

ENGINE

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1. SPECIFICATIONS




| Description | Specifications | Remarks |
|---|--|---------|
| Cylinder head | | |
| Material | Aluminum alloy | |
| Combustion chamber type | Swirl chamber | |
| Combustion chamber jet | | |
| Material | Heat resisting steel (press-fit in cylinder head) | |
| Inlet and exhaust port type | Turn flow type | |
| Camshaft | | |
| Material | Cast iron (with cam face specially treated) | |
| Arrangement – drive | OHC – cogged type belt | |
| Rocker arm | | |
| Material | Aluminum alloy, with tip | |
| Identification mark | | |
| In. | I | |
| Ex. | E | |
| Valve seat | | |
| Material | Heat resisting steel (press-fit in cylinder head) | |
| Valve | | |
| Face angle | 45° | |
| Identification mark | | |
| In. | N | |
| Ex. | N | |
| Valve spring | | |
| Type | Non-uniform pitch, single | |
| Identification color | Orange | |
| Cylinder head gasket | | |
| | Steel asbestos | |
| Cylinder head bolt | | |
| | Special steel, 18 pcs. | |
| Cylinder block | | |
| Cylinder bore | 91.1 mm | |
| Cylinder liner | Dry type | |
| Water jacket | Full Siamese type | |
| Crankshaft | | |
| Material | Special alloy | |
| Surface treatment | Full surface, specially treated | |
| Identification (by surface color) | Full surface, gray | |
| Journal dia. x pin dia. x distance between journal and pin centers | 66 x 53 x 45 mm | |
| Crankshaft pulley | | |
| | With damper | |
| Drive plate | | |
| | Ring gear welded | |


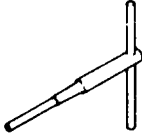



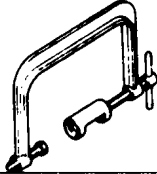
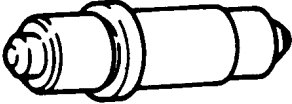

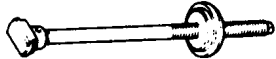
| Description | Specifications | Remarks |
|----------------------------|--|---------|
| Piston | | |
| Type | Autothermic type | |
| Coupling to connecting rod | Full floating type | |
| Cooling | Oil jet cooling | |
| Piston ring | | |
| No. 1 | Barrel type, chrome face | |
| No. 2 | Taper type, chrome face | |
| Oil | Bevel cutter type, chrome face, with coil expander | |
| Silent shaft | | |
| Right | Counterclockwise rotation by idler gear (opposite to crankshaft rotation) | |
| Left | Clockwise rotation | |
| Timing belt | | |
| Type | Cogged type | |
| Driven units | Camshaft and fuel injection pump | |
| Loose belt alarm | Timing belt switch | |
| Timing belt "B" | | |
| Type | Cogged type | |
| Driven units | Right and left silent shafts | |
| Oil pump | | |
| Type | Geared type (internal gear in mesh) | |
| Drive | Directly coupled to crankshaft | |

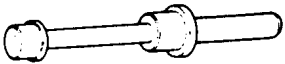

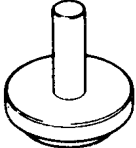
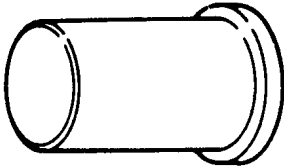

2. TORQUE

| Item | Torque | |
|---|-----------|-------------|
| | Nm | kgm |
| Cylinder head bolts – Cold engine | 103 – 112 | 10.5 – 11.5 |
| Cylinder head bolts – Hot engine | 113 – 122 | 11.5 – 12.5 |
| Camshaft bearing cap bolts | 19 – 20 | 1.9 – 2.1 |
| Camshaft sprocket bolt | 64 – 73 | 6.5 – 7.5 |
| Rocker arm shaft bolts | 35 – 39 | 3.5 – 4 |
| Rocker cover bolts | 5 – 7 | 0.5 – 0.7 |
| Intake and exhaust manifold nuts or bolts | 15 – 19 | 1.5 – 2 |
| Rocker arm adjusting nuts | 12 – 17 | 1.2 – 1.8 |
| Main bearing cap bolts | 74 – 83 | 7.5 – 8.5 |
| Connecting rod cap nuts | 45 – 47 | 4.5 – 4.8 |
| Crankshaft pulley bolts | 167 – 186 | 17 – 19 |
| Silent shaft sprocket bolt | 34 – 39 | 3.4 – 4 |
| Timing belt tensioner nut | 22 – 29 | 2.2 – 3 |
| Front case bolts | 12 – 14 | 1.2 – 1.5 |
| Silent shaft chamber cover bolts | 4 – 5 | 0.4 – 0.6 |
| Drive plate bolts | 128 – 137 | 13 – 14 |
| Engine support bracket bolts | 40 – 49 | 4 – 5 |
| Oil pressure switch or gauge unit | 8 – 11 | 0.8 – 1.2 |
| Oil pan bolt | 6 – 7 | 0.6 – 0.8 |
| Oil pan drain plug | 59 – 78 | 6 – 8 |
| Oil filter | 11 – 12 | 1.1 – 1.3 |
| Oil relief valve plug | 30 – 45 | 3 – 4.5 |
| Water temperature gauge unit | 30 – 39 | 3 – 4 |
| Clutch wheel | 128 – 137 | 13 – 14 |
| Fluid coupling to drive plate bolt | 49 – 57 | 5 – 5.9 |

3. SPECIAL TOOLS

| Tool name | Part No. | Shape | Use |
|-----------------------------|----------|--|--|
| Cylinder Head Bolt Wrench | MD998051 |  | Loosening and tightening cylinder head bolts |
| Camshaft Oil Seal Installer | MD998381 |  | Driving in camshaft oil seal |
| Valve Guide Installer | MD998115 |  | Removing and installing valve guide |

| Tool name | Part No. | Shape | Use |
|---|--|--|--|
| Valve Stem Seal Installer | MD998377 |  | Driving in valve stem seal |
| Valve Seat Cutter Pilot | MD998148 |  | Correcting valve seat |
| Valve Seat Cutter 45° | MD998158 |  | |
| Valve Seat Cutter 65° | MD998165 |  | |
| Valve Seat Cutter 30° | MD998175 |  | |
| Valve Spring Compressor | MD998303 (Commercially available tool acceptable) |  | Compressing valve spring |
| Connecting Rod Small End Bushing Replacement Tool | MD998386 |  | Replacing connecting rod small end bushing |
| Silent Shaft Drive Gear Oil Seal Guide | MD998385 |  | Mounting silent shaft drive gear oil seal |
| Silent Shaft Bearing Puller | MD998251 |  | Removing silent shaft rear bearing |

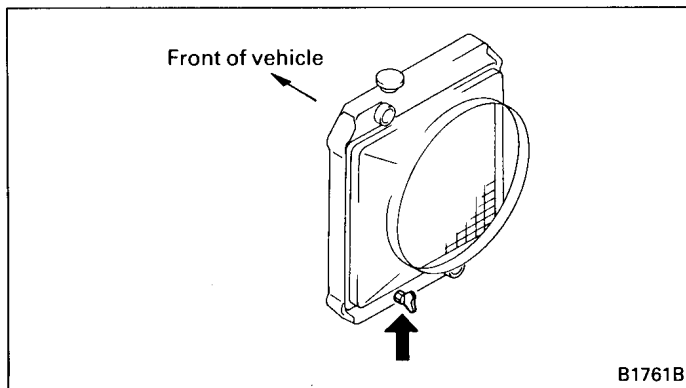
| Tool name | Part No. | Shape | Use |
|-------------------------------------|----------|---|--------------------------------------|
| Silent Shaft Bearing Installer | MD998250 |  | Driving in silent shaft rear bearing |
| Bearing Installer Stopper | MD998380 |  | |
| Crankshaft Rear Oil Seal Installer | MD998376 |  | Driving in crankshaft rear seal |
| Crankshaft Front Oil Seal Guide | MD998382 |  | Driving in crankshaft front seal |
| Crankshaft Front Oil Seal Installer | MD998383 |  | |

4. ENGINE REMOVAL AND INSTALLATION

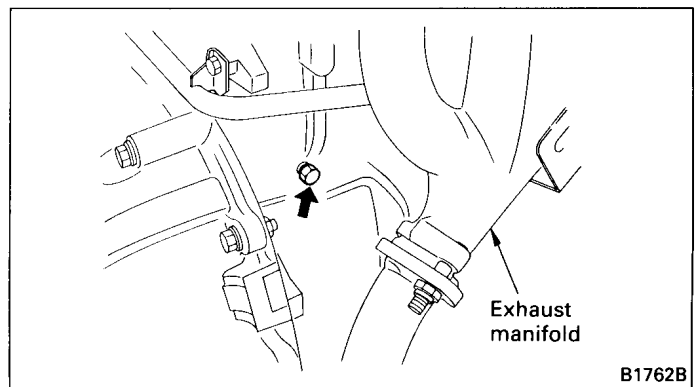
4.1 PREPARATION BEFORE REMOVAL

1. Apply chocks to the rear wheels.
2. Disconnect the negative (ground) cable from the battery.
3. Drain off the coolant.

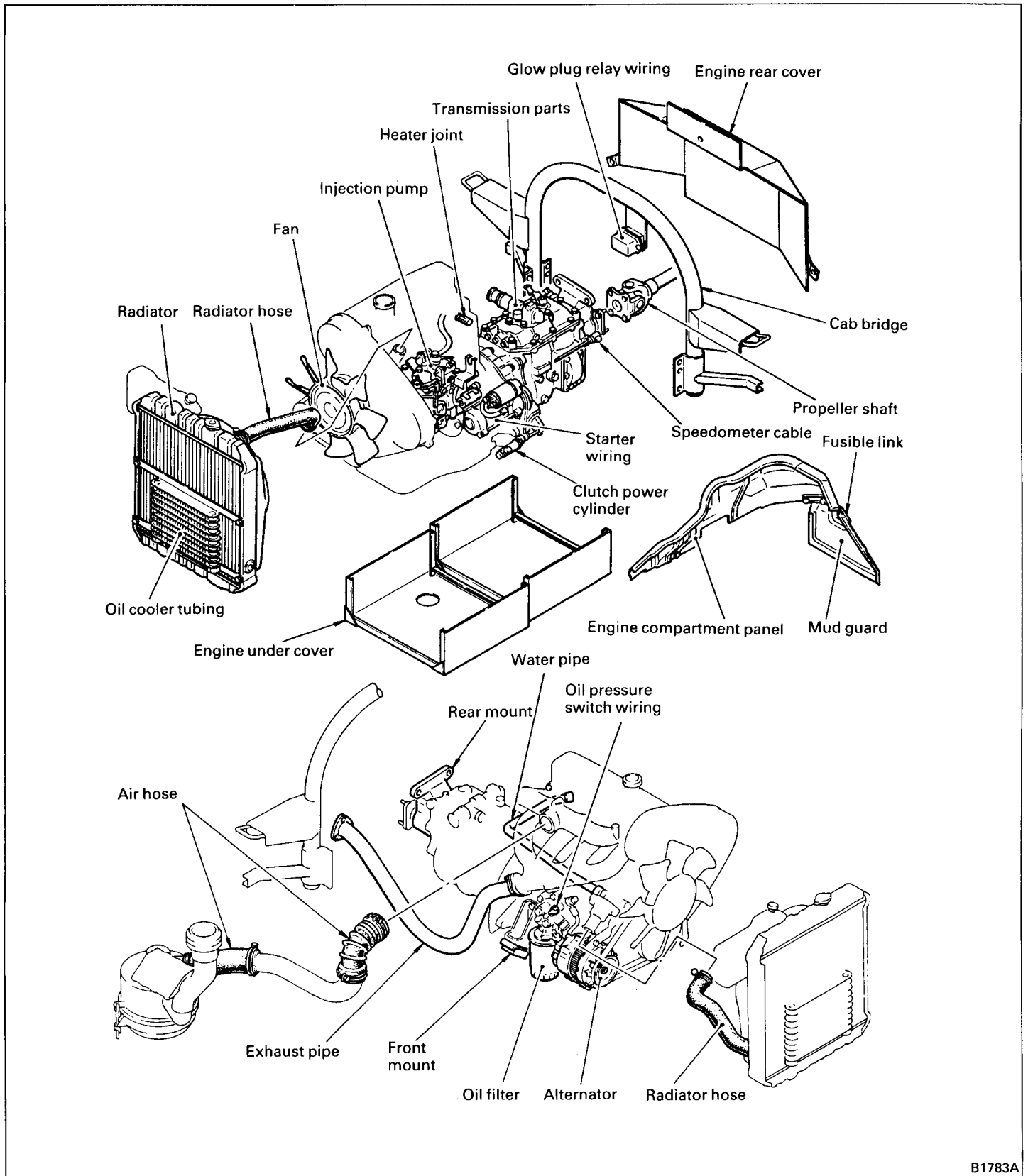
Radiator Drain Cock



Crankcase Drain Plug



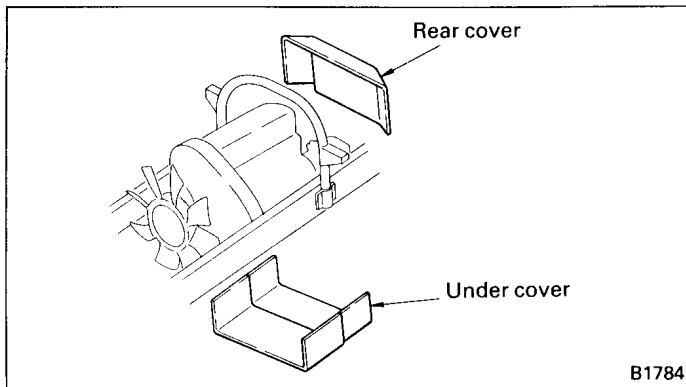
4.2 MAJOR PARTS FOR REMOVAL



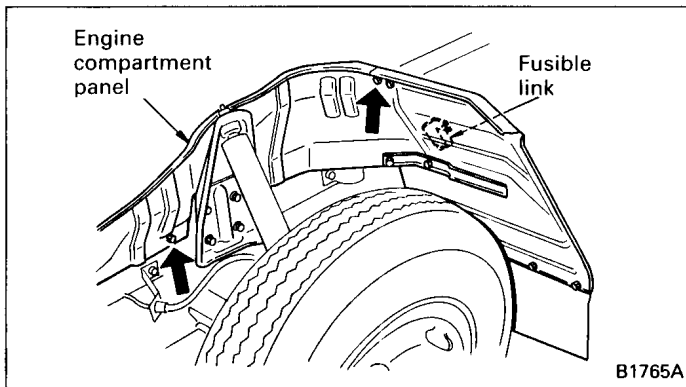
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4.3 REMOVAL OF EACH PART

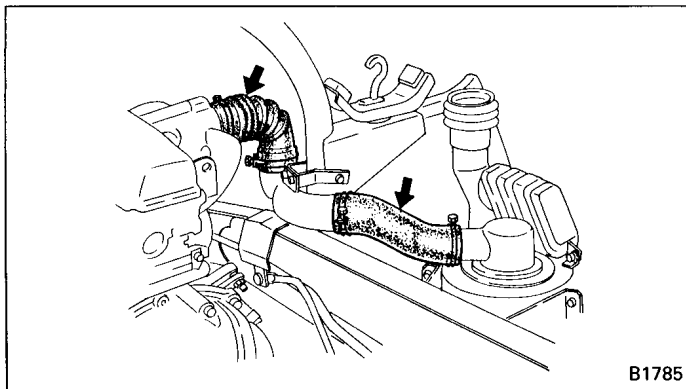
Engine Rear Cover and Under Cover



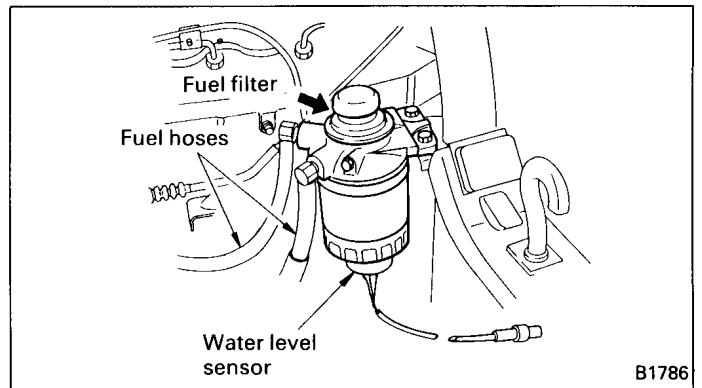
Engine Compartment Panel



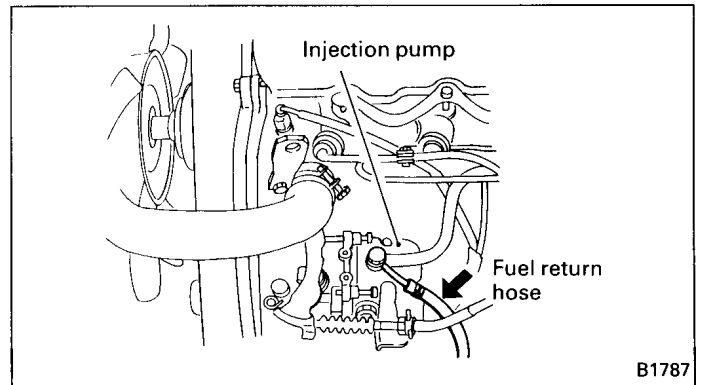
Air Intake Hose



Fuel Filter

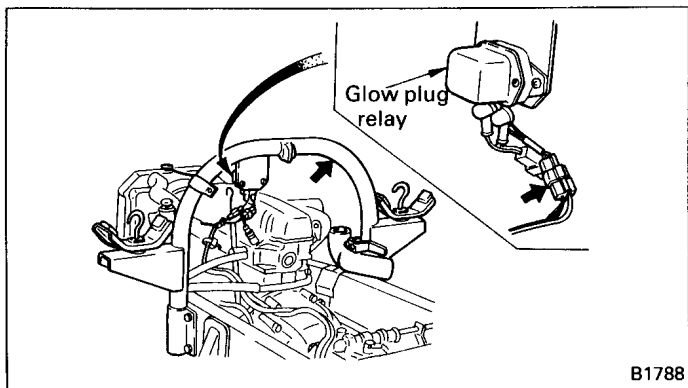


Fuel Hose

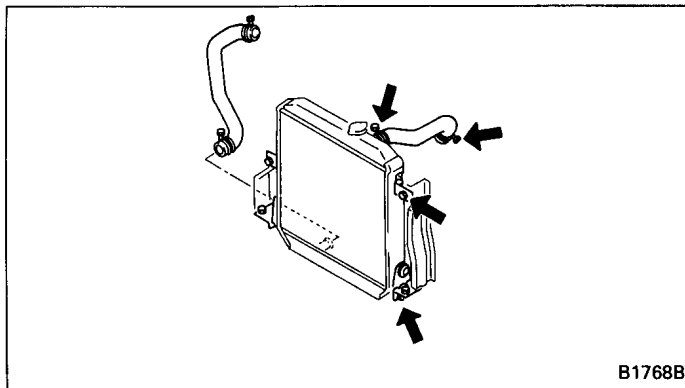


After removal of the hose, hold its end at a higher level than the fuel tank to prevent the fuel from flowing out of the hose.

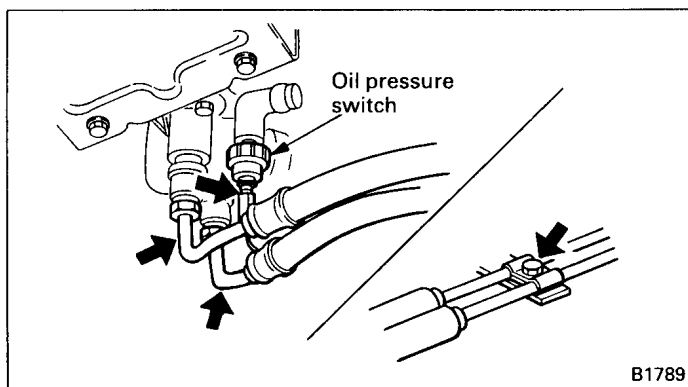
Cab Bridge and Glow Plug Relay Wiring



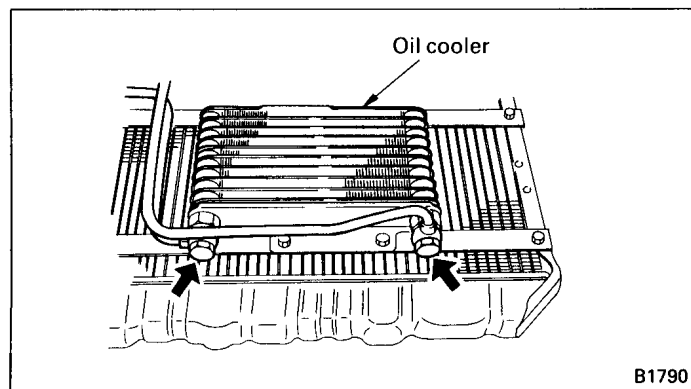
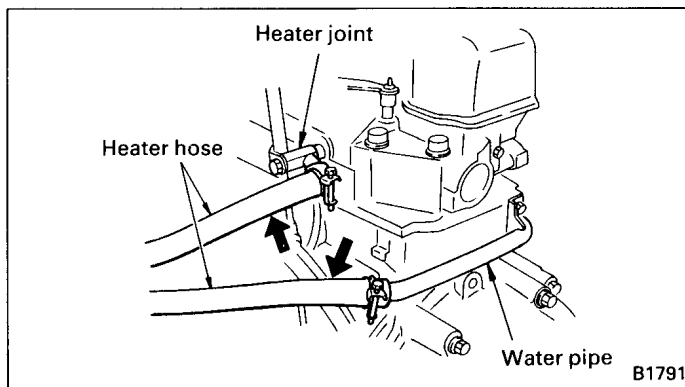
Radiator and Radiator Hose



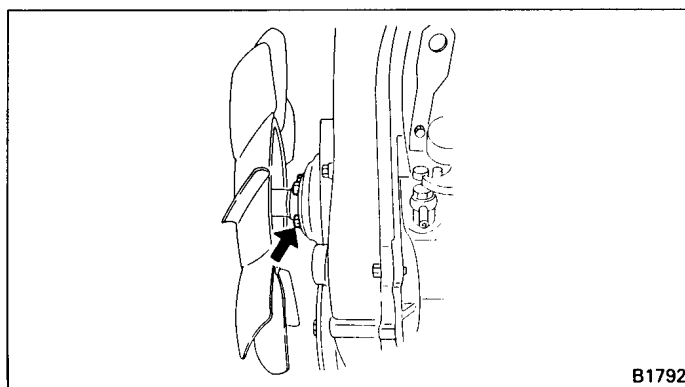
Oil Cooler Piping and Oil Pressure Switch Wiring



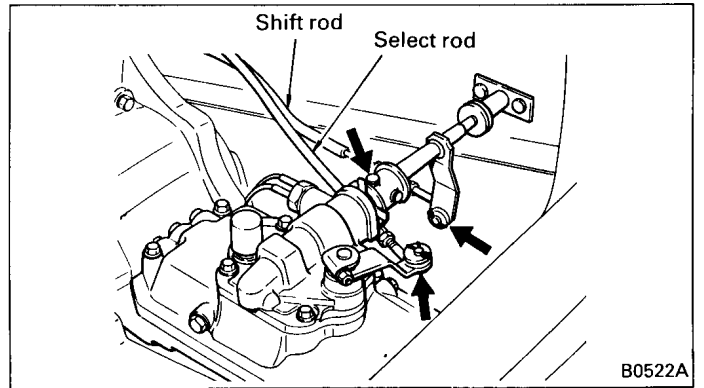
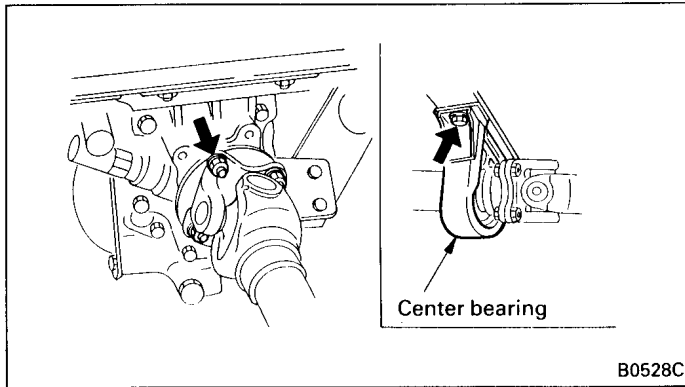
Heater Hose (Engine with Heater)



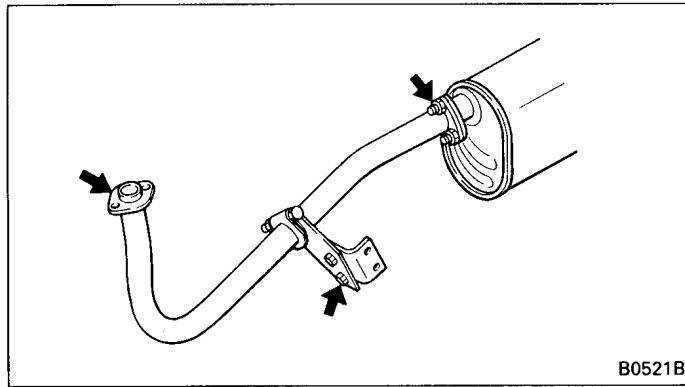
Cooling Fan



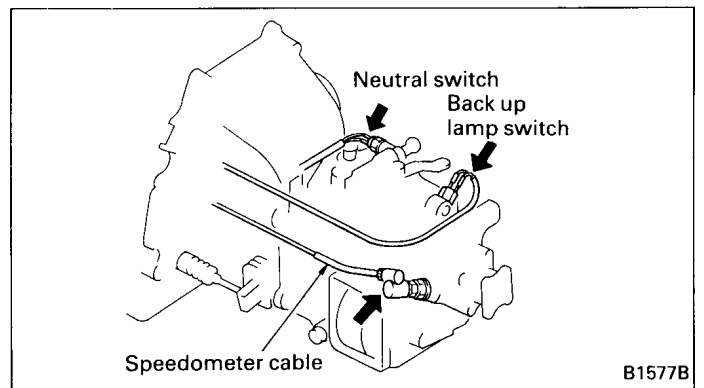
Propeller Shaft



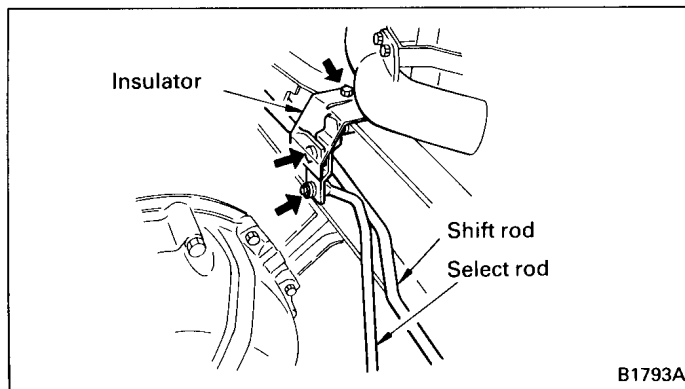
Exhaust Pipe



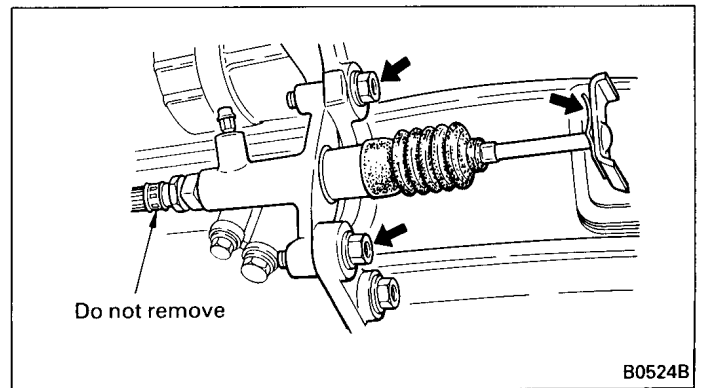
Transmission Wiring



Transmission Control

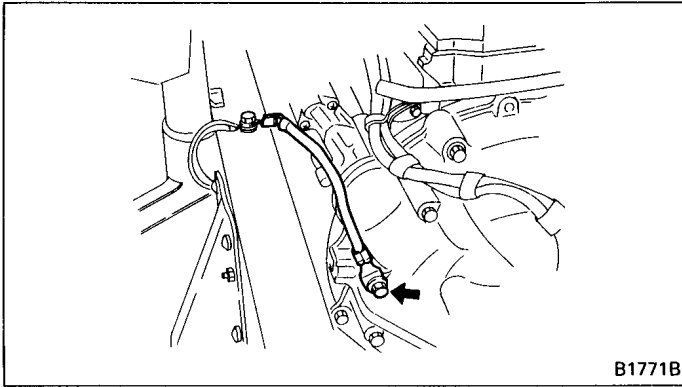


Clutch Power Cylinder



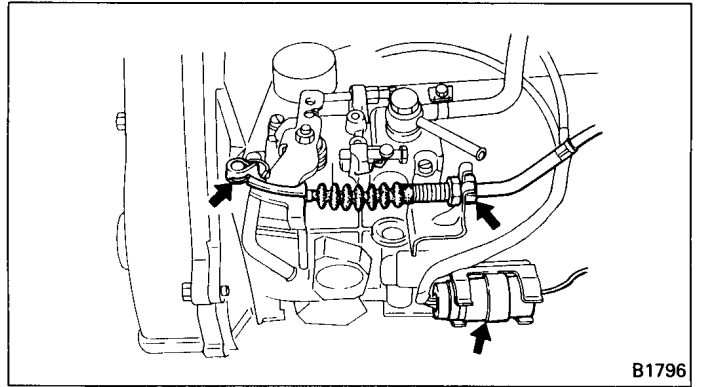
After removal of the ground secure it with a rope or the like.

