting
5. Water outlet fitting gasket
6. Thermostat
7. Thermostat case
8. Thermostat case gasket
- ◆A◆ 9. Water inlet pipe
- ◆A◆ 10. O-ring
- Timing belt covers and timing belt  
(Refer to Page 11A-3-1)
11. Water pump
12. Water pump gasket

**◆A◆ INSTALLATION OF WATER 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.

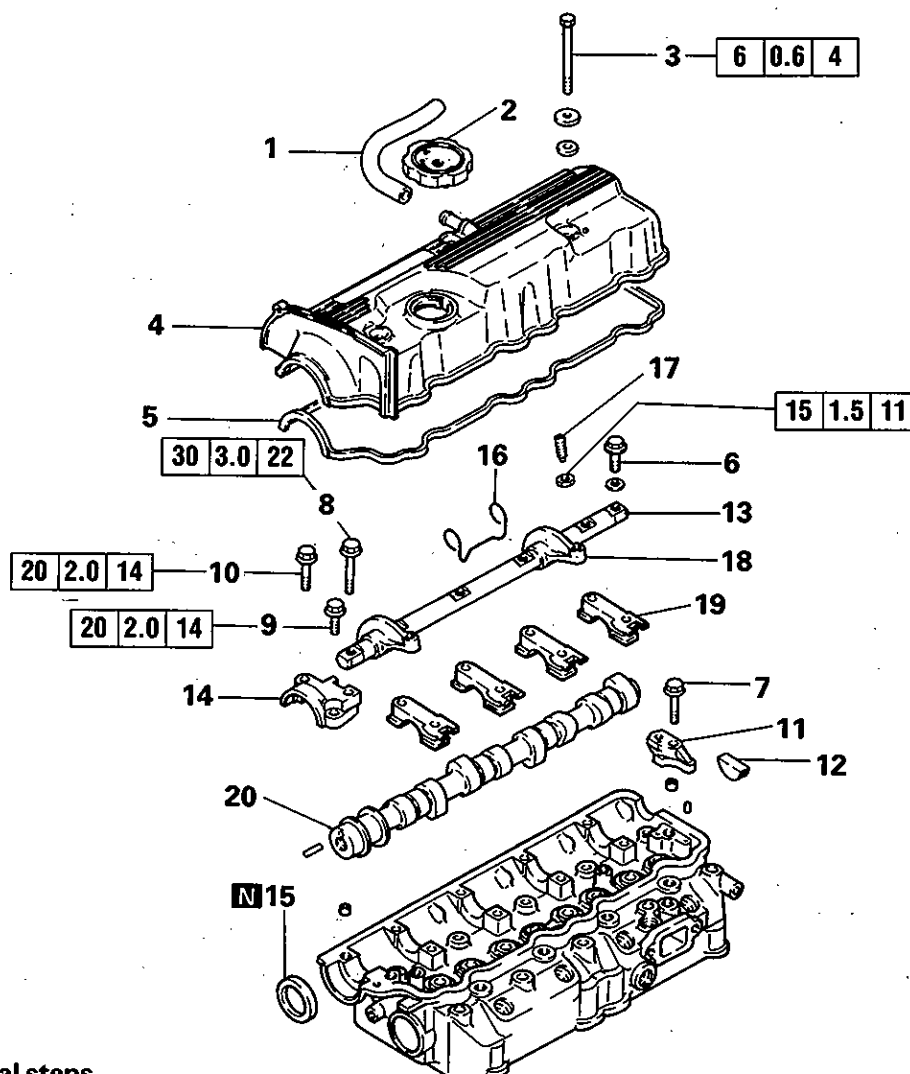
**◆B◆ INSTALLATION OF COOLANT TEMPERATURE GAUGE UNIT**

- (1) Apply sealant to threads.

**Specified sealant:**

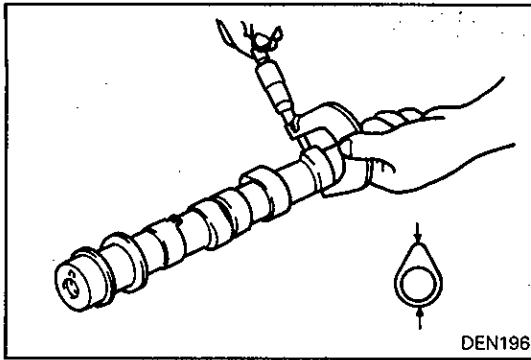
**3M Nut Locking Part No.4171 or equivalent**

## 7. ROCKER ARM, ROCKER SHAFT AND CAMSHAFT REMOVAL AND INSTALLATION



### Removal steps

1. Breather hose
2. Oil filler cap
3. Bolt
4. Rocker cover
5. Rocker cover gasket
6. Bolt
7. Bolt
8. Bolt
9. Bolt
10. Bolt
11. Rocker shaft support
- ▶D▶ 12. Semi-circular packing
13. Rocker shaft
14. Camshaft bearing cap
- ▶C▶ 15. Camshaft oil seal
- ▶B▶ 16. Rocker shaft spring
17. Adjusting screw
18. Rocker arm
- ▶A▶ 19. Camshaft bearing cap
20. Camshaft

**INSPECTION****CAMSHAFT**

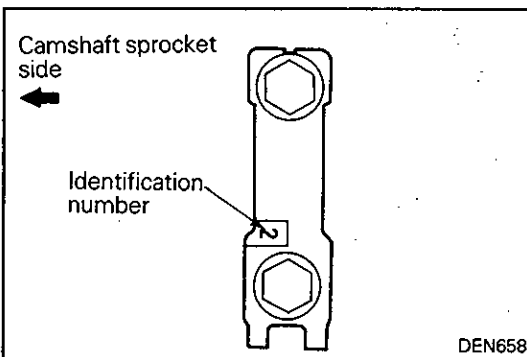
- (1) Measure the cam height.

**Standard value: 41.83 mm (1.6468 in.)**

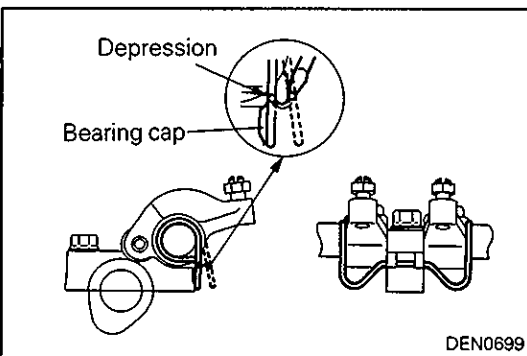
**Limit: 41.33 mm (1.6272 in.)**

**ROCKER ARM SHAFT**

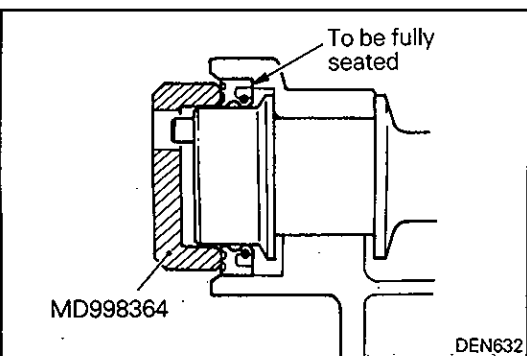
- (1) Check the oil holes for clogging and clean if clogged.
- (2) Check the outer circumference of the portion where the rocker arm is installed and replace if damage or seizure is evident.

**◆A◆ INSTALLATION OF CAMSHAFT BEARING CAP**

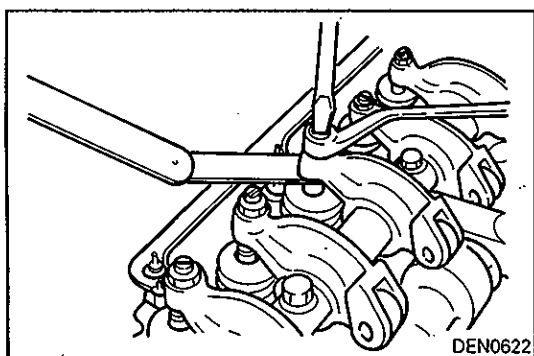
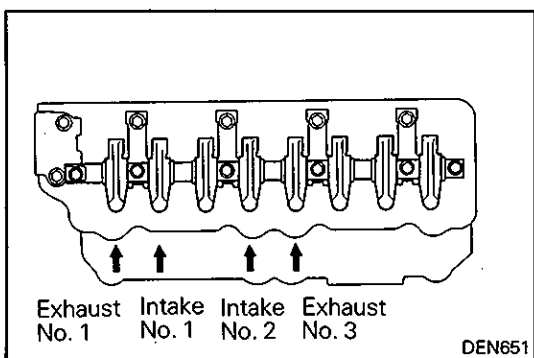
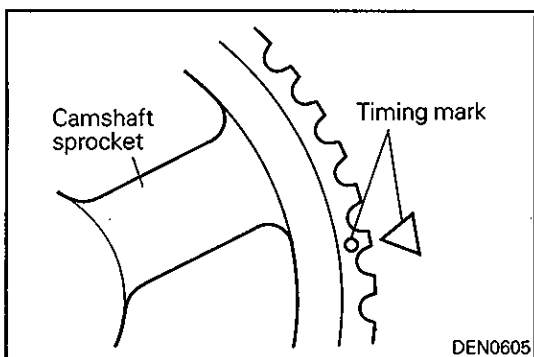
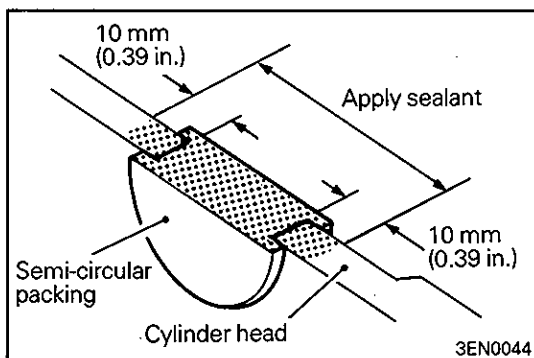
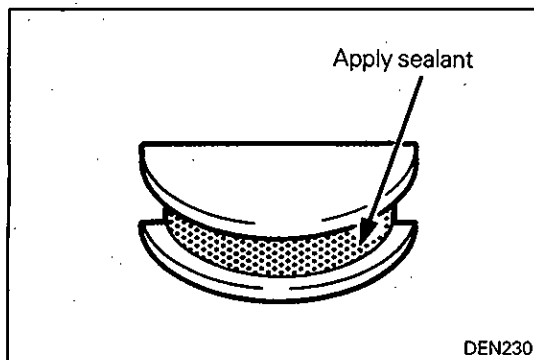
- (1) Install the bearing caps in the designated position confirming the identification numbers stamped on the cap front. The No.5 cap has no identification number stamped.

**◆B◆ INSTALLATION OF ROCKER SHAFT SPRING**

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

**◆C◆ INSTALLATION OF CAMSHAFT OIL SEAL**

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



### ◆D◆ INSTALLATION OF SEMI-CIRCULAR PACKING

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

**Specified sealant:**

**3M Part No. 8660 or equivalent**

### VALVE CLEARANCE ADJUSTMENT

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

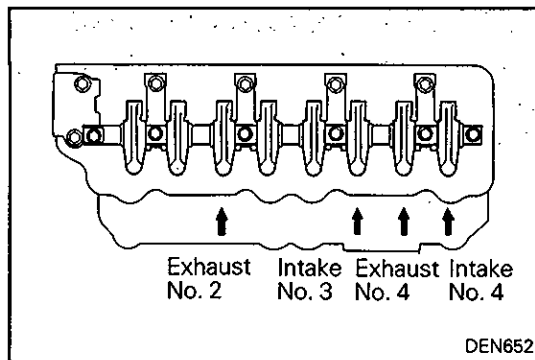
- (2) Adjust the valve clearance at points shown in the illustration.

