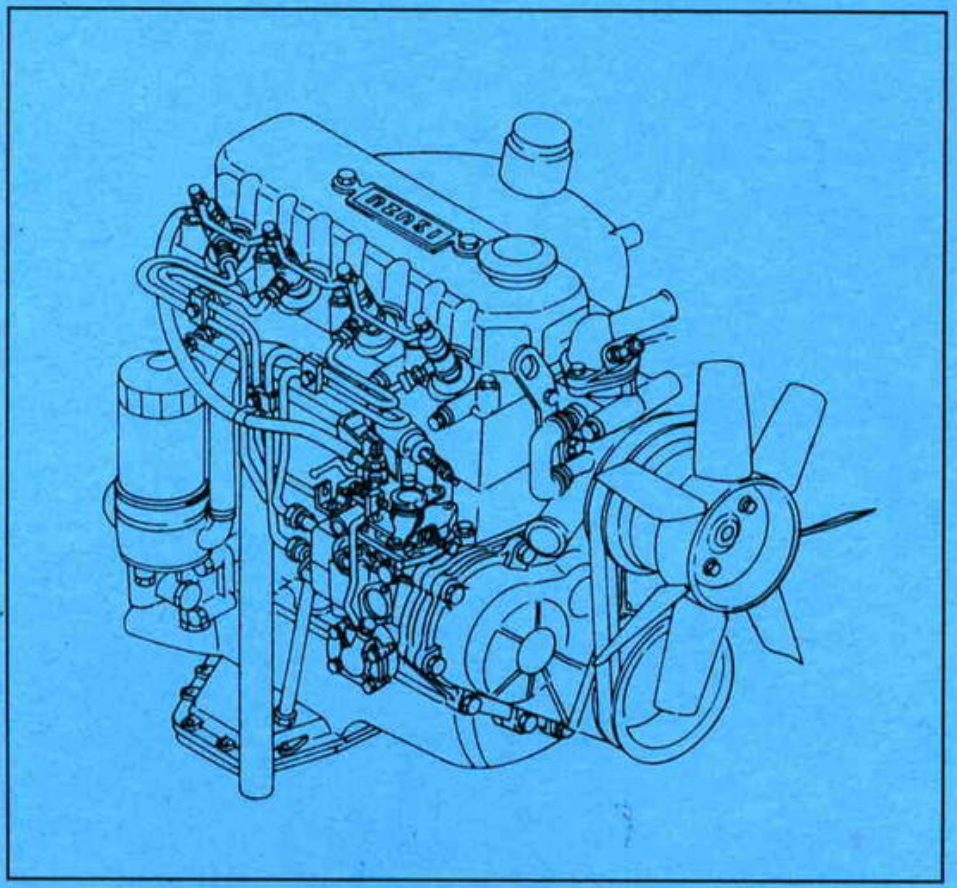
No. ME-C240PKJBE

TCM®

# SHOP MANUAL

## MODEL: ISUZU C240 DIESEL ENGINE



TCM CORPORATION

# FOREWORD

This manual is written to give the information about maintenance procedures for the model C240 Diesel engine, which is mounted on our forklift trucks. It is compiled based on the work shop manual (Publication No. IDE-2220) published by Isuzu Corporation. The relationship of the engine models and our applicable trucks is as follows:

| Applicable truck model | | | | | |
|---|---|---|---|---|---|
| FHD15Z7 | FHD18Z7 | | | | |
| FHD15Z8 | FHD18Z8 | | | | |
| FD15C9H | FD15T9H | FD18C9H | FD18T9H | | |
| FCD15Z8 | FCD18Z8 | | | | |
| FA15D | | | | | |
| FD20Z2S | FD23Z2S | FD25Z2S | FD28Z7S | FD30Z7S | |
| FD20Z3 | FD23Z3 | FD25Z3 | FD28Z8 | FD30Z8 | |
| FD20Z4 | FD23Z4 | FD25Z4 | FD28Z9 | FD30Z9 | |
| FD20Z5 | FD23Z5 | FD25Z5 | FD28Z5 | FD30Z5 | |
| FD20C6 | FD20T6 | FD25C6 | FD25T6 | FD30C6 | FD30T6 |
| FCD20Z7 | FCD23Z7 | FCD25Z7 | FCD28Z7 | FCD30Z7 | |

June, 2002

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SECTION 1

# GENERAL INFORMATION

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## GENERAL REPAIR INSTRUCTIONS

1. Before performing any service operation with the engine mounted, disconnect the grounding cable from the battery.

   This will reduce the chance of cable damage and burning due to short circuiting.

2. Always use the proper tool or tools for the job at hand.

   Where specified, use the specially designed tool or tools.

3. Use genuine ISUZU parts referring ISUZU PARTS CATALOG for the engines surely.
4. Never reuse cotter pins, gaskets, O-rings, lock washers, and self locking nuts. Discard them as you remove them. Replace them with new ones.
5. Always keep disassembled parts neatly in groups. This will ensure a smooth reassembly operation.

   It is especially important to keep fastening parts separate. These parts vary in hardness and design, depending on their installation position.

6. All parts should be carefully cleaned before inspection or reassembly.

   Oil ports and other openings should be cleaned with compressed air to make sure that they are completely free of obstructions.

7. Rotating and sliding part surfaces should be lubricated with oil or grease before reassembly.
8. If necessary, use a sealer on gaskets to prevent leakage.
9. Nut and bolt torque specifications should be carefully followed.
10. Always release the air pressure from any machine-mounted air tank(s) before dismounting the engine or disconnecting pipes and hoses. To not do so is extremely dangerous.
11. Always check and recheck your work. No service operation is complete until you have done this.
12. Information contained in the "Main Data and Specifications" of the Workshop Manual and the Instruction Book may differ. In this case, the information contained in the Instruction Book should be considered applicable.

## NOTES ON THE FORMAT OF THIS MANUAL

This Workshop Manual is applicable to the ISUZU industrial diesel engines model specified in the title of this Workshop Manual.

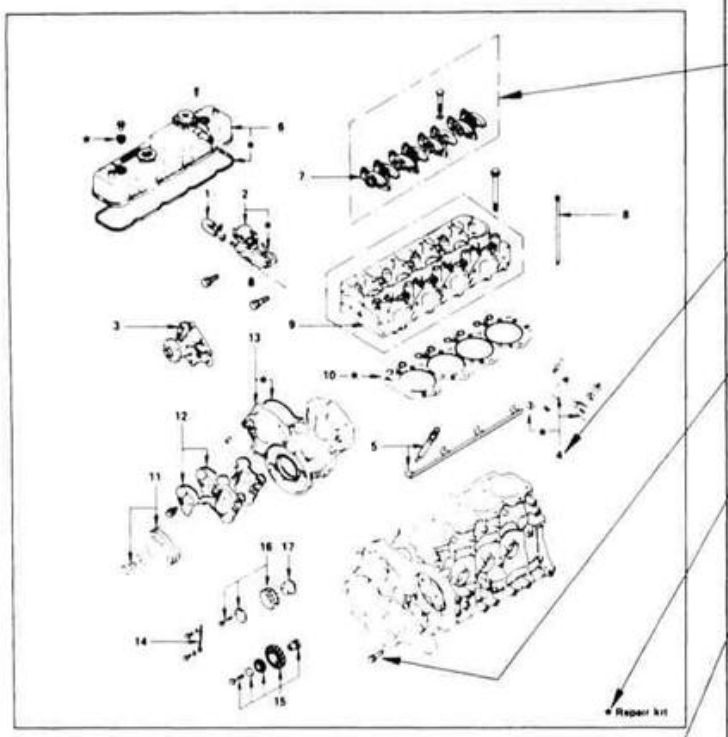
1. Find the applicable section by referring to the Table of Contents at the beginning of the Manual.
2. Common technical data such as general maintenance items, service specifications, and tightening torques are included in the "General Information" section.
3. Eash section is divided into sub-sections dealing with disassembly, inspection and repair, and reassembly.

   The section ENGINE ASSEMBLY is an exception. This part is divided into three sections to facilitates quick indexing.

4. When the same servicing operation is applicable to several different units, the manual will direct you to the appropriate page.
5. For the sake of brevity, self-explanatory removal and installation procedures are omitted.

   More complex procedures are covered in detail.

6. Each service operation section in this Workshop Manual begins with an exploded view of the applicable area. A brief explanation of the notation used follows.




**Disassembly Steps - 2**

1. Water by-pass hose
2. Thermostat housing
3. Water pump
▲ 4. Injection nozzle holder
5. Glow plug and glow plug connector
6. Cylinder head cover
▲ 7. Rocker arm shaft and rocker arm
8. Push rod
▲ 9. Cylinder head
10. Cylinder head gasket
▲ 11. Crankshaft damper pulley with dust seal
12. Timing gear case cover
13. Timing gear cover
14. Timing gear oil pipe
15. Idler gear "B" and shaft
▲ 16. Idler gear "A"
▲ 17. Idler gear shaft

Inverted Engine

Parts within a frame are to be removed and installed as a single unit, and their disassembly steps or reassembly steps are shown in the illustrations respectively.

The number tells you the service operation sequence.

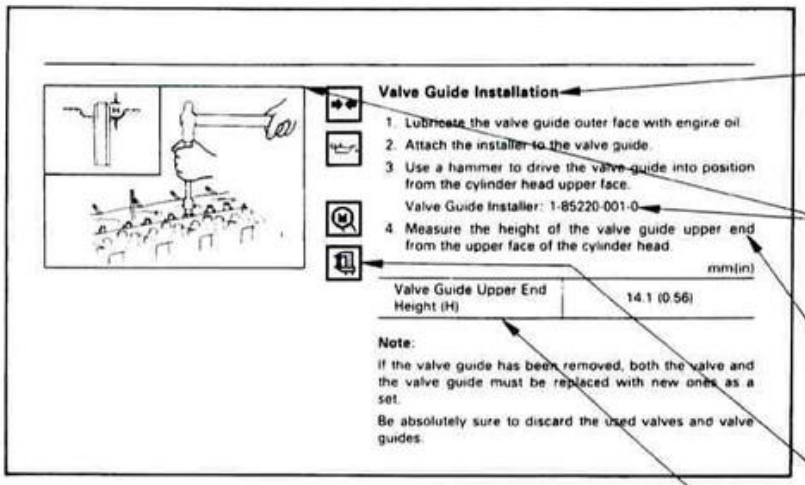
Removal of unnumbered parts is unnecessary unless replacement is required.

The "* Repair Kit" indicates that a repair kit is available.

The parts listed under "Disassembly Steps" or "Reassembly Steps" are in the service operation sequence.

The removal or installation of parts marked with a triangle (▲) is an important operation. Detailed information is given in the text.

7. Below is a sample of the text of the Workshop Manual.




This is the item shown in the illustration. It is marked with a triangle (▲) on the Major Components page.

Special tools are identified by the tool name and/or number.

The illustration shows how the special tool is to be used.

Letters and numbers contained in a circle refer to the illustration.

Symbols indicate the type of service operation or step to be performed. A detailed explanation of these symbols follows.

Service data and specifications are given in this table.

8. The following symbols appear throughout this Workshop Manual. They tell you the type of service operation or step to perform.

 .... Removal

 .... Installation

 .... Disassembly

 .... Reassembly

 .... Alignment (Marks)

 .... Directional Indication

 .... Inspection

 ..... Measurement

 ..... Liquid Gasket Application

 .... Adjustment

 .... Cleaning

 .... Important Operation Requiring Extra Care

 .... Specified Torque (Tighten)

 .... Special Tool Use Required or Recommended (Isuzu Tool or Tools)

 .... Commercially Available Tool Use Required or Recommended

 .... Lubrication (Oil)

 .... Lubrication (Grease)

9. Measurement criteria are defined by the terms "standard" and "limit".

   A measurement falling within the "standard" range indicates that the applicable part of parts are serviceable.

   "Limit" should be thought of as an absolute value.

   A measurement which is outside the "limit" indicates that the applicable part of parts must be either repaired or replaced.

10. Components and parts are listed in the singular form throughout the Manual.

11. Directions used in this Manual are as follows:

    Front;

    The cooling fan side of the engine viewed from the flywheel.

    Right;

    The injection pump side of the engine.

    Left;

    The exhaust manifold side of the engine.

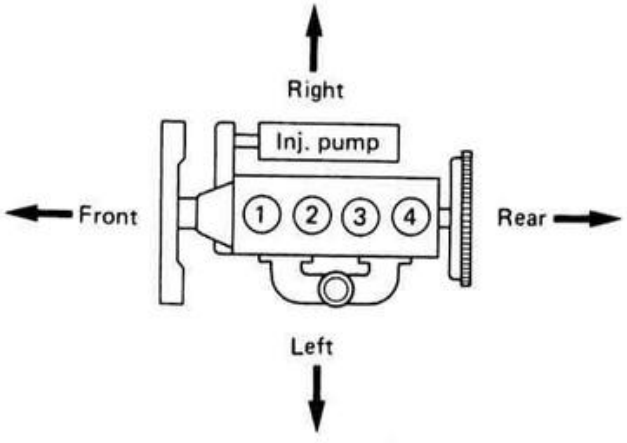
    Rear;

    The flywheel side of the engine.

    Cylinder numbers are counted from the front of the engine.

    The front most cylinder is No. 1 and rear most cylinder is the final cylinder number of the engine.

    The engine's direction of rotation is counterclockwise viewed from the flywheel.



**NOTE:**

1. **These specifications are based on the standard model engine.**
2. **Specifications for items marked with asterisk (*) will vary according to the type of equipment on which the engine is installed.**
3. **As the fuel injection timing crank angle differs depending on an engine application, respective engine's timing crank angle, when necessary, should be asked ISUZU MOTORS LIMITED via the machine supply source or the engine supply source. In such case, be sure to give the supply source full information on your engine's identification such as the engine serial number etc. which is stamped or affixed on the engine.**

## DESIGN FEATURES AND GENERAL OUTLINE

1. General Outline of ISUZU C240 Diesel Engine

   The model C240 which has been used by various original equipment manufactures is one of a main industrial diesel in ISUZU's own engine line-up.

   Its wide versatility and superior long engine life which are brought by the simple engine construction and easy maintenance is a reason why the C240 is welcomed to the world wide industrial engine market.

2. Main Engine Parts and Their Features

   It is consists of a mono-block casted cylinder block with five crankshaft journal supporting bulbheads and detachable crankcase along with a stamped oil sump. The cylinder bores are of a dry type Chromard Liner.

   The cylinder head is also of a mono-block casted type with an antechamber cavity to form a swirl combustion chamber along with the press-in heat plug per cylinder. The intake ports and exhaust ports are arranged at the engine left hand side giving a superior maintenance accessibility at the engine RH side.

3. Fuel System

   This engine uses the Bosch in-line A type injection pump of distributor VE type injection pump depending on the engine application. A variable speed control RSV type mechanical governor is mainly equipped on the in-line injection pump and, a semi-variable speed control type mechanical govenor is equipped on the distributor type injection pump.

   A built-in feed pump is equipped on the in-line type, while the distributor type has no feed pump, which is remotely installed on the water sedimentor.

# TIGHTENING TORQUE SPECIFICATIONS

## STANDARD BOLTS

The torque values given in the following table should be applied where a particular torque is not specified.

kg·m(lb.ft/N·m)

| Bolt identification / Bolt diameter x pitch (mm) |  |  |  |
|---|---|---|---|
| | 4T (Low carbon steel) | 7T (High carbon steel) | 9T (Alloy steel) |
| M 6 ×1.0 | 0.6 ±0.2 ( 4.4± 1.4/ 5.88± 1.96) | 0.75± 0.2 ( 5.43± 1.43/ 7.35± 1.96) | — |
| M 8 ×1.25 | 1.3 ±0.5 ( 0.4± 3.4/ 12.74± 4.90) | 1.75± 0.5 ( 12.66± 3.00/ 17.15± 4.90) | 2.0 ± 0.7 ( 17.36± 5.36/ 19.60± 6.86) |
| M10 ×1.25 | 2.8 ±0.7 ( 20.3± 5.2/ 27.44± 6.86) | 3.75± 0.9 ( 27.20± 7.2 / 36.75± 8.82) | 5.0 ± 1.3 ( 36.88± 9.88/ 49.00± 12.74) |
| M12 ×1.25 | 6.25±1.2 ( 45.2± 9.2/ 61.25±11.76) | 7.75± 1.5 ( 56.03± 11.03/ 75.95± 14.70) | 9.65± 1.9 ( 69.77± 13.77/ 94.57± 18.62) |
| M14 ×1.5 | 8.75±1.9 ( 70.5±14.5/ 85.75±18.62) | 11.85± 2.3 ( 85.67± 16.6 /116.13± 22.54) | 14.50± 2.9 (104.84± 20.83/142.1 ± 28.42) |
| M16 ×1.5 | 13.3 ±2.7 ( 94.0±17.0/130.34±26.46) | 17.30± 3.5 (125.07± 25.07/169.54± 34.30) | 20.40± 4.1 (147.50± 29.49/199.92± 40.18) |
| M18 ×1.5 | 19.2 ±3.8 (138.9±27.9/188.16±37.24) | 24.90± 5.0 (180.03± 36.3 /244.02± 4.90) | 29.30± 5.9 (211.84± 42.83/287.14± 57.82) |
| M20 ×1.5 | 26.3 ±5.3 (190.2±38.2/257.74±51.94) | 34.40± 6.9 (248.72± 49.7 /337.12± 67.62) | 40.40± 8.1 (292.10± 58.09/395.92± 79.38) |
| M22 ×1.5 | 33.0 ±8.3 (245.1±60.1/323.40±81.34) | 46.25± 9.2 (334.39± 66.38/453.25± 90.16) | 54.10±10.8 (391.15± 78.14/530.18±105.84) |
| M24 ×2.0 | 45.8 ±9.2 (331.2±60.2/448.84±90.16) | 58.20±14.0 (420.70±102.78/570.36±137.20) | 70.60±14.1 (510.44±101.44/691.88±138.18) |
| *M10 ×1.5 | 2.7 ±0.7 ( 19.6± 5.6/ 26.46± 6.86) | 3.7 ± 0.9 ( 26.75± 6.7 / 36.26± 8.82) | 4.9 ± 1.2 ( 35.43± 8.42/ 48.02± 11.76) |
| *M12 ×1.5 | 5.8 ±1.2 ( 42.0± 9.0/ 56.84±11.76) | 7.2 ± 1.4 ( 52.02± 10.05/ 70.56± 13.72) | 9.1 ± 1.8 ( 65.80± 12.80/ 89.18± 17.64) |
| *M14 ×2.0 | 9.1 ±1.8 ( 65.8±12.8/ 89.18±17.64) | 11.2 ± 2.2 ( 80.97± 15.7 /109.76± 21.56) | 13.6 ± 2.7 ( 98.33± 19.33/133.28± 26.46) |
| *M16 ×2.0 | 12.7 ±2.5 ( 91.9±17.9/124.46±24.5 ) | 16.5 ± 3.3 (119.30± 24.3 /161.70± 32.34) | 19.5 ± 3.9 (140.99± 27.99/191.1 ± 38.22) |

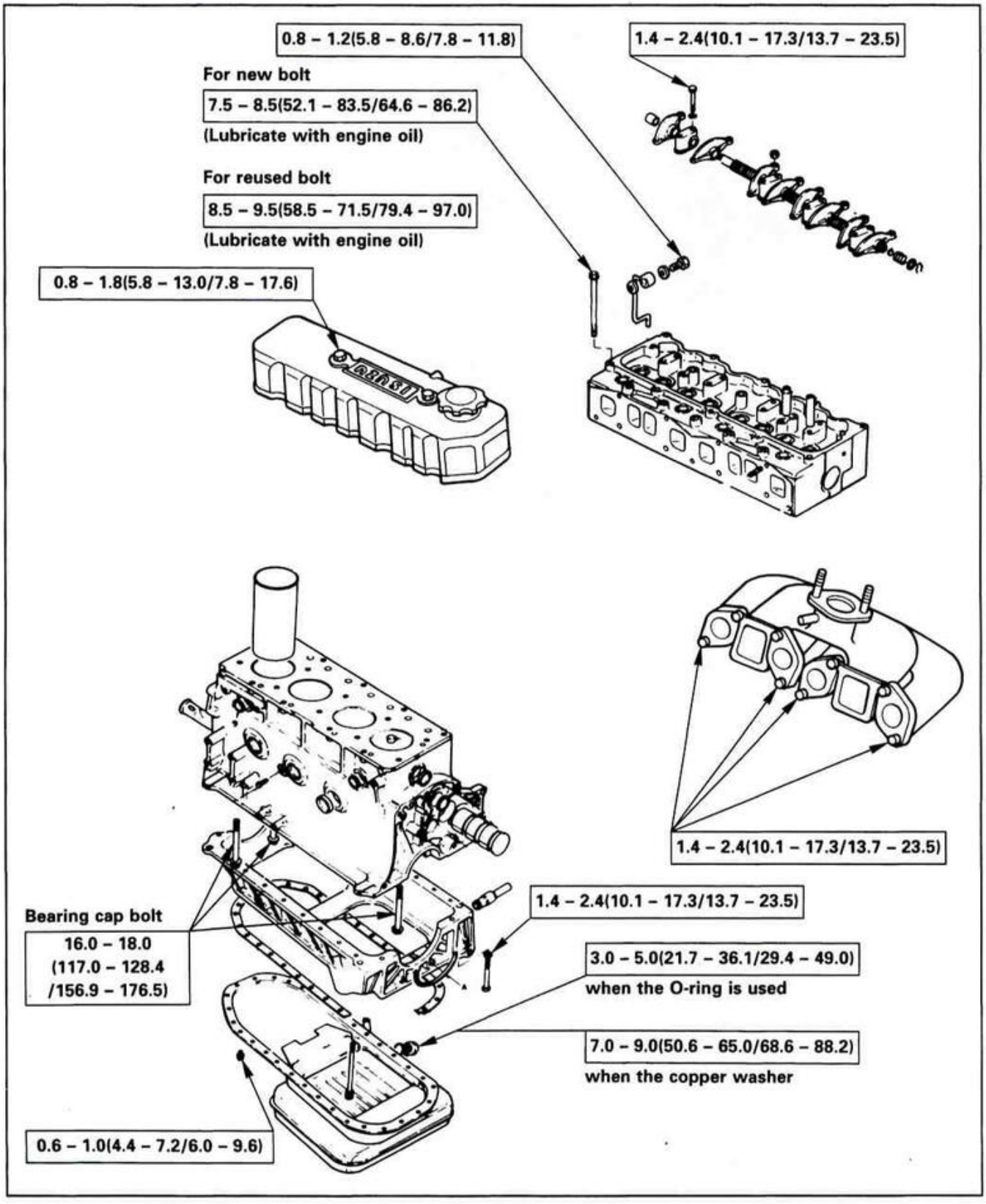
**Note:**

**The astarisk (*) indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting.**

# MAJOR PART FIXING NUTS AND BOLTS

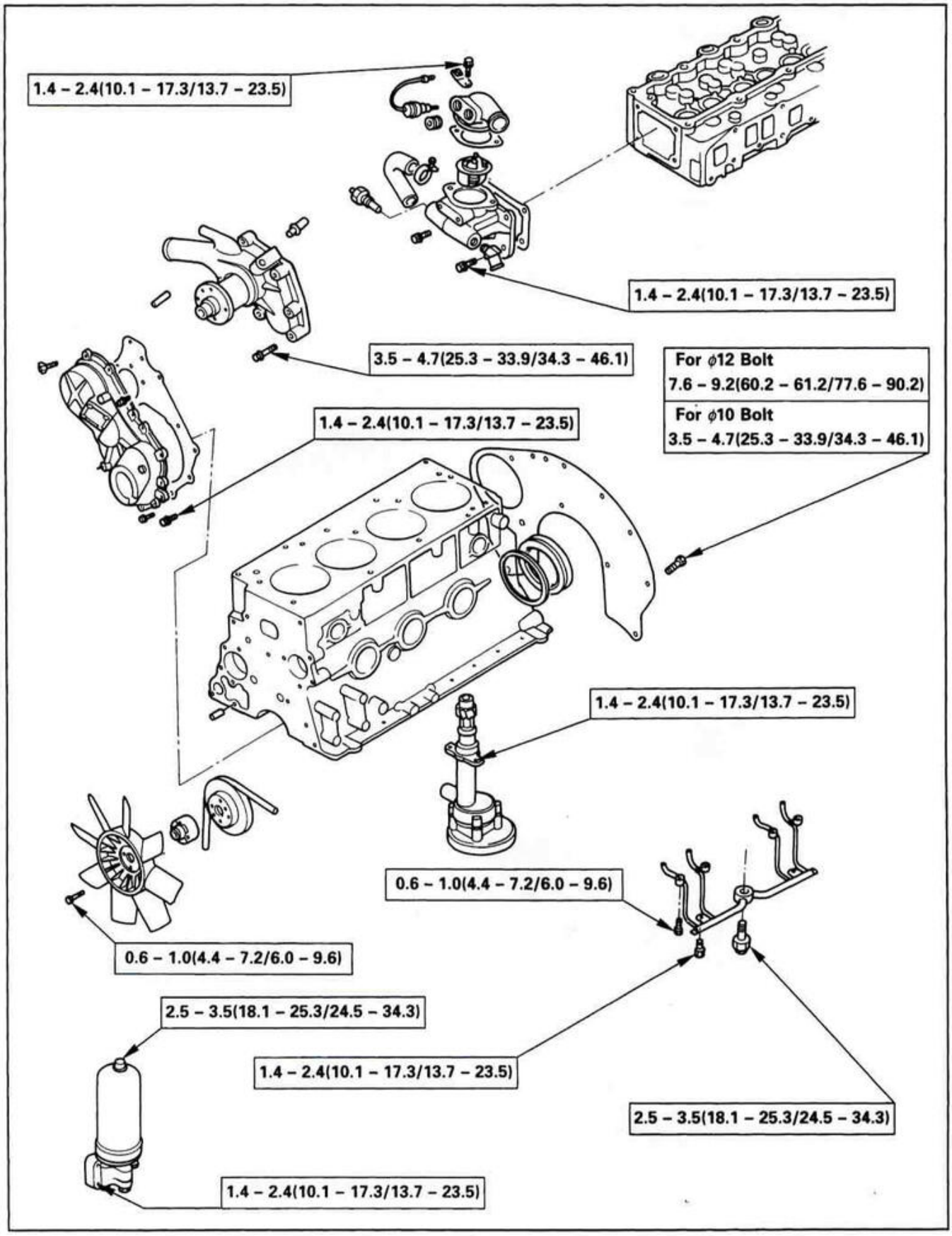
## Cylinder body, cylinder head, crankcase, oil pan and rocker arm shaft

kg·m(lb.ft/N·m)



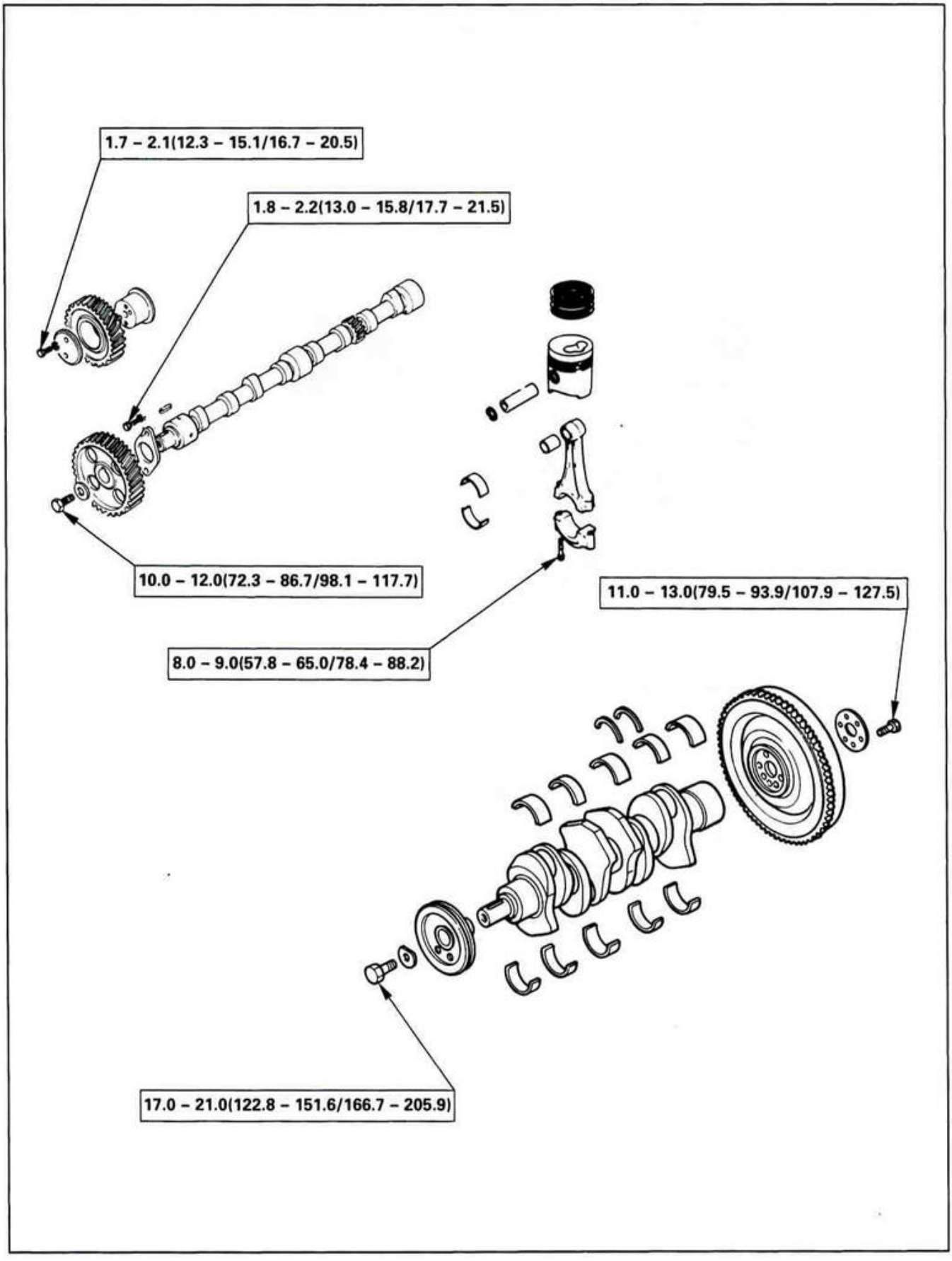
## Timing gear case, water pump, flywheel housing, oil pump and oil filter

kg·m(lb.ft/N·m)



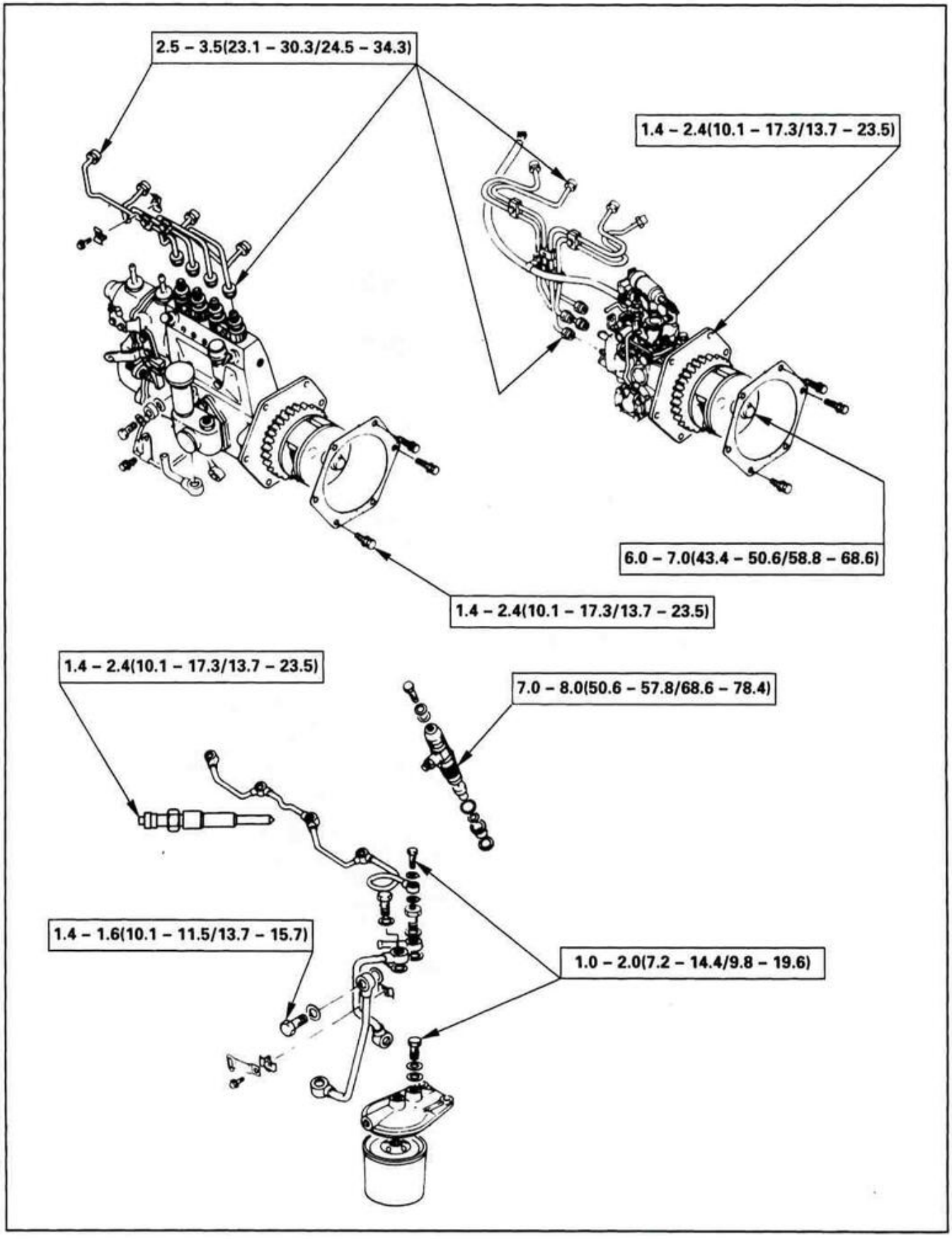
## Crankshaft, flywheel, camshaft and camshaft gear

kg·m(lb.ft/N·m)

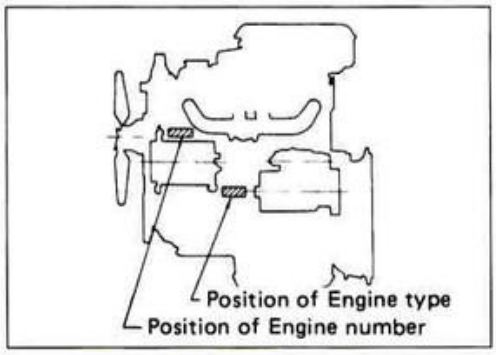


## Injection pump, fuel pipe, injection nozzle holder and glow plug

kg·m(lb.ft/N·m)



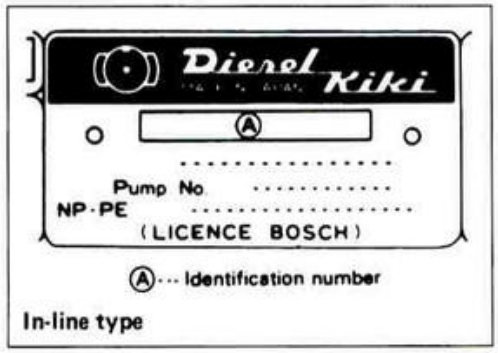
# IDENTIFICATIONS




## MODEL IDENTIFICATION

**Engine Serial Number**

The engine number is stamped on the right hand side of the cylinder body.




In-line type

## INJECTION PUMP IDENTIFICATION

**Injection Pump Number**

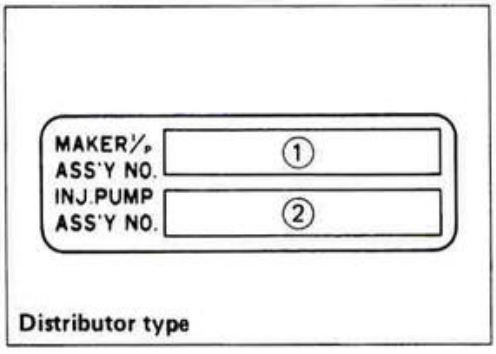
Injection volume should be adjusted after referring to the adjustment data applicable to the injection pump installed.

The injection pump identification number (A) is stamped on the injection pump identification plate.

**Note:**

**Always check the identification number before beginning a service operation.**

**Applicable service data will vary according to the identification number. Use of the wrong service data will result in reduced engine performance and engine damage.**




Distributor type

① DKC (Manufacturer of the injection pump) identification number

② ISUZU Parts Number

## SECTION 2

# MAINTENANCE

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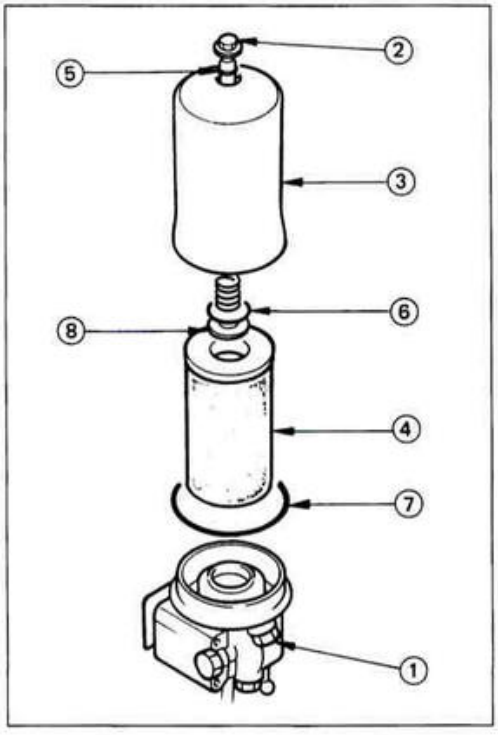
Note: Maintenance intervals such as fuel or oil filter changes should be referred to INSTRUCTION BOOK.

## LUBRICATING SYSTEM

### Main Oil Filter Replacement

### Replaceable Element Type




**Removal**

1. Loosen the drain plug ① to drain the engine oil from the oil filter.

   Place a receptacle beneath the drain port to contain the drained oil.
2. Remove the center bolt ② and the filter body ③ from the filter cover along with the filter element ④.
3. Discard the used filter element.
4. Wipe the oil filter fitting face clean with a rag. This will allow the new oil filter to seat properly.

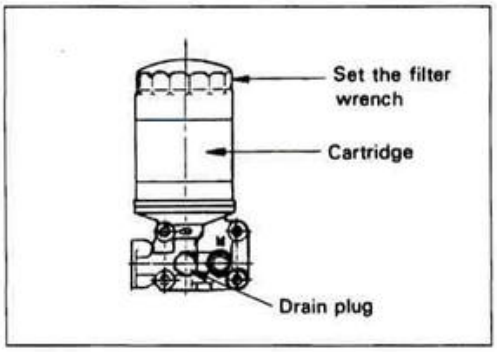
**Installation**

1. Install the three O-rings ⑤, ⑥, ⑦ and new element ④ and, check that they are correctly positioned.
2. Reassemble the filter body ③ with the center bolt ②.

Oil filter Center Bolt Torque kg·m(lb.ft/N·m)

| 2.7 – 3.3 (20.5 – 23.7 / 26.5 – 32.3) |
|---|

3. Check that the gasket is properly seated. This will prevent oil leakage.
4. Start the engine and check for oil leakage from the oil filter.
5. Check the engine oil level and replenish to the specified level if required.




### Disposable Cartridge (Spin-On) Type

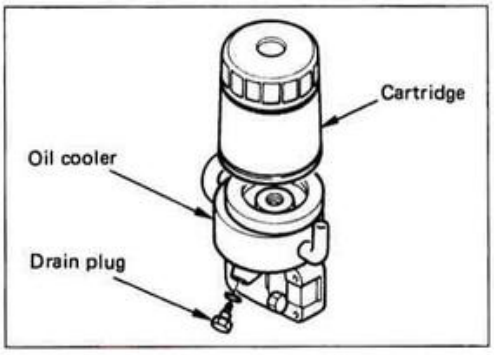
**Removal**

Removal and Installer: Filter Wrench

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
2. Discard the use coil filter.

**Installation**

1. Wipe the oil filter mounting face with a clean rag.
   This will allow the new oil filter to seal properly.
2. Lightly oil the O-ring.
3. Turn in the new oil filter until the sealing face is fitted against the O-ring
4. Use the filter wrench to turn in the oil filter an additional 1-1/4 of a turn or one turn.
5. Start the engine and check for oil leakage from the oil filter.
6. Check the engine oil level and replenish to the specified level if required.




## Disposable Cartridge Spin-on Type with Built-in Oil Cooler Type

**Removal**

Removal and Installer: Filter Wrench

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
2. Discard the used filter.

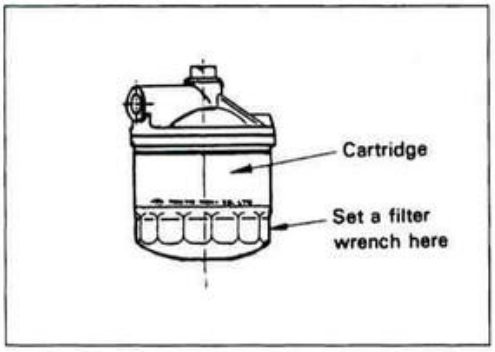
**Installaltion**

1. Wipe the oil filter mounting face with a clean rag.
   This will allow the new oil filter to seat properly.
2. Lightly oil the O-ring
3. Turn in the filter until the sealing face is fitted against the O-ring.
4. Use the filter wrench to turn in the oil filter an additional 1-1/4 of a turn.
5. Start the engine and check for oil leakage from the oil filter.
6. Check the engine oil level and replenish to the specified level if required.

# FUEL SYSTEM

## Fuel filter Replacement

## Disposable Cartridge Spin-on Type

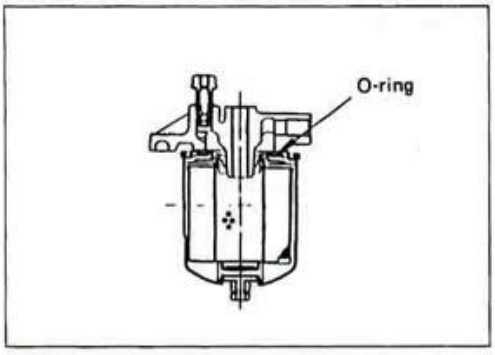



### Removal

1. Loosen the fuel filter by turning it counterclockwise with the filter wrench or your hand. Discard the used filter.

   Filter Wrench
2. Wipe the fuel filter fitting face clean with a rag.

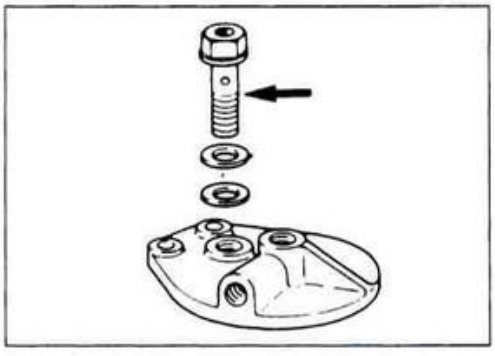
   This will allow the new fuel filter to seat properly.




### Installaltion

1. Apply a light coat of engine oil to the O-ring
2. Supply fuel to the new fuel filter.

   This will facilitate air bleeding.
3. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
4. Use the filter wrench to turn in the fuel filter an additional 2/3 of a turn.



## Overflow Valve

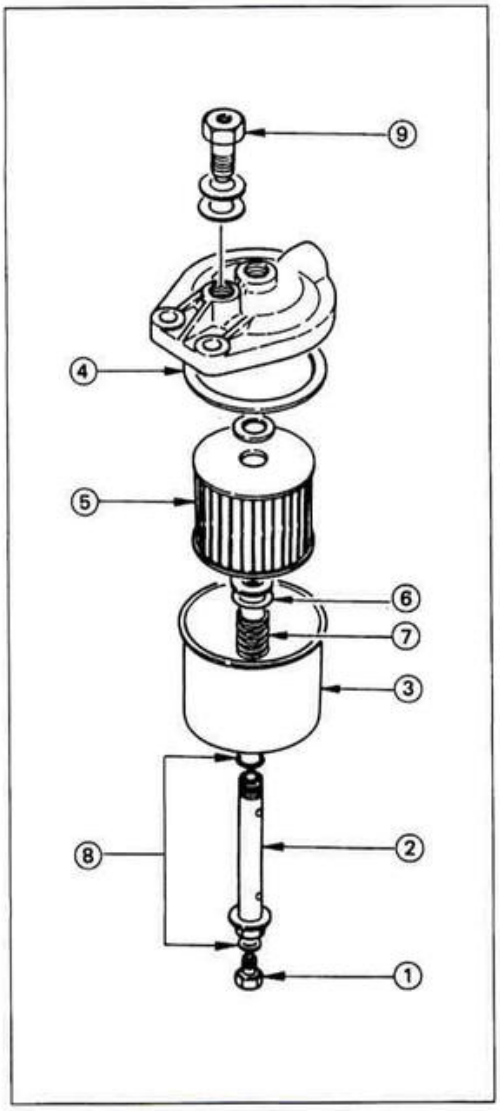
Check the overflow valve for clogging.

Check the ball side for suction leakage.

kg/cm² (psi/kPa)

| | |
|---|---|
| Overflow Valve Opening Pressure (Reference) | 1.5 (21.33/147) |

## Replaceable Element Type




### Removal

1. Loosen the drain plug ① to drain the fuel from the fuel filter.
2. Loosen the center bolt ② to remove the filter body ③, the spring ⑦, the spring seat ⑥ and the gaskets ⑧.
3. Discard the used element.

### Installation

1. Wash the filter body and the other fuel filter parts immersing them into clean diesel fuel.
2. Reinstall the parts in reverse order of the removal. Use the new element.

Fuel Filter Center Bolt Torque kg·m(lb.ft/N·m)

| 2.5 – 3.5 (18.0 – 25.2 / 24.5 – 34.3) |
|---|

3. Check that the gaskets are properly seated. This will prevent fuel from leakage.

## Overflow Valve

Check that the overflow valve ⑨ for clogging.

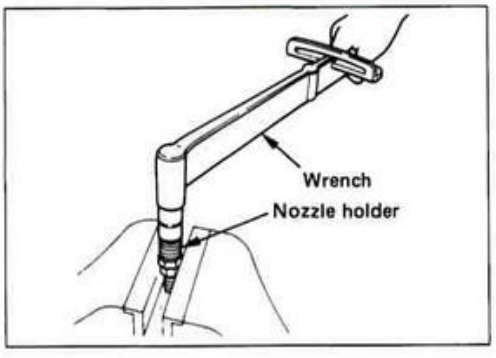
Check the ball side for suction leakage.

kg/cm² (psi/kPa)

| | |
|---|---|
| Overflow Valve Opening Pressure (Reference) | 1.5 (21.33 / 147) |

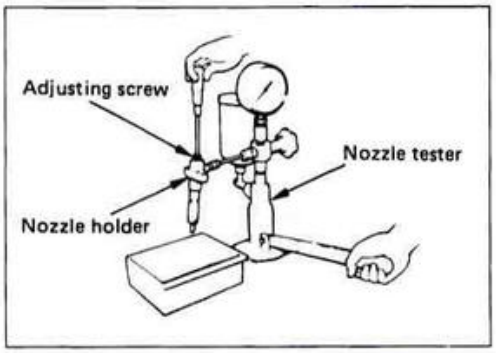
## Injection Nozzle

Regarding the injection pipe and the nozzle holder removal and installation, refer to the section 3 DISASSEMBLY page 3- and the section 5 REASSEMBLY 5- .



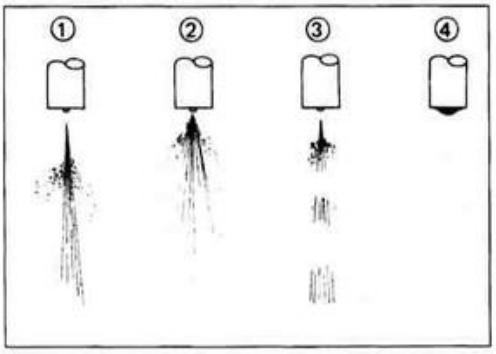

### Injection Nozzle Adjustment

1. Clamp the injection nozzle holder in a vise.
2. Use a wrench to remove the injection nozzle holder cap.
3. Loosen the adjusting screw lock nut (if so equipped).
4. Remove the injection nozzle holder from the vise.

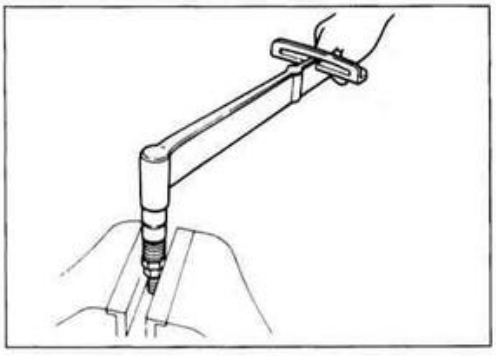



5. Attach the injection nozzle holder to the injection nozzle tester.
6. Adjust the injection starting pressure and the spray condition by turning the adjusting screw while operating the injection nozzle tester.

| Injection Nozzle Injection Starting Pressure | kg/cm² (psi/kPa) |
|---|---|
| | 120 (1706/11.8) |



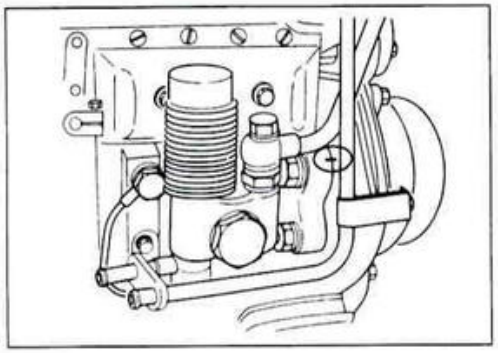

7. Refer to the illustration for different spray conditions.
   ① Correct
   ② Incorrect (Restrictions in orifice)
   ③ Incorrect (Restrictions in orifice)
   ④ Incorrect (Dripping)
8. Temporarily tighten the cap nut (lock nut).
9. Clamp the injection nozzle holder in a vise.

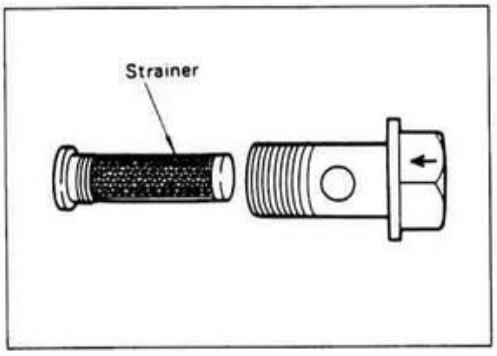


10. Tighten the cap nut (lock nut) to the specified torque.

| Cap Nut Torque | kg·m(lb.ft/N·m) |
|---|---|
| | 3.0 – 4.0 (21.7 – 28.9 / 29.4 – 39.2) |

**WARNING:**
**TEST FLUID FROM THE INJECTION NOZZLE TESTER WILL SPRAY OUT UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN. KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE HOLDER TIP AT ALL TIMES.**

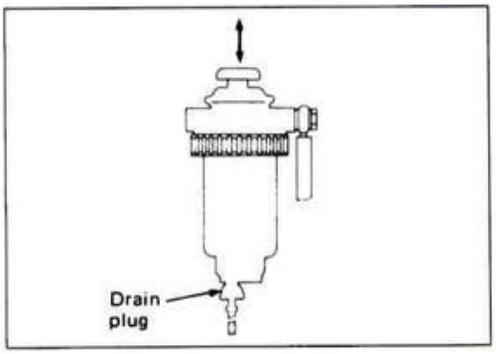





**Feed Pump Strainer (In-line type injection pump only)**

1. Remove the joint bolt.
2. Use a screwdriver to remove the strainer.
3. Wash the strainer in clean diesel fuel.

## Water Sedimentor

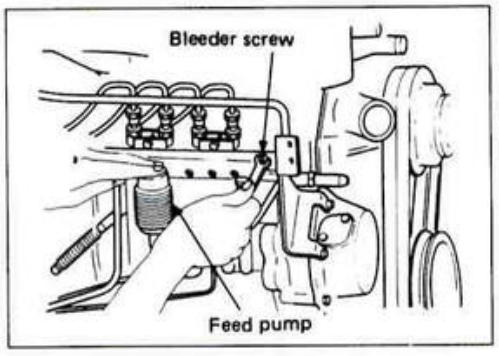



**Dewatering Procedure**

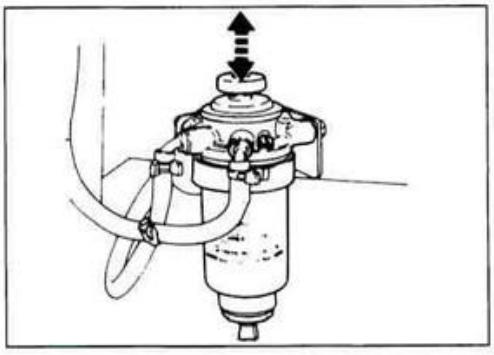
1. Loosen the water sedimentor drain plug at the bottom of the sedimentor.
2. Pump the priming pump with operating the priming pump cap up and down.

   The sedimented water will be drained from the drain plug.
3. After the draining, retighten the drain plug securely.
4. Do the air bleeding referring AIR BLEEDING described in this section.
5. Start and idle the engine to check the fuel leakage arround the fuel system.

## Air Bleeding




1. For the engine equipped with in-line type injection pump
   - ① Loosen the feed pump cap on the injection pump.
   - ② Loosen the bleeder screw on the injection pump shown in the illustration.
   - ③ Operate the feed pump until no more bubbles visible in the fuel being discharged from the bleeding screw.
   - ④ Retighten the bleeding screw and the feed pump cap screw and the feed pump cap securely after the bleeding.



2. For the engine equipped with distributor type injection pump

   ① Unscrew the feed pump cap on the water sedimentor.

   ② Pump the feed pump with repeatedly pushing down the cap to force the air in the fuel circuit into the injection pump.

   ③ Do the cranking a short while with operating starter motor.

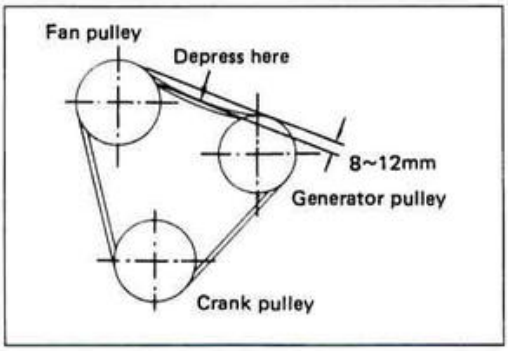
   ④ The bleeding will be accomplished within ten seconds by this procedure.

   When the engine does not still start despite of the bleeding, repeat the procedure until the engine will start.

   ⑤ Firmly screw in the feed pump cap after the bleeding.

# COOLING SYSTEM

## Cooling Fan Drive Belt



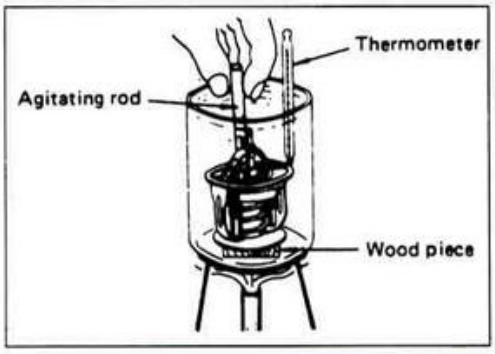

### Adjustment

1. Check the cooling fan drive belt for cracking and other damage.
2. Check the drive belt tension by exerting a force of 10 kg (22 lb) midway between the fan pulley and the generator pulley.
3. Adjust the belt tension by loosing the generator mounting bolt and the generator adjusitng bolt and pivoting the generator.

   Be sure to retighten the bolts after adjusting the belt tension.

| Cooling Fan Drive Belt Deflection | mm(in) |
|---|---|
| 8 – 12 (0.3 – 0.57) | |

## Thermostat




### Inspection

Visually inspect the thermotat.

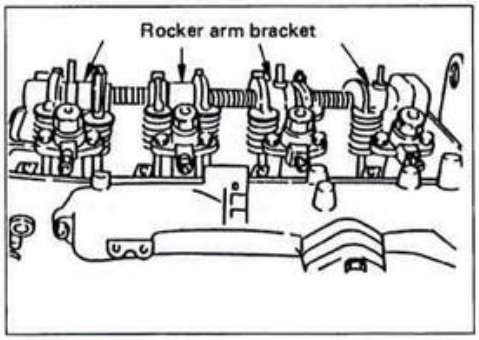
Replace the thermostat if excessive wear or damage is discovered during inspection.

Measure the valve lift.

| Amount of Valve Lift at 95°C (203°F) | mm(in) |
|---|---|
| 8.0 (0.30) | |

| Valve Opening Temperature | °C(°F) |
|---|---|
| 80 – 84 (176 – 183) | |

## VALVE CLEARANCE AND ADJUSTMENT

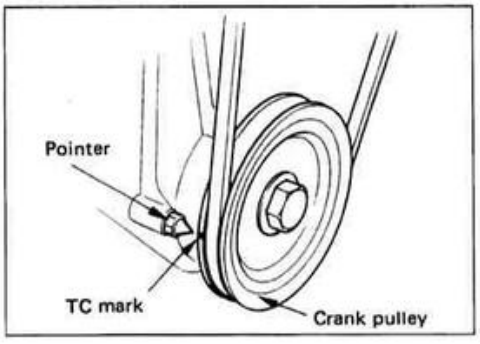



**Inspection**

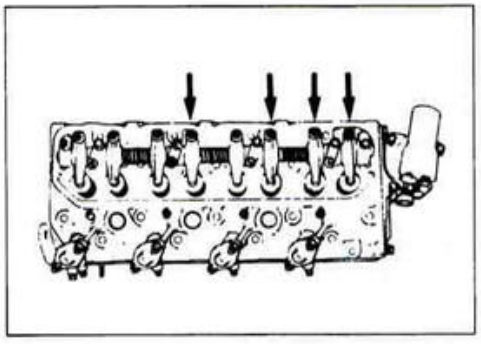
Check the rocker arm bracket bolts for looseness and retighten as necessary before adjusting the valve clearance.

Rocker Arm Bracket Bolt Torque — kg·m(lb.ft/N·m)

| 1.4 – 2.4 (10.1 – 17.3 / 13.7 – 23.5) |
|---|




1. Bring the piston in either the No. 1 cylinder or the No. 4 cylinder to TDC on the compression stroke by turning the crankshaft until the crankshaft pulley TDC line is aligned with the timing pointer.



3. Check for play in the No. 1 intake and exhaust valve push rods.

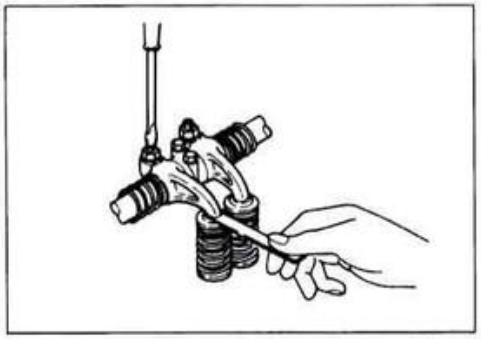
   If the No. 1 cylinder intake and exhaust valve push rods have play, the No. 1 piston is at TDC on the compression stroke.

   If the No. 1 cylinder intake and exhaust valve push rods are depressed, the No. 4 piston is at TDC on the compression stroke.

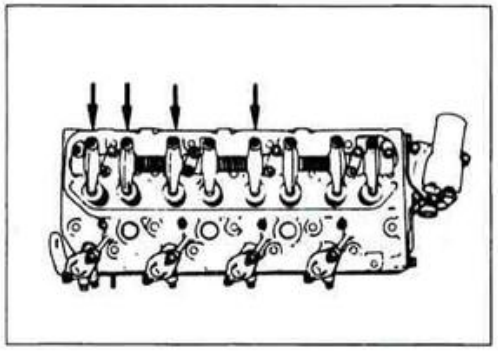
Intake and Exhaust Valve Clearance — mm(in)

| 0.45 (0.018) |
|---|

Adjust the No. 1 or the No. 4 cylinder valve clearances while their respective cylinders are at TDC on the compression stroke.

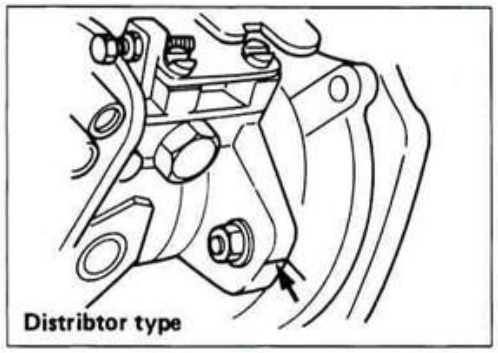


4. Loosen each valve clearance adjusting screw as shown in the illustration.
5. Insert a feeler gauge of the appropriate thickness between the rocker arm and the valve stem end.
6. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.



7. Tighten the lock nut securely.
8. Rotate the crankshaft 360°.
9. Realign the crankshaft damper pulley TDC notched line with the timing pointer.
10. Adjust the clearance for the remaining valves as shown in the illustration.

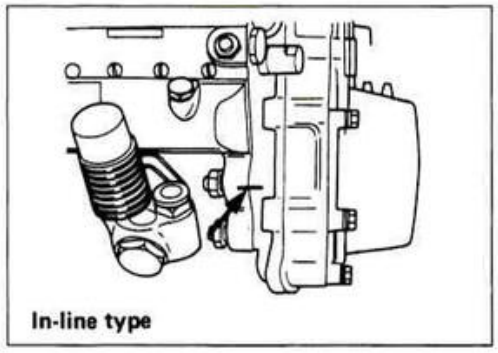
## INJECTION TIMING



Distribtor type

**Checking Procedure**

1. Check that the notched line on the injection pump fixing flange is aligned with the injection pump mounting flange's notched line.
2. If a timing marks misalignment is discovered in the timing inspection, do the following adjustment after all of the fuel system parts have installed.



In-line type

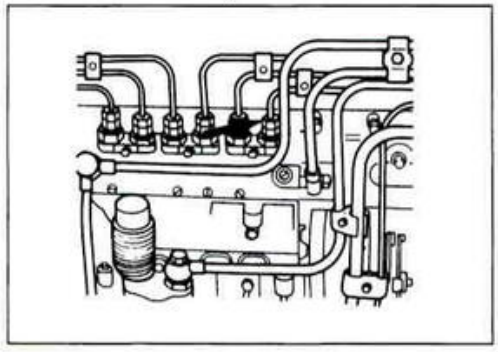
**Adjustment Procedure**

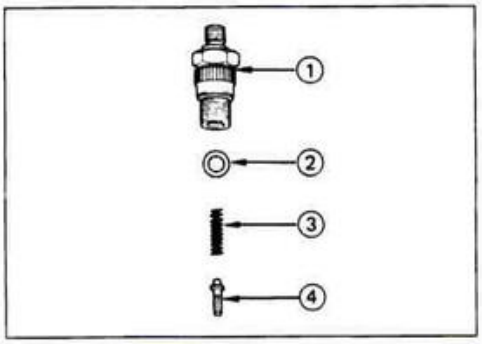
The fuel injection timing procedure differs depending on the fuel injection pump type used.

**The procedure for the in-line type injection pump**

1. Disconnect the injection pipe from the No. 1 plunger.

   This will allow you to visually check the fuel injection starting at the No. 1 plunger.






2. Remove the delivery valve holder ①, the valve seat ②, valve spring ③ and the delivery valve ④ from the No. 1 plunger.
3. Reinstall the delivery valve holder ① and tighten it to the specified torque.

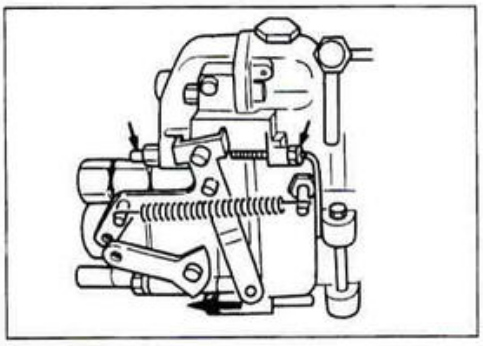
Delivery Valve Tightening Torque kg·m(lb.ft/N·m)

| 4.0 – 4.5 (28.9 – 32.5 / 39.2 – 44.2) |
|---|

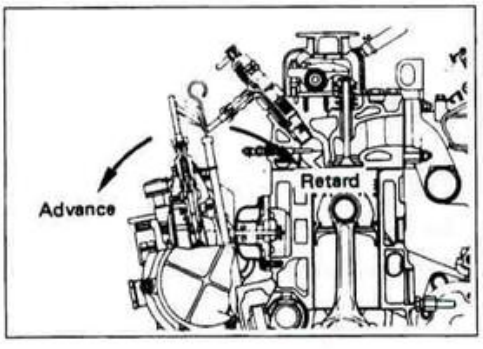
**Note:**

**Take care to avoid entry of dust or foreign particles into the injection pump interior when the delivery valve has been removed.**

Do not reinstall the delivery valve spring, the valve seat and the delivery valve. They will be reinstalled after the procedure have finished.



4. Hold the fuel control lever at the full fuel position.




5. The injection timing adjustment is done by pivoting the injection pump at the pump drive shaft.

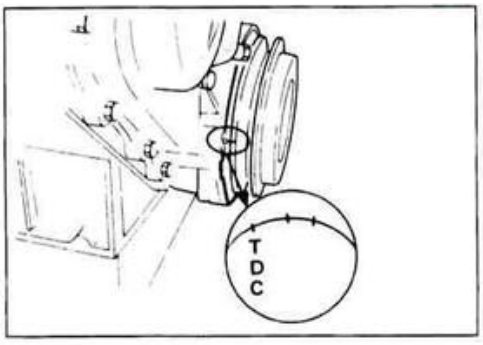
**To advance the timing**

Pivot the injection pump body at the drive shaft toward the engine outside.

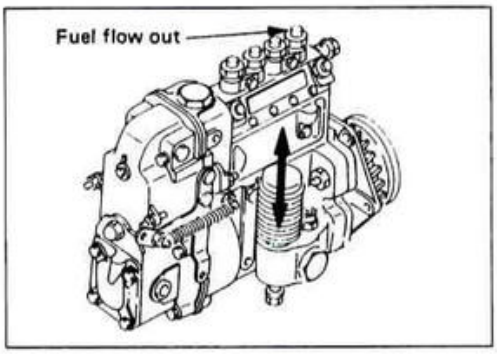
**To retard the timing**

Pivot the injection pump body at the drive shaft toward the engine inside.

6. Disconnect the No. 2 to No. 4 injection pipes to allow the pump is pivoted easily.




7. Align the timing pointer at the timing gear case and the specified injection timing notch line on the crankshaft pulley as illustrated.



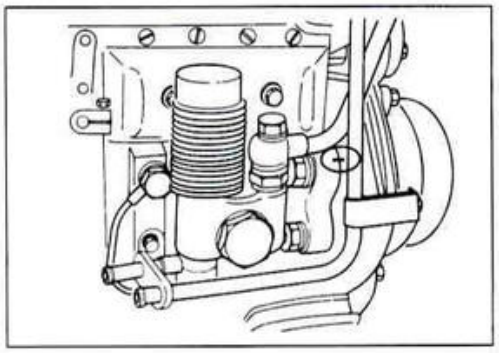

8. Loosen the four injection pump fixing nuts to allow the pump body to pivot.
9. Operate the priming pump to allow the fuel to follow out from the No. 1 plunger.

**Note:**

**The crank angle differs depending on the engine application, therefore, contact your machine supply source or ISUZU MOTORS LIMITED when you need the crank angle.**

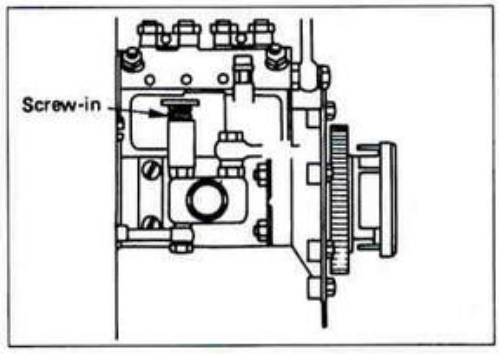
10. With continuing the pumping described in the item 9, pivot the injection pump body toward the engine inside or the engine out side as required slowly.
11. The fuel flow will stop at some injection pump position. This shows the fuel injection starting at the No. 1 plunger, thus correct fuel injection timing is obtained.

    Blow out the fuel remaining on the No. 1 delivery valve holder and check that no fuel is flowed out at place as pumping is done.



12. Retighten the four injection pump fixing nuts to the specified torque.

| Injection Pump Fixing Nut Torque | kg·m(lb.ft/N·m) |
|---|---|
| 1.8 – 2.2 (12.7 – 15.5 / 17.7 – 21.5) | |



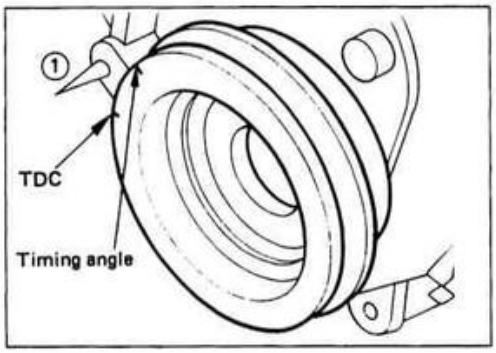

13. Remove the delivery valve holder at the No. 1 plunger. Install the valve spring, valve seat and delivery valve. Reinstall the delivery valve holder and tighten it to the specified torque.

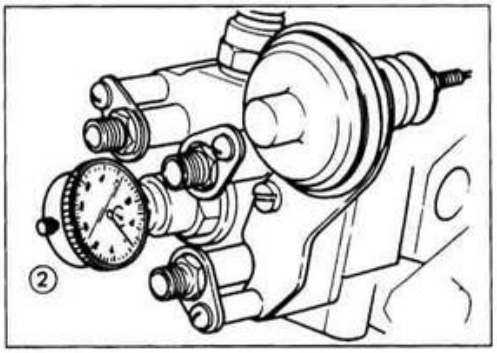
| Delivery Valve Tightening Torque | kg·m(lb.ft/N·m) |
|---|---|
| 4.0 – 4.5 (28.9 – 32.5 / 39.2 – 44.2) | |

14. Reconnect the injection pipes and screw-in the feed pump knob.

**Note:**

**The engine operation with feed pump knob in unscrewed condition will result the feed pump failure.**




**The procedure for the distributor type injection pump**

1. Disconnect the injection pipes from the injection pump to install the Static Timing Gauge.
2. Rotate the crankshaft to bring the piston in the No. 1 cylinder to TDC on the compression stroke.

   ① = Timing pointer
3. Remove one bolt from the distributor head screw.

   Install the static timing gauge ②.

   The probe of the gauge should be depressed inward approximately 1 mm (0.039 in).

   Static Timing Gauge : 5-8840-0145-0
   (J-28827)
4. Then reversely (counterclockwise) turn the crankshaft about 60° before the TDC, and set the dial gauge needle to 0 position.

   Slightly rotate the crankshaft in both directions and check that the needle is stable at 0 position.
5. Slowly turn the crankshaft pulley in engine normal rotating direction with watching the dial indicator on the injection pump.

   When, doing like this, the dial indicator indicates 0.50 mm (0.0197 in), the injection pump plunger is lifted to the fuel injection starting position.

   Accordingly, the injection starting timing mark notched line on the crankshaft pulley and the timing pointer must be aligned at this plunger position.

Plunger Lifted Position at
Fuel Injection Starting Timing — mm(in)

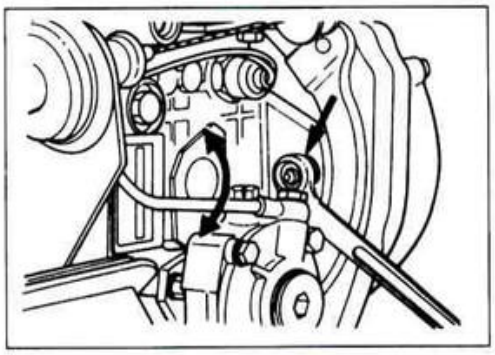
| *0.50 (0.0197) |
|---|

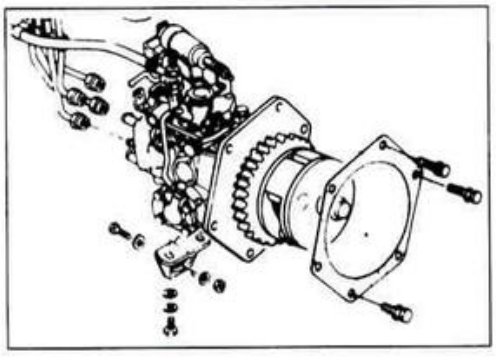
**Note:**

**This valve with an asterisk (*) is based on the standard engine.**

As the fuel injection timing crank angle differs depending on the engine application, respective engine's timing crank angle, when necessary, should be asked ISUZU MOTORS LIMITED via the machine supply source or the engine supply source. In such case, be sure to give the supply sourcefull information on your engine's identification such as the engine serial number etc. which is stamped or affixed on the engine.

If the injection timing is outside the specified plunger position continue with the following steps.





6. Loosen the injection pump fixing nuts and bracket bolts.

   Adjust the injection pump setting angle.

   **To advance the timing**

   Pivot the injection pump body at the drive shaft toward the engine outside.

   **To retard the timing**

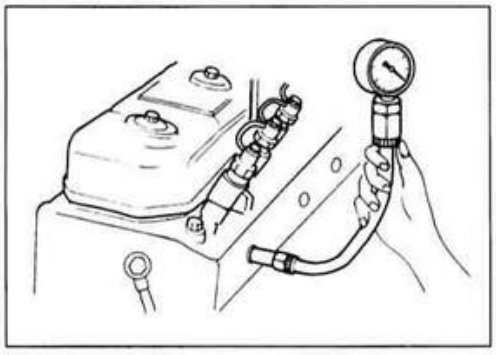
   Pivot the injection pump body at the drive shaft toward the engine inside.

7. Tighten the injection pump fixing nuts and the bracket bolts to the specified torque. Remove the dial indicator and install the bolt to the distributor head screw.

