

**ENGINE BASE**

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# **SERVICE MANUAL**

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**ISUZU  
4JG2**

**REFERENCE ONLY**

**- FORK LIFT(HDF20-30, -2 SERIES)**

**ISUZU  
FORK  
LIFT**

## **FOREWORD**

This Workshop Manual is designed to help you perform necessary maintenance, service, and repair procedures on applicable Isuzu industrial engines.

Information contained in this Workshop Manual is the latest available at the time of publication.

Isuzu reserves the right to make changes at any time without prior notice.

This Workshop Manual is applicable to 1996 and later models.

## **NOTICE**

Before using this Workshop Manual to assist you in performing engine service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section - 1 under the headings "General Repair Instruction" and "Notes on The Format of This Manual"

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## SECTION 1

## GENERAL INFORMATION

## TABLE OF CONTENTS

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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.
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 dismantling 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.

### NOTES ON THE FORMAT OF THIS MANUAL

This Workshop Manual is applicable to ISUZU industrial engine or engines which is or are stated in the title.

When more than two engine models are dealt in the manual, such engines have common parts and components as well as data and specifications, unless otherwise specified.

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.  
The section ENGINE ASSEMBLY is an exception. This parts are divided in three sections to facilitates indexing.
3. Each section is divided into sub-sections dealing with disassembly, inspection and repair, and reassembly.

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 marked with an asterisk (\*) are included in the repair kit.

Parts within a square 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.

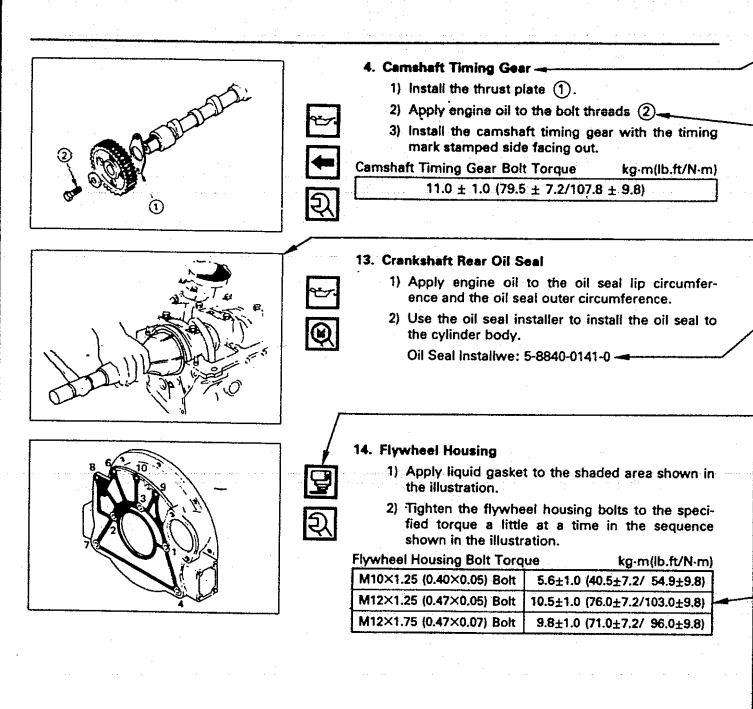
The "\* Repair Kit" indicates that a repair kit is available.

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.

## GENERAL INFORMATION

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



**4. 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)

|                                     |
|-------------------------------------|
| 11.0 ± 1.0 (79.5 ± 7.2/107.8 ± 9.8) |
|-------------------------------------|

**13. Crankshaft Rear Oil Seal**

- 1) Apply engine oil to the oil seal lip circumference and the oil seal outer circumference.
- 2) Use the oil seal installer to install the oil seal to the cylinder body.

Oil Seal Installw: 5-8840-0141-0

**14. Flywheel Housing**

- 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)

|                           |                               |
|---------------------------|-------------------------------|
| M10×1.25 (0.40×0.05) Bolt | 5.6±1.0 (40.5±7.2/ 54.9±9.8)  |
| M12×1.25 (0.47×0.05) Bolt | 10.5±1.0 (76.0±7.2/103.0±9.8) |
| M12×1.75 (0.47×0.07) Bolt | 9.8±1.0 (71.0±7.2/ 96.0±9.8)  |

- This is the item shown in the illustration. It is marked with a triangle (▲) on the Major Components page.
- Letters and numbers contained in a circle refer to the illustration.
- Special tools are identified by the tool name and/or number. The illustration shows how the special tool is to be used.
- 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                |  | .... Adjustment                                                     |
|  | .... Installation           |  | .... Cleaning                                                       |
|  | .... Disassembly            |  | .... Important operation requiring extra care                       |
|  | .... Reassembly             |  | .... Specified torque (tighten)                                     |
|  | .... Alignment (marks)      |  | .... Special tool use required or recommended (Isuzu tool or tools) |
|  | .... Directional indication |  | .... Commercially available tool use required or recommended        |
|  | .... Inspection             |  | .... Lubrication (oil)                                              |
|  | .... Measurement            |  | .... Lubrication (grease)                                           |
|  |                             |  | .... Sealant application                                            |

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

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

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

A measurement which is outside the "limit" indicates that the applicable part or 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 right hand side viewed from the same position.

**Left**

The left hand side viewed from the same position.

**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.

## MAIN DATA AND SPECIFICATIONS

| <div>Engine Model</div> <div>Item</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4JG2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Engine type<br>Combustion chamber type<br>Cylinder liner type<br>No. of cylinders - Bore x Stroke    mm(in.)<br>Total piston displacement            cc(cid)<br>Compression ratio (To 1)<br>*Engine dimensions                    mm(in.)<br>Length x Width x Height<br>*Engine weight (Dry)                   kg(lb.)<br>Fuel injection order<br>*Fuel injection timing (B.T.D.C.)    degrees<br>Specified fuel<br>Injection pump<br>Governor<br>*Low idle speed                          rpm<br>Injection nozzle<br>Injection starting pressure   MPa(kg/cm <sup>2</sup> /psi)<br>Fuel filter type<br>Water sedimentor (if so equipped)<br>Compression pressure            MPa(kg/cm <sup>2</sup> /psi)<br>Valve clearance (at cold) Intake    mm(in.)<br>Exhaust mm(in.)<br>Lubrication method<br>Oil pump<br>Main oil filter type<br>Partial oil filter<br>*Lubricating oil volume                lit.(US/gal.)<br>Oil cooler (if so equipped)<br>Cooling method<br>Coolant volume (engine only)    lit.(US/gal.)<br>Water pump<br>Thermostat type<br>*Alternator                                V-A<br>*Starter                                      V-kW | Water cooled, four-cycle, in-line, overhead valve<br>Swirl chamber<br>Dry<br>4 - 95.4 x 107 (3.76 x 4.21)<br>3,059 (187)<br>20.1<br>710 x 555 x 733 (28.0 x 21.9 x 28.9)<br>244 (538)<br>1 - 3- 4 - 2<br>6<br>Diesel fuel<br>Bosch VE type<br>Mechanical, type<br>675 - 725<br>Throttle type<br>14.7 (150/2,130)<br>Cartridge paper element<br>Sediment/water level indicating type<br>2.94 (30/427)<br>0.40 (0.016)<br>0.40 (0.016)<br>Pressurized circulation<br>Trochoid type<br>Cartridge paper element, full flow<br>Not equipped<br>7.5 (1.98)<br>Water cooled built in oil filter<br>Pressurized forced circulation<br>4.5 (1.19)<br>Belt driven impeller type<br>Wax pellet type<br>12 - 35<br>12 - 2.2 |

Specifications marked with an asterisk (\*) will vary according to engine application.

## TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

### STANDARD BOLT

kg·m (lb.ft/N·m)

| Strength Class<br>Bolt Identification | 4.8 (4T)                                                                                  | (7T)                                                                              | 8.8                                                                               |                                                                                     | 9.8 (9T)                                                                            |
|---------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                       |                                                                                           |                                                                                   | Refined                                                                           | Non-Refined                                                                         |                                                                                     |
|                                       |          |  |  |  |  |
| Bolt Diameter × pitch (mm)            |  No mark | —                                                                                 |  |  |  |
| <b>M 6 × 1.0</b>                      | 0.4 ~ 0.8<br>(2.9 ~ 5.8/3.9 ~ 7.8)                                                        | 0.5 ~ 1.0<br>(3.6 ~ 7.2/4.9 ~ 9.8)                                                |                                                                                   |                                                                                     | —                                                                                   |
| <b>M 8 × 1.25</b>                     | 0.8 ~ 1.8<br>(5.8 ~ 13.0/7.8 ~ 17.7)                                                      | 1.2 ~ 2.3<br>(8.7 ~ 16.6/11.8 ~ 22.6)                                             |                                                                                   |                                                                                     | 1.7 ~ 3.1<br>(12.3 ~ 22.4/16.7 ~ 30.4)                                              |
| <b>M10 × 1.25</b>                     | 2.1 ~ 3.5<br>(15.2 ~ 25.3/20.6 ~ 34.3)                                                    | 2.8 ~ 4.7<br>(20.3 ~ 34.0/27.5 ~ 46.1)                                            |                                                                                   |                                                                                     | 3.8 ~ 6.4<br>(27.5 ~ 46.3/37.3 ~ 62.8)                                              |
| <b>M12 × 1.25</b>                     | 5.0 ~ 7.5<br>(36.2 ~ 54.2/49.0 ~ 73.6)                                                    | 6.2 ~ 9.3<br>(44.8 ~ 67.3/60.8 ~ 91.2)                                            |                                                                                   |                                                                                     | 7.7 ~ 11.6<br>(55.7 ~ 83.9/75.5 ~ 113.8)                                            |
| <b>M14 × 1.5</b>                      | 7.8 ~ 11.7<br>(56.4 ~ 84.6/78.5 ~ 114.7)                                                  | 9.5 ~ 14.2<br>(68.7 ~ 102.7/93.2 ~ 139.3)                                         |                                                                                   |                                                                                     | 11.6 ~ 17.4<br>(83.9 ~ 125.6/113.8 ~ 170.6)                                         |
| <b>M16 × 1.5</b>                      | 10.6 ~ 16.0<br>(76.7 ~ 115.7/103.0 ~ 156.9)                                               | 13.8 ~ 20.8<br>(99.8 ~ 150.4/135.3 ~ 204.0)                                       |                                                                                   |                                                                                     | 16.3 ~ 24.5<br>(118.9 ~ 177.2/159.9 ~ 240.3)                                        |
| <b>M18 × 1.5</b>                      | 15.4 ~ 23.0<br>(111.1 ~ 166.4/151.0 ~ 225.6)                                              | 19.9 ~ 29.9<br>(143.9 ~ 216.3/195.2 ~ 391.3)                                      |                                                                                   |                                                                                     | 23.4 ~ 35.2<br>(169.3 ~ 254.6/229.5 ~ 345.2)                                        |
| <b>M20 × 1.5</b>                      | 21.0 ~ 31.6<br>(151.9 ~ 228.6/205.9 ~ 307.9)                                              | 27.5 ~ 41.3<br>(198.9 ~ 298.7/269.7 ~ 405.0)                                      |                                                                                   |                                                                                     | 32.3 ~ 48.5<br>(233.6 ~ 350.8/316.8 ~ 475.6)                                        |
| <b>M22 × 1.5</b>                      | 25.6 ~ 42.2<br>(185.2 ~ 305.2/251.1 ~ 413.8)                                              | 37.0 ~ 55.5<br>(267.6 ~ 401.4/362.9 ~ 544.3)                                      |                                                                                   |                                                                                     | 43.3 ~ 64.9<br>(313.2 ~ 469.4/424.6 ~ 636.5)                                        |
| <b>M24 × 2.0</b>                      | 36.6 ~ 55.0<br>(264.7 ~ 397.8/358.9 ~ 539.4)                                              | 43.9 ~ 72.5<br>(317.5 ~ 523.9/430.5 ~ 711.0)                                      |                                                                                   |                                                                                     | 56.5 ~ 84.7<br>(408.7 ~ 612.6/554.1 ~ 830.6)                                        |
| <b>*M10 × 1.5</b>                     | 2.0 ~ 3.4<br>(14.5 ~ 24.6/19.6 ~ 32.4)                                                    | 2.8 ~ 4.6<br>(20.3 ~ 33.3/27.5 ~ 45.1)                                            |                                                                                   |                                                                                     | 3.7 ~ 6.1<br>(26.8 ~ 44.1/36.3 ~ 59.8)                                              |
| <b>*M12 × 1.5</b>                     | 4.6 ~ 7.0<br>(33.3 ~ 50.6/45.1 ~ 68.7)                                                    | 5.8 ~ 8.6<br>(42.0 ~ 62.2/56.9 ~ 84.3)                                            |                                                                                   |                                                                                     | 7.3 ~ 10.9<br>(52.8 ~ 78.8/71.6 ~ 106.9)                                            |
| <b>*M14 × 2.0</b>                     | 7.3 ~ 10.9<br>(52.8 ~ 78.8/71.6 ~ 106.9)                                                  | 9.0 ~ 13.4<br>(65.1 ~ 96.9/88.3 ~ 131.4)                                          |                                                                                   |                                                                                     | 10.9 ~ 16.3<br>(78.8 ~ 118.9/106.9 ~ 159.9)                                         |
| <b>*M16 × 2.0</b>                     | 10.2 ~ 15.2<br>(73.8 ~ 110.0/100.0 ~ 149.1)                                               | 13.2 ~ 19.8<br>(95.5 ~ 143.2/129.5 ~ 194.2)                                       |                                                                                   |                                                                                     | 15.6 ~ 23.4<br>(112.8 ~ 169.3/162.8 ~ 229.5)                                        |

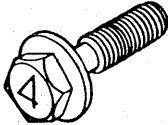
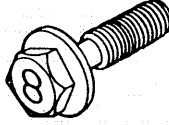
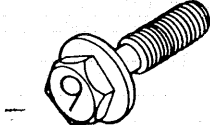
An asterisk (\*) indicates that the bolts are used for female threaded parts that are made of soft materials such as casting. Those shown in parentheses in the strength class indicate the classification by the old standard.

TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

FLANGED HEAD BOLT

kg·m (lb.ft/N·m)

| <div>Bolt head marking</div> <div>Nominal size (dia. x pitch)</div> |  |  |  |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| M 6 × 1                                                             | 0.5 ~ 0.9<br>(3.61 ~ 6.50/4.6 ~ 8.5)                                              | 0.6 ~ 1.2<br>(4.33 ~ 8.67/5.88 ~ 11.76)                                           | —                                                                                   |
| M 8 × 1.25                                                          | 1.1 ~ 2.0<br>(7.95 ~ 14.46/10.78 ~ 19.61)                                         | 1.4 ~ 2.9<br>(4.33 ~ 8.67/5.88 ~ 11.76)                                           | 1.9 ~ 3.4<br>(13.74 ~ 24.59/18.63 ~ 33.34)                                          |
| M10 × 1.25                                                          | 2.3 ~ 3.9<br>(17.35 ~ 28.20/23.53 ~ 38.24)                                        | 3.6 ~ 6.4<br>(26.03 ~ 44.12/35.30 ~ 59.82)                                        | 4.3 ~ 7.2<br>(31.10 ~ 52.07/42.16 ~ 70.60)                                          |
| *M10 × 1.5                                                          | 2.3 ~ 3.8<br>(16.63 ~ 27.48/22.55 ~ 37.26)                                        | 3.5 ~ 5.8<br>(25.31 ~ 41.95/34.32 ~ 56.87)                                        | 4.1 ~ 6.8<br>(29.65 ~ 49.18/40.20 ~ 66.68)                                          |
| M12 × 1.25                                                          | 5.6 ~ 8.4<br>(40.50 ~ 60.75/54.91 ~ 82.37)                                        | 7.9 ~ 11.9<br>(57.14 ~ 86.07/77.47 ~ 116.69)                                      | 8.7 ~ 13.0<br>(62.92 ~ 94.02/85.31 ~ 127.48)                                        |
| *M12 × 1.75                                                         | 3.5 ~ 9.5<br>(37.61 ~ 56.41/50.99 ~ 76.49)                                        | 7.3 ~ 10.9<br>(52.80 ~ 78.83/71.58 ~ 106.89)                                      | 8.1 ~ 12.2<br>(58.58 ~ 88.24/79.43 ~ 119.64)                                        |
| M14 × 1.5                                                           | 8.5 ~ 12.7<br>(61.48 ~ 91.85/83.35 ~ 124.54)                                      | 11.7 ~ 17.6<br>(84.62 ~ 127.30/114.73 ~ 172.59)                                   | 12.6 ~ 18.9<br>(91.13 ~ 136.70/123.56 ~ 185.34)                                     |
| *M14 × 2                                                            | 7.6 ~ 11.5<br>(57.14 ~ 85.34/77.47 ~ 115.71)                                      | 11.1 ~ 16.6<br>(80.28 ~ 120.06/108.85 ~ 162.79)                                   | 11.8 ~ 17.7<br>(85.34 ~ 128.02/115.71 ~ 173.57)                                     |
| M16 × 1.5                                                           | 11.8 ~ 17.7<br>(85.34 ~ 128.02/115.71 ~ 173.57)                                   | 17.1 ~ 26.5<br>(125.85 ~ 189.50/170.63 ~ 256.93)                                  | 18.0 ~ 27.1<br>(130.19 ~ 196.01/176.52 ~ 265.76)                                    |
| *M16 × 2                                                            | 11.2 ~ 16.7<br>(81.00 ~ 120.79/109.83 ~ 163.77)                                   | 16.6 ~ 24.9<br>(120.06 ~ 180.10/162.79 ~ 244.18)                                  | 17.2 ~ 25.7<br>(124.40 ~ 186.61/168.67 ~ 253.01)                                    |

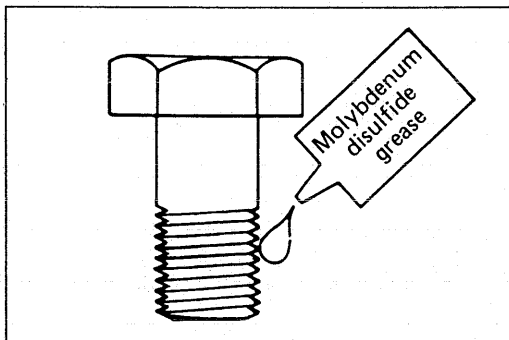
A bolt with an asterisk (\*) is used for female screws of soft material such as cast iron.



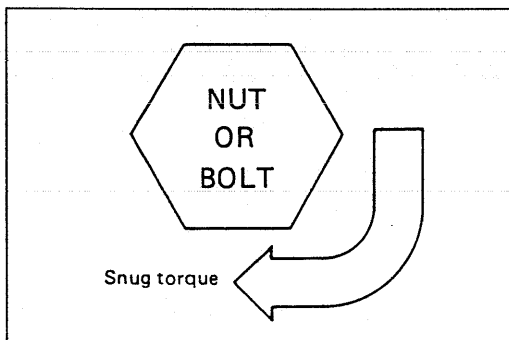
## ANGULAR NUT AND BOLT TIGHTENING METHOD



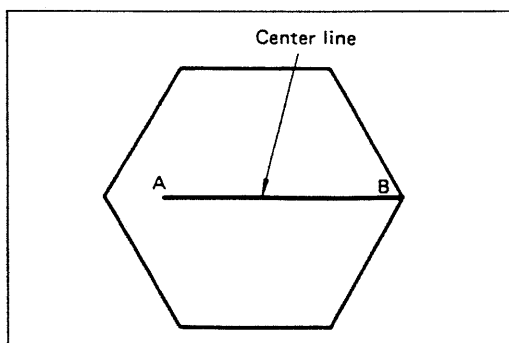
1. Carefully wash the nuts and bolts to remove all oil and grease.



2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.



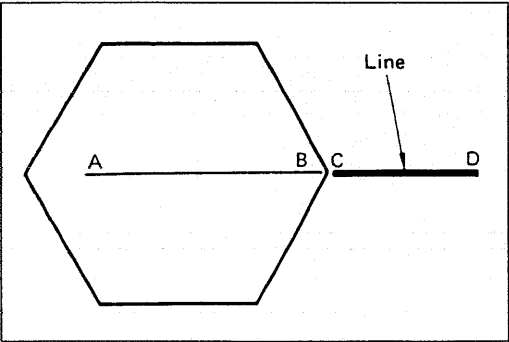
3. Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.



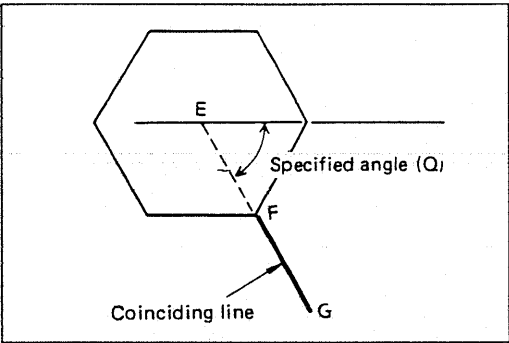
4. Draw a line [A-B] across the center of each bolt.



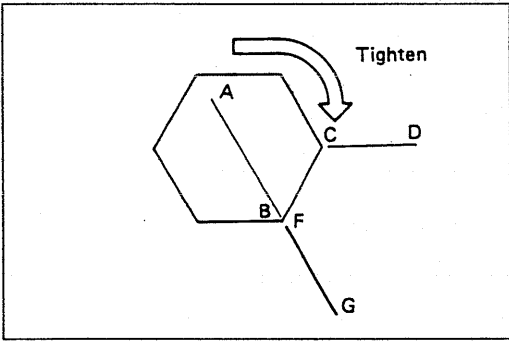
GENERAL INFORMATION



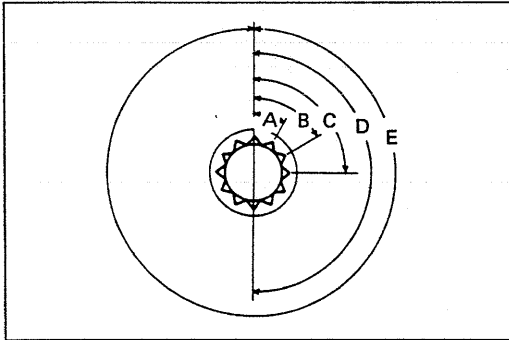
5. Draw another line (C-D) on the face of each of the parts to be clamped. This line should be an extension of the line [A-B].



6. Draw another line [F-G] on the face of each of the parts to be clamped. This line will be in the direction of the specified angle (Q) across the center [E] of the nut or bolt.



7. Use a socket wrench to tighten each nut or bolt to the point where the line [A-B] is aligned with the line [F-G].



Example: Specified Angle and Tightening Rotation

|   |      |                |
|---|------|----------------|
| A | 30°  | 1/12 of a turn |
| B | 60°  | 1/6 of a turn  |
| C | 90°  | 1/4 of a turn  |
| D | 180° | 1/2 of a turn  |
| E | 360° | One full turn  |

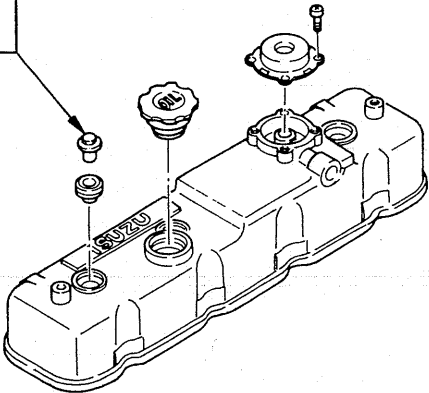


SPECIAL PARTS FIXING NUTS AND BOLTS

Cylinder Head Cover, Cylinder Head, and Rocker Arm Shaft Bracket

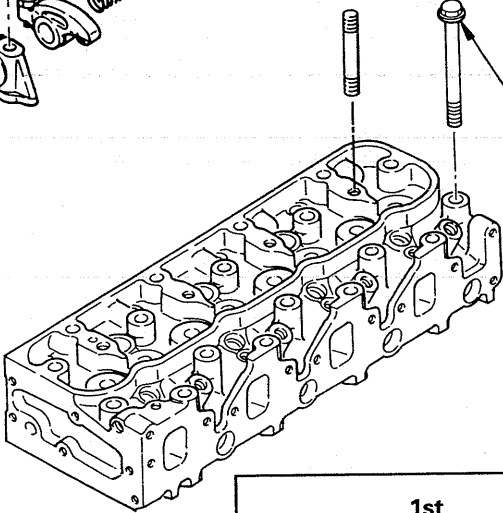
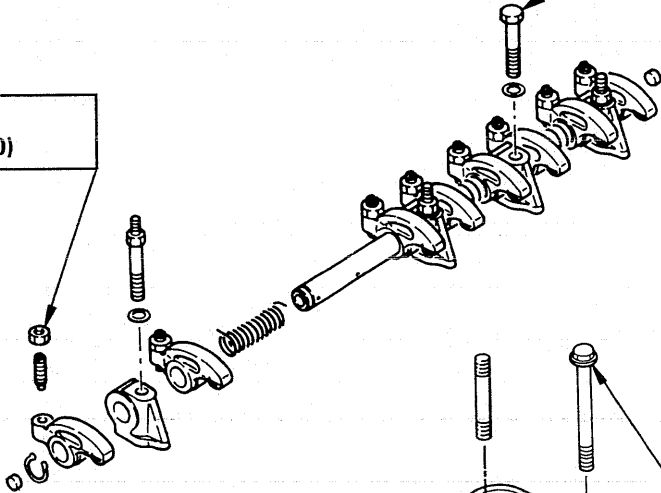
kg·m(lb.ft./N·m)

0.8 – 1.8  
(5.8 – 13.0/8 – 18)



5.0 – 6.0  
(36 – 43/49 – 59)

1.0 – 2.0  
(7 – 14/10 – 20)