- (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 (0.0059 in.)** ..... Intake  
**0.15 mm (0.0059 in.)** ..... Exhaust

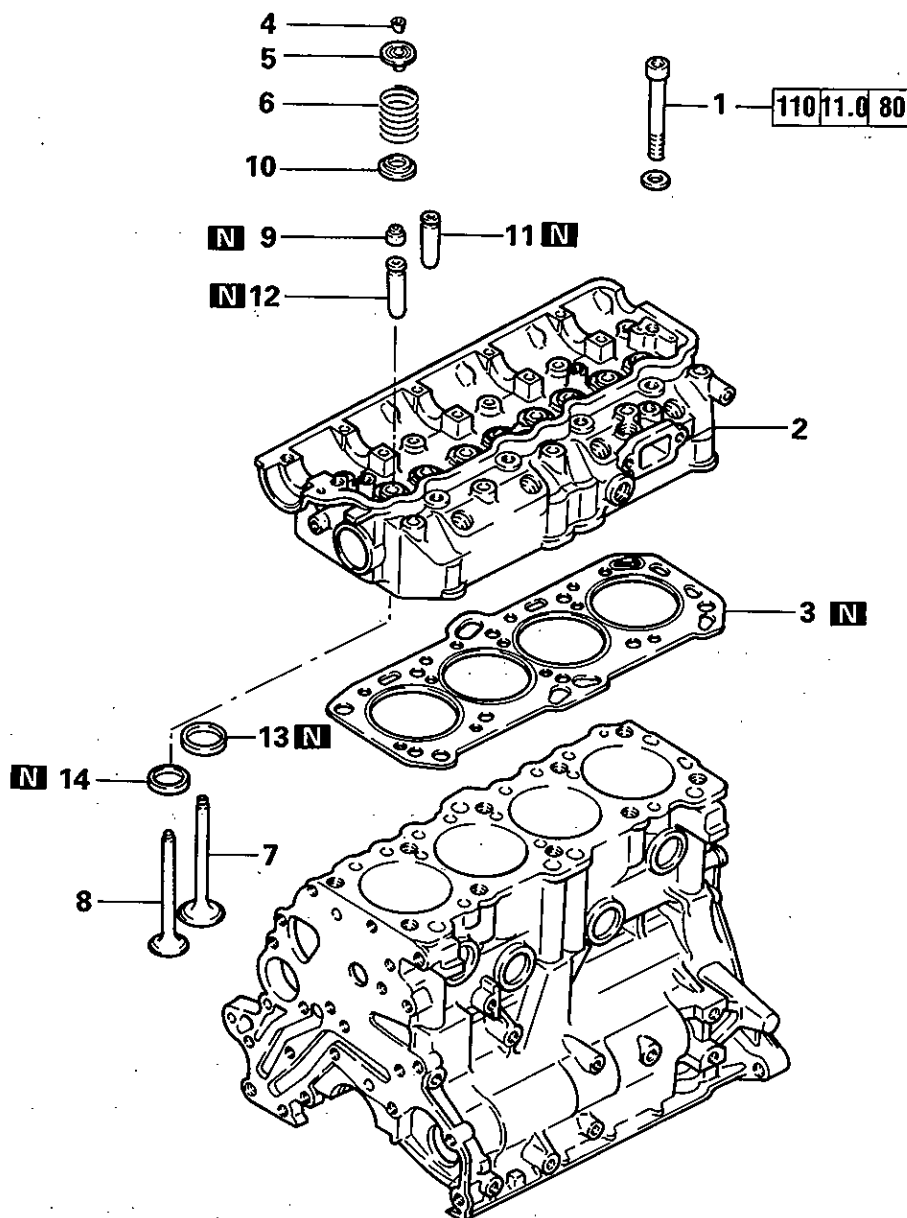
- (5) While holding the adjusting screw with a screwdriver, tighten the lock nut.



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

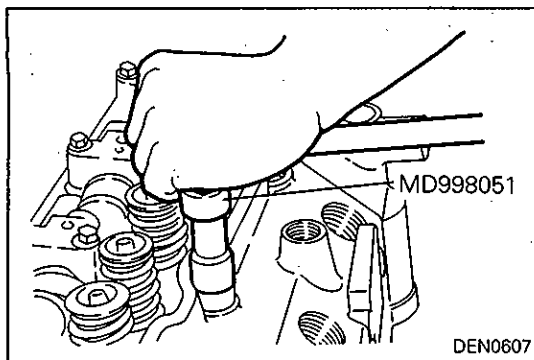
**NOTE**

With the engine mounted on vehicle, warm up the engine. Then, check for valve clearance on 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
- ◆B◆◆A◆ 9. Valve stem seal
- 10. Spring seat
- 11. Intake valve guide
- 12. Exhaust valve guide
- 13. Intake valve seat
- 14. Exhaust valve seat

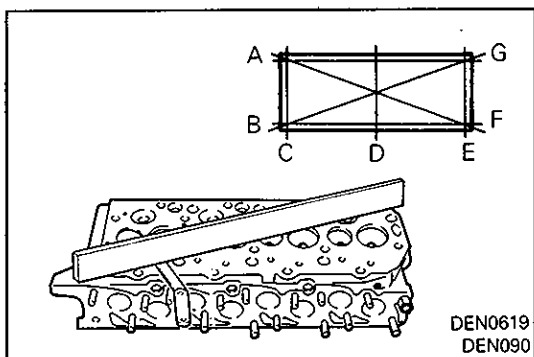


**SERVICE POINTS OF REMOVAL****◀A▶ REMOVAL OF CYLINDER HEAD BOLTS**

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

**◀B▶ REMOVAL OF VALVE STEM SEAL****Caution**

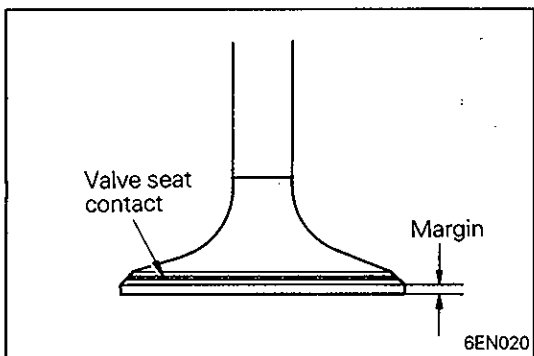
- The stem seal is not reusable.

**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.)**

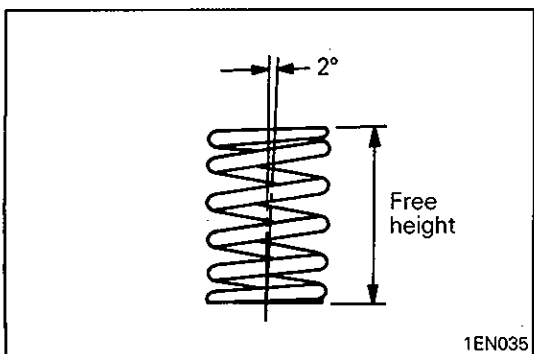
**Limit: 0.2 mm (0.008 in.)**

**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: 1.5 mm (0.059 in.)**

**Limit: 0.7 mm (0.028 in.)**

**VALVE SPRING**

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

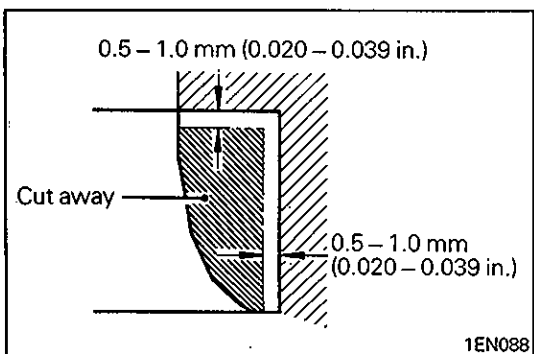
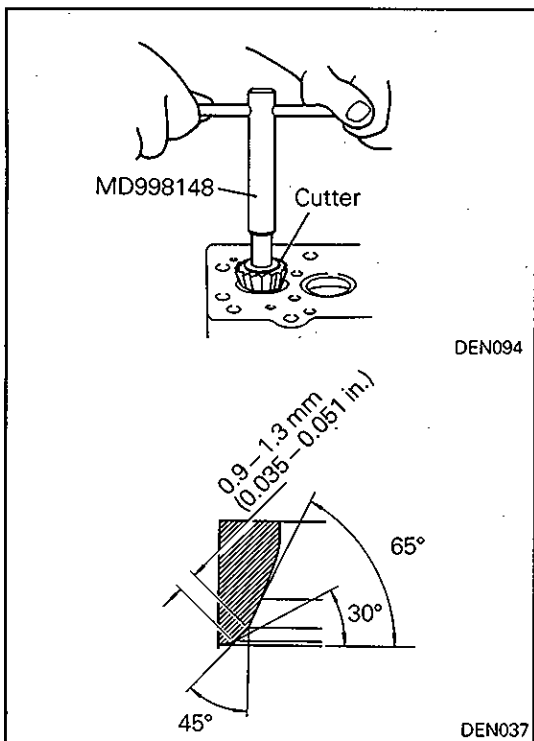
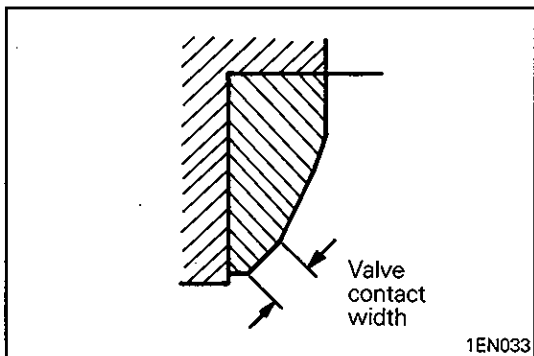
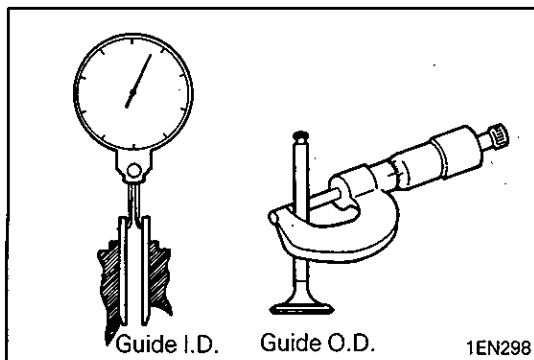
**Standard value: 49.1 mm (1.934 in.)**

**Limit: 48.1 mm (1.895 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 N/A

0.05 – 0.09 mm (0.0020 – 0.0035 in.) ..... Intake

T/C & Taxi

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**

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

**Standard value: 0.9 – 1.3 mm (0.035 – 0.051 in.)**

**VALVE SEAT RECONDITIONING PROCEDURE**

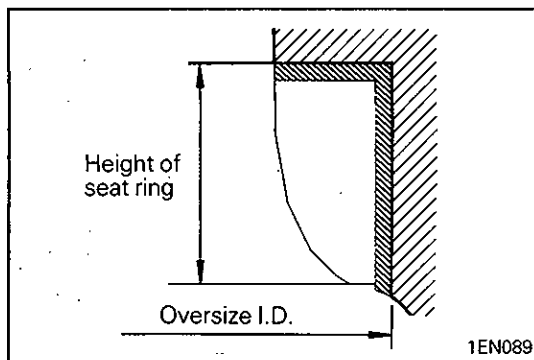
- (1) Before correcting the valve seat, check for clearance between the valve guide and valve and, if necessary, replace the valve guide.
- (2) Using the special tool or seat grinder, correct to obtain the specified seat width and angle.

Cutter angle	Tool number	
	Intake	Exhaust
45°	MD998159	MD998158
65°	MD998165	MD998165
30°	MD998175	MD998173

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

**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 a selected oversize valve seat diameter.

#### Intake valve seat hole diameter

0.30 O.S.: 38.300 – 38.325 mm  
(1.5079 – 1.5089 in.)

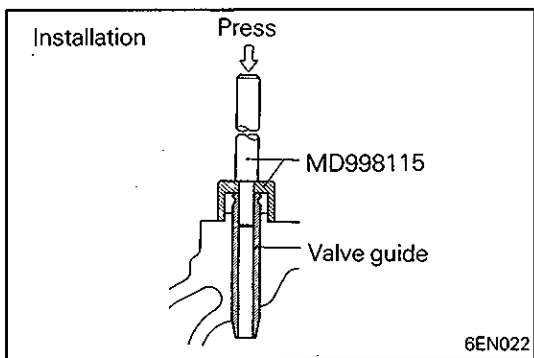
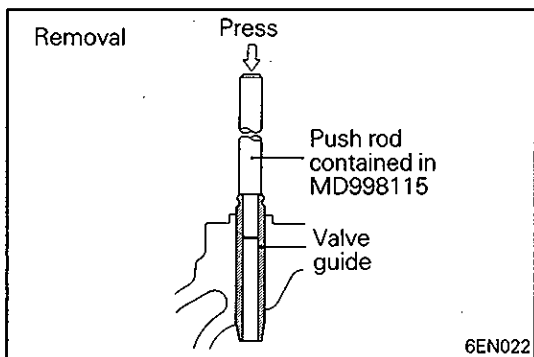
0.60 O.S.: 38.600 – 38.625 mm  
(1.5197 – 1.5207 in.)