   Reinstall the injection pipes.

## COMPRESSION PRESSURE MEASUREMENT

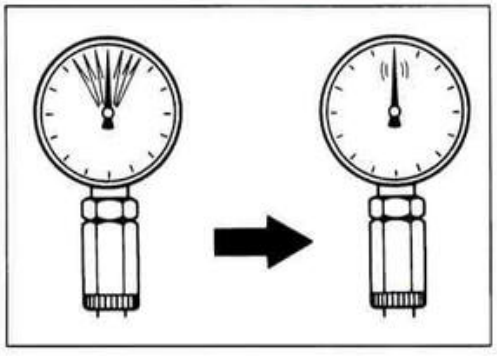
1. Start the engine and allow it to warm up.
   Engine Coolant Temperature; Above 80°C (176°F).
2. Remove the glow plugs.



3. Set the adapter and compression gauge to the No. 1 cylinder glow plug hole.
   Compression Gauge
   (with Adapter) : 5-8840-2008-0 (J-29762)
   Adapter : 5-8531-7002-0 (J-26999-20)
4. Turn the engine over with the starter motor and take the compression gauge reading.

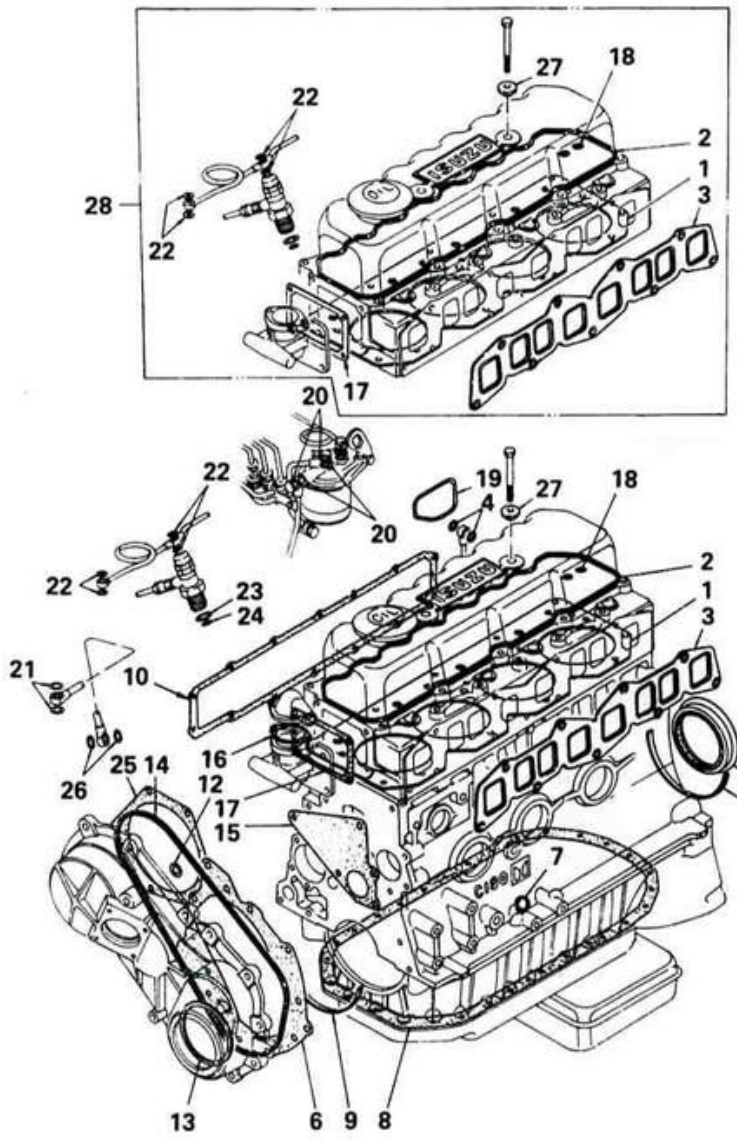
Compression Pressure kg/cm²(psi/kPa) at 200rpm at seal level

| Standard | Limit |
|---|---|
| 31 (441/3038) | 23 (327/2254) |



5. Repeat the procedure (Steps 3 and 4) for the remaining cylinders.
   If the measured value is less than the specified limit, refer to "Trouble Shooting" in this Manual.

# ENGINE REPAIR KIT

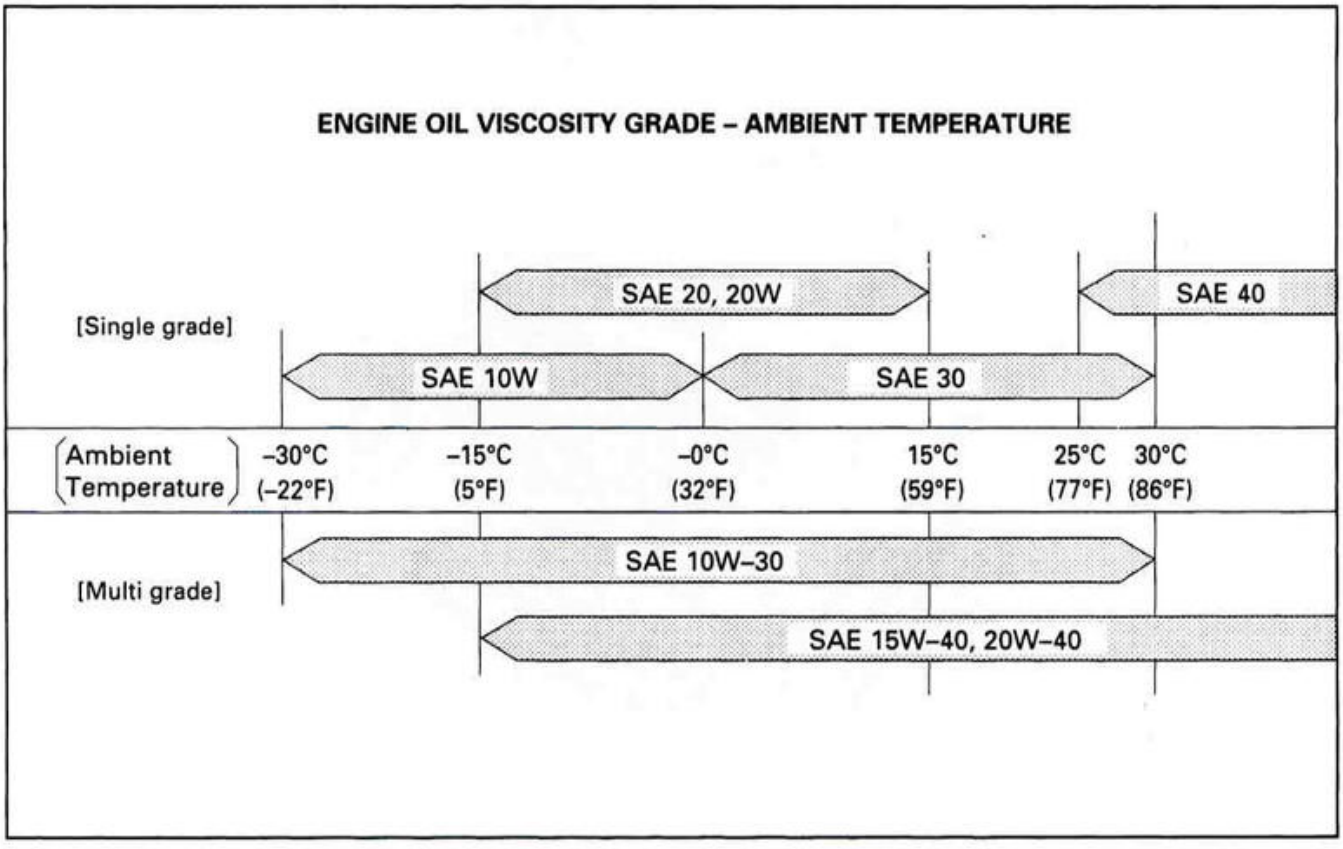



1. Gasket ; cylinder head
2. Gasket ; cylinder head cover
3. Gasket ; intake and exhaust manifold
4. Gasket ; joint bolt
5. Seal ; crankshaft rear
6. Gasket ; front plate
7. Gasket ; drain plug
8. Gasket ; oil pan to case
9. Gasket ; oil pan to bearing cap
10. Gasket ; tappet cover
12. Gasket ; gear case
13. Seal ; oil
14. Gasket ; gear case
15. Gasket ; water pump to cylinder block
16. Gasket ; outlet pipe
17. Gasket ; cylinder head to housing
18. Sealing ring ; split collar
19. Gasket ; oil filter
20. Gasket ; fuel pump
21. Gasket ; vacuum pipe
22. Gasket
23. Washer ; nozzle holder
24. Washer ; corrugated
25. Gasket ; bracket to front plate
26. Gasket
27. Gasket ; head cover bolt
28. Repair kit ; top overhaul kit

## RECOMMENDED LUBRICANTS

| TYPE OF LUBRICANTS (API) | DIESEL ENGINE OIL; CC OR CD GRADE |
|---|---|

## ENGINE OIL VISCOSITY CHART



## SECTION 3

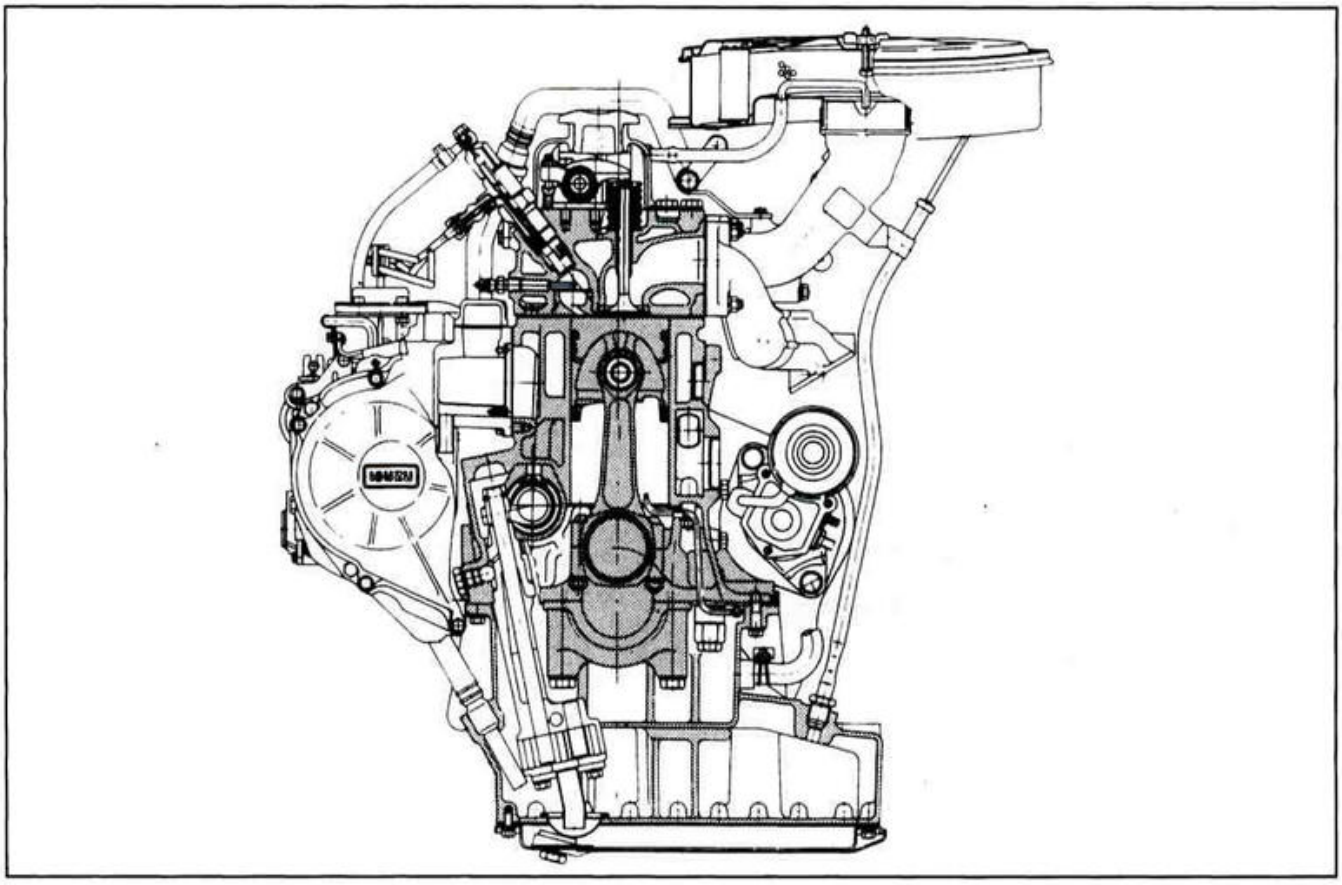
# ENGINE ASSEMBLY ( 1 ) (DISASSEMBLY)

### TABLE OF CONTENTS

# ENGINE ASSEMBLY

## GENERAL DESCRIPTION

**FOR YOUR REFERENCE:**



**Note: This sectional drawing is based on the C240 standard engine.**

The cylinder liners used are the chromard type, which has a proven record of a superior durability.

The crankshaft is of an one-piece precision forging five bearing support and induction hardened journal surface type.

To give this engine more adaptability as a superior industrial engine than the original one, a two types of piston ring configuration are used depending on an engine application.

1. Four piston rings type pistons

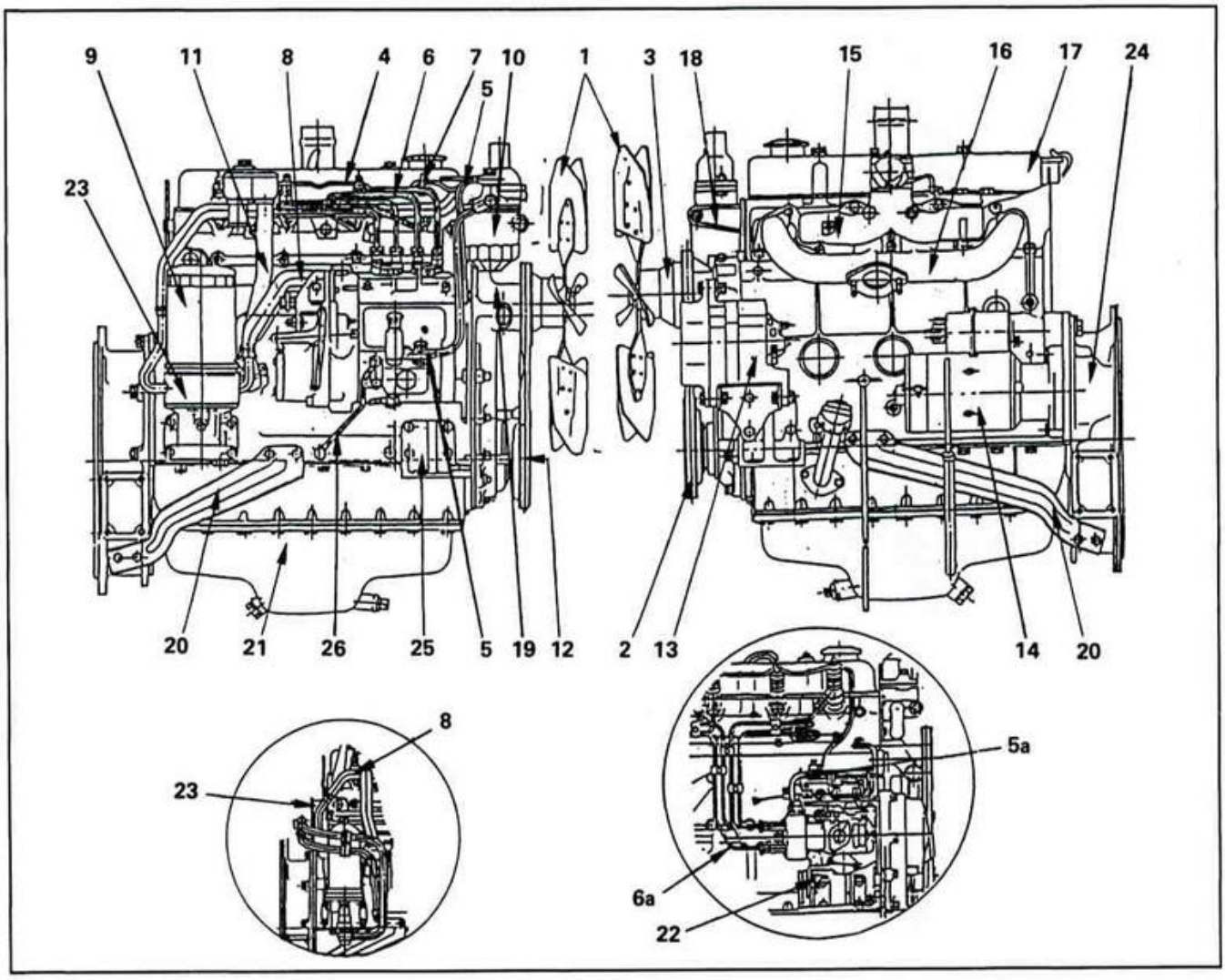
   This type of piston ring configuration is used depending on an engine application.

2. Three piston rings type pistons

   This piston ring configuration along with an piston cooling by oiling jet and an auto-thermatic type piston, which built-in a steel strut to minimize the piston thermal distortion, are also used depending on an engine application.

(Hereinafter, in the description, the four piston rings type piston is called Four Rings Type and the three piston rings type piston is called Three Rings Type.)

# DISASSEMBLY 1ST STEP




## Disassembly Steps

1. Cooling fan
2. Fan belt
3. Fan pulley
4. Leak off pipe
5. Fuel pipe

5a Fuel pipe

▲ 6. Fuel injection pipe

▲ 6a Fuel injection pipe

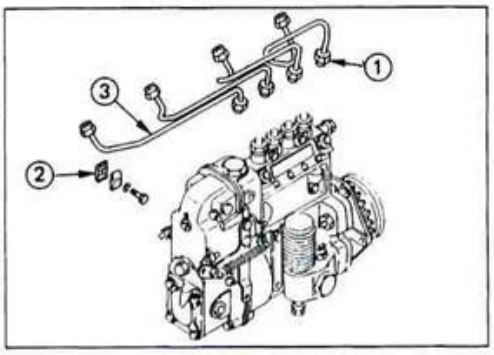
▲ 7. Injection nozzle and glow plug

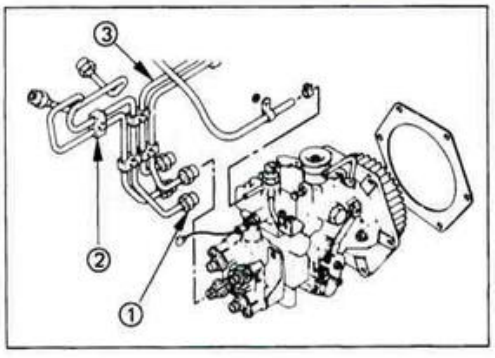
8. Water hose (For oil cooler. If so equipped.)
9. Oil filter assembly
10. Fuel filter assembly
11. Air breather hose
12. Crankshaft pulley
13. Generator
14. Starter

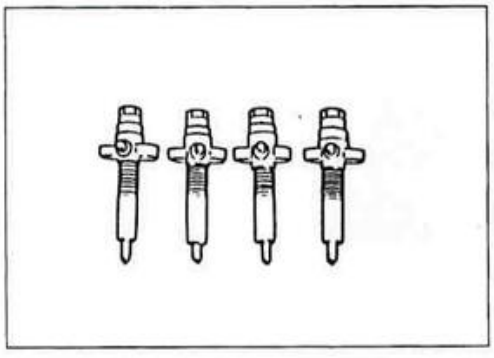
▲ 15. Intake manifold

▲ 16. Exhaust manifold

17. Cylinder head cover
18. Thermostat housing
19. Water pump
20. Stiffener
21. Oil pan
22. Injection pump bracket
23. Oil cooler (if so equipped)
24. Flywheel housing
25. Engine foot
26. Injection pump oil pipe



## Important Operations

**▲ Fuel Injection Pipe with Clip**

1) Loosen the injection pipe sleeve nuts at the delivery valve side ①.

   Do not apply excessive force to the injection pipes.

2) Loosen the injection pipe clips ②.

3) Remove the injection pipes ③.

**Note:**

**Plug the delivery valve holder ports with the shipping cap to prevent the entry of foreign material.**

**▲ Injection Nozzle and Glow plug**

When the nozzles are reused, they must be installed to the original place without interchanging. Handle them carefully so that not to damage the nozzle tip.

**▲ Intake and Exhaust manifold**

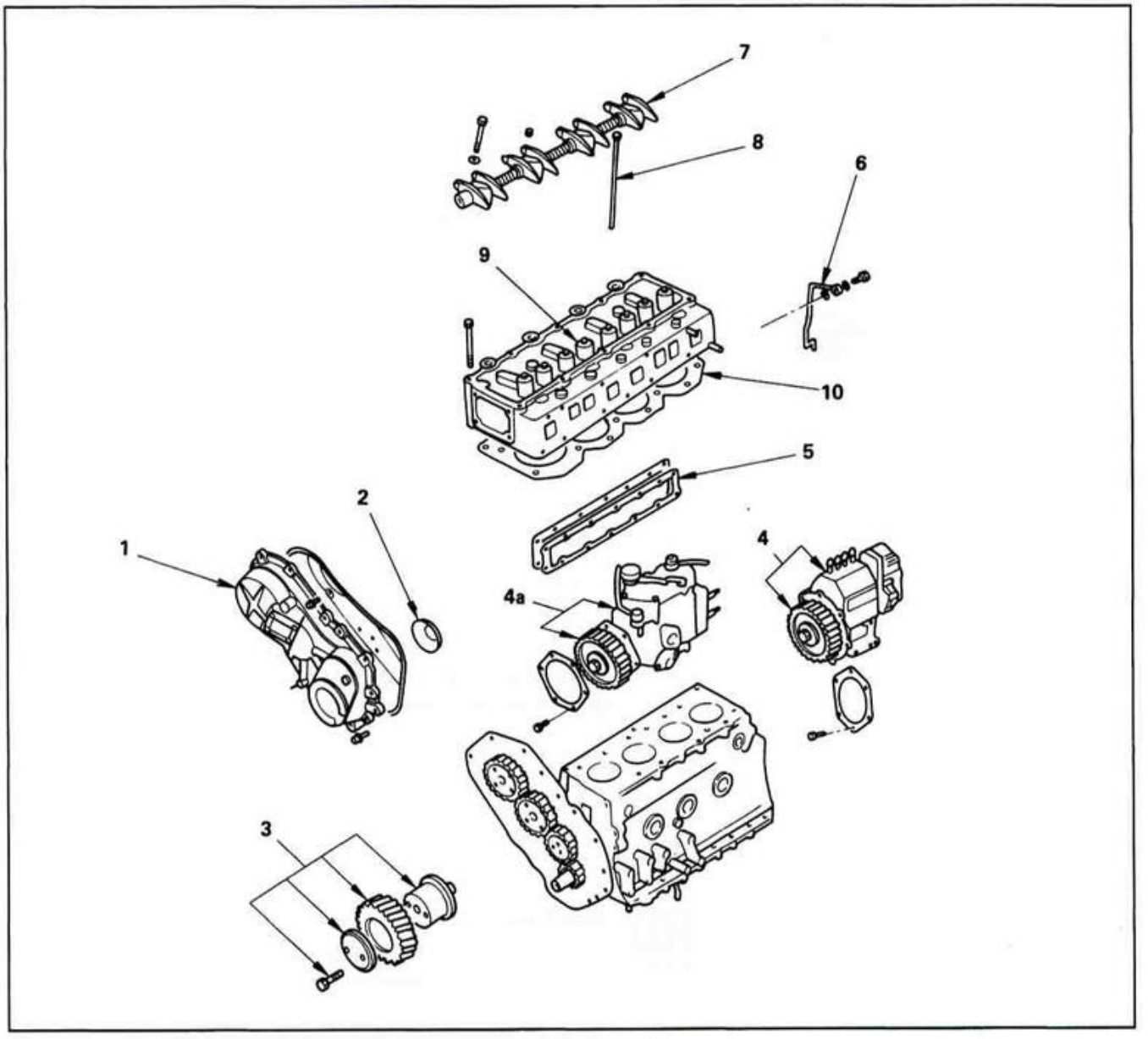
Before the removal of the intake and exhaust manifold, remove the air breather hose and the vacuum hose. (If so equipped.)

**▲ Crankshaft pulley**

Use an appropriate wrench to remove the crankshaft pulley nut.

Width between the hexagonal two edges of the crankshaft pulley bolt wrench: 36 mm (1.41 in).

# DISASSEMBLY 2ND STEP



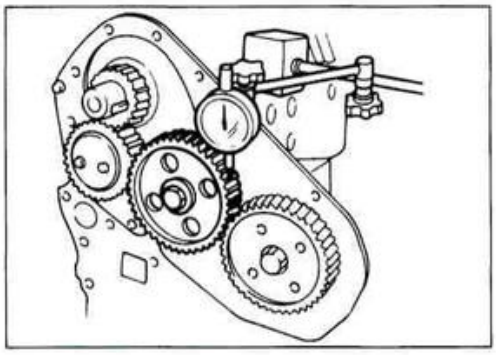

## Disassembly Steps

- ▲ 1. Timing gear case
- 2. Crankshaft oil thrower
- 3. Idler gear and shaft
- ▲ 4. Injection pump with drive gear (In-line type)
- ▲ 4a Injection pump with drive gear (Distributor type)
- 5. Tappet chamber cover
- 6. Valve rocker oil feed pipe
- ▲ 7. Rocker arm shaft bracket and rocker arm
- 8. Push rod
- ▲ 9. Cylinder head
- 10. Cylinder head gasket

## Important Operations

### ▲ Timing Gear Case

After the timing gear case removal, measure the timing gear backlash.



**Timing Gear Backlash Measurement**

1) Set a dial indicator to the timing gear to be measured.

   Hold both the gear to be checked and the adjoining gear stationary.

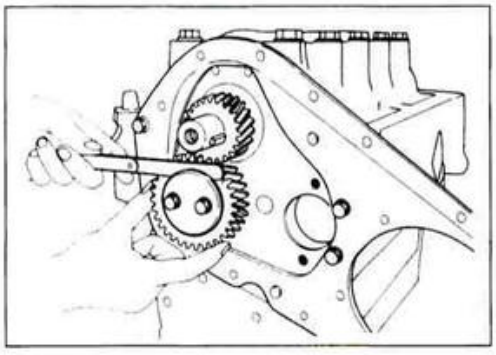
2) Move the gear tooth side to side in the backlash. Take the indicator reading of the backlash.

Timing Gear Backlash (TIR) mm (in)

| Standard | Limit |
|---|---|
| 0.10 – 0.17 (0.004 – 0.007) | 0.30 (0.012) |

TIR = Total Indicator Reading

If the measured value exceeds the specified limit, the gear must be replaced.



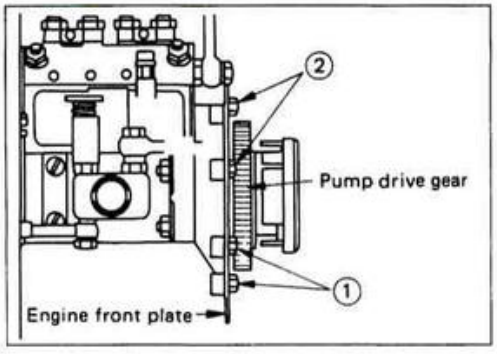
**Idler Gear End Play Measurement**

Insert a feeler gauge between the idler gear and the thrust collar to measure the gap and determine the idler gear end play.

If the measured value exceeds the specified limit, the thrust collar must be replaced.

Idler Gear End Play mm (in)

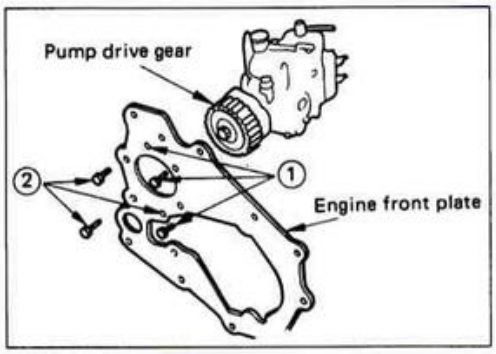
| Standard | Limit |
|---|---|
| 0.07 (0.003) | 0.2 (0.008) |




### ▲ Injection Pump with Driver Gear (In-Line Type)

The injection pump can be removed after the idler gear removal.

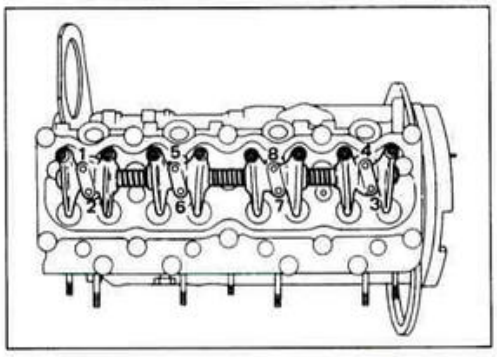
1) Remove the injection pump fixing bolt ① and ②.
2) Pull the injection pump out free from the engine front plate.




**▲ Injection Pump with Drive Gear (Distributor Type)**

The removal procedure for the distributor type injection pump is identical with that of the in-line type injection pump.

Before the removal, make sure that the injection pump bracket bolts fixing the pump body at the pump bottom has already been removed in the Disassembly 1st Step.

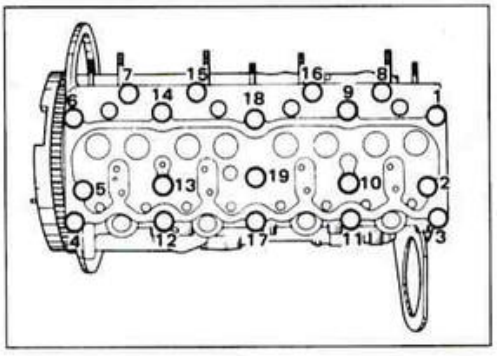



**▲ Rocker Arm Shaft and Rocker Arm**

Loosen the rocker arm shaft bracket bolts in numerical order a little at a time.

**Note:**

**Failure to loosen the rocker arm shaft bracket bolts in numerical order a little at a time will adversely effect the rocker arm shaft.**



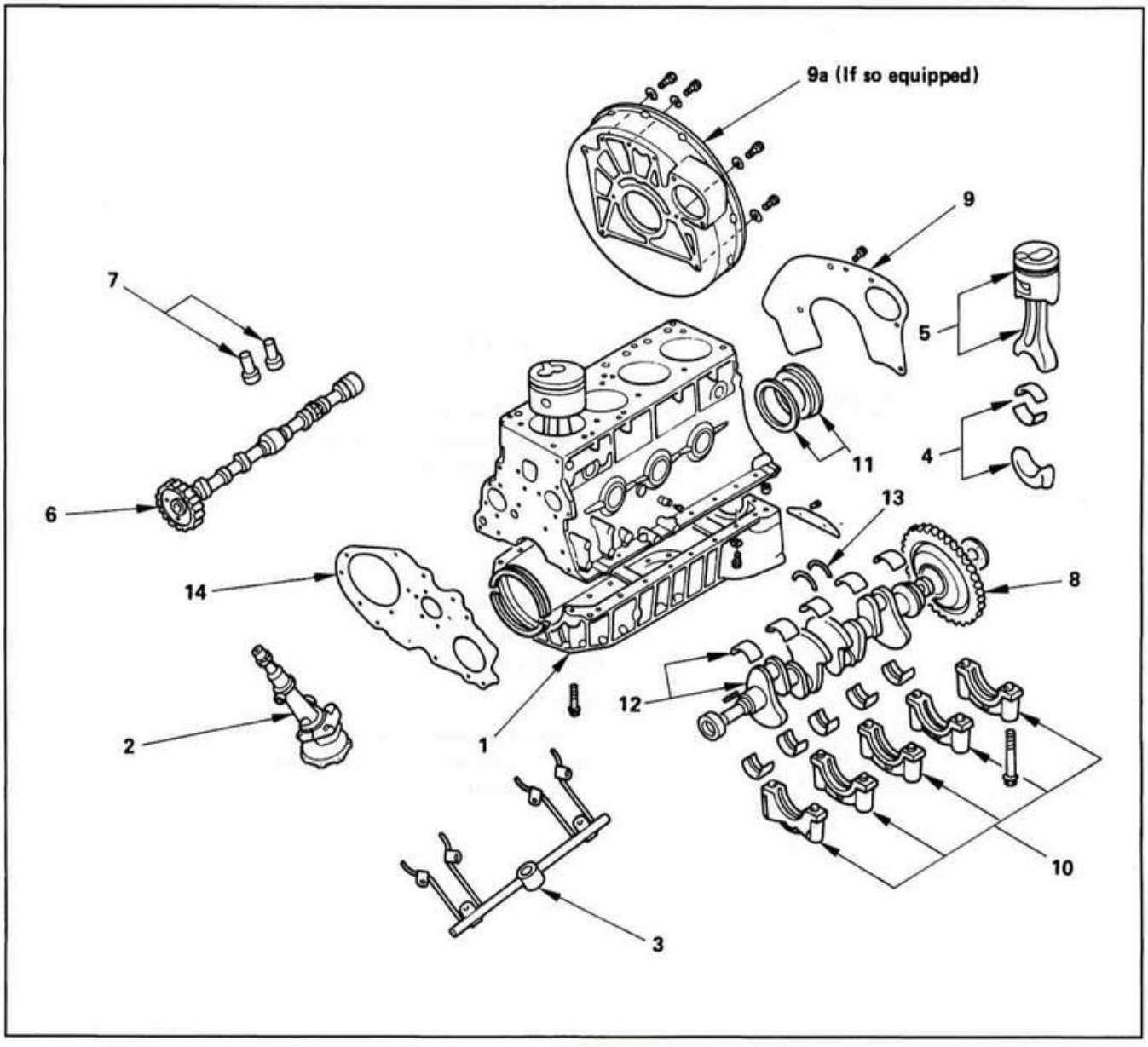

**▲ Cylinder Head**

Loosen the cylinder head bolts in the numerical order a little at a time.

**Note:**

**Failure to loosen the cylinder head bolts in numerical order a little at a time will adversely effect the cylinder lower surface.**

# DISASSEMBLY 3RD STEP




## Disassembly Steps

(Inverted Engine)

▲ 1. Crankcase
▲ 2. Oil pump
▲ 3. Oiling jet (If so equipped)
▲ 4. Connecting rod bearing cap and bearing lower half

(Overturn to the normal position)

▲ 5. Piston and connecting rod
▲ 6. Camshaft
▲ 7. Tappet
▲ 8. Flywheel
9. Rear plate
9a Flywheel housing (If so equipped)
▲ 10. Main bearing cap and bearing
▲ 11. Oil seal
▲ 12. Crankshaft and bearing upper halves
13. Thrust bearing
14. Front plate

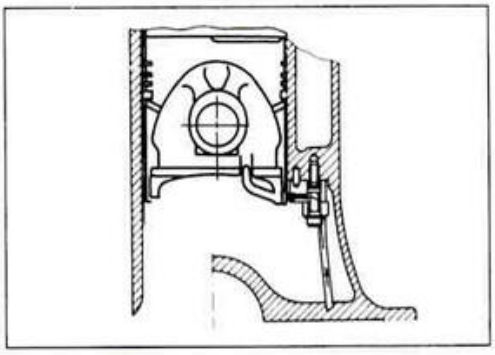
### ▲ Crankcase

A slit to provided on the crankcase mounting flange to facilitate the crankcase removal.

Use a screw driver or such like to peel off the crankcase at the slit.

### ▲ Oil Pump

1) Disconnect the oil pipe at the sleeve nut.
2) Remove the oil pump mounting bolt and remove the oil pump along with the oil pipe.
3) Remove the oil pipe from the pump.

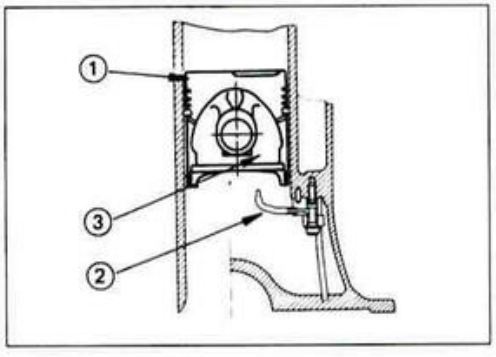


### ▲ Oiling Jet (If so equipped)

The oiling jet used thin steel tubing which is easily bent.

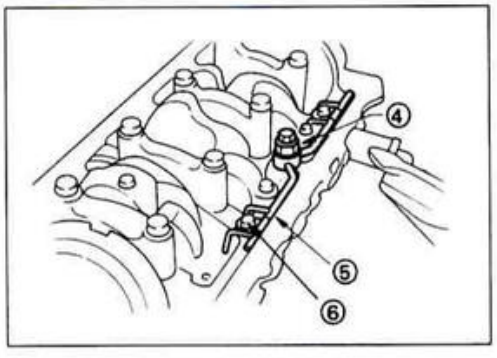
When the piston is at BCD, it is very close to the oiling jet.

Carefully follow the procedure below to avoid damaging the oiling jets.




1) Move the piston ① to near TDC.

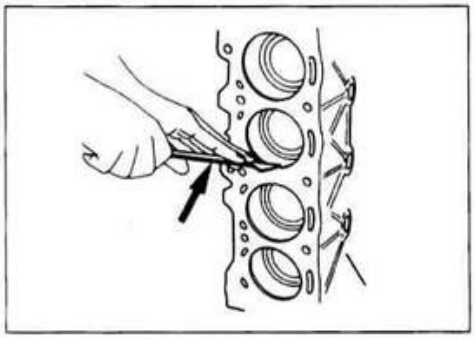
   This will create a space between the oiling jet ② and the piston back cavity ③.
2) Remove the relief valve ④ (attached to the piston cooling oil pipe ⑤) and the bolts ⑥.



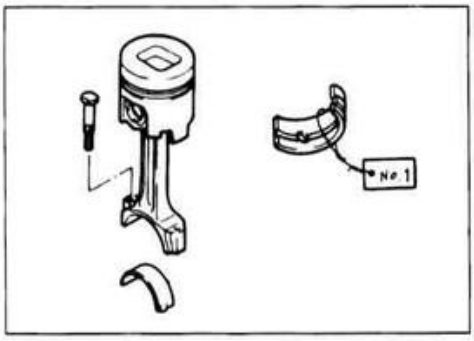

**Note:**

**Do not attempt to repair an oiling jet if it is damaged. Replace it with a new one.**

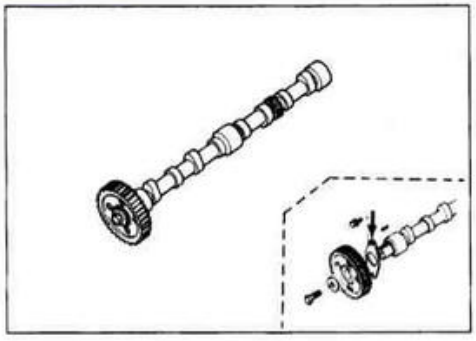
**▲ Connecting Rod Bearing Cap and Bearing Lower Half**
**▲ Piston and Connecting Rod**



1) Remove carbon deposits from the upper portion of the cylinder wall with a scraper before removing the piston and connecting rod.
2) Move the piston to the top of the cylinder and tap it with a hammer grip or similar object from the connecting rod lower side to drive it out.




3) If the connecting rod bearings are to be reused, mark and tag their original installation position to facilitate the reinstallation.

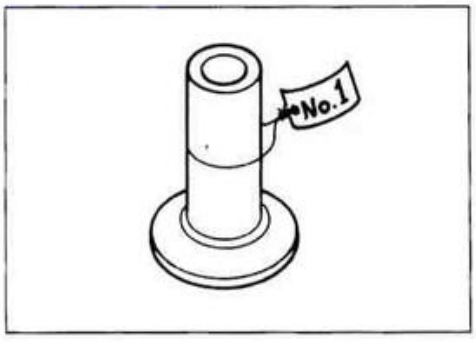


**▲ Camshaft**

1) Remove the thrust plate bolts.
2) Pull the camshaft free along with the camshaft timing gear and the thrust plate.

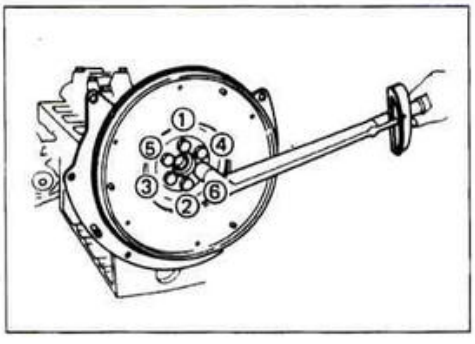
**Note:**

**Be careful not to damage the camshaft journal, the cam, and the camshaft during the disassembly procedure.**




**▲ Tappet**

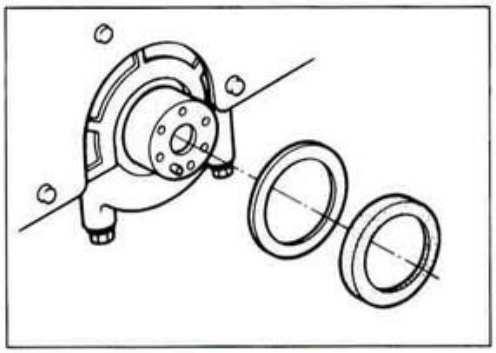
If the tappets are to be reinstalled, tag them with the mark of original fitting cylinder number.




**▲ Flywheel**

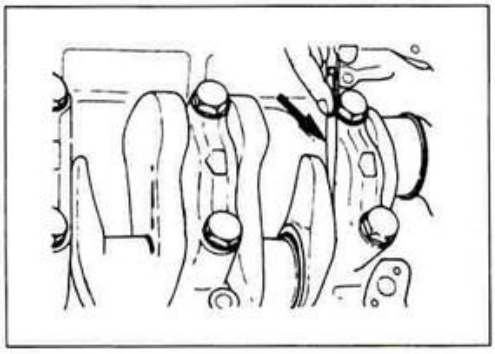
Block the flywheel with a piece of hard wood.

Loosen the flywheel bolts in numerical order a little at a time.



**▲ Oil Seal**

Be careful not to scratch the crankshaft rear oil seal fitting surfaces during the removal procedure.



**▲ Main Bearing Cap and Bearing**

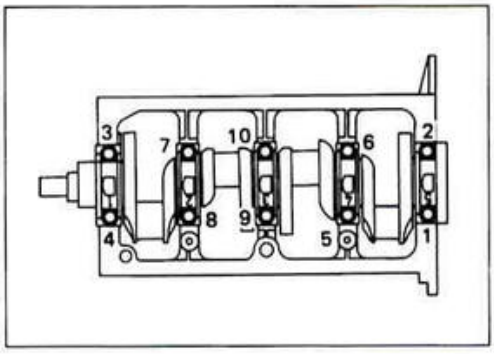
1) Measure the crankshaft end play at the center journal of the crankshaft.

   Do this before removing the crankshaft bearing caps.

   If the measured value exceeds the specified limit, the crankshaft thrust bearing must be replaced.

Crankshaft End Play mm (in)

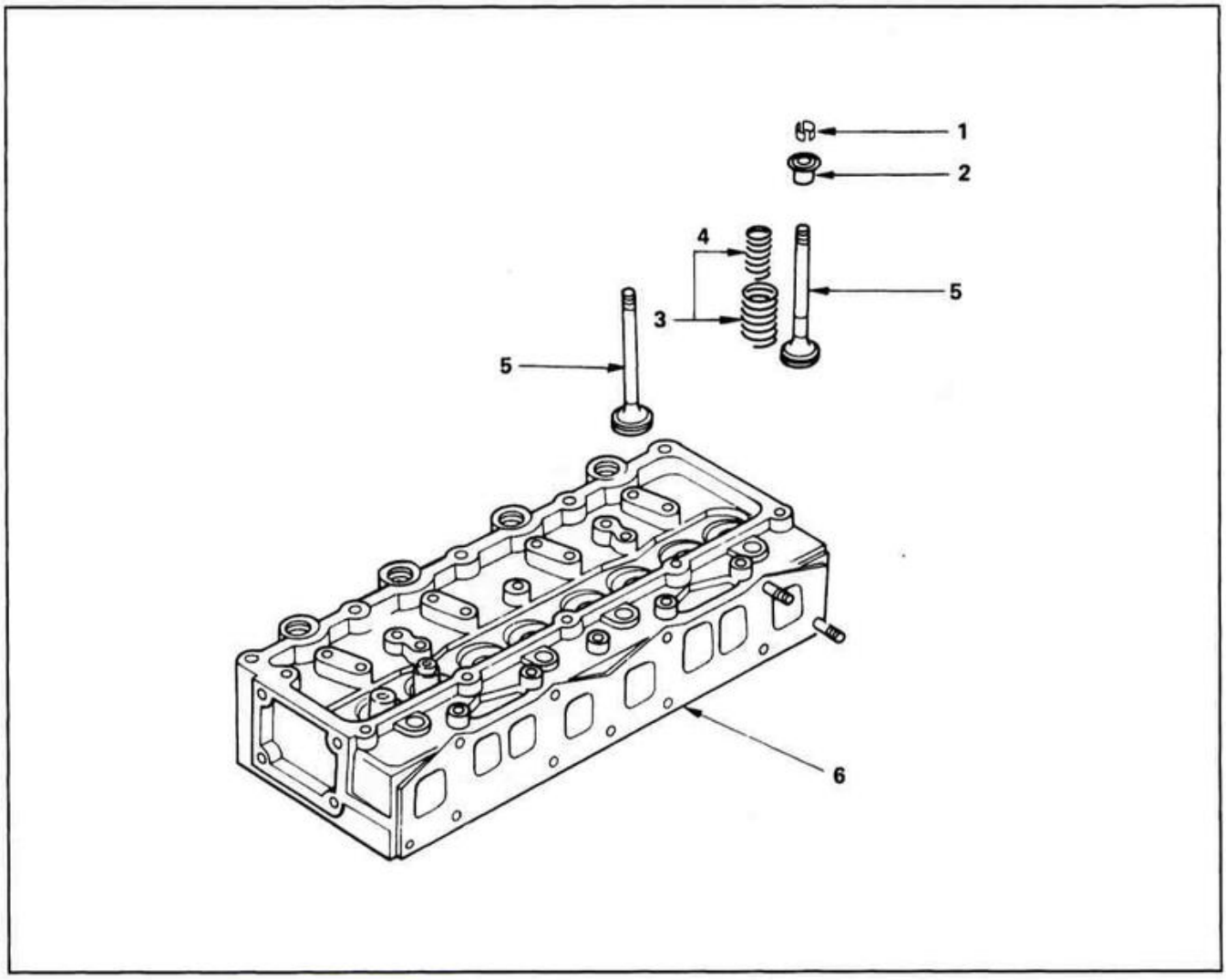
| Standard | Limit |
|---|---|
| 0.10 (0.004) | 0.30 (0.012) |




2) Loosen the crankshaft bearing cap bolts in numerical order a little at a time.

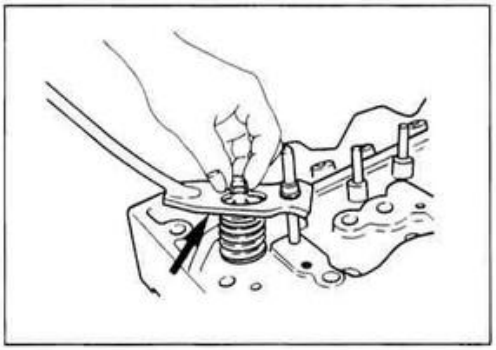
   If the crankshaft bearings are to be reinstalled, tag them with their original installation position

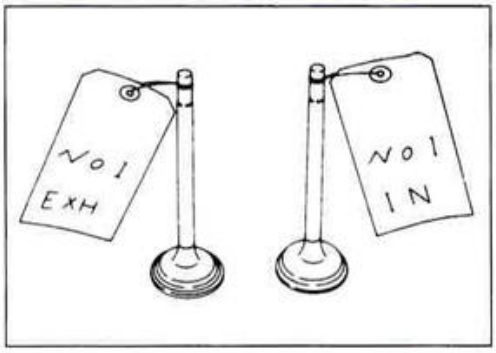
# CYLINDER HEAD DISASSEMBLY SEP




## Disassembly Steps

▲ 1. Split collar
2. Valve spring upper seat
3. Valve spring (Outer)
4. Valve spring (Inner)
▲ 5. Intake and exhaust valves
6. Cylinder head






## Important Operations

**▲ Split Collar**

1) Place the cylinder head on a flat wooden surface.
2) Use the spring compressor to remove the split collar.

   Do not allow the valve to fall from the cylinder head.

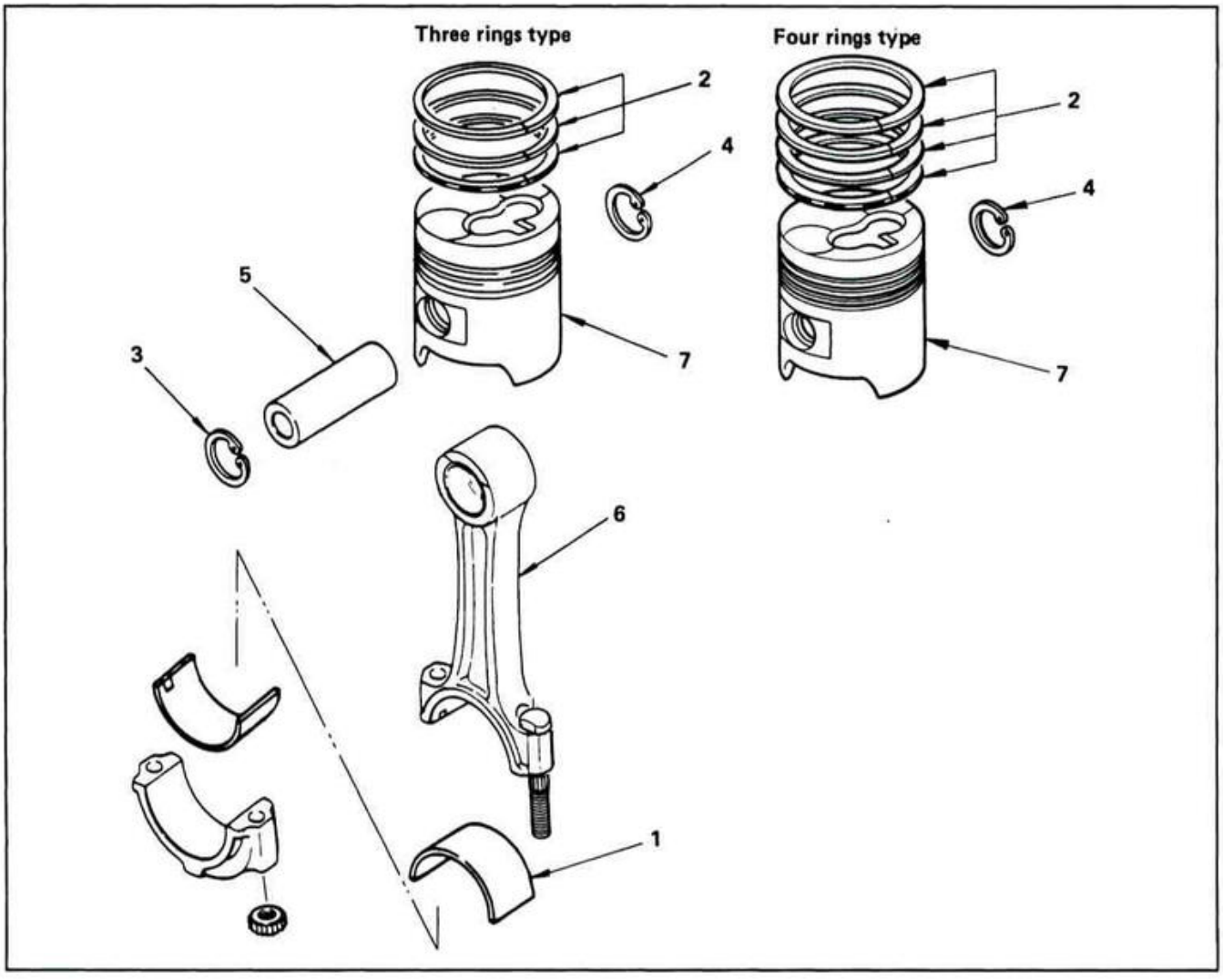
   Spring Compressor: 9-8523-1423-0 (J-29760)

**▲ Intake and Exhaust Valves**

If the intake and exhaust valves are to be reinstalled, mark their installation positions by tagging each valve with the cylinder number from which it was removed.

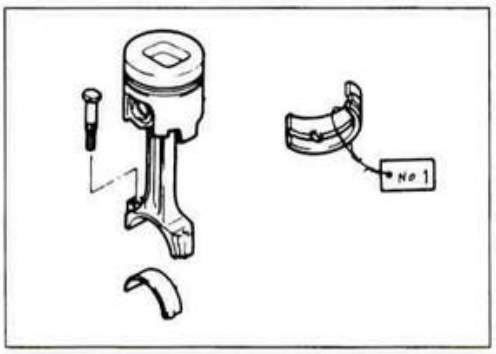
If the intake and exhaust valves are to be replaced, the valve guides must also be replaced.

# PISTON AND CONNECTING ROD DISASSEMBLY STEP




## Disassembly Steps

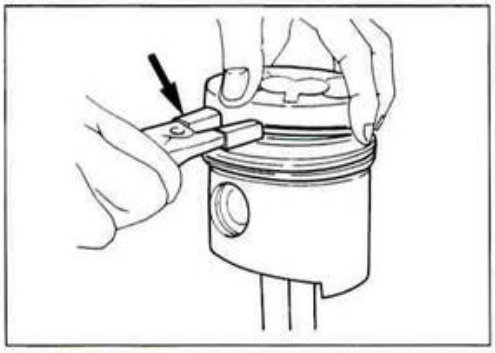
- ▲ 1. Connecting rod bearing
- ▲ 2. Piston ring
- ▲ 3. Piston pin snap ring
- ▲ 4. Piston pin snap ring
- ▲ 5. Piston pin
- 6. Connecting rod
- ▲ 7. Piston




## Important Operations

**▲ Connecting Rod Bearing**

If the connecting rod bearings are to be reinstalled, tag them with mark of their original cylinder number.



**▲ Piston Ring**

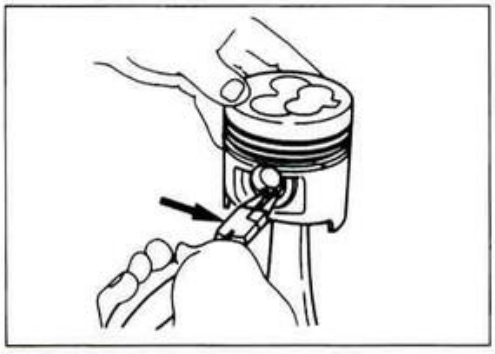
1) Clamp the connecting rod in a vise.

   Take care not to damage the connecting rod.

2) Use a piston pin replacer to remove the piston rings.

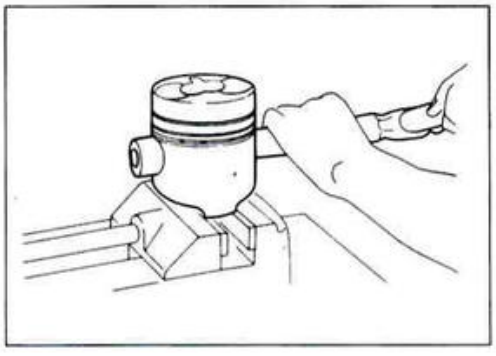
   Piston Ring Replacer

   Do not attempt to use some other tool to remove the piston rings. Piston ring stretching will result in reduced piston ring tension.



**▲ Piston Pin Snap Ring**

Use a pair of snap ring pliers to remove the piston pin snap ring.



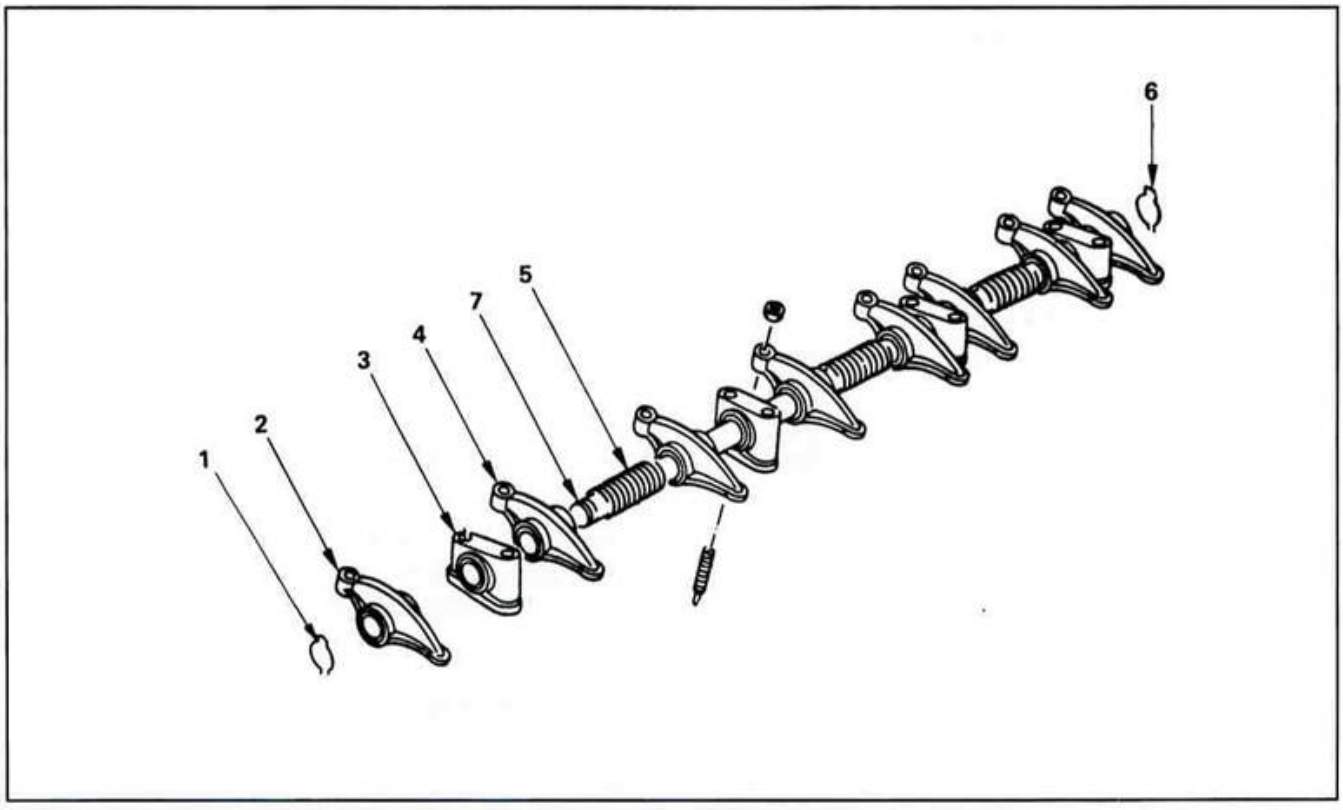
**▲ Piston Pin**

**▲ Piston**

Tap the piston pin out with a hammer and a brass bar.

If the pistons and piston pins are to be reinstalled, mark their installation positions by tagging each piston and piston pin with the cylinder number from which it was removed.

## ROCKER ARM AND SHAFT DISASSEMBLY STEP




### Disassembly Steps

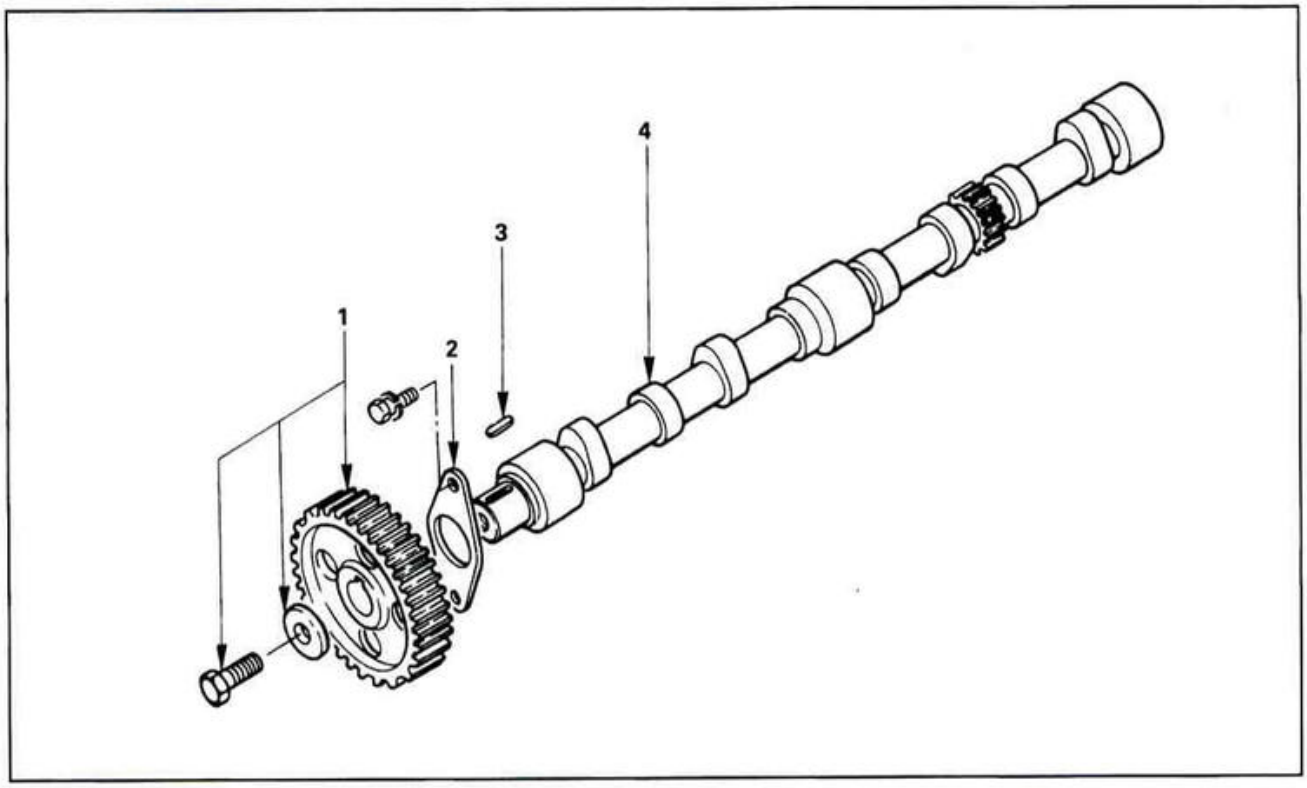
▲ 1. Rocker arm shaft snap ring
▲ 2. Rocker arm "A"
3. Rocker arm shaft bracket
4. Rocker arm "D"
5. Rocker arm shaft spring
6. Rocker arm shaft snap ring
7. Rocker arm shaft

### Important Operations

**▲ Rocker Arm Shaft Snap Ring**
**▲ Rocker Arm "A"**

1) Use a pair of snap ring pliers to remove the snap ring.
2) Remove rocker arm "A".

# CAMSHAFT AND GEAR DISASSEMBLY STEP



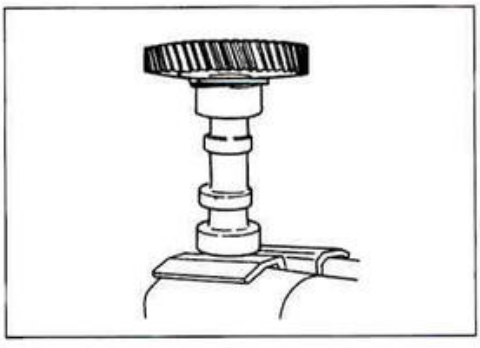

## Disassembly Steps

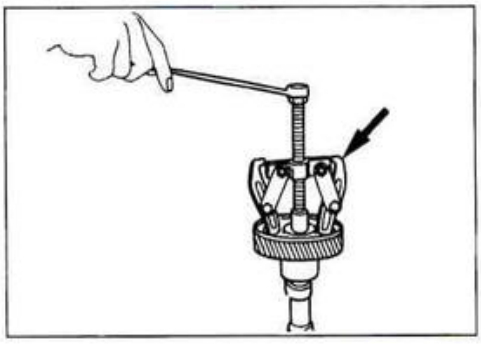
▲ 1. Camshaft timing gear
▲ 2. Thrust plate
3. Feather key
4. Camshaft

## Important Operations

**▲ Camshaft Timing Gear**
**▲ Thrust Plate**

1) Clamp the camshaft in a vise.
   Take care not to damage the camshaft.





2) Use the universal puller to pull out the camshaft timing gear.
   Universal Puller : 5-8521-0002-0
3) Remove the thrust plate.

## SECTION 4

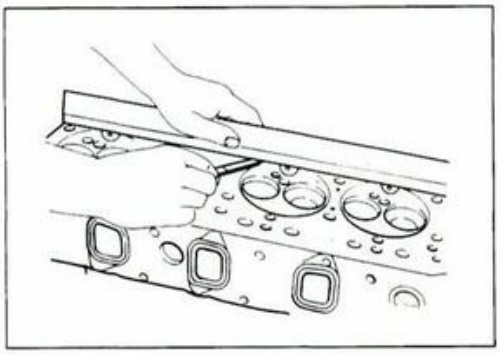
# ENGINE ASSEMBLY ( 2 )
# (INSPECTION AND REPAIR)

### TABLE OF CONTENTS

# INSPECTION AND REPAIR

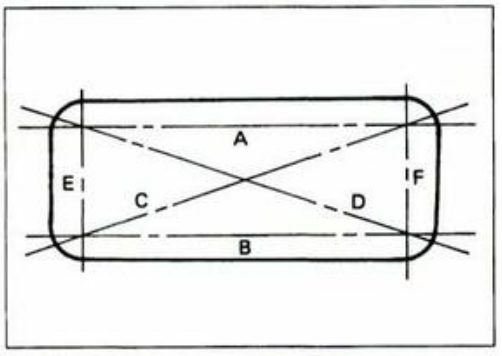
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

## CYLINDER HEAD



### Cylinder Head lower Face Warpage

1. Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder head lower face.
2. Regrind the cylinder head lower face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

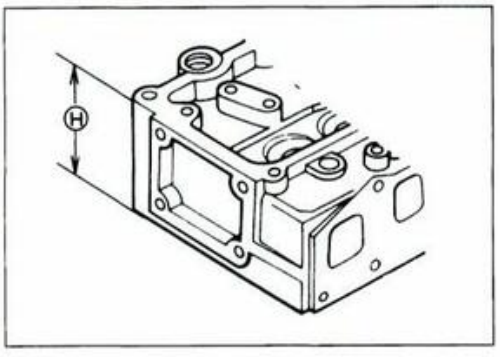



If the measured values exceed the maximum grinding allowance, the cylinder head must be replaced.

Cylinder Head Lower Face Warpage mm (in)

| Standard | Limit | Maximum Grinding Allowance |
|---|---|---|
| 0.05 (0.002) or less | 0.2 (0.008) | 0.30 (0.012) |

### Cylinder Head Height



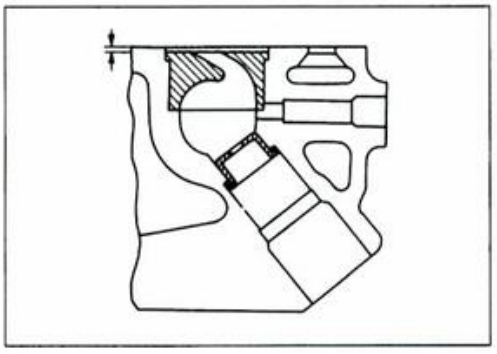

Cylinder Head Height (Reference) mm(in)

| Standard Ⓗ | Limit |
|---|---|
| 91.95 – 92.05 (3.622 – 3.626) | 91.75 (3.614) |

**Note:**

**If the cylinder head lower face is reground, valve depression must be checked.**

## HOT PLUG



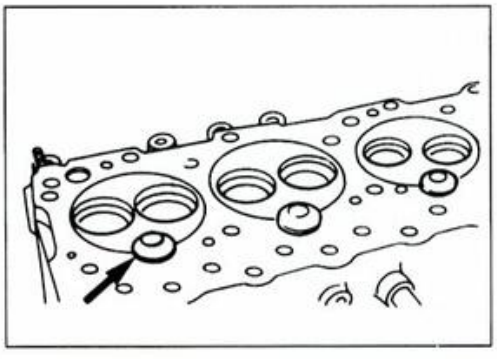
### Hot Plug Depression

1. Clean the cylinder head lower face, taking care not to damage the hot plug surfaces.
2. Use a straight edge and a feeler gauge to measure the hot plug depression in a straight line from the No. 1 hot plug to the No. 4 hot plug.

   If the measured value exceeds the specified limit, the hot plugs must be replaced.

Hot Plug Depression mm (in)

| Limit |
|---|
| 0.02 (0.0008) |



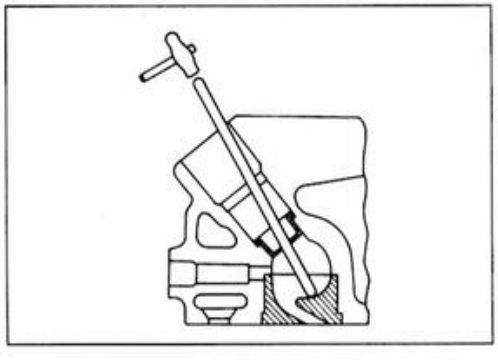
### Combustion Chamber Inspection

1. Remove the carbon adhering to the inside of the combustion chamber. Take care not to damage the hot plug fitting positions.
2. Inspect the combustion chamber, the hot plug hole, and the hot plug machined faces for cracking and other damage.

   If cracking or damage is present, the cylinder head must be replaced.

**Note:**

**Be absolutely certain that there are no scratches or protuberances on the combustion chamber surfaces which will be in contact with the hot plug after it is installed. These flaws will prevent the hot plug from seating correctly.**



### Hot Plug Replacement

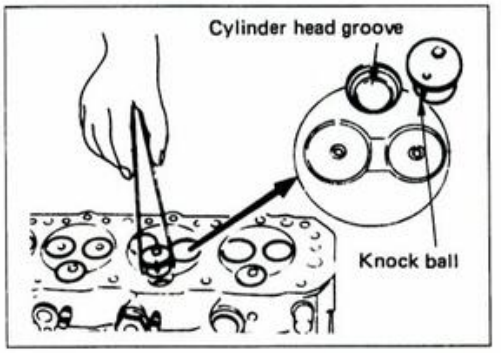
### Hot Plug Removal

1. Insert a 3.0 – 5.0 mm (0.12 – 0.20 in) diameter brass bar into the nozzle holder fitting hole until it makes contact with the hot plug.
2. Lightly tap the bar with a hammer to drive the hot plug free.

### Hot Plug Inspection

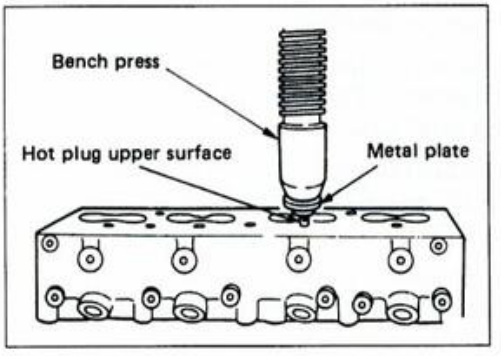
Inspect the hot plugs for excessive wear and other damage. Replace the hot plugs if either of these conditions are discovered.

Refer to "Hot Plug Installation".




### Hot Plug Installation

1. Align the hot plug knock ball with the cylinder head groove and tap it temporarily into position with a plastic hammer.



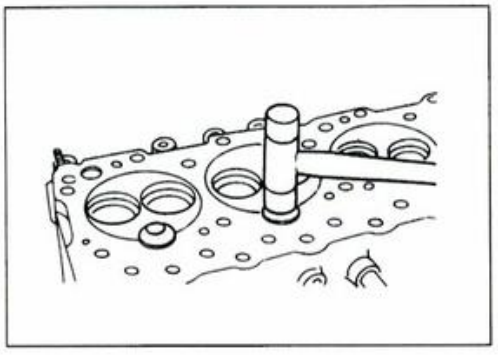

2. Place a metal plate approximately 25 mm (1 in) thick over the hot plug upper surface.
3. Use a bench press to exert a pressure of 4,500 – 5,500 kg (9,923 – 12,128 lb/44,100 – 53,900 N) on the metal plate covering the hot plug upper surface. This will drive the hot plug into position.
4. Lightly tap the hot plug head to make sure that it is firmly seated.
5. Repeat the procedure (Steps 1 – 4) for the remaining hot plugs.

**Note:**

**Do not apply pressure greater than that specified. Damage to the cylinder head will result.**

6. Use a surface grinder to grind off any hot plug surface protuberances.

   The hot plug surfaces must be perfectly flush with the cylinder head lower face.

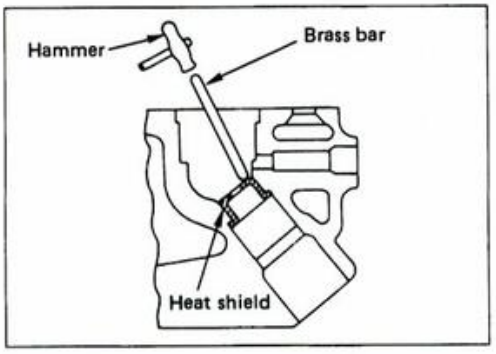


7. After grinding, make sure that the hot plug surfaces are completely free of protuberances.

   The hot plug surfaces must also be free of depressions.

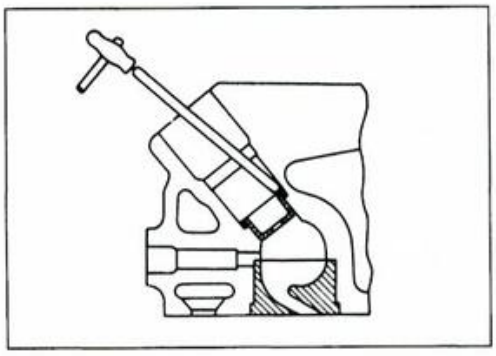
   Once again, lightly tap the hot plug heads to make sure that they are firmly seated.

## Heat Shield Replacement




### Heat Shield Removal

After removing the hot plugs, use a hammer and a brass bar to lightly tap the lower side of the heat shield and drive it free.