Engine Ground



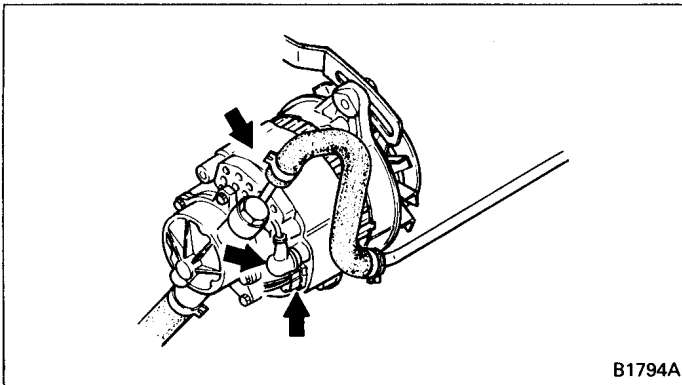
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Accelerator Control Cable and Chassis Wiring



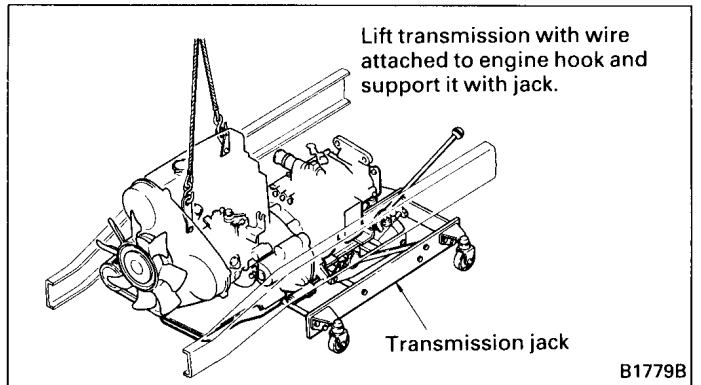
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Alternator



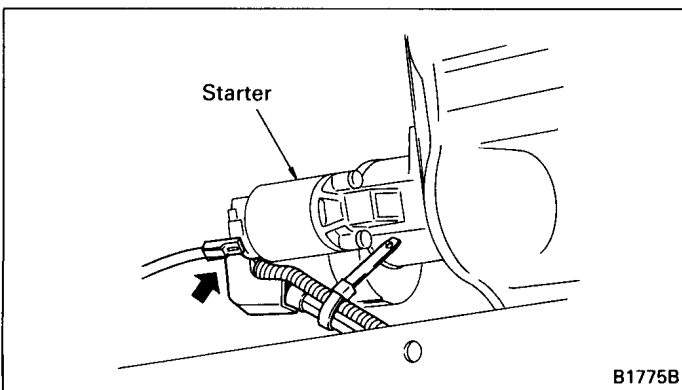
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Supporting of Transmission



B1798B

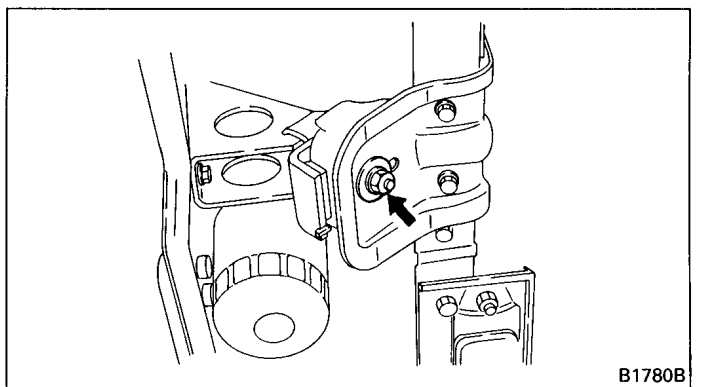
Starter Wiring



B1775B

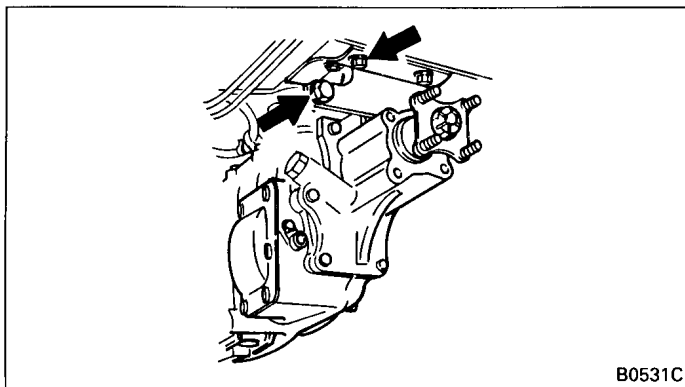
Use engine lifting wire adjustable in length so that the lifting angle may be adjusted for smooth operation.

Front Engine Mount

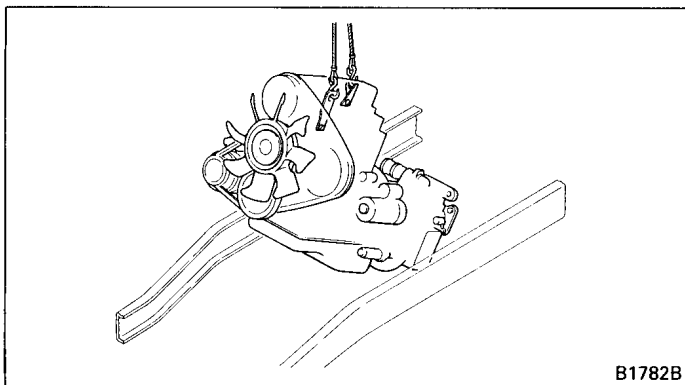


B1780B

Rear Engine Mount



Lifting of Engine



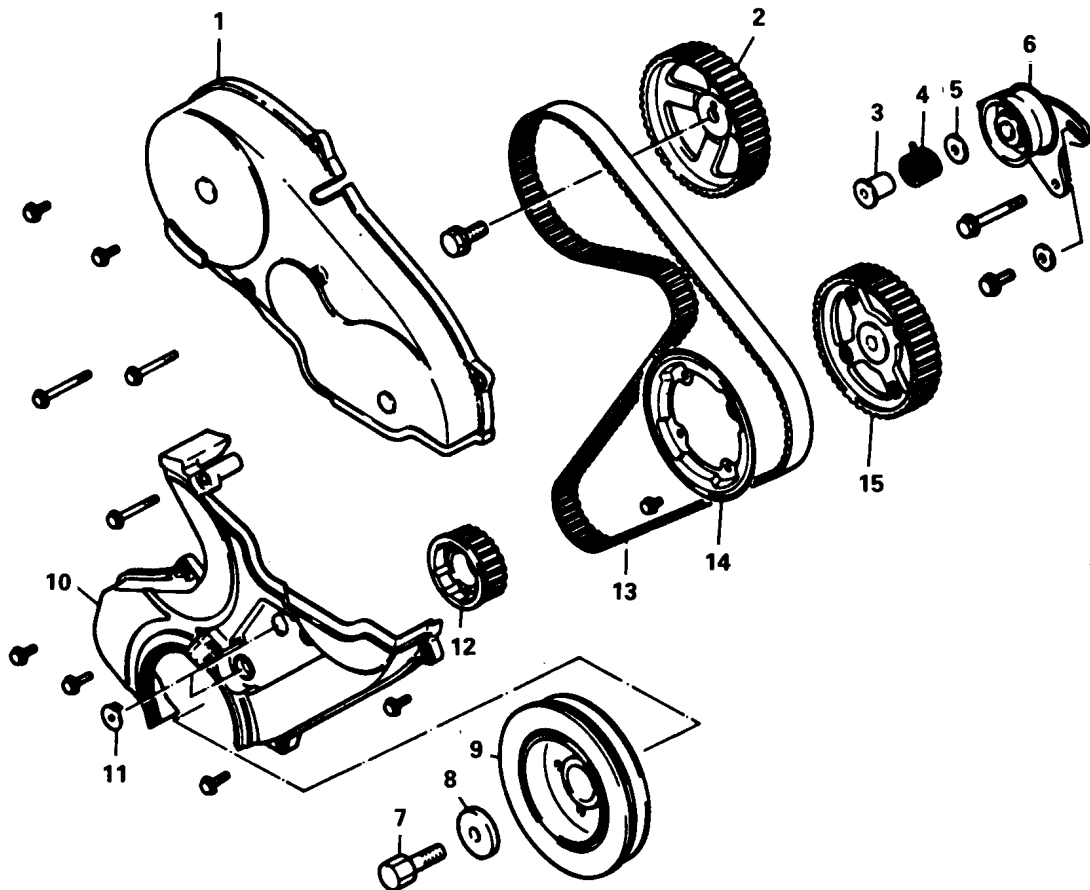
Lift the engine with care not to hit the rear body, cab, etc.

Get the transmission out of the front end of rear body, while the engine lifting angle is finely adjusted. Then, using care not to hit the cab, frame, etc., move the engine sidewise and lower it.

4.4 INSTALLATION

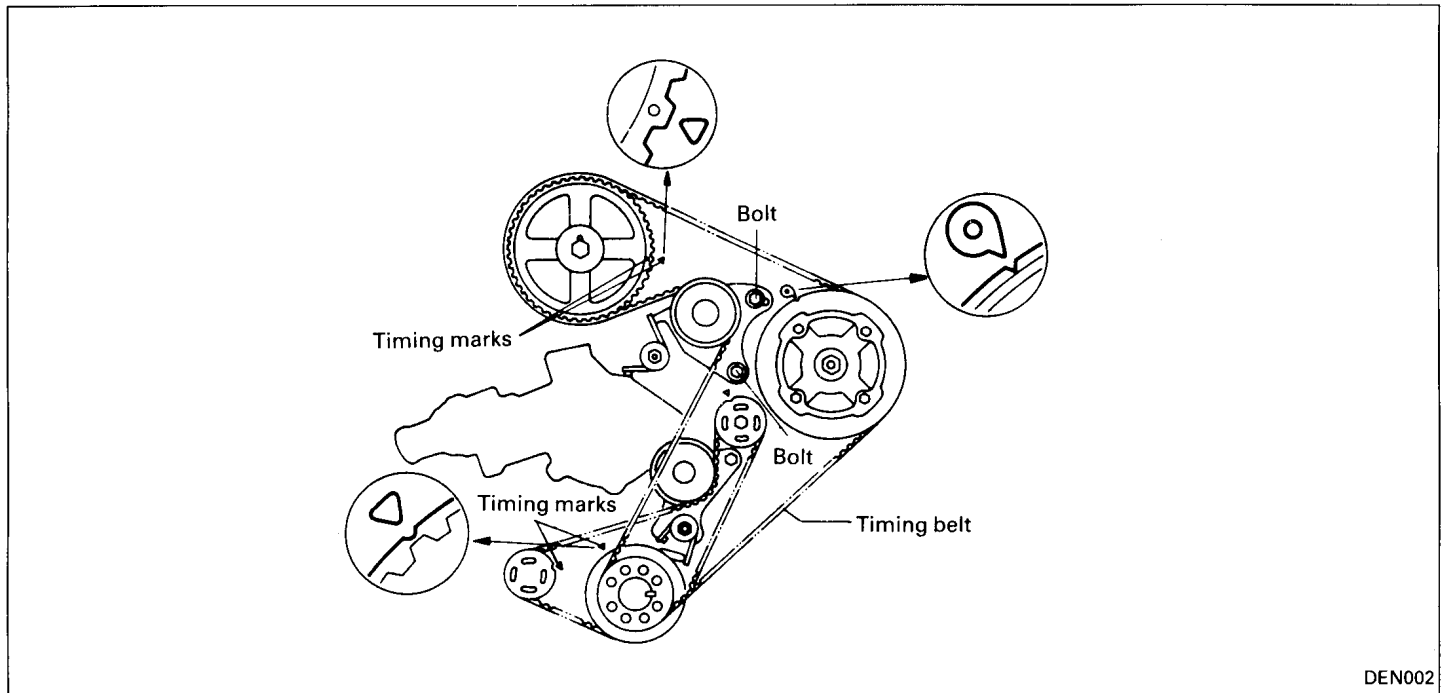
To install the engine, reverse the removal procedure.

5. TIMING BELT

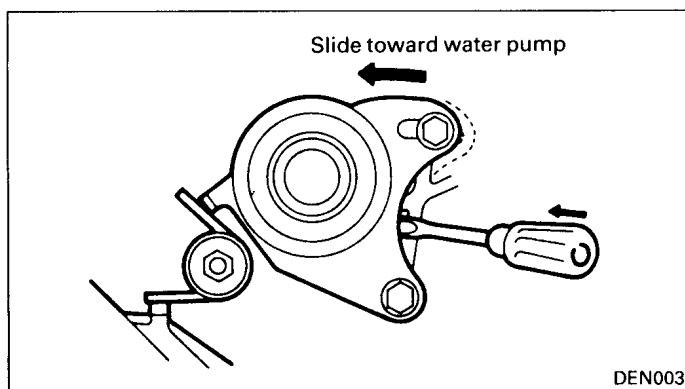


- | | | | |
|---|-------------------------|----|-------------------------|
| 1 | Timing belt upper cover | 9 | Crankshaft pulley |
| 2 | Camshaft sprocket | 10 | Timing belt lower cover |
| 3 | Tensioner spacer | 11 | Access cover |
| 4 | Tensioner spring | 12 | Crankshaft sprocket |
| 5 | Washer | 13 | Timing belt |
| 6 | Timing belt tensioner | 14 | Flange |
| 7 | Bolt | 15 | Injection pump sprocket |
| 8 | Special washer | | |

5.1 REMOVAL



1. Remove the cooling fan, water pump, crankshaft pulley and timing belt cover.
2. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke.
The piston in No. 1 cylinder is at the top dead center on the compression stroke when all timing marks at the three places are aligned as shown in illustration.
3. Using chalk or the like, put an arrow on the back of the timing belt, indicating the direction of drive.



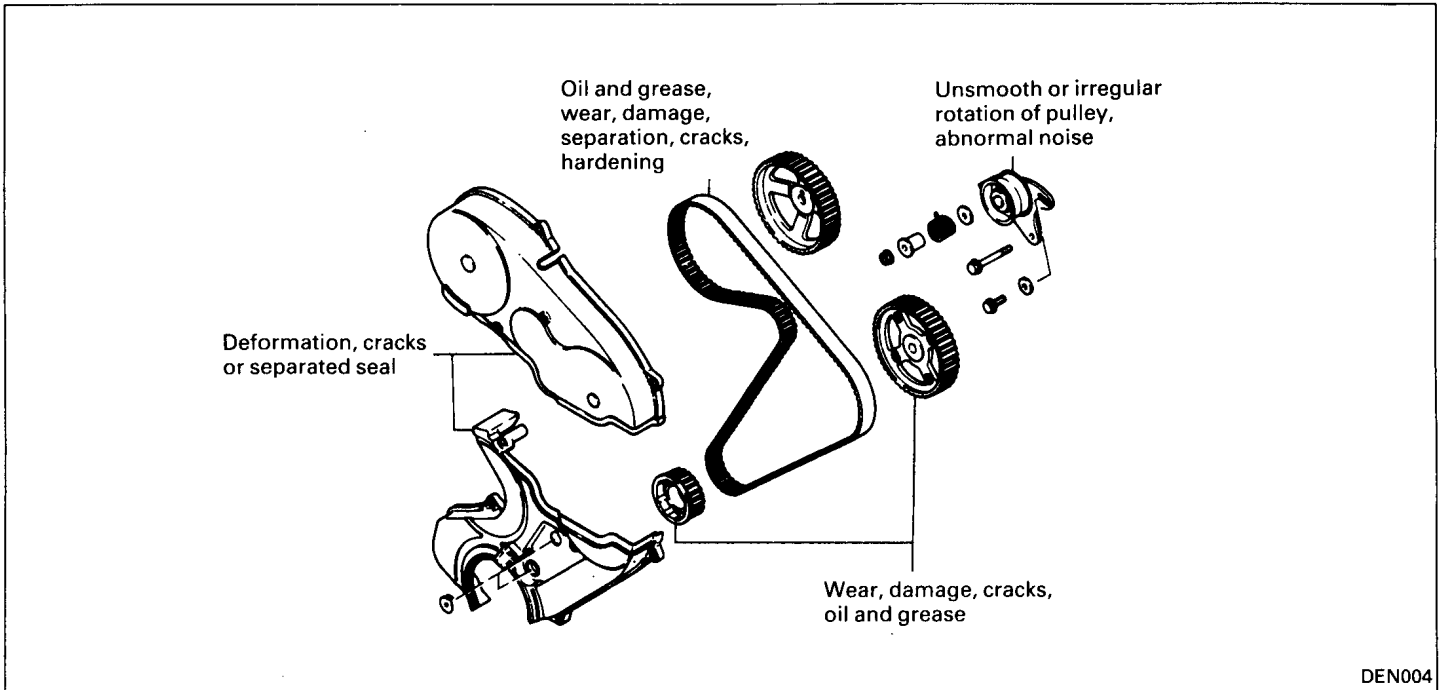
4. Slightly loosen the two bolts securing the tensioner. Then, slide the tensioner toward the water pump and tighten the bolts temporarily to secure the tensioner in place.

5. Remove the timing belt.
6. Loosen the bolt securing the camshaft sprocket and remove the camshaft sprocket.
7. Loosen the nut securing the injection pump sprocket and using a small puller (available commercially) remove the sprocket.
8. Remove the tensioner and tensioner spring.

Caution:

- **Keep the removed parts free from oil and grease.**
- **Do not use detergent to clean the timing belt, sprockets and tensioner. Wipe clean with rag if found dirty. Replace if excessively contaminated by dirt, oil or grease.**

5.2 INSPECTION

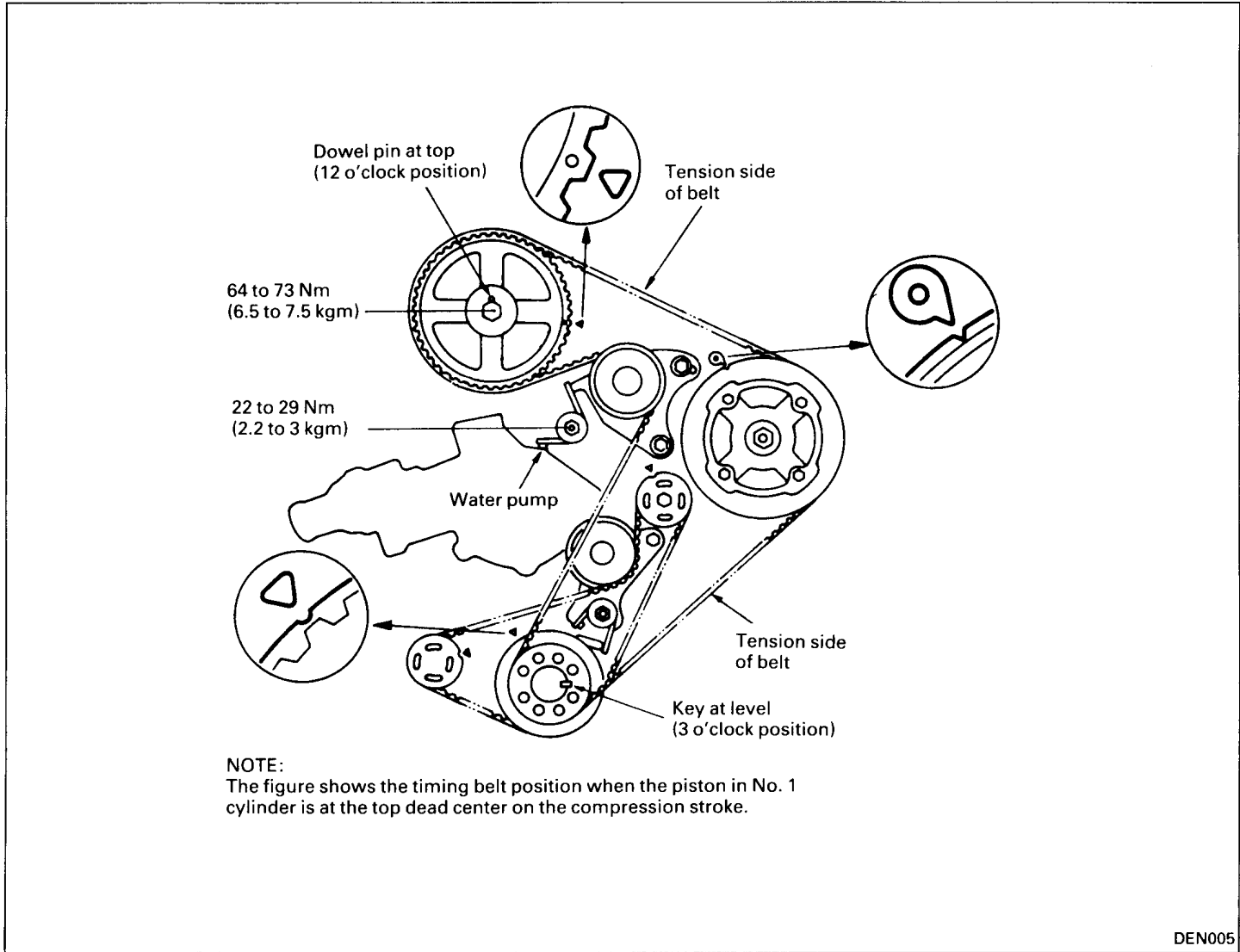


Replace defective parts.

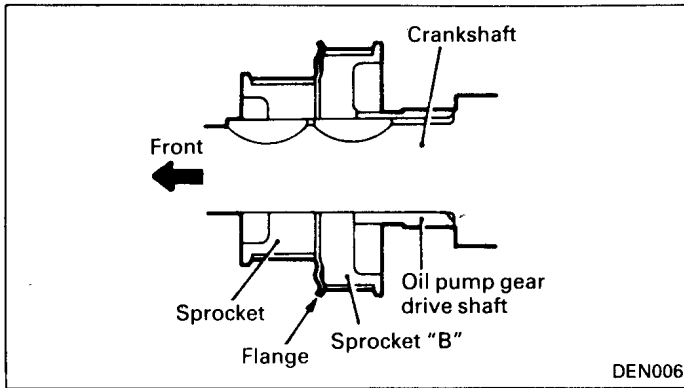
Caution:

- **If trace of oil is found on the parts, check the front case oil seals.**

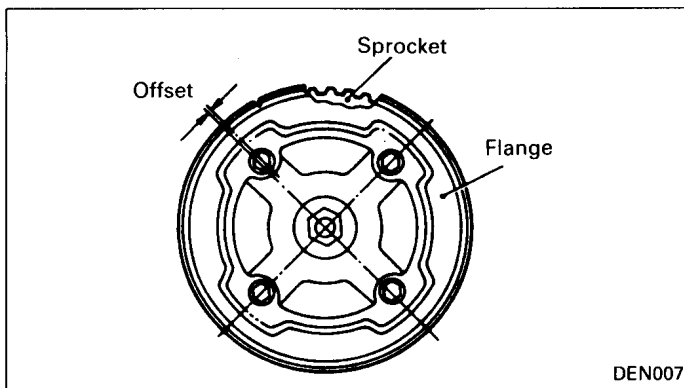
5.3 INSTALLATION



When installing the timing belt "B", pay attention to the following.



1. Mount the crankshaft sprocket to the crankshaft noting the direction of the sprocket as well as the flange.
2. Mount the camshaft sprocket and tighten the flange bolts to specified torque.
3. Mount the injection pump sprocket and tighten the nut to specified torque.



4. Mount the flange to the injection pump sprocket.
5. Mount the tensioner, tensioner spring and tensioner spacer. Shift the tensioner toward the water pump as far as it goes and secure in place temporarily. (See page 11-15.)
6. Correctly align the timing marks of the three sprockets.
7. Engage the timing belt first with the crankshaft sprocket, then with the injection pump sprocket, tensioner and the camshaft sprocket in the order of mention.

