MITSUBISHI

ENGINE
4D6 SERIES

WORKSHOP MANUAL

FOREWORD

This Workshop Manual contains procedures for removal, disassembly, inspection, adjustment, reassembly and installation, etc. for service mechanics.

All information, illustrations and product descriptions contained in this manual are current as at the time of publication. We, however, reserve the right to make changes at any time without prior notice or obligation.

FILING INSTRUCTION

Please keep these manual pages in the binder No. BN890001.
File these pages according to the signs "Added", "Revised" and "Deleted" on the "List of effective pages" which are interpreted below.
Added: File the pages with this label additionally in your manual.
Revised.Deleted: Replace the existing pages with the corresponding pages with this sign.

Missing sheets will be supplied upon request.

Engine 4D65 ..... 11A

Engine 4D68 ..... 11B

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EXPLANATION OF MANUAL CONTENTS

Maintenance and Servicing Procedures

(1) A diagram of the component parts is provided near the front of each section in order to give the reader a better understanding of the installed condition of component parts.
(2) The numbers provided within the diagram indicate the sequence for maintenance and servicing procedures; the symbol ■ indicates a non-reusable part; the tightening torque is provided where applicable.

- Removal steps:
  The part designation number corresponds to the number in the illustration to indicate removal steps.
- Disassembly steps:
  The part designation number corresponds to the number in the illustration to indicate disassembly steps.
- Installation steps:
  Specified in case installation is impossible in reverse order of removal steps. Omitted if installation is possible in reverse order of removal steps.
- Reassembly steps:
  Specified in case reassembly is impossible in reverse order of disassembly steps. Omitted if reassembly is possible in reverse order of disassembly steps.

Classification of Major Maintenance/Service Points

When there are major points relative to maintenance and servicing procedures (such as essential maintenance and service points, maintenance and service standard values, information regarding the use of special tools, etc.), these are arranged together as major maintenance and service points and explained in detail.

◇A◇: Indicates that there are essential points for removal or disassembly.
◆A◆: Indicates that there are essential points for installation or reassembly.

Symbols for Lubrication, Sealants and Adhesives

Information concerning the locations for lubrication and for application of sealants and adhesives is provided, by using symbols, in the diagram of component parts, or on the page following the component parts page, and explained.

..... Grease
(multipurpose grease unless there is a brand or type specified)

..... Sealant or adhesive

..... Brake fluid, automatic transmission fluid or air conditioner compressor oil

..... Engine oil or gear oil

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Indicates the group title.

Indicates the section title.

Indicates the group number.

Indicates the section number.

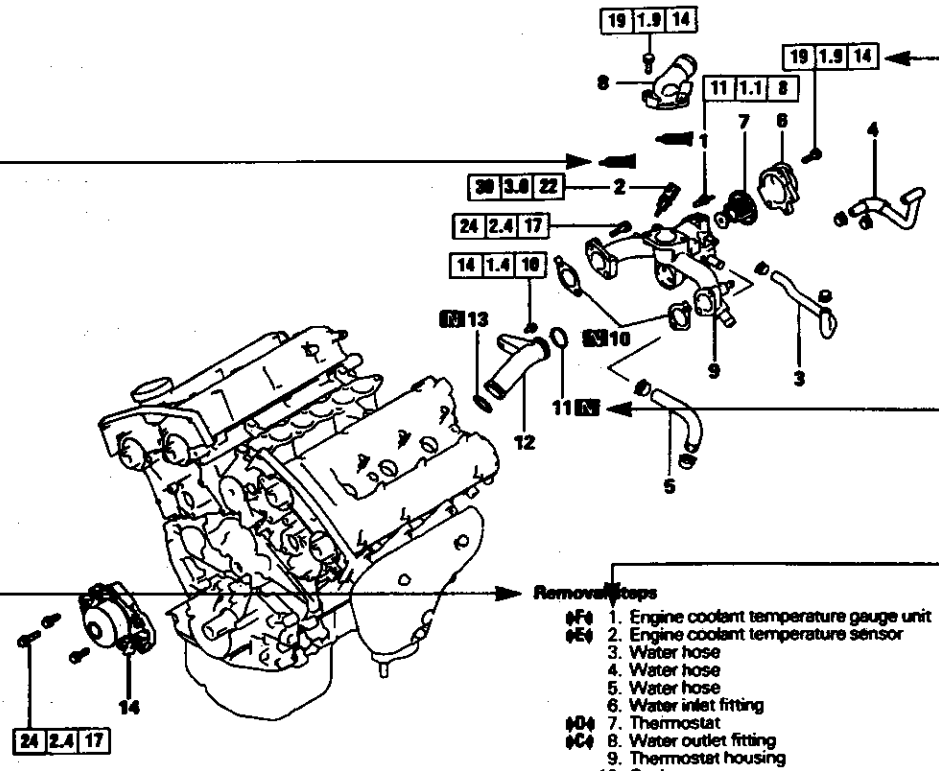
Indicates the page number.

7. WATER PUMP AND WATER PIPE

REMOVAL AND INSTALLATION

Denotes tightening torque.

Nm	Kgm	ft.lbs.



Denotes non-reusable part.

This number corresponds to the number appearing in "Removal steps", "Disassembly steps", "Installation steps" or "Reassembly steps".

Removal steps

- ◆F◆ 1. Engine coolant temperature gauge unit
- ◆E◆ 2. Engine coolant temperature sensor
- 3. Water hose
- 4. Water hose
- 5. Water hose
- 6. Water inlet fitting
- ◆D◆ 7. Thermostat
- ◆C◆ 8. Water outlet fitting
- 9. Thermostat housing
- 10. Gasket
- ◆B◆ 11. O-ring
- ◆B◆ 12. Water pipe
- ◆B◆ 13. O-ring
- ◆A◆ 14. Water pump

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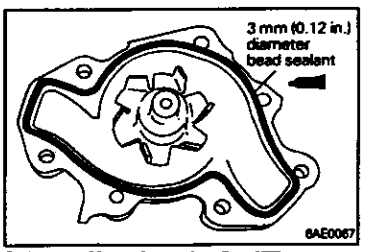

INSTALLATION SERVICE POINTS

◆A◆ **SEALANT APPLICATION TO WATER PUMP**

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent

Operating procedures, cautions, etc. on removal, installation, disassembly and reassembly are described.

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Issue date

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List of Effective Pages

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ENGINE

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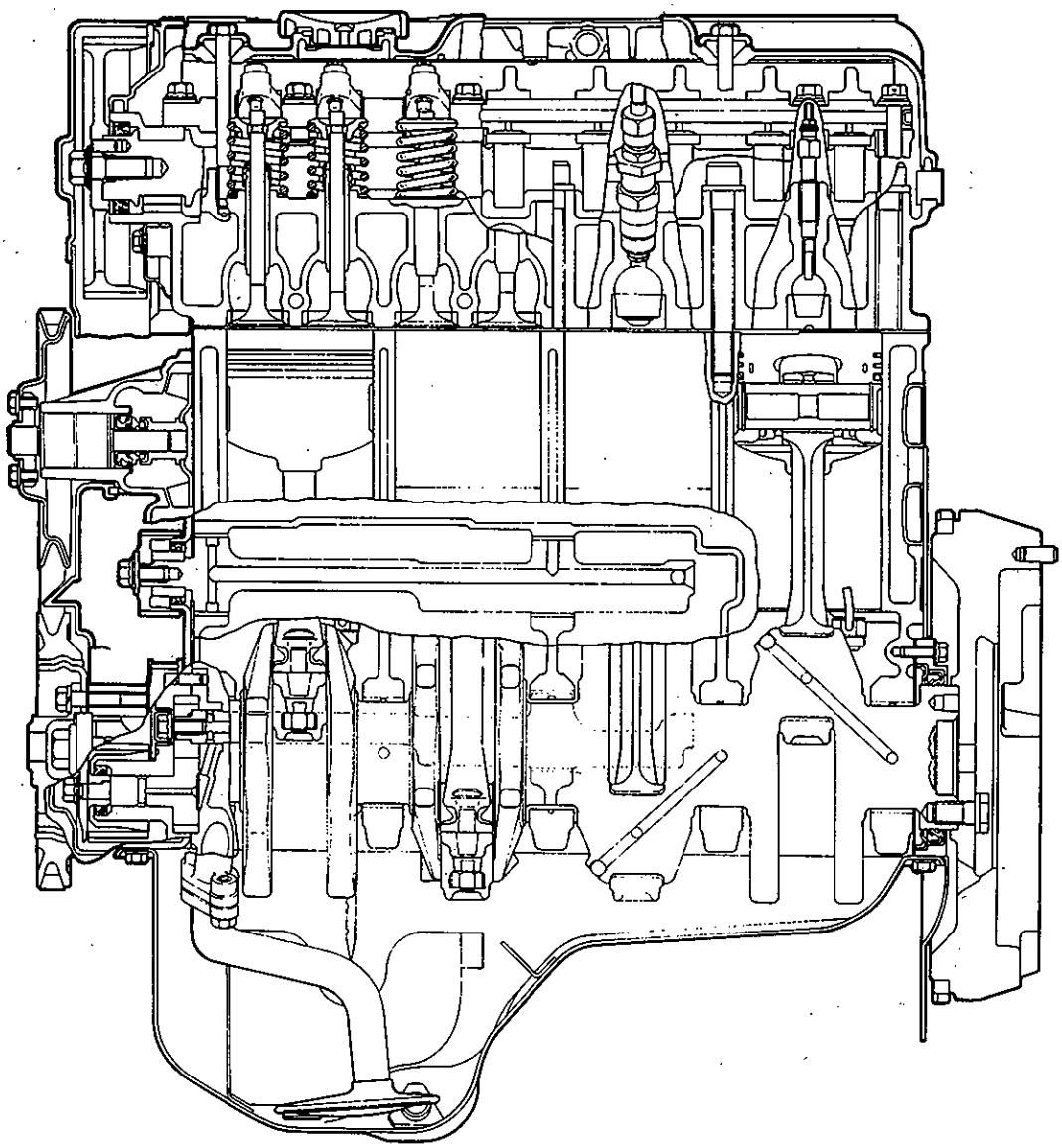
GENERAL INFORMATION

ENGINE SECTIONAL VIEW



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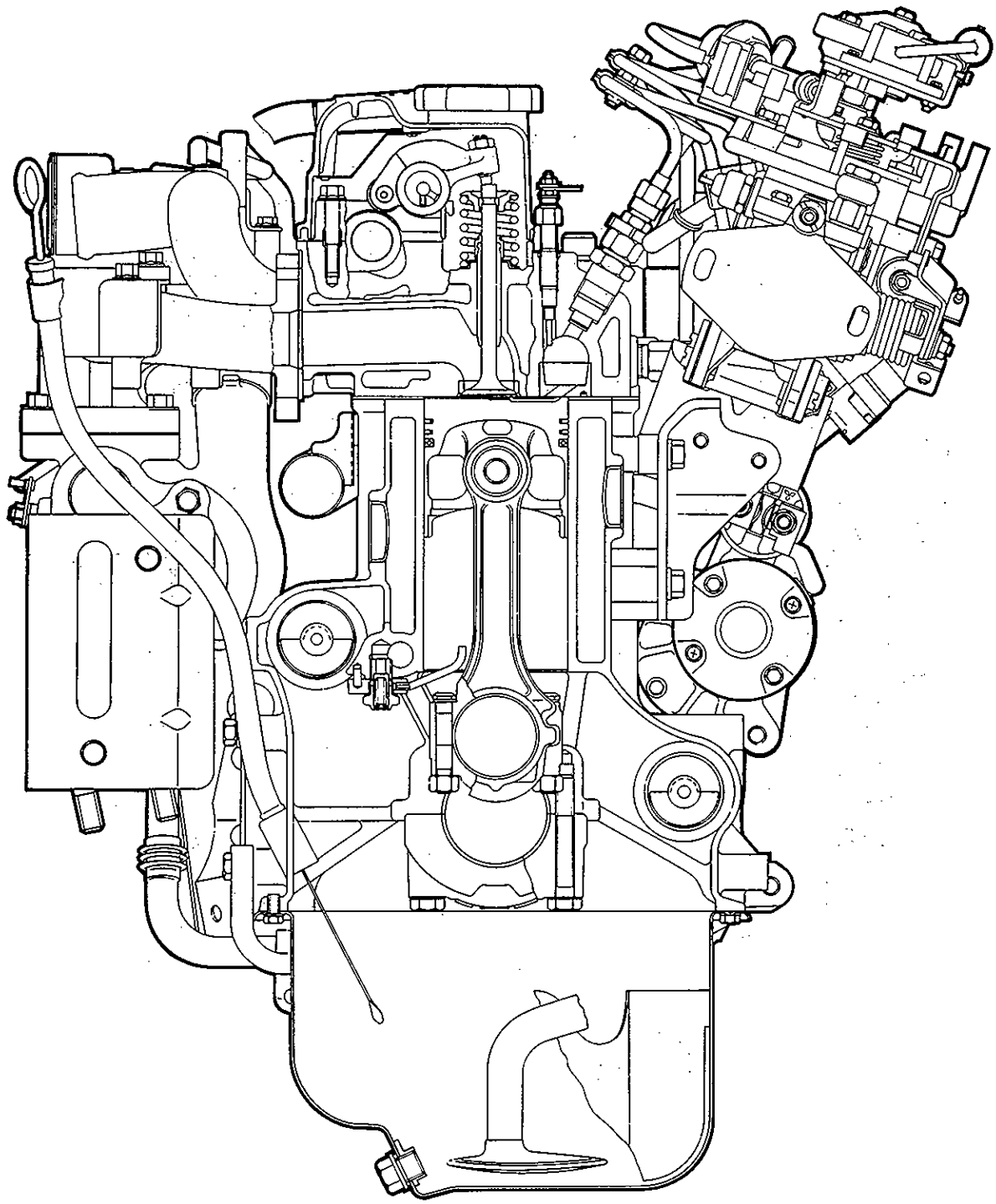

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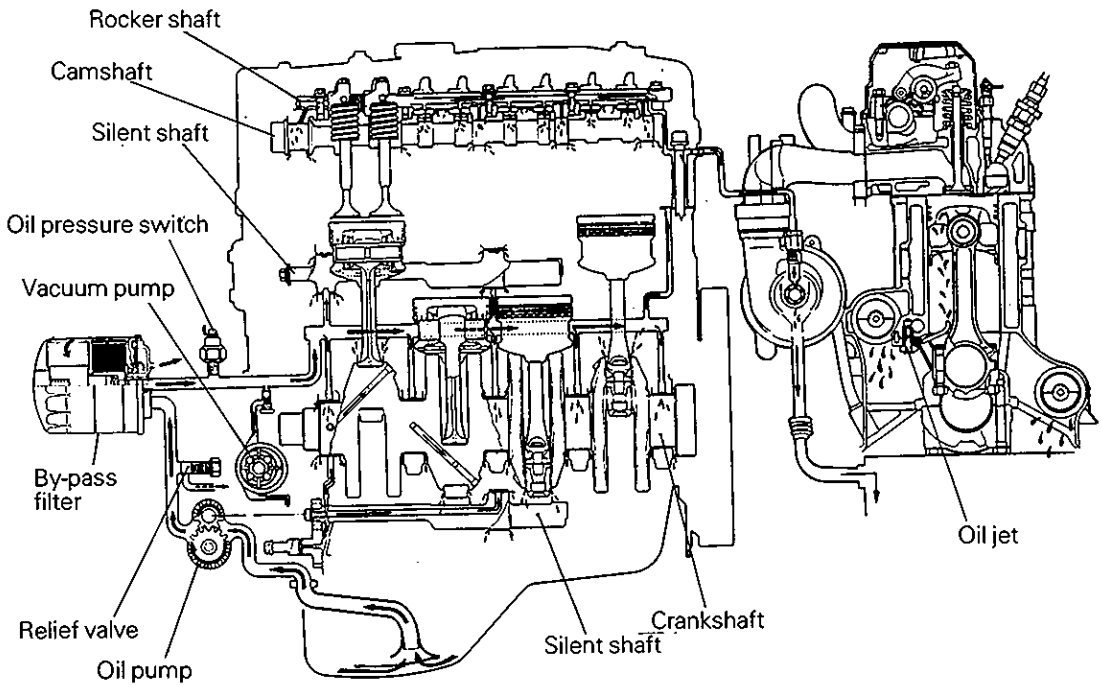
LUBRICATION SYSTEM



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NOTES

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1. SPECIFICATIONS

GENERAL SPECIFICATIONS

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

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SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
Cylinder head		
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)	
Camshaft		
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)	
Rocker arm		
I.D.	18.910 – 18.928 (0.7445 – 0.7452)	
Rocker arm-to-shaft clearance	0.01 – 0.05 (0.0004 – 0.0020)	
Rocker shaft		
O.D.	18.878 – 18.898 (0.7432 – 0.7440)	
Overall length	410 (16.14)	
Valve		
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) 0.10 (0.0039)
Exhaust	0.05 – 0.09 (0.0020 – 0.0035)	0.15 (0.0059)

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mm (in.)

	Standard	Limit
Valve spring		
Free height	49.1 (1.934)	48.1 (1.895)
Load/installed height N (kg, lbs.)/mm (in.)	276 (27.6, 61)/40.4 (1.591)	
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) over size	
Press-in temperature	Room temperature	
Valve seat		
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	
Silent shaft		
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)	
Piston		
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	
Piston ring		
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) T/C & Taxi: 0.11 – 0.13 (0.0043 – 0.0051)	0.1 (0.004) 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	

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mm (in.)

	Standard	Limit
Piston pin		
O.D.	24.994 – 25.000 (0.9840 – 0.9843)	
Connecting rod		
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)
Crankshaft		
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)	
Cylinder block		
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)	
Flywheel		
Runout		0.13 (0.0051)
Oil pump		
Side clearance		
Drive gear	0.08 – 0.14 (0.0031 – 0.0055)	
Driven gear	0.06 – 0.12 (0.0024 – 0.0047)	
Drive belt		
Deflection	7 – 10 (0.28 – 0.39)	
Thermostat		
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

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mm (in.)

	Standard	Limit
Coolant temperature gauge unit		
Resistance		
Coolant temperature gauge element	90.5 – 117.5 Ω / 70°C (158°F)	
	21.3 – 26.3 Ω / 115 °C (239°F)	
Glow control element	22.3 – 27.3 kΩ / –20°C (–4°F)	
	2.92 – 3.58 kΩ / 20°C (68°F)	

TORQUE SPECIFICATIONS

	Torque		
	Nm	kgm	ft.lbs.
Drive belt and timing belt			
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
Intake and exhaust manifolds			
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
Turbocharger			
Waste gate actuator bolt	12	1.2	9
Coupling bolt	5	0.5	4

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	Torque		
	Nm	kgm	ft.lbs.
Water pump, thermostat, hose and pipe			
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
Rocker arm, rocker shaft and camshaft			
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
Cylinder head, valves and valve spring			
Cylinder head bolt	110	11.0	80
Front case, silent shaft and oil pan			
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
Piston and connecting rod			
Connecting rod cap nut	52	5.2	38
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	68	6.8	49
Cylinder block			
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

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SEALANT

	Specified sealant	Quantity
Semi-circular packing	3M ATD Part No. 8660 or equivalent	As required
Oil pan gasket	MITSUBISHI GENUINE Part No. MD997110 or equivalent	As required
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

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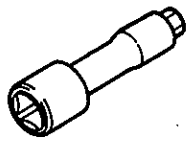
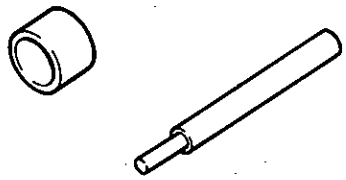
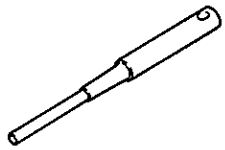
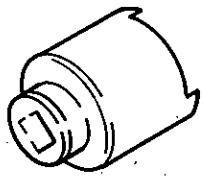
2. SPECIAL TOOLS

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

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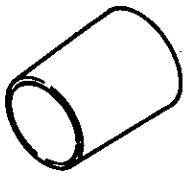
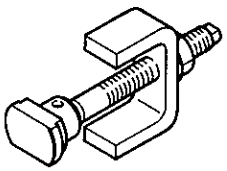
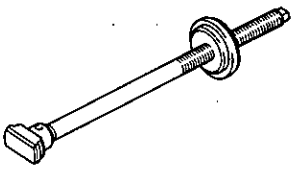
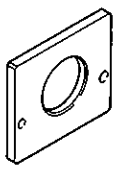
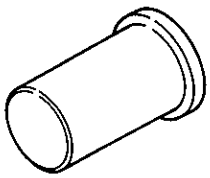
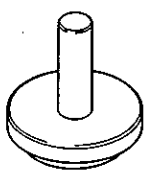
Tool	Number	Name	Use
	MD998285	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal
	MD998364	Camshaft oil seal installer	Installation of camshaft oil seal
	MD998371	Silent shaft bearing puller	Removal of silent shaft front bearing
	MD998372	Silent shaft bearing puller	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

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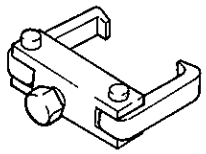
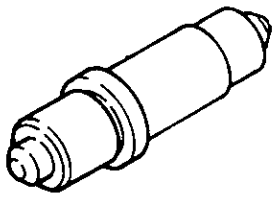
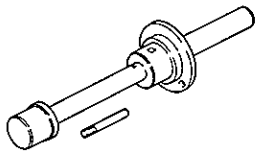
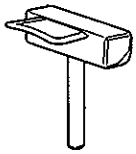
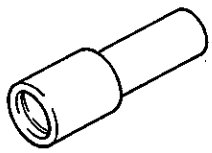
Tool	Number	Name	Use
	MD998388	Injection pump sprocket puller	Removal of injection pump sprocket
	MD998702	Connecting-rod small-end bushing replacement tool	Replacement of connecting-rod small-end bushing
	MD998705	Silent shaft bearing installer	Installation of silent shaft bearing
	MD998727	Oil pan sealer cutter	Removal of oil pan
	MD998729	Valve stem seal installer	Installation of valve stem seal

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NOTES

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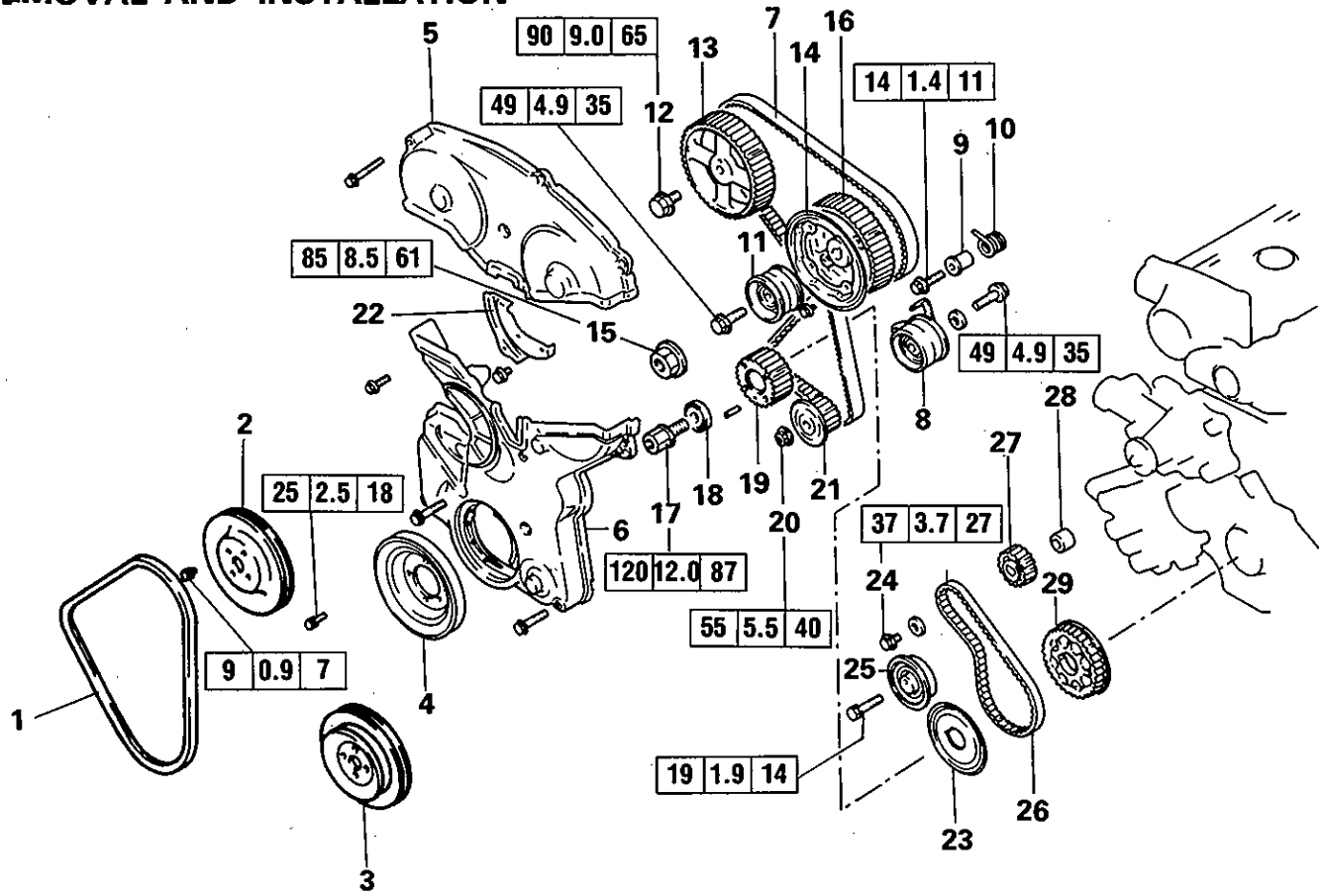
3. DRIVE BELT AND TIMING BELT

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
◇A◇ 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
◇B◇ 16. Injection pump sprocket
17. Bolt
18. Special washer
19. Crankshaft sprocket
◇C◇ 20. Flange nut
21. Oil pump sprocket
22. Cover
23. Flange
24. Bolt
25. Tensioner "B"
◇D◇ 26. Timing belt "B"
27. Silent shaft sprocket
28. Spacer
29. Crankshaft sprocket "B"

Installation step

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

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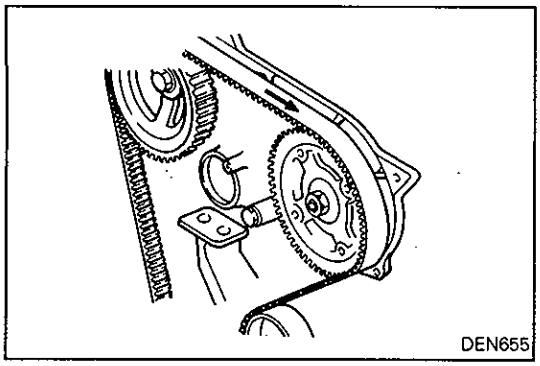
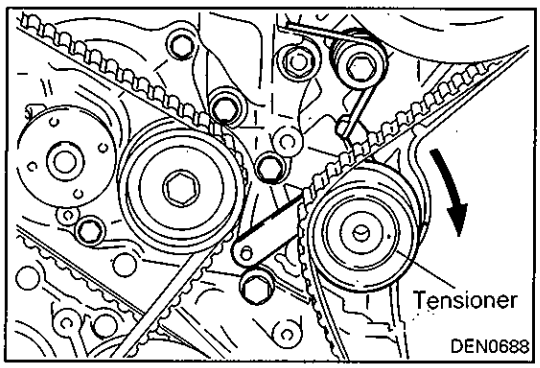


SERVICE POINTS OF REMOVAL

◇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.



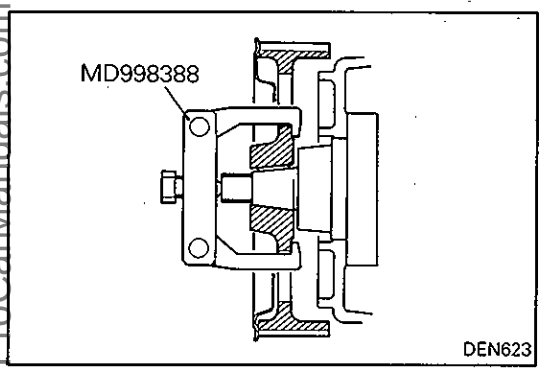
(2) With the timing belt tensioner pushed down, tighten the tensioner mounting bolt temporarily to hold the tensioner in place.

(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.

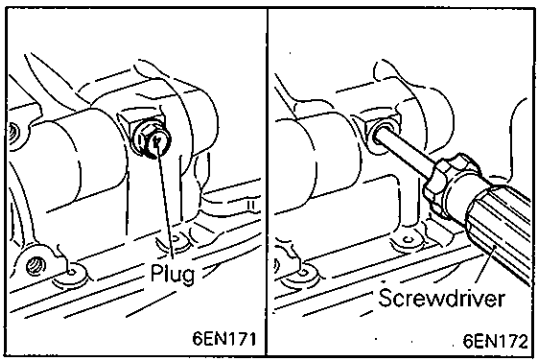


◇B◇ REMOVAL OF INJECTION PUMP SPROCKET

(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.**

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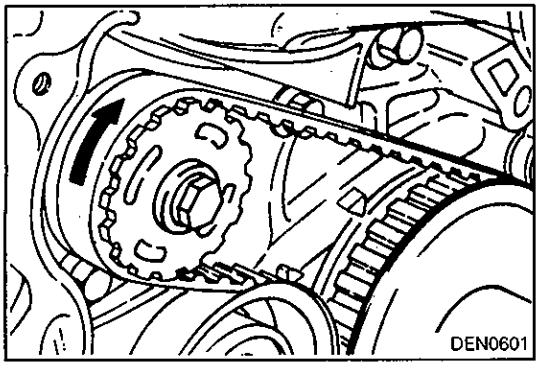


◇D◇ REMOVAL OF TIMING BELT "B"

(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.

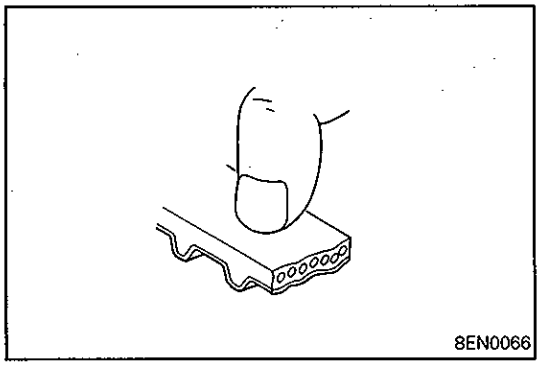
NOTE
(1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
(2) If there is oil or water on any part, check front case oil seals, camshaft oil seal and water pump for leaks.

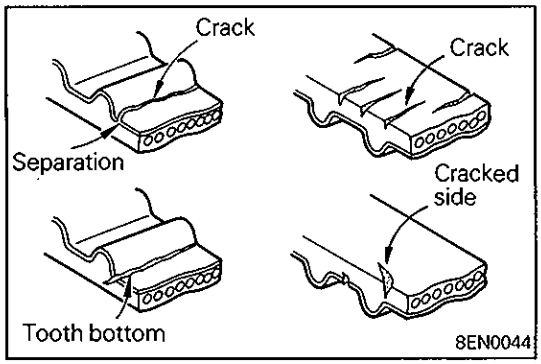
INSPECTION

TIMING BELTS

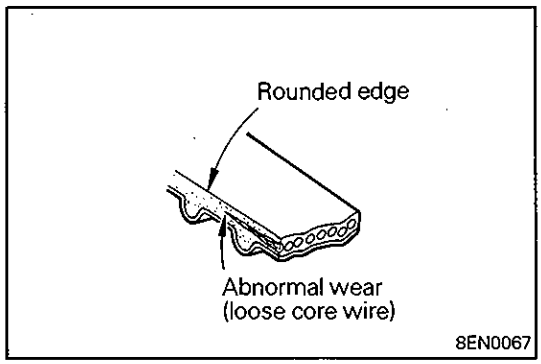
The timing belts must be checked closely. Should the following defects be evident, replace the belt with a new one.

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



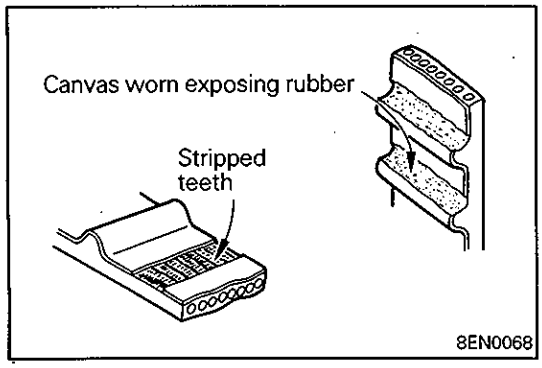


(2) Cracked back surface rubber
(3) Cracked or separated canvas
(4) Cracked tooth bottom
(5) Cracked side



(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

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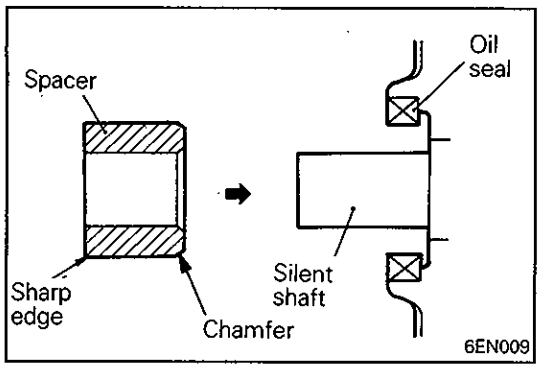
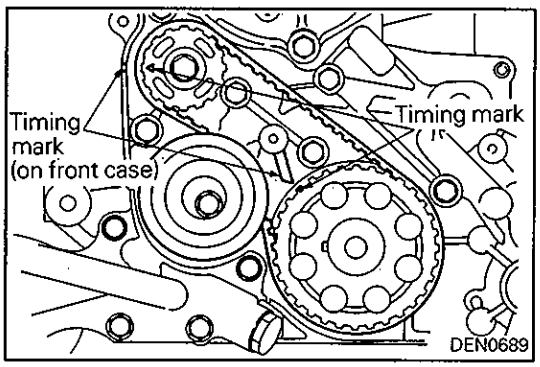


SERVICE POINTS OF INSTALLATION

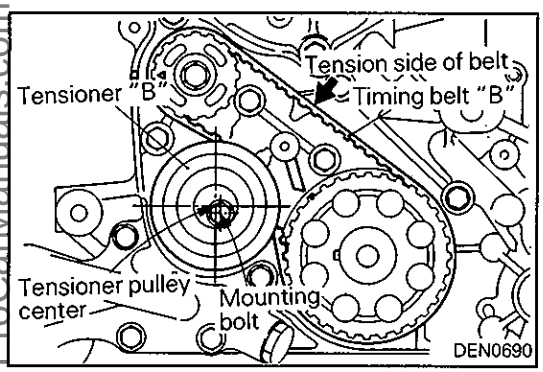
◆A◆ INSTALLATION OF SPACER

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

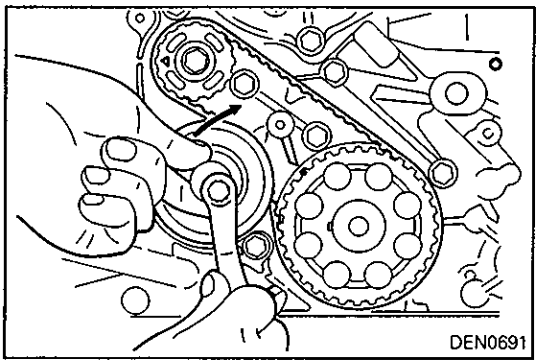


◆B◆ INSTALLATION OF TIMING BELT "B"

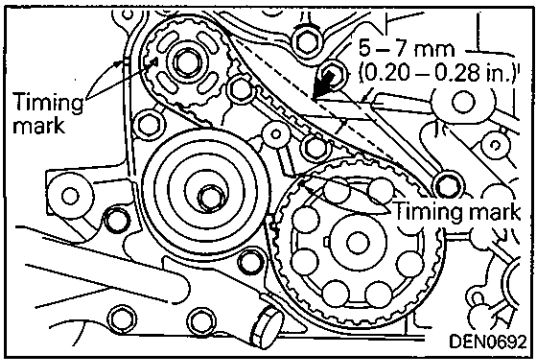
(1) Align timing marks on the crankshaft sprocket "B" and silent shaft sprocket with the marks on the front case respectively.
(2) Install the timing belt "B" on the crankshaft sprocket "B" and silent shaft sprocket. There should be no slack on the tension side.



(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.)

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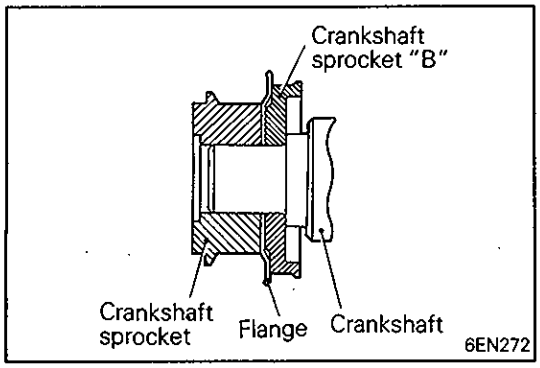
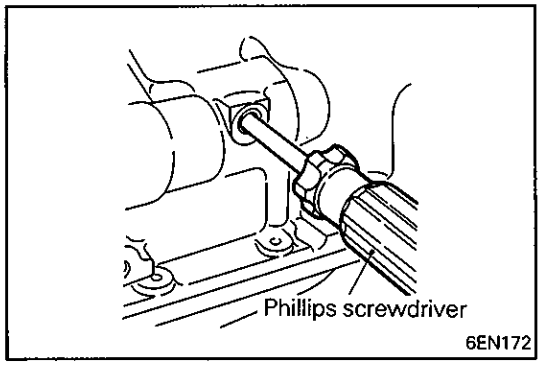


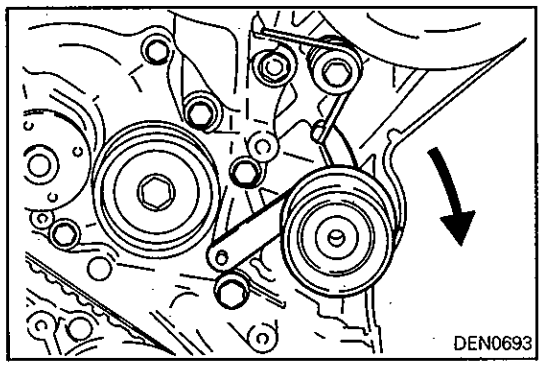
◆C◆ INSTALLATION OF FLANGE AND CRANKSHAFT SPROCKET

(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.

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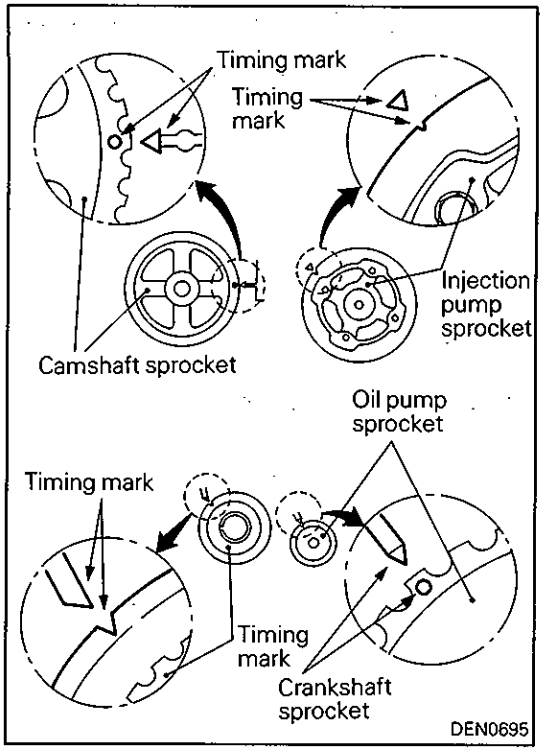
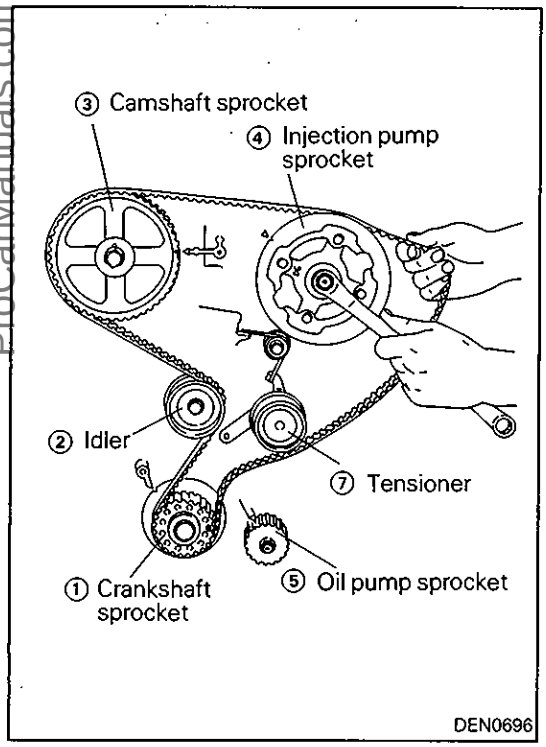


(3) Turn the crankshaft to bring the No. 1 piston at the top dead center on compression stroke.
(4) Align the timing marks of all sprockets with their mating marks as shown.

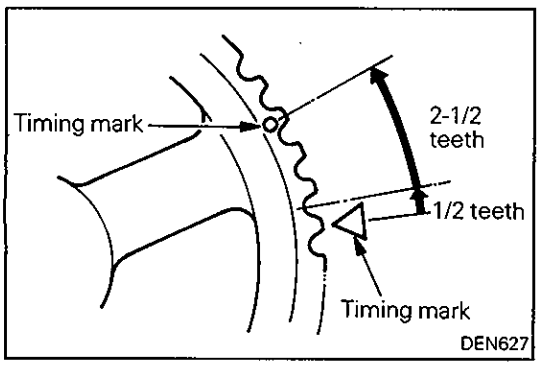
NOTE
If the injection pump sprocket is released, it turns about one tooth in a counterclockwise direction. Therefore, the timing mark of the injection pump sprocket should be aligned when the timing belt is installed.



(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.

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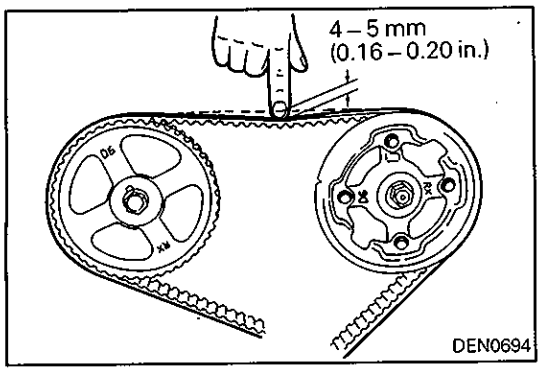
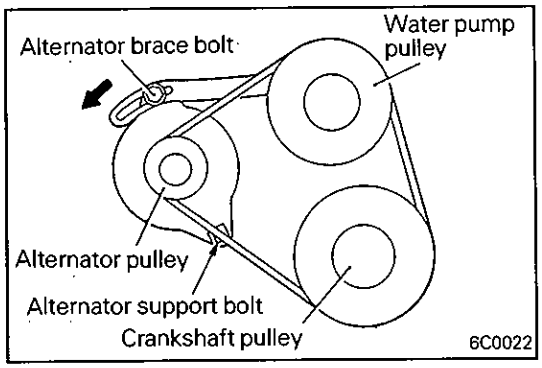
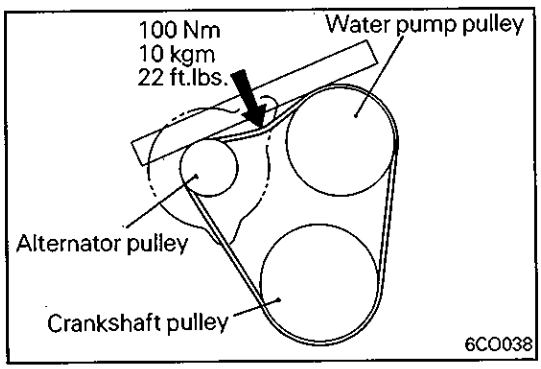


(10)Check that the belt deflects 4 – 5 mm (0.16 – 0.20 in.) when its midpoint is pushed by an index finger.

