

# SPECIFICATIONS

## GENERAL SPECIFICATIONS

Descriptions			Specifications
Type			60° V, SOHC (per bank)
Number of cylinders			6
Combustion chamber			Pentroof type
Total displacement cc			6G72 – 2,972 / 6G74 – 3,497
Cylinder bore mm			6G72 – 91.1 / 6G74 – 93.0
Piston stroke mm			6G72 – 76 / 6G74 – 85.8
Valve timing	Intake valve	Opens (BTDC)	9°
		Closes (ABDC)	59°
	Exhaust valve	Opens (BBDC)	47°
		Closes (ATDC)	21°
Lubrication system			Pressure feed, full-flow filtration
Oil pump type			Trochoid type
Cooling system			Water-cooled forced circulation
Water pump type			Centrifugal impeller type
EGR type			Single type
Injector type and number			Electromagnetic, 6
Injector identification mark			CDH210
Throttle bore mm			65
Throttle position sensor			Variable resistor type
Closed throttle position switch			Movable contact type, within throttle position sensor

## SERVICE SPECIFICATIONS

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Items			Standard value	Limit
Alternator				
Drive belt	Tension N	New belt	784–980	–
		Used belt	539–637	–
	Deflection mm (Reference value)	New belt	6.0–7.2	–
		Used belt	8.2–9.3	–
Fuel and emission parts				
Injector coil resistance Ω			13–16 at 20° C	–
Rocker arms and camshaft				
Camshaft	Cam height mm	Intake	37.58	37.08
		Exhaust	36.95	36.45
Camshaft	Journal diameter mm		44.93 – 44.94	–
Cylinder head and valve				
Cylinder head	Flatness of gasket surface mm		0.03	0.2
	Grinding limit of gasket surface *Includes/combined with cylinder block grinding mm		–	*0.2
	Overall height mm		120	–
Valve	Thickness of valve head (margin) mm	Intake	1.0	0.5
		Exhaust	1.2	0.7
	Stem diameter mm	Intake	6.0	–
		Exhaust	6.0	–
	Stem to guide clearance mm	Intake	0.02–0.05	0.10
		Exhaust	0.04–0.07	0.15
Valve face angle			45°–45.5°	–
Valve spring	Free height mm		51.0	50.0
	Load/installed height N/mm		267/44.2	–
	Out of squareness		2° or less	Max. 4°
Valve seat	Valve contact width mm		0.9–1.3	–
Valve guide	Inner diameter mm		6.0	–
	Outer diameter mm		11.0	–

## ENGINE OVERHAUL – Specifications

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Items		Standard value	Limit
<b>Front case, oil pump and oil pan</b>			
Oil pump	Tip clearance mm	0.06–0.18	–
	Side clearance mm	0.04–0.10	–
	Body clearance mm	0.10–0.18	0.35
<b>Piston and connecting rod</b>			
Piston	Outer diameter mm	6G72 – 91.1 / 6G74 – 93.0	–
	Piston to cylinder clearance mm	0.02–0.04	–
Piston ring	Ring to ring groove clearance No. 1 ring mm	0.03–0.07	0.1
	Ring to ring groove clearance No. 2 ring mm	0.02–0.06	0.1
	End gap No. 1 ring mm	0.30–0.45	0.8
	End gap No. 2 ring mm	0.45–0.60	0.8
	End gap oil ring mm	6G72 – 0.20–0.60 6G74 – 0.10–0.35	1.0
Piston pin	Outer diameter mm	22.0	–
	Press-in load	6G72 – 7,350 – 17,200 N 6G74 – Finger pressure	–
	Press-in temperature	6G72 – Room Temp 6G74 – 70°C	–
Crankshaft	Oil clearance of pin mm	0.02–0.05	0.1
Connecting rod	Big end side clearance mm	0.10–0.25	0.4
<b>Crankshaft, Flywheel and drive plate</b>			
Crankshaft	End play mm	0.05–0.25	0.3
	Journal outer diameter mm	60	–
	Pin outer diameter mm	50	–
	Oil clearance of journal mm	0.02–0.04	0.1
Drive plate and Flywheel	Runout mm	–	0.13
<b>Cylinder Block</b>			
Cylinder block	Flatness of gasket surface mm	0.05	0.1
	Grinding limit of gasket surface *Includes/combined with cylinder block grinding mm	–	*0.2
	Overall height mm	210.4–210.6	–
	Cylinder bore inner diameter mm	6G72 – 91.9 / 6G74 – 93.0	–

**REWORK DIMENSIONS**

Items			Standard value	Limit
Cylinder head and valve				
Cylinder head	Oversize valve guide hole (both intake and exhaust)	0.05	11.05–11.07	–
		0.25	11.25–13.32	–
		0.50	11.50–11.52	–
	Oversize intake valve seat ring hole mm	0.3	34.30–34.33	–
		0.6	34.60–34.63	–
	Oversize exhaust valve seat ring hole mm	0.3	31.80–32.83	–
		0.6	32.10–32.13	–
Crankshaft				
Crankshaft	Out of roundness and taper of journal and pin mm		0.005	–

**TORQUE SPECIFICATIONS**

Items		Nm
<b>Alternator and drive belt</b>		
Alternator bolt		21
Tensioner pulley nut		50
Alternator bracket bolt	M8	48
	M10	23
Alternator pivot nut		44
Crankshaft bolt		180-190
<b>Intake manifold plenum and throttle body</b>		
Manifold differential pressure sensor bolt		4.9
Intake manifold plenum bolt and nut		18
Vacuum hose assembly bolt		9.8
Water outlet fitting bracket bolt		19
EGR pipe bolt		18
EGR pipe flare nut		59
Intake manifold plenum stay bolt	M8	18
	M10	36
EGR valve bolt		22
Bracket bolt		24
Throttle body bolt		12
<b>Ignition system</b>		
Spark plug		25
Distributor nut		23
<b>Timing belt</b>		
Crank angle sensor bolt		9
Auto tensioner bolt		24
Tensioner pulley bolt		49
Tensioner arm bolt		44
Idler pulley bolt		44
Camshaft sprocket bolt		88
<b>Intake manifold and fuel parts</b>		
Injector and fuel rail bolt		12
Fuel pressure regulator bolt		9
Fuel pipe bolt		9
Heat pipe bolt		18
Engine coolant temperature gauge unit		11
Engine coolant temperature sensor		30
Water outlet fitting bolt		19
Water inlet fitting bolt		19
Thermostat case bolt		19
Water (outlet) pipe bolt		14
Intake manifold nut		21

## ENGINE OVERHAUL – Specifications

Items		Nm
<b>Exhaust manifold</b>		
Oil level gauge guide bolt		14
Heat protector bolt		14
Exhaust manifold nut		29
Water pump bolt	M8	24
	M10	41
<b>Rocker arms and camshafts</b>		
Rocker cover bolt		3.5
Distributor adaptor bolt		23
Thrust case bolt		13
Rocker arm, rocker arm shaft bolt		31
<b>Cylinder head and valve</b>		
Cylinder head bolt		108
<b>Oil pan and oil pump</b>		
Oil pressure switch		10
Oil filter bracket bolt	M8	24
	M10	40
Drain plug		40
Oil pan (upper) bolt		6
Oil pan lower bolt		11
Cover bolt		11
Baffle plate bolt	M6	11
	M8	9
Oil screen bolt		19
Plug		45
Oil pump case bolt		14
Oil pump cover bolt		10
<b>Piston and connecting rod</b>		
Connecting rod cap nut		52
<b>Crankshaft, Flywheel and drive plate</b>		
Drive plate bolt		75
Flywheel bolt		98
Bell housing cover bolt		9
Oil seal case bolt		11
Bearing cap bolt		93
<b>Bracket</b>		
Bracket bolt	M8	22
	M10	41
	M12	75

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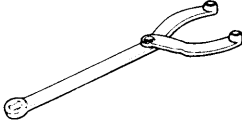

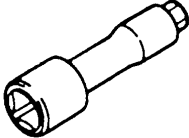
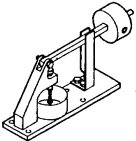

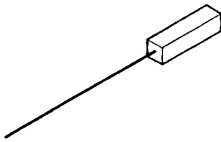
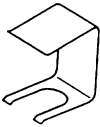
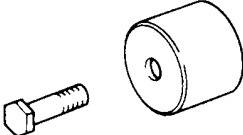
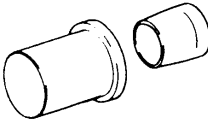
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**SEALANTS**

Items	Specified sealant	Quantity
Engine coolant temperature sensor	Loctite 577	As required
Engine coolant temperature gauge unit	Loctite 577	As required
Oil pressure switch / gauge unit	Loctite 577	As required
Oil pump case	MD970389 / Loctite 587	As required
Oil pan	MD970389 / Loctite 587	As required
Rear main oil seal	MD970389 / Loctite 587	As required
Welsh plugs and spark plug sleeves	Loctite 262	As required
Water outlet fitting	Loctite 577	As required

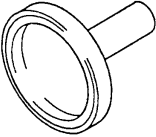
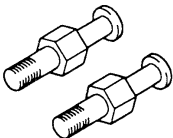
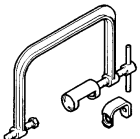
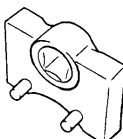
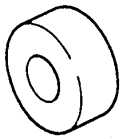
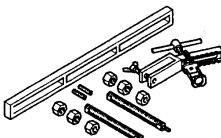
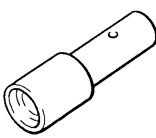
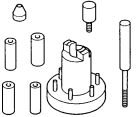
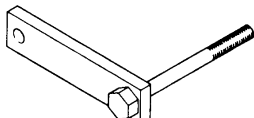
## SPECIAL TOOLS

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Tool	Tool number and name	Supersession	Application
	MB990767 End yoke holder	EMB990767	Holding camshaft sprocket when loosening bolt.
	MD991559 Camshaft oil seal installer adaptor	EMD991559	Installation of camshaft oil seal (Left bank) (Use with MD998713)
	MD998051 Cylinder head bolt wrench	E1139	Loosening and tightening cylinder head bolts
	MD998440 Leak-down tester	49U012005	Leak-down test of lash adjuster
	MD998441 Lash adjuster retainer	EMD998441	Bleeding of air inside adjuster
	MD998442 Air bleed wire	E9M40–1	Air bleeding of auto lash adjuster
	MD998443 Lash adjuster holder (8)	E9M40–2	Supporting lash adjuster to prevent it from falling when rocker shaft assembly is removed or installed
	MD998713 Camshaft oil seal installer	EMD998713	Installation of camshaft oil seal
	MD998717 Crankshaft front oil seal installer	EMD998717	Installation of crankshaft front oil seal

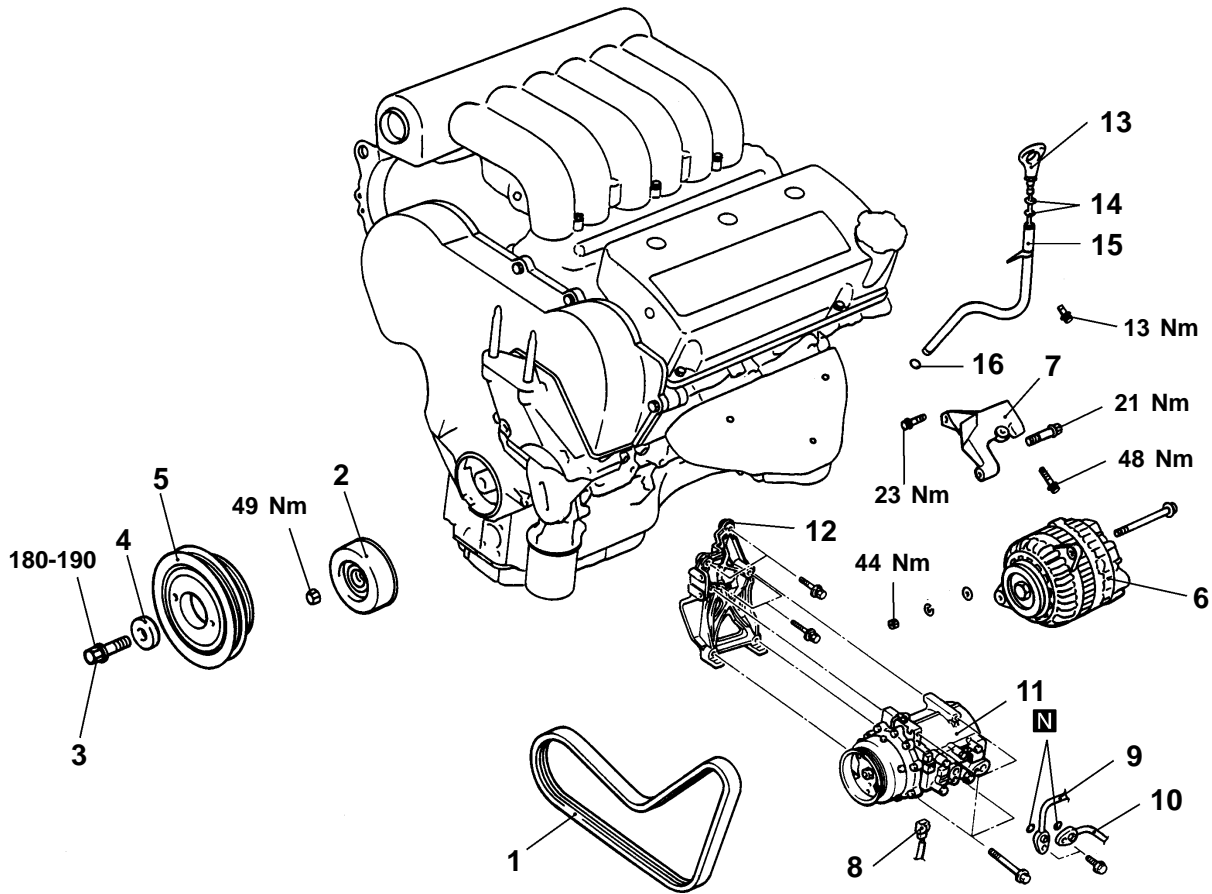


## ENGINE OVERHAUL – Special Tools

Tool	Tool number and name	Supersession	Application
	MD998718 Crankshaft rear oil seal installer	EMD998718	Installation of crankshaft rear oil seal
	MD998715 Pulley holding pins (2)	EMD998715	Holding camshaft sprocket when loosening or torquing bolt
	MD998715 Valve spring compressor	J8062	Removal and installation of valve and related parts
	MD998767 Tension pulley wrench	EMD998767	Adjustment of timing belt tension
	MD998769 Crankshaft spacer	—	Rotation of crankshaft when installing piston and timing belt
	MD998772 Valve spring compressor	—	Compression of valve spring
	MD998774 Valve stem seal installer	EMD998774	Installation of valve stem seal
	MD998780 Piston pin setting tool	—	Removal and installation of piston pin
	MD998781 Flywheel stopper	—	Loosening and tightening crankshaft bolts

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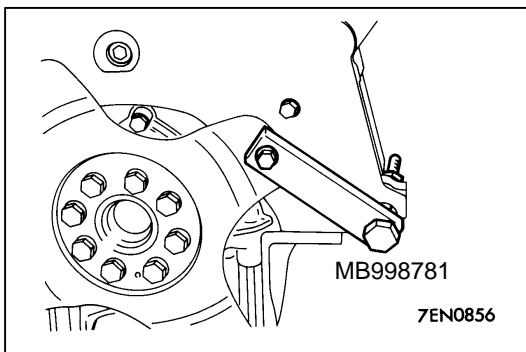
**ALTERNATOR AND DRIVE BELT****REMOVAL AND INSTALLATION**

01TH035A

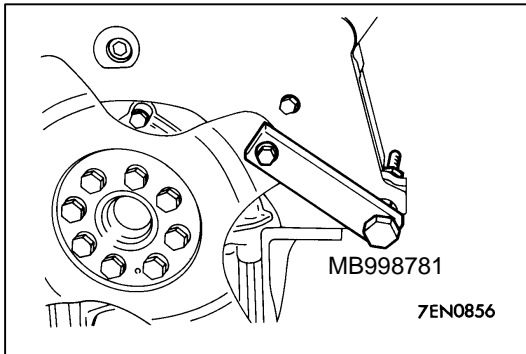
**Removal steps**

- ▶B◀ 1. Drive belt  
 ▶A◀ ▶A◀ 2. Tensioner pulley  
 ▶A◀ ▶A◀ 3. Crankshaft bolt  
 ▶A◀ ▶A◀ 4. Washer  
 ▶A◀ ▶A◀ 5. Crankshaft pulley  
 ▶A◀ ▶A◀ 6. Alternator  
 ▶A◀ ▶A◀ 7. Alternator bracket  
 ▶A◀ ▶A◀ 8. Harness connector

9. Suction hose connection  
 10. Discharge hose connection  
 11. Compressor  
 12. Compressor bracket  
 13. Dip stick  
 14. O-ring  
 15. Dip stick tube  
 16. O-ring

**REMOVAL SERVICE POINT****◀A▶ CRANKSHAFT BOLT LOOSENING**

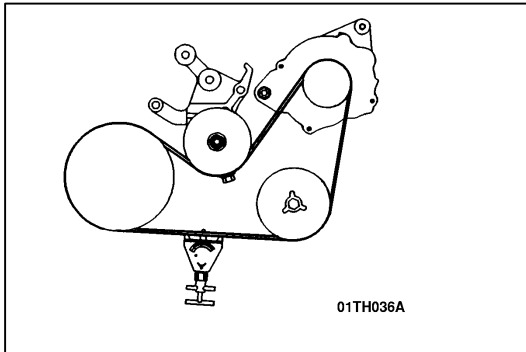
1. Using the special tool, hold the drive plate.
2. Remove the crankshaft bolt.



## INSTALLATION SERVICE POINT

### ►A◄ CRANKSHAFT BOLT TIGHTENING

1. Using the special tool, hold the drive plate or flywheel.
2. Install the crankshaft bolt.

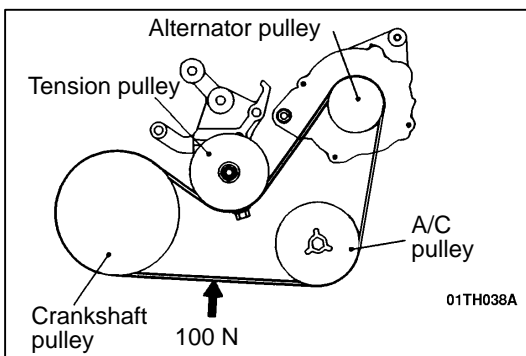
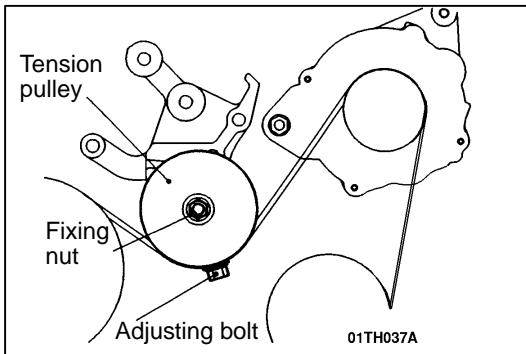


### ►B◄ DRIVE BELT TENSION ADJUSTMENT

1. Use a belt tension gauge to check belt tension, or check deflection by applying 98 N to the shown point.

#### Standard value:

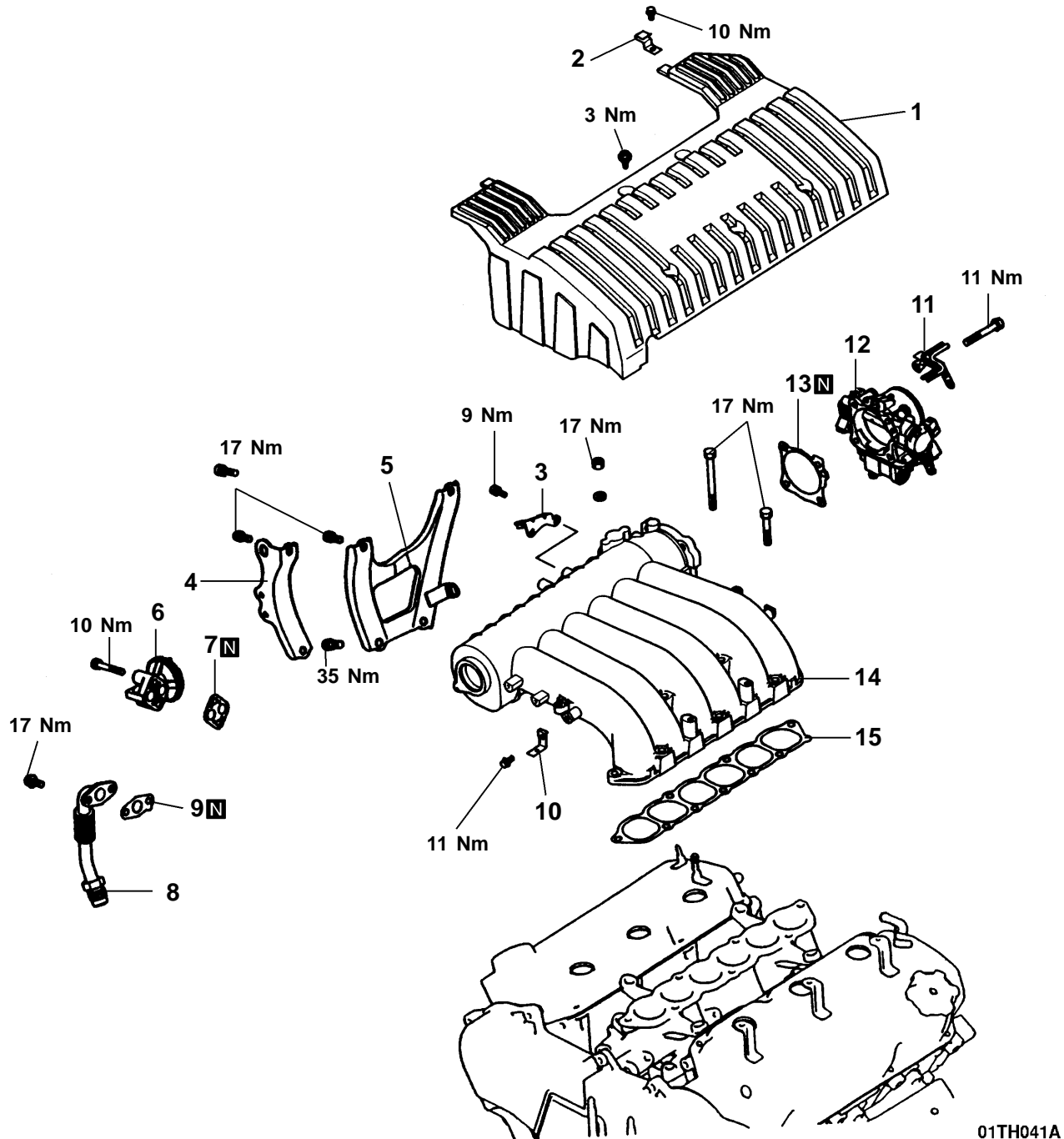
Alternator drive belt	Tension N
New	784 – 980
Used	539 – 637