### Heat Shield Installation

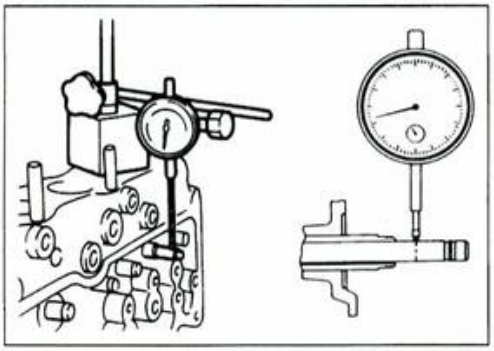
Install the heat shield to the cylinder head from the nozzle holder installation hole side. Lightly tap the heat shield flange into place with a hammer and a brass bar.

The heat shield flange side must be facing up.

**Note:**

**Always install a new heat shield. Never reuse the old heat shield.**

## VALVE GUIDE



### Valve Stem and Valve Guide Clearance

**Measuring Method-I**

1. With the valve stem inserted in the valve guide, set the dial indicator needle to "0".
2. Move the valve head from side to side.

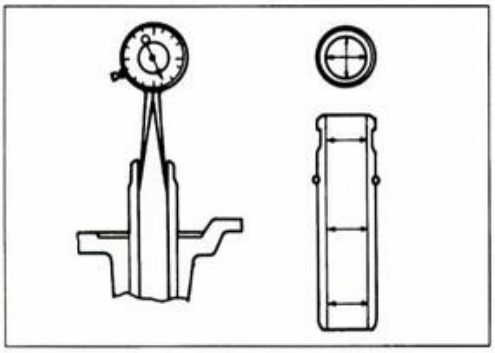
   Read the dial indicator.

   Note the highest dial indication.

   If the measured values exceed the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Clearance mm (in)

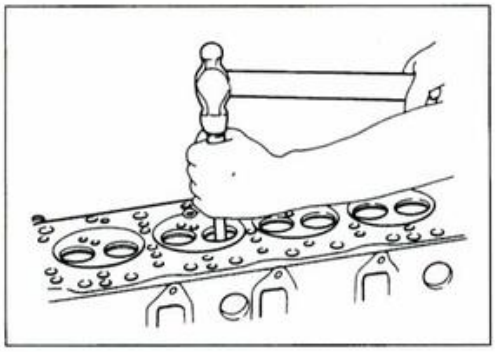
| | Standard | Limit |
|---|---|---|
| Intake Valve | 0.039 – 0.069 (0.0015 – 0.0027) | 0.20 (0.008) |
| Exhaust Valve | 0.064 – 0.093 (0.0025 – 0.0037) | 0.25 (0.0098) |



**Measuring Method -II**

1. Measure the valve stem outside diameter.

   Refer to the Item "Valve Stem Outside Diameter".
2. Use a caliper calibrator or a telescoping gauge to measure the valve guide inside diameter.

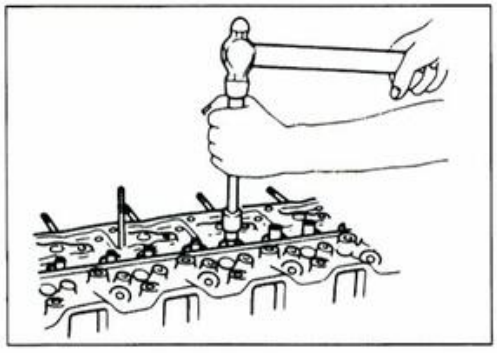


### Valve Guide Replacement

### Valve Guide Removal

Use a hammer and the valve guide replacer to drive out the valve guide from the cylinder head lower face.

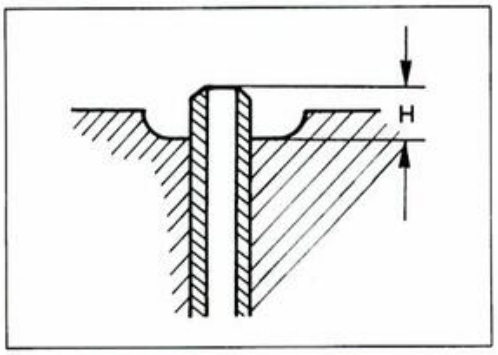
Valve Guide Replacer: 5-8523-0002-0 (J-26512-1)



### Valve Guide Installation

1. Apply engine oil to the valve guide outer circumference.
2. Attach the valve guide installer to the valve guide.
3. Use a hammer to drive the valve guide into position from the cylinder head upper face.

   Valve Guide Installer: 5-8523-0002-0 (J-26512-2)




4. Measure the height of the valve guide upper end from the upper face of the cylinder head.

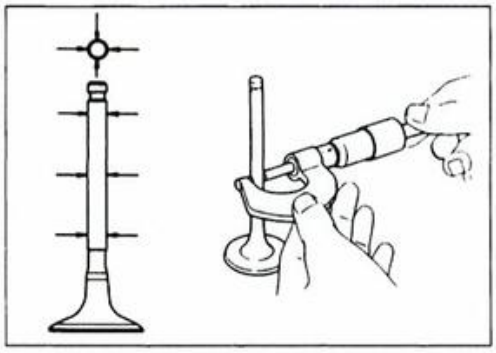
Valve Guide Upper End Height (H)
(Refereance) mm (in)

| 12.0 (0.47) |
|---|

**Note:**

**If the valve guide has been removed, both the valve and the valve guide must be replaced as a set.**

## VALVE AND VALVE SEAT INSERT



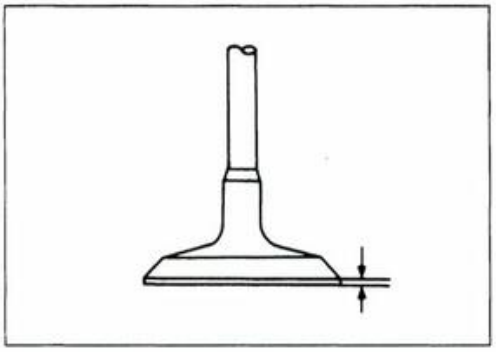
### Valve Stem Outside Diameter

Measure the valve stem diameter at three points.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Outside Diameter mm (in)

| | Standard | Limit |
|---|---|---|
| Intake Valve | 7.949 – 7.961 (0.3129 – 0.3134) | 7.88 (0.3102) |
| Exhaust Valve | 7.921 – 7.936 (0.3118 – 0.3124) | 7.85 (0.3091) |



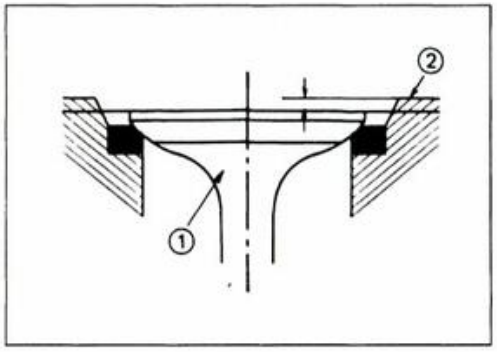
### Valve Thickness

**Measure the valve thickness**

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Intake and Exhaust Valve Thickness mm (in)

| Standard | Limit |
|---|---|
| 1.3 (0.05) | 1.0 (0.04) |



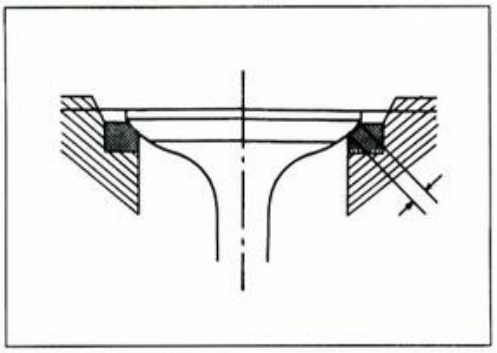

### Valve Depression

1. Install the valve ① to the cylinder head ②.
2. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.

   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Depression mm (in)

| Standard | Limit |
|---|---|
| 0.7 (0.028) | 2.7 (0.11) |



## Valve Contact Width

1. Check the valve contact faces for roughness and unevenness.

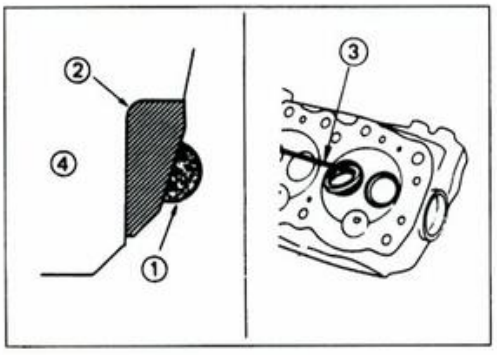
   Make smooth the valve contact surfaces.

2. Measure the valve contact width.

   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Contact Width mm (in)

| Standard | Limit |
|---|---|
| 1.2 – 1.5 (0.05 – 0.06) | 2.0 (0.08) |




## Valve Seat Insert Replacement

## Valve Seat Insert Removal

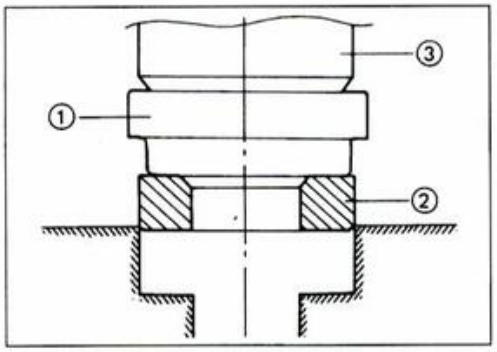
1. Arc weld the entire inside circumference ① of the valve seat insert ②.
2. Allow the valve seat insert to cool for a few minutes.

   This will invite contraction and make removal of the valve seat insert easier.

3. Use a screwdriver ③ to pry the valve seat insert free.

   Take care not to damage the cylinder head ④.

4. Carefully remove carbon and other foreign material from the cylinder head insert bore.




## Valve Seat Insert Installation

1. Carefully place the attachment ① (having a smaller outside diameter than the valve seat insert) on the valve seat insert ②.

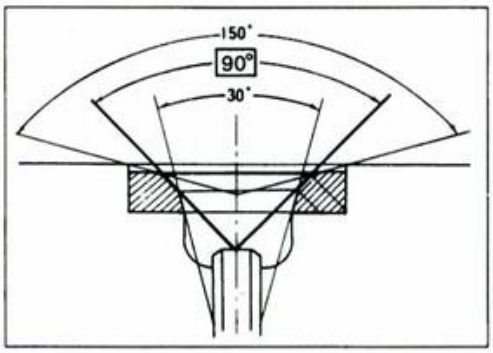
**Note:**

**The smooth side of the attachment must contact the valve seat insert.**

2. Use a bench press ③ to gradually apply pressure to the attachment and press the valve seat insert into place.

**Note:**

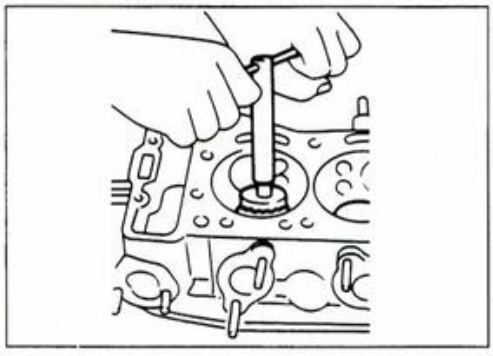
**Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.**




## Valve Seat Insert Correction

1. Remove the carbon from the valve seat insert surface.
2. Use a valve cutter (15°, 45°, and 75° blades) to minimize scratches and other rough areas. This will bring the contact width back to the standard value.

   Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished areas of the valve seat surface.

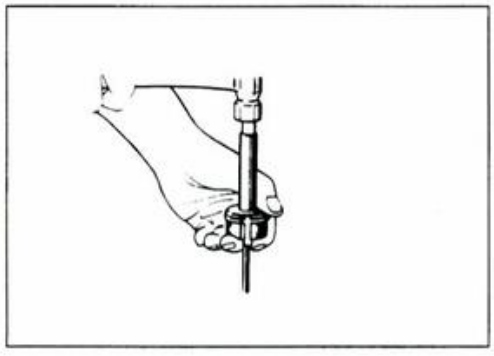


| Valve Seat Angle | degree |
|---|---|
| 45 | |

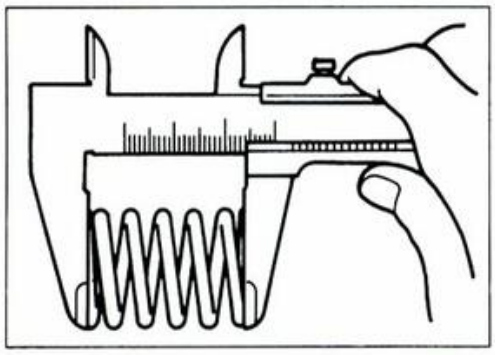
**Note:**

**Use an adjustable valve cutter pilot.**

**Do not allow the valve cutter pilot to wobble inside the valve guide.**



3. Apply abrasive compound to the valve seat insert surface.
4. Insert the valve into the valve guide.
5. Turn the valve while tapping it to fit the valve seat insert.
6. Check that the valve contact width is correct.
7. Check that the valve seat insert surface is in contact with the entire circumference of the valve.



## VALVE SPRING

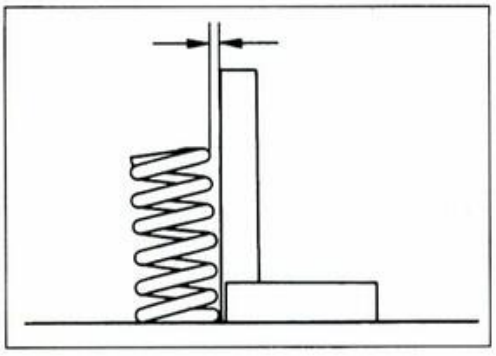
### Valve Spring Free Height

Use a vernier caliper to measure the valve spring free height.

If the measured value is less than the specified limit, the valve spring must be replaced.

Inner and Outer Spring Free Height mm (in)

| | Standard | Limit |
|---|---|---|
| Inner | 47.9 (1.89) | 46.5 (1.83) |
| Outer | 47.3 (1.86) | 45.8 (1.80) |



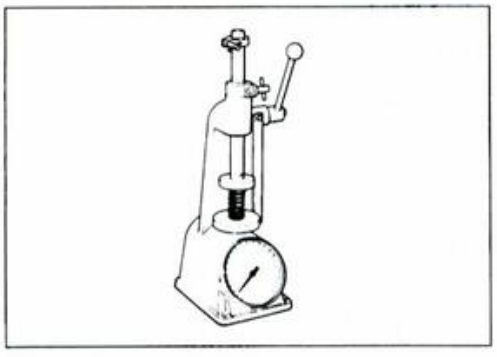
### Valve Spring Inclination

Use a surface plate and a square to measure the valve spring inclination.

If the measured value exceeds the specified limit, the valve spring must be replaced.

Inner and Outer Spring Inclination mm (in)

| |
|---|
| 1.0 (0.04) |



### Valve Spring Tension

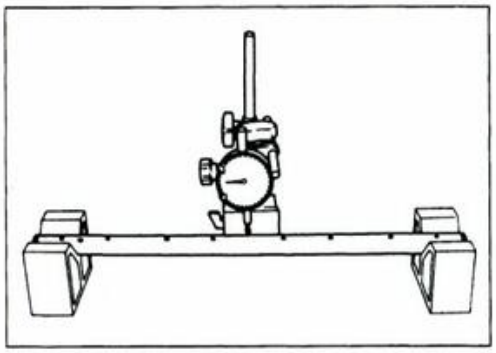
Use a spring tester to measure the valve spring tension.

If the measured value is less than the specified limit, the valve spring must be replaced.

Valve Spring Tension kg (lb/N)

| | Compressed Height | Standard | Limit |
|---|---|---|---|
| Inner Spring | 37.0 mm (1.46 in) | 5.55 – 6.25 (12.21 – 13.78/ 54.39 – 61.25) | 5.0 (11.03/ 49.00) |
| Outer Spring | 39.0 mm (1.54 in) | 19.65 – 22.15 (43.33 – 48.84/ 192.57 – 217.07) | 18.0 (39.69/ 176.40) |

## ROCKER ARM SHAFT AND ROCKER ARM



### Rocker Arm Shaft Run-Out

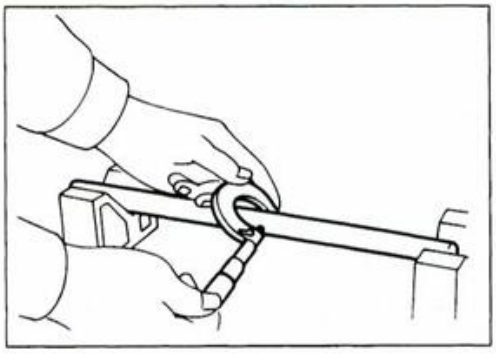
1. Place the rocker arm shaft on a V-block.
2. Use a dial indicator to measure the rocker arm shaft central portion run-out.

   If the run-out is very slight, correct the rocker arm shaft run-out with a bench press. The rocker arm must be at cold condition.

   If the measured rocker arm shaft run-out exceeds the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Run-Out mm (in)

| Limit |
|---|
| 0.6 (0.0024) |



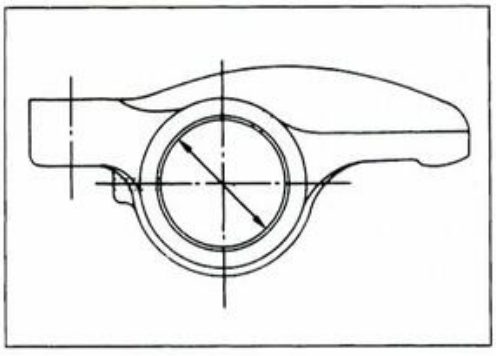
### Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm fitting portion outside diameter.

If the measured value is less than the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Outside Diameter mm (in)

| Standard | Limit |
|---|---|
| 18.98 – 19.00<br>(0.747 – 0.748) | 18.90 (0.744) |



### Rocker Arm Shaft and Rocker Arm Clearance

1. Use either a vernier caliper or a dial indicator to measure the rocker arm bushing inside diameter.

Rocker Arm Bushing Inside Diameter mm (in)

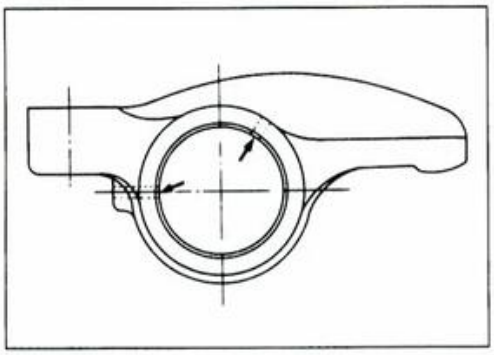
| Standard | Limit |
|---|---|
| 19.036 – 19.060<br>(0.749 – 0.750) | 19.10 (0.752) |

2. Measure the rocker arm shaft outside diameter.

   If the measured value exceeds the specified limit, replace either the rocker arm or the rocker arm shaft.

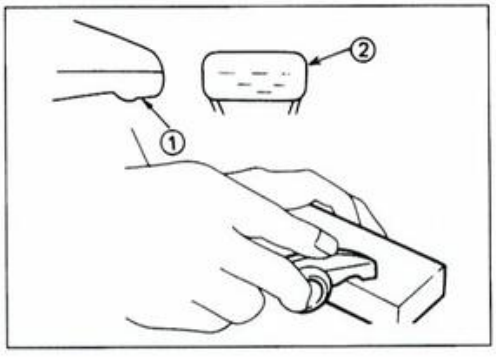
Rocker Arm and Rocker Arm Shaft Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.04 (0.0016) | 0.20 (0.008) |



3. Check that the rocker arm oil port is free of obstructions.

   If necessary, use compressed air to clean the rocker arm oil port.




**Rocker Arm Correction**

Inspect the rocker arm valve stem contact surfaces for step wear ① and scoring ②.

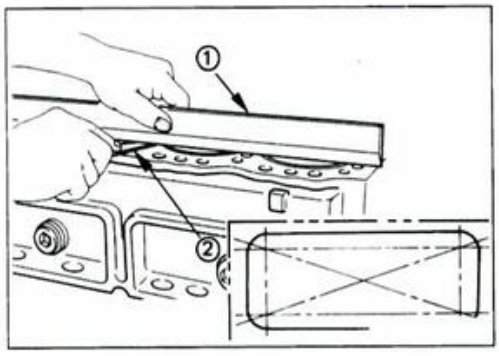
If the contact surfaces have light step wear or scoring, they may be honed with an oil stone.

If the step wear or scoring is severe, the rocker arm must be replaced.

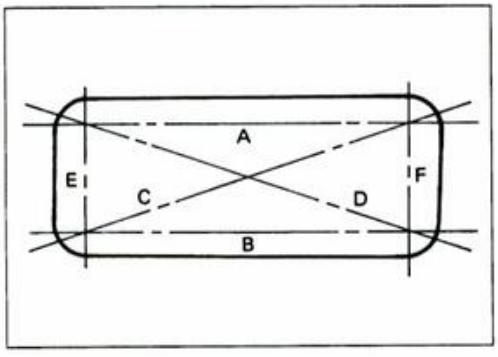
## CYLINDER BODY

### Cylinder Body Upper Face Warpage

1. Remove the cylinder body dowel
2. Remove the cylinder liner (If so equipped).
   Refer to "Cylinder Liner Replacement".




3. Use a straight edge ① and a feeler gauge ② to measure the four sides and the two diagonals of the cylinder body upper face.
4. Regrind the cylinder body upper face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

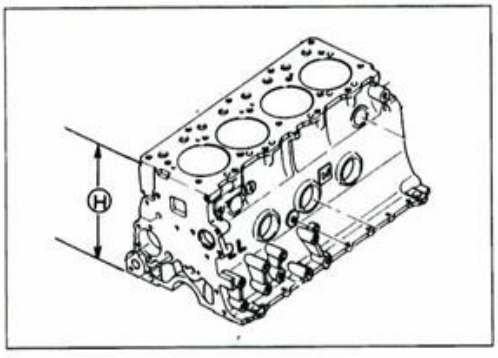



If the measured values exceed the maximum grinding allowance, the cylinder body must be replaced.

Cylinder Body Upper Face Warpage mm (in)

| Standard | Limit | Maximum Grinding Allowance |
|---|---|---|
| 0.05 (0.002) or less | 0.2 (0.008) | 0.4 (0.016) |

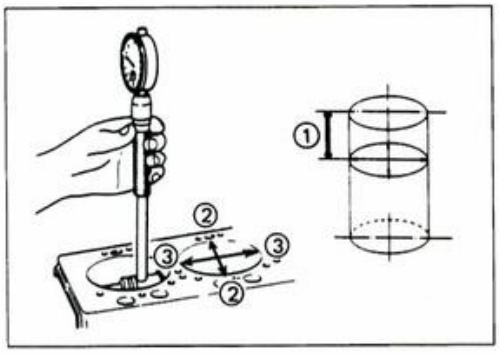
If the measured value is less than the limit, the cylinder body may be reground.




Cylinder Body Height Ⓗ (Reference) mm (in)

| Standard | Limit |
|---|---|
| 273 (10.756) | 272.6 (10.740) |

5. Reinstall the cylinder liner (If so equipped).
   Refer to "Cylinder Body Bore Measurement".
6. Reinstall the cylinder body dowel.




### Cylinder Liner Bore Measurement

Use a cylinder indicator to measure the cylinder liner bore at measuring position ① in the thrust ② – ② and axial ③ – ③ directions of the crankshaft.

Measuring Point ①: Where is a most worn point at 15 – 19 mm (0.59 – 0.75 in).

If the measured value exceeds the specified limit, the cylinder liner must be replaced.

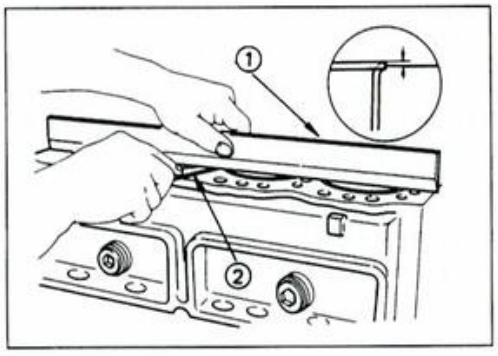
Cylinder Liner Bore mm (in)

| Standard | Limit |
|---|---|
| 86.0 (3.388) | 86.2 (3.396) |

**Note:**

**The inside of the dry type cylinder liner is chrome plated. It cannot be rebored or honed.**

**If the inside of the cylinder liner is scored or scorched, the cylinder liner must be replaced.**




## Cylinder Liner Projection Inspection

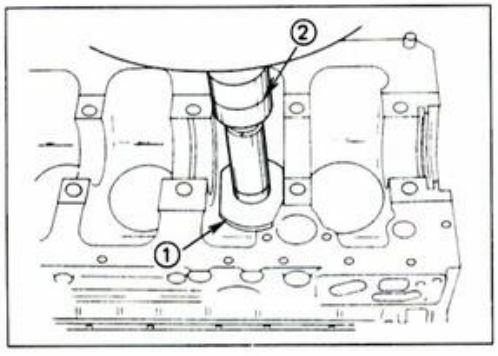
1. Hold a straight edge ① along the top edge of the cylinder liner to be measured.
2. Use a feeler gauge ② to measure each cylinder liner projection.

Cylinder Liner Projection mm (in)

| Standard |
|---|
| 0 – 0.10 (0 – 0.004) |

The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 mm (0.0012 in).

## Cylinder Liner Replacement




## Cylinder Liner Removal

1. Insert the cylinder liner remover ① into the cylinder body (from the lower side of the cylinder body) until it makes firm contact with the cylinder liner.

   Cylinder Liner Remover: 5-8523-2552-0

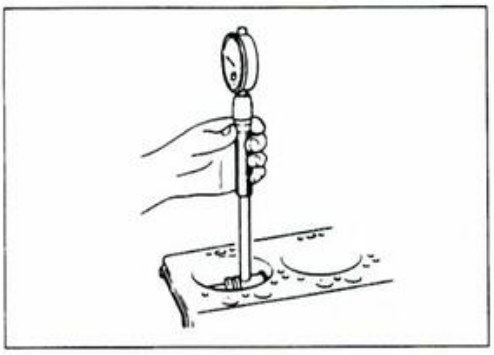
   Grip: 9-8522-1148-0
2. Use a bench press ② to slowly force the cylinder liner from the cylinder body.

**Note:**

**Take care not to damage the cylinder body upper face during the cylinder liner removal procedure.**

3. Measure the cylinder body upper face warpage.

   Refer to "Cylinder Body Upper Face Warpage".



## Cylinder Bore Measurement

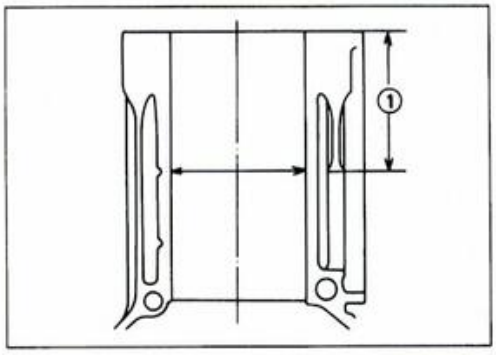
### Cylinder Liner Grade Selection

The term "grade" refers to the cylinder body inside diameter and the cylinder liner outside diameter combination.

Measure the cylinder body bore and select the appropriate cylinder liner grade.

Loose fitting cylinder liners (the liner is too small for the cylinder bore) will adversely affect engine cooling efficiency and may lead to serious engine damage.

Cylinder liners which are too large for the cylinder bore will be difficult to install.



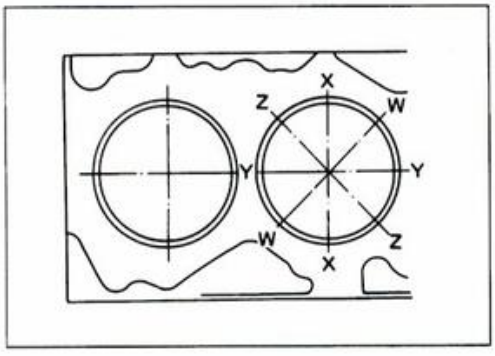

Standard Fitting Interference mm (in)

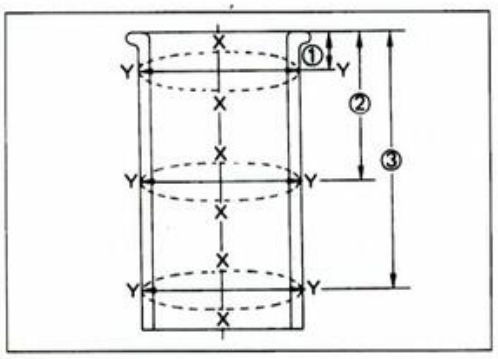
| 0 – 0.02 (0 – 0.0007) |
|---|

1. Take measurements at measuring point ① across the positions W – W, X – X, Y – Y, and Z – Z.

   Measuring Point ①:

2. Calculate the average value of the four measurements to determine the correct cylinder liner grade.




## Cylinder Liner Outside Diameter Measurement

1. Take two measurements at measuring points ①, ②, and ③.

Measuring Points mm (in)

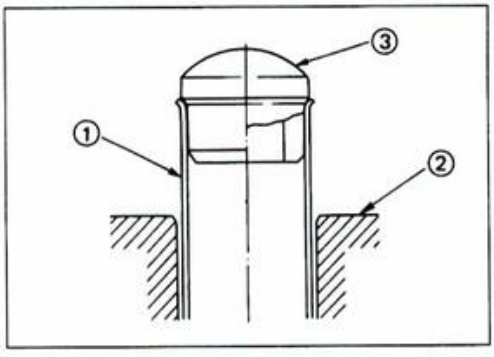
| | |
|---|---|
| ① | 20.0 (0.79) |
| ② | 90.0 (3.54) |
| ③ | 140.0 (5.50) |

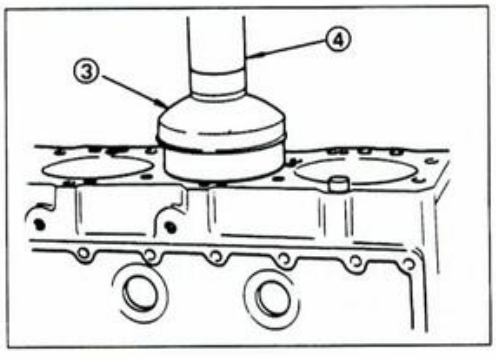
2. Calculate the average value of the six measurements to determine the correct cylinder liner grade.

Cylinder Bore and Cylinder Liner
Grade Combination (Reference) mm (in)

| Grade | Cylinder Bore | Cylinder Liner Outside Diameter |
|---|---|---|
| 1 | 88.001 – 88.010 (3.4672 – 3.4675) | 88.011 – 88.020 (3.4675 – 3.4679) |
| 2 | 88.011 – 88.020 (3.4675 – 3.4679) | 88.021 – 88.030 (3.4679 – 3.4683) |
| 3 | 88.021 – 88.030 (3.4679 – 3.4683) | 88.031 – 88.040 (3.4683 – 3.4687) |
| 4 | 88.031 – 88.040 (3.4683 – 3.4687) | 88.041 – 88.050 (3.4687 – 3.4691) |

## Cylinder Liner Installation




1. **Cylinder Liner Installation Using The Special Tool**
   1) Use new kerosene or diesel oil to thoroughly clean the cylinder liners and bores.
   2) Use compressed air to blow-dry the cylinder liner and bore surfaces.

**Note:**

**All foreign material must be carefully removed from the cylinder liner and the cylinder bore before installation.**

   3) Insert the cylinder liner ① into the cylinder body ② from the top of the cylinder body.
   4) Set the cylinder liner installer ③ to the top of the cylinder liner.

      Cylinder Liner Installer : 9-8523-2551-0
   5) Position the cylinder body so that the installer center ③ is directly beneath the bench press shaft center ④.

**Note:**

**Check that the cylinder liner is set perpendicular to the bench press and that there is no wobble.**

   6) Use the bench press to apply a seating force of 500 kg (1,102.5 lb/4,900 N) to the cylinder liner.
   7) Apply a force of 2,500 kg (5,512.5 lb/24,500 N) to fully seat the cylinder liner.
   8) After installing the cylinder liner, measure the cylinder liner projection.

      Refer to "Cylinder Liner Projection Inspection".

2. **Cylinder Liner Installation Using Dry Ice**

   Cooling the cylinder liner with dry ice will cause the cylinder liner to contract, thus making installation easier.

**Note:**

**It is important that the cylinder liner be inserted to the cylinder body immediately after it has been cooled.**

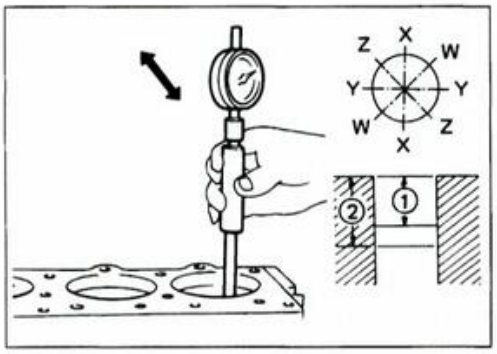
**WARNING:**

**DRY ICE MUST BE USED WITH GREAT CARE. CARELESS HANDLING OF DRY ICE CAN RESULT IN SEVERE FROSTBITE.**

## Piston Grade Selection

The term "piston grade" refers to the piston diameter and cylinder liner bore combination.

Selection of the proper piston grade will ensure efficient engine operation, free from cylinder liner and piston problems.




## Cylinder Liner Bore Measurement

Measure the cylinder liner bore after installing the cylinder liner. Then select the appropriate piston grade for the installed cylinder liner.

1. Measure the cylinder liner bore.

   Refer to "Cylinder Liner Bore Measurement".

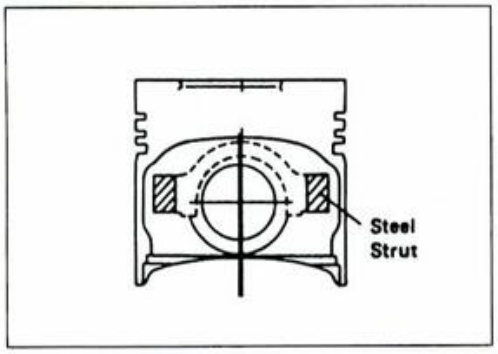
Measuring Points ①: 20 mm (0.79 in)
140 mm (5.51 in)

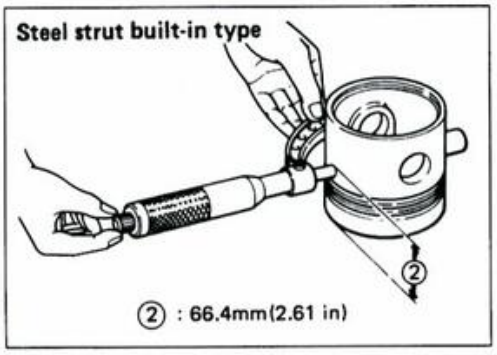
2. Measure the cylinder liner bore at measuring point ① and ② in four different directions (W – W, X – X, Y – Y, and Z – Z).
3. Calculate the average value of the eight measurements.

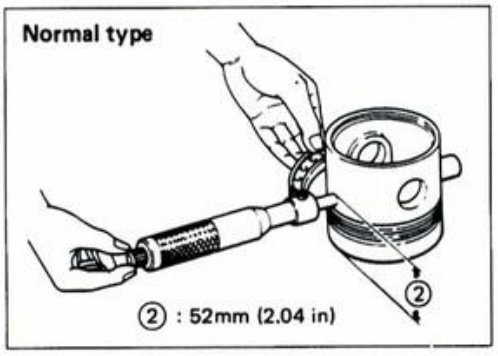
| Cylinder Liner Bore | mm (in) |
|---|---|
| 86.021 – 86.060 (3.389 – 3.390) | |

**Note:**

**It is most important that the correct piston grade be used. Failure to select the correct piston grade will result in engine failure. Always measure the cylinder bore and select the correct piston grade.**




## Piston Outside Diameter

1. Piston outside diameter vary depending on the piston type to be used.
2. Measure the piston outside diameter at the measuring piston ② shown in the illustration.

**Piston Grade**

**1) Steel Strut Built-in Type (Autothermatic Type)**

You can find steel strut on the inner surface of piston as shown in the illustration.

Piston Grade and Piston Diameter mm (in)

| | |
|---|---|
| Ⓐ | 85.976 – 85.995 (3.3874 – 3.3882) |
| Ⓒ | 85.996 – 86.015 (3.3882 – 3.3889) |

**2) Normal Type**

Piston Grade and Piston Diameter mm (in)

| | |
|---|---|
| Ⓐ | 85.864 – 85.883 (3.3830 – 3.3837) |
| Ⓒ | 85.884 – 85.903 (3.3838 – 3.3845) |

## Cylinder Liner Bore and Piston Clearance

**1) Steel Strut Built-in Type**

Cylinder Liner Bore and Piston Clearance mm (in)

| |
|---|
| 0.035 – 0.065 (0.0013 – 0.0025) |

**2) Normal Type**

Cylinder Liner Bore and Piston Clearance mm (in)

| |
|---|
| 0.146 – 0.196 (0.0057 – 0.0077) |

**Note:**

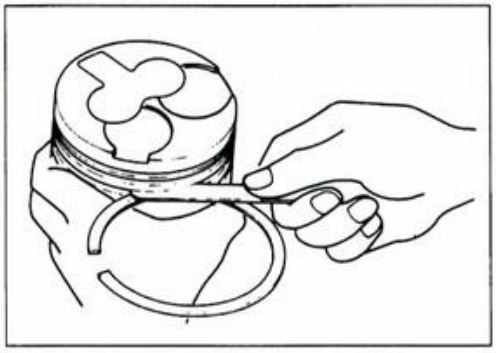
**Cylinder liner piston kit clearances are preset. However, the cylinder liner installation procedure may result in slight decreases in cylinder liner bore clearances.**

**Always measure the cylinder liner bore clearance after installation to be sure that it is correct.**

## PISTON

### Piston Grade Selection and Cylinder Bore Measurement

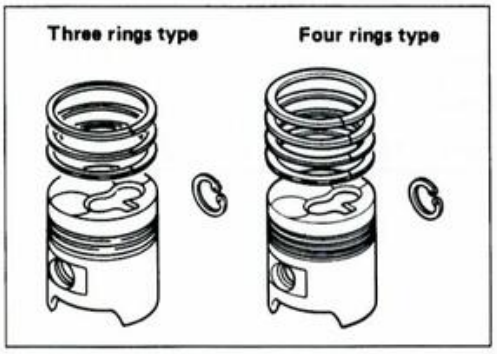
Refer to the Section "CYLINDER BODY", Items "Cylinder Bore Measurement" and "Cylinder Liner Bore Measurement" for details on piston grade selection and cylinder or liner bore measurement.



### Piston Ring and Piston Ring Groove Clearance

Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.

If the clearance between the piston ring and the piston ring groove exceeds the specified limit, the piston ring must be replaced.




**Three Rings Type**

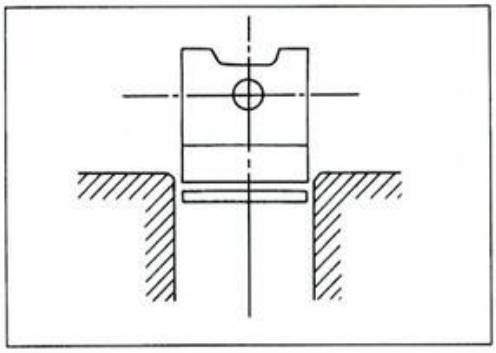
Piston Ring and Piston Ring Groove Clearance — mm (in)

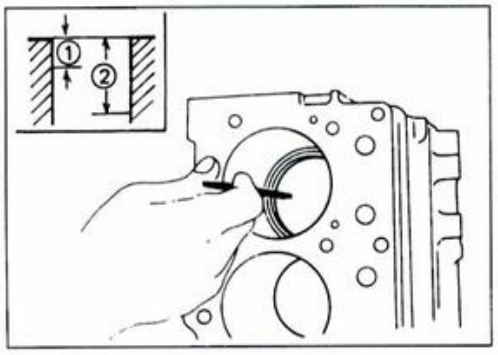
| | Standard | Limit |
|---|---|---|
| 1st Compression Ring | 0.09 – 0.11 (0.0035 – 0.0043) | 0.3 (0.012) |
| 2nd Compression Ring | 0.030 – 0.055 (0.0012 – 0.0021) | |
| Oil Ring | 0.020 – 0.055 (0.0008 – 0.0021) | 0.15 (0.0059) |

**Four Rings Type**

Piston Ring and Piston Ring Groove Clearance — mm(in)

| | Standard | Limit |
|---|---|---|
| 1st Compression Ring | 0.045 – 0.070 (0.0017 – 0.0027) | 0.15 (0.0059) |
| 2nd Compression Ring | 0.045 – 0.070 (0.0017 – 0.0027) | 0.15 (0.0059) |
| 3rd Compression Ring | 0.045 – 0.070 (0.0017 – 0.0027) | 0.15 (0.0059) |
| Oil Ring | 0.020 – 0.055 (0.0008 – 0.0021) | 0.15 (0.0059) |






## PISTON RING

### Piston Ring Gap

1. Insert the piston ring horizontally (in the position it would assume if it were installed to the piston) into the cylinder liner bore.
2. Use an inverted piston to push the piston ring into the cylinder liner until it reaches either measuring point ① or the measuring point ②. Cylinder liner diameter is smallest at these two points.

   Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.

   Cylinder Liner Measuring Point ①: 10 mm (0.39 in)

   Cylinder Liner Measuring Point ②: * A point where the liner diameter is smallest.

3. Use a feeler gauge to measure the piston ring gap.

   If the measured value exceeds the specified limit, the piston ring must be replaced.

Piston Ring Gap mm (in)

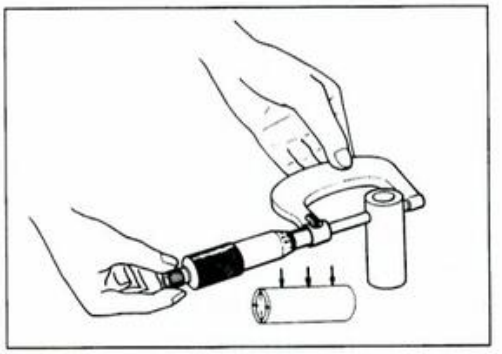
| | Standard | Limit |
|---|---|---|
| 1st Compression Ring Gap | 0.2 – 0.4 (0.0079 – 0.0158) | 1.5 (0.0591) |
| 2nd Compression Ring Gap | 0.2 – 0.4 (0.0079 – 0.0158) | 1.5 (0.0591) |
| 3rd Compression Ring Gap* | 0.2 – 0.4 (0.0079 – 0.0158) | 1.5 (0.0591) |
| Oil Ring Gap | 0.1 – 0.3 (0.0039 – 0.0118) | 1.5 (0.0591) |

* Where the Four Rings Type is used.

4. Visually inspect the piston rings.

   If a piston ring groove is damaged or distorted, the piston must be replaced.

## PISTON PIN



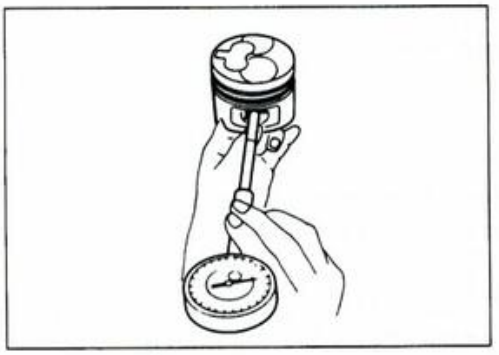
### Piston Pin Diameter

Use a micrometer to measure the piston pin outside diameter at several points.

If the measured value is less than the specified limit, the piston pin must be replaced.

Piston Pin Diameter mm (in)

| Standard | Limit |
|---|---|
| 27.01 (1.0638) | 26.97 (1.0626) |



### Piston Pin and Piston Clearance

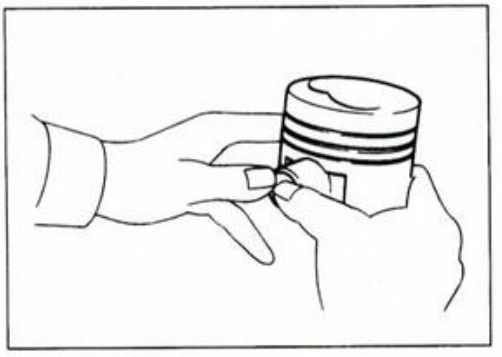
Use an inside dial indicator to measure the piston pin hole (in the piston).

Piston Pin Hole mm (in)

| Standard |
|---|
| 26.988 – 26.997 (1.0633 – 1.0637) |

Piston Pin and Piston Pin Hole mm (in)

| |
|---|
| 0 – 0.005 (0 – 0.0002) |

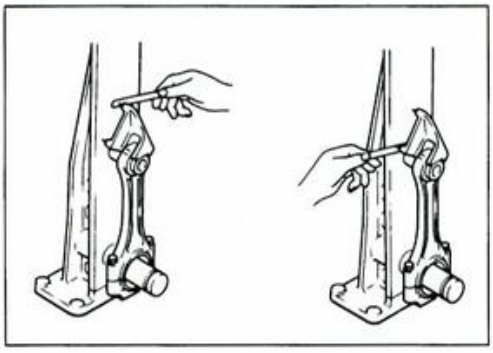


If an inside dial indicator is not available, use the following procedure to check the piston pin clearance.

1. Use a piston heater to heat the piston to approximately 100°C (220°F)
2. Push strongly against the piston pin with your thumbs.

   The piston pin should move smoothly with little or no resistance.

## CONNECTING ROD



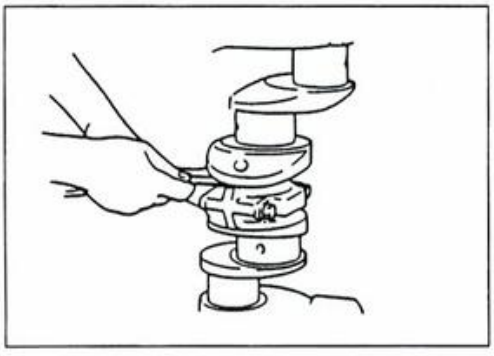
### Connecting Rod Alignment

Use a connecting rod aligner to measure the distortion and the parallelism between the connecting rod big end hole and the connecting rod small end hole.

If either the measured distortion or parallelism exceed the specified limit, the connecting rod must be replaced.

Connecting Rod Alignment
Per Length of 100 mm (3.94 in) mm (in)

| | Standard | Limit |
|---|---|---|
| Distortion | 0.08 or Less (0.0030) | 0.20 (0.008) |
| Parallelism | 0.05 or Less (0.0020) | 0.15 (0.006) |



### Connecting Rod Side Face Clearance

1. Install the connecting rod to the crankpin.
2. Use a feeler gauge to measure the clearance between the connecting rod big end side face and the crankpin web face.

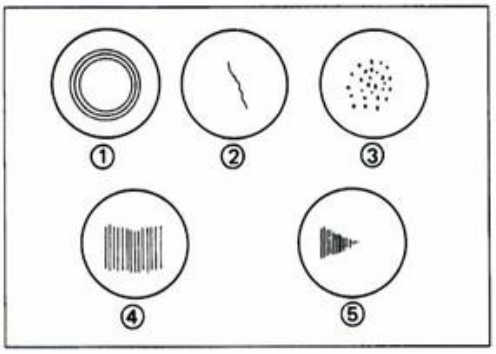
   If the measured value exceeds the specified limit, the connecting rod must be replaced.

Connecting Rod Big End and Crankpin Web Face Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.23 (0.009) | 0.35 (0.014) |

## TAPPET AND PUSH ROD

Visually inspect the tappet contact surfaces for pitting, cracking, and other abnormal conditions. The tappet must be replaced if any of these conditions are present.

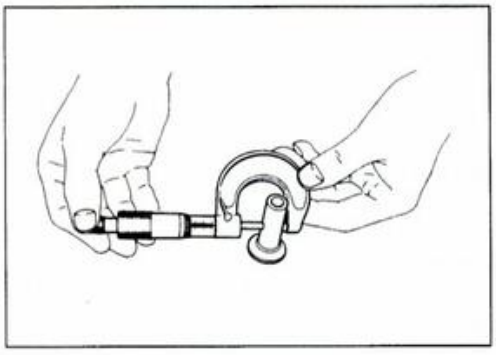



Refer to the illustration at the left.

① Normal contact
② Cracking
③ Pitting
④ Uneven contact
⑤ One-sided contact

**Note:**

**The tappet surfaces are spherical. Do not grind them with an oil stone or similar tool in an attempt to repair the tappet. If the tappet is damaged, it must be replaced.**



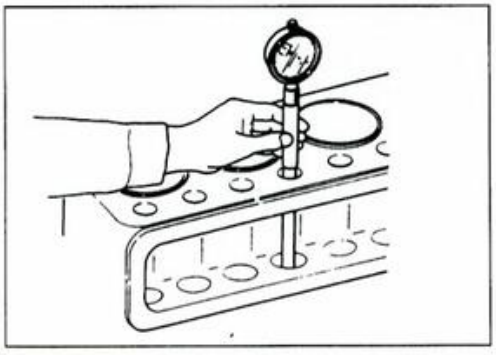
### Tappet Outside Diameter

Measure the tappet outside diameter with a micrometer.

If the measured value is less than the specified limit, the tappet must be replaced.

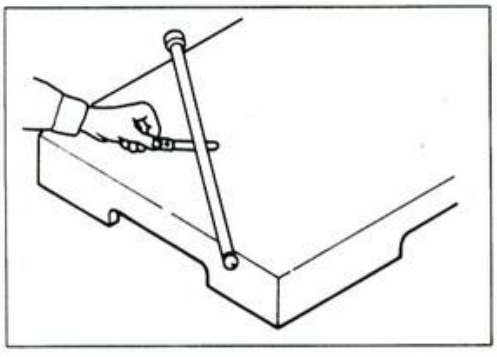
Tappet Outside Diameter mm (in)

| Standard | Limit |
|---|---|
| 12.97 – 12.99 (0.510 – 0.511) | 12.95 (0.509) |



Tappet and Cylinder Body Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.03 (0.001) | 0.1 (0.004) |



### Push Rod Curvature

1. Lay the push rod on a surface plate.
2. Roll the push rod along the surface plate and measure the push rod curvature with a thickness gauge.
   If the measured value exceeds the specified limit, the push rod must be replaced.

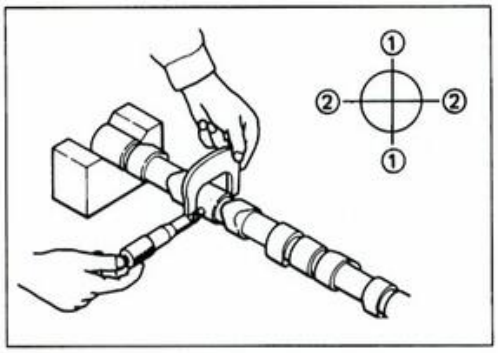
Push Rod Curvature mm (in)

| Standard |
|---|
| 0.3 (0.012) |

3. Visually inspect both ends of the push rod for excessive wear and damage. The push rod must be replaced if these conditions are discovered during inspection.

## CAMSHAFT

Visually inspect the journals, the cams, the oil pump drive gear, and the camshaft bearings for excessive wear and damage. The camshaft and the camshaft bearings must be replaced if these conditions are discovered during inspection.

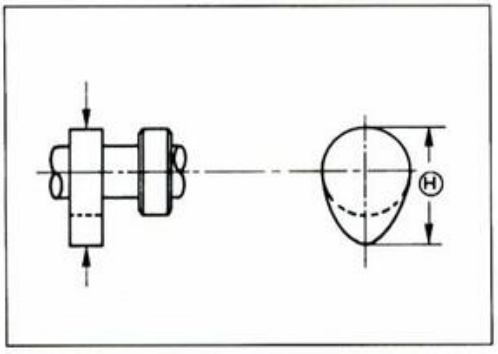



### Camshaft Journal Diameter

Use a micrometer to measure each camshaft journal diameter in two directions (① and ②). If the measured value is less than the specified limit, the camshaft must be replaced.

Camshaft Journal Diameter mm (in)

| Standard | Limit |
|---|---|
| 47.94 – 47.97 (1.88 – 1.89) | 47.6 (1.87) |

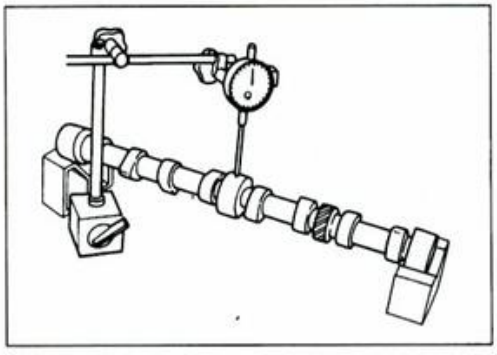



### Cam Height

Measure the cam height Ⓗ with a micrometer. If the measured value is less than the specified limit, the camshaft must replaced.

Cam Height Ⓗ mm (in)

| Standard | Limit |
|---|---|
| 40.57 (1.60) | 40.2 (1.58) |



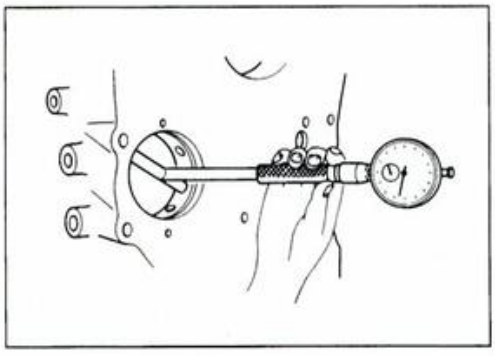
### Camshaft Run-Out

1. Mount the camshaft on V-blocks
2. Measure the run-out with a dial indicator.

   If the measured value exceeds the specified limit, the camshaft must be replaced.

Camshaft Run-Out mm (in)

| Standard | Limit |
|---|---|
| 0.05 (0.002) | 0.10 (0.004) |



### Camshaft and Camshaft Bearing Clearance

Use an inside dial indicator to measure the camshaft bearing inside diameter.

Camshaft Bearing Inside Diameter mm (in)

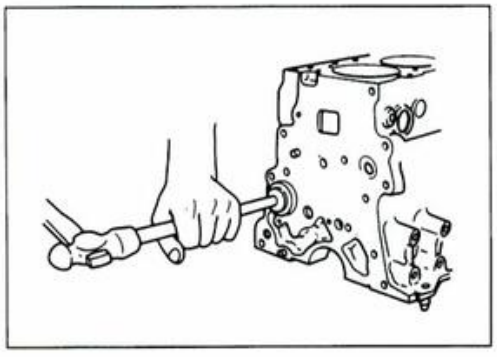
| Standard | Limit |
|---|---|
| 48.0 – 48.03 (1.8897 – 1.8909) | 48.08 (1.8929) |

If the clearance between the camshaft bearing inside diameter and the journal exceeds the specified limit, the camshaft bearing must be replaced.

Camshaft Bearing Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.05 (0.002) | 0.12 (0.005) |

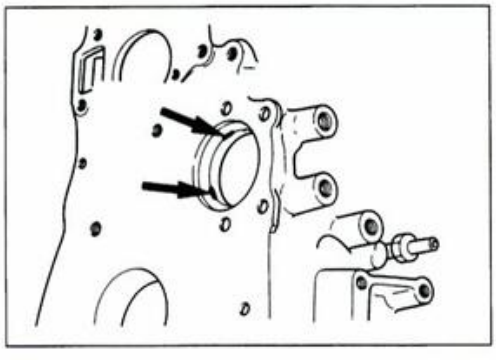
### Camshaft Bearing Replacement



#### Camshaft Bearing Removal

1. Remove the cylinder body plug plate.
2. Use the bearing remover to remove the camshaft bearing.

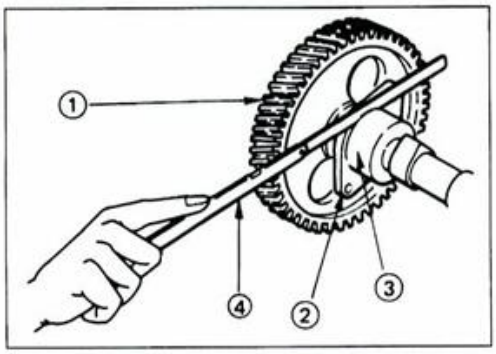
   Bearing Remover: 9-8523-1360-0



#### Camshaft Bearing Installation

1. Align the bearing oil holes with the cylinder body of holes.
2. Use the installer to install the camshaft bearing.

   Bearing Installer: 9-8523-1360-0



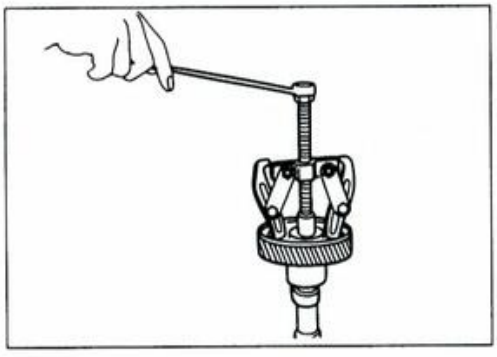

**Camshaft End Play**

1. Before removing the camshaft gear ①, push the thrust plate ② as far as it will go toward the camshaft gear ③.
2. Use a feeler gauge ④ to measure the clearance between the thrust plate and the camshaft journal. If the measured value exceeds the specified limit, the thrust plate must be replaced.

Camshaft End Play mm (in)

| Standard | Limit |
|---|---|
| 0.050 – 0.114 (0.002 – 0.0044) | 0.2 (0.008) |

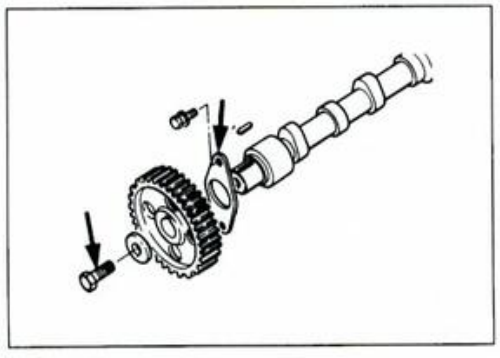
**Thrust Plate Replacement (Timing Gear Drive)**



**Thrust Plate Removal**

1. Use the universal puller to remove the camshaft gear.

   Universal Puller : 5-8521-0002-0
2. Remove the thrust plate.



**Thrust Plate Installation**

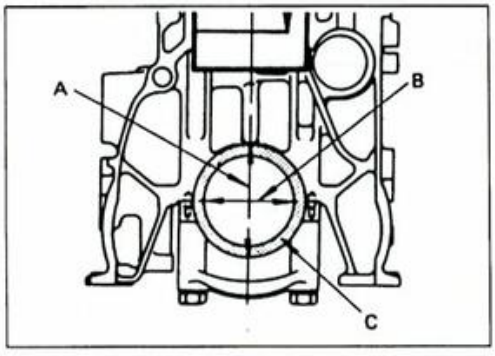
1. Install the thrust plate.
2. Apply engine oil to the bolt and threads.
3. Install the camshaft gear.

Camshaft Gear Bolt Torque kg·m (lb.ft/N·m)

| 10.0 – 12.0 (72.3 – 86.7/98.1 – 117.7) |
|---|

## CRANKSHAFT AND BEARING

The C240 engine's crankshaft can be repaired by regrinding and the use of undersize main bearings and the connecting rod bearings.




Summarization of the Basic Dimension Measurement Steps

Main Bearing Inside Diameter = A
Crankshaft Journal Diameter = B
Crankshaft Journal-to-Main Bearing Clearance = C

A – B = C

To obtain C, A and B is measured.

Also measure the crankpin-to-connecting rod bearing clearance (C') in similar way.

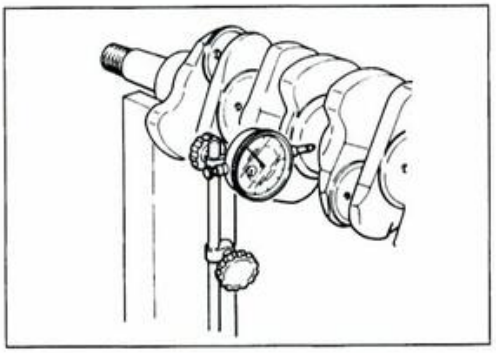
The clearances C or C' are a base to determine a way of repair.

Further the descriptions cover the way of repair as summarized below.

1) Replace the bearings with of standard sized ones when the crankshaft journal wear amount and/or crankpin wear amount is within an allowable extent but the bearing wear amount is close to the specified limit.
2) Regrind the crankshaft journal surfaces and/or crankpin surfaces and, replace the bearings with of undersized ones when the crankshaft journal wear and crankpin wear are exceeding the specified limit.

**Crankshaft and Bearings Inspection**

1. Inspect the crankshaft journal surfaces and the crankpin surfaces for excessive wear and damage.
2. Inspect the oil seal fitting surfaces of the crankshaft front and rear ends for excessive wear and damage.
3. Replace or repair the crankshaft if any excessive wear or damage is discovered.
4. Inspect the crankshaft oil ports for obstructions.
5. Use high pressure air to clean the oil ports is necessary.



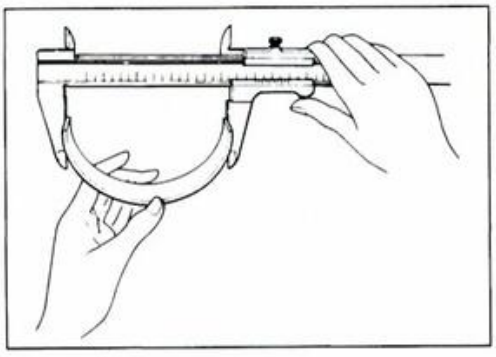
**Crankshaft Run-Out**

1. Set a dial indicator to the center of the crankshaft journal.
2. Gently turn the crankshaft in the normal direction of rotation.

   Read the dial indicator as you turn the crankshaft. If the measured value exceeds the specified limit, the crankshaft must be replaced.

Crankshaft Run-Out mm (in)

| Standard | Limit |
|---|---|
| 0.03 (0.012) or less | 0.06 (0.0024) |



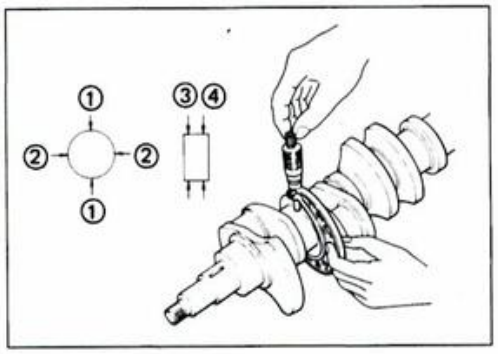
**Bearing Spread**

Use a vernier caliper to measure the bearing spread.

If the measured value is less than the specified limit, the bearing must be replaced.

Bearing Spread mm (in)

| Crankshaft | Limit |
|---|---|
| Bearing | 74.5 (2.94) |
| Connecting Rod Bearing | 56.5 (2.22) |




**Crankshaft Journal and Crankpin Diameter**

1. Use a micrometer to measure the crankshaft journal diameter across points ① – ① and ② – ②.
2. Use the micrometer to measure the crankshaft journal diameter at the two points (③ and ④).
3. Repeat Steps 1 and 2 to measure the crankpin diameter.

   If the measured values are less than the limit, the crankshaft must be replaced.

Crankshaft Journal Diameter mm (in)

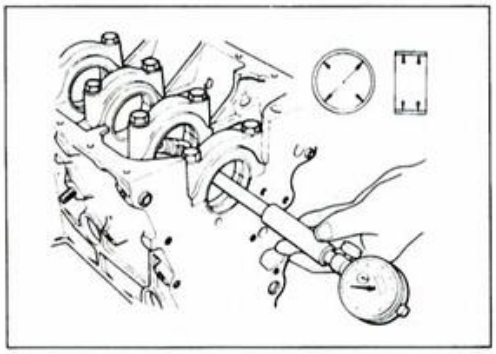
| Standard | Limit |
|---|---|
| 69.920 – 69.932 (2.7548 – 2.7553) | 69.420 (2.735) |

Crankshaft Diameter mm (in)

| Standard | Limit |
|---|---|
| 52.9188 – 52.930 (2.0849 – 2.0854) | 52.418 (2.065) |

Crankshaft Journal and Crankpin Uneven Wear mm (in)

| Standard | Limit |
|---|---|
| 0.001 (0.00004) | 0.05 (0.002) |



**Crankshaft Journal and Bearing Clearance**

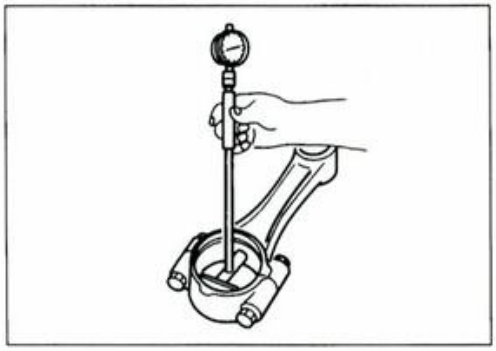
If the clearance between the measured bearing inside diameter and the crankshaft journal diameter exceeds the specified limit, the bearing and/or the crankshaft must be replaced.

Crankshaft Journal Bearing Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.018 – 0.065 (0.0007 – 0.0025) | 0.12 (0.0047) |

Crankshaft Bearing Cap Bolt Torque kg·m (lb.ft/N·m)

| 16.0 – 18.0 (117.0 – 128.4/156.9 – 176.5) |
|---|



**Connecting Rod Bearing Inside Diameter**

1. Install the bearing to the connecting rod big end.
2. Tighten the bearing cap to the specified torque.

Connecting Rod Bearing Cap Bolt Torque kg·m (lb.ft/N·m)

| 8.0 – 9.0 (57.8 – 65.0/78.4 – 88.2) |
|---|

3. Use an inside dial indicator to measure the connecting rod bearing inside diameter.

### Crankpin and Bearing Clearance

If the clearance between the measured bearing insi diameter and the crankpin exceeds the specified lim the bearing and/or the crankshaft must be replaced.

Crankpin and Bearing Clearance mm (i

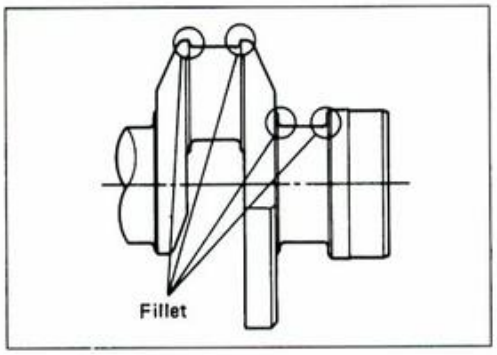
| Standard | Limit |
|---|---|
| 0.018 – 0.065<br>(0.0007 – 0.0025) | 0.12 (0.0047) |

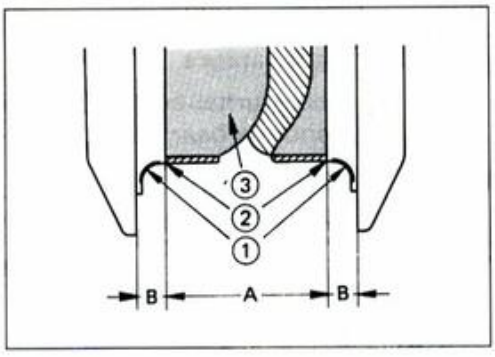
### Crankshaft Regrinding

To ensure crankshaft reliability, pay close attention the following items during and after the crankshaft r grinding procedure.

mm (i

| | | |
|---|---|---|
| Undersize Bearing Availability | 0.25 (0.010) | 0.50 (0.020) |




### Crankshaft Regrinding Procedure

1. Regrind the crankshaft journal and the crankpi observing the following Note.

**Note:**

**In the regrinding procedure, never grind down the fill curved surfaces ① shown in the illustration.**

**If once the original fillet surfaces, whose a wo hardening have been made in the manufacturi process, are removed out, the crankshaft fillets will l weakened resulting a lowered crankshaft durability.**

2. Grind the zone "A" (hatched part in the illustratio only keeping the fillet curves "B" in order to secu the work hardened surfaces ①.
3. Remove the steps ② after regrinding the shaft blending the surfaces "A" and fillet curves "B" smooth as you can.

Width of Work Hardened Surfaces "B" mm (i

| |
|---|
| 4.0 – 4.5 (0.15 – 0.17) |

4. Finish the crankshaft journal, crankpin, and oil pc corners to a smooth surface having a chamfer radi of 1 mm (0.04 in).

| | |
|---|---|
| Crankshaft Journal and Crankpin Roughness | 0.4 μ or less |

5. Measure the crankshaft journal and crankpin cle ance.

   Refer to "Crankshaft Journal Clearance" and "Crar pin and Clearance" on Page 82.
6. Measure the crankshaft run-out.

**Crankshaft Grinding Tolerance**

mm (in)

| Undersize Bearings | Crank Journal Diameter |
|---|---|
| 0.25 (0.010) | 69.670 – 69.682 (2.7450 – 2.7455) |
| 0.50 (0.020) | 69.420 – 69.432 (2.7351 – 2.7356) |

mm (in)

| Undersize Bearings | Crankpin Diameter |
|---|---|
| 0.25 (0.010) | 52.668 – 52.680 (20.751 – 2.0756) |
| 0.50 (0.020) | 52.418 – 52.430 (2.0653 – 2.0657) |

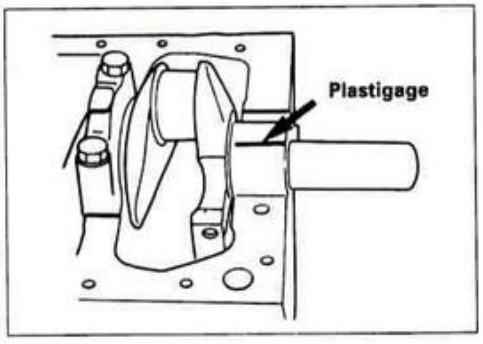
Undersize bearings 0.25 mm (0.010 in) and 0.50 mm (0.020 in) are available to compensate for excessive clearance between the crankshaft journal bearing and the crankshaft. Regrinding of the crankshaft to fit the undersize bearings is required.

Crankshaft Journal and Bearing Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.018 – 0.065 (0.0007 – 0.0025) | 0.12 (0.0047) |

Crankpin and Bearing Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.018 – 0.065 (0.0007 – 0.0025) | 0.12 (0.0047) |




**Clearance Measurement (With Plastigage)**

**Crankshaft Journal and Bearing Clearance**

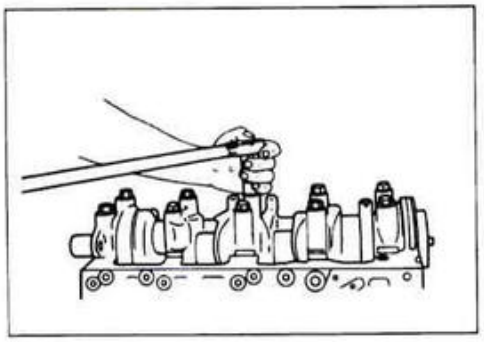
1. Clean the cylinder body, the journal bearing fitting surface, the bearing caps, and the bearings.
2. Install the bearings to the cylinder body.
3. Carefully place the crankshaft on the bearings.
4. Rotate the crankshaft approximately 30° to seat the bearing.
5. Place the Plastigage (arrow) over the crankshaft journal across the full width of the bearing.
6. Install the bearing caps with the bearing.
7. Tighten the bearing caps to the specified torque.

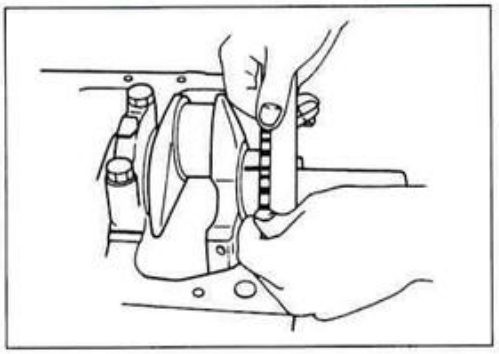
Crankshaft Bearing Cap Bolt Torque kg·m (lb.ft/N·m)

| 16.0 – 18.0 (117.0 – 128.4/156.9 – 176.5) |
|---|

Do not allow the crankshaft to turn during bearing cap installation and tightening.

8. Remove the bearing cap.





9. Compare the width of the Plastigage attached to either the crankshaft or the bearing against the scale printed on the Plastigage container.

   If the measured value exceeds the limit, perform the following additional steps.

   1) Use a micrometer to measure the crankshaft outside diameter.
   2) Use an inside dial indicator to measure the bearing inside diameter.

      If the crankshaft journal and bearing clearance exceeds the limit, the crankshaft and/or the bearing must be replaced.

Crankshaft Journal and Bearing Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.018 – 0.065<br>(0.0007 – 0.0025) | 0.12 (0.0047) |

**Crankpin and Bearing Clearance**

1. Clean the crankshaft, the connecting rod, the bearing cap, and the bearings.
2. Install the bearing to the connecting rod and the bearing cap.

   Do not allow the crankshaft to move when installing the bearing cap.
3. Prevent the connecting rod from moving.
4. Attach the Plastigage to the crankpin.

   Apply engine oil to the Plastigage to keep it from falling.
5. Install the bearing cap and tighten it to the specified torque.

   Do not allow the connecting rod to move when installing and tightening the bearing cap.

Connecting Rod Bearing Cap Bolt
Torque kg·m (lb.ft/N·m)

| 8.0 – 9.0 (57.8 – 65.0/78.4 – 88.0) |
|---|

6. Remove the bearing cap.
7. Compare the width of the Plastigage attached to either the crankshaft or the bearing against the scale printed on the Plastigage container.

   If the measured value exceeds the specified limit, perform the following additional steps.

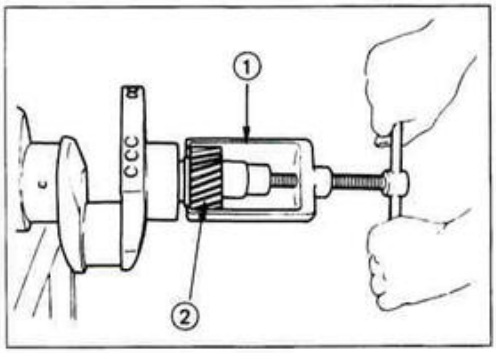
   1) Use a micrometer to measure the crankpin outside diameter.
   2) Use an inside dial indicator to measure the bearing inside diameter.