(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

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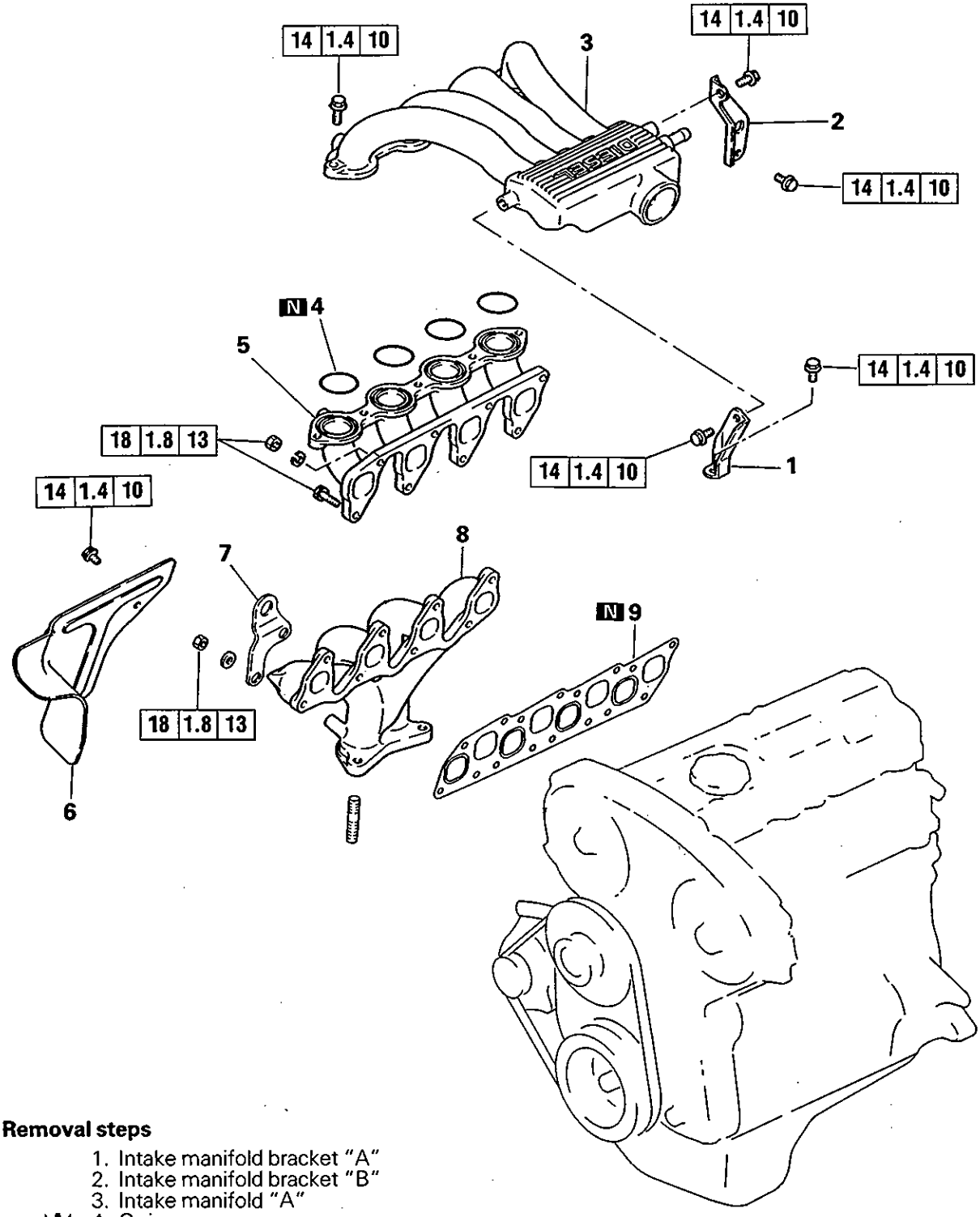
4. INTAKE AND EXHAUST MANIFOLDS

REMOVAL AND INSTALLATION

<Engine without turbocharger>



Removal steps

1. Intake manifold bracket "A"
2. Intake manifold bracket "B"
3. Intake manifold "A"

▶A◀ 4. O-ring

5. Intake manifold "B"
6. Heat protector
7. Engine hanger
8. Exhaust manifold
9. Exhaust manifold gasket

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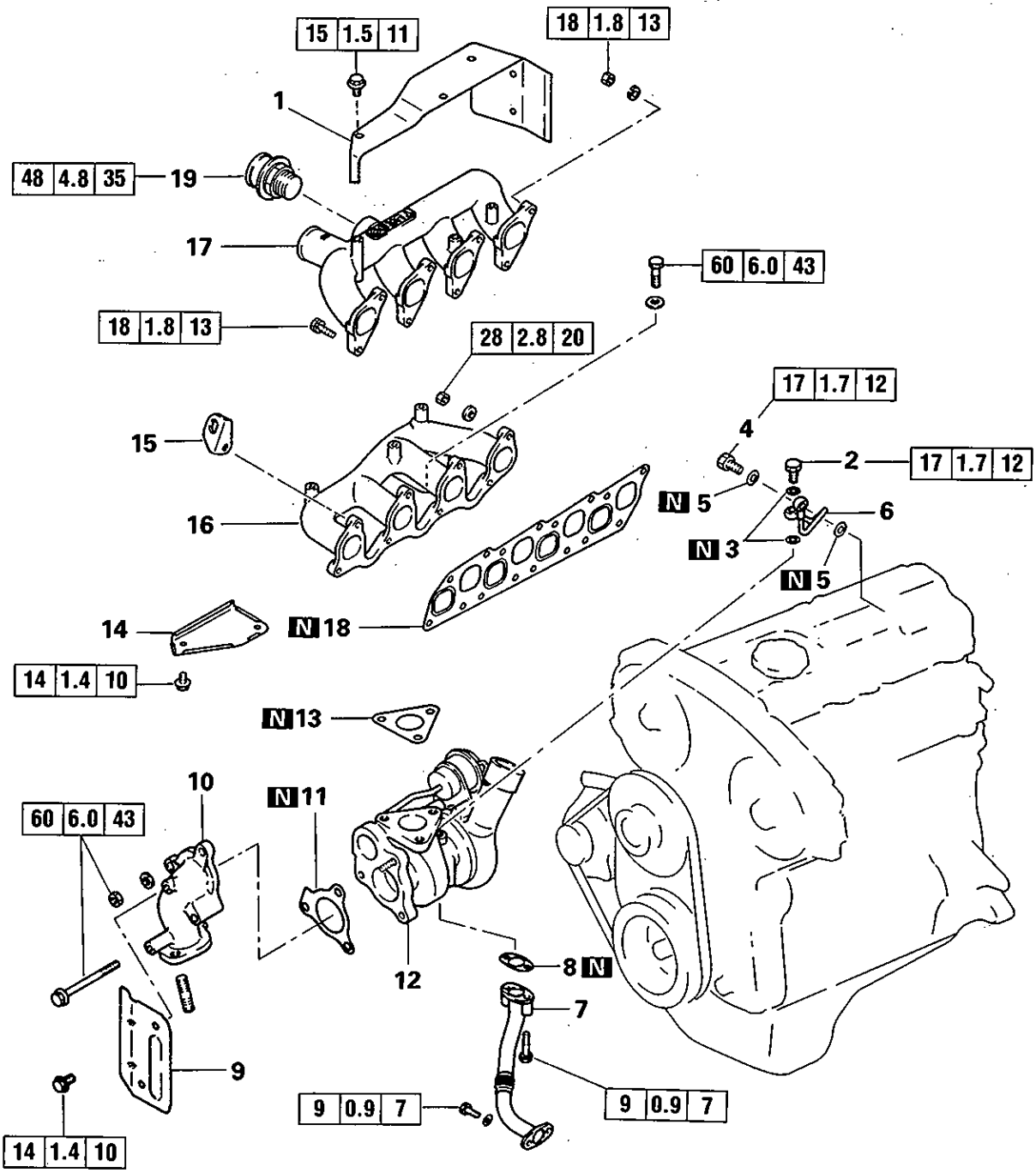
REMOVAL AND INSTALLATION

<Engine with turbocharger>



Removal steps

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

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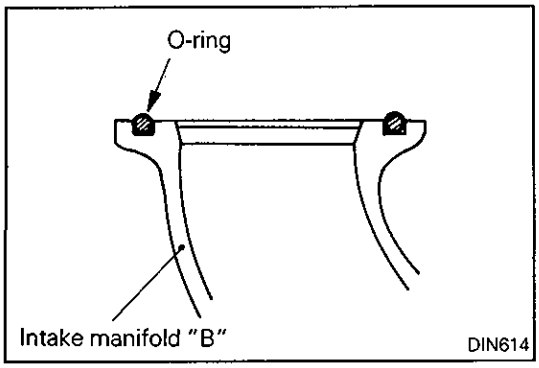

SERVICE POINTS OF INSTALLATION

◆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

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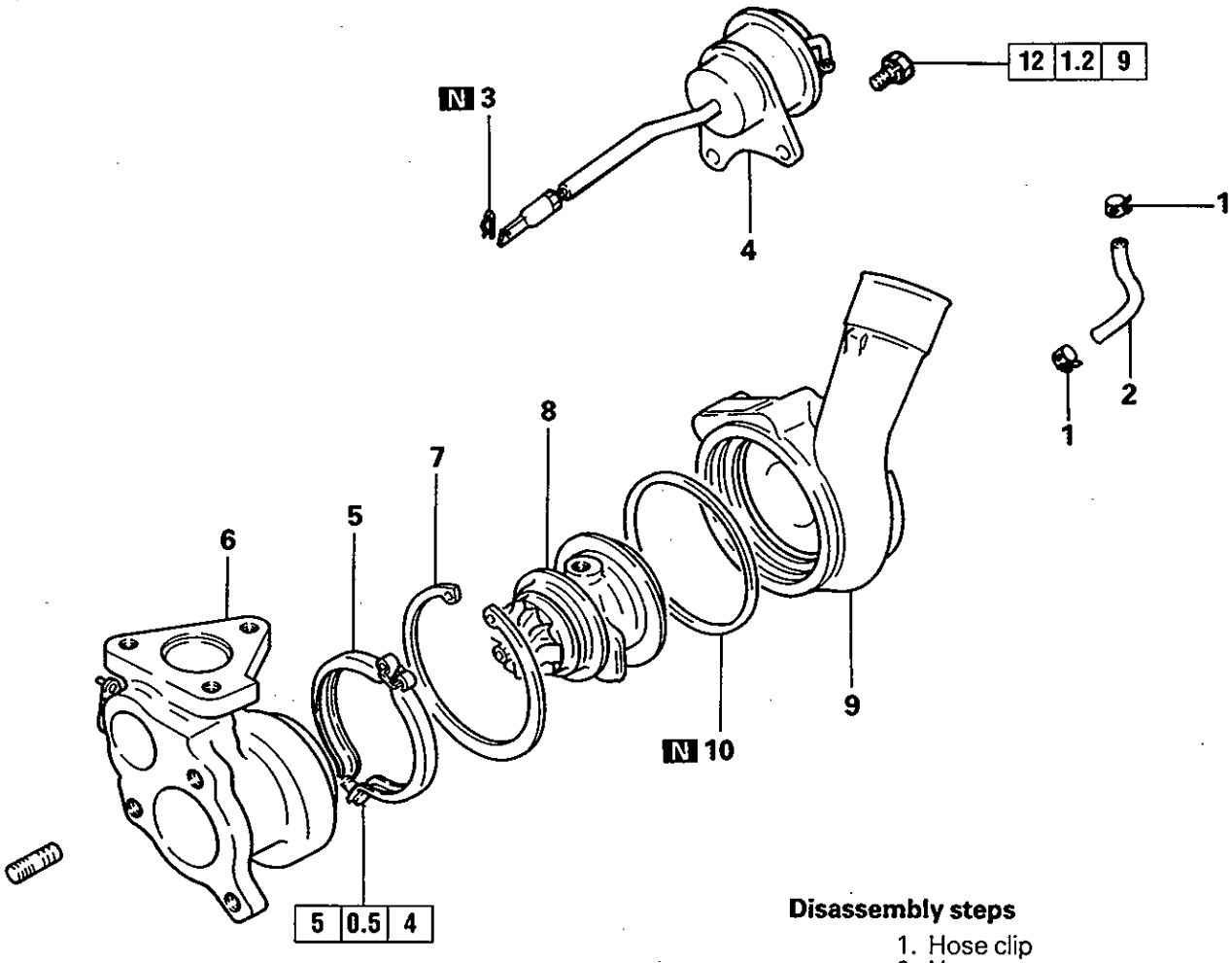
5. TURBOCHARGER

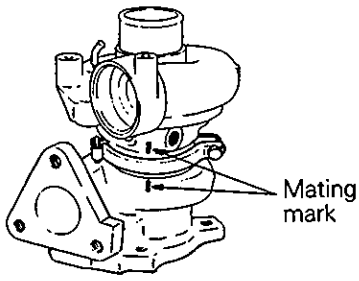
DISASSEMBLY AND REASSEMBLY



Disassembly steps

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

DIN615



3IN044

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.**

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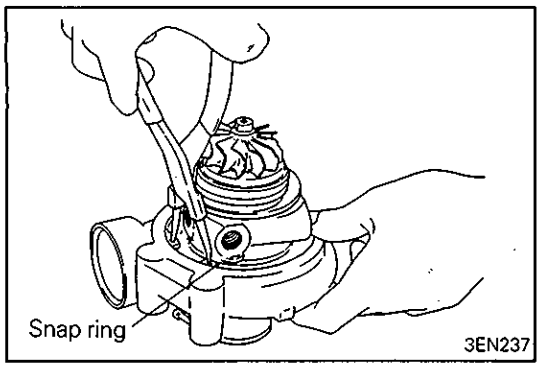
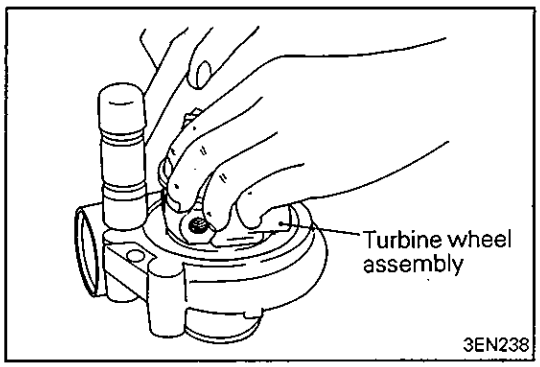


◇B◇ REMOVAL OF SNAP RING

(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.

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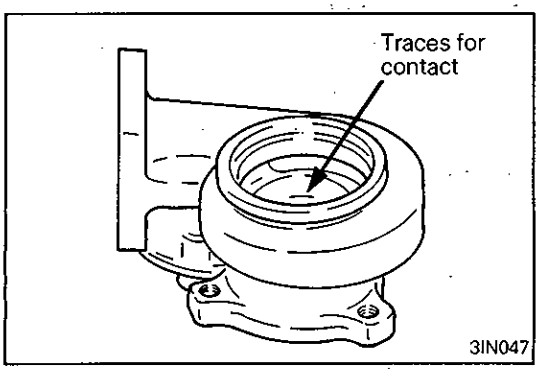


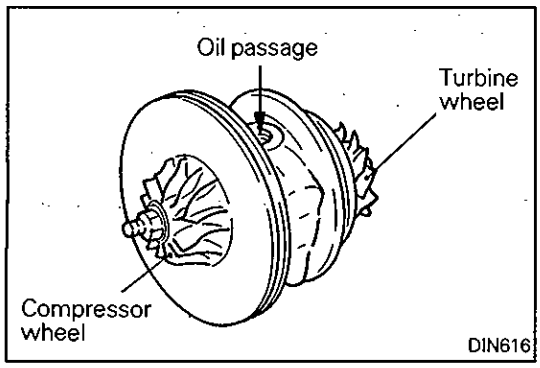
INSPECTION

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.

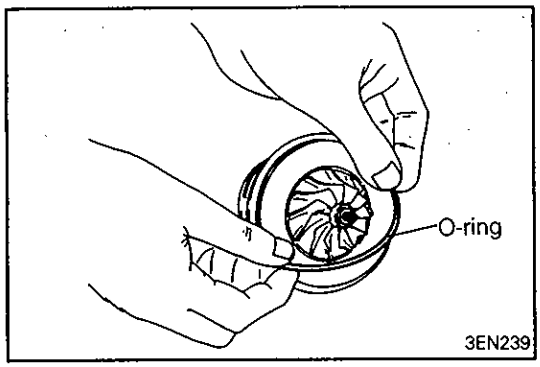


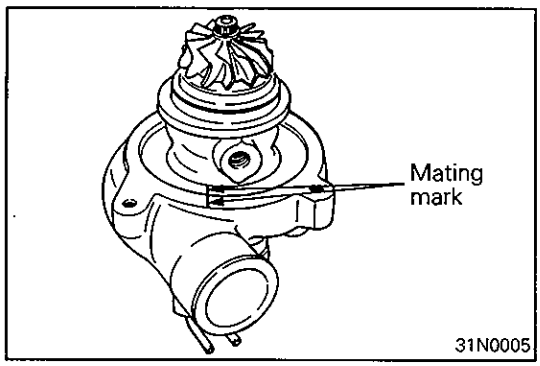
TURBINE WHEEL ASSEMBLY

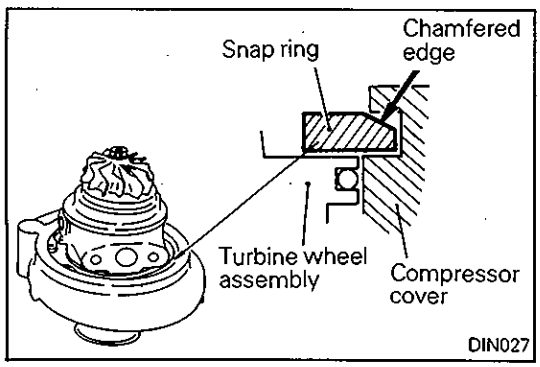
(1) Check the turbine and compressor wheel blades for bend, burr, damage, corrosion and traces of contact on the back side and replace if defective.
(2) Check the oil passage of the turbine wheel assembly for deposit and clogging.
(3) In the case of water cooled type, check also the water passage for 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.**

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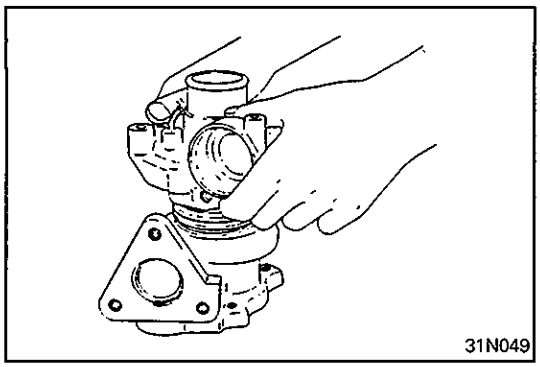
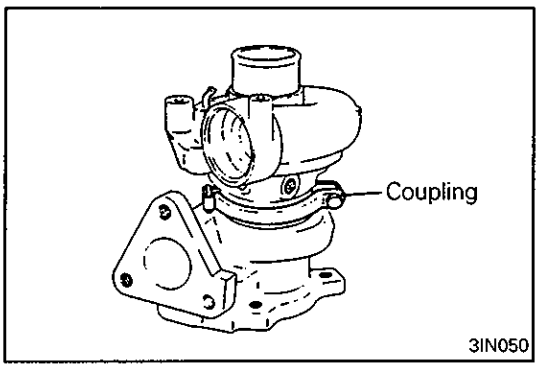


◆D◆ INSTALLATION OF TURBINE HOUSING

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

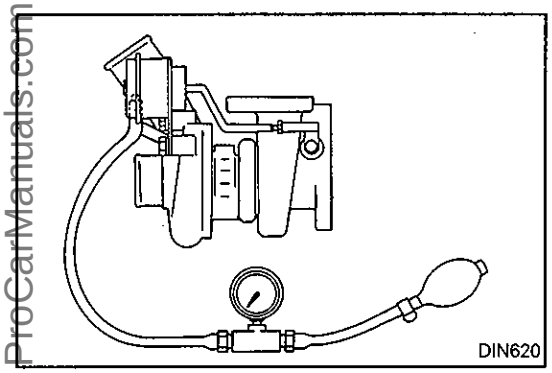
Caution

- **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/cm², 10.80 psi)

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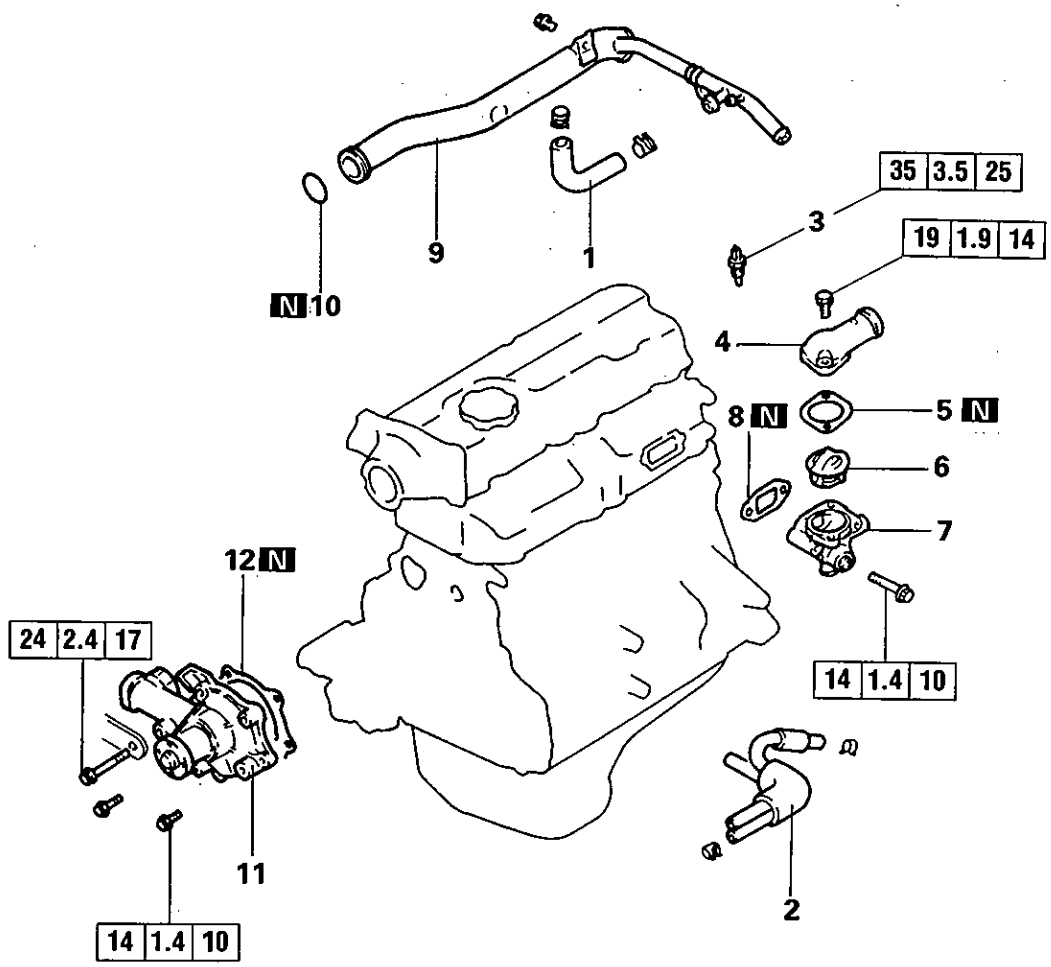
6. WATER PUMP, THERMOSTAT, HOSE AND PIPE

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

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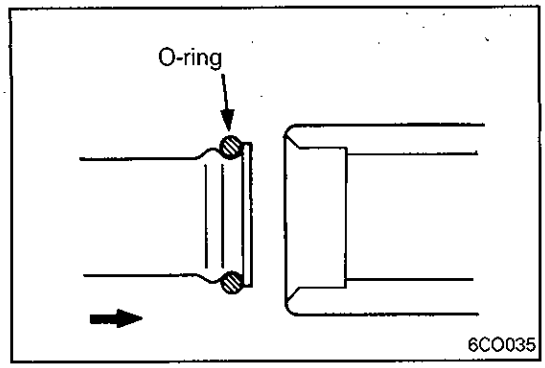
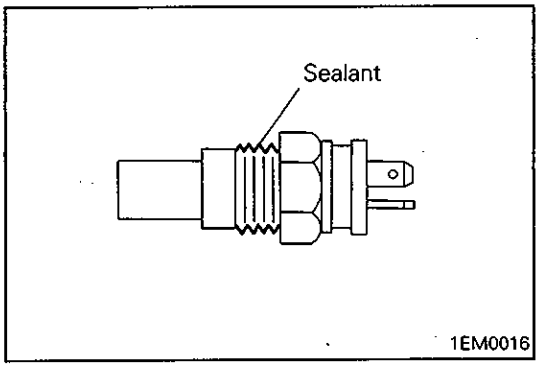


◆A◆ INSTALLATION OF WATER PIPE / O-RING

(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

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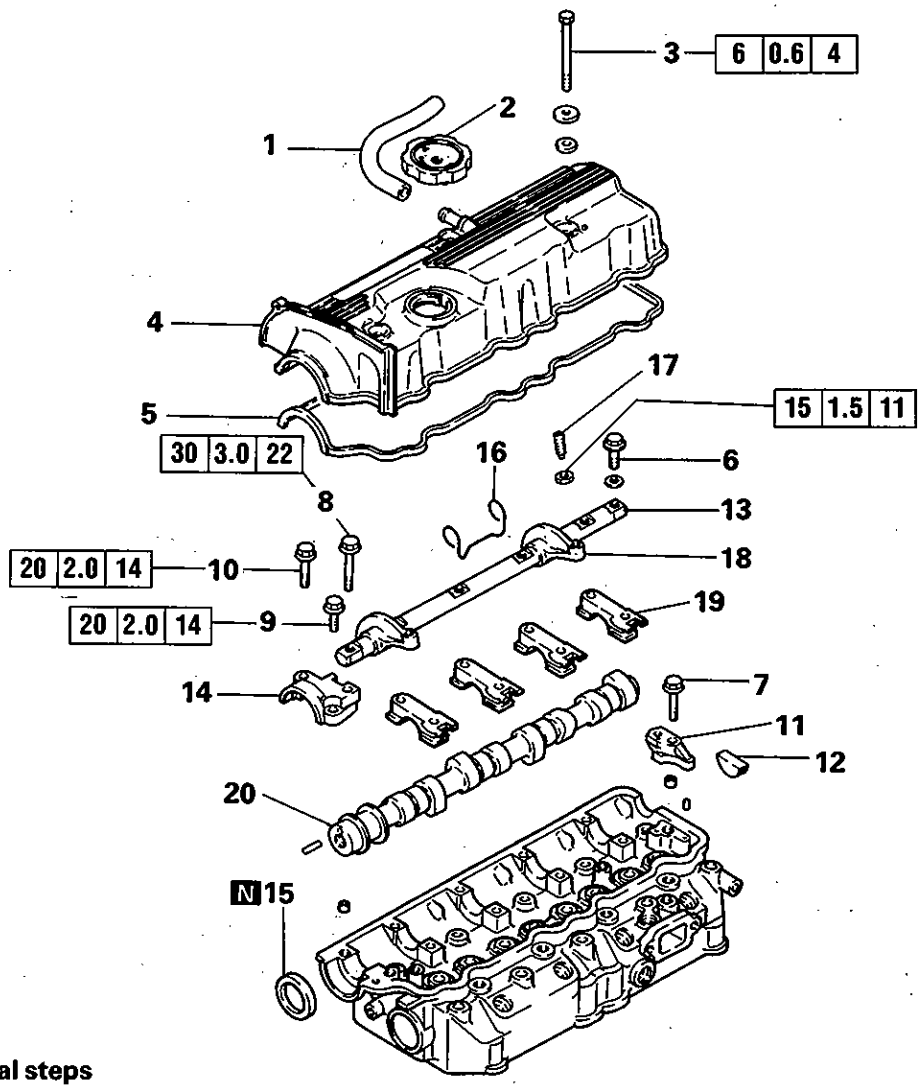
7. ROCKER ARM, ROCKER SHAFT AND CAMSHAFT

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

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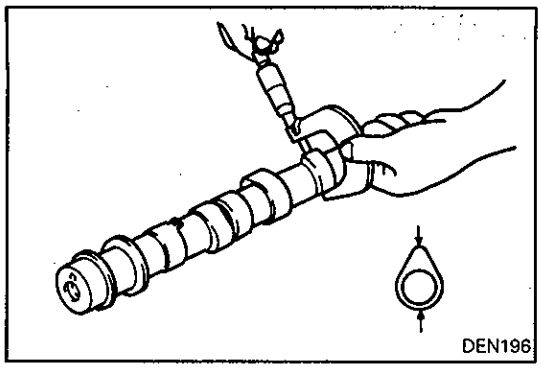
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INSPECTION

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.

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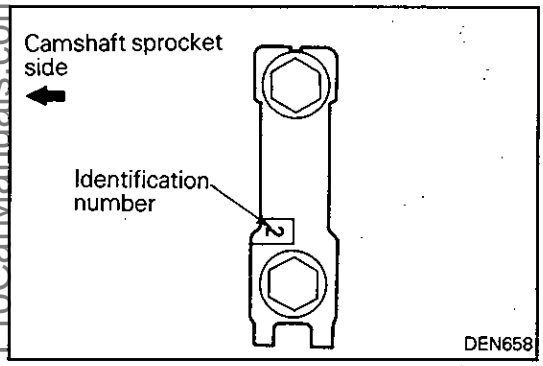

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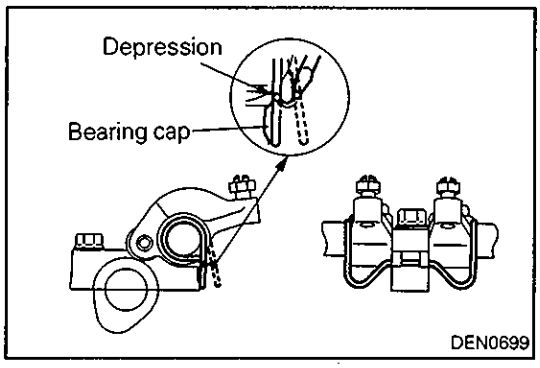
◆A◆ INSTALLATION OF CAMSHAFT BEARING CAP

(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.



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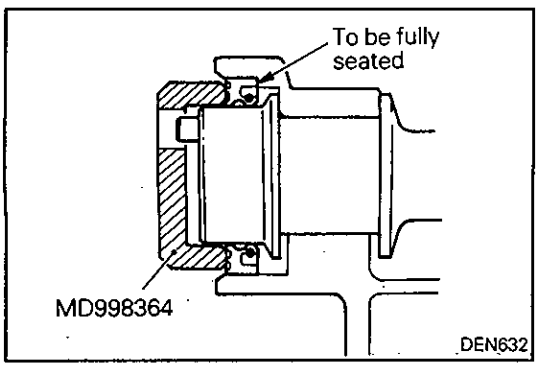
◆B◆ INSTALLATION OF ROCKER SHAFT SPRING

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



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◆C◆ INSTALLATION OF CAMSHAFT OIL SEAL

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

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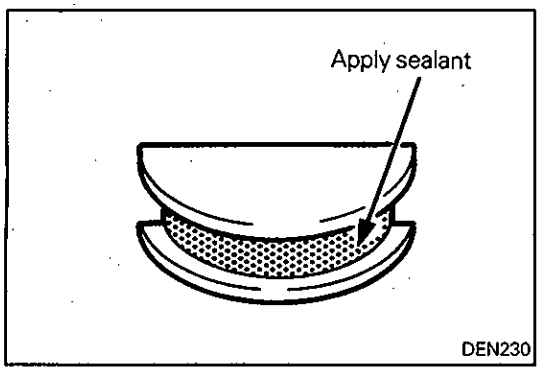
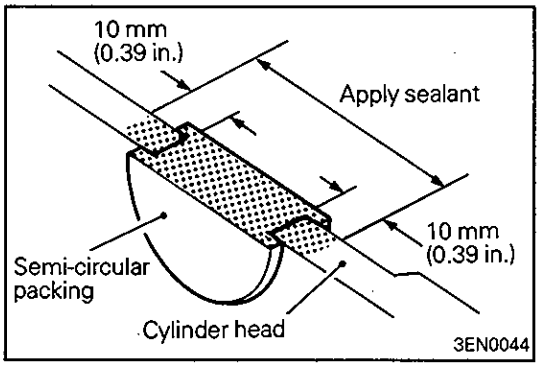


◆D◆ INSTALLATION OF SEMI-CIRCULAR PACKING

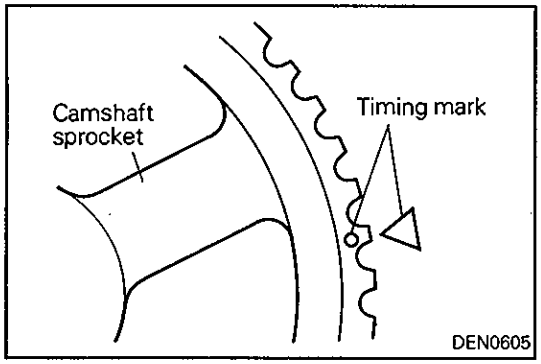
(1) Apply specified sealant to portions indicated in illustration.

Specified sealant:
3M Part No. 8660 or equivalent

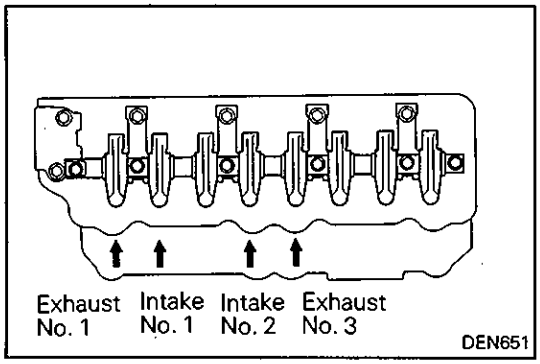


VALVE CLEARANCE ADJUSTMENT

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



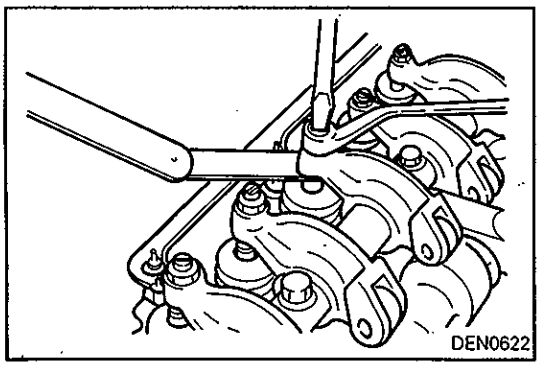
(2) Adjust the valve clearance at points shown in the illustration.



(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.



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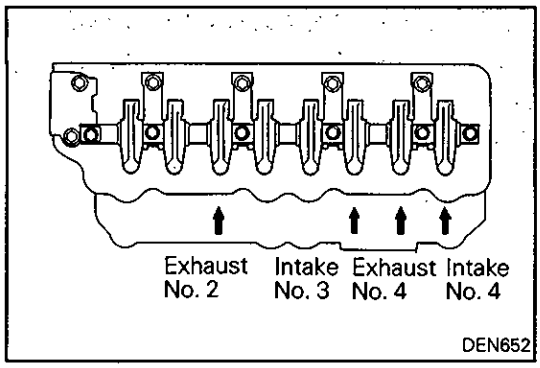

(6) Rotate clockwise the crankshaft one complete turn (360° degrees).
(7) Adjust the valve clearance at points shown in the illustration.
(8) Repeat steps (3) to (5) to adjust the valve clearance of remaining valves.

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

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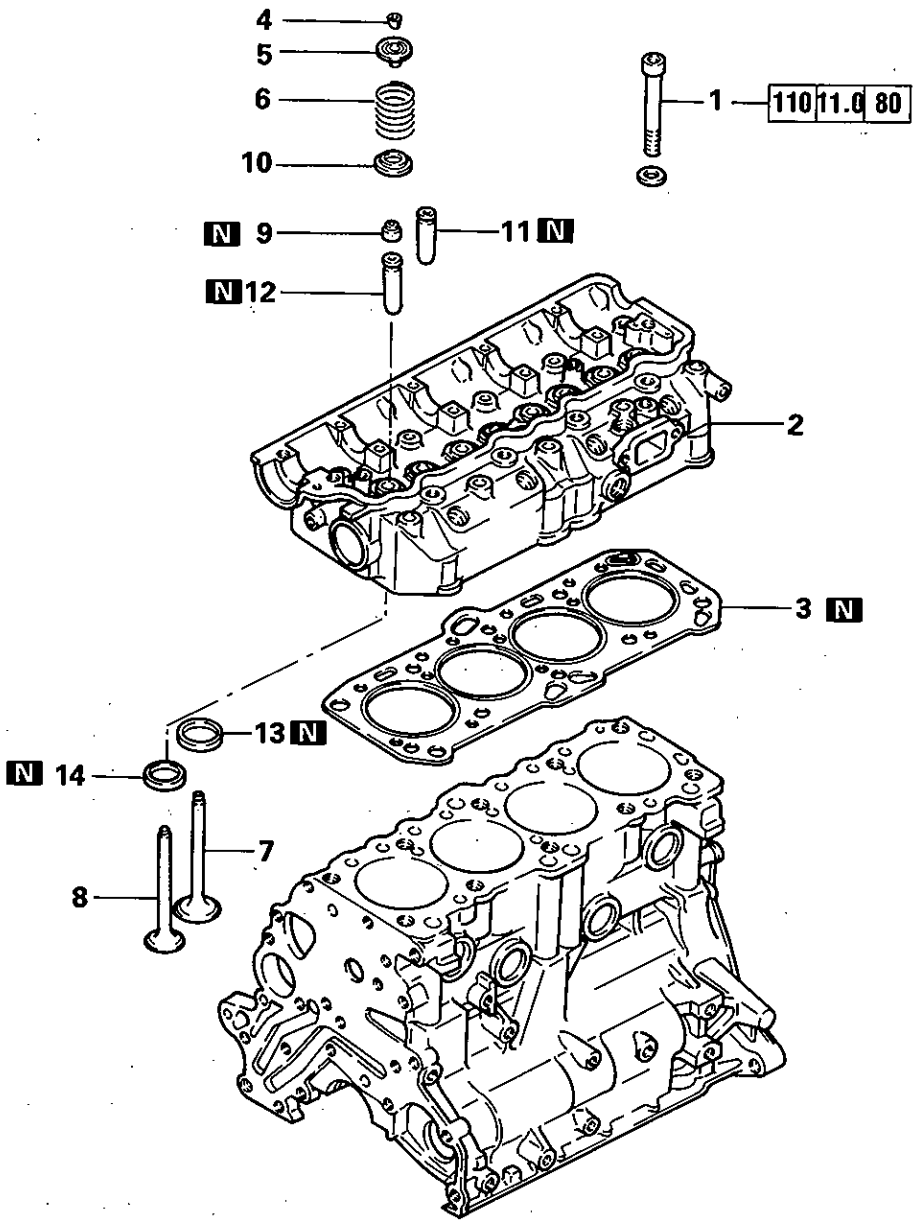
8. CYLINDER HEAD, VALVES AND VALVE SPRING

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

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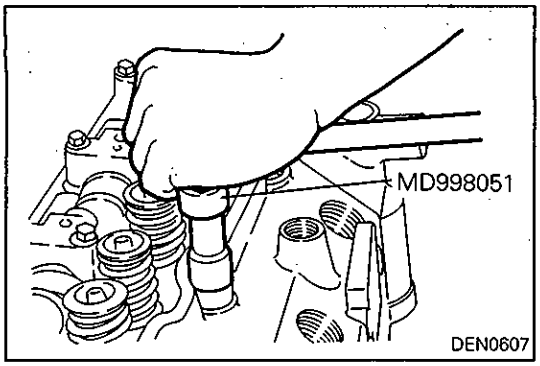

SERVICE POINTS OF REMOVAL

◊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.**

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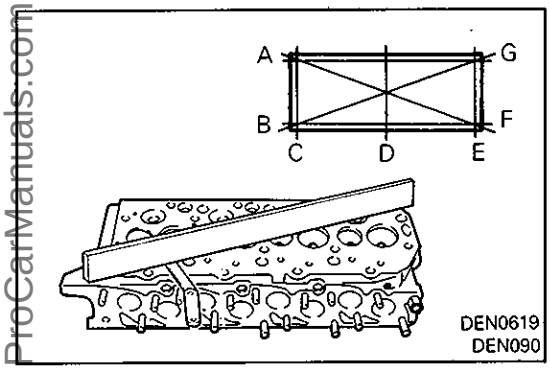
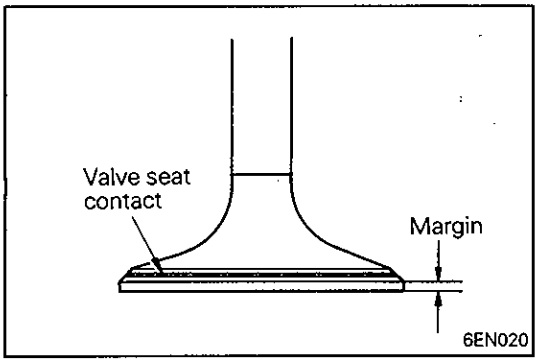


INSPECTION

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.

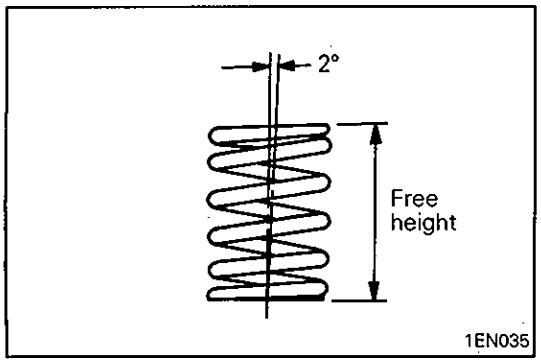
Standard value: 0.05 mm (0.0020 in.)
Limit: 0.2 mm (0.008 in.)



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°

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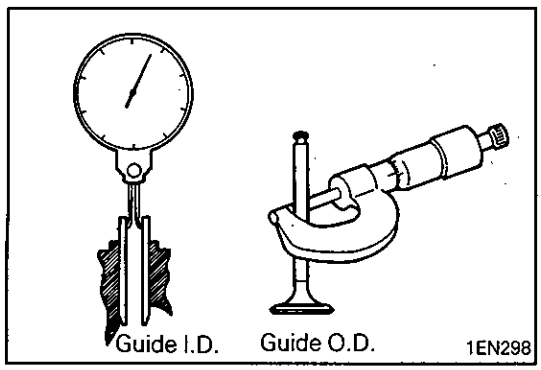
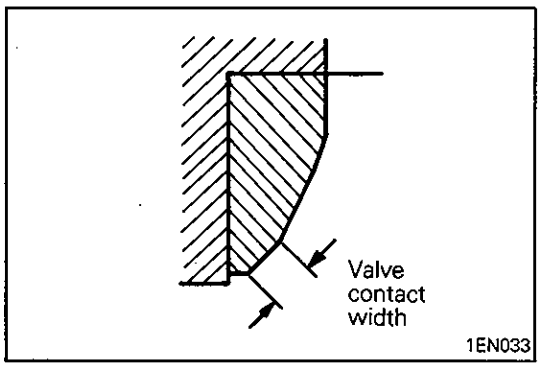


VALVE GUIDE

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

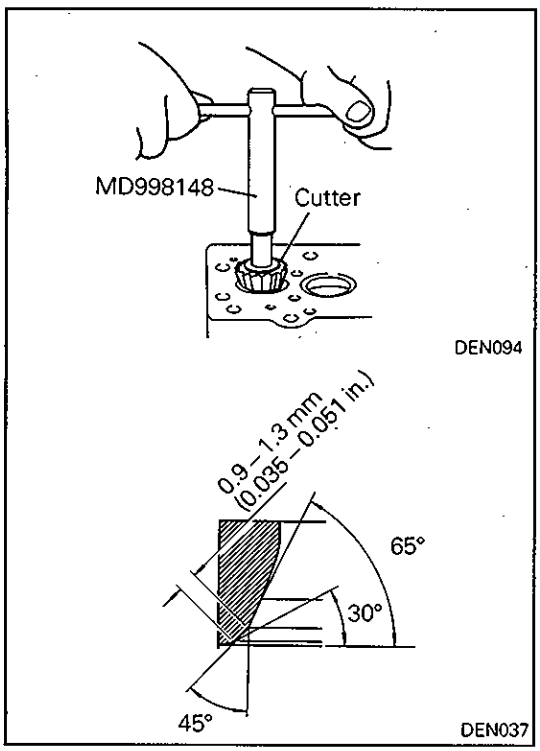
Standard value:
0.03 – 0.06 mm (0.0012 – 0.0024 in.) .... Intake N/A
0.05 – 0.09 mm (0.0020 – 0.0035 in.) ..... Intake T/C & Taxi
0.05 – 0.09 mm (0.0020 – 0.0035 in.) ..... Exhaust
Limit:
0.10 mm (0.0039 in.) ..... Intake
0.15 mm (0.0059 in.) ..... Exhaust



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.)

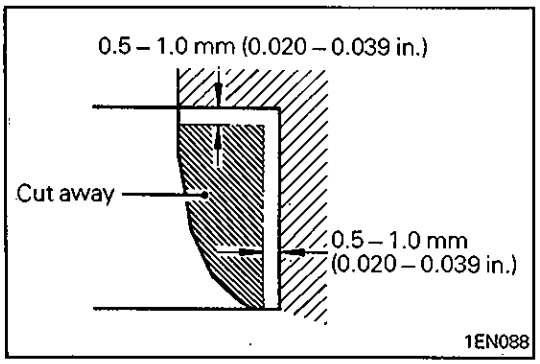


VALVE SEAT RECONDITIONING PROCEDURE

(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.

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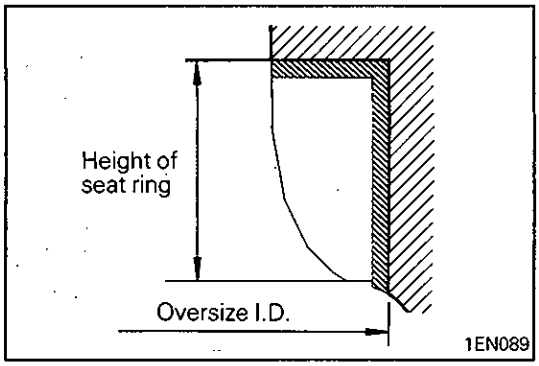

(2) Rebore the valve seat hole in cylinder head to a selected oversize valve seat diameter.

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".

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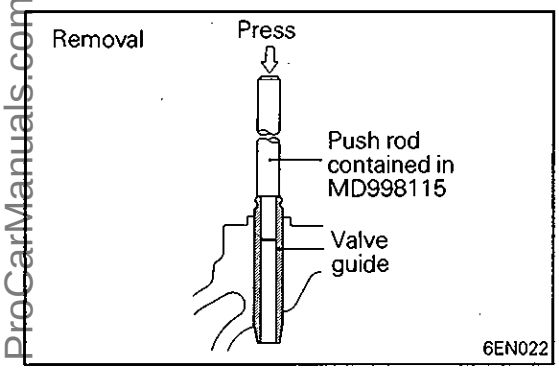

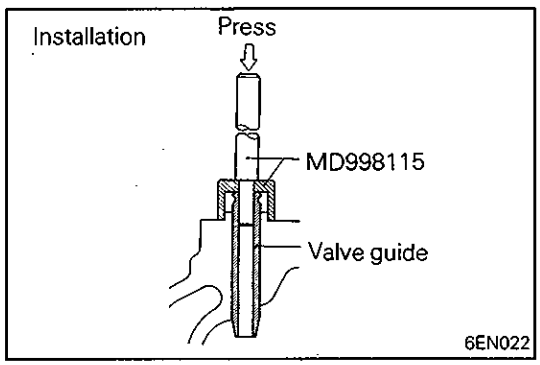

VALVE GUIDE REPLACEMENT PROCEDURE

(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.

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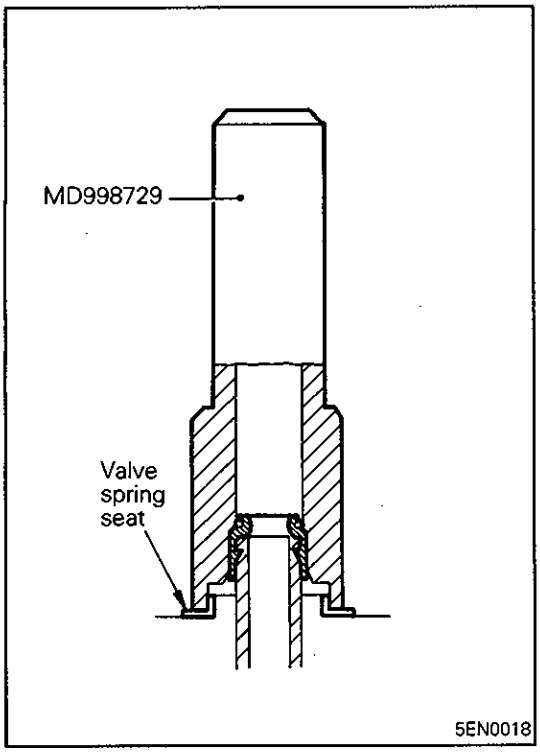
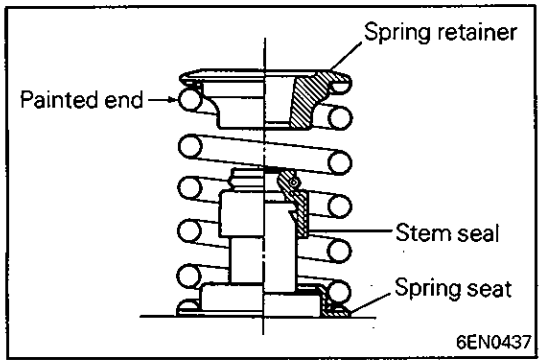


SERVICE POINTS OF INSTALLATION

◆A◆ INSTALLATION OF VALVE STEM SEAL

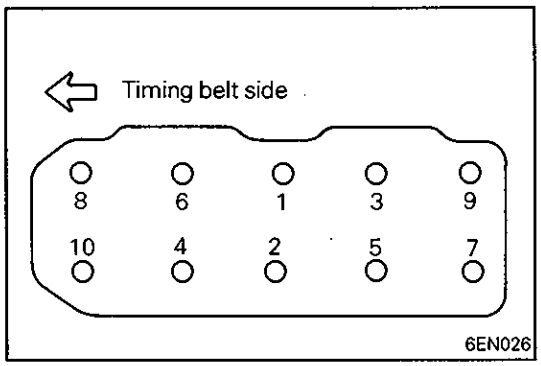
(1) Install the valve spring seat.
(2) The special tool must be used to install the valve stem seal. Improper installation could result in oil leaks through valve guide.

NOTE
The valve stem seal cannot be reused.



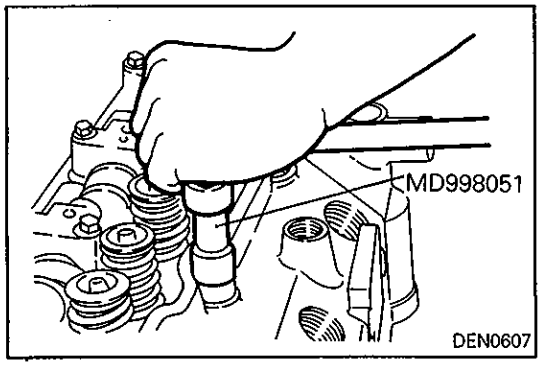
◆B◆ INSTALLATION OF VALVE SPRING

(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.