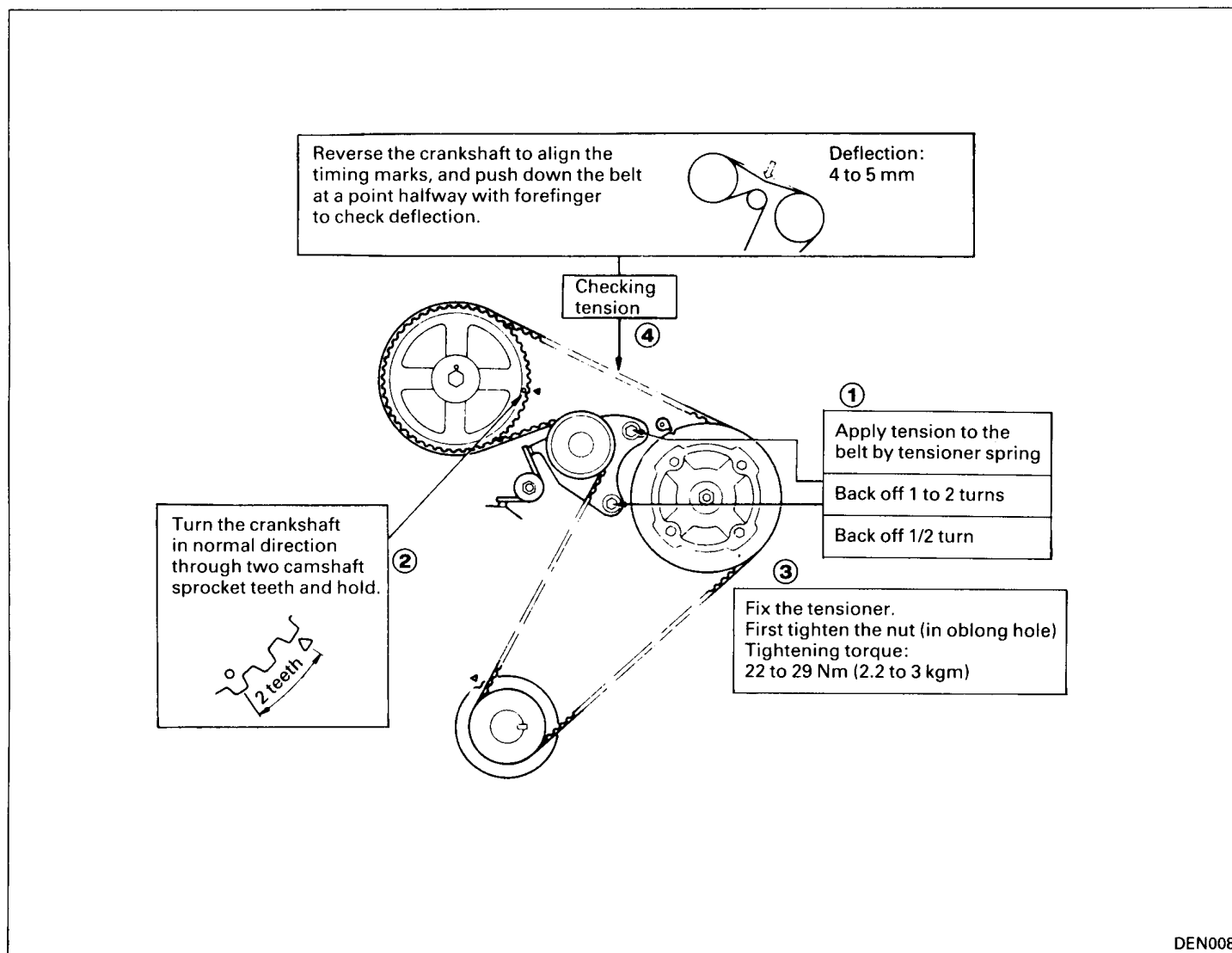
Caution:

- With the tension side kept taut, engage the belt with each sprocket.
- When aligning the timing marks, the injection pump sprocket tends to rotate itself. Therefore, engage the belt, holding the sprocket to prevent rotation.
- When refitting the belt, note the arrow put on its back during disassembly to indicate the direction of drive.

8. Adjust the belt tension.
9. Mount the timing belt covers.
10. Mount the crankshaft pulley, washer and bolt and torque the bolt to 167 to 186 Nm (17 to 19 kgm).

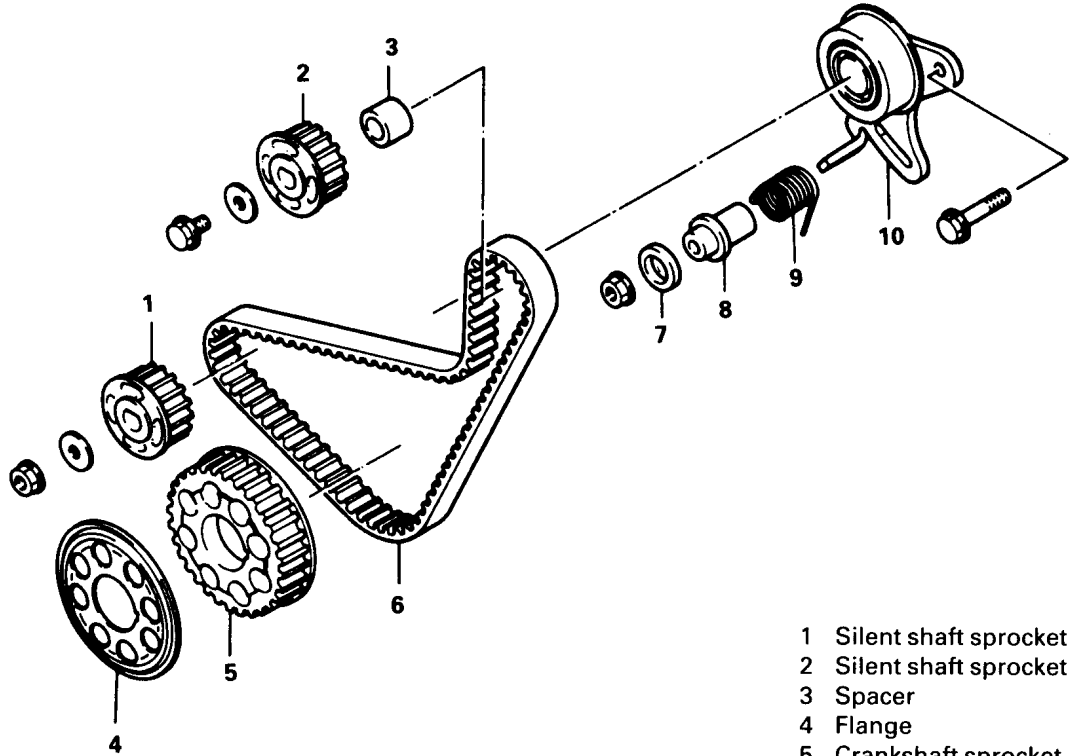
5.4 ADJUSTING TIMING BELT TENSION

Adjust the belt tension as follows (carry out the steps in numerical order).

**Caution:**

- **Crankshaft rotation ② is necessary to give specified tension to the tension side of the belt.**
Turn the crankshaft through exactly two camshaft sprocket teeth.
- **Do not turn the crankshaft in the reverse direction.**
- **During adjustment, do not touch the belt.**

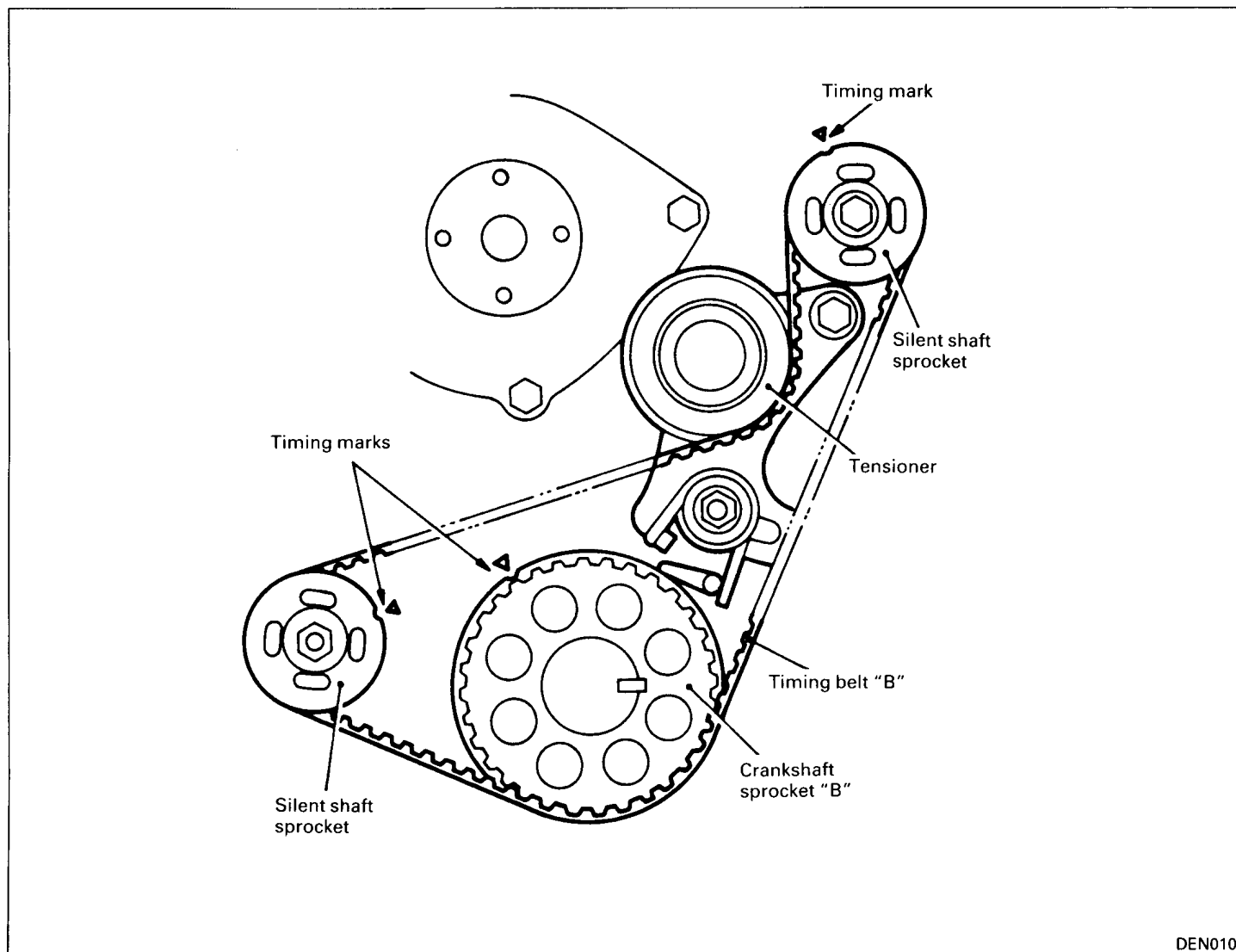
6. TIMING BELT “B”



- 1 Silent shaft sprocket (right)
- 2 Silent shaft sprocket (left)
- 3 Spacer
- 4 Flange
- 5 Crankshaft sprocket "B"
- 6 Timing belt "B"
- 7 Gasket
- 8 Tensioner spacer
- 9 Tensioner spring
- 10 Timing belt "B" tensioner

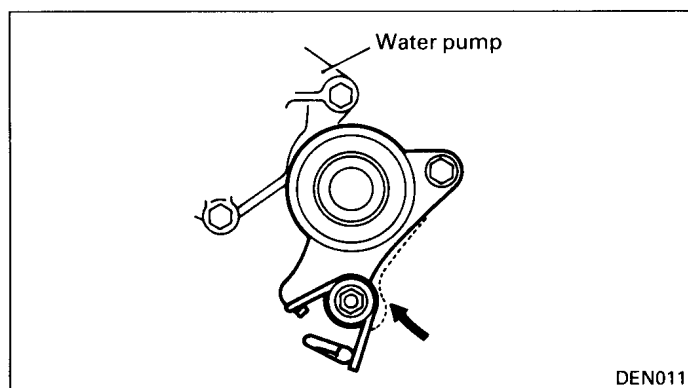
DEN009

6.1 REMOVAL

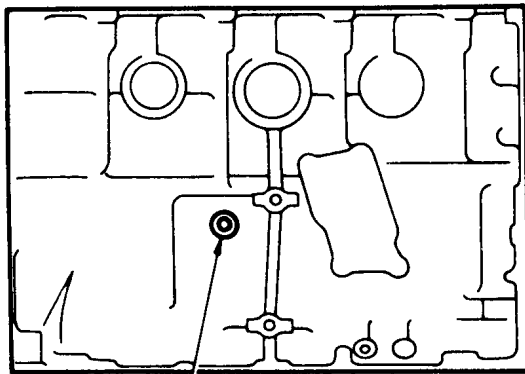
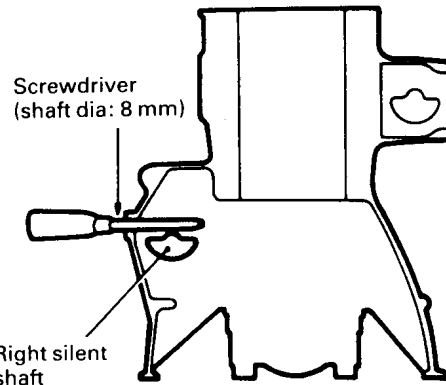


DEN010

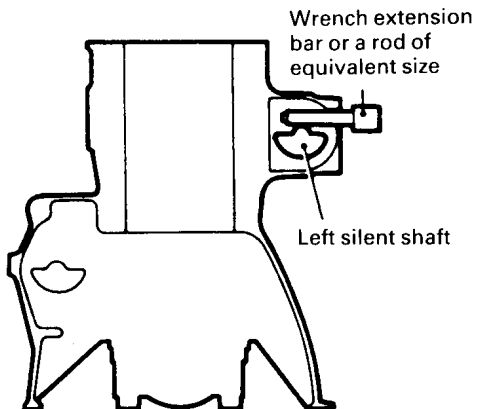
1. Remove the timing belt. (See the preceding section.)
2. Using chalk or the like, put an arrow on the back of the timing belt "B" to indicate the direction of drive.
3. Slightly loosen the bolts and nuts securing the tensioner. Then, slide the tensioner toward the water pump and tighten the nuts to secure the tensioner in place temporarily.
4. Remove the timing belt "B".
5. Remove the crankshaft sprocket "B".



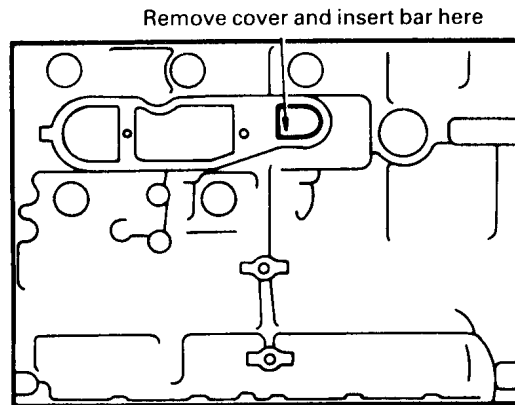
DEN011

Cylinder block,
right sideRemove this plug and insert
screwdriverScrewdriver
(shaft dia: 8 mm)Right silent
shaft

DEN012

Wrench extension
bar or a rod of
equivalent size

Left silent shaft



Remove cover and insert bar here

Cylinder block, left side

DEN013

6. Remove the two silent shaft sprockets. When loosening the sprocket nut and bolt, hold the silent shaft as shown in illustration to prevent the shaft from turning with them.

Caution:

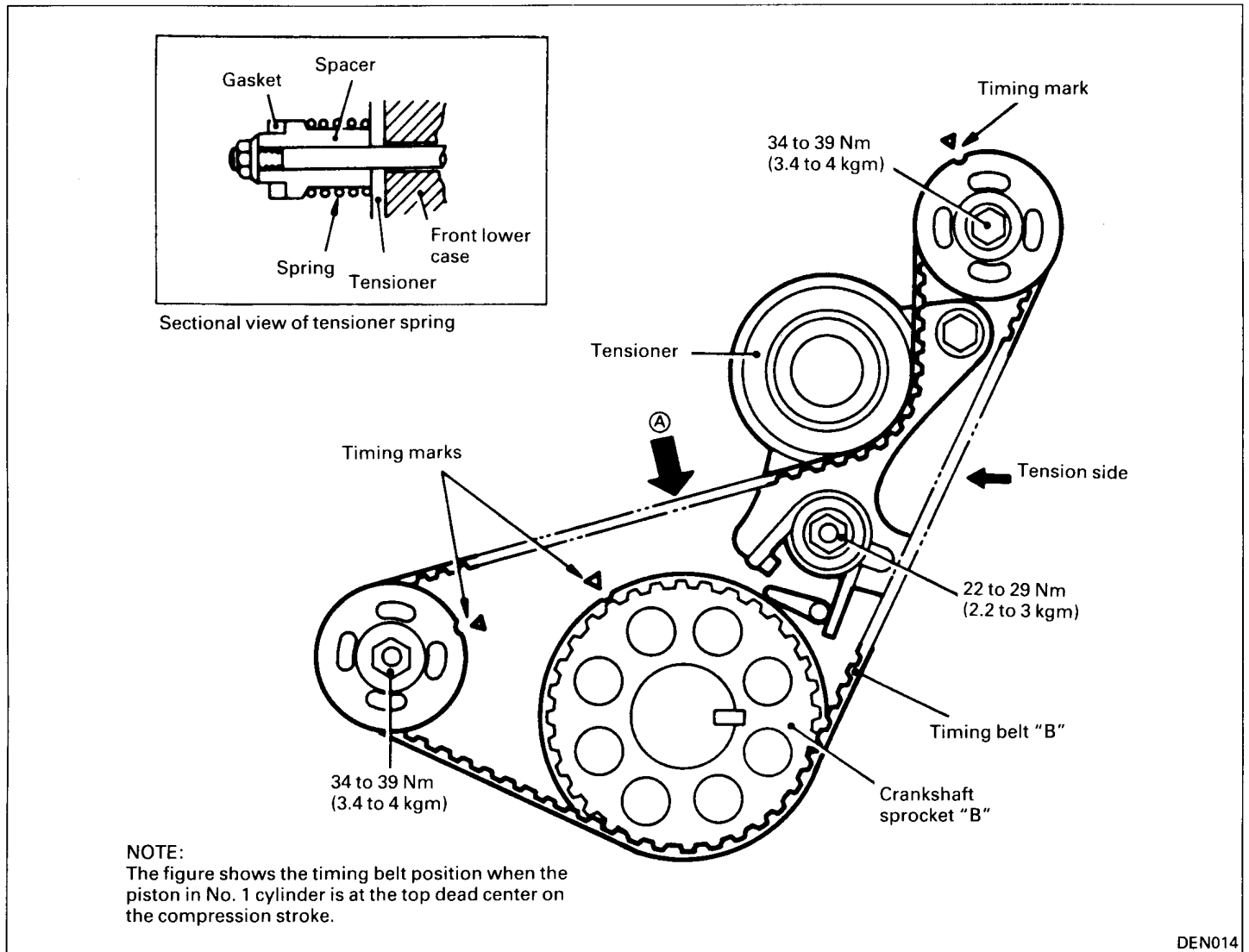
- **Keep the removed parts free from oil and grease.**
- **Do not use detergent to clean the timing belt “B”, sprocket and tensioner. Wipe clean with rag if found dirty. Replace if excessively contaminated with dirt, grease or oil.**

6.2 INSPECTION

See the preceding section. Inspection of “Timing Belt”.

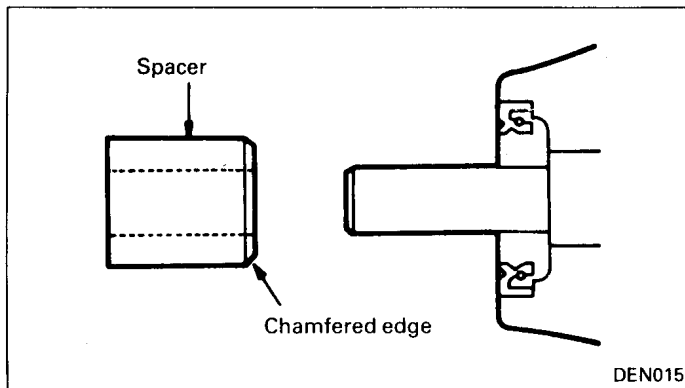
6.3 INSTALLATION

When installing the timing belt “B”, pay attention to the following.



DEN014

1. Mount the crankshaft sprocket “B” to the crankshaft, noting the direction of the sprocket “B”. (See page 11-18.)



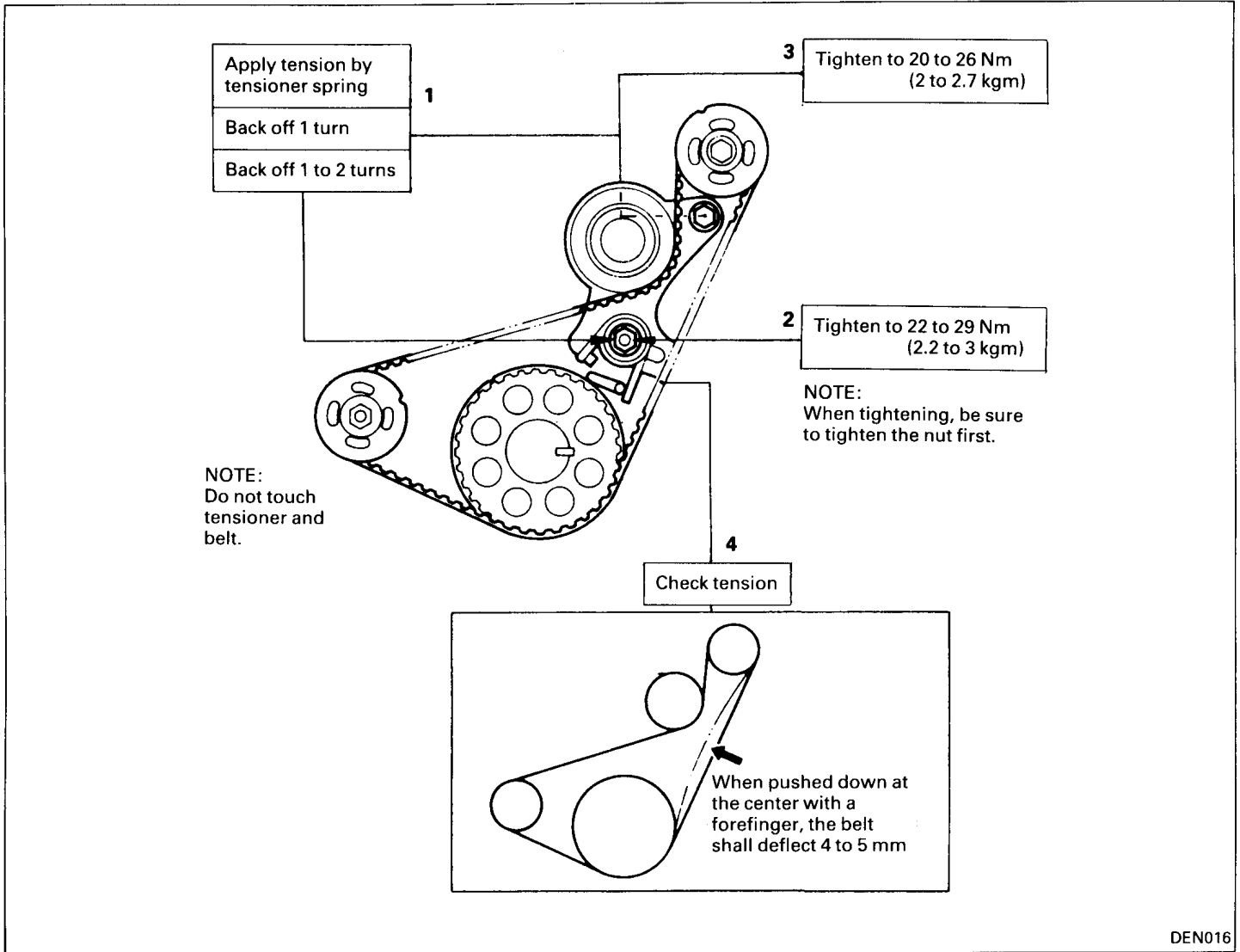
2. Mount the spacer to the left silent shaft, with its chamfered end toward the oil seal. Note that mounting the spacer in opposite direction will result in damaged oil seal.
3. Mount the two silent shaft sprockets and tighten the nuts and bolts to specified torque while holding the silent shafts to prevent from turning with them. (See page 11-22.)
4. Mount the tensioner, tensioner spring and spacer. Shift the tensioner toward the water pump as far as it goes and secure it in place temporarily. (See page 11-21.) Be sure to install the gasket. (See page 11-23.)
5. Align the timing marks of sprockets. (See page 11-23.)
6. With the tension side kept taut, engage the timing belt “B” with the sprockets.