      If the crank pin and bearing clearance exceeds the specified limit, the crankshaft and/or the bearing must be replaced.

Crankpin and Bearing Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.018 – 0.065<br>(0.0007 – 0.0025) | 0.12 (0.0047) |

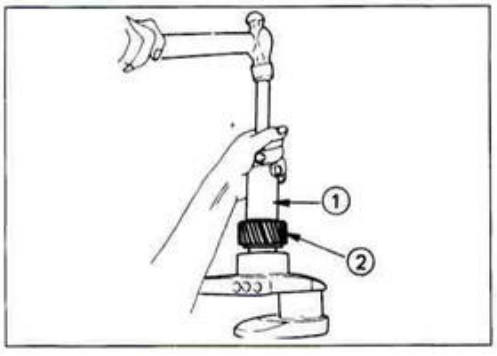
**Crankshaft Gear Replacement (Timing Gear Drive)**




**Crankshaft Gear Removal**

1. Use the crankshaft gear remover ① to remove the crankshaft gear ②.

   Crankshaft Gear Remover: 9-8521-0074-0 (JKM-2005)
2. Remove the crankshaft feather key.



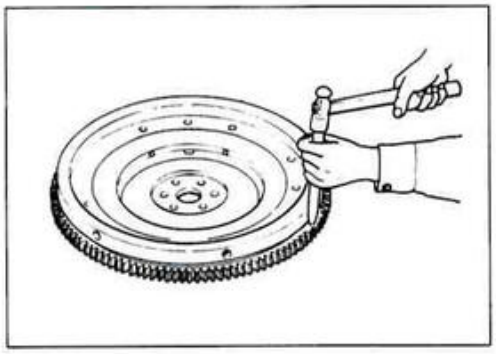

**Crankshaft Gear Installation**

Use the crankshaft gear installer ① to install the crankshaft gear ②.

The crankshaft gear timing mark ("X – X") must be facing outward.

Crankshaft Gear Installer : 9-8522-0021-0 (J-26587)

## FLYWHEEL AND RING GEAR



### Ring Gear Replacement

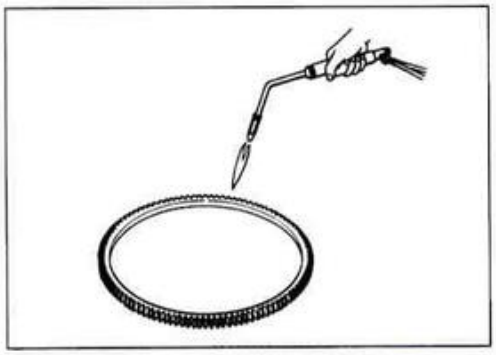
### Ring Gear

Inspect the ring gear.

If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.

### Ring Gear Removal

Strike around the edges of the ring gear with a hammer and chisel to remove it.



### Ring Gear Installation

1. Heat the ring gear evenly with a gas burner to invite thermal expansion.

   Do not allow the temperature of the gas burner to exceed 200°C (390°F).

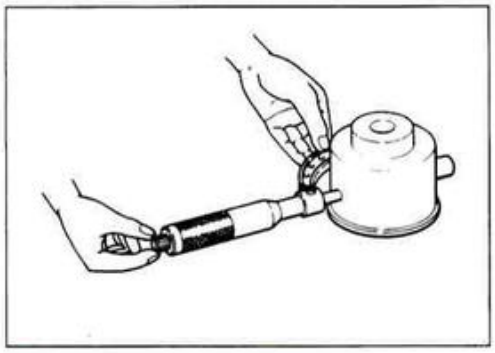
2. Install the ring gear when it is sufficiently heated.

   The ring gear must be installed with the chamfer facing the clutch.

**Note:**

**Another method of heating the ring gear to invite thermal expansion is to soak a rag in diesel fuel, wrap the diesel fuel soaked rag around the rim of the ring gear, and then light the rag.**

## IDLER GEAR SHAFT AND IDLER GEAR



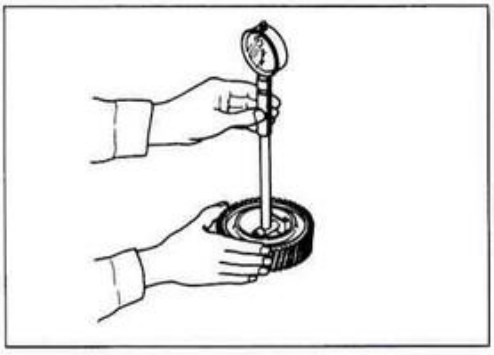
### Idler Gear Shaft Outside Diameter

Use a micrometer to measure the idler gear shaft outside diameter.

If the measured value is less than the specified limit, the idler gear must be replaced.

Idler Gear Shaft Outside Diameter mm (in)

| Standard | Limit |
|---|---|
| 44.95 – 44.98<br>(1.769 – 1.770) | 44.90 (1.767) |



### Idler Gear Inside Diameter

1. Use an inside dial indicator or an inside micrometer to measure the idler gear inside diameter.

Idler Gear Inside Diameter mm (in)

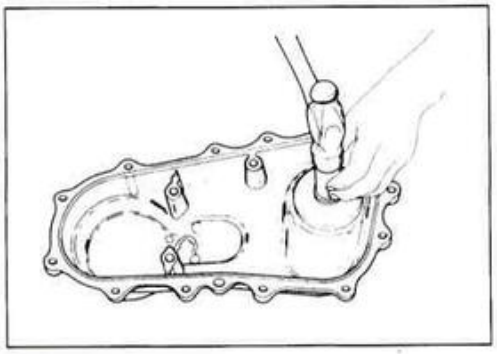
| Standard | Limit |
|---|---|
| 45.0 – 45.03<br>(1.7717 – 1.7718) | 45.10 (1.7756) |

If the clearance between the idler gear shaft outside diameter and the idler gear inside diameter exceeds the limit, the idler gear must be replaced.

Idler Gear Shaft and Idler Gear Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.025 – 0.085<br>(0.0010 – 0.0033) | 0.2 (0.008) |

## TIMING GEAR CASE COVER



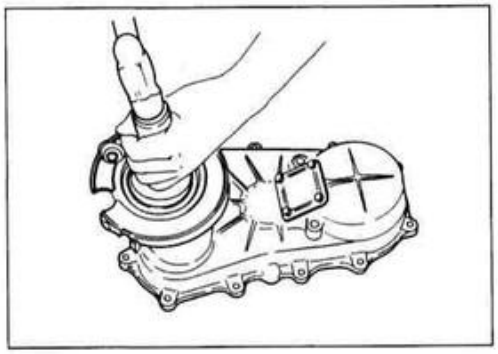
Replace the crankshaft front oil seal if it is excessively worn or damaged.

### Crankshaft Front Oil Seal Replacement

**Oil Seal Removal**

Use a plastic hammer and a screwdriver to tap around the oil seal to free it from the gear case.

Take care not to damage the oil seal fitting surfaces.



**Oil Seal Installation**

Use the installer to install the case oil seal to the gear case.

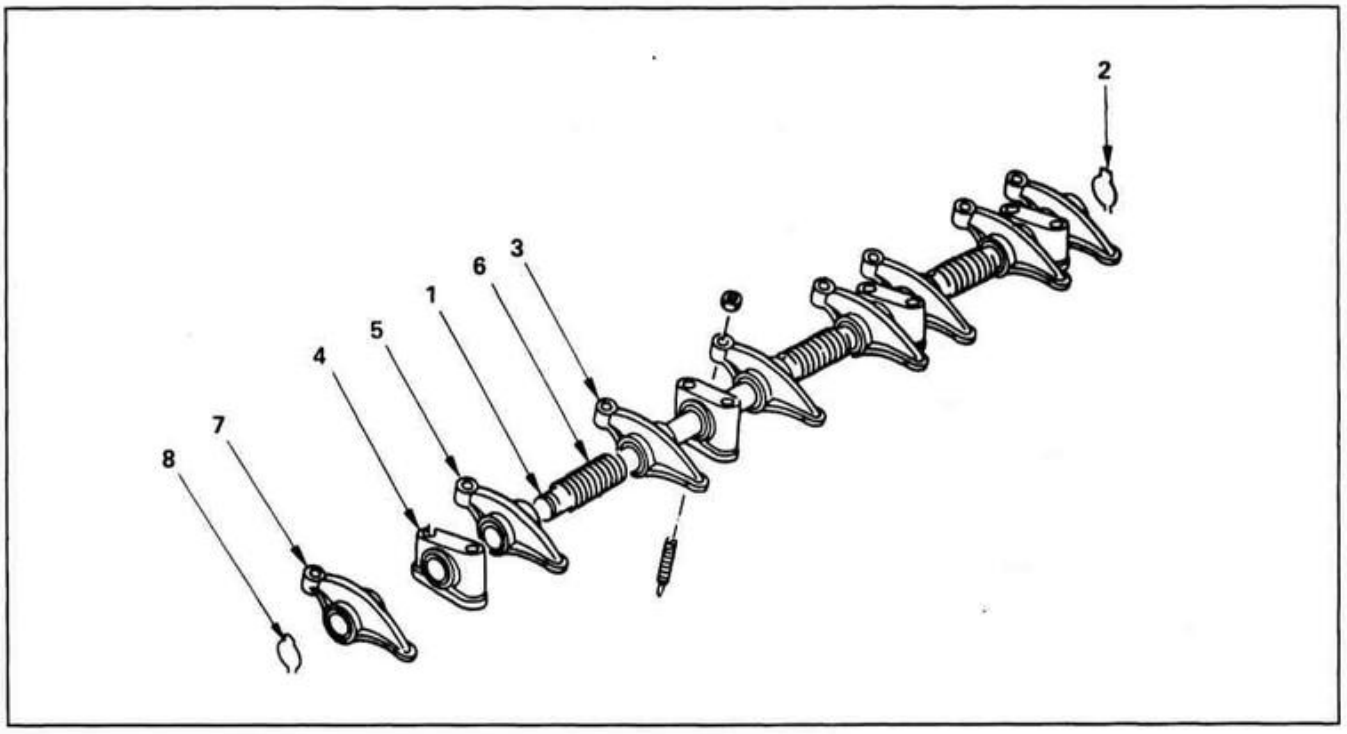
Oil Seal Installer: 5-8522-0013-0 (J-2658-7013)

## SECTION 5

# ENGINE ASSEMBLY ( 3 ) (REASSEMBLY)

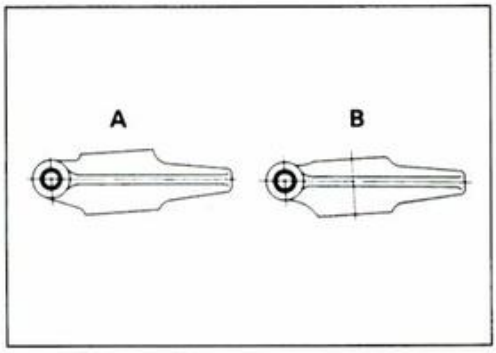
### TABLE OF CONTENTS

## ROCKER ARM AND SHAFT REASSEMBLY STEP




**Reassembly Steps**

- ▲ 1. Rocker arm shaft
- 2. Rocker arm shaft snap ring
- ▲ 3. Rocker arm "C"
- ▲ 4. Rocker arm shaft bracket
- 5. Rocker arm "D"
- 6. Rocker arm shaft spring
- 7. Rocker arm "A"
- 8. Rocker arm shaft snap ring

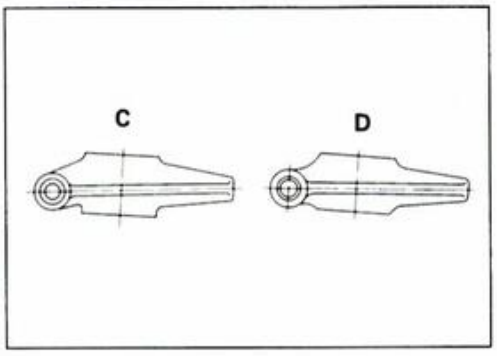



## Important Operations

**▲ Rocker Arm shaft**

**▲ Rocker Arm "A", "B", "C", "D"**

1) Use compressed air to thoroughly clean the rocker arm shaft and the rocker arm oil holes.
2) Apply a coat of engine oil to the rocker arm shaft and the rocker arm bushings.



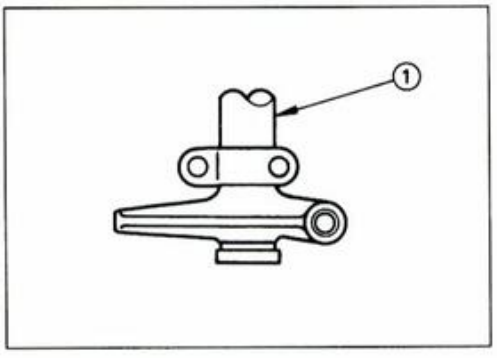

The rocker arm shaft positioning is done by a cutaway machined on the shaft end. Therefore, install the bracket and the shaft so that the cutaway facing the mating bolt stem.

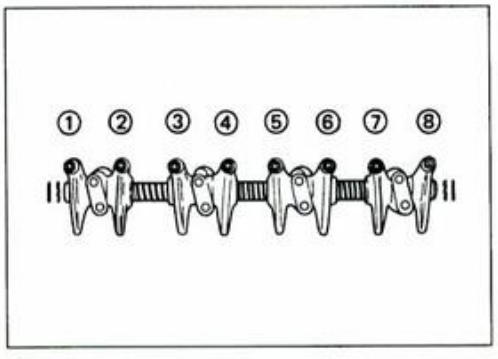
(1) = Cutaway on the rocker arm shaft end

**Note:**

**Rocker arms "A", "B", "C" and "D" each have a different shape. Be sure to install them in their correct position.**

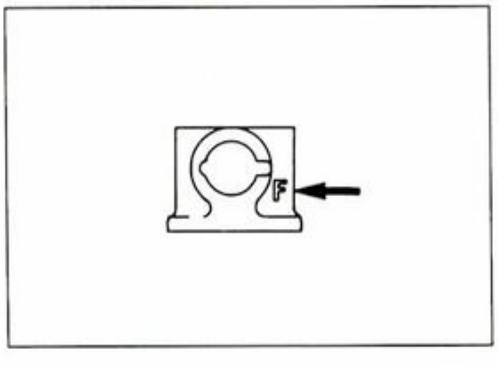
Rocker arm "A"
Rocker arm "B"
Rocker arm "C"
Rocker arm "D"




**Rocker Arm Fitting Positions** (From the Front)

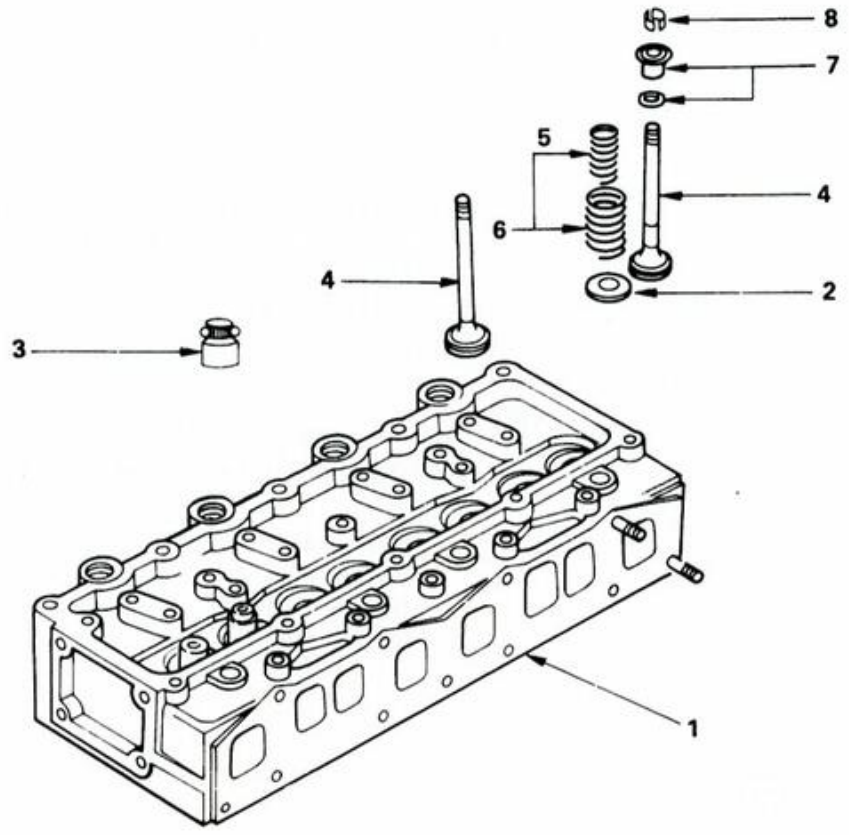
Rocker arm "A" : ①
Rocker arm "B" : ⑧
Rocker arm "C" : ③, ⑤, and ⑦
Rocker arm "D" : ②, ④, and ⑥




**▲ Rocker Arm Shaft Bracket**

Install the rocker arm shaft brackets with the "F" marked side turned to the front of the engine.

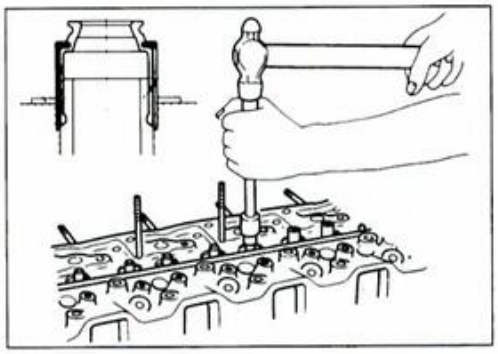
# CYLINDER HEAD REASSEAMBLY STEP




## Reassembly Steps

1.. Cylinder head
2. Valve spring lower seat
▲ 3. Valve guide oil seal
▲ 4. Intake and exhaust valve
▲ 5. Valve spring (Inner)
▲ 6. Valve spring (Outer)
7. Valve spring upper seat
▲ 8. Split collar

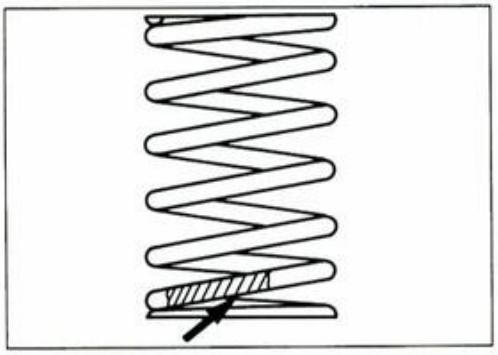
## Important Operations



**▲ Valve Guide Oil Seal**

1) Apply a coat of engine oil to the oil seal inner face.
2) Use an oil seal installer to install the oil seal to the valve guide.

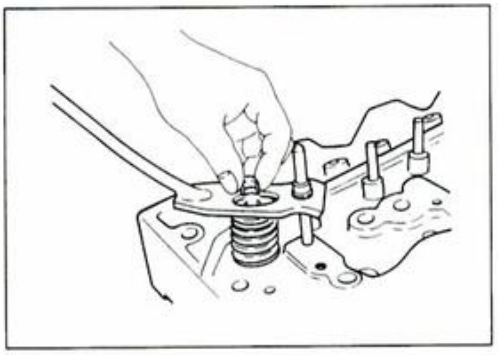
   Oil Seal Installer



**▲ Intake and Exhaust Valves**

1) Apply a coat of engine oil to each valve stem before installation.
2) Install the intake and exhaust valves.
3) Turn the cylinder head up to install the valve springs.

   Take care not to allow the installed valves to fall free.



**▲ Valve Spring (Inner)**

**▲ Valve Spring (Outer)**

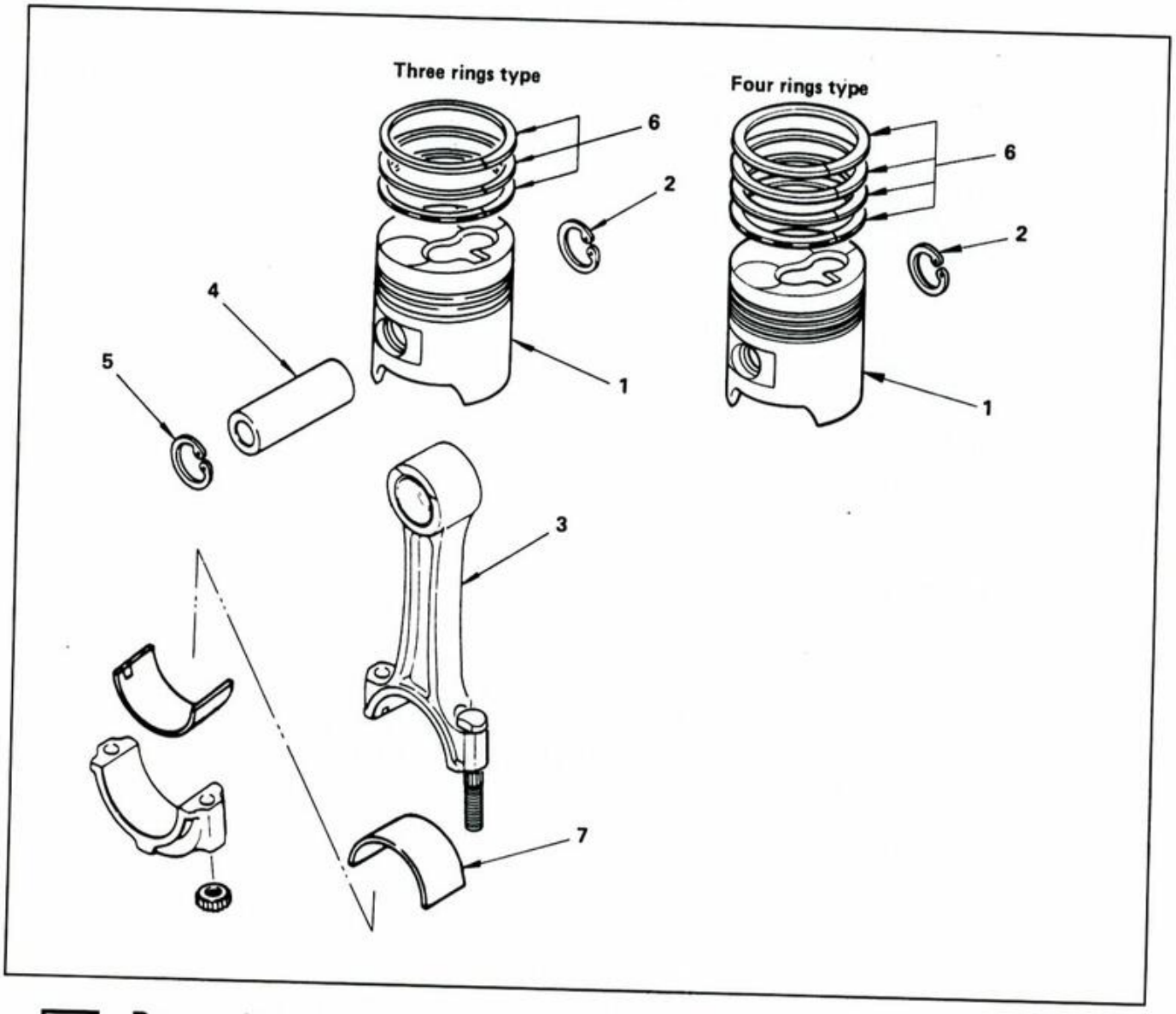
Install the inner and outer valve springs with their fine pitched end (painted) facing down.

**▲ Split Collar**

1) Use the spring compressor to push the valve spring into position.

   Spring Compressor : 9-8523-1423-0 (J-29760)
2) Install the split collar to the valve stem.
3) Set the split collar by tapping around the head of the collar with a rubber hammer.

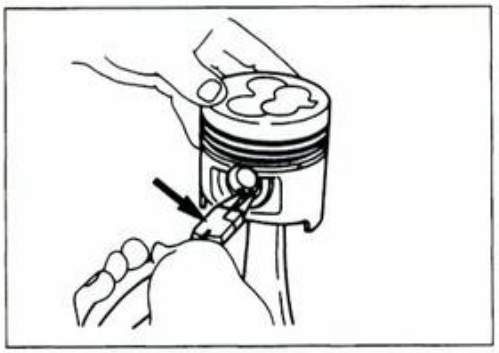
# PISTON AND CONNECTING ROD REASSEMBLY STEP




## Reassembly Steps

- ▲ 1. Piston
- ▲ 2. Piston pin snap ring
- ▲ 3. Connecting rod
- ▲ 4. Piston pin
- 5. Piston pin snap ring
- ▲ 6. Piston ring
- ▲ 7. Connecting rod bearing

## Important Operations

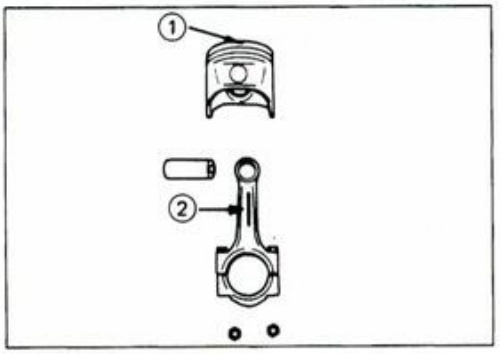


**▲ Piston**

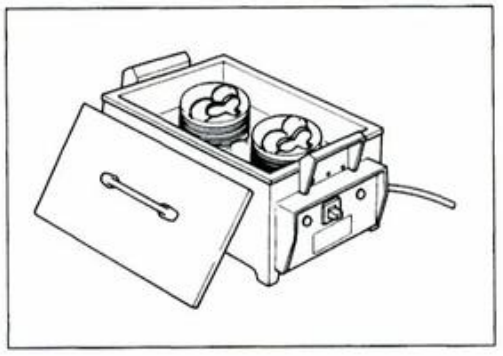
**▲ Piston Pin Snap Ring**

**▲ Connecting Rod**

1) Clamp the connecting rod in a vise.
   Take care not to damage the connecting rod.
2) Use a pair of snap ring pliers to install the piston pin snap ring to the piston.

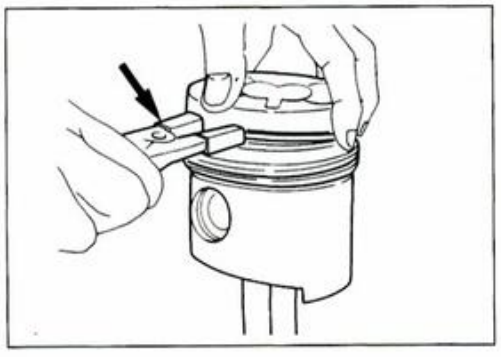



Install the piston to the connecting rod so that the piston head front mark ① and the connecting rod "ISUZU" forging mark ② are facing in the same direction.



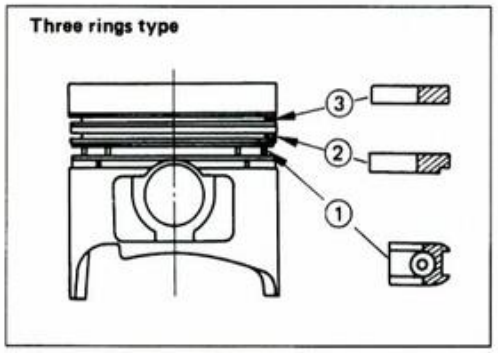
**▲ Piston Pin**

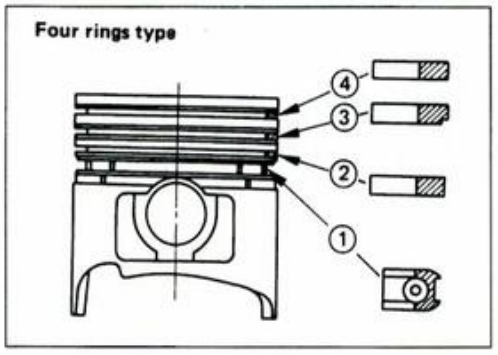
1) Use a piston heater to heat the piston to approximately 80°C (176°F).
2) Apply a coat of engine oil to the piston pin.
3) Use your fingers to force the piston pin into the piston until it makes contact with the snap ring.
4) Use a pair of snap ring pliers to install the other snap ring.
5) Check that the connecting rod moves smoothly on the piston pin.

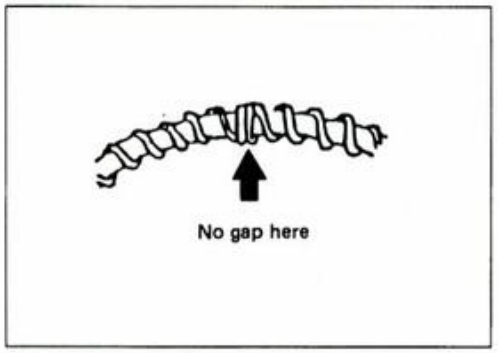


**▲ Piston Ring**

1) Use a piston ring replacer to install the piston rings.
   Piston Ring Replacer
   Install the piston rings in the order shown in the illustration.




**Piston Ring Configuration**

| Three Rings Type | Four Rings Type |
|---|---|
| ① Oil ring | ① Oil ring |
| ② 1st compression ring | ② 1st compression ring |
| ③ 2nd compression ring | ③ 2nd compression ring |
| ——— | ④ 3rd compression ring |

**Note:**

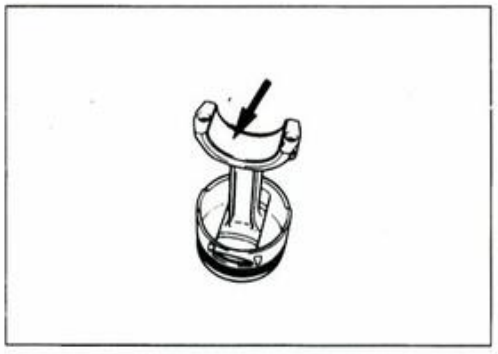
**Install the compression rings with the stamped side facing up.**

**Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.**

2) Apply engine oil to the piston ring surfaces.

3) Check that the piston rings slide smoothly in the piston ring grooves.

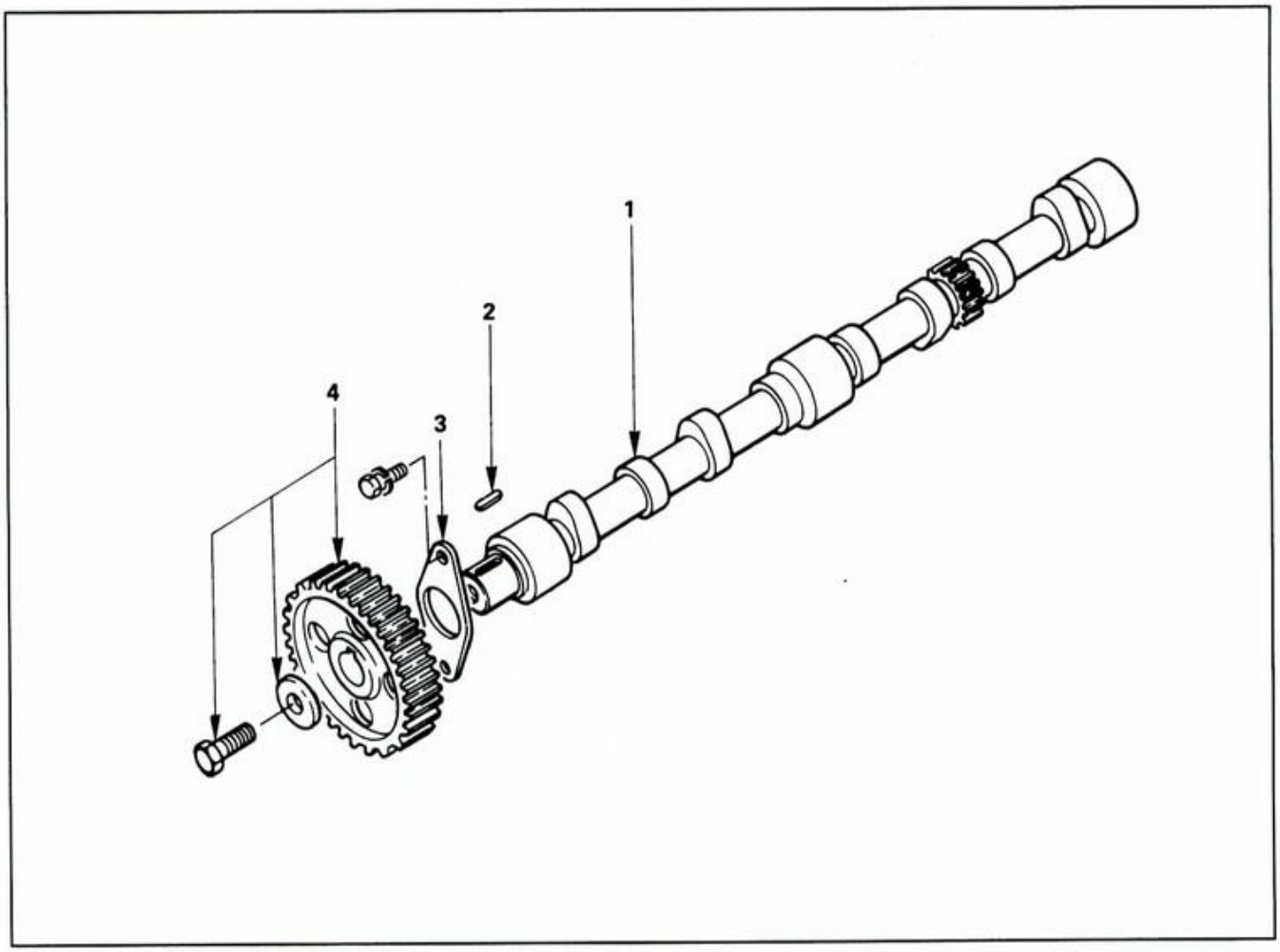
4) The oil ring coil expander connecting portion must not have gap.



**▲ Connecting Rod Bearing**

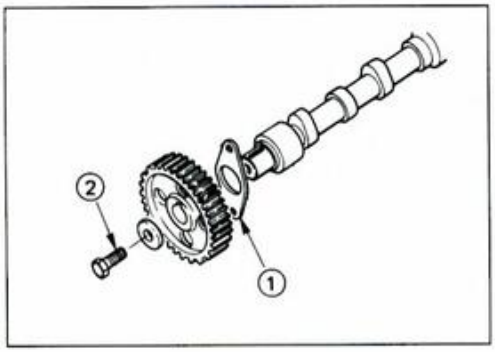
Carefully wipe any oil or other foreign material from the connecting rod bearing back face and the connecting rod bearing fitting surface.

# CAMSHAFT REASSEMBLY STEP




## Reassembly Steps

1. Camshaft
2. Feather key
3. Thrust plate
▲ 4. Camshaft timing gear




## Important Operations

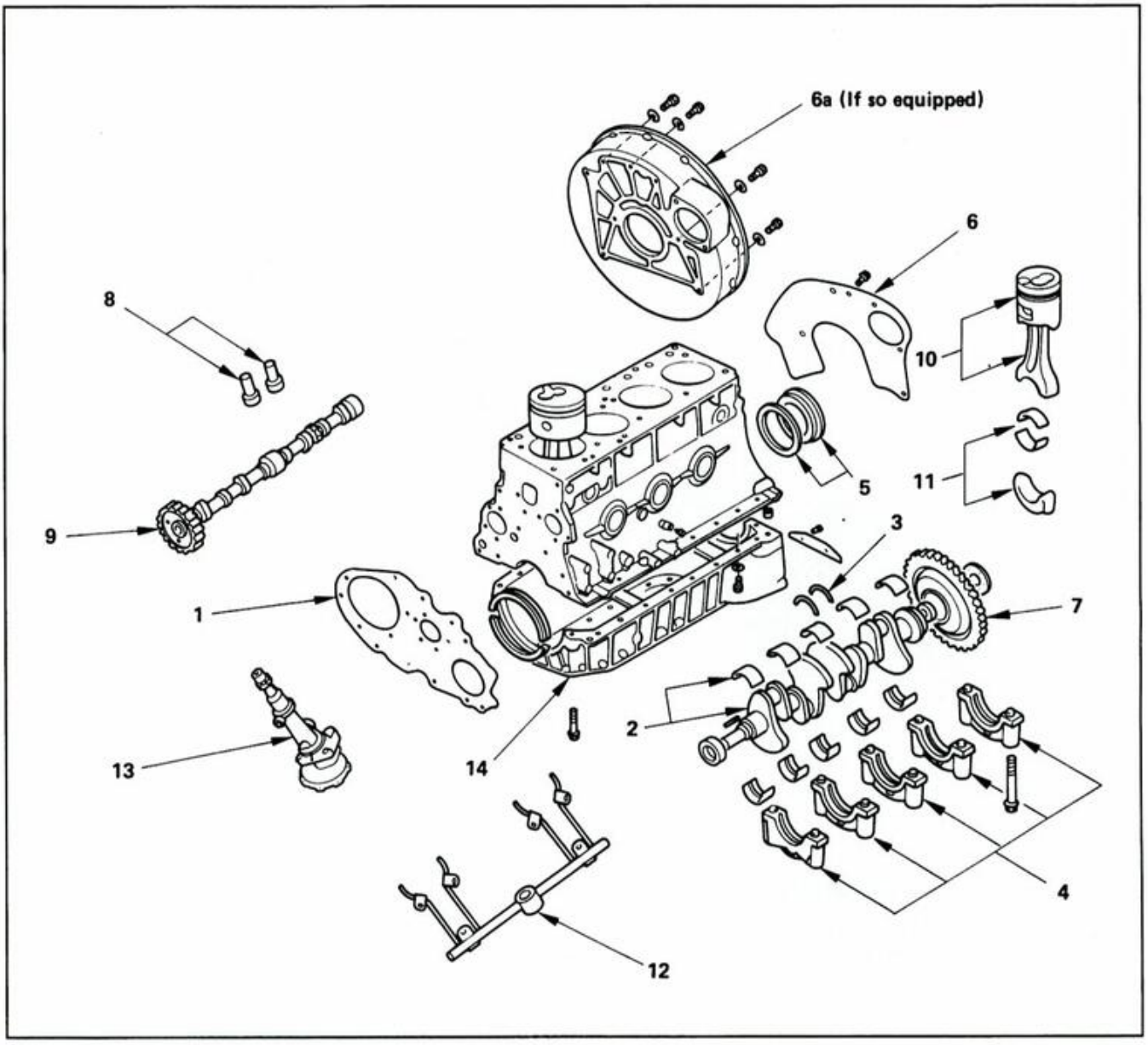
**▲ Camshaft Timing Gear**

1) Install the thrust plate ①.
2) Apply engine oil to the bolt threads ②.
3) Install the camshaft timing gear with the timing mark stamped side facing out.

Camshaft Timing Gear Bolt Torque kg·m (lb.ft/N·m)

| 10.0 – 12.0 (72.3 – 86.7/98.1 – 117.7) |
|---|

# REASSEMBLY 1ST STEP




## Reassembly Steps

- ▲ 1. Front plate
- ▲ 2. Crankshaft and bearing upper halves
- ▲ 3. Thrust bearing
- ▲ 4. Main bearing cap and bearing lower halves
- ▲ 5. Oil seal
- ▲ 6. Rear plate
- ▲ 6a Flywheel housing (If so equipped)
- ▲ 7. Flywheel
- ▲ 8. Tappet
- ▲ 9. Camshaft
- ▲ 10. Piston and connecting rod with bearing upper halves

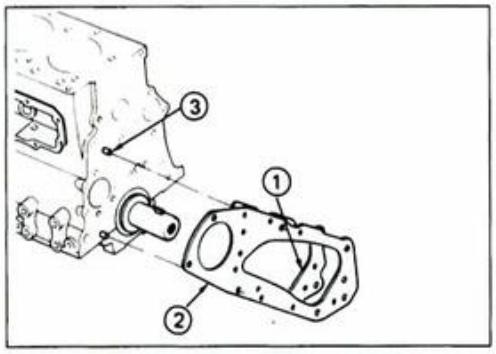
(Inverted engine)

- ▲ 11. Connecting rod bearing cap with bearing lower halves
- ▲ 12. Oiling jet
- ▲ 13. Oil pump
- ▲ 14. Crankcase

## Important Operations

**Note**

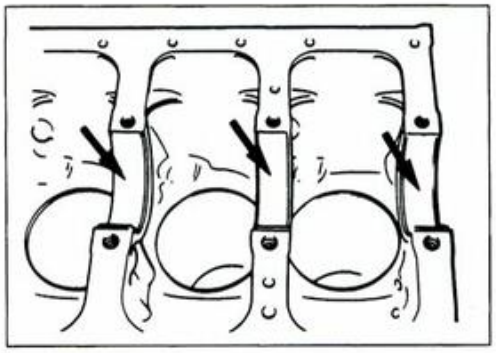
**Use compressed air to thoroughly clean the cylinder body interior and exterior, the oil holes and the water jackets before the reassembly.**




**▲ Front Plate**

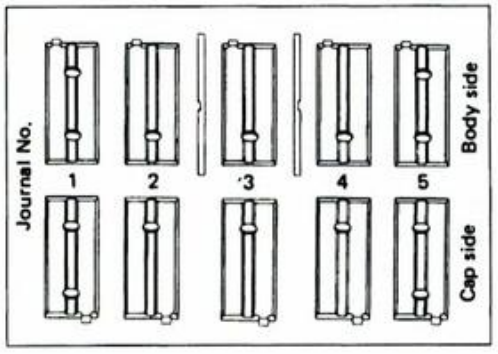
1) Install the front plate gasket ① to the cylinder body side.
2) Align the cylinder body front plate ② with the cylinder body straight pins ③.
3) Tighten the cylinder body front plate to the specified torque.

| Front Plate Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |

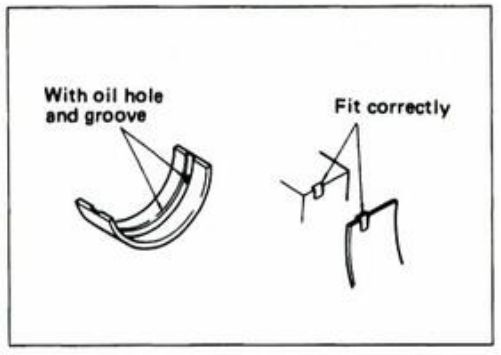


**▲ Crankshaft and Bearing Upper Halves**

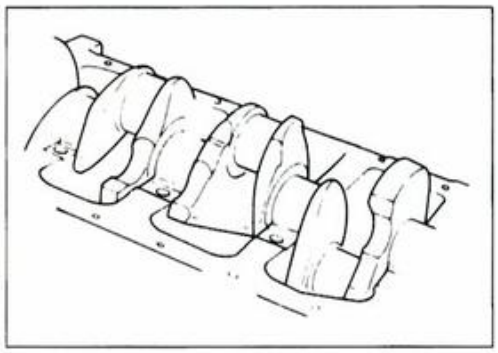
1) Carefully wipe any foreign material from the upper bearing.
2) Locate the position mark applied at disassembly if the removed upper bearings are to be reused.




The illustration shows correct bearing location at the cylinder body bearing fitting arches and the bearing caps.



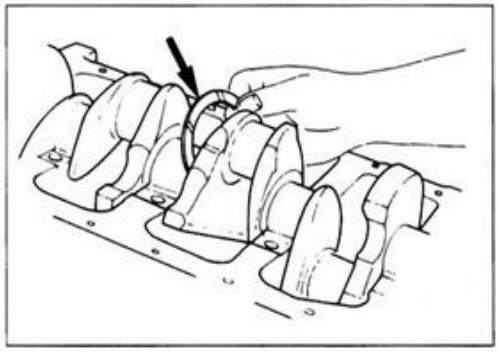

Fit the bearing tang firmly into the slot machined on the cylinder body bearing arches.



Apply an ample coat of engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft.

**Note:**

**Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surfaces.**

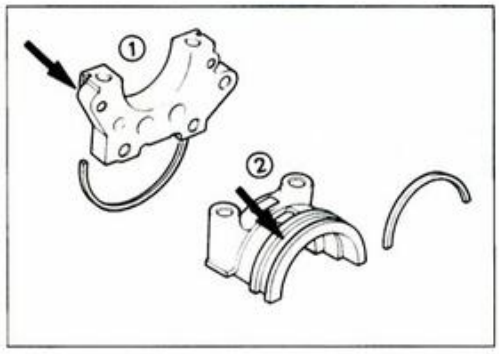


**▲ Thrust Bearing**

Apply an ample coat of engine oil to the thrust bearings before installation.

Install the thrust bearings to the crankshaft center journal.

The thrust bearing grooves must be facing the crankshaft web.



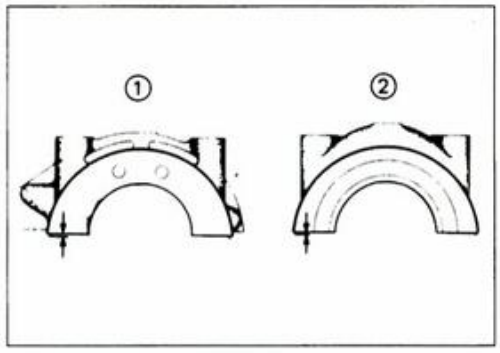

**▲ Main Bearing Cap and Lower Bearing Halves**

1) Install an arch gasket to both the No. 1 ① and the No. 5 ② crankshaft bearing caps.

   Apply liquid gasket to the inside surface of the arch gasket.

   Use your fingers to push the arch gasket into the bearing cap groove.

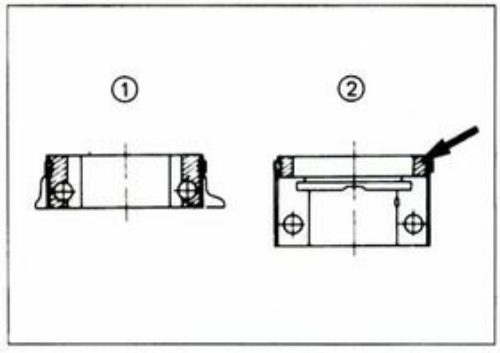
   Take care not to scratch the outer surface of the arch gasket.



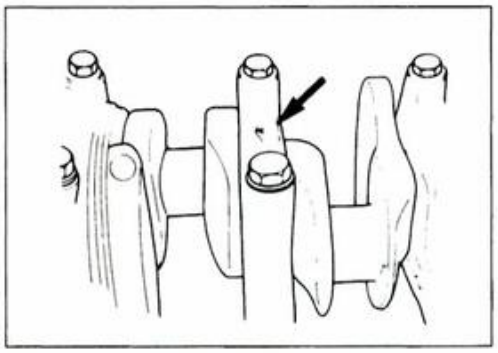

2) Check the arch gasket projection.

| Arch Gasket Projection | mm (in) |
|---|---|
| 0 – 0.005 (0 – 0.002) | |

Check that the arch gaskets are making firm contact with the cylinder body side.

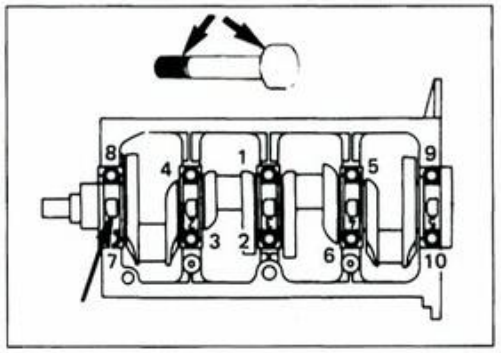



3) Apply a coat of silicon adhesive to the cylinder body fitting surfaces of the No. 1 ① and the No. 5 ② crankshaft bearing caps.



4) Install the bearing caps with the bearing cap head arrow mark facing forward.

The bearing cap with the stamped "A" mark on the bearing cap head must be installed to the No. 2 position.



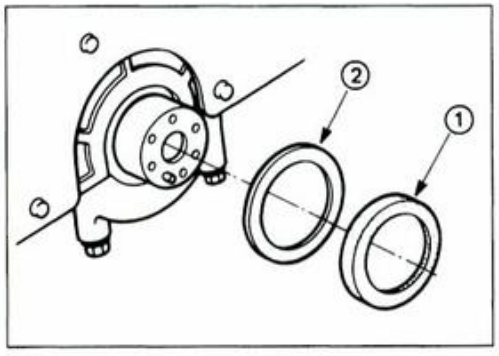

5) Apply a coat of engine oil to the bearing cap bolts.

6) Tighten the bearing cap bolts to the specified torque a little at a time in the sequence shown in the illustration.

Crankshaft Bearing Cap Bolt Torque kg·m (lb.ft/N·m)

| |
|---|
| 16.0 – 18.0 (117.0 – 128.4/156.9 – 176.5) |

7) Check to see that the crankshaft turns smoothly by rotating it manually.




**▲ Crankshaft Rear Oil Seal and Spacer**

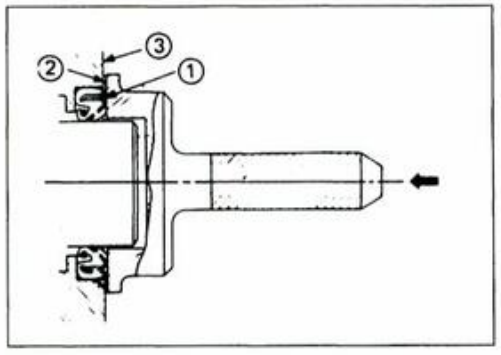
1) Apply engine oil to the oil seal lip circumference and the oil seal outer circumference.

2) Apply silicon adhesive to the oil seal ① outer circumference.

3) Set the spacer ② to the oil seal.

If the oil seal surface at the crankshaft rear end has been excessively grooved due to wear, remove the spacer.

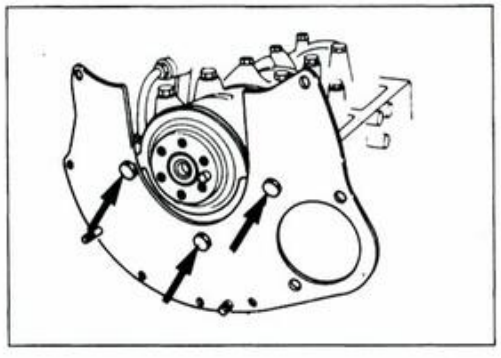
This will renew the oil seal surface at place.




4) Use the oil seal installer to install the oil seal to the cylinder body ③.

There must be no gap between the spacer and the oil seal.

Oil Seal Installer: 9-8522-1279-0 (J-22928)



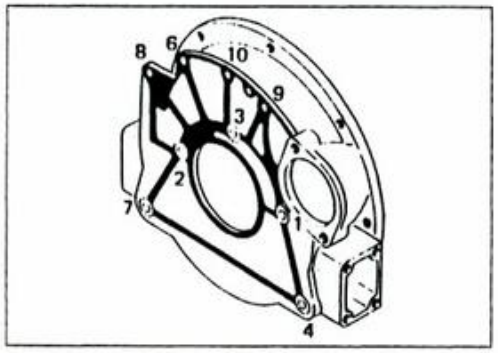
**▲ Rear Plate**

1) Align the rear plate with the cylinder body knock pins.

2) Tighten the rear plate bolt to the specified torque.

Rear Plate Bolt Torque kg·m (lb.ft/N·m)

| | |
|---|---|
| 12ϕ | 7.6 – 9.2 (60.2 – 61.2/77.6 – 90.2) |
| 10ϕ | 3.5 – 4.7 (25.3 – 33.9/34.3 – 46.1) |

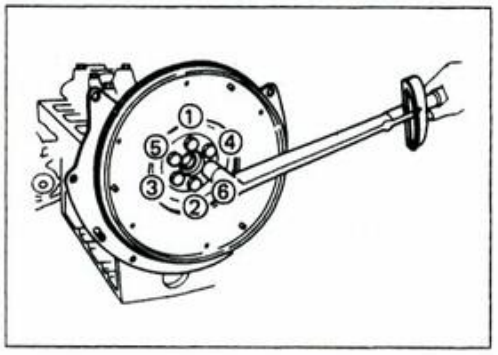



**▲ Flywheel Housing (If so equipped)**

1) Apply liquid gasket to the shaded area shown in the illustration.
2) Tighten the flywheel housing bolts to the specified torque a little at a time in the sequence shown in the illustration.

Flywheel Housing Bolt Torque kg·m (lb.ft/N·m)

| | |
|---|---|
| 12φ | 7.6 – 9.2 (60.2 – 61.2/77.6 – 90.2) |
| 10φ | 3.5 – 4.7 (25.3 – 33.9/34.3 – 46.1) |

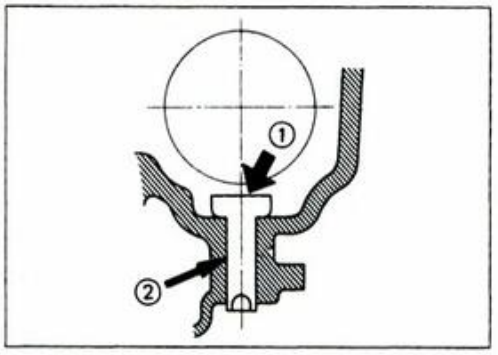



**▲ Flywheel**

1) Apply a coat of engine oil to the threads of the flywheel bolts.
2) Align the flywheel with the crankshaft dowel pin.
3) Tighten the flywheel bolts in the numerical order shown in the illustration.

Flywheel Bolt Torque kg·m (lb.ft/N·m)

| |
|---|
| 11.0 – 13.0 (79.5 – 93.9/107.9 – 127.5) |

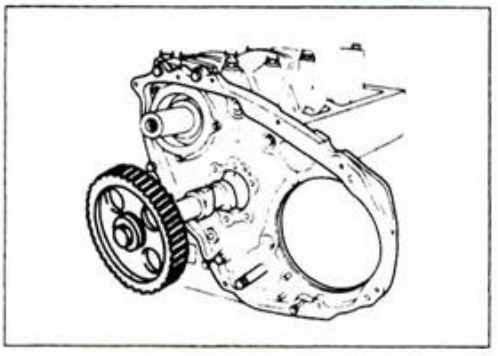



**▲ Tappet**

1) Apply a coat of engine oil to the tappet ① and the cylinder body tappet travelling bore ②.
2) Locate the position mark applied at disassembly (if the tappet is to be reused).

**Note:**

**The tappet must be installed before the camshaft installation.**



**▲ Camshaft**

1) Apply a coat of engine oil to the camshaft and the camshaft bearings.
2) Install the camshaft to the cylinder body.

   Take care not to damage the camshaft bearings.
3) Tighten the thrust plate bolt to the specified torque.

Thrust Plate Bolt Torque kg·m (lb.ft/N·m)

| |
|---|
| 1.8 – 2.2 (13.0 – 15.8/17.7 – 21.5) |

4) Check to see that the camshaft turns smoothly by rotating it manually.

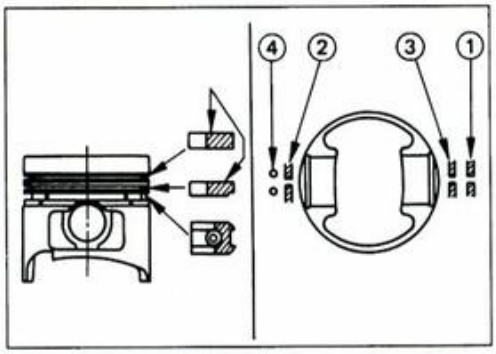
▲ **Piston and Connecting Rod with Bearing Upper Halves**

▲ **Connecting Rod Bearing Cap with Bearing Lower Halves**

1) Apply a coat of engine oil to the circumference of each piston ring and piston.
2) Position the piston ring gaps as shown in the illustration respectively.

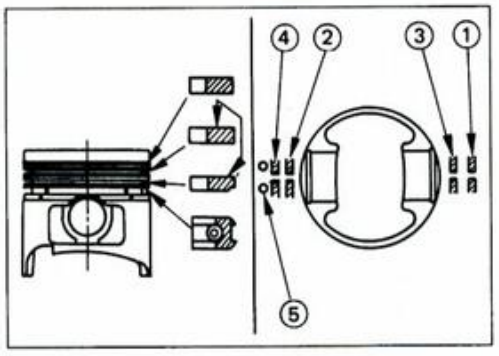
**Note:**

**The piston ring gaps must not be placed at the lateral pressure side of the piston, but place them at the piston pin end side having no lateral pressure application.**



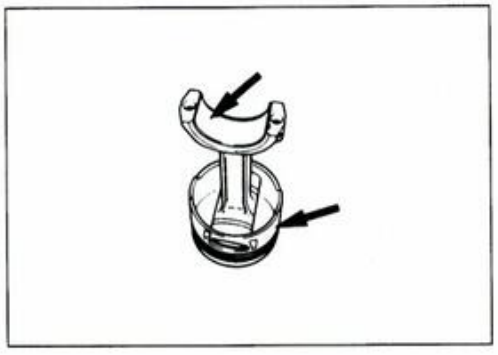

**For Three Rings Type Piston**

① 1st Compression Ring's Ring Gap
② 2nd Compression Ring's Ring Gap
③ Oil Ring's Ring Gap
④ Coil Expander Jointing End




**For Four Rings Type Piston**

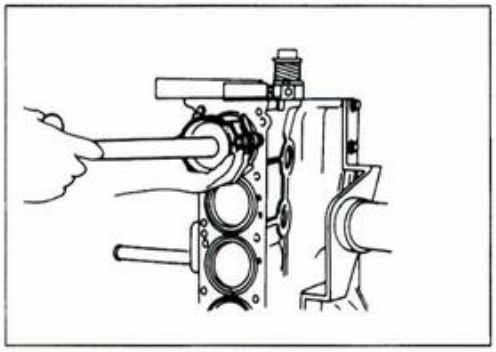
① 1st Compression Ring's Ring Gap
② 2nd Compression Ring's Ring Gap
③ 3rd Compression Ring's Ring Gap
④ Oil Ring's Ring Gap
⑤ Coil Expander Jointing End



3) Apply a coat of molybdenum disulfide grease to the two piston skirts.

   This will facilitate smooth break-in when the engine is first started after reassembly.

4) Apply a coat of engine oil to the upper bearing surfaces.
5) Apply a coat of engine oil to the cylinder bore.

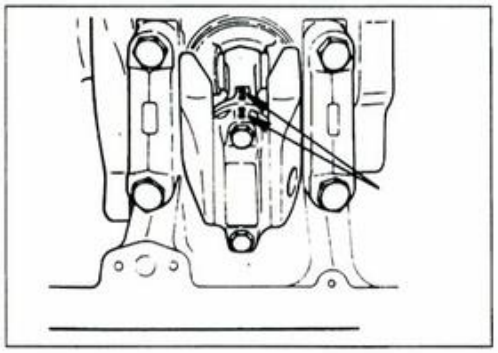


6) Position the piston head front mark so that it is facing the front of engine.
7) Use a piston ring compressor to compress the piston rings.

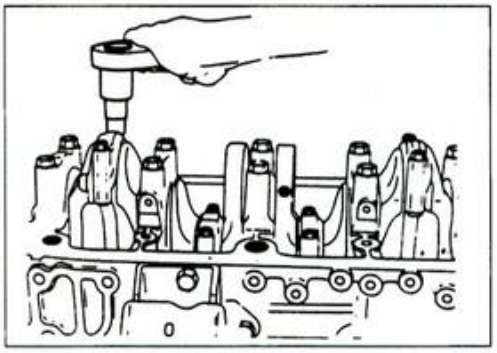
   Piston Ring Compressor: 5-8840-9018-0

8) Use a hammer grip to push the piston in until the connecting rod makes contact with the crankpin.

   At the same time, rotate the crankshaft until the crankpin is at BDC.



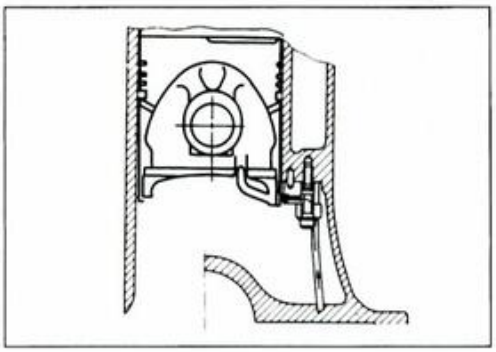
9) Align the bearing cap cylinder number marks and the connecting rod cylinder number marks.



10) Apply a coat of engine oil to the threads and setting faces of each connecting rod cap bolt.
11) Tighten the connecting rod caps to the specified torque.

Connecting Rod Bearing Cap Bolt

| Torque | kg·m (lb.ft/N·m) |
|---|---|
| | 8.0 – 9.0 (57.8 – 65.0/78.4 – 88.2) |



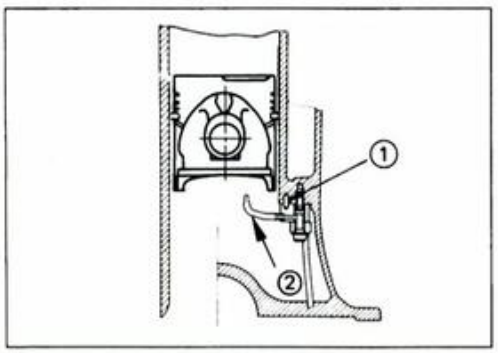
**▲ Oiling Jet**

The oiling jet injects oil into the piston cooling channel when the piston is at BDC. This provides maximum cooling efficiency.

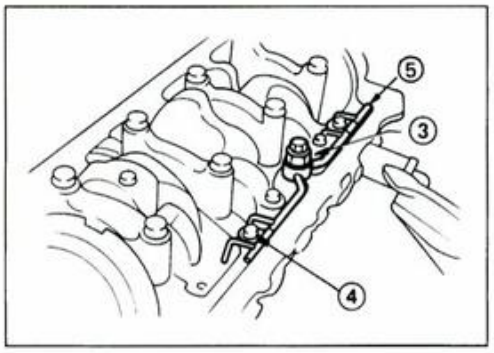
The oiling jet must be carefully installed in the specified position to prevent its being damaged by the piston.

The oiling jet uses thin steel tubing which is easily bent. Accidental contact between the oiling jet and the cylinder body, piston, or a tool will damage the oiling jet.

Never attempt to repair a damaged oiling jet. Replace it with a new one.



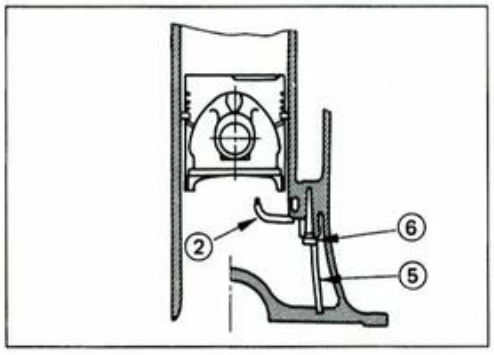

1) Move the piston to TDC.
2) Align the oiling jet knock pin hole with the cylinder body knock pin ①.
3) Install the oiling jet ②.




4) Use the relief valve ③ and the bolt ④ to temporarily tighten the oiling jet pipe ⑤.

5) Move the piston to BDC.

Check that the oiling jet tips are properly facing the piston back cavity.




6) Use the inner hexagon wrench to tighten the four joint bolts ⑥ fixing the oiling jet ② and the oiling jet pipe ⑤ to the specified torque.

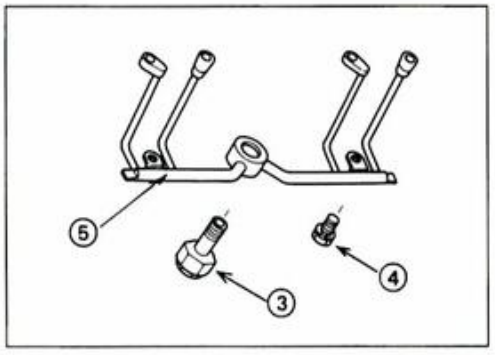
5mm (0.197 in) Inner Hexagon Wrench

| Joint Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 0.6 – 1.0 (4.4 – 7.2/6.0 – 9.6) | |

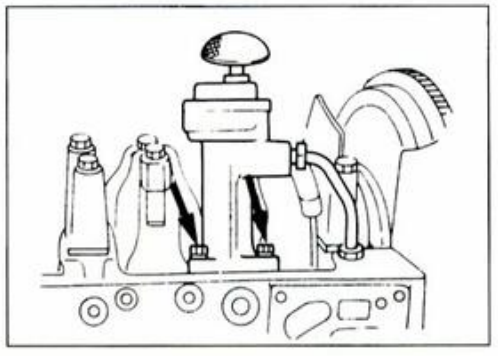
7) Tighten the oiling jet pipe relief valve and the oiling jet pipe bolt to the specified torque.

| Relief Valve Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (18.1 – 25.3/24.5 – 34.3) | |

| Oiling Jet Pipe Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |



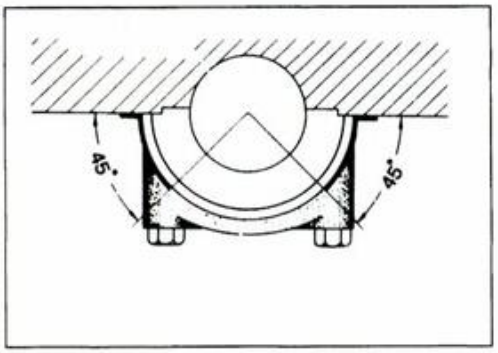

8) Check that there is no interference between the piston and the oiling jet pipe by slowly rotating the crankshaft.

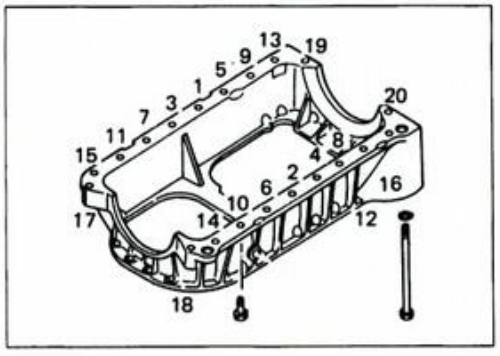


**▲ Oil Pump**

Install the oil pump and tighten it to the specified torque.

| Oil Pump Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |



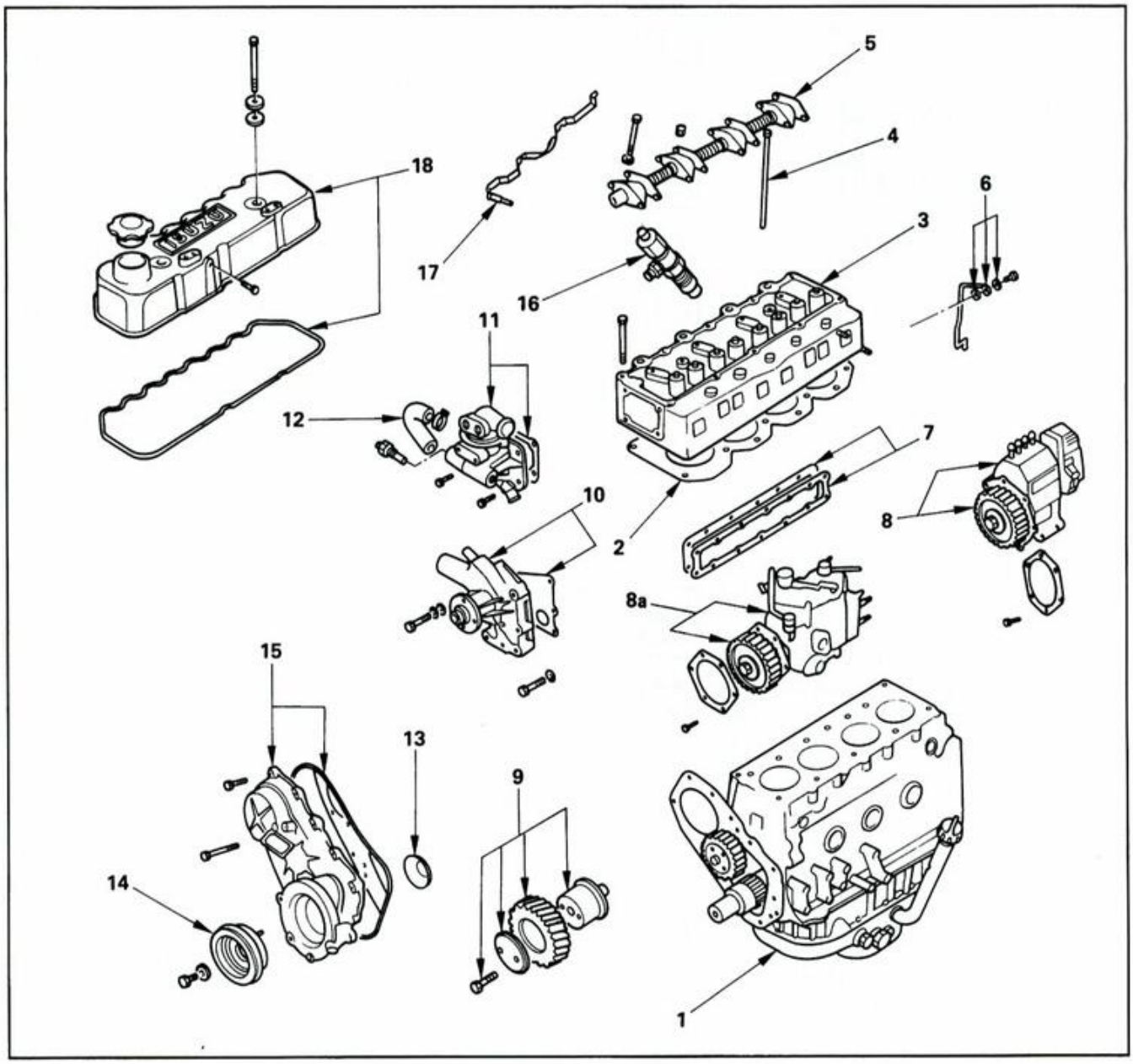




**▲ Crankcase**

1) Apply a coat of liquid gasket to the cylinder body flange surface and the No. 1 and No. 5 bearing cap arch gaskets at positions shown in the illustration.
2) Install the crankcase with aligning the knock pin and the knock pin hole of the cylinder body.
3) Tighten the crankcase bolt to the specified torque a little at a time in numerical order.

| Crankcase Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |

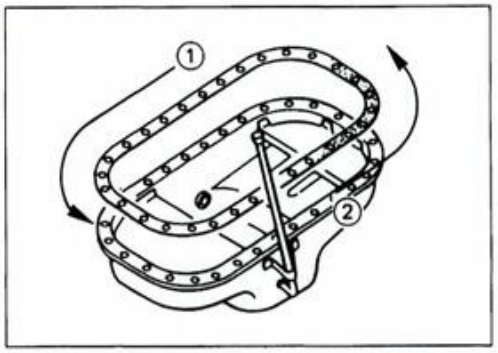
# REASSEMBLY 2ND STEP




## Reassembly Steps

- ▲ 1. Oil pan
- ▲ 2. Cylinder head gasket
- ▲ 3. Cylinder head
- ▲ 4. Push rod
- ▲ 5. Rocker arm shaft bracket and rocker arm
- ▲ 6. Valve rocker oil feed pipe
- ▲ 7. Tappet chamber cover
- ▲ 8. Injection pump (In-line type)
- ▲ 8a Injection pump (Distributor type) with bracket
- ▲ 9. Idler gear
- ▲10. Water pump
- ▲11. Thermostat housing
- ▲12. Water by-path pipe
- ▲13. Crankshaft oil thrower
- ▲14. Crankshaft pulley
- ▲15. Timing gear case
- ▲16. Injection nozzle
- ▲17. Glow plug
- ▲18. Cylinder head cover

## Important Operations

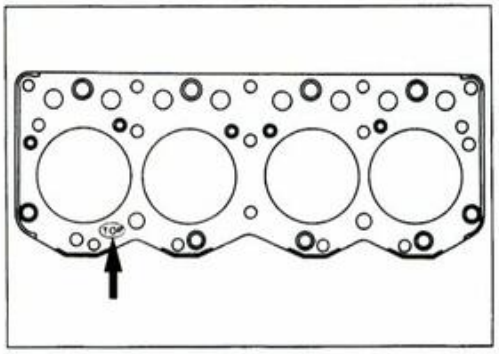



### ▲ Oil Pan

1) Wipe the crankcase oil pan mounting flange surfaces and oil pan flange surfaces before the liquid gasket coating.
2) Apply a coat of liquid gasket on the crankcase flange evenly.
3) Affix the oil pan gasket and install the oil pan.
4) Tighten the oil pan bolts to the specified torque starting from ① and ② alternately, as shown in the illustration and, work out toward the arrow directions.

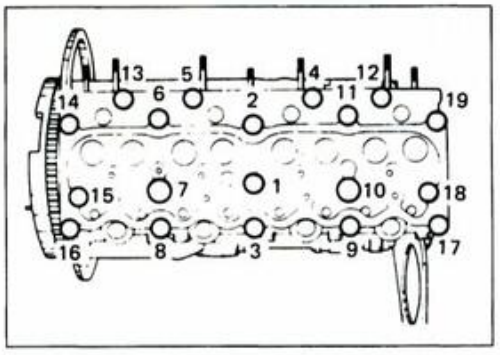
Oil Pan Bolt Torque — kg·m (lb.ft/N·m)

| 0.6 – 1.0 (4.4 – 7.2/6.0 – 9.6) |
|---|



### ▲ Cylinder Head Gasket

The cylinder gasket "TOP" mark must be facing up.



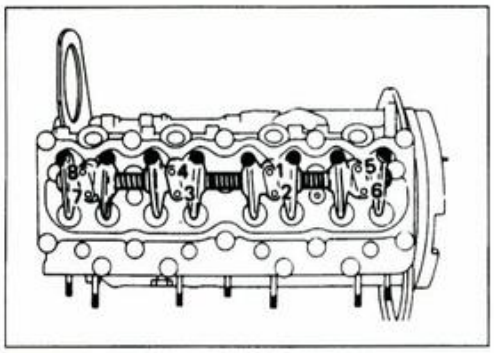

### ▲ Cylinder Head

1) Align the cylinder body dowels and the cylinder head dowel holes.

   Carefully place the cylinder head on the cylinder head gasket.
2) Lubricate the bolt head setting faces and threads with a coat of engine oil.
3) Tighten the cylinder head bolts to the specified torque in two steps and in the numerical orders as illustrated.

Cylinder Head Torque — kg·m (lb.ft/N·m)

| | 1st Step | 2nd Step |
|---|---|---|
| New Bolt | 6.0 – 7.0 (45.4–50.6/55.8–68.6) | 7.5 – 8.5 (52.1–83.5/64.6–86.2) |
| Used Bolt | 6.0 – 7.0 (45.4–50.6/55.8–68.6) | 8.5 – 9.5 (58.5–71.5/79.4–97.0) |




**▲ Rocker Arm Shaft Bracket and Rocker Arm**

Tighten the rocker arm shaft bracket bolts in the numerical order shown in the illustration.