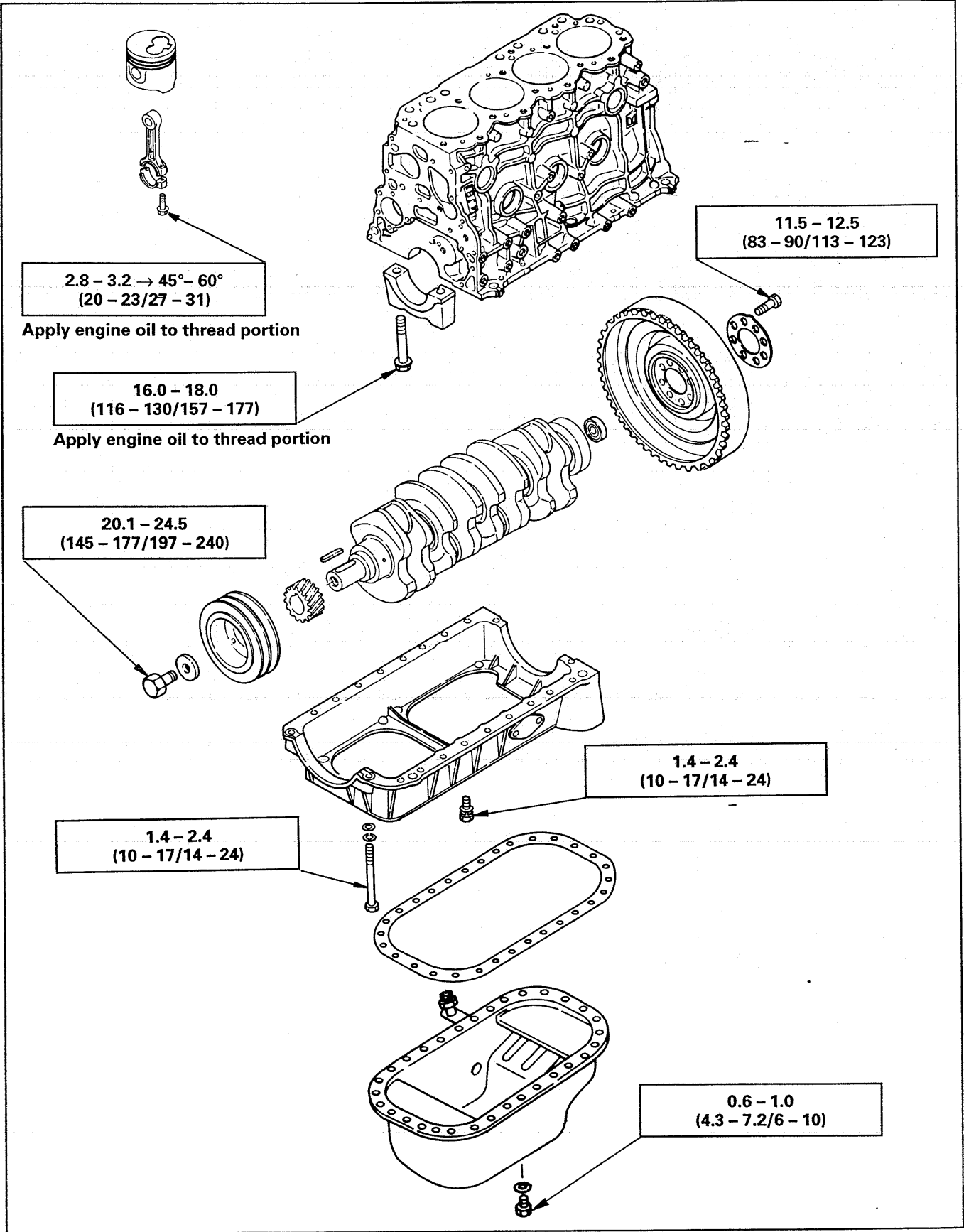
| 1st                            | 2nd      | 3rd      |
|--------------------------------|----------|----------|
| 4.5 – 5.5<br>(33 – 40/44 – 54) | 60 – 75° | 60 – 75° |

Apply engine oil to thread portion



Crankshaft Bearing Cap, Connecting Rod Bearing Cap, Crankshaft Damper Pulley, Flywheel, and Oil Pan

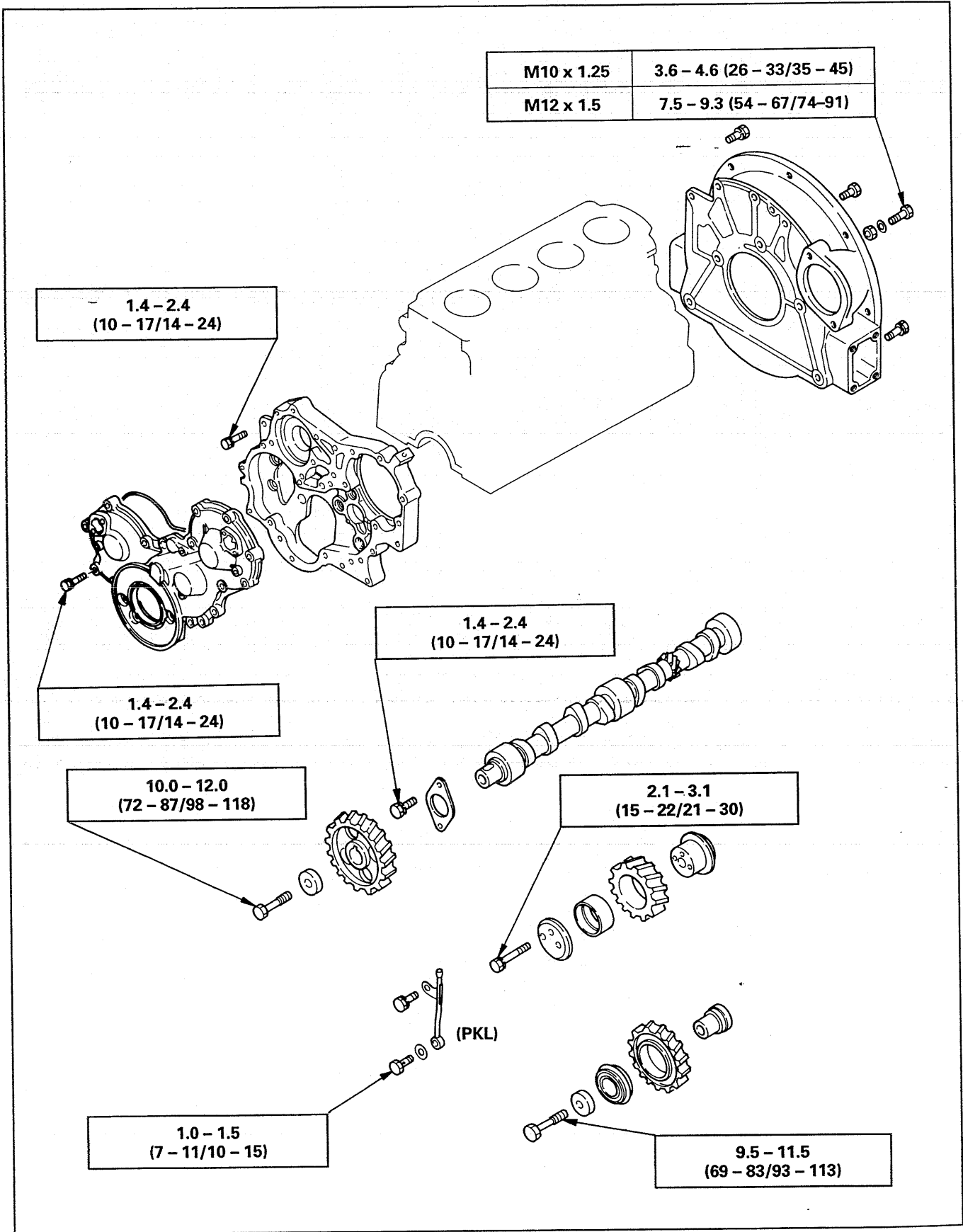
kg·m(lb.ft./N·m)





Timing Gear Case, Flywheel Housing, Camshaft, and Timing Gear

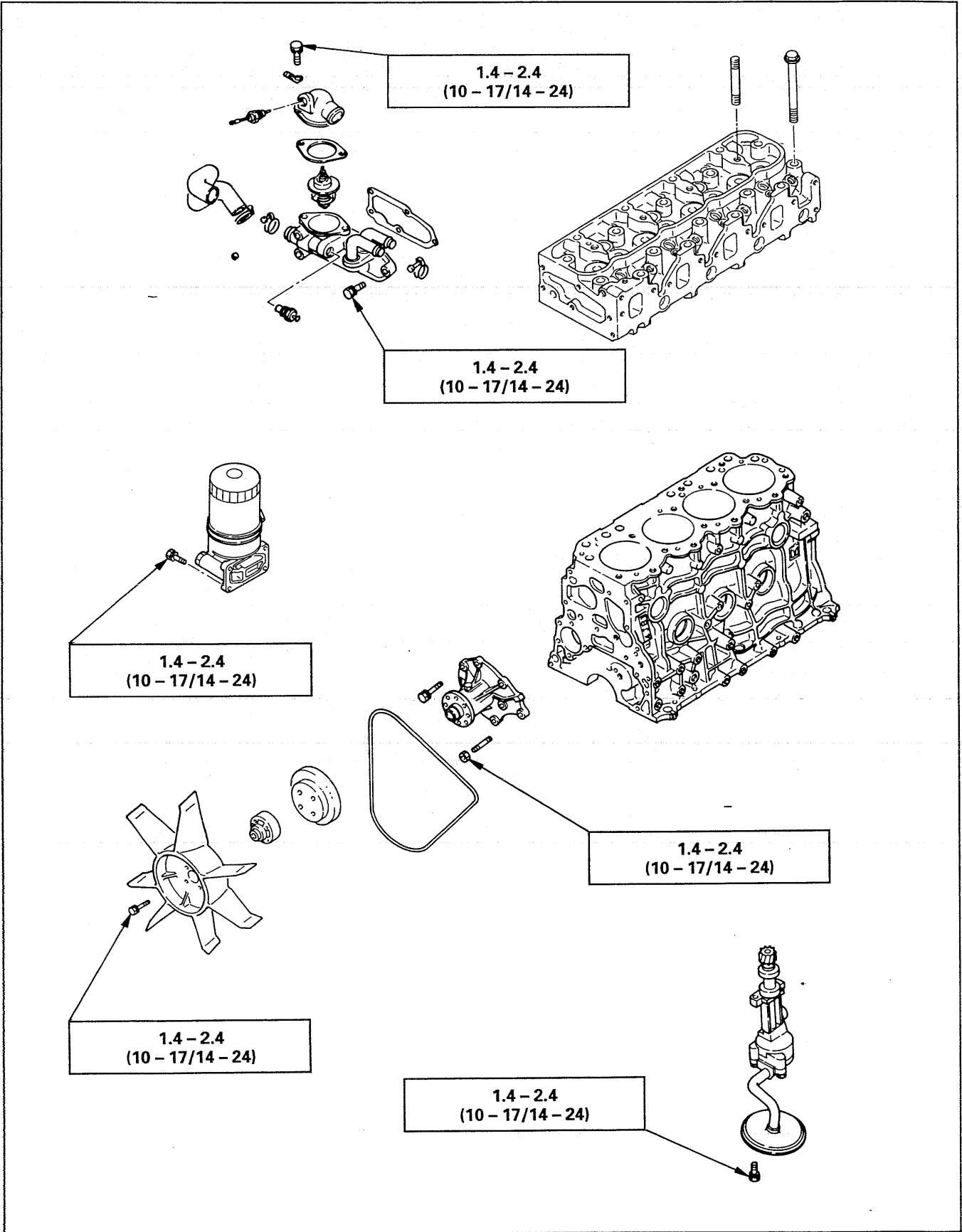
kg·m(lb.ft./N·m)





Cooling and Lubricating System

kg·m(lb.ft./N·m)

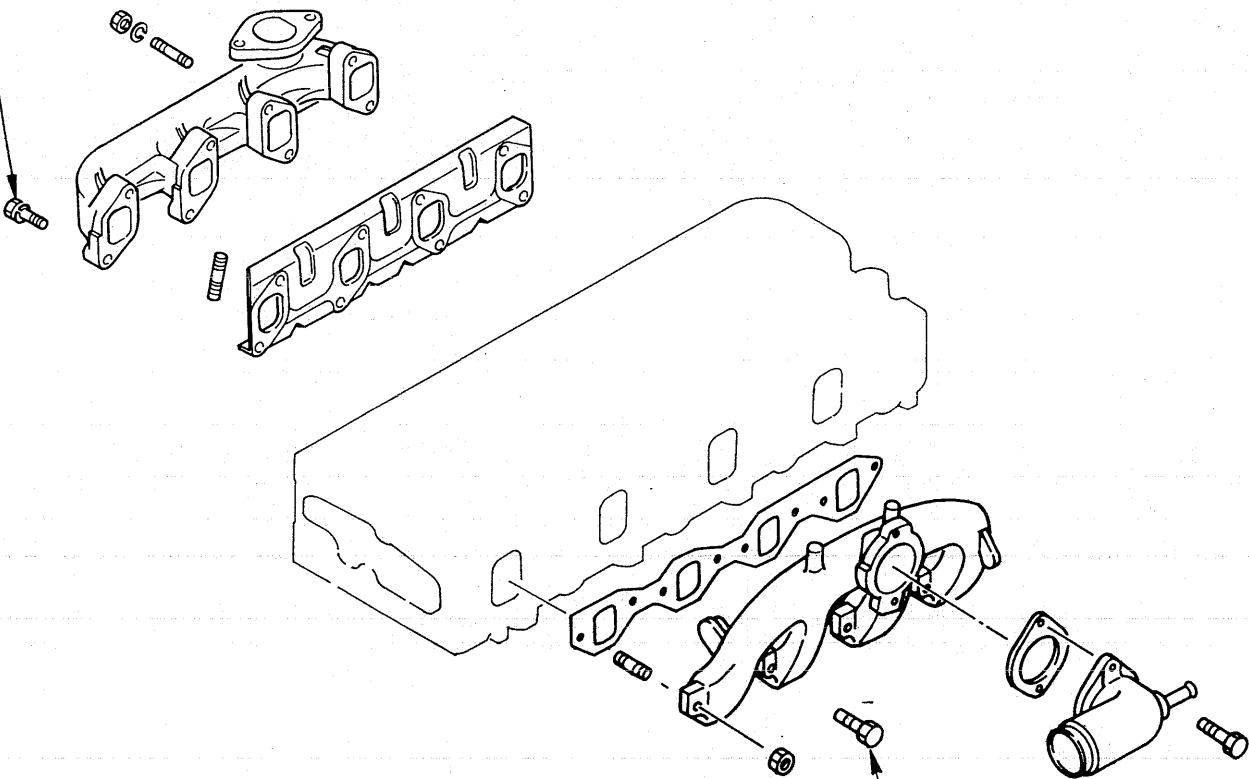




Intake and Exhaust Manifold

kg·m(lb.ft./N·m)