Caution:

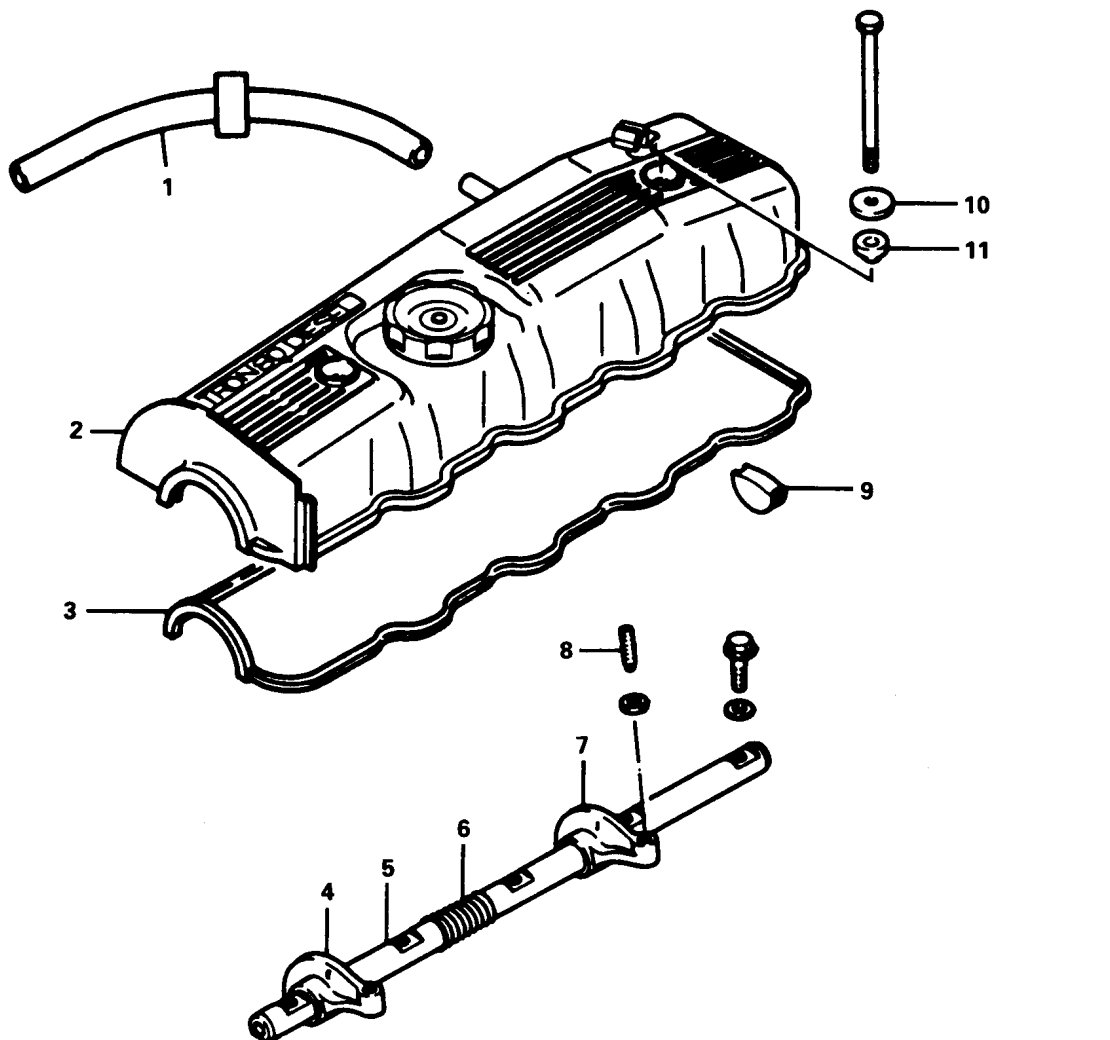
- **When reusing the belt, install it noting the arrow put on its back during dis-assembly to show the direction of drive.**
7. With the slack side of the timing belt “B” pushed down with a finger (at a point indicated by an arrow Ⓐ in illustration on page 11-23) to keep the tension side tight, check that all of the timing marks are properly aligned.
 8. Adjust the tension of the timing belt “B”.

6.4 ADJUSTING TIMING BELT “B” TENSION

Adjust the belt tension paying attention to the following.



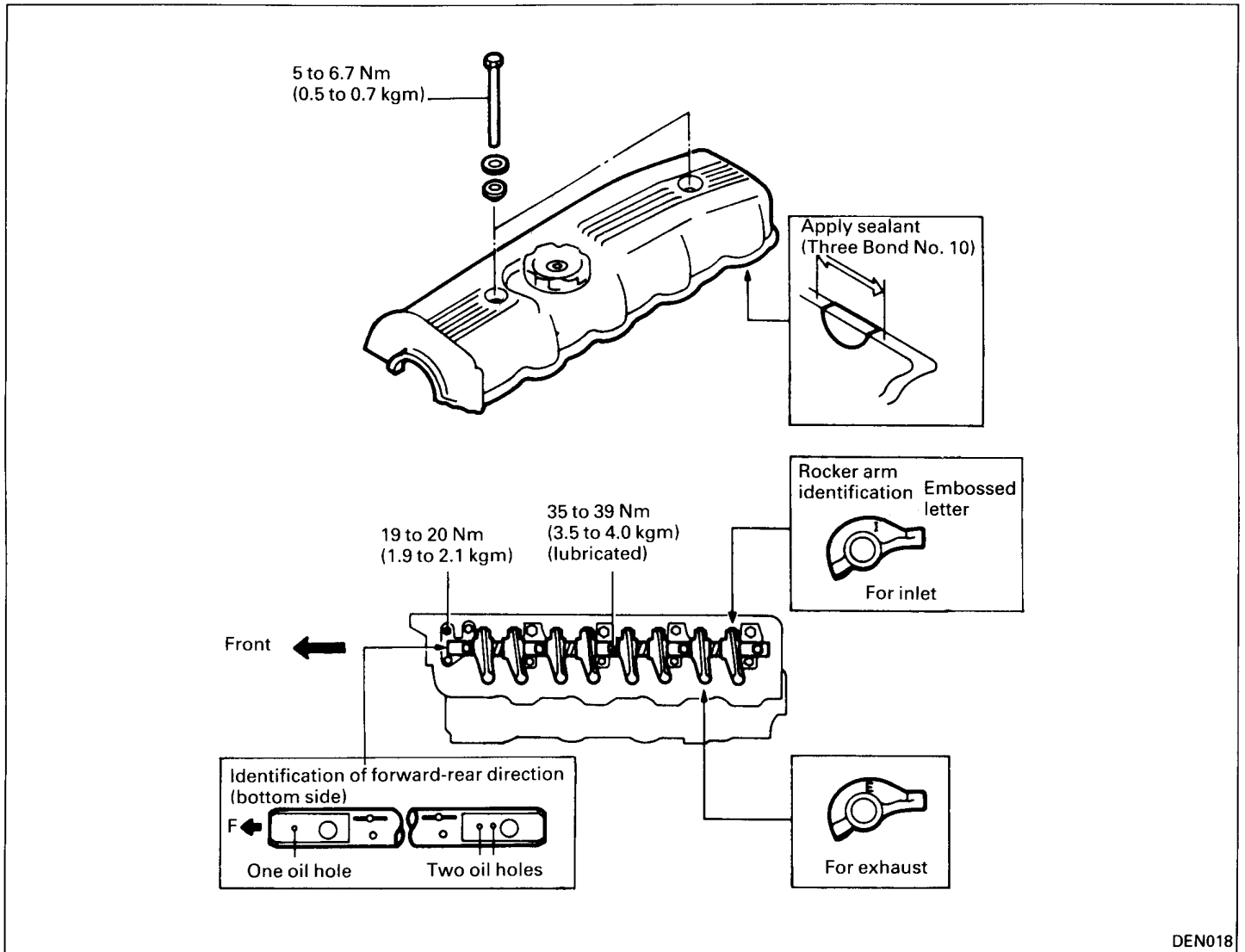
7. ROCKER ARM AND ROCKER SHAFT



- | | |
|------------------------|------------------------|
| 1 Breather hose | 7 Rocker arm (inlet) |
| 2 Rocker cover | 8 Adjust screw |
| 3 Rocker cover gasket | 9 Semicircular packing |
| 4 Rocker arm (exhaust) | 10 Seal |
| 5 Rocker shaft | 11 Special washer |
| 6 Rocker shaft spring | |

7.1 REMOVAL AND INSTALLATION

When removing or installing, pay attention to the following.

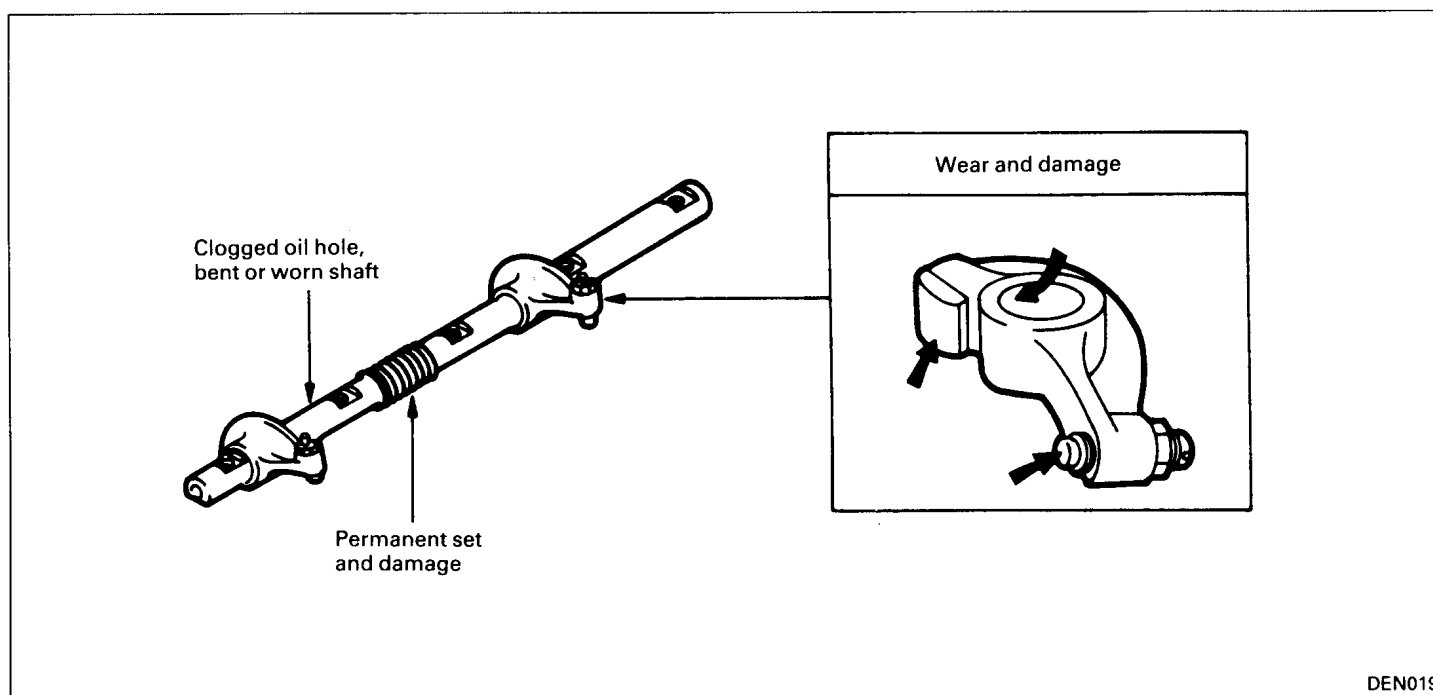


DEN018

1. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke. This reduces the cam lift to minimum and facilitates installation.
2. After installation, adjust the valve clearance.

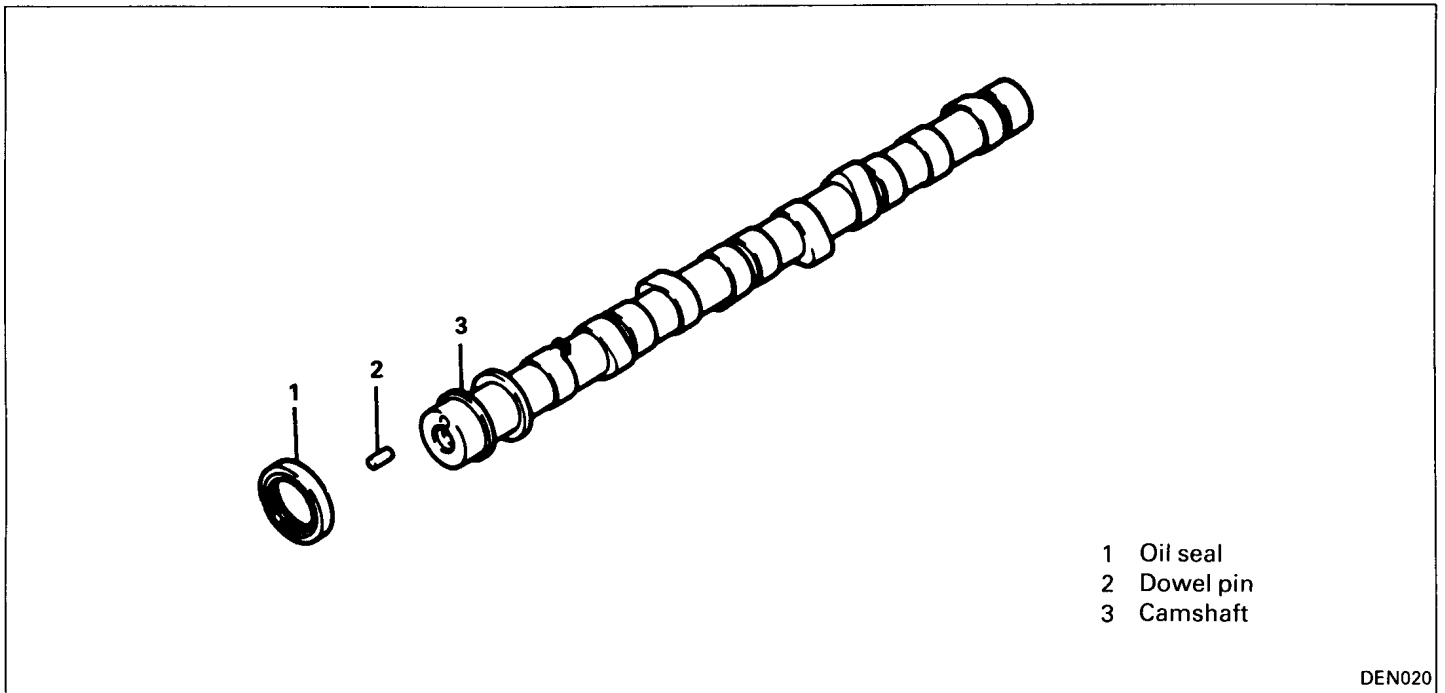
7.2 INSPECTION

Replace defective parts.



DEN019

8. CAMSHAFT

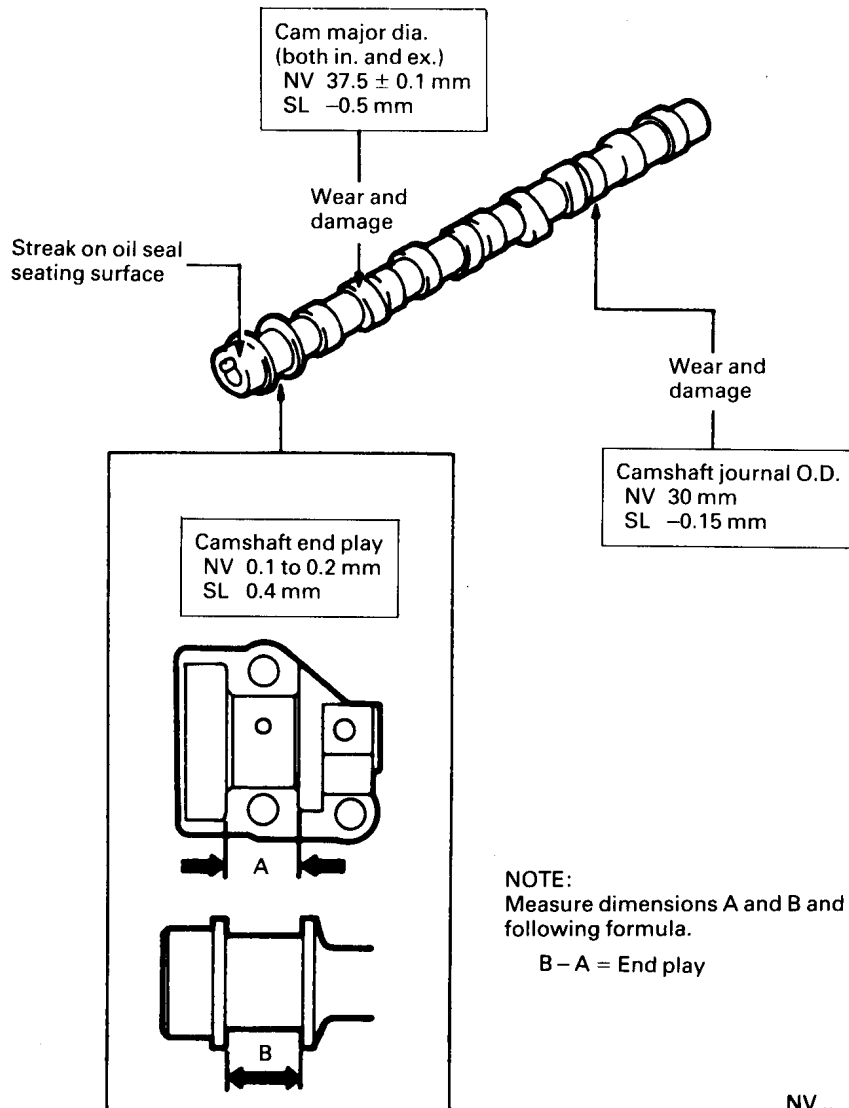


8.1 REMOVAL

1. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke. (The piston in cylinder is at the top dead center on the compression stroke when the dowel pin is at the topmost.)
2. Remove the timing belt upper cover. With the timing belt as installed, remove the camshaft sprocket, and place on the timing belt lower cover.
3. Remove the rocker shaft assembly.
4. Remove the camshaft bearing cap and take out the camshaft.

8.2 INSPECTION

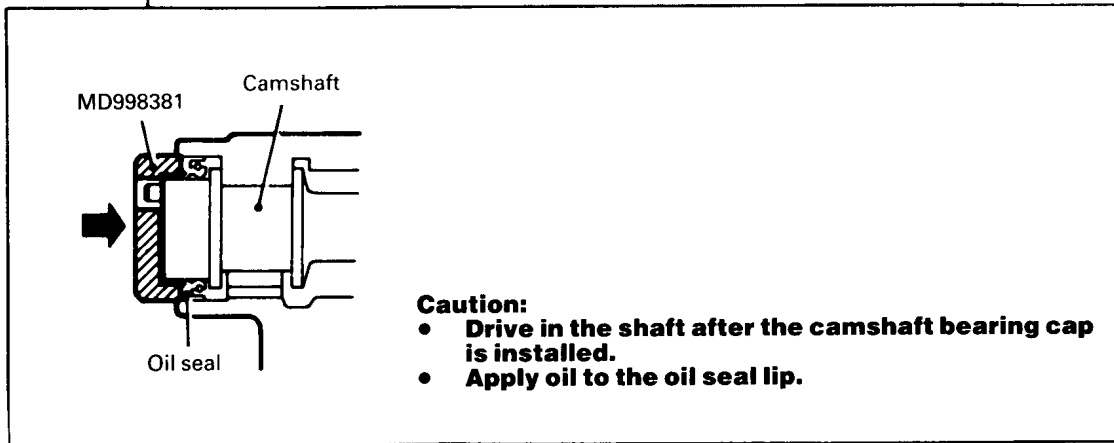
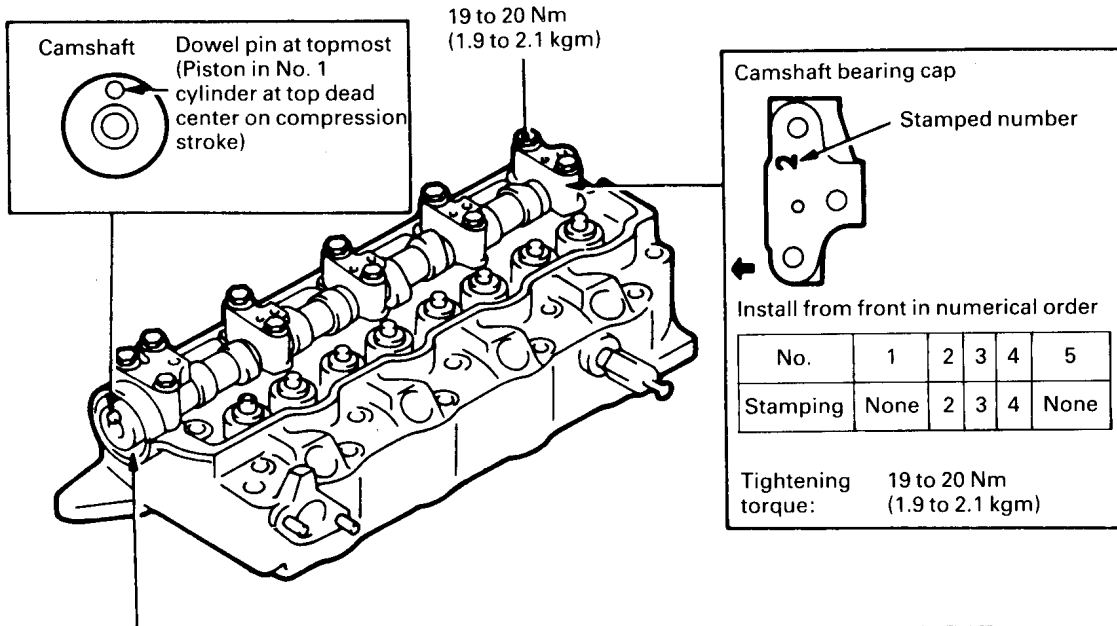
Check the camshaft and replace it defective.



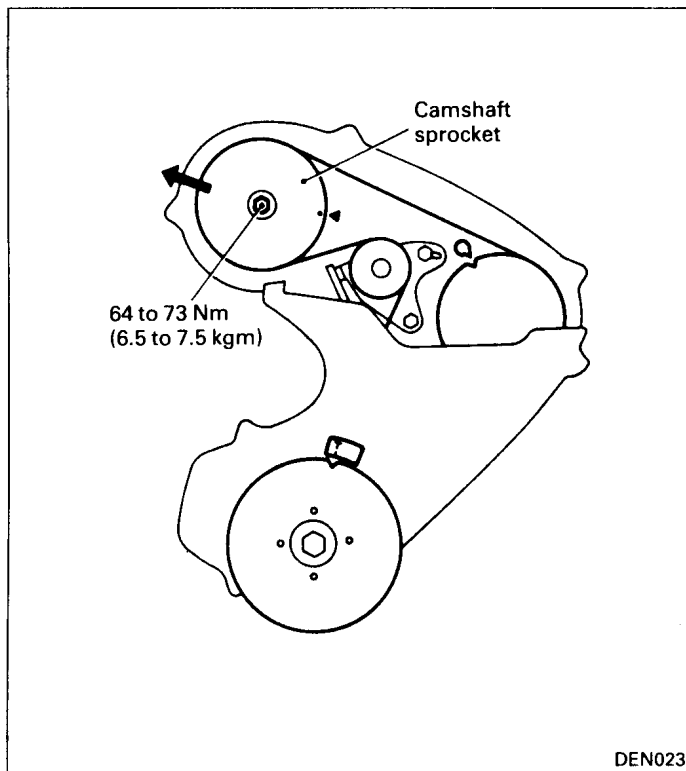
NV.. Nominal Value
SL.. Service Limit

8.3 INSTALLATION

Install the camshaft paying attention to the following.

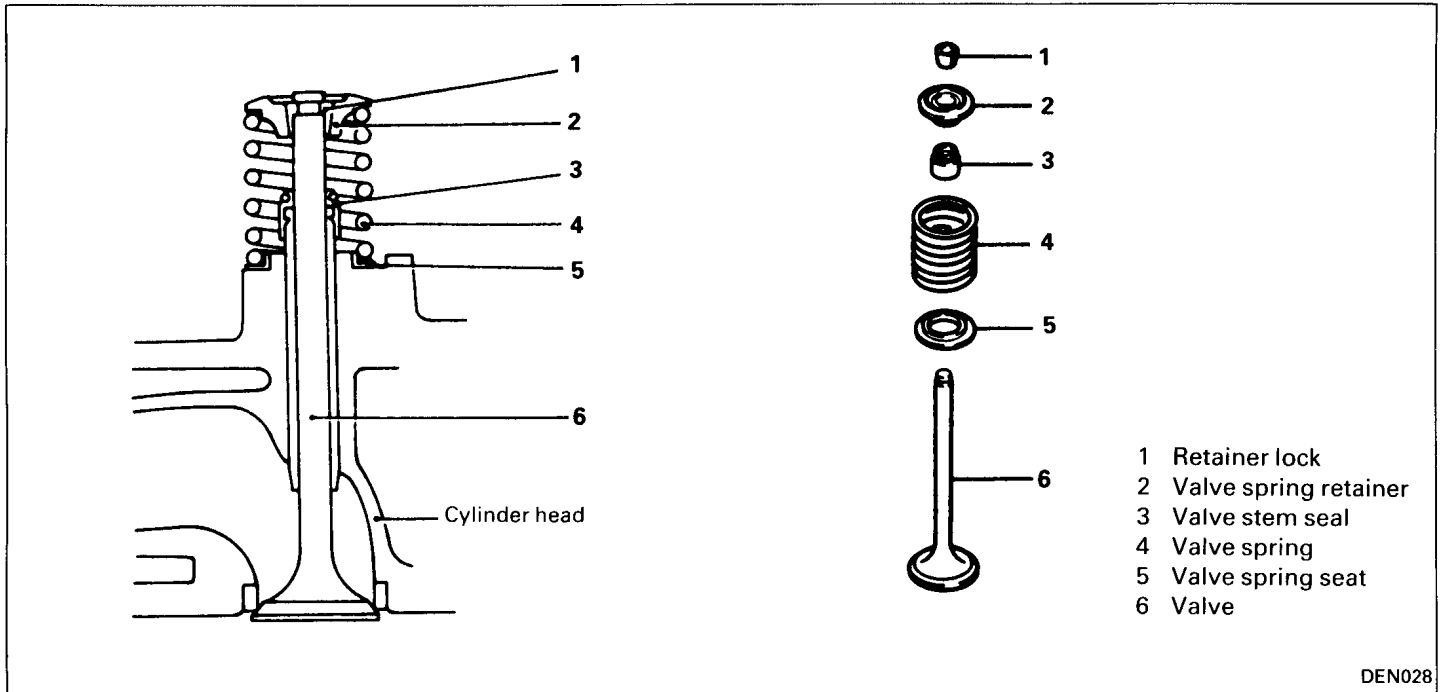


1. Install the rocker shaft assembly.
2. Make sure that the timing marks on the crank pulley and the pump sprocket are aligned. Then, install the camshaft sprocket while pulling it firmly in the direction of the arrow.