Rocker Arm Shaft Bracket Bolt Torque kg·m (lb.ft/N·m)

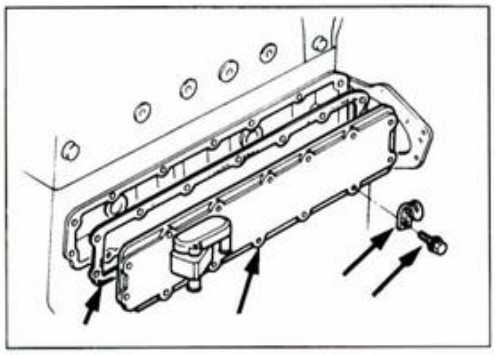
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) |
|---|

**▲ Valve Rocker Oil Feed Pipe**

Install the oil pipe and tighten the pipe eye bolt to the specified torque.

Valve Rocker Oil Pipe Eye Bolt Torque kg·m (lb.ft/N·m)

| 0.8 – 1.2 (5.8 – 8.6/7.8 – 11.8) |
|---|

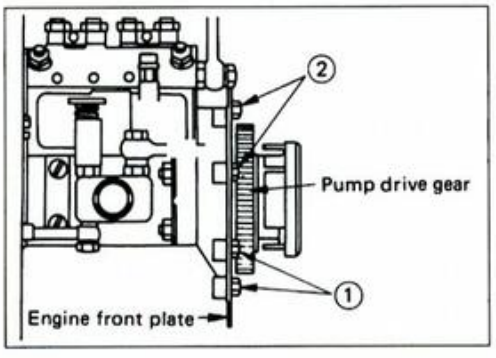


**▲ Tappet Chamber Cover**

1) Affix the tappet chamber cover gasket to the cylinder body and install the cover.
2) Tighten the bolts to the specified torque with working up from central bolts to the both end alternately and evenly.

Tappet Chamber Cover Bolt Torque kg·m (lb.ft/N·m)

| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) |
|---|

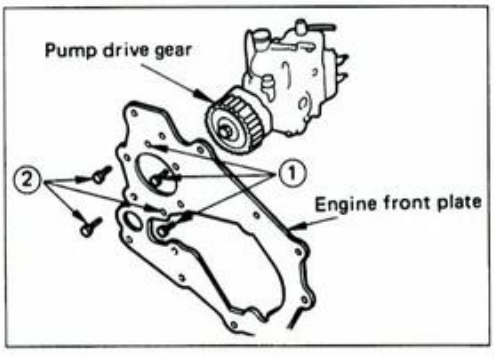



**▲ Injection Pump (In-line type)**

Install the injection pump to the engine front plate with aligning the gear setting mark "Z" with the camshaft gear setting mark "Z–Z" and, tighten the bolts ① and ② to the specified torque.

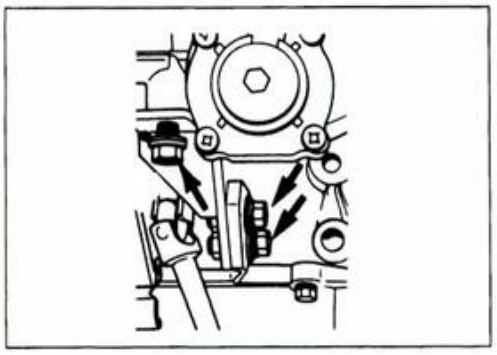
Injection Pump Fixing Bolt Torque kg·m (lb.ft/N·m)

| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) |
|---|



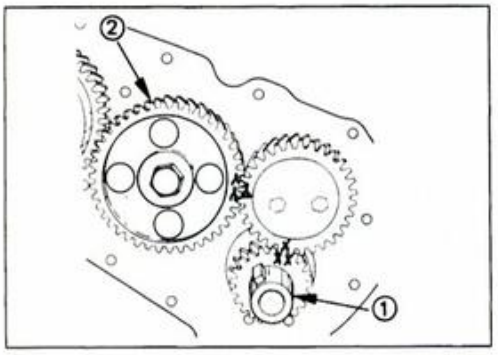

**▲ Injection Pump (Distributor type) with Bracket**

1) The installation procedure for the distributor type injection pump is identical with the procedure of the in-line type injection pump.
2) Install the injection pump bracket and tighten the bracket bolt to the specified torque evenly.



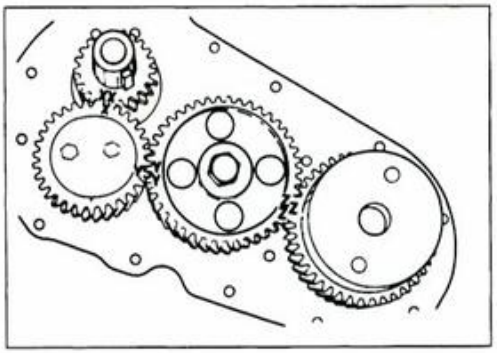
Injection Pump Bracket Bolt Torque
(Distributor Type Only) kg·m (lb.ft/N·m)

| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) |
|---|




**▲ Idler Gear**

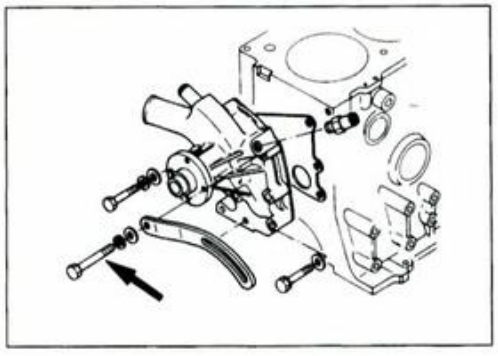
1) Apply engine oil to the idler gear and the idler gear shaft bearing.
2) Position the idler gear setting marks "X" and "Y" so that they are facing the front of the engine.
3) Align the idler gear "X" setting mark with the crank shaft timing gear ① "X–X" setting mark.



4) Align the idler gear "Y" setting mark with the camshaft timing gear ② "Y–Y" setting mark.
5) Tighten the idler gear bolt.

Idler Gear Bolt Torque kg·m (lb.ft/N·m)

| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) |
|---|



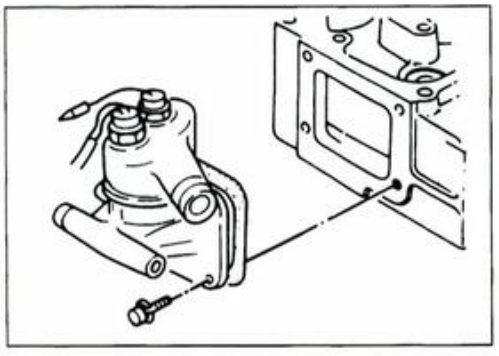
**▲ Water Pump**

1) Temporarily tighten the water pump bolt marked with an arrow in the illustration.

   This bolt will be tightened to the specified torque when the alternator adjusting plate is installed.
2) Tighten the other water pump bolts to the specified torque.

Water Pump Bolt Torque kg·m (lb.ft/N·m)

| 3.5 – 4.7 (25.3 – 33.9/34.3 – 46.1) |
|---|

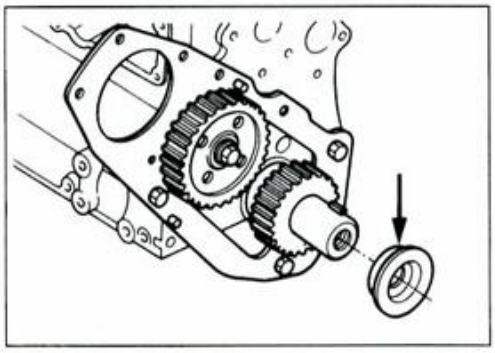


**▲ Thermostat Housing**

1) Install the thermostat housing.
2) Tighten the thermostat housing bolts to the specified torque.

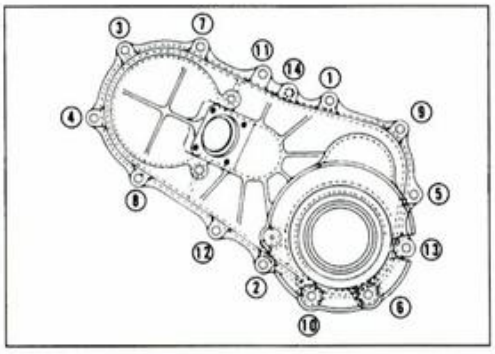
Thermostat Housing Bolt Torque kg·m (lb.ft/N·m)

| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) |
|---|



**▲ Crankshaft Oil Thrower**

Install the crankshaft oil thrower flange so that it is facing outward.



**▲ Timing Gear Case**

1) Check that the timing gear case gasket is firmly inserted into the gear case groove.
2) Tighten the timing gear case bolts to the specified torque in the order shown in the illustration.

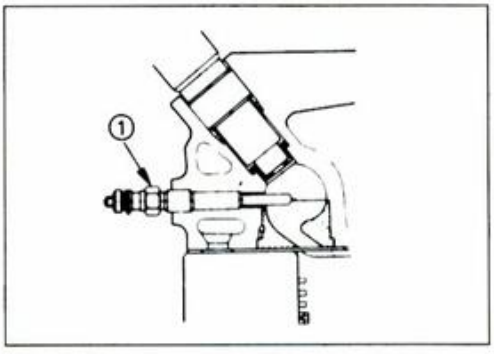
| Timing Gear Case Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |

**▲ Crankshaft Pulley**

Tighten the crankshaft pulley to the specified torque.

| Crankshaft Pulley Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 17.0 – 21.0 (122.8 – 151.6/166.7 – 205.9) | |

Take care not to damage the oil seal lip when the pulley is installed.



**▲ Glow Plug**

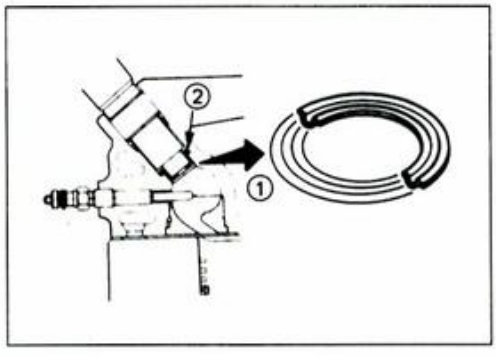
1) Tighten the glow plugs ① to the specified torque.

| Glow Plug Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |

**Note:**

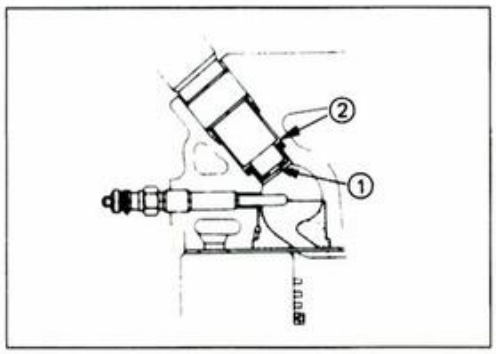
**Always replace the four glow plugs as a set. Never replace just one glow plug.**

2) Install and tighten the connector ②.

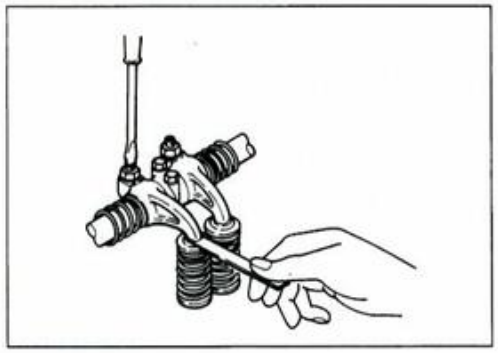


**▲ Injection Nozzle Holder**

1) Install the new corrugated washer ① with the groove facing up.



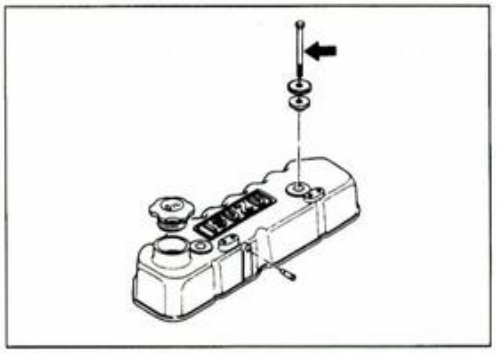

2) Install the new injection nozzle holder washer ②.
3) Install the nozzle holder and temporarily tighten it.
   Final tightening will be performed after installation of the injection pipe.



**Note on Valve Clearance Adjustment**

Valve clearances must be adjusted before the cylinder head cover reinstalled.

Refer to "Valve Clearance Adjustment" in the "Servicing" Section of this Manual.



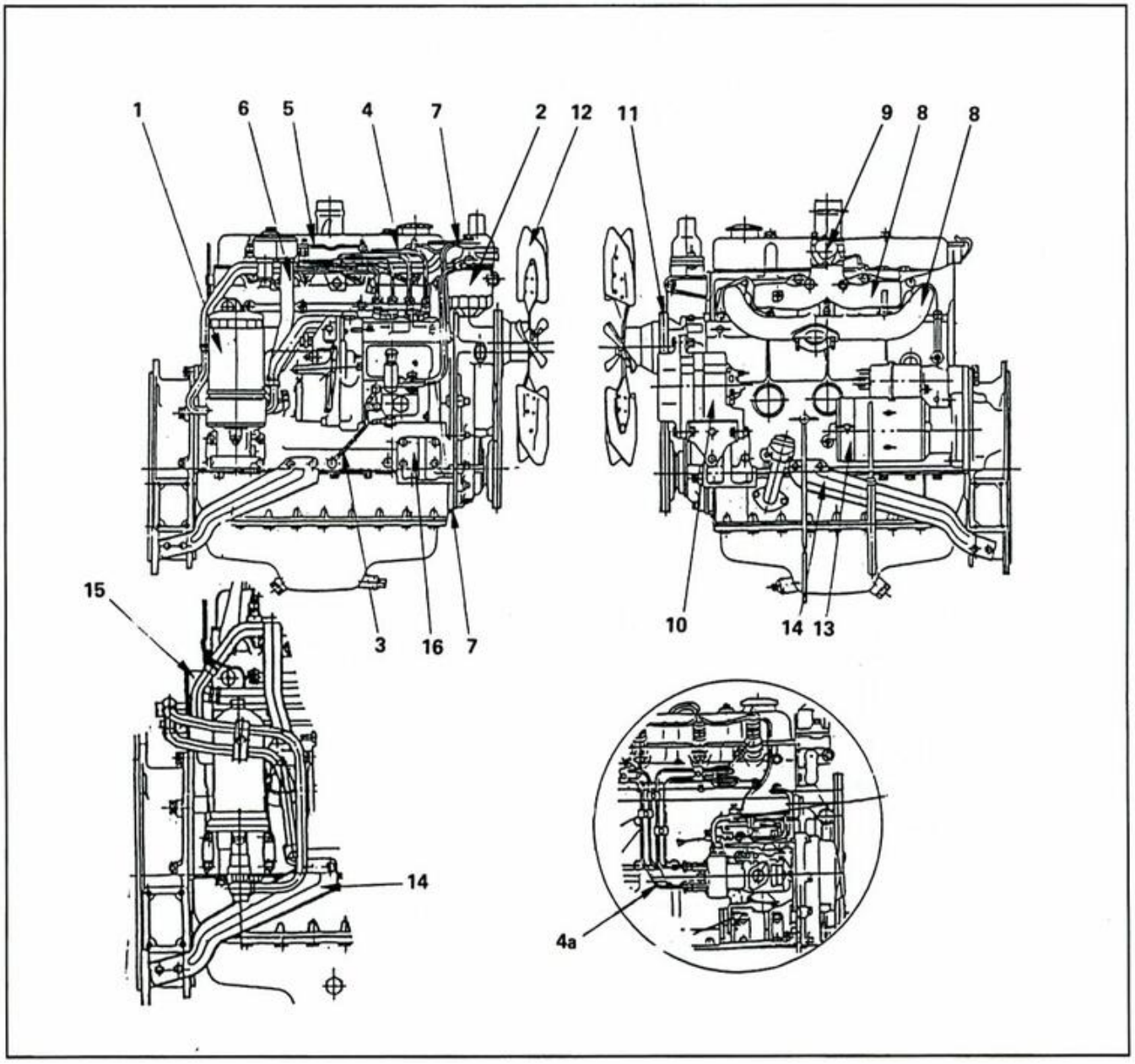
**▲ Cylinder Head Cover**

1) Apply engine oil to the rocker arm and the valve spring.
2) Install the cylinder head cover gasket to the head cover.
   Check to see that the head cover gasket has no loose areas.
3) Tighten the cylinder head cover bolts to the specified torque.

Cylinder Head Cover Bolt Torque kg·m (lb.ft/N·m)

| 0.8 – 1.8 (5.8 – 13.0/7.8 – 17.6) |
|---|

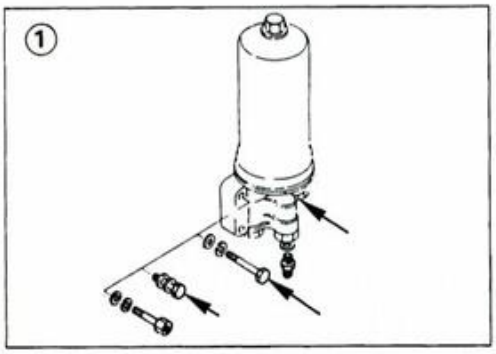
## REASSEMBLY 3RD STEP




### Reassembly Steps

- ▲ 1. Oil filter
- 2. Fuel filter
- 3. Injection pump oil pipe
- ▲ 4. Injection pipe (In-line type)
- ▲ 4a Injection pipe (Distributor type)
- ▲ 5. Leak off pipe
- ▲ 6. Air breather hose
- ▲ 7. Fuel pipe
- ▲ 8. Inlet and exhaust manifold
- ▲ 9. Engine control (If so equipped)
- ▲ 10. Generator
- ▲ 11. Fan pulley and fan belt
- 12. Cooling fan
- ▲ 13. Starter
- 14. Stiffener (If so equipped)
- ▲ 15. Oil cooler (If so equipped and removed in disassembly)
- ▲ 16. Engine foot

## Important Operations



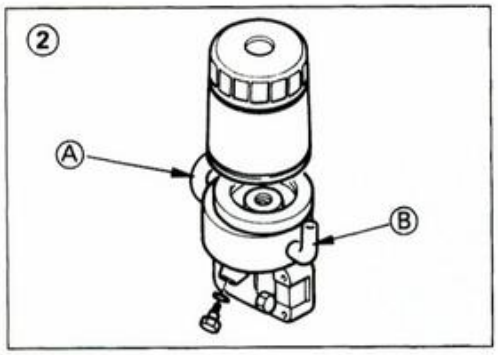

**▲ Oil Filter**

Install the oil filter and tighten the fixing bolts to the specified torque.

| Oil Filter Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |

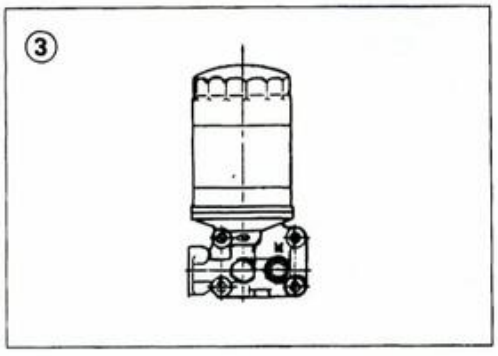
This specified oil filter mounting bolt torque is identical on the three types of oil filter used in this engine.

① Replaceable Element Type
② Disposable cartridge Spin-on Type with Built-in Oil Cooler
③ Disposable Cartridge Spin-on Type

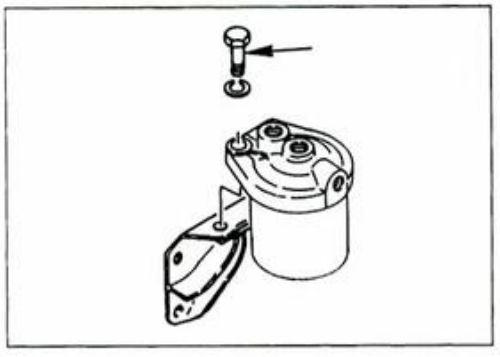



**Coolant Hose for Filter ② (With Built-in Oil Cooler)**

After the oil filter installation, install the coolant hose to the respective connecting pipe Ⓐ and Ⓑ.

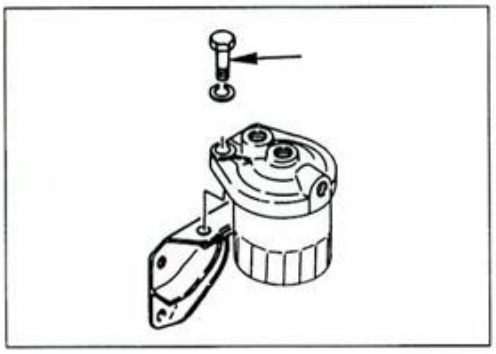



Refer to page 16 of MAINTENANCE for information.



**▲ Fuel Filter (Replaceable Element Type)**

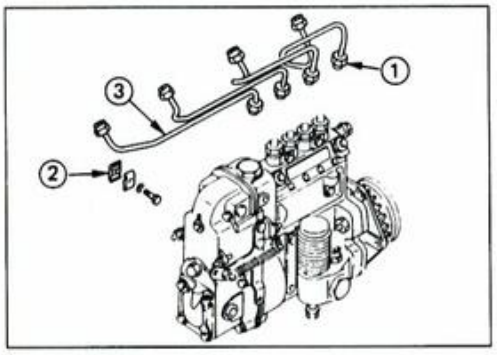
1) Install the fuel filter to the fuel filter bracket.
2) Temporarily tighten the fuel filter bracket bolts.
   This will facilitate fuel pipe installation.
3) Tighten the fuel filter bracket bolts after the fuel pipes have been installed to the fuel filter.



**▲ Fuel Filter (Disposable Cartridge Spin-on Type)**

Depending on the engine application, a disposable cartridge type fuel filter is used.

The installation procedure for this type of fuel filter is identical with the same of the replaceable element type fuel filter.




**▲ Injection Pipe (In-Line Type)**

**▲ Injection Pipe (Distributor Type)**

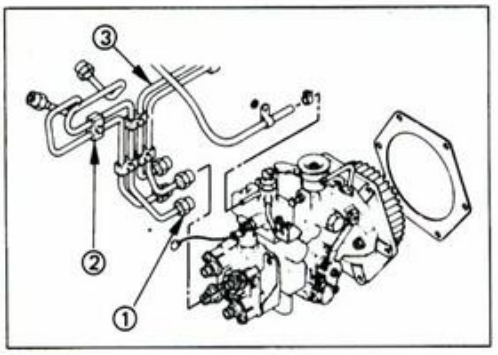
1) Install the fuel injection pipes ③ and tighten the sleeve nuts ① to the specified torque.

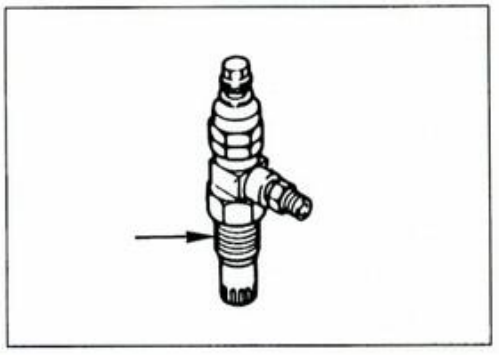
   The sleeve nut tightening torque for in-line type injection pump and the distributor type pump is identical.

   Tighten them a little at a time evenly so that no undue stress is applied on the pipe line.

| Injection Pipe Sleeve Nut Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (23.1 – 30.3/24.5 – 34.3) | |

2) Carefully position and set the clips ②.



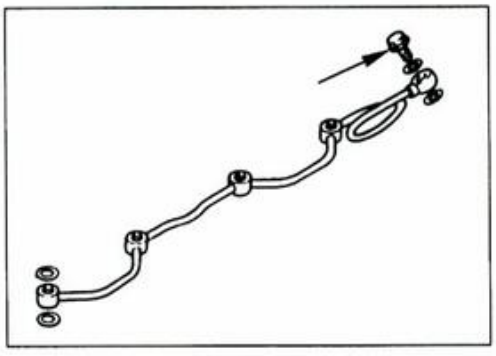



**Note:**

**An improperly positioned clip will result in objectionable fuel pulsing noise and injection pipe breakage.**

3) Tighten the injection nozzle holders, which are in temporarily tightened condition in Reassembly 2nd Step, to the specified torque.

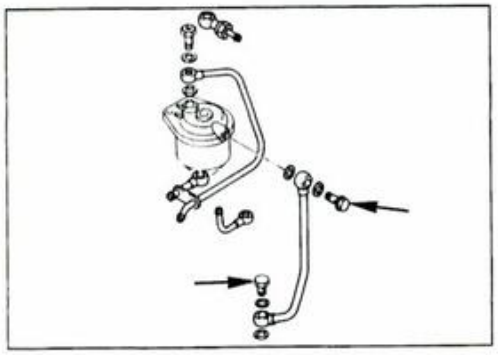
| Injection Nozzle Holder Tightening Torque | kg·m (lb.ft/N·m) |
|---|---|
| 7.0 – 8.0 (50.6 – 57.8/68.6 – 78.4) | |



**▲ Leak Off Pipe**

Install the leak off pipe and tighten the eye bolts to the specified torque.

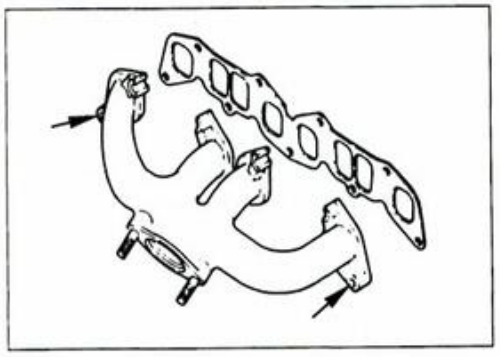
| Leak Off Pipe Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.0 – 2.0 (7.2 – 14.4/9.8 – 19.6) | |



**▲ Fuel Pipe**

Install the fuel pipes shown in the illustration with tightening the joint bolts to the specified torque.

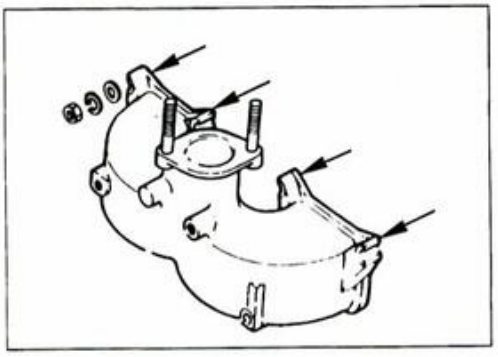
| Fuel Pipe Joint Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.0 – 2.0 (7.2 – 14.4/9.8 – 19.6) | |



**▲ Inlet and Exhaust Manifold**

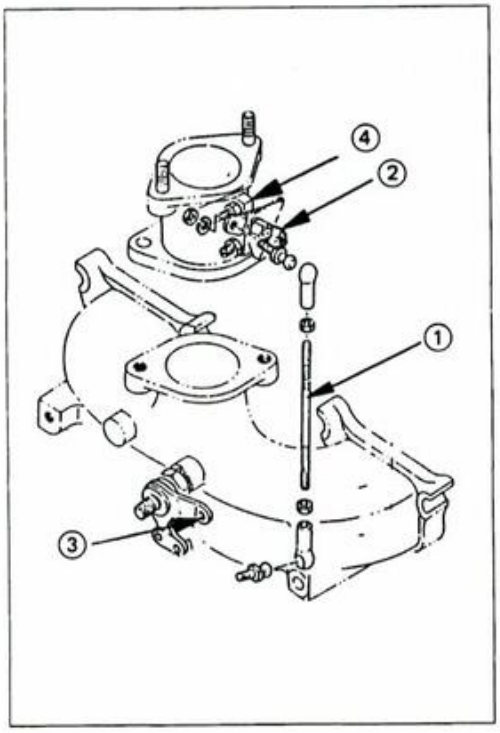
1) Install the inlet and exhaust manifold gasket.
2) Install the exhaust manifold first with temporarily tightening the mounting nuts at positions shown by arrows in the illustration.

   The nuts at remaining positions will be tightened together with the inlet manifold.



3) Install the inlet manifold with temporarily tightening the mounting nuts at positions shown by arrows in the illustration.
4) Tighten all of the mounting nuts to the specified torque.

| Inlet and Exhaust Manifold Mounting Nut Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.4 – 2.4 (10.1 – 17.3/13.7 – 23.5) | |




**▲ Engine Control Link (If so equipped)**

For the engine equipped with RBD type injection pump governor, a throttle valve and control link is used at the inlet manifold as an engine control.

1) Install the link rod ① to the throttle valve ② and the fulcrum lever ③ but keep the adjusting bolt ④ in fully loosened condition.

   In this procedure, adjust the link rod length so that the throttle valve to close completely.
2) Adjust the engine idle speed adjusting bolt ④ to permit the engine run in the specified idling speed.

**▲ Fan Pulley and Fan Belt**

Adjust the fan belt tension referring MAINTENANCE page 23.

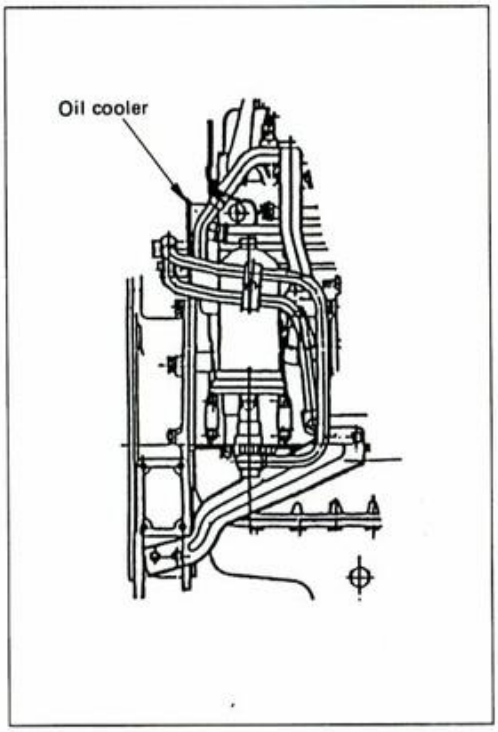
**▲ Generator**

**▲ Starter**

Install the generator and the starter with tightening the fixing bolts to the specified torque.

| Generator Fixing Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.3 – 2.3 (9.7 – 15.7/12.3 – 22.1) | |

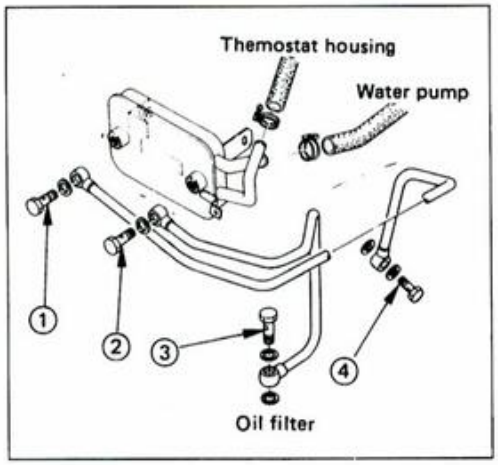
| Starter Fixing bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 6.3 – 9.3 (45.0 – 67.0/61.3 – 90.7) | |




**▲ Oil Cooler (If so equipped and removed in disassembly)**

Depending on an engine application, an externally mounted oil cooler is used.

Connect the oil cooler water hoses and the oil pipe lines to the outlet or inlet of the related parts respectively.




**Note:**

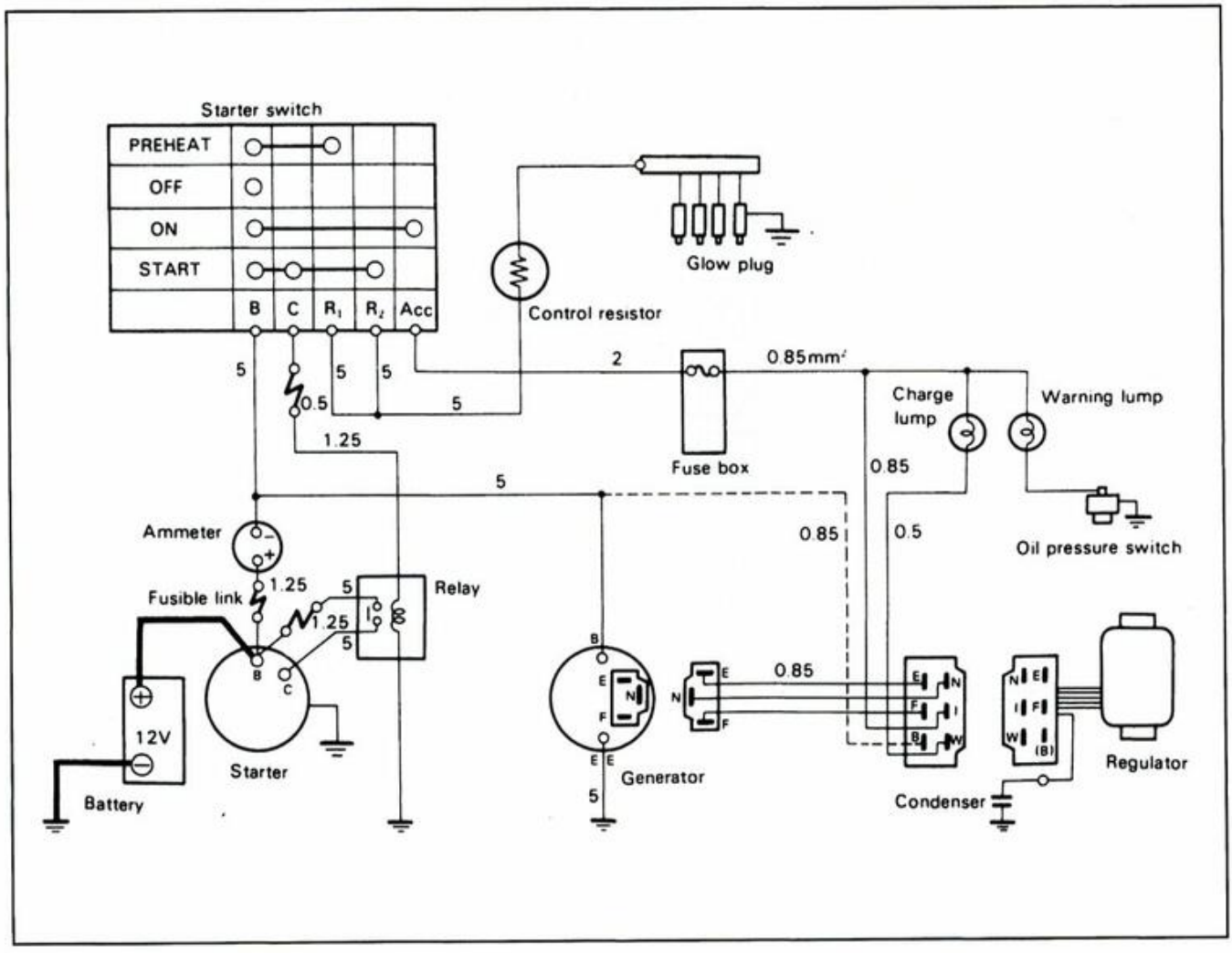
**The tightening torques for the oil pipe joint bolts ①, ②, ③, ④ are not particularly specified. Therefore, tighten them carefully with an adequate torque so that the bolts does not be twisted off in a tightening but no oil leakages take place.**

## ENGINE TUNING OPERATION

After reassembly, the engine must be turned. This will ensure that the engine operates at its maximum efficiency.

1. Mount the engine on a test bench.
2. Fill the engine with the specified oil.
3. Connect the cooling pipes pipes and the fuel pipes.

Reference




4. Connect the electrical wiring.
   Refer to the wiring diagram.
5. Connect the air intake line to the air cleaner.
6. Connect the exhaust pipe.
7. Manually operate the fuel feed pump to feed fuel to the engine.
8. Bleed the fuel lines of air.
   Refer to Page 21 of Section 2 MAINTENANCE for the air bleeding procedure.

9. Crank the engine with the starter (non-ignition operation) for about twenty seconds.

   This will prelubricate the engine internal components.

10. Start the engine and allow it to run at 750 to 800 rpm for five minutes.

11. Remove the cylinder head cover while the engine is running.

12. Check that the engine oil is continuously circulating from the oil pump to the valve rockers through the cylinder head.

    If there is no oil circulation or if the oil circulation is sluggish, stop the engine and make the appropriate repairs or adjustments.

    Reinstall the cylinder head cover.

13. Increase the engine speed to 1,500 rpm to do the engine warming-up operation.

14. Check the engine for oil, fuel, coolant, and air intake leakage.

15. Check for abnormal noise and odor.

16. Check for abnormal electrical charging.

17. Check the engine fastening parts for looseness.

18. When the engine coolant temperature reached to 75°C (167°F) or more, increase the engine speed to 2,000 rpm and allow it to run for twenty minutes.

    This will give the engine the essential run-in operating time.

19. Adjust the engine operation speed to the specified value.

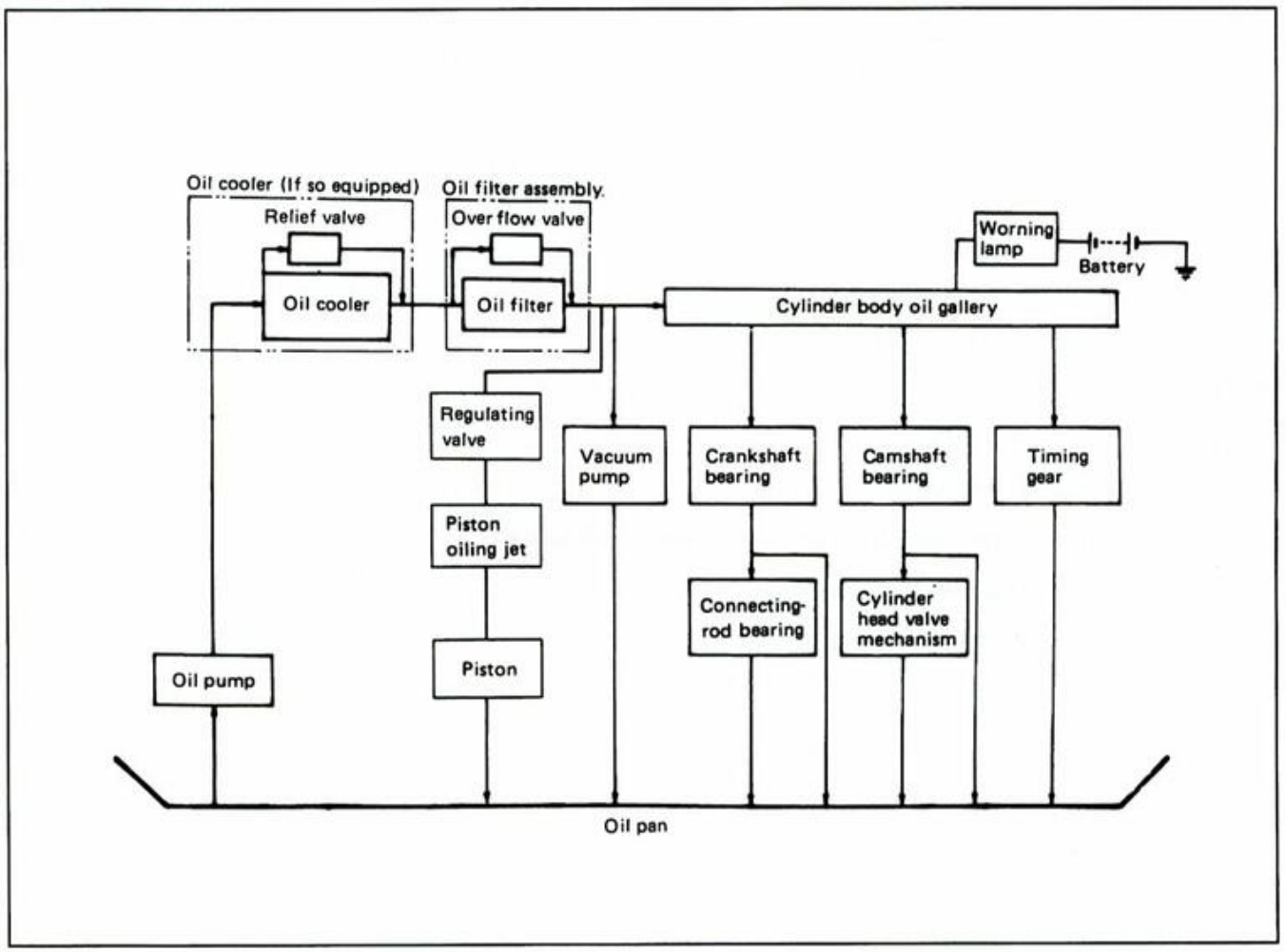
20. Stop the engine to complete the tuning procedure.

## SECTION 6

# LUBRICATING SYSTEM

### TABLE OF CONTENTS

# GENERAL DESCRIPTION




The C240 engine lubricating system consists mainly of a full flow type oil filter and trochoid type oil pump. Lubricating oil is pumped from the oil pump to the cylinder body oil gallery.
It is then branched off to the vital parts of the engine from the oil gallery.

Depending on the engine application, the following oil filter is used.

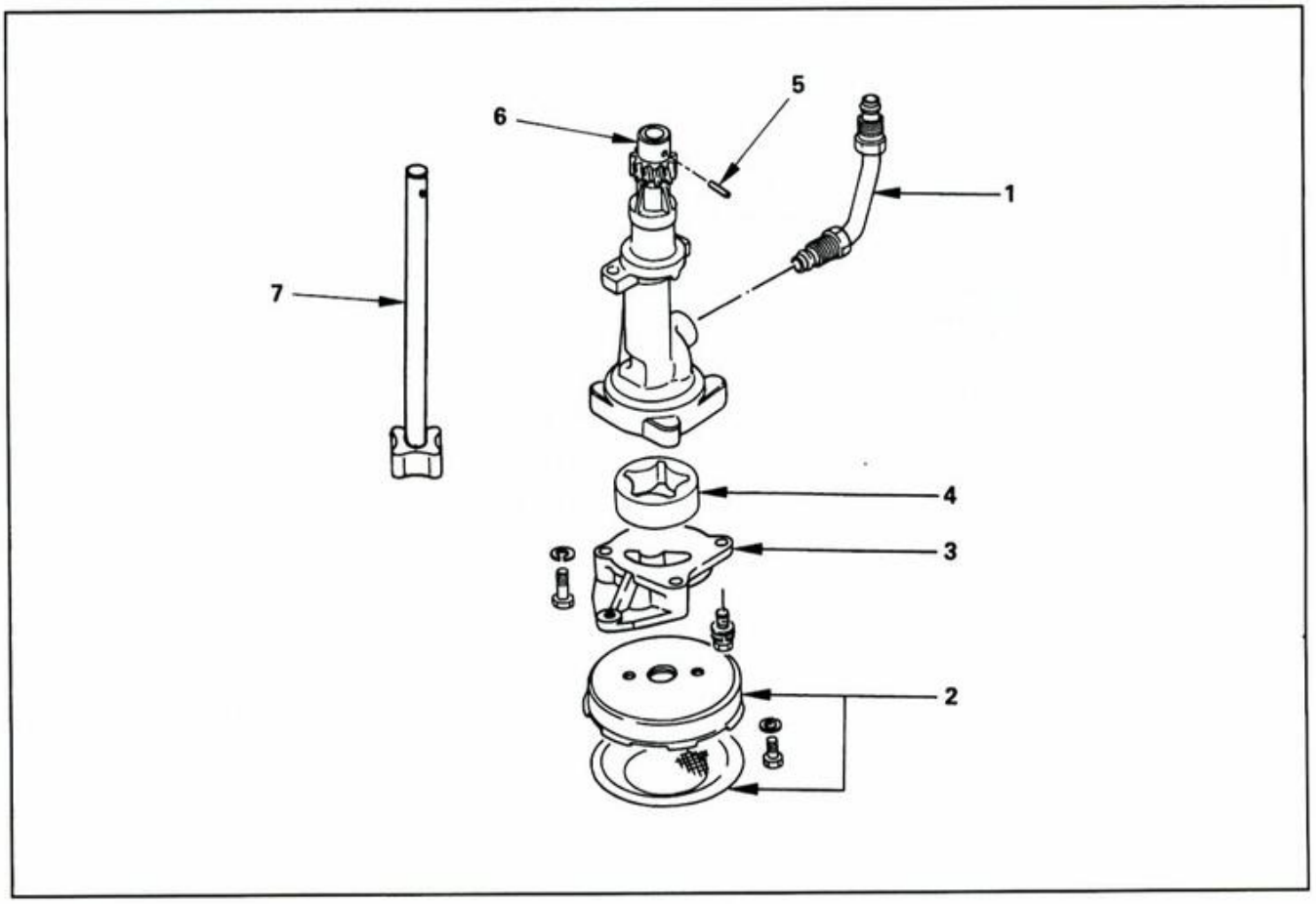
1. Replaceable element type.
2. Disposable cartridge spin-on type with built-in oil cooler.
3. Disposable cartridge spin-on type.

Also depending on the engine application, an externally mounted oil cooler is used.

# OIL PUMP

## DISASSEMBLY

### Rotor type

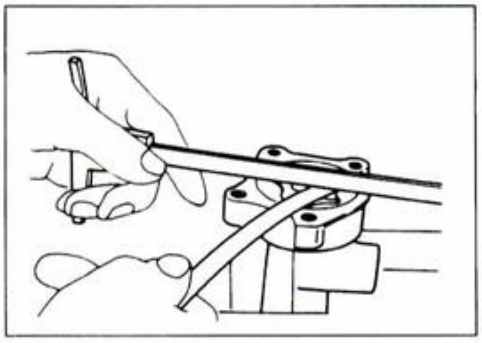



**Disassembly Steps**

1. Oil pipe
2. Strainer
3. Pump cover
4. Vane
5. Pin
6. Pinion
7. Rotor shaft

## INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



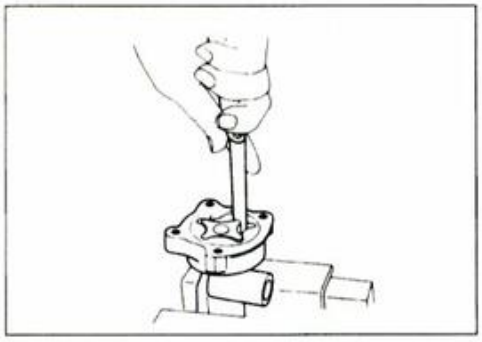
### Vane, Rotor, and Cover Clearance

Use a feeler gauge to measure the clearance between the vane, the rotor, and the cover.

If the clearance between the vane, the rotor, and the cover exceeds the specified limit, the rotor set (pin shaft, rotor, and vane) must be replaced.

Vane, Rotor, and Cover Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.02 – 0.07<br>(0.0008 – 0.0028) | 0.15 (0.0059) |



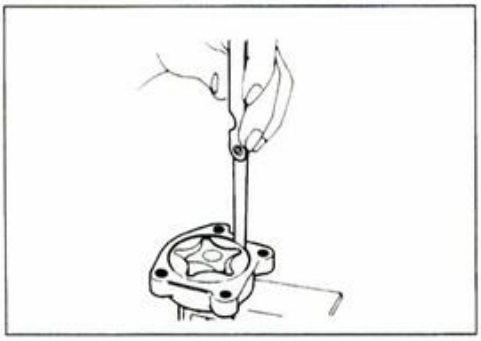
### Rotor and Vane Clearance

Use a feeler gauge to measure the clearance between the rotor and the valve.

If the clearance between the rotor and the vane exceeds the specified limit, the rotor set (pin, shaft, rotor, and vane) must be replaced.

Rotor and Vane Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.14 (0.0055) or less | 0.20 (0.0079) |



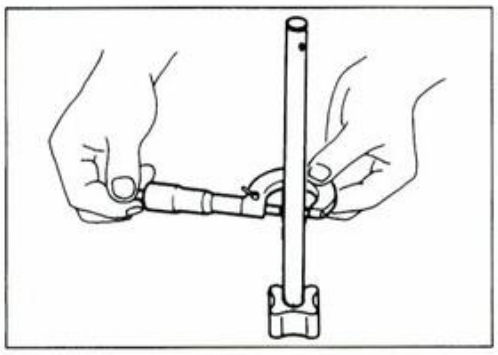
### Vane and Pump Body Clearance

Use a feeler gauge to measure the clearance between the vane and the pump body.

If the clearance between the vane and the pump body exceeds the specified limit, the entire pump assembly must be replaced.

Vane and Pump Body Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.20 – 0.27<br>(0.0079 – 0.0106) | 0.40 (0.016) |



**Rotor Shaft and Oil Pump Body Clearance**

Use a micrometer to measure the rotor shaft outside diameter.

Use an inside dial indicator to measure the pump body inside diameter.

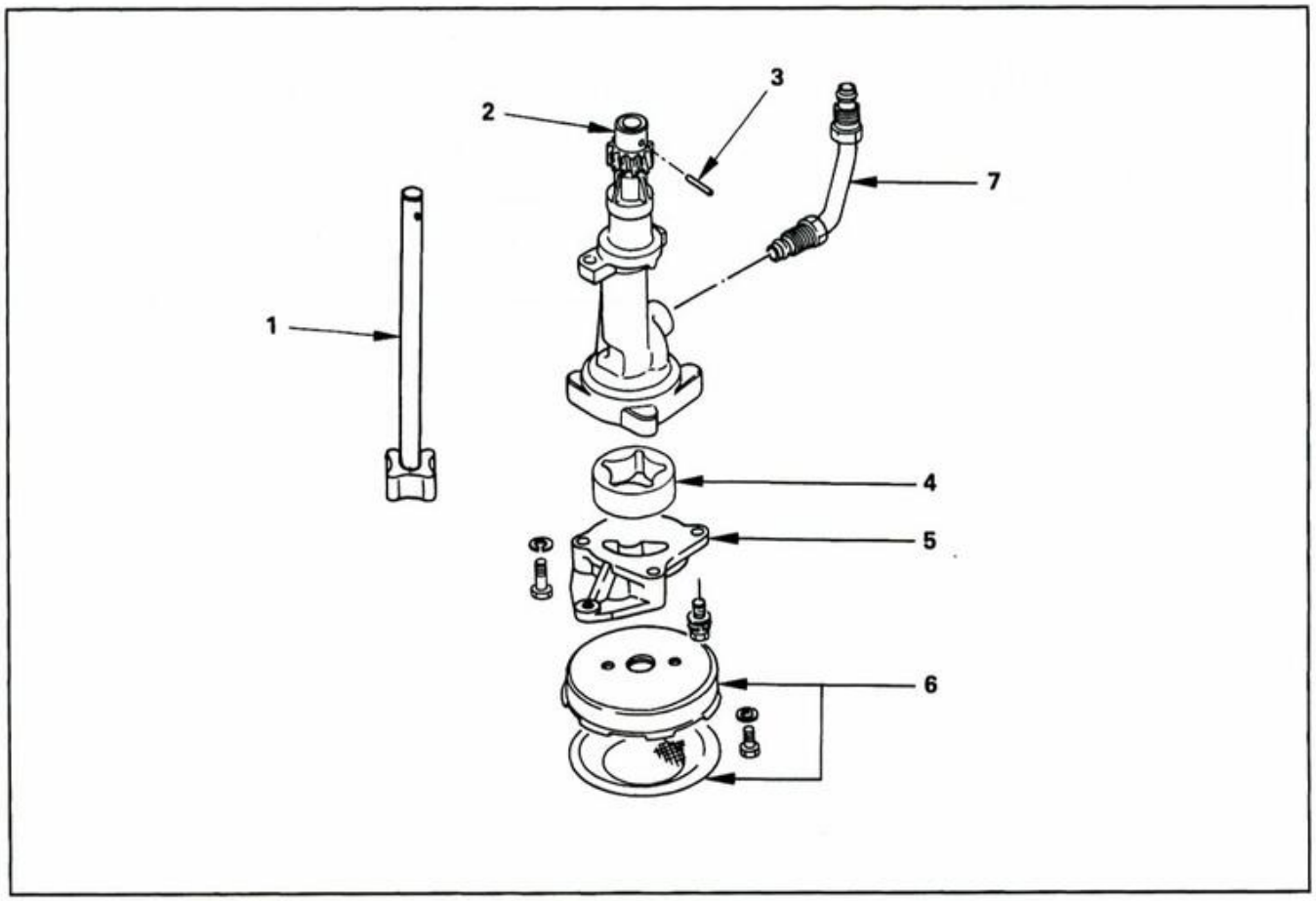
If the clearance between the rotor shaft and the pump body exceeds the specified limit, the entire pump assembly must be replaced.

Rotor Shaft and Pump Body Clearance mm (in)

| Standard | Limit |
|---|---|
| 0.04 (0.0016) | 0.20 (0.0079) |

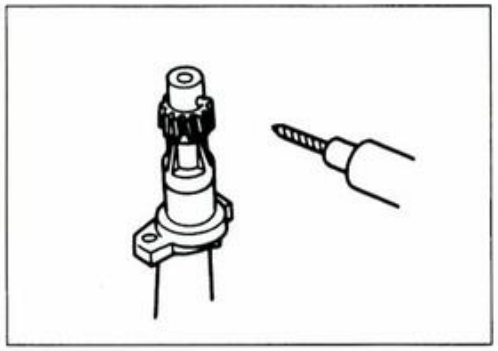
## REASSEMBLY

### Rotor type




**Reassembly Steps**

1. Rotor shaft
▲ 2. Pinion
▲ 3. Pin
4. Vane
5. Pump cover
6. Strainer
7. Oil pipe



## Important Operations

▲ **Pinion**

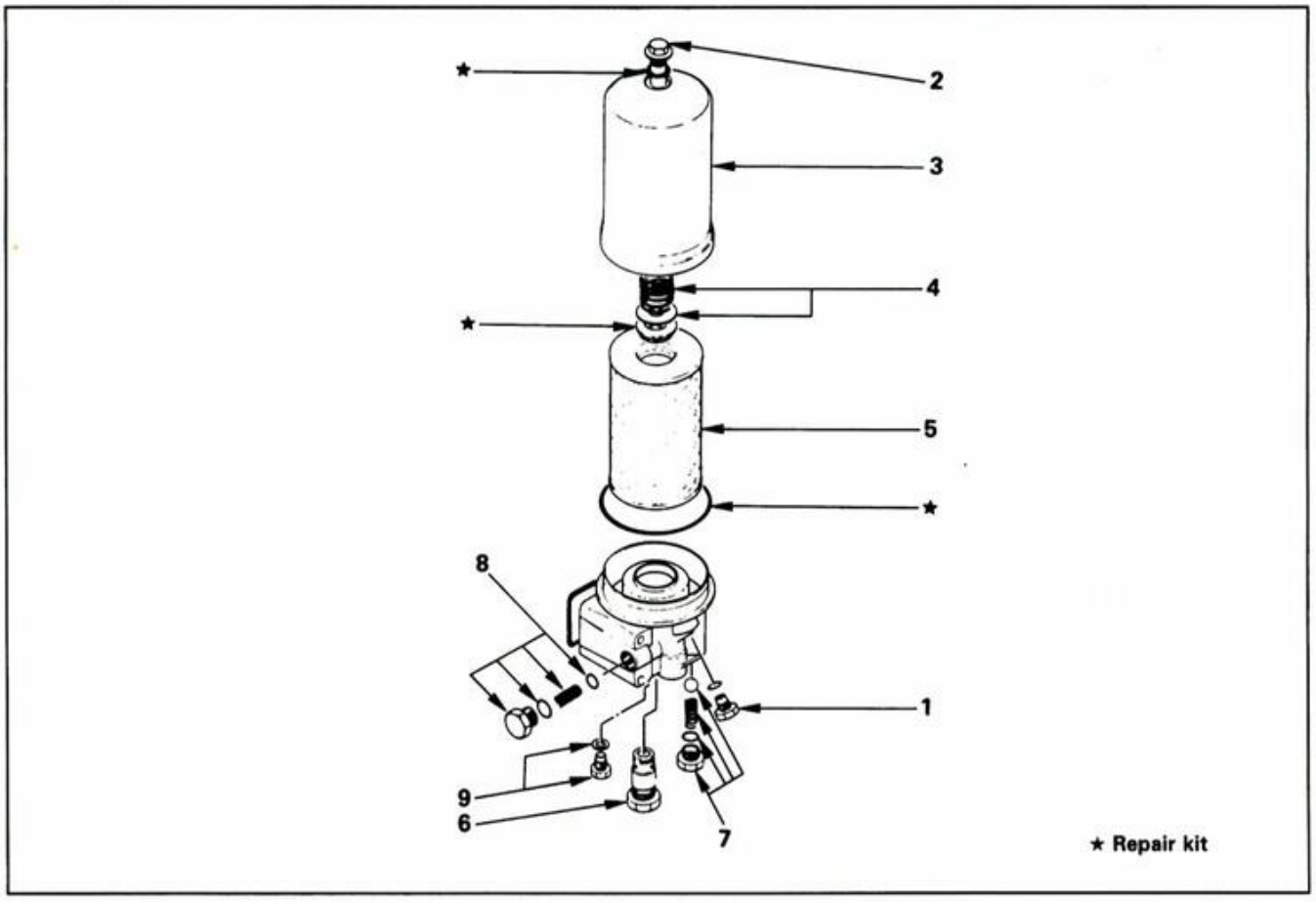
▲ **Pin**

1) Install the new rotor shaft to the pump body.
2) Set the pinion to the rotor shaft.
3) Use a 5 mm (0.20 in) drill a hole through the pinion and the rotor shaft.
4) Insert the pin into the hole.
5) Caulk the pin.

# OIL FILTER

## (REPLACEABLE ELEMENT TYPE)

### DISASSEMBLY



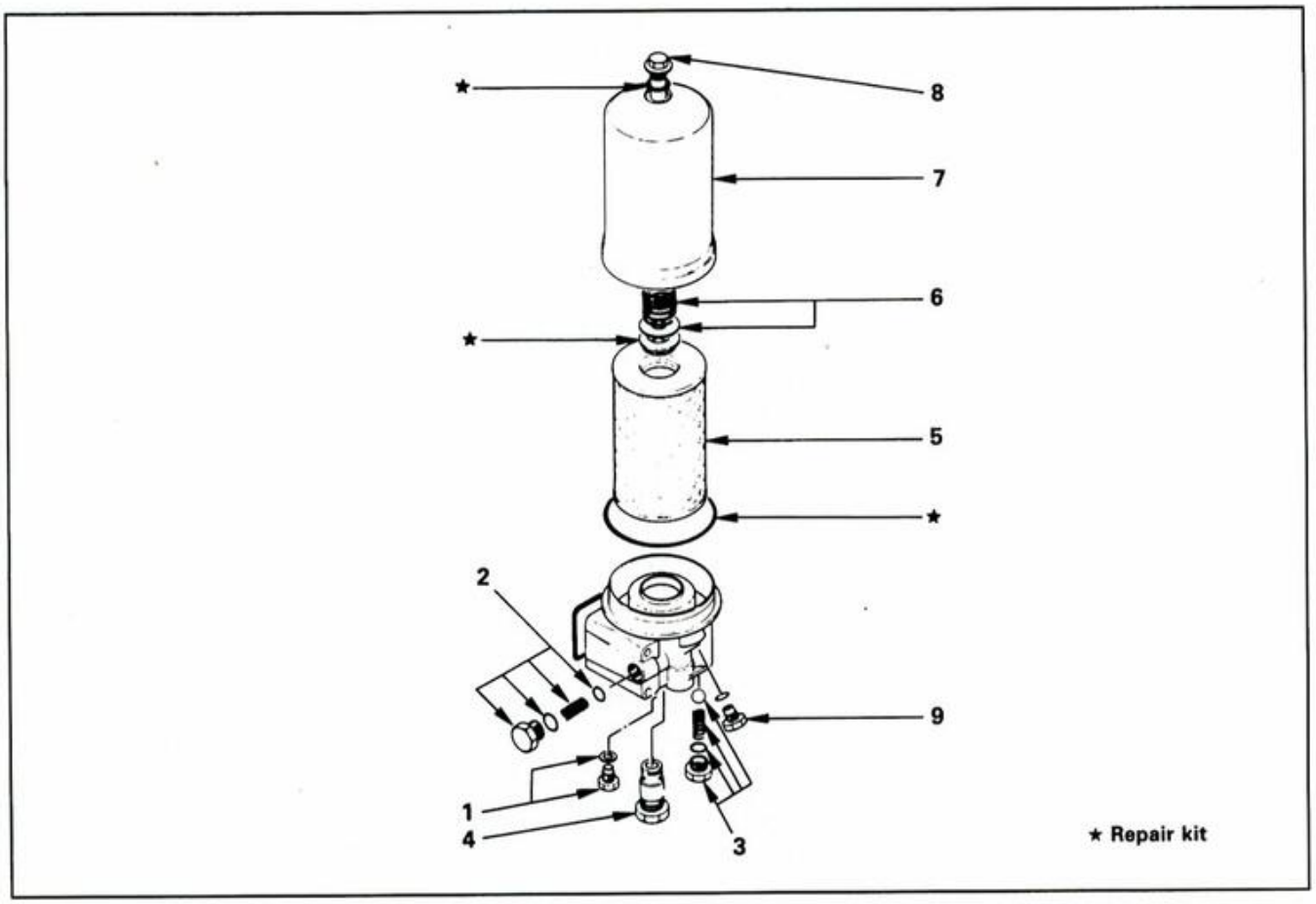

### Disassembly Steps

1. Drain plug
2. Center bolt
3. Filter body
4. Spring, seat and gasket
5. Element
6. Relief valve assembly
7. Overflow valve assembly
8. Oil cooler relief valve (Model with oil cooler)
9. Plug and O-ring (Model without oil cooler)

### INSPECTION AND REPAIR

Make necessary correction or parts replacements if damage or any other abnormal conditions are found through inspection.

## REASSEMBLY




**Reassembly Steps**

- ▲ 1. Plug and O-ring (Model without oil cooler)
- ▲ 2. Oil cooler relief valve (Model with oil cooler)
- ▲ 3. Overflow valve assembly
- ▲ 4. Relief valve assembly
- 5. Element
- 6. Spring, seat and gasket
- 7. Filter body
- ▲ 8. Center bolt
- ▲ 9. Drain plug

**▲ Plug and O-ring**

Install the O-ring the plug with tightening the plug to the specified torque.

| Oil Filter Plug Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.0 – 2.0 (7.3 – 14.5/9.8 – 19.6) | |

**▲ Oil Cooler Relief Valve (Model with Oil Cooler)**

Install the oil cooler relief valve with the gaskets and the spring and, tighten the valve to the specified torque.

| Oil Cooler Relief Valve Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.0 – 3.0 (14.5 – 21.7/19.6 – 29.4) | |

**▲ Overflow Valve Assembly**

Install the overflow valve with the spring, valve ball and the gasket. Tighten the valve to the specified torque.

| Overflow Valve Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.0 – 3.0 (14.5 – 21.7/19.6 – 29.4) | |

**▲ Relief Valve Assembly**

Install the relief valve assembly with gasket and tighten the valve to the specified torque.

| Relief Valve Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (18.0 – 25.2/24.5 – 34.3) | |

**▲ Center Bolt Torque**

Install the center bolt with tightening it to the specified torque.

| Center Bolt Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (18.0 – 25.2/24.5 – 34.3) | |

**▲ Drain Plug**

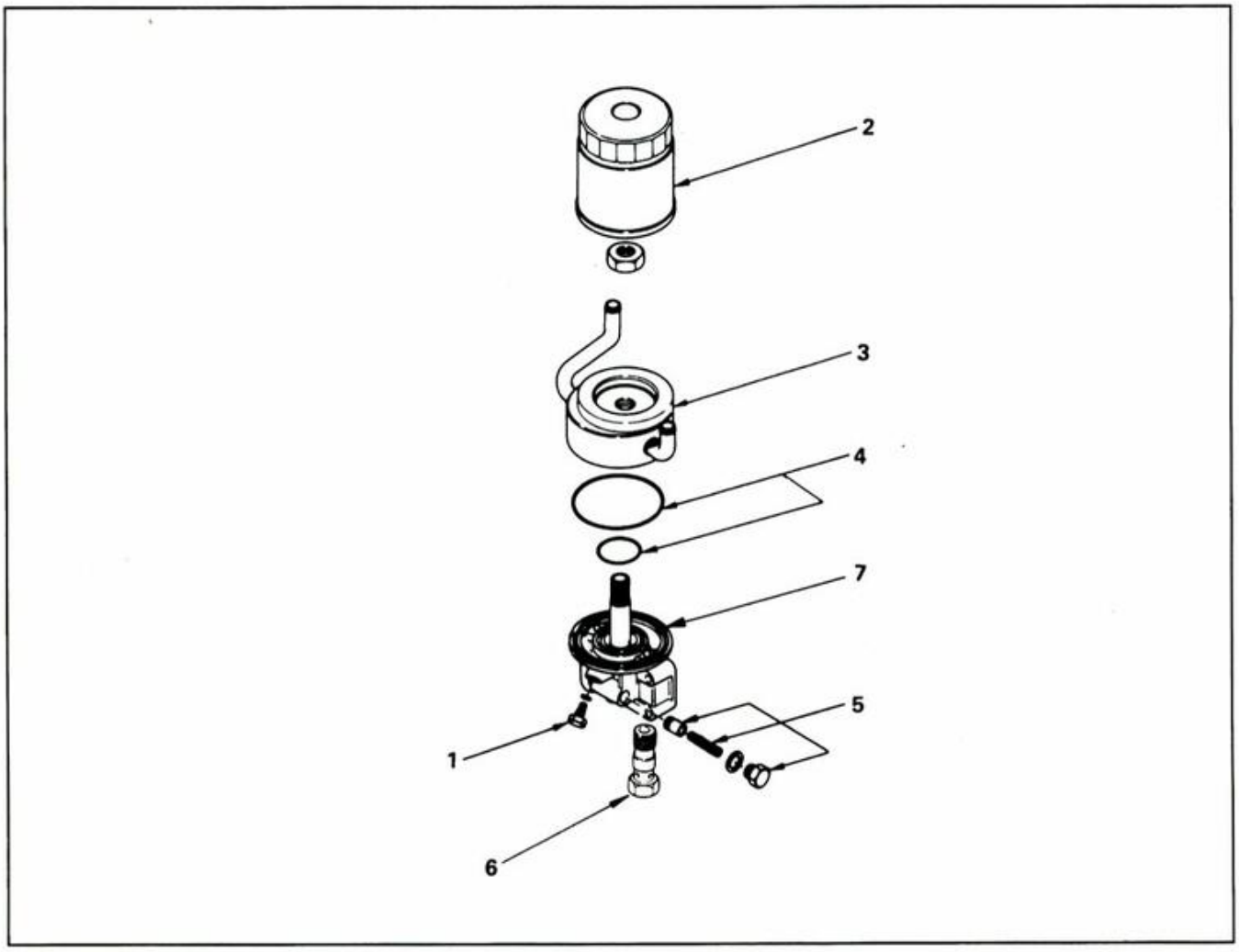
Install the drain plug and the gasket with tightening the plug.

Oil Filter Drain Plug Torque kg·m (lb.ft/N·m)

| 1.0 – 2.0 (7.3 – 14.5/9.8 – 19.6) |
|---|

## (DISPOSABLE CARTRIDGE SPIN-ON TYPE WITH BUILT-IN OIL COOLER)

### DISASSEMBLY

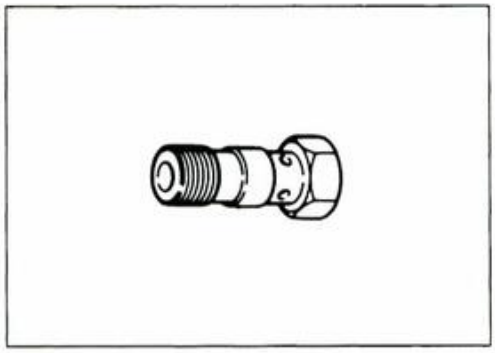



**Disassembly Steps**

1. Drain plug
2. Cartridge oil filter
3. Oil cooler
4. O-ring
5. Safety valve
6. Relief valve

## INSPECTION AND REPAIR

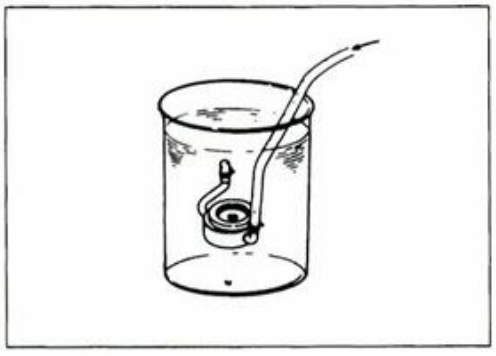
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



**Relief Valve**

1. Attach an oil pressure gauge to the oil gallery near the oil filter.
2. Start the engine to check the relief valve opening pressure.

| Relief Valve Opening Pressure | kg/cm²(psi/kPa) |
|---|---|
| 5.8 – 6.2 (82.5 – 88.2/568.4 – 608.6) | |



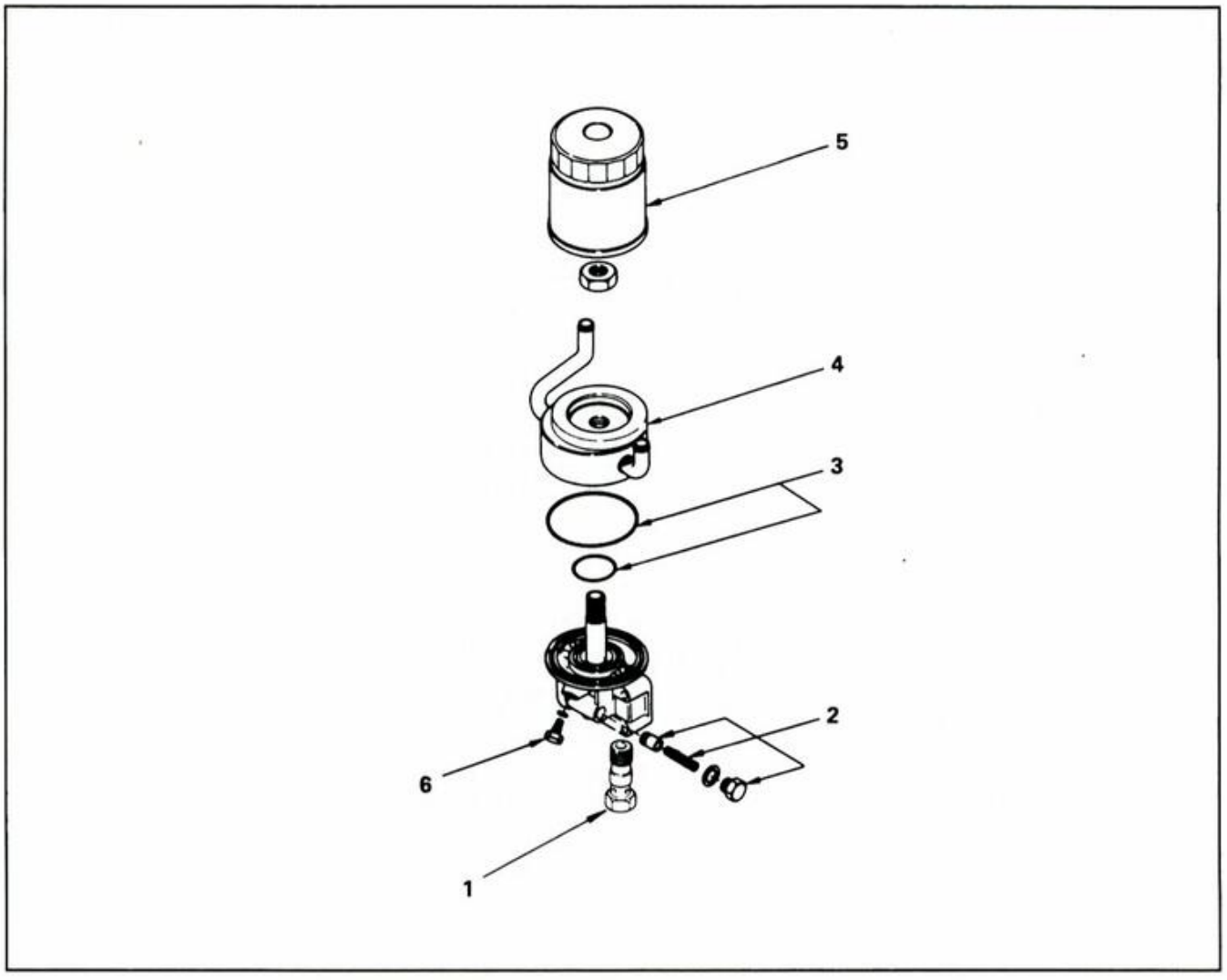
**Oil Cooler**

Water Leakage At Water Passage

1. Plug one side of the oil cooler water passage.
2. Submerge the oil cooler in water.
3. Apply compressed air (2 kg/cm² (28.4 psi/196 kPa)) to the other side of the oil cooler water passage.

   If air bubbles rise to the surface, there is water leakage.

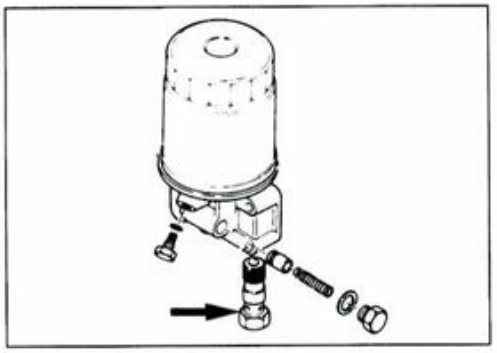
## REASSEMBLY




### Reassembly Steps

- ▲ 1. Relief valve
- ▲ 2. Safety valve
- 3. O-ring
- ▲ 4. Oil cooler
- ▲ 5. Oil filter cartridge
- ▲ 6. Drain plug

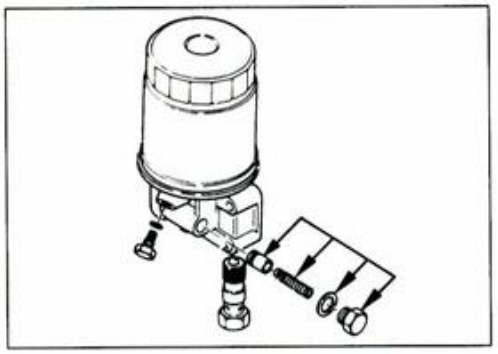
## Important Operations



### ▲ Relief Valve

Tighten the relief valve to the specified torque.