#### Standard value:

Alternator drive belt	Deflection (Reference value) mm
New	6.0 – 7.2
Used	8.2 – 9.3

# INTAKE MANIFOLD PLENUM AND THROTTLE BODY REMOVAL AND INSTALLATION

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01TH041A

## Removal steps

- |                              |                          |
|------------------------------|--------------------------|
| 1. Engine cover              | 9. EGR pipe gasket       |
| 2. Clamp                     | 10. Connector bracket    |
| 3. Accelerator cable bracket | 11. Vacuum pipe          |
| 4. Intake plenum stay, front | 12. Throttle body        |
| 5. Intake plenum stay, rear  | 13. Throttle body gasket |
| 6. EGR valve                 | 14. Intake plenum        |
| 7. EGR valve gasket          | 15. Intake plenum gasket |
| 8. EGR pipe                  |                          |

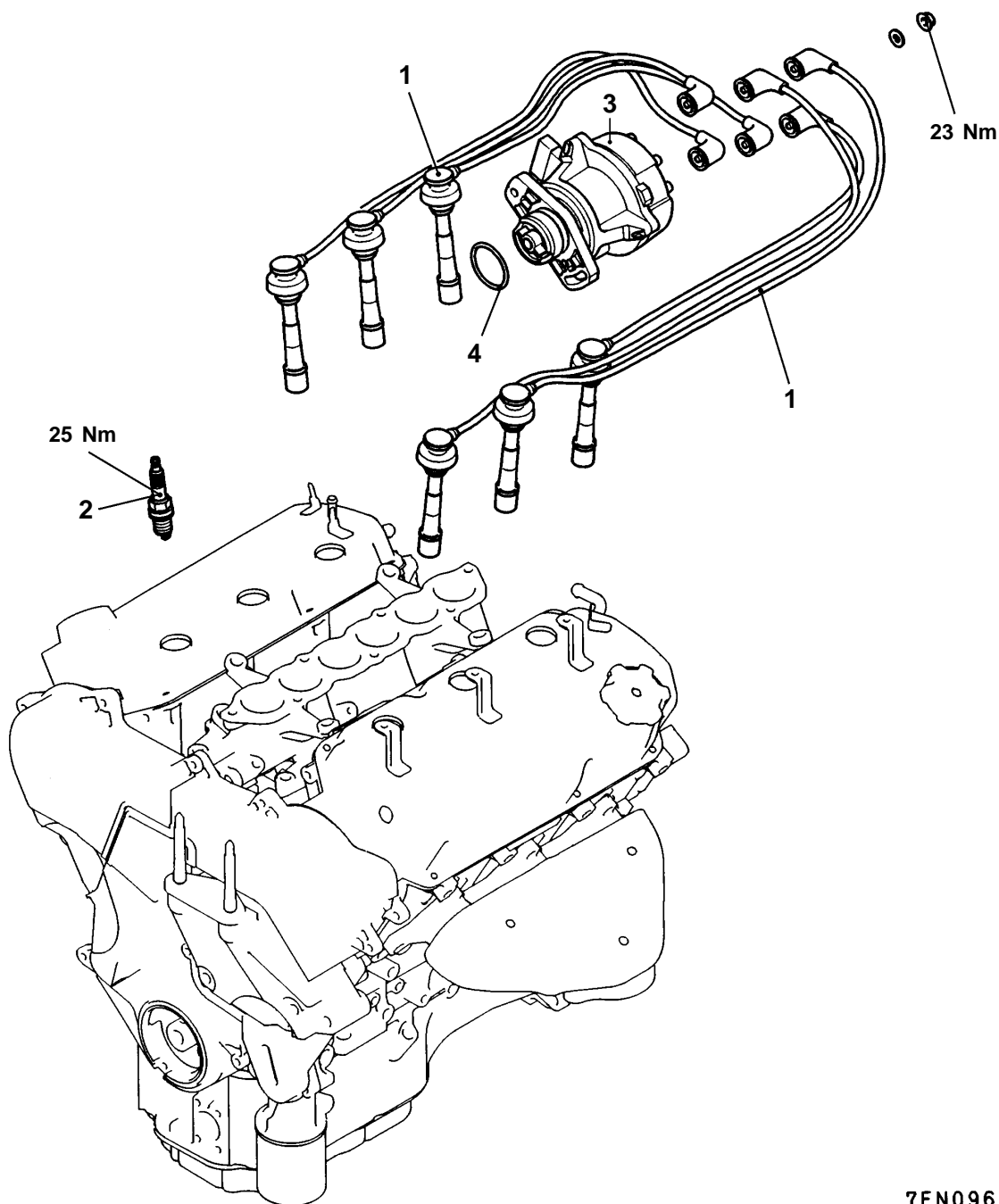
# IGNITION SYSTEM

## REMOVAL AND INSTALLATION

### Pre-removal and Post-installation Operation

Removal and installation

- Intake manifold plenum (Refer to [P.11B-14](#))

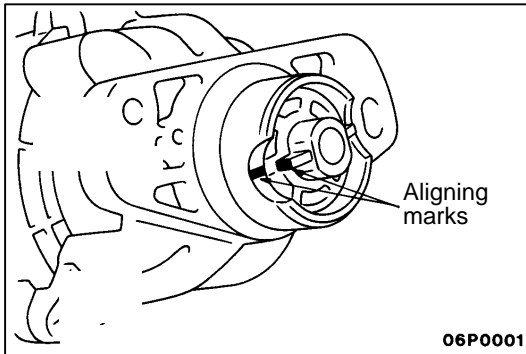


7EN0965

### Removal steps

1. Spark plug cables
2. Spark plugs
3. Distributor
4. O-ring





### INSTALLATION SERVICE POINT

#### ►A◄ DISTRIBUTOR INSTALLATION

1. Align the mark on the distributor housing with that of the coupling and install the distributor.
2. Once the engine has been started verify that the ignition timing is correct.

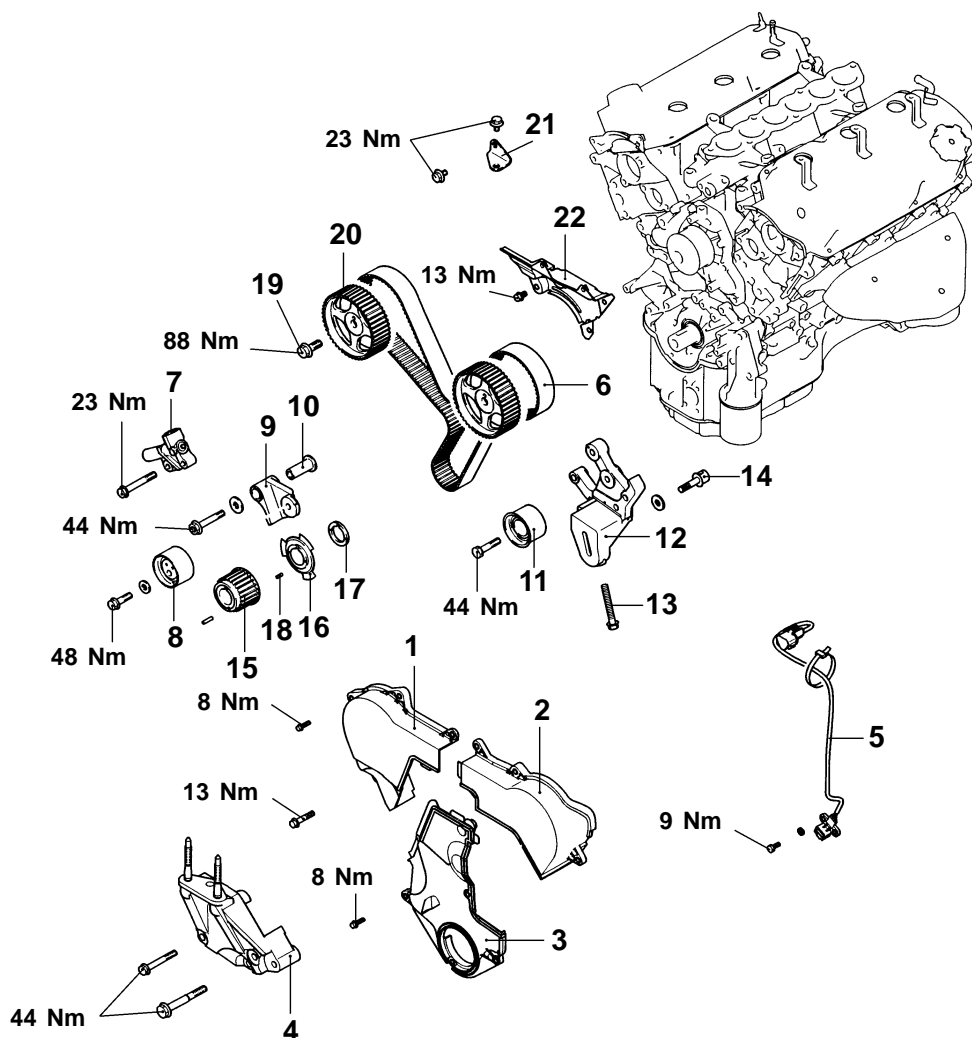
## TIMING BELT

## REMOVAL AND INSTALLATION

## Pre-removal and Post-installation Operation

Removal and installation

- Crankshaft pulley (Refer to P.11B-12)

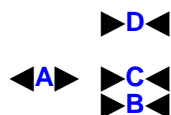


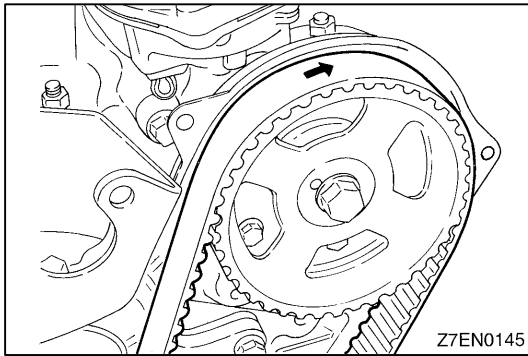
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## Removal steps

1. Timing belt front upper cover, rear
2. Timing belt front upper cover, front
3. Timing belt front lower cover
4. Engine support bracket
5. Crank angle sensor
6. Timing belt
7. Automatic tensioner
8. Tensioner pulley
9. Tensioner arm
10. Shaft
11. Idler pulley

12. Idler pulley adjusting bracket
13. Adjusting bolt
14. Adjusting stud
15. Crankshaft sprocket
16. Sensing blade
17. Crankshaft spacer
18. Crankshaft key
19. Camshaft sprocket bolt
20. Camshaft sprocket
21. Bracket
22. Timing belt rear cover





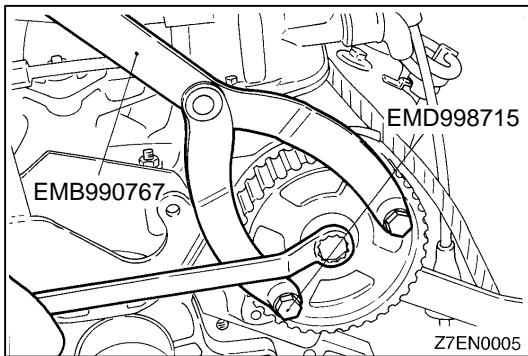
## REMOVAL SERVICE POINTS

### ◀A▶ TIMING BELT REMOVAL

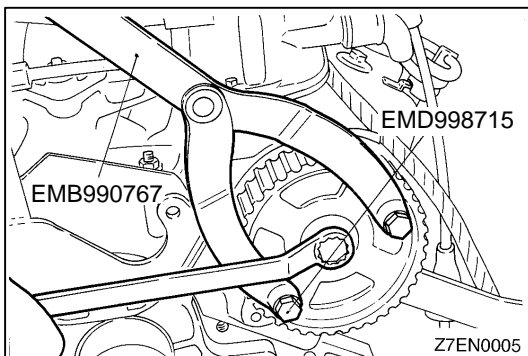
1. Mark the belt running direction for reference in reinstallation.

#### NOTE

1. Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be kept 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 seal, camshaft oil seal and water pump for leaks.

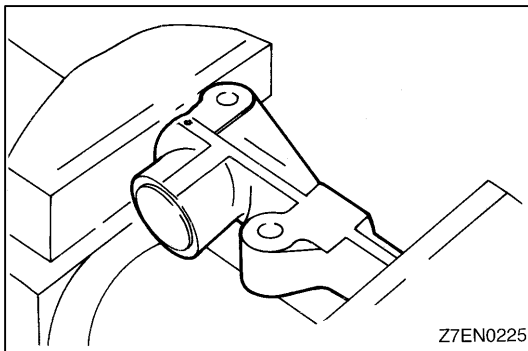


### ◀B▶ CAMSHAFT SPROCKET BOLT LOOSENING



## INSTALLATION SERVICE POINTS

### ▶A▶ CAMSHAFT SPROCKET BOLT TIGHTENING

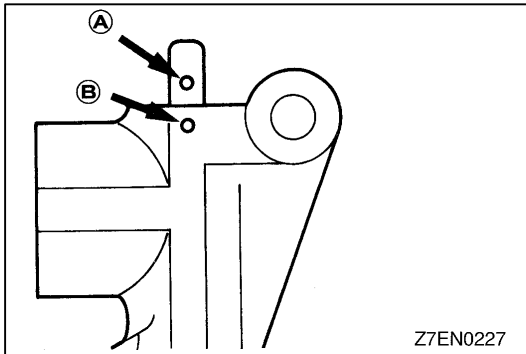


### ▶B▶ AUTO-TENSIONER INSTALLATION

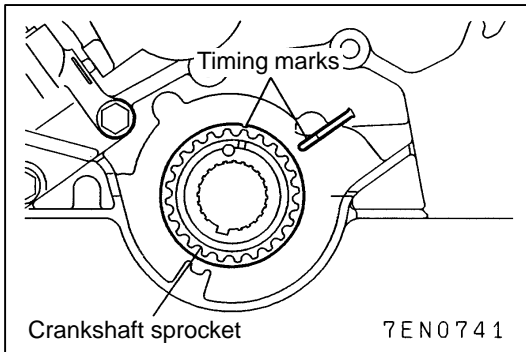
If the auto-tensioner rod is fully extended, set it in the retracted position with the following procedure.

1. Set the auto-tensioner in a vice.





2. Slowly close the vice to force the rod in until the set hole (A) of the rod is lined up with the set hole (B) of the cylinder.
3. Insert a wire [1.4 mm in diameter] into the set holes.
4. Remove the auto-tensioner from the vice.

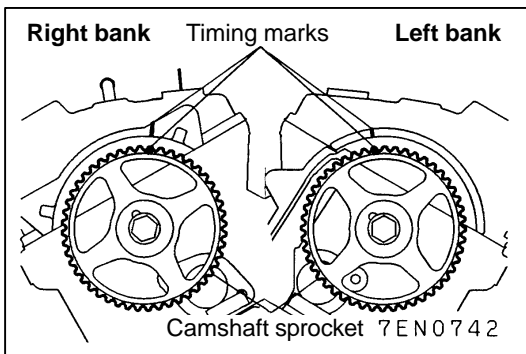


## ►C◄ TIMING BELT INSTALLATION

1. Move the timing mark of the crankshaft sprocket three teeth to slightly lower the piston below the top dead centre on the compression stroke of the No. 1 cylinder.

### Caution

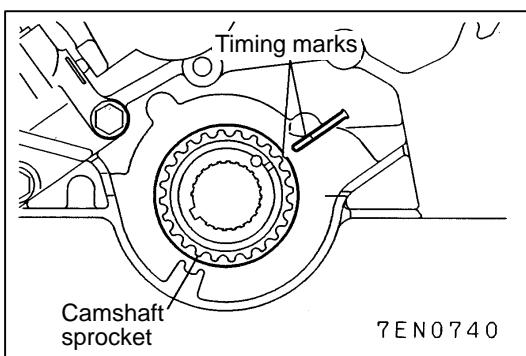
If the camshaft sprocket is rotated with the piston at the top dead centre on the compression stroke of the No. 1 cylinder, the valve and piston might interfere.



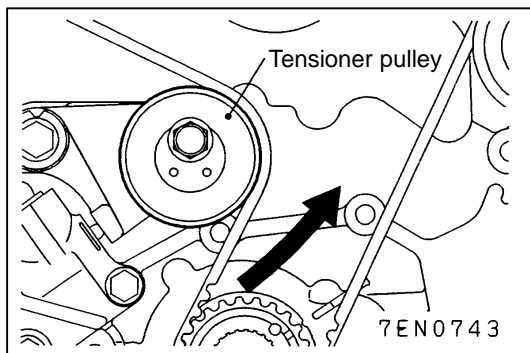
2. Line up the timing marks of the left bank camshaft sprockets.
3. Line up the timing marks of the right bank camshaft sprockets.

### Caution

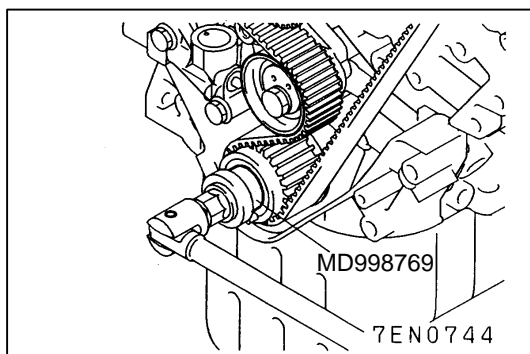
Since the camshaft sprocket readily turns because of spring action, use care to make sure that your finger is not caught.



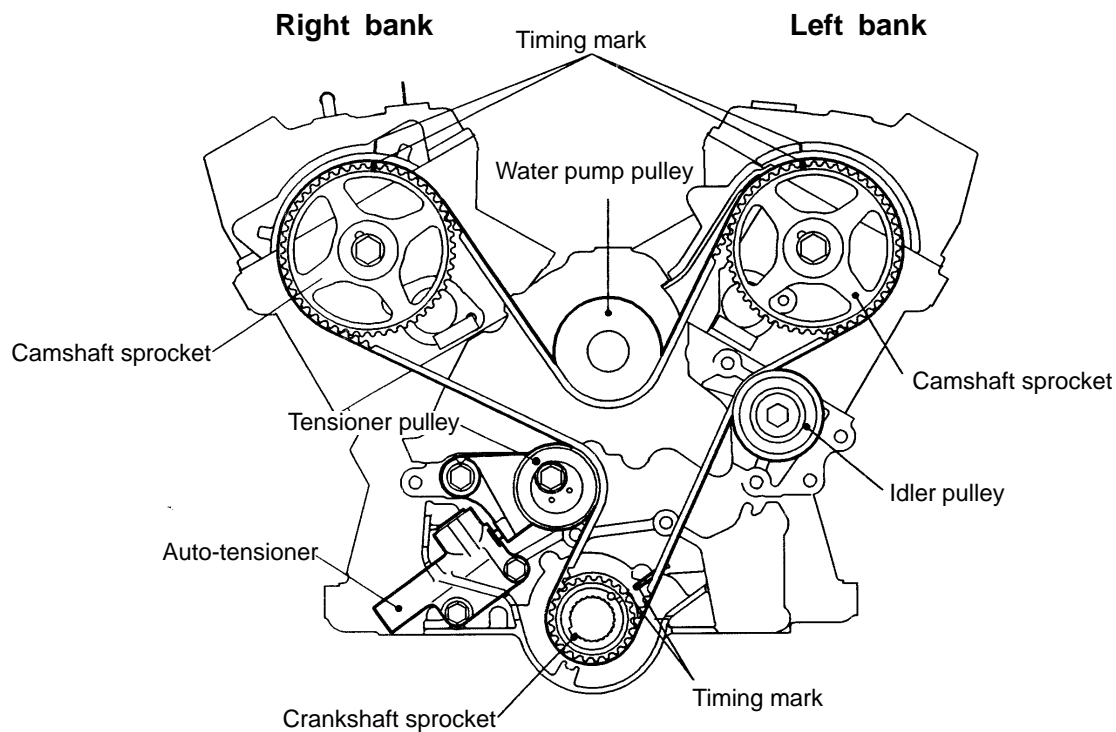
4. Line up the timing marks of the crankshaft sprockets.
5. Install the timing belt on each sprocket in the following sequence.
  - (1) Install the timing belt on the crankshaft sprocket and then on the idler pulley, while tightening it to prevent slackness.
  - (2) Install the timing belt on the left bank camshaft sprocket.
  - (3) Install the timing belt on the water pump pulley, while taking up the slack.
  - (4) Install the timing belt on the right bank camshaft sprocket.
  - (5) Install the timing belt on the tensioner pulley.

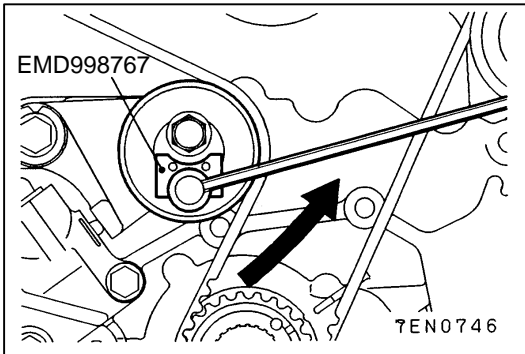


6. Lightly press the tensioner pulley against the belt and temporarily tighten the centre bolt.
7. Check to see that the timing marks of all the sprockets are in alignment.

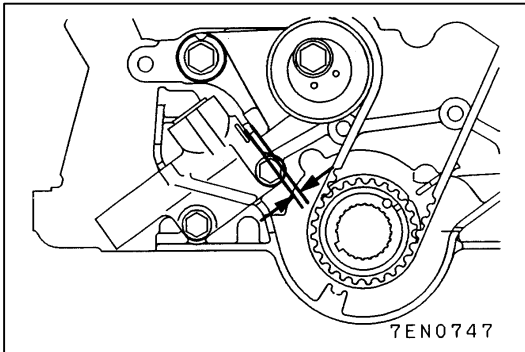


8. Using a special tool, rotate the crankshaft a quarter of a turn counter-clockwise. Then rotate it back clockwise to verify that all the timing marks are in alignment.





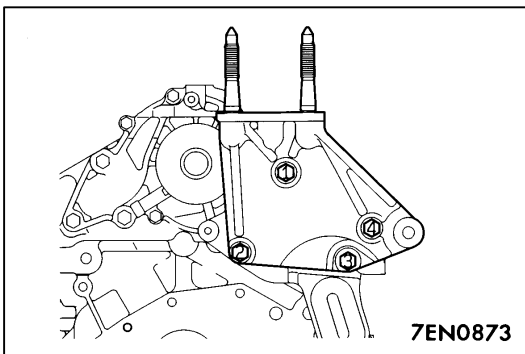
9. Mount a special tool and torque wrench on the tensioner pulley.
10. Torque it to 4.4 Nm with the torque wrench.
11. While holding the tensioner pulley in position, tighten the centre bolt to the specified torque.



12. Remove the metal wire inserted when the auto-tensioner was installed.
13. Rotate the crankshaft two turns clockwise and let it stand for approx. 5 minutes. In this condition, check that the projection of the rod of the auto-tensioner is within the standard value.