#### Exhaust valve seat hole diameter

0.30 O.S.: 34.300 – 34.325 mm  
(1.3504 – 1.3514 in.)

0.60 O.S.: 34.600 – 34.625 mm  
(1.3622 – 1.3632 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.)

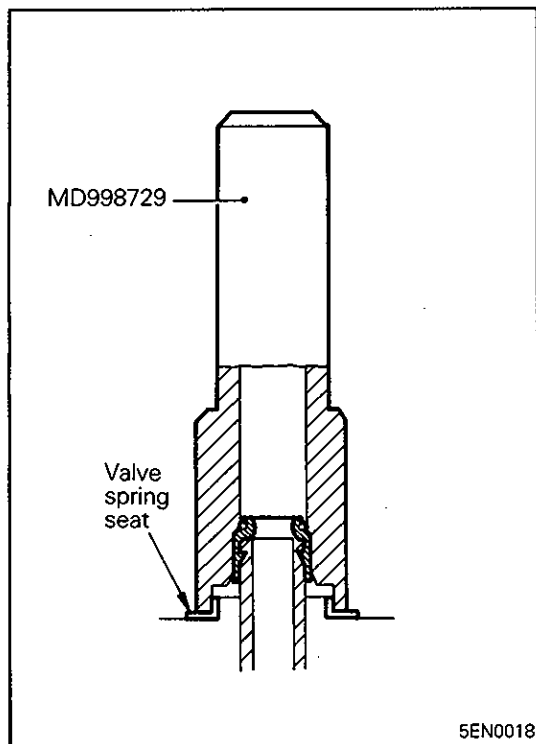
0.50 O.S.: 13.500 – 13.518 mm  
(0.5315 – 0.5322 in.)

#### 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.

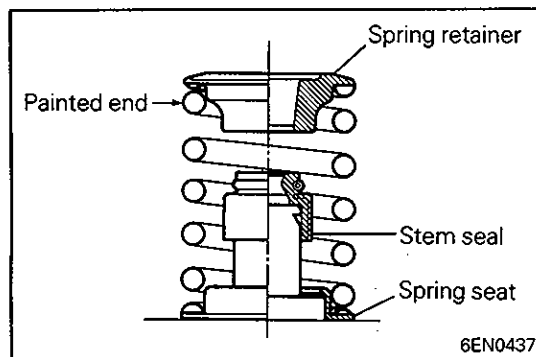
- (4) After installing valve guides, insert new valves in them to check for sliding condition.
- (5) When valve guides have been replaced check for valve contact and correct valve seats as necessary.

**SERVICE POINTS OF INSTALLATION****◆A◆ INSTALLATION OF VALVE STEM SEAL**

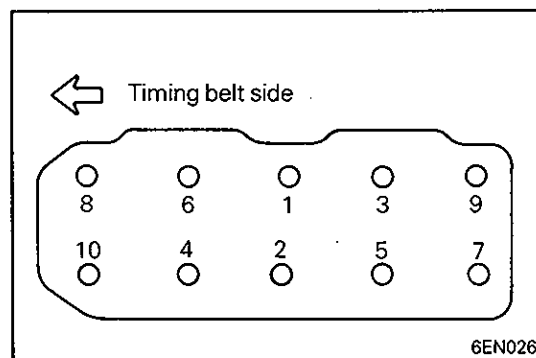
- (1) Install the valve spring seat.
- (2) The special tool must be used to install the valve stem seal. Improper installation could result in oil leaks through valve guide.

**NOTE**

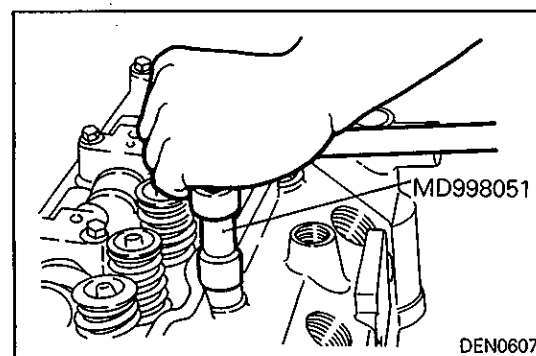
The valve stem seal cannot be reused.

**◆B◆ INSTALLATION OF VALVE SPRING**

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

**◆C◆ INSTALLATION OF CYLINDER HEAD BOLT**

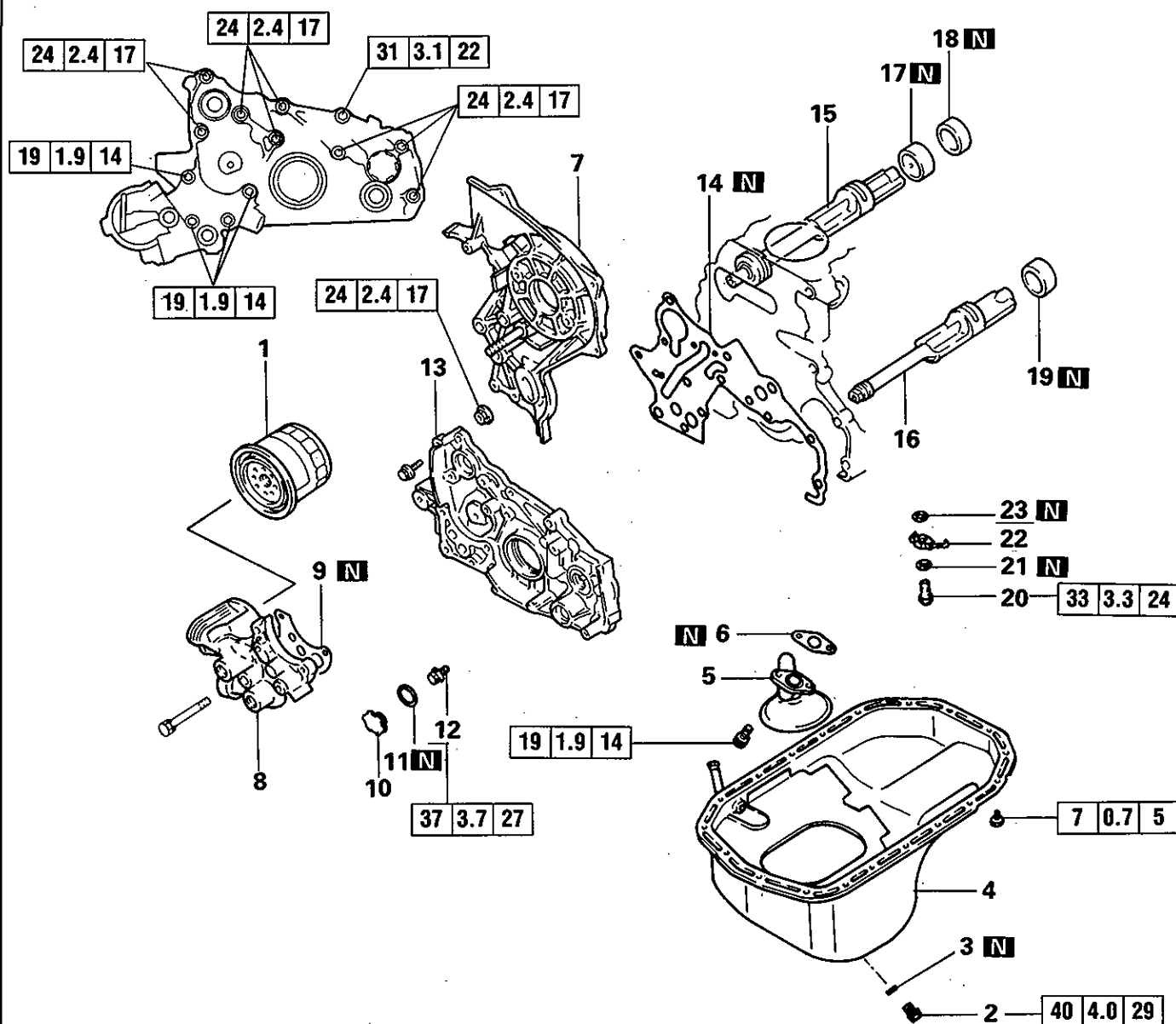
- (1) Using the special tool and torque wrench, tighten bolts in the shown sequence.



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## NOTES

## 9. FRONT CASE, SILENT SHAFT AND OIL PAN REMOVAL AND INSTALLATION

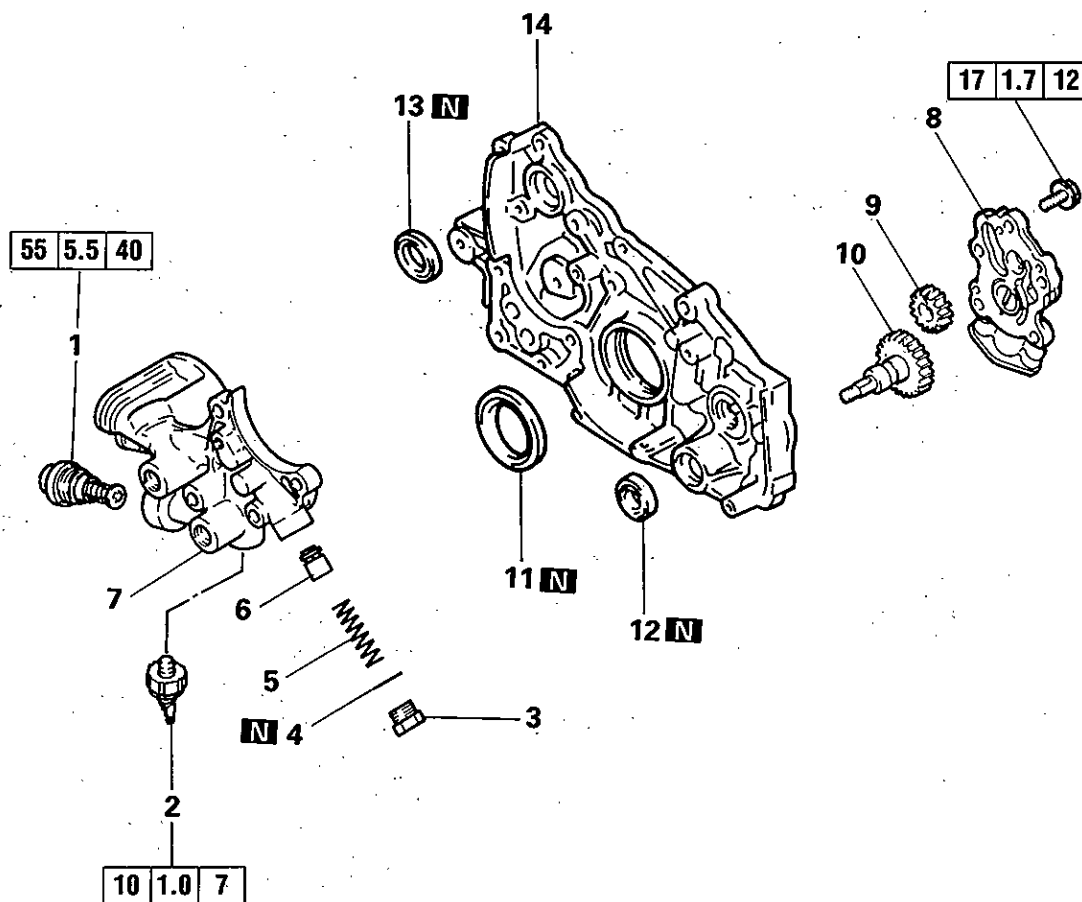


### Removal steps

- ▶L 1. Oil filter  
 2. Drain plug  
 3. Drain plug gasket  
 ◀A◀ ▶K 4. Oil pan  
 5. Oil screen  
 6. Oil screen gasket  
 7. Injection pump bracket  
 8. Oil filter bracket  
 9. Oil filter bracket gasket  
 ◀B◀ ▶J 10. Plug  
 11. O-ring  
 ◀C◀ ▶I 12. Flange bolt

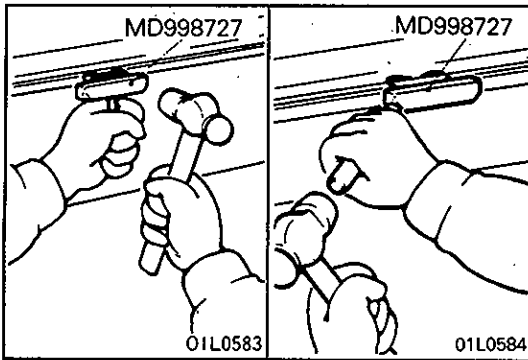
- ▶H 13. Front case  
 14. Front case gasket  
 15. Silent shaft, right  
 16. Silent shaft, left  
 ◀D◀ ▶G 17. Silent shaft front bearing  
 ◀E◀ ▶F 18. Silent shaft rear bearing, right  
 ◀E◀ ▶E 19. Silent shaft rear bearing, left  
 20. Check valve  
 21. Gasket  
 ▶D 22. Oil jet  
 23. Gasket