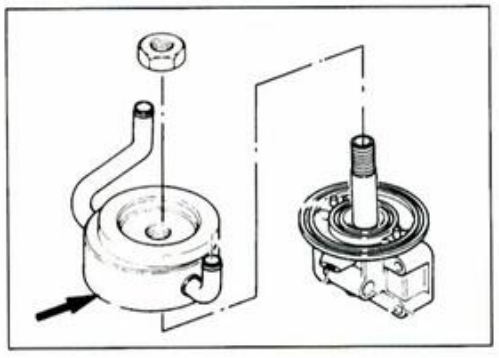
| Relief Valve Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (18.0 – 25.2/24.5 – 34.3) | |



### ▲ Safety Valve

Tighten the safety valve to the specified torque.

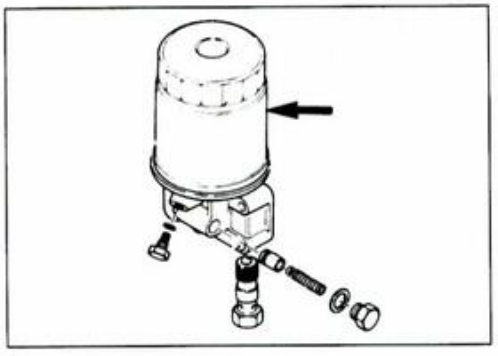
| Safety Valve Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.5 – 2.5 (10.9 – 18.1/14.7 – 24.5) | |



### ▲ Oil Cooler

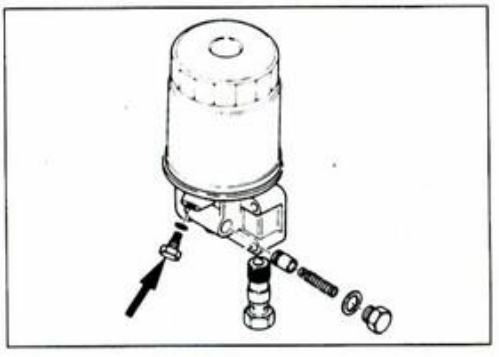
1) Align the oil filter holes with the body knock pins at installation.
2) Tighten the oil cooler to the specified torque.

| Oil Cooler Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (18.0 – 25.2/24.5 – 34.3) | |



### ▲ Oil Filter Cartridge

1) Apply engine oil to the O-ring.
2) Turn in the cartridge oil filter until the filter sealing face makes contact with the O-ring.
3) Turn in the cartridge oil filter an additional 1-1/4 of a turn.



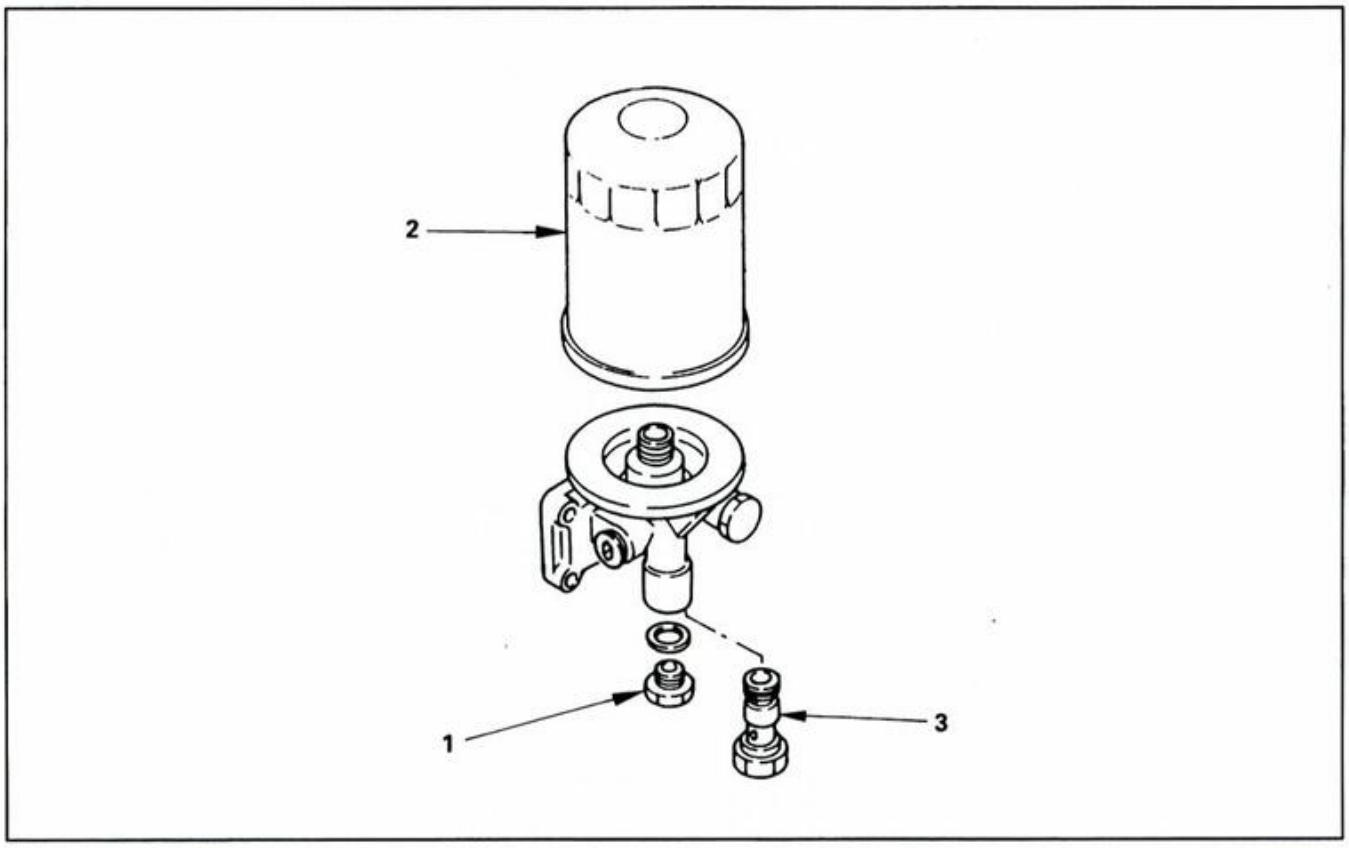
### ▲ Drain Plug

Tighten the drain plug to the specified torque.

| Drain Plug Torque | kg·m (lb.ft/N·m) |
|---|---|
| 1.0 – 2.0 (7.3 – 14.5/9.8 – 19.6) | |

Refer to MAINTENANCE on the page 16 of this WORKSHOP MANUAL.

## (DISPOSABLE CARTRIDGE SPIN-ON TYPE)




### Disassembly Steps

1. Drain plug
2. Cartridge
3. Relief valve

### INSPECTION AND REPAIR

Make necessary correction or parts replacements if damage or any other abnormal conditions are found through inspection.

To reassemble the cartridge spin-on type oil filter follow to the disassemble procedure in reverse order

Refer to MAINTENANCE on the page 16 of this Workshop Manual.

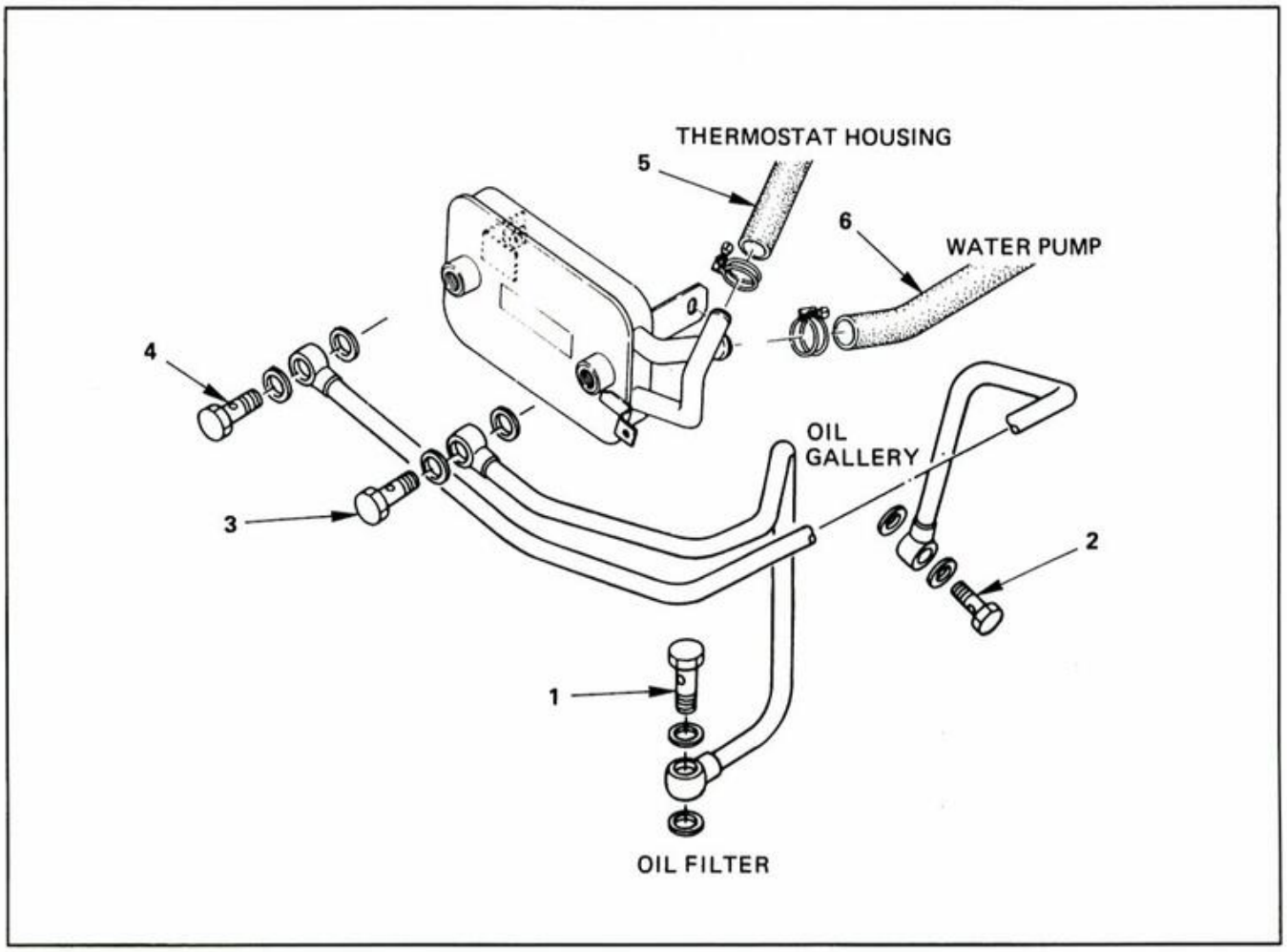
Cartridge Type Oil Filter Relief Valve

| Torque | kg·m (lb.ft/N·m) |
|---|---|
| 2.5 – 3.5 (18.0 – 25.2 / 24.5 – 34.3) | |

# OIL COOLER

## (EXTERNALLY MOUNTED TYPE)

### REMOVAL AND INSTALLATION




**Removal Steps**

1. Eye bolt (Oil filter side)
2. Eye bolt (Cylinder body oil gallery side)
3. Eye bolt (Oil cooler side)
4. Eye bolt (Oil cooler side)
5. Water hose (Thermostat housing side)
6. Water hose (Water pump side)

**Installation Steps**

To install the oil cooler follow to the removal steps in reverse order.

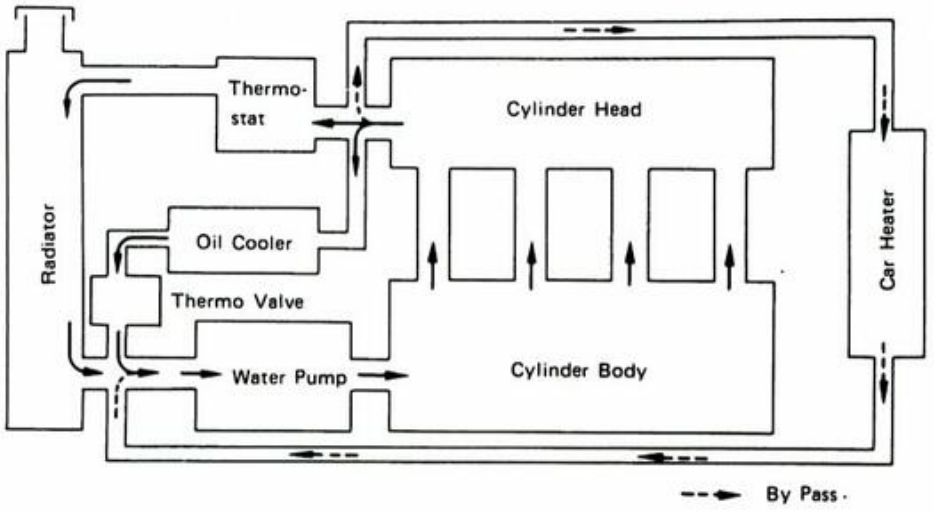
Refer to REASSEMBLY on the page 117 of this Workshop Manual.

## SECTION 7

# COOLING SYSTEM

### TABLE OF CONTENTS

# GENERAL DESCRIPTION




The engine cooling system consists of the radiator, the water pump, the cooling fan, and the thermostat.

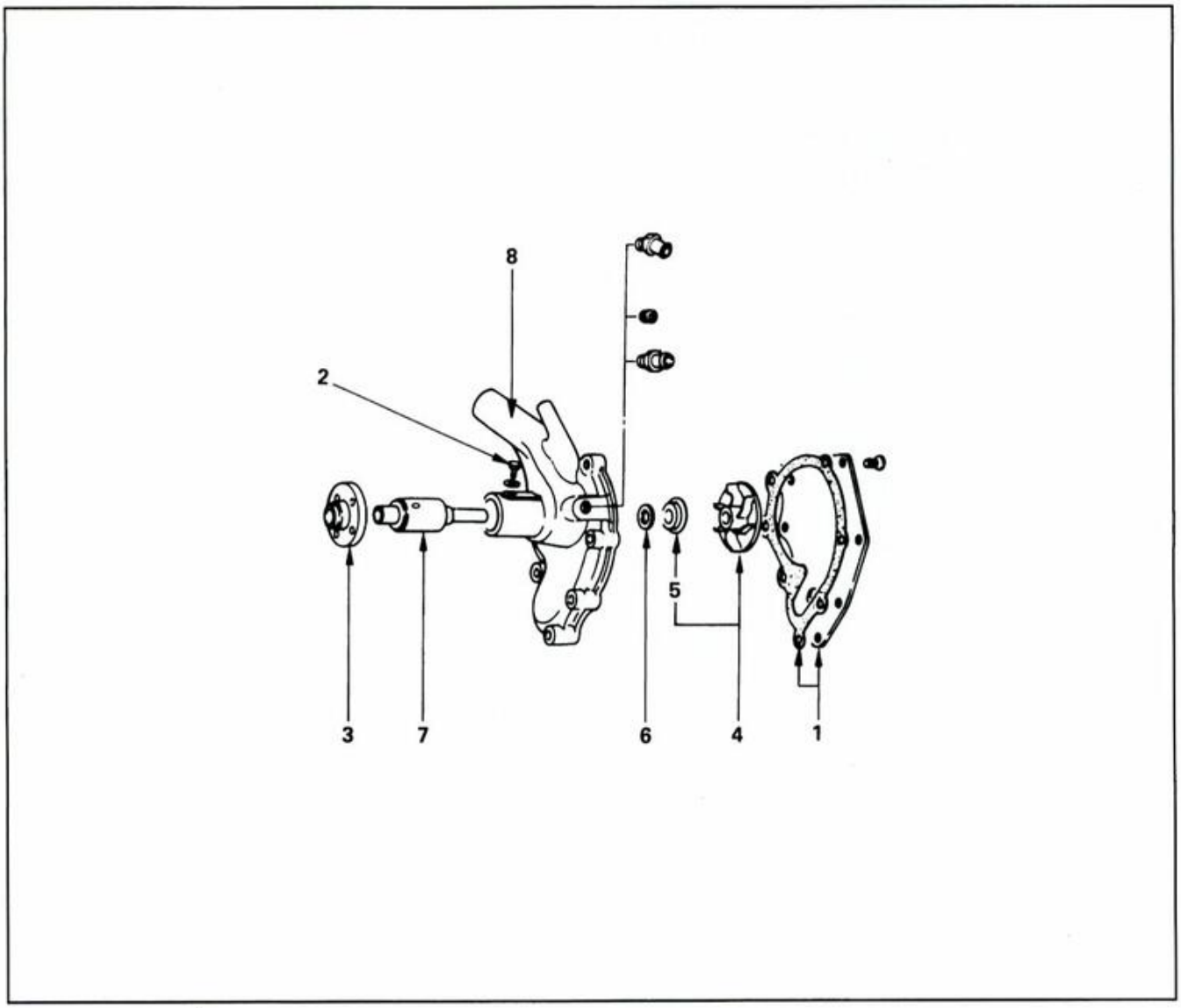
To quickly increase cold engine coolant temperature for smooth engine operation, the coolant is circulated by the water pump and thermostat through the by-pass hose and back to the cylinder body. The coolant does not circulate through the radiator.

When the coolant temperature reaches 82°C (180°F), the thermostat will begin to open and a gradually increasing amount of coolant will circulate through the radiator.

The thermostat will be fully open when the coolant temperature reaches 95°C (203°F). All of the coolant is now circulating through the radiator for effective engine cooling.

# WATER PUMP

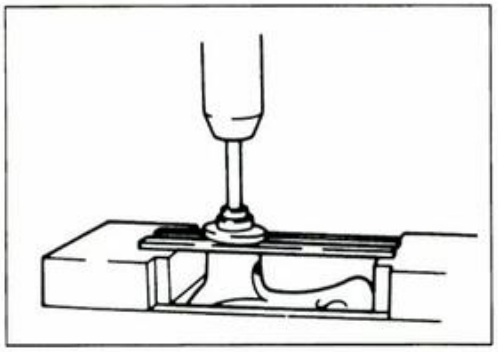
## DISASSEMBLY




### Disassembly Steps

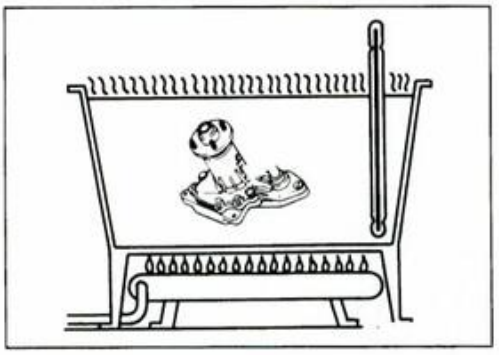
1. Cover
2. Set screw
- ▲ 3. Cooling fan center
4. Impeller
- ▲ 5. Seal unit
6. Thrower
7. Bearing unit
8. Water pump body

## Important Operations



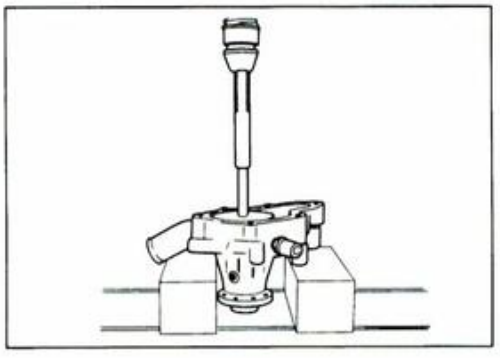
**▲ Cooling Fan Center**

Remove the fan center with a bench press and a bar.



**▲ Bearing Unit**

1) Heat the pump body in hot water 80 – 90°C/176 – 194°F).



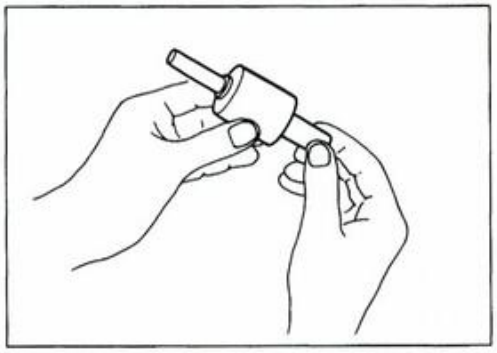
2) Remove the impeller and seal unit with a bench press and bar.

**Note:**

**Do not drive out the impeller with a hammer. Damage to the impeller will result.**

## INSPECTION AND REPAIR

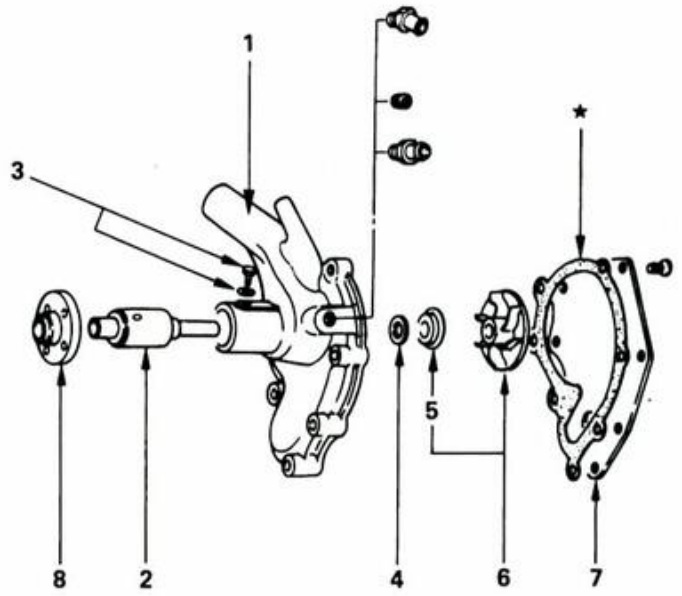
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



**Bearing Unit**

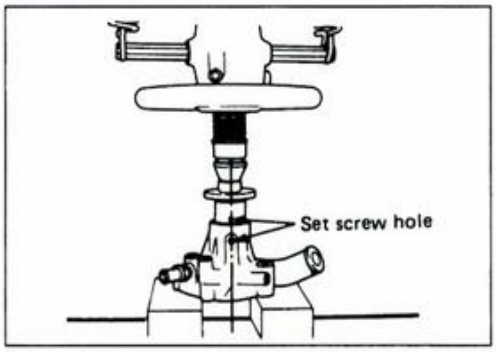
Check the bearing for abnormal noise, binding, and other abnormal conditions.

## REASSEMBLY




### Reassembly Steps

1.. Water pump body
▲ 2. Bearing unit
▲ 3. Set screw
4. Thrower
▲ 5. Seal unit
6. Impeller
7. Cover
8. Cooling fan center

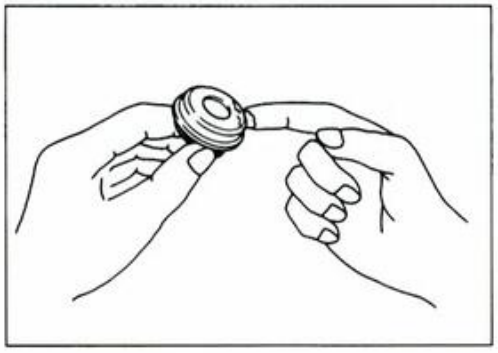



## Important Operations

**▲ Bearing Unit**

**▲ Set Screw**

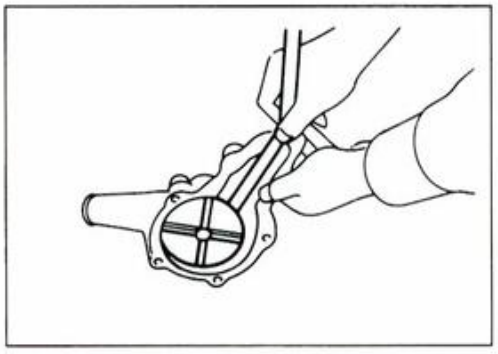
1) Align the bearing set screw hole with the pump body set screw hole.
2) Press the bearing unit into place.
3) Secure the bearing with the set screw.



**▲ Seal Unit**

**▲ Impeller**

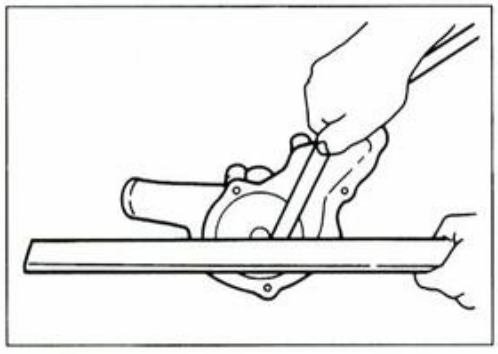
1) Apply a thin coat of liquid gasket to the seal unit outer periphery.
2) Install the seal unit.



3) Use a bench press to install the impeller so that the specified clearance is provided between the impeller and the pump body.

Impeller and Body Clearance — mm (in)

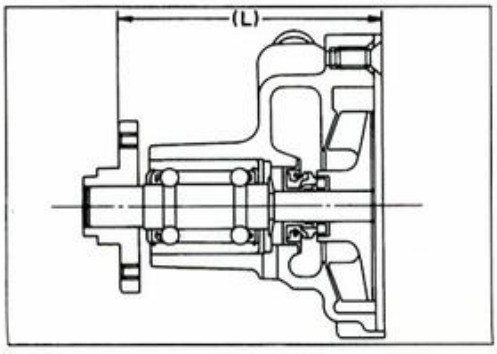
| Standard |
|---|
| 0.3 – 0.6 (0.012 – 0.024) |



4) Use a feeler gauge and a straight edge to measure the impeller rear face depth from the pump body face.

Impeller Rear Face Depth — mm (in)

| Standard |
|---|
| 0.6 – 0.8 (0.024 – 0.031) |

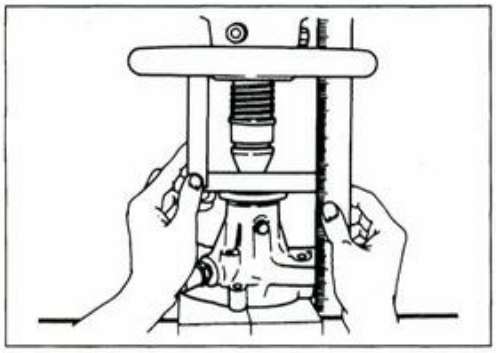



**▲ Cooling Fan Center**

Measure the distance between the cooling fan fitting face and the rear cover fitting face.

Cooling Fan Center and Rear Cover Fitting Face Distance — mm (in)

| Standard |
|---|
| 110.7 – 111.3 (4.36 – 4.38)<br>or 119.1 – 119.7 (4.69 – 4.71) |



**Note:**

1. **The fan center and impeller and installed to the water pump shaft with a press.**

   **Never attempt to remove and reinstall the fan center and the impeller a second time. Replace the entire water pump assembly.**

   **Removing and reinstalling the fan center and the impeller a second time may result in the break-down of the water pump during engine operation and subsequent serious overheating problems.**

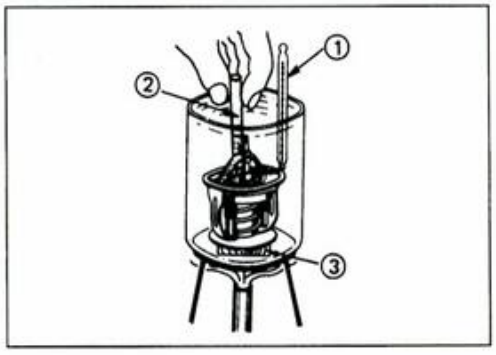
2. **The water pump assembly must be replaced whenever the fan center and impeller pressure force falls below 200 kg (441 lb/1,960 N).**

3. **Do not attempt to strike the bearing into position with a hammer or similar object. Damage to the bearing will result.**

# THERMOSTAT

## INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.




**Operation Test**

1. Completely submerge the thermostat in water.
2. Heat the water.

   Stir the water constantly to avoid direct heat being applied to the thermostat.
3. Check the thermostat initial opening temperature.

| Thermostat Initial Opening Temperature | °C (°F) |
|---|---|
| 80 – 84 (176 – 183) | |

4. Check the thermostat full opening temperature.

| Thermostat Full Opening Temperature | °C (°F) |
|---|---|
| 95 (203) | |

| Valve Lift At Fully Open Position | mm (in) |
|---|---|
| 8.0 (0.30) | |

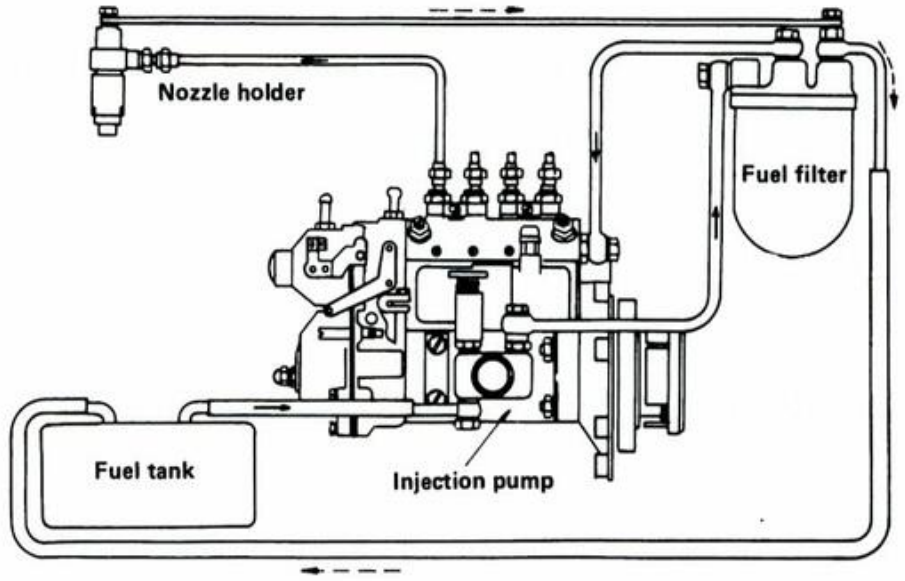
① Thermometer
② Agitating rod
③ Wooden piece

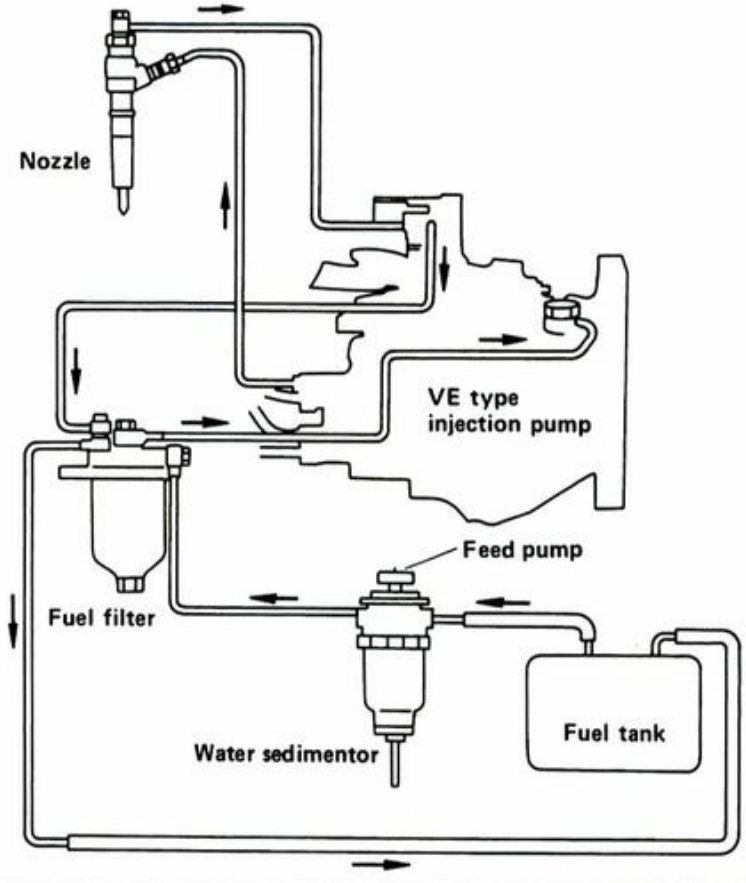
## SECTION 8

# FUEL SYSTEM

### TABLE OF CONTENTS

# GENERAL DESCRIPTION



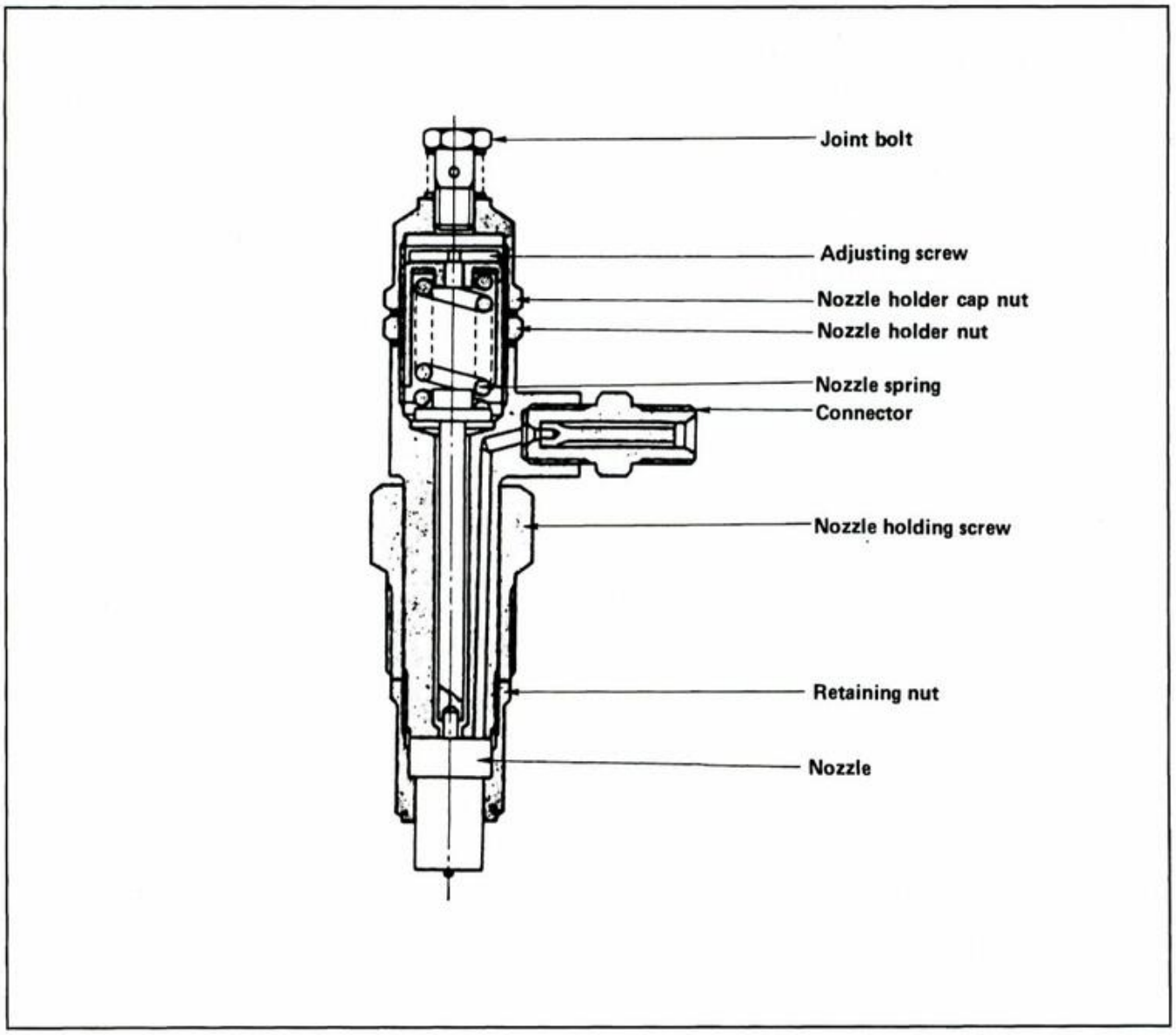
Although, as described in DESIGN FEATURES AND GENERAL OUTLINE of the section 1, GENERAL INFORMATION, either of the in-line type injection pump or the VE type (i.e. distributor type) injection pump is equipped depending on the engine application, the basic system function is identical.

The fuel system consists of the fuel tank, the water sedimentor (if so equipped) the fuel filter, the injection pump, and the injection nozzle.
The fuel from the fuel tank passes through the water sedimentor and the fuel filter where water particles and other foreign material are removed from the fuel.

Fuel, fed by the injection pump plunger, is delivered to the injection nozzle in the measured volume at the optimum timing for effective engine operation.

As no fuel feed pump is provided on the VE engine type injection pump, a water sedimentor with built-in type feed pump is used in this type of fuel systems.

## INJECTION NOZZLE

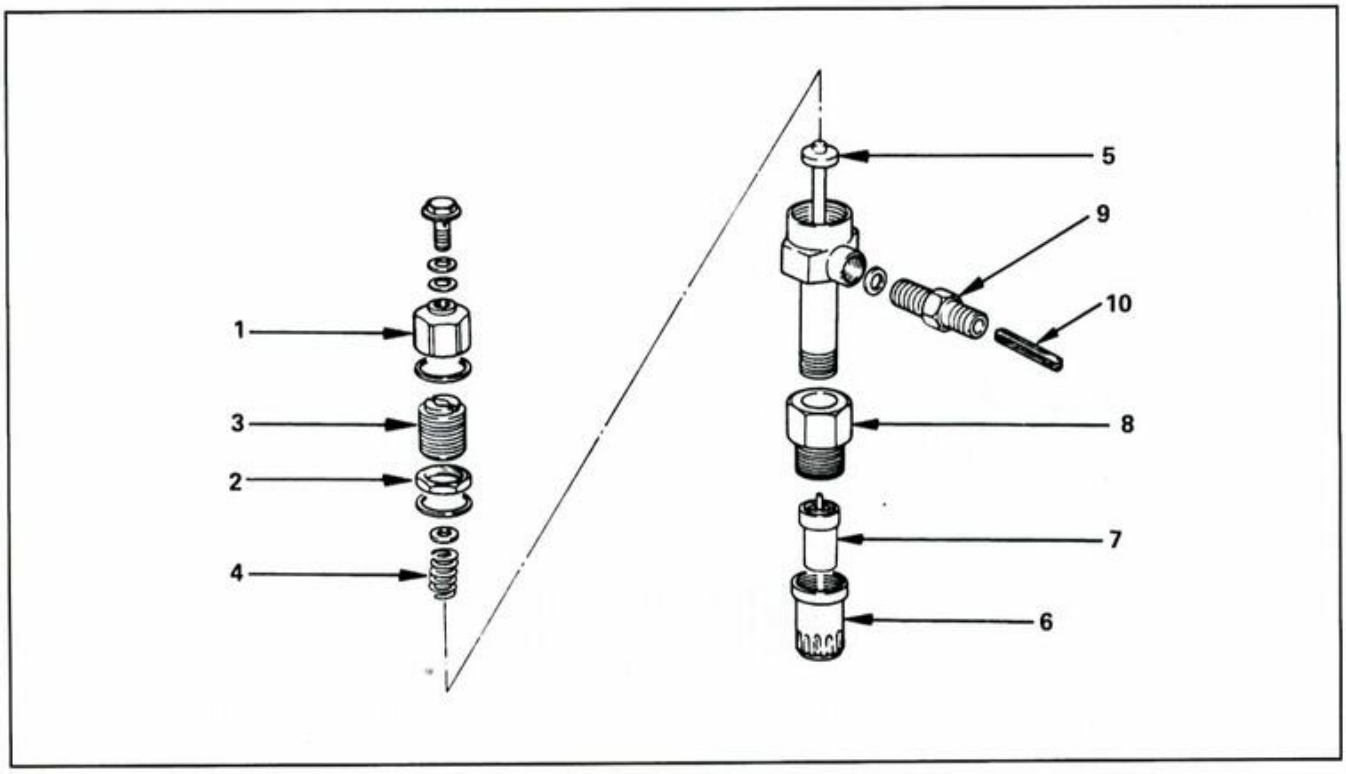



A Bosch throttle type injection nozzle is used. It consists of the nozzle body and the needle valve assembly.

The injection nozzle assembly sprays pressurized fuel from the injection pump into the combustion chamber through the nozzle body injection orifice.

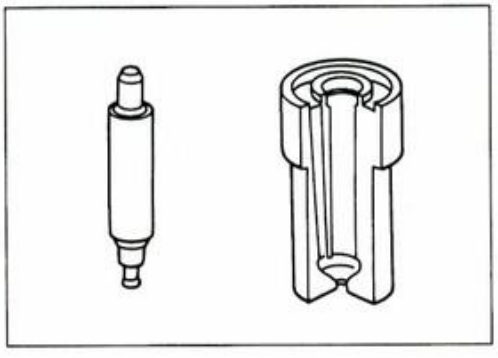
# INJECTION NOZZLE

## DISASSEMBLY




### Disassembly Steps

1. Nozzle holder cap nut
2. Nozzle holder nut (C223 only)
3. Adjusting screw
4. Nozzle spring
5. Push rod
6. Retaining nut
▲ 7. Nozzle and body
8. Nozzle holding screw
9. Connector
10. Edge filter



### Important Operations

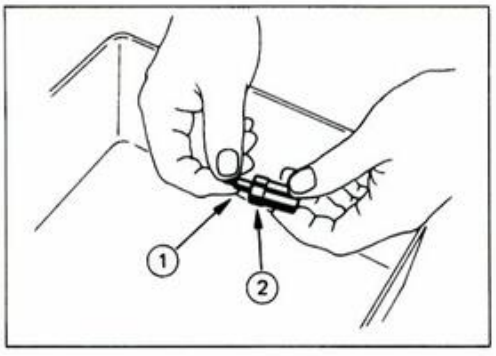
**▲ Nozzle and Body**

Remove the nozzle assemblies from the nozzle holders.

The nozzle needle valve and nozzle body combinations must not be interchanged.

## INSPECTION AND REPAIR

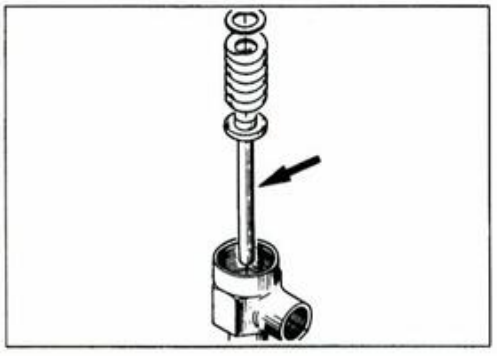
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.




**Injection nozzle Needle Inspection**

1. Remove the nozzle needle from the nozzle body.
2. Carefully wash the nozzle needle and the nozzle body in clean diesel fuel.
3. Check that the nozzle needle moves smoothly inside the injection nozzle body.

   If the nozzle needle does not move smoothly, it must be replaced.



**Push Rod Inspection**

Check both push rod seating positions (needle valve and spring seat) for excessive wear and cracking.

If either of these two conditions are present, the push rod must be replaced.

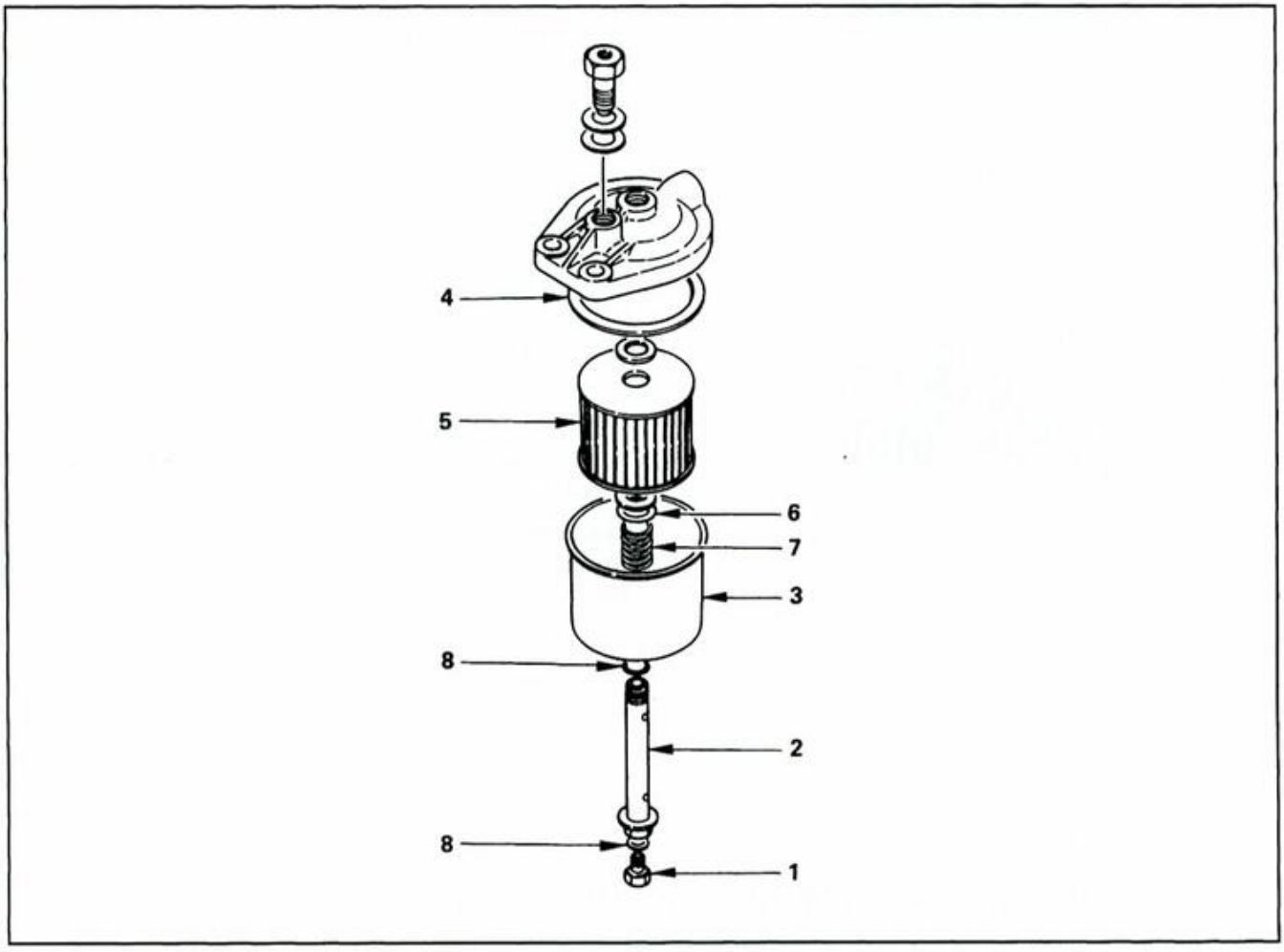
## REASSEMBLY

To reassemble the injection nozzle assembly, follow the disassembly procedure in the reverse order.

# FUEL FILTER

## (REPLACEMENT ELEMENT TYPE)

### DISASSEMBLY




**Disassembly Steps**

1. Drain plug
2. Center bolt
3. Filter body
4. Body cover gasket
5. Filter element
6. Spring seat
7. Spring
8. Gasket

### INSPECTION AND REPAIR

Make necessary adjustments, repairs and part replacements if excessive wear or damage is discovered during inspection.

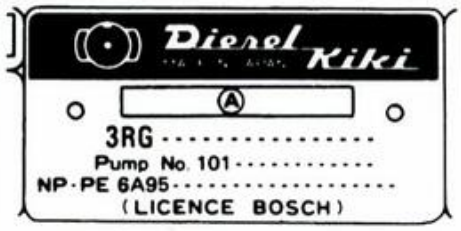
### REASSEMBLY

To reassemble the fuel filter, follow the disassembly procedure in the reverse order.

Refer to MAINTENANCE on the page 2-4 of this Workshop Manual.

# INJECTION PUMP CALIBRATION DATA

In-line type




Ⓐ··· Identification number

Distributor type


## IDENTIFICATION PLATE AND PRODUCT SERIAL NUMBER

1. Injection pump adjustment and repair should be made by the nearest DKKC (Diesel Kiki Co., Ltd.) or ROBERT BOSCH Authorized Service Outlet.
2. When you ask such authorized service outlet the adjustment or repair, the Identification Plate and Product Serial Number will give them a necessary clue to get technical data distributed by the manufacturers previously.

   Without this data, the Service Outlet will be unable to effectively service your injection pump.

   If you are unable to locate the data applicable to your injection pump.

   Please contact ISUZU MOTORS LTD through your machine supplier.
3. Do not remove the Identification Plate and Product Serial Number from the injection pump.

   Keep the Identification Plate and Product Serial Number clean at all times. Do not allow it to rust or become illegible.

**Note:** Examples of test conditions and calibration data are as follows.

## 1. In-Line Type

### TEST CONDITIONS REQUIRED FOR THE FUEL INJECTION AMOUNT ADJUSTMENT

| | | |
|---|---|---|
| Injection Nozzle | | *DKKC No.: 105780-0000<br>Bosch Type No.: DN12DS12T |
| Injection Nozzle Holder | | DKKC No.: 105780-2080<br>Boshc Type No.: EF8511/9A |
| Injection Starting Pressure | kg/cm²(psi) | 175 (2488.5) |
| Injection Line Dimensions | mm(in.) | |
| Inside Diameter | | 2.0 (0.079) |
| Outside Diameter | | 6.0 (0.236) |
| Length | | 600.0 (23.6) |
| Transfer Pump Pressure | | 1.6 (22.75) |
| Testing Diesel Fuel | | ISO4113 or SAE Standard Test Oil (SAEJ967D) |
| Operating Temperature | °C(°F) | 40 — 45 (104 — 113) |
| Pump Rotation Direction | | Clockwise (Viewed from the drive side) |

# INJ. PUMP CALIBRATION DATA

Ass'y No. 000000–0000
Date : 2
Company : ISUZU
No. 0–00000–000–0

ENGINE MODEL 6BD1T

Injection pump : PES4A 000000–0000 Governor : EP/RSV 000000–0000 Timing device :

## 1. Test Conditions :

Pump rotation : clockwise (viewed from drive side)

Nozzle : 000000–0000 (BOSCH Type No. DN12SD12T) Nozzle Holder : 000000–0000 (BOSCH Type No. EF8511/9A)

Nozzle opening pressure : 175 Kg/cm² ressure : 1.6 Kg/cm²

Injection pipe : Inner Dia. 2 mm ... — Length 600 mm

Test Oil : ISO4113 or SAE ... Oil(SAE J967d) Oil Temp. : $40^{+5}$ °C

Overflow valve opening pressure Kg/cm²



## 2. Injection Timing :

Pre-stroke : No. 1 Plunger 3.4 ±0.05mm

Note : Adjust with control rod position of mm

Injection order : 1 $\frac{}{90°\pm30'}$ 3, 1 $\frac{}{180°\pm30'}$ 4, 1 $\frac{}{270°\pm30'}$ 2 (interval : °±30')

Plungers are numbered from the Drive side.

Tappet clearance : Bolt adjustment type ; More than 0.3mm for all cylinders.
: Shim adjustment type ; Manually rotate the camshaft 2~3 times and confirm that it rotates smoothly.

## 4. Injection Quantity :

| Adjusting Point | Rod Position (mm) | Pump Speed (r.p.m) | Injection Q'ty (cc/1000 strokes) | Max. var bet. cyl (%) | Fixed | Remarks |
|---|---|---|---|---|---|---|
| A | 9.5 | 1,100 | 71.1 ~ 74.1 | ±2 | Rod | Basic |
| H | Approx. 6.5 | 400 | 7.4 ~ 10.2 | ±14 | Rod | |
| A | 9.5 | 1,100 | 71.1 ~ 74.1 | — | Lever | Basic |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

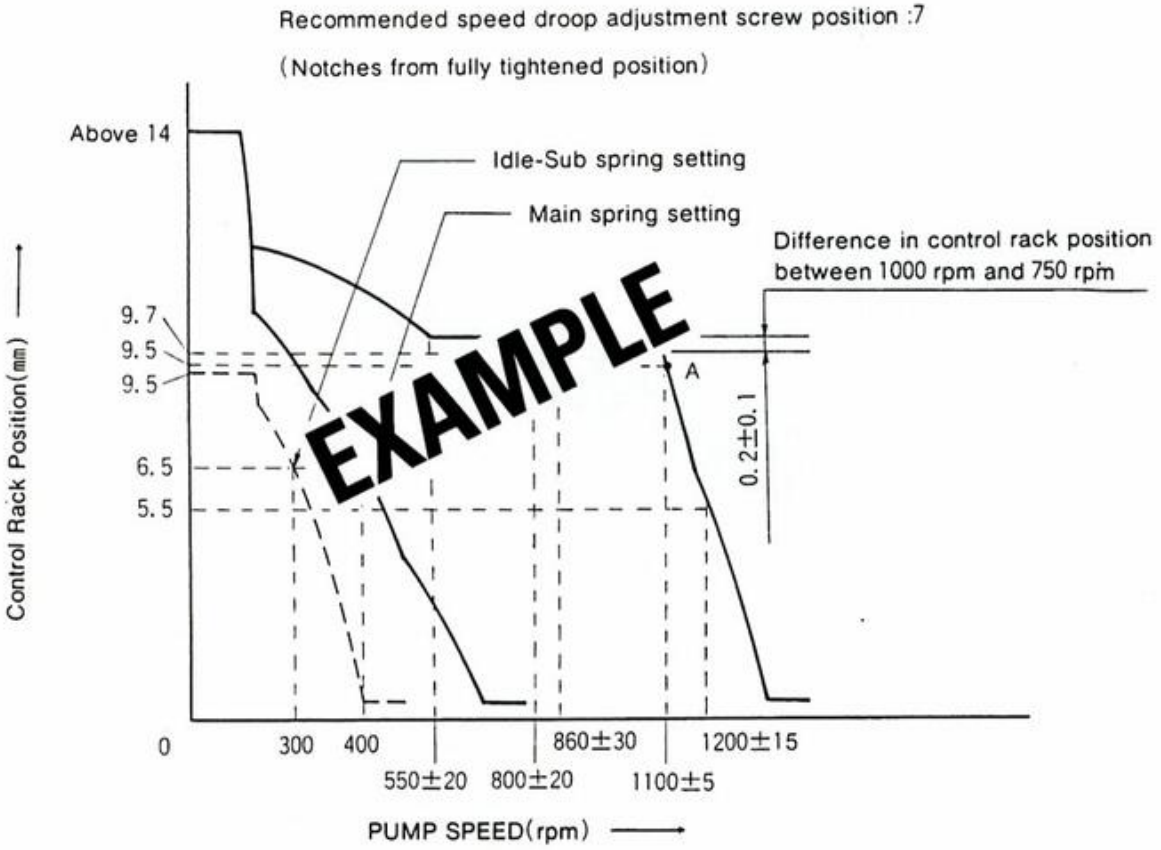


## 5. Timing Advance Specification :

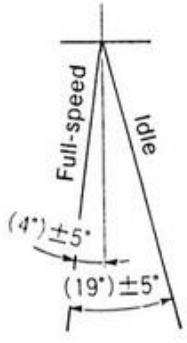
| Pump Speed (r.p.m) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Advance Angle (deg.) | | | | | | | |

DIESEL KIKI DIESEL KIKI CO., LTD. Service Department 3-6-7 SHIBUYA, SHIBUYA-KU, TOKYO 150, JAPAN Tel. (03) 400-1551 · Fax: (03) 499-4115

## 3. GOVERNOR ADJUSTMENT




SPEED LEVER ANGLE

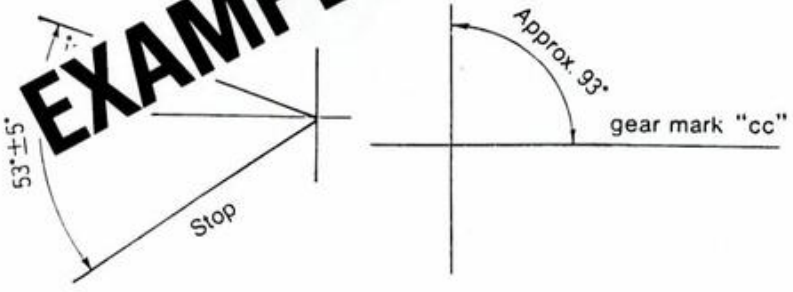



STOP LEVER ANGLE

TIMING SETTING

plunger beginning of injection

18°



## 2. Distributor Type

### INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

**Identification number : 104749−1030**

**Test diesel fuel : Bosch diesel fuel OL61V11**

| 1. Settings | Pump Speed (rpm) | Fuel delivery (cc/1000st.) |
|---|---|---|
| 1.1 Idle speed regulation | 315 | 4.7−8.7 |
| 1.2 Start | 100 | Above 58 |

| 2. Test Specifications | | | | |
|---|---|---|---|---|
| 2.1 Timing device | N = rpm<br>mm | 000<br>−21 | 1500<br>3.6−4.2 | 2300<br>7.0−7.8 |
| 2.2 Supply pump | N = rpm<br>kg/ | 00<br>3.9−4.5 | 1500<br>5.3−5.7 | 2150<br>6.6−7.2 |
| Overflow delivery | | 1000<br>48−91 | | |

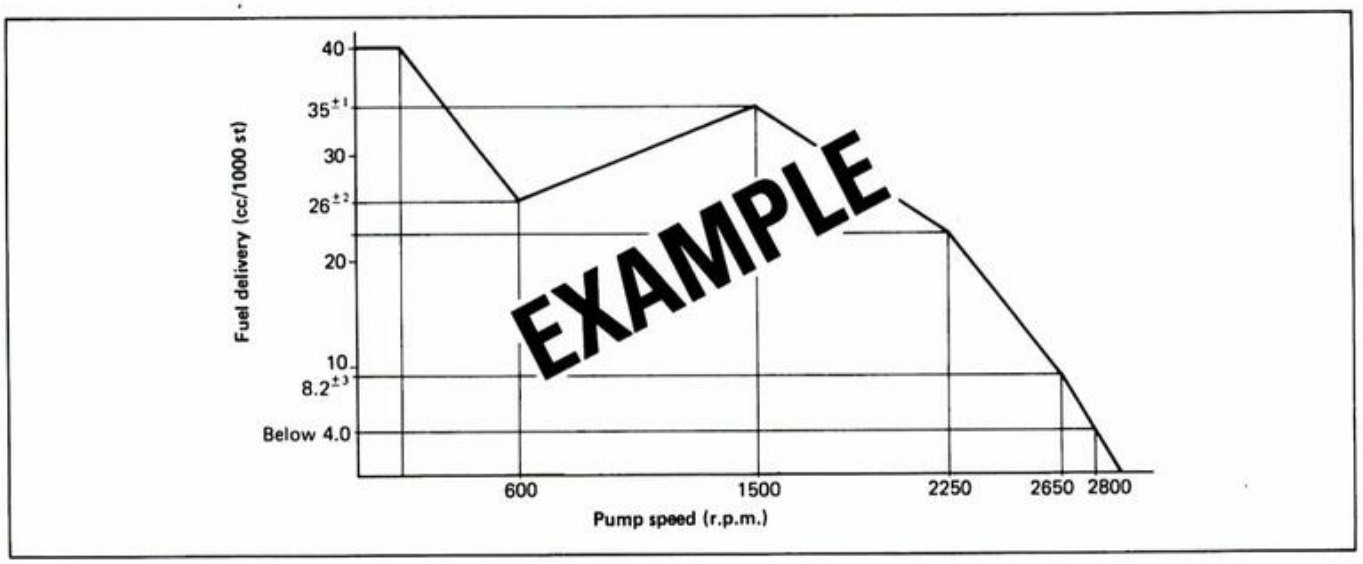


2.3 Fuel deliveries

| Speed control lever | Pump speed (rpm) | Fuel delivery (cc/1000st.) |
|---|---|---|
| End stop | 1500 | 34.6−36.6 |
| | 600 | 24.4−28.4 |
| | 2225 | 30.3−34.3 |
| | 2650 | 5.2−11.2 |
| | 2800 | Below 4.1 |
| Switch-off | 315 | 0 |
| Idle stop | 315 | 4.7−8.7 |
| | 365 | Below 3.6 |
| Cold start device | 0 | 1.9−2.3mm |
| | 560−760 | Cancel |
| 2.4 Solenoid | Max. cut-in voltage | 8V |
| | test voltage | 12V−14V |

| 3. Dimensions | |
|---|---|
| Desig-nation | For assembly and adjustment (mm) |
| K | 3.2−3.4 |
| KF | 5.7−5.9 |
| MS | 1.7−1.9 |
| $\alpha$ | 21−29 deg. |
| A | 7.5−11 mm |
| $\beta$ | 36−46 deg. |
| B | 10.5−14.6 mm |
| Observations | |

### GOVERNOR PERFORMANCE DIAGRAM



## SECTION 9

# ENGINE ELECTRICALS

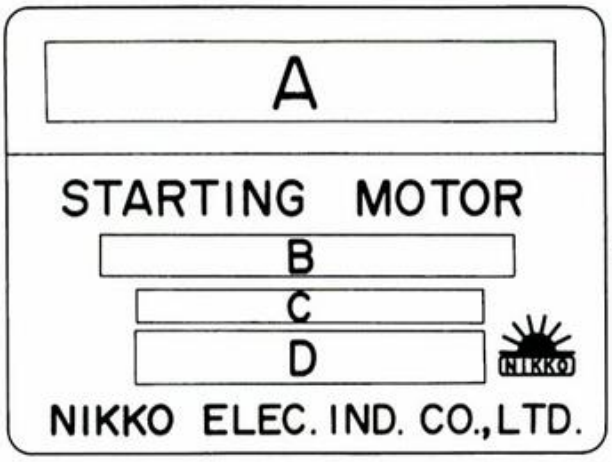
### TABLE OF CONTENTS

# STARTER IDENTIFICATION

The starter identification plate is attached to the starter outside yoke. The ISUZU part number, the manufacturer's code number, and other important information are stamped on the plate.
Refer to the identification plate together with the "Main Data and Specifications" Tables and accompanying charts in this Manual when requesting service assistance from a qualified electrical repair shop.

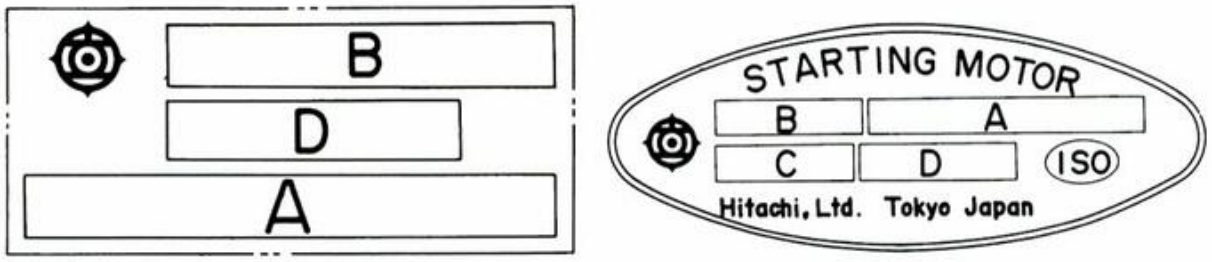
If you are unable to locate the data applicable to your engine, please contact ISUZU MOTOR LIMITED through your machine supplier.

### NIKKO IDENTIFICATION PLATE




A: Isuzu part number
B: Manufacturer's code number
C: Rated output
D: Manufacturer's production mark

### HITACHI IDENTIFICATION PLATE



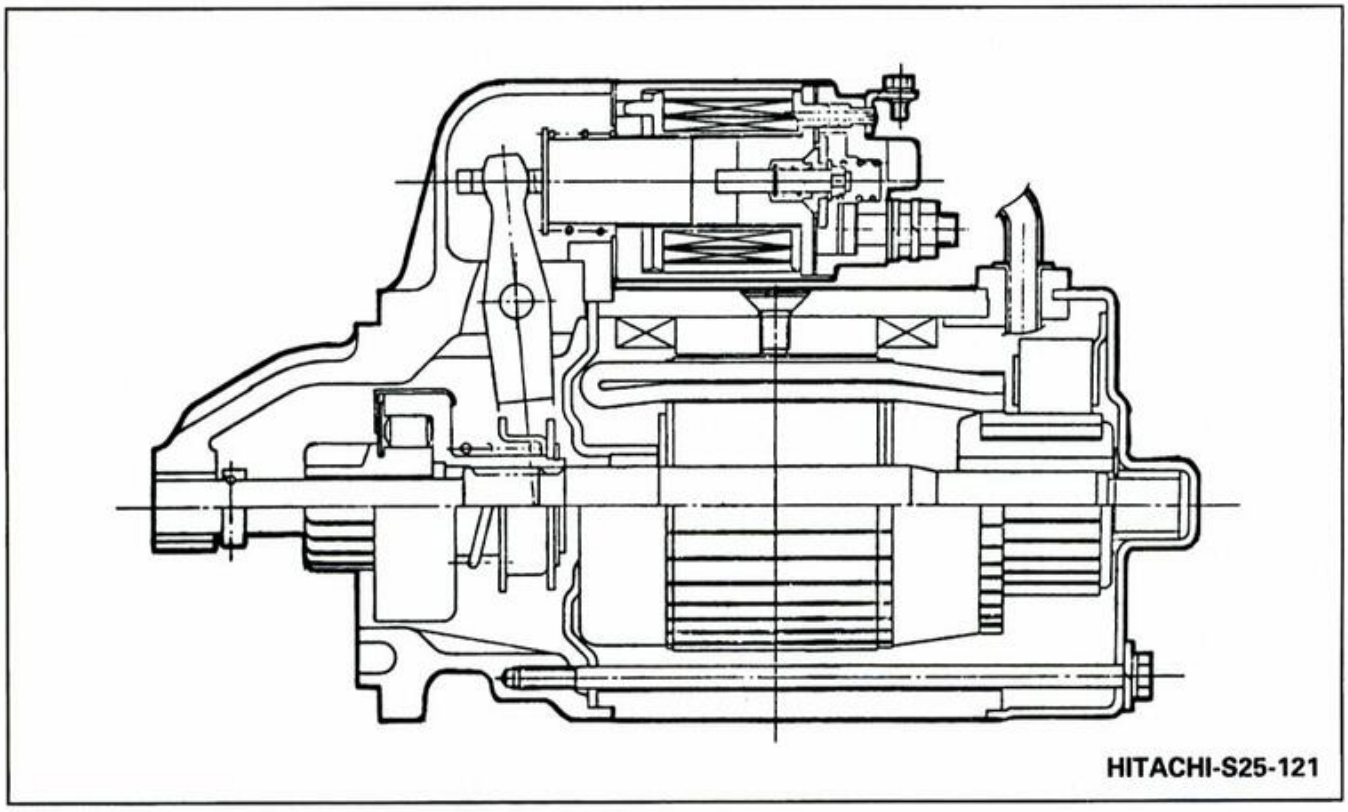

A: Isuzu part number
B: Manufacturer's code number
C: Rated output
D: Manufacturer's production mark

# STARTER

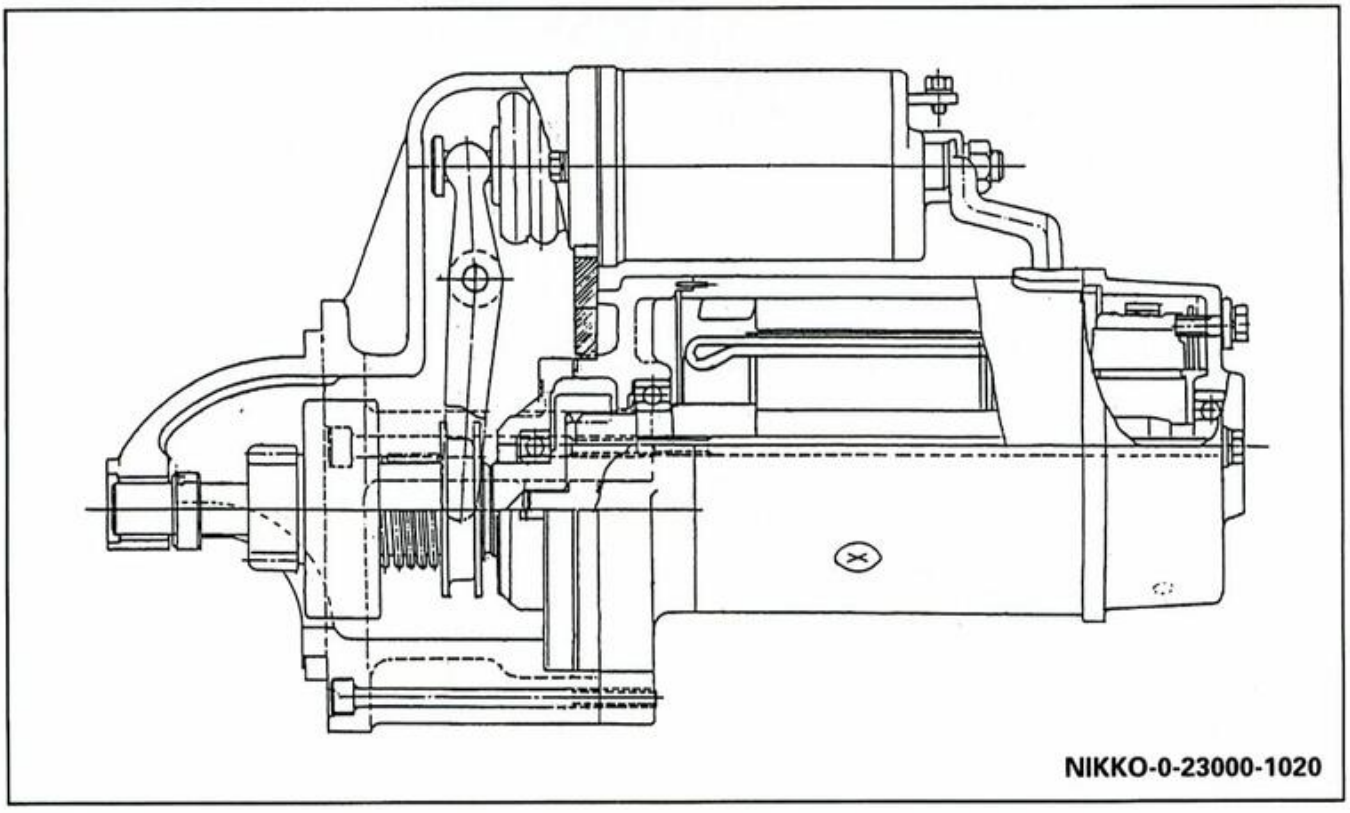
## MAIN DATA AND SPECIFICATIONS

| Isuzu Part No. | | 5-81100-129-0 | 5-81100-174-2 |
|---|---|---|---|
| Manufacturer's code No. | | S25-121 (HITACHI) | 0-23000-1020 (NIKKO) |
| Rated voltage | (V) | 24 | 12 |
| Rated output | (kW) | 3.5 | 2.2 |
| Rating | (Sec) | 30 | 30 |
| Direction of rotation (Viewed from the pinion side) | | Clockwise | Clockwise |
| Clutch type | | Roller | Roller |
| Terminal voltage (No load) | (V) | 24 | 12 |
| Minimum current (No load) | (A) | Less than 90 | 130 |
| Starter minimum operating speed (No load) | (rpm) | More than 6000 | More than 4000 |
| Pinion gear | | | |
| Modules | | 2.75 | 2.75 |
| Number of teeth | | 9 | 9 |
| Outside diameter | mm(in.) | 33 | 33 |
| Travel distance | mm(in.) | 1.51 | 1.51 |
| Yoke outside diameter | mm(in.) | | 90 (3.55) |
| Number of poles | | | 4 |
| Magnetic switch (at 20°C [68°F] ) | | | |
| Series coil resistance | (Ω) | 0.70 | 0.23 |
| Shunt coil resistance | (Ω) | 2.0 | 0.69 |
| Brush length | | | |
| Standard | mm(in.) | 19.5 (0.77) | 19.0 (0.75) |
| Limit | mm(in.) | 11.5 (0.45) | 12.0 (0.47) |
| Brush spring standard fitting load | kg/(lbs.) | 2.75 (6.01) | 4.5 (9.92) |
| Commutator | | | |
| Outside diameter | | | |
| Standard | mm(in.) | 48.0 (1.89) | 36.0 (1.42) |
| Limit | mm(in.) | 45.0 (1.77) | 35.0 (1.38) |
| Difference between the largest and smallest diameters (Run-out) | | | |
| Standard | mm(in.) | 0.05 (0.002) | 0.015 (0.0006) |
| Limit | mm(in.) | 0.4 (0.016) | 0.1 (0.004) |
| Depth of undercut mica | | | |
| Standard | mm(in.) | 0.5 — 0.8 (0.020 — 0.031) | 0.7 — 0.9 (0.028 — 0.036) |
| Limit | mm(in.) | 0.2 (0.008) | 0.2 (0.008) |

## STARTER SECTIONAL VIEW

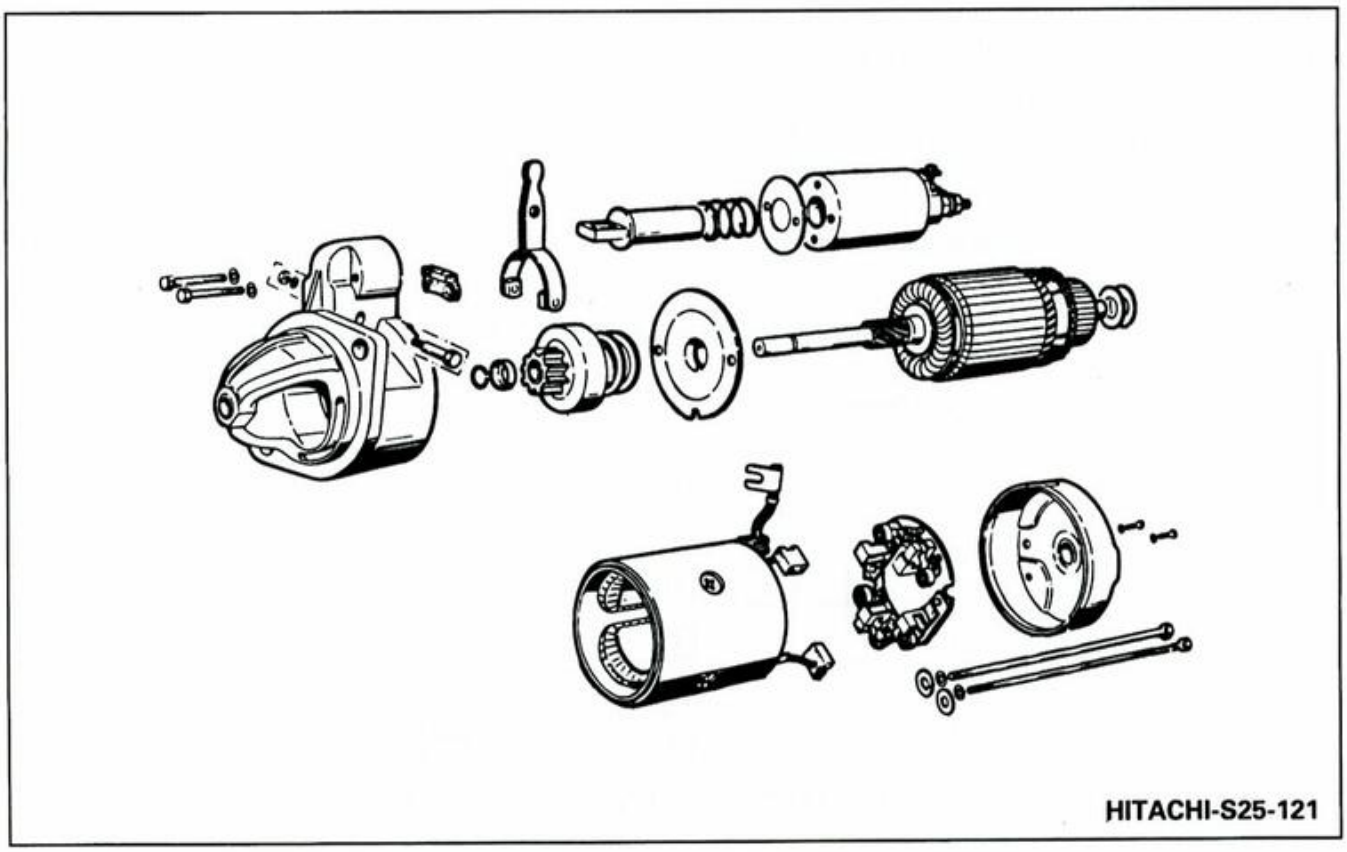


HITACHI-S25-121

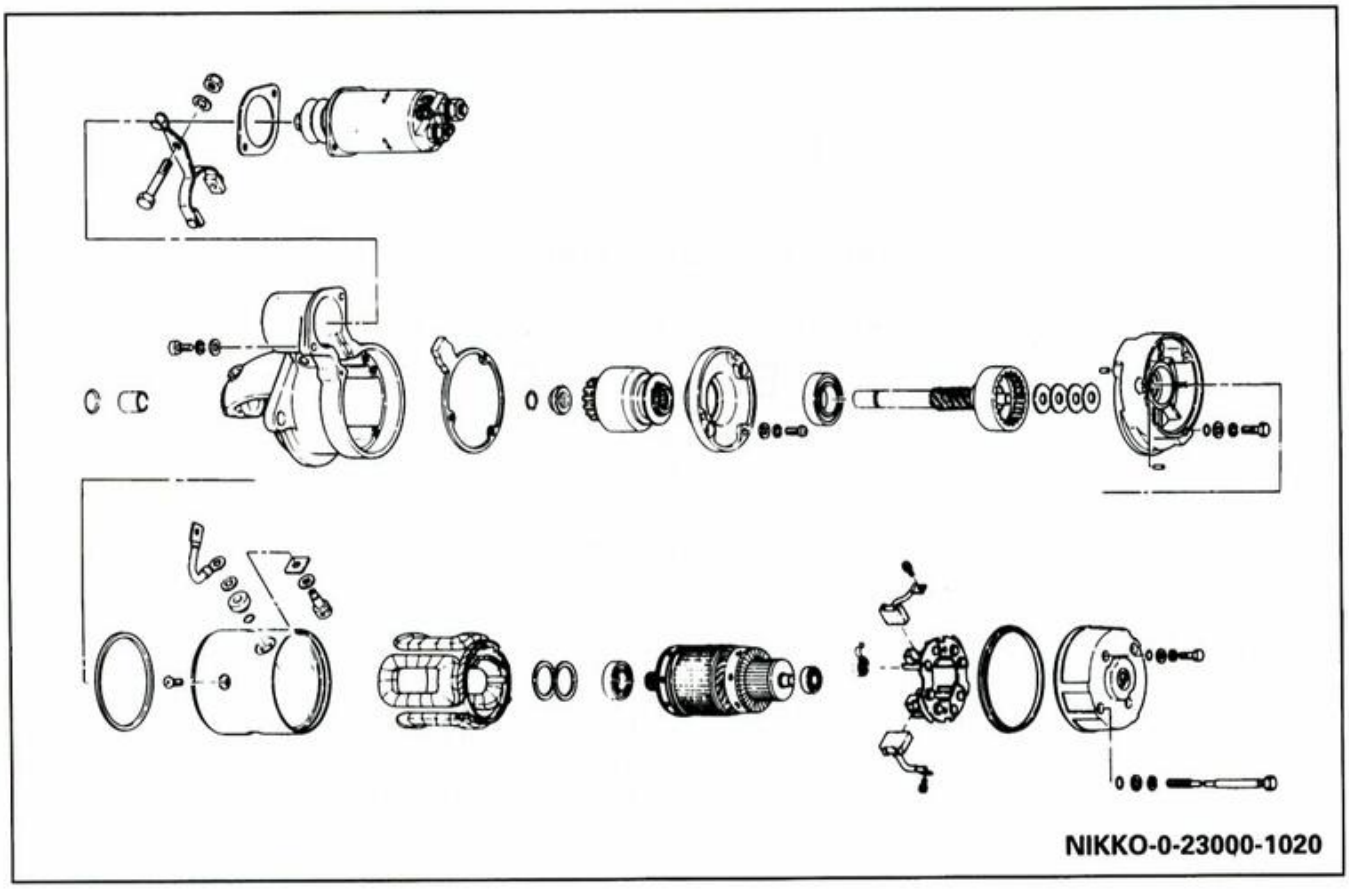


NIKKO-0-23000-1020

## STARTER EXPLODED VIEW



HITACHI-S25-121



NIKKO-0-23000-1020

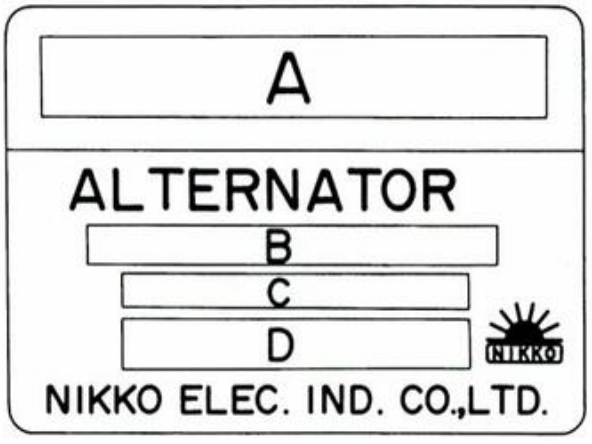
# GENERATOR IDENTIFICTAION

The generator identification plate is attached to the generator rear bracket. The ISUZU part number, the manufacturer's code number, and other important information are stamped on the plate.