**Caution:**

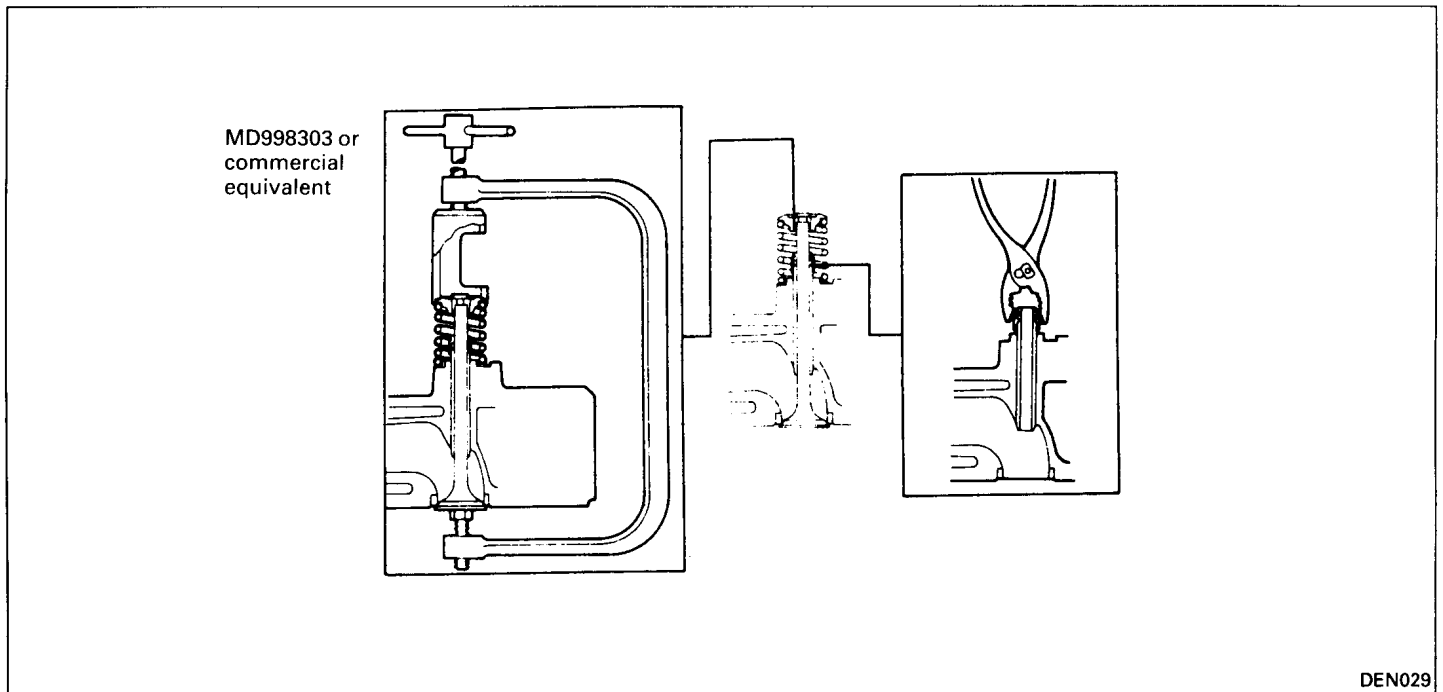
- **The injection pump sprocket tends to rotate causing misalignment of timing marks. Be sure to check alignment of the timing marks after the installation.**
- **After installation, check the belt tension and readjust as necessary.**
- **Check the valve clearance and adjust as necessary.**

9. VALVE AND VALVE SPRING



9.1 REMOVAL

1. Remove the cylinder head assembly.



2. Remove the parts as illustrated above and store them separately for each cylinder.

9.2 INSPECTION AND CORRECTION

Check and correct or replace parts if defective.

Permanent set and damage

| | NV | SL |
|-------------|-------------------------------|-------|
| Free length | 49.1 mm | -1 mm |
| Load | 270.7 N (27.6 kg)/ 40.4 mm | - |
| Squareness | 1°30' max. | 3° |

Margin
NV 2 mm
SL 1 mm

Stepped wear and damage

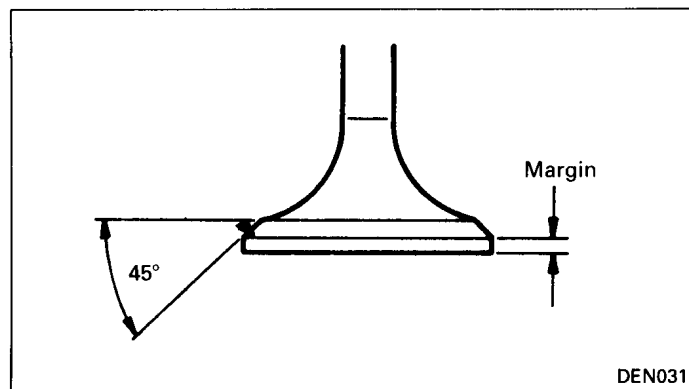
Dent and damage

Contact and wear

NV .. Nominal Value
SL .. Service Limit

DEN030

Correcting Valve Face



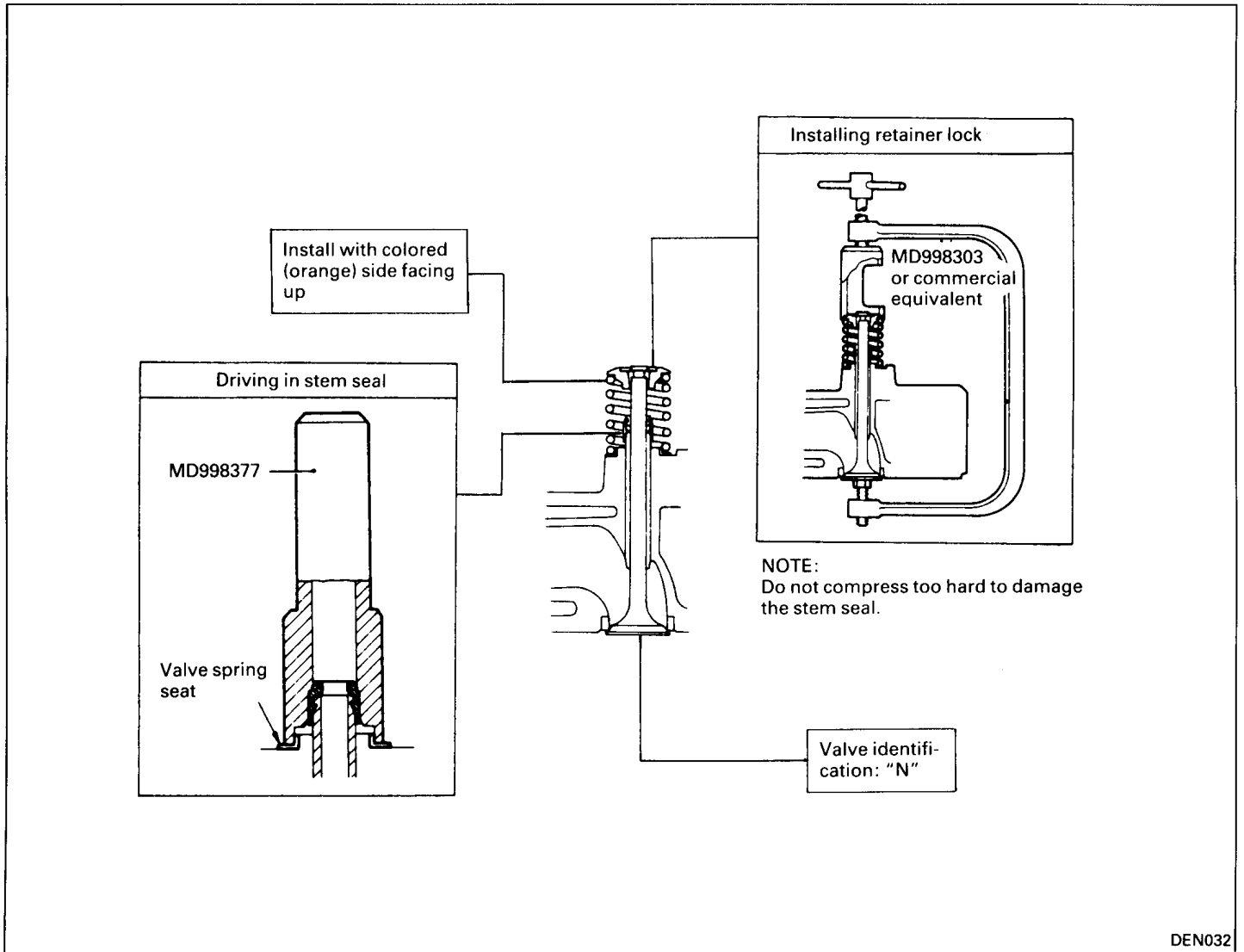
Correct worn valve face with a valve refacer. If the margin after correction is not within the service limit, replace the valve.

Correcting Valve Stem End

Correct worn or dented stem end to the minimum necessary degree using a valve refacer, oilstone or other tool.

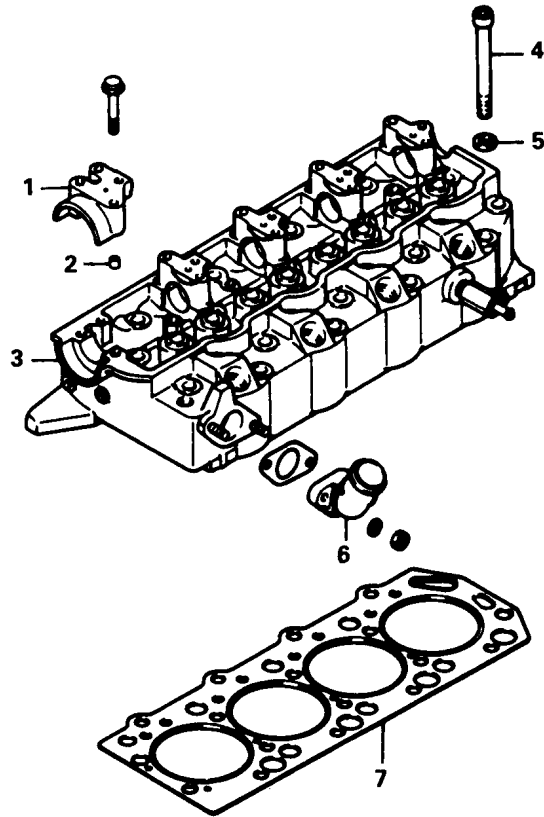
9.3 INSTALLATION

1. In the installation, pay attention to the following.

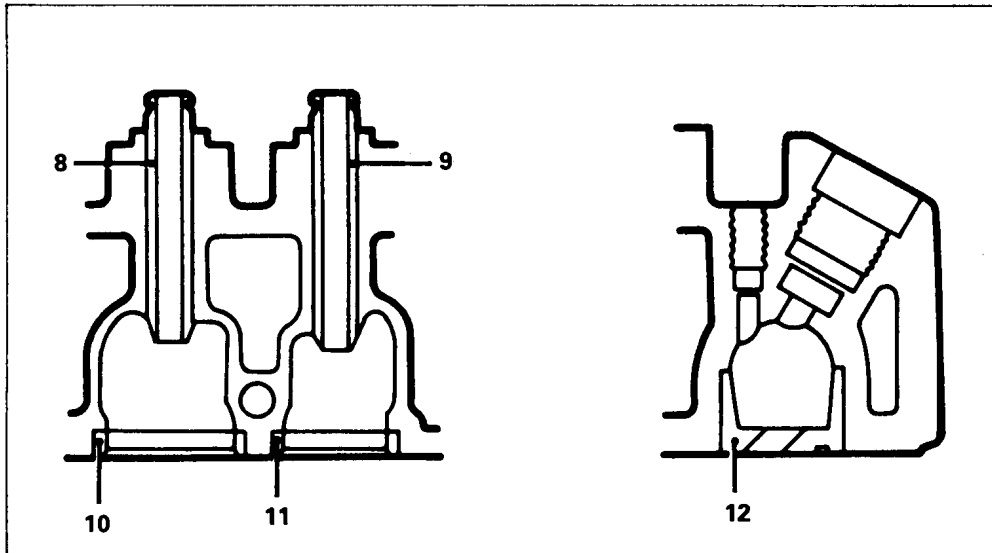


2. Install the cylinder head assembly.
3. Adjust the valve clearance.

10. CYLINDER HEAD



- 1 Camshaft bearing cap
- 2 Bushing knock
- 3 Cylinder head
- 4 Cylinder head bolt
- 5 Washer
- 6 Water outlet fitting
- 7 Cylinder head gasket
- 8 Valve guide (In.)
- 9 Valve guide (Ex.)
- 10 Seat ring (In.)
- 11 Seat ring (Ex.)
- 12 Combustion chamber jet



10.1 REMOVAL

1. Remove the injection pipe assembly. When loosening, the injection pipe nut, hold the nozzle holder and the delivery valve holder with a spanner to prevent them from turning with the nut.

Caution:

- **After the injection pipe is removed, put a cap on the nozzle holder and the delivery valve holder to prevent ingress of dust and foreign matter.**

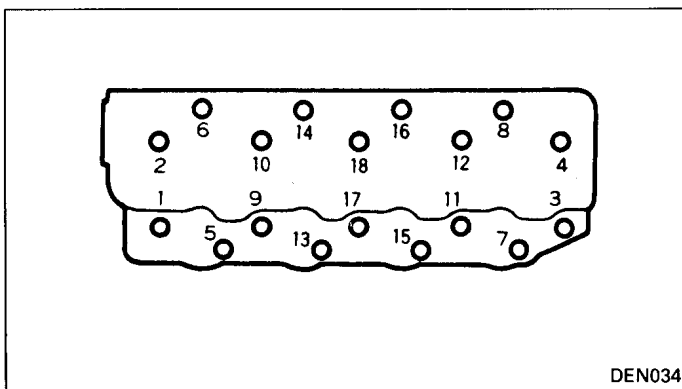
2. Remove the timing belt upper cover.
3. Loosen the camshaft sprocket bolt to such an extent that it can be further loosened with fingers.
4. Bring the piston in No. 1 cylinder to the top dead center on the compression stroke. Align the timing mark on the camshaft sprocket with that made on the upper case. (See page 11-17.)
5. Manually remove the camshaft sprocket bolt.
6. With the timing belt engaged, remove the sprocket from the camshaft and place the assembly on the timing belt lower cover.

Caution:

- **Do not turn the crankshaft once the sprocket is removed.**
- **Keep the timing belt taut.**

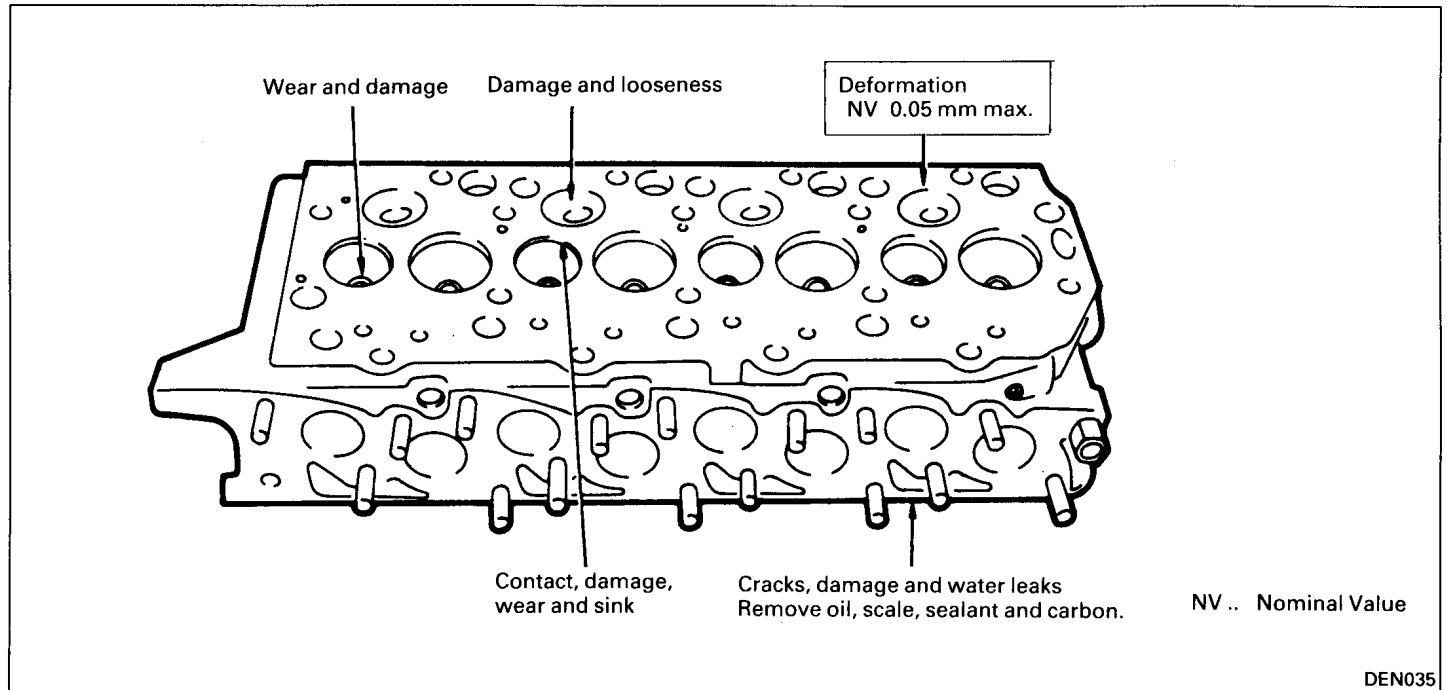
7. Remove the rocker cover, rocker arm shaft assembly and camshaft.

8. Using the special tool Cylinder Head Bolt Wrench (MD998051), loosen 18 cylinder head bolts and remove them. Loosen the bolts in the sequence shown in illustration and in two to three steps.
9. Remove the cylinder head.
10. Remove the cylinder head gasket. Clean the cylinder head and cylinder block gasket surfaces.



10.2 INSPECTION AND CORRECTION

Check the cylinder head and correct or replace if defective.

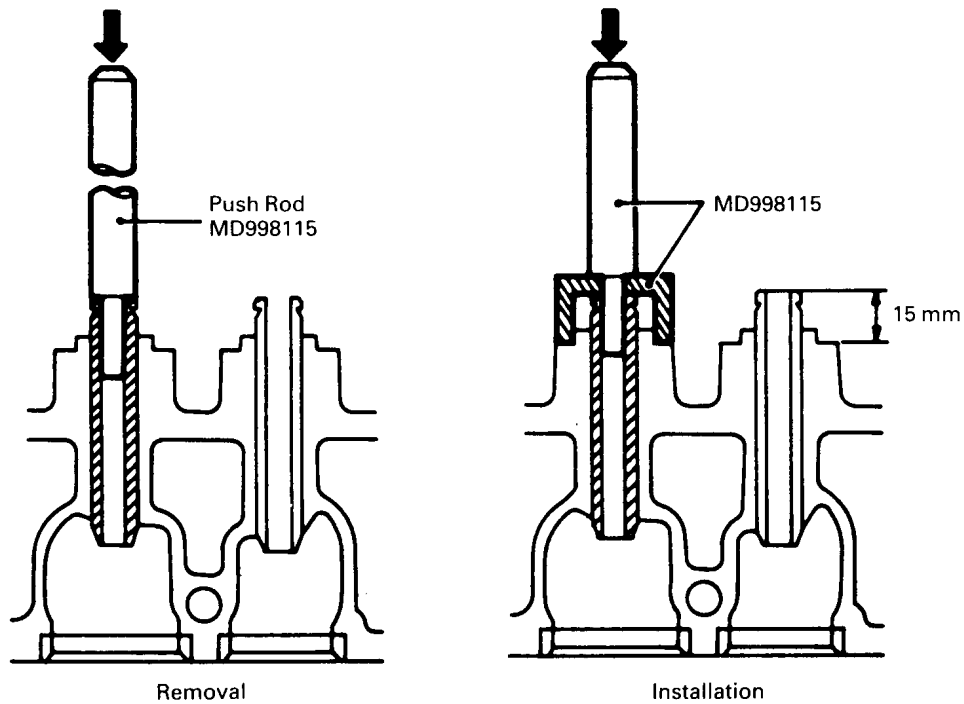


10.3 REPLACING VALVE GUIDE

Replace defective valve guide with O.S. part.

Valve guide service size

| Size | Symbol | Cylinder head bore |
|--------------|--------|---------------------|
| 0.05 mm O.S. | 5 | 13.050 to 13.068 mm |
| 0.25 mm O.S. | 25 | 13.250 to 13.268 mm |
| 0.50 mm O.S. | 50 | 13.500 to 13.518 mm |



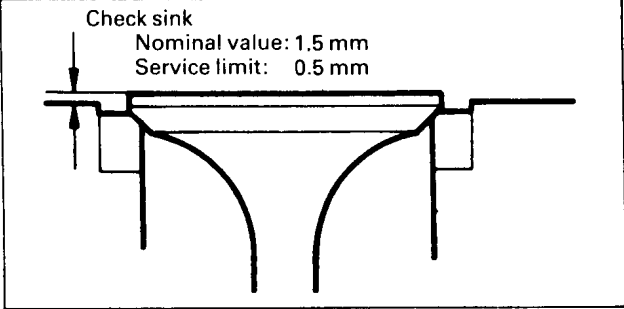
DEN036

10.4 CORRECTING VALVE SEAT RING

Correct or replace defective valve seat ring.

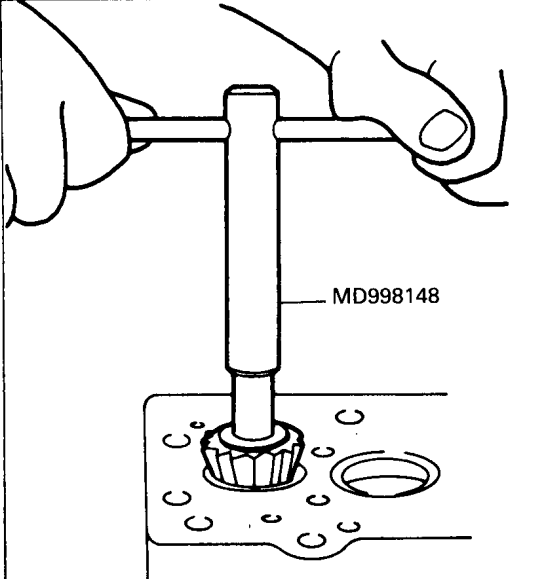
Poor seating or wear

Check sink
Nominal value: 1.5 mm
Service limit: 0.5 mm

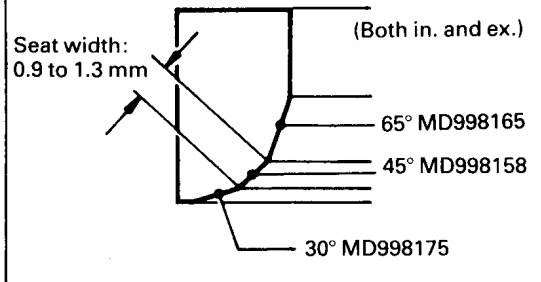


Sink: too small

Sink: over service limit



MD998148



(Both in. and ex.)

Seat width: 0.9 to 1.3 mm

65° MD998165
45° MD998158
30° MD998175

Seat ring service size

| Item | Size mark | Valve seat height | Cylinder head hole dia. |
|-------------|-----------|-------------------|-------------------------|
| In. | | | |
| 0.3 mm O.S. | 30 | 7.3 mm | 43.3 to 43.325 mm |
| 0.6 mm O.S. | 60 | 7.6 mm | 43.6 to 43.625 mm |
| Ex. | | | |
| 0.3 mm O.S. | 30 | 7.3 mm | 37.3 to 37.325 mm |
| 0.6 mm O.S. | 60 | 7.6 mm | 37.6 to 37.625 mm |

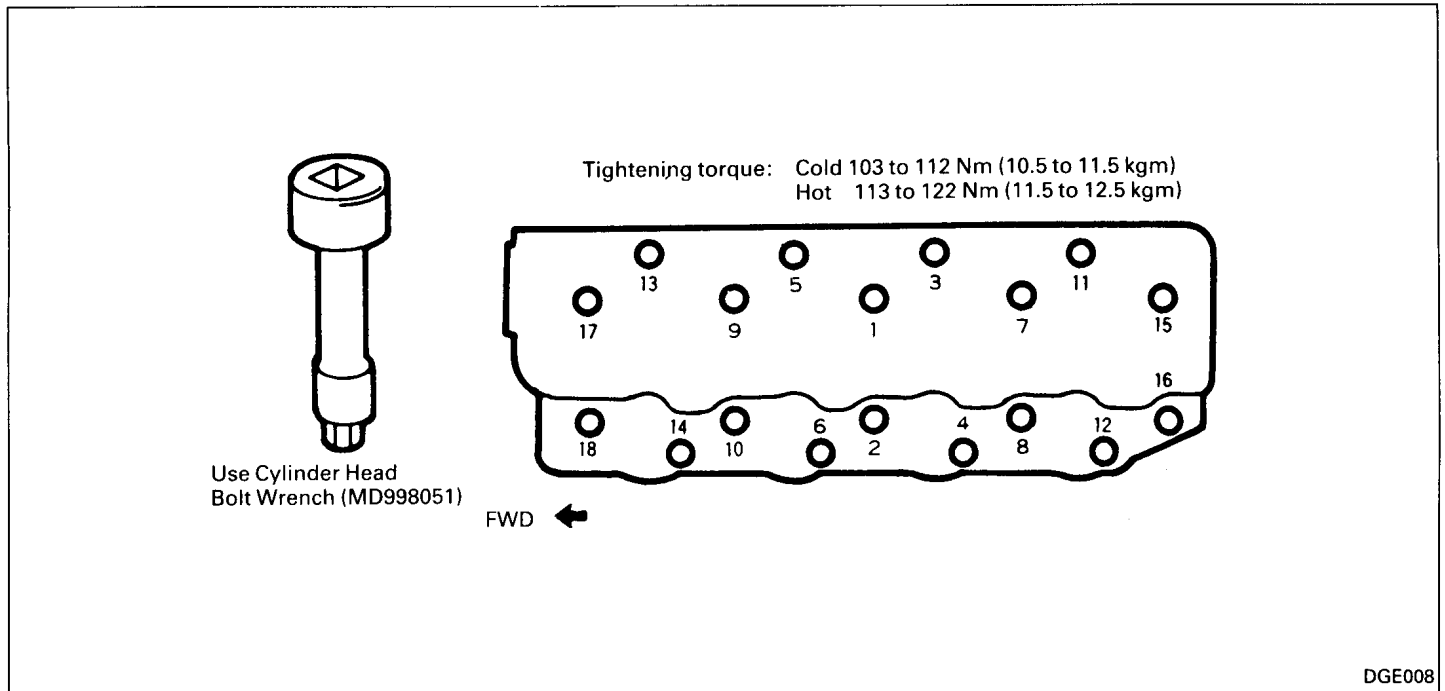
Caution:

- **Correct the valve seat ring with the valve guide in normal condition.**
- **Correct so that the seat contacts the valve face at its center.**

10.5 INSTALLATION

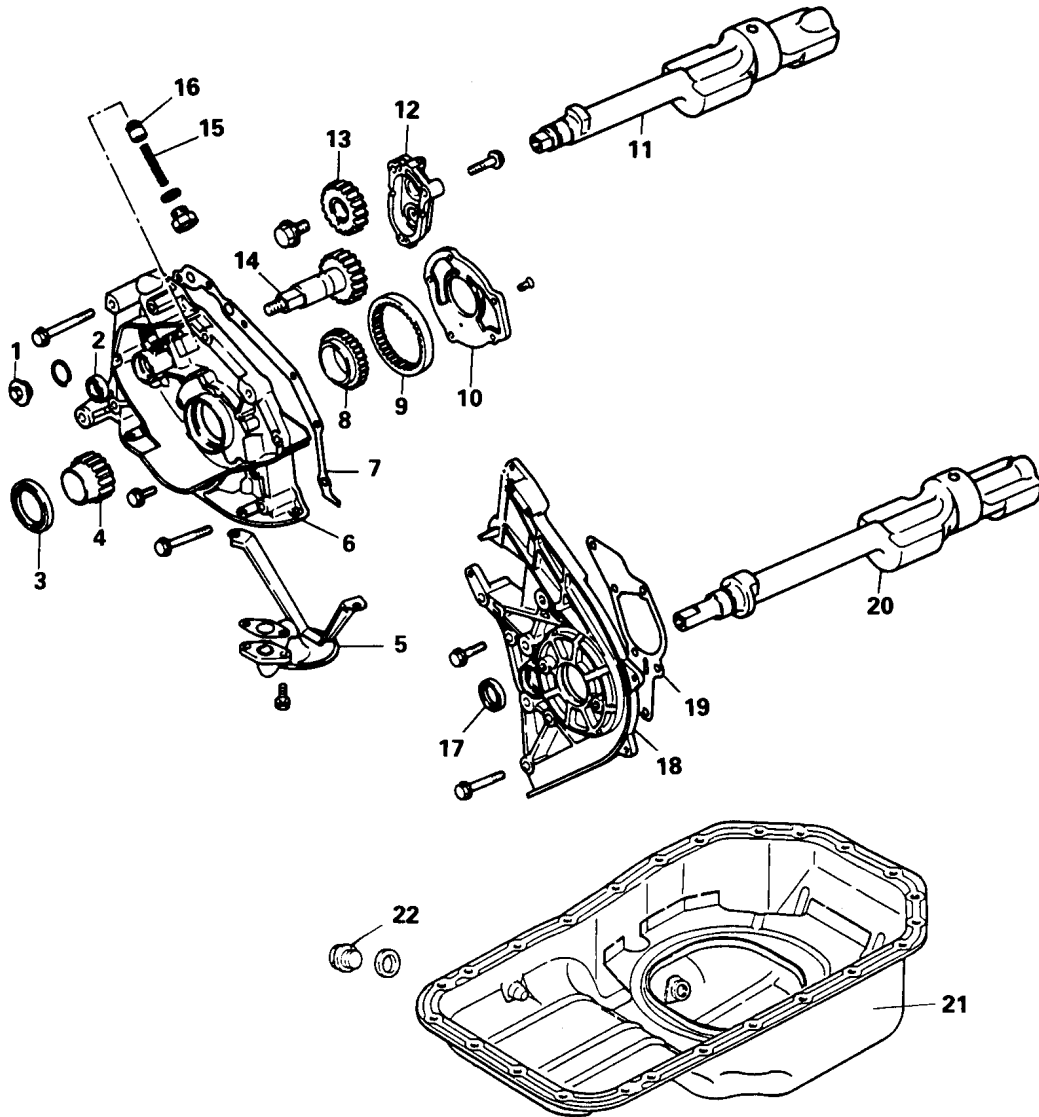
Install the cylinder head in reverse order of the removal, paying attention to the following.