## DISASSEMBLY AND REASSEMBLY

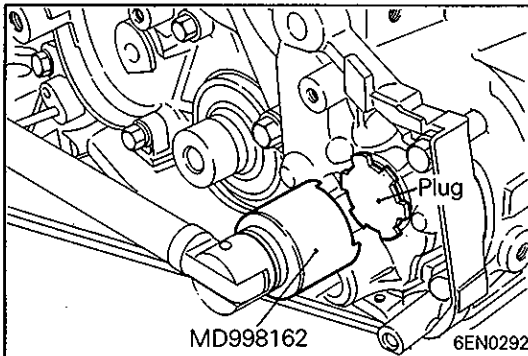


## Removal steps

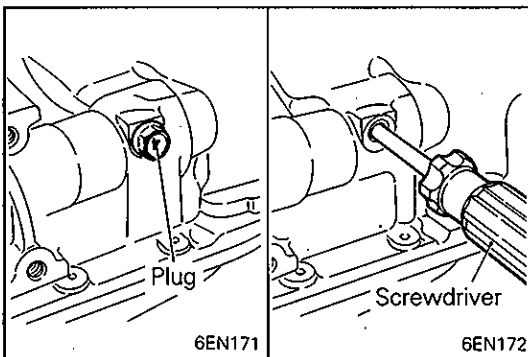
1. Oil cooler by-pass valve
2. Oil pressure switch
3. plug
4. Gasket
5. Relief spring
6. Relief plunger
7. Oil filter bracket
8. Oil pump cover
- ▶C▶ 9. Oil pump driven gear
- ▶C▶ 10. Oil pump drive gear
- ▶B▶ 11. Crankshaft front oil seal
- ▶A▶ 12. Oil pump oil seal
- ▶A▶ 13. Silent shaft oil seal
14. Front case

**SERVICE POINTS OF REMOVAL****◁A▷ REMOVAL OF OIL PAN**

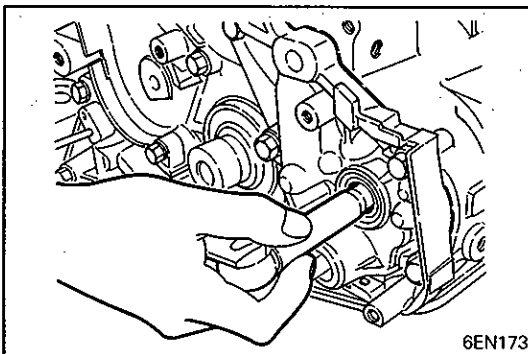
- (1) Knock the special tool deeply between the oil pan and the cylinder block.
- (2) Hitting the side of the special tool, slide the special tool along the oil pan to remove it.

**◁B▷ REMOVAL OF PLUG**

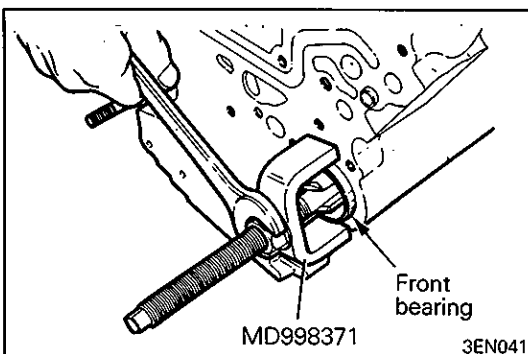
- (1) If the plug is tightened too firmly to loosen, tap the plug head two or three times with a hammer, and the plug will loosen easily.

**◁C▷ REMOVAL OF FLANGE BOLT**

- (1) When loosening the oil pump driven gear flange bolt, first insert a Phillips screwdriver [shank diameter 8 mm (0.32 in.)] into the plug hole on the left side of cylinder block to block the silent shaft.



- (2) Loosen the flange bolt.

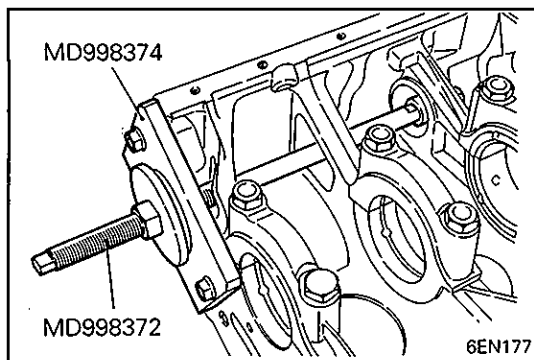
**◁D▷ REMOVAL OF SILENT SHAFT FRONT BEARINGS**

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

**NOTE**

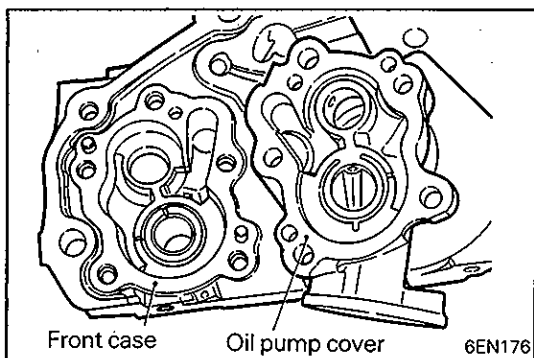
Be sure to remove the front bearing first. If it has not been removed, the Rear Bearing Puller cannot be used.





### REMOVAL OF RIGHT SILENT SHAFT REAR BEARING / LEFT SILENT SHAFT REAR BEARING

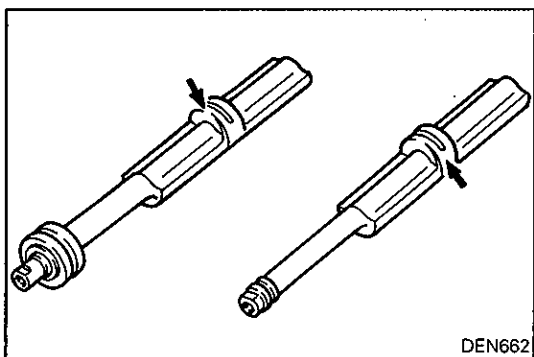
- (1) Using the special tool, remove two rear bearings from cylinder block.
- (2) To remove the left rear bearing, install the special tool, Silent Shaft Bearing Installer Stopper, to the front of the cylinder block, then remove the bearing using the special tool, Silent Shaft Bearing Puller.



### INSPECTION

#### FRONT CASE

- (1) Check oil holes for clogging and clean if necessary.
- (2) Check 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.



#### SILENT SHAFT

- (1) Check oil holes for clogging.
- (2) Check journal for seizure, damage, and contact with bearing. If there is anything wrong with the journal, replace silent shaft, bearing or front case assembly.
- (3) Check the silent shaft oil clearance. If the clearance is excessively due to wear, replace the silent shaft bearing, silent shaft or front case assembly.

#### Standard value:

##### Front

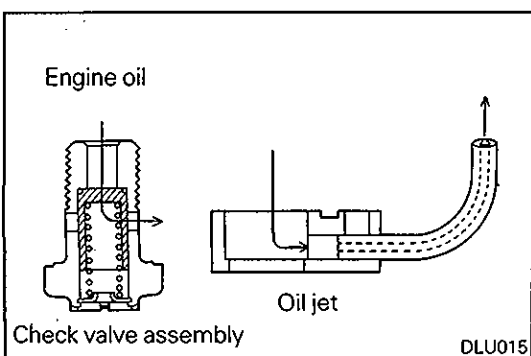
0.02 – 0.06 mm (0.0008 – 0.0024 in.) ..... Right

0.02 – 0.05 mm (0.0008 – 0.0020 in.) ..... Left

##### Rear

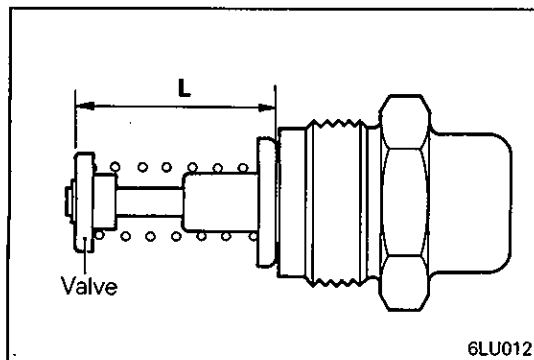
0.05 – 0.09 mm (0.0020 – 0.0036 in.) ..... Right

0.05 – 0.09 mm (0.0020 – 0.0036 in.) ..... Left



#### OIL JET, CHECK VALVE

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

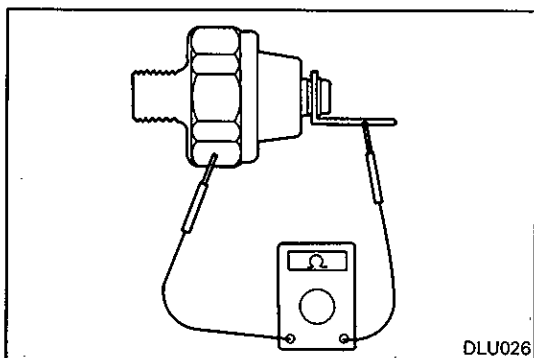
**OIL COOLER BYPASS VALVE (Models with oil cooler)**

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

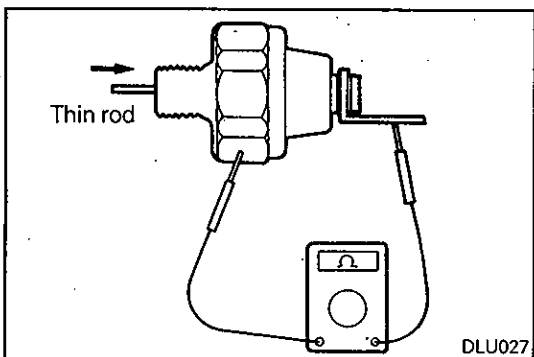
**Dimension L: 34.5 mm (1.358 in.)**

- (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.



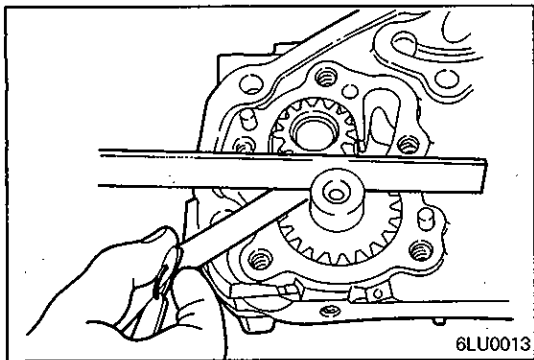
- (2) Insert a thin rod in the oil hole of the switch and push it in lightly. The switch is normal if no continuity is detected (infinite resistance on the tester). If there is continuity, replace the switch.
- (3) Apply a 0.5 kg/cm<sup>2</sup> pressure to the oil hole. The switch is normal if there 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 FILTER BRACKET**

- (1) Check the oil filter mounting surface for damage.
- (2) Check for cracks and oil leaks.
- (3) Make sure that the relief plunger slides smoothly and the relief spring is not damaged.

**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:**

0.08 – 0.14 mm (0.0031 – 0.0055 in.) .... Drive gear

0.06 – 0.12 mm (0.0024 – 0.0047 in.) .... Driven gear

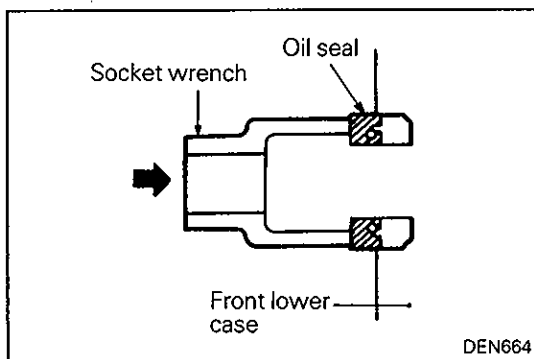
**OIL SEAL**

- (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**

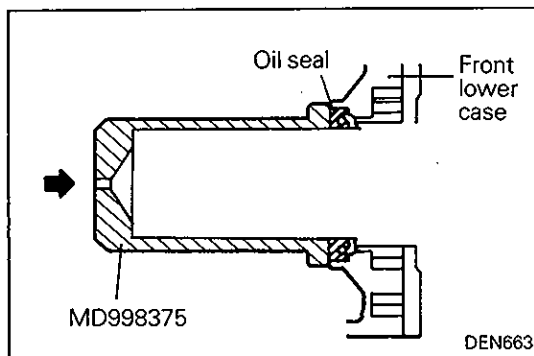
**▶A▶ INSTALLATION OF SILENT SHAFT OIL SEAL**

- (1) Using a 34 mm (1.34 in.) O.D. socket wrench, press-in the silent shaft oil seal into front lower case.