Refer to the identification plate together with the "Main Data and Specifications" Tables and accompanying charts in this Manual when requesting service assistance from a qualified electrical repair shop.

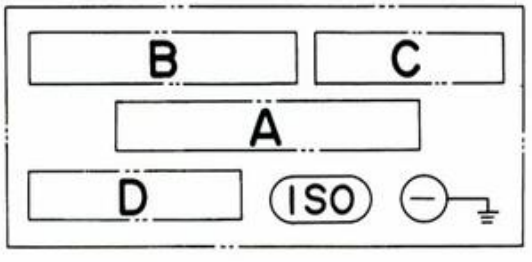
If you are unable to locate the data applicable to your engine, please contact ISUZU MOTORS LIMITED through your machine supplier.

**NIKKO IDENTIFICATION PLATE**




A: Isuzu part number
B: Manufacturer's code number
C: Rated output
D: Manufacturer's production mark

**HITACHI IDENTIFICATION PLATE**




A: Isuzu part number
B: Manufacturer's code number
C: Rated output
D: Manufacturer's production mark

# MAIN DATA AND SPECIFICATIONS

## GENERATOR

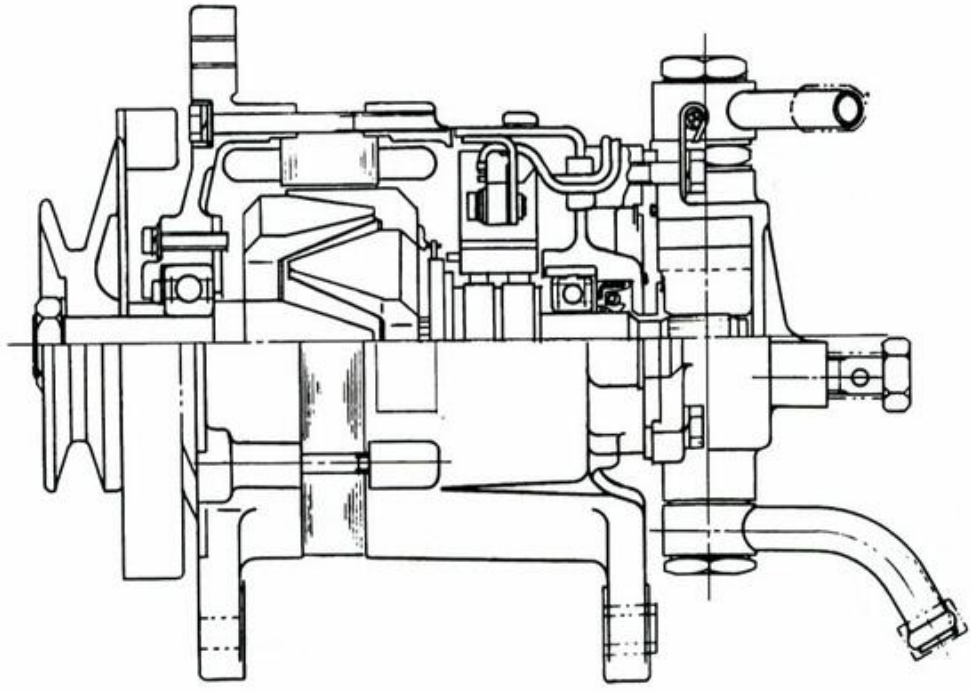
| | | |
|---|---|---|
| Isuzu Part No. | | 5-81200-266-2 |
| Manufacturer's code No. (HITACHI) | | LT140-109 |
| Rated voltage | (V) | 12 |
| Rated output | (A) | 40 |
| Operating speed | (rpm) | 1050 — 11000 |
| Rated speed | (rpm) | 5000 |
| Rated output at r.p.m. | (Amp./Volt/rpm) | 30 or more/14/2500<br>39 or more/14/5000 |
| No-load output at 0 Amp. | (Volt/rpm) | 14/1050 or less |
| Direction of rotation as viewed from pulley side | | Clockwise |
| Polarity grounded | | Negative |
| Pulley diameter | mm(in.) | 77 |
| Coil resistance at 20°C | | |
| Rotor coil | | 4.0 |
| Stator coil [U-V-W] | (Ω) | 0.40 |
| Brush length | | |
| Standard | mm(in.) | 20 |
| Limit | mm(in.) | 14 |
| Brush spring standard fitting load | (g) | 360 |
| Slip ring diameter | | |
| Standard | mm(in.) | 31.6 |
| Limit | mm(in.) | 30.6 |
| Shaft diameter | | |
| Front | mm(in.) | 15 |
| Rear | mm(in.) | 12 |
| Regulator's applicable | | |
| Isuzu part No. | | 9-8225-3107-0 |
| Manufacturer's code No. | | TL1Z-66 |

# MAIN DATA AND SPECIFICATIONS

## REGULATOR

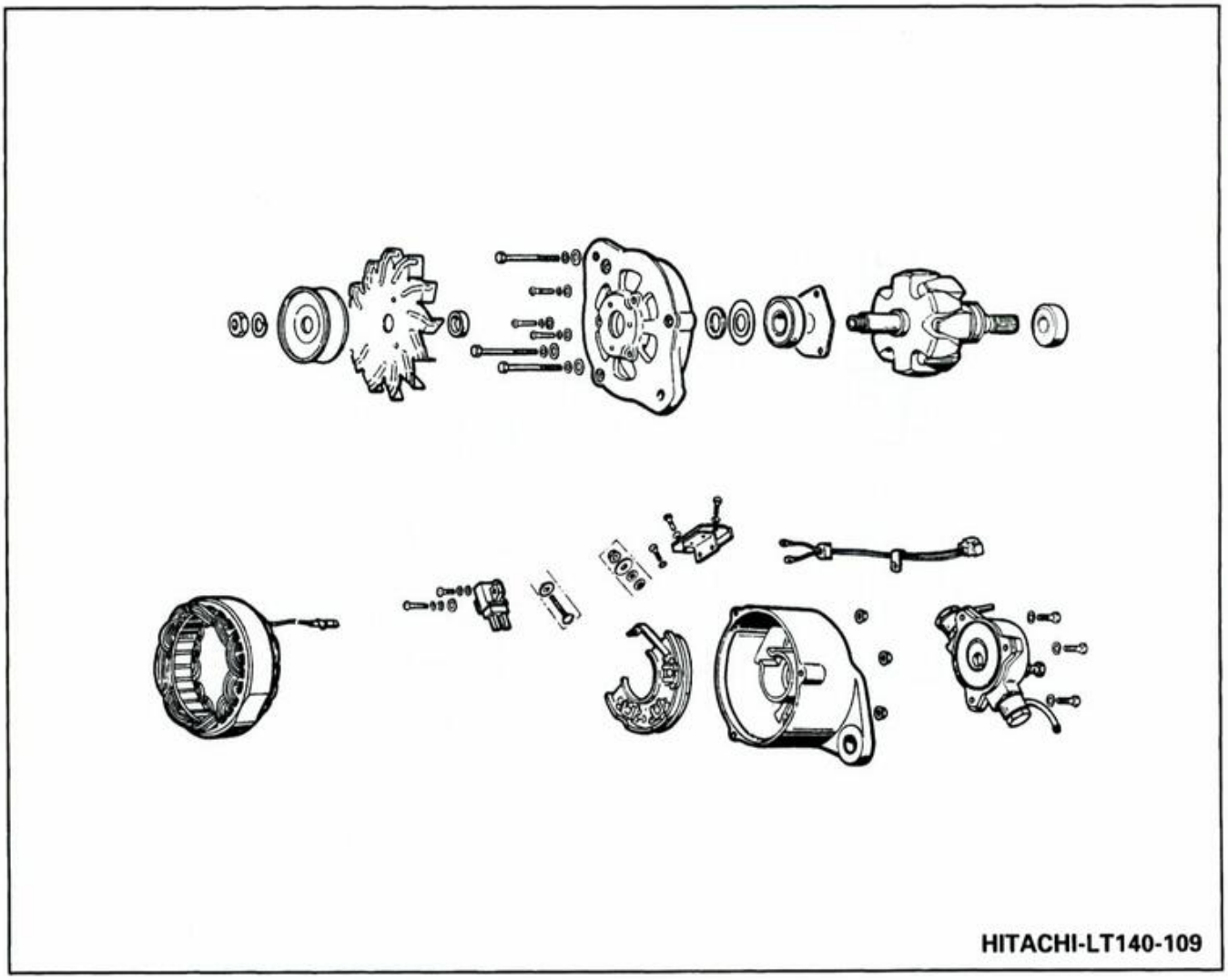
| | | |
|---|---|---|
| Isuzu Part No. | | 9-8225-3107-0 |
| Manufacturer's code No. (HITACHI) | | TL1Z-66 |
| Voltage regulator | | |
| Regulated voltage | (V) | 14.0 — 15.0 |
| Yoke gap | mm(in.) | 0.9 — 1.0 (0.035 — 0.040) |
| Core gap | mm(in.) | 0.6 — 1.0 (0.031 — 0.040) |
| Point gap | mm(in.) | 0.35 — 0.45 (0.016 — 0.020) |
| Relays | | |
| Actuating voltage | | |
| Generator relay: at N. terminal | | — |
| Field relay: at A. terminal | | 2 — 3 |
| Yoke gap | mm(in.) | 0.9 — 1.0 (0.035 — 0.040) |
| Core gap | mm(in.) | 0.8 — 1.2 (0.031 — 0.047) |
| Point gap | mm(in.) | 0.4 — 0.6 (0.016 — 0.024) |
| Resistance | | |
| Voltage coil | (Ω) | 10.3 |
| Generator coil | (Ω) | — |
| Field coil | (Ω) | 31.9 |
| Conditions for adjustment | | With connector faced up<br>Charging current 5A or less |

## GENERATOR SECTIONAL VIEW



HITACHI-LT140-109

## GENERATOR EXPLODED VIEW



HITACHI-LT140-109

## SECTION 10

# TROUBLESHOOTING

### TABLE OF CONTENTS



**Note:**

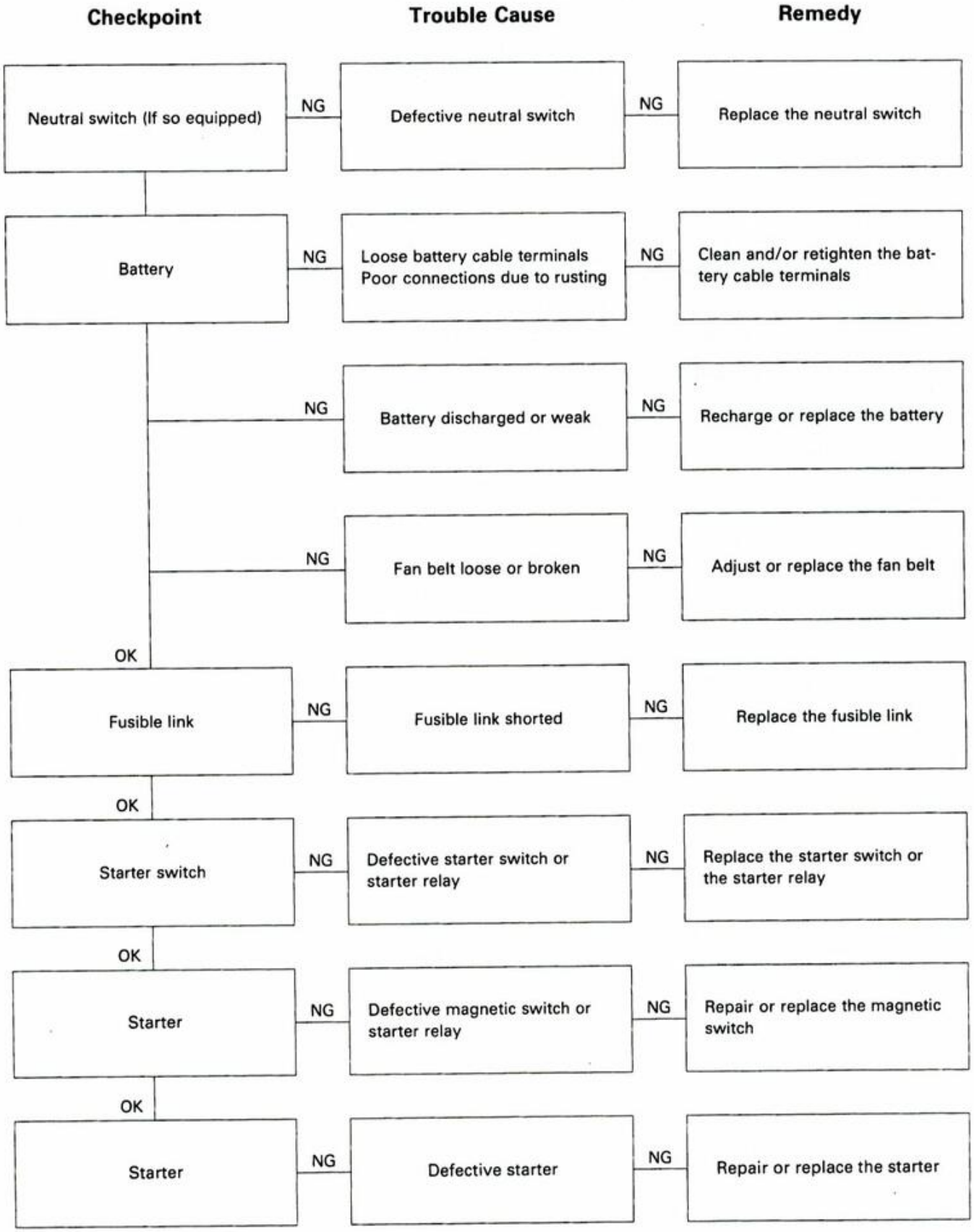
Use this section to quickly diagnose and repair engine failures.

Each troubleshooting chart has three headings arranged from left to right

(1) Check point (2) Trouble cause (3) Remedy

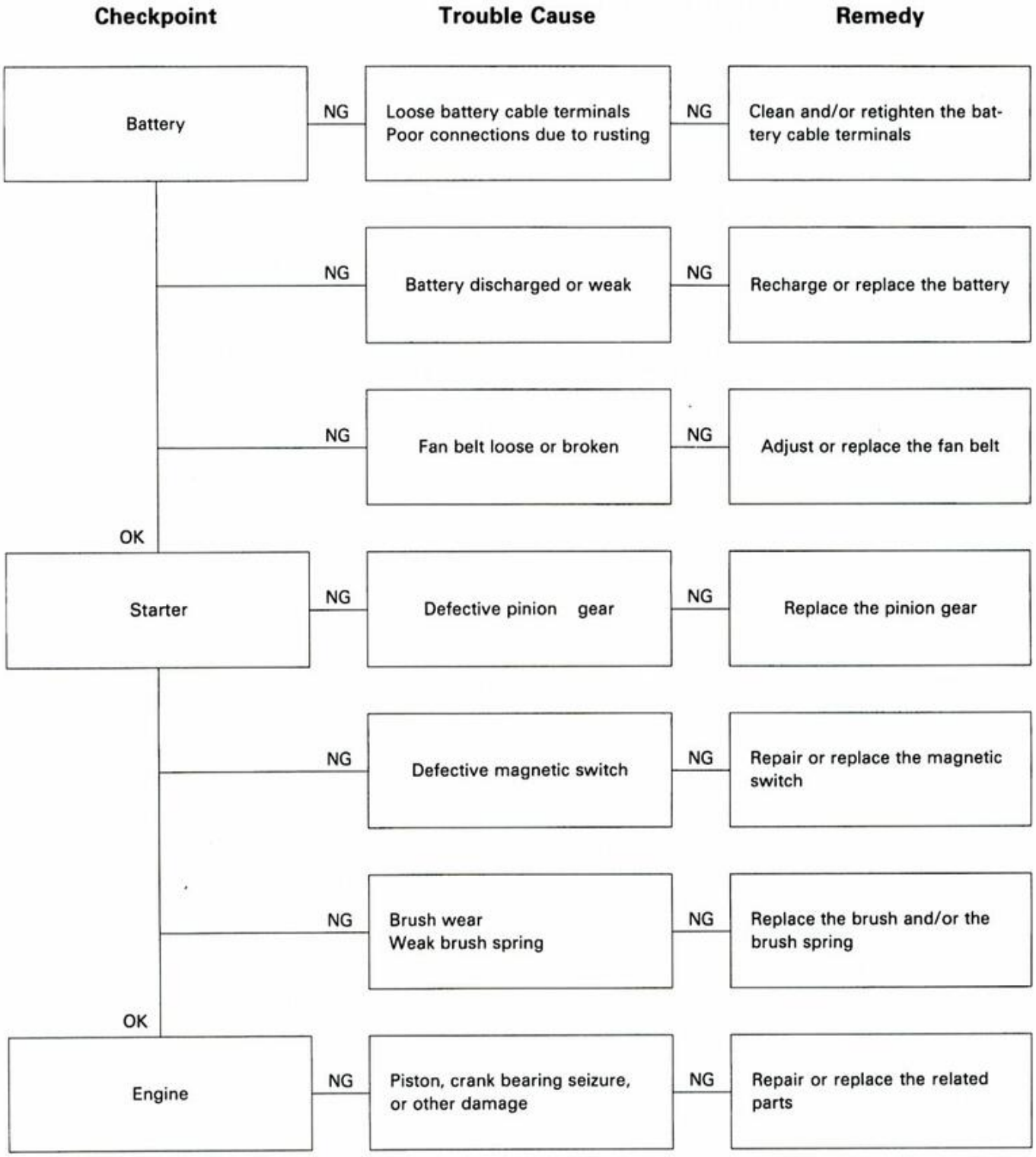
# HARD STARTING

## 1) STARTER INOPERATIVE



# HARD STARTING

## 2) STARTER OPERATES BUT ENGINE DOES NOT TURN OVER

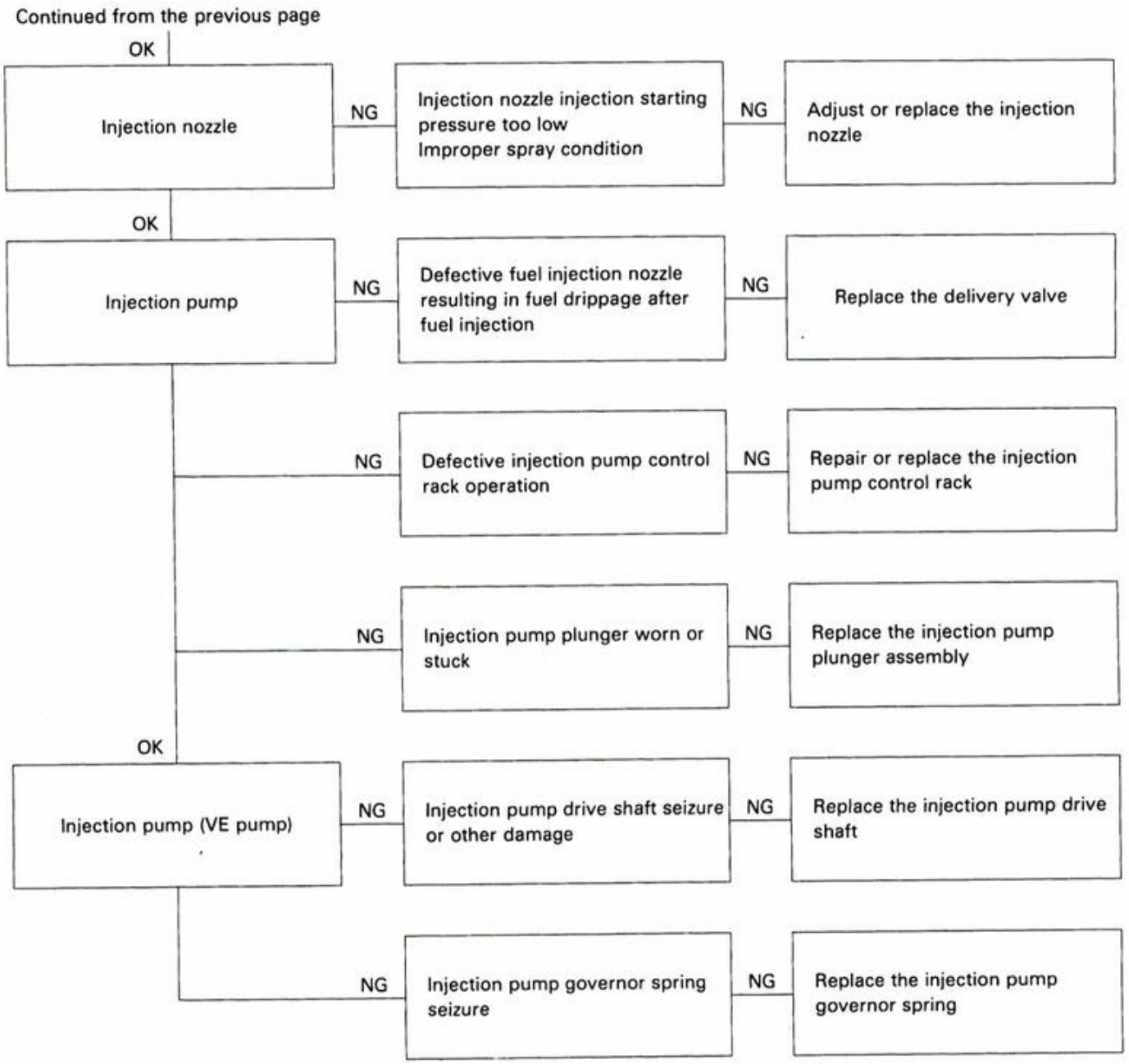


# HARD STARTING

## 3) ENGINE TURNS OVER BUT DOES NOT START

## FUEL IS BEING DELIVERED TO THE INJECTION PUMP

Continued from the previous page



# HARD STARTING

## 4) ENGINE TURNS OVER BUT DOES NOT START

| Checkpoint | | Trouble Cause | | Remedy |
|---|---|---|---|---|
| Engine stop mechanism | NG | Defective engine stop mechanism<br>Control wire improperly adjusted (In-line pump) | NG | Replace the engine stop mechanism<br>Adjust the control wire |
| | NG | Defective fuel cut solenoid valve (VE pump) | NG | Replace the fuel cut solenoid valve |

## FUEL IS NOT BEING DELIVERED TO THE INJECTION PUMP

| | | | | |
|---|---|---|---|---|
| Fuel | NG | Fuel tank is empty | NG | Fill the fuel tank |
| OK | | | | |
| Fuel piping | NG | Clogged or damaged fuel lines<br>Loose fuel line connections | NG | Repair or replace the fuel lines<br>Retighten the fuel line connections |
| OK | | | | |
| Fuel filter | NG | Fuel filter overflow valve does not close | NG | Repair or replace the fuel filter overflow valve |
| | NG | Clogged fuel filter element | NG | Replace the fuel filter element or the fuel filter cartridge |
| OK | | | | |
| Fuel system | NG | Air in the fuel system | NG | Bleed the air from the fuel system |

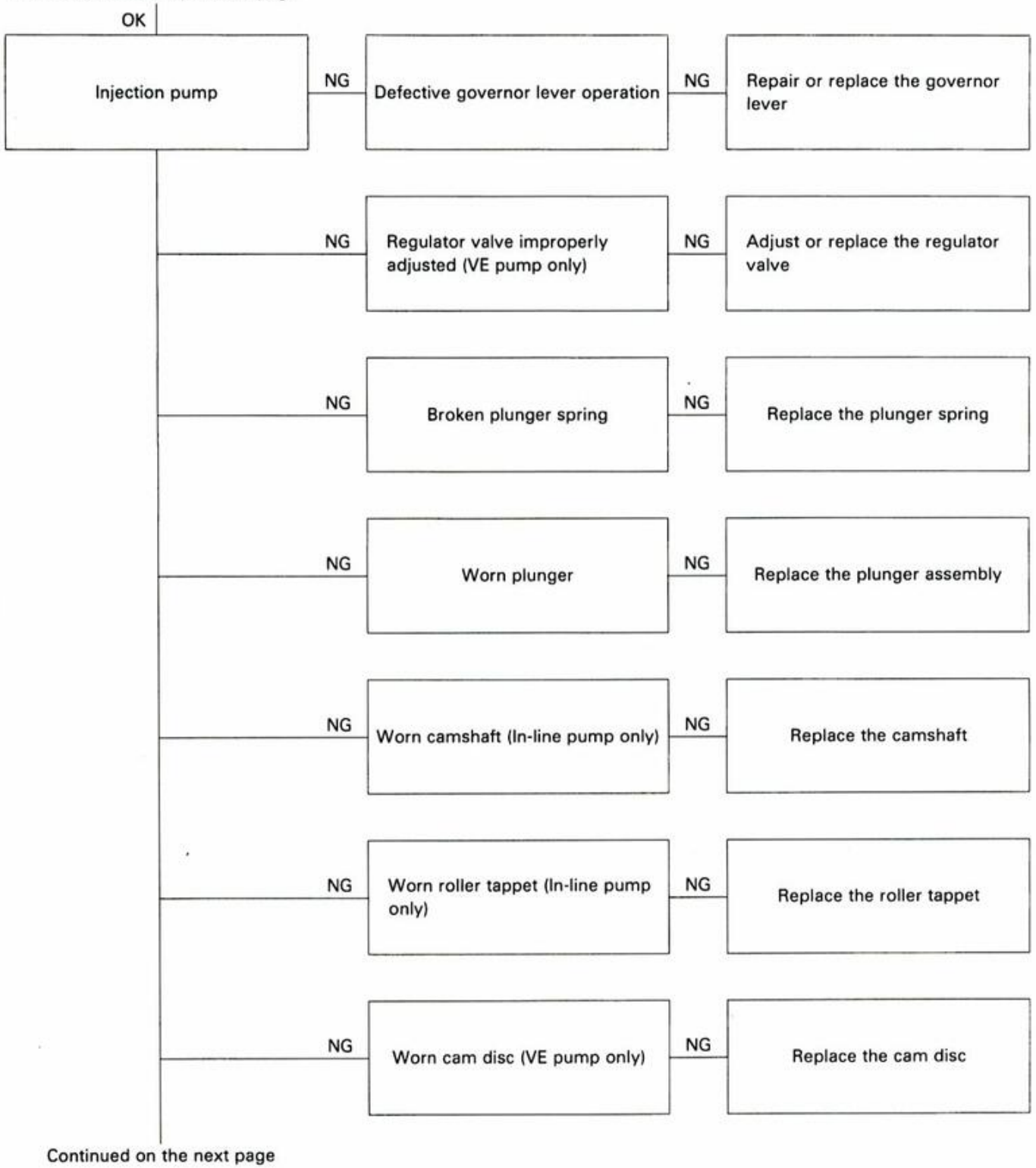
Continued on the next page

# UNSTABLE LOW IDLING


Continued on the next page

# UNSTABLE LOW IDLING

Continued from the previous page

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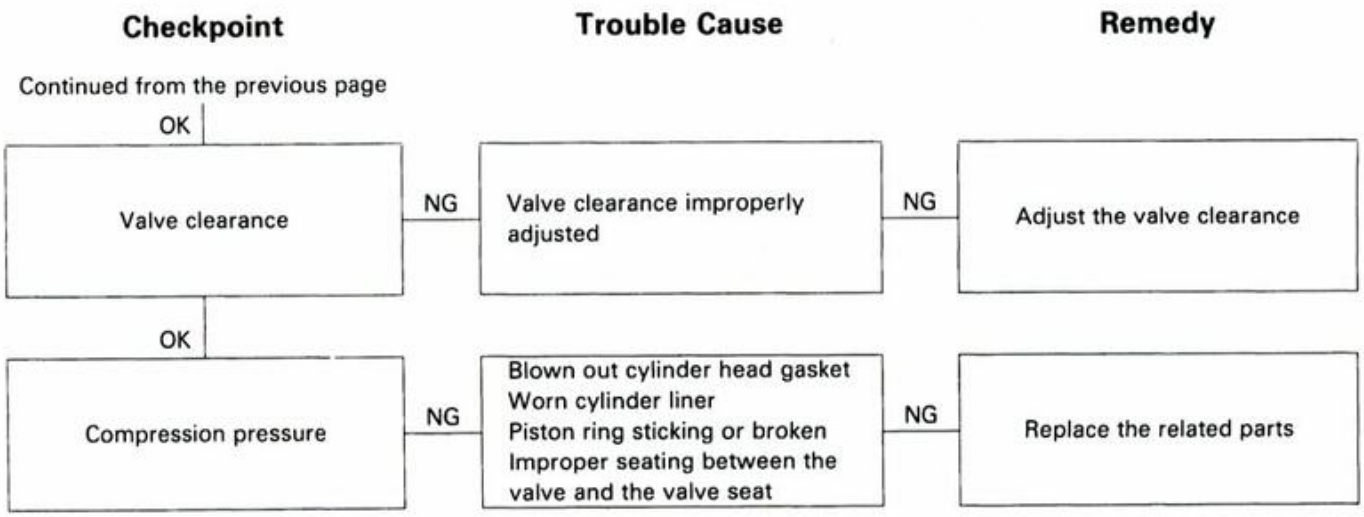
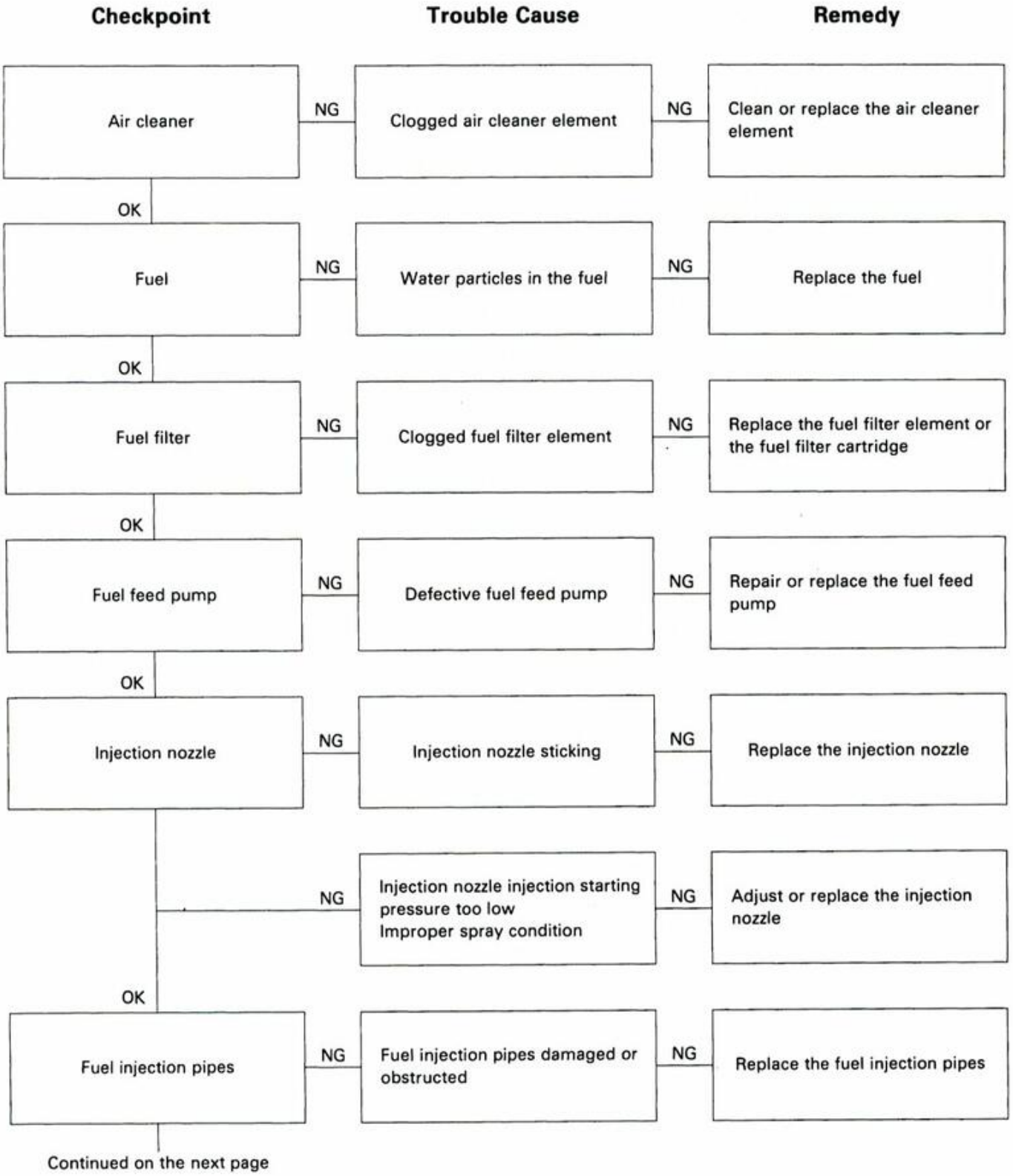
# UNSTABLE LOW IDLING



# INSUFFICIENT POWER

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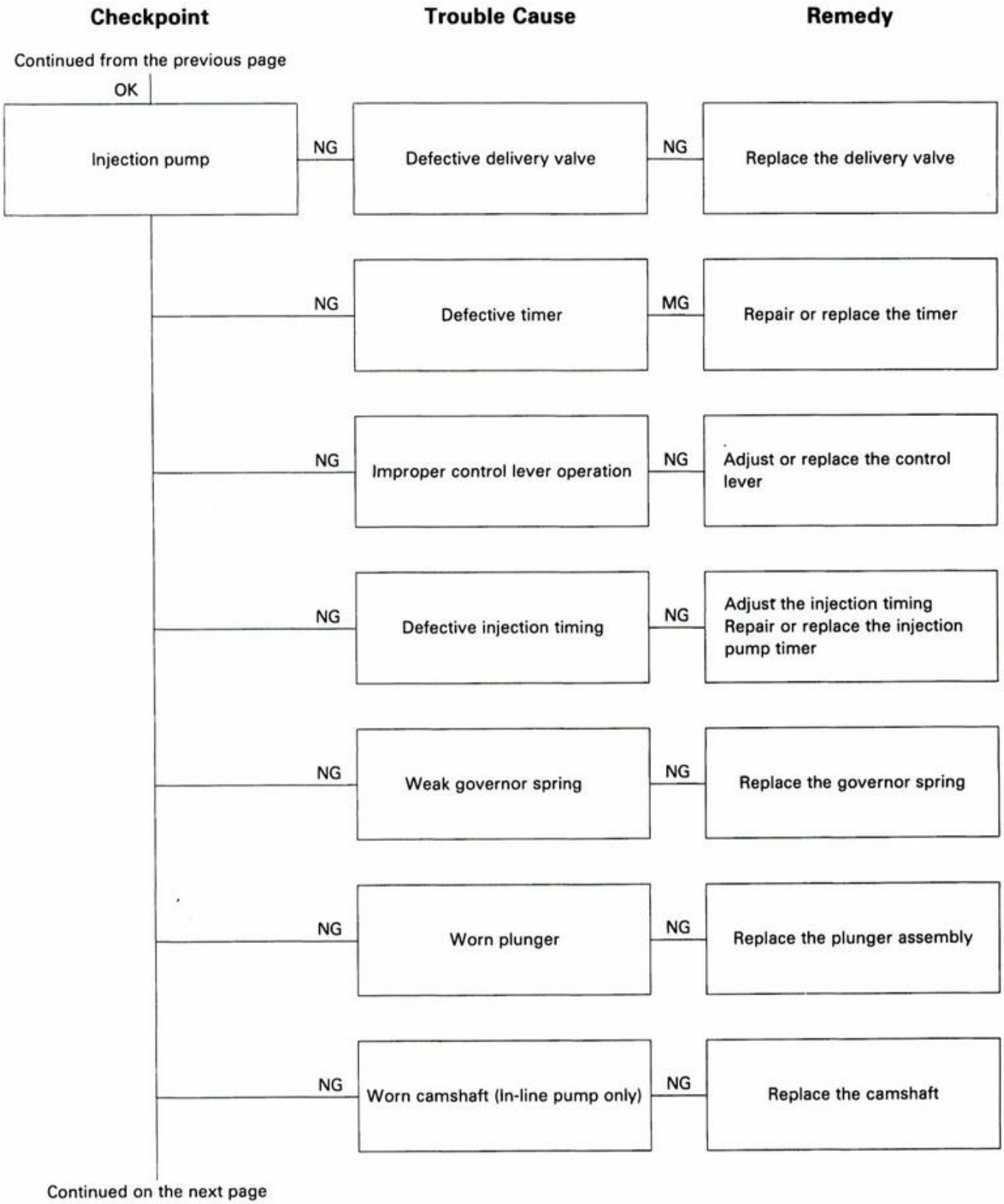
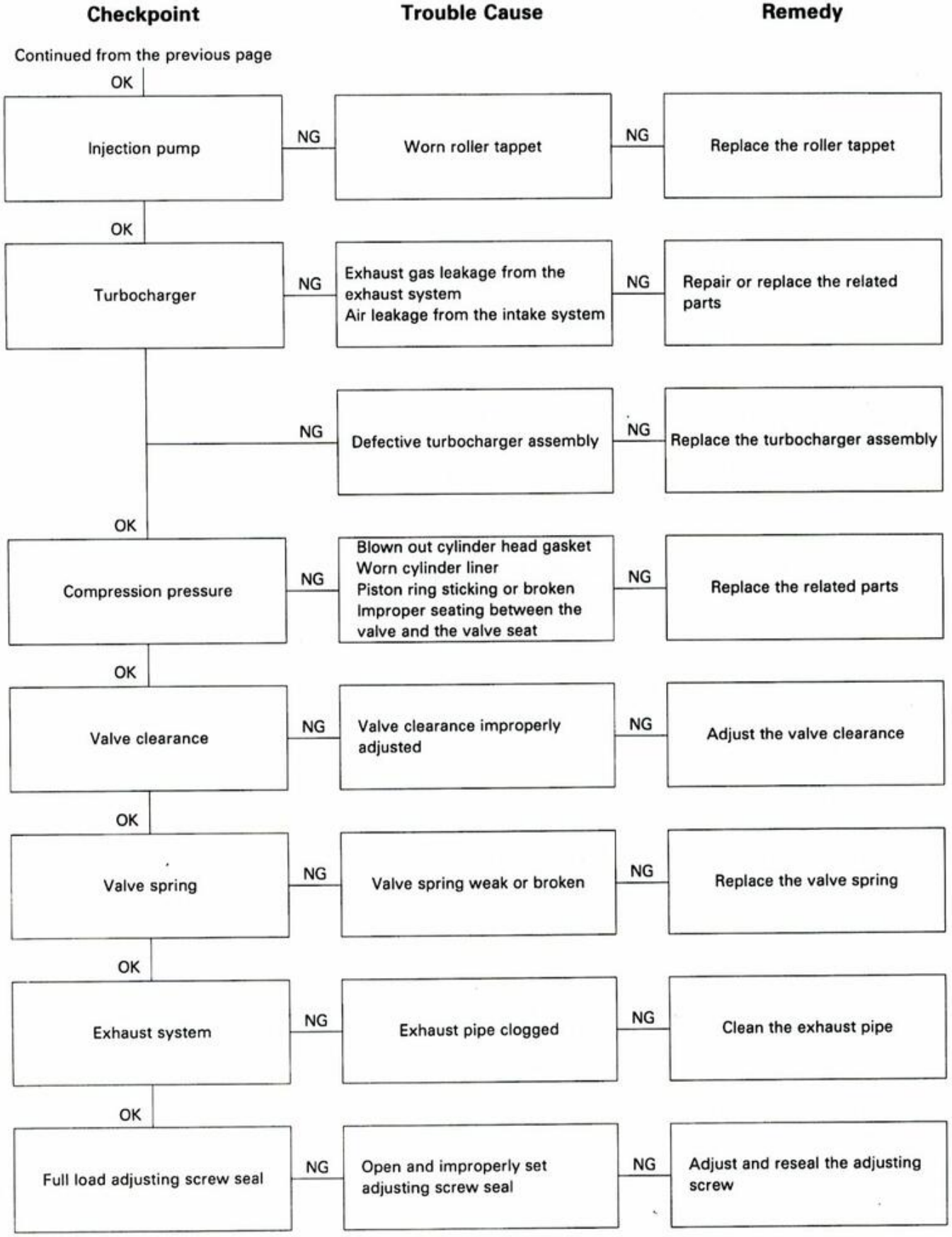
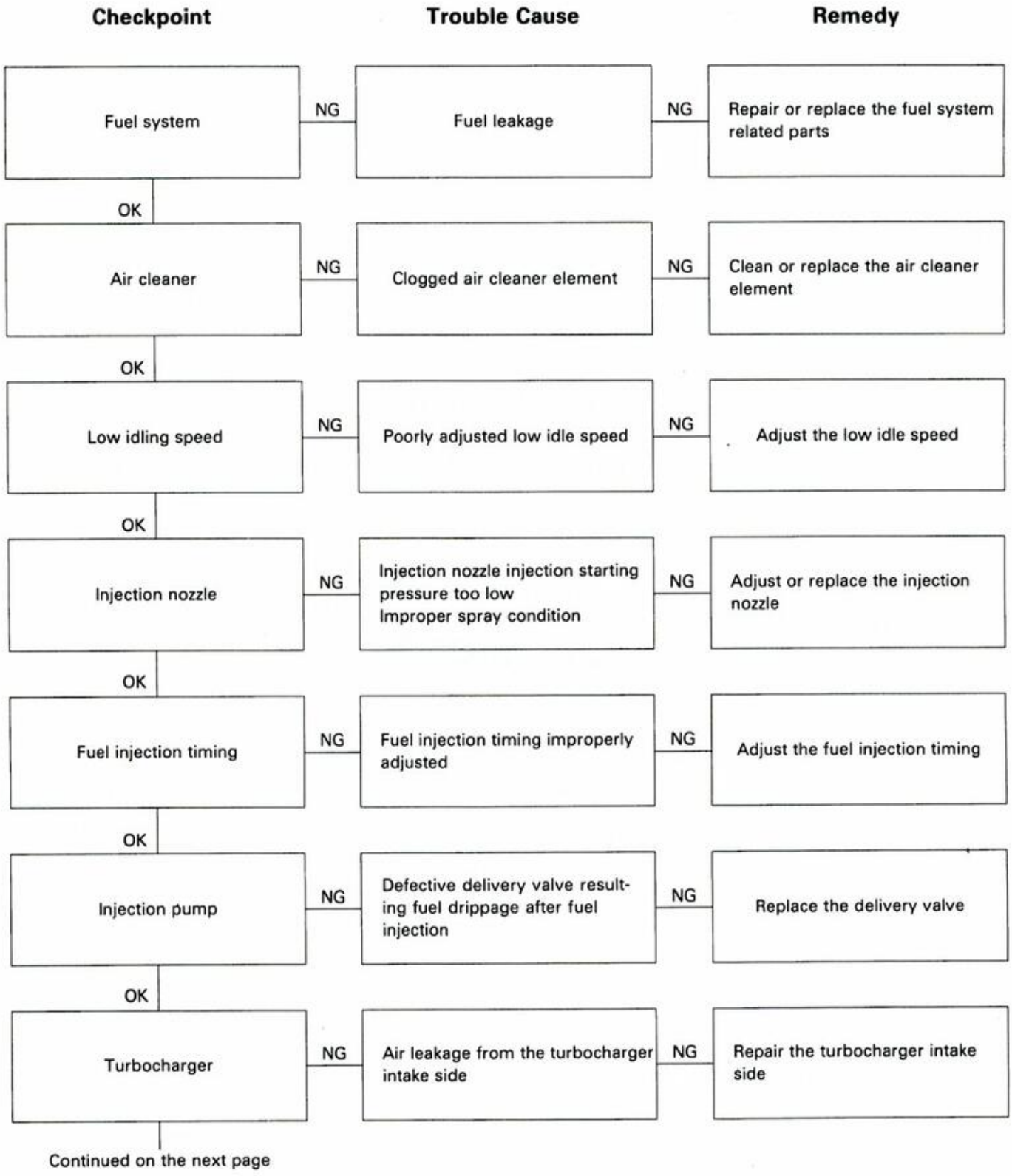
# INSUFFICIENT POWER



# INSUFFICIENT POWER



# EXCESSIVE FUEL CONSUMPTION

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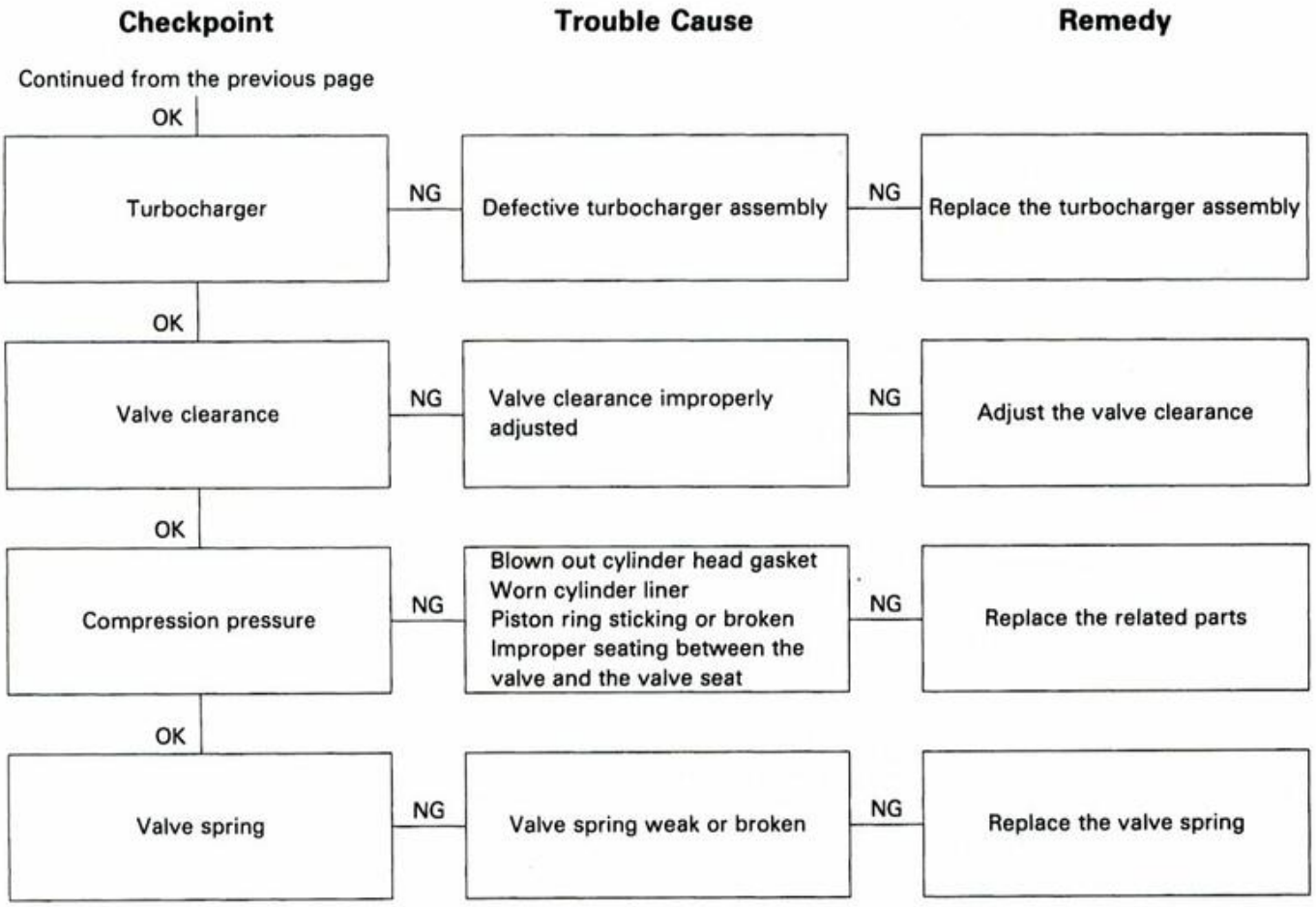
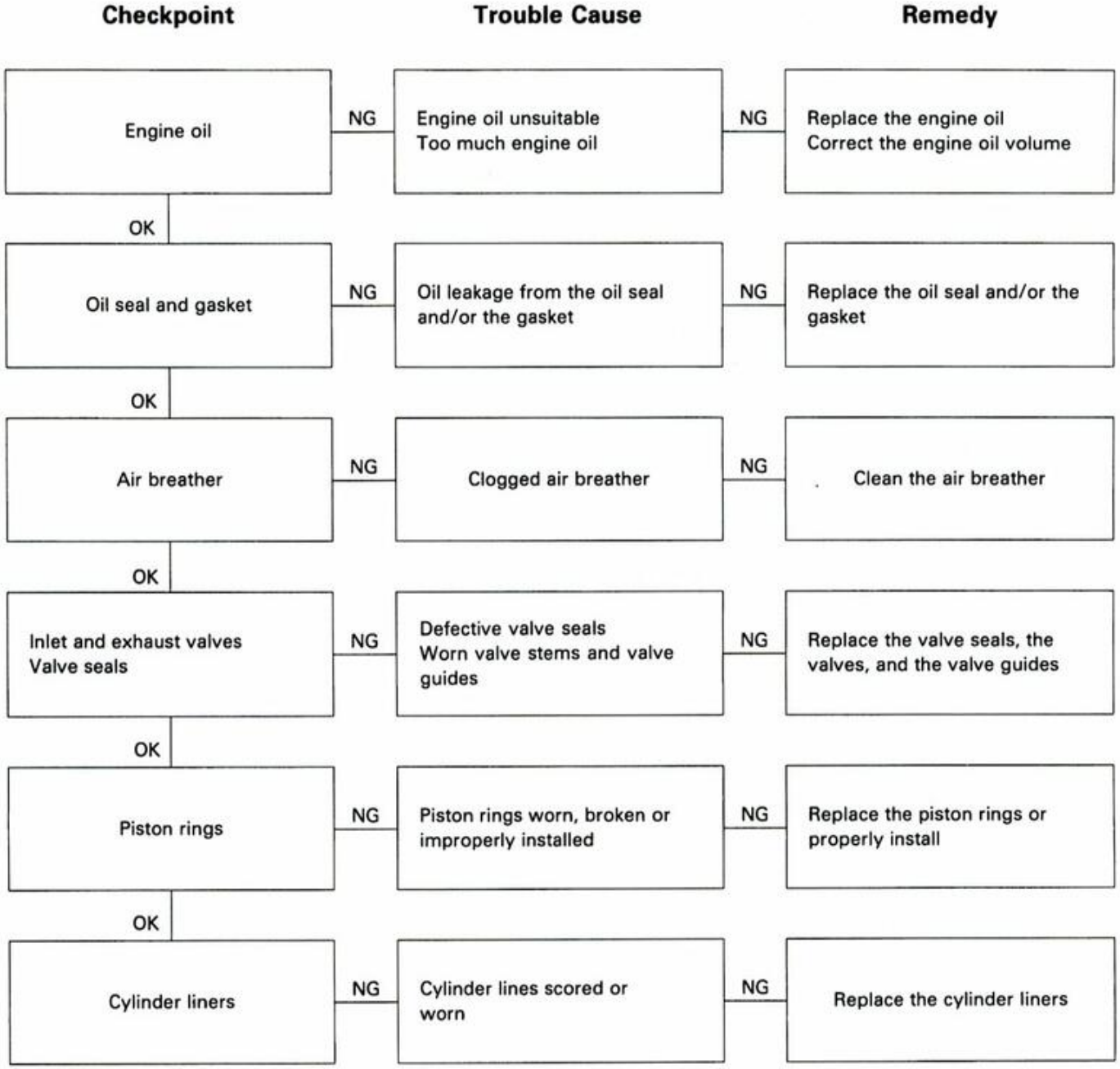
# EXCESSIVE FUEL CONSUMPTION



# EXCESSIVE OIL CONSUMPTION

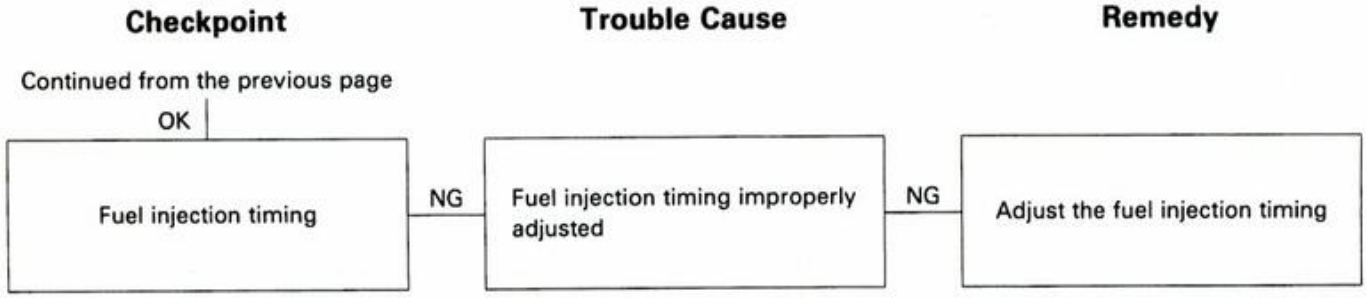


# OVERHEATING

| Checkpoint | | Trouble Cause | | Remedy |
|---|---|---|---|---|
| Cooling water | NG | Insufficient cooling water | NG | Replenish the cooling water |
| OK | | | | |
| Fan belt | NG | Fan belt loose or cracked causing slippage | NG | Replace the fan belt |
| OK | | | | |
| Radiator | NG | Defective radiator cap or clogged radiator core | NG | Replace the radiator cap or clean the radiator core |
| OK | | | | |
| Water pump | NG | Defective water pump | NG | Repair or replace the water pump |
| OK | | | | |
| Cylinder head and cylinder body sealing cap | NG | Defective sealing cap resulting in water leakage | NG | Replace the sealing cap |
| OK | | | | |
| Thermostat | NG | Defective thermostat | NG | Replace the thermostat |
| OK | | | | |
| Cooling system | NG | Cooling system clogged by foreign material | NG | Clean the foreign material from the cooling system |

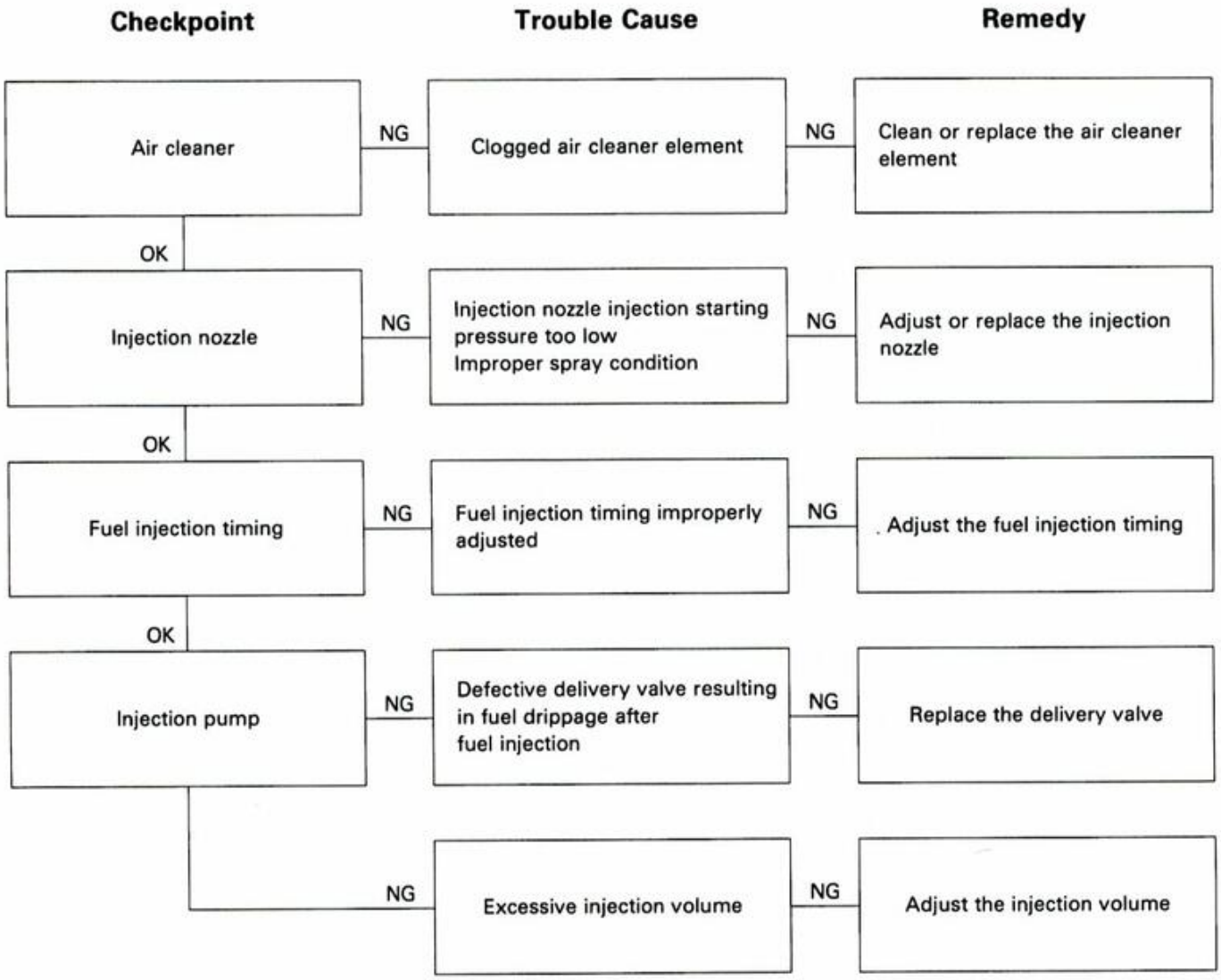
Continued on the next page

## OVERHEATING

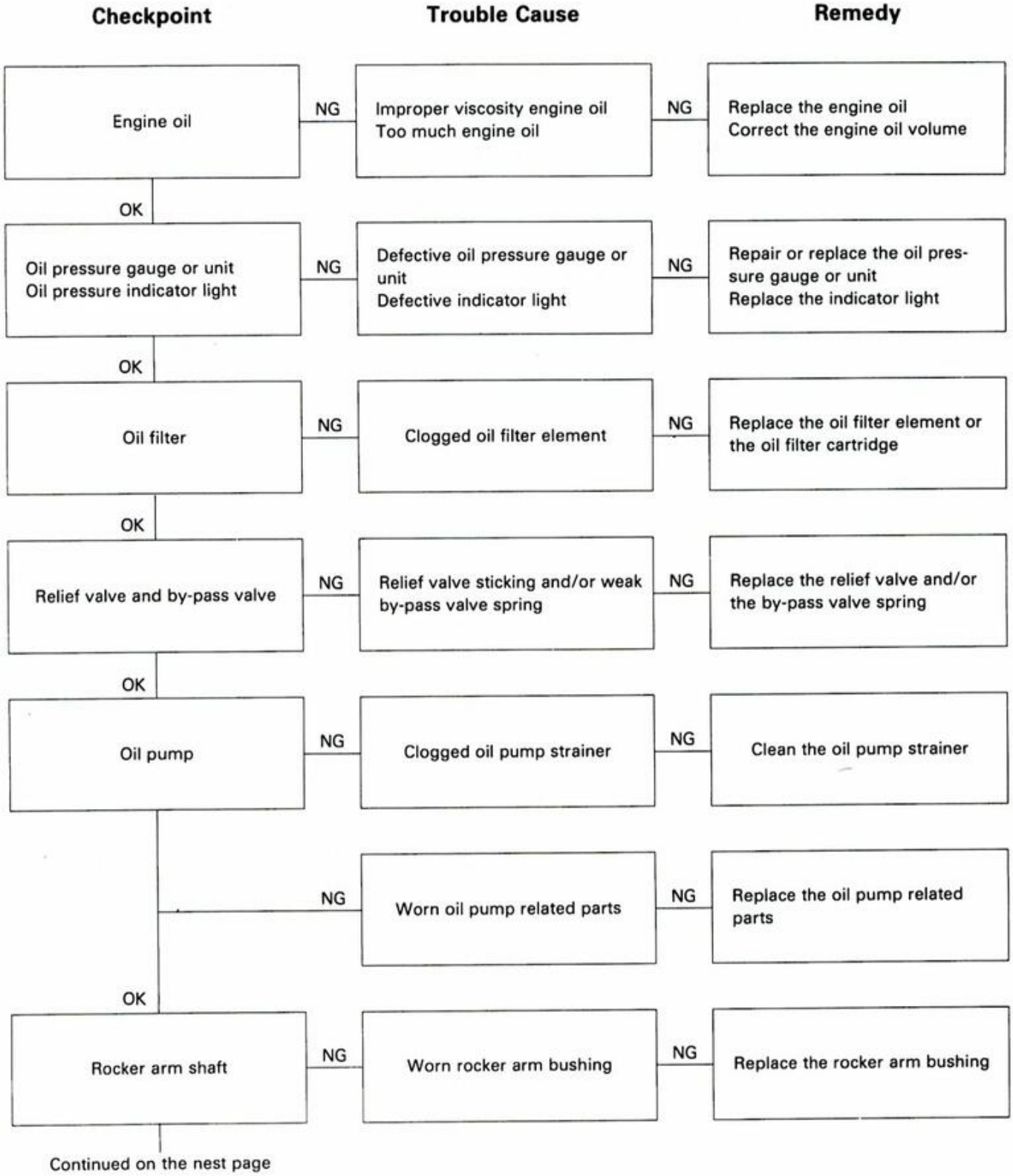


# WHITE EXHAUST SMOKE

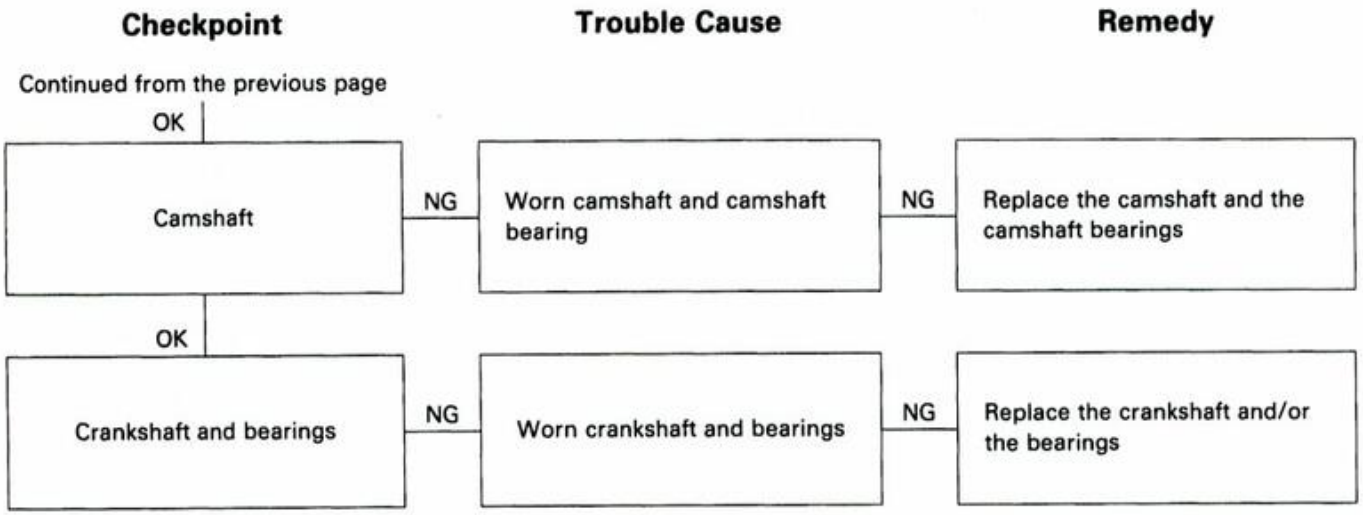
# DARK EXHAUST SMOKE



# OIL PRESSURE DOES NOT RISE



# OIL PRESSURE DOES NOT RISE



# ABNORMAL ENGINE NOISE

## 1. Engine Knocking

| Checkpoint | | Trouble Cause | | Remedy |
|---|---|---|---|---|
| Fuel | NG | Fuel unsuitable | NG | Replace the fuel |
| OK | | | | |
| Fuel injection timing | NG | Fuel injection timing improperly adjusted | NG | Adjust the fuel injection timing |
| OK | | | | |
| Injection nozzle | NG | Improper injection nozzle starting pressure and spray condition | NG | Adjust or replace the injection nozzle |
| OK | | | | |
| Compression pressure | NG | Blown out head gasket<br>Broken piston ring | NG | Replace the head gasket or the piston ring |

## 2. Gas Leakage Noise

| | | | | |
|---|---|---|---|---|
| Exhaust pipes | NG | Loosely connected exhaust pipes<br>Broken exhaust pipes | NG | Tighten the exhaust pipe connections<br>Replace the exhaust pipes |
| OK | | | | |
| Injection nozzles and/or glow plugs | NG | Loose injection nozzles and/or glow plugs | NG | Replace the washers<br>Tighten the injection nozzles and/or the glow plugs |