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

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NOTES

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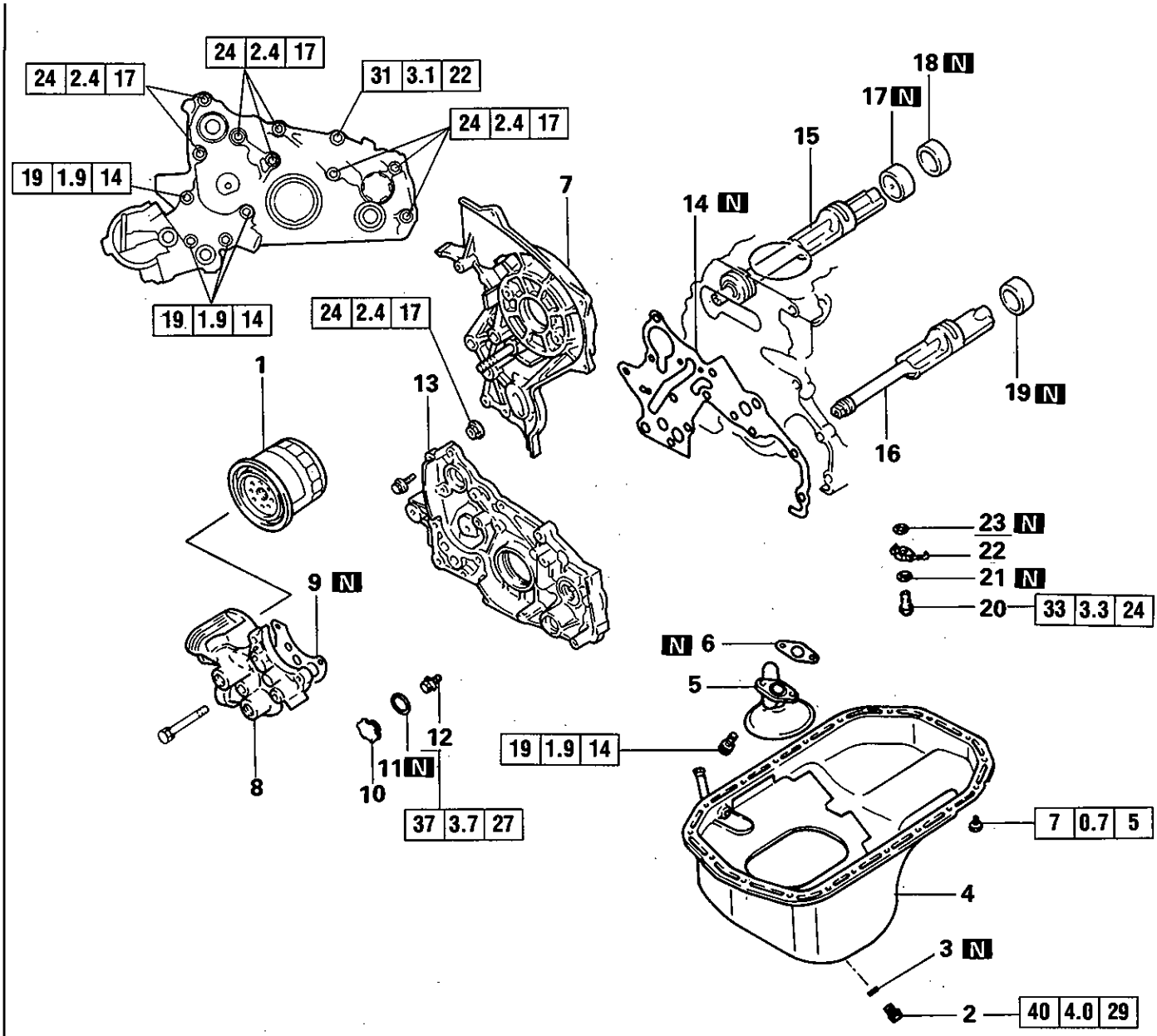
9. FRONT CASE, SILENT SHAFT AND OIL PAN

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

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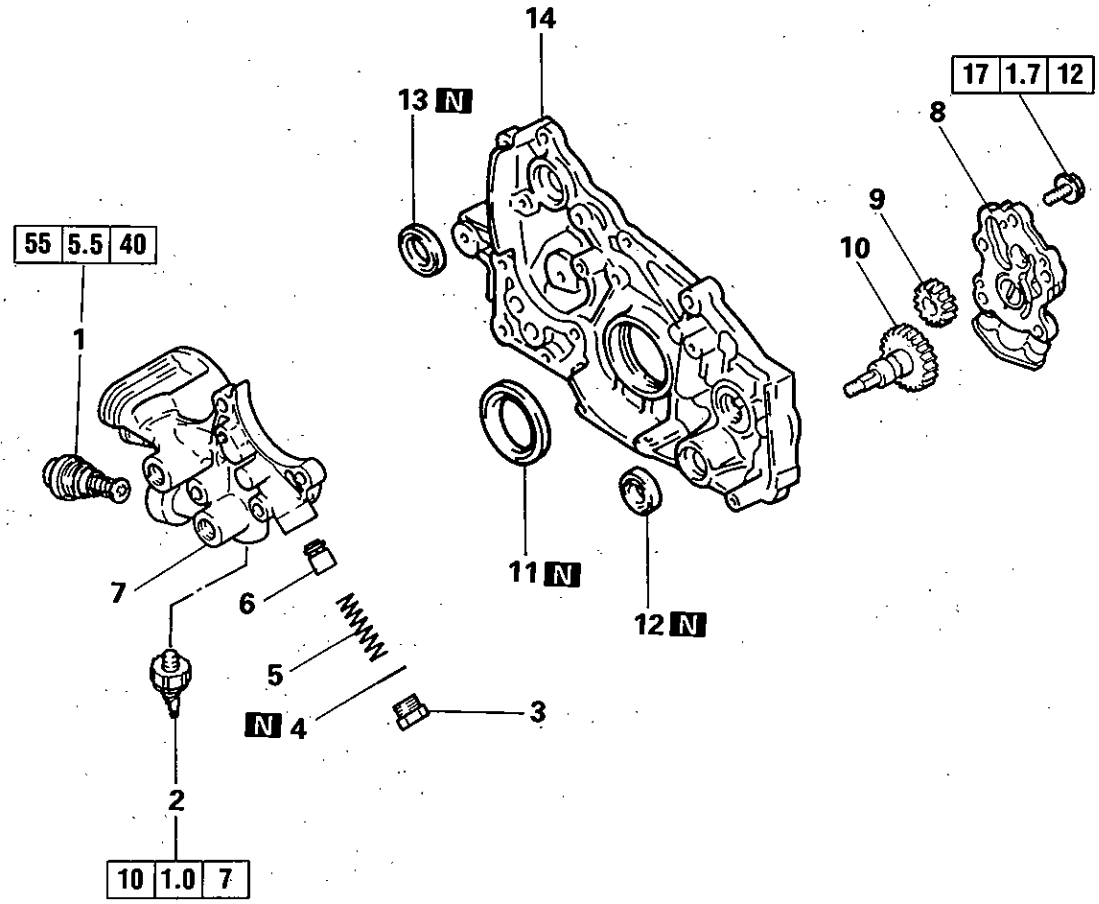
DISASSEMBLY AND REASSEMBLY



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
12. Oil pump oil seal
◆A◆ 13. Silent shaft oil seal
14. Front case

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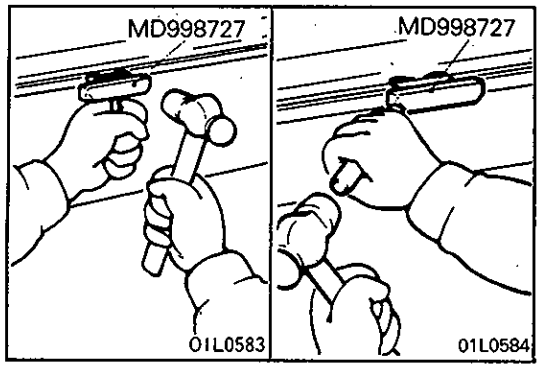
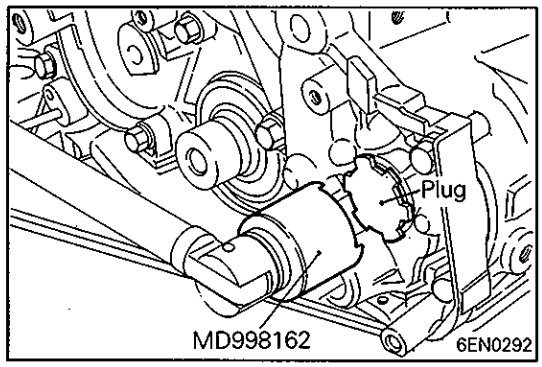


SERVICE POINTS OF REMOVAL

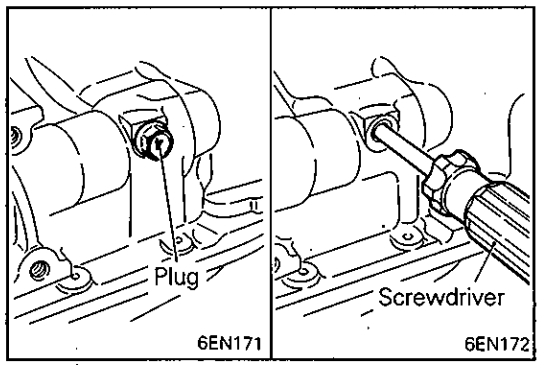
◊A◊ REMOVAL OF OIL PAN

(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.



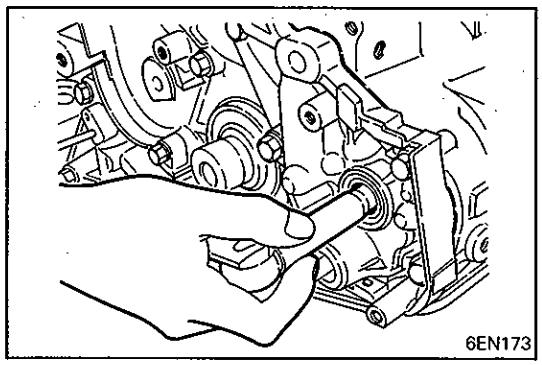
◊B◊ REMOVAL OF PLUG

(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.

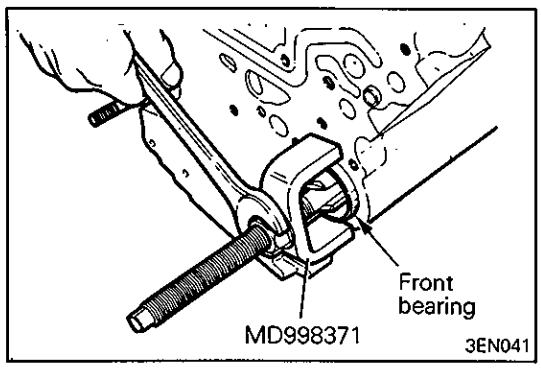


◊C◊ REMOVAL OF FLANGE BOLT

(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.

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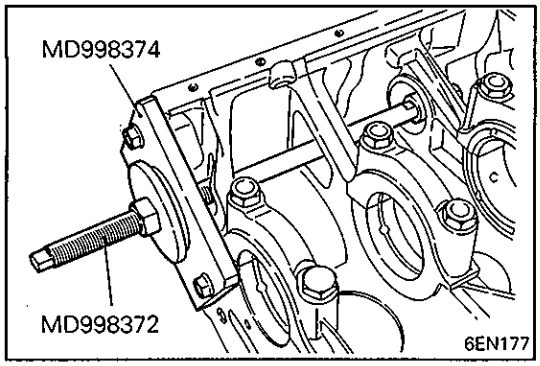
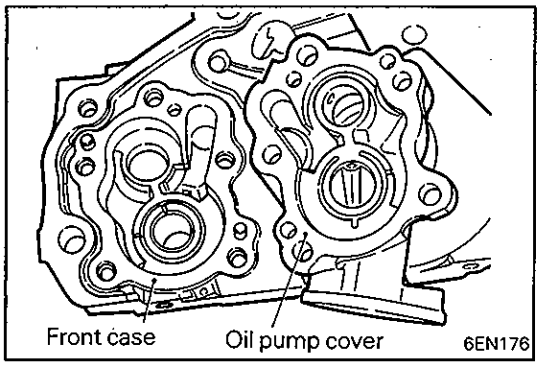


◇E◇ REMOVAL OF RIGHT SILENT SHAFT REAR BEARING / LEFT SILENT SHAFT REAR BEARING

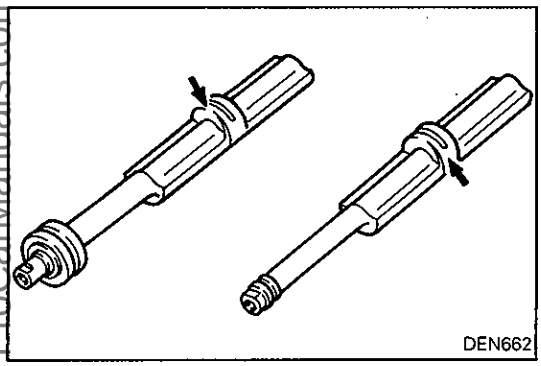
(1) Using the special tool, remove two rear bearings from cylinder block.
(2) To remove the left rear bearing, install the special tool, Silent Shaft Bearing Installer Stopper, to the front of the cylinder block, then remove the bearing using the special tool, Silent Shaft Bearing Puller.



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.

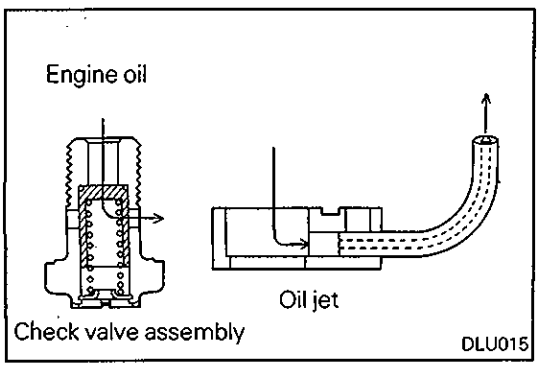
Standard value:

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.

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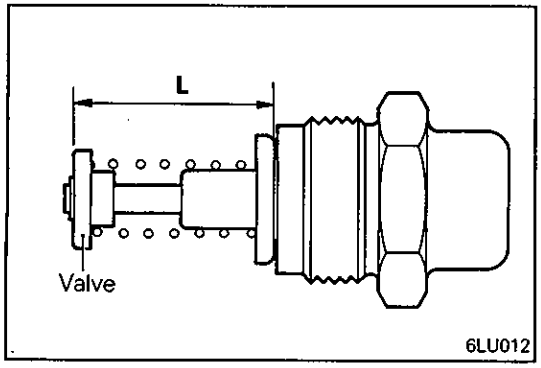
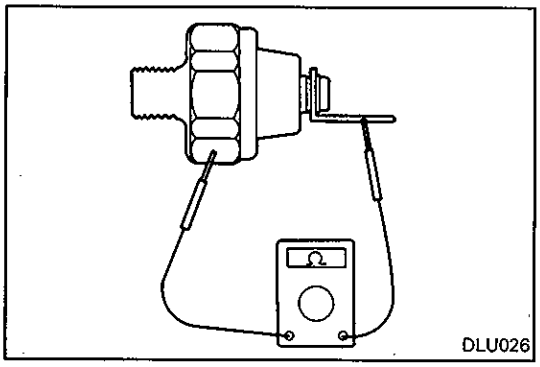


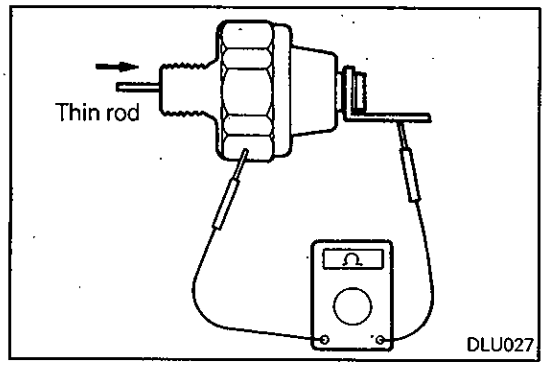
OIL COOLER BYPASS VALVE (Models with oil cooler)

(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 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.

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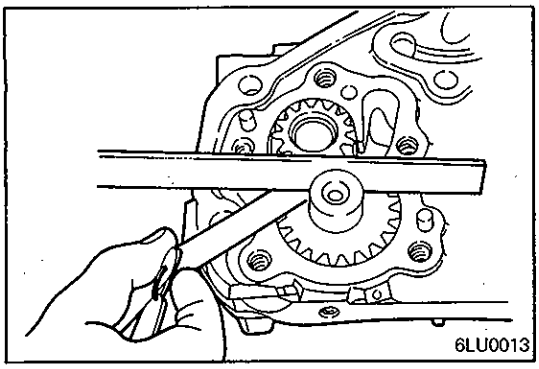

(3) Check the side clearance

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.

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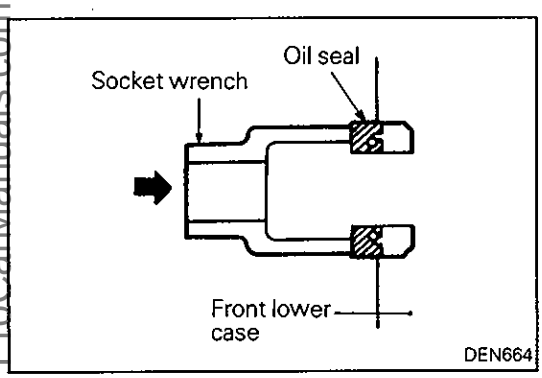
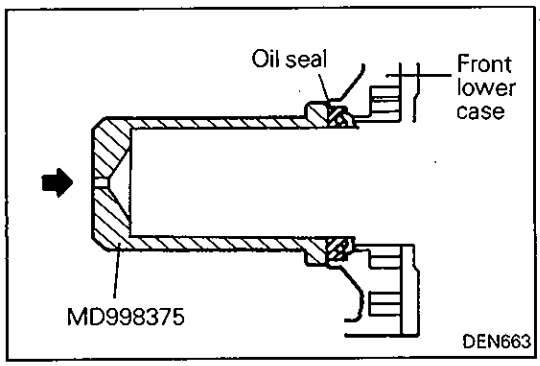


SERVICE POINTS OF INSTALLATION

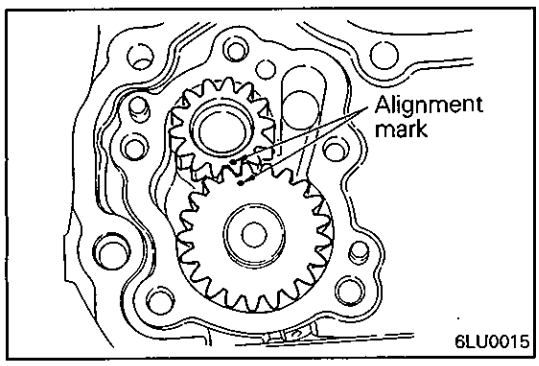
◆A◆ INSTALLATION OF SILENT SHAFT OIL SEAL

(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.

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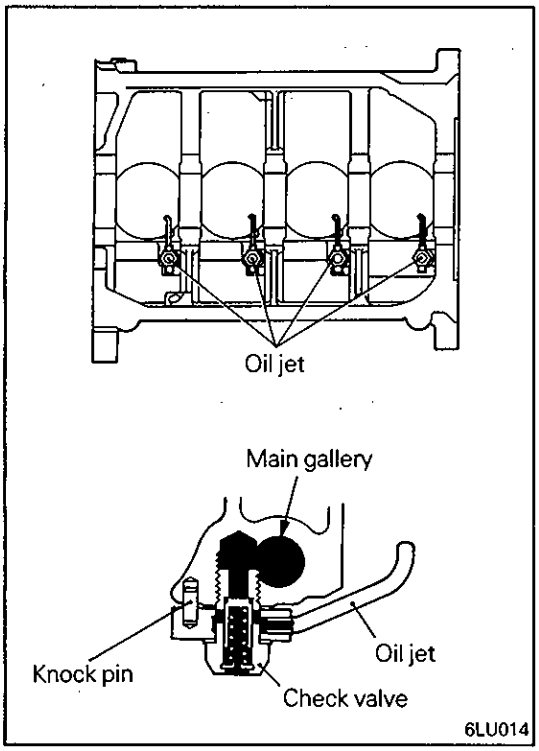
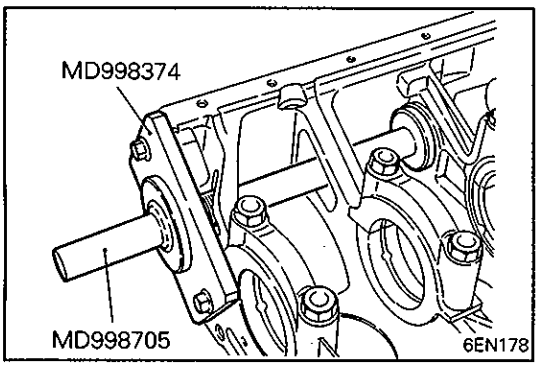


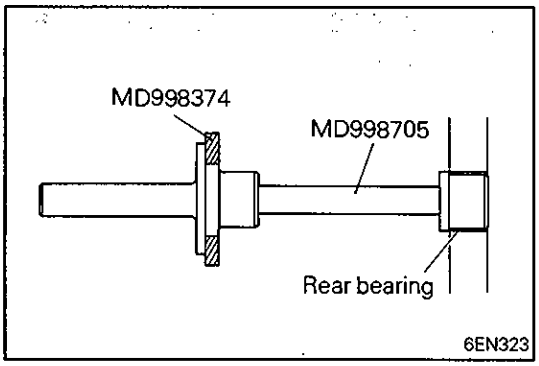
◆D◆ INSTALLATION OF OIL JET

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

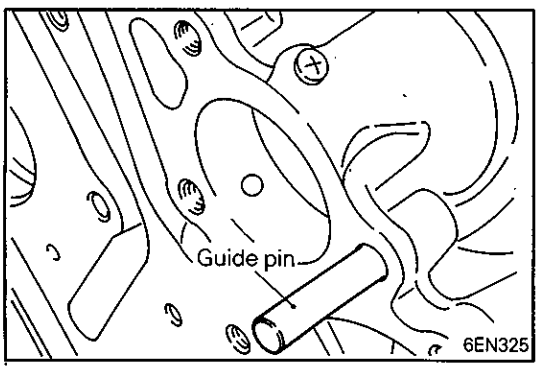


◆E◆ INSTALLATION OF LEFT SILENT SHAFT REAR BEARING

(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.

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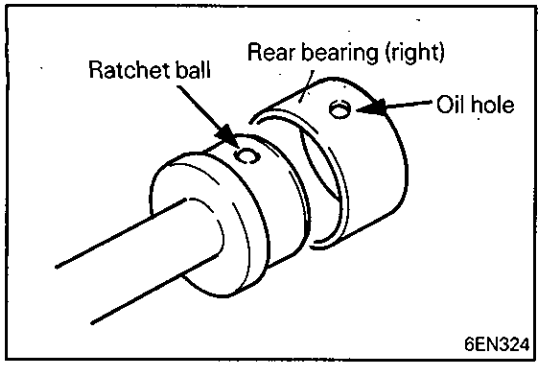
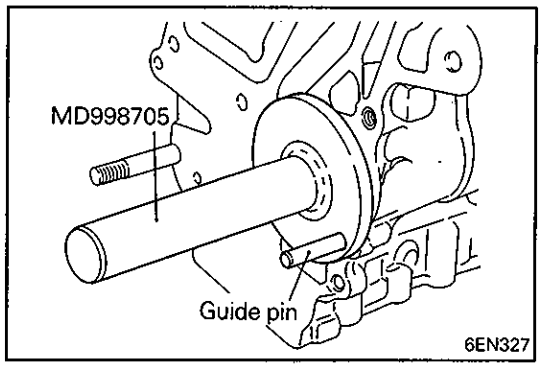
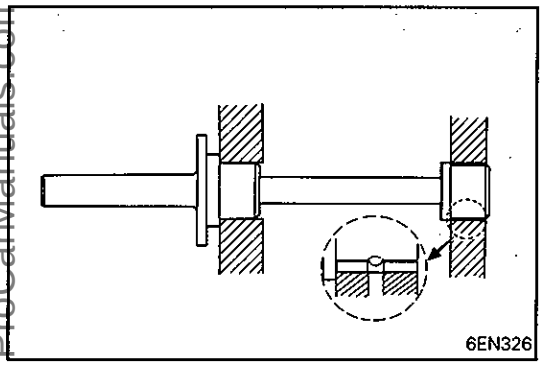


(2) Install the bearing to the special tool, aligning the ratchet ball of the special tool with the oil hole of the rear bearing.
(3) Apply engine oil to the outer circumference of the bearing and to the bearing hole of the cylinder block.



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



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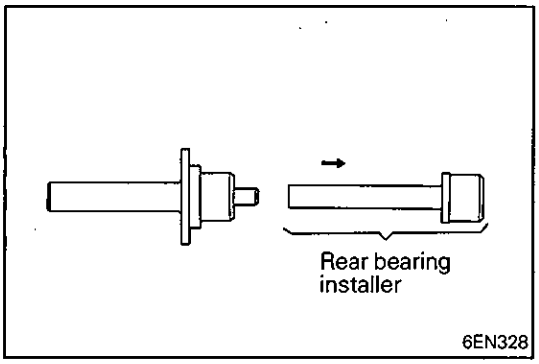
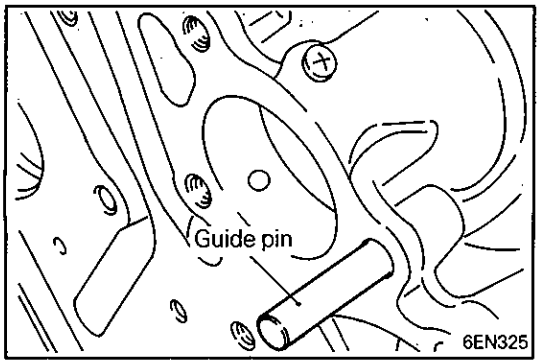


◆G◆ INSTALLATION OF SILENT SHAFT FRONT BEARING

(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.

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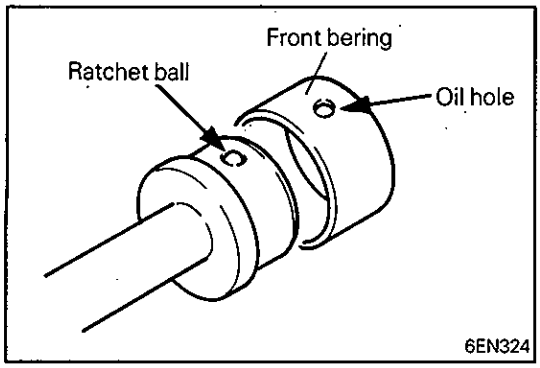
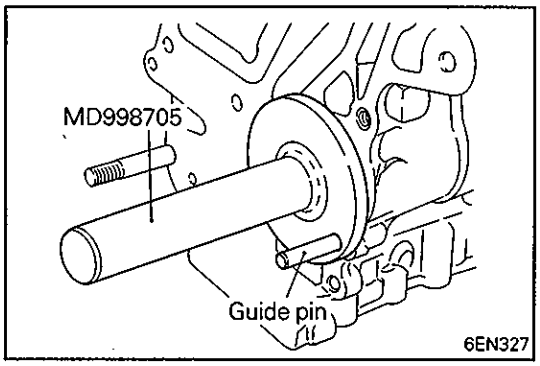
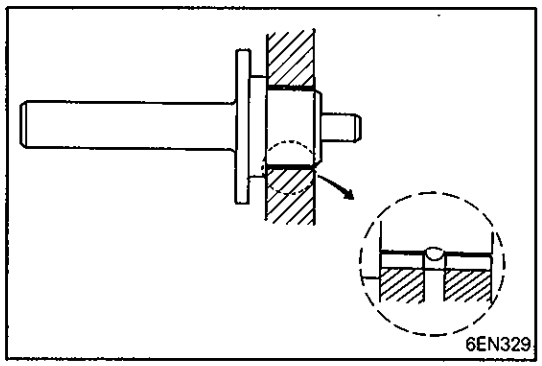
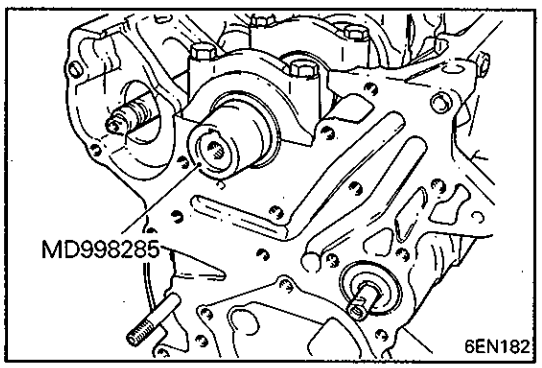


(3) Install the bearing to the special tool, aligning the ratchet ball of the special tool with the oil hole of the front bearing.
(4) Apply engine oil to the outer circumference of the bearing and to the bearing hole of the cylinder block.



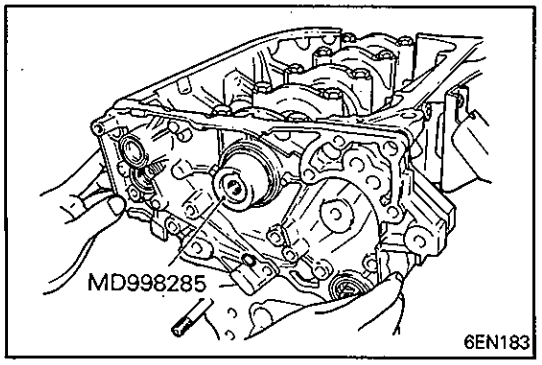
(5) Insert the installer aligning with the guide pin and install the bearing.





◆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.

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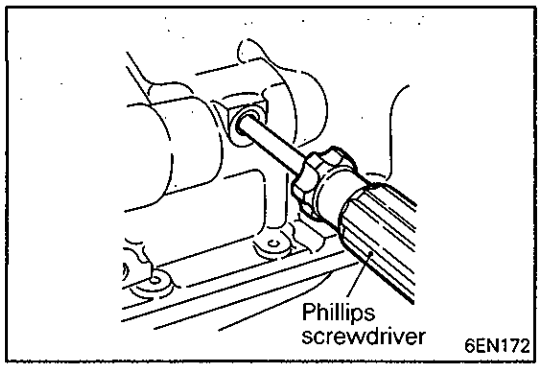
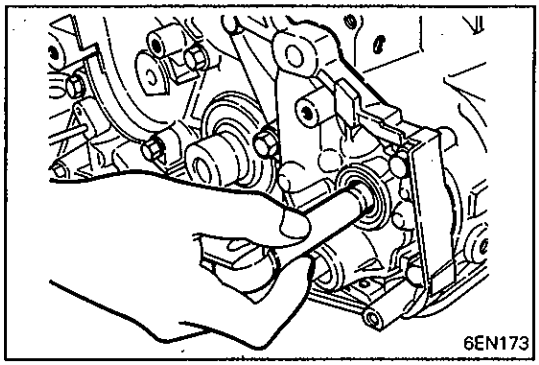
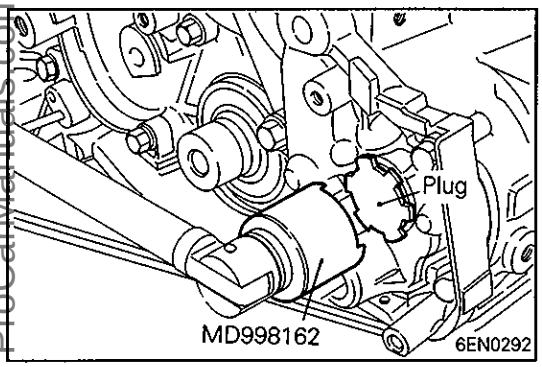


◆I◆ INSTALLATION OF FLANGE BOLT

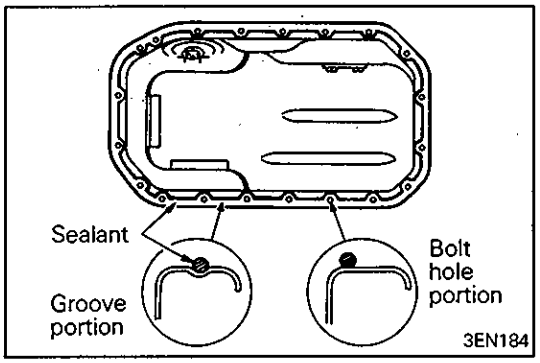
(1) Insert a Phillips screwdriver [shank diameter 8 mm (0.32 in.)] into the plug hole on the left side of cylinder block to block the silent shaft, then tighten the flange bolt.





◆J◆ INSTALLATION OF PLUG

(1) Install the plug using the special tool.

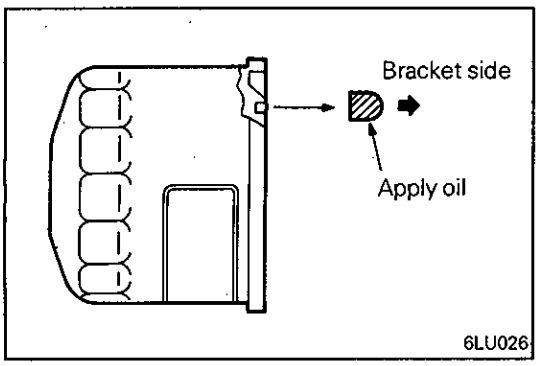


◆K◆ INSTALLATION OF OIL PAN

(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.



◆L◆ 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.**

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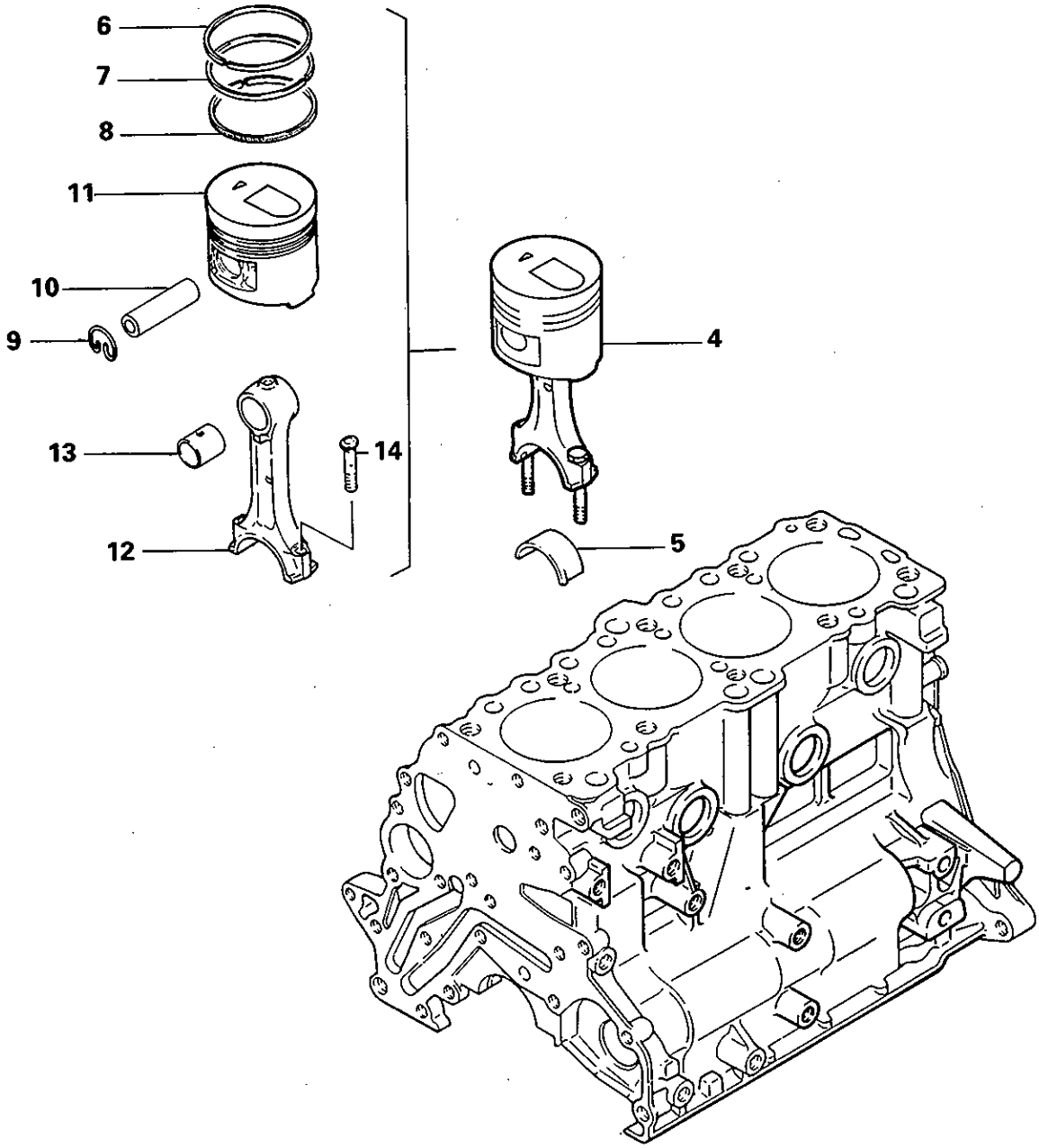
10. PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION



Removal steps

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

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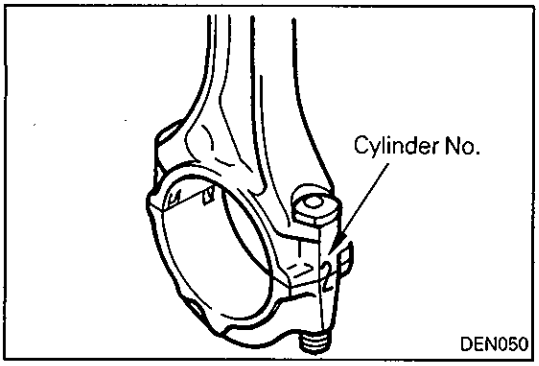
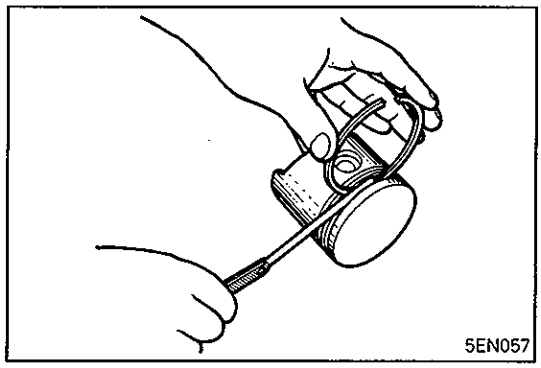


SERVICE POINTS OF REMOVAL

⟨A⟩ REMOVAL OF CONNECTING ROD CAP

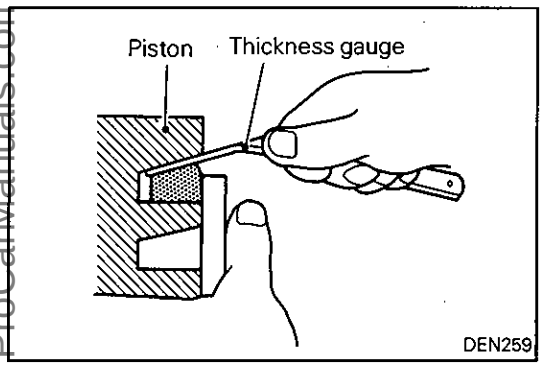
(1) Mark the cylinder number on the side of the connecting rod big end for correct reassembly.



INSPECTION

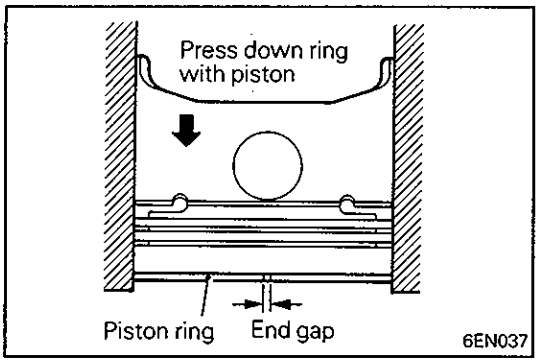
PISTON RING

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



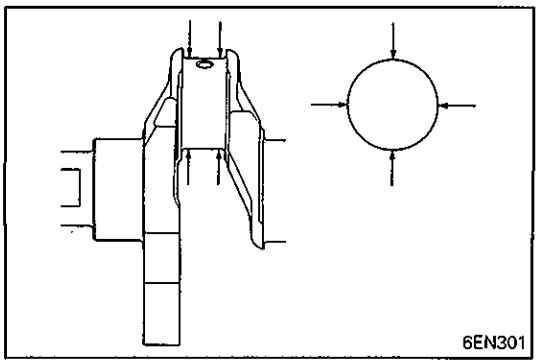
(2) In the case of semi-keystone type piston rings, check the ring to ring groove clearance as illustrated.

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 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.**

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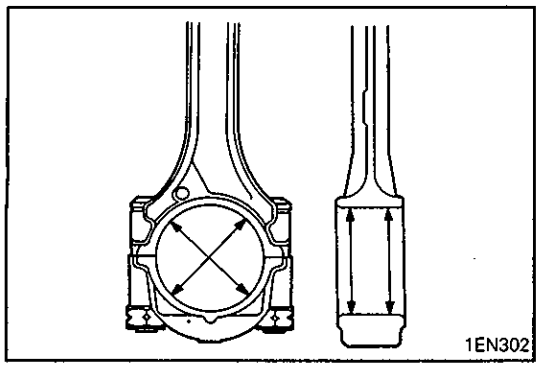

(2) Measure the connecting rod bearing I.D. and crankshaft pin O.D. if the oil clearance exceeds the limit, replace bearing, and crankshaft if necessary.
Or, regrind the crankshaft to an undersize and replace bearing with an undersize one.

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.

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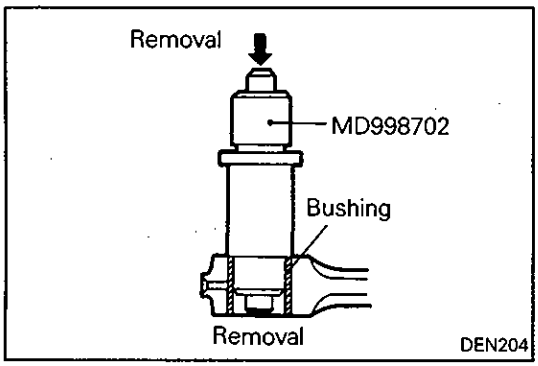
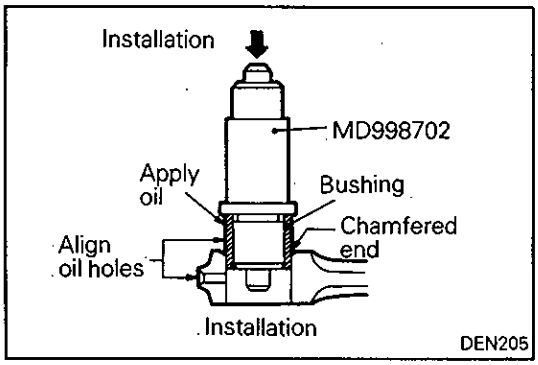
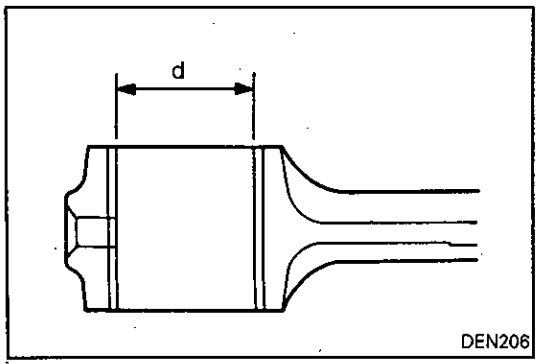
REPLACEMENT OF CONNECTING ROD BUSHING



(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.)

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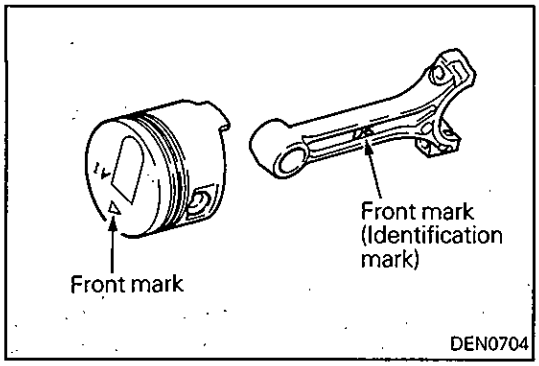
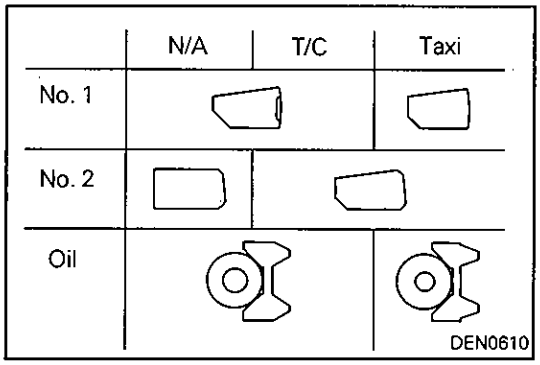


SERVICE POINTS OF INSTALLATION

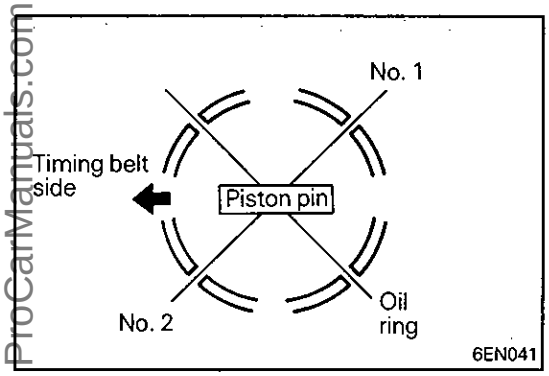
◆A◆ INSTALLATION OF PISTON PIN / PISTON / CONNECTING ROD

(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.



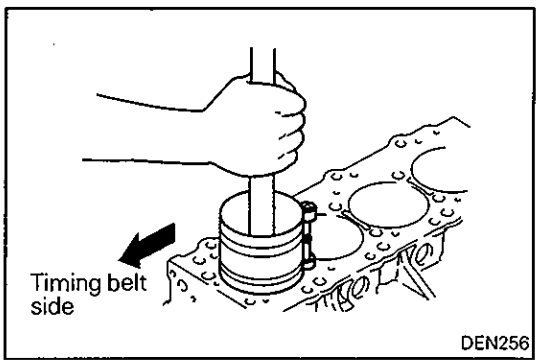
◆B◆ INSTALLATION OF PISTON RING NO. 1 / PISTON RING NO. 2 / OIL RING

(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.



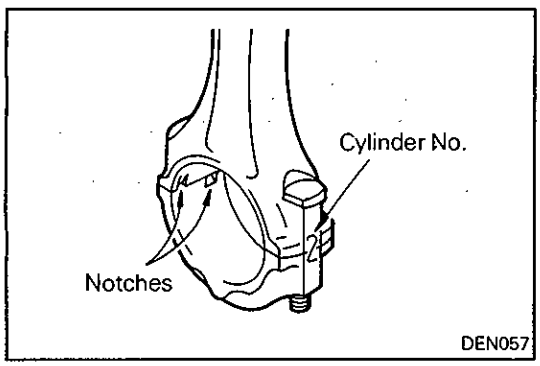
◆C◆ INSTALLATION OF PISTON AND CONNECTING ROD ASSEMBLY

(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.

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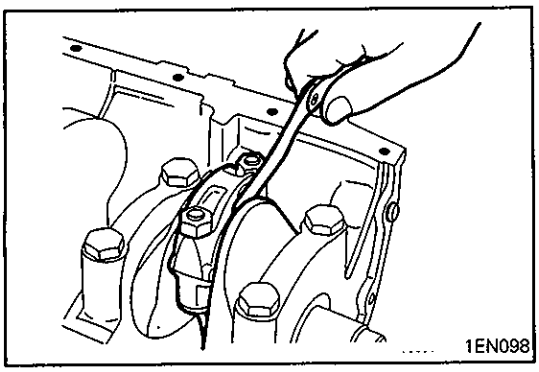

(2) Make sure that connecting rod big end side clearance meets the specification.

Standard value: 0.10 – 0.25 mm (0.0039 – 0.0098 in.)
Limit: 0.4 mm (0.0157 in.)

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NOTES

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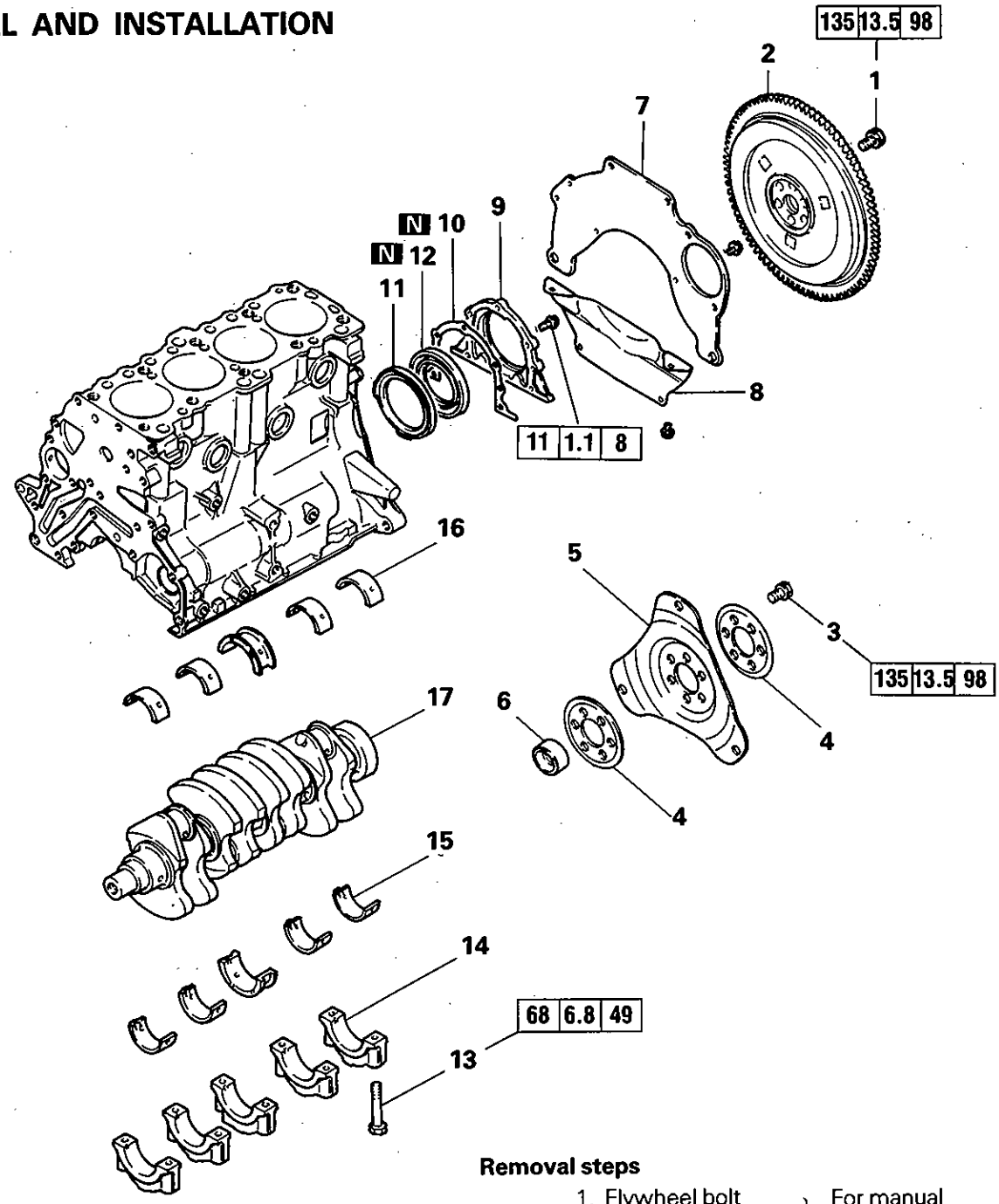
11. CRANKSHAFT, FLYWHEEL AND DRIVE PLATE

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
- ◆E◆ 11. Oil separator
- ◆D◆ 12. Rear oil seal
13. Bearing cap bolt
- ◆C◆ 14. Bearing cap
- ◆B◆ 15. Crankshaft bearing, lower
- ◆A◆ 16. Crankshaft bearing, upper
17. Crankshaft

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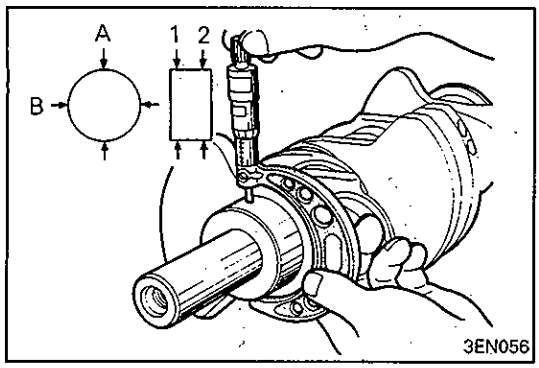


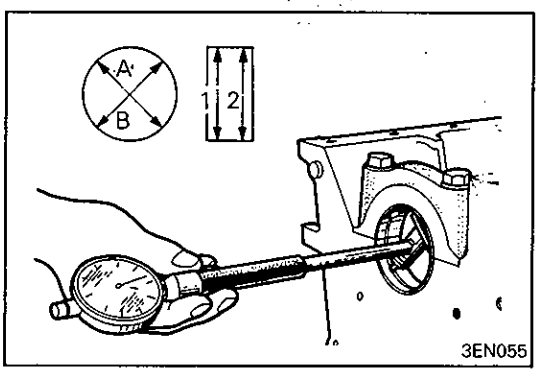
INSPECTION

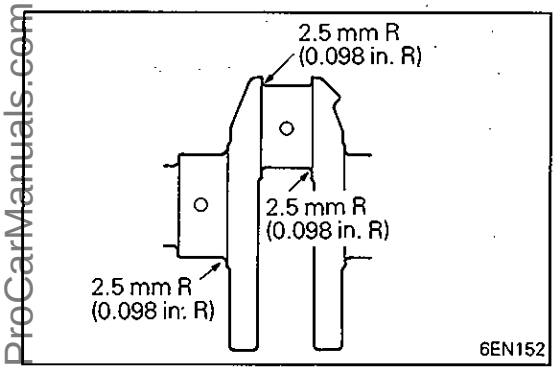
CRANKSHAFT

(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.**



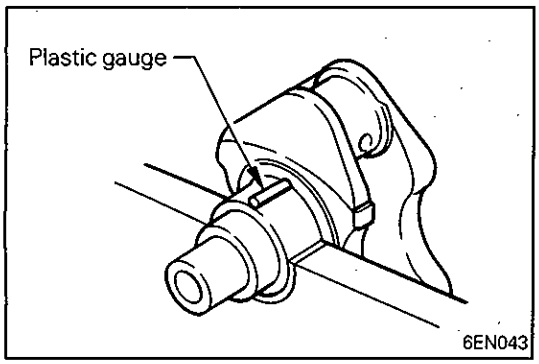


(2) When the crankshaft is machined to undersize, finish the fillets of journals and pins to the specified radius.