1. Use a new cylinder gasket. Do not apply sealant.
2. Tighten the cylinder head bolts in the sequence shown and in two to three steps. Finally, tighten to specified torque.



3. Loosen the pipe clamp before installing the injection pipe assembly. Tighten the nuts on both ends of the pipe to 21 to 34 Nm (2.3 to 3.7 kgm). When tightening the nuts, hold the nozzle holder and the delivery valve holder to prevent them from turning with them. Also take care to prevent ingress of foreign matter in the fuel passage.
4. After installing the camshaft sprocket, make sure that the timing marks of the sprockets are aligned.

11. FRONT CASE, SILENT SHAFT AND OIL PUMP



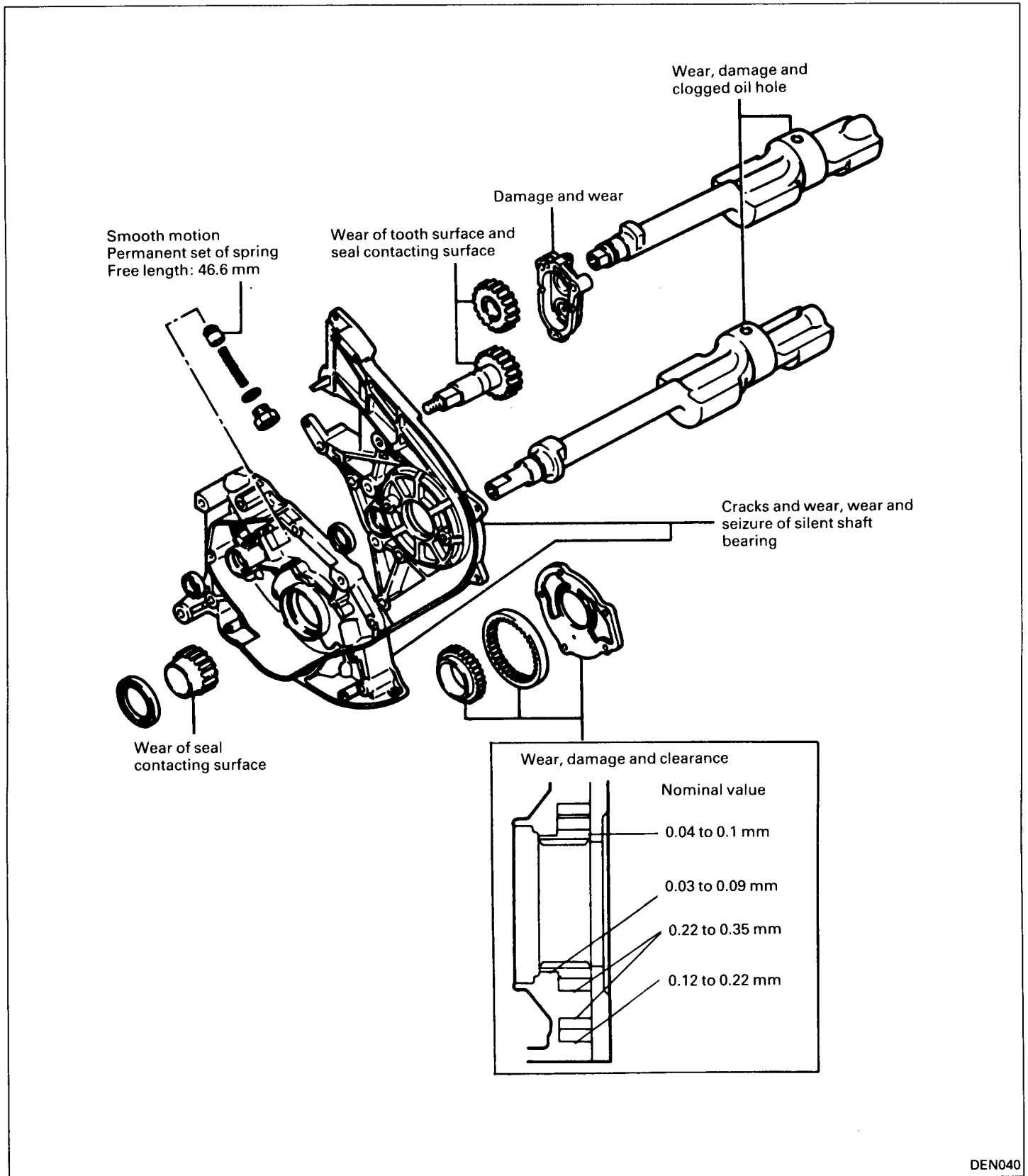
- | | | |
|-----------------------------|-----------------------------|----------------------------|
| 1 Plug cap | 9 Oil pump outer gear | 16 Relief valve |
| 2 Oil seal | 10 Oil pump cover | 17 Oil seal |
| 3 Front oil seal | 11 Right silent shaft | 18 Front upper case |
| 4 Oil pump gear drive shaft | 12 Silent shaft gear cover | 19 Front upper case gasket |
| 5 Oil screen | 13 Silent shaft driven gear | 20 Left silent shaft |
| 6 Front lower case | 14 Silent shaft drive gear | 21 Oil pan |
| 7 Front lower case gasket | 15 Relief valve spring | 22 Oil drain plug |
| 8 Oil pump inner gear | | |

11.1 REMOVAL

1. Remove the oil pan.
2. Remove the oil screen.
3. Remove the spacer from the forward end of the left silent shaft.
4. Remove the front upper case.
5. Remove the left silent shaft.
6. Remove the plug cap from the top of the right silent shaft drive gear.
7. Slightly loosen the flange bolt at the forward end of the right silent shaft. When loosening the bolt, remove the plug on the right side of the cylinder block and insert a screwdriver to prevent rotation. (See page 11-22.)
8. Remove the front lower case and the silent shaft as an assembly.
9. Remove the left silent shaft from the front lower case.
10. Remove the oil pump cover from the front lower case.
11. Remove the oil pump outer gear and inner gear. Put mating mark on the outer gear to insure correct reassembly.
12. Remove the silent shaft drive gear cover and then remove the drive gear and driven gear.

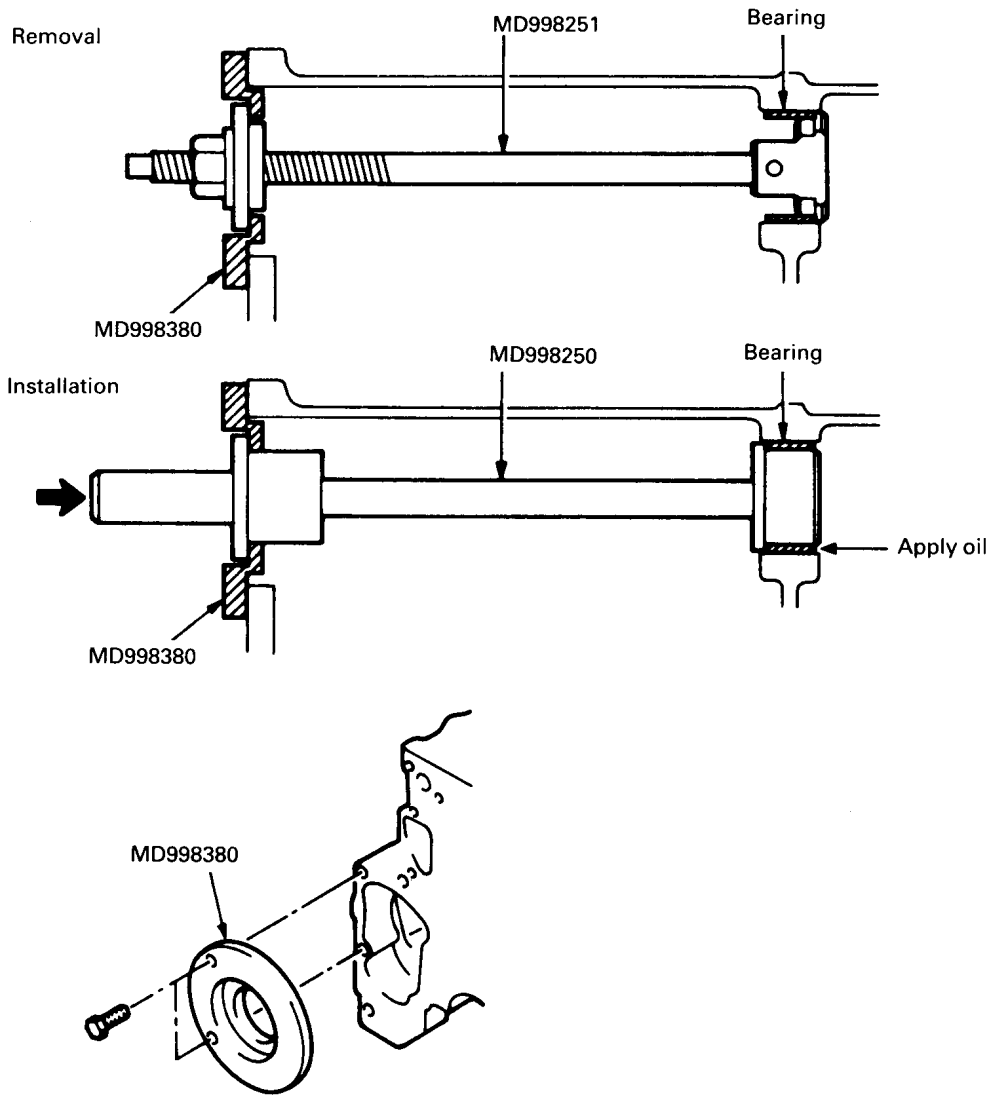
11.2 INSPECTION

Check and replace if defective.



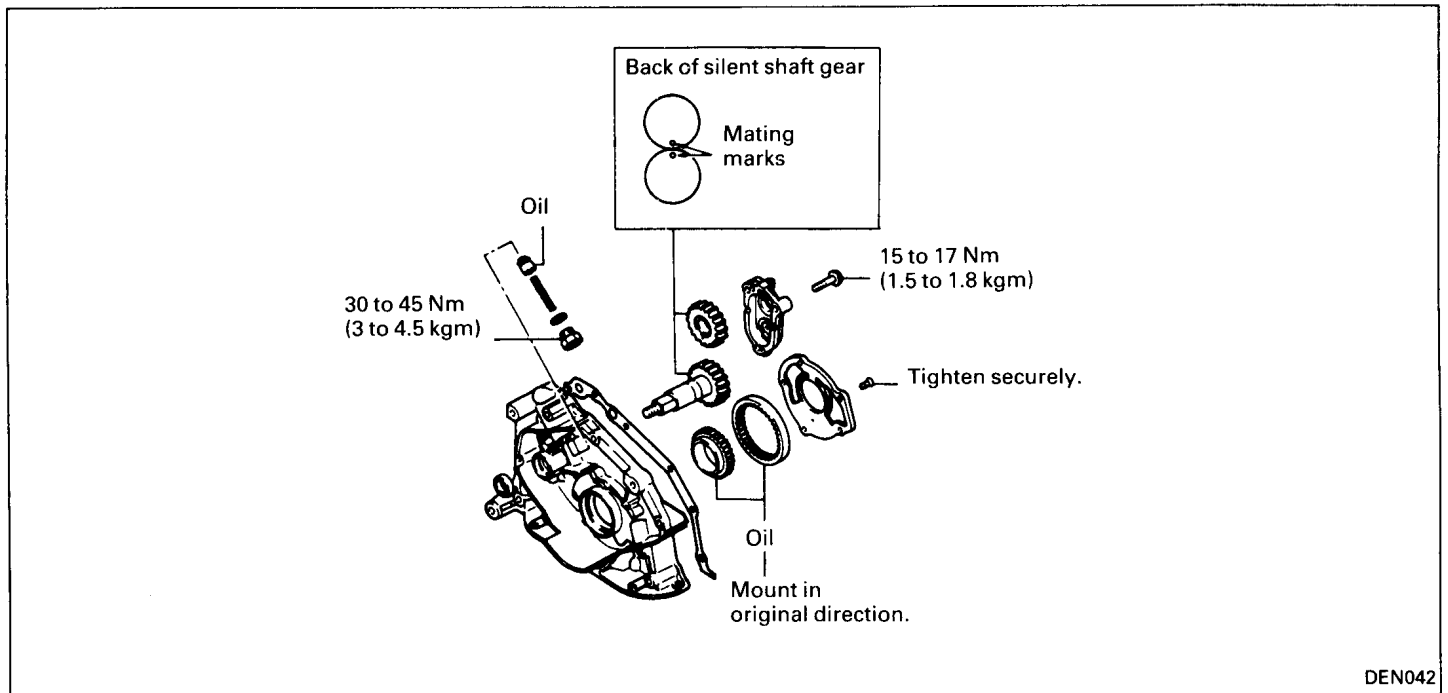
DEN040

11.3 REPLACING SILENT SHAFT BEARING

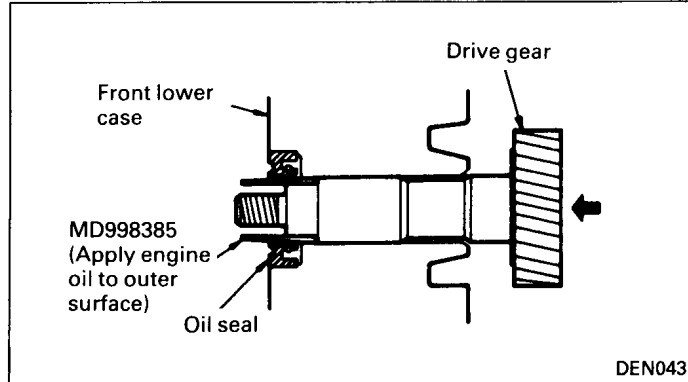


NOTE:
Use the Bearing Installer Stopper (MD998380) only when removing/installing the right side bushing.

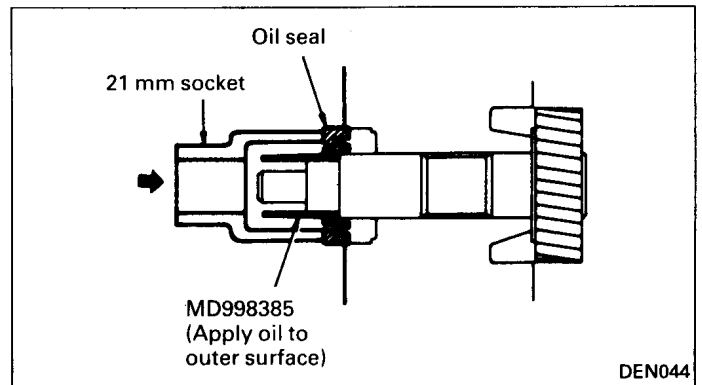
11.4 ASSEMBLING FRONT LOWER CASE



When installing the oil pump drive gear and the oil seal, pay attention to the following.

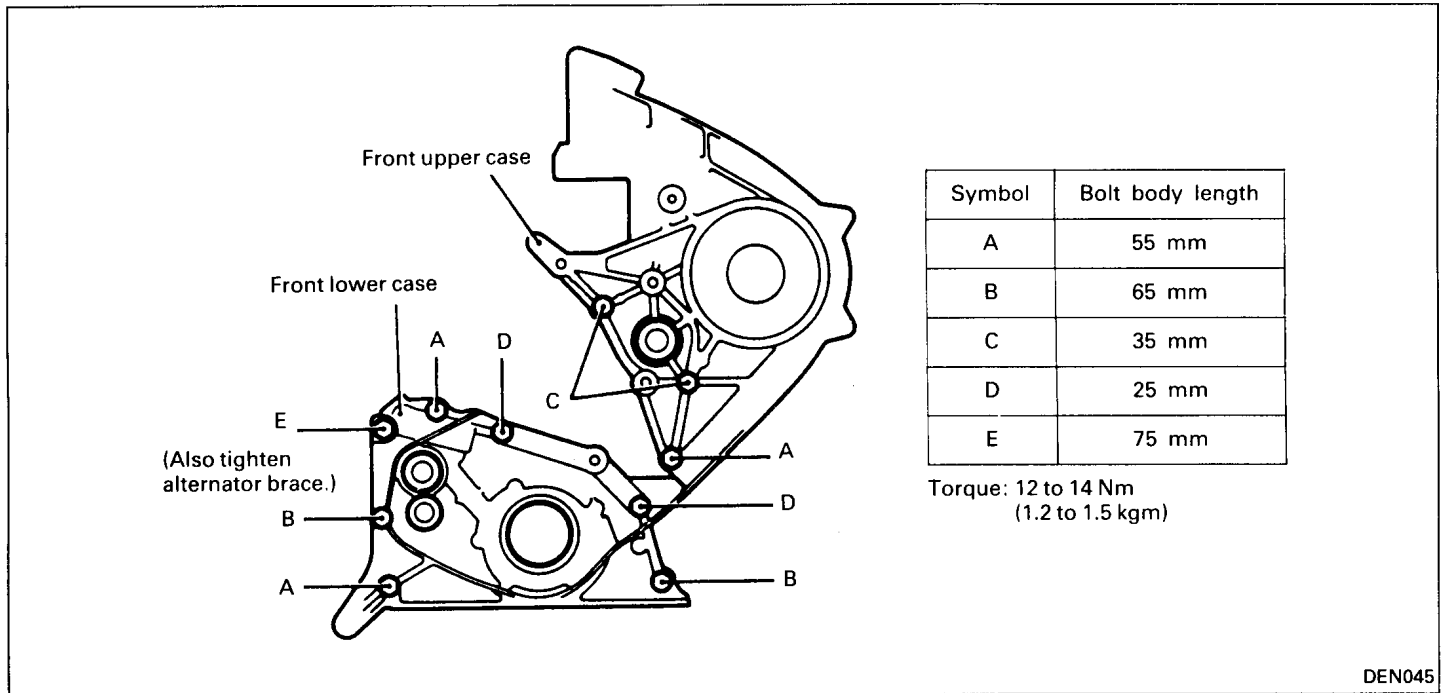


1. When installing the drive gear shaft after pressfitting of gear oil seal in the front lower case, fit the special tool Oil Seal Guide (MD998385) over the drive gear shaft before the gear is inserted.



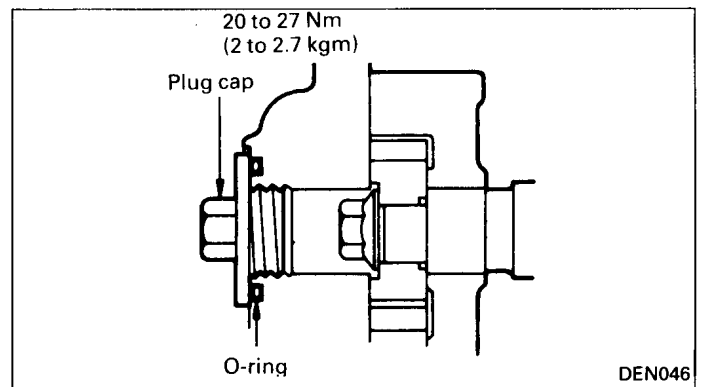
2. When pressing in the oil seal after installation of drive gear shaft, similarly fit the special tool Oil Seal Guide (MD998385) over the drive gear shaft to prevent the oil seal from being caught by the stepped section of the shaft.

11.5 INSTALLATION



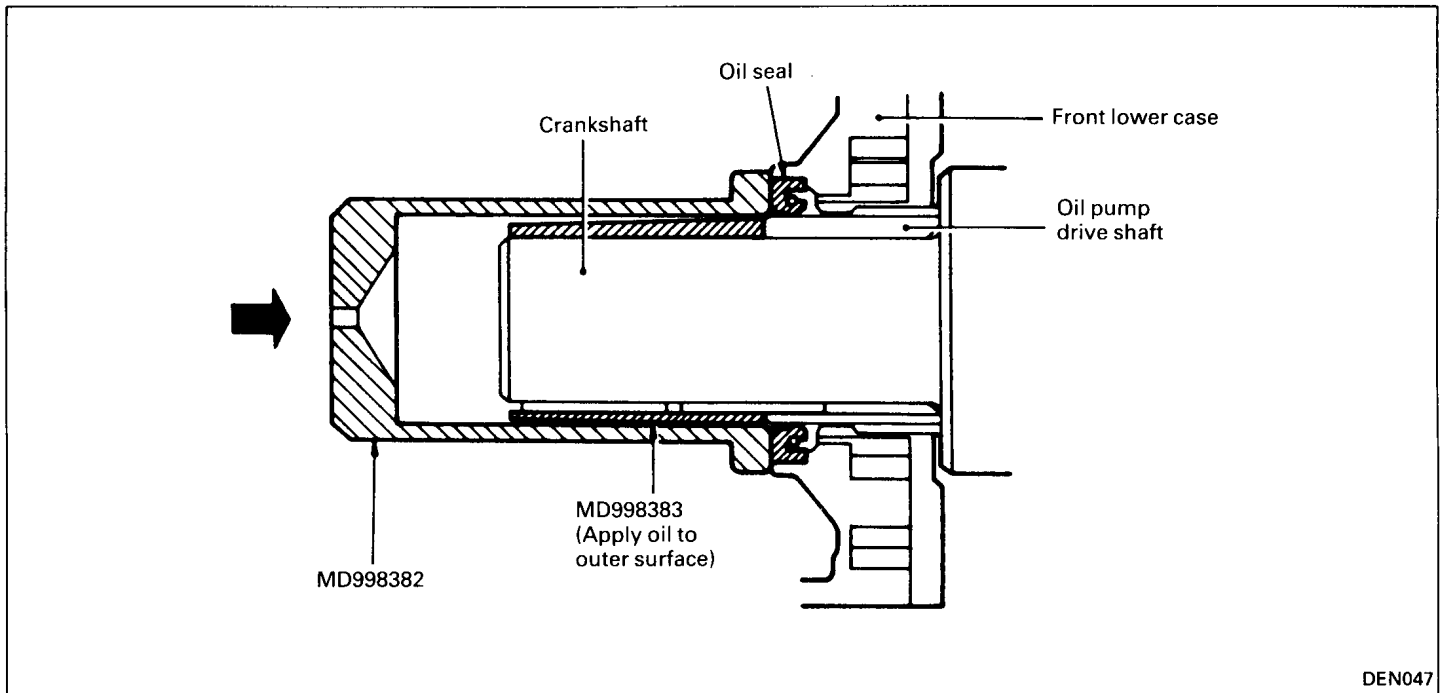
DEN045

1. Install the right silent shaft to the front lower case assembly and tighten the flange bolt temporarily. Apply oil to the silent shaft journal.
2. Install a new front lower case gasket to the cylinder block. Then, install the front lower case while inserting the right silent shaft in the cylinder block. Tighten the 7 flange bolts to specified torque.



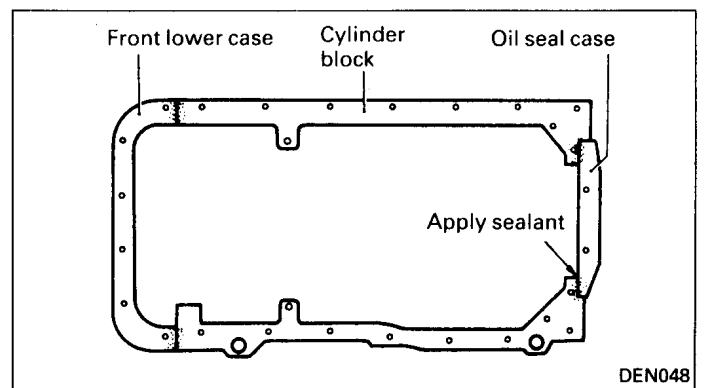
DEN046

3. Tighten the bolt at the forward end of the right silent shaft to 20 to 27 Nm (2 to 2.7 kgm). When tightening the bolt, hold the silent shaft to prevent its rotation.
4. Fit O-ring in the groove of the case and install the plug cap.