**Standard value: 3.8 – 5.0 mm**

14. Ensure the timing marks of the sprockets are still aligned correctly.



### ►D◄ ENGINE SUPPORT BRACKET

1. Tighten bolts to specified torque in the sequence shown.

## INSPECTION

### TIMING BELT

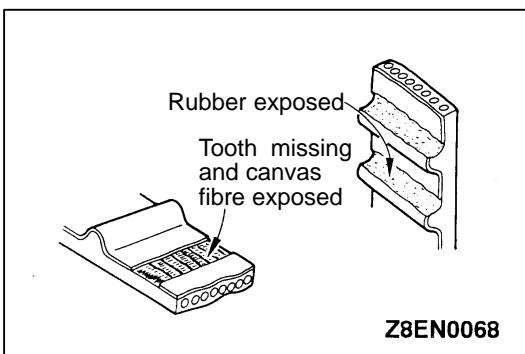
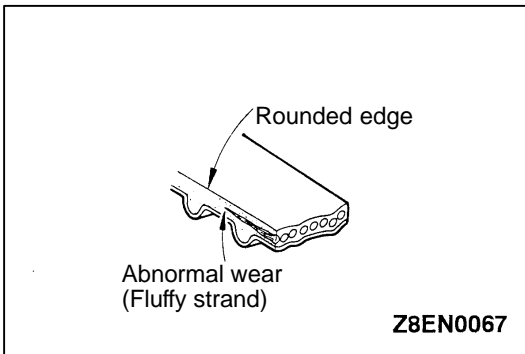
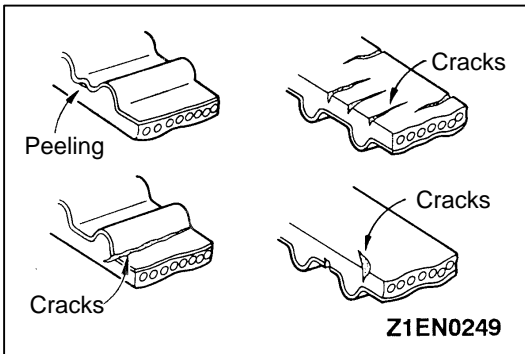
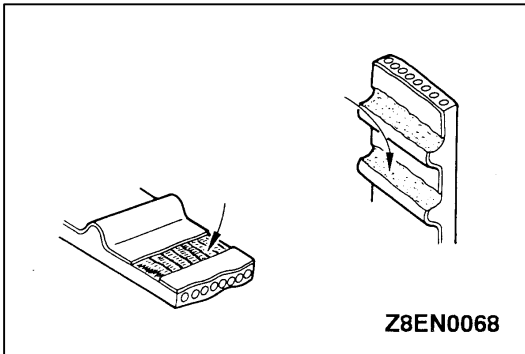
Replace belt if any of the following conditions exist.

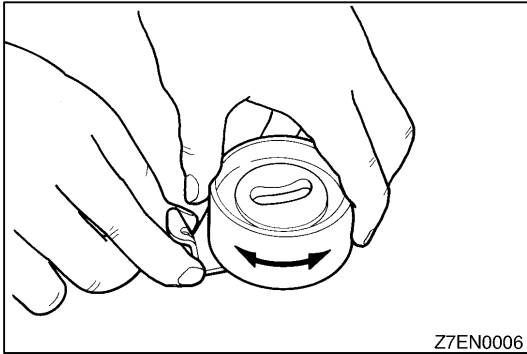
1. Hardening of backing rubber, backing rubber is glossy, without resilience and leaves no indent when pressed with fingernail.

2. Cracks on backing rubber
3. Cracks or peeling of canvas
4. Cracks on tooth bottom
5. Cracks on side of belt

6. Abnormal wear of belt sides. The sides are normal if they are sharp as if cut by a knife.

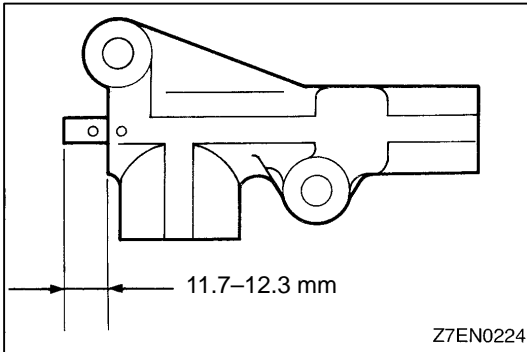
7. Abnormal wear on teeth
8. Tooth missing and canvas fibre exposed.





### TENSIONER PULLEY AND IDLER PULLEY

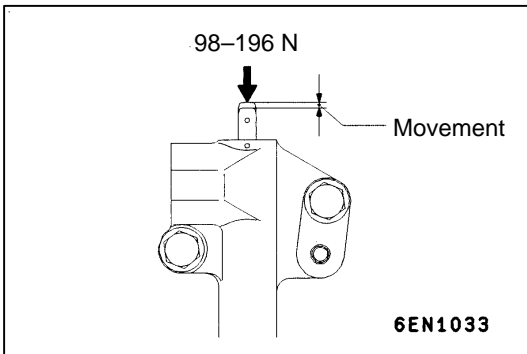
1. Turn the pulley. If pulley does not rotate smoothly, develops noise or excessive play, replace the pulley.



### AUTO-TENSIONER

1. Check for oil leaks. If oil leaks are evident, replace the auto-tensioner.
2. Check the rod end for wear or damage and replace the auto-tensioner if necessary.
3. Measure the rod projection length. If the reading is outside the standard value, replace the auto-tensioner.

**Standard value: 11.7–12.3 mm**

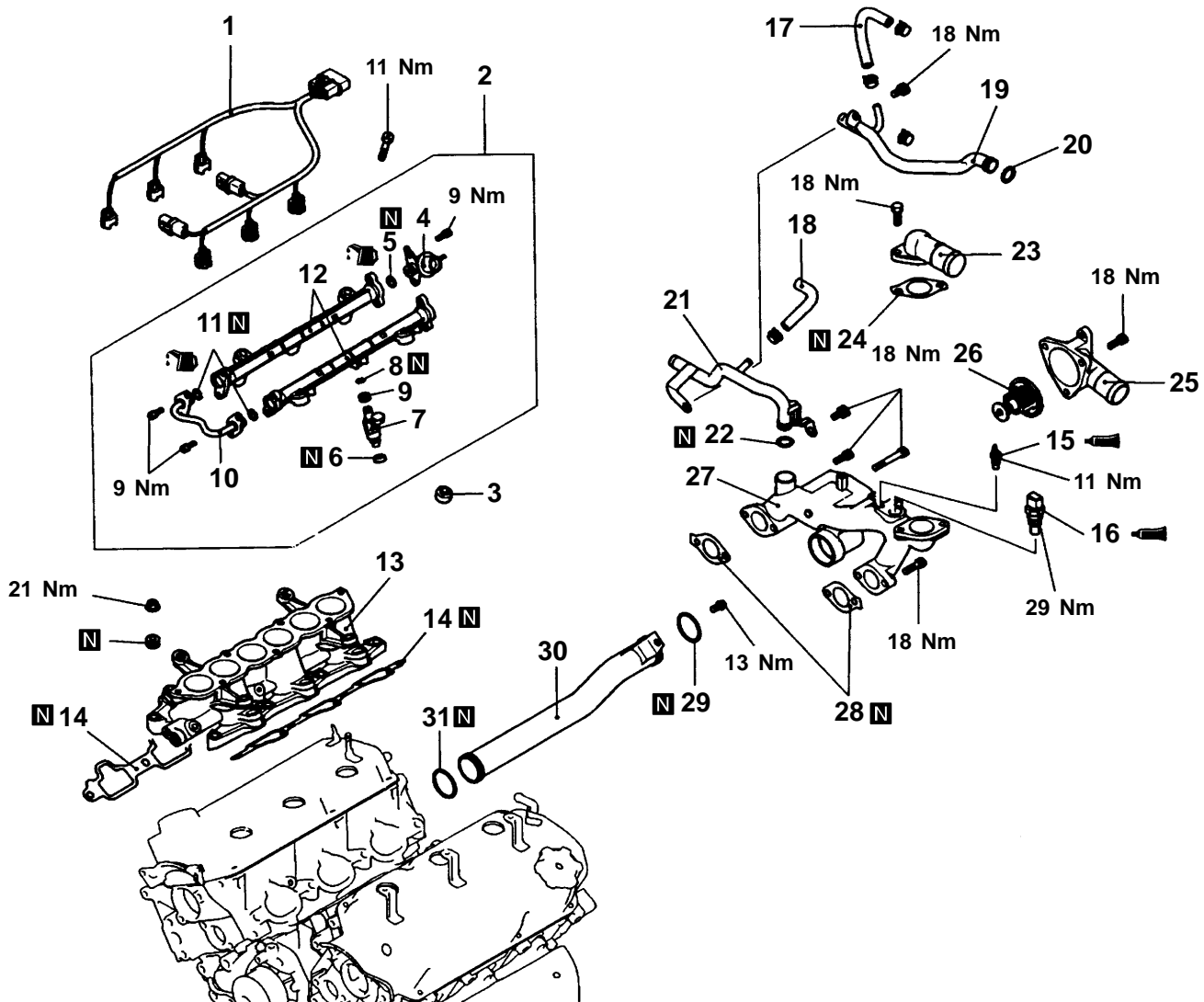


4. Press the rod with a force of 98 to 196 N and measure the movement of rod.  
If the measured value is out of the standard value, replace the auto-tensioner.

**Standard value: 1 mm or less.**

# INTAKE MANIFOLD AND FUEL PARTS

## REMOVAL AND INSTALLATION

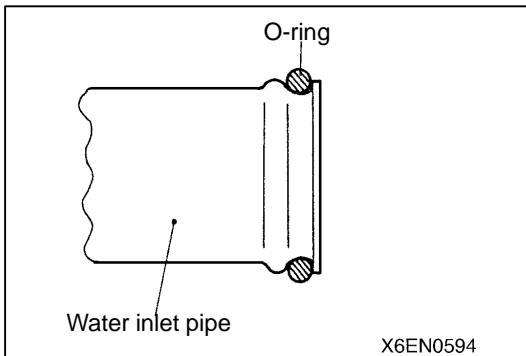
Main  
Index11B  
Index

7EN0874

### Removal steps

1. Engine harness
2. Injector and fuel rail
3. Insulator
- ▶H◀ 4. Fuel pressure regulator
- ▶G◀ 5. O-ring
- ▶G◀ 6. Insulator
- ▶G◀ 7. Injector
- ▶G◀ 8. O-ring
- ▶G◀ 9. Grommet
10. Fuel pipe
11. O-ring
- ▶F◀ 12. Delivery pipe
- ▶F◀ 13. Intake manifold
- ▶E◀ 14. Intake manifold gasket
- ▶E◀ 15. Engine coolant temperature gauge unit
- ▶D◀ 16. Engine coolant temperature sensor

17. Water hose
18. Water hose
- ▶C◀ 19. Heater inlet pipe
- ▶A◀ 20. O-ring
- ▶C◀ 21. Heater inlet pipe
- ▶A◀ 22. O-ring
23. Water outlet fitting
24. Water outlet fitting gasket
25. Water inlet fitting
- ▶B◀ 26. Thermostat
27. Thermostat housing
- ▶A◀ 28. Thermostat housing gasket
- ▶A◀ 29. O-ring
30. Water pipe
- ▶A◀ 31. O-ring



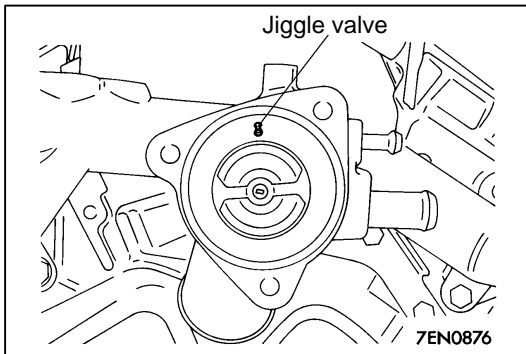
## INSTALLATION SERVICE POINTS

### ►A◄ O-RING AND WATER PIPE INSTALLATION

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

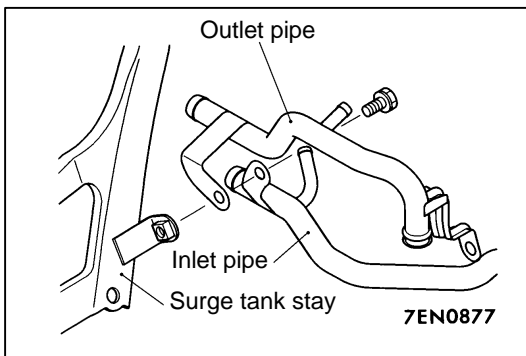
#### Caution

Keep the O-ring free of oil or grease.



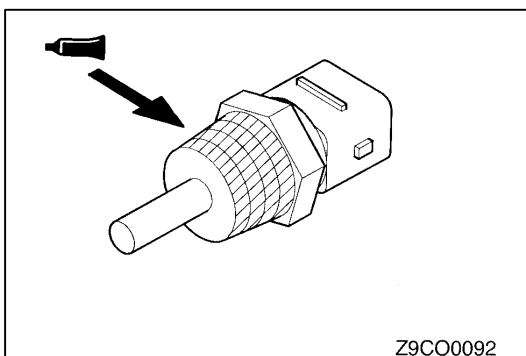
### ►B◄ THERMOSTAT INSTALLATION

1. Install the thermostat in the thermostat housing with its jiggle valve located at the top position.



### ►C◄ HEATER INLET AND OUTLET PIPES

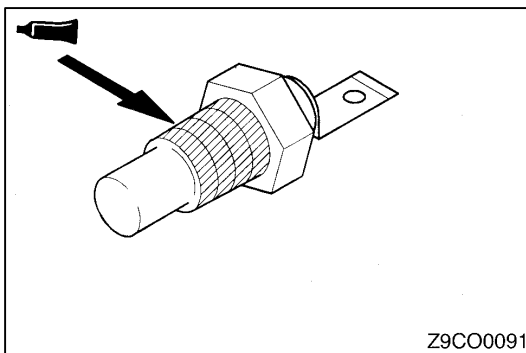
1. Attach the outlet and inlet pipes in this order, one on the top of the other.



### ►D◄ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE SENSOR

Specified sealant:

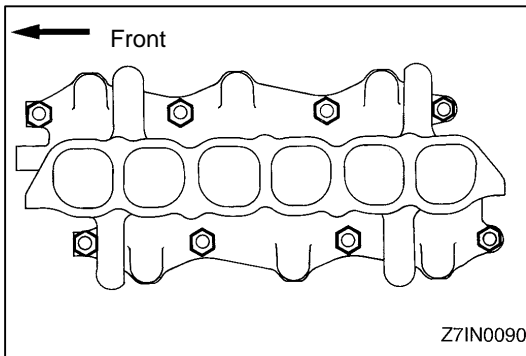
Loctite 577 or equivalent



### ►E◄ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE GAUGE UNIT

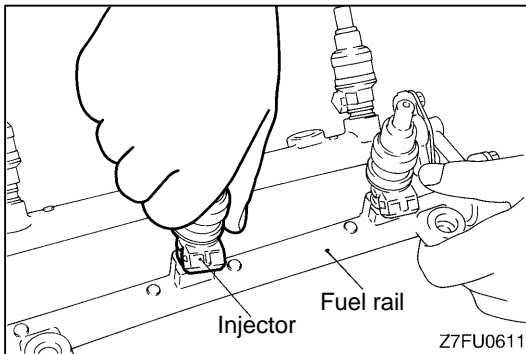
Specified sealant:

Loctite 577 or equivalent



### ►F◄ INTAKE MANIFOLD INSTALLATION

1. Tighten the nuts on the right bank to 5 – 8 Nm.
2. Tighten the nuts on the left bank to the specified torque. Then tighten the nuts on right bank to the specified torque.
3. Tighten the nuts on the left bank and those on the right bank again in that order.



### ►G◄ INJECTOR INSTALLATION

1. Before installing the injector, the rubber O-ring must be lubricated with a drop of new engine oil for easy installation.

#### Caution

**Use care not to let the engine oil enter the fuel rail.**

2. Insert the injector top end into the fuel rail. Be careful not to damage O-ring during installation.

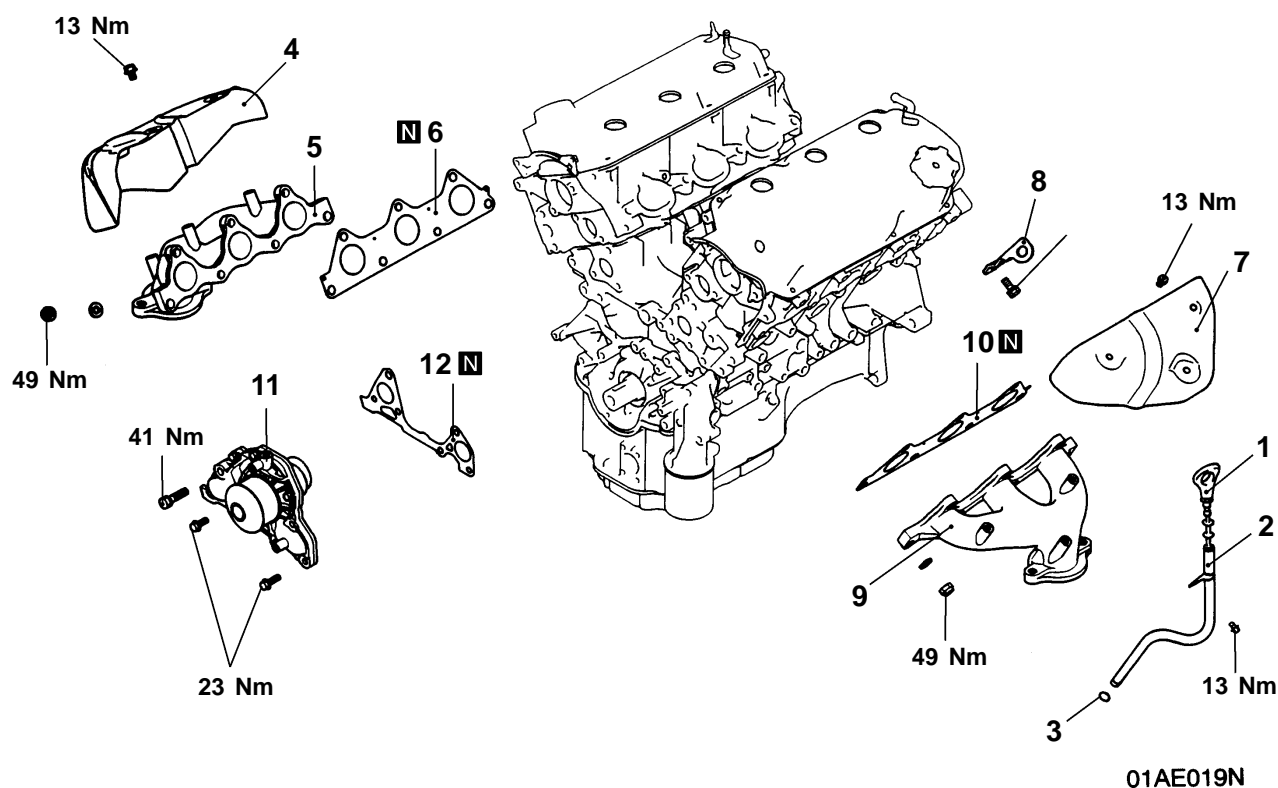
### ►H◄ FUEL PRESSURE REGULATOR INSTALLATION

1. Before installing the pressure regulator, the O-ring must be lubricated with a drop of new engine oil for easy installation.

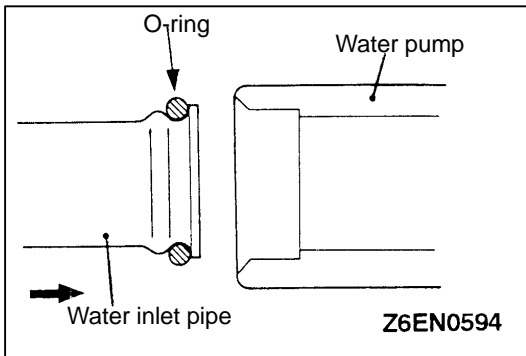
#### Caution

**Use care not to let the engine oil enter the fuel rail.**



**EXHAUST MANIFOLD AND WATER PUMP****REMOVAL AND INSTALLATION****Removal steps**

1. Oil level gauge
2. Oil level gauge guide
3. O-ring
4. Heat protector, rear
5. Exhaust manifold, rear
- ▶ **B** ▶ 6. Exhaust manifold gasket, rear
7. Heat protector, front
8. Engine lift bracket
9. Exhaust manifold, front
- ▶ **B** ▶ 10. Exhaust manifold gasket, front
- ▶ **A** ▶ 11. Water pump
12. Water pump gasket



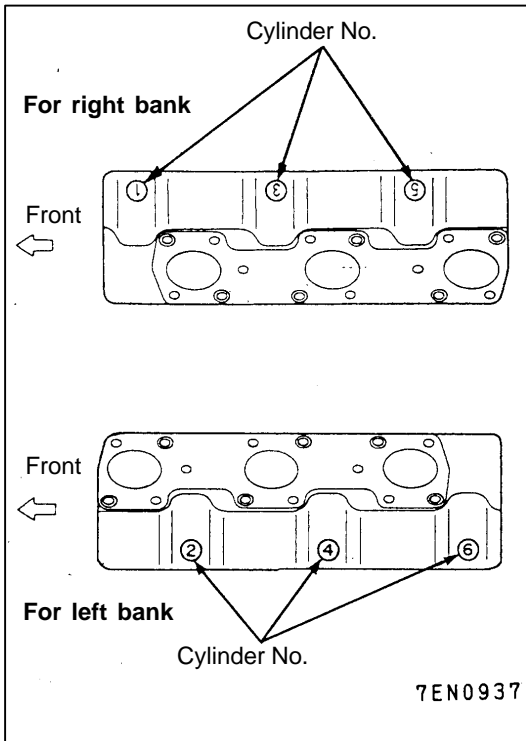
## INSTALLATION SERVICE POINTS

### ►A◄ O-RING AND WATER PIPE INSTALLATION

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

#### Caution

Keep the O-ring free of oil or grease.