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.

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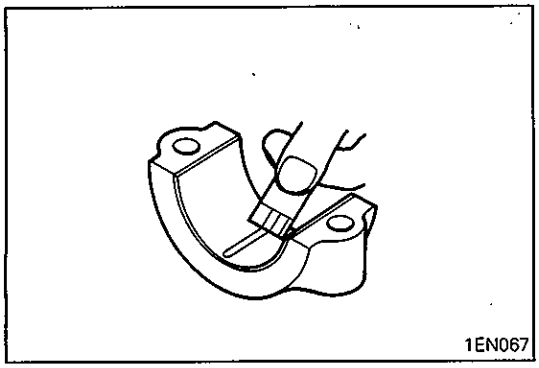
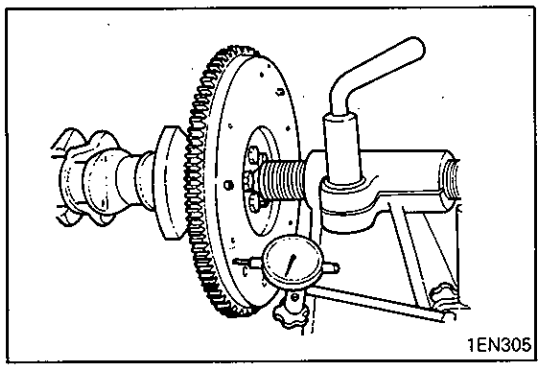
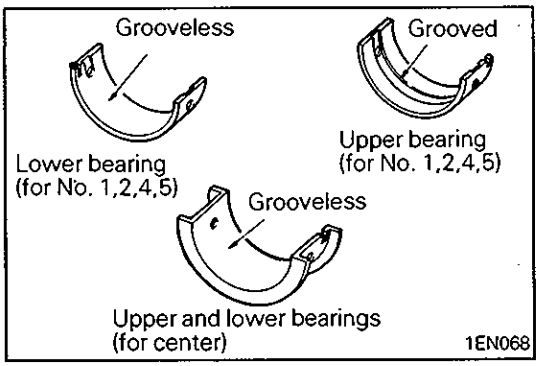

1EN067

(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.


1EN305

FLYWHEEL

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



1EN068

SERVICE POINTS OF INSTALLATION

◆A◆ INSTALLATION OF CRANKSHAFT BEARING (UPPER)

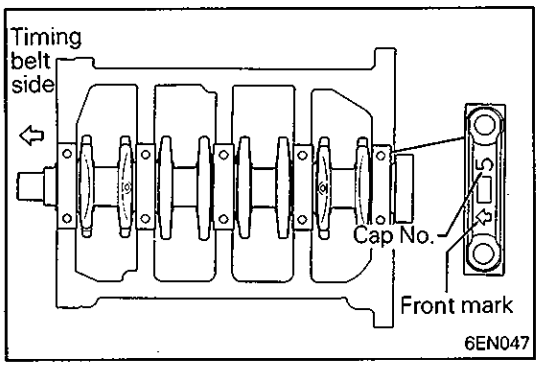
(1) Install the upper crankshaft bearing to the cylinder block. There is an oil groove in the upper crankshaft bearing. There is no difference between upper and lower bearings for the center (with flange).

◆B◆ INSTALLATION OF CRANKSHAFT BEARING (LOWER)

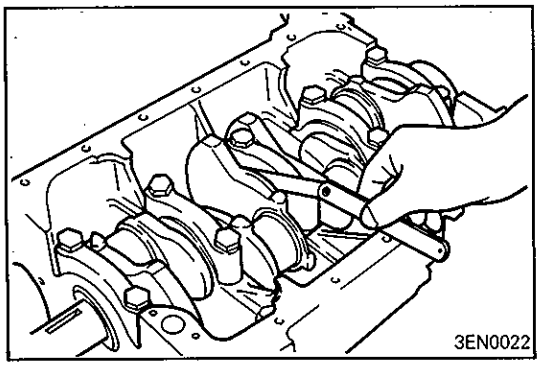
(1) Install the lower crankshaft bearing (with no oil groove; there is no difference for center) to each bearing cap and apply engine oil to bearing surfaces.

◆C◆ INSTALLATION OF BEARING CAP

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



6EN047


3EN0022

(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.)

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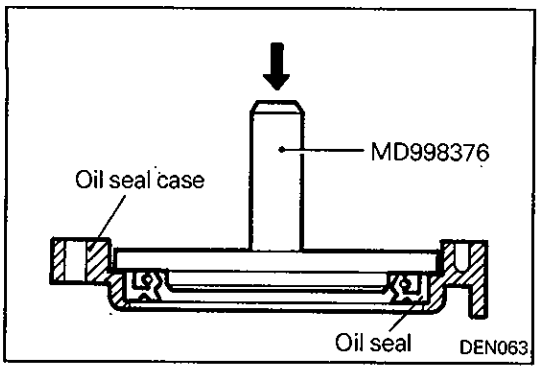
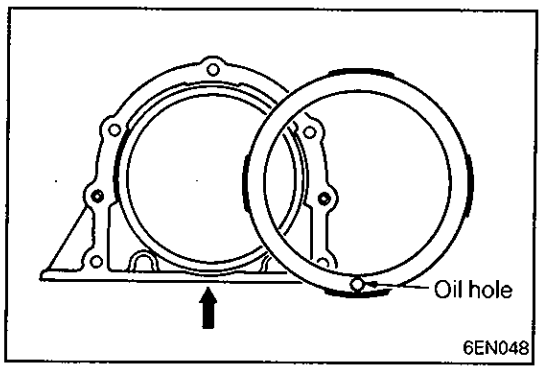


◗D◖ INSTALLATION OF OIL SEAL



◗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).

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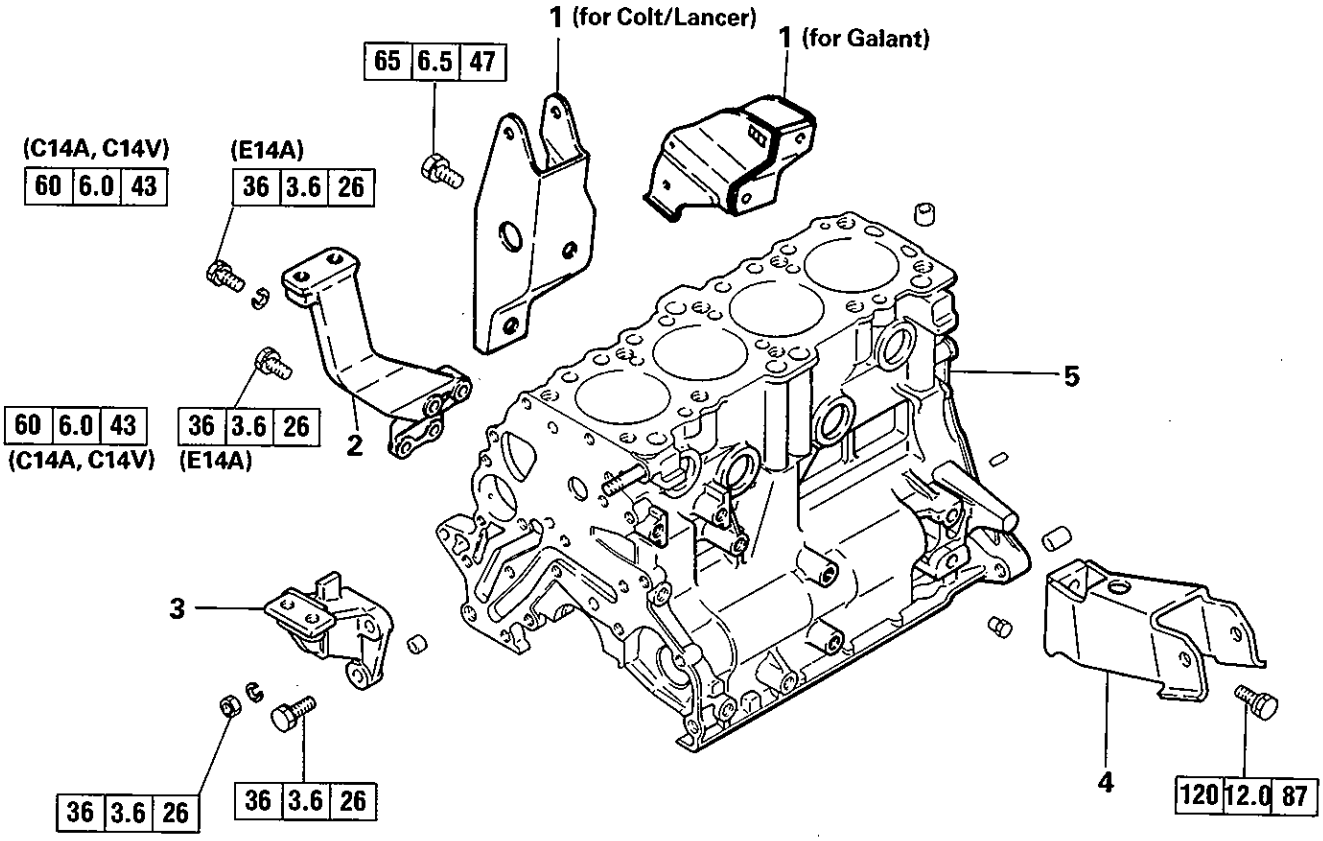
12. CYLINDER BLOCK

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

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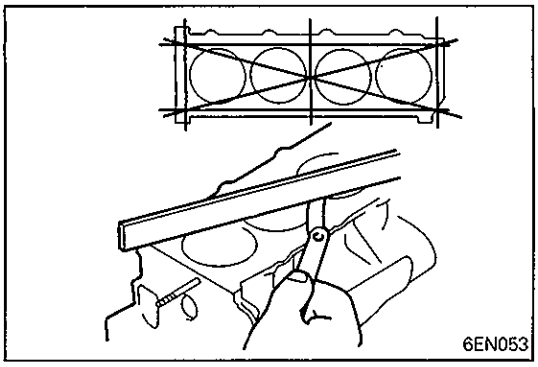

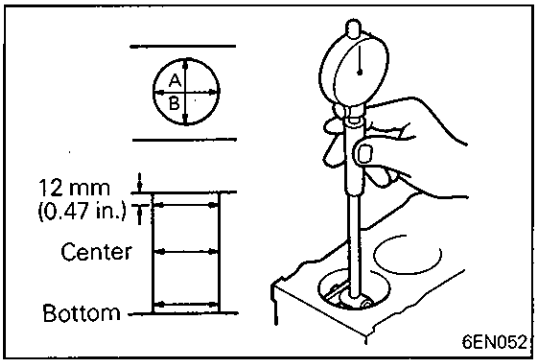

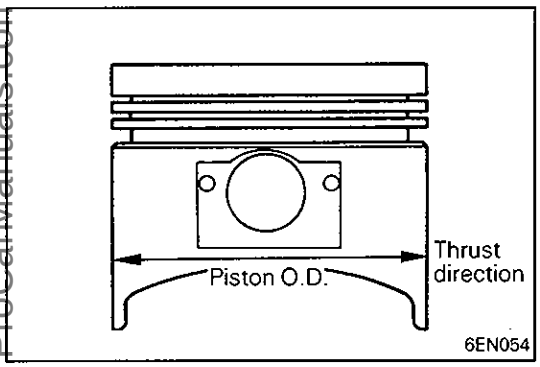

INSPECTION

(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.**

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(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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ENGINE

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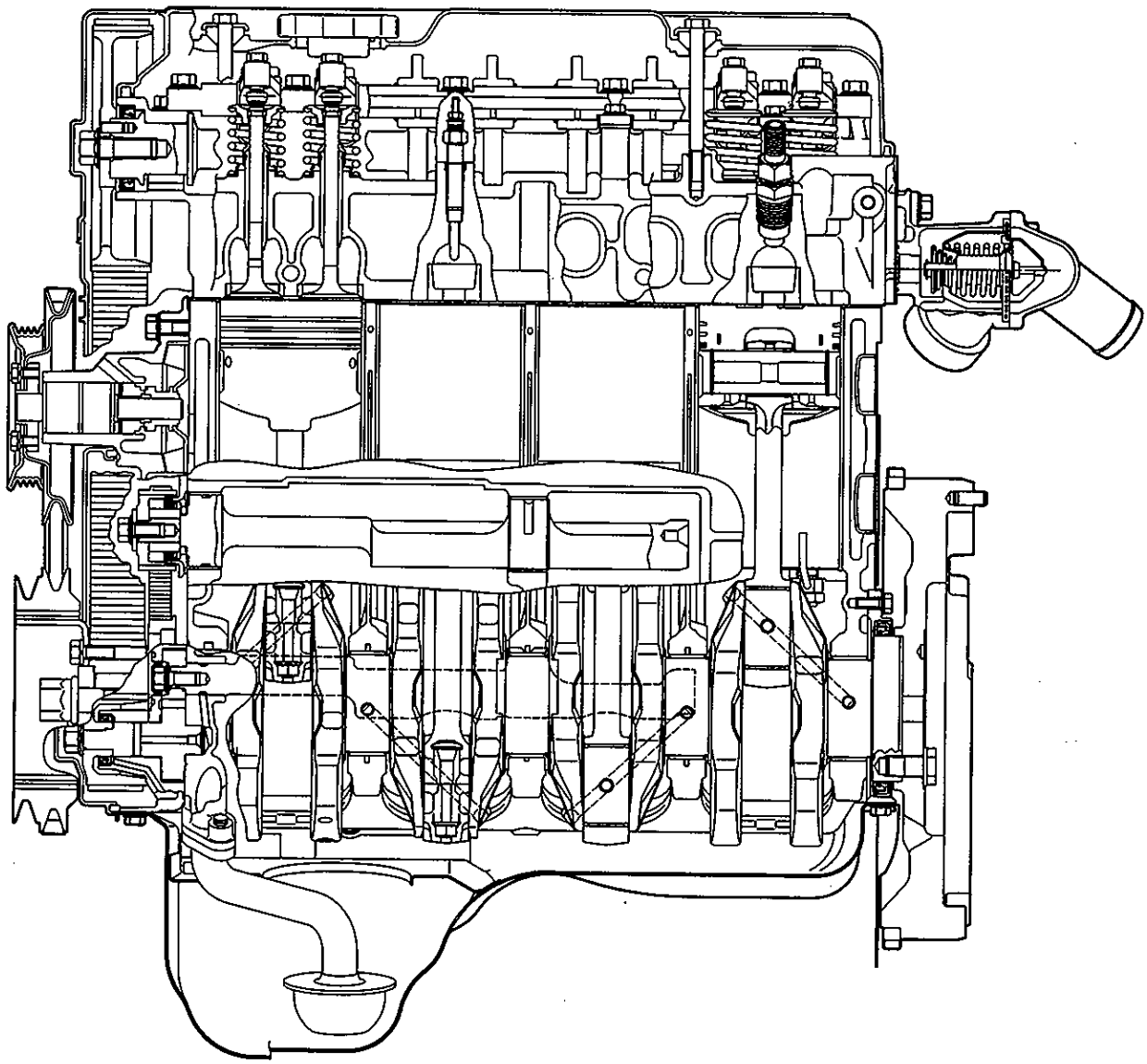
GENERAL INFORMATION

ENGINE SECTIONAL VIEW



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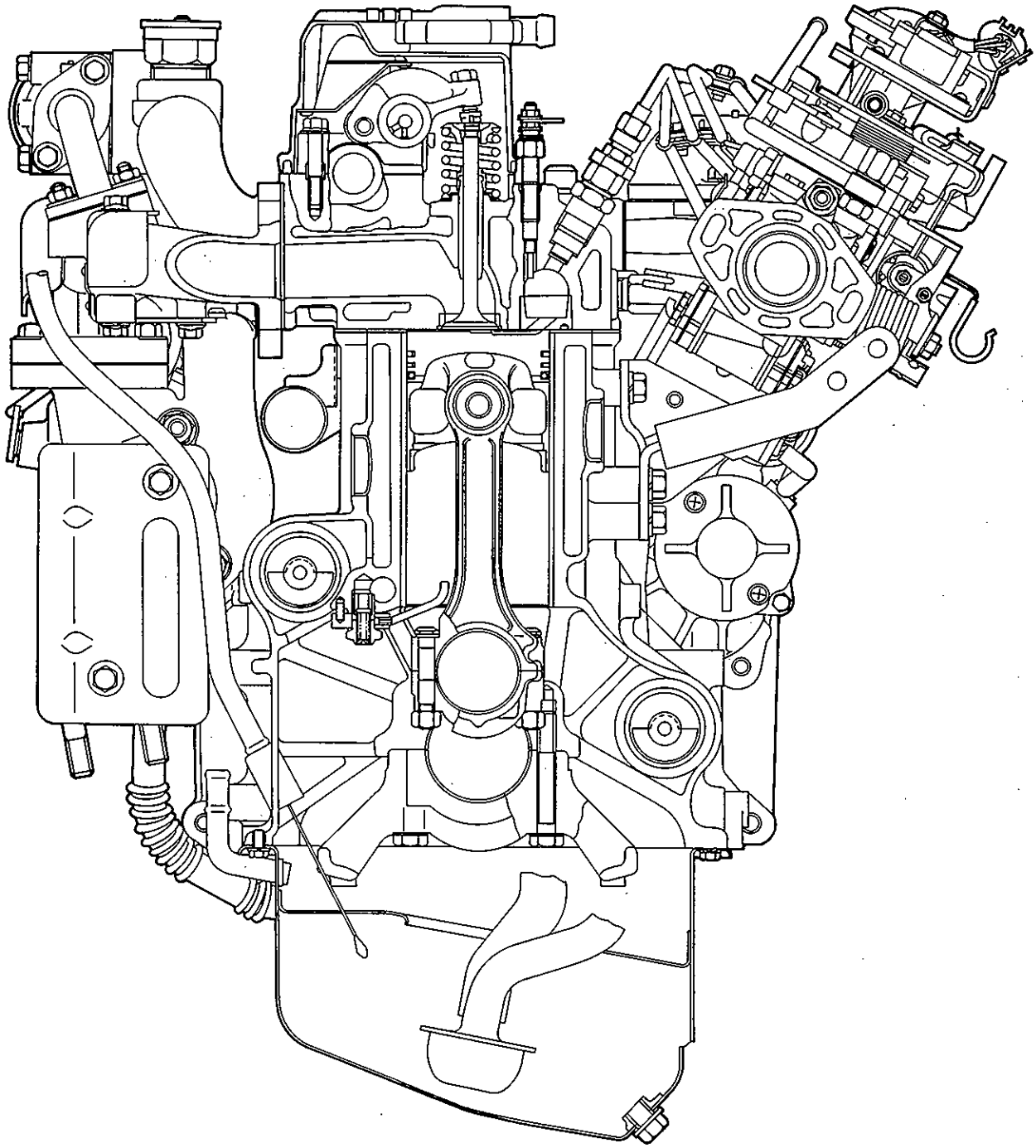

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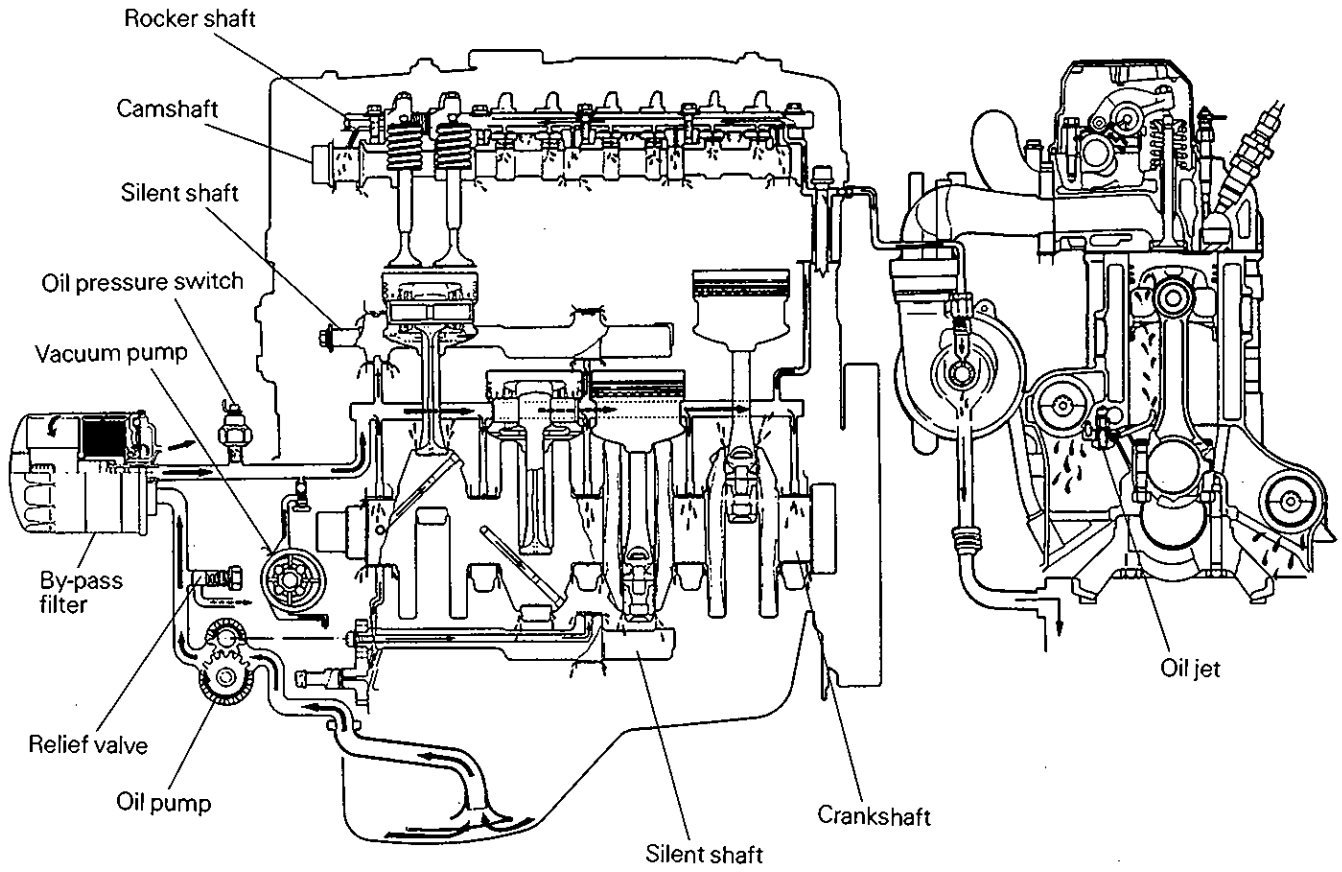
LUBRICATION SYSTEM



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NOTES

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1. SPECIFICATIONS

GENERAL SPECIFICATIONS

Description	Specifications
Type	Diesel engine
No. and arrangement of cylinders	4 in-line
Combustion chamber	Swirl chamber
Total displacement	1,998 cm³ (121.9 cu.in.)
Cylinder bore x stroke	82.7 x 93.0 mm (3.26 x 3.66 in.)
Compression ratio	22.4
Valve mechanism	Single overhead camshaft
Rocker arm	Roller follower type
Valve timing	
Intake valve	
Open	20°BTDC
Close	48°ABDC
Exhaust valve	
Open	54°BBDC
Close	22°ATDC
Lubrication system	Pressure feed, full-flow filtration
Oil pump type	External gear type
Turbocharger	Water-cooled
Cooling system	Water-cooled, electric cooling fan
Water pump type	Centrifugal impeller type

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SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
Cylinder head		
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)	
Camshaft		
Cam height		
Intake	41.84 (1.6472)	41.34 (1.6276)
Exhaust	41.84 (1.6472)	41.34 (1.6276)
Journal diameter	29.935 – 29.950 (1.1785 – 1.1791)	
Oil clearance	0.05 – 0.09 (0.0020 – 0.0035)	
Rocker arm		
I.D.	18.910 – 18.928 (0.7445 – 0.7452)	
Rocker arm-to-shaft clearance	0.01 – 0.05 (0.0004 – 0.0020)	
Rocker shaft		
O.D.	18.878 – 18.898 (0.7432 – 0.7440)	
Overall length	410 (16.14)	
Valve		
Overall length		
Intake	114.05 (4.490)	
Exhaust	113.80 (4.480)	
Stem diameter		
Intake	N/A: 7.960 – 7.975 (0.3134 – 0.3140) T/C: 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: 0.05 – 0.09 (0.0020 – 0.0035)	0.10 (0.0039) 0.10 (0.0039)
Exhaust	0.05 – 0.09 (0.0020 – 0.0035)	0.15 (0.0059)

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mm (in.)

	Standard	Limit
Valve spring		
Free height	49.1 (1.934)	48.1 (1.895)
Load/installed height N (kg, lbs.)/mm (in.)	276 (27.6, 61)/40.4 (1.591)	
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	43.45 (1.7106)	43.95 (1.7303)
Service size	0.30 (0.012), 0.60 (0.024) over size	
Silent shaft		
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)	
Piston		
O.D.	82.66 – 82.69 (3.2543 – 3.2555)	
Piston-to-cylinder clearance	0.03 – 0.05 (0.0012 – 0.0020)	
Piston ring		
End gap		
No. 1 ring	0.20 – 0.32 (0.0079 – 0.0126)	0.8 (0.031)
No. 2 ring	0.35 – 0.50 (0.0138 – 0.0197)	0.8 (0.031)
Oil ring	0.10 – 0.30 (0.0039 – 0.0118)	0.8 (0.031)
Ring-to-ring groove clearance		
No. 1 ring	0.05 – 0.07 (0.0020 – 0.0028)	0.1 (0.004)
No. 2 ring	N/A: 0.02 – 0.06 (0.0008 – 0.0024)	0.1 (0.004)
	T/C: 0.05 – 0.07 (0.0020 – 0.0028)	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) oversize	

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mm (in.)

	Standard	Limit
Piston pin		
O.D.	24.994 – 25.000 (0.9840 – 0.9843)	
Connecting rod		
Big end center-to-small end center length	149.9 – 150.0 (5.902 – 5.906)	
Bend	0.05 (0.0020)	
Twist	0.10 (0.0039)	
Big end side clearance	0.10 – 0.25 (0.0039 – 0.0098)	0.4 (0.016)
Crankshaft		
End play	0.05 – 0.18 (0.0020 – 0.0071)	0.25 (0.0098)
Journal O.D.	56.98 – 57.00 (2.2433 – 2.440)	
Pin O.D.	44.98 – 45.00 (1.7709 – 1.7717)	
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 – 0.04 (0.0008 – 0.0016)	0.1 (0.004)
Oil clearance of pin	0.02 – 0.05 (0.0008 – 0.0020)	0.1 (0.004)
Cylinder block		
Cylinder I.D.	82.70 – 82.73 (3.2559 – 3.2571)	
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)	
Oil pump		
Side clearance		
Drive gear	0.08 – 0.14 (0.0031 – 0.0055)	
Driven gear	0.06 – 0.12 (0.0024 – 0.0047)	
Drive belt		
Deflection	7 – 10 (0.28 – 0.39)	

NOTE
O.D.: Outer Diameter
I.D.: Inner Diameter
U.S.: Undersize Diameter

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TORQUE SPECIFICATIONS

		Nm	Torque kgm	ft.lbs.
Drive belt and glow plug				
Oil level gauge guide bolt	M6	10	1.0	7
	M8	14	1.4	11
Water pump pulley bolt		9	0.9	7
Eye bolt		17	1.7	12
Generator brace bolt		14	1.4	10
Generator pivot bolt		23	2.3	17
Crankshaft pulley bolt		25	2.5	18
Glow plug		18	1.8	13
Timing belt				
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		46	4.6	33
Timing belt "B" tensioner bolt		19	1.9	14
Crankshaft position sensor bolt		9	0.9	7
Fuel injection pump and injection nozzle				
Injection pipe union nut		30	3.0	22
Injection pipe clamp bolt		9	0.9	6.5
Engine hanger nut		12	1.2	9
Fuel injection pump nut		24	2.4	17
Injection pump stay bolt		19	1.9	14
Injection pump-to-pump stay bolt		24	2.4	17
Pump stay-to-cylinder block bolt		36	3.6	26
Fuel return pipe nut		30	3.0	22
Injection nozzle		55	5.5	40
Injection pump bracket nut		24	2.4	17
Intake and exhaust manifolds				
EGR valve bolt				
CB8A and CB8W only		25	2.5	18
Except CB8A and CB8W		18	1.8	13
EGR pipe bolt and nut		18	1.8	13
Eye bolt (oil pipe)		17	1.7	12
Oil return pipe bolt		9	0.9	7
Exhaust fitting bolt and nut		60	6.0	43
Eye bolt (water pipe)		31	3.1	24
Turbocharger bolt		60	6.0	43
Water pipe bolt		10	1.0	7

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	Torque		
	Nm	kgm	ft.lbs.
Air intake fitting bolt	18	1.8	13
Intake fitting stay bolt	18	1.8	13
Intake manifold bracket bolt	14	1.4	11
Relief valve	50	5.0	36
Intake manifold bolt and nut	18	1.8	13
Heat protector bolt			
Engine without turbocharger	30	3.0	22
Engine with turbocharger	14	1.4	11
Exhaust manifold nut			
Engine without turbocharger	18	1.8	13
Engine with turbocharger	28	2.8	20
Turbocharger			
Waste gate actuator bolt	12	1.2	9
Coupling bolt	5	0.5	4
Water pump, thermostat, hose and pipe			
Engine coolant temperature gauge unit			
Except SPACE RUNNER 1997 models and on	35	3.5	25
SPACE RUNNER 1997 models and on	11	1.1	8
Engine coolant temperature sensor	36	3.6	26
Engine coolant temperature switch			
Engine with turbocharger	8	0.8	6
N18W and N38W only	30	3.0	22
Water pump bolt			
Bolt which also tightens generator brace	24	2.4	17
Bolt not tightening generator brace	14	1.4	10
Water inlet pipe bolt	13	1.3	9
Water inlet fitting bolt	13	1.3	9
Water outlet fitting bolt	24	2.4	17
Thermostat housing bolt	24	2.4	17
Rocker arm, rocker shaft and camshaft			
Rocker cover bolt	6	0.6	4
Rocker shaft support bolt	20	2.0	14
Rocker shaft bolt	30	3.0	22
Camshaft bearing cap bolt	20	2.0	14
Rocker arm adjusting screw lock nut	15	1.5	11
Cylinder head, valves and valve spring			
Cylinder head bolt	40+1/4 turns +1/4 turns	4.0+1/4 turn +1/4 turn	29+1/4 turn +1/4 turn
Front case, silent shaft and oil pan			
Oil drain plug	40	4.0	29
Oil level sensor	9	0.9	7
Oil pan bolt	7	0.7	5
Oil screen bolt	19	1.9	14
Oil cooler by-pass valve	55	5.5	40
Oil pressure switch	10	1.0	7

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	Torque		
	Nm	kgm	ft.lbs.
Front case, silent shaft and oil pan			
Relief plug	45	4.5	33
Oil filter bracket bolt	19	1.9	14
Plug	24	2.4	17
Left silent shaft flange bolt	37	3.7	27
Front case bolt	24	2.4	17
Oil pump cover screw	10	1.0	7
Oil pump cover bolt	17	1.7	12
Check valve	33	3.3	24
Stiffener plate bolt	22	2.2	16
Piston and connecting rod			
Connecting rod cap nut	20+1/4 turns	2.0+1/4 turns	14.5+1/4 turns
Crankshaft, cylinder block and flywheel			
Front engine support bracket	60	6.0	43
Flywheel bolt	135	13.5	98
Oil seal case bolt	11	1.1	8
Bearing cap bolt	25+1/4 turns	2.5+1/4 turns	18+1/4 turns

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

A new type of bolts, to be tightened in plastic area, is currently used in some parts of the engine. The tightening method for the bolts is different from the conventional one. Be sure to observe the method described in the text when tightening the bolts.
Service limits are provided for the bolts. Make sure that the service limits described in the text are strictly observed.

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

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SEALANT

	Specified sealant	Quantity
Thermostat housing	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Water outlet fitting	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Engine coolant temperature gauge unit	3M Nut Locking Part No. 4171 or equivalent	As required
Engine coolant temperature sensor	3M ATD Part No. 8660 or equivalent	As required
Semi-circular packing	3M ATD Part No. 8660 or equivalent	As required
Oil pan	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Oil pressure switch	3M ATD Part No. 8660 or equivalent	As required
Oil seal case	Mitsubishi Genuine Part No. MD970389 or equivalent	As required

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FORM-IN-PLACE GASKET

The engine has several areas where the form-in-place gasket (FIPG) is in use. To ensure that the gasket fully serves its purpose, it is necessary to observe some precautions when applying the gasket. Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of the fluid feed line. To eliminate the possibility of leaks from a joint, therefore, it is absolutely necessary to apply the gasket evenly without a break, while observing the correct bead size.
The FIPG used in the engine is a room temperature vulcanization (RTV) type and is supplied in a 100-gram tube (Part No. MD970389 or MD997110). Since the RTV hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas. The FIPG, Part No. MD970389, can be used for sealing both engine oil and coolant, while Part No. 997110 can only be used for engine oil sealing.

Diassembly

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

Surface Preparation

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

Form-In Place Gasket Application

When assembling parts with the FIPG, you must observe some precautions, but the procedure is very simple as in the case of a conventional precut gasket.
Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only.
The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.

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NOTES

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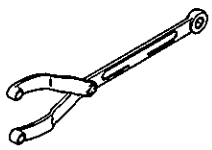
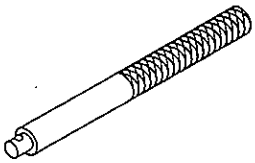
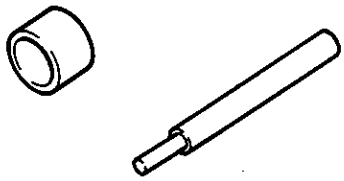
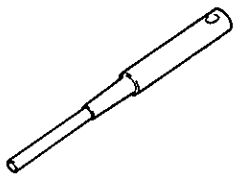
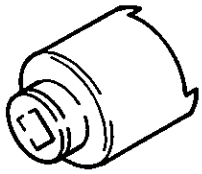
2. SPECIAL TOOLS

Tool	Number	Name	Use
	MB990767	End yoke holder	Holding camshaft sprocket or fuel injection pump when loosening or tightening bolts. Use with MD998719
	MD990938	Handle	Installation of crankshaft rear oil seal (Use with MD998776)
	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

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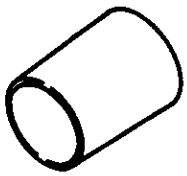
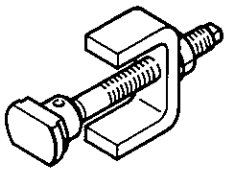
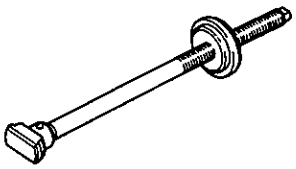
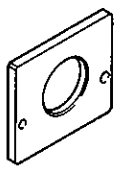
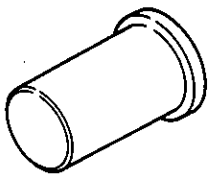
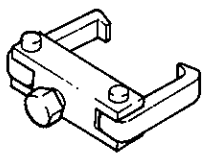
Tool	Number	Name	Use
	MD998173 (exhaust) MD998175 (intake)	Valve seat cutter 30°	Correction of valve seat
	MD998285	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal
	MD998371	Silent shaft bearing puller	Removal of silent shaft front bearing
	MD998372	Silent shaft bearing 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
	MD998388	Injection pump sprocket puller	Removal of injection pump sprocket

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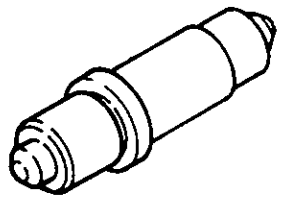
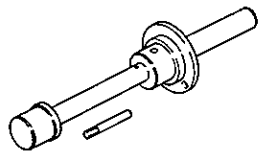
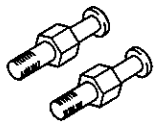
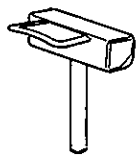
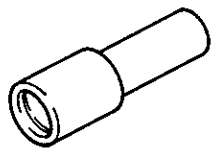
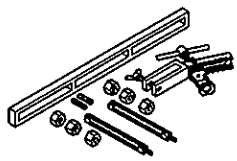
Tool	Number	Name	Use
	MD998702	Connecting-rod small-end bushing replacement tool	Replacement of connecting-rod small-end bushing
	MD998705	Silent shaft bearing installer	Installation of silent shaft bearing
	MD998713	Camshaft oil seal installer	Installation of camshaft oil seal
	MD998719	Pulley holder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

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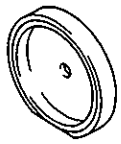
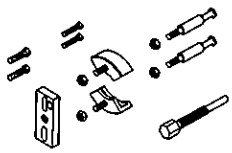
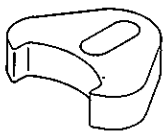
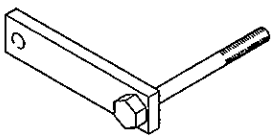
Tool	Number	Name	Use
	MD998776	Crankshaft rear oil seal installer	Installation of crankshaft rear oil seal (Use with MB990938)
	MD998778	Crankshaft sprocket puller	Removal of crankshaft sprocket
	MD998779	Sprocket stopper	Holding of silent shaft sprocket
	MD998781	Flywheel stopper	Holding of flywheel and drive plate

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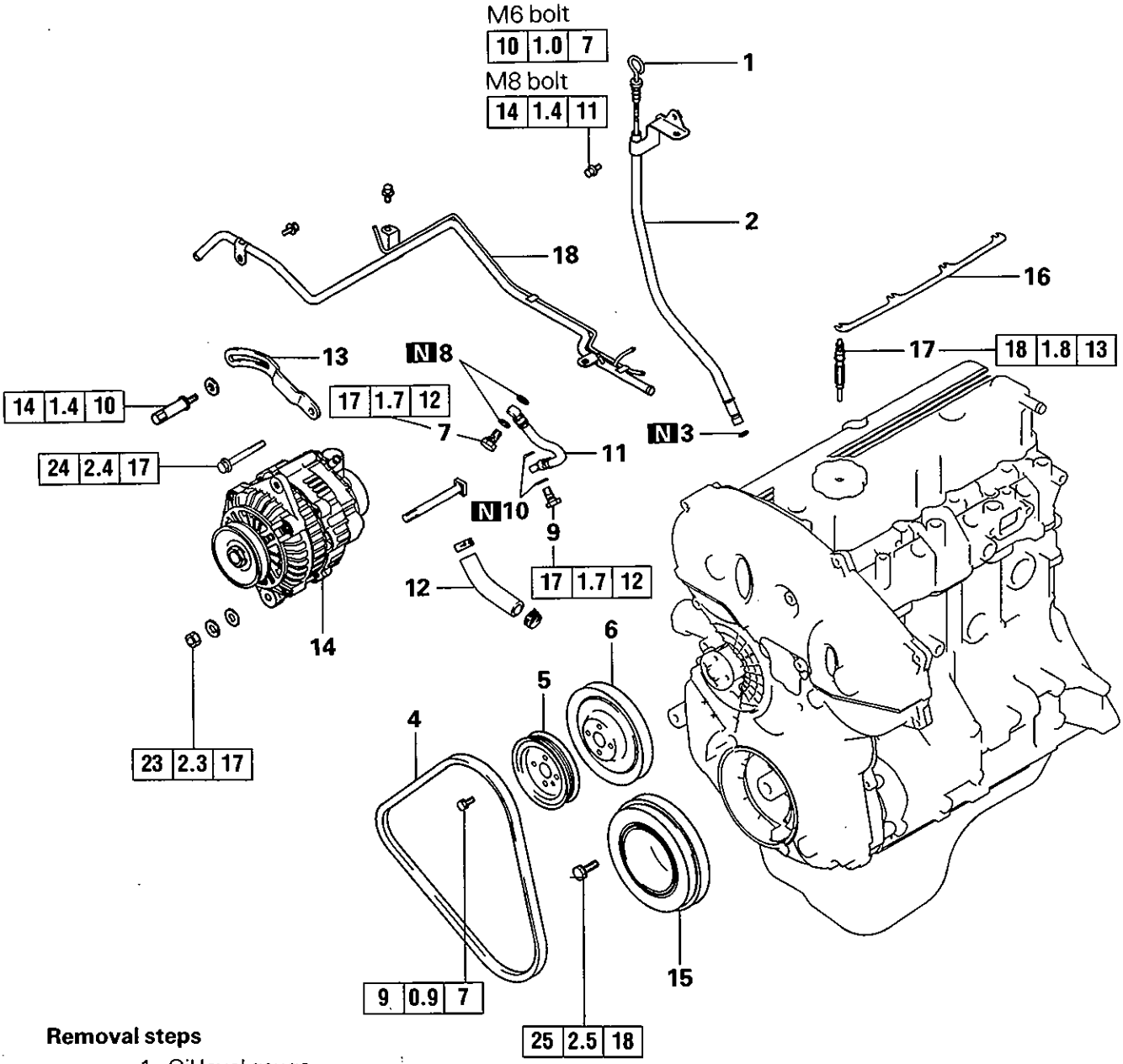
3. DRIVE BELT AND GLOW PLUG

REMOVAL AND INSTALLATION



Removal steps

1. Oil level gauge
2. Oil level gauge guide
3. O-ring
◆B◆ 4. Drive belt (V-type)
5. Pulley (for power steering pump drive)
6. Water pump pulley
7. Eye bolt
8. Gasket
9. Eye bolt
10. Gasket
11. Oil tube
12. Oil hose
13. Generator brace
14. Generator
15. Crankshaft pulley
16. Glow plug plate
◇A◇ ◆A◆ 17. Glow plug
18. Vacuum pipe

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Added

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REMOVAL SERVICE POINTS

◇A◇ GLOW PLUG REMOVAL

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

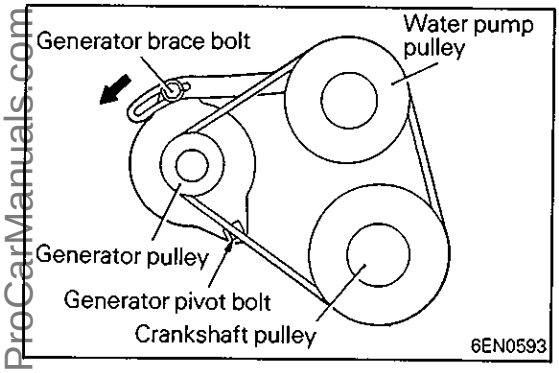
Caution

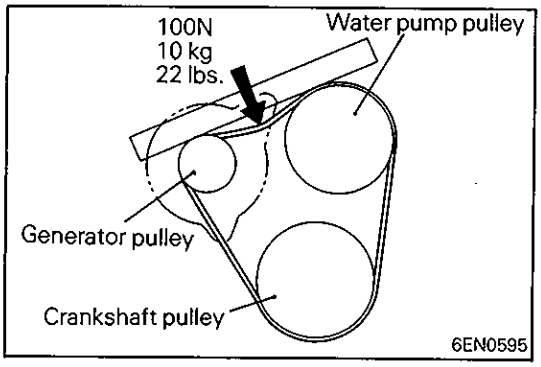
- **Do not reuse a glow plug that has been dropped from a height of 10 cm (4 in.) or more.**

INSTALLATION SERVICE POINTS

◆A◆ GLOW PLUG INSTALLATION

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





◆B◆ DRIVE BELT TENSION ADJUSTMENT

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

Standard value: 7 – 10 mm (0.28 – 0.39 in.)

(4) Tighten the generator brace bolt.
(5) Tighten the nut for the generator support bolt.

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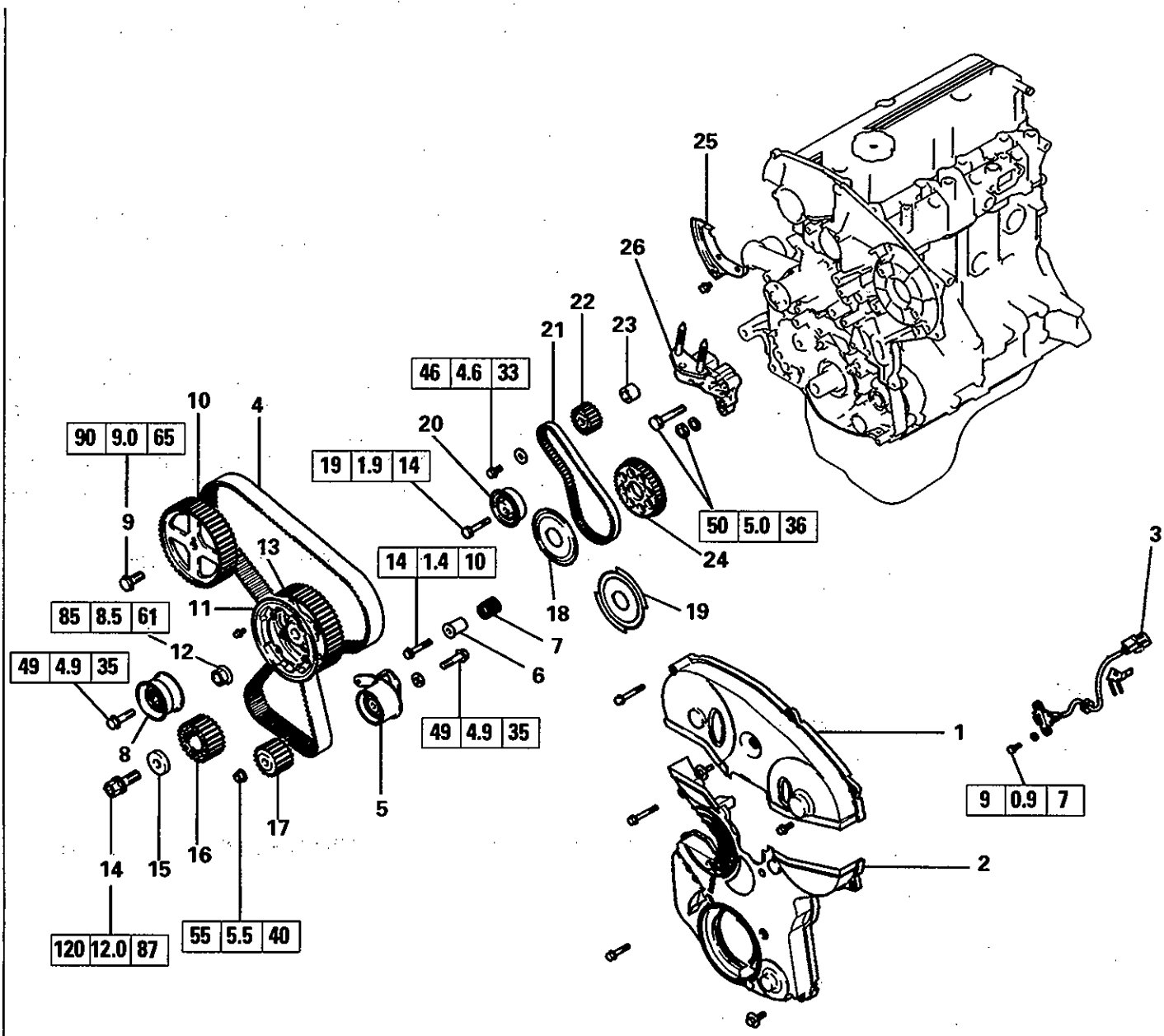
4. TIMING BELT

REMOVAL AND INSTALLATION



Removal steps

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

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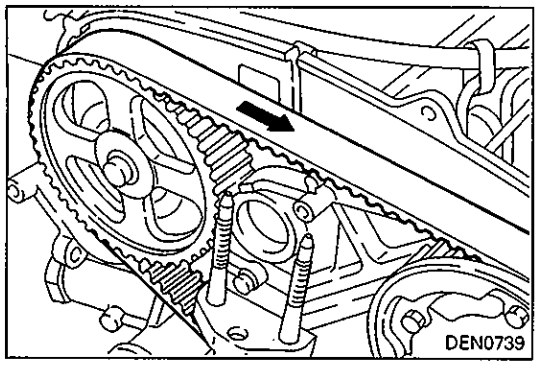
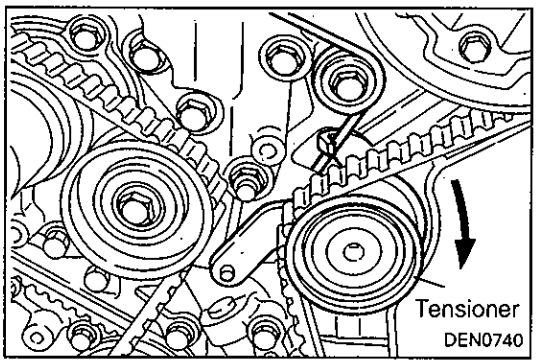


REMOVAL SERVICE POINTS

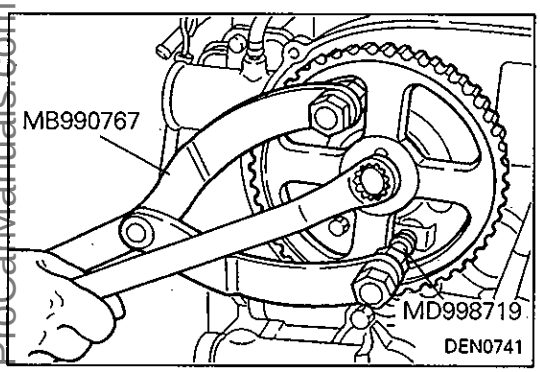
◇A◇ TIMING BELT REMOVAL

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

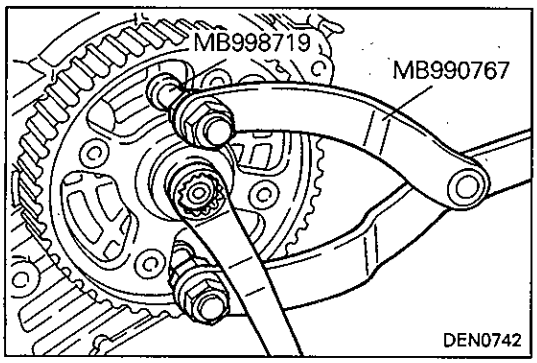


(2) With the timing belt tensioner pushed down, tighten the tensioner mounting bolt temporarily to hold the tensioner in place.
(3) Remove the timing belt.