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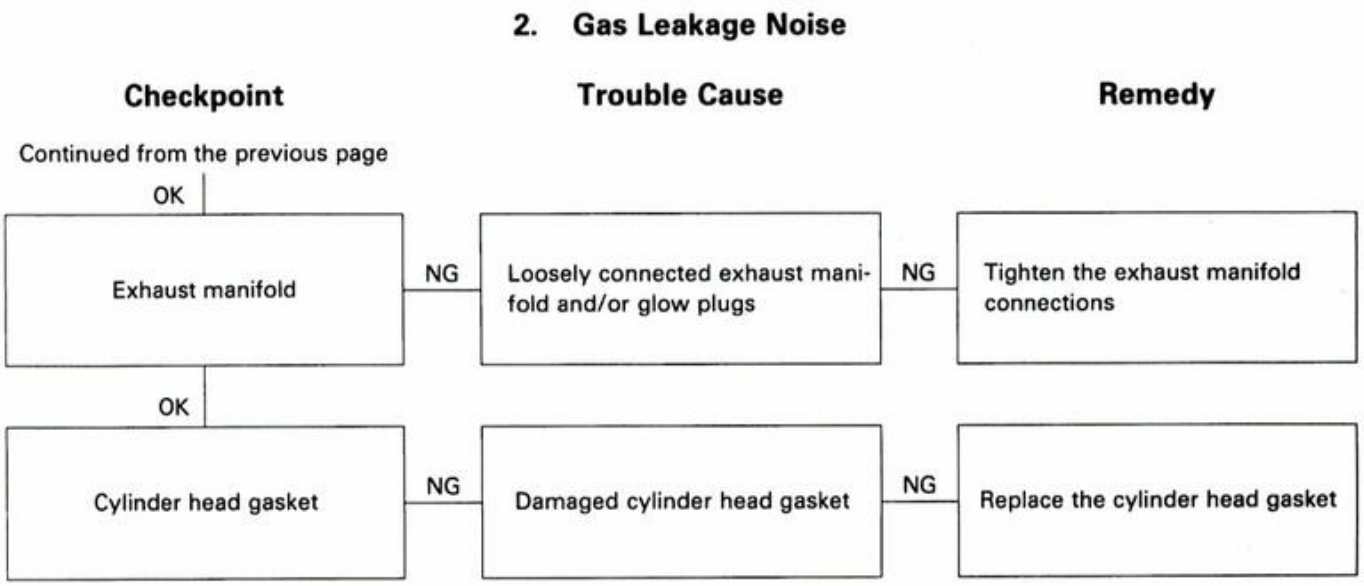
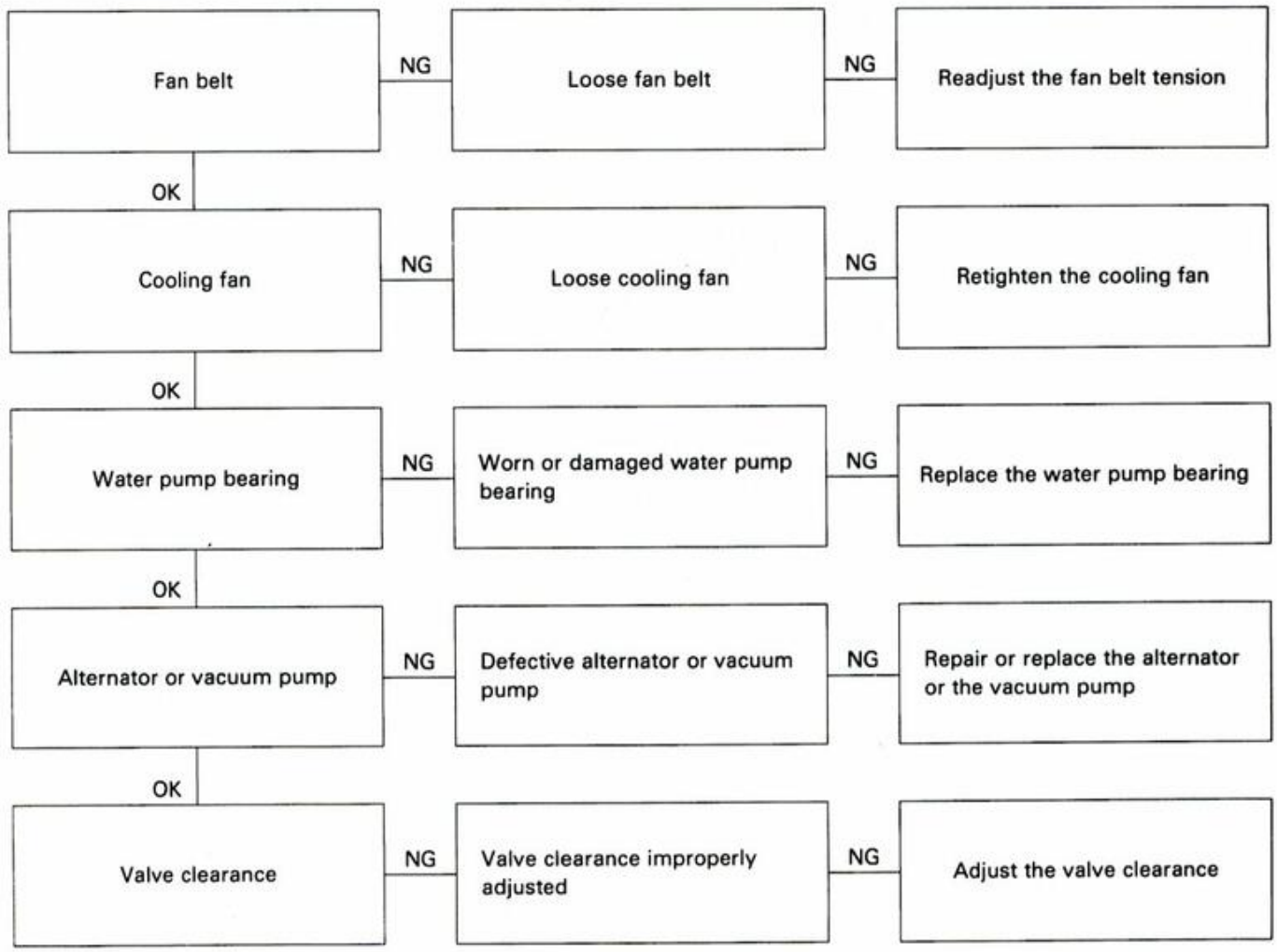
# ABNORMAL ENGINE NOISE

## 2. Gas Leakage Noise




## 3. Continuous Noise



# ABNORMAL ENGINE NOISE

## 4. Slapping Noise

| Checkpoint | | Trouble Cause | | Remedy |
|---|---|---|---|---|
| Valve clearance | NG | Valve clearance improperly adjusted | NG | Adjust the valve clearance |
| OK | | | | |
| Rocker arm | NG | Damaged rocker arm | NG | Replace the rocker arm |
| OK | | | | |
| Flywheel | NG | Loose flywheel bolts | NG | Retighten the flywheel bolts |
| OK | | | | |
| Crankshaft and thrust bearings | NG | Worn or damaged crankshaft and/or thrust bearings | NG | Replace the crankshaft and/or the thrust bearings |
| OK | | | | |
| Crankshaft and connecting rod bearings | NG | Worn or damaged crankshaft and/or connecting rod bearings | NG | Replace the crankshaft and/or the connecting rod bearings |
| OK | | | | |
| Connecting rod bushing and piston pin | NG | Worn or damaged connecting rod bushing and piston pin | NG | Replace the connecting rod bushing and/or the piston pin |
| OK | | | | |
| Piston and cylinder liner | NG | Worn or damaged piston and cylinder liner<br>Foreign material in the cylinder | NG | Replace the piston and the cylinder liner |

## SECTION 11

# SPECIAL TOOL LIST

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# SPECIAL TOOL LIST

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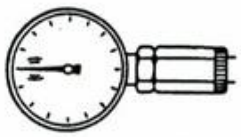
| 2. |  | 5-8840-2008-0 (J-29762) | Compression gauge with adaptor | 30 |
| 3. |  | 5-8531-7002-0 (J-26999-20) | Compression gauge adaptor | 30 |
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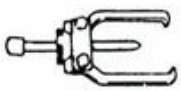
| 5. |  | 5-8521-0002-0 | Universal puller | 49<br>77 |
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|---|---|---|---|---|
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| 13. |  | 9-8522-1279-0 | Rear oil seal installer | 101 |
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## SECTION 12

# CONVERSION TABLE

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## LENGTH

### MILLIMETERS TO INCHES

| mm | in. | mm | in. | mm | in. | mm | in. |
|---|---|---|---|---|---|---|---|
| 1 | 0.0394 | 26 | 1.0236 | 51 | 2.0079 | 76 | 2.9921 |
| 2 | 0.0787 | 27 | 1.0630 | 52 | 2.0472 | 77 | 3.0315 |
| 3 | 0.1181 | 28 | 1.1024 | 53 | 2.0866 | 78 | 3.0709 |
| 4 | 0.1575 | 29 | 1.1417 | 54 | 2.1260 | 79 | 3.1102 |
| 5 | 0.1969 | 30 | 1.1811 | 55 | 2.1654 | 80 | 3.1496 |
| 6 | 0.2362 | 31 | 1.2205 | 56 | 2.2047 | 81 | 3.1890 |
| 7 | 0.2756 | 32 | 1.2598 | 57 | 2.2441 | 82 | 3.2283 |
| 8 | 0.3150 | 33 | 1.2992 | 58 | 2.2835 | 83 | 3.2677 |
| 9 | 0.3543 | 34 | 1.3386 | 59 | 2.3228 | 84 | 3.3071 |
| 10 | 0.3937 | 35 | 1.3780 | 60 | 2.3622 | 85 | 3.3465 |
| 11 | 0.4331 | 36 | 1.4173 | 61 | 2.4016 | 86 | 3.3858 |
| 12 | 0.4724 | 37 | 1.4567 | 62 | 2.4409 | 87 | 3.4252 |
| 13 | 0.5118 | 38 | 1.4961 | 63 | 2.4803 | 88 | 3.4646 |
| 14 | 0.5512 | 39 | 1.5354 | 64 | 2.5197 | 89 | 3.5039 |
| 15 | 0.5906 | 40 | 1.5748 | 65 | 2.5591 | 90 | 3.5433 |
| 16 | 0.6299 | 41 | 1.6142 | 66 | 2.5984 | 91 | 3.5827 |
| 17 | 0.6693 | 42 | 1.6535 | 67 | 2.6378 | 92 | 3.6220 |
| 18 | 0.7087 | 43 | 1.6929 | 68 | 2.6772 | 93 | 3.6614 |
| 19 | 0.7480 | 44 | 1.7323 | 69 | 2.7165 | 94 | 3.7008 |
| 20 | 0.7874 | 45 | 1.7717 | 70 | 2.7559 | 95 | 3.7402 |
| 21 | 0.8268 | 46 | 1.8110 | 71 | 2.7953 | 96 | 3.7795 |
| 22 | 0.8661 | 47 | 1.8504 | 72 | 2.8346 | 97 | 3.8189 |
| 23 | 0.9055 | 48 | 1.8898 | 73 | 2.8740 | 98 | 3.8583 |
| 24 | 0.9449 | 49 | 1.9291 | 74 | 2.9134 | 99 | 3.8976 |
| 25 | 0.9843 | 50 | 1.9685 | 75 | 2.9528 | 100 | 3.9370 |
| 101 | 3.9764 | 111 | 4.3701 | 121 | 4.7638 | 131 | 5.1575 |
| 102 | 4.0157 | 112 | 4.4094 | 122 | 4.8031 | 132 | 5.1968 |
| 103 | 4.0551 | 113 | 4.4488 | 123 | 4.8425 | 133 | 5.2362 |
| 104 | 4.0945 | 114 | 4.4882 | 124 | 4.8819 | 134 | 5.2756 |
| 105 | 4.1339 | 115 | 4.5276 | 125 | 4.9213 | 135 | 5.3150 |
| 106 | 4.1732 | 116 | 4.5669 | 126 | 4.9606 | 136 | 5.3543 |
| 107 | 4.2126 | 117 | 4.6063 | 127 | 5.0000 | 137 | 5.3937 |
| 108 | 4.2520 | 118 | 4.6457 | 128 | 5.0394 | 138 | 5.4331 |
| 109 | 4.2913 | 119 | 4.6850 | 129 | 5.0787 | 139 | 5.4724 |

### INCHES TO MILLIMETERS

| in. | mm | in. | mm |
|---|---|---|---|
| 1/64 | 0.3969 | 33/64 | 13.0969 |
| 1/32 | 0.7938 | 17/32 | 13.4938 |
| 3/64 | 1.1906 | 35/64 | 13.8906 |
| 1/16 | 1.5875 | 9/16 | 14.2875 |
| 5/64 | 1.9844 | 37/64 | 14.6844 |
| 3/32 | 2.3813 | 19/32 | 15.0813 |
| 7/64 | 2.7781 | 39/64 | 15.4781 |
| 1/8 | 3.1750 | 5/8 | 15.8750 |
| 9/64 | 3.5719 | 41/64 | 16.2719 |
| 5/32 | 3.9688 | 21/32 | 16.6688 |
| 11/64 | 4.3656 | 43/64 | 17.0656 |
| 3/16 | 4.7625 | 11/16 | 17.4625 |
| 13/64 | 5.1594 | 45/64 | 17.8594 |
| 7/32 | 5.5563 | 23/32 | 18.2563 |
| 15/64 | 5.9531 | 47/64 | 18.6531 |
| 1/4 | 6.3500 | 3/4 | 19.0500 |
| 17/64 | 6.7469 | 49/64 | 19.4469 |
| 9/32 | 7.1438 | 25/32 | 19.8438 |
| 19/64 | 7.5406 | 51/64 | 20.2406 |
| 5/16 | 7.9375 | 13/16 | 20.6375 |
| 21/64 | 8.3344 | 53/64 | 21.0344 |
| 11/32 | 8.7313 | 27/32 | 21.4313 |
| 23/64 | 9.1281 | 55/64 | 21.8281 |
| 3/8 | 9.5250 | 7/8 | 22.2250 |
| 25/64 | 9.9219 | 57/64 | 22.6219 |
| 13/32 | 10.3188 | 29/32 | 23.0188 |
| 27/64 | 10.7156 | 59/64 | 23.4156 |
| 7/16 | 11.1125 | 15/16 | 23.8125 |
| 29/64 | 11.5094 | 61/64 | 24.2094 |
| 15/32 | 11.9063 | 31/32 | 24.6063 |
| 31/64 | 12.3031 | 63/64 | 25.0031 |
| 1/2 | 12.7000 | 1 | 25.4000 |

## LENGTH

### FEET TO METERS

| ft. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | m | m | m | m | m | m | m | m | m | m | |
| — | | 0.305 | 0.610 | 0.914 | 1.219 | 1.524 | 1.829 | 2.134 | 2.438 | 2.743 | — |
| 10 | 3.048 | 3.353 | 3.658 | 3.962 | 4.267 | 4.572 | 4.877 | 5.182 | 5.486 | 5.791 | 10 |
| 20 | 6.096 | 6.401 | 6.706 | 7.010 | 7.315 | 7.620 | 7.925 | 8.230 | 8.534 | 8.839 | 20 |
| 30 | 9.144 | 9.449 | 9.754 | 10.058 | 10.363 | 10.668 | 10.973 | 11.278 | 11.582 | 11.887 | 30 |
| 40 | 12.192 | 12.497 | 12.802 | 13.106 | 13.411 | 13.716 | 14.021 | 14.326 | 14.630 | 14.935 | 40 |
| 50 | 15.240 | 15.545 | 15.850 | 16.154 | 16.459 | 16.764 | 17.069 | 17.374 | 17.678 | 17.983 | 50 |
| 60 | 18.288 | 18.593 | 18.898 | 19.202 | 19.507 | 19.812 | 20.117 | 20.422 | 20.726 | 21.031 | 60 |
| 70 | 21.336 | 21.641 | 21.946 | 22.250 | 22.555 | 22.860 | 23.165 | 23.470 | 23.774 | 24.079 | 70 |
| 80 | 24.384 | 24.689 | 24.994 | 25.298 | 25.603 | 25.908 | 26.213 | 26.518 | 26.822 | 27.127 | 80 |
| 90 | 27.432 | 27.737 | 28.042 | 28.346 | 28.651 | 28.956 | 29.261 | 29.566 | 29.870 | 30.175 | 90 |
| 100 | 30.480 | 30.785 | 31.090 | 31.394 | 31.699 | 32.004 | 32.309 | 32.614 | 32.918 | 33.223 | 100 |

### METERS TO FEET

| m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | |
| — | | 3.2808 | 6.5617 | 9.8425 | 13.1234 | 16.4042 | 19.6850 | 22.9659 | 26.2467 | 29.5276 | — |
| 10 | 32.8084 | 36.0892 | 39.3701 | 42.6509 | 45.9318 | 49.2126 | 52.4934 | 55.7743 | 59.0551 | 62.3360 | 10 |
| 20 | 65.6168 | 68.8976 | 72.1785 | 75.4593 | 78.7402 | 82.0210 | 85.3018 | 88.5827 | 91.8635 | 95.1444 | 20 |
| 30 | 98.4252 | 101.7060 | 104.9869 | 108.2677 | 111.5486 | 114.8294 | 118.1102 | 121.3911 | 124.6719 | 127.9528 | 30 |
| 40 | 131.2336 | 134.5144 | 137.7953 | 141.0761 | 144.3570 | 147.6378 | 150.9186 | 154.1995 | 175.4803 | 160.7612 | 40 |
| 50 | 164.0420 | 167.3228 | 170.6037 | 173.8845 | 177.1654 | 180.4462 | 183.7270 | 187.0079 | 190.2887 | 193.5696 | 50 |
| 60 | 196.8504 | 200.1312 | 203.4121 | 206.6929 | 209.9738 | 213.2546 | 216.5354 | 219.8163 | 223.0971 | 226.3780 | 60 |
| 70 | 229.6588 | 232.9396 | 236.2205 | 239.5013 | 242.7822 | 246.0630 | 249.3438 | 252.6247 | 255.9055 | 259.1864 | 70 |
| 80 | 262.4672 | 265.7480 | 269.0289 | 272.3097 | 275.5906 | 278.8714 | 282.1522 | 285.4331 | 288.7139 | 291.9948 | 80 |
| 90 | 295.2756 | 298.5564 | 301.8373 | 305.1181 | 308.3990 | 311.6798 | 314.9606 | 318.2415 | 321.5223 | 324.8032 | 90 |
| 100 | 328.0840 | 331.3648 | 334.6457 | 337.9265 | 341.2074 | 344.4882 | 347.7690 | 351.0499 | 354.3307 | 357.6116 | 100 |

### MILES TO KILOMETERS

| miles | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | miles |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | km | km | km | km | km | km | km | km | km | km | |
| — | | 1.609 | 3.219 | 4.828 | 6.437 | 8.047 | 9.656 | 11.265 | 12.875 | 14.484 | — |
| 10 | 16.093 | 17.703 | 19.312 | 20.921 | 22.531 | 24.140 | 25.750 | 27.359 | 28.968 | 30.578 | 10 |
| 20 | 32.187 | 33.796 | 35.406 | 37.015 | 38.624 | 40.234 | 41.843 | 43.452 | 45.062 | 46.671 | 20 |
| 30 | 48.280 | 49.890 | 51.499 | 53.108 | 54.718 | 56.327 | 57.936 | 59.546 | 61.155 | 62.764 | 30 |
| 40 | 64.374 | 65.983 | 67.592 | 69.202 | 70.811 | 72.420 | 74.030 | 75.639 | 77.249 | 78.858 | 40 |
| 50 | 80.467 | 82.077 | 83.686 | 85.295 | 86.905 | 88.514 | 90.123 | 91.733 | 93.342 | 94.951 | 50 |
| 60 | 96.561 | 98.170 | 99.779 | 101.389 | 103.000 | 104.607 | 106.217 | 107.826 | 109.435 | 111.045 | 60 |
| 70 | 112.654 | 114.263 | 115.873 | 117.482 | 119.091 | 120.700 | 122.310 | 123.919 | 125.529 | 127.138 | 70 |
| 80 | 128.748 | 130.357 | 131.966 | 133.576 | 135.185 | 136.794 | 138.404 | 140.013 | 141.622 | 143.232 | 80 |
| 90 | 144.841 | 146.450 | 148.060 | 149.669 | 151.278 | 152.888 | 154.497 | 156.106 | 157.716 | 159.325 | 90 |
| 100 | 160.934 | 162.544 | 164.153 | 165.762 | 167.372 | 168.981 | 170.590 | 172.200 | 173.809 | 175.418 | 100 |

### KILOMETERS TO MILES

| km | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | km |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | miles | miles | miles | miles | miles | miles | miles | miles | miles | miles | |
| — | | 0.621 | 1.243 | 1.864 | 2.485 | 3.107 | 3.728 | 4.350 | 4.971 | 5.592 | — |
| 10 | 6.214 | 6.835 | 7.456 | 8.078 | 8.699 | 9.321 | 9.942 | 10.563 | 11.185 | 11.806 | 10 |
| 20 | 12.427 | 13.049 | 13.670 | 14.292 | 14.913 | 15.534 | 16.156 | 16.777 | 17.398 | 18.020 | 20 |
| 30 | 18.641 | 19.262 | 19.884 | 20.505 | 21.127 | 21.748 | 22.370 | 22.990 | 23.612 | 24.233 | 30 |
| 40 | 24.855 | 25.476 | 26.098 | 26.719 | 27.340 | 27.962 | 28.583 | 29.204 | 29.826 | 30.447 | 40 |
| 50 | 31.065 | 31.690 | 32.311 | 32.933 | 33.554 | 34.175 | 34.797 | 35.418 | 36.039 | 36.661 | 50 |
| 60 | 37.282 | 37.904 | 38.525 | 39.146 | 39.768 | 40.389 | 41.010 | 41.632 | 42.253 | 42.875 | 60 |
| 70 | 43.496 | 44.117 | 44.739 | 45.360 | 45.981 | 46.603 | 47.224 | 47.845 | 48.467 | 49.088 | 70 |
| 80 | 49.711 | 50.331 | 50.952 | 51.574 | 52.195 | 52.816 | 53.438 | 54.059 | 54.681 | 55.302 | 80 |
| 90 | 55.923 | 56.545 | 57.166 | 57.187 | 58.409 | 59.030 | 59.652 | 60.273 | 60.894 | 61.516 | 90 |
| 100 | 62.137 | 62.758 | 63.380 | 64.001 | 64.622 | 65.244 | 65.865 | 66.487 | 67:108 | 67.729 | 100 |

## AREA

### SQUARE INCHES TO SQUARE CENTIMETERS

| $in^2$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $in^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | $cm^2$ | |
| — | | 6.452 | 12.903 | 19.355 | 25.806 | 32.258 | 38.710 | 45.161 | 51.613 | 58.064 | — |
| 10 | 64.516 | 70.968 | 77.419 | 83.871 | 90.322 | 96.774 | 103.226 | 109.677 | 116.129 | 122.580 | 10 |
| 20 | 129.032 | 135.484 | 141.935 | 148.387 | 154.838 | 161.290 | 167.742 | 174.193 | 180.645 | 187.096 | 20 |
| 30 | 193.548 | 200.000 | 206.451 | 212.903 | 219.354 | 225.806 | 232.258 | 238.709 | 245.161 | 251.612 | 30 |
| 40 | 258.064 | 264.516 | 270.967 | 277.419 | 283.870 | 290.322 | 296.774 | 303.225 | 309.677 | 316.128 | 40 |
| 50 | 322.580 | 329.032 | 335.483 | 341.935 | 348.386 | 354.838 | 361.290 | 367.741 | 374.193 | 380.644 | 50 |
| 60 | 387.096 | 393.548 | 399.999 | 406.451 | 412.902 | 419.354 | 425.806 | 432.257 | 438.709 | 445.160 | 60 |
| 70 | 451.612 | 458.064 | 464.515 | 470.967 | 477.418 | 483.870 | 490.322 | 496.773 | 503.225 | 509.676 | 70 |
| 80 | 516.128 | 522.580 | 529.031 | 535.483 | 541.934 | 548.386 | 554.838 | 561.289 | 567.741 | 574.192 | 80 |
| 90 | 580.644 | 587.096 | 593.547 | 599.999 | 606.450 | 612.902 | 619.354 | 625.805 | 632.257 | 638.708 | 90 |
| 100 | 645.160 | 651.612 | 658.063 | 664.515 | 670.966 | 677.418 | 683.870 | 690.312 | 696.773 | 703.224 | 100 |

### SQUARE CENTIMETERS TO SQUARE INCHES

| $cm^2$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $cm^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $in^2$ | $in^2$ | $in^2$ | $in^2$ | $in^2$ | $in^2$ | $in^2$ | $in^2$ | $in^2$ | $in^2$ | |
| — | | 0.155 | 0.310 | 0.465 | 0.620 | 0.775 | 0.930 | 1.085 | 1.240 | 1.395 | — |
| 10 | 1.550 | 1.705 | 1.860 | 2.015 | 2.170 | 2.325 | 2.480 | 2.635 | 2.790 | 2.945 | 10 |
| 20 | 3.100 | 3.255 | 3.410 | 3.565 | 3.720 | 3.875 | 4.030 | 4.185 | 4.340 | 4.495 | 20 |
| 30 | 4.650 | 4.805 | 4.960 | 5.115 | 5.270 | 5.425 | 5.580 | 5.735 | 5.890 | 6.045 | 30 |
| 40 | 6.200 | 6.355 | 6.510 | 6.665 | 6.820 | 6.975 | 7.130 | 7.285 | 7.440 | 7.595 | 40 |
| 50 | 7.750 | 7.905 | 8.060 | 8.215 | 8.370 | 8.525 | 8.680 | 8.835 | 8.990 | 9.145 | 50 |
| 60 | 9.300 | 9.455 | 9.610 | 9.765 | 9.920 | 10.075 | 10.230 | 10.385 | 10.540 | 10.695 | 60 |
| 70 | 10.850 | 11.005 | 11.160 | 11.315 | 11.470 | 11.625 | 11.780 | 11.935 | 12.090 | 12.245 | 70 |
| 80 | 12.400 | 12.555 | 12.710 | 12.865 | 13.020 | 13.175 | 13.330 | 13.485 | 13.640 | 13.795 | 80 |
| 90 | 13.950 | 14.105 | 14.260 | 14.415 | 14.570 | 14.725 | 14.880 | 15.035 | 15.190 | 15.345 | 90 |
| 100 | 15.500 | 15.655 | 15.810 | 15.965 | 16.120 | 16.275 | 16.430 | 16.583 | 16.740 | 16.895 | 100 |

## VOLUME

### CUBIC INCHES TO CUBIC CENTIMETERS

| $in^3$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $in^3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | $cm^3$(cc) | |
| | | 16.387 | 32.774 | 49.161 | 65.548 | 81.935 | 98.322 | 114.709 | 131.097 | 147.484 | — |
| 10 | 163.871 | 180.258 | 196.645 | 213.032 | 229.419 | 245.806 | 262.193 | 278.580 | 294.967 | 311.354 | 10 |
| 20 | 327.741 | 344.128 | 360.515 | 376.902 | 393.290 | 209.677 | 426.064 | 442.451 | 458.838 | 475.225 | 20 |
| 30 | 491.612 | 507.999 | 524.386 | 540.773 | 557.160 | 573.547 | 589.934 | 606.321 | 622.708 | 639.095 | 30 |
| 40 | 655.483 | 671.870 | 688.257 | 704.644 | 721.031 | 737.418 | 753.805 | 770.192 | 786.579 | 802.966 | 40 |
| 50 | 819.353 | 835.740 | 852.127 | 868.514 | 884.901 | 901.289 | 917.676 | 934.063 | 950.450 | 966.837 | 50 |
| 60 | 983.224 | 999.611 | 1015.998 | 1032.385 | 1048.772 | 1065.159 | 1081.546 | 1097.933 | 1114.320 | 1130.707 | 60 |
| 70 | 1147.094 | 1163.482 | 1179.869 | 1196.256 | 1212.643 | 1229.030 | 1245.417 | 1261.804 | 1278.191 | 1294.578 | 70 |
| 80 | 1310.965 | 1327.352 | 1343.739 | 1360.126 | 1376.513 | 1392.900 | 1409.288 | 1425.675 | 1442.062 | 1458.449 | 80 |
| 90 | 1474.836 | 1491.223 | 1507.610 | 1523.997 | 1540.384 | 1556.771 | 1573.158 | 1589.545 | 1605.932 | 1622.319 | 90 |
| 100 | 1638.706 | 1655.093 | 1671.481 | 1687.868 | 1704.255 | 1720.642 | 1737.029 | 1753.416 | 1769.803 | 1786.190 | 100 |

### CUBIC CENTIMETERS TO CUBIC INCHES

| $cm^3$(cc) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $cm^3$(cc) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $in^3$ | $in^3$ | $in^3$ | $in^3$ | $in^3$ | $in^3$ | $in^3$ | $in^3$ | $in^3$ | $in^3$ | |
| — | | 0.0610 | 0.1220 | 0.1831 | 0.2441 | 0.3051 | 0.3661 | 0.4272 | 0.4882 | 0.5492 | — |
| 10 | 0.6102 | 0.6713 | 0.7323 | 0.7933 | 0.8543 | 0.9153 | 0.9764 | 1.0374 | 1.0984 | 1.1594 | 10 |
| 20 | 1.2205 | 1.2815 | 1.3425 | 1.4035 | 1.4646 | 1.5256 | 1.5866 | 1.6476 | 1.7086 | 1.7697 | 20 |
| 30 | 1.8307 | 1.8917 | 1.9527 | 2.0138 | 2.0748 | 2.1358 | 2.1968 | 2.2579 | 2.1389 | 2.3799 | 30 |
| 40 | 2.4409 | 2.5020 | 2.5630 | 2.6240 | 2.6850 | 2.7460 | 2.8071 | 2.8681 | 2.9291 | 2.9901 | 40 |
| 50 | 3.0512 | 3.1122 | 3.1732 | 3.2342 | 3.2952 | 3.3563 | 3.4173 | 3.4783 | 3.5393 | 3.6004 | 50 |
| 60 | 3.6614 | 3.7224 | 3.7834 | 3.8444 | 3.9055 | 3.9665 | 4.0275 | 4.0885 | 4.1496 | 4.2106 | 60 |
| 70 | 4.2716 | 4.3326 | 4.3937 | 4.4547 | 4.5157 | 4.5767 | 4.6377 | 4.6988 | 4.7598 | 4.8208 | 70 |
| 80 | 4.8818 | 4.9429 | 5.0039 | 5.0649 | 5.1259 | 5.1870 | 5.2480 | 5.3090 | 5.3700 | 5.4310 | 80 |
| 90 | 5.4921 | 5.5531 | 5.6141 | 5.6751 | 5.7362 | 5.7972 | 5.8582 | 5.9192 | 5.9803 | 6.0413 | 90 |
| 100 | 6.1023 | 6.1633 | 6.2243 | 6.2854 | 6.3464 | 6.4074 | 6.4684 | 6.5295 | 6.5905 | 6.6515 | 100 |

## VOLUME

### GALLONS (U. S.) TO LITERS

| U.S. gal. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | U.S. gal. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | liters | liters | liters | liters | liters | liters | liters | liters | liters | liters | |
| — | | 3.7854 | 7.5709 | 11.3563 | 15.1417 | 18.9271 | 22.7126 | 26.4980 | 30.2834 | 34.0633 | — |
| 10 | 37.8543 | 41.6397 | 45.4251 | 49.2105 | 52.9960 | 56.7814 | 60.5668 | 64.3523 | 68.1377 | 71.9231 | 10 |
| 20 | 75.7085 | 79.4940 | 83.2794 | 87.0648 | 90.8502 | 94.6357 | 98.4211 | 102.2065 | 105.9920 | 109.7774 | 20 |
| 30 | 113.5629 | 117.3482 | 121.1337 | 124.9191 | 128.7045 | 132.4901 | 136.2754 | 140.0608 | 143.8462 | 147.6316 | 30 |
| 40 | 151.4171 | 155.2025 | 158.9879 | 162.7734 | 166.5588 | 170.3442 | 174.1296 | 177.9151 | 181.7005 | 185.4859 | 40 |
| 50 | 189.2713 | 193.0568 | 196.8422 | 200.6276 | 204.4131 | 208.1985 | 211.9839 | 215.7693 | 219.5548 | 223.3402 | 50 |
| 60 | 227.1256 | 230.9110 | 234.6965 | 238.4819 | 242.2673 | 246.0527 | 249.8382 | 253.6236 | 257.4090 | 261.1945 | 60 |
| 70 | 264.9799 | 268.7653 | 272.5507 | 276.3362 | 280.1216 | 283.9070 | 287.6924 | 291.4779 | 295.2633 | 299.0487 | 70 |
| 80 | 302.8342 | 306.6196 | 310.4050 | 314.1904 | 317.9759 | 321.7613 | 325.5467 | 329.3321 | 333.1176 | 336.9030 | 80 |
| 90 | 340.6884 | 344.4738 | 348.2593 | 352.0447 | 355.8301 | 359.6156 | 363.4010 | 367.1864 | 370.9718 | 374.7573 | 90 |
| 100 | 378.5427 | 382.3281 | 386.1135 | 389.8990 | 393.6844 | 397.4698 | 401.2553 | 405.0407 | 408.8261 | 412.6115 | 100 |

### LITERS TO GALLONS (U.S.)

| liters | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | liters |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | |
| — | | 0.2642 | 0.5283 | 0.7925 | 1.0567 | 1.3209 | 1.5850 | 1.8492 | 2.1134 | 2.3775 | — |
| 10 | 2.6417 | 2.9059 | 3.1701 | 3.4342 | 3.6984 | 3.9626 | 4.2268 | 4.4909 | 4.7551 | 5.0193 | 10 |
| 20 | 5.2834 | 5.5476 | 5.8118 | 6.0760 | 6.3401 | 6.6043 | 6.8685 | 7.1326 | 7.3968 | 7.6610 | 20 |
| 30 | 7.9252 | 8.1893 | 8.4535 | 8.7177 | 8.9818 | 9.2460 | 9.5102 | 9.7743 | 10.0385 | 10.3027 | 30 |
| 40 | 10.5669 | 10.8311 | 11.0952 | 11.3594 | 11.6236 | 11.8877 | 12.1519 | 12.4161 | 12.6803 | 12.9444 | 40 |
| 50 | 13.2086 | 13.4728 | 13.7369 | 14.0011 | 14.2653 | 14.5295 | 14.7936 | 15.0578 | 15.3220 | 15.5861 | 50 |
| 60 | 15.8503 | 16.1145 | 16.3787 | 16.6428 | 16.9070 | 17.1711 | 17.4354 | 17.6995 | 17.9637 | 18.2279 | 60 |
| 70 | 18.4920 | 18.7562 | 19.0204 | 19.2846 | 19.5487 | 19.8129 | 20.0771 | 20.3412 | 20.6054 | 20.8696 | 70 |
| 80 | 21.1338 | 21.3979 | 21.6621 | 21.9263 | 22.1904 | 22.4546 | 22.7188 | 22.9830 | 23.2471 | 23.5113 | 80 |
| 90 | 23.7755 | 24.0397 | 24.3038 | 24.5680 | 24.8322 | 25.0963 | 25.3605 | 25.6247 | 25.8889 | 26.1530 | 90 |
| 100 | 26.4172 | 26.6814 | 26.9455 | 27.2097 | 27.4739 | 27.7381 | 28.0022 | 28.2664 | 28.5306 | 28.7947 | 100 |

### GALLONS (IMP.) TO LITERS

| Imp gal. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Imp gal. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | liters | liters | liters | liters | liters | liters | liters | liters | liters | liters | |
| — | | 4.5459 | 9.0918 | 13.6377 | 18.1836 | 22.7295 | 27.2754 | 31.8213 | 36.3672 | 40.9131 | — |
| 10 | 45.4590 | 50.0049 | 54.5508 | 59.0967 | 63.6426 | 68.1885 | 72.7344 | 77.2803 | 81.8262 | 86.3721 | 10 |
| 20 | 90.9180 | 95.4639 | 100.0098 | 104.5557 | 109.1016 | 113.6475 | 118.1934 | 122.7393 | 127.2852 | 131.8311 | 20 |
| 30 | 136.3770 | 140.9229 | 145.4688 | 150.0147 | 154.5606 | 159.1065 | 163.6524 | 168.1983 | 172.7442 | 177.2901 | 30 |
| 40 | 181.8360 | 186.3819 | 190.9278 | 195.4737 | 200.0196 | 204.5655 | 209.1114 | 213.6573 | 218.2032 | 222.7491 | 40 |
| 50 | 227.2950 | 231.8409 | 236.3868 | 240.9327 | 245.4786 | 250.0245 | 254.5704 | 259.1163 | 263.6622 | 268.2081 | 50 |
| 60 | 272.7540 | 277.2999 | 281.8458 | 286.3917 | 290.9376 | 295.4835 | 300.0294 | 304.5753 | 309.1212 | 313.6671 | 60 |
| 70 | 318.2130 | 322.7589 | 327.3048 | 331.8507 | 336.8966 | 340.9425 | 345.4884 | 350.0343 | 354.5802 | 359.1261 | 70 |
| 80 | 363.6720 | 368.2179 | 372.7638 | 377.3097 | 381.8556 | 386.4015 | 390.9474 | 395.4933 | 400.0392 | 404.5851 | 80 |
| 90 | 409.1310 | 413.6769 | 418.2228 | 422.7687 | 427.3146 | 431.8605 | 436.4064 | 440.9523 | 445.4982 | 450.0441 | 90 |
| 100 | 454.5900 | 459.1359 | 463.6818 | 468.2277 | 472.7736 | 477.3195 | 481.8654 | 486.4113 | 490.9572 | 495.5031 | 100 |

### LITERS TO GALLONS (IMP.)

| liters | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | liter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | |
| — | | 0.2200 | 0.4400 | 0.6599 | 0.8799 | 1.0999 | 1.3199 | 1.5399 | 1.7598 | 1.9798 | — |
| 10 | 2.1998 | 2.4198 | 2.6398 | 2.8597 | 3.0797 | 3.2997 | 3.5197 | 3.7397 | 3.9596 | 4.1796 | 10 |
| 20 | 4.3996 | 4.6196 | 4.8396 | 5.0595 | 5.2795 | 5.4995 | 5.7195 | 5.9395 | 6.1594 | 6.3794 | 20 |
| 30 | 6.5994 | 6.8194 | 7.0394 | 7.2593 | 7.4793 | 7.6993 | 7.9193 | 8.1393 | 8.3592 | 8.5792 | 30 |
| 40 | 8.7992 | 9.0192 | 9.2392 | 9.4591 | 9.6791 | 9.8991 | 10.1191 | 10.3391 | 10.5590 | 10.7790 | 40 |
| 50 | 10.9990 | 11.2190 | 11.4390 | 11.6590 | 11.8789 | 12.0989 | 12.3189 | 12.5389 | 12.7588 | 12.9788 | 50 |
| 60 | 13.1988 | 13.4188 | 13.6388 | 13.8587 | 14.0787 | 14.2987 | 14.5187 | 14.7387 | 14.9586 | 15.1786 | 60 |
| 70 | 15.3986 | 15.6186 | 15.8386 | 16.0585 | 16.2785 | 16.4985 | 16.7185 | 16.9385 | 17.1584 | 17.3784 | 70 |
| 80 | 17.5984 | 17.8184 | 18.0384 | 18.2583 | 18.4783 | 18.6983 | 18.9183 | 19.1383 | 19.3582 | 19.5782 | 80 |
| 90 | 19.7982 | 20.0182 | 20.2382 | 20.4581 | 20.6781 | 20.8981 | 21.1181 | 21.3381 | 21.5580 | 21.7780 | 90 |
| 100 | 21.9980 | 22.2180 | 22.4380 | 22.6579 | 22.8779 | 23.0979 | 23.3179 | 23.5379 | 23.7578 | 23.9778 | 100 |

## MASS

### POUNDS TO KILOGRAMS

| lbs. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg | kg | kg | kg | kg | kg | kg | kg | kg | kg | |
| — | | 0.454 | 0.907 | 1.361 | 1.814 | 2.268 | 2.722 | 3.175 | 3.629 | 4.082 | — |
| 10 | 4.536 | 4.990 | 5.443 | 5.897 | 6.350 | 6.804 | 7.257 | 7.711 | 8.165 | 8.618 | 10 |
| 20 | 9.072 | 9.525 | 9.979 | 10.433 | 10.886 | 11.340 | 11.793 | 12.247 | 12.701 | 13.154 | 20 |
| 30 | 13.608 | 14.061 | 14.515 | 14.969 | 15.422 | 15.876 | 16.329 | 16.783 | 17.237 | 17.690 | 30 |
| 40 | 18.144 | 18.597 | 19.051 | 19.504 | 19.958 | 20.412 | 20.865 | 21.319 | 21.772 | 22.226 | 40 |
| 50 | 22.680 | 23.133 | 23.587 | 24.040 | 24.494 | 24.948 | 25.401 | 25.855 | 26.308 | 26.762 | 50 |
| 60 | 27.216 | 27.669 | 28.123 | 28.576 | 29.030 | 29.484 | 29.937 | 30.391 | 30.844 | 31.298 | 60 |
| 70 | 31.751 | 32.205 | 32.659 | 33.112 | 33.566 | 34.019 | 34.473 | 34.927 | 35.380 | 35.834 | 70 |
| 80 | 36.287 | 36.741 | 37.195 | 37.648 | 38.102 | 38.555 | 39.009 | 39.463 | 39.916 | 40.370 | 80 |
| 90 | 40.823 | 41.277 | 41.731 | 42.184 | 42.638 | 43.091 | 43.545 | 43.998 | 44.452 | 44.906 | 90 |
| 100 | 45.359 | 45.813 | 46.266 | 46.720 | 47.174 | 47.627 | 47.081 | 48.534 | 48.988 | 49.442 | 100 |

### KILOGRAMS TO POUNDS

| kg | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | |
| — | | 2.205 | 4.409 | 6.614 | 8.818 | 11.023 | 13.228 | 15.432 | 17.637 | 19.842 | — |
| 10 | 22.046 | 24.251 | 26.455 | 28.660 | 30.865 | 33.069 | 35.274 | 37.479 | 39.683 | 41.888 | 10 |
| 20 | 44.092 | 46.297 | 48.502 | 50.706 | 52.911 | 55.116 | 57.320 | 59.525 | 61.729 | 63.934 | 20 |
| 30 | 66.139 | 68.343 | 70.548 | 72.753 | 74.957 | 77.162 | 79.366 | 81.571 | 83.776 | 85.980 | 30 |
| 40 | 88.185 | 90.390 | 92.594 | 94.799 | 97.003 | 99.208 | 101.413 | 103.617 | 105.822 | 108.026 | 40 |
| 50 | 110.231 | 112.436 | 114.640 | 116.845 | 119.050 | 121.254 | 123.459 | 125.633 | 127.868 | 130.073 | 50 |
| 60 | 132.277 | 134.482 | 136.687 | 138.891 | 141.096 | 143.300 | 145.505 | 147.710 | 149.914 | 152.119 | 60 |
| 70 | 154.324 | 156.528 | 158.732 | 160.937 | 163.142 | 165.347 | 167.551 | 169.756 | 171.961 | 174.165 | 70 |
| 80 | 176.370 | 178.574 | 180.780 | 182.984 | 185.188 | 187.393 | 189.597 | 191.802 | 194.007 | 196.211 | 80 |
| 90 | 198.416 | 200.621 | 202.825 | 205.030 | 207.234 | 209.439 | 211.644 | 213.848 | 216.053 | 218.258 | 90 |
| 100 | 220.462 | 222.667 | 224.871 | 227.076 | 229.281 | 231.485 | 233.690 | 235.895 | 238.099 | 240.304 | 100 |

### KILOGRAMS TO NEWTON

| kg | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | N | N | N | N | N | N | N | N | N | |
| — | — | 9.81 | 19.61 | 29.42 | 39.23 | 49.03 | 58.84 | 68.65 | 78.45 | 88.26 | — |
| 10 | 98.07 | 107.87 | 117.68 | 127.49 | 137.29 | 147.10 | 156.91 | 166.71 | 176.52 | 186.33 | 10 |
| 20 | 196.13 | 205.94 | 215.75 | 225.55 | 235.36 | 245.17 | 254.97 | 264.78 | 274.59 | 284.39 | 20 |
| 30 | 294.20 | 304.01 | 313.81 | 323.62 | 333.43 | 343.23 | 353.04 | 362.85 | 372.65 | 382.46 | 30 |
| 40 | 392.27 | 402.07 | 411.88 | 421.69 | 431.49 | 441.30 | 451.11 | 460.91 | 470.72 | 480.53 | 40 |
| 50 | 490.33 | 500.14 | 509.95 | 519.75 | 529.56 | 539.37 | 549.17 | 558.98 | 568.79 | 578.59 | 50 |
| 60 | 558.40 | 598.21 | 608.01 | 617.82 | 627.63 | 637.43 | 647.24 | 657.05 | 666.85 | 676.66 | 60 |
| 70 | 686.47 | 696.27 | 706.08 | 715.89 | 725.69 | 735.50 | 745.31 | 755.11 | 764.92 | 774.73 | 70 |
| 80 | 784.53 | 794.34 | 804.15 | 813.95 | 823.76 | 833.57 | 843.37 | 853.18 | 862.99 | 872.79 | 80 |
| 90 | 882.60 | 892.41 | 902.21 | 912.02 | 921.83 | 931.63 | 941.44 | 951.25 | 961.05 | 970.86 | 90 |
| 100 | 980.67 | 990.47 | 1000.28 | 1010.08 | 1019.89 | 1029.70 | 1039.50 | 1049.31 | 1059.12 | 1068.92 | 100 |

### NEWTON TO KILOGRAMS

| N | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg | kg | kg | kg | kg | kg | kg | kg | kg | kg | |
| — | — | 1.020 | 2.039 | 3.059 | 4.079 | 5.099 | 6.118 | 7.138 | 8.158 | 9.177 | — |
| 100 | 10.197 | 11.217 | 12.237 | 13.256 | 14.276 | 15.296 | 16.316 | 17.335 | 18.355 | 19.375 | 100 |
| 200 | 20.394 | 21.414 | 22.434 | 23.453 | 24.473 | 25.493 | 26.513 | 27.532 | 28.552 | 29.572 | 200 |
| 300 | 30.592 | 31.611 | 32.631 | 33.651 | 34.670 | 35.690 | 36.710 | 37.730 | 38.749 | 39.769 | 300 |
| 400 | 40.789 | 41.809 | 42.828 | 43.848 | 44.868 | 45.887 | 46.907 | 47.927 | 48.947 | 49.966 | 400 |
| 500 | 50.986 | 52.006 | 53.025 | 54.045 | 55.065 | 56.085 | 57.104 | 58.124 | 59.144 | 60.163 | 500 |
| 600 | 61.183 | 62.203 | 63.223 | 64.242 | 65.262 | 66.282 | 67.302 | 68.321 | 69.341 | 70.361 | 600 |
| 700 | 71.380 | 72.400 | 73.420 | 74.440 | 75.459 | 76.479 | 77.499 | 78.518 | 79.538 | 80.558 | 700 |
| 800 | 81.578 | 82.597 | 83.617 | 84.637 | 85.656 | 86.676 | 87.696 | 88.716 | 89.735 | 90.755 | 800 |
| 900 | 91.775 | 92.795 | 93.814 | 94.834 | 95.854 | 96.873 | 97.893 | 98.913 | 99.933 | 100.952 | 900 |
| 1000 | 101.972 | 102.992 | 104.011 | 105.031 | 106.051 | 107.071 | 108.090 | 109.110 | 110.130 | 111.149 | 1000 |

## PRESSURE

### POUNDS PER SQUARE INCHES TO KILOGRAMS PER SQUARE CENTIMETERS

| lb/in² (psi) | 0 kg/cm² | 1 kg/cm² | 2 kg/cm² | 3 kg/cm² | 4 kg/cm² | 5 kg/cm² | 6 kg/cm² | 7 kg/cm² | 8 kg/cm² | 9 kg/cm² | lb/in² (psi) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| — | | 0.0703 | 0.1406 | 0.2109 | 0.2812 | 0.3515 | 0.4218 | 0.4921 | 0.5625 | 0.6328 | — |
| 10 | 0.7031 | 0.7734 | 0.8437 | 0.9140 | 0.9843 | 1.0546 | 1.1249 | 1.1952 | 1.2655 | 1.3358 | 10 |
| 20 | 1.4061 | 1.4764 | 1.5468 | 1.6171 | 1.6874 | 1.7577 | 1.8280 | 1.8983 | 1.9686 | 2.0389 | 20 |
| 30 | 2.1092 | 2.1795 | 2.2498 | 2.3201 | 2.3904 | 2.4607 | 2.5311 | 2.6014 | 2.6717 | 2.7420 | 30 |
| 40 | 2.8123 | 2.8826 | 2.9529 | 3.0232 | 3.0935 | 3.1638 | 3.2341 | 3.3044 | 3.3747 | 3.4450 | 40 |
| 50 | 3.5154 | 3.5857 | 3.6560 | 3.7263 | 3.7966 | 3.8669 | 3.9372 | 4.0075 | 4.0778 | 4.1481 | 50 |
| 60 | 4.2184 | 4.2887 | 4.3590 | 4.4293 | 4.4996 | 4.5700 | 4.6403 | 4.7106 | 4.7809 | 4.8512 | 60 |
| 70 | 4.9215 | 4.9918 | 5.0621 | 5.1324 | 5.2027 | 5.2730 | 5.3433 | 5.4136 | 5.4839 | 5.5543 | 70 |
| 80 | 5.6246 | 5.6947 | 5.7652 | 5.8355 | 5.9058 | 5.9761 | 6.0464 | 6.1167 | 6.1870 | 6.2573 | 80 |
| 90 | 6.3276 | 6.3979 | 6.4682 | 6.5386 | 6.6089 | 6.6792 | 6.7495 | 6.8198 | 6.8901 | 6.9604 | 90 |
| 100 | 7.0307 | 7.1010 | 7.1713 | 7.2416 | 7.3119 | 7.3822 | 7.4525 | 7.5228 | 7.5932 | 7.6635 | 100 |

### KILOGRAMS PER SQUARE CENTIMETERS TO POUNDS PER SQUARE INCHES

| kg/cm² | 0 lb/in²(psi) | 1 lb/in²(psi) | 2 lb/in²(psi) | 3 lb/in²(psi) | 4 lb/in²(psi) | 5 lb/in²(psi) | 6 lb/in²(psi) | 7 lb/in²(psi) | 8 lb/in²(psi) | 9 lb/in²(psi) | kg/cm² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| — | | 14.22 | 28.45 | 42.67 | 56.89 | 71.12 | 85.34 | 99.56 | 113.78 | 128.01 | — |
| 10 | 142.23 | 156.45 | 170.68 | 184.90 | 199.12 | 213.35 | 227.57 | 241.79 | 256.01 | 270.24 | 10 |
| 20 | 284.46 | 298.68 | 312.91 | 327.13 | 341.35 | 355.58 | 369.80 | 384.02 | 398.24 | 412.47 | 20 |
| 30 | 426.69 | 440.91 | 455.14 | 469.36 | 483.58 | 497.81 | 512.03 | 526.25 | 540.47 | 554.70 | 30 |
| 40 | 568.92 | 583.14 | 597.37 | 611.59 | 625.81 | 640.04 | 654.26 | 668.48 | 682.70 | 696.93 | 40 |
| 50 | 711.16 | 725.37 | 739.60 | 753.82 | 768.04 | 782.27 | 795.49 | 810.71 | 824.93 | 839.16 | 50 |
| 60 | 853.38 | 867.60 | 881.83 | 896.05 | 910.27 | 924.50 | 938.72 | 952.94 | 967.16 | 981.39 | 60 |
| 70 | 995.61 | 1009.83 | 1024.06 | 1038.28 | 1052.50 | 1066.73 | 1080.95 | 1095.17 | 1109.39 | 1123.62 | 70 |
| 80 | 1137.84 | 1152.06 | 1166.27 | 1180.51 | 1194.73 | 1208.96 | 1223.18 | 1237.40 | 1251.62 | 1265.85 | 80 |
| 90 | 1280.07 | 1294.20 | 1308.52 | 1322.74 | 1336.96 | 1351.19 | 1365.41 | 1379.63 | 1393.85 | 1408.08 | 90 |
| 100 | 1422.30 | 1436.52 | 1450.75 | 1464.97 | 1479.19 | 1493.42 | 1507.64 | 1521.86 | 1536.08 | 1550.31 | 100 |

### KILOGRAMS PER SQUARE CENTIMETERS TO KILO PASCAL

| kg/cm² | 0 KPa | 1 KPa | 2 KPa | 3 KPa | 4 KPa | 5 KPa | 6 KPa | 7 KPa | 8 KPa | 9 KPa | kg/cm² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| — | — | 98.1 | 196.1 | 294.2 | 392.3 | 490.3 | 588.4 | 686.5 | 784.5 | 882.6 | — |
| 10 | 980.7 | 1078.7 | 1176.8 | 1274.9 | 1372.9 | 1471.0 | 1569.1 | 1667.1 | 1765.2 | 1863.3 | 10 |
| 20 | 1961.3 | 2059.4 | 2157.5 | 2255.5 | 2353.6 | 2451.7 | 2549.7 | 2647.8 | 2745.9 | 2843.9 | 20 |
| 30 | 2942.0 | 3040.1 | 3138.1 | 3236.2 | 3334.3 | 3432.3 | 3530.4 | 3628.5 | 3726.5 | 3824.6 | 30 |
| 40 | 3922.7 | 4020.7 | 4118.8 | 4216.9 | 4314.9 | 4413.0 | 4511.1 | 4609.1 | 4707.2 | 4805.3 | 40 |
| 50 | 4903.3 | 5001.4 | 5099.5 | 5197.5 | 5295.6 | 5393.7 | 5491.7 | 5589.8 | 5687.9 | 5785.9 | 50 |
| 60 | 5584.0 | 5982.1 | 6080.1 | 6178.2 | 6276.3 | 6374.3 | 6472.4 | 6570.5 | 6668.5 | 6766.6 | 60 |
| 70 | 6864.7 | 6962.7 | 7060.8 | 7158.9 | 7256.9 | 7355.0 | 7453.1 | 7551.1 | 7649.2 | 7747.3 | 70 |
| 80 | 7845.3 | 7943.4 | 8041.5 | 8139.5 | 8237.6 | 8335.7 | 8433.7 | 8531.8 | 8629.9 | 8727.9 | 80 |
| 90 | 8826.0 | 8924.1 | 9022.1 | 9120.2 | 9218.3 | 9316.3 | 9414.4 | 9512.5 | 9610.5 | 9708.6 | 90 |
| 100 | 9806.7 | 9904.7 | 10002.8 | 10100.8 | 10198.9 | 10297.0 | 10395.0 | 10493.1 | 10591.2 | 10689.2 | 100 |

### KILO PASCAL TO KILOGRAMS PER SQUARE CENTIMETERS

| KPa | 0 kg/cm² | 100 kg/cm² | 200 kg/cm² | 300 kg/cm² | 400 kg/cm² | 500 kg/cm² | 600 kg/cm² | 700 kg/cm² | 800 kg/cm² | 900 kg/cm² | KPa |
|---|---|---|---|---|---|---|---|---|---|---|---|
| — | — | 1.020 | 2.039 | 3.059 | 4.079 | 5.099 | 6.118 | 7.138 | 8.158 | 9.177 | — |
| 1000 | 10.197 | 11.217 | 12.237 | 13.256 | 14.276 | 15.296 | 16.316 | 17.335 | 18.355 | 19.375 | 1000 |
| 2000 | 20.394 | 21.414 | 22.434 | 23.453 | 24.473 | 25.493 | 26.513 | 27.532 | 28.552 | 29.572 | 2000 |
| 3000 | 30.592 | 31.611 | 32.631 | 33.651 | 34.670 | 35.690 | 36.710 | 37.730 | 38.749 | 39.769 | 3000 |
| 4000 | 40.789 | 41.809 | 42.828 | 43.848 | 44.868 | 45.887 | 46.907 | 47.927 | 48.947 | 49.966 | 4000 |
| 5000 | 50.986 | 52.006 | 53.025 | 54.045 | 55.065 | 56.085 | 57.104 | 58.124 | 59.144 | 60.163 | 5000 |
| 6000 | 61.183 | 62.203 | 63.223 | 64.242 | 65.262 | 66.282 | 67.302 | 68.321 | 69.341 | 70.361 | 6000 |
| 7000 | 71.380 | 72.400 | 73.420 | 74.440 | 75.459 | 76.479 | 77.499 | 78.518 | 79.538 | 80.558 | 7000 |
| 8000 | 81.578 | 82.597 | 83.617 | 84.637 | 85.656 | 86.676 | 87.696 | 88.716 | 89.735 | 90.755 | 8000 |
| 9000 | 91.775 | 92.794 | 93.814 | 94.834 | 95.854 | 96.873 | 97.893 | 98.913 | 99.933 | 100.952 | 9000 |
| 10000 | 101.972 | 102.992 | 104.011 | 105.031 | 106.051 | 107.071 | 108.090 | 109.110 | 110.130 | 111.149 | 10000 |

## TORQUE

### FOOT POUNDS TO KILOGRAMMETERS

| ft. lbs. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ft. lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | |
| — | | 0.138 | 0.277 | 0.415 | 0.553 | 0.691 | 0.830 | 0.968 | 1.106 | 1.244 | — |
| 10 | 1.383 | 1.521 | 1.659 | 1.797 | 1.936 | 2.074 | 2.212 | 2.350 | 2.489 | 2.627 | 10 |
| 20 | 2.765 | 2.903 | 3.042 | 3.180 | 3.318 | 3.456 | 3.595 | 3.733 | 3.871 | 4.009 | 20 |
| 30 | 4.148 | 4.286 | 4.424 | 4.562 | 4.700 | 4.839 | 4.977 | 5.115 | 5.253 | 5.392 | 30 |
| 40 | 5.530 | 5.668 | 5.807 | 5.945 | 6.083 | 6.221 | 6.360 | 6.498 | 6.636 | 6.774 | 40 |
| 50 | 6.913 | 7.051 | 7.189 | 7.328 | 7.466 | 7.604 | 7.742 | 7.881 | 8.019 | 8.157 | 50 |
| 60 | 8.295 | 8.434 | 8.572 | 8.710 | 8.848 | 8.987 | 9.125 | 9.263 | 9.401 | 9.540 | 60 |
| 70 | 9.678 | 9.816 | 9.954 | 10.093 | 10.231 | 10.369 | 10.507 | 10.646 | 10.784 | 10.922 | 70 |
| 80 | 11.060 | 11.199 | 11.337 | 11.475 | 11.613 | 11.752 | 11.890 | 12.028 | 12.166 | 12.305 | 80 |
| 90 | 12.442 | 12.581 | 12.719 | 12.858 | 12.996 | 13.134 | 13.272 | 13.410 | 13.549 | 13.687 | 90 |
| 100 | 13.826 | 13.964 | 14.102 | 14.240 | 14.379 | 14.517 | 14.655 | 14.793 | 14.932 | 15.070 | 100 |

### KILOGRAMMETERS TO FOOT POUNDS

| kg-m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg-m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | |
| — | | 7.23 | 14.47 | 21.70 | 28.93 | 36.17 | 43.40 | 50.63 | 57.86 | 65.10 | — |
| 10 | 72.33 | 79.56 | 86.80 | 94.03 | 101.26 | 108.50 | 115.73 | 122.96 | 130.19 | 137.43 | 10 |
| 20 | 144.66 | 151.89 | 159.13 | 166.36 | 173.59 | 180.83 | 188.06 | 195.29 | 202.52 | 209.76 | 20 |
| 30 | 217.00 | 224.22 | 231.46 | 238.69 | 245.92 | 253.16 | 260.39 | 267.62 | 274.85 | 282.09 | 30 |
| 40 | 289.32 | 296.55 | 303.79 | 311.02 | 318.25 | 325.49 | 332.72 | 339.95 | 347.18 | 354.42 | 40 |
| 50 | 361.65 | 368.88 | 376.12 | 383.35 | 390.58 | 397.82 | 405.05 | 412.28 | 419.51 | 426.75 | 50 |
| 60 | 433.98 | 441.21 | 448.45 | 455.68 | 462.91 | 470.15 | 477.38 | 484.61 | 491.84 | 499.08 | 60 |
| 70 | 506.31 | 513.54 | 520.78 | 528.01 | 535.24 | 542.48 | 549.71 | 556.94 | 564.17 | 571.41 | 70 |
| 80 | 578.64 | 585.87 | 593.11 | 600.34 | 607.57 | 614.81 | 622.04 | 629.27 | 636.50 | 643.74 | 80 |
| 90 | 650.97 | 658.20 | 665.44 | 672.67 | 679.90 | 687.14 | 694.37 | 701.60 | 708.83 | 716.07 | 90 |
| 100 | 723.30 | 730.53 | 737.77 | 745.00 | 752.23 | 759.47 | 766.70 | 773.93 | 781.16 | 788.40 | 100 |

### KILOGRAMMETERS TO NEWTONMETERS

| kg-m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg-m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N-m | N-m | N-m | N-m | N-m | N-m | N-m | N-m | N-m | N-m | |
| — | — | 9.81 | 19.61 | 29.42 | 39.23 | 49.03 | 58.84 | 68.65 | 78.45 | 88.26 | — |
| 10 | 98.07 | 107.87 | 117.68 | 127.49 | 137.29 | 147.10 | 156.91 | 166.71 | 176.52 | 186.33 | 10 |
| 20 | 196.13 | 205.94 | 215.75 | 225.55 | 235.36 | 245.17 | 254.97 | 264.78 | 274.59 | 284.39 | 20 |
| 30 | 294.20 | 304.01 | 313.81 | 323.62 | 333.43 | 343.23 | 353.04 | 362.85 | 372.65 | 382.46 | 30 |
| 40 | 392.27 | 402.07 | 411.88 | 421.69 | 431.49 | 441.30 | 451.11 | 460.91 | 470.72 | 480.53 | 40 |
| 50 | 490.33 | 500.14 | 509.95 | 519.75 | 529.56 | 539.37 | 549.17 | 558.98 | 568.79 | 578.59 | 50 |
| 60 | 588.40 | 598.21 | 608.01 | 617.82 | 627.63 | 637.43 | 647.24 | 657.05 | 666.85 | 676.66 | 60 |
| 70 | 686.47 | 696.27 | 706.08 | 715.89 | 725.69 | 735.50 | 745.31 | 755.11 | 764.92 | 774.73 | 70 |
| 80 | 784.53 | 794.34 | 804.15 | 813.95 | 823.76 | 833.57 | 843.37 | 853.18 | 862.99 | 872.79 | 80 |
| 90 | 882.60 | 892.41 | 902.21 | 912.02 | 921.83 | 931.63 | 941.44 | 951.25 | 961.05 | 970.86 | 90 |
| 100 | 980.67 | 990.47 | 1000.28 | 1010.08 | 1019.89 | 1029.70 | 1039.50 | 1049.31 | 1059.12 | 1068.92 | 100 |

### NEWTONMETERS TO KILOGRAMMETERS

| N-m | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | N-m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | |
| — | — | 1.020 | 2.039 | 3.059 | 4.079 | 5.099 | 6.118 | 7.138 | 8.158 | 9.177 | — |
| 100 | 10.197 | 11.217 | 12.236 | 13.256 | 14.276 | 15.296 | 16.315 | 17.335 | 18.355 | 19.374 | 100 |
| 200 | 20.394 | 21.414 | 22.433 | 23.453 | 24.473 | 25.493 | 26.512 | 27.532 | 28.552 | 29.571 | 200 |
| 300 | 30.591 | 31.611 | 32.630 | 33.650 | 34.670 | 35.690 | 36.710 | 37.729 | 38.749 | 39.768 | 300 |
| 400 | 40.789 | 41.808 | 42.827 | 43.847 | 44.867 | 45.887 | 46.906 | 47.926 | 48.946 | 49.965 | 400 |
| 500 | 50.986 | 52.005 | 53.024 | 54.044 | 55.064 | 56.084 | 57.103 | 58.123 | 59.143 | 60.162 | 500 |
| 600 | 61.183 | 62.202 | 63.221 | 64.241 | 65.261 | 66.281 | 67.300 | 68.320 | 69.340 | 70.359 | 600 |
| 700 | 71.380 | 72.399 | 73.418 | 74.438 | 75.458 | 76.478 | 77.497 | 78.517 | 79.537 | 80.556 | 700 |
| 800 | 81.577 | 82.596 | 83.615 | 84.635 | 85.655 | 86.675 | 87.694 | 88.714 | 89.734 | 90.753 | 800 |
| 900 | 91.774 | 92.793 | 93.812 | 94.832 | 95.852 | 96.872 | 97.891 | 98.911 | 99.931 | 100.950 | 900 |
| 1000 | 101.972 | 102.990 | 104.009 | 105.029 | 106.049 | 107.069 | 108.088 | 109.108 | 110.128 | 111.147 | 1000 |

## TEMPERATURE

### FAHRENHEIT TO CENTIGRADE

| °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -60 | -51.1 | -2 | -18.9 | 56 | 13.3 | 114 | 45.6 | 172 | 77.8 | 230 | 110.0 | 288 | 142.2 | 346 | 174.4 |
| -58 | -50 | 0 | -17.8 | 58 | 14.4 | 116 | 46.7 | 174 | 78.9 | 232 | 111.1 | 290 | 143.3 | 348 | 175.6 |
| -56 | -48.9 | 2 | -16.7 | 60 | 15.6 | 118 | 47.8 | 176 | 80.0 | 234 | 112.2 | 292 | 144.4 | 350 | 176.7 |
| -54 | -47.8 | 4 | -15.6 | 62 | 16.7 | 120 | 48.9 | 178 | 81.1 | 236 | 113.3 | 294 | 145.6 | 352 | 177.8 |
| -52 | -46.7 | 6 | -14.4 | 64 | 17.8 | 122 | 50.0 | 180 | 82.2 | 238 | 114.4 | 296 | 146.7 | 354 | 178.9 |
| -50 | -45.6 | 8 | -13.3 | 66 | 18.9 | 124 | 51.1 | 182 | 83.3 | 240 | 115.6 | 298 | 147.8 | 356 | 180.0 |
| -48 | -44.4 | 10 | -12.2 | 68 | 20.0 | 126 | 52.2 | 184 | 84.4 | 242 | 116.7 | 300 | 148.9 | 358 | 181.1 |
| -46 | -43.3 | 12 | -11.1 | 70 | 21.1 | 128 | 53.3 | 186 | 85.6 | 244 | 117.8 | 302 | 150.0 | 360 | 182.2 |
| -44 | -42.2 | 14 | -10.0 | 72 | 22.2 | 130 | 54.4 | 188 | 86.7 | 246 | 118.9 | 304 | 151.1 | 362 | 183.3 |
| -42 | -41.1 | 16 | -8.9 | 74 | 23.3 | 132 | 55.6 | 190 | 87.8 | 248 | 120.0 | 306 | 152.2 | 364 | 184.4 |
| -40 | -40.0 | 18 | -7.8 | 76 | 24.9 | 134 | 56.7 | 192 | 88.9 | 250 | 121.1 | 308 | 153.3 | 366 | 185.6 |
| -38 | -38.9 | 20 | -6.7 | 78 | 25.6 | 136 | 57.8 | 194 | 90.0 | 252 | 122.2 | 310 | 154.4 | 368 | 186.7 |
| -36 | -37.8 | 22 | -5.6 | 80 | 26.7 | 138 | 58.9 | 196 | 91.1 | 254 | 123.3 | 312 | 155.6 | 370 | 187.8 |
| -34 | -36.7 | 24 | -4.4 | 82 | 27.8 | 140 | 60.0 | 198 | 92.2 | 256 | 124.4 | 314 | 156.7 | 372 | 188.9 |
| -32 | -35.6 | 26 | -3.3 | 84 | 28.9 | 142 | 61.1 | 200 | 93.3 | 258 | 125.6 | 316 | 157.8 | 374 | 190.0 |
| -30 | -34.4 | 28 | -2.2 | 86 | 30.0 | 144 | 62.2 | 202 | 94.4 | 260 | 126.7 | 318 | 158.9 | 376 | 191.1 |
| -28 | -33.3 | 30 | -1.1 | 88 | 31.1 | 146 | 63.3 | 204 | 95.6 | 262 | 127.8 | 320 | 160.0 | 378 | 192.2 |
| -26 | -32.2 | 32 | -0 | 90 | 32.2 | 148 | 64.4 | 206 | 96.7 | 264 | 128.9 | 322 | 161.1 | 380 | 193.3 |
| -24 | -31.1 | 34 | 1.1 | 92 | 33.3 | 150 | 65.6 | 208 | 97.8 | 266 | 130.0 | 324 | 162.2 | 382 | 194.4 |
| -22 | -30.0 | 36 | 2.2 | 94 | 34.4 | 152 | 66.7 | 210 | 98.9 | 268 | 131.1 | 326 | 163.3 | 384 | 195.6 |
| -20 | -28.9 | 38 | 3.3 | 96 | 35.6 | 154 | 67.8 | 212 | 100.0 | 270 | 132.2 | 328 | 164.4 | 386 | 196.7 |
| -18 | -27.8 | 40 | 4.4 | 98 | 36.7 | 156 | 68.9 | 214 | 101.1 | 272 | 133.3 | 330 | 165.6 | 388 | 197.8 |
| -16 | -26.7 | 42 | 5.6 | 100 | 37.8 | 158 | 70.0 | 216 | 102.2 | 274 | 134.4 | 332 | 166.7 | 390 | 198.9 |
| -14 | -25.6 | 44 | 6.7 | 102 | 38.9 | 160 | 71.1 | 218 | 103.3 | 276 | 135.6 | 334 | 167.8 | 392 | 200.0 |
| -12 | -24.4 | 46 | 7.8 | 104 | 40.0 | 162 | 72.2 | 220 | 104.4 | 278 | 136.7 | 336 | 168.9 | 400 | 204.4 |
| -10 | -23.3 | 48 | 8.9 | 106 | 41.1 | 164 | 73.3 | 222 | 105.6 | 280 | 137.8 | 338 | 170.0 | 410 | 210.0 |
| -8 | -22.2 | 50 | 10.0 | 108 | 42.2 | 166 | 74.4 | 224 | 106.7 | 282 | 138.9 | 340 | 171.1 | 420 | 215.6 |
| -6 | -21.1 | 52 | 11.1 | 110 | 43.3 | 168 | 75.6 | 226 | 107.8 | 284 | 140.0 | 342 | 172.2 | 430 | 221.1 |
| -4 | -20.0 | 54 | 12.2 | 112 | 44.4 | 170 | 76.7 | 228 | 108.9 | 286 | 141.1 | 344 | 173.3 | 440 | 226.7 |

### CENTIGRADE TO FAHRENHEIT

| °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -50 | -58.0 | -18 | - 0.4 | 14 | 57.2 | 46 | 114.8 | 78 | 172.4 | 110 | 230.0 | 142 | 287.6 | 174 | 345.2 |
| -49 | -56.2 | -17 | 1.4 | 15 | 59.0 | 47 | 116.6 | 79 | 174.2 | 111 | 231.8 | 143 | 289.4 | 175 | 347.0 |
| -48 | -54.4 | -16 | 3.2 | 16 | 60.8 | 48 | 118.4 | 80 | 176.0 | 112 | 233.6 | 144 | 291.2 | 176 | 348.8 |
| -47 | -52.6 | -15 | 5.0 | 17 | 62.6 | 49 | 120.2 | 81 | 177.8 | 113 | 235.4 | 145 | 293.0 | 177 | 350.6 |
| -46 | -50.8 | -14 | 6.8 | 18 | 64.4 | 50 | 122.0 | 82 | 179.6 | 114 | 237.2 | 146 | 294.8 | 178 | 352.4 |
| -45 | -49.0 | -13 | 8.6 | 19 | 66.2 | 51 | 123.8 | 83 | 181.4 | 115 | 239.0 | 147 | 296.6 | 179 | 354.2 |
| -44 | -47.2 | -12 | 10.4 | 20 | 68.0 | 52 | 125.6 | 84 | 183.2 | 116 | 240.8 | 148 | 298.4 | 180 | 356.0 |
| -43 | -45.4 | -11 | 12.2 | 21 | 69.8 | 53 | 127.4 | 85 | 185.0 | 117 | 242.6 | 149 | 300.2 | 181 | 357.8 |
| -42 | -43.6 | -10 | 14.0 | 22 | 71.6 | 54 | 129.2 | 86 | 186.8 | 118 | 244.4 | 150 | 302.0 | 182 | 359.6 |
| -41 | -41.8 | -9 | 15.8 | 23 | 73.4 | 55 | 131.0 | 87 | 188.6 | 119 | 246.2 | 151 | 303.8 | 183 | 361.4 |
| -40 | -40.0 | -8 | 17.6 | 24 | 75.2 | 56 | 132.8 | 88 | 190.4 | 120 | 248.0 | 152 | 305.6 | 184 | 363.2 |
| -39 | -38.2 | -7 | 19.4 | 25 | 77.0 | 57 | 134.6 | 89 | 192.2 | 121 | 249.8 | 153 | 307.4 | 185 | 365.0 |
| -38 | -36.4 | -6 | 21.2 | 26 | 78.8 | 58 | 136.4 | 90 | 194.0 | 122 | 251.6 | 154 | 309.2 | 186 | 366.8 |
| -37 | -34.6 | -5 | 23.0 | 27 | 80.6 | 59 | 138.2 | 91 | 195.8 | 123 | 253.4 | 155 | 311.0 | 187 | 368.6 |
| -36 | -32.8 | -4 | 24.8 | 28 | 82.4 | 60 | 140.0 | 92 | 197.6 | 124 | 255.2 | 156 | 312.8 | 188 | 370.4 |
| -35 | -31.0 | -3 | 26.6 | 29 | 84.2 | 61 | 141.8 | 93 | 199.4 | 125 | 257.0 | 157 | 314.6 | 189 | 372.2 |
| -34 | -29.2 | -2 | 28.4 | 30 | 86.0 | 62 | 143.6 | 94 | 201.2 | 126 | 258.8 | 158 | 316.4 | 190 | 374.0 |
| -33 | -27.4 | -1 | 30.2 | 31 | 87.8 | 63 | 145.4 | 95 | 203.0 | 127 | 260.6 | 159 | 318.2 | 191 | 375.8 |
| -32 | -25.6 | 0 | 32.0 | 32 | 89.6 | 64 | 147.2 | 96 | 204.8 | 128 | 262.4 | 160 | 320.0 | 192 | 377.6 |
| -31 | -23.8 | 1 | 33.8 | 33 | 91.4 | 65 | 149.0 | 97 | 206.6 | 129 | 264.2 | 161 | 321.8 | 193 | 379.4 |
| -30 | -22.0 | 2 | 35.6 | 34 | 93.2 | 66 | 150.8 | 98 | 208.4 | 130 | 266.0 | 162 | 323.6 | 194 | 381.2 |
| -29 | -20.2 | 3 | 37.4 | 35 | 95.0 | 67 | 152.6 | 99 | 210.2 | 131 | 267.8 | 163 | 325.4 | 195 | 383.0 |
| -28 | -18.4 | 4 | 39.2 | 36 | 96.8 | 68 | 154.4 | 100 | 212.0 | 132 | 269.6 | 164 | 327.2 | 196 | 384.8 |
| -27 | -16.6 | 5 | 41.0 | 37 | 98.6 | 69 | 156.2 | 101 | 213.8 | 133 | 271.4 | 165 | 329.0 | 197 | 386.6 |
| -26 | -14.8 | 6 | 42.8 | 38 | 100.4 | 70 | 158.0 | 102 | 215.6 | 134 | 273.2 | 166 | 330.8 | 198 | 388.4 |
| -25 | -13.0 | 7 | 44.6 | 39 | 102.2 | 71 | 159.8 | 103 | 217.4 | 135 | 275.0 | 167 | 332.6 | 199 | 390.2 |
| -24 | -11.2 | 8 | 46.4 | 40 | 104.0 | 72 | 161.6 | 104 | 219.2 | 136 | 276.8 | 168 | 334.4 | 200 | 392.0 |
| -23 | -9.4 | 9 | 48.2 | 41 | 105.8 | 73 | 163.4 | 105 | 221.0 | 137 | 278.6 | 169 | 336.4 | 210 | 410.0 |
| -22 | -7.6 | 10 | 50.0 | 42 | 107.6 | 74 | 165.2 | 106 | 222.8 | 138 | 280.4 | 170 | 338.0 | 220 | 428.0 |
| -21 | -5.8 | 11 | 51.8 | 43 | 109.4 | 75 | 167.0 | 107 | 224.6 | 139 | 282.2 | 171 | 339.8 | 230 | 446.0 |
| -20 | -4.4 | 12 | 53.6 | 44 | 111.2 | 76 | 168.8 | 108 | 226.4 | 140 | 284.0 | 172 | 341.6 | 240 | 464.0 |
| -19 | -2.2 | 13 | 55.4 | 45 | 113.0 | 77 | 170.6 | 109 | 228.2 | 141 | 285.8 | 173 | 343.4 | 250 | 482.0 |

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