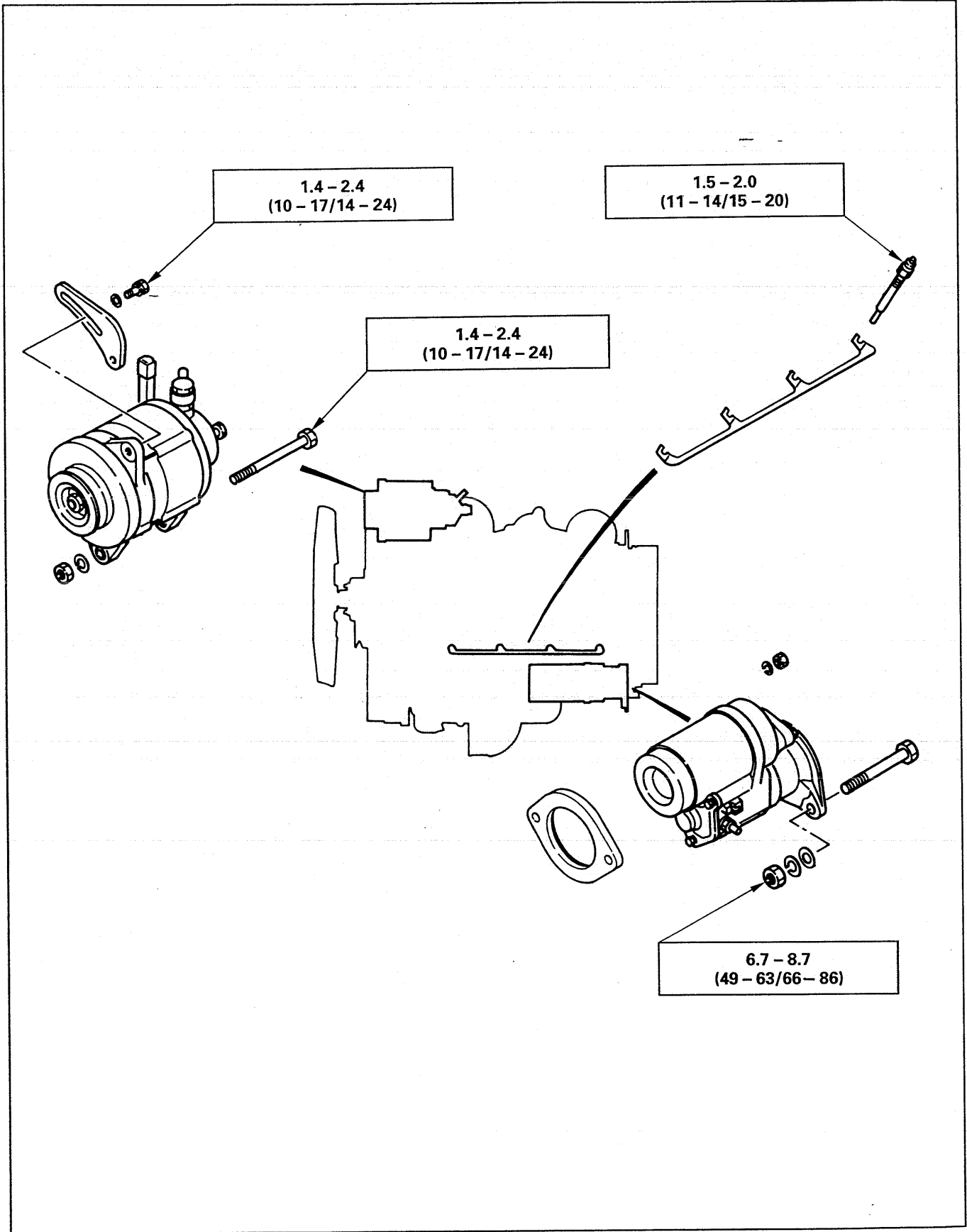
1.4 - 2.4  
(10 - 17/14 - 24)



1.4 - 2.4  
(10 - 17/14 - 24)



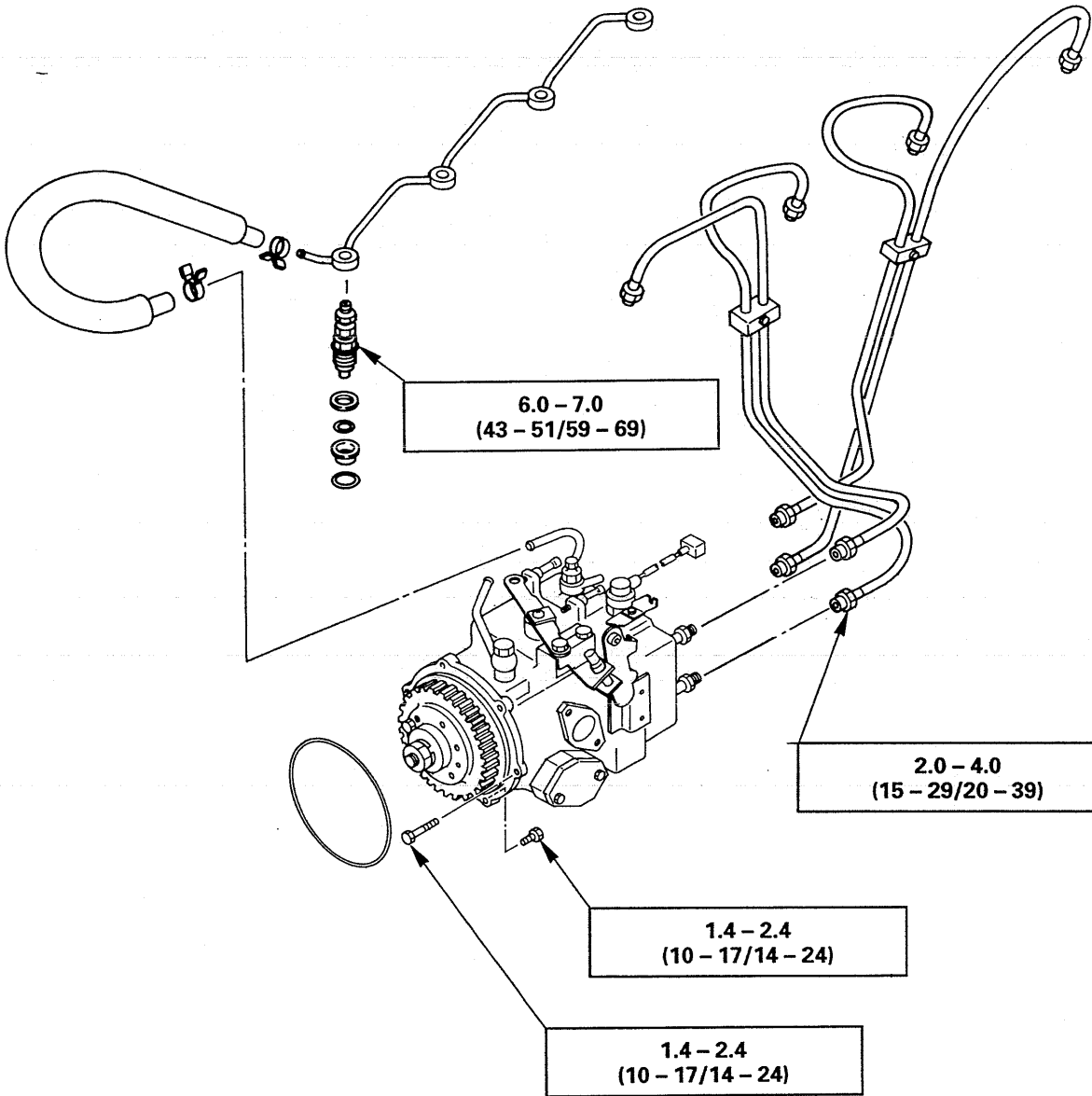
kg·m(lb.ft./N·m)





Fuel Injection System

kg·m(lb.ft./N·m)





GENERAL INFORMATION

MEMO

Handwriting practice area with horizontal dotted lines.

SECTION 2

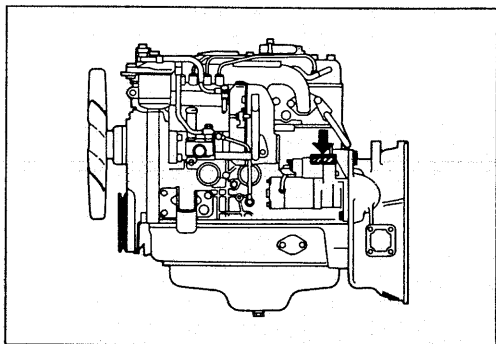
MAINTENANCE

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| Injection pump identification .....    | 20   |
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## MAINTENANCE

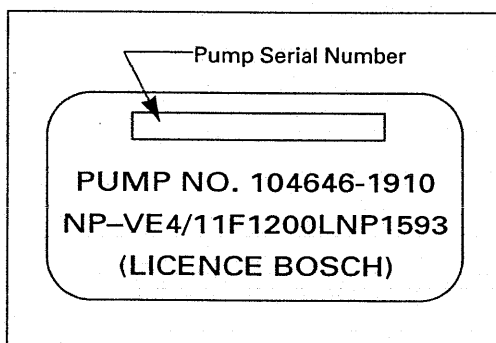
Servicing refers to general maintenance procedures to be performed by qualified service personnel. Maintenance interval such as fuel or oil filter changes should be referred to "INSTRUCTION MANUAL".



### MODEL IDENTIFICATION

#### Engine Serial Number

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



### INJECTION PUMP IDENTIFICATION

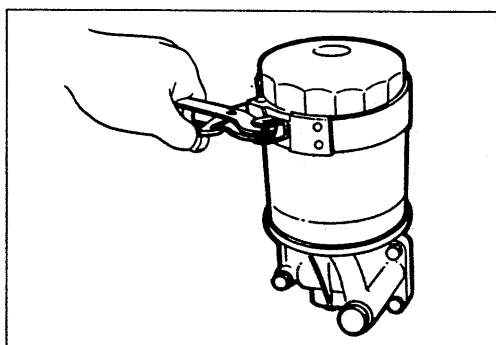
Injection volume should be adjusted after referring to the adjustment data applicable to the injection pump installed.

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



### LUBRICATING SYSTEM

#### Main Oil Filter

##### Replacement Procedure

1. Loosen the drain plug to drain the engine oil.
2. Wait a few minutes and then retighten the drain plug.
3. Loosen the used oil filter by turning it counterclockwise with a filter wrench.

Filter Wrench





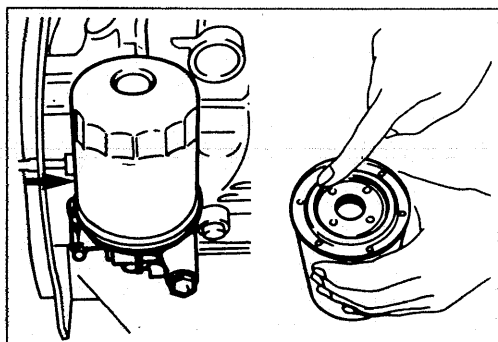
4. Clean the oil filter fitting face.

This will allow the new oil filter to seat properly.



5. Apply a light coat of engine oil to the O-ring.

6. Turn in the new oil filter until the filter O-ring is fitted against the sealing face.



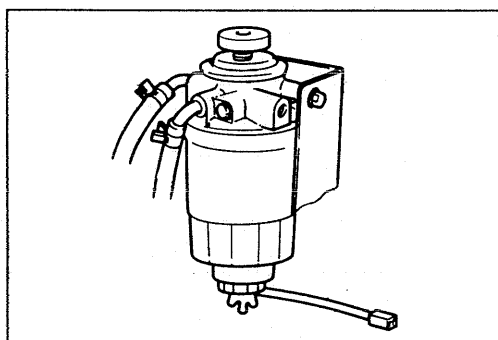
7. Use a filter wrench to turn in the filter an additional 1 and 1/4 of a turn.

Filter Wrench

8. Check the engine oil level and replenish to the specified level if required.



9. Start the engine and check for oil leakage from the main oil filter.



## FUEL SYSTEM

### Fuel Filter

#### Replacement Procedure

1. Loosen the used fuel filter by turning it counter-clockwise with the filter wrench.



Filter Wrench: 5-8840-0253-0 (J-22700)

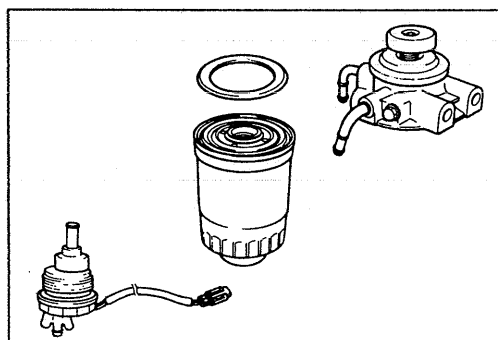
2. Remove the level sensor from the filter by turning it counterclockwise with a wrench.



3. Install the level sensor to the new fuel filter with a wrench.

Level Sensor Torque kg-m (lb-ft/N-m)

- 1.3 (9/13)



4. Clean the filter cover fitting faces.  
This will allow the new fuel filter to seat properly.



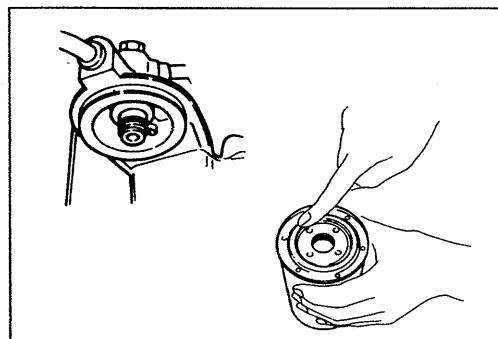
5. Apply a light coat of engine oil to the O-ring.

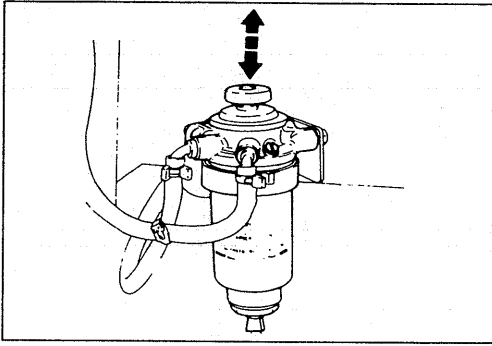
6. Turn in the fuel filter until the sealing face comes in contact with the O-ring.