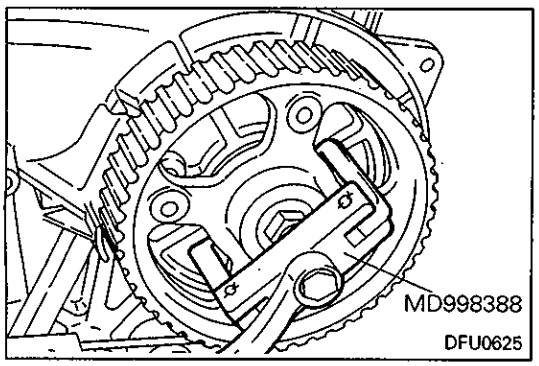
NOTE
(1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.
(2) If there is oil or water on any part, check the front case oil seals, camshaft oil seal and water pump for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



◇B◇ CAMSHAFT SPROCKET BOLT LOOSENING



◇C◇ INJECTION PUMP SPROCKET NUT LOOSENING



◇D◇ INJECTION PUMP SPROCKET REMOVAL

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

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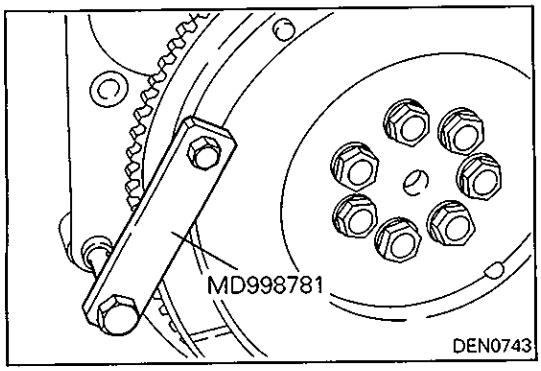
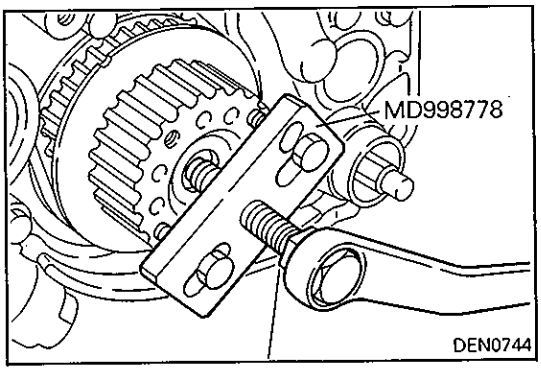
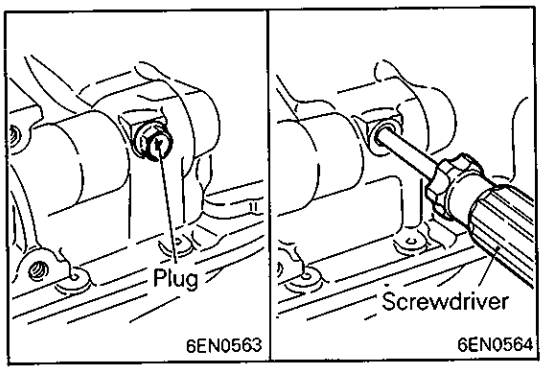


◊E◊ CRANKSHAFT BOLT LOOSENING



◊F◊ CRANKSHAFT SPROCKET REMOVAL

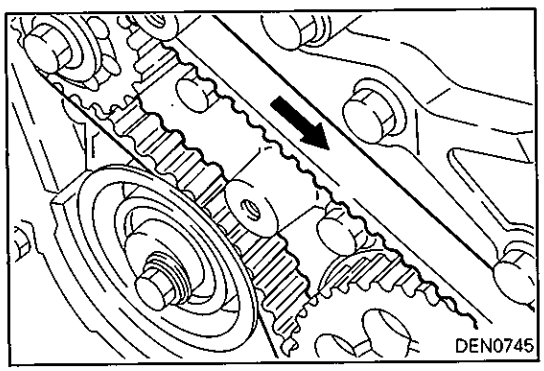


◊G◊ OIL PUMP SPROCKET REMOVAL

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



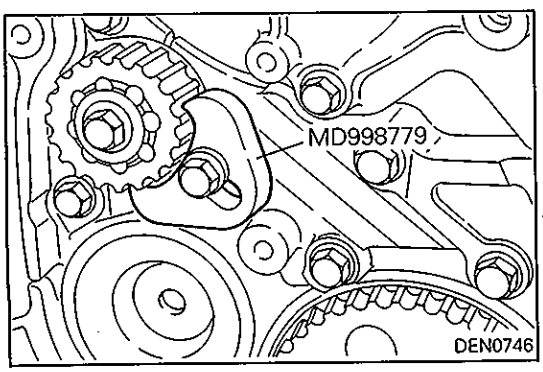
◊H◊ TIMING BELT "B" REMOVAL

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

NOTE

(1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. Do not immerse parts in cleaning solvent.

(2) If there is oil or water on any part, check the front case oil seals, camshaft oil seal and water pump for leaks.



◊I◊ SILENT SHAFT SPROCKET REMOVAL

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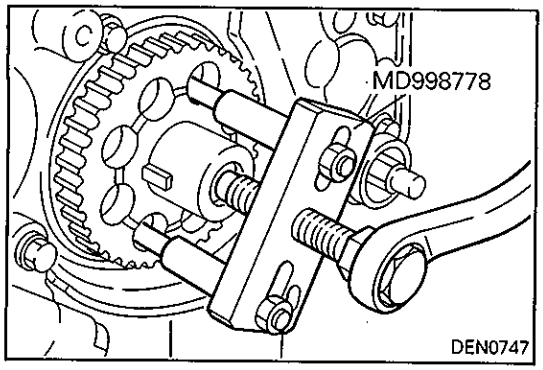
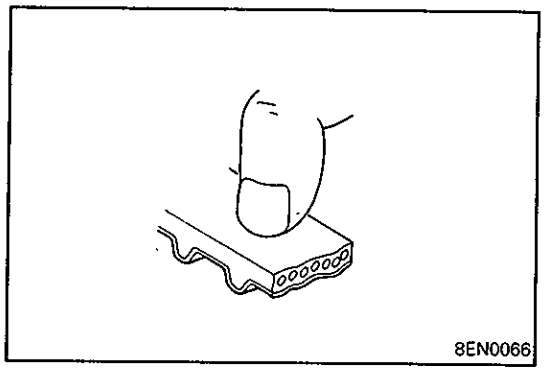
Added



⟨J⟩ CRANKSHAFT SPROCKET "B" REMOVAL

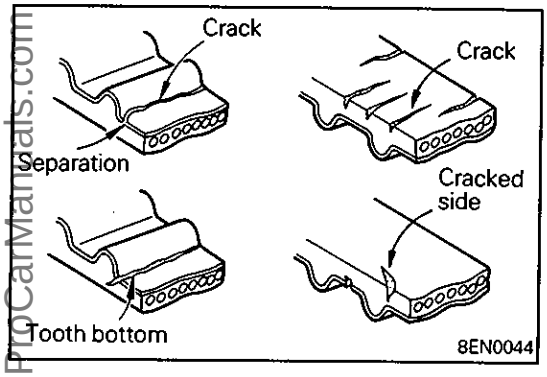


INSPECTION

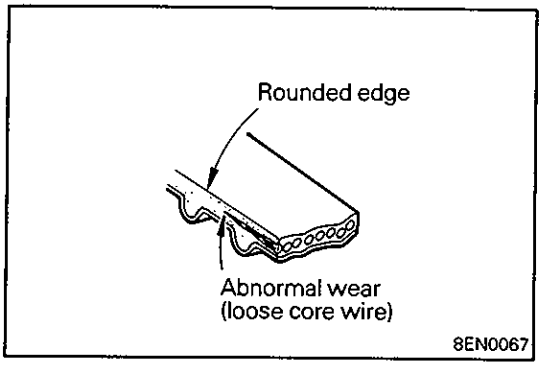
TIMING BELTS

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

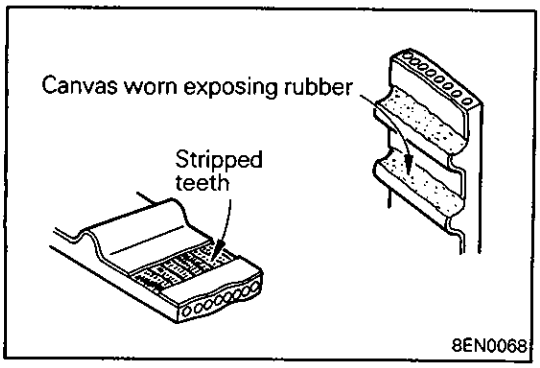
(1) Hardened back surface rubber
Glossy, non-elastic, and so hard that no mark is produced even when scratched by fingernails.



(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

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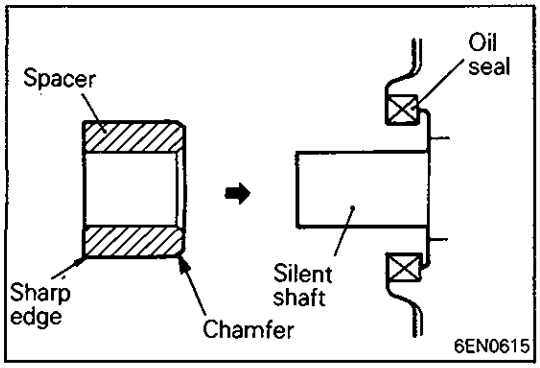
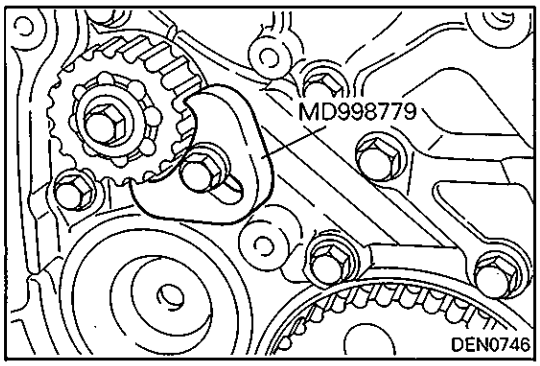


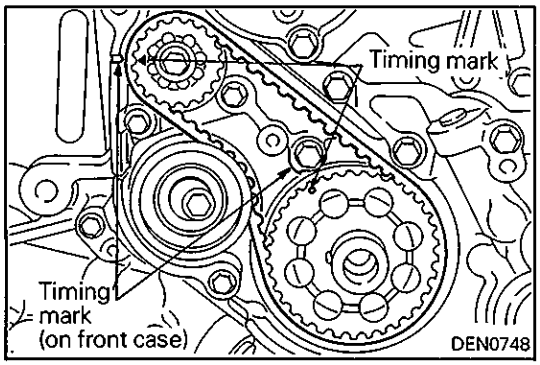
INSTALLATION SERVICE POINTS

◆A◆ SPACER INSTALLATION

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



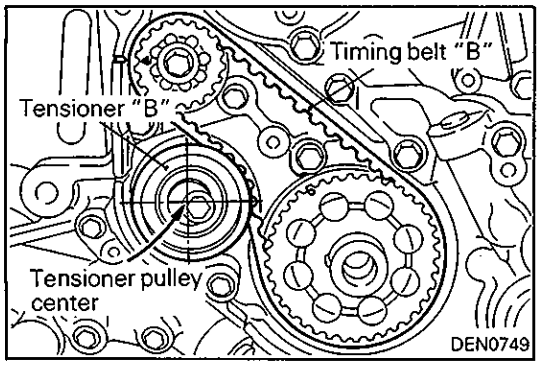
◆B◆ SILENT SHAFT SPROCKET INSTALLATION



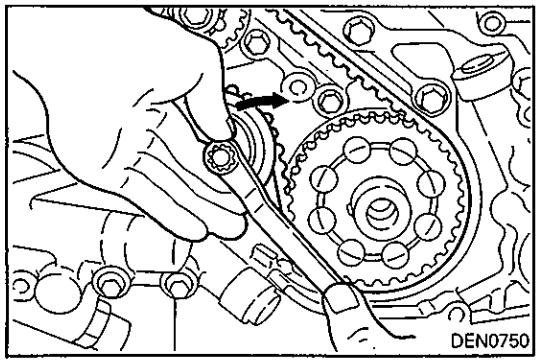
◆C◆ TIMING BELT "B" INSTALLATION

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

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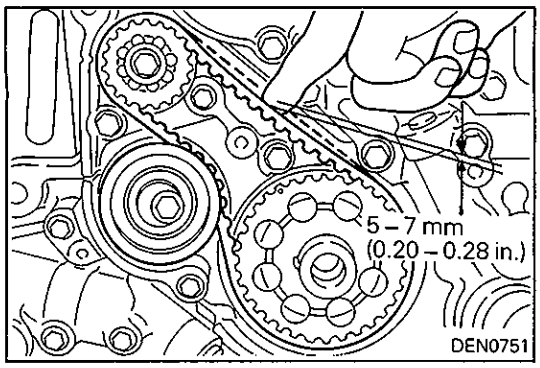
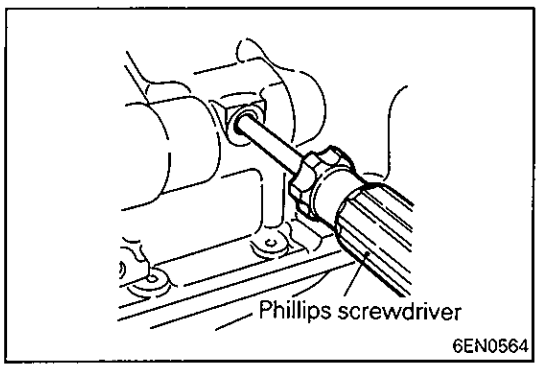
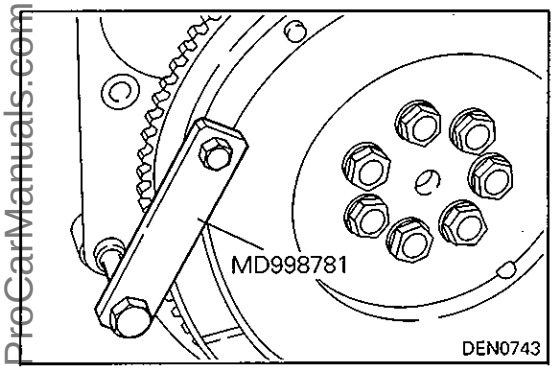


(5) Check to ensure that the timing marks on the sprockets and the front case are in alignment.
(6) Press with index finger the center of span on the tension side of timing belt "B". The bolt must deflect 5 to 7 mm (0.20 to 0.28 in.)

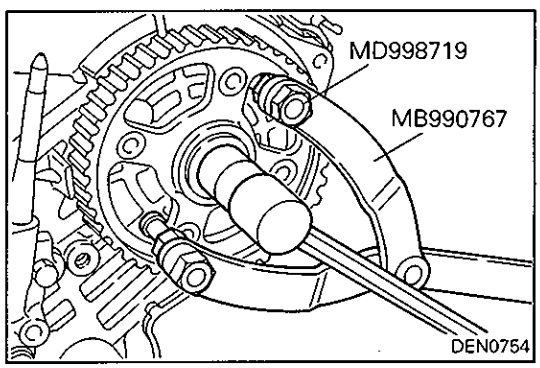


◆D◆ OIL PUMP SPROCKET INSTALLATION

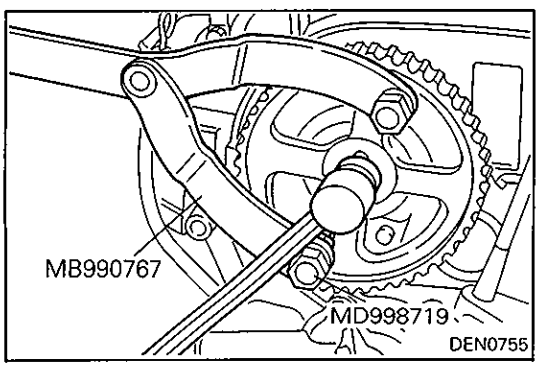
(1) Keep the silent shaft in position in the same way as when it was loosened.
(2) Install the oil pump sprocket.
(3) Apply a minimum quantity of engine oil to the bearing surface of the nut.
(4) Tighten the nuts to the specified torque.



◆E◆ CRANKSHAFT BOLT TIGHTENING



◆F◆ INJECTION PUMP SPROCKET NUT TIGHTENING



◆G◆ CAMSHAFT SPROCKET BOLT TIGHTENING

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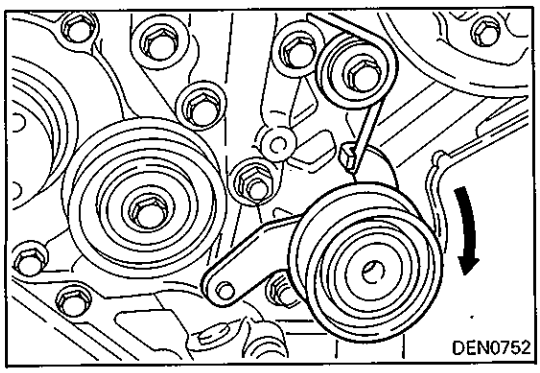
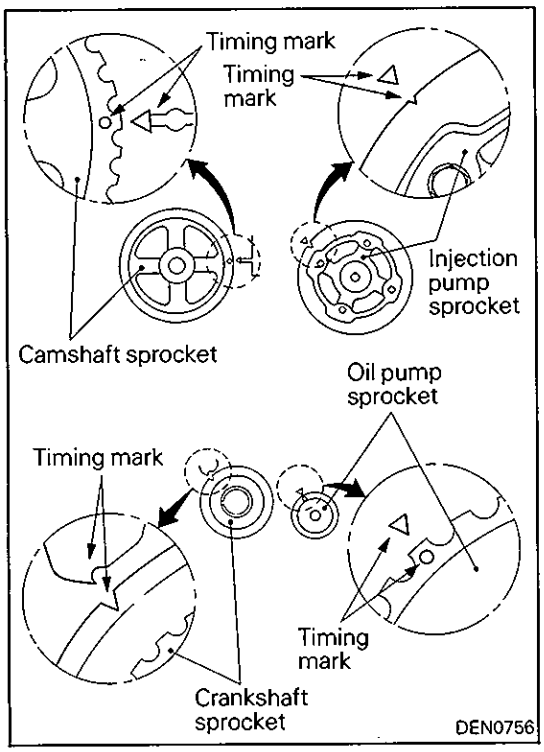


◆H◆ TIMING BELT TENSIONER INSTALLATION

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

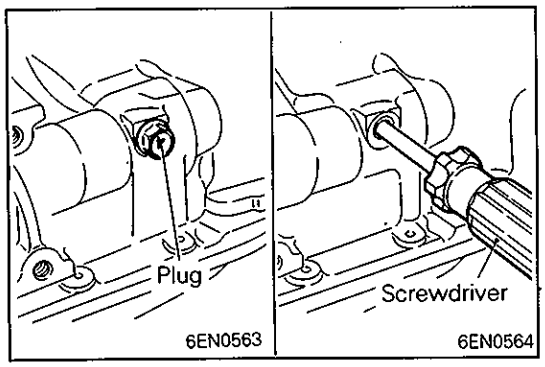
◆I◆ TIMING BELT INSTALLATION

(1) Temporarily fix the tensioner at the most lower position in the injection pump bracket slot.



(2) Turn the crankshaft to bring the No. 1 piston at the top dead center on the compression stroke.
(3) Align the timing marks of all sprockets with their mating marks as shown.

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



(4) Remove the plug on the cylinder block and insert a Phillips screwdriver [shank diameter 8 mm (0.31 in.)] through the hole.
If it can be inserted as deep as 60 mm (2.4 in.) or more, the timing marks are correctly aligned. If the inserted depth is only 20 – 25 mm (0.8 – 1.0 in.), turn the oil pump sprocket one turn and realign the timing marks. Then check to ensure that the screwdriver can be inserted 60 mm (2.4 in.) or more. Keep the screwdriver inserted until installation of the timing belt is finished.

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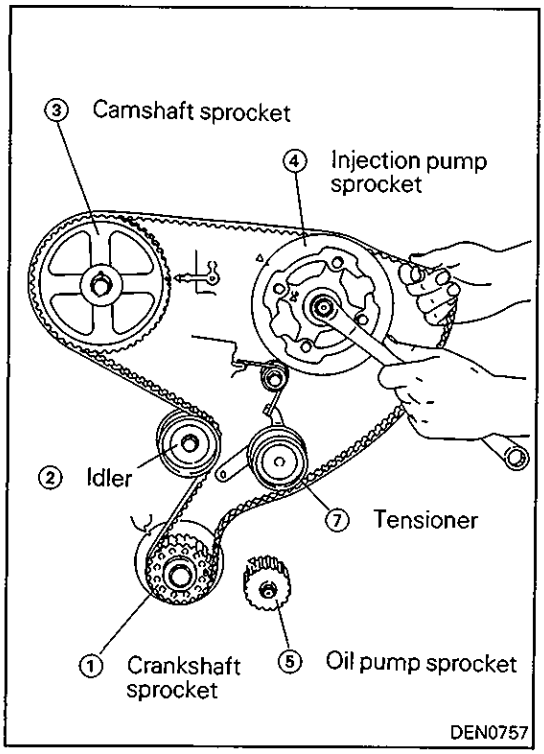
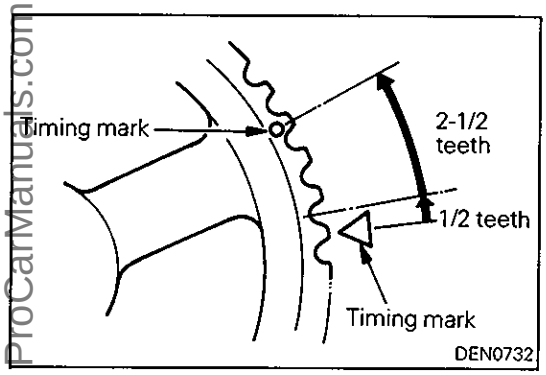


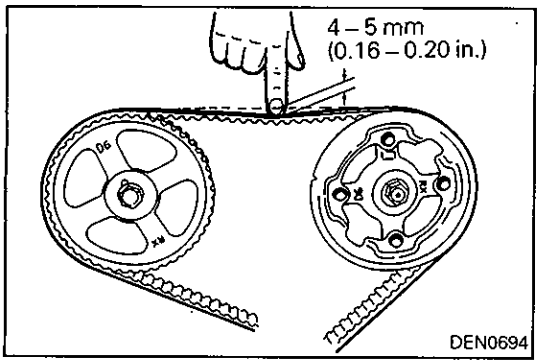
(5) Install the timing belt on the sprockets in the following sequence while taking care so that the belt is not slack between sprockets or between sprocket and pulley.
① Crankshaft sprocket
② Timing belt idler
③ Camshaft sprocket
④ Injection pump sprocket
⑤ Oil pump sprocket
⑥ Turn the crankshaft in the reverse direction by 1/2 tooth of the camshaft sprocket to remove the slackness of the belt on the idler side.
⑦ Timing belt tensioner

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

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



(7) Turn the crankshaft counterclockwise by three teeth of the cam sprocket from the timing mark and hold this position. Check that the belt is in complete mesh with the sprockets.
(8) Fix the tensioner.
(9) Turn the crankshaft clockwise to align the timing marks.



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

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

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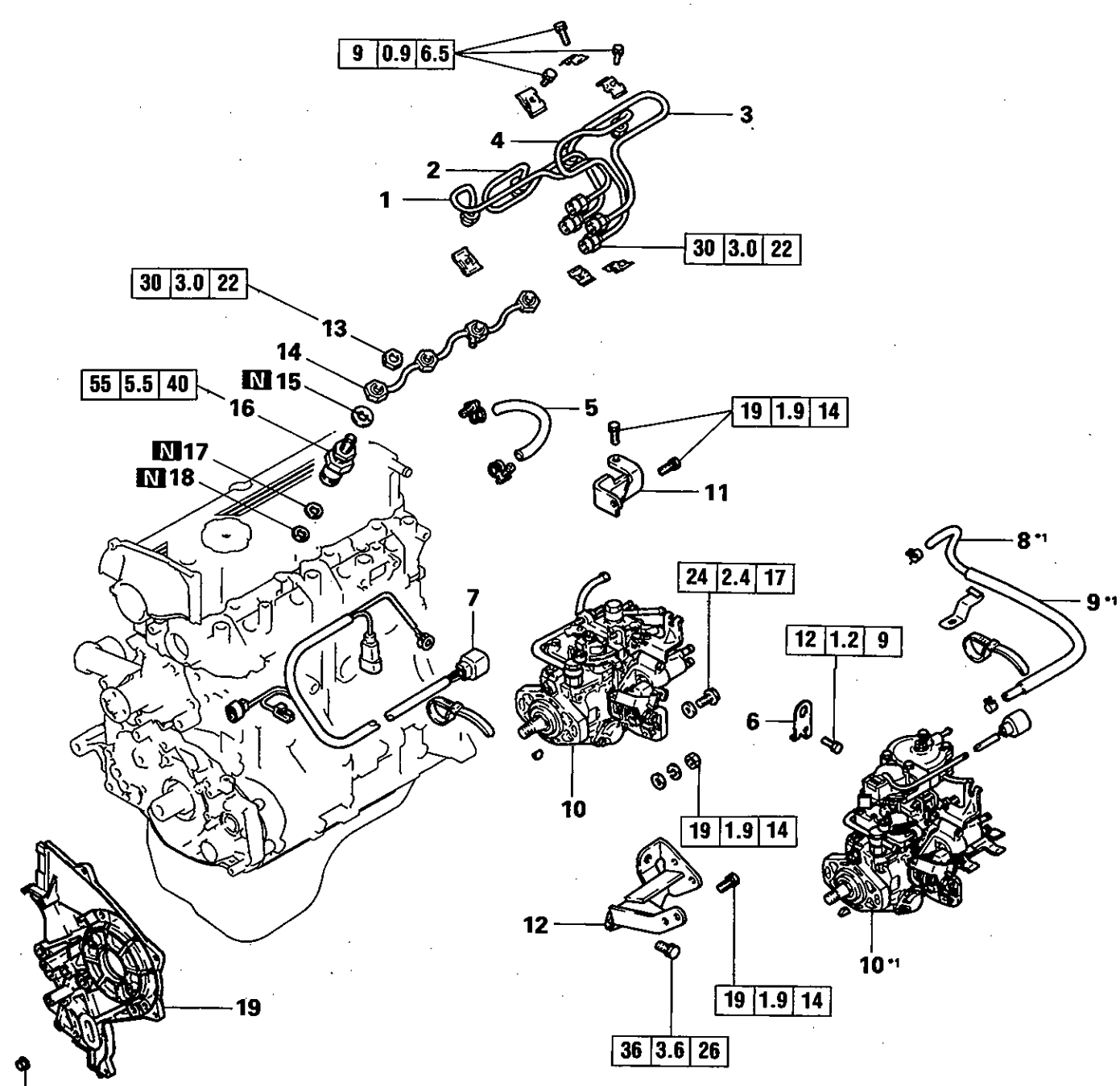
5. GLOW PLUG, FUEL INJECTION PUMP AND INJECTION NOZZLE

REMOVAL AND INSTALLATION



Removal steps

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

NOTE
*1: Engines with turbocharger (except SPACE RUNNER 1997 models and on)

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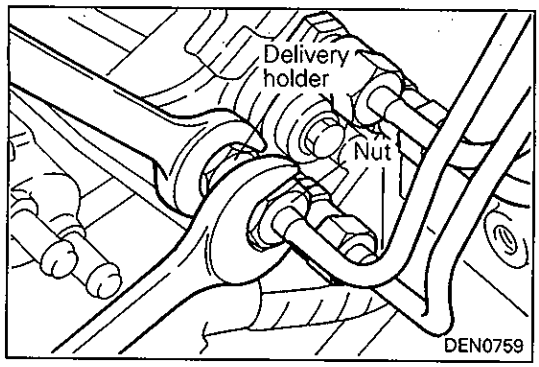

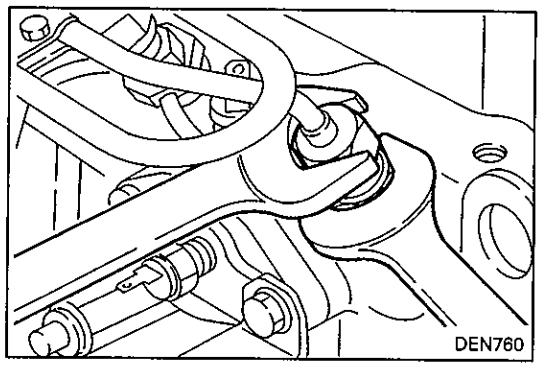

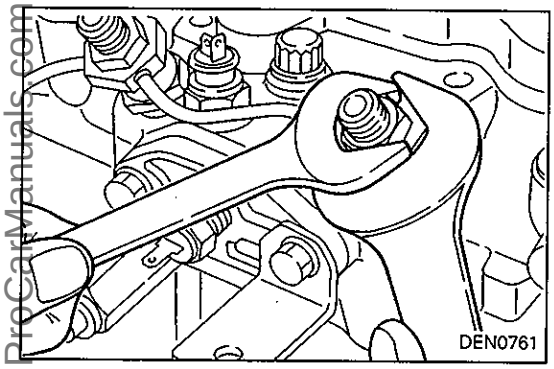

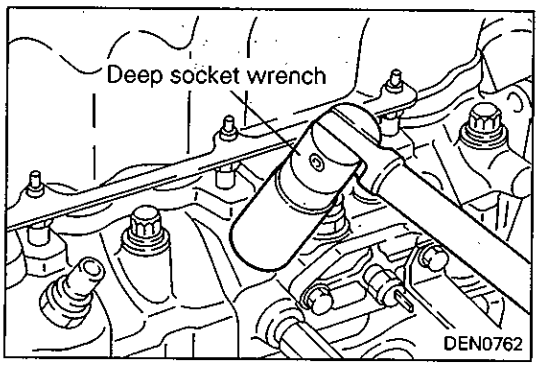

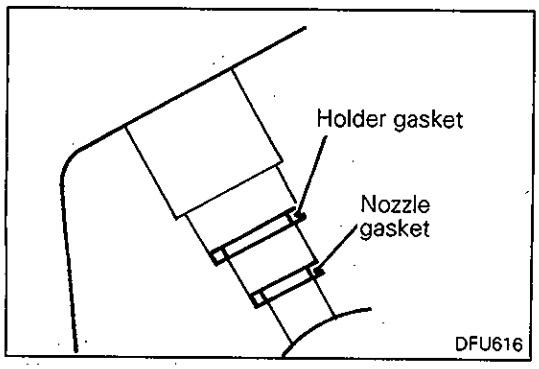

REMOVAL SERVICE POITNS

◇A◇ INJECTION PIPE REMOVAL

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

Caution

- **If the injection pipe has been removed, plug the delivery valve holder to prevent foreign matter from entering the injection pump.**

(2) When loosening the union nuts on the injection nozzles hold, the hexagon nut of the fuel return pipe with a spanner to prevent it from rotating along with the union nut.

◇B◇ FUEL INJECTION PUMP REMOVAL

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

◇C◇ FUEL RETURN PIPE NUT REMOVAL

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

◇D◇ INJECTION NOZZLE REMOVAL

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

Caution

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

INSTALLATION SERVICE POINTS

◆A◆ NOZZLE GASKET / HOLDER GASKET INSTALLATION

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

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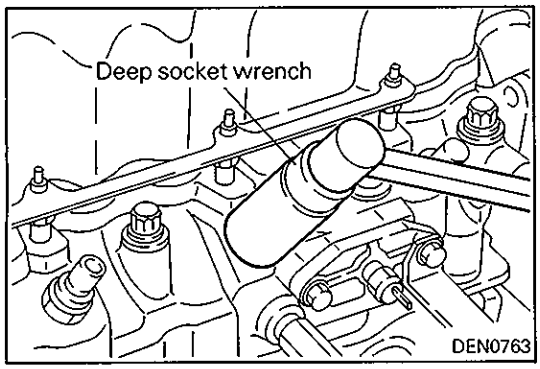
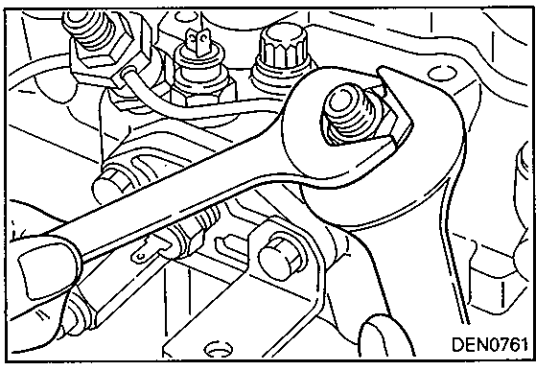
Added

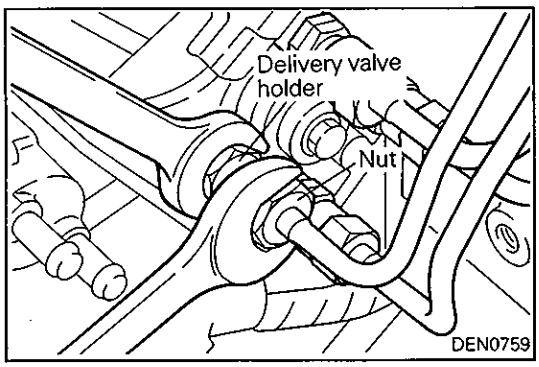


◆B◆ INJECTION NOZZLE INSTALLATION



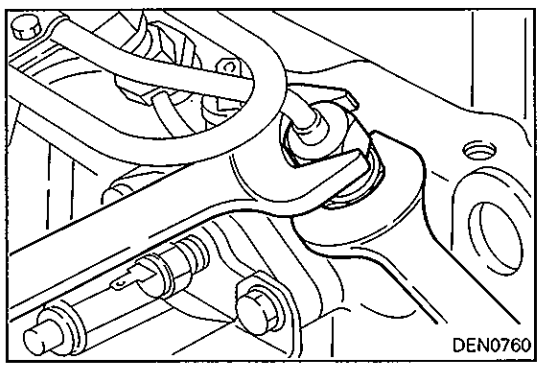
◆C◆ FUEL RETURN PIPE NUT INSTALLATION

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



◆D◆ INJECTION PIPE INSTALLATION

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



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

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NOTES

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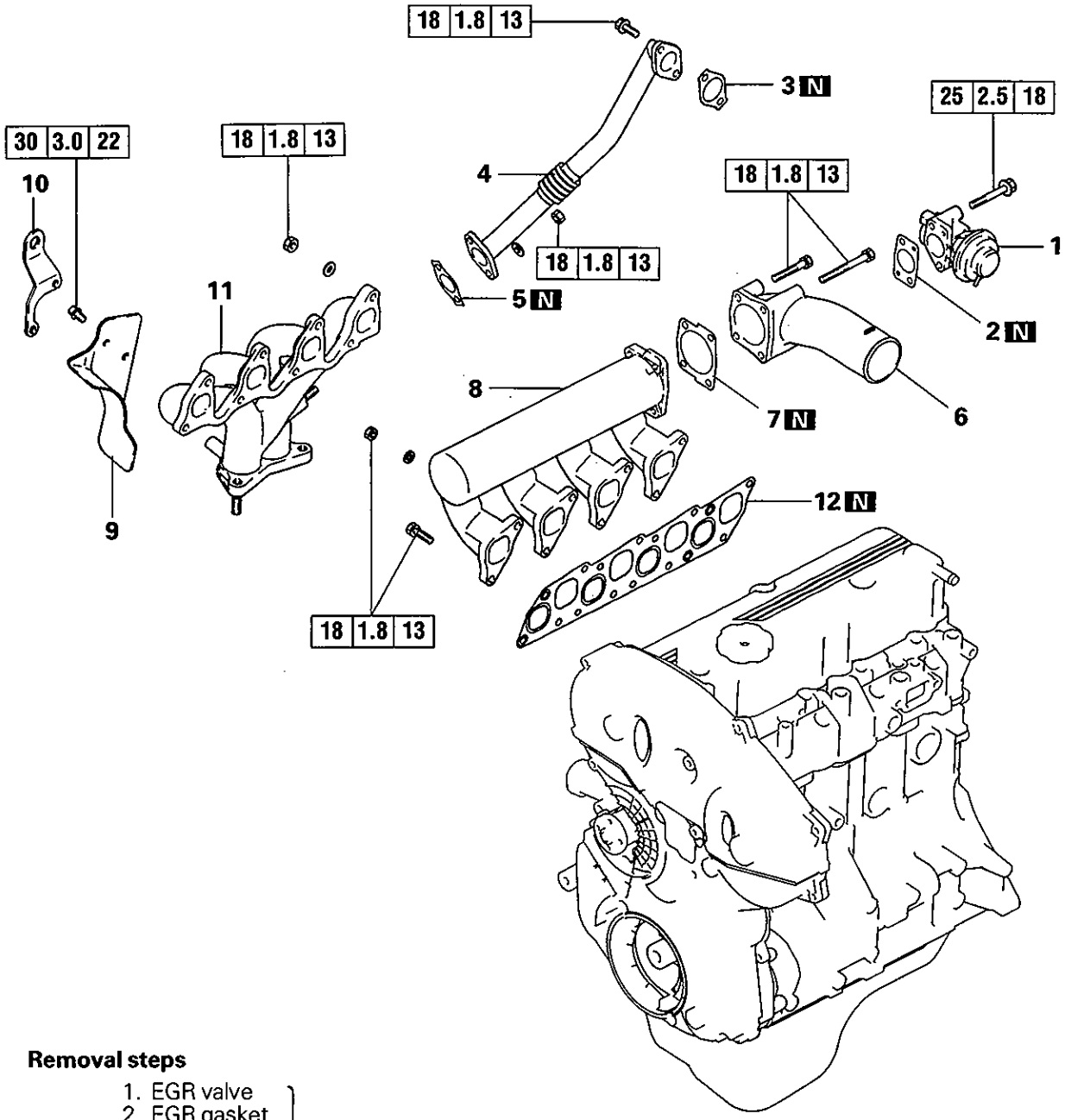
6. INTAKE AND EXHAUST MANIFOLDS

REMOVAL AND INSTALLATION

<Engine without turbocharger – CB8A, CB8W>



Removal steps

1. EGR valve
2. EGR gasket
3. Gasket
4. EGR pipe
5. Gasket

} Engine with EGR system

6. Air inlet fitting
7. Gasket
8. Intake manifold
9. Heat protector
10. Engine hanger
11. Exhaust manifold
12. Exhaust manifold gasket

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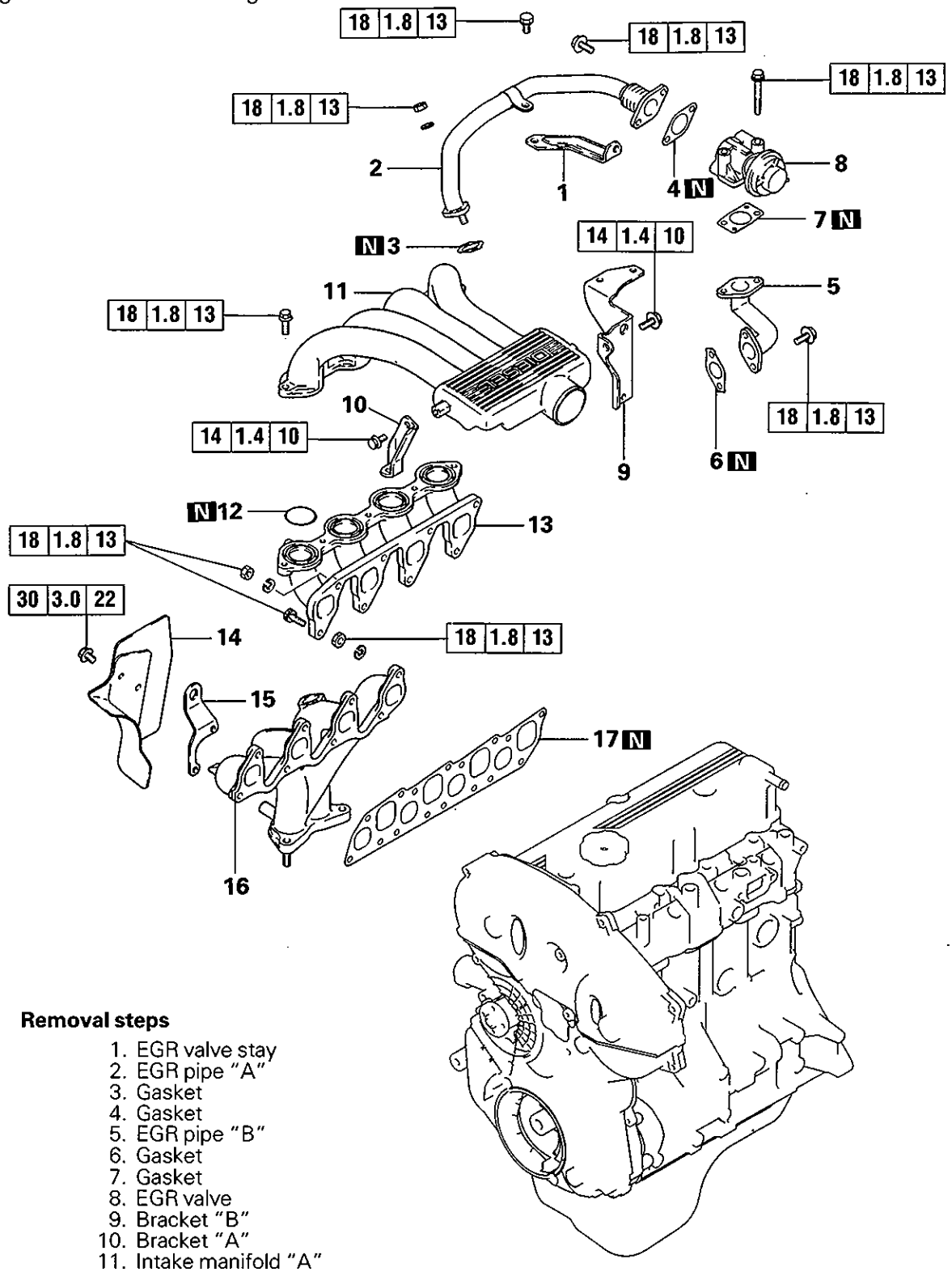
REMOVAL AND INSTALLATION

<Engine without turbocharger – C67A>



Removal steps

1. EGR valve stay
2. EGR pipe "A"
3. Gasket
4. Gasket
5. EGR pipe "B"
6. Gasket
7. Gasket
8. EGR valve
9. Bracket "B"
10. Bracket "A"
11. Intake manifold "A"

◆A◆ 12. O-ring

13. Intake manifold "B"
14. Heat protector
15. Engine hanger
16. Exhaust manifold
17. Exhaust manifold gasket

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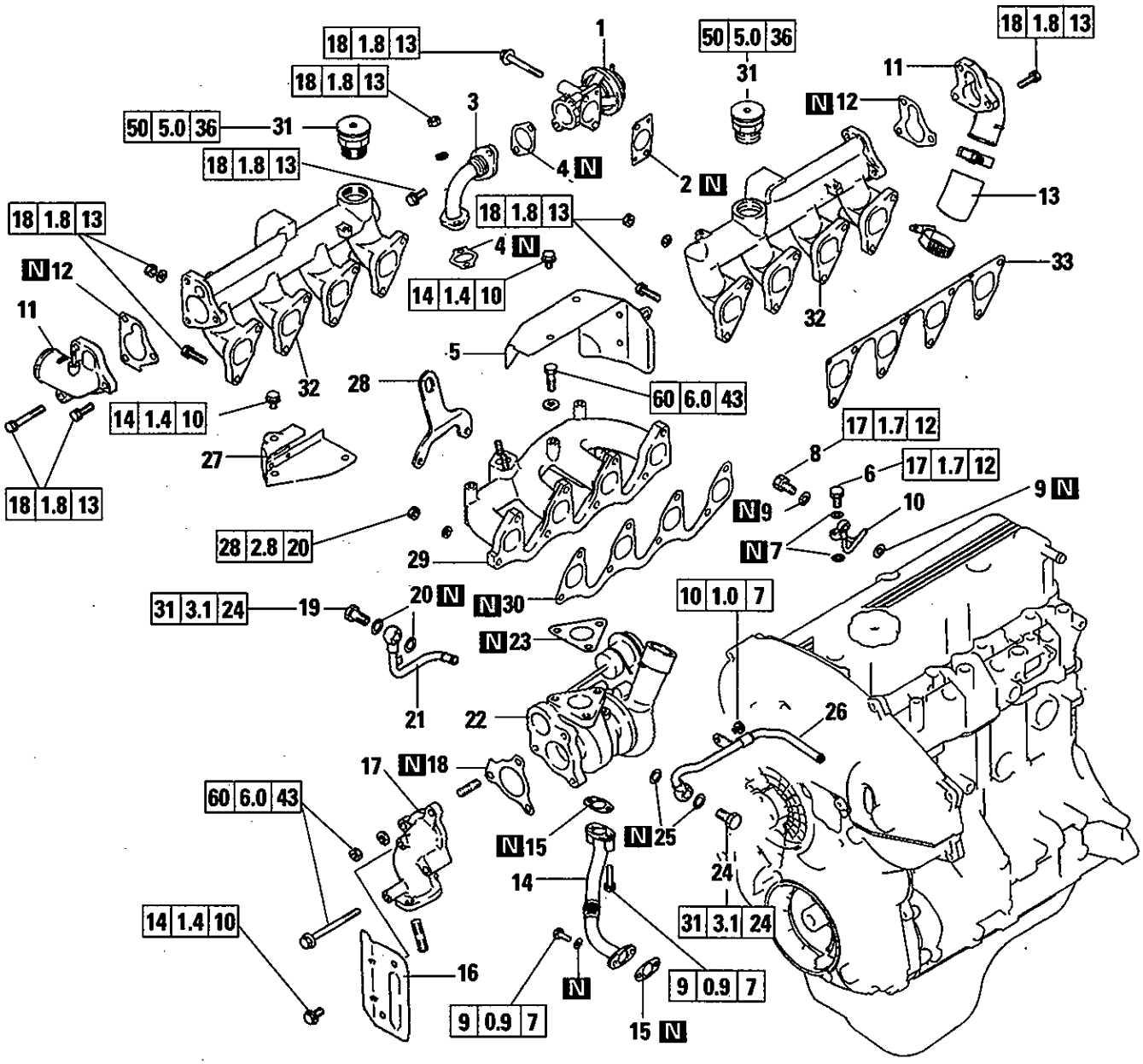
REMOVAL AND INSTALLATION