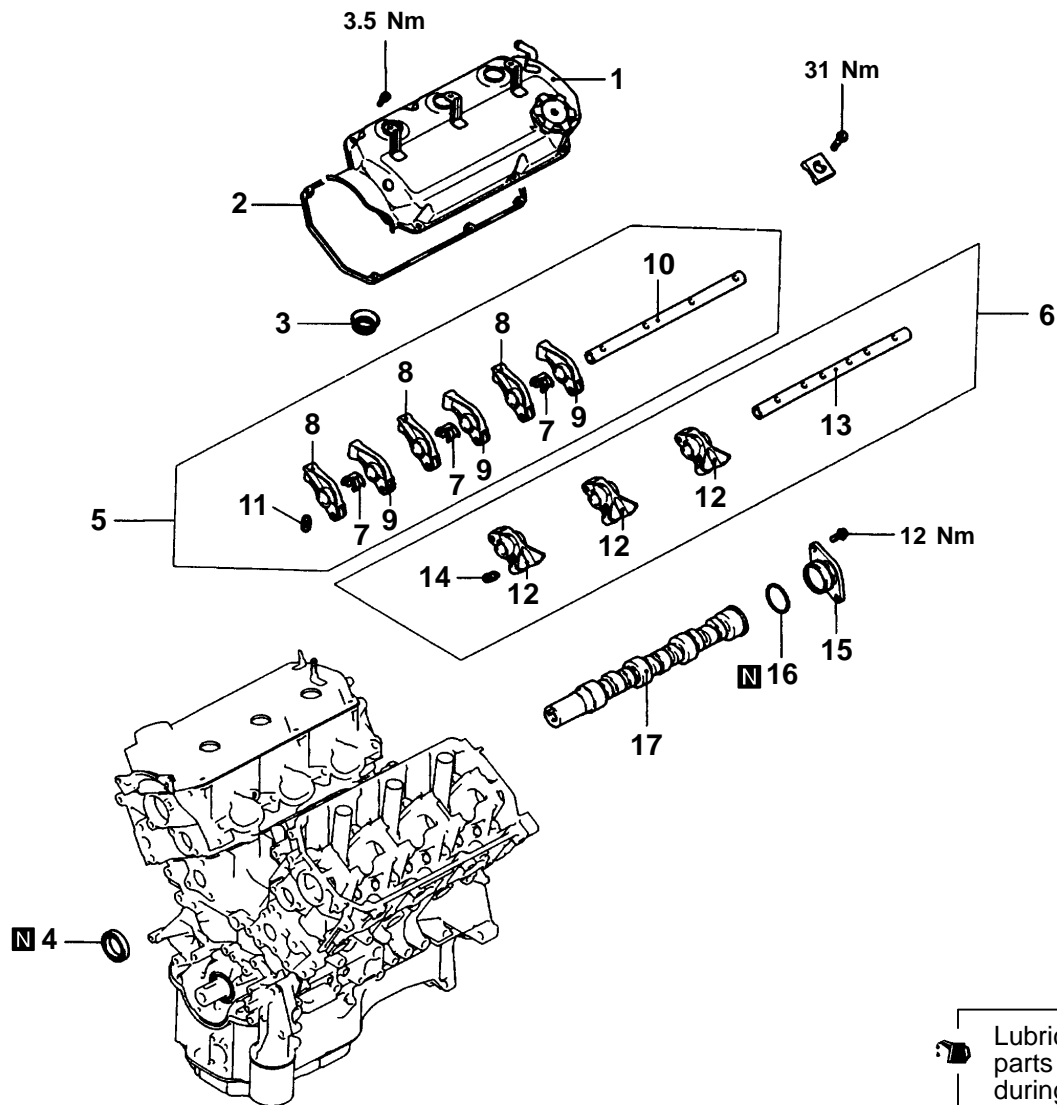



### ►B◄ EXHAUST MANIFOLD GASKET INSTALLATION

1. Install gaskets with cylinder number 1, 3 and 5 embossed on their top side to the right bank and install those with cylinder number 2, 4 and 6 to the left bank.

## ROCKER ARMS AND CAMSHAFT

## REMOVAL AND INSTALLATION



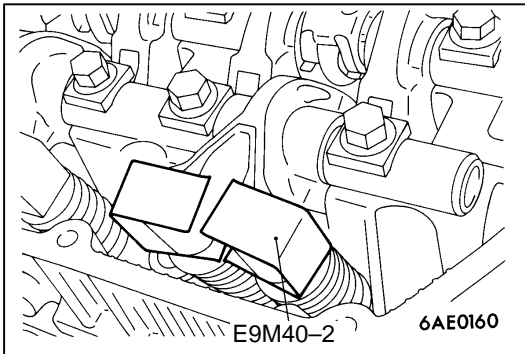
 Lubricate all internal parts with engine oil during reassembly.

7EN0879

## Removal steps

- 1. Rocker cover
- 2. Rocker cover gasket
- 3. Oil seal
- ▶E◀ 4. Camshaft oil seal
- ▶A◀ 5. Rocker arm, rocker arm shaft
- ▶D◀ 6. Rocker arm, rocker arm shaft
- 7. Rocker shaft spring
- 8. Rocker arm A
- 9. Rocker arm B

- ▶C◀ 10. Rocker arm shaft
- ▶B◀ 11. Lash adjuster
- ▶C◀ 12. Rocker arm C
- ▶B◀ 13. Rocker arm shaft
- 14. Lash adjuster
- 15. Thrust case
- 16. O-ring
- ▶A◀ 17. Camshaft



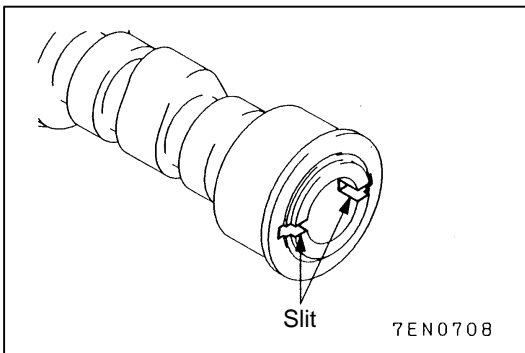
## REMOVAL SERVICE POINT

### ◀A▶ ROCKER ARM, ROCKER ARM SHAFT REMOVAL

1. Install the special tools to the rocker arm to hold the lash adjuster.
2. Loosen the camshaft bearing cap bolt. Do not remove the bolts from the cap.
3. Remove the rocker arm, shaft and bearing cap as an assembly.

#### NOTE

If the lash adjuster is to be re-used, it must be cleaned and checked before installation, refer to [“Lash Adjuster Cleaning and Checking”](#).



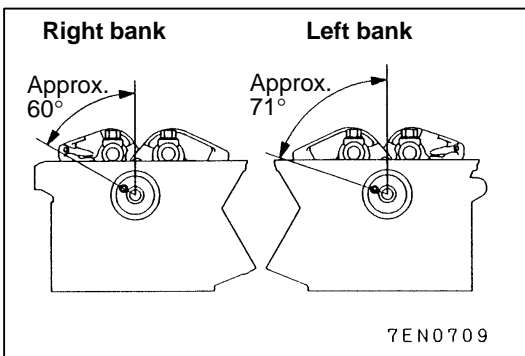
## INSTALLATION SERVICE POINTS

### ▶A◀ CAMSHAFT INSTALLATION

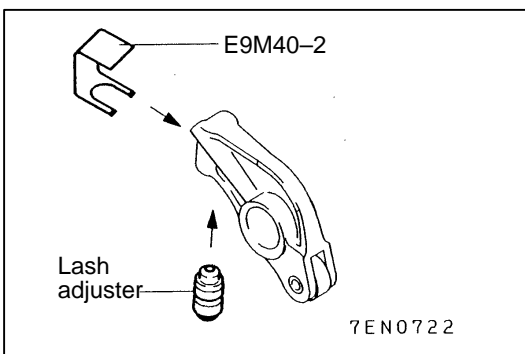
1. Apply engine oil to the camshaft journals and cams and then install the camshafts.  
Use care to prevent confusion of the right and left bank camshafts.

#### NOTE

The right bank camshaft is identified by a slit 4 mm wide at the rear end of the camshaft.



2. Check to see that the dowel pin of the camshaft is located at the position shown.



### ▶B◀ LASH ADJUSTER INSTALLATION

#### NOTE

If the lash adjuster is to be re-used, it must be cleaned and checked before installation. refer to [“Lash adjuster cleaning and checking”](#).

1. Fit the lash adjuster onto the rocker arm without allowing diesel fuel to spill out. Fit special tool E9M40 – 2 to prevent the lash adjuster coming free and falling to the floor.

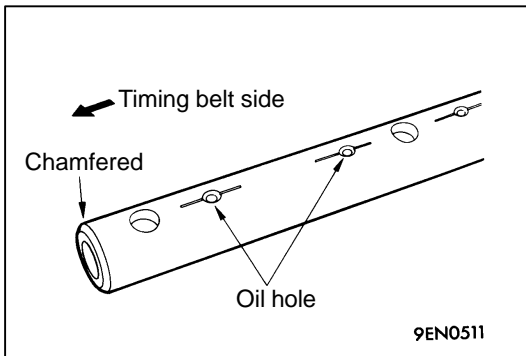
## ►C◄ ROCKER ARM SHAFT

1. The end with the larger chamfer is at the right on the left bank and at the left on the right bank.

### NOTE

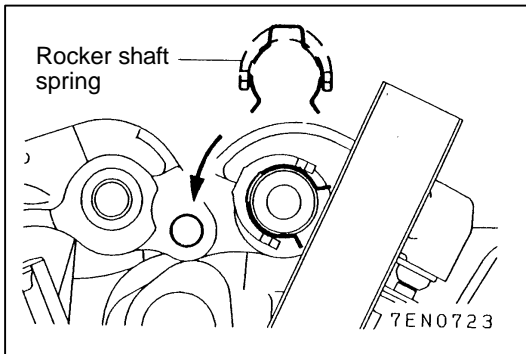
Before installing the exhaust rocker arms and rocker arm shaft, mount the rocker shaft spring.

2. The side with the oil holes is on the lower side (cylinder head side).

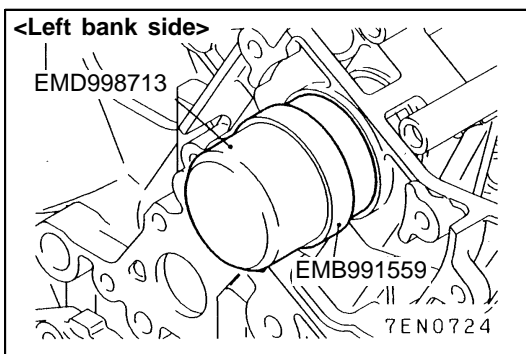
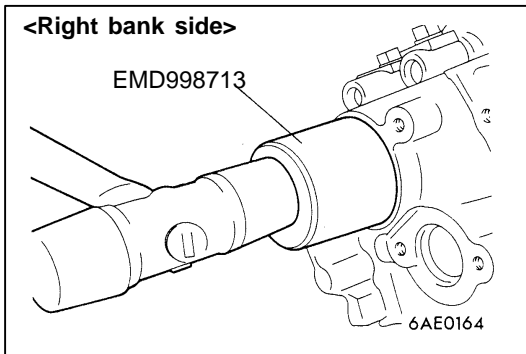


## ►D◄ ROCKER SHAFT SPRING

1. Insert the rocker shaft spring at a slant with respect to the spark plug guide and install it normal to the guide.



## ►E◄ CAMSHAFT OIL SEAL INSTALLATION



### INSPECTION

#### ROCKER ARM SHAFT

1. Check the rocker arm mounting portions of the rocker arm shafts for wear or damage. Replace as necessary.

#### ROCKER ARM

1. Check the roller surface and replace the rocker arm if recesses, damage or heat seizure is observed.
2. Check roller rotation and replace the rocker arm if uneven rotation or roller backlash is observed.
3. Check the inside diameter and replace the rocker arm if damage or seizure is observed.

#### CAMSHAFT

1. Inspect the camshaft bearing journals for damage and binding. If the journals are binding, also check the cylinder head for damage. Also check the cylinder head oil holes for clogging.
2. Check the cam surface for abnormal wear and damage and replace if defective. Also measure the cam height and replace if out of limit.

	Standard value	Limit
Intake mm	37.58	37.08
Exhaust mm	36.95	36.45

## LASH ADJUSTER CLEANING AND CHECKING

### Caution

- The lash adjusters are precision-engineered mechanisms. Do not allow them to become contaminated by dirt or other foreign substances.
- Do not attempt to disassemble the lash adjusters.
- Use only fresh diesel fuel to clean the lash adjusters.

1. Prepare three containers and approximately five litres of diesel fuel. Into each container, pour enough diesel fuel to completely cover a lash adjuster when it is standing upright. Then, perform the following steps with each lash adjuster.
2. Place the lash adjuster in container A and clean its outside surface.

### NOTE

Use a nylon brush if deposits are hard to remove.

3. Fit special tool EMD998441 onto the lash adjuster.

### Caution

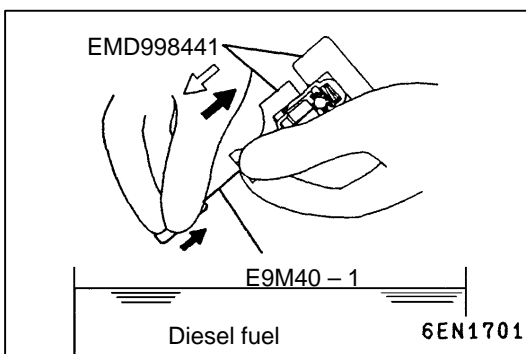
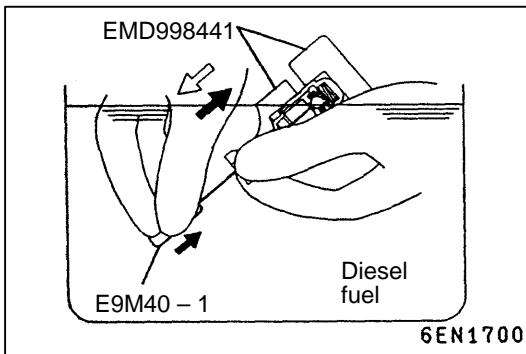
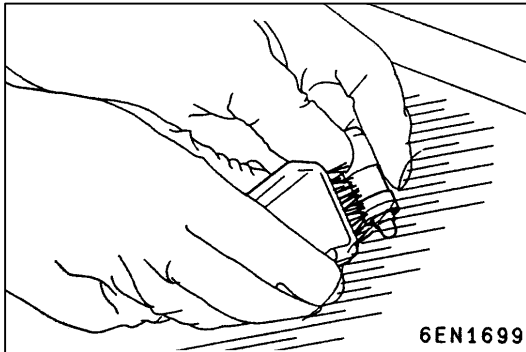
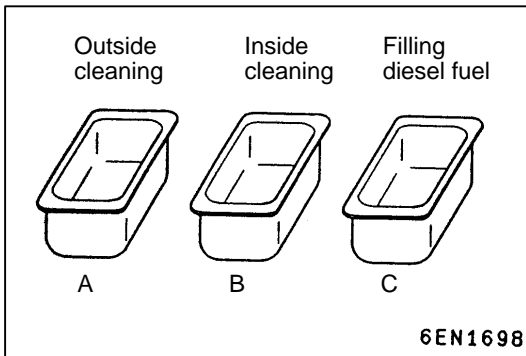
The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.

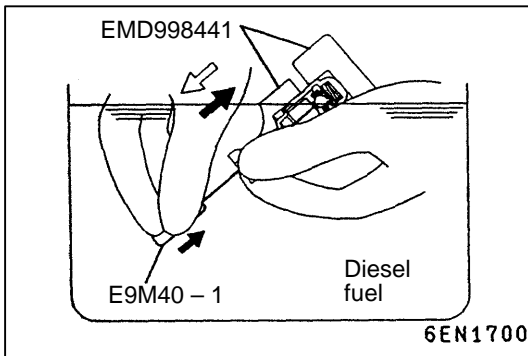
4. While gently pushing down the internal steel ball using special tool E9M40 – 1, move the plunger through five to ten strokes until it slides smoothly. In addition to eliminating stiffness in the plunger, this operation will remove dirty oil.

### NOTE

If the plunger remains stiff or the mechanism appears otherwise abnormal, replace the lash adjuster.

5. Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.



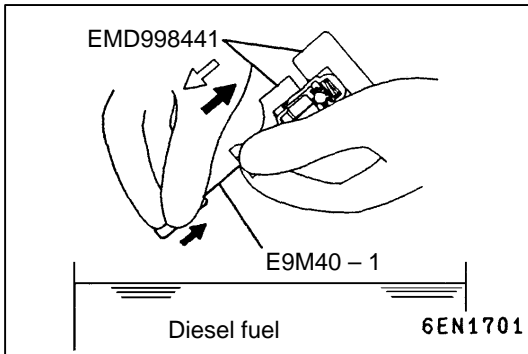


6. Fit special tool EMD998441 onto the lash adjuster.

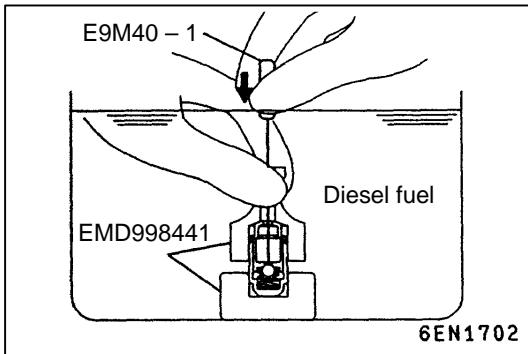
**Caution**

The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.

7. Place the lash adjuster in container B. Then, gently push down the internal steel ball using special tool E9M40 – 1 and move the plunger through five to ten strokes until it slides smoothly. This operation will clean the lash adjuster's pressure chamber.



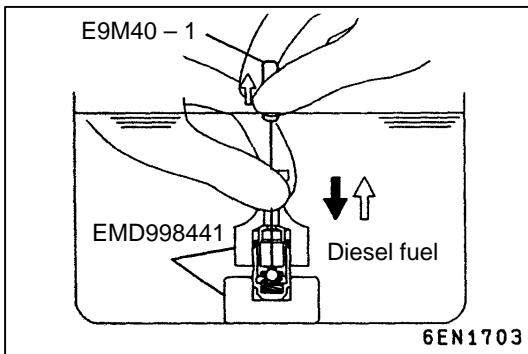
8. Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.



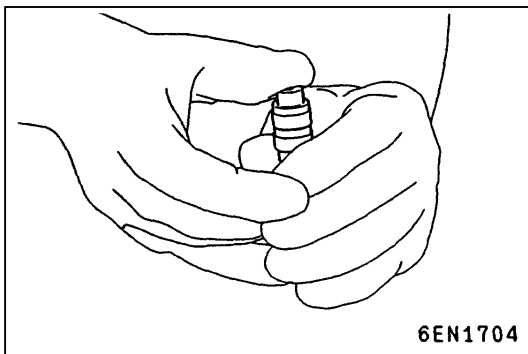
**Caution**

Do not use container C for cleaning. If cleaning is performed in container C, foreign matter could enter the pressure chamber when the chamber is filled with diesel fuel.

9. Place the lash adjuster in container C. Then, gently push down the internal steel ball using special tool E9M40 – 1.



10. Stand the lash adjuster with its plunger at the top, then push the plunger downward firmly until it moves through its greatest possible stroke. Return the plunger slowly, then release the steel ball and allow the pressure chamber to fill with diesel fuel.
11. Remove special tool EMD998441.

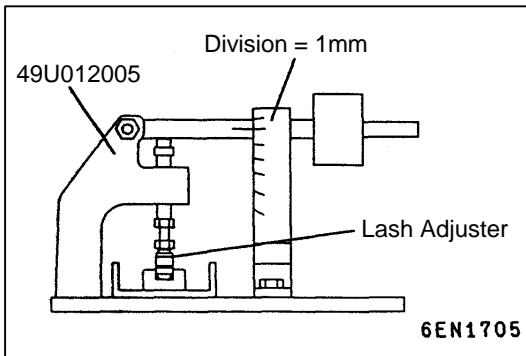


12. Remove the lash adjuster from the container, then stand the lash adjuster with its plunger at the top. Push the plunger firmly and check that it does not move. Also, check that the lash adjuster's height matches that of a new lash adjuster.

**NOTE**

If lash adjuster contracts, perform the operations (9) through (12) again to fill it with diesel fuel completely. Replace the lash adjuster if it still contracts after performing these steps.



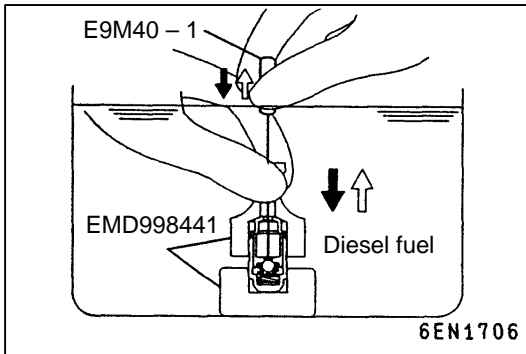


13. Set the lash adjuster on the special tool 49U012005 (leak down tester).
14. After the plunger has moved downward slightly [ 0.2 to 0.5mm ], measure the time taken for it to move downward by a further 1 mm.

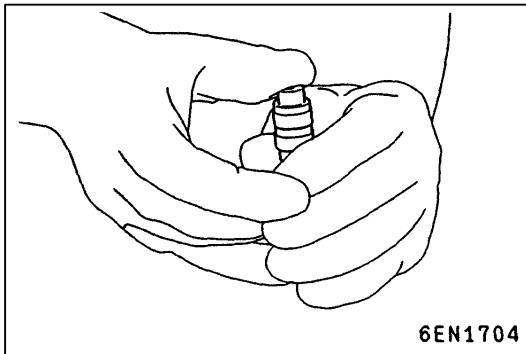
**Standard value: 5 – 20 seconds/1mm [with diesel fuel at 15 to 20°C]**

**NOTE**

Replace the lash adjuster if the time measurement is out of specification.



15. Fit special tool EMD998441 onto the lash adjuster.
16. Place the lash adjuster in container C again, then gently push down the internal steel ball using special tool E9M40 – 1.
17. Stand the lash adjuster with its plunger at the top, then push the plunger downward firmly until it moves through its greatest possible stroke. Return the plunger slowly, then release the steel ball and allow the pressure chamber to fill with diesel fuel.
18. Remove special tool EMD998441.



19. Remove the lash adjuster from the container, then stand the lash adjuster with its plunger at the top. Push the plunger firmly and check that it does not move. Also, check that the lash adjuster's height matches that of a new lash adjuster.