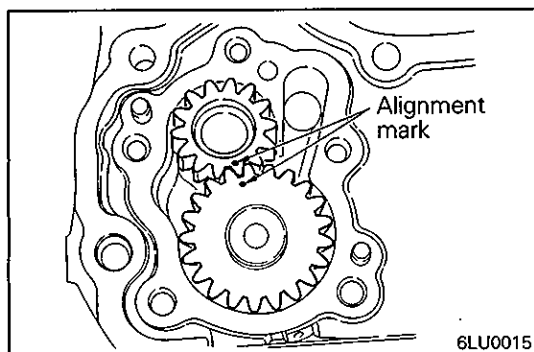
**▶B▶ INSTALLATION OF CRANKSHAFT FRONT OIL SEAL**

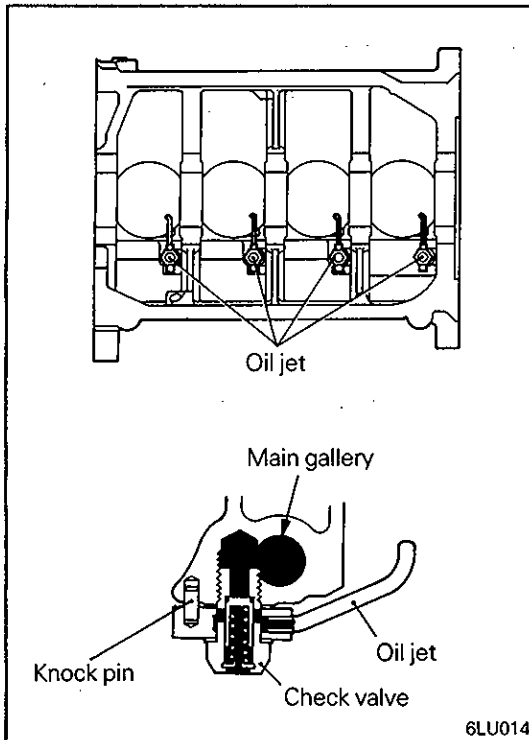
- (1) Using the special tool, install the crankshaft front oil seal into the front lower case.



**▶C▶ INSTALLATION OF OIL PUMP DRIVEN GEAR / OIL PUMP DRIVE GEAR**

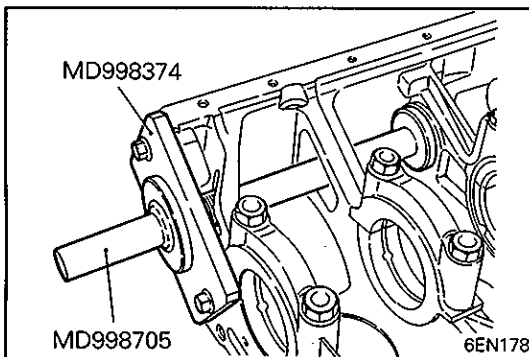
- (1) Apply engine oil amply to the gears and line up the alignment marks.





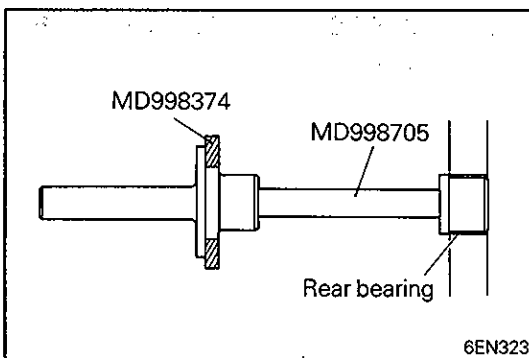
### ◆D◆ INSTALLATION OF OIL JET

- (1) When installing the oil jet, make sure that the nozzle is in correct direction, that is, toward the piston.



### ◆E◆ INSTALLATION OF LEFT SILENT SHAFT REAR BEARING

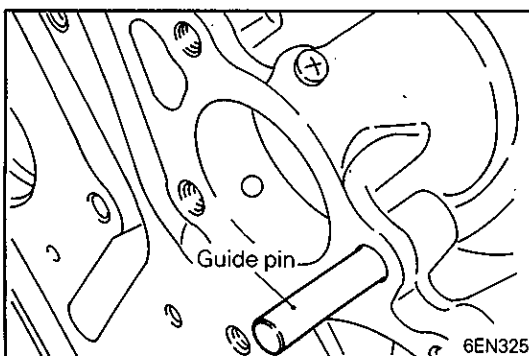
- (1) Install the special tool in the cylinder block.
- (2) Apply engine oil to the rear bearing outer circumference and bearing hole in cylinder block.



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

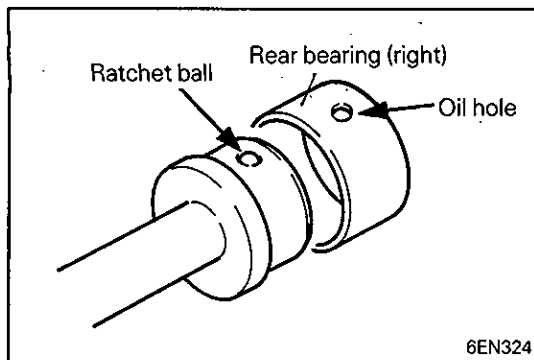
#### NOTE

The bearing for left side is without oil hole.

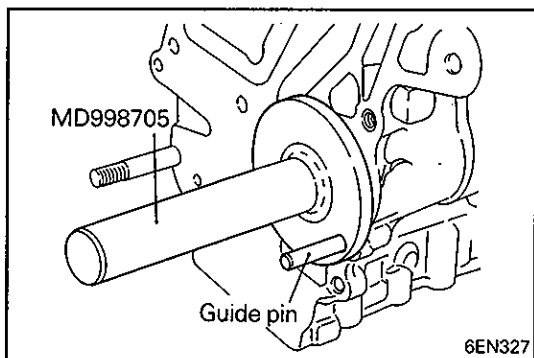


### ◆F◆ INSTALLATION OF SILENT SHAFT REAR BEARING RIGHT

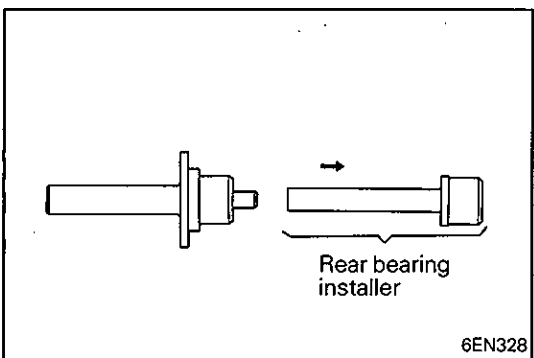
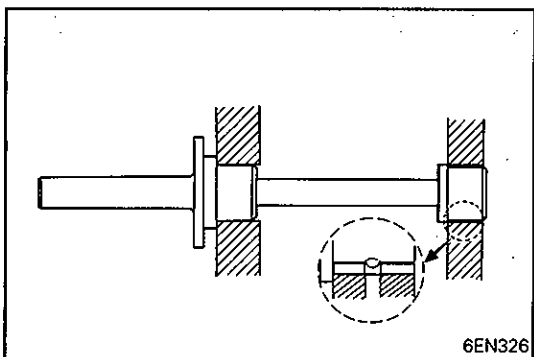
- (1) Install the guide pin of the special tool to the threaded hole of the cylinder block as illustrated.



- (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.

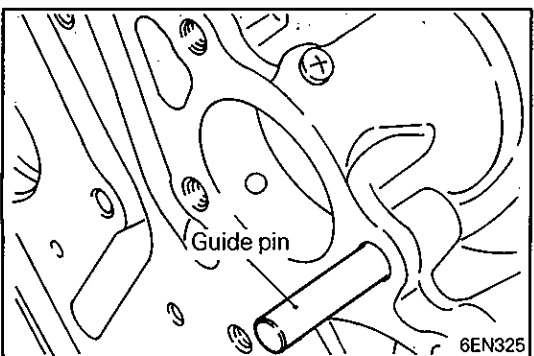


- (4) Insert the installer aligning with the guide pin and install the bearing.

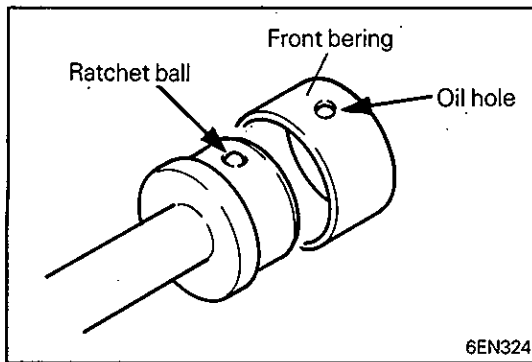


#### ◆G◆ INSTALLATION OF SILENT SHAFT FRONT BEARING

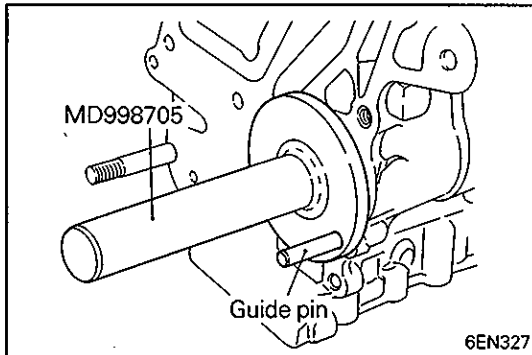
- (1) Remove the rear bearing installer portion from the special tool.



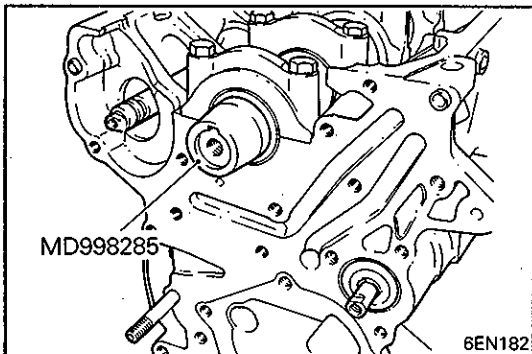
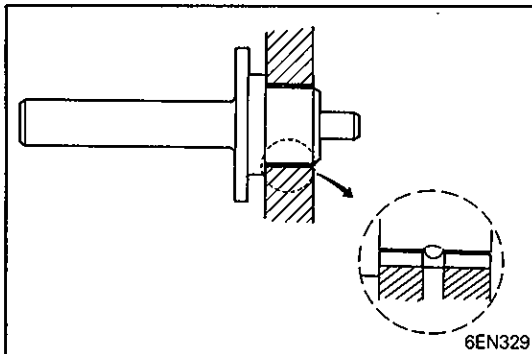
- (2) Install the guide pin of the special tool to the threaded hole of the cylinder block as illustrated.



- (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.

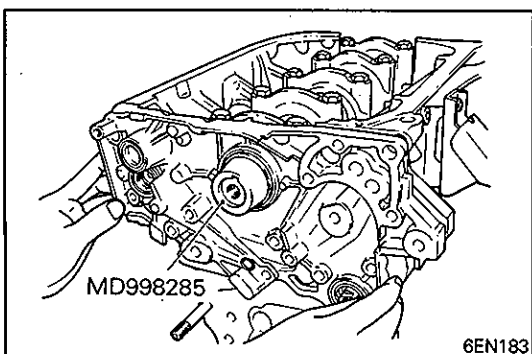


- (5) Insert the installer aligning with the guide pin and install the bearing.

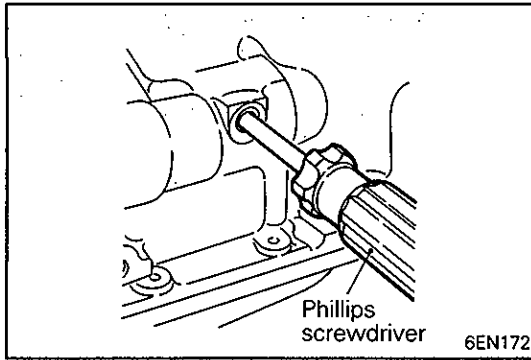


#### ◆H◆ INSTALLATION OF FRONT CASE

- (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.

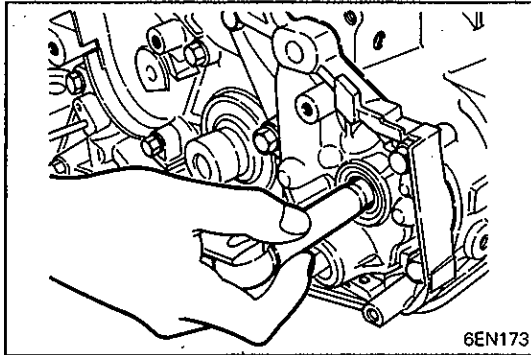


- (2) Install the front case assembly via a new front case gasket and temporarily tighten the flange bolts (other than those for tightening the filter bracket.)
- (3) Install the oil filter bracket via the oil filter bracket gasket and temporarily tighten four bolts with washers.
- (4) Tighten the front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



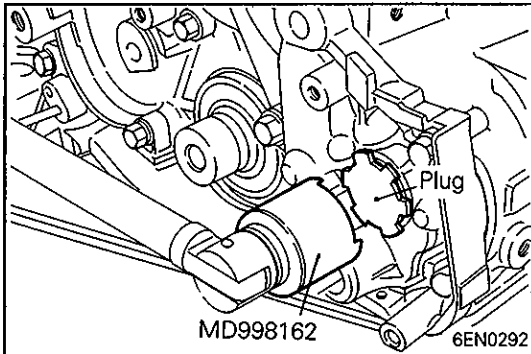
### INSTALLATION OF FLANGE BOLT

- (1) Insert a Phillips screwdriver [shank diameter 8 mm (0.32 in.)] into the plug hole on the left side of cylinder block to block the silent shaft, then tighten the flange bolt.