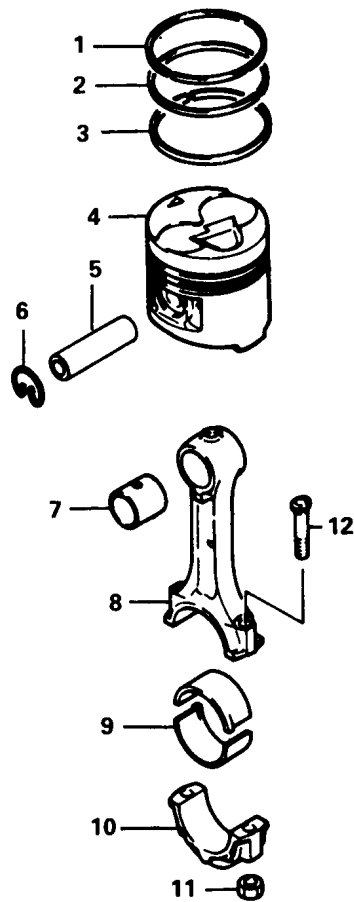
DEN047

5. Using the special tool Oil Seal Installer (MD998382) and Guide (MD998383), install the crankshaft front oil seal. Insert the oil pump drive shaft before installing the front oil seal. When installing the front lower case assembly with a press-fit front oil seal, install the Oil Seal Guide (MD998383) to the crankshaft in advance.
6. Apply oil to the left silent shaft journal and place the shaft in the cylinder block.
7. Install a new front upper case gasket to the cylinder block and install the front upper case. Tighten the three flange bolts to specified torque. (See page 11-47.)
8. Press the silent shaft oil seal into the front upper case, until the oil seal end is flush with the case end.
9. Apply oil to the spacer outer surface and insert it with the chamfered end facing the oil seal.



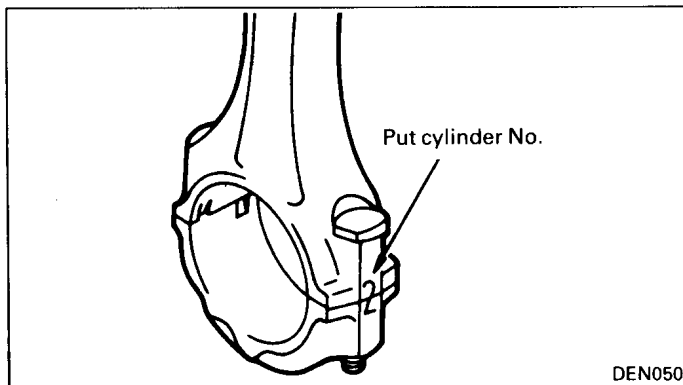
DEN048

10. Apply sealant to the lower surface (surface on which the oil pan is to be mounted) in areas indicated in illustration.
11. Install a new oil pan gasket and oil pan, and tighten the bolts to 6 to 7.5 Nm (0.6 to 0.8 kgm).

12. PISTON AND CONNECTING ROD

- 1 Piston ring No. 1
- 2 Piston ring No. 2
- 3 Oil ring
- 4 Piston
- 5 Piston pin
- 6 Snap ring
- 7 Bushing
- 8 Connecting rod
- 9 Connecting rod bearing
- 10 Connecting rod cap
- 11 Connecting rod nut
- 12 Connecting rod bolt

DEN049

12.1 REMOVAL

DEN050

1. Put cylinder No. on the side of the connecting rod big end for reference in reassembly.

2. Remove the connecting rod cap and lift out the connecting rod and piston assembly from the cylinder, taking sufficient care to prevent the connecting rod from contacting the cylinder and the crank pin.

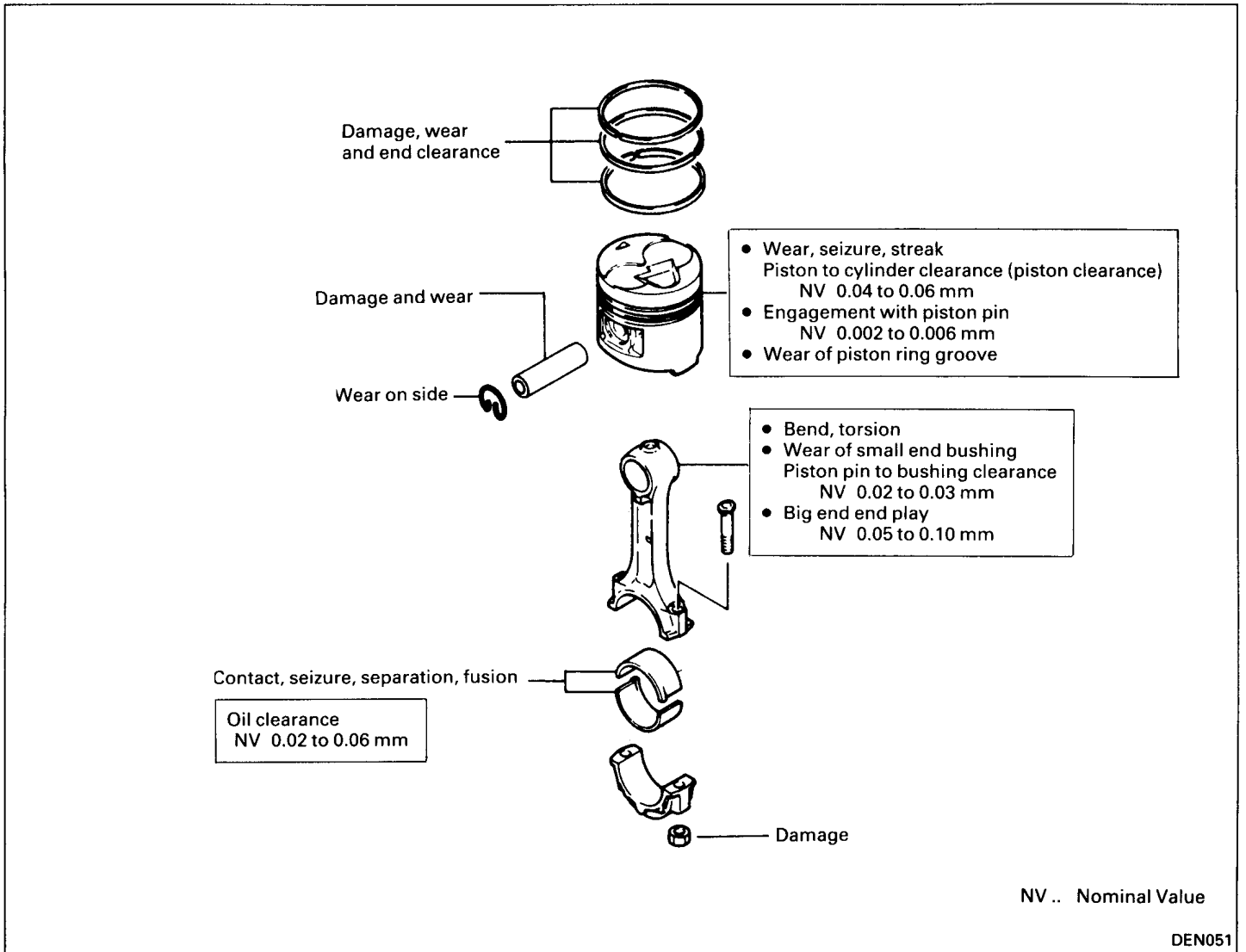
Store the removed connecting rod and piston assembly together with the connecting rod cap and bearing, separately for each cylinder.

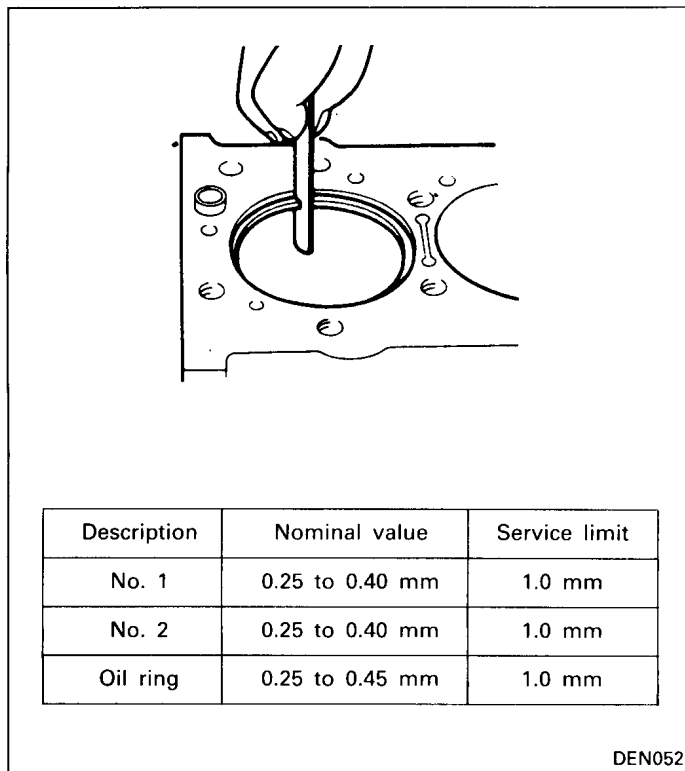
Caution:

- **Do not allow the connecting rod to come in contact with the oil jet.**
- **Oil jet in improper direction will result in sharp reduction of the piston cooling effect.**

12.2 INSPECTION

Correct or replace if defective.

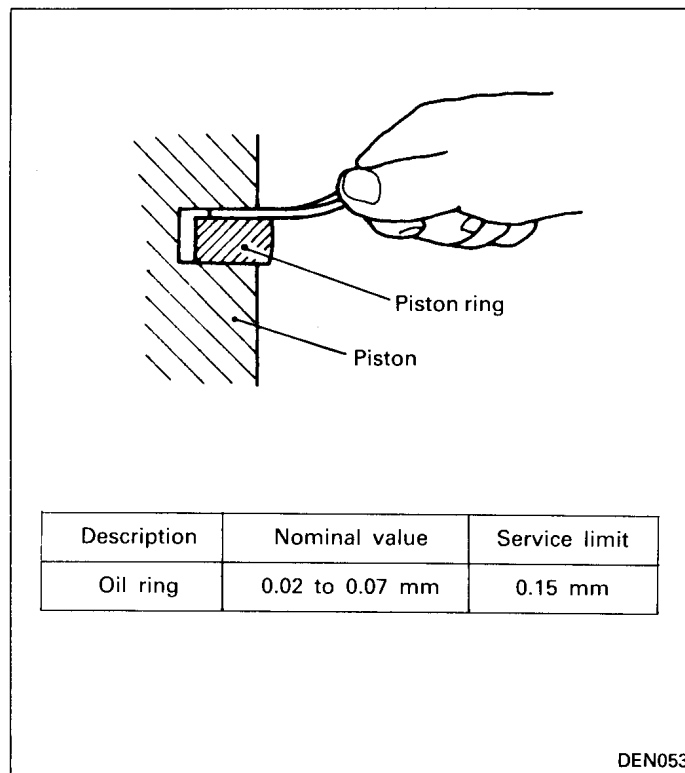


Checking Piston Ring End Clearance

Place a piston ring in the cylinder bore and set it square by pushing it down with the piston. Then, measure the end clearance using a thickness gauge. Replace the piston ring if the end clearance exceeds the service limit.

Caution:

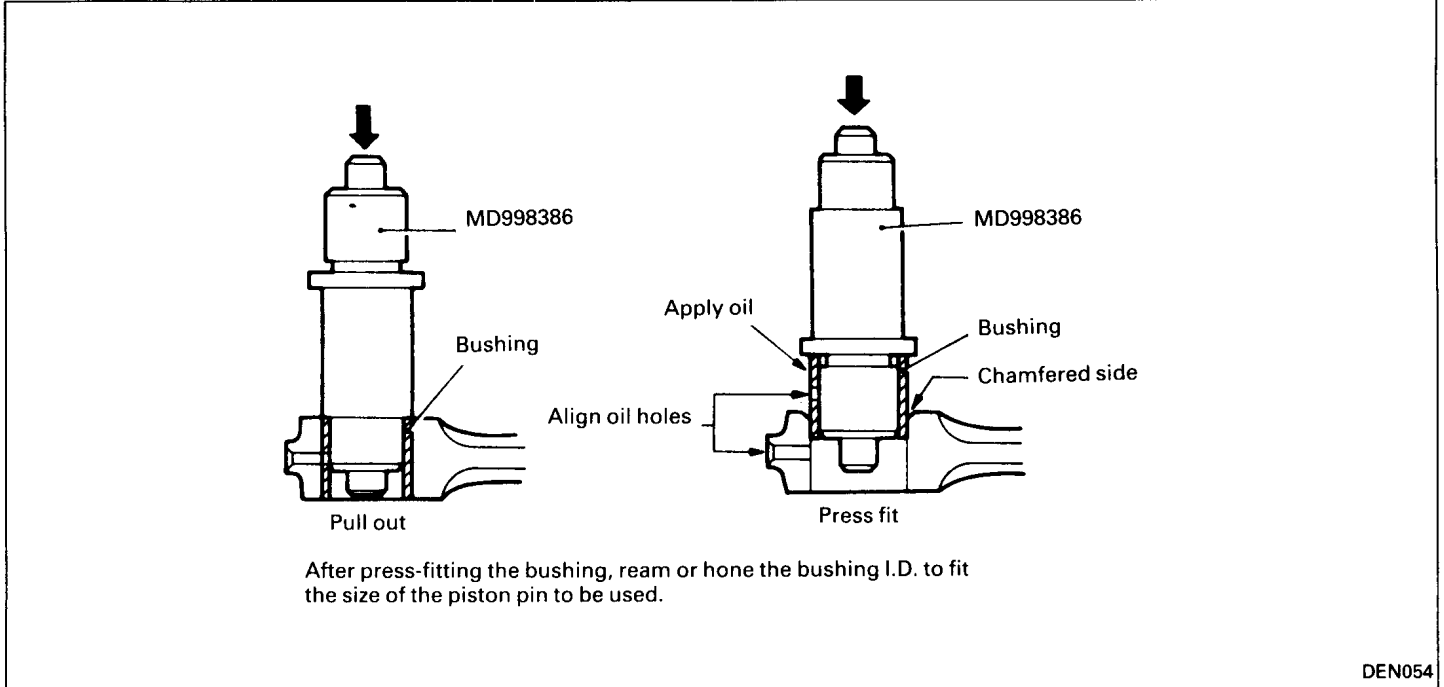
- **If the ring only is replaced without reboring the cylinder bore, measure the end clearance with the ring placed at the lower part of the cylinder where wear is minimum.**
- **When the ring is replaced, use ring of the same size as the piston.**
- **Rings are available in the service size of STD and oversize (0.25, 0.50, 0.75 and 1.00 mm).**

Checking Ring Grooves

Measure the piston ring groove to ring clearance (side clearance). If the clearance exceeds the service limit, use a new ring and measure the clearance again. If the clearance still exceeds the service limit, replace both the piston and ring.

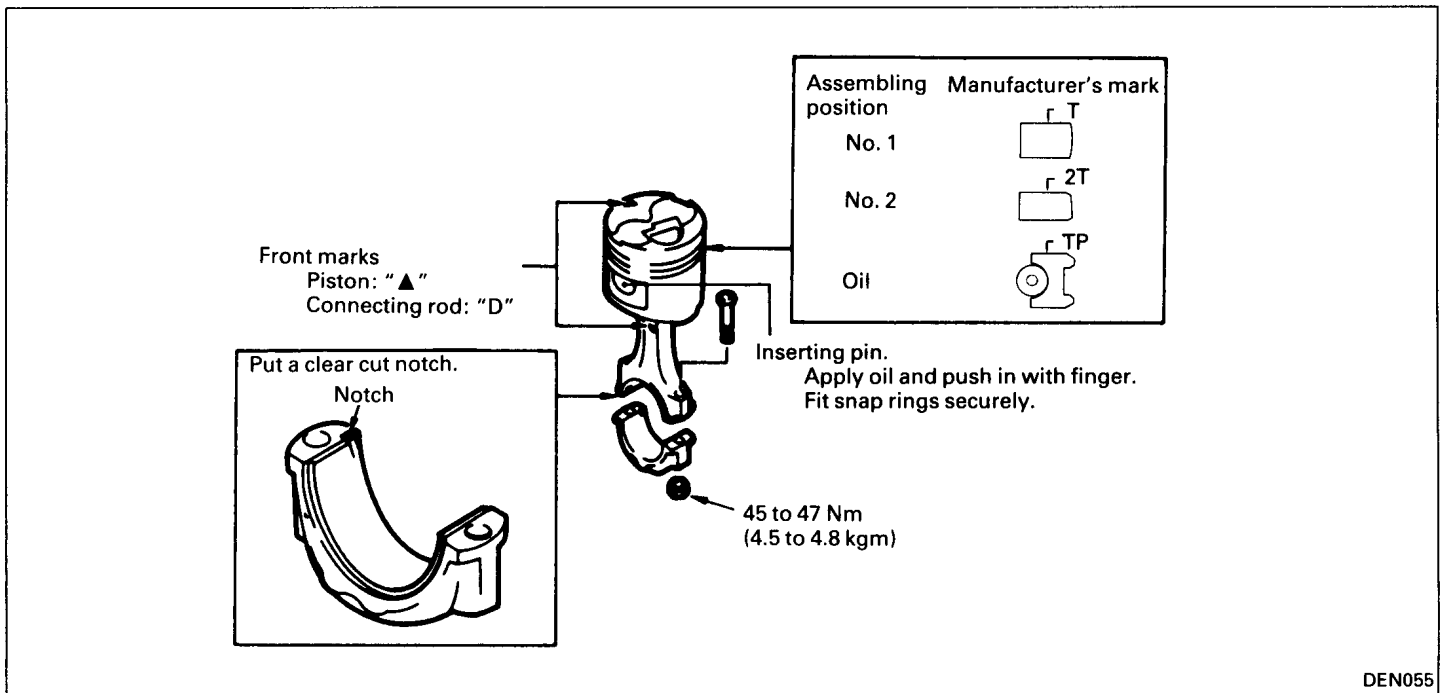
12.3 REPLACING CONNECTING ROD SMALL END BUSHING

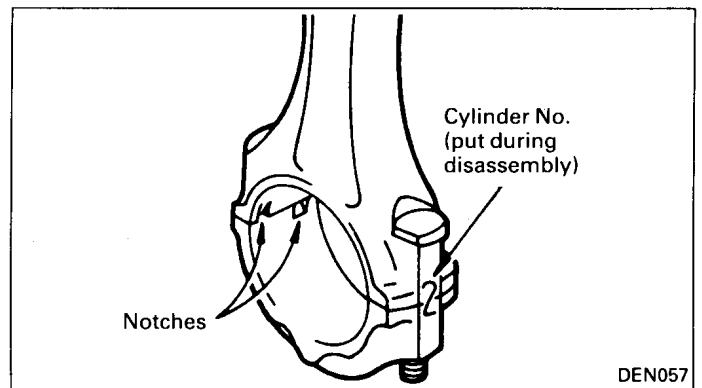
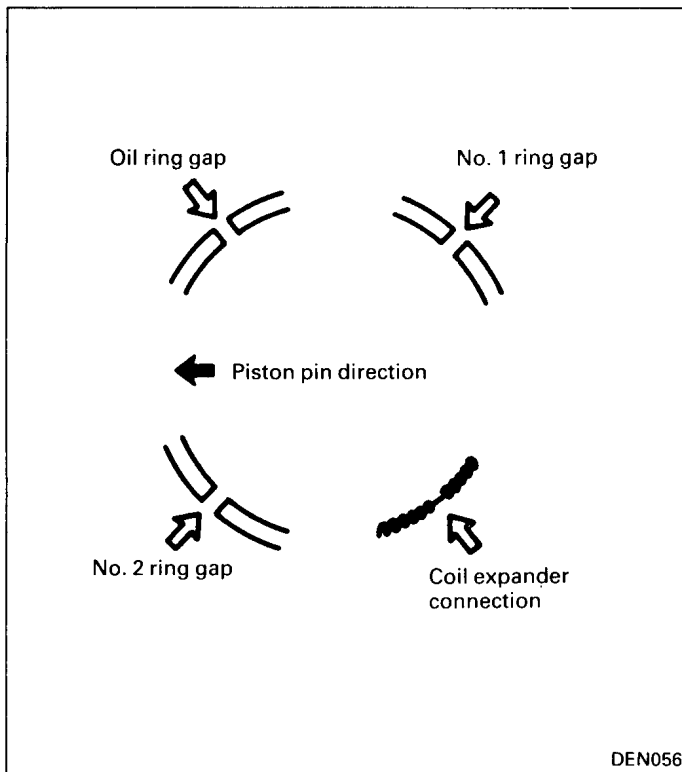
Replace the connecting rod small end bushing as follows.



12.4 INSTALLATION

1. In the installation, pay attention to the following.





4. Apply engine oil to the bearing surface of the connecting rod cap and assemble referring to the mating marks put during disassembly. In the case of a new connecting rod without mating marks, assemble with the bearing stopper notches on the same side as shown in illustration.

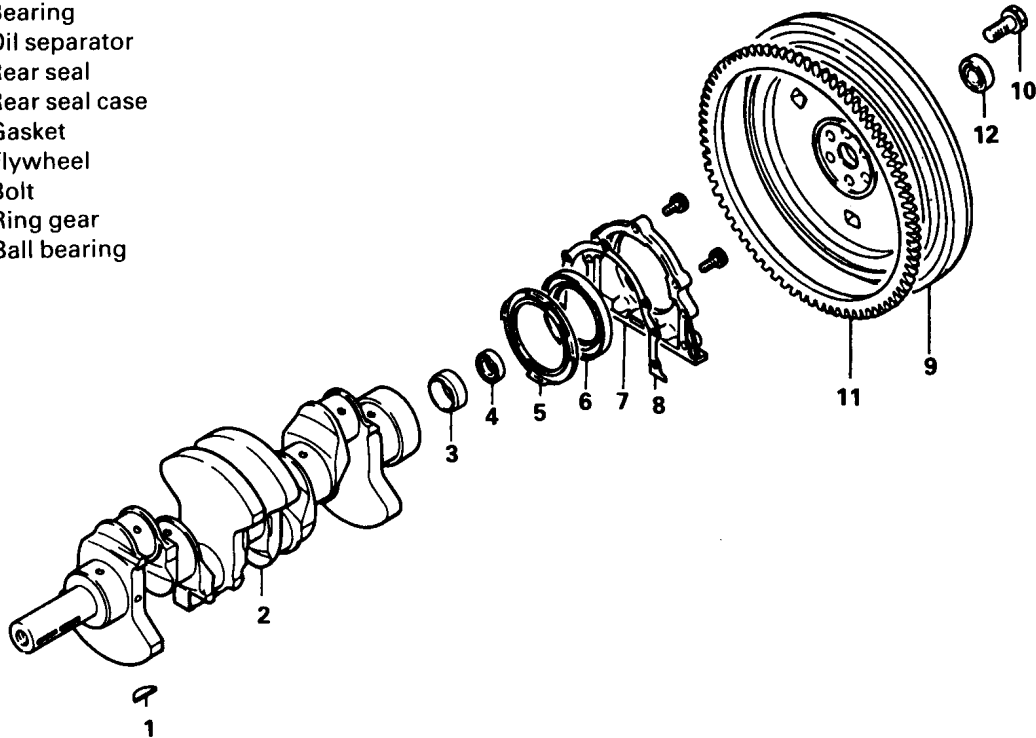
2. Position the piston ring gaps as shown in illustration and apply oil to the piston, rings and cylinder wall.
3. Holding the ring securely with a piston ring band, insert the piston and connecting rod assembly into the cylinder from the top. Do not give a hard blow to the piston crown. Otherwise, the ring could be broken. Make sure that the piston and connecting rod front marks face toward the front of the engine.

Caution:

- **Never allow the connecting rod to come in contact with the oil jet.**
- **After assembling the piston and connecting rod, visually check that the oil jet faces toward the reverse side of the piston crown.**

13. CRANKSHAFT AND FLYWHEEL

- 1 Key
- 2 Crankshaft
- 3 Crankshaft bushing
- 4 Bearing
- 5 Oil separator
- 6 Rear seal
- 7 Rear seal case
- 8 Gasket
- 9 Flywheel
- 10 Bolt
- 11 Ring gear
- 12 Ball bearing



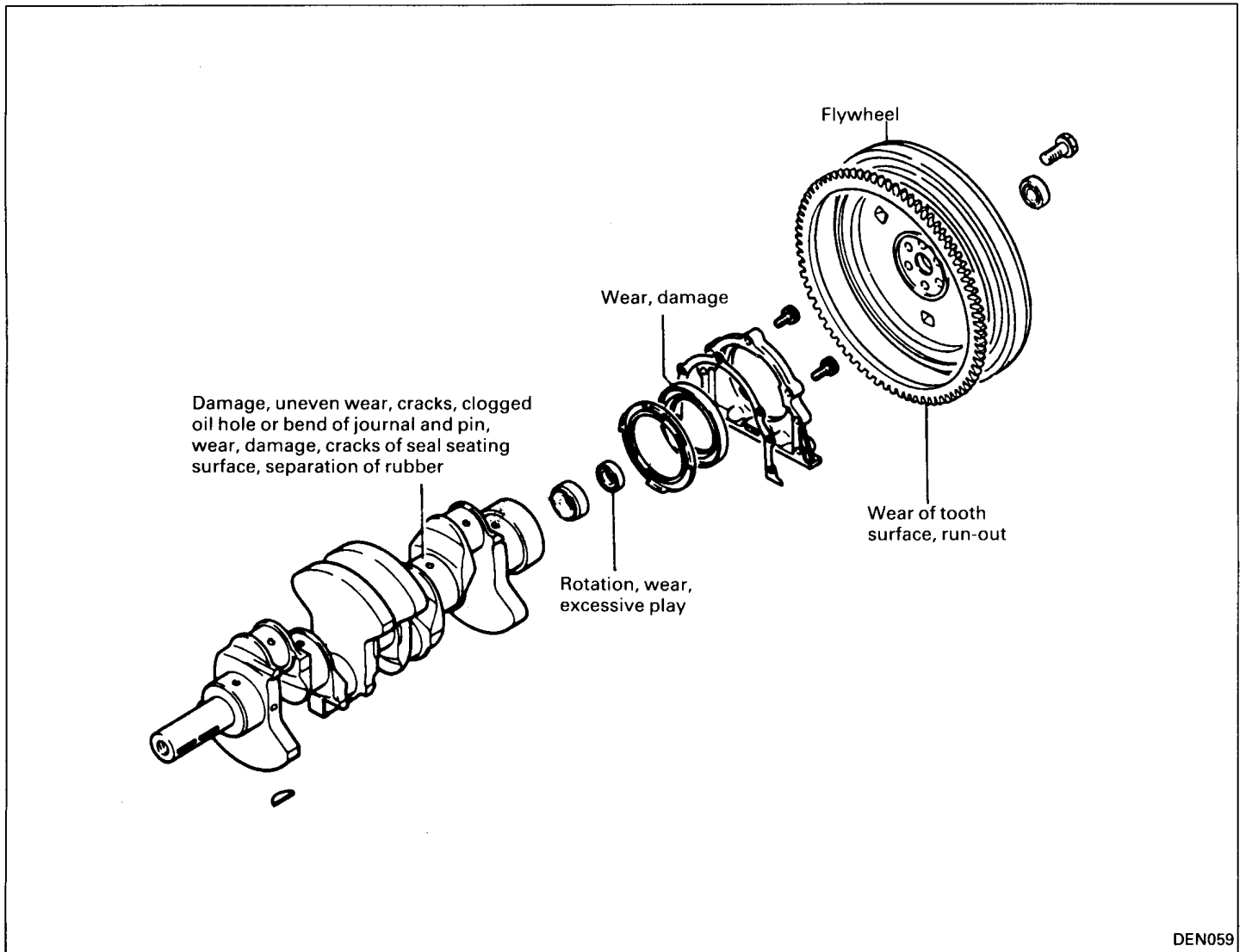
DEN058

13.1 REMOVAL

1. Remove the six bolts securing the drive plate and remove the drive plate.
2. Remove the rear oil seal case assembly.
3. Remove the main bearing caps. Store the main bearing separately for each bearing cap No.
4. Remove the crankshaft.