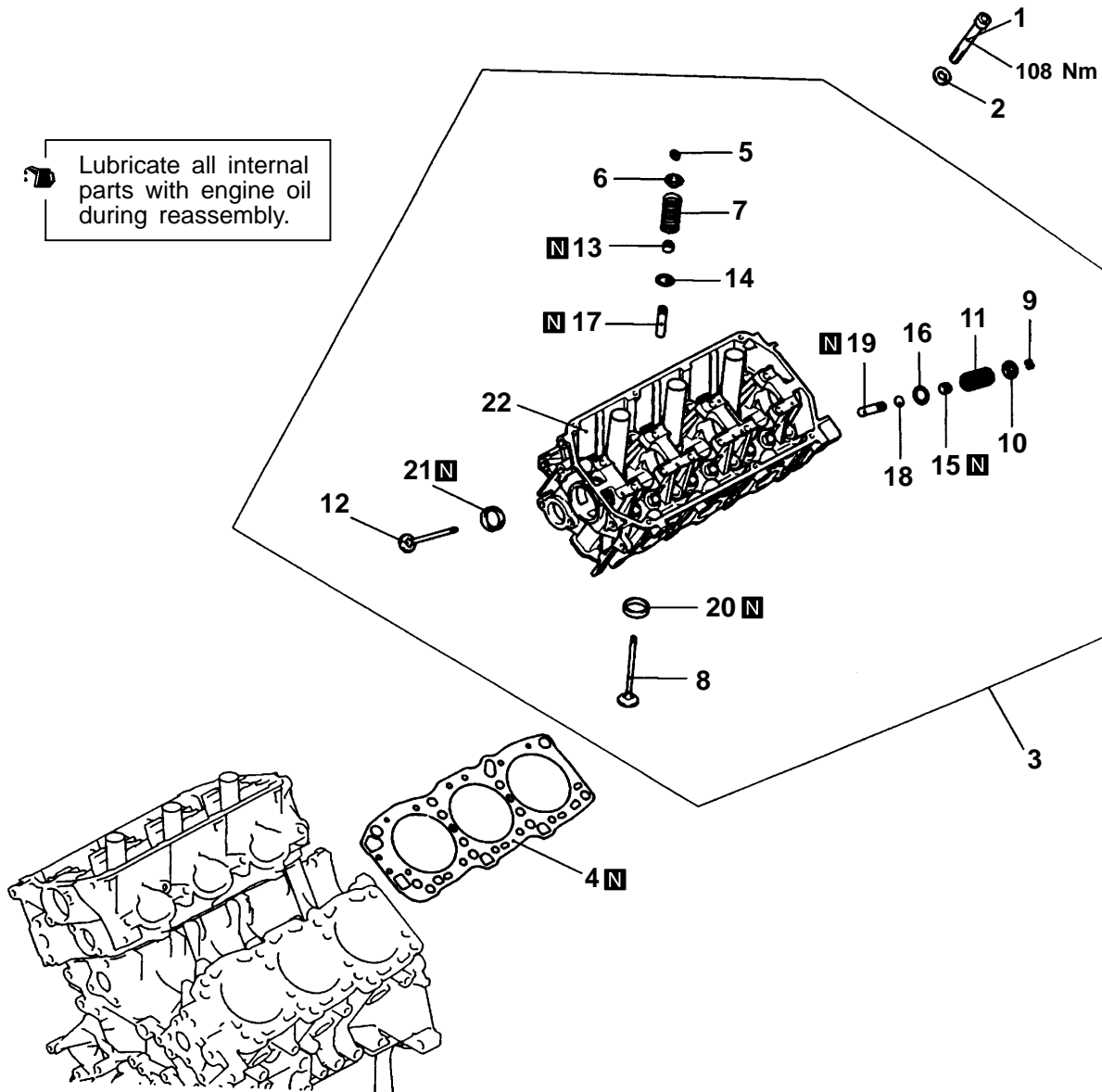
**NOTE**

If lash adjuster contracts, perform the operations (15) through (19) again to fill it with diesel fuel completely. Replace the lash adjuster if it still contracts after performing these steps.

20. Stand the lash adjuster upright to prevent diesel fuel spilling out. Do not allow the lash adjuster to become contaminated by dirt or other foreign matter. Fit the lash adjuster onto the engine as soon as possible.

## CYLINDER HEAD AND VALVE

## REMOVAL AND INSTALLATION



7EN0915

## Removal steps

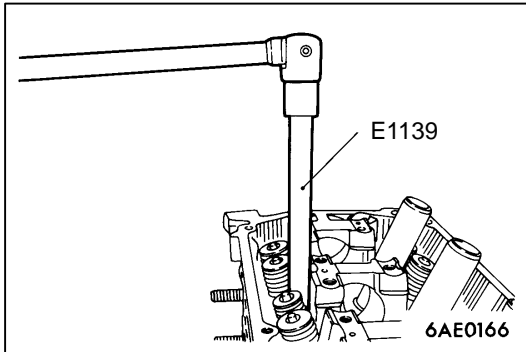
- ◀A▶ ▶D▶ 1. Cylinder head bolt  
 ▶D▶ 2. Washer  
 ▶D▶ 3. Cylinder head assembly  
 ▶D▶ 4. Cylinder head gasket  
 ▶B▶ ▶C▶ 5. Retainer lock  
 ▶B▶ ▶C▶ 6. Valve spring retainer  
 ▶B▶ ▶C▶ 7. Valve spring  
 ▶B▶ ▶C▶ 8. Intake valve  
 ▶B▶ ▶C▶ 9. Retainer lock  
 ▶B▶ ▶C▶ 10. Valve spring retainer  
 ▶B▶ ▶C▶ 11. Valve spring

- ▶C▶ ▶A▶ 12. Exhaust valve  
 ▶C▶ ▶A▶ 13. Valve stem seal  
 ▶C▶ ▶A▶ 14. Valve spring seat  
 ▶C▶ ▶A▶ 15. Valve stem seal  
 ▶C▶ ▶A▶ 16. Valve spring seat  
 ▶C▶ ▶A▶ 17. Intake valve guide  
 ▶C▶ ▶A▶ 18. Snap ring  
 ▶C▶ ▶A▶ 19. Exhaust valve guide  
 ▶C▶ ▶A▶ 20. Intake valve seat  
 ▶C▶ ▶A▶ 21. Exhaust valve seat  
 ▶C▶ ▶A▶ 22. Cylinder head

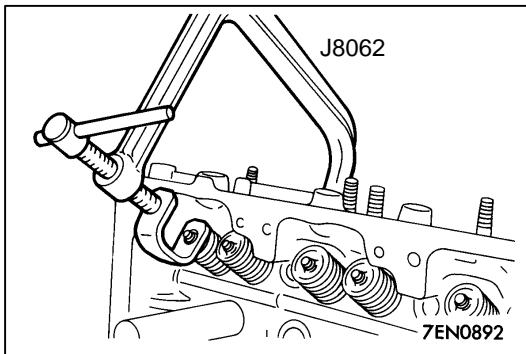
## REMOVAL SERVICE POINTS

### PRECAUTION FOR REMOVED PARTS

1. Keep removed parts in order according to the cylinder number and intake/exhaust.

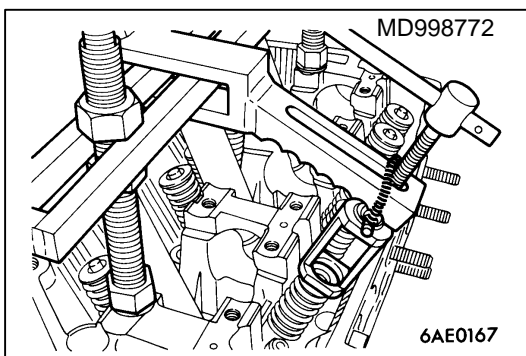


### ◀A▶ CYLINDER HEAD BOLT REMOVAL



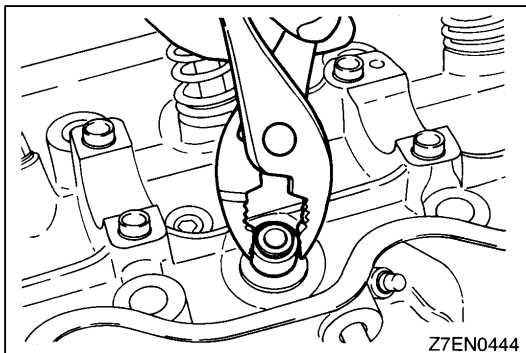
### ◀B▶ RETAINER LOCK REMOVAL

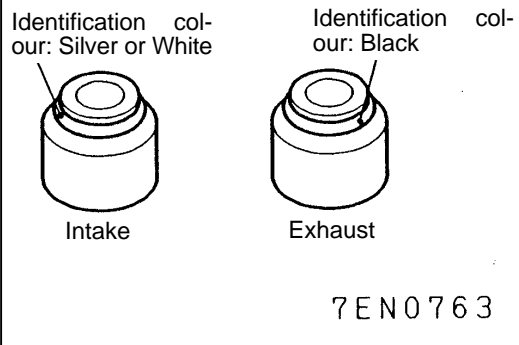
1. Using the special tool, compress the spring.
2. Remove the retainer locks.



### ◀C▶ VALVE STEM SEAL REMOVAL

1. Do not re-use removed valve stem seals.

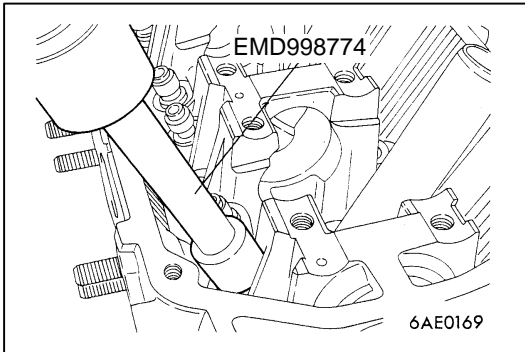




## INSTALLATION SERVICE POINTS

### ►A◄ VALVE STEM SEAL INSTALLATION

1. Install the valve spring seat.



2. Using the special tool, install a new stem seal to the valve guide.

#### Caution

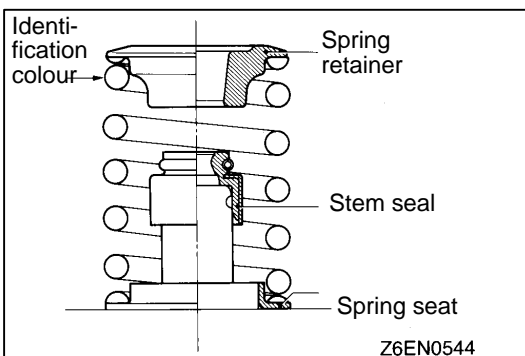
1. Valve stem seals for intake valve and for exhaust valve are different. Be sure to install the correct ones.

#### Valve stem seal identification colour

Intake: Silver or White

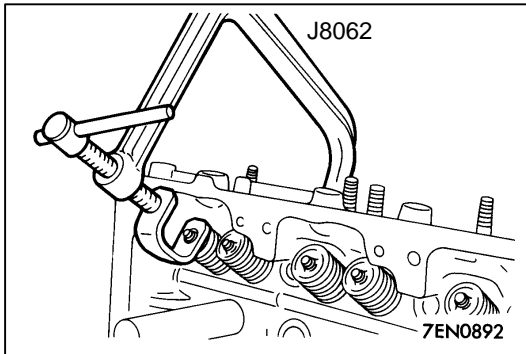
Exhaust: Black

2. Do not re-use removed valve stem seal.
3. Always use the special tool to install the valve stem seal. Improperly installed valve stem seal may cause oil leak.



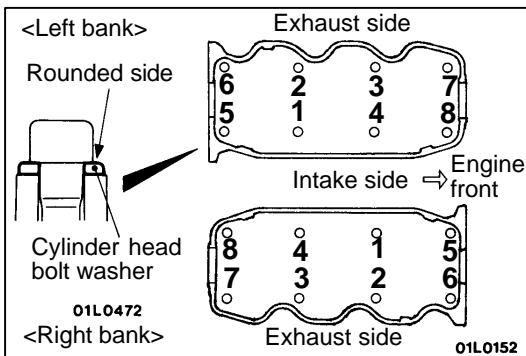
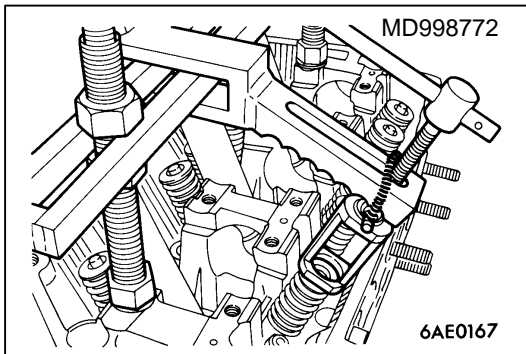
### ►B◄ VALVE SPRING INSTALLATION

1. Direct the valve spring end with identification colour toward the spring retainer.



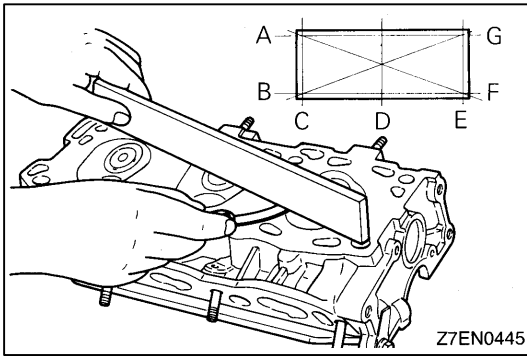
## ►C◄ RETAINER LOCK INSTALLATION

1. Using the special tool, compress the valve spring and insert the retainer lock into position.



## ►D◄ CYLINDER HEAD BOLT INSTALLATION

1. Tighten the cylinder head bolts using the special tool in the sequence shown. Each bolt should be tightened in two to three steps, torquing progressively. Tighten to the specified torque in the final sequence.



## 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 the illustration.

**Standard value**  
**0.03 mm**

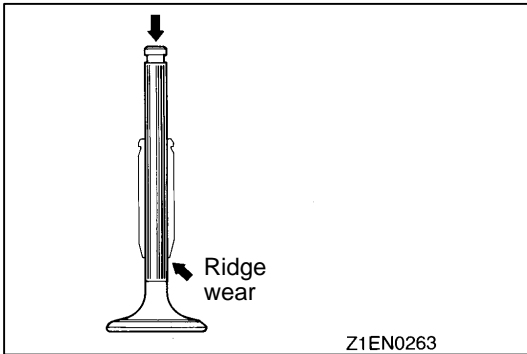
**Limit: 0.2 mm**

2. If the service limit is exceeded, correct to meet the specification.

**Grinding limit: \*0.2 mm**

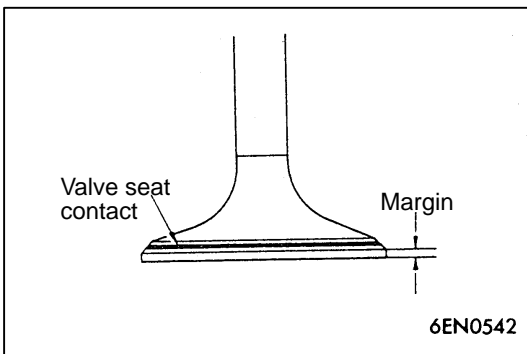
\* Total resurfacing depth of both cylinder head and cylinder block.

**Overall height**  
**120 mm**



## VALVE

1. If the valve stem is worn (ridge wear) or otherwise damaged, replace. Also replace the valve if the stem end (that contacts the rocker arm lash adjuster) has an indentation.



2. Check the valve face for correct contact. If incorrect, reface using a valve refacer. Valve should make a uniform contact with the seat at the centre of valve face.
3. If the margin exceeds the service limit, replace the valve.

**Standard value**

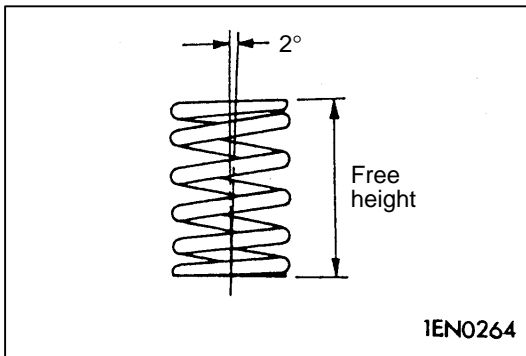
**<Intake>**  
**1.0 mm**

**<Exhaust>**  
**1.2 mm**

**Limit**

**<Intake>**  
**0.5 mm**

**<Exhaust>**  
**1.2 mm**



## VALVE SPRINGS

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

**Standard value**

**51.0 mm**

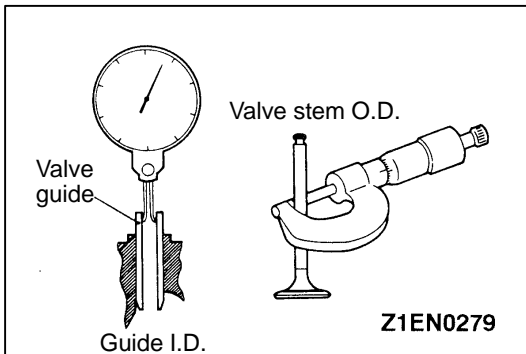
**Limit**

**50.0 mm**

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

**Standard value: 2°**

**Limit: Max. 4°**



## VALVE GUIDES

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>**

**0.02–0.05 mm**

**<Exhaust>**

**0.04–0.07 mm**

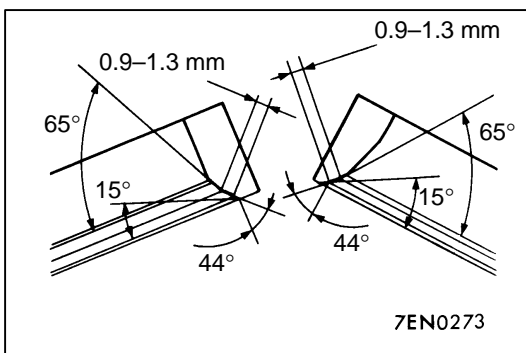
**Limit**

**<Intake>**

**0.10 mm**

**<Exhaust>**

**0.15 mm**

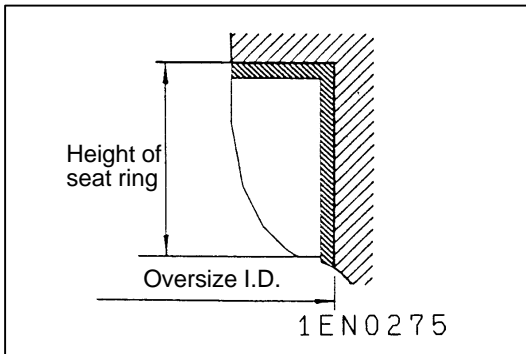
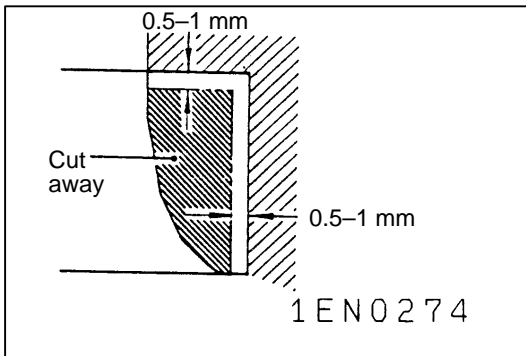


## VALVE SEAT RECONDITIONING PROCEDURE

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

## VALVE SEAT REPLACEMENT PROCEDURE

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



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

**Seat ring hole diameter:**

See [“Rework Dimensions”](#).

3. Before fitting the valve seat, either heat the cylinder head up to approximately 250°C or cool the valve seat in liquid nitrogen, 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. Remove the snap ring from the exhaust valve guide.
2. Using the press, remove the valve guide toward the cylinder block.
3. Rebore the valve guide hole of the cylinder head so that it may fit to the press-fitted oversize valve guide.

**Caution**

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

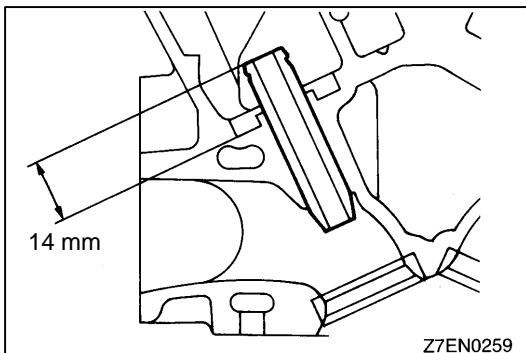
**Valve guide hole diameter:**

See [“Rework Dimensions”](#).

4. Press-fit the valve guide until it protrudes 14 mm from the cylinder head top surface as shown in the illustration.

**NOTE**

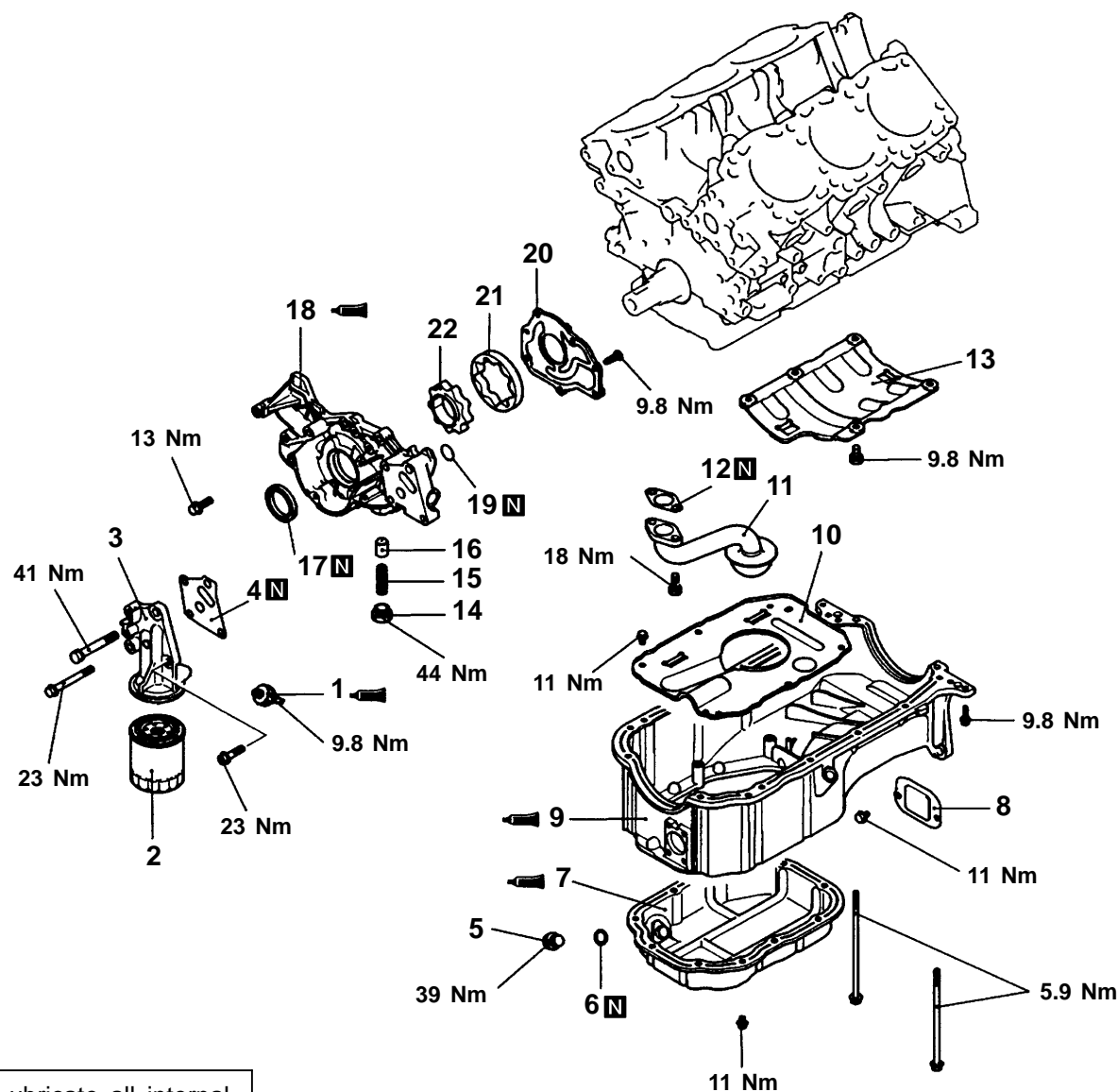
1. When press-fitting the valve guide, work from the cylinder head top surface.
2. Pay attention to the difference in length of the valve guides. [intake side: 45.5 mm; exhaust side: 50.5 mm]
3. After installing the valve guides, insert new valves in them to check for sliding condition.





## OIL PAN AND OIL PUMP

## REMOVAL AND INSTALLATION



Lubricate all internal parts with engine oil during reassembly.