### INSTALLATION OF PLUG

- (1) Install the plug using the special tool.



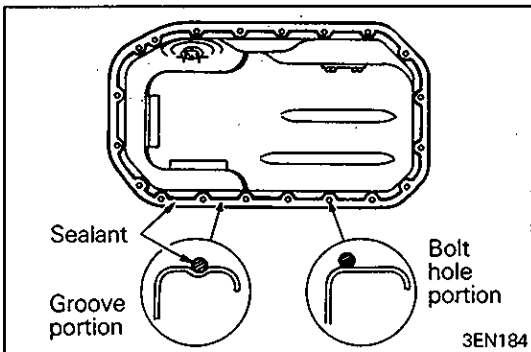
### INSTALLATION OF OIL PAN

- (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.

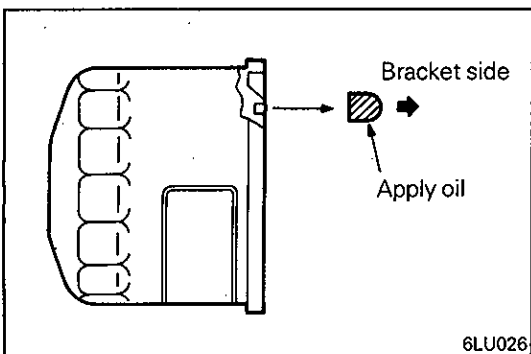


### INSTALLATION OF OIL FILTER

- (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.

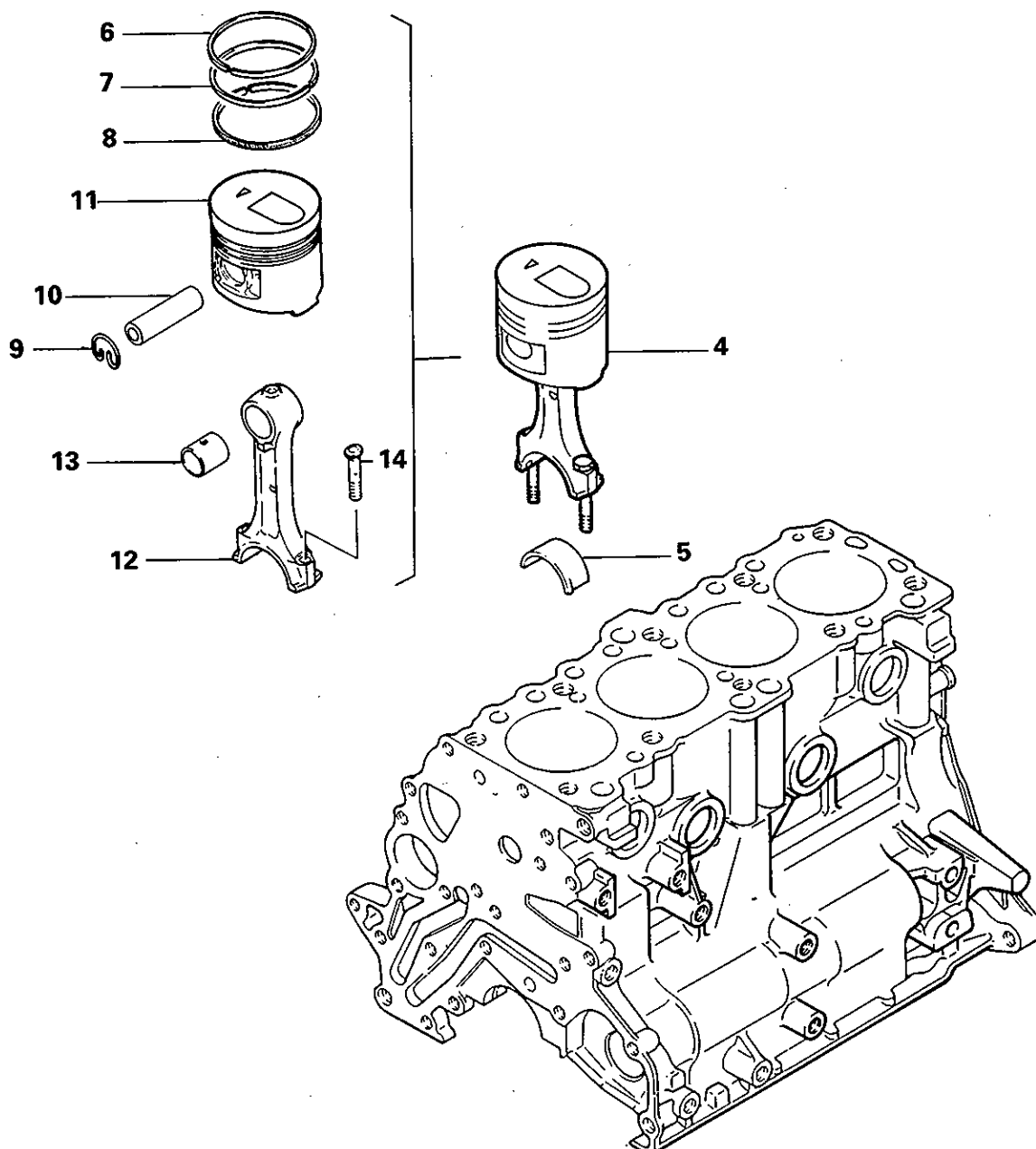
#### Caution

- Never use a wrench to tighten the oil filter.



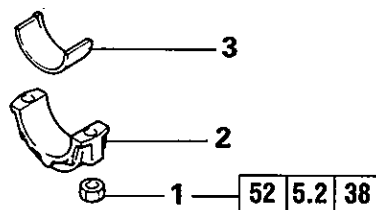
## 10. PISTON AND CONNECTING ROD

## REMOVAL AND INSTALLATION



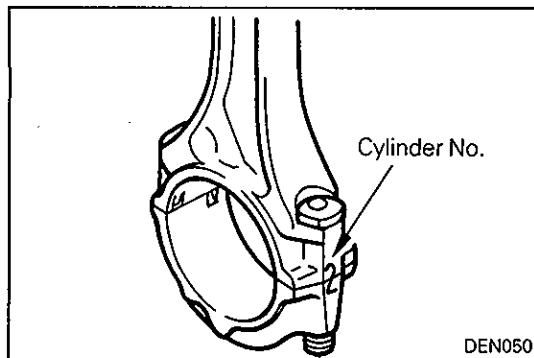
## Removal steps

1. Nut
2. Connecting rod cap
3. Connecting rod bearing
4. Piston and connecting rod assembly
5. Connecting rod bearing
6. Piston ring No. 1
7. Piston ring No. 2
8. Oil ring
9. Snap ring
10. Piston pin
11. Piston
12. Connecting rod
13. Bushing
14. Connecting rod bolt



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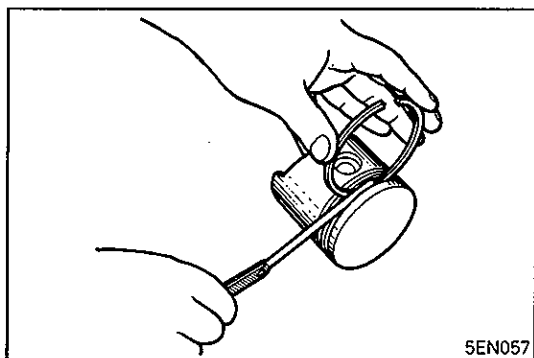




## SERVICE POINTS OF REMOVAL

### ◊A◊ REMOVAL OF CONNECTING ROD CAP

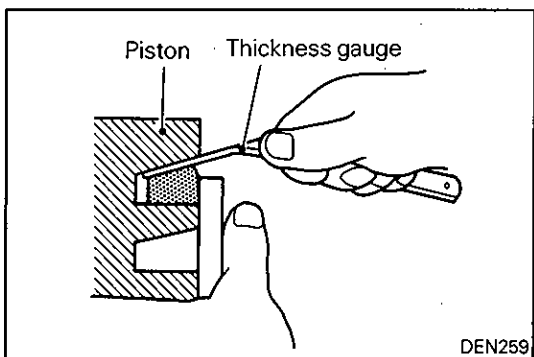
- (1) Mark the cylinder number on the side of the connecting rod big end for correct reassembly.



## INSPECTION

### PISTON RING

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



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

#### Standard Value:

##### No. 1

0.07 – 0.09 mm (0.0028 – 0.0035 in.)

##### No. 2

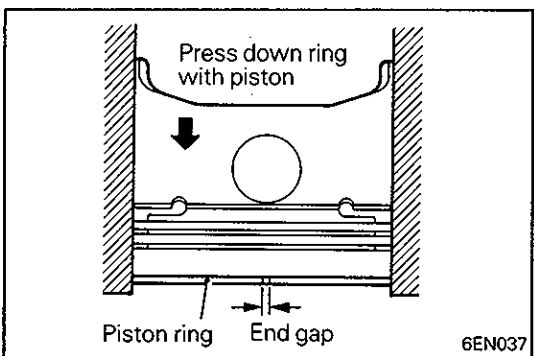
0.02 – 0.06 mm (0.0008 – 0.0024 in.) ..... N/A

0.11 – 0.13 mm (0.0043 – 0.0051 in.) .... T/C & Taxi

##### Oil

0.02 – 0.07 mm (0.0008 – 0.0028 in.)

**Limit: 0.1 mm (0.004 in.)**



- (4) 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.

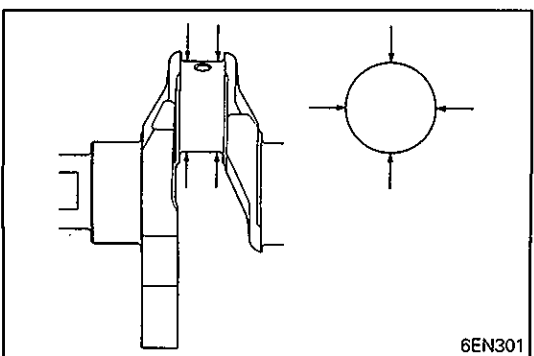
#### Standard value:

0.35 – 0.5 mm (0.0138 – 0.0197 in.) ..... No.1

0.25 – 0.4 mm (0.0098 – 0.0157 in.) ..... No.2

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

**Limit: 0.8 mm (0.031 in.)**



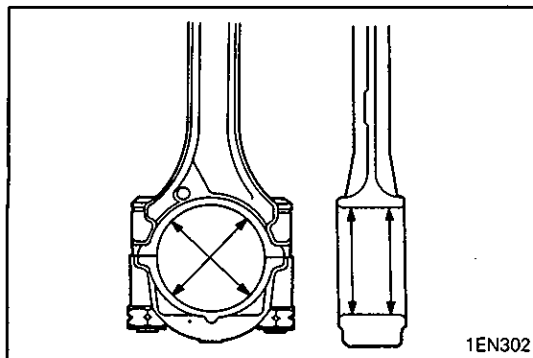
## CONNECTING ROD BEARING

- (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 grind 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.

PWEE9073



- (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: 0.1 mm (0.004 in.)**

**Crankshaft pin diameter:**

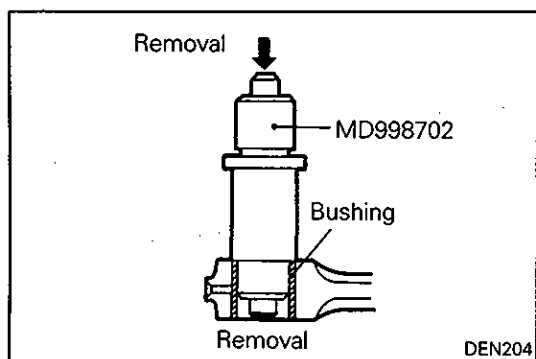
**0.25 U.S. .... 44.735 – 44.750 mm (1.7612 – 1.7618 in.)**

**0.50 U.S. .... 44.485 – 44.500 mm (1.7514 – 1.7520 in.)**

**0.75 U.S. .... 44.235 – 44.250 mm (1.7415 – 1.7421 in.)**

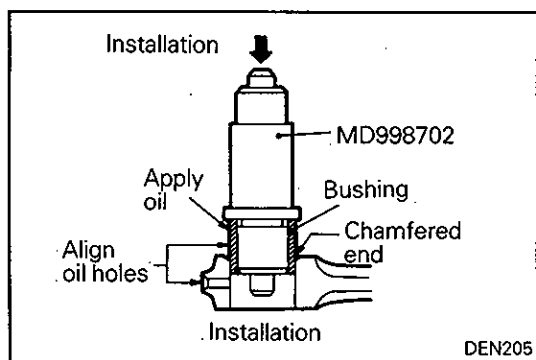
**NOTE**

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

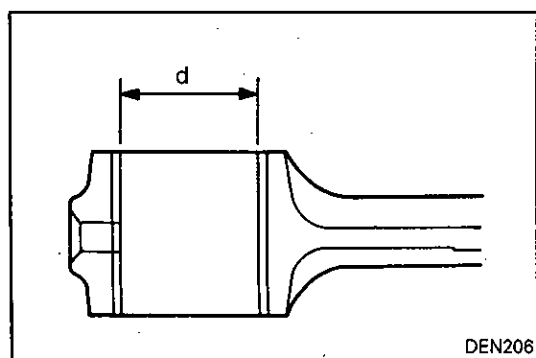


**REPLACEMENT OF CONNECTING ROD BUSHING**

- (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.