<Engine with turbocharger (except SPACE RUNNER 1997 models and on)>



Removal steps

1. EGR valve
2. EGR gasket
3. EGR pipe
4. Gasket
5. Heat protector "A"
- ◆B◆ 6. Eyebolt
7. Gasket
- ◆B◆ 8. Eyebolt
9. Gasket
10. Oil pipe
11. Air intake fitting
12. Intake fitting gasket
13. Air hose <Vehicles without intercooler>
14. Oil return pipe
15. Oil return pipe gasket
16. Heat protector "C"
17. Exhaust fitting
18. Gasket
19. Eyebolt
20. Gasket
21. Water pipe "B"
22. Turbocharger assembly
23. Gasket
24. Eyebolt
25. Gasket
26. Water pipe "A"
27. Heat protector "B"
28. Engine hanger
29. Exhaust manifold
30. Exhaust manifold gasket
31. Relief valve
32. Intake manifold
33. Intake manifold gasket

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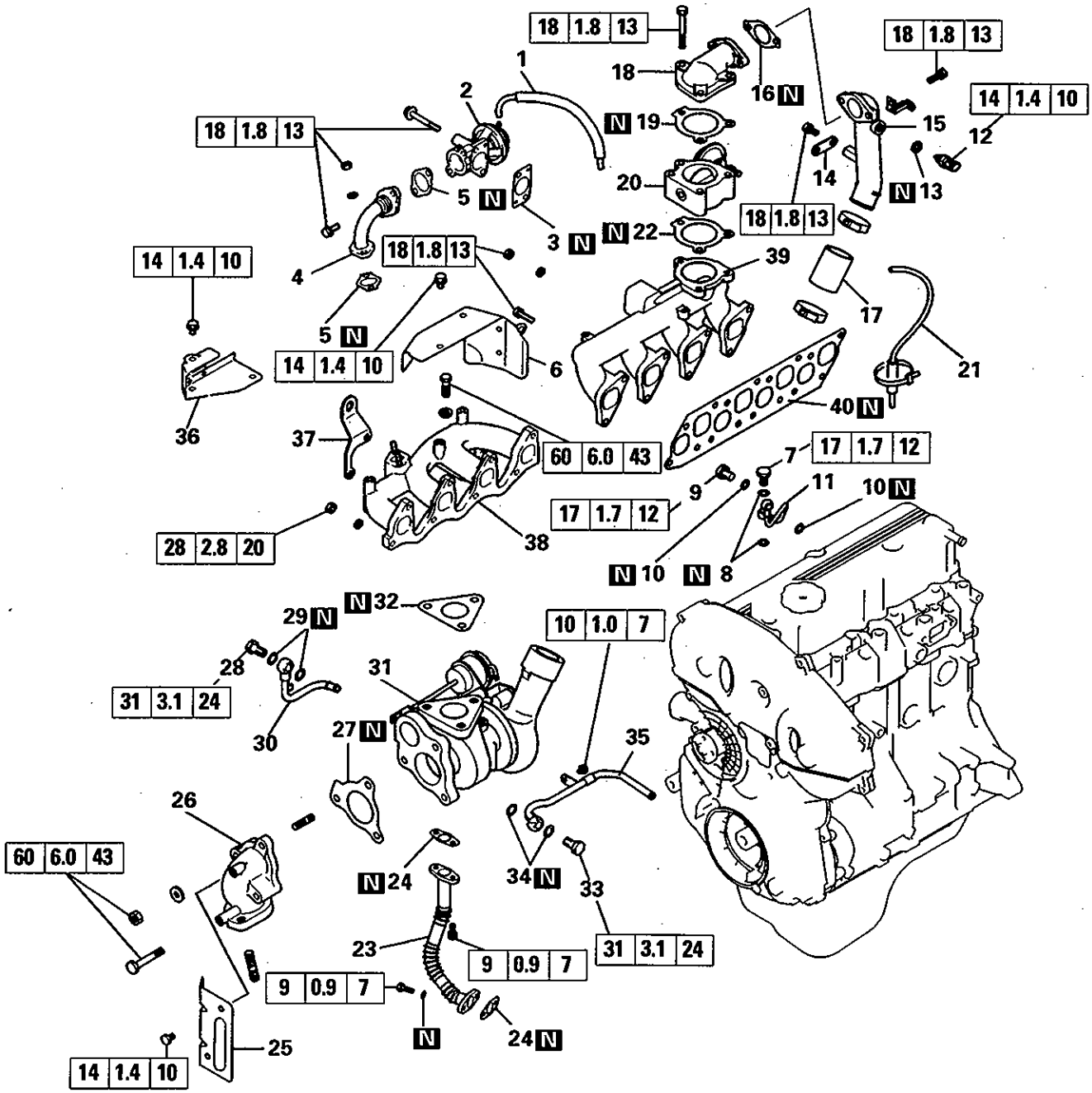
REMOVAL AND INSTALLATION

<SPACE RUNNER 1997 models and on>



Removal steps

1. Vaccume hose
2. EGR valve
3. Gasket
4. EGR pipe
5. Gasket
6. Heat protector "A"
- ◆B◆ 7. Eye bolt
8. Gasket
- ◆B◆ 9. Eye bolt
10. Gasket
11. Oil pipe
12. Air temperature sensor
13. Gasket
14. Intake fitting stay
15. Air intake fitting "A"
16. Gasket
17. Air hose
18. Air intake fitting "B"
19. Gasket
20. Throttle body assembly
21. Vacuum hose
22. Gasket
23. Oil return pipe
24. Gasket
25. Heat protector "C"
26. Exhaust fitting
27. Gasket
28. Eye bolt
29. Gasket
30. Water pipe "B"
31. Turbocharger assembly
32. Gasket
33. Eye bolt
34. Gasket
35. Water pipe "A"
36. Heat protector "B"
37. Engine hanger
38. Exhaust manifold
39. Intake manifold
40. Gasket

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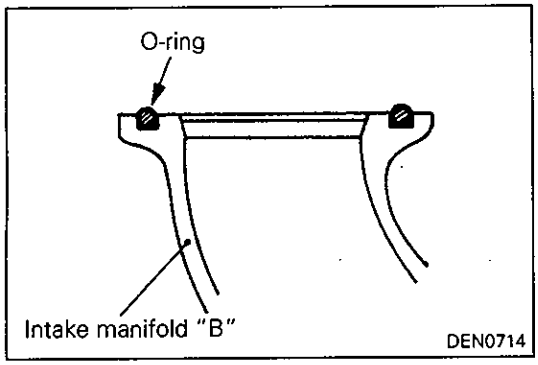

INSTALLATION SERVICE POINTS

◆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

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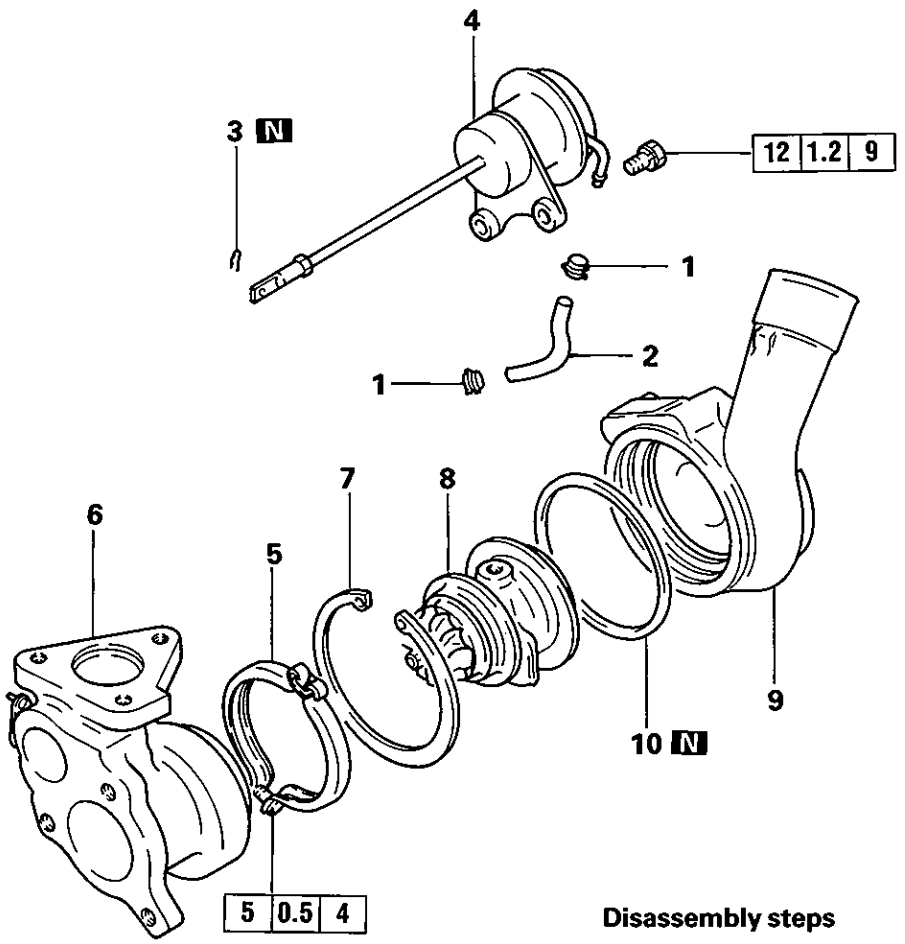
7. TURBOCHARGER

DISASSEMBLY AND REASSEMBLY



Disassembly steps

1. Hose clip
2. Hose
3. Snap pin
4. Turbocharger waste gate actuator
◆E◆ 5. Coupling
◆D◆ 6. Turbine housing
◇A◇ ◆C◆ 7. Snap ring
◇B◇ ◆B◆ 8. Turbine wheel assembly
9. Compressor cover
◆A◆ 10. O-ring

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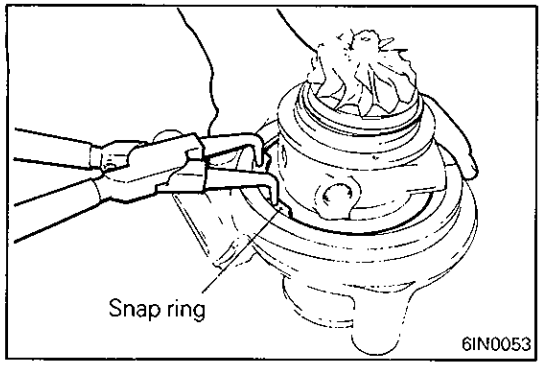


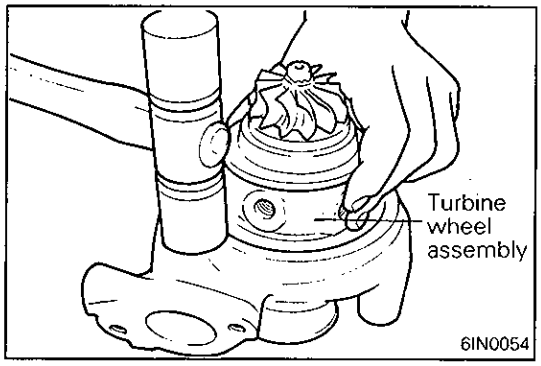
DISASSEMBLY SERVICE POINTS

◇A◇ SNAP RING REMOVAL

(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.**



◇B◇ TURBINE WHEEL ASSEMBLY REMOVAL

(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 damage to some parts.
(2) Use a plastic scraper or hard brush to clean aluminum parts.

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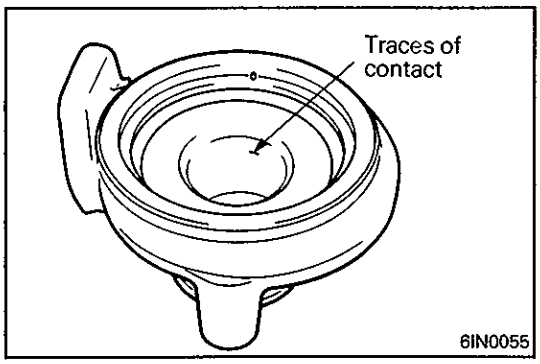


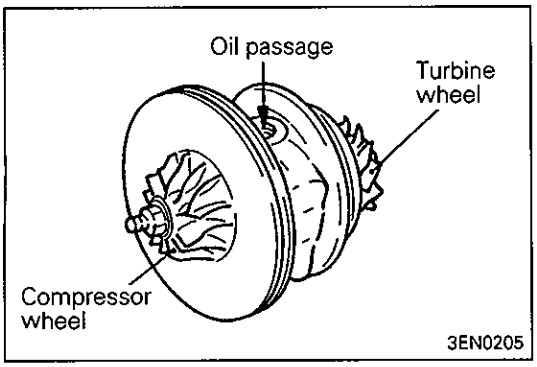
INSPECTION

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 turbocharger 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.

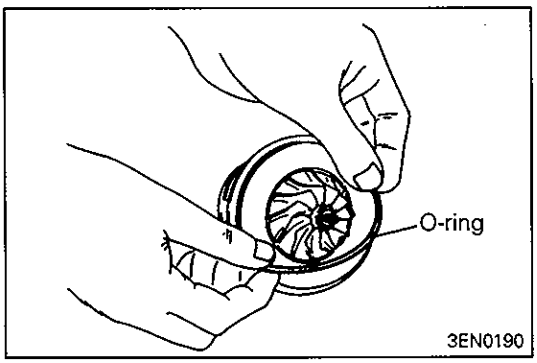


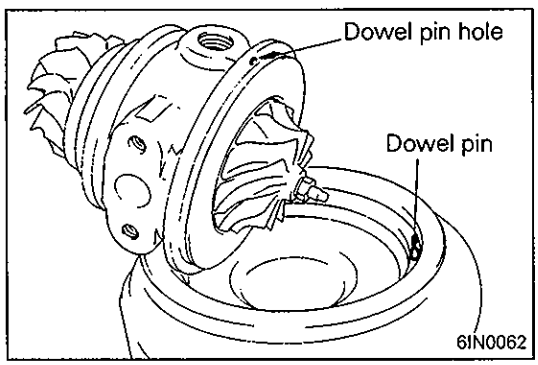
TURBINE WHEEL ASSEMBLY

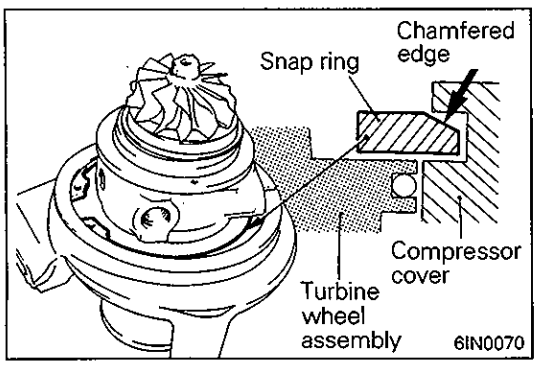
(1) Check the turbine and compressor wheel blades for bend, burr, damage, corrosion and traces of contact on the back side and replace if defective.
(2) Check the oil passage of the turbine wheel assembly for deposit and clogging.
(3) Check also the water passage for deposit and clogging.
(4) Check the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







REASSEMBLY SERVICE POINTS

◗A◖ O-RING INSTALLATION

(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◖ TURBINE WHEEL ASSEMBLY INSTALLATION

(1) Apply a light coat of engine oil to the periphery of the O-ring.
(2) Install the turbine wheel assembly to the compressor cover while aligning the dowel pin with the hole.

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

◗C◖ SNAP RING INSTALLATION

(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.**

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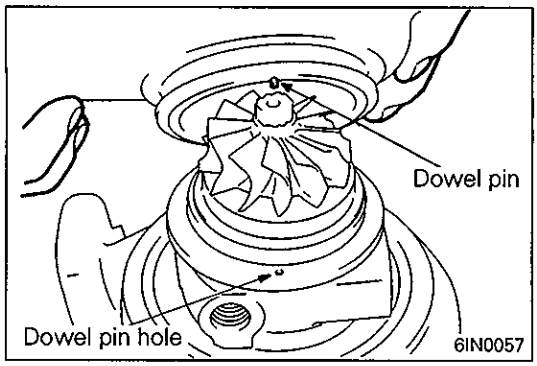
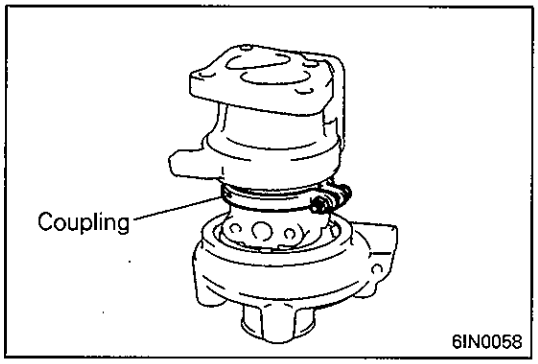


◆D◆ TURBINE HOUSING INSTALLATION

(1) Install the turbine housing while aligning the dowel pin and the hole.

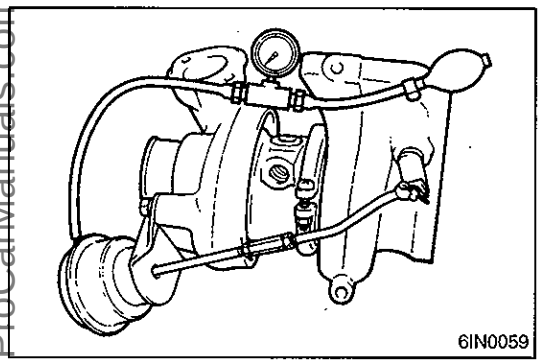
Caution

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



◆E◆ COUPLING INSTALLATION

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



◆F◆ TURBOCHARGER WASTE GATE ACTUATOR OPERATION INSPECTION

(1) Using a tester, apply pressure to the actuator and check the pressure when the rod starts moving [moves approx. 1 mm (0.04 in.)].

Standard value:
Vehicles without intercooler: Approx. 63.3 kPa (0.65 kg/cm², 9.2 psi)
Vehicles with intercooler: Approx. 76.7 kPa (0.78 kg/cm², 11 psi)

Caution

- **Do not apply a pressure of more than 71.7 kPa (0.73 kg/cm², 10 psi) <Vehicles without intercooler> or 103 kPa (1.05 kg/cm², 15 psi) <Vehicles with intercooler> to the actuator. Otherwise, diaphragm may be damaged.**
  Never attempt to adjust the turbocharger waste gate valve.

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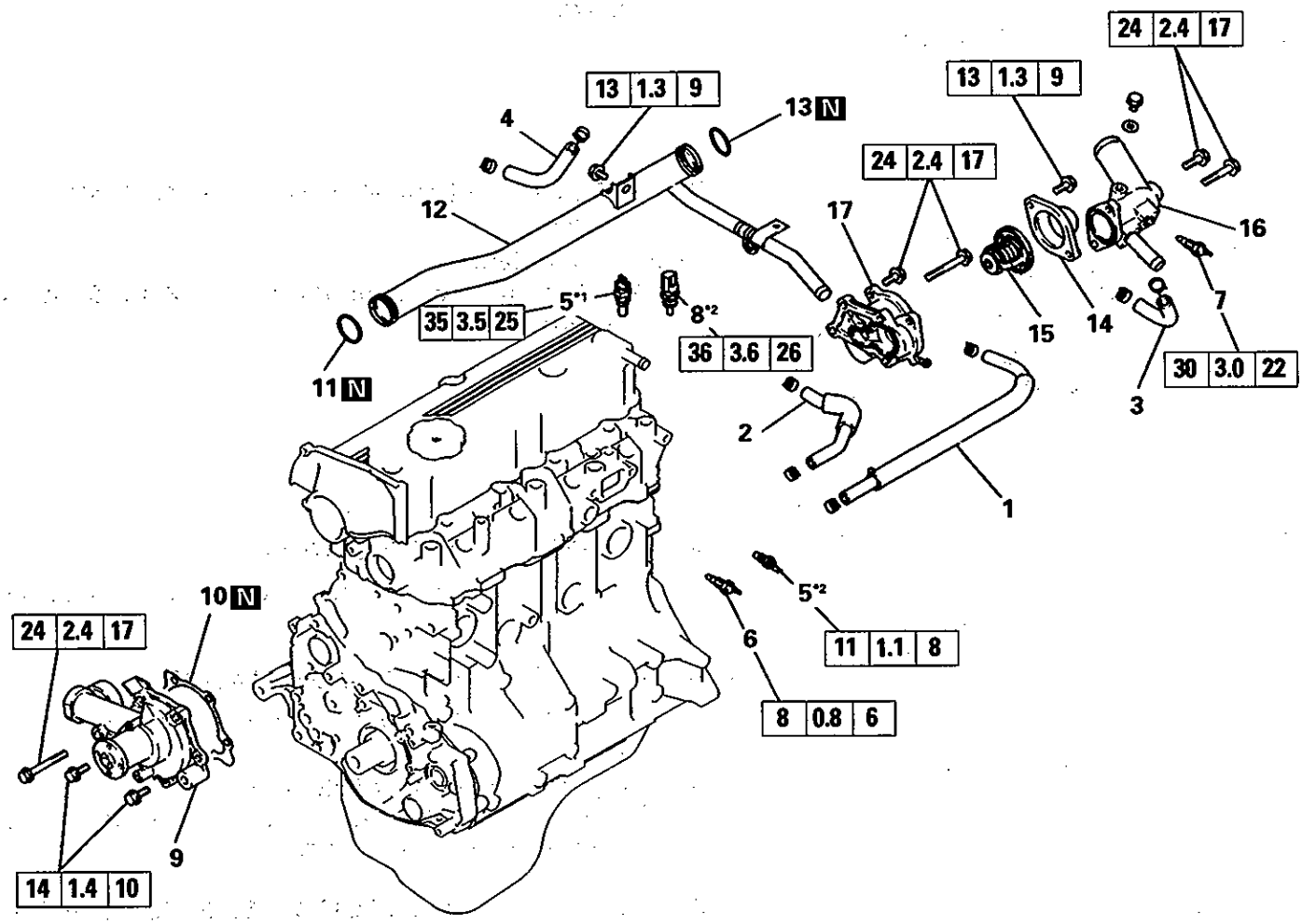
8. WATER PUMP, THERMOSTAT, HOSES AND PIPES

REMOVAL AND INSTALLATION



Removal steps

1. Water hose
2. Water hose
3. Water hose
4. Water hose

} Except SPACE RUNNER 1997 models and on
} Engine with turbocharger

◆F◆ 5. Engine coolant temperature gauge unit
◆E◆ 6. Engine coolant temperature switch — Engine with turbocharger
◆E◆ 7. Engine coolant temperature switch — N18W and N38W only
8. Engine coolant temperature sensor
9. Water pump
10. Water pump gasket
◆D◆ 11. O-ring
◆D◆ 12. Water inlet pipe
◆D◆ 13. O-ring
14. Water inlet fitting
◆C◆ 15. Thermostat
◆B◆ 16. Water outlet fitting
◆A◆ 17. Thermostat housing

NOTE
*1: Except SPACE RUNNER 1997 models and on
*2: SPACE RUNNER 1997 models and on

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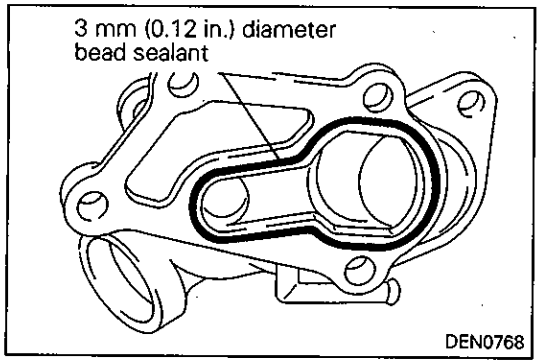

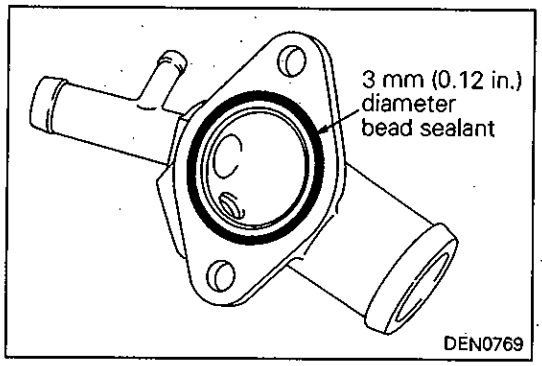

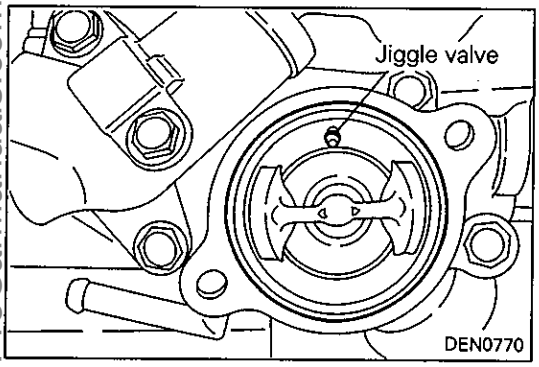

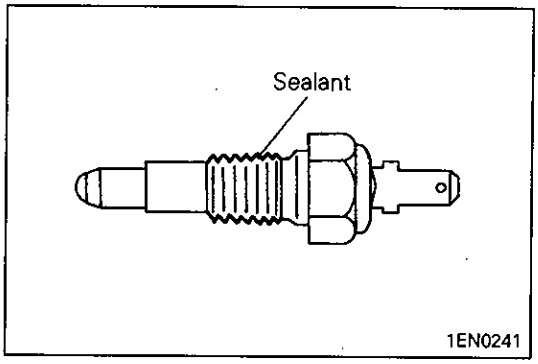

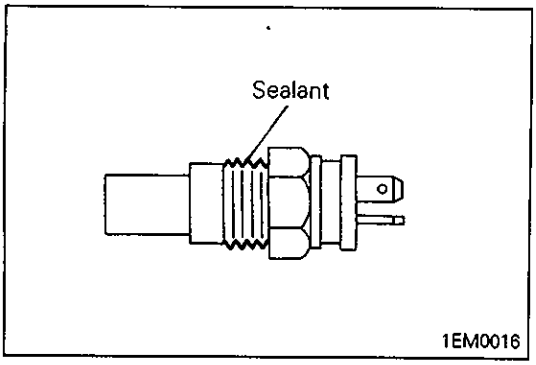

INSTALLATION SERVICE POINTS

◆A◆ SEALANT APPLICATION TO THERMOSTAT HOUSING

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent

◆B◆ SEALANT APPLICATION TO WATER OUTLET FITTING

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent

◆C◆ THERMOSTAT INSTALLATION

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

◆D◆ WATER PIPE / O-RING INSTALLATION

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

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

◆E◆ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE SWITCH

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

◆F◆ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE GAUGE UNIT

Specified sealant:
3M Nut Locking Part No. 4171 or equivalent

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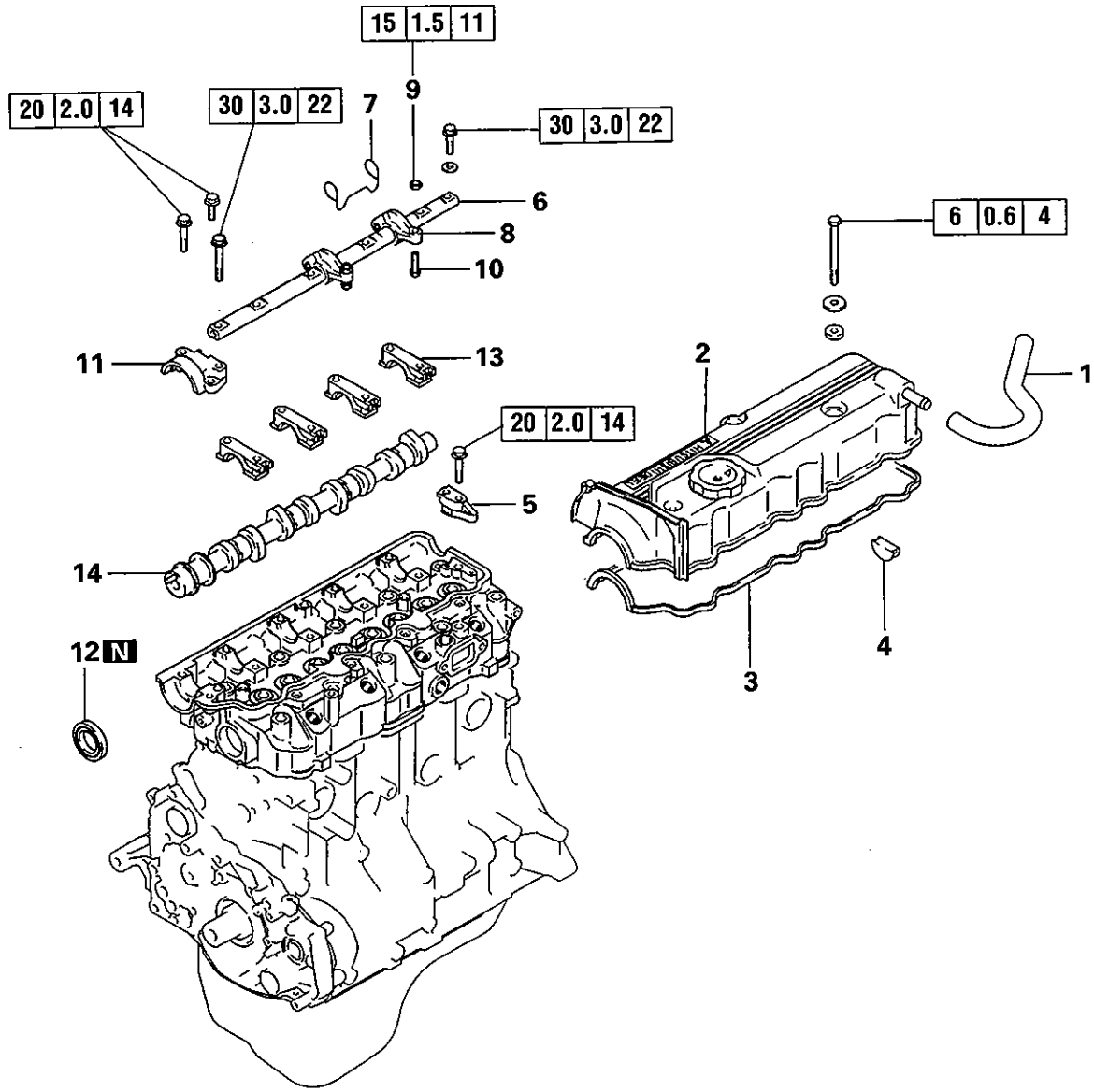
9. ROCKER ARMS, ROCKER SHAFT AND CAMSHAFT

REMOVAL AND INSTALLATION



Removal steps

1. Breather hose
2. Rocker cover
3. Rocker cover gasket
4. Semi-circular packing
5. Rocker shaft support
6. Rocker shaft
7. Rocker shaft spring
8. Rocker arm
9. Nut
10. Rocker arm adjusting screw
11. Front camshaft bearing cap
12. Camshaft oil seal
13. Camshaft bearing cap
14. Camshaft

Installation steps

14. Camshaft
◆A◆ 13. Camshaft bearing cap
11. Front camshaft bearing cap
10. Rocker arm adjusting screw
9. Nut
8. Rocker arm
◆B◆ 7. Rocker shaft spring
6. Rocker shaft
5. Rocker shaft support
◆C◆ 12. Camshaft oil seal
◆D◆ 4. Semi-circular packing
3. Rocker cover gasket
2. Rocker cover
1. Breather hose

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Added

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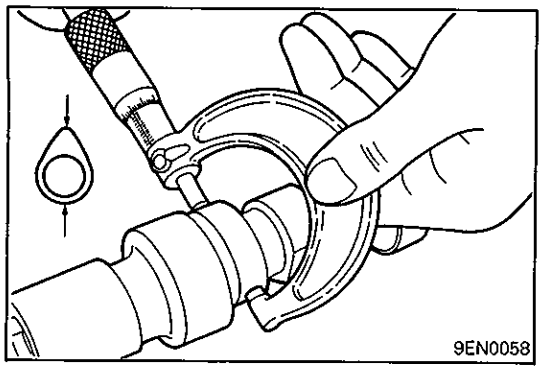


INSPECTION

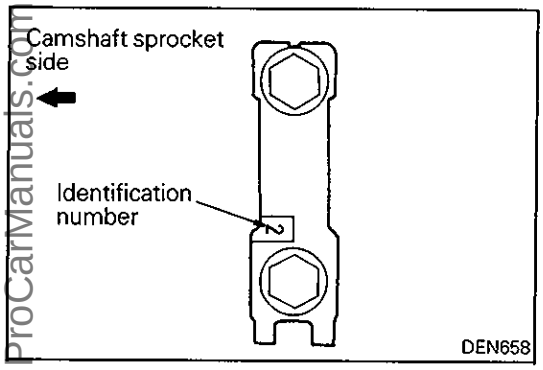
CAMSHAFT

(1) Measure the cam height.

Standard value: 41.84 mm (1.6472 in.)
Limit: 41.34 mm (1.6276 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.



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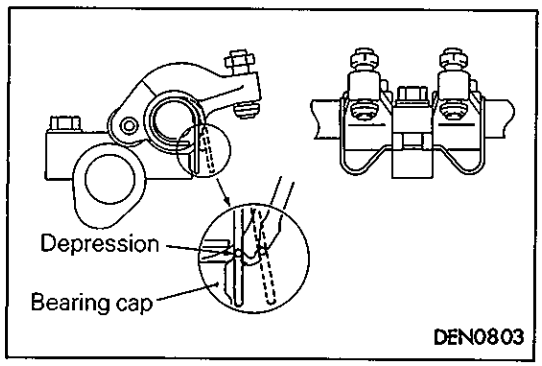
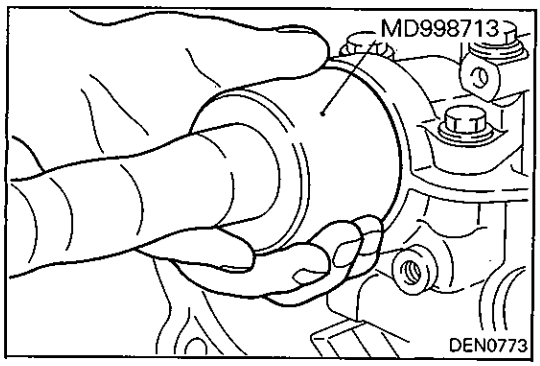
◗A◖ CAMSHAFT BEARING CAP INSTALLATION

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



◗B◖ ROCKER SHAFT SPRING INSTALLATION

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



◗C◖ CAMSHAFT OIL SEAL INSTALLATION

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

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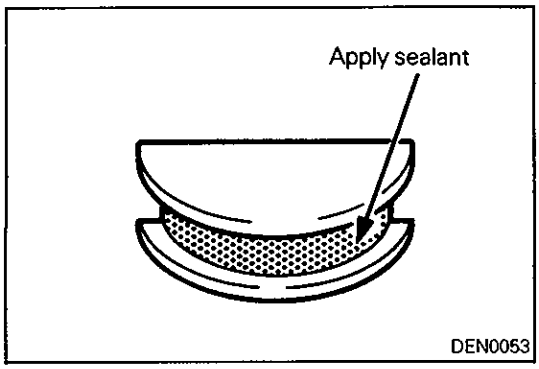
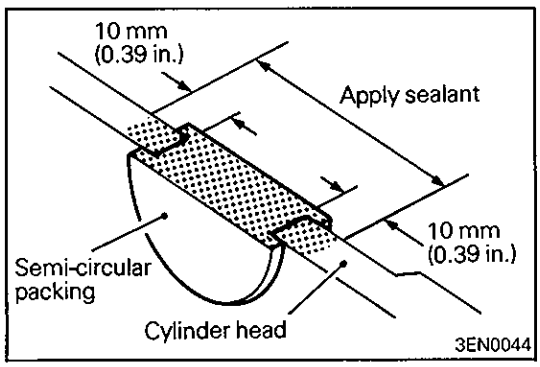
Added



◆D◆ SEMI-CIRCULAR PACKING INSTALLATION

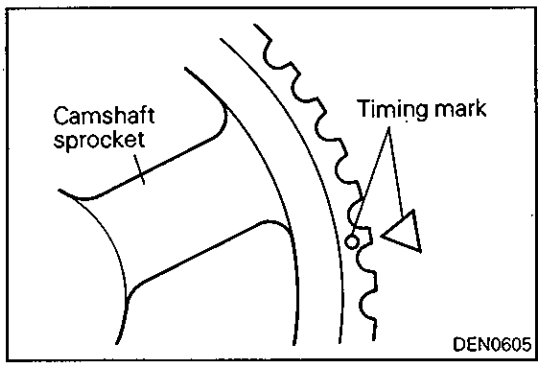
(1) Apply specified sealant to the portions indicated in the illustration.

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

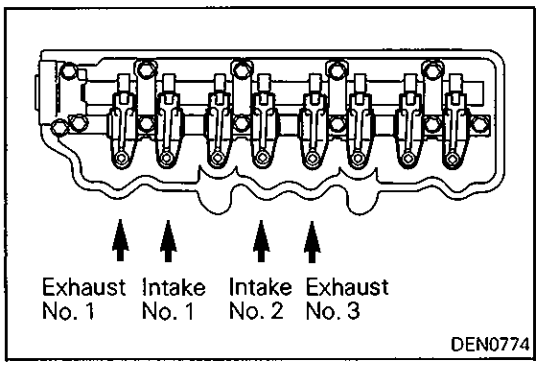


VALVE CLEARANCE ADJUSTMENT

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



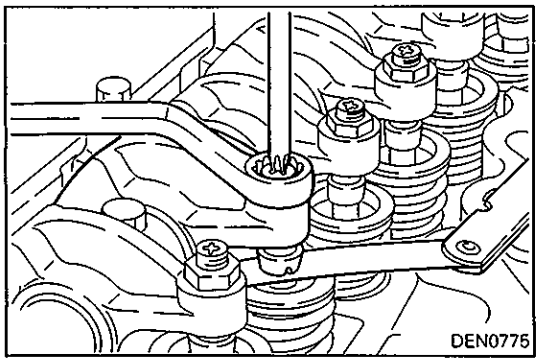
(2) Adjust the valve clearance at the points shown in the illustration.



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

Standard value (on cold engine):

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



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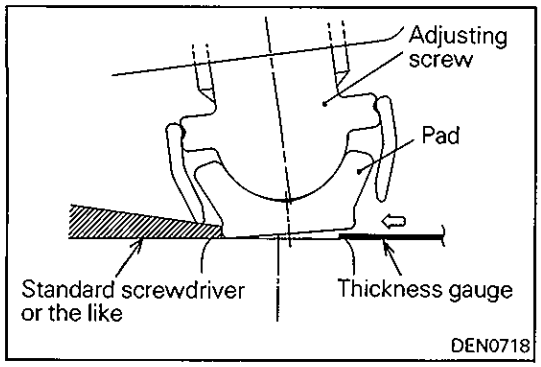
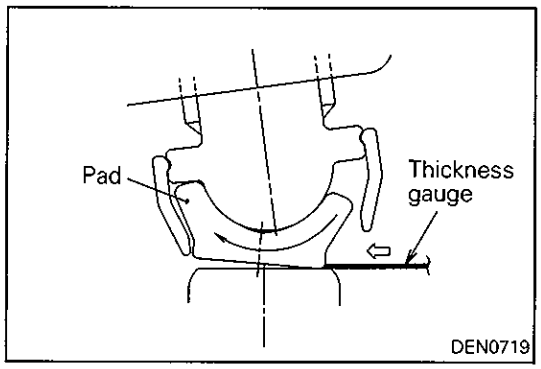
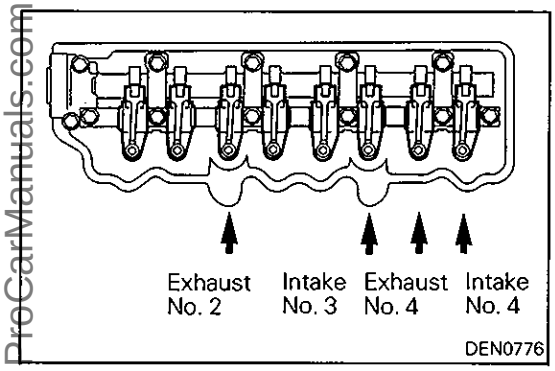


NOTE
Before insertion of a thickness gauge, provide clearance for inserting the gauge by pushing the pad with a standard screwdriver or the like from the opposite side.



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



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

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

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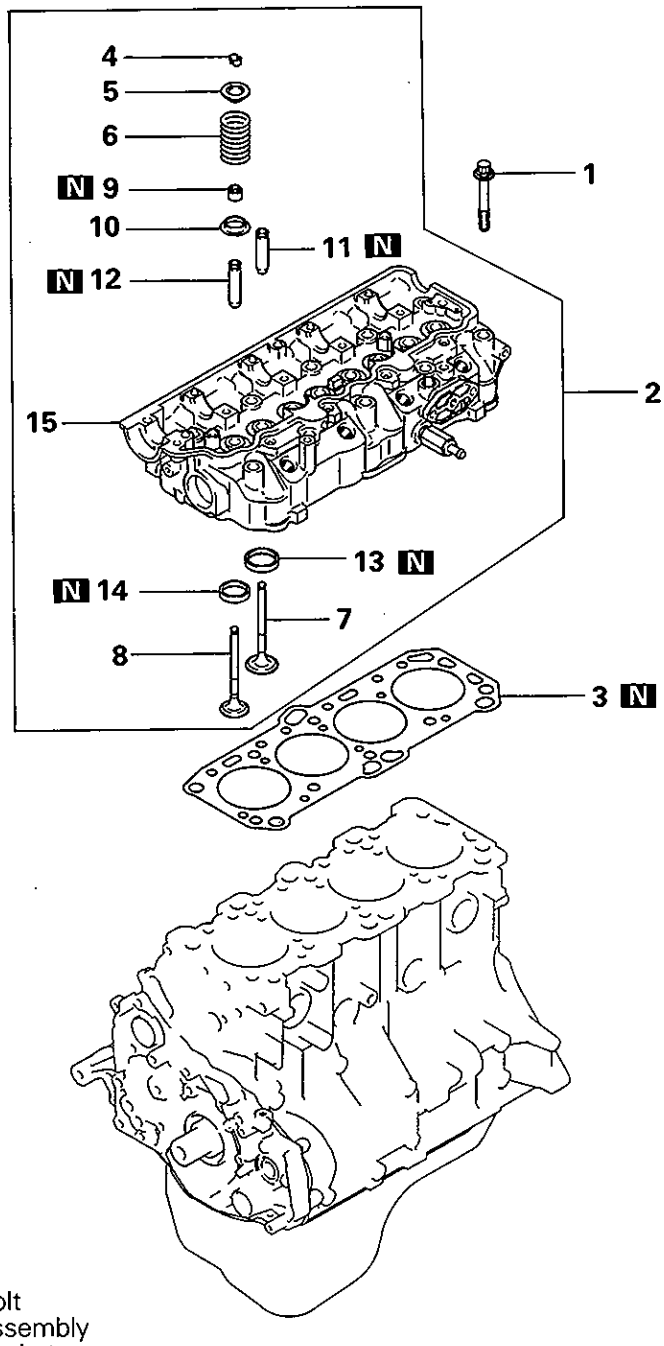
10. CYLINDER HEAD, VALVES AND VALVE SPRINGS

REMOVAL AND INSTALLATION



Removal steps

◇A◇ ◆E◆ 1. Cylinder head bolt
2. Cylinder head assembly
◆D◆ 3. Cylinder head gasket
◇B◇ ◆C◆ 4. Valve spring retainer lock
5. Valve spring retainer
◆B◆ 6. Valve spring
7. Intake valve
8. Exhaust valve
◇C◇ ◆A◆ 9. Valve stem seal
10. Spring seat
11. Intake valve guide
12. Exhaust valve guide
13. Intake valve seat
14. Exhaust valve seat
15. Cylinder head

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Added

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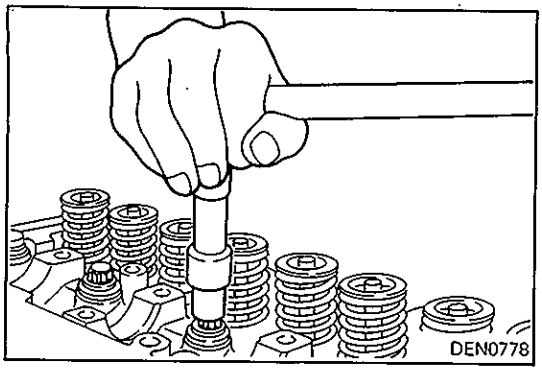
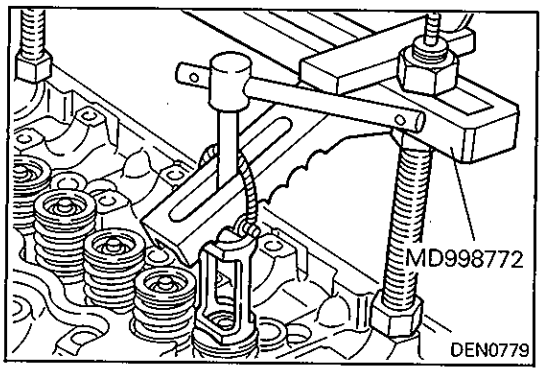


REMOVAL SERVICE POINTS

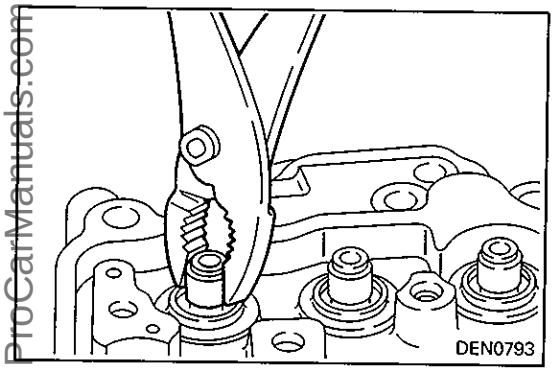
◇A◇ CYLINDER HEAD BOLT REMOVAL

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



◇B◇ RETAINER LOCK REMOVAL

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



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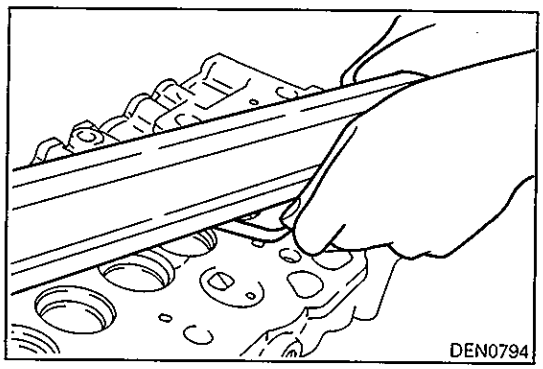
◇C◇ VALVE STEM SEAL REMOVAL

(1) Do not reuse removed stem seals

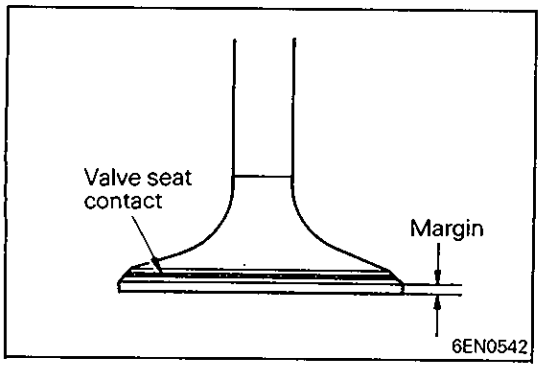


INSPECTION

CYLINDER HEAD

(1) Check the cylinder head gasket surface for flatness by using a straightedge and thickness gauge.

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 a valve refacer. Valve seat contact should be maintained uniform at the center of valve face.
(2) If the margin is smaller than the service limit, replace the valve.

Standard value: 1.5 mm (0.059 in.)
Limit: 0.7 mm (0.028 in.)

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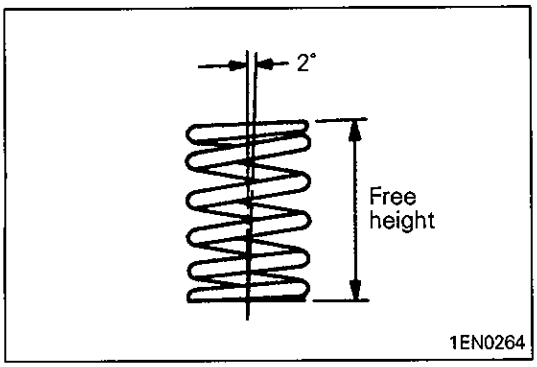
Added



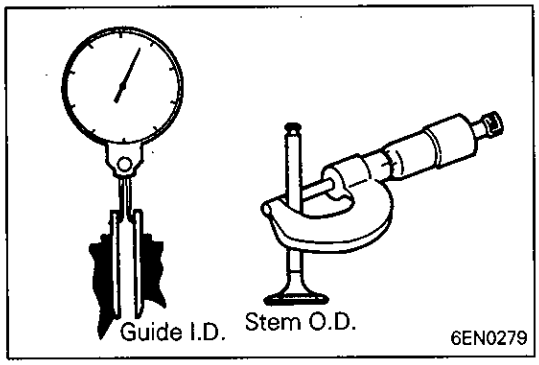
VALVE SPRING

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

Standard value: 49.1 mm (1.933 in.)
Limit: 48.1 mm (1.894 in.)

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

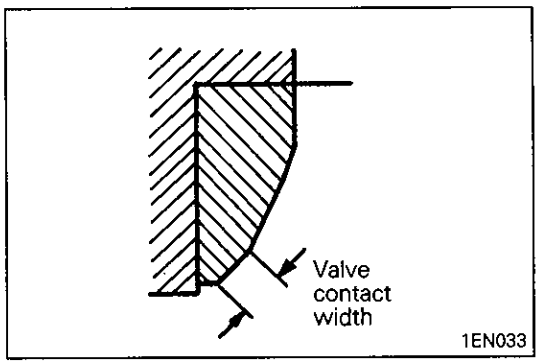
Standard value: 2° or less
Limit: Max. 4°



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.