7EN0893

## Removal steps

- |         |                              |                                  |
|---------|------------------------------|----------------------------------|
| ▶H▶     | 1. Oil pressure gauge unit   | 12. Oil screen gasket            |
| ▶G▶     | 2. Oil filter                | 13. Baffle plate                 |
|         | 3. Oil filter bracket        | 14. Plug                         |
|         | 4. Oil filter bracket gasket | 15. Relief spring                |
|         | 5. Drain plug                | 16. Relief plunger               |
| ▶F▶     | 6. Drain plug gasket         | ▶C▶ 17. Crankshaft oil seal      |
| ▶A▶ ▶E▶ | 7. Oil pan, lower            | ▶B▶ 18. Oil pump case            |
|         | 8. Cover                     | 19. O-ring                       |
| ▶B▶ ▶D▶ | 9. Oil pan, upper            | 20. Oil pump cover               |
|         | 10. Baffle plate             | ▶C▶ ▶A▶ 21. Oil pump outer rotor |
|         | 11. Oil screen               | ▶C▶ ▶A▶ 22. Oil pump inner rotor |

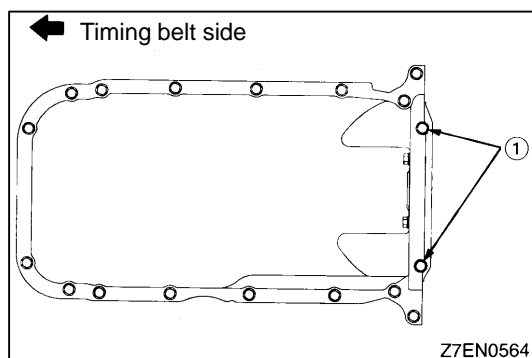
### REMOVAL SERVICE POINT

#### ◀A▶ OIL PAN, LOWER REMOVAL

1. Apply wood to the oil pan side and remove the oil pan lower with a plastic hammer.

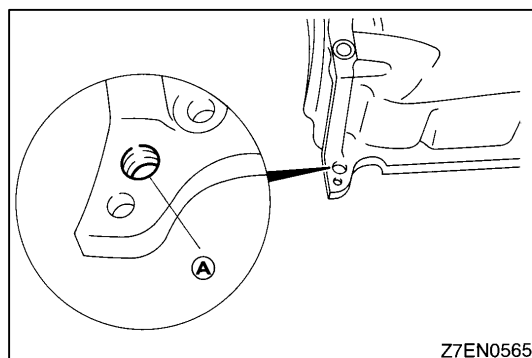
#### Caution

Do not use a scraper or special tool to remove the oil pan.



#### ◀B▶ OIL PAN, UPPER REMOVAL

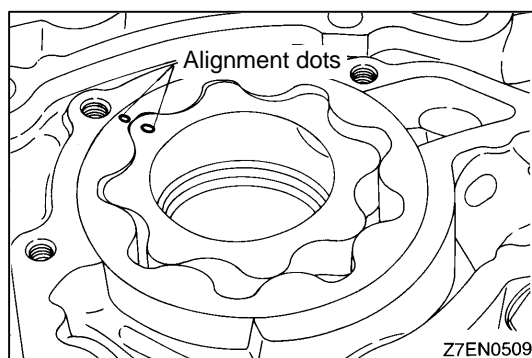
1. Remove the bolts 1 shown in the illustration.
2. Remove all other bolts.



3. Thread the bolt into the illustrated bolt hole A (at each end) to float and remove the oil pan.

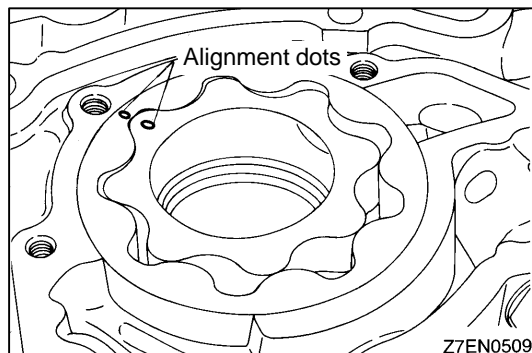
#### Caution

Do not use a scraper or special tool to remove the oil pan.



#### ◀C▶ OUTER ROTOR/INNER ROTOR REMOVAL

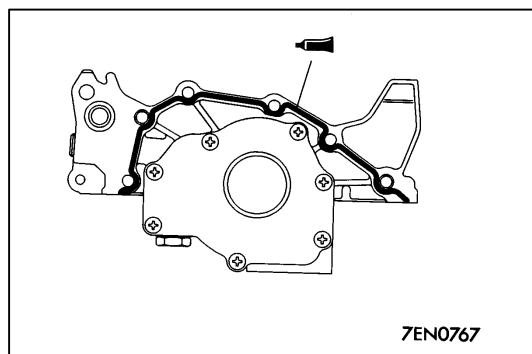
1. Make alignment dots on the outer and inner rotors for reference in reassembly.



## INSTALLATION SERVICE POINTS

### ►A◄ INNER ROTOR/OUTER ROTOR INSTALLATION

1. Apply engine oil to the rotors. Then, install the rotors ensuring that the alignment dots made at disassembly are properly aligned.



### ►B◄ OIL PUMP CASE INSTALLATION

1. Remove the sealant from the cylinder block (oil pump mounting plane) and oil pump
2. Apply a 3 mm diameter bead of sealant to the oil pump case. Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).
3. After installation, keep the sealed area away from the oil and coolant for approx. 1 hour.

**Specified sealant:**

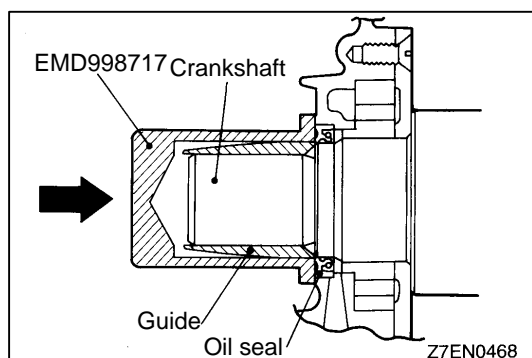
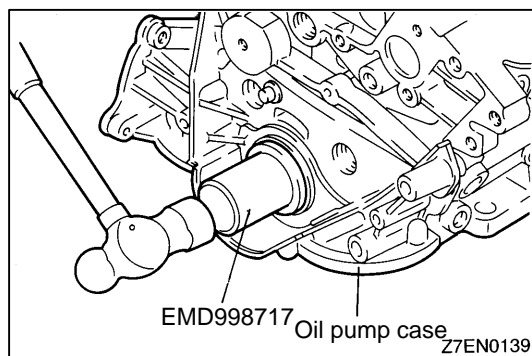
**mitsubishi GENUINE Part No. MD970389 / Loctite 587 Ultra blue or equivalent**

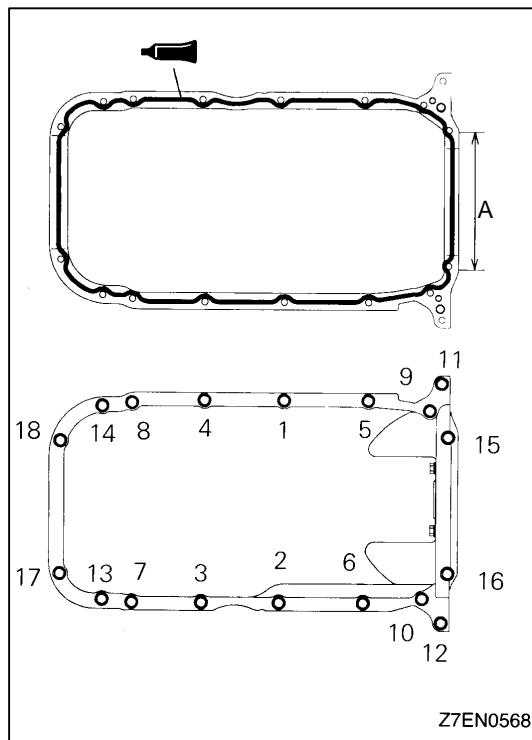
### ►C◄ CRANKSHAFT FRONT OIL SEAL INSTALLATION

1. Using the special tool, knock the oil seal into the oil pump case.

**NOTE**

Knock the seal in until it is fully based.





## ►D◄ OIL PAN, UPPER INSTALLATION

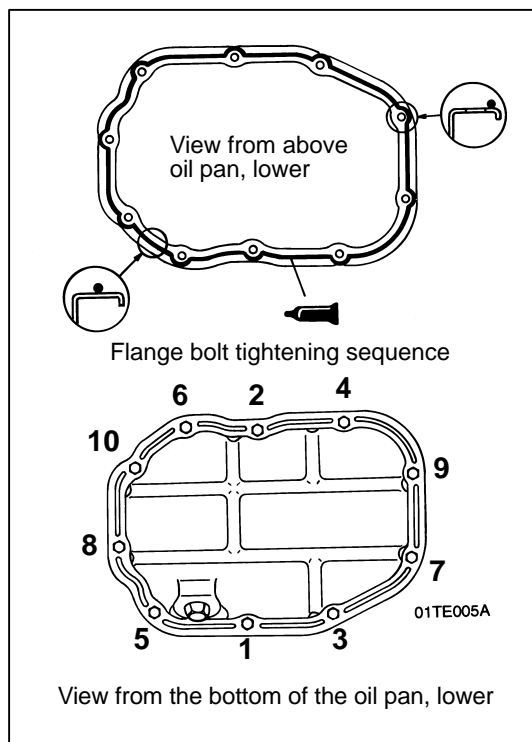
1. Clean the gasket surfaces of the cylinder block and upper oil pan.
2. Apply a 4 mm diameter bead of sealant to the oil pump case. Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).
3. After installation, keep the sealed area away from the oil and coolant for approx. 1 hour.

### Caution

When installing the upper oil pan, be sure not to expel the sealant from the oil pan flange at portion A in the illustration.

### Specified sealant:

**MITSUBISHI GENUINE** Part No. MD970389 / Loctite 587 Ultra blue or equivalent

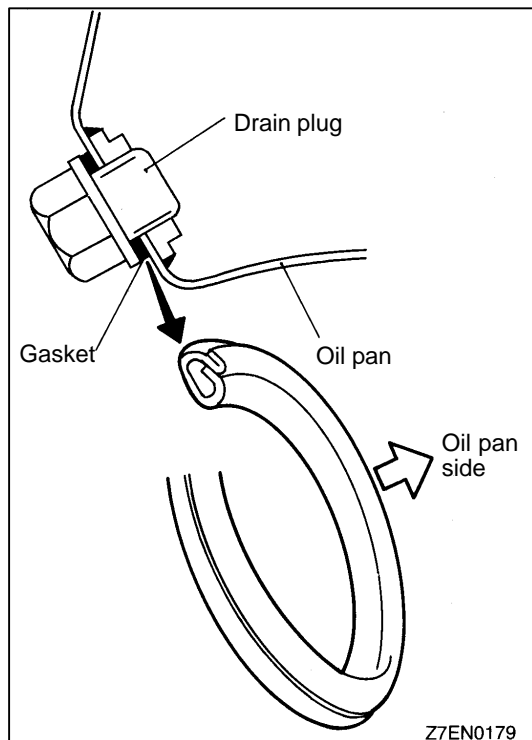


## ►E◄ OIL PAN, LOWER INSTALLATION

1. Clean the gasket surfaces of the upper and lower oil pans.
2. Apply a 4 mm diameter bead of sealant to the oil pump case. Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).
3. After installation, keep the sealed area away from the oil and coolant for approx. 1 hour.

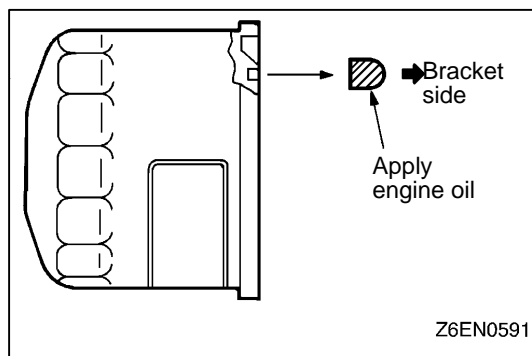
### Specified sealant:

**MITSUBISHI GENUINE** Part No. MD970389 / Loctite 587 Ultra blue or equivalent



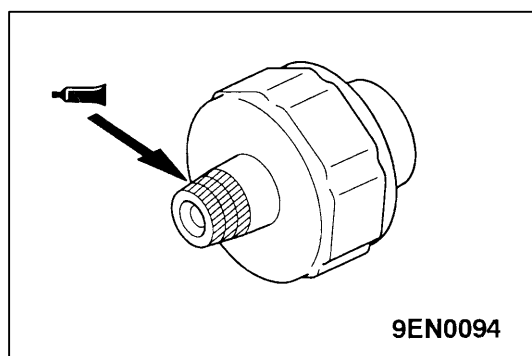
## ►F◄ DRAIN PLUG GASKET INSTALLATION

1. Install the drain plug gasket as illustrated.



## ►G◄ OIL FILTER INSTALLATION

1. Clean the installation surface of the filter bracket.
2. Apply engine oil to the O-ring of the oil filter.
3. Screw the oil filter on until the O-ring contacts the bracket. Then tighten approximately one turn [14 Nm].



## ►H◄ SEALANT APPLICATION TO OIL PRESSURE SWITCH

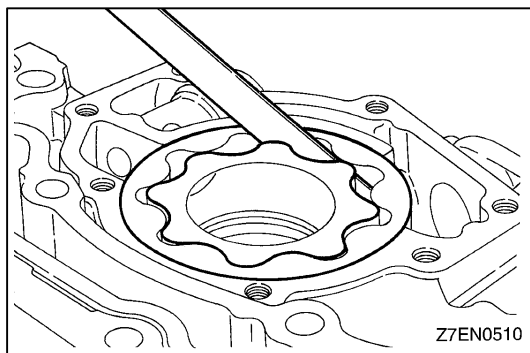
1. Coat the threads of the switch with sealant and install the switch using the special tool.

### Specified sealant:

Loctite 577 or equivalent

### Caution

1. Keep the end of threaded portion clear of sealant.
2. Avoid over tightening.

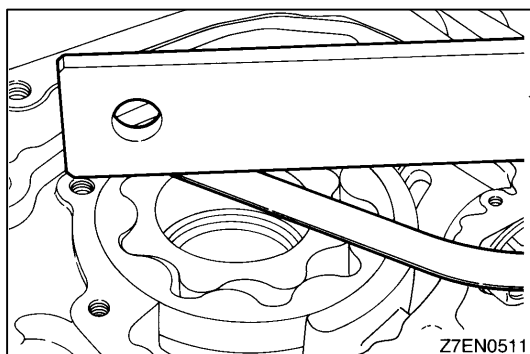


### INSPECTION

#### OIL PUMP

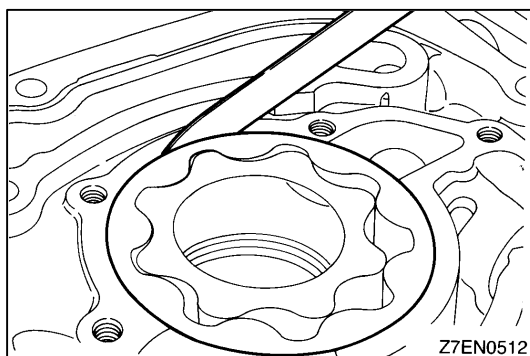
1. Check the tip clearance.

**Standard value: 0.06–0.18 mm**



2. Check the side clearance.

**Standard value: 0.04–0.10 mm**



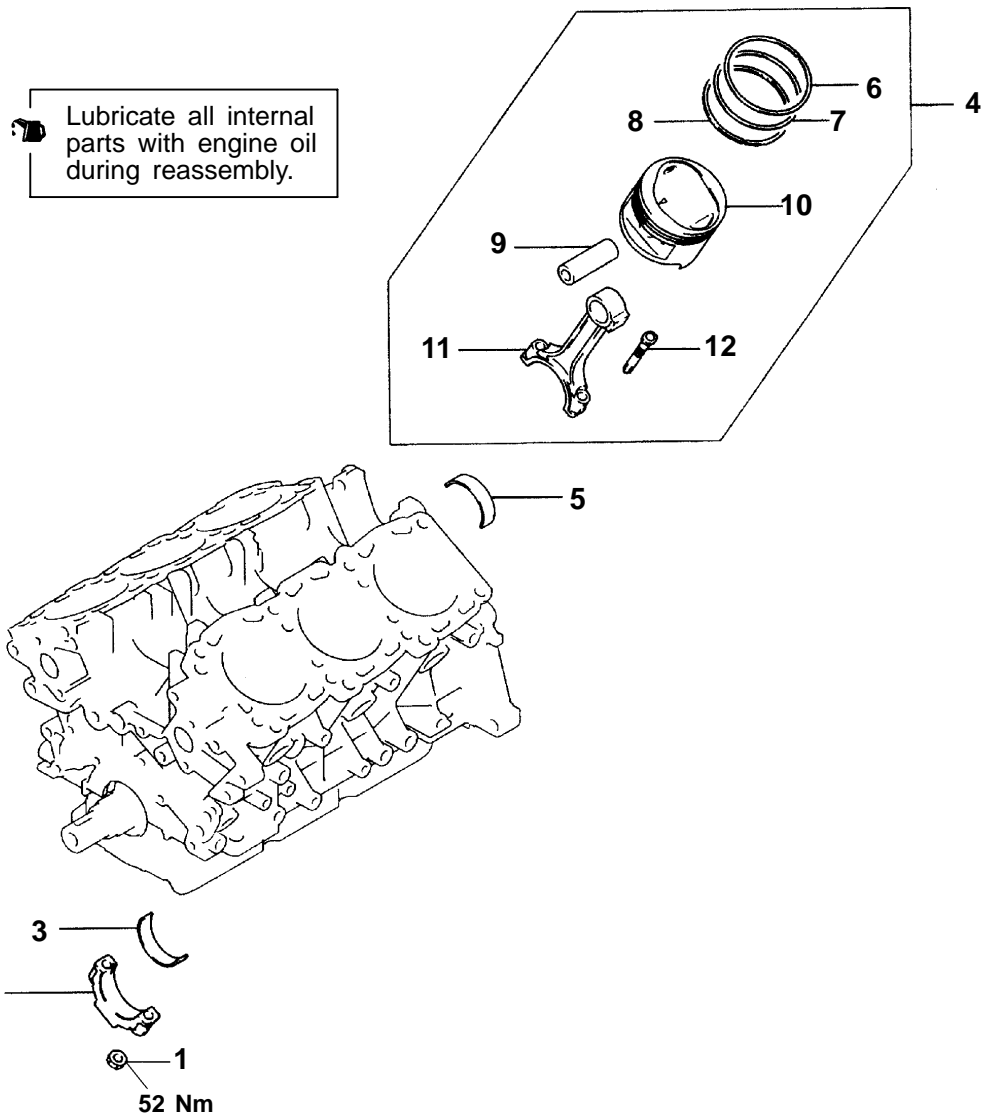
3. Check the body clearance.

**Standard value: 0.10–0.18 mm**

**Limit: 0.35 mm**

## PISTON AND CONNECTING ROD

## REMOVAL AND INSTALLATION &lt;6G72&gt;



01TH031A

## Removal steps


- ◀A▶ ▶E▶ 1. Nut  
 ▶D▶ 2. Connecting rod cap  
 ▶D▶ 3. Connecting rod bearing, lower  
 ▶C▶ 4. Piston and connecting rod assembly  
 ▶C▶ 5. Connecting rod bearing, upper  
 ▶C▶ 6. Piston ring No.1

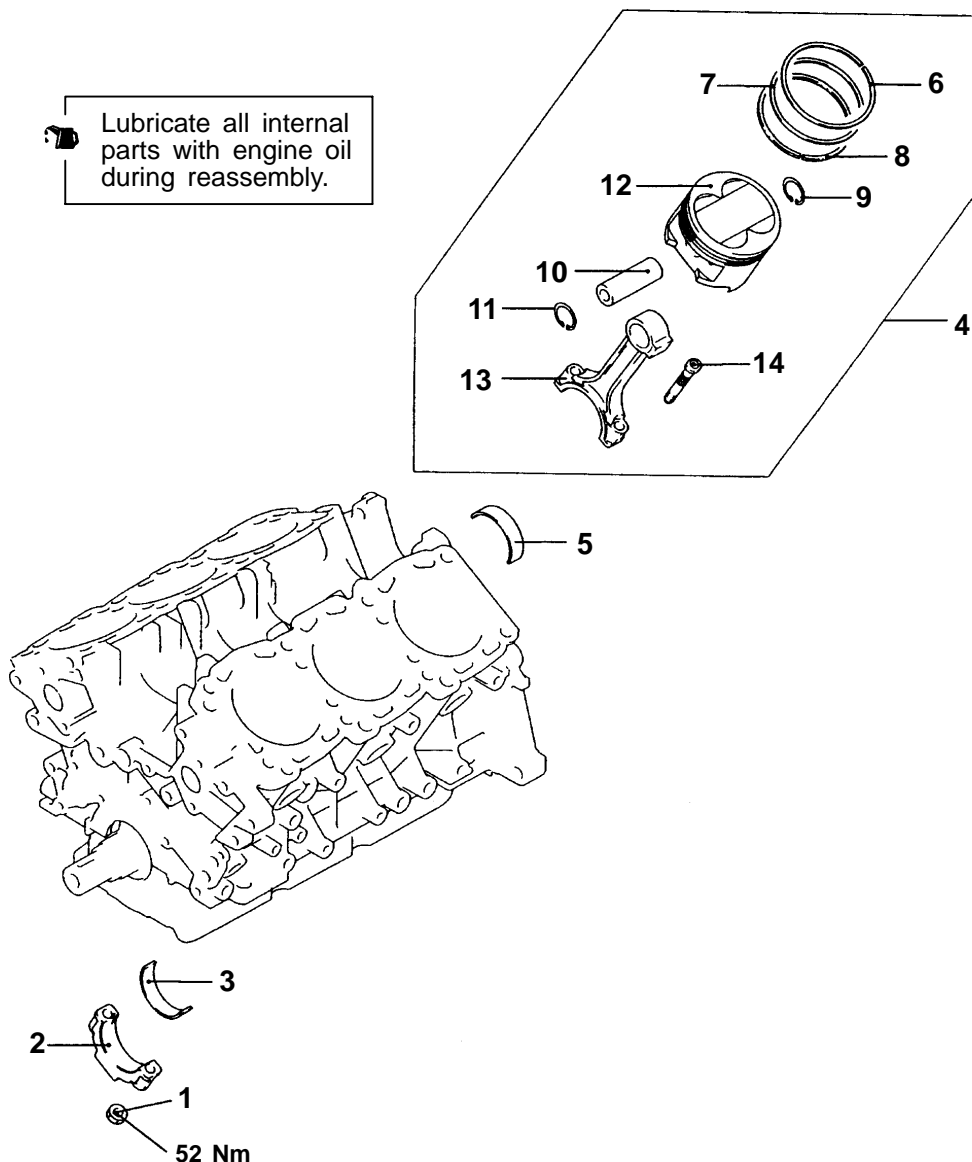
- ▶C▶ ▶B▶ ▶A▶ 7. Piston ring No.2  
 ▶B▶ 8. Oil ring  
 ▶B▶ 9. Piston pin  
 ▶B▶ 10. Piston  
 ▶B▶ 11. Connecting rod  
 ▶B▶ 12. Bolt

## REMOVAL AND INSTALLATION <6G74>

Main  
Index

11B  
Index

 Lubricate all internal parts with engine oil during reassembly.