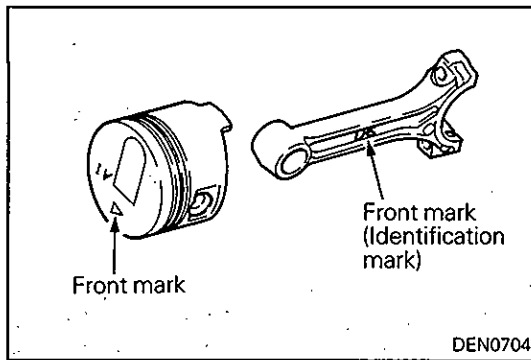
- (3) Finish the bushing I.D. to standard value.

**Bushing I.D. (d) standard value:**

**25.015 – 25.025 mm (0.9848 – 0.9852 in.)**

**Parallelism between big end center and small end center: 0.03 mm (0.0012 in.)**

**Deflection between big end center and small end center: 0.03 mm (0.0012 in.)**

**SERVICE POINTS OF INSTALLATION****◆A◆ INSTALLATION OF PISTON PIN / PISTON / CONNECTING ROD**

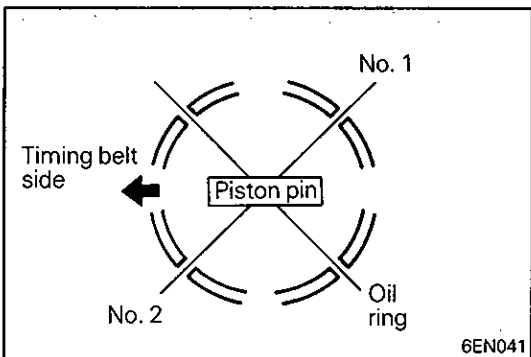
- (1) Assemble the piston and connecting rod, aligning the front marks.
- (2) Insert the piston pin. The pin should be inserted finger tight. Replace if there is a play.

	N/A	T/C	Taxi
No. 1			
No. 2			
Oil			

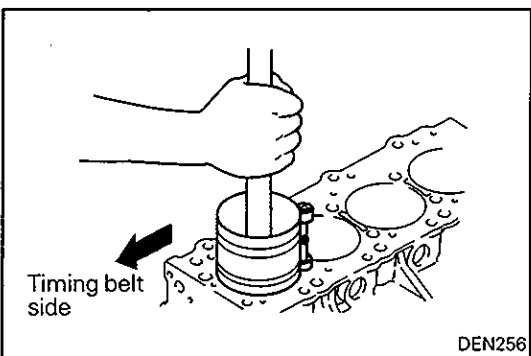
DEN0610

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

- (1) Install the oil ring expander and oil ring to the piston.
- (2) Install No. 2 piston ring and then No. 1 piston ring, facing the side with manufacturer's mark and size mark toward the piston top.

**◆C◆ INSTALLATION OF PISTON AND CONNECTING ROD ASSEMBLY**

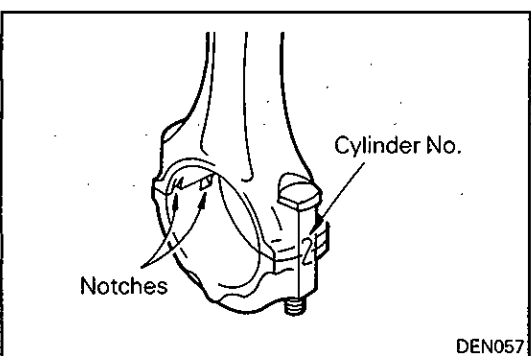
- (1) Liberally coat engine oil on the circumference of the piston, piston ring, and oil ring.
- (2) Arrange the piston ring and oil ring gaps (side rail and spacer) as shown in the figure.
- (3) Rotate crankshaft so that crank pin is on center of cylinder bore.



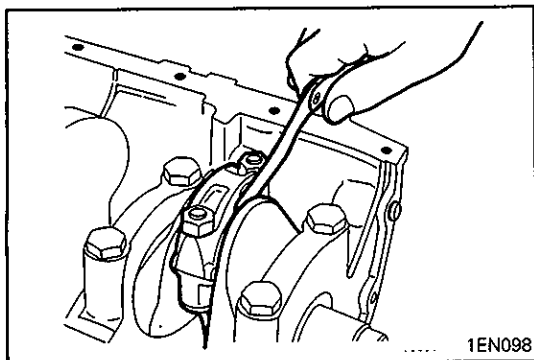
- (4) Use suitable thread protectors on connecting rod bolts before inserting piston and connecting rod assembly into cylinder block. Care must be taken not to nick crank pin.
- (5) Using a suitable piston ring compressor tool, install piston and connecting rod assembly into cylinder block.

**Caution**

- Face the front mark (arrow) on the piston top towards 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.)**

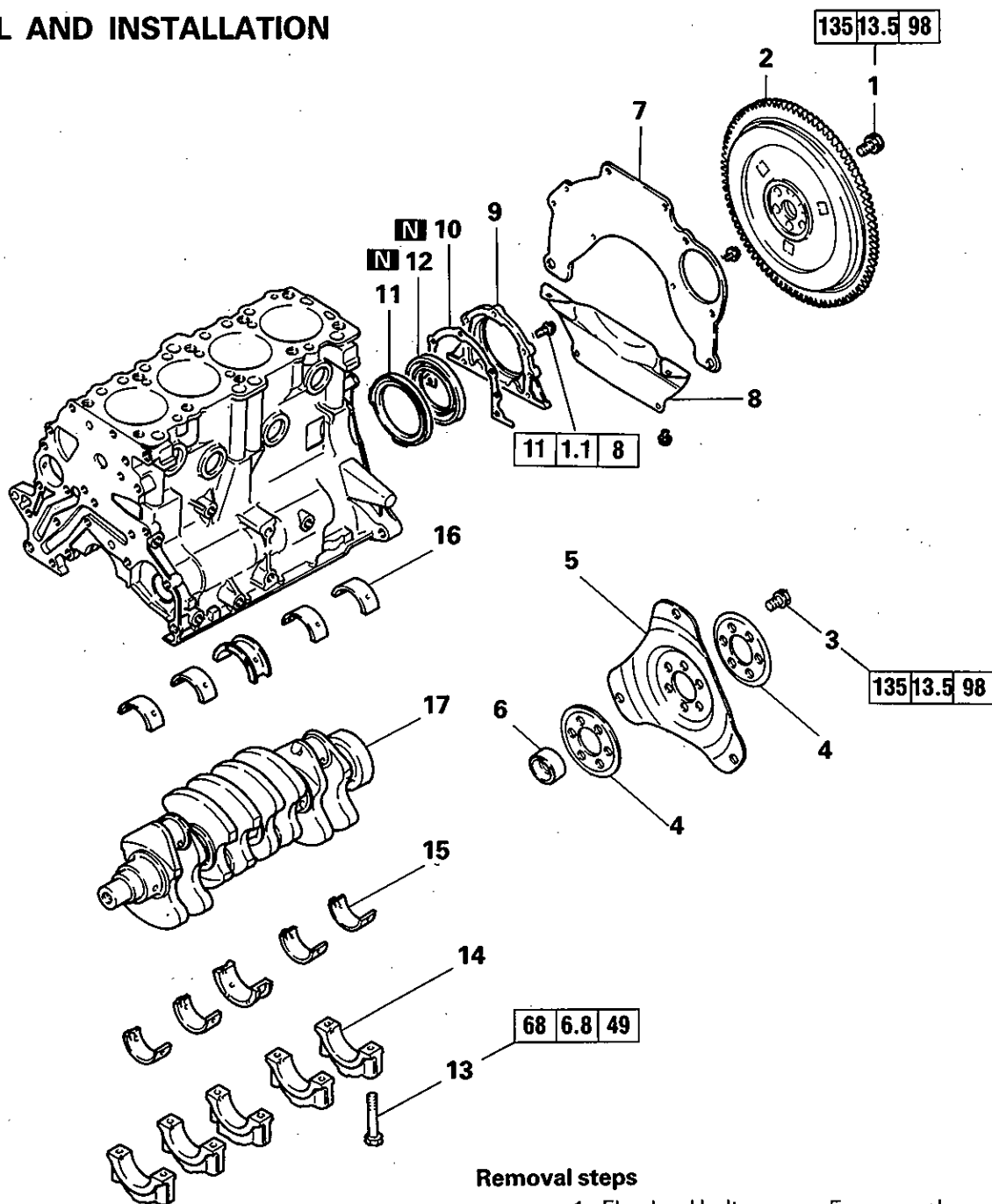
**Limit: 0.4 mm (0.0157 in.)**

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**NOTES**

## 11. CRANKSHAFT, FLYWHEEL AND DRIVE PLATE

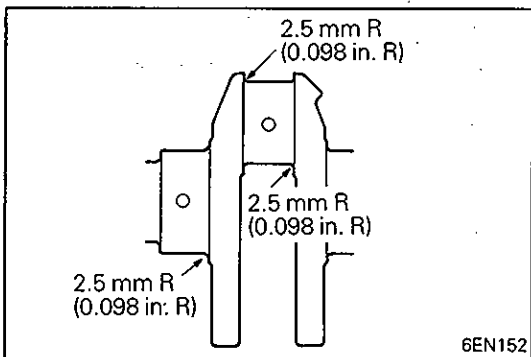
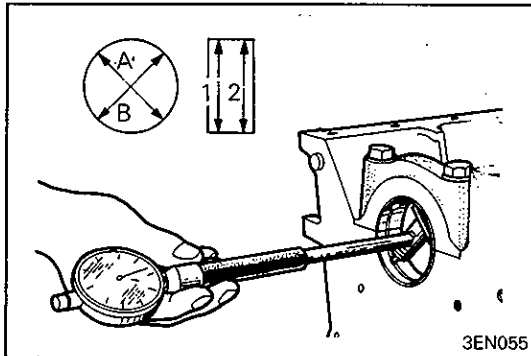
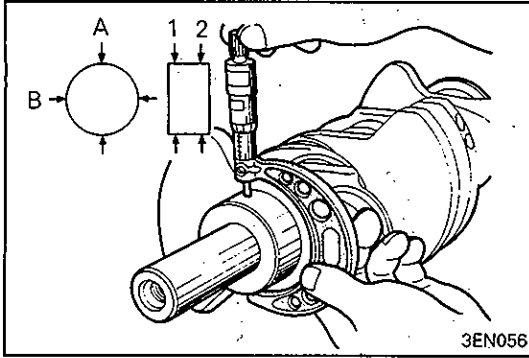
## REMOVAL AND INSTALLATION



## Removal steps

- |                               |                              |
|-------------------------------|------------------------------|
| 1. Flywheel bolt              | } For manual transmission    |
| 2. Flywheel                   |                              |
| 3. Drive plate bolt           | } For automatic transmission |
| 4. Adapter plate              |                              |
| 5. Drive plate                |                              |
| 6. Crankshaft bushing         |                              |
| 7. Rear plate                 |                              |
| 8. Bell housing cover         |                              |
| 9. Oil seal case              |                              |
| 10. Gasket                    |                              |
| 11. Oil separator             |                              |
| 12. Rear oil seal             |                              |
| 13. Bearing cap bolt          |                              |
| 14. Bearing cap               |                              |
| 15. Crankshaft bearing, lower |                              |
| 16. Crankshaft bearing, upper |                              |
| 17. Crankshaft                |                              |

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## 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 (0.004 in.)**

#### Caution

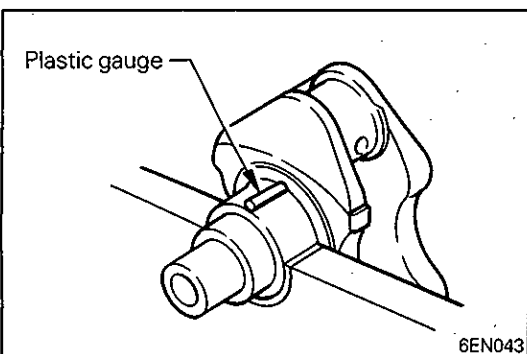
- Do not attempt an undersize machining on the crankshaft with special surface treatment which is used in engines with a turbocharger. This type of crankshaft can be identified by its dull gray appearance.