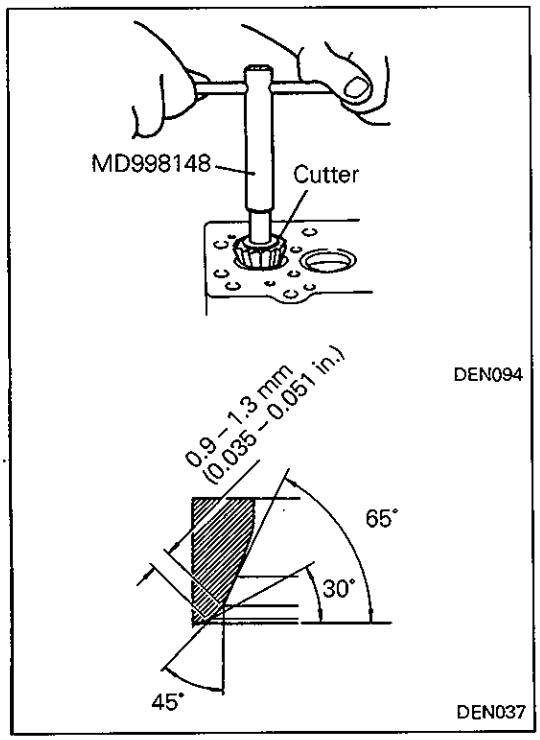
Standard value:
Intake
Engines without turbocharger
0.03 – 0.06 mm (0.0012 – 0.0024 in.)
Engines with turbocharger
0.05 – 0.09 mm (0.0020 – 0.0035 in.)
Exhaust
0.05 – 0.09 mm (0.0020 – 0.0035 in.)
Limit:
Intake 0.10 mm (0.0039 in.)
Exhaust 0.15 mm (0.0059 in.)



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 a 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, the valve and valve seat should be lapped with a lapping compound.

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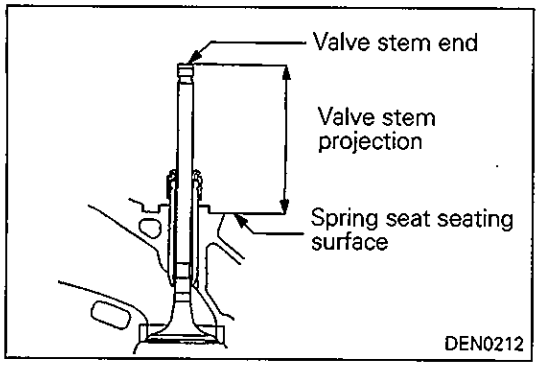
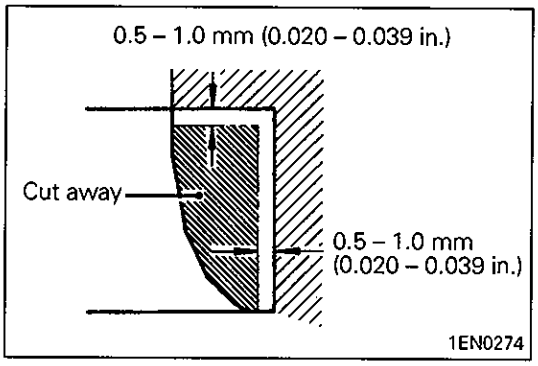


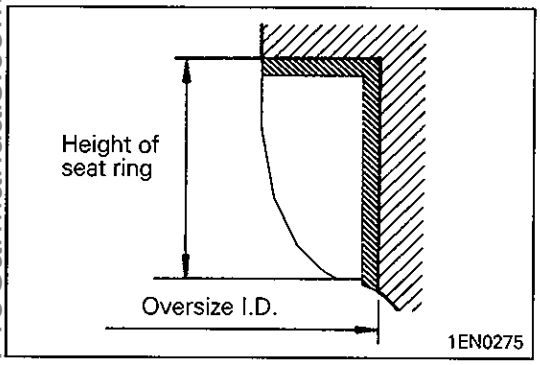
(4) Install the valve and, while pressing the valve against the valve seat, measure the valve stem projection between the valve stem end and the valve spring seat seating surface.

Standard value: 43.45 mm (1.7106 in.)
Limit: 43.95 mm (1.7303 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 the cylinder head to a selected oversize valve seat diameter.

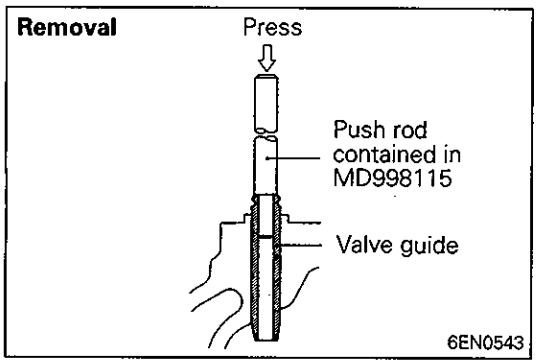
Intake valve seat hole diameter
0.30 O.S.: 38.300 – 38.325 mm (1.5079 – 1.5089 in.)
0.60 O.S.: 38.600 – 38.625 mm (1.5197 – 1.5207 in.)

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 a valve seat cutter, correct the valve seat to the specified width and angle.
See "VALVE SEAT RECONDITIONING PROCEDURE".

VALVE GUIDE REPLACEMENT PROCEDURE



(1) Using the special tool and a press, remove the valve guide toward the cylinder head gasket surface.

(2) Rebore the valve guide hole to the new oversize valve guide outside diameter.

Valve guide hole diameter
0.05 O.S.: 13.050 – 13.068 mm (0.5138 – 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.)

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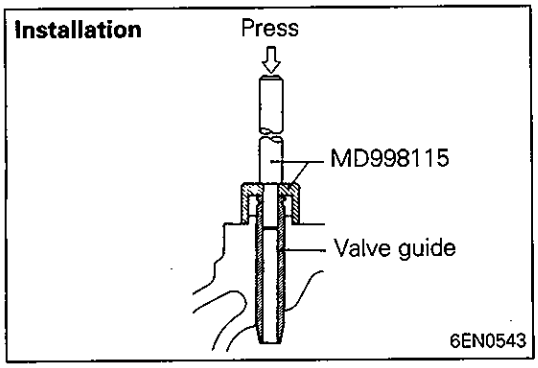

NOTE
Do not install a valve guide of the same size again.

(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.

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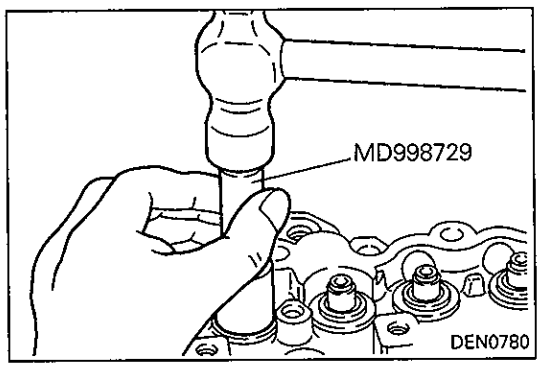
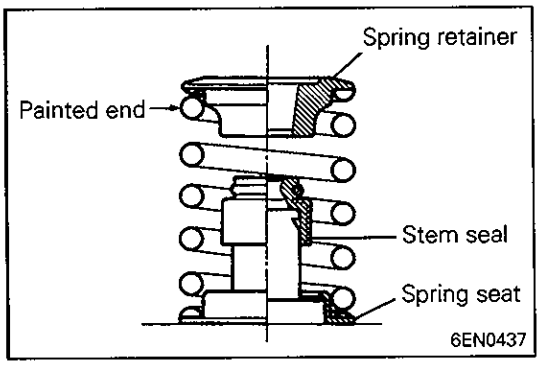


INSTALLATION SERVICE POINTS

◗A◖ VALVE STEM SEAL INSTALLATION

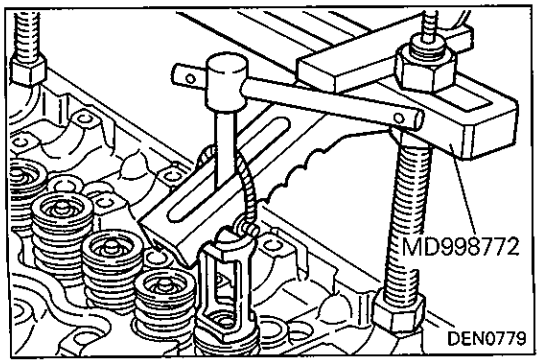
(1) Install the valve spring seat.
(2) The special tool must be used to install valve stem seals. Improper installation could result in oil leaks past the valve guide.

Caution
- **Do not reuse removed valve stem seals.**



◗B◖ VALVE SPRING INSTALLATION

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



◗C◖ RETAINER LOCK INSTALLATION

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

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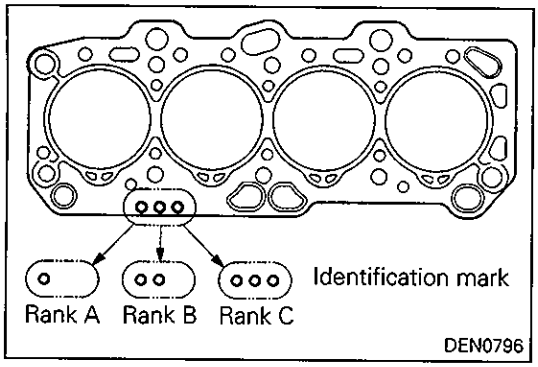
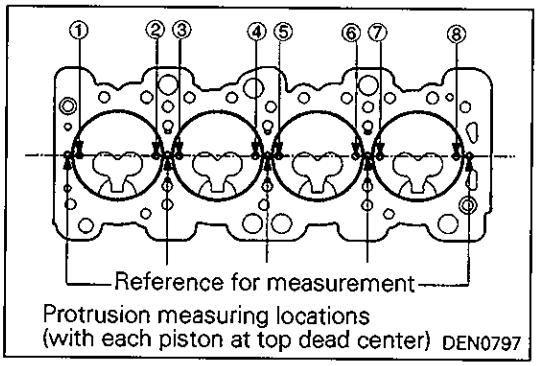
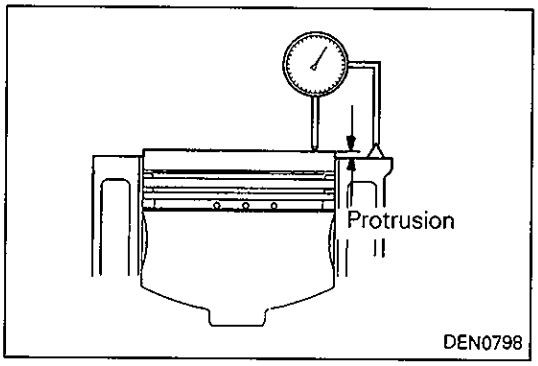


◆D◆ CYLINDER HEAD GASKET INSTALLATION

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

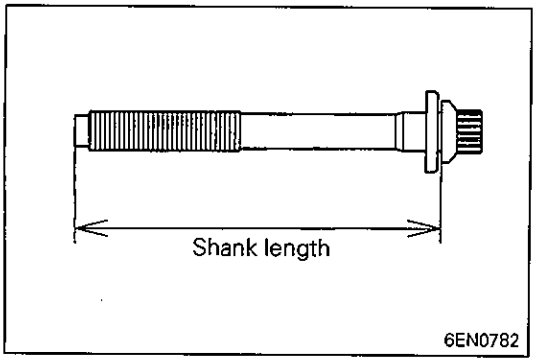


(2) In case any of the cylinder block, piston, connecting rod and crankshaft have been replaced, reselect and install the gasket in accordance with the following procedure.
   ① With each piston held at the top dead center, measure its protrusion from the upper block surface at the locations shown in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



mm (in.)

Rank	Average value of piston protrusions	Protrusion tolerance for each rank	Thickness of selected gasket (when tightened)
A	0.641 – 0.700 (0.0252 – 0.0276)	0.750 (0.0295)	1.40±0.05 (0.055±0.002)
B	0.700 – 0.760 (0.0276 – 0.0299)	0.810 (0.0319)	1.45±0.05 (0.057±0.002)
C	0.760 – 0.823 (0.0299 – 0.0324)		1.50±0.05 (0.059±0.002)



◆E◆ CYLINDER HEAD BOLT INSTALLATION

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

Limit: max. 119.7 mm (4.71 in.)

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

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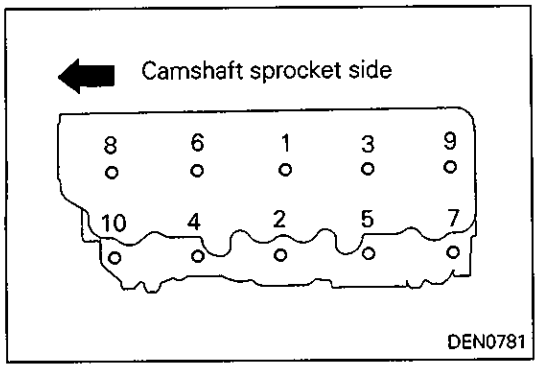

(3) According to the tightening sequence, tighten the bolts to 90 Nm (9.0 kgm, 65 ft.lbs.) using a 12 mm – 12 points socket wrench.
(4) Loosen the bolts completely.
(5) Torque the bolts to 40 Nm (4.0 kgm, 29 ft.lbs.).
(6) Tighten the bolts 1/4 turns (90°) more.
(7) Tighten the bolts 1/4 turns (90°) additionally.

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NOTES

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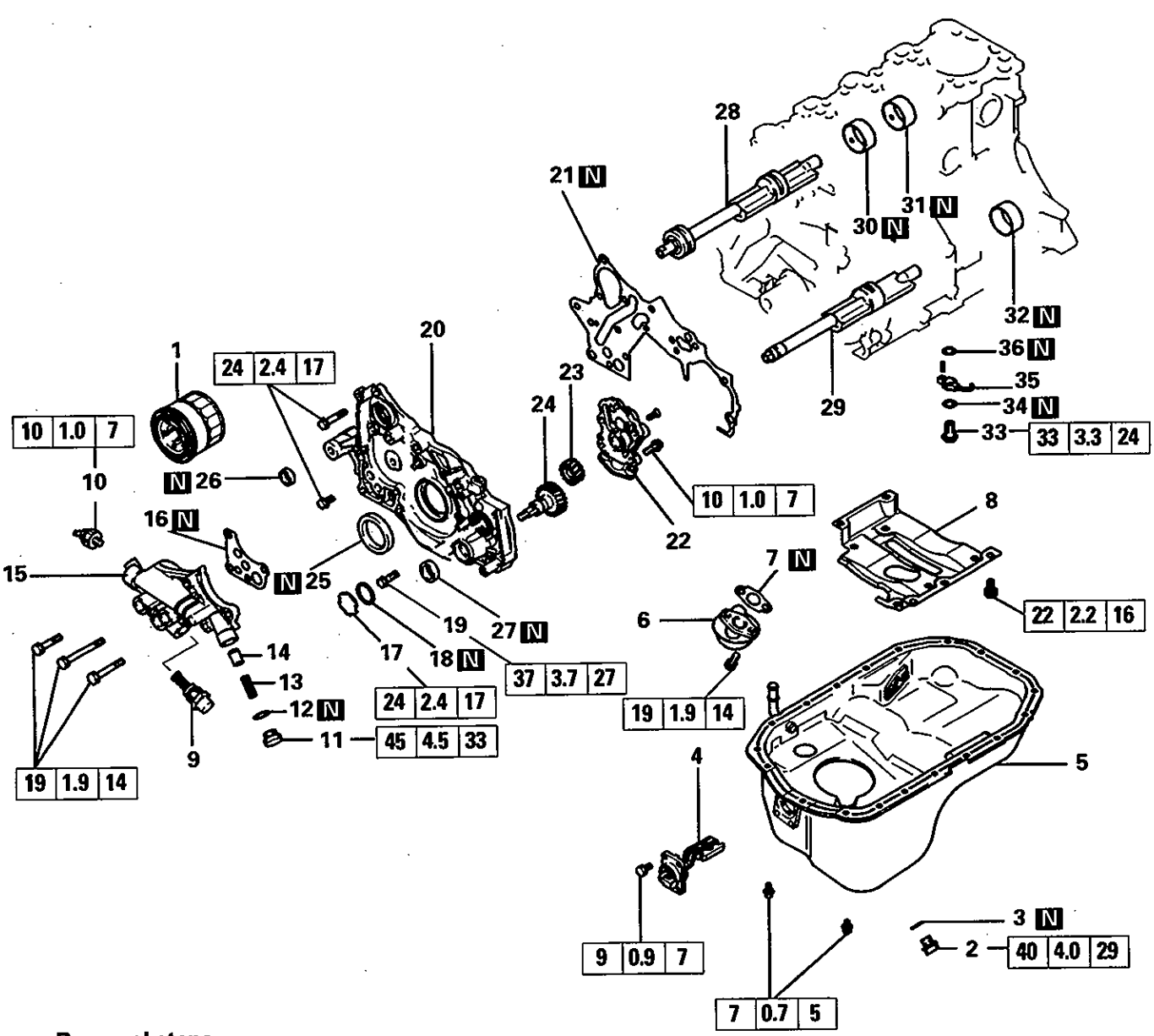
11. FRONT CASE, SILENT SHAFTS AND OIL PAN

REMOVAL AND INSTALLATION



Removal steps

1. Oil filter
2. Drain plug
3. Drain plug gasket
4. Oil level sensor
◇A◇ ◆L◆ 5. Oil pan
6. Oil screen
7. Oil screen gasket
8. Stiffener plate
9. Oil cooler bypass valve
◆K◆ 10. Oil pressure switch
11. Plug
12. Gasket
13. Relief spring
14. Relief plunger
15. Oil filter bracket
16. Oil filter bracket gasket
◇B◇ ◆J◆ 17. Plug
18. O-ring
◇C◇ ◆I◆ 19. Flange bolt
◆H◆ 20. Front case
21. Front case gasket
22. Oil pump cover
◆G◆ 23. Oil pump driven gear
◆G◆ 24. Oil pump drive gear
◆F◆ 25. Crankshaft front oil seal
◆E◆ 26. Silent shaft oil seal
◆D◆ 27. Oil pump oil seal
28. Silent shaft, right
29. Silent shaft, left
◇D◇ ◆C◆ 30. Silent shaft front bearing
◇E◇ ◆C◆ 31. Silent shaft rear bearing, right
◇E◇ ◆A◆ 32. Silent shaft rear bearing, left
33. Check valve
34. Gasket
35. Oil jet
36. Gasket

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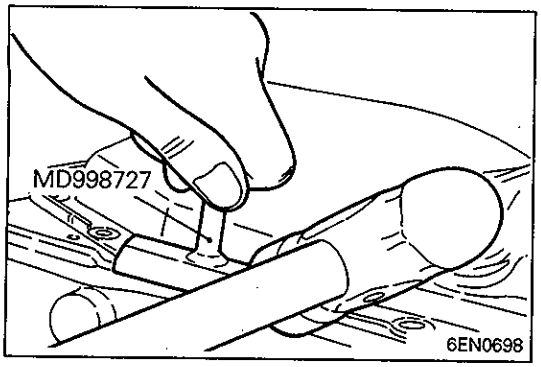
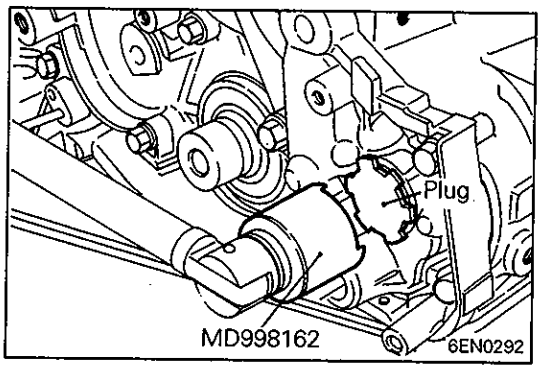


REMOVAL SERVICE POINTS

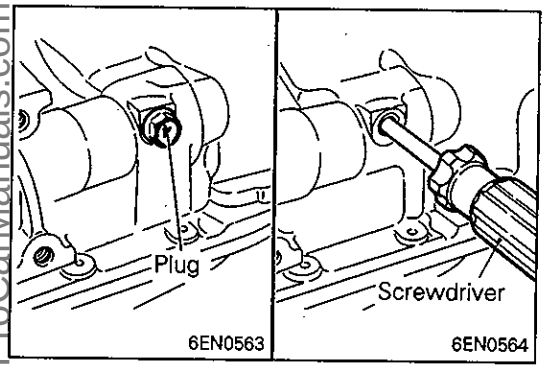
◇A◇ OIL PAN REMOVAL

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



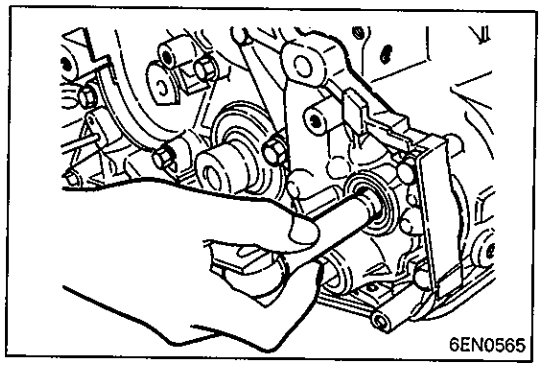
◇B◇ PLUG REMOVAL

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

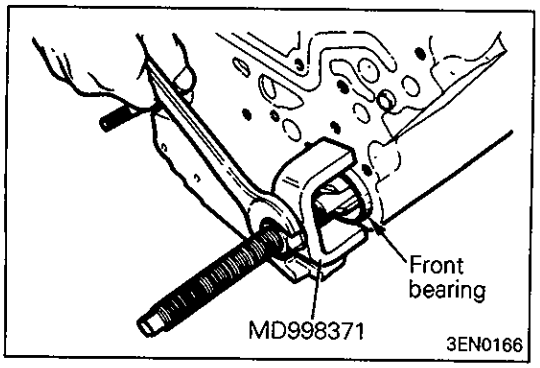


◇C◇ FLANGE BOLT REMOVAL

(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 the cylinder block to block the silent shaft.



(2) Loosen the flange bolt.



◇D◇ SILENT SHAFT FRONT BEARING REMOVAL

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

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

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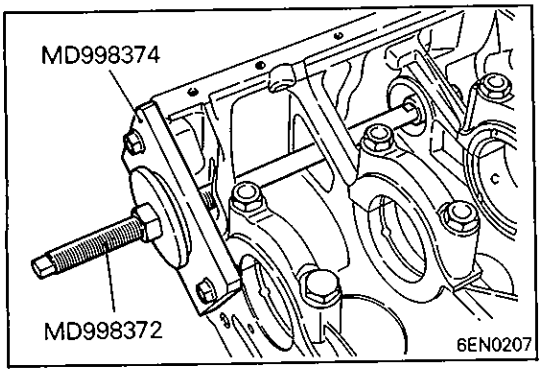


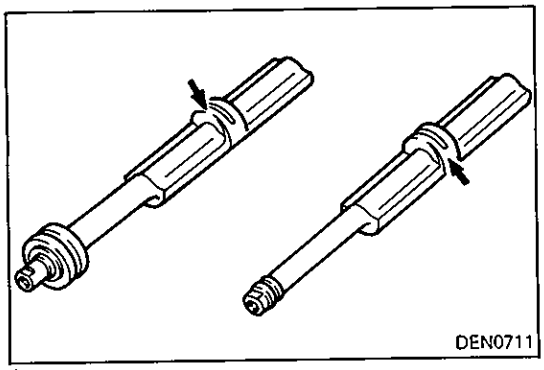
⟨E⟩ RIGHT SILENT SHAFT REAR BEARING / LEFT SILENT SHAFT REAR BEARING REMOVAL

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

INSPECTION

FRONT CASE

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



SILENT SHAFT

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

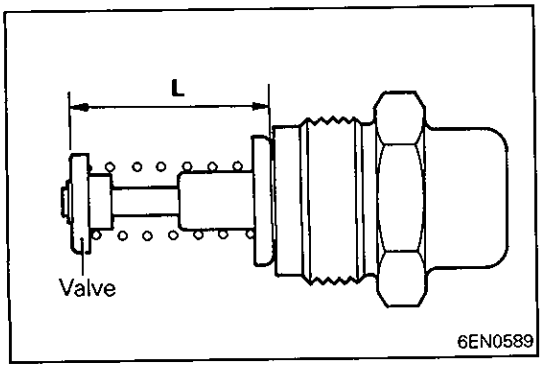
Standard value:

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 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

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Added

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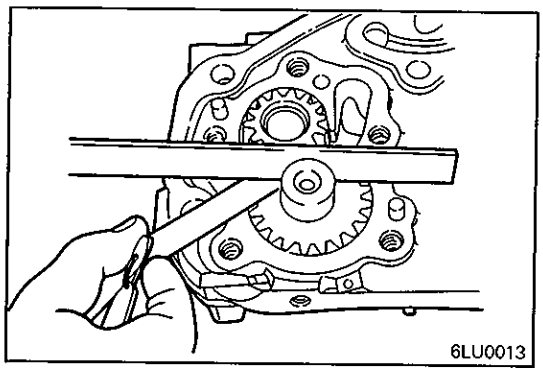
OIL PUMP

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



(3) Check the side clearance

Standard value:

Drive gear	**0.08 – 0.14 mm (0.0031 – 0.0055 in.)**
Driven gear	**0.06 – 0.12 mm (0.0024 – 0.0047 in.)**

OIL SEAL

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

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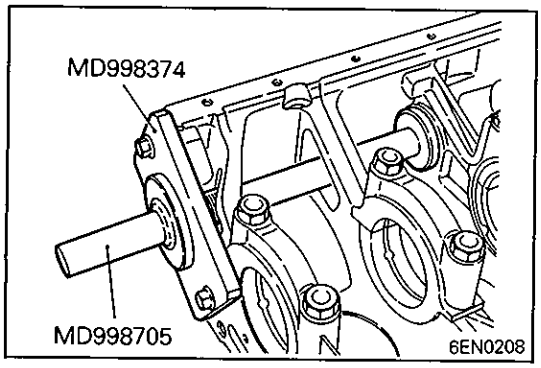
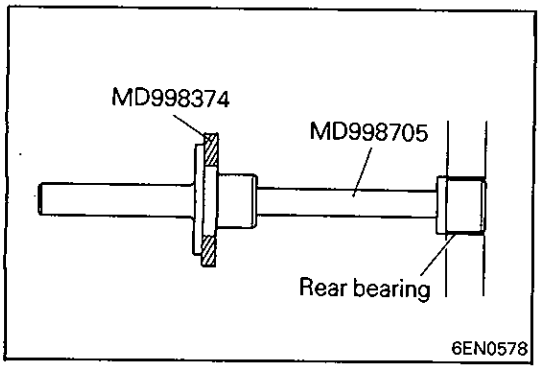


INSTALLATION SERVICE POINTS

◆A◆ LEFT SILENT SHAFT REAR BEARING INSTALLATION

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



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

NOTE
The left side bearing is provided with no oil hole.

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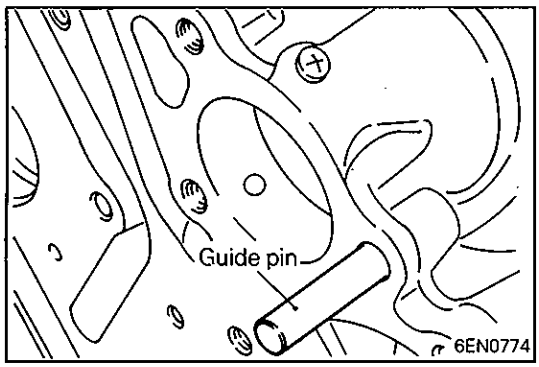
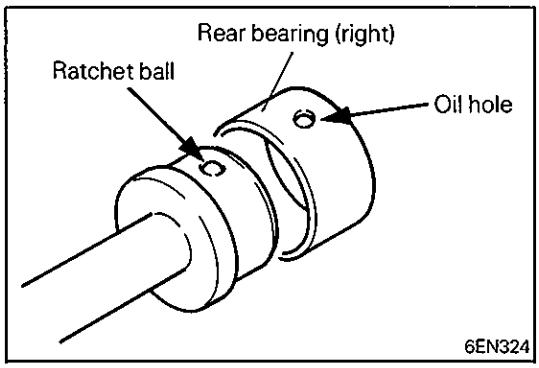
Added

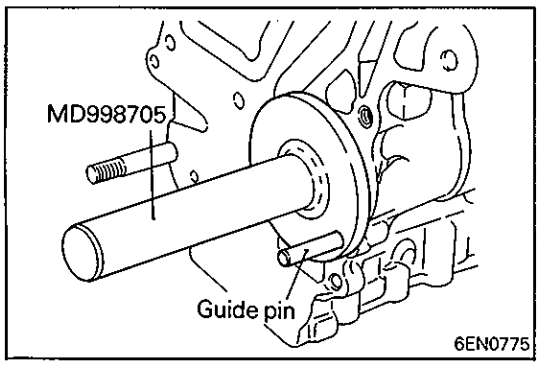


◆B◆ RIGHT SILENT SHAFT REAR BEARING INSTALLATION

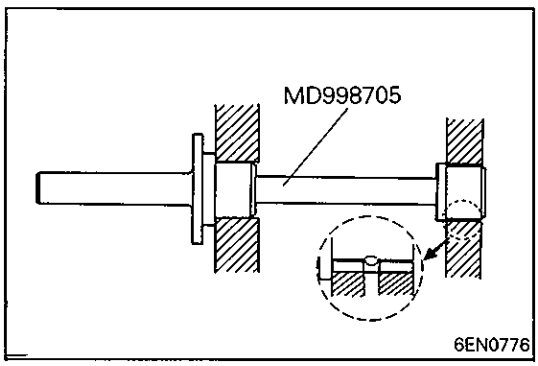
(1) Install the guide pin of the special tool to the threaded hole of the cylinder block as illustrated.

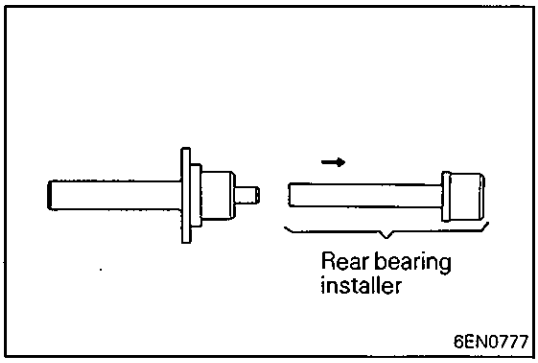


(2) Install the bearing to the special tool, aligning the ratchet ball of the special tool with the oil hole of the rear bearing.
(3) Apply engine oil to the outer circumference of the bearing and to the bearing hole of the cylinder block.



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





◆C◆ SILENT SHAFT FRONT BEARING INSTALLATION

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

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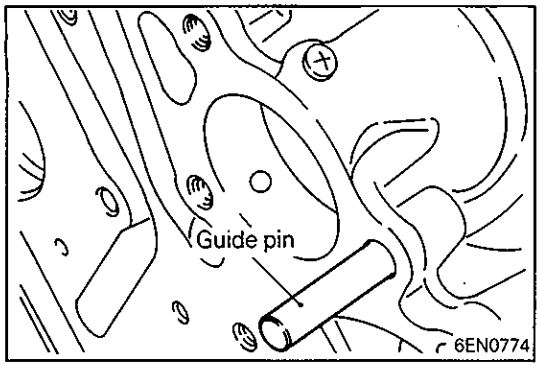
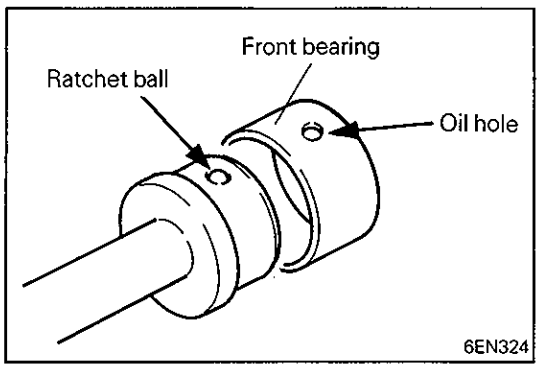
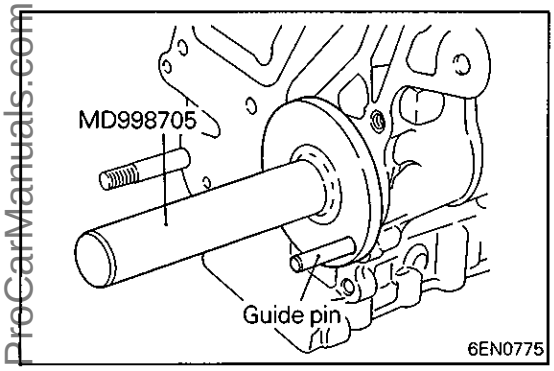


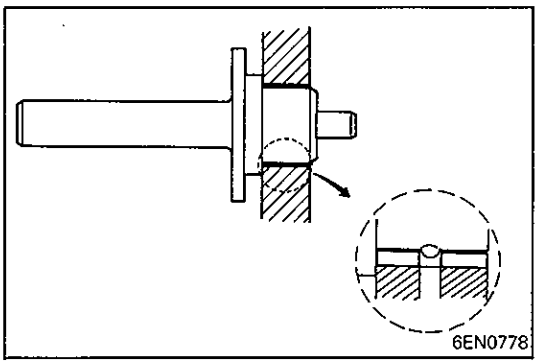
(2) Install the guide pin of the special tool to the threaded hole of the cylinder block as illustrated.

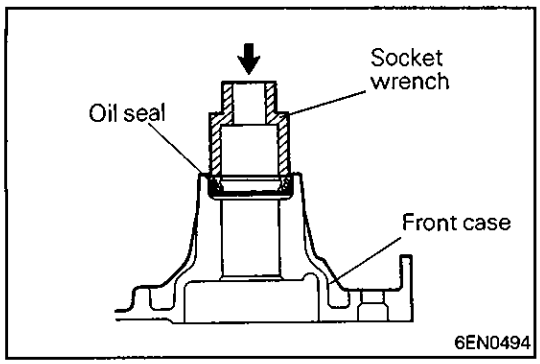


(3) Install the bearing to the special tool, aligning the ratchet ball of the special tool with the oil hole of the front bearing.
(4) Apply engine oil to the outer circumference of the bearing and to the bearing hole of the cylinder block.



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





◆D◆ OIL PUMP OIL SEAL INSTALLATION

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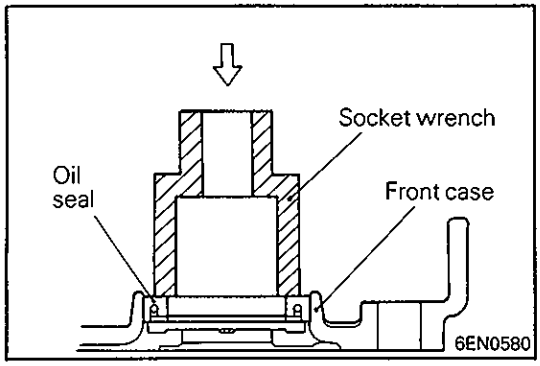
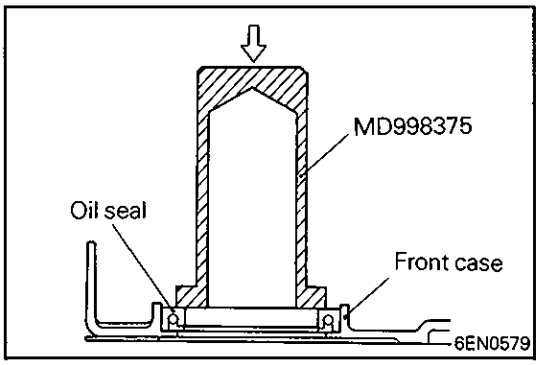
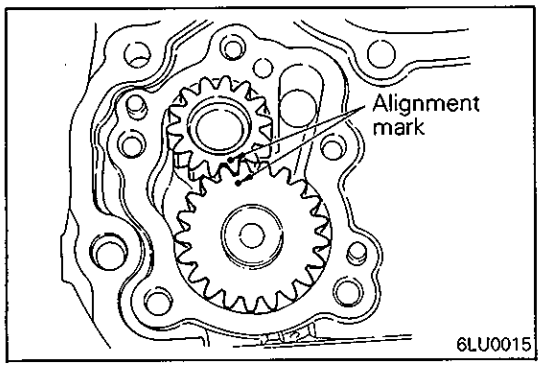


◆E◆ SILENT SHAFT OIL SEAL INSTALLATION



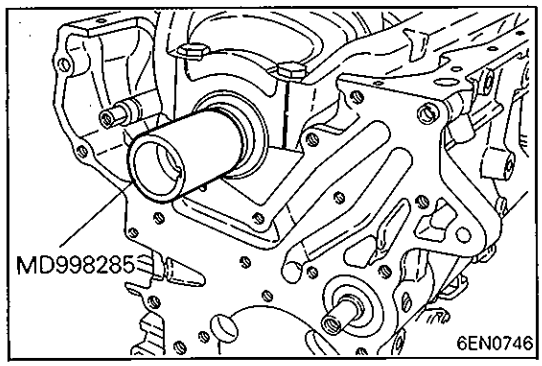
◆F◆ CRANKSHAFT FRONT OIL SEAL INSTALLATION

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



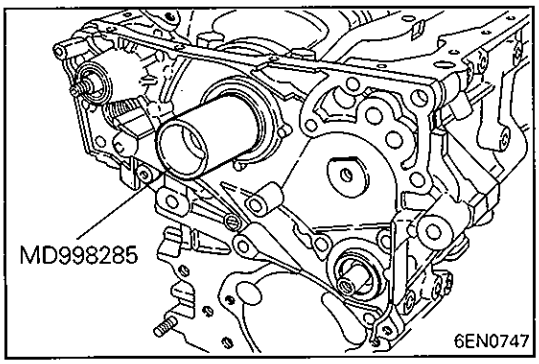
◆G◆ OIL PUMP DRIVEN GEAR / OIL PUMP DRIVE GEAR INSTALLATION

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



◆H◆ FRONT CASE INSTALLATION

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



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

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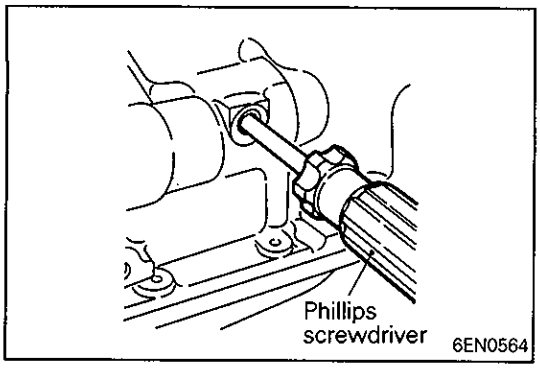
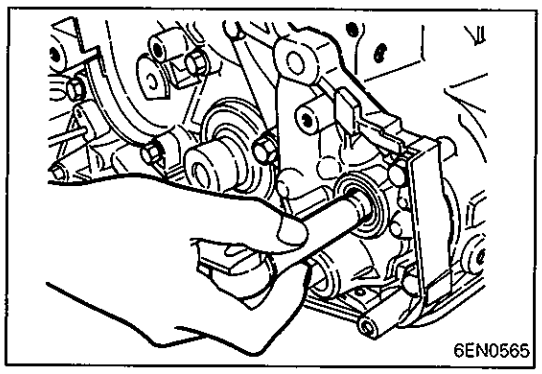
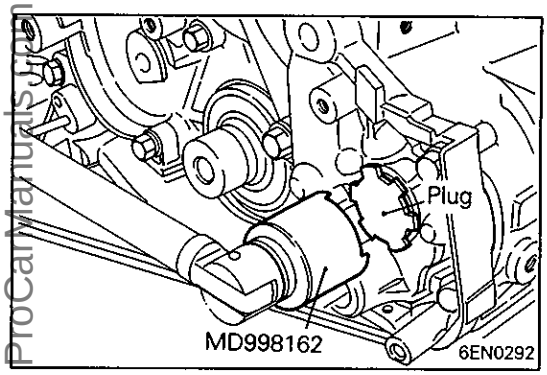


◆I◆ FLANGE BOLT INSTALLATION

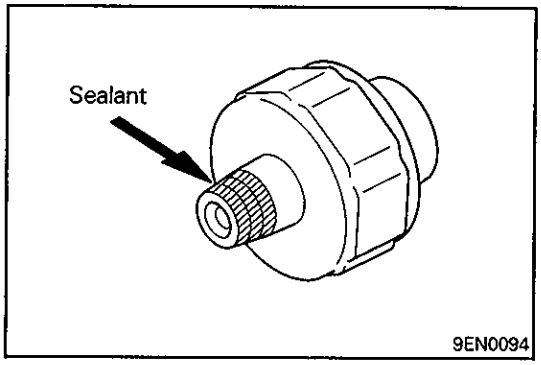
(1) Insert a Phillips screwdriver [shank diameter 8 mm (0.32 in.)] into the plug hole on the left side of the cylinder block to block the silent shaft, then tighten the flange bolt.





◆J◆ PLUG INSTALLATION

(1) Install the plug using the special tool.



◆K◆ SEALANT APPLICATION TO OIL PRESSURE SWITCH

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

Caution

- **Keep the end of the threaded portion clear of sealant.**
- **Avoid an overtightening.**

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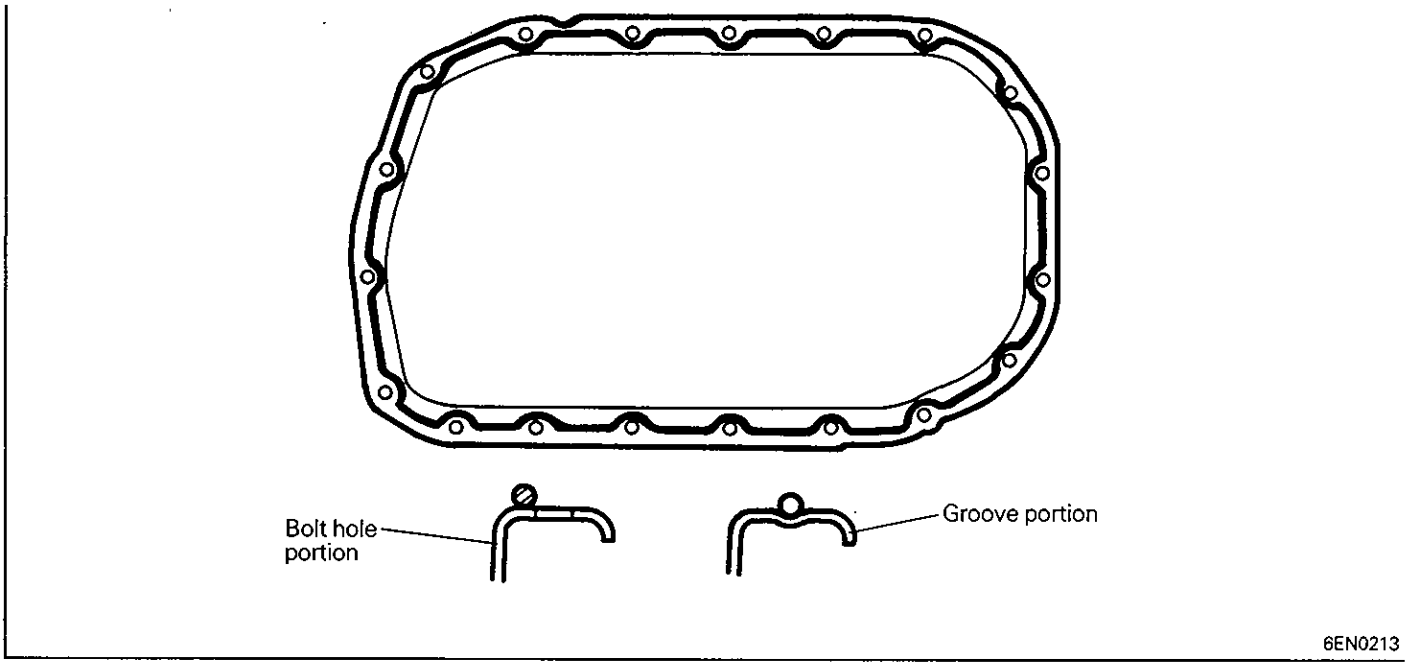
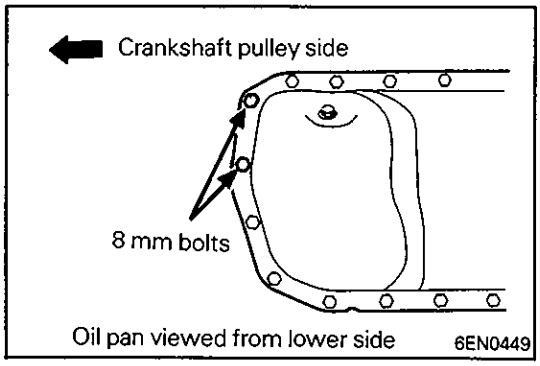
◆L◆ OIL PAN INSTALLATION

(1) Clean both mating surface 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. MD970389 or equivalent

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





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

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NOTES

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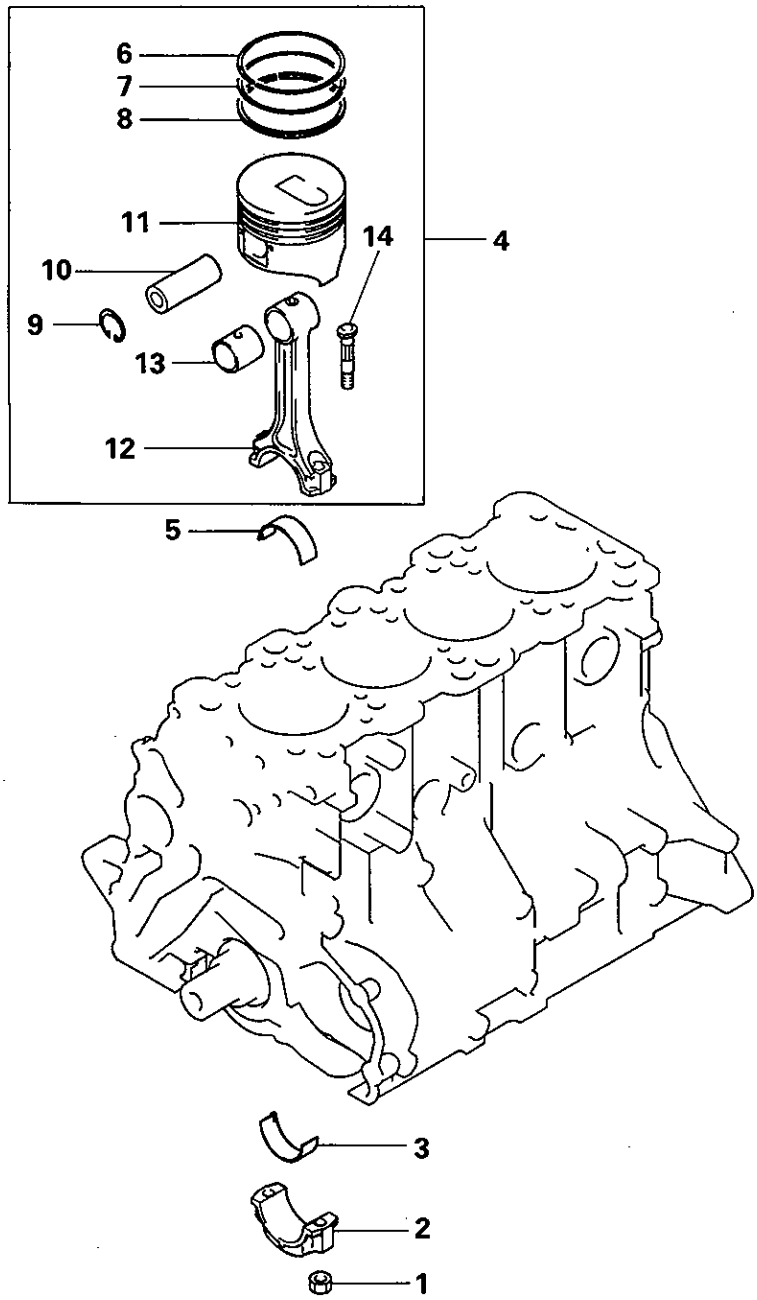
12. PISTONS AND CONNECTING RODS

REMOVAL AND INSTALLATION



Removal steps

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

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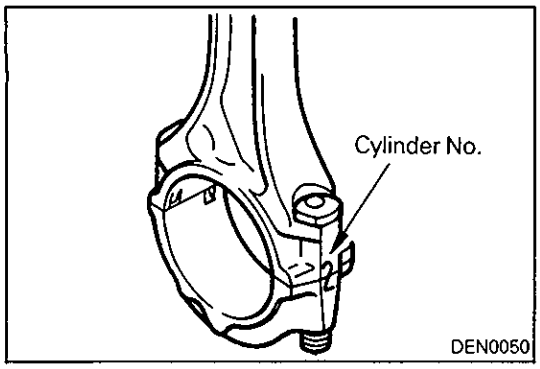
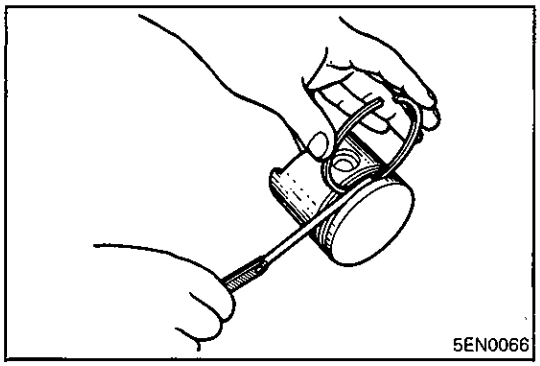


REMOVAL SERVICE POINTS

〈A〉 CONNECTING ROD CAP REMOVAL

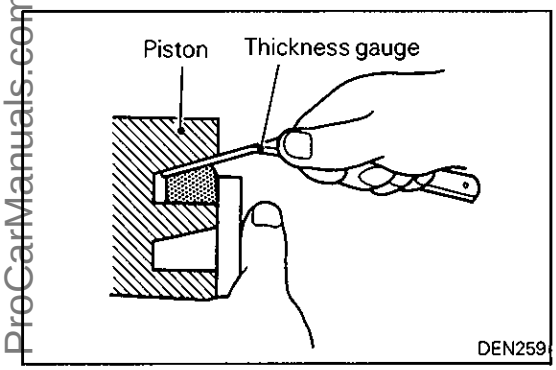
(1) Mark the cylinder number on the side of the connecting rod big end for correct reassembly.