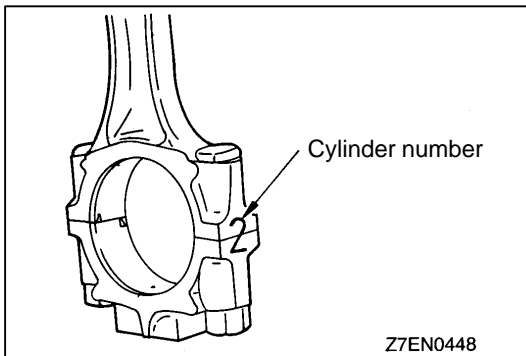
7EN0569

### Removal steps

- ◀A▶ ▶E▶ 1. Nut
- ▶E▶ 2. Connecting rod cap
- ▶D▶ 3. Connecting rod bearing, lower
- ▶D▶ 4. Piston and connecting rod assembly
- ▶C▶ 5. Connecting rod bearing, upper
- ▶C▶ 6. Piston ring No.1
- ▶C▶ 7. Piston ring No.2

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





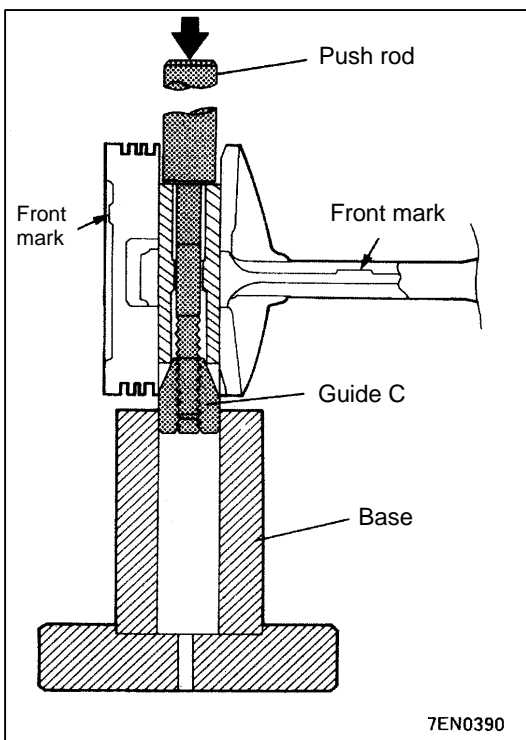
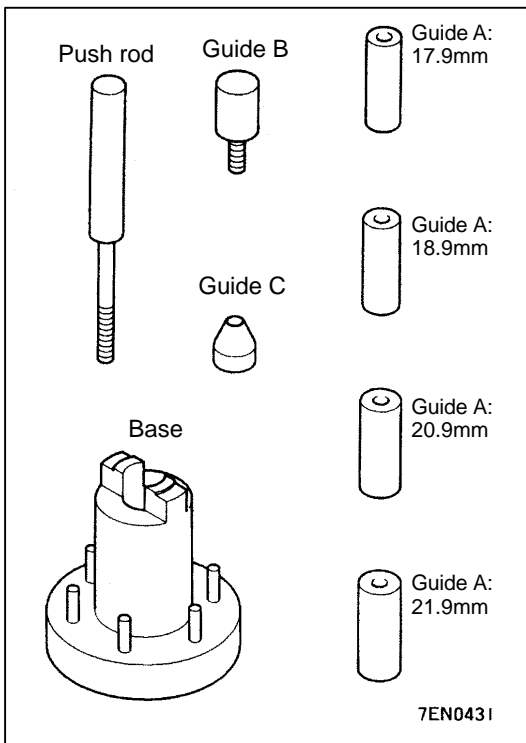
## REMOVAL SERVICE POINTS

### ◀A▶ CONNECTING ROD CAP REMOVAL

1. Mark the cylinder number on the side of the connecting rod big end for correct reassembly.
2. Keep the removed connecting rods, caps, and bearings in order according to the cylinder number.

### ◀B▶ REMOVAL OF PISTON PIN<6G72>

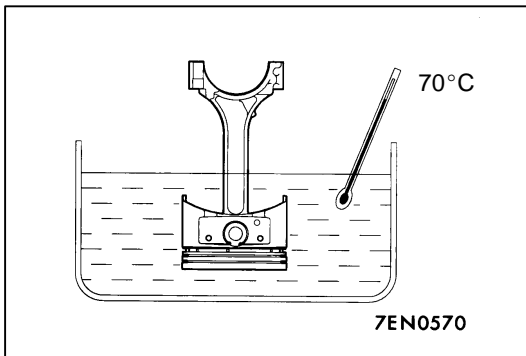
The special piston pin setting tool (MD998780) consists of the parts shown at left.



1. Insert the special push rod tool from the front marked (arrow) side of the piston and attach guide "C".
2. Set the piston and connecting rod assembly to the special tool piston pin setting base such that the front mark on the piston faces upward.
3. Remove the piston pin with a press.

#### NOTE:

After removing the piston pin, place the piston, the piston pin, and the connecting rod in order for each cylinder number.



## ◀B▶ REMOVAL OF PISTON PIN<6G74>

1. Remove the snap rings.
2. Heat the piston to approximately 70°C and pull out the piston pin.

### Caution

The clearance between the piston and the piston pin is an almost tight fit at normal temperature. Therefore, be sure to heat the piston before pulling out the piston pin. In addition, note that the piston is hot after heating.

## INSTALLATION SERVICE POINTS

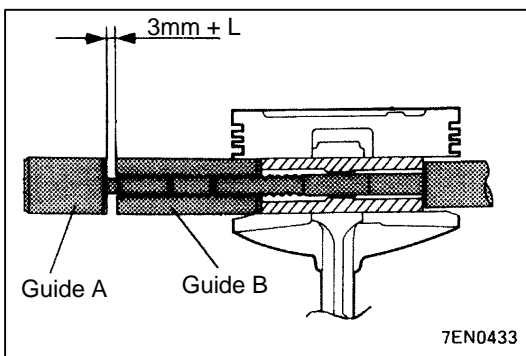
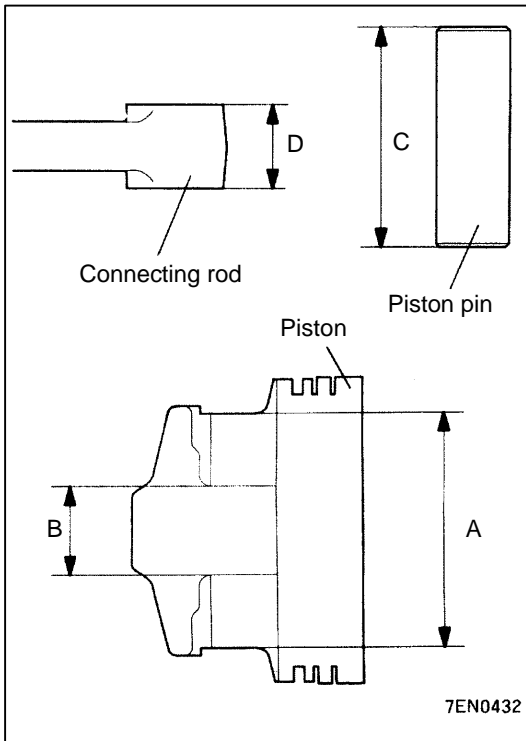
### ▶A◀ PISTON PIN INSTALLATION<6G72>

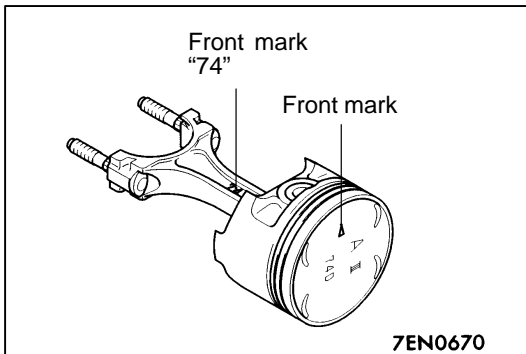
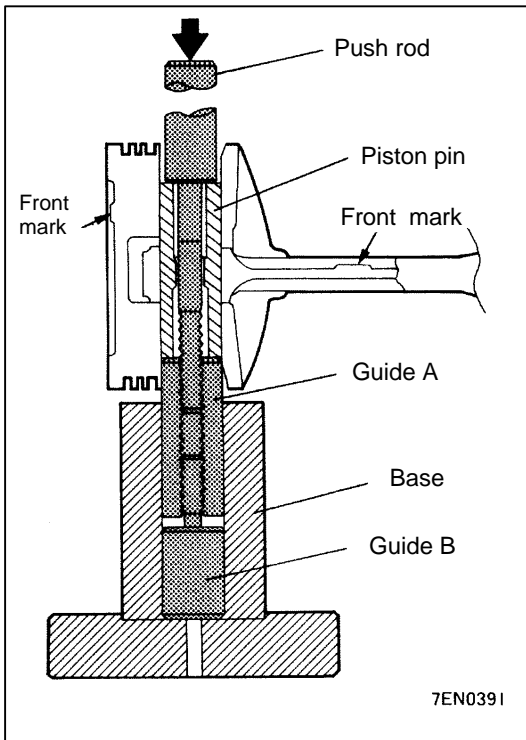
1. Measure the dimensions of the following parts and portions.  
A: Piston pin mounting portion  
B: Distance between piston bosses  
C: Piston pin  
D: Connecting rod
2. Calculate by subtracting each measured value into the following equation.

$$L = \frac{(A - C) - (B - D)}{2}$$

3. Insert the special push rod tool into the piston pin and attach guide A to it.
4. Combine the piston and connecting rod, matching their front marks.
5. Apply engine oil to the outer periphery of the piston pin.
6. Insert the side of the piston pin guide A attached per step (3) into the pin hole from the side of the piston containing the front mark.
7. Screw guide B into guide A until they are distance L (obtained per step (2) above) plus 3 mm apart as shown.
8. Use special tools to set the piston pin to a special tool piston base with the front mark of the piston facing up.
9. Press fit the piston pin with a press. When the load required for press fitting the piston pin is below the standard value, change the piston pin (piston assembly) or connecting rod or both.

**Standard value: 7,350 – 17,200 N**





## ►A◄ PISTON PIN INSTALLATION<6G74>

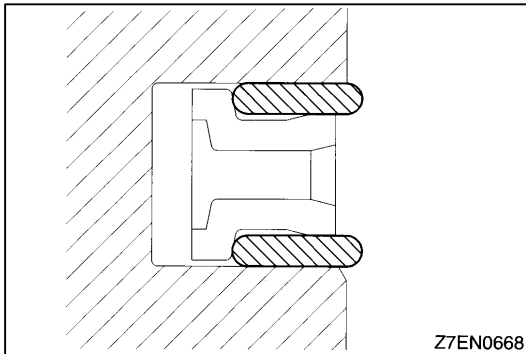
1. Heat the piston to approximately 70°C and set the snap ring on one side first. Be sure to install the snap ring with the shear droop directed toward the inside.
2. With the front mark of the connecting rod and that of the piston located on the same side, insert the piston pin.
3. After insertion of the piston pin, set the other snap ring.

### Caution

Apply an ample coat of engine oil to the periphery of the piston pin and the hole of the connecting rod small end.

The clearance between the piston and the piston pin is an almost tight fit at normal temperature. Therefore, be sure to heat the piston before inserting the piston pin.

In addition, note that the piston is hot after heating.

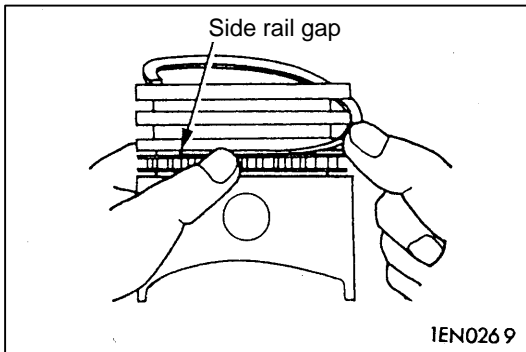


## ►B◄ OIL RING INSTALLATION

1. Fit the oil ring spacer into the piston ring groove.

### NOTE

The side rails and spacer may be installed in either direction.

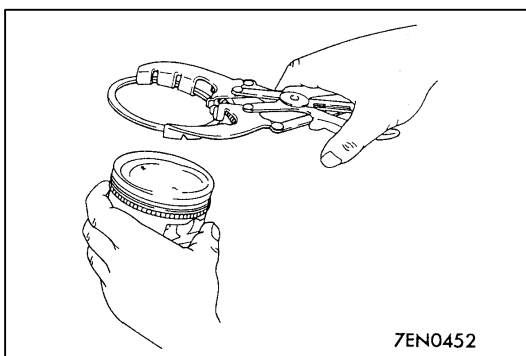


2. Install the upper side rail  
To install the side rail, first fit one end of the rail into the piston groove, then press the remaining portion into the position by finger. See illustration.  
Use of a ring expander to expand the side rail end gap can break the side rail, unlike other piston rings.

### NOTE

Do not use any piston ring expander when installing the side rail.

3. Install the lower side rail in the same procedure as described in step (2).
4. Make sure that the side rails move smoothly in either direction.



## ►C◄ PISTON RING NO.2/PISTON RING NO.1 INSTALLATION

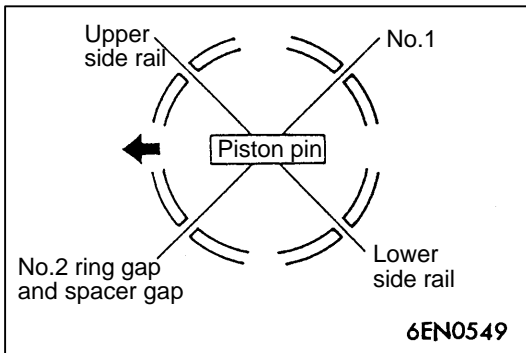
1. Using a piston ring expander, fit No.2 and then No.1 piston ring into position.

### NOTE

1. The ring end is provided with the identification mark.

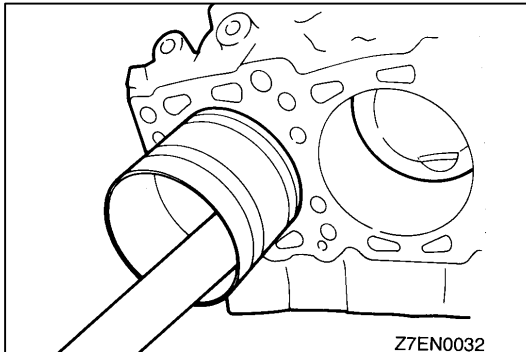
	Identification mark
No. 1 ring	T
No. 2 ring	T2

2. Install piston rings with identification mark facing up, to the piston crown side.



## ►D◄ PISTON AND CONNECTING ROD INSTALLATION

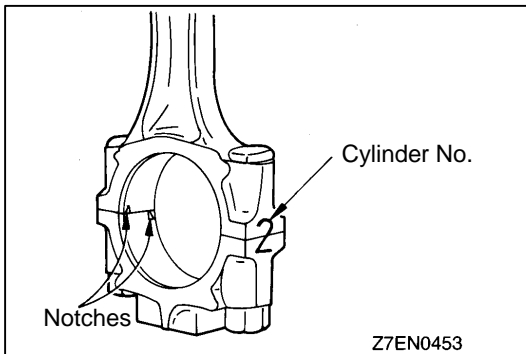
1. Liberally coat the circumference of the piston, piston ring, and oil ring with engine oil.
2. Arrange the piston ring and oil ring gaps (side rail and spacer) as shown in the illustration.
3. Rotate the crankshaft so that the crank pin is on the centre of the cylinder bore.



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

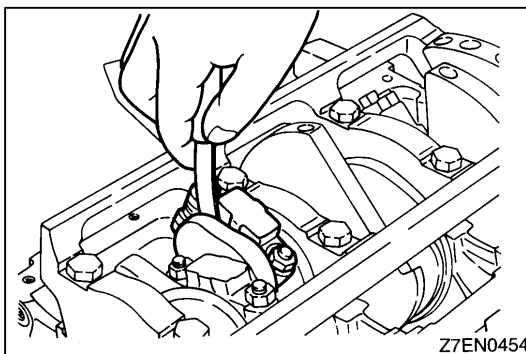
### Caution

Install the piston with the front mark (arrow mark) on the top of the piston directed towards the engine front (timing belt side).



## ►E◄ CONNECTING ROD CAP INSTALLATION

1. Mate the correct bearing cap with the correct connecting rod by checking with the alignment marks marked during disassembly. If a new connecting rod is used which has no alignment mark, position the notches for locking the bearing on the same side.



2. Check if the thrust clearance in the connecting rod big end is correct.

**Standard value: 0.10–0.25 mm**

**Limit: 0.4 mm**

## INSPECTION

### CYLINDER BLOCK

1. Visually check for scratches, rust, and corrosion. Also use a flaw detecting agent for the check. If defects are evident, correct, or replace.
2. Using a straightedge and feeler gauge, check the flatness of the block top surface. Make sure that the surface is free from gasket pieces and other foreign matter.

**Standard value: 0.05 mm**

**Limit: 0.1 mm**

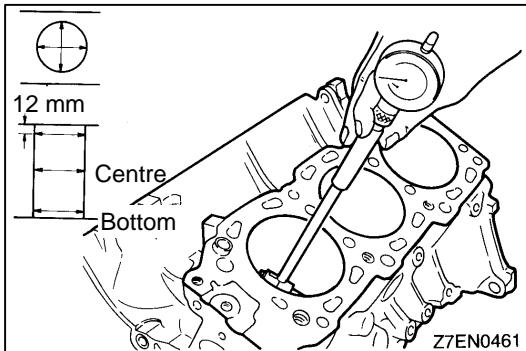
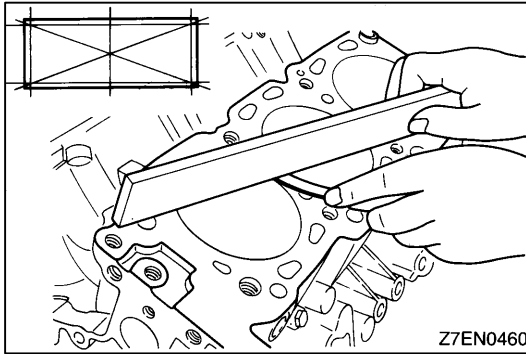
3. If distortion is excessive, correct within the allowable limit or replace.

**Grinding limit: 0.2 mm**

**\*Includes/combined with cylinder head grinding.**

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

**210.4–210.6 mm**



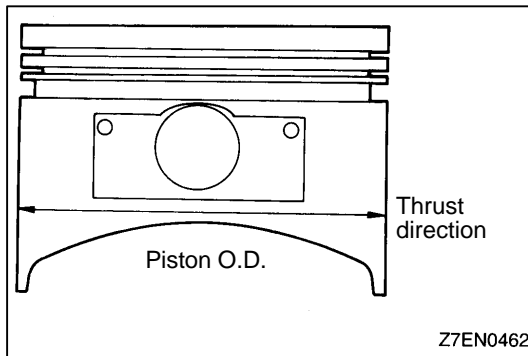
4. Check the cylinder walls for scratches and seizure. If defects are evident, correct (rebore to an oversize) or replace.
5. Using a cylinder gauge, measure the cylinder bore and cylindricity. If worn badly, correct by boring the cylinders to an oversize and replace pistons and piston rings. Measure at the points shown in the illustration.

**Standard value:**

**6G72 Cylinder I.D.: 91.1 mm**

**6G74 Cylinder I.D.: 93.0 mm**

**Cylindricity: 0.01 mm**



## BORING CYLINDER

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

### Piston size identification

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

#### NOTE

Size mark is stamped on the piston top.

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

#### Boring finish dimension =

**Piston O.D. + (clearance between piston O.D. and cylinder) – 0.02 mm (honing margin)**

4. Bore all cylinders to the calculated boring finish dimension.

#### Caution

**To prevent distortion that may result from temperature rise during honing, bore cylinders in the order of No.2, No.4, No.6, No.1, No.3 and No.5.**

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

#### Clearance between piston and cylinder:

**0.02–0.04 mm**

#### NOTE

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

## PISTON

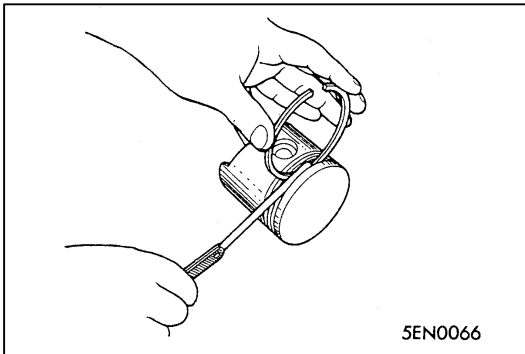
1. Replace the piston if scratches or seizure are evident on its surfaces (especially the thrust surface). Replace the piston if it is cracked.

### PISTON PIN

1. Insert the piston pin into the piston pin hole with a thumb. You should feel a slight resistance. Replace the piston pin if it can be easily inserted or there is an excessive play.
2. The piston and piston pin must be replaced as an assembly.

### PISTON RING

1. Check the piston ring for damage, excessive wear, and breakage and replace if defects are evident. If the piston has been replaced with a new one, the piston rings must also be replaced with new ones.



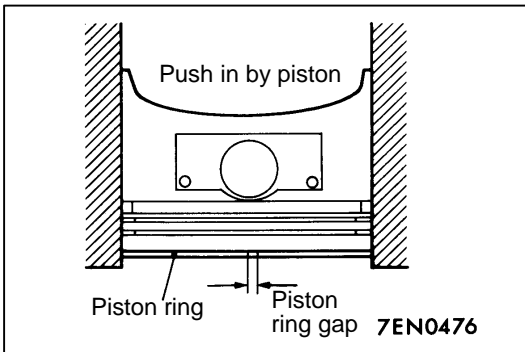
2. Check for clearance between the piston ring and ring groove. If the limit is exceeded, replace the ring or piston, or both.

**Standard value:**

**No. 1 0.03–0.07 mm**

**No. 2 0.02–0.06 mm**

**Limit: 0.1 mm**



3. Insert the piston ring into the cylinder bore. Force the ring down with a piston, the piston 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 feeler gauge.

If the ring gap is excessive, replace the piston ring.