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

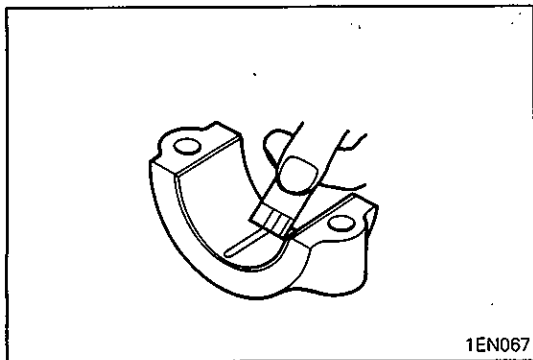
### CRANKSHAFT OIL CLEARANCE (PLASTIC GAUGE METHOD)

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

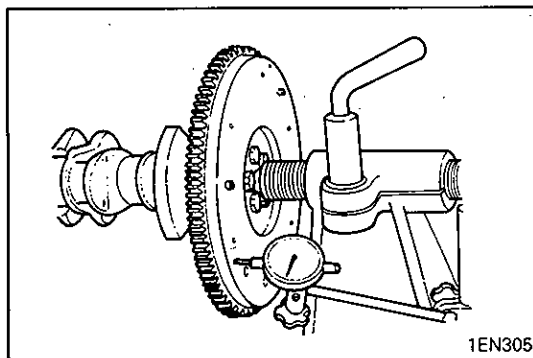
- (1) Remove oil and grease and any other foreign matters from crankshaft journal and bearing inner surface.
- (2) Install the crankshaft.



- (3) Cut the plastic gauge to the same length as the width of bearing and place it on journal in parallel with its axis.

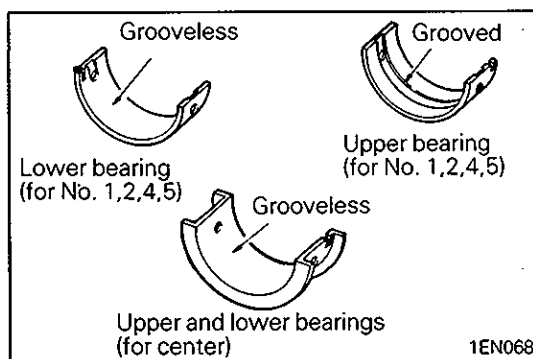


- (4) Gently place the crankshaft bearing cap over it and tighten the bolts to the specified torque.
- (5) Remove the bolts and gently remove the crankshaft bearing cap.
- (6) Measure the width of the smashed plastic gauge at its widest section by using a scale printed on the plastic gauge bag.



### FLYWHEEL

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



### SERVICE POINTS OF INSTALLATION

#### ▶A▶ INSTALLATION OF CRANKSHAFT BEARING (UPPER)

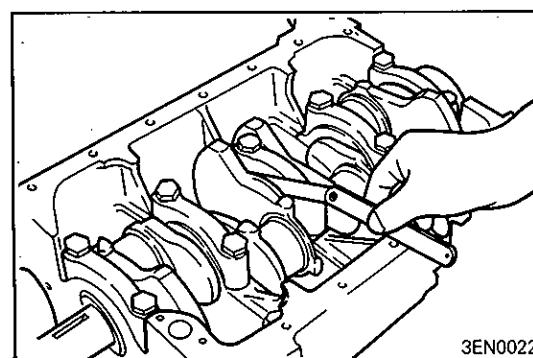
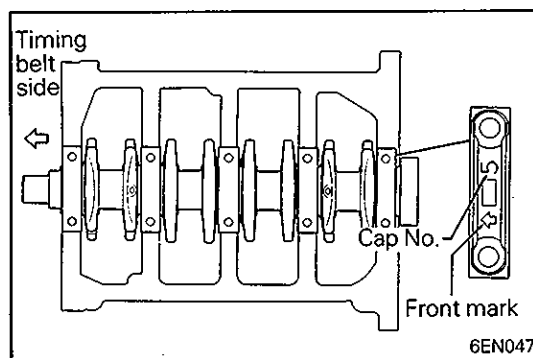
- (1) Install the upper crankshaft bearing to the cylinder block. There is an oil groove in the upper crankshaft bearing. There is no difference between upper and lower bearings for the center (with flange).

#### ▶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

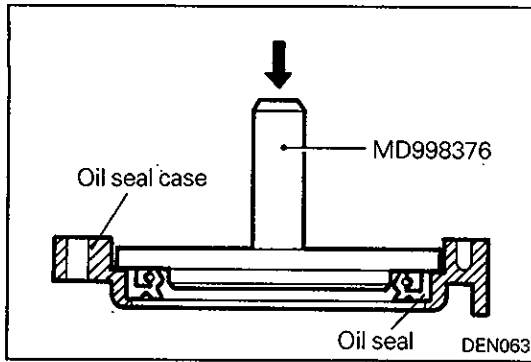
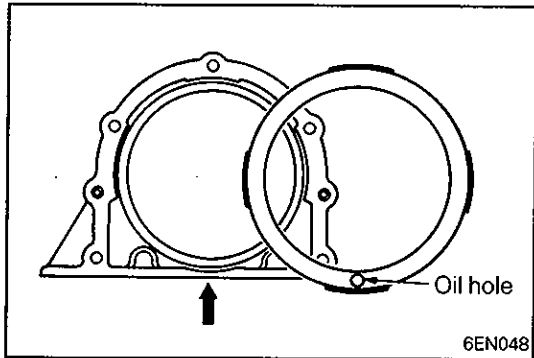
- (1) Install according to the front mark and cap No.



- (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.)**

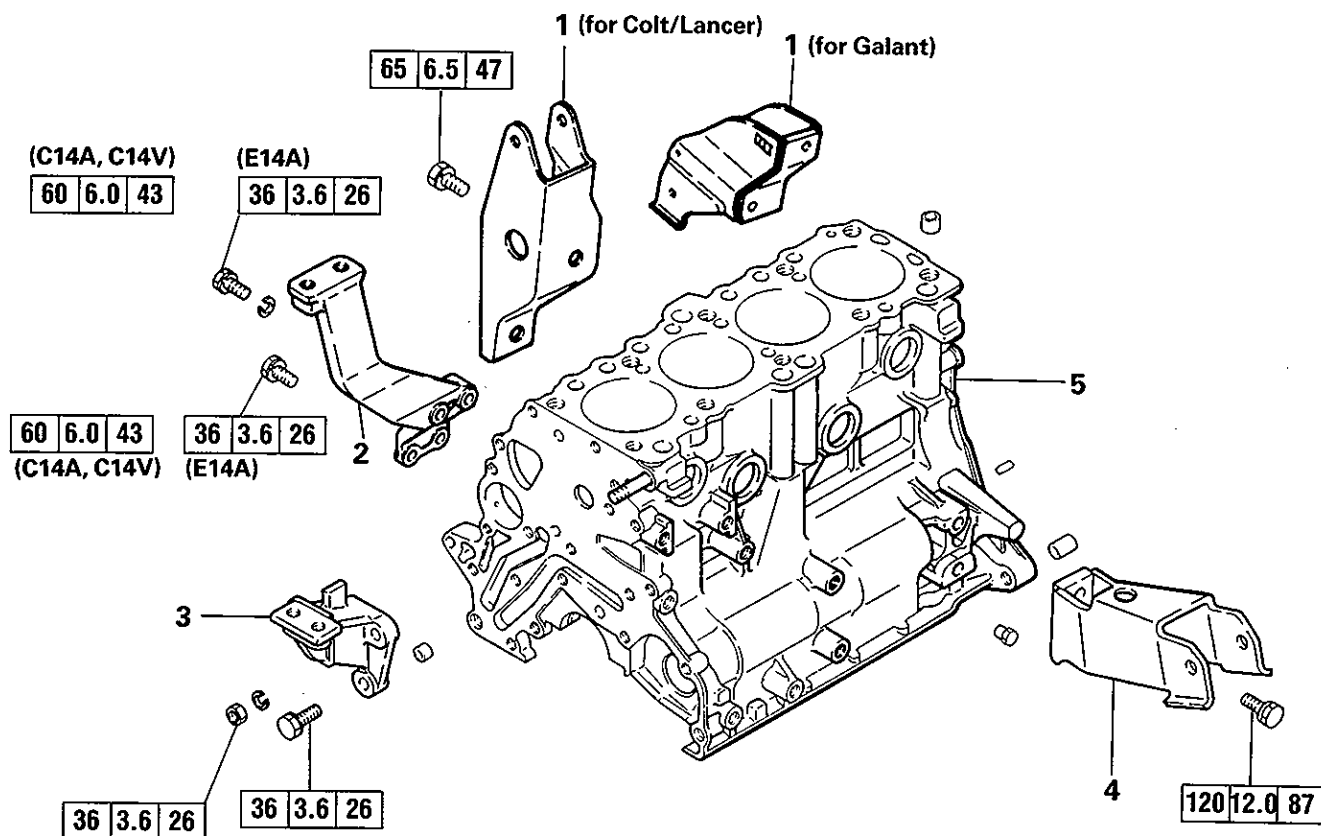


**◆D◆ INSTALLATION OF OIL SEAL****◆E◆ OIL SEPARATOR**

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

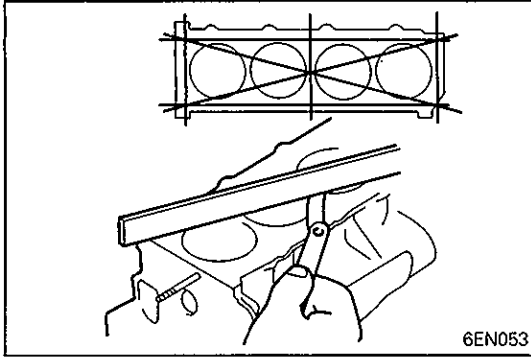
## 12. CYLINDER BLOCK

### REMOVAL AND INSTALLATION



#### Removal steps

1. Roll stopper bracket, front
2. Engine support bracket, front
3. Engine support bracket, left
4. Roll stopper bracket, rear
5. Cylinder block



### INSPECTION

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

**Standard value: 0.05 mm (0.0020 in.)**

**Limit: 0.1 mm (0.004 in.)**

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

**Cylinder block height (when new):**

**289.95 – 290.05 mm (11.4153 – 11.4193 in.)**

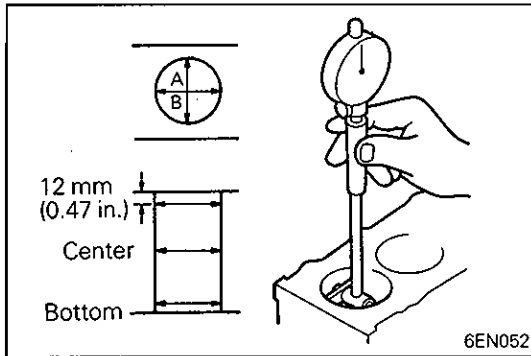
- (3) Check cylinder walls for scratches and seizure. If defects are evident, correct (bored to oversize) or replace.
- (4) Using cylinder gauge, measure the cylinder bore and cylindricity. If worn badly, correct cylinder to an oversize and replace piston and piston rings. Measure at the points shown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

**Standard value:**

**80.60 – 80.63 mm ..... Cylinder I.D.**

**(3.1732 – 3.1744 in.)**

**0.01 mm (0.0004 in.) ..... Cylindricity**



### 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.

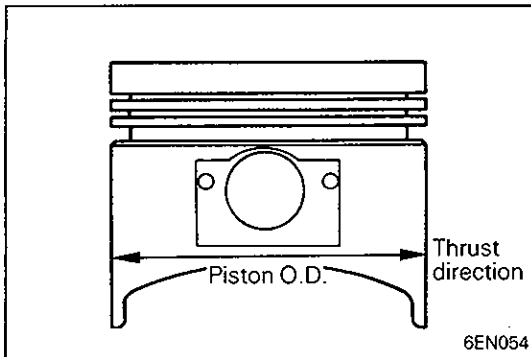
- (2) Measure the outside diameter of piston to be used. Measure it in thrust direction as shown.
- (3) Based on the measured piston O.D. calculate the boring finish dimension.

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

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

#### Caution

- To prevent distortion that may result from temperature rise during boring, bore the 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:**  
**0.03 – 0.05 mm (0.0012 – 0.0020 in.)**

**NOTE**

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

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**NOTES**