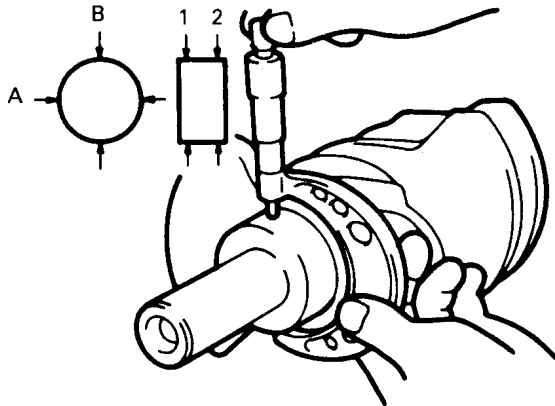
13.2 INSPECTION

Correct or replace if defective.



DEN059

Checking Crankshaft Wear



Journal O.D. and pin O.D.

| Description | Nominal value |
|--------------|---------------|
| Journal O.D. | 66 mm |
| Pin O.D. | 53 mm |

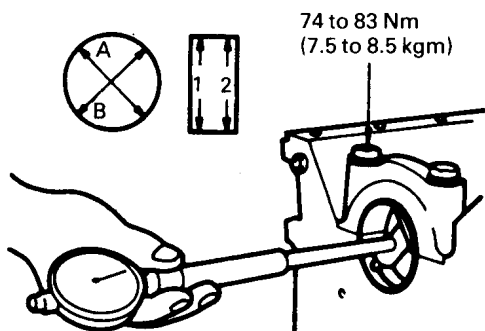
Undersize finish dimensions

| | Journal O.D. | Pin O.D. |
|--------------|---|---|
| 0.25 mm U.S. | $65.75 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix}$ mm | $52.75 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix}$ mm |
| 0.50 mm U.S. | $65.50 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix}$ mm | $52.50 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix}$ mm |
| 0.75 mm U.S. | $65.25 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix}$ mm | $52.25 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix}$ mm |

DEN060

Measure the journal and pin dimensions in directions A and B at front and rear (1 and 2) positions. If worn excessively, grind to an undersize. If the service limit is exceeded, replace the crankshaft.

Checking Crankshaft Oil Clearance



| Description | Nominal value |
|------------------------|-------------------|
| Main bearing | 0.021 to 0.046 mm |
| Connecting rod bearing | 0.019 to 0.056 mm |

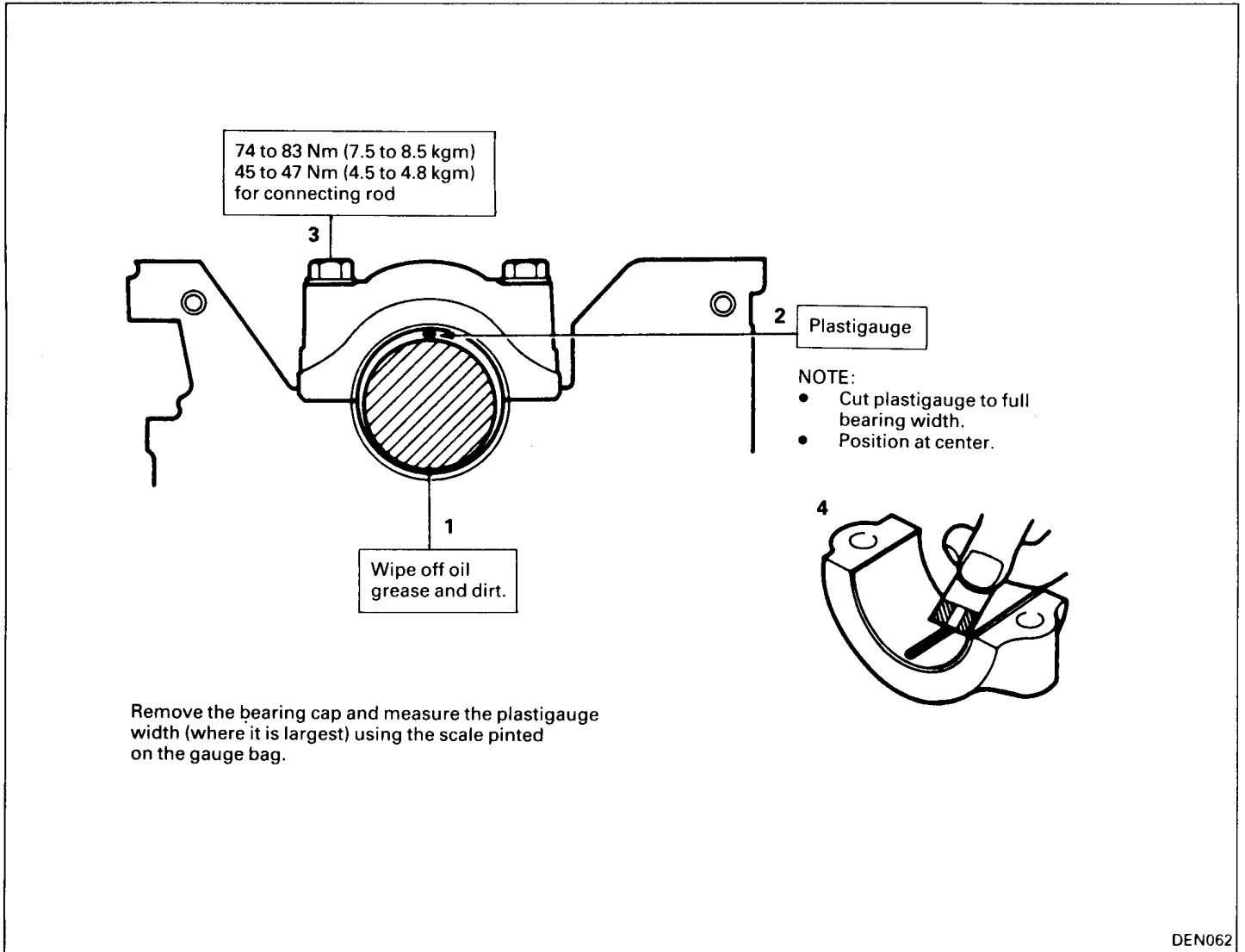
DEN061

Determine the clearance from the difference between the O.D. of journal as well as pin O.D. and the I.D. of each bearing as assembled to the crankshaft. Measure the bearing I.D. in directions A and B at front and rear (1 and 2) positions as shown in illustration.

If the use of a new bearing still results in an oil clearance larger than the standard value, grind the crankshaft to an undersize and use a bearing of corresponding undersize.

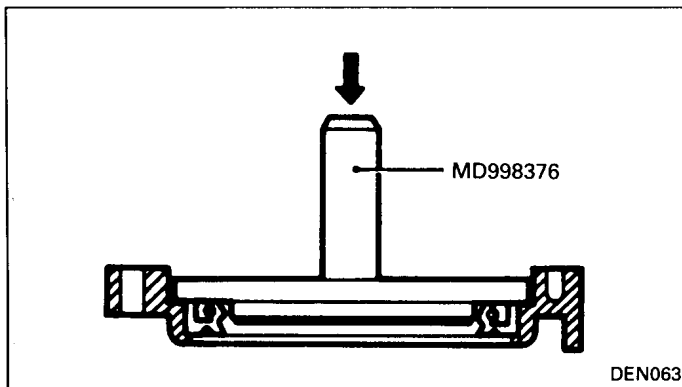
(Reference)

Checking oil clearance with a plastigauge



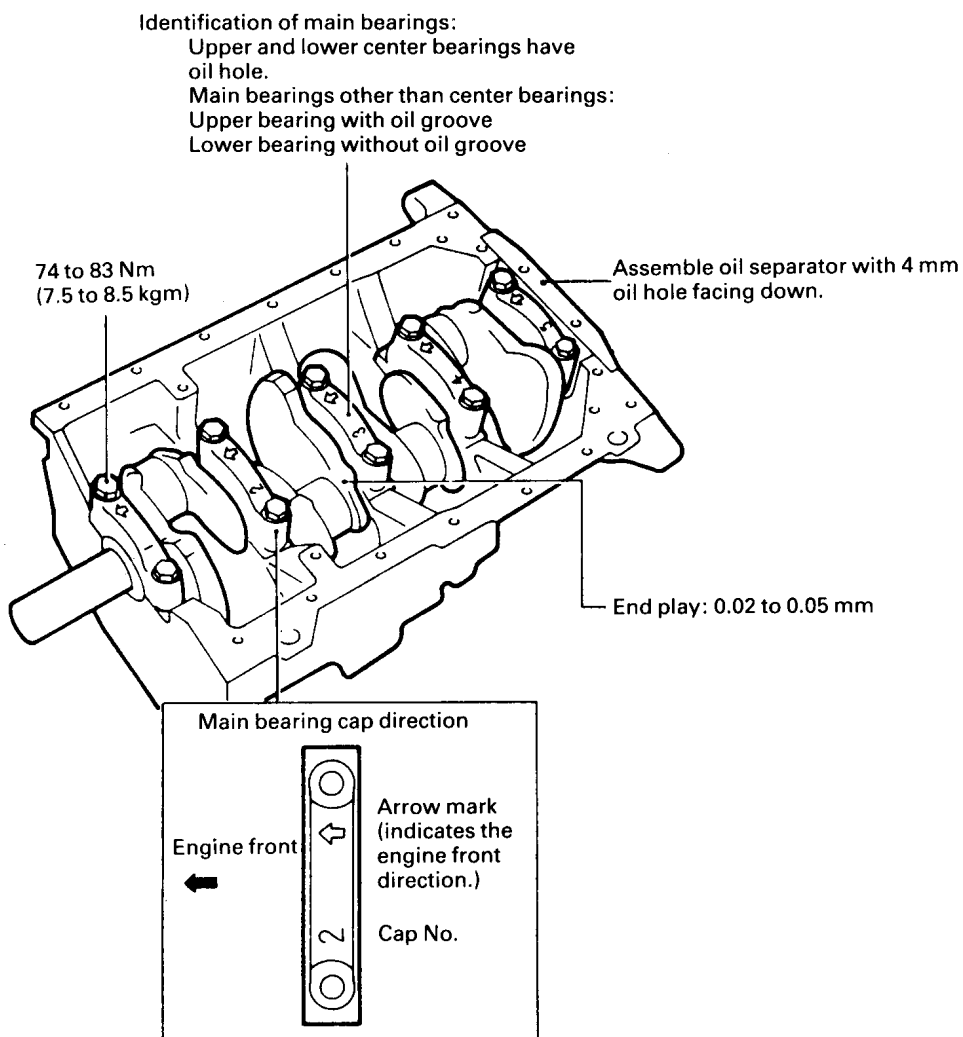
13.3 REPLACING CRANKSHAFT REAR OIL SEAL

1. Remove the oil seal using a screwdriver.
2. Drive in a new oil seal using the special tool Oil Seal Installer (MD998376).



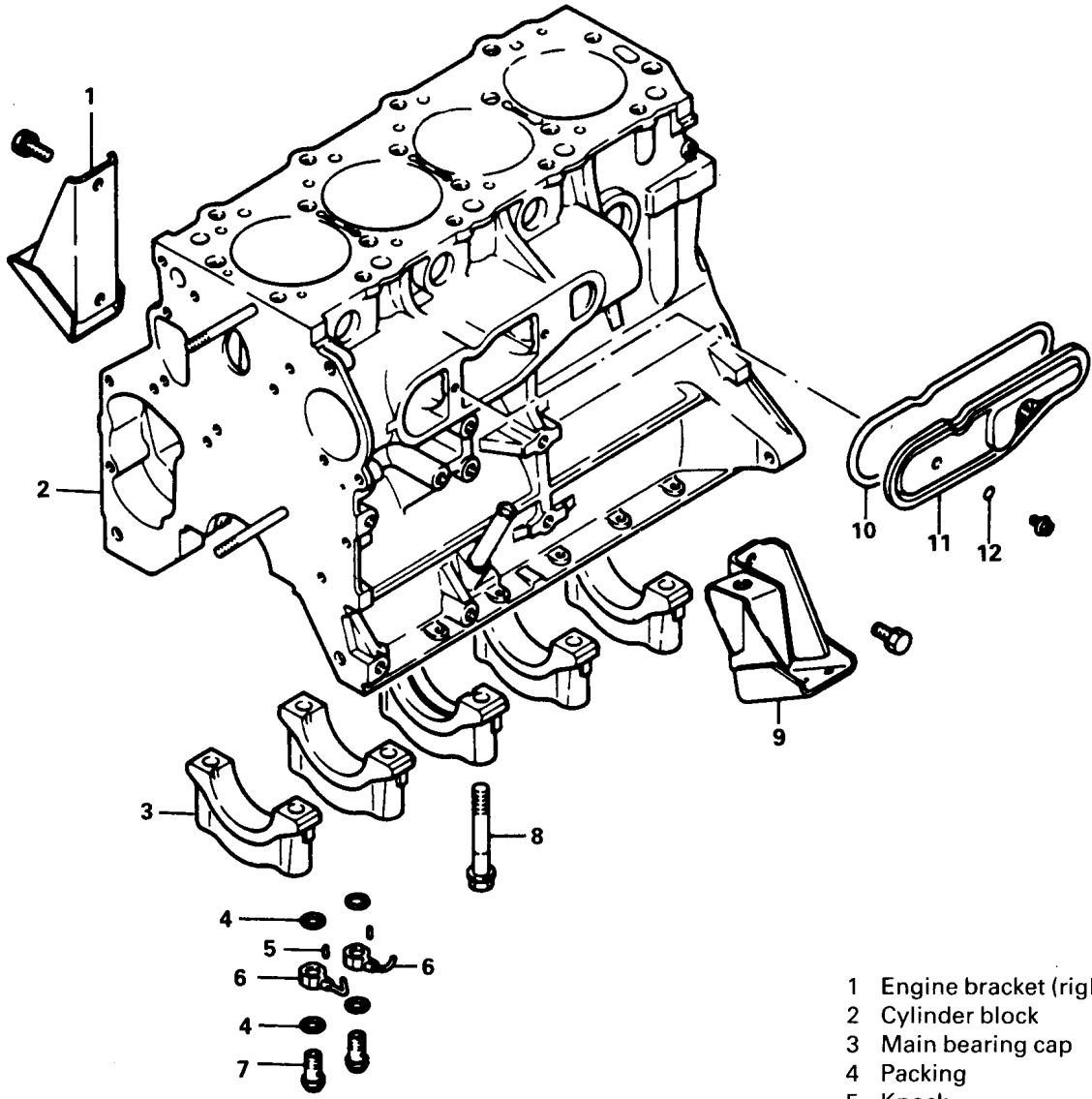
13.4 INSTALLATION

When installing, pay attention to the following.



DEN064

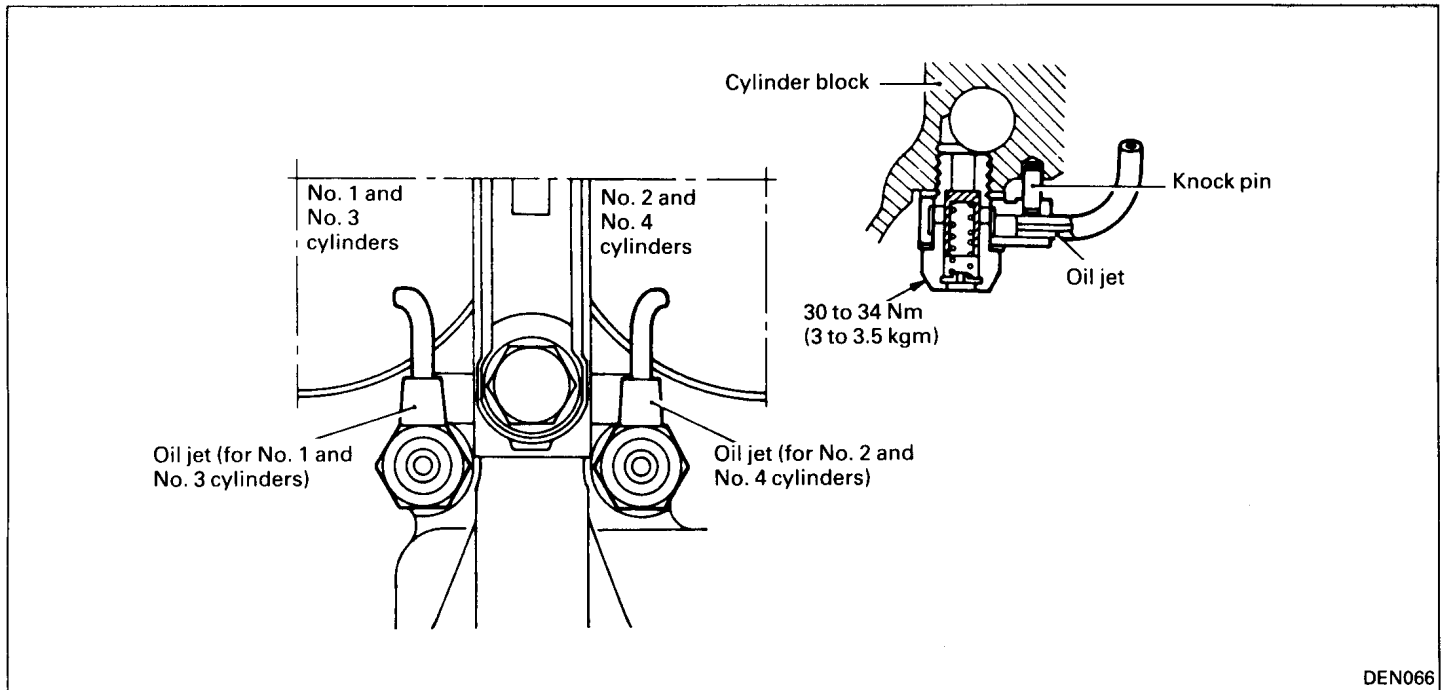
14. CYLINDER BLOCK



- 1 Engine bracket (right)
- 2 Cylinder block
- 3 Main bearing cap
- 4 Packing
- 5 Knock
- 6 Oil jet
- 7 Check valve
- 8 Cap bolt
- 9 Engine bracket (left)
- 10 Packing
- 11 Cover
- 12 O-ring

DEN065

14.1 DISASSEMBLY AND ASSEMBLY



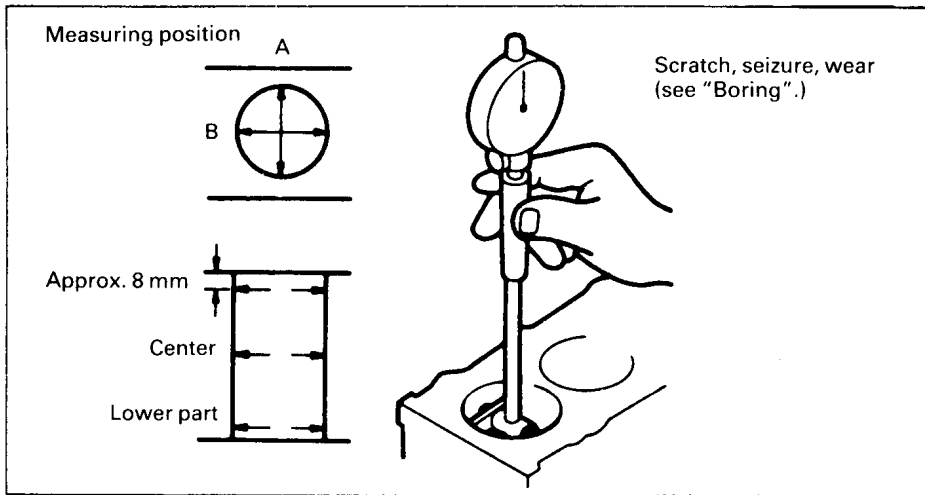
DEN066

When assembling or disassembling, pay attention to the following.

1. The journal cap has been worked with the cylinder block. Handle with care not to damage it. Do not intermix the journal caps.
2. There are two types of oil jets, i.e. one for No. 1 and No. 3 cylinders and the other for No. 2 and No. 4 cylinders. Install in correct direction as illustrated above.

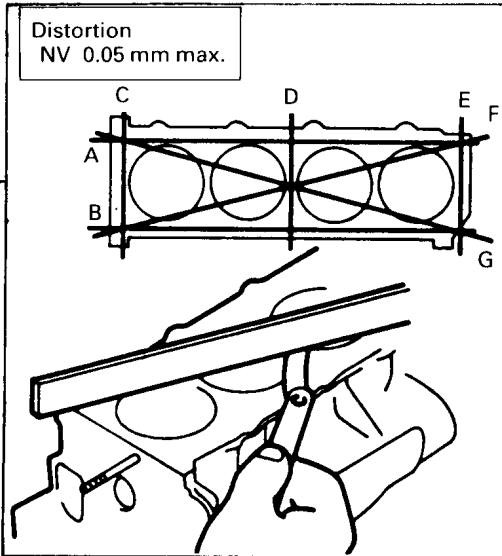
14.2 INSPECTION

Correct or replace if defective.



Cracks, damage, corrosion, sludge, scale

Clogging, Check valve function



NV.. Nominal Value

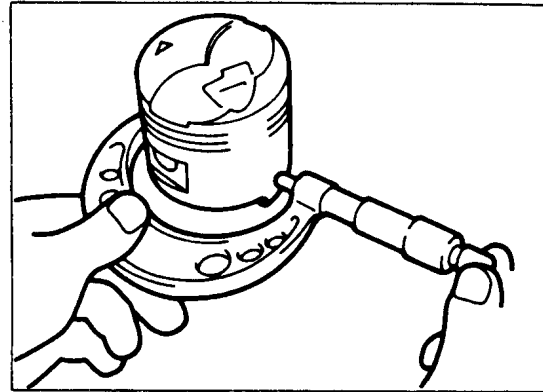
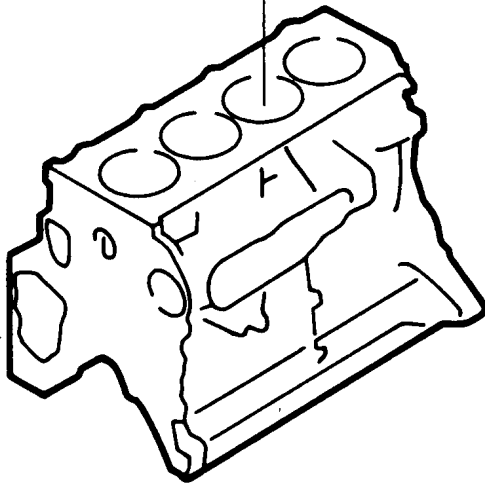
14.3 BORING CYLINDER

To bore the cylinder, proceed as follows.

Piston service size

| Size | Size symbol |
|--------------|-------------|
| STD | None |
| 0.25 mm O.S. | 0.25 |
| 0.50 mm O.S. | 0.50 |
| 0.75 mm O.S. | 0.75 |
| 1.00 mm O.S. | 1.00 |

1 Selecting O.S. piston



2 Measuring piston O.D.

3 Boring finish dimensions
 Piston O.D. + clearance – honing allowance:
 0.02 mm
 Clearance (piston to cylinder clearance)
 Nominal value: 0.04 to 0.06 mm

4 Boring, honing

NOTE:

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

15. TROUBLESHOOTING

| Problem | Probable cause | Remedy |
|----------------------|---|--|
| Low compression | Blow cylinder head gasket | Install new head gasket. |
| | Worn or broken piston rings | Horn cylinder bores and install new rings. |
| | Warped or pitted valves | Install new valves. |
| | Excessive run-out of valve seats on valve faces | Reconditioning valve seats and valves. |
| Noisy valves | Incorrect valve clearance | Adjust to specifications. |
| | Worn valve guides | Install new valves and/or new valve guides with O.S. |
| | Excessive run-out of valve seats on valve faces | Reconditioning valve seats and valves. |
| Connecting rod noise | Insufficient oil supply | Check engine oil level. |
| | Low oil pressure | Check engine oil level, Inspect oil relief valve and spring. |
| | Thin or diluted oil | Change oil to correct viscosity. |
| | Excessive bearing clearance | Measure bearings for correct clearance. |
| | Connecting rod journals out-of-round | Replace crankshaft or regrind journals. |
| | Misaligned connecting rods | Replace bent connecting rods. |
| Main bearing noise | Insufficient oil supply | Check engine oil level. |
| | Low oil pressure | Check engine oil level. Inspect oil relief valve and spring. |
| | Thin or diluted oil | Change oil to correct viscosity. |
| | Excessive bearing clearance | Measure bearings for correct clearances. |
| | Excessive end play | Check No. 3 main bearing for wear on flanges. |
| | Crankshaft journal out-of-round worn | Replace crankshaft or regrind journals. |
| | Loose flywheel or torque converter | Tighten to correct torque. |

| Problem | Probable cause | Remedy |
|-------------------|-----------------------------------|---|
| Oil consumption | Worn, scuffed, or broken rings | Hone cylinder bores and install new rings. |
| | Carbon in oil ring slot | Install new rings. |
| | Rings fitted too tight in grooves | Remove the rings. Check grooves. If groove is not proper width, replace piston. |
| | Worn valve guides | Install new valves and/or new valve guides with O.S. |
| | Faulty valve stem seals | Install new valve stem seals. |
| Oil pressure drop | Low oil level | Check engine oil level. |
| | Faulty oil pressure switch | Install new switch. |
| | Clogged oil filter | Install new oil filter. |
| | Worn parts in oil pump | Replace worn parts or pump. |
| | Thin or diluted oil | Change oil to correct viscosity. |
| | Excessive bearing clearance | Measure bearings for correct clearance. |
| | Oil relief valve stuck | Remove valve and inspect, clean, and reinstall. |
| | Oil pump cover bent or cracked | Install new oil pump. |