**Standard value:**

**No. 1: 0.30–0.45 mm**

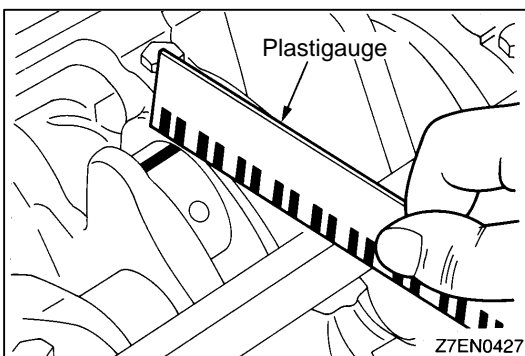
**No. 2: 0.45–0.60 mm**

**Oil: 0.20–0.60 mm**

**Limit:**

**No. 1, No. 2: 0.8 mm**

**Oil: 1.0 mm**



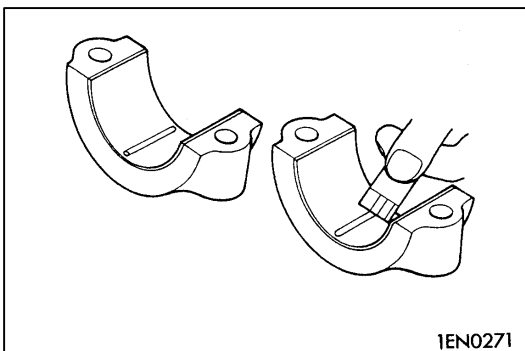
## CRANKSHAFT PIN OIL CLEARANCE (PLASTIGAUGE METHOD)

The crankshaft oil clearance can be measured easily by using Plastigauge, as follows:

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

**Standard value: 0.02–0.05 mm**

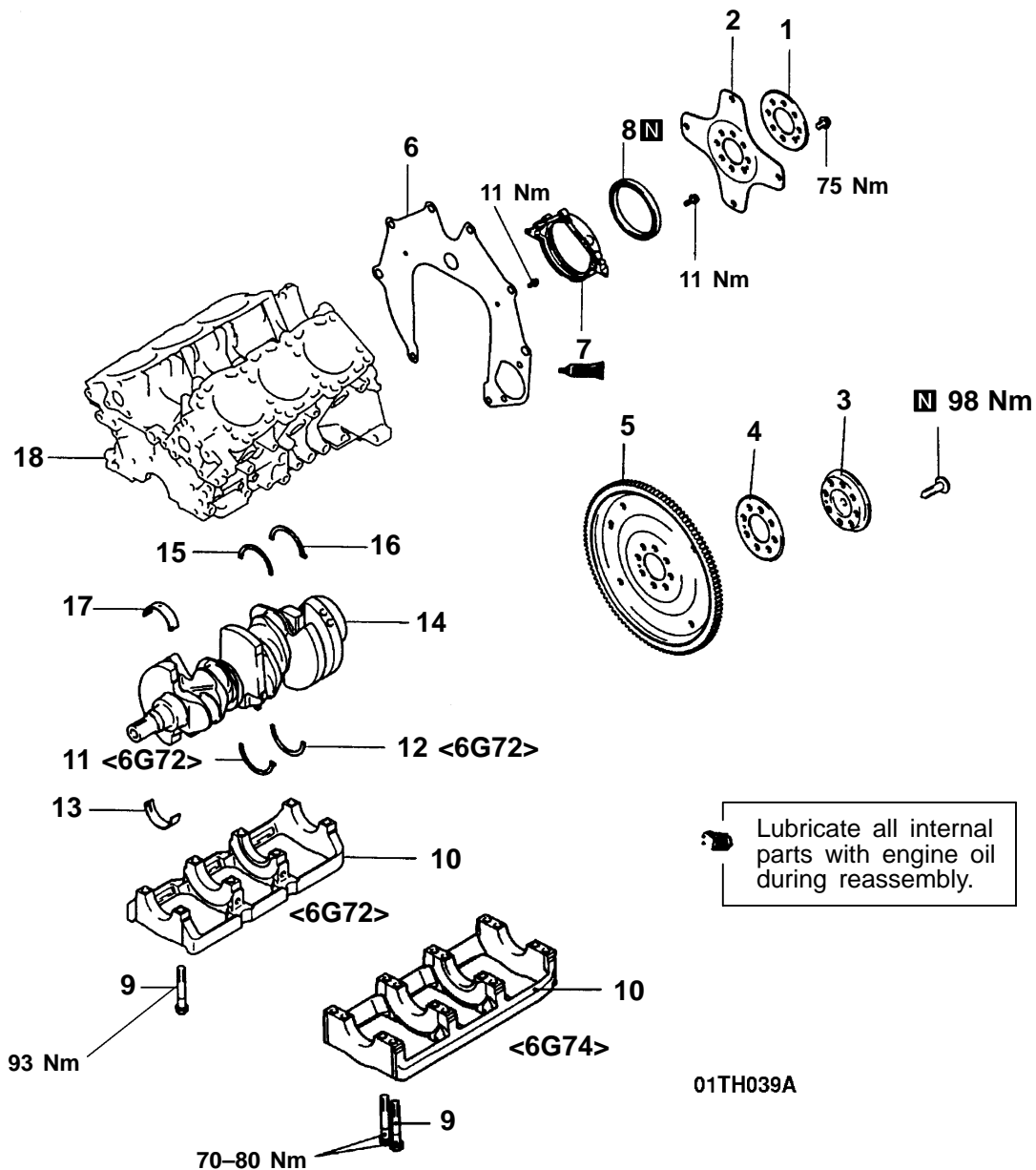
**Limit: 0.1 mm**





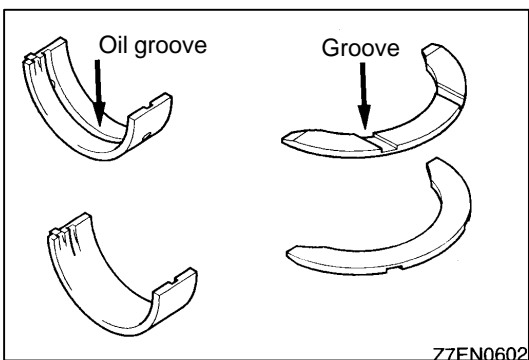
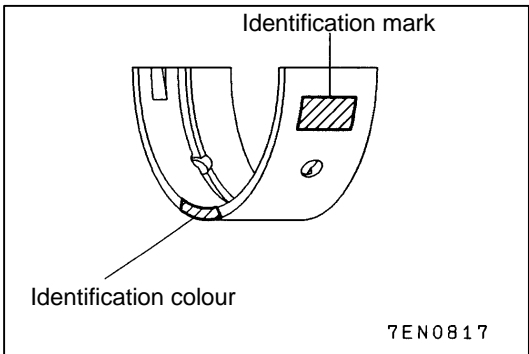
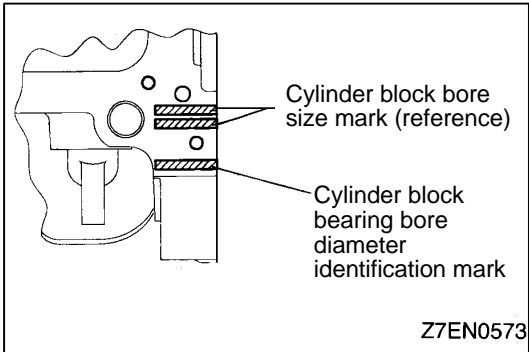
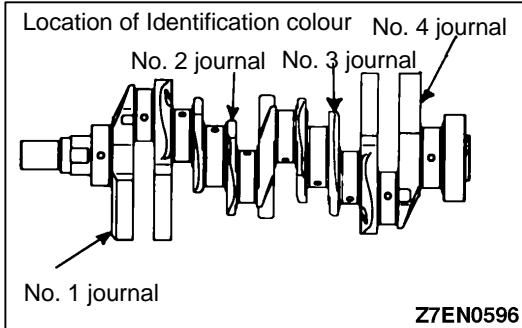
## CRANKSHAFT, FLYWHEEL AND DRIVE PLATE

## REMOVAL AND INSTALLATION



## Removal steps

- |     |                             |     |                               |
|-----|-----------------------------|-----|-------------------------------|
| ▶D◀ | 1. Adaptor plate            | ▶B◀ | 10. Bearing cap               |
| ▶C◀ | 2. Drive plate              | ▶A◀ | 11. Thrust bearing A <6G72>   |
| ▶B◀ | 3. Plate                    | ▶A◀ | 12. Thrust bearing B <6G72>   |
|     | 4. Adaptor plate            | ▶A◀ | 13. Crankshaft bearing, lower |
|     | 5. Flywheel                 |     | 14. Crankshaft                |
|     | 6. Rear plate               | ▶A◀ | 15. Thrust bearing B          |
|     | 7. Oil seal case            | ▶A◀ | 16. Thrust bearing A          |
|     | 8. Crankshaft rear oil seal | ▶A◀ | 17. Crankshaft bearing, upper |
|     | 9. Bearing cap bolt         |     | 18. Cylinder block            |



## ▶A◀ CRANKSHAFT BEARING INSTALLATION MAIN BEARINGS

When bearing replacement is required, select and install the correct bearing by the following procedure.

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

<6G72>

Combination of crankshaft journal diameter and cylinder block bearing bore diameter				Cylinder block bearing bore diameter identification mark	Bearing identification colour or identification mark (for service part)
Crankshaft journal					
Classification	Identification colour		O.D. mm		
	Production part	Service part			
1	None	Yellow	59.994	I	Pink(1)
			—	II	Red(2)
			60.000	III	Green(3)
2	None	None	59.988	I	Red(2)
			—	III	Green(3)
			59.994	III	Black(4)
3	None	White	59.982	I	Green(3)
			—	II	Black(4)
			59.988	III	Brown(5)

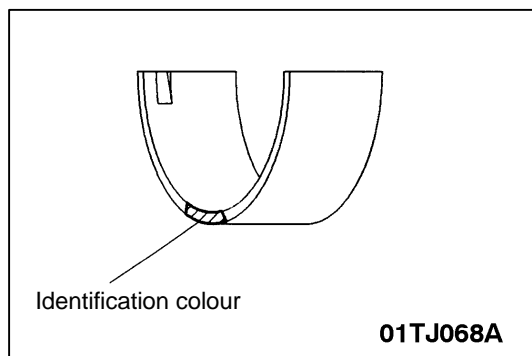
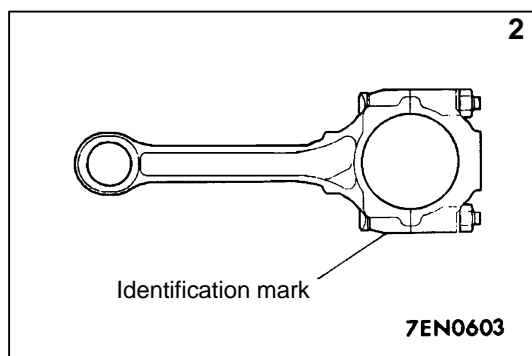
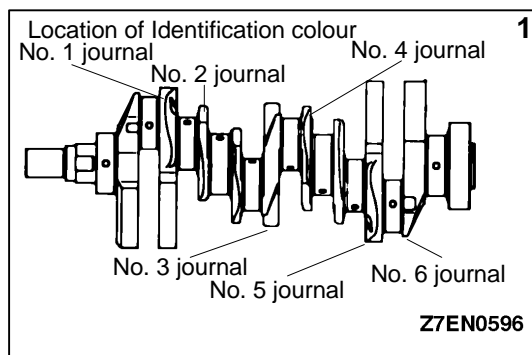
<6G74>

Combination of crankshaft journal diameter and cylinder block bearing bore diameter					Bearing identification colour or identification mark (for service part)
Crankshaft journal				Cylinder block bearing bore diameter identification mark	
Classification	Identification colour		O.D. mm		
	Production part	Service part			
1	None	Yellow	63.994	I	Pink(1)
			—	II	Red(2)
			64.000	III	Green(3)
2	None	None	63.988	I	Red(2)
			—	III	Green(3)
			63.994	III	Black(4)
3	None	White	63.982	I	Green(3)
			—	II	Black(4)
			63.988	III	Brown(5)

3. Select the correct bearing from the above tables on the basis of the identification data confirmed at steps 1 and 2.

**Example <6G72>**

1. If the measured value of a crankshaft journal outer diameter is 59.996 mm the journal is classified as "1" in the table.  
In case the crankshaft is also replaced by a spare part, check the identification colours of the journals painted on the new crankshaft. If the colour is yellow, for example, the journal is classified as "1".
2. Next, check the cylinder block bearing bore identification mark stamped on the cylinder block. If it is "1", read the "Bearing identification colour" column to find the identification colour of the bearing to be used. In this case, it is "pink".
4. Install the bearing halves with oil groove in the cylinder block side.
5. Install the bearing halves without oil groove on the bearing cap side.
6. Install the thrust bearings on both sides of the No.3 bearing with the grooves facing outward.



## INSTALLATION SERVICE POINTS

### ►A◄ CRANKSHAFT BEARING INSTALLATION CONNECTING ROD <6G74>

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

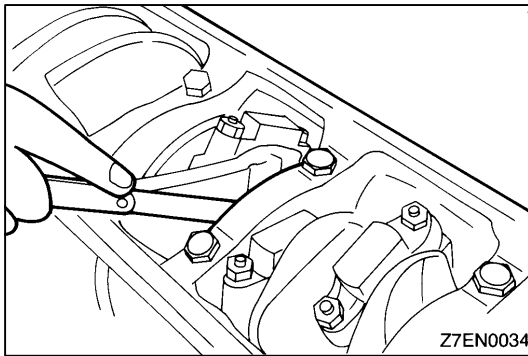
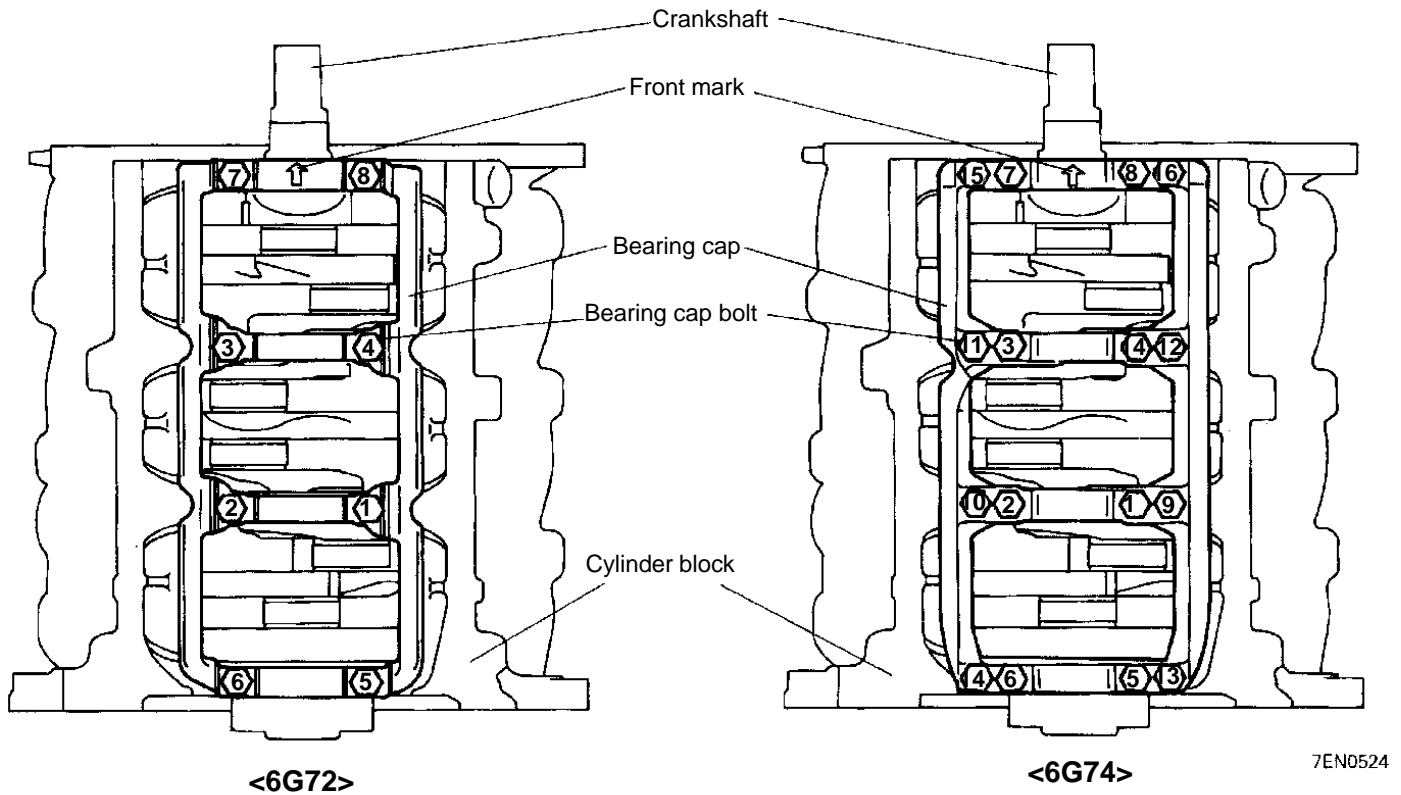
1. Measure the crankshaft journal diameter and confirm its classification from the following table. In the case of a bearing supplied as a service part, its identification colour is painted at the position shown in the illustration.
2. The connecting rod identification mark is stamped at the position shown in the illustration.
3. Select a suitable bearing from the following table on the basis of the identification data confirmed under Items 1. and 2.

Items	Standard value	Limit
-------	----------------	-------

Crankshaft			Connecting rod			
Identification mark (colour)		Journal O.D. mm	Big end		Bearing	
Production part	Spare part		Identification mark	I.D. mm	Identification colour	Thickness mm
None	Yellow	54.994–55.000	0	58.000–58.006	Pink	1.483–1.486
			1	58.006–58.012	Red	1.486–1.489
			2	58.012–58.018	Green	1.489–1.492
None	None	54.998–54.994	0	58.000–58.006	Red	1.486–1.489
			1	58.006–58.012	Green	1.489–1.492
			2	58.012–58.018	Black	1.492–1.495
None	White	54.982–54.988	0	58.000–58.006	Green	1.489–1.492
			1	58.006–58.012	Black	1.492–1.495
			2	58.012–58.018	Brown	1.495–1.498

## ►B◄ BEARING CAP/BEARING BOLT INSTALLATION

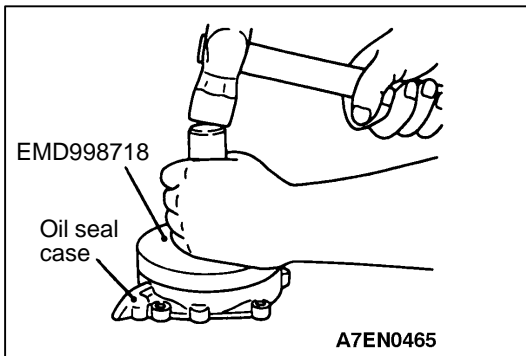
1. Attach the bearing cap on the cylinder block as shown in the illustration.
2. Tighten the bearing cap bolts to the specified torque in the sequence shown in the illustration.
3. Check that the crankshaft rotates smoothly.



4. Check the end plate. If it exceeds the limit value, replace the thrust bearing.

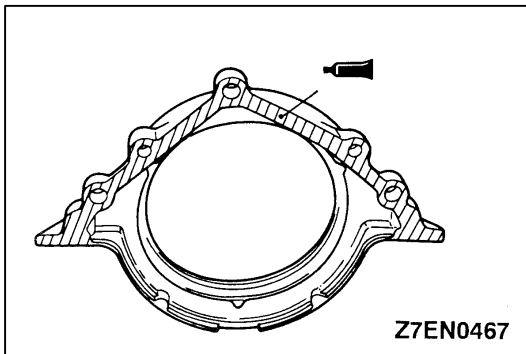
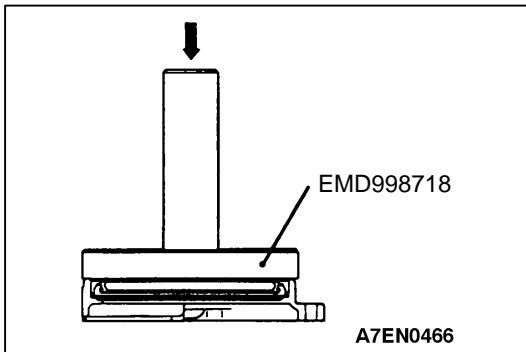
**Standard value : 0.05–0.25 mm**

**Limit: 0.3 mm**



## ►C◄ CRANKSHAFT REAR OIL SEAL INSTALLATION

1. Using the special tool, press-fit a new crankshaft rear oil seal into the oil seal case.



## ►D◄ OIL SEAL CASE INSTALLATION

1. Apply specified sealant to the area shown in the illustration.

**Specified sealant:**

**MITSUBISHI GENUINE Part No. MD970389 / Loctite 587 Ultra blue or equivalent**

2. Apply a small amount of engine oil to the entire circumference of the oil seal lip section, and place the oil seal on the cylinder block.

## INSPECTION

### CRANKSHAFT

If the oil clearance exceeds the limit, replace the bearing, and crankshaft if necessary.

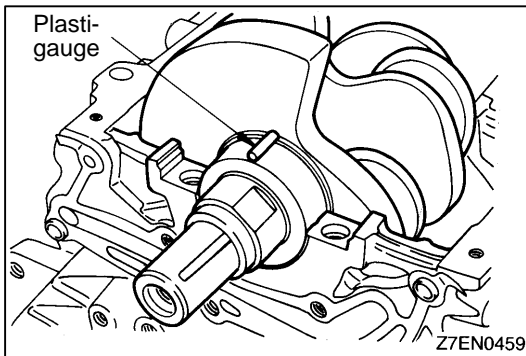
1. Measure the outside diameter of the journals and the inside diameter of the crankshaft bearings. If the difference between them (oil clearance) exceeds the limit, replace the crankshaft bearing and, if necessary, crankshaft.

**Standard value: 0.02–0.04 mm**

**Limit: 0.1 mm**

#### Caution

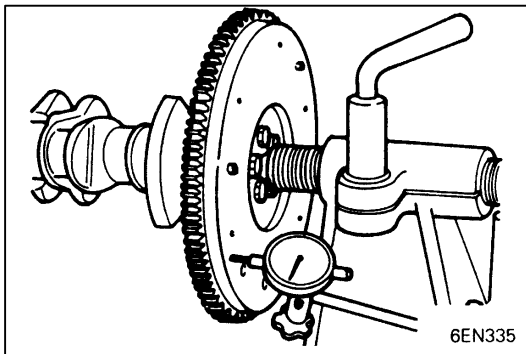
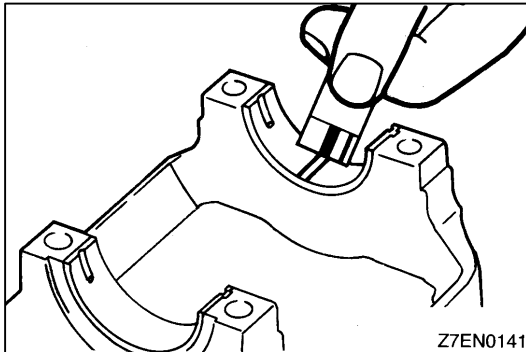
Do not attempt an undersize machining of the crankshaft with special surface treatment. This crankshaft can be identified by its dull gray appearance.



## CRANKSHAFT JOURNAL OIL CLEARANCE <PLASTIGAUGE METHOD>

The crankshaft oil clearance can be measured easily by using Plastigauge, as follows:

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



## FLYWHEEL

1. Check the clutch disc friction surface for ridge wear, cracks and seizure.
2. If the runout of the flywheel exceeds the limit, replace the flywheel assembly.

**Limit: 0.13 mm**

### Caution

The flywheel mounting bolts shown must not be removed. If the bolts are removed, the flywheel will lose its original balance and could break during operation.