7. Turn in the fuel filter an additional 2/3 of a turn with a filter wrench.



Filter Wrench: 5-8840-0253-0 (J-22700)





8. Loosen the bleeder plug on the injection pump overflow valve.
9. Operate the priming pump until fuel begins to flow from the fuel filter.
10. Retighten the bleeder plug.
11. Operate the priming pump several times and check for fuel leakage.

## NOTE:

The use of an ISUZU genuine fuel filter is strongly recommended.



## Water Separator (Water Sedimentor) (Optional Equipment)

Check the water separator float ① level.

If the float ① has reached level ②, loosen the drain plug ③ (at the bottom side of the water separator) to drain the water.



Drain Plug Torque kg·m(lb.ft./N·m)

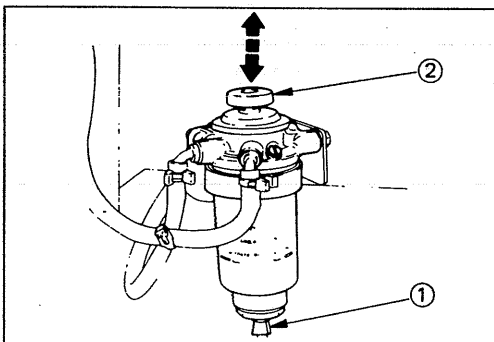
0.9 – 1.5 (6.5 – 10.9/8.8 – 14.7)

## Fuel Filter with Water Level Sensor

### Water Draining Procedure

The indicator light will come on when the water level in the water separator exceeds the specified level.

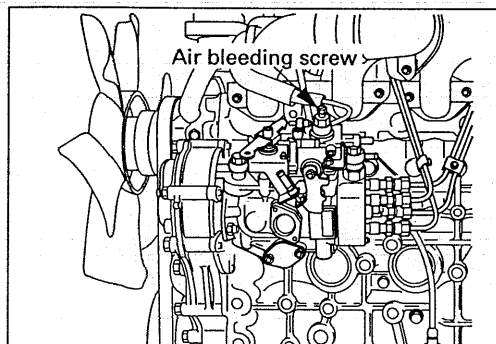
Drain the water and foreign material from the water separator with the following procedure.



1. Open the engine hood and place a container (Approximately 0.2 liter capacity) at the end of the vinyl hose beneath the drain plug on the separator.
2. Loosen the drain plug by turning it counterclockwise (Approximately 5-turns) and operate the priming pump up and down about 10 times until water is drained approximately 0.1 liter.
3. After draining, securely tighten the drain plug by turning it clockwise and operate the priming pump manually up and down several times.
4. After starting the engine, check to see that there is no fuel leak from the drain plug.

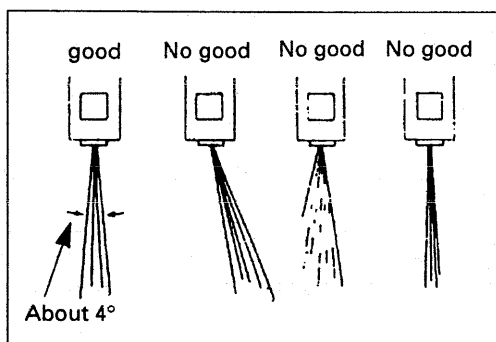
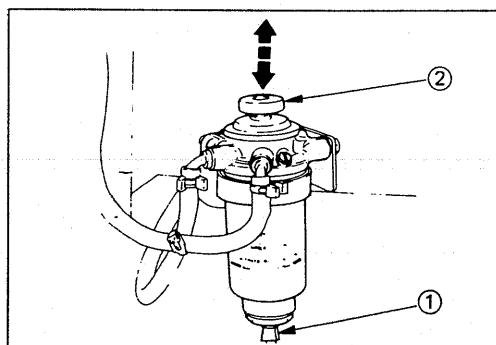
Also check to see that the fuel filter water indicator light has turned off.

If water separator requires frequent draining, have the fuel tank drained for removal of water at your Isuzu Dealer.



### Air Bleeding

1. Loosen the bleeder screw on the injection pump overflow valve.
2. Operate the priming pump until fuel mixed with foam flows from the bleeder screw.
3. Tighten the bleeder screw.
4. Operate the priming pump several times and check for fuel leakage.



### Injection nozzle

Check to see if the spray condition and the injection pressure are normal. Adjust them to the specified value respectively when they don't meet the standard value.

kg/cm<sup>2</sup> (psi/MPa)

|                    |                 |
|--------------------|-----------------|
| Injection pressure | 150 (2130/14.7) |
|--------------------|-----------------|



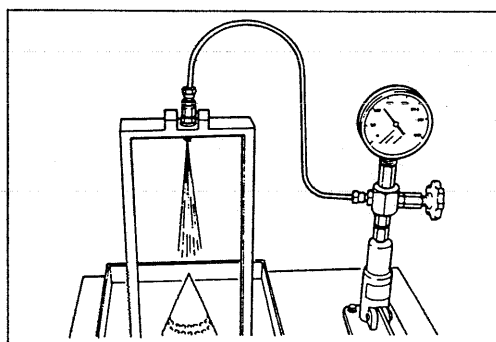
Using a nozzle tester, adjust the injection pressure with a shim.

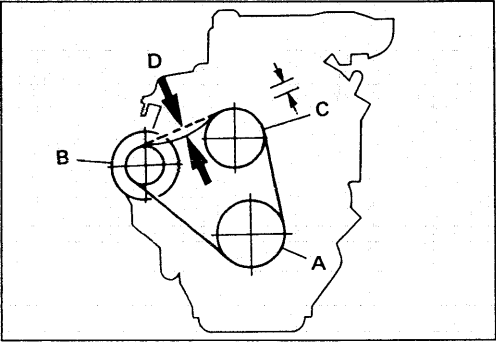
Special tool: Nozzle tester



### WARNING:

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





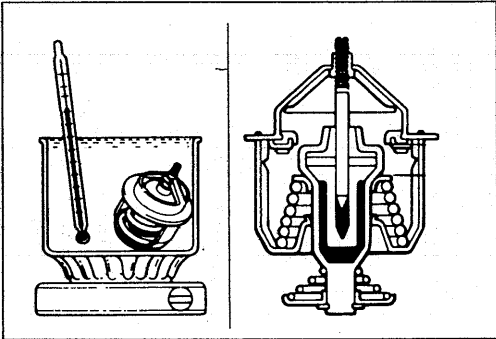
COOLING SYSTEM

Cooling Fan Drive Belt

Fan belt tension is adjusted by moving the alternator.

- A Crankshaft damper pulley
- B Alternator pulley
- C Cooling fan drive pulley
- D Depress the drive belt mid-portion with a 10 kg (22 lb/98 N) force.

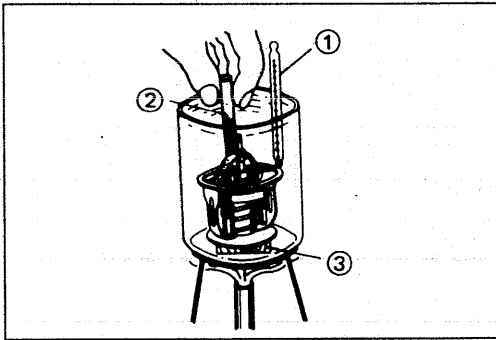
| Drive Belt Deflection | mm(in.) |
|-----------------------|---------|
| 10.0 (0.39)           |         |



Thermostat

Operating 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) |
|----------------------------------------|--------|
| 76.5 (170)                             |        |



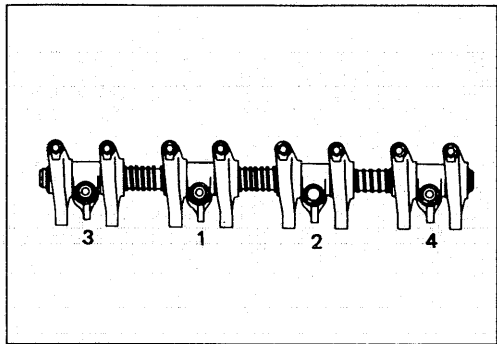
4. Check the thermostat full opening temperature.

| Thermostat Full Opening Temperature | °C(°F) |
|-------------------------------------|--------|
| 90 (194)                            |        |



| Valve Lift at Fully Open Position | mm(in.) |
|-----------------------------------|---------|
| 8.0 (0.31)                        |         |

- ① Thermostat
- ② Agitating Rod
- ③ Wooden Piece



## VALVE CLEARANCE ADJUSTMENT



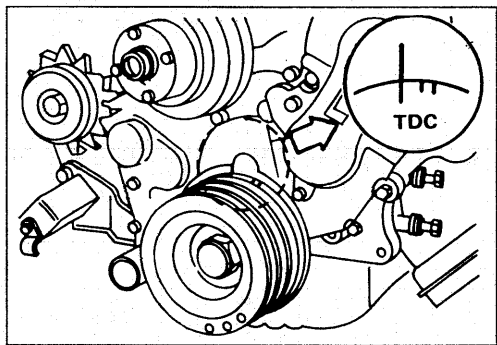
1. Retighten the rocker arm shaft bracket bolts in sequence as shown in the illustration.

Rocker Arm Shaft Bracket Bolt

Torque

kg·m(lb.ft./N·m)

5.0 – 6.0 (36 – 43/49 – 59)

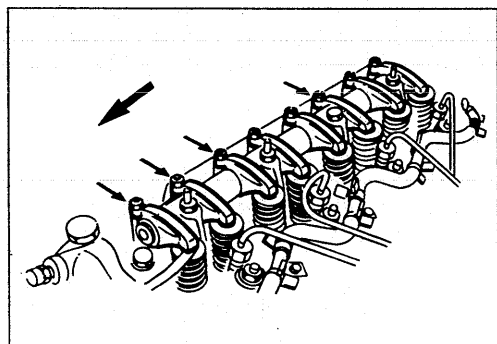


2. Bring the piston in either the No. 1 cylinder or the No. 4 cylinder to TDC on the compression stroke by turning the crankshaft until the crankshaft damper pulley TDC line is aligned with the timing pointer.

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.



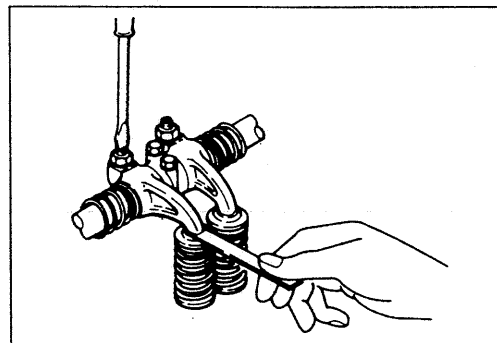
Adjust the No. 1 or the No. 4 cylinder valve clearances while their respective cylinders are at TDC on the compression stroke.

Valve Clearance

mm(in.)

0.40 (0.016)

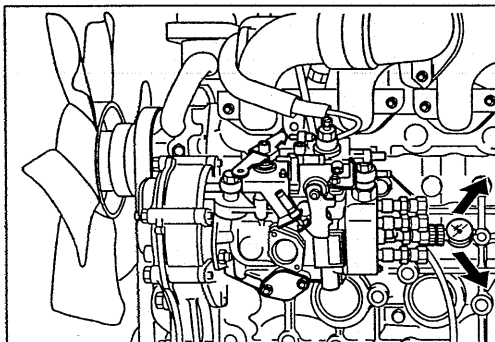
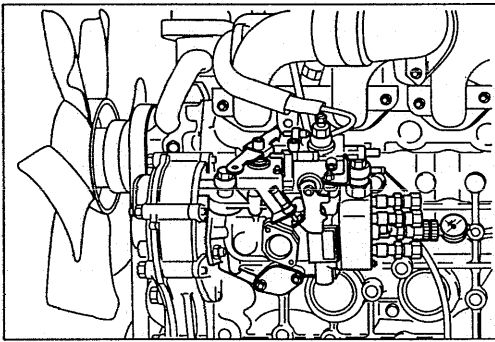
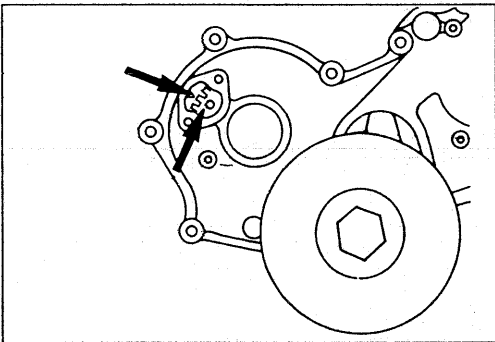
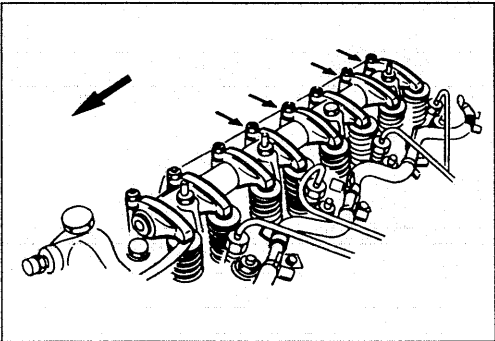
Loosen each valve clearance adjusting screw as shown in the illustration. (At TDC on the compression stroke of the No. 1 cylinder)



Insert a feeler gauge of the appropriate thickness between the rocker arm and the valve stem end.

4. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
5. Tighten the lock nut securely.





Rotate the crankshaft 360°.

Realign the crankshaft damper pulley TDC line with the timing pointer.

Adjust the clearances for the remaining valves as shown in the illustration. (At TDC on the compression stroke of the No. 4 stroke)

## INJECTION TIMING

### Injection Timing Confirmation Procedure

1. Rotate the crankshaft clockwise to align the camshaft gear timing mark "O" with the timing gear case cover pointer.

The No. 1 cylinder will now be at the point where nearly injection timing.

2. Remove injector pump distributor head plug.
3. Fit a dial gauge and set lift to 1 mm.
4. Set crankshaft damper pulley Top Dead Center mark about 45° before Top Dead Center from the pointer.
5. Set dial gauge in the "0" position.

Measuring device: 5-8840-0145-0

6. Turn the crankshaft a little rightwise and leftwise and see if the pointer is stable in the "0" position.
7. Turn the crankshaft in the normal direction and read the measuring device's indication at TDC.

| Starting Timing | mm (in) |
|-----------------|---------|
| 0.5 (0.02)      |         |

8. If the injection timing is outside the specified range, continue with the following steps.

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

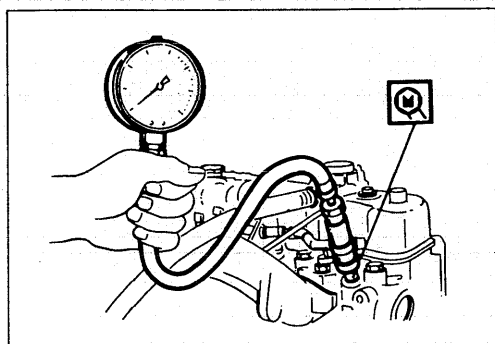
10. Adjust the injection pump setting angle.
  - If injection timing will be advanced, move the injection pump away from the engine.
  - If injection timing will be retarded, move the injection pump toward the engine.

Tighten the pump fixing nut, adjust bolt and pump distribution head plug to the specified torque.

| Pump Fixing Bolt | kg·m (lb·ft/N·m) |
|------------------|------------------|
| 1.9 (13/19)      |                  |

| Injection Pump<br>Distributor Head Plug | kg·m (lb·ft/N·m) |
|-----------------------------------------|------------------|
| 1.7 (12/17)                             |                  |





## COMPRESSION PRESSURE MEASUREMENT

1. Start the engine and allow it to run for several minutes to warm it up.
2. Stop the engine and cut the fuel supply.
3. Remove all of the glow plugs from the engine.



Compression Gauge :5-8840-2008-0  
Adapter :5-8531-7001-0

4. Set a compression gauge to the No. 1 cylinder glow plug hole.
5. Turn the engine over with the starter motor and take the compression gauge reading.

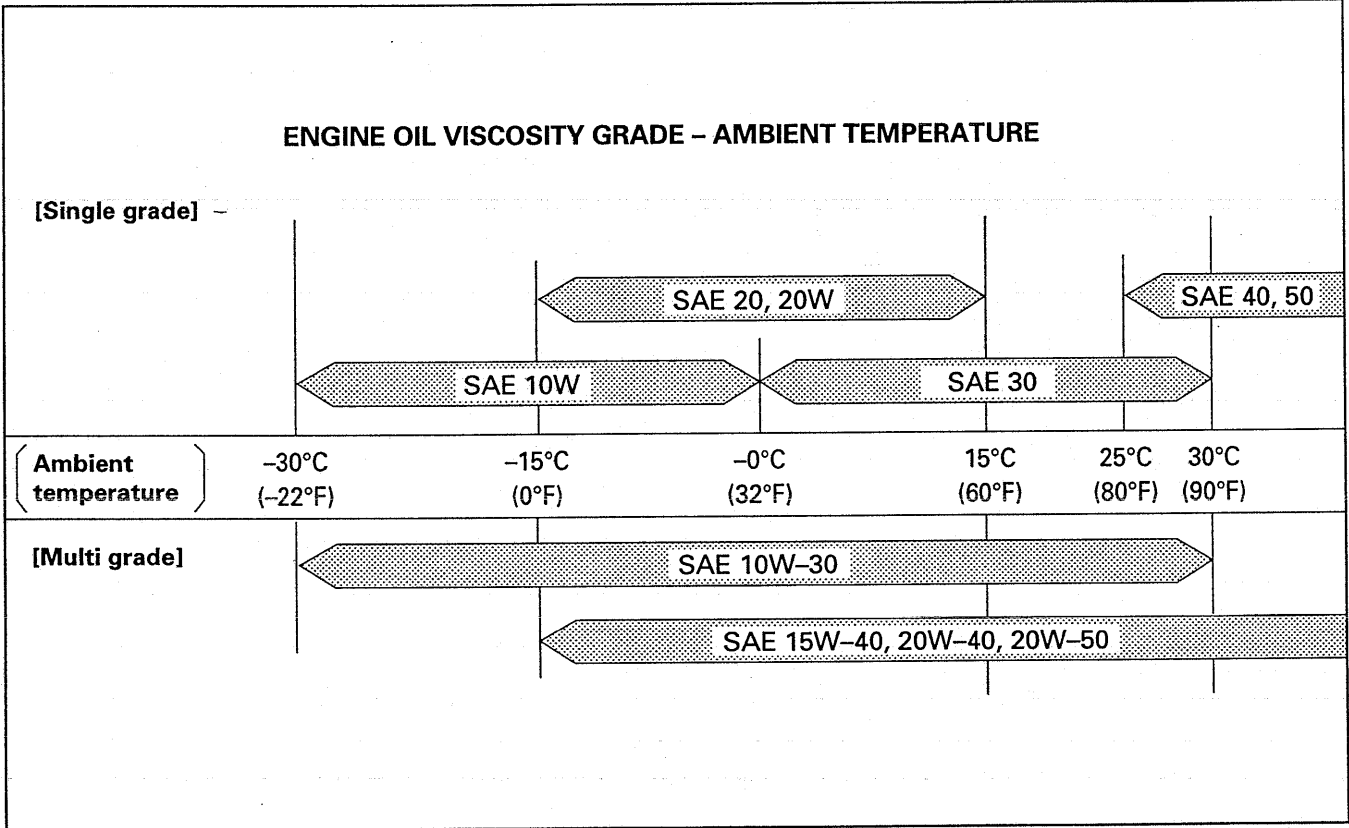
Compression Pressure      kg/cm<sup>2</sup>(psi/MPa) at 250 rpm

| Standard      | Limit         |
|---------------|---------------|
| 30 (427/2.94) | 22 (313/2.16) |

RECOMMENDED LUBRICANTS

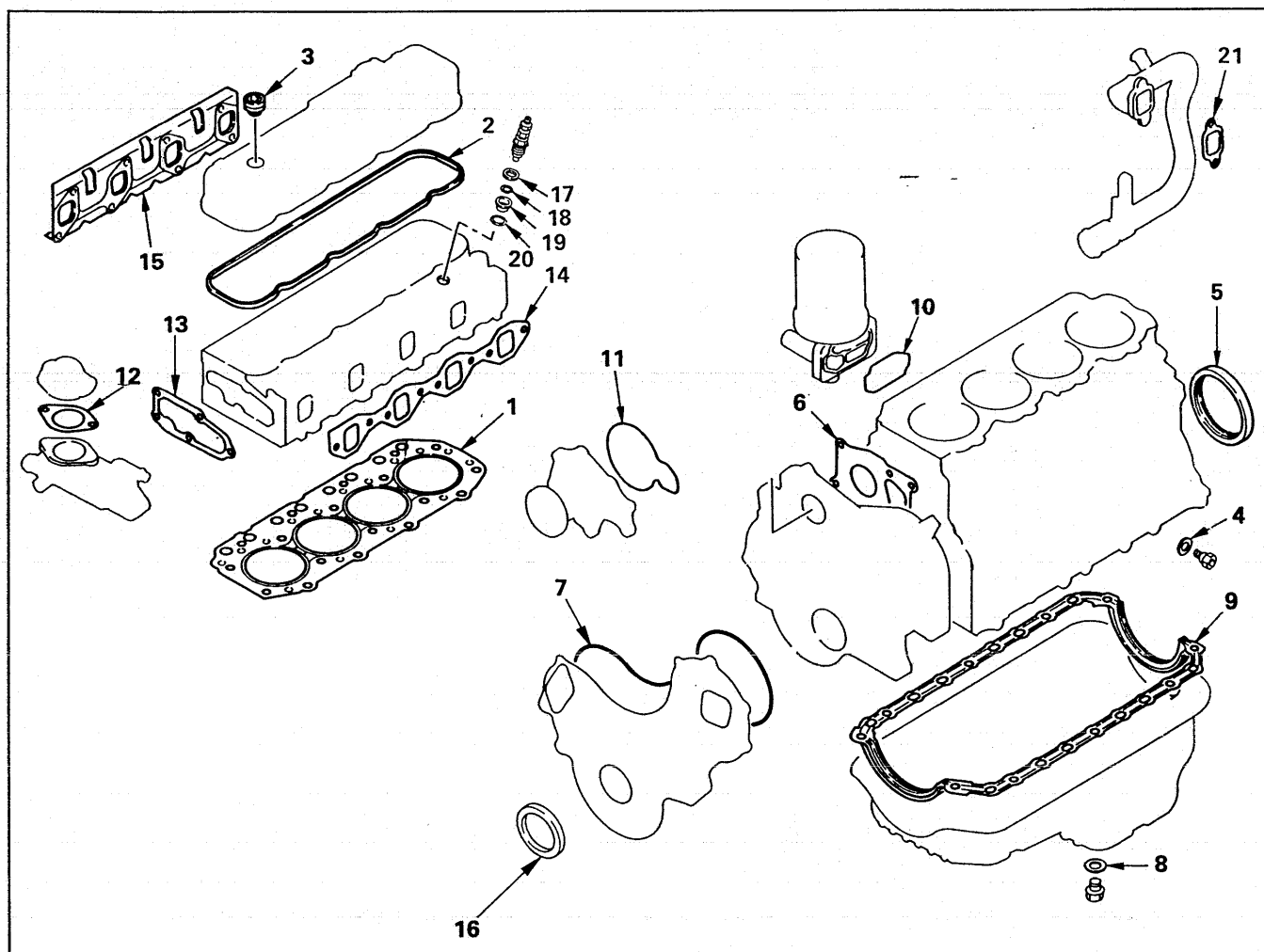
| ENGINE TYPE          | TYPES OF LUBRICANTS                 |
|----------------------|-------------------------------------|
| Without turbocharger | Diesel engine oil<br>CC or CD grade |

ENGINE OIL VISCOSITY CHART



# ENGINE REPAIR KIT

All of the numbered parts listed below are included in the Engine Repair Kit.



- |                               |                               |
|-------------------------------|-------------------------------|
| 1. Cylinder head gasket       | 11. Water pump gasket         |
| 2. Cylinder head cover gasket | 12. Water outlet pipe gasket  |
| 3. Head cover cap nut gasket  | 13. Thermostat housing gasket |
| 4. Drain cock gasket          | 14. Intake manifold gasket    |
| 5. Crankshaft rear oil seal   | 15. Exhaust manifold gasket   |
| 6. Gear case gasket           | 16. Crankshaft front oil seal |
| 7. Gear case cover gasket     | 17. Nozzle holder washer      |
| 8. Oil pan drain plug gasket  | 18. Corrugated washer         |
| 9. Oil pan gasket             | 19. Heat shield               |
| 10. Oil filter gasket         | 20. Heat shield washer        |
|                               | 21. Cyl. block side gasket    |

MEMO

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SECTION 3

ENGINE ASSEMBLY ( 1 )

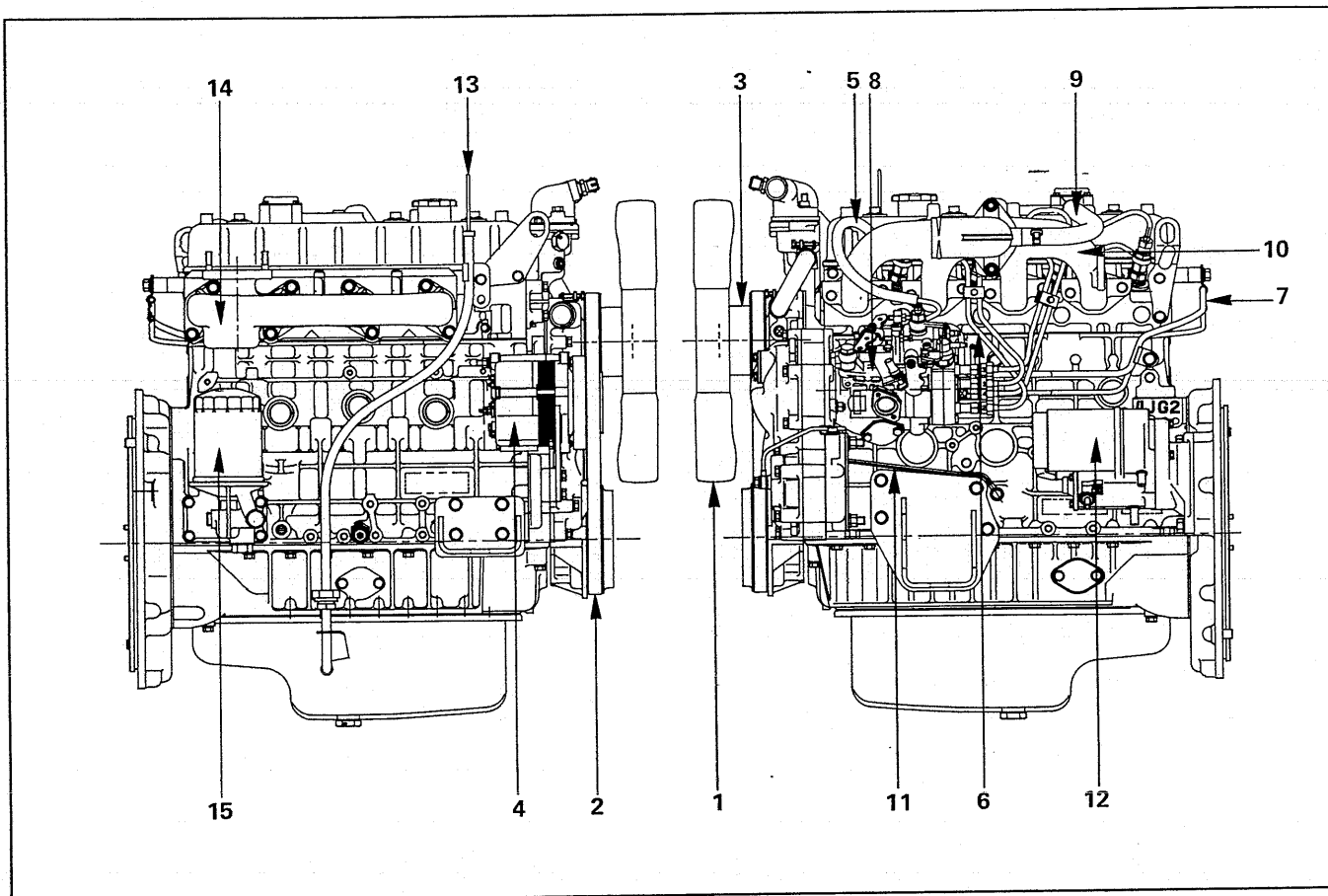
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## DISASSEMBLY

These disassembly steps are based on the 4JG2PE engine.

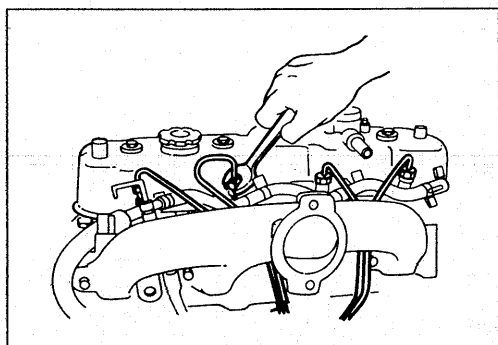


### Disassembly Steps - 1

- |                                   |                             |
|-----------------------------------|-----------------------------|
| 1. Cooling fan and spacer         | 9. Breather hose            |
| 2. Cooling fan drive belt         | 10. Inlet manifold          |
| 3. Cooling fan drive pulley       | 11. Oil pipe                |
| 4. Alternator and adjusting plate | 12. Starter motor           |
| 5. Fuel hose (Leak off)           | 13. Dipstick and guide tube |
| 6. Injection pipe                 | 14. Exhaust manifold        |
| 7. Fuel pipe                      | 15. Oil filter              |
| 8. Injection pump                 |                             |

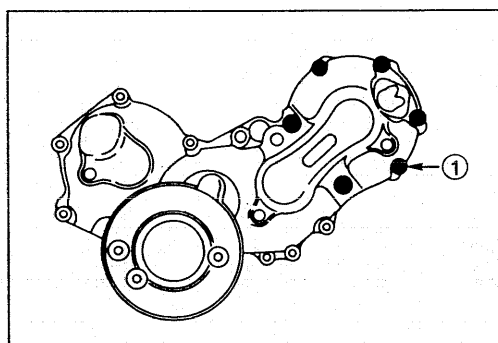


## Important Operations (Disassembly Steps - 1)



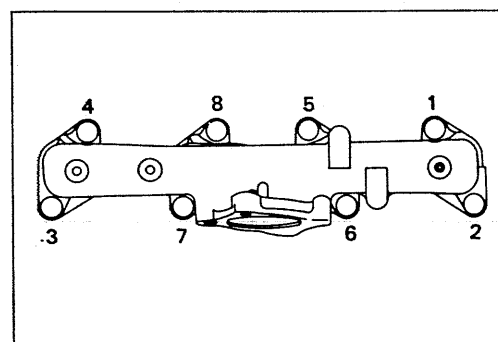
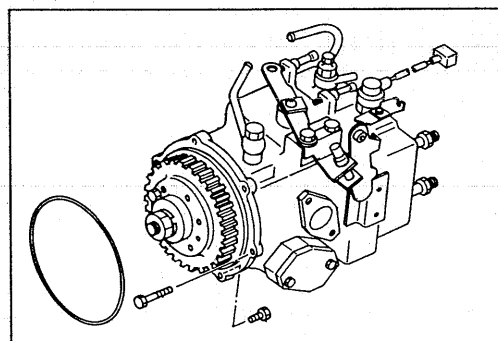
### 6. Fuel Injection Pipe with Clip

- 1) Loosen the injection pipe sleeve nuts at the delivery valve side.  
Do not apply excessive force to the injection pipes.
- 2) Loosen the injection pipe clips.
- 3) Remove the injection pipes.



### 8. Injection Pump

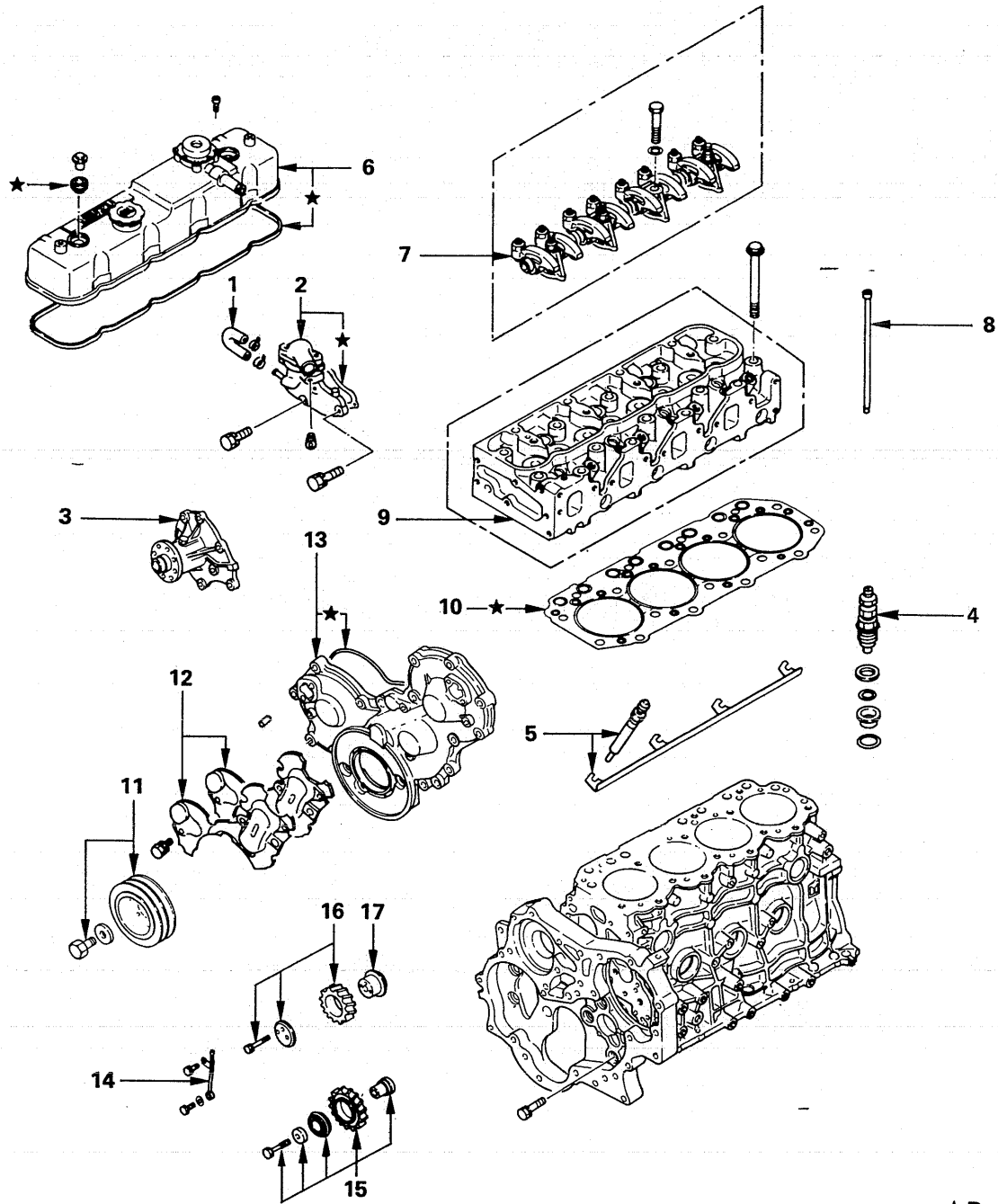
- 1) Remove the six injection pump bracket bolts from the cylinder body timing gear case.
- 2) Pull the injection pump with the injection pump timing gear free from the rear.



### 14. Exhaust Manifold

Loosen the exhaust manifold bolts a little at a time in the numerical order shown in the illustration.



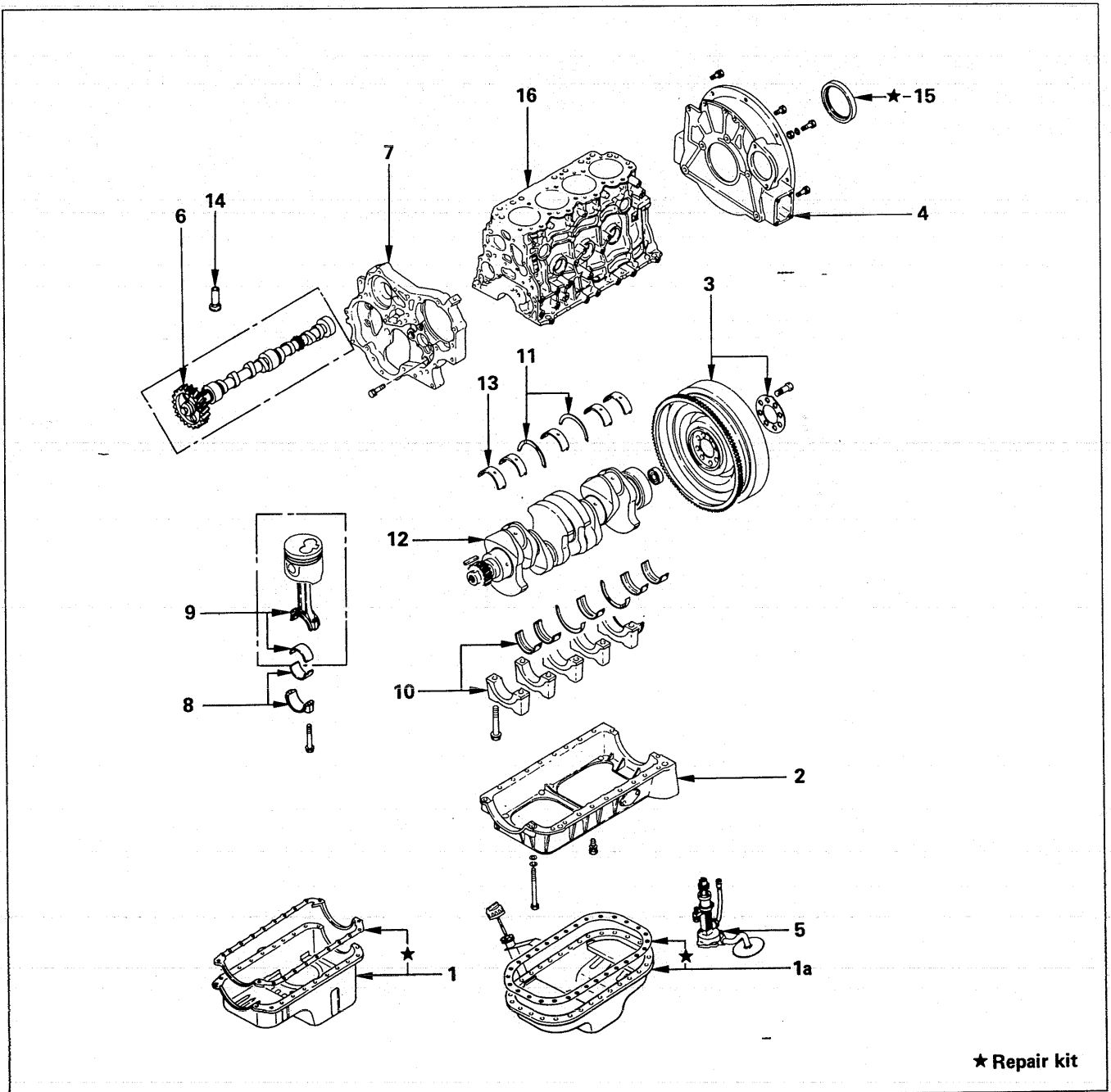


★ Repair kit

## Disassembly Steps - 2

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

Inverted Engine



### Disassembly Steps - 3

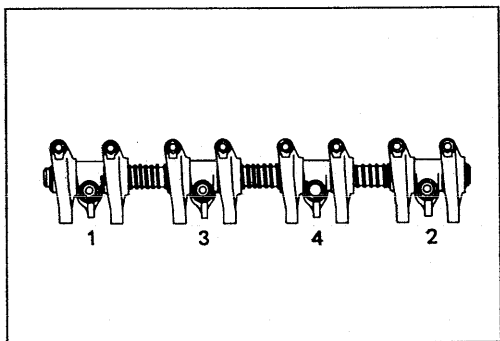
- |                                                          |                                                   |
|----------------------------------------------------------|---------------------------------------------------|
| 1. Oil pan                                               | ▲ 9. Piston and connecting rod with upper bearing |
| 1a. Oil pan (If so crankcase equipped)                   | ▲ 10. Crankshaft bearing cap with lower bearing   |
| 2. Crankcase (If so equipped)                            | 11. Crankshaft thrust bearing                     |
| ▲ 3. Flywheel                                            | 12. Crankshaft with crankshaft timing gear        |
| 4. Flywheel housing                                      | ▲ 13. Crankshaft upper bearing                    |
| 5. Oil pump with oil pipe                                | ▲ 14. Tappet                                      |
| ▲ 6. Camshaft with camshaft timing gear and thrust plate | 15. Crankshaft rear oil seal                      |
| 7. Timing gear case                                      | 16. Cylinder body                                 |
| ▲ 8. Connecting rod cap with lower bearing               |                                                   |



## Important Operations (Disassembly Steps - 2)

### 4. Injection Nozzle Holder

- 1) Remove the nozzle holder fixing nuts.

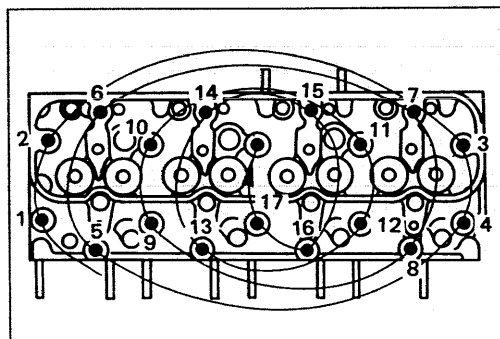


### 7. Rocker Arm Shaft and Rocker Arm

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.

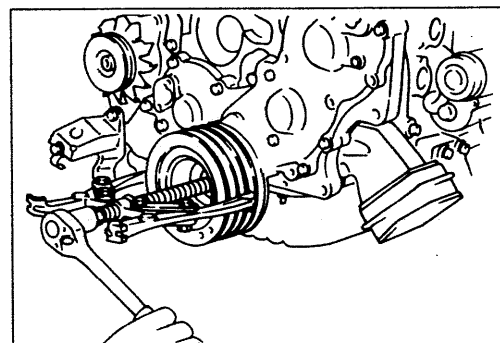


### 9. Cylinder Head

Loosen the cylinder head bolts in 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 head lower surface.



### 11. Crankshaft Damper Pulley

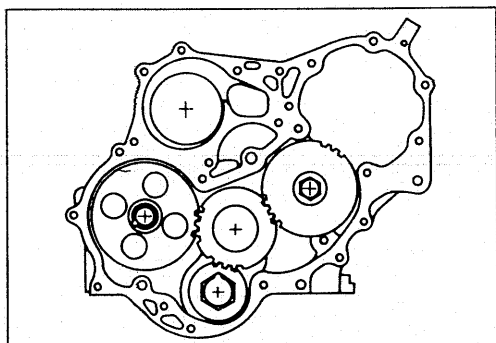
- 1) Block the flywheel with a piece of wood to prevent it from turning.
- 2) Use the damper pulley remover to remove the damper pulley.

Damper Pulley Remover



**16. Idler Gear "A"**

Measure the camshaft timing gear backlash, the crankshaft timing gear backlash, and the idler gear "A" end play before removing the idler gear "A" and shaft.

**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.

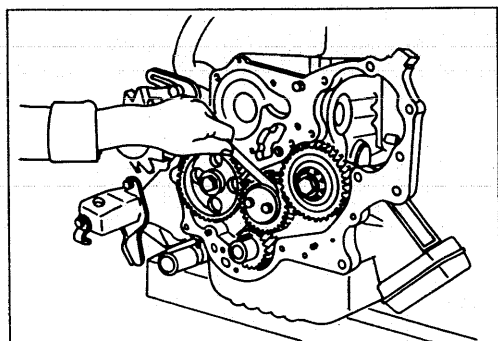
- 2) Move the gear to be checked as far as possible to both the right and the left.

Take the dial indicator reading.

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

Timing Gear Backlash mm(in.)

| Standard                  | Limit        |
|---------------------------|--------------|
| 0.10–0.17 (0.0039–0.0067) | 0.30 (0.012) |

**Idler Gear "A" 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.

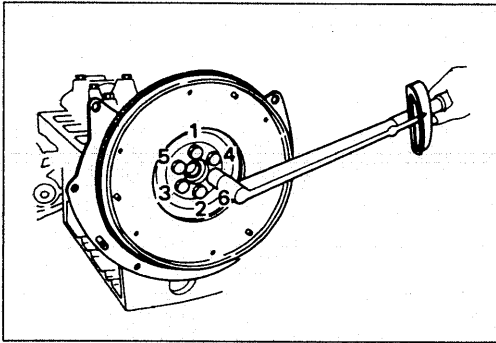
If the measured value exceeds the specified limit, the thrust collar must be replaced.

Idler Gear End Play mm(in.)

| Standard      | Limit         |
|---------------|---------------|
| 0.080 (0.180) | 0.003 (0.007) |

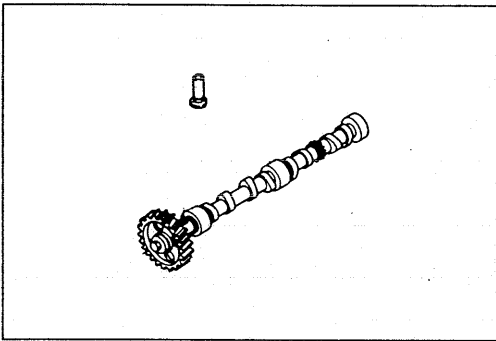


## Important Operations (Disassembly Steps - 3)



### 3. Flywheel

- 1) Block the flywheel with a piece of wood to prevent it from turning.
- 2) Loosen the flywheel bolts a little at a time in the numerical order shown in the illustration.

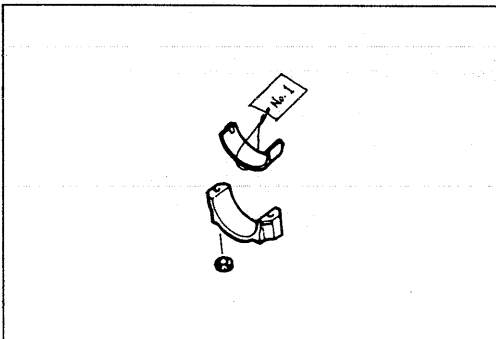


### 6. Camshaft with Camshaft Timing Gear and Thrust Plate

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

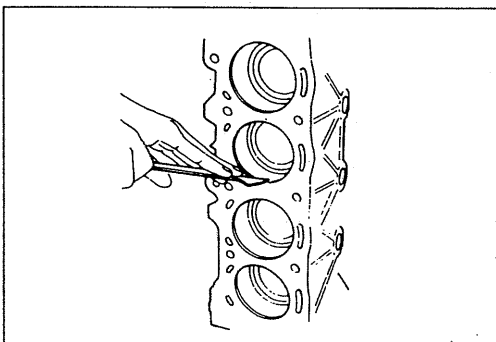
#### Note:

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



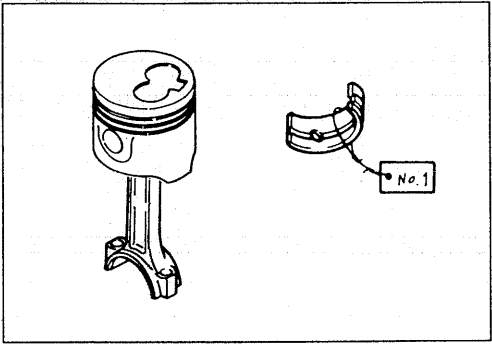
### 8. Connecting Rod Cap with Lower Bearing

If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

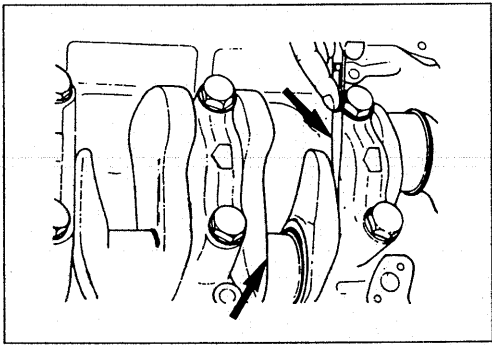


### 9. Piston and Connecting Rod with Upper Bearing

- 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.



If the connecting rod upper bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



**10. Crankshaft Bearing Cap with Lower Bearing**

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

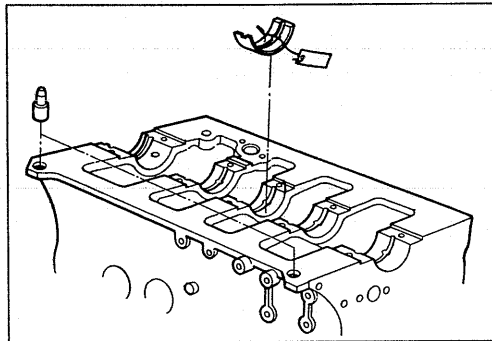
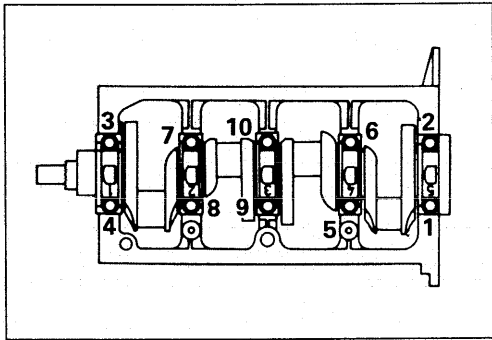
Do this before removing the crankshaft bearing caps.

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) |         |

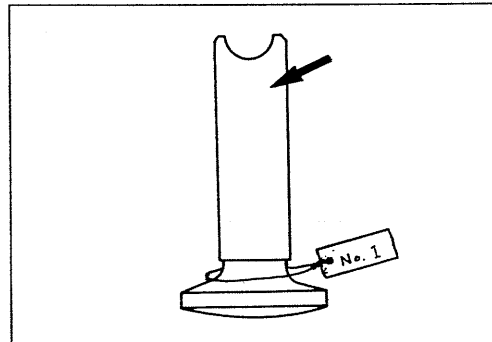
- 2) Loosen the crankshaft bearing cap bolts in numerical order a little at a time.

If the crankshaft bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



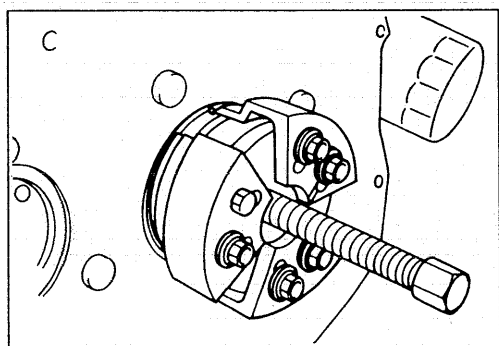
**13. Crankshaft Upper Bearing**

If the crankshaft upper bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



**14. Tappet**

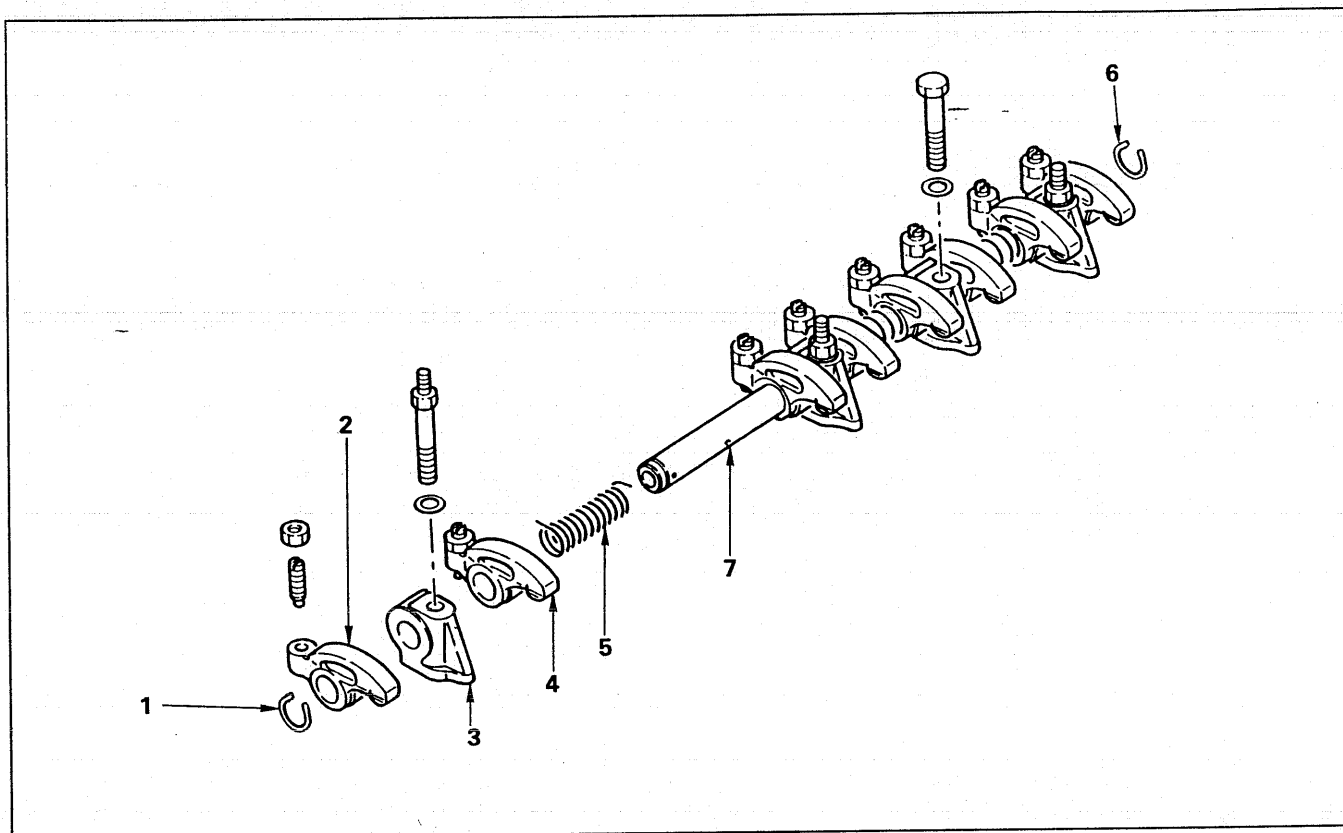
If the tappets are to be reinstalled, mark their fitting positions by tagging each tappet with the cylinder number from which it was removed.



**15. Rear Oil Seal**

With the oil seal pushed in deep, install the special tool as shown in the illustration and remove the oil seal.

Oil Seal Remover: 5-8840-2362-0

**DISASSEMBLY****SINGLE UNIT****ROCKER ARM SHAFT AND ROCKER ARM****Disassembly Steps**

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





### Important Operations

#### **1. Rocker Arm Shaft Snap Ring**