INSPECTION

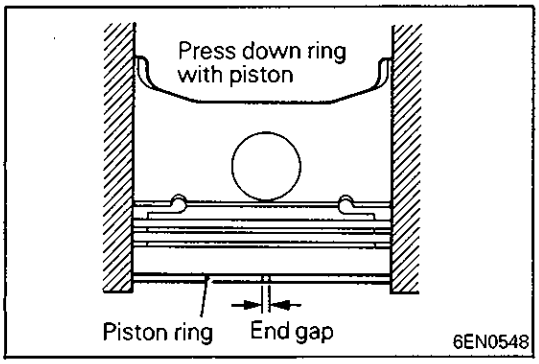
PISTON RING

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



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

Standard value:
No. 1 0.05 – 0.07 mm (0.0020 – 0.0028 in.)
No. 2
Engines without turbocharger
0.02 – 0.06 mm (0.0008 – 0.0024 in.)
Engines with turbocharger
0.05 – 0.07 mm (0.0020 – 0.0028 in.)
Oil 0.02 – 0.07 mm (0.0008 – 0.0028 in.)
Limit: 0.1 mm (0.004 in.)



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

Standard value:
No. 1 0.20 – 0.32 mm (0.0079 – 0.0126 in.)
No. 2 0.35 – 0.50 mm (0.0138 – 0.0197 in.)
Oil 0.10 – 0.30 mm (0.0039 – 0.0118 in.)
Limit: 0.8 mm (0.031 in.)

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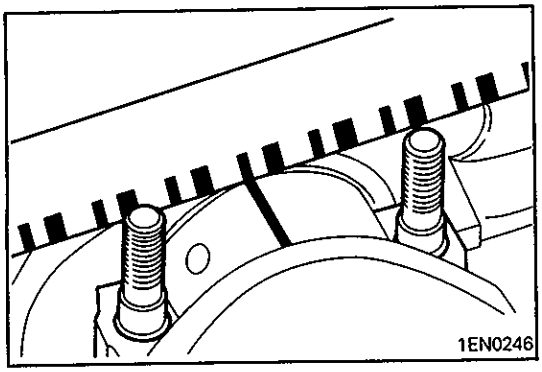

CRANKSHAFT PIN OIL CLEARANCE (PLASTIC GAUGE METHOD)

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

Standard value: 0.02 – 0.05 mm (0.0008 – 0.0020 in.)
Limit: 0.1 mm (0.004 in.)

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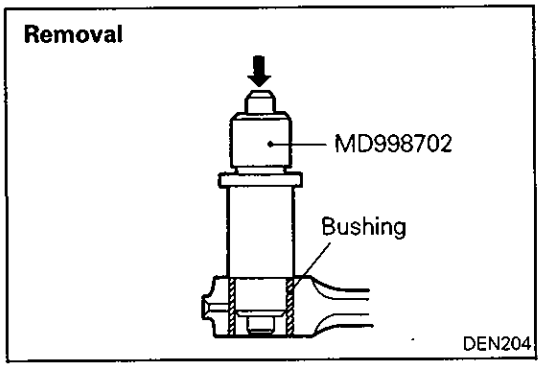
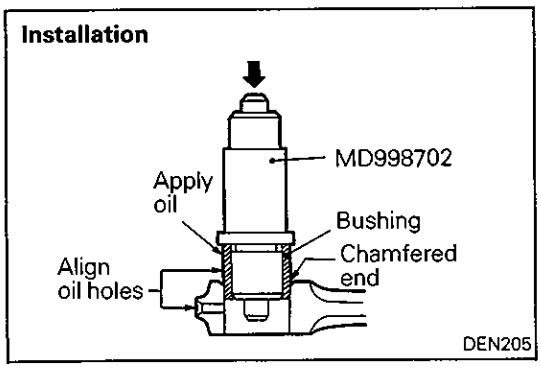
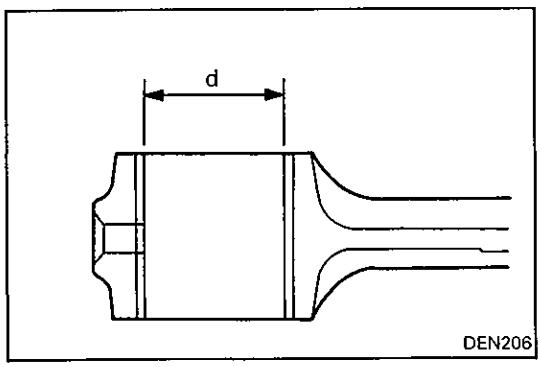


CONNECTING ROD BUSHING REPLACEMENT

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



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



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

Bushing I.D. (d) standard value:
25.015 – 25.025 mm (0.9848 – 0.9852 in.)
Bend (Parallelism between big end center line and small end center line): 0.03 mm (0.0012 in.)
Twist (Deflection between big end center line and small end center line): 0.03 mm (0.0012 in.)

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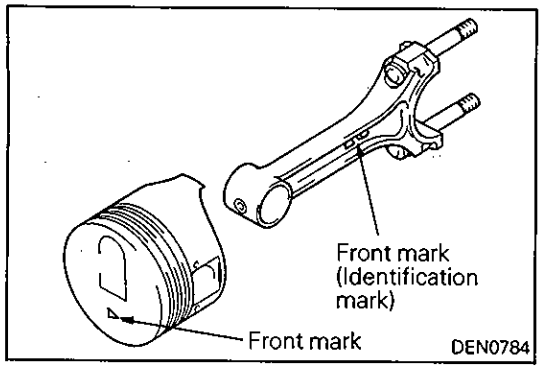
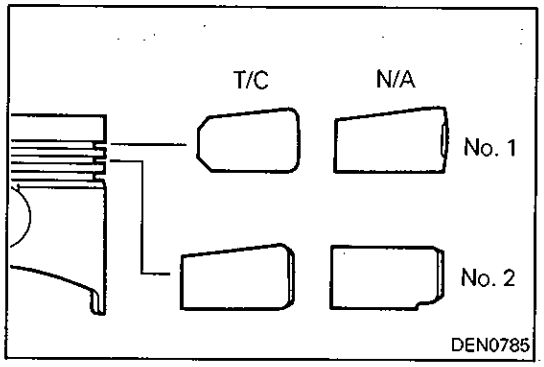


INSTALLATION SERVICE POINTS

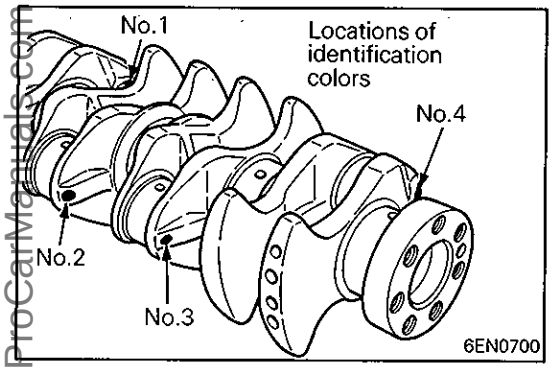
◆A◆ PISTON PIN / PISTON / CONNECTING ROD INSTALLATION

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



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

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



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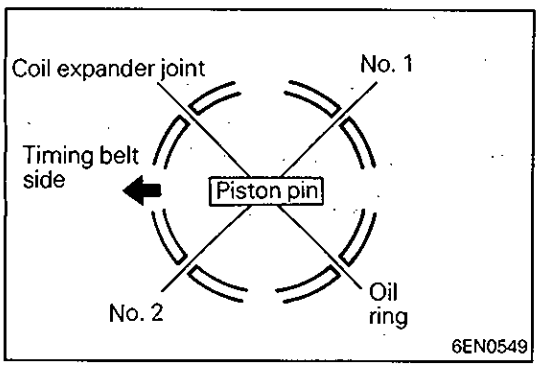
◆C◆ CONNECTING ROD BEARING INSTALLATION

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

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



◆D◆ PISTON AND CONNECTING ROD ASSEMBLY INSTALLATION

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

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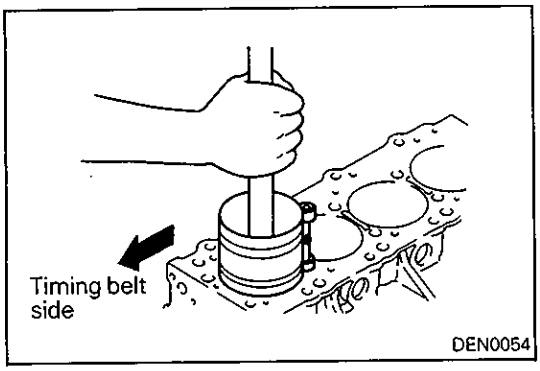
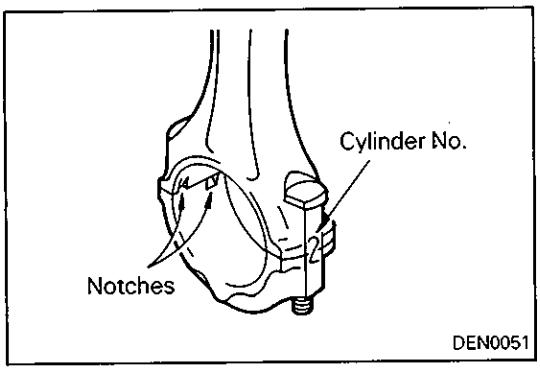
Added



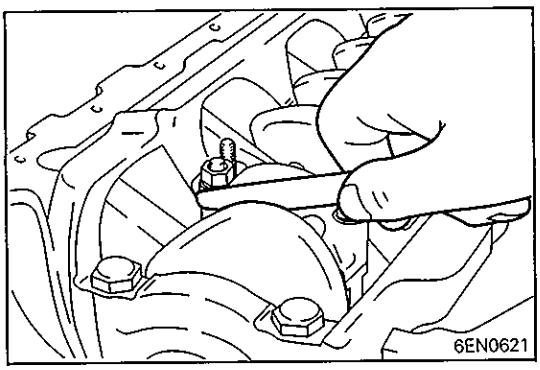
(4) Use suitable thread protectors on the connecting rod bolts before inserting the piston and connecting rod assembly into the cylinder block. Care must be taken not to nick the crank pin.
(5) Using a suitable piston ring compressor tool, install the piston and connecting rod assembly into the cylinder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

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



◆E◆ CONNECTING ROD CAP INSTALLATION

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



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

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

◆F◆ CONNECTING ROD CAP NUT INSTALLATION

(1) Since the connecting rod bolts and nuts are torqued using a new procedure, they should be examined BEFORE reuse. If the bolt threads are "necked down", the bolts should be replaced.
Necking can be checked by running a nut with fingers to the full length of the bolt's thread. If the nut does not run down smoothly, the bolt should be replaced.
(2) Install the connecting rod cap on the big end of the connecting rod.
(3) Before installing the nuts, the threads should be oiled with engine oil.
(4) Install both nuts on the connecting rod bolts finger tight, then alternately torque each nut to assemble the cap properly.
(5) Tighten the nuts to 20 Nm (2 kgm, 14.5 ft.lbs.) and plus 1/4 (90°) turn.

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NOTES

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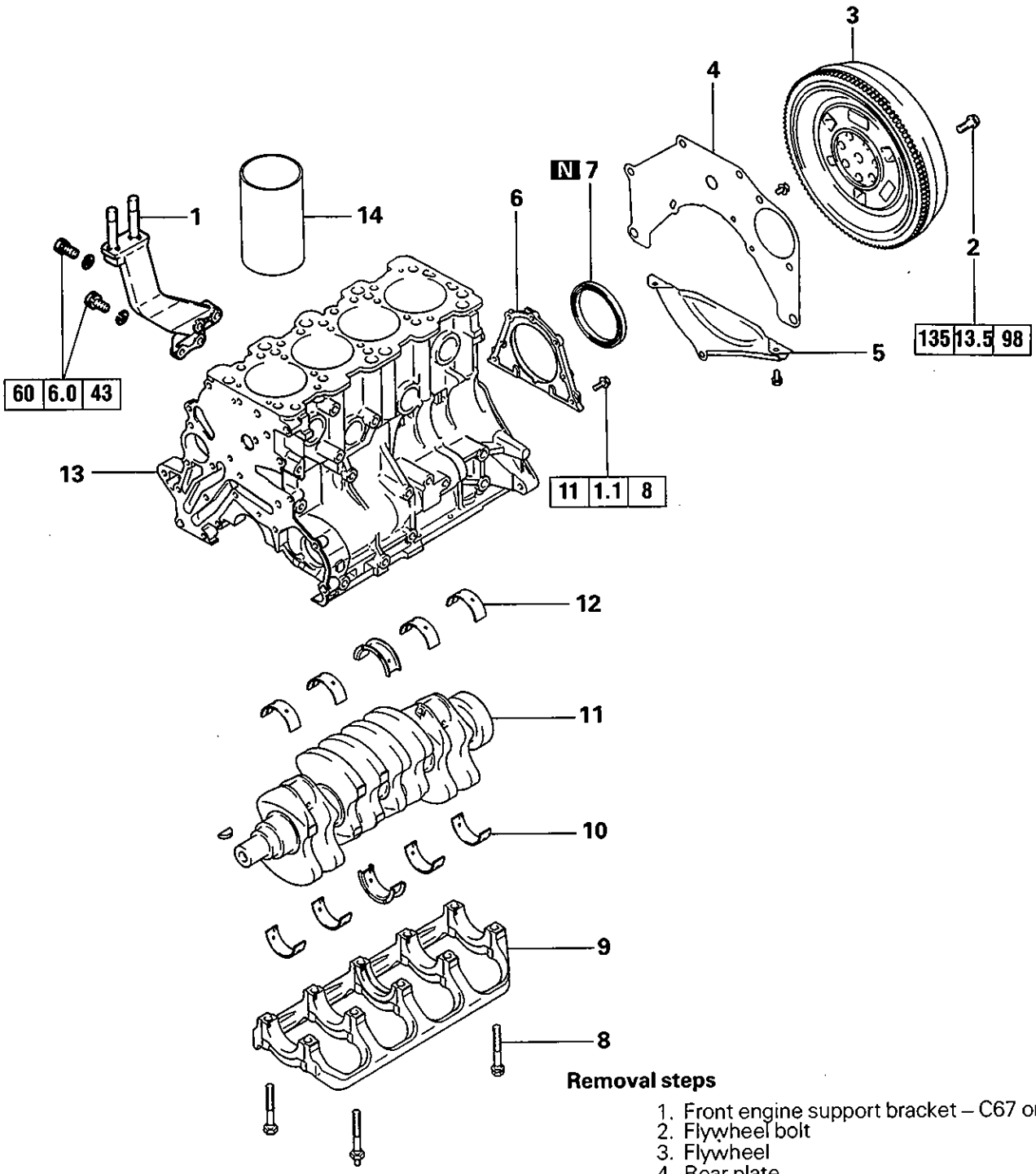
13. CRANKSHAFT, CYLINDER BLOCK AND FLYWHEEL

REMOVAL AND INSTALLATION



Removal steps

1. Front engine support bracket – C67 only
2. Flywheel bolt
3. Flywheel
4. Rear plate
5. Bell housing cover
◆D◆ 6. Oil seal case
◆C◆ 7. Oil seal
◆B◆ 8. Bearing cap bolt
◆B◆ 9. Bearing cap
◆A◆ 10. Crankshaft bearing, lower
11. Crankshaft
◆A◆ 12. Crankshaft bearing, upper
13. Cylinder block
14. Cylinder sleeve

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Added

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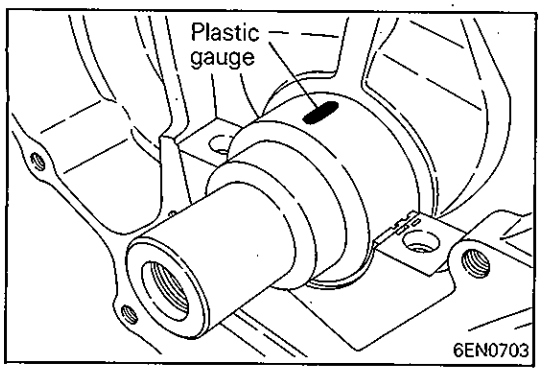
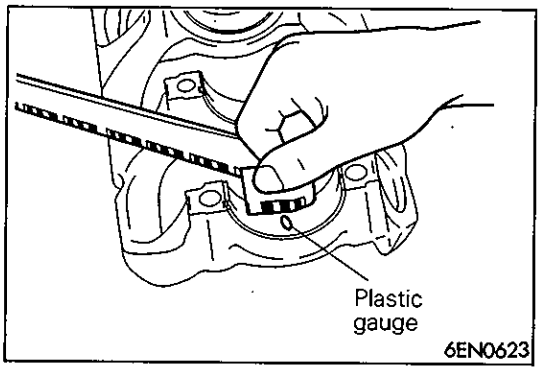


INSPECTION

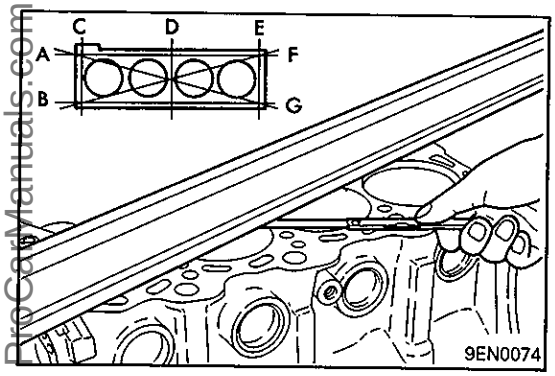
CRANKSHAFT OIL CLEARANCE (PLASTIC GAUGE METHOD)

(1) Remove oil from the crankshaft journal and the crankshaft bearing.
(2) Install the crankshaft.
(3) Cut the plastic gauge to the same length as the width of the bearing and place it on the journal in parallel with its axis.



(4) Install the crankshaft bearing cap carefully and tighten the bolts to the specified torque.
(5) Carefully remove the crankshaft bearing cap.
(6) Measure the width of the plastic gauge at its widest part by using a scale printed on the plastic gauge package.

Standard value: 0.02 – 0.04 mm (0.0008 – 0.0016 in.)
Limit: 0.1 mm (0.004 in.)

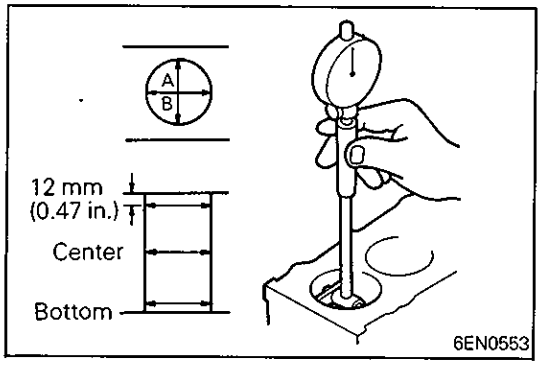


CYLINDER BLOCK

(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 matter.

Standard value: 0.05 mm (0.0020 in.) or less
Limit: 0.1 mm (0.004 in.)

(2) If the distortion is excessive, replace the cylinder block.



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

Standard value:
Cylinder I.D.: 82.70 – 82.73 mm (3.2559 – 3.2571 in.)
Out-of-roundness and taper of cylinder bore:
0.01 mm (0.0004 in.) or less

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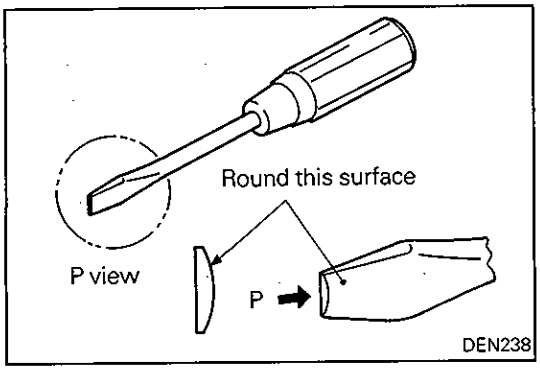
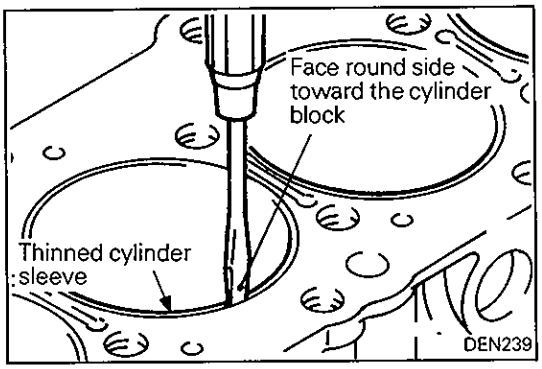




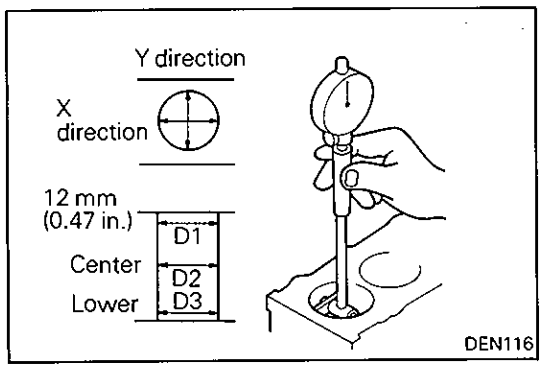
CYLINDER SLEEVE CHANGE PROCEDURES

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 (0.02 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.
If there is damage, insufficient interference-fit-margin or other problems, bore the cylinder block sleeve hole to an oversize.



(3) To check the interference, 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 (0.02 in.) oversize and install an 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.**

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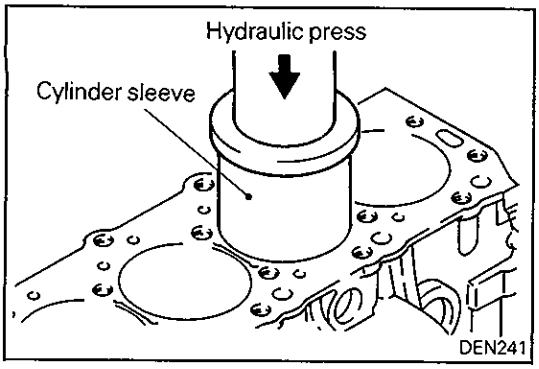


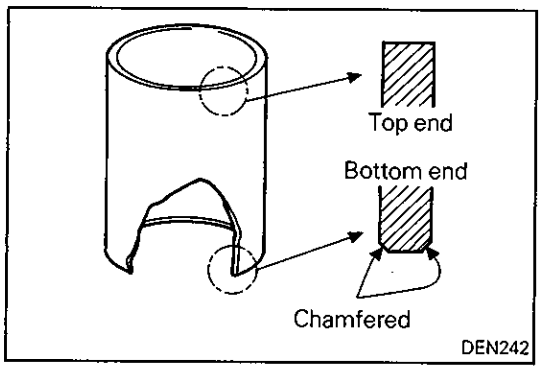
INSTALLATION

When cylinder block sleeve hole has not been bored

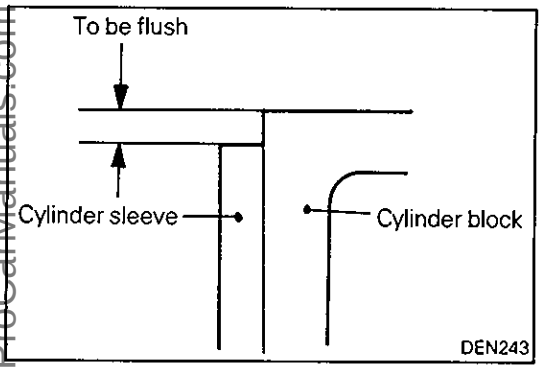
(1) Amply apply press oil to the cylinder block sleeve hole and sleeve outer circumference.

(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.

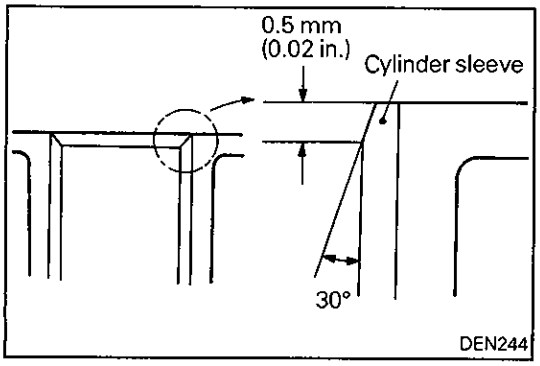
Installation load: 22,000 N (2,200 kg, 4,850 lbs.) or more



(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 (0.008 in.).



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

(6) The service cylinder sleeve has the I.D. machined to 81.5 to 81.7 mm (3.209 to 3.217 in.). After installation of the sleeve, therefore, hone the I.D. to the standard value.

Cylinder I.D.: 82.70 – 82.73 mm (3.2559 – 3.2571 in.)
Honing finished surface roughness: 2 – 4 μ
Honing cross hatch angle: 15 – 25°
Cylinder bore squareness: 0.05 mm (0.002 in.)

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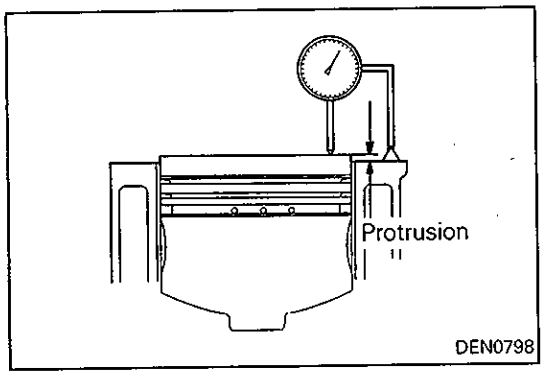
When boring the cylinder block sleeve hole

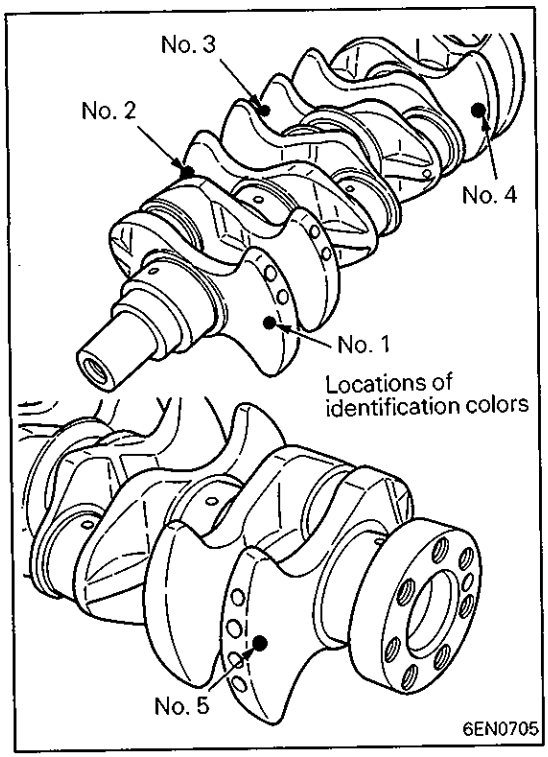
(1) Prepare a cylinder sleeve of 0.5 mm (0.02 in.) oversize (identification color: red)
(2) Hone the cylinder block sleeve hole to 86.13 to 86.15 mm (3.3909 to 3.3917 in.).
(3) Install the cylinder sleeve and finish the I.D. The installation and machining procedures are the same as in the case when the 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 piston and connecting rod in order to reduce the protrusion to within the limit.
(2) If the protrusion still exceeds the limit after piston reassembly, replace the cylinder block.

Limit: 0.823 mm (0.0324 in.)

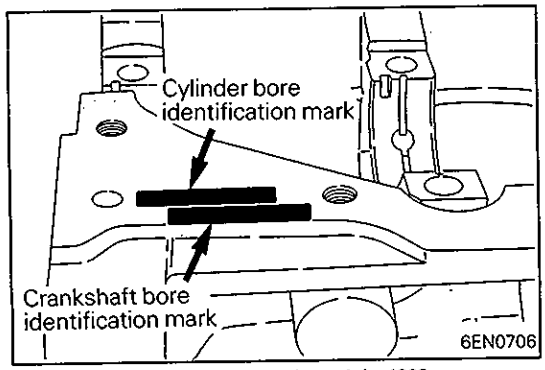


INSTALLATION SERVICE POINTS

◆A◆ CRANKSHAFT BEARING INSTALLATION

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

Journal OD identification color	Identification mark for cylinder block bearing support section ID	Crankshaft bearing identification mark
Yellow	0	1
	1	2
	2	3
None	0	2
	1	3
	2	4
White	0	3
	1	4
	2	5



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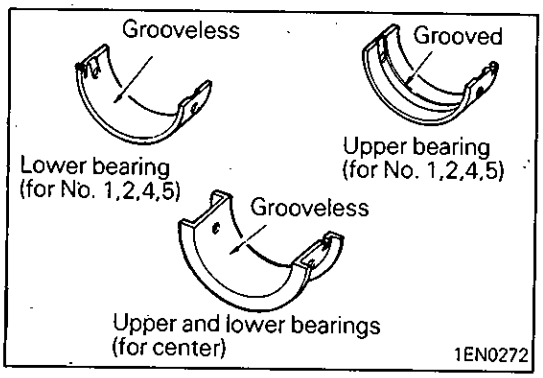
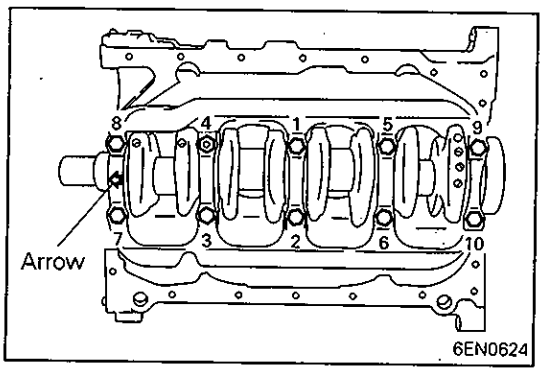


(2) Install the upper crankshaft bearings to the cylinder block. There is an oil groove in the upper crankshaft bearing. There is no difference between upper and lower bearings for the center (with flange).
(3) Install the lower crankshaft bearing (with no oil groove; there is no difference for center) to bearing cap and apply engine oil to the bearing surfaces.



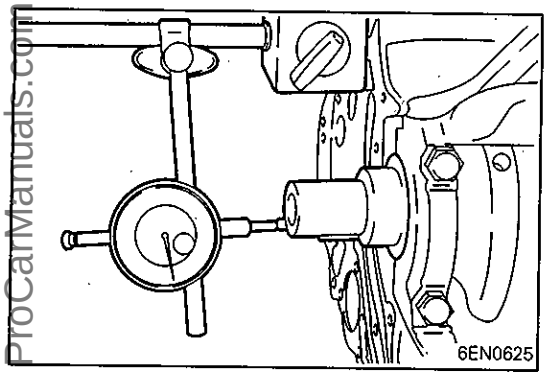
◆B◆ BEARING CAP / BEARING CAP BOLT INSTALLATION

(1) Install the bearing cap so that its arrow is positioned on the timing belt side.
(2) When installing the bearing cap bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.

Limit: max. 71.1 mm (2.79 in.)

(3) Torque the bearing cap bolts to 25 Nm (2.5 kgm, 18 ft.lbs.) in order shown in the illustration then, retighten them 1/4 (90°) turns more in the same order.
(4) After installing the bearing caps, make sure that the crankshaft turns smoothly and the end play is correct. If the end play exceeds the limit, replace the crankshaft bearings.

Standard value: 0.05 – 0.18 mm (0.0020 – 0.0071 in.)
Limit: 0.25 mm (0.010 in.)



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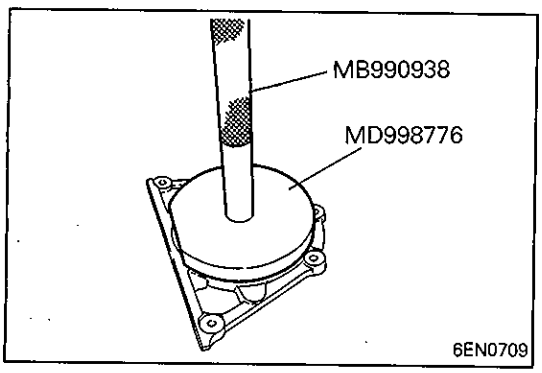
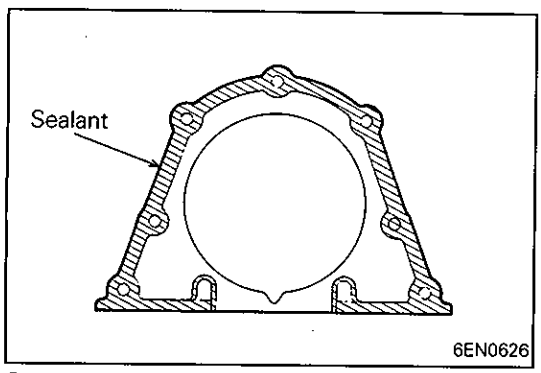


◆C◆ OIL SEAL INSTALLATION



◆D◆ SEALANT APPLICATION TO OIL SEAL CASE

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent

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Added

Service Bulletins

Click on the applicable bookmark to select the Service Bulletin.

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SERVICE BULLETIN

QUALITY INFORMATION ANALYSIS
OVERSEAS SERVICE DEPT. MITSUBISHI MOTORS CORPORATION

SERVICE BULLETIN	**No.:** MSB-01E11-003	
	Date: 2002-04-05	**<Model>** / **<M/Y>**

Subject: CHANGE IN GLOW PLUG TIGHTENING CONDITION AND ADDITION OF NOTE

Group: ENGINE

Draft No.: 01EN509

INFORMATION

INTERNATIONAL CAR ADMINISTRATION OFFICE

T.Inoue - Manager
SERVICE PUBLICATION

<Model>	<M/Y>
(EC)PAJERO/MONTERO(V10-40, V60-70) (EC)MONTERO SPORT/PAJERO SPORT(K80W,K90W) (EC)L200/4WD L200(K00-K30, K60-K70) (EC)L300(L30,L60, P00,P10,P40) (EC)L400(PA,PB,PD) (EC)GALANT(E50-80, EA0) (EC)GALANT WAGON(EA0W) (EC)SPACERUNNER/ WAGON(N10,N20, N30,N40) (EC)COLT LANCER/ STATION WAGON(CA0,CB0)	97-10

1. Description:

On the 4D56 and 4D68 engines, the glow plug tightening condition has been changed, and a note added.

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2. Applicable Manuals:

Manual	Pub. No.	Language	Page(s)
ENGINE 4D5	PWEE9067	(English)	11B-3-1, 3-1A, 3-2
Workshop Manual	PWES9068	(Spanish)	
CD	PWEF9069	(French)	
	PWEG9070	(German)	
	PWED9071	(Dutch)	
	PWEW9072	(Swedish)	
	PWEH9903R-D	(English)	
	PWEH9903R-D	(Spanish)	
	PWEH9903R-D	(Swedish)	
	PWEK9904R-D	(French)	
	PWEK9904R-D	(German)	
	PWEK9904R-D	(Dutch)	
ENGINE 4D6 (W-E)	PWEE9073	(English)	11B-3-1, 3-2
Workshop Manual	PWES9074	(Spanish)	
CD	PWEF9075	(French)	
	PWEG9076	(German)	
	PWED9077	(Dutch)	
	PWEW9078	(Swedish)	
	PWEH9903R-D	(English)	
	PWEH9903R-D	(Spanish)	
	PWEH9903R-D	(Swedish)	
	PWEK9904R-D	(French)	
	PWEK9904R-D	(German)	
	PWEK9904R-D	(Dutch)	
ENGINE 4D6 (W-E)	PWEE9609	(English)	11B-3-1, 3-2
Workshop Manual	PWES9610	(Spanish)	
CD	PWEF9611	(French)	
	PWEG9612	(German)	
	PWED9613	(Dutch)	
	PWEW9614	(Swedish)	
	PWEH9903R-D	(English)	
	PWEH9903R-D	(Spanish)	
	PWEH9903R-D	(Swedish)	
	PWEK9904R-D	(French)	
	PWEK9904R-D	(German)	
	PWEK9904R-D	(Dutch)	

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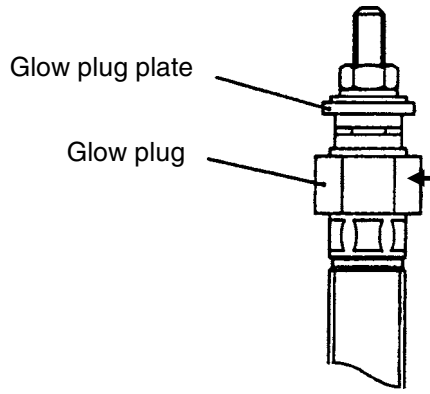
3. Details:

In order to improve reliability, the glow plug tightening condition has been changed as follows.

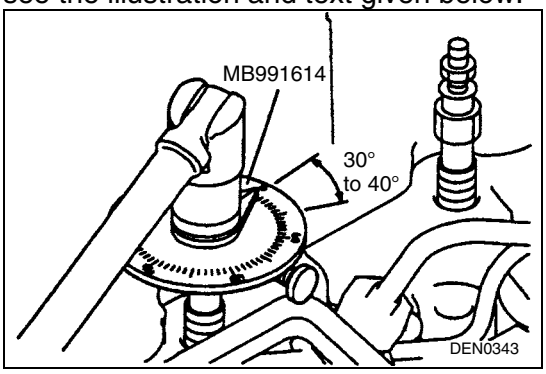


<New> Tightening condition: After tightening the glow plug to 9±1 N·m, tighten it further through 30° to 40°.

Note:
During tightening of the glow plug, the glow plug and cylinder head threaded portions sealing surfaces must be dry.

<Old> Tightening condition: Tighten the glow plug to 18±2 N·m.

For angular tightening method of the glow plug, see the illustration and text given below.



After tightening the glow plug to 9±1 N·m, tighten it further through 30° to 40°.

Note:
During tightening of the glow plug, the glow plug and cylinder head threaded portions sealing surfaces must be dry.

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SERVICE BULLETIN

QUALITY INFORMATION ANALYSIS
OVERSEAS SERVICE DEPT. MITSUBISHI MOTORS CORPORATION

SERVICE BULLETIN	**No.:** MSB-02E11-001	
	Date: 2002-05-06	**<Model>** **<M/Y>**
Subject: CHANGE IN CRANKSHAFT IDENTIFICATION MARKS AND THEIR POSITIONS ON 4G6, 4D68 ENGINES		(EC)GALANT (EA0) 91-01 (EC)ECLIPSE (D30) (EC)SPACE RUNNER (N60) (EC)SPACE WAGON (N30-N40,N80-N90) (EC)L200 (K60,K70) (EC)L300 (P00) (EC)L400 (PA0-PD0)
Group: ENGINE	**Draft No.:** 02EN501	
INFORMATION	**INTERNATIONAL CAR ADMINISTRATION OFFICE**	T.Inoue - Manager SERVICE PUBLICATION

1. Description:

On the 4G6 and 4D68 engines, the crankshaft identifications marks and their positions have been changed.

2. Applicable Manuals:

Manual	Pub. No.	Language	Page(s)
ENGINE 4G6 (W-E) WORKSHOP MANUAL	PWEE9037	(English)	11B-11-8
	PWES9038	(Spanish)	12-4
	PWEF9039	(French)	
	PWEG9040	(German)	
	PWED9041	(Dutch)	
	PWEW9042	(Swedish)	
ENGINE 4G6 (E-W) WORKSHOP MANUAL	PWEE9616	(English)	11A-11-5, 6
	PWES9617	(Spanish)	12-2, 3
	PWEF9618	(French)	
	PWEG9619	(German)	
	PWED9620	(Dutch)	
	PWEW9621	(Swedish)	
ENGINE 4G6 (W-E) WORKSHOP MANUAL	PWEE9073	(English)	11B-12-4
	PWES9674	(Spanish)	13-5
	PWEF9075	(French)	
	PWEG9076	(German)	
	PWED9077	(Dutch)	
	PWEW9078	(Swedish)	

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ENGINE 4D6 (E-W) WORKSHOP MANUAL	PWEE9609	(English)	11A-11-2 12-2
	PWES9610	(Spanish)	
	PWEF9611	(French)	
	PWEG9612	(German)	
	PWED9613	(Dutch)	
	PWEW9614	(Swedisch)	
CD-ROM	PWEH9903R-C (English, Spanish, Swedish) PWEK9904R-C (French, German, Dutch)		

3. Effective Date (Effective Model)

From October 1, 2001

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4. Details:

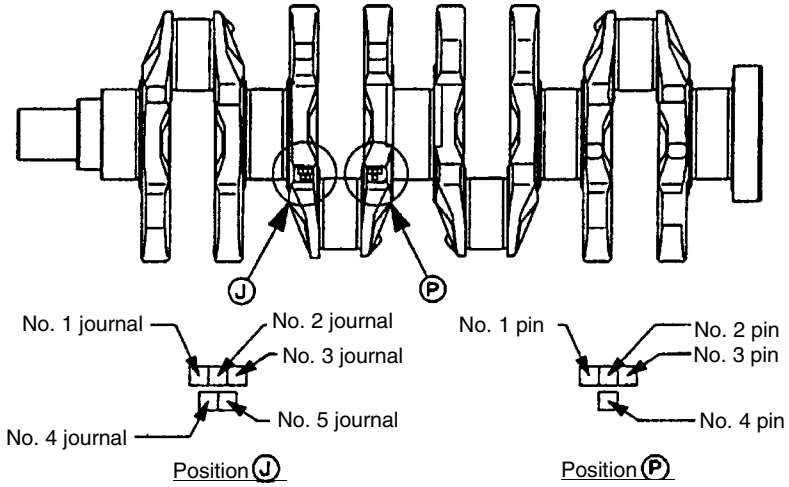
The crankshaft identification marks and their positions have been changed.

<New>

In accordance with the table below, an identification mark has been stamped On positions J and P.

Journal			Pin		
Classification	ϕ D	Indentification mark	Classi-fication	ϕ d	Indentification mark
I	ϕ 57 $^{0}_{-0.006}$	0	I	ϕ 45 $^{0}_{-0.005}$	I
II	ϕ 57 $^{-0.006}_{-0.012}$	1	II	ϕ 45 $^{-0.005}_{-0.015}$	II
III	ϕ 57 $^{-0.012}_{-0.018}$	2	III	ϕ 45 $^{-0.015}_{-0.020}$	III

Unit: mm

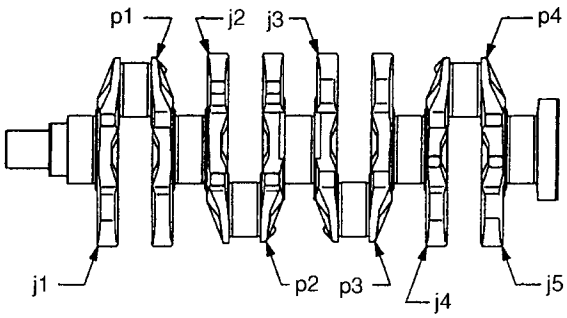


<Old>

In accordance with the table below, an identification color has been painted at positions j1 through j5 and p1 through p4.

Journal			Pin		
Classi-fication	ϕ D	Indentification mark	Classi-fication	ϕ d	Indentification mark
I	ϕ 57 $^{0}_{-0.006}$	Yellow	I	ϕ 45 $^{0}_{-0.005}$	Yellow
II	ϕ 57 $^{-0.006}_{-0.012}$	No mark	II	ϕ 45 $^{-0.005}_{-0.015}$	No mark
III	ϕ 57 $^{-0.012}_{-0.018}$	White	III	ϕ 45 $^{-0.015}_{-0.020}$	White

Unit: mm



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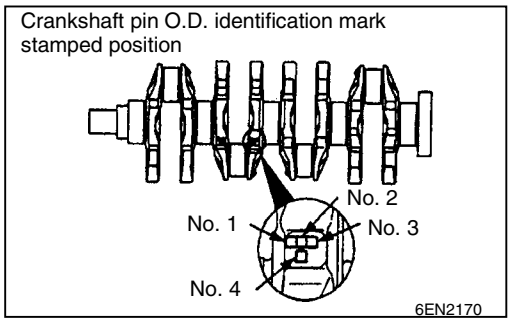

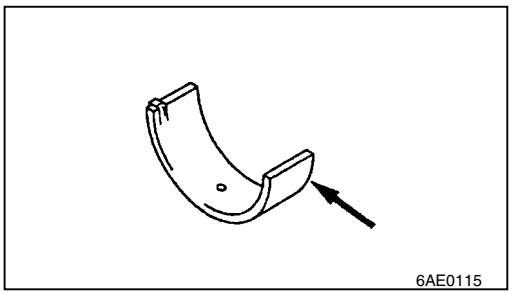

CONNECTING ROD BEARING INSTALLATION

1. When the connecting rod bearing or the crankshaft is replaced, select a bearing of the size that corresponds to the crankshaft pin O.D. in accordance with identification of the crankshaft pin and the connecting rod bearing given in the table below.
2. A crankshaft identification mark is stamped at the illustrated position.
3. A connecting rod bearing identification mark is stamped, or a connecting rod bearing identification color is painted at the illustrated position.

Crankshaft pin		Connecting rod bearing
Identification mark	Pin O.D. mm	Identification mark or color
I	44.995 – 45.005	1 or yellow
II	44.985 – 44.995	2 or none
III	44.980 – 44.985	3 or blue

<Example of bearing selection>
When the crankshaft identification mark is I, select a bearing whose identification mark is 1 or whose identification color is yellow.
If crankshaft identification is difficult to make, measure the crankshaft pin O.D. to select a bearing that corresponds to the measurement.

4. Install the selected bearing in the big end and in the cap of the connecting rod.

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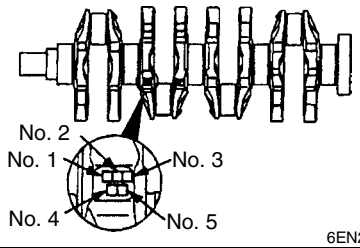
Crankshaft journal diameter identification mark stamped position



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CRANKSHAFT BEARING INSTALLATION

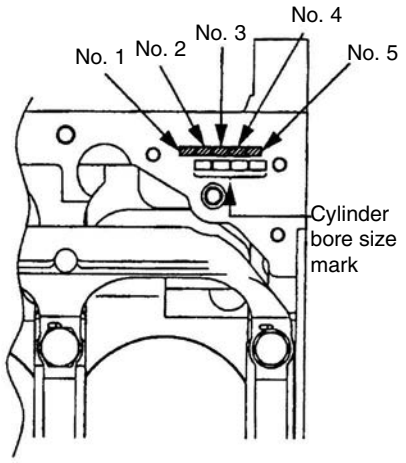
1. Select a crankshaft bearing of the size that corresponds to the crankshaft journal diameter in accordance with the tables given below.
   <Example of bearing selection>
   When the crankshaft journal identification mark is 0 and the cylinder block bearing identification is 1, select a crankshaft bearing (No. 1, 2, 4, 5) whose identification mark is 2 or whose identification color is yellow, and select a bearing (No. 3) whose identification mark is 1 or whose identification color is green.
   If crankshaft identification is difficult to make, measure the journal I.D. to select a bearing that corresponds to the measurement.

Bearing No. 1, 2, 4, 5			
Crankshaft journal O.D.		Cylinder block bearing	Crank-shaft bearing
Identification mark	Journal diameter mm		
0	56.994 – 57.000	0	1 or green
		1	2 or yellow
		2	3 or none
1	56.988 – 56.994	0	2 or yellow
		1	3 or none
		2	4 or blue
2	56.982 – 56.988	0	3 or none
		1	4 or blue
		2	5 or red

Bearing No. 3			
Crankshaft journal O.D.		Cylinder block bearing	Crank-shaft bearing
Identification mark	Journal diameter mm		
0	56.994 – 57.000	0	0 or black
		1	1 or green
		2	2 or yellow
1	56.988 – 56.994	0	1 or green
		1	2 or yellow
		2	3 or none
2	56.982 – 56.988	0	2 or yellow
		1	3 or none
		2	4 or blue

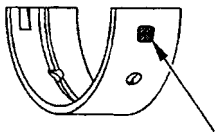
← Timing belt side

Cylinder block bearing bore identification mark

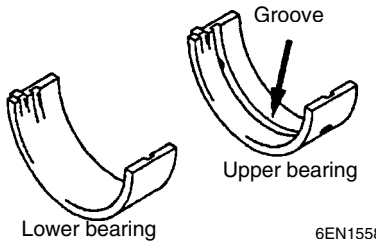


6EN1618

Crankshaft bearing size identification mark or color showing position



6EN1096



6EN1558

2. Install the bearing with an oil groove to the cylinder block.
3. Install the bearing with no oil groove to the bearing cap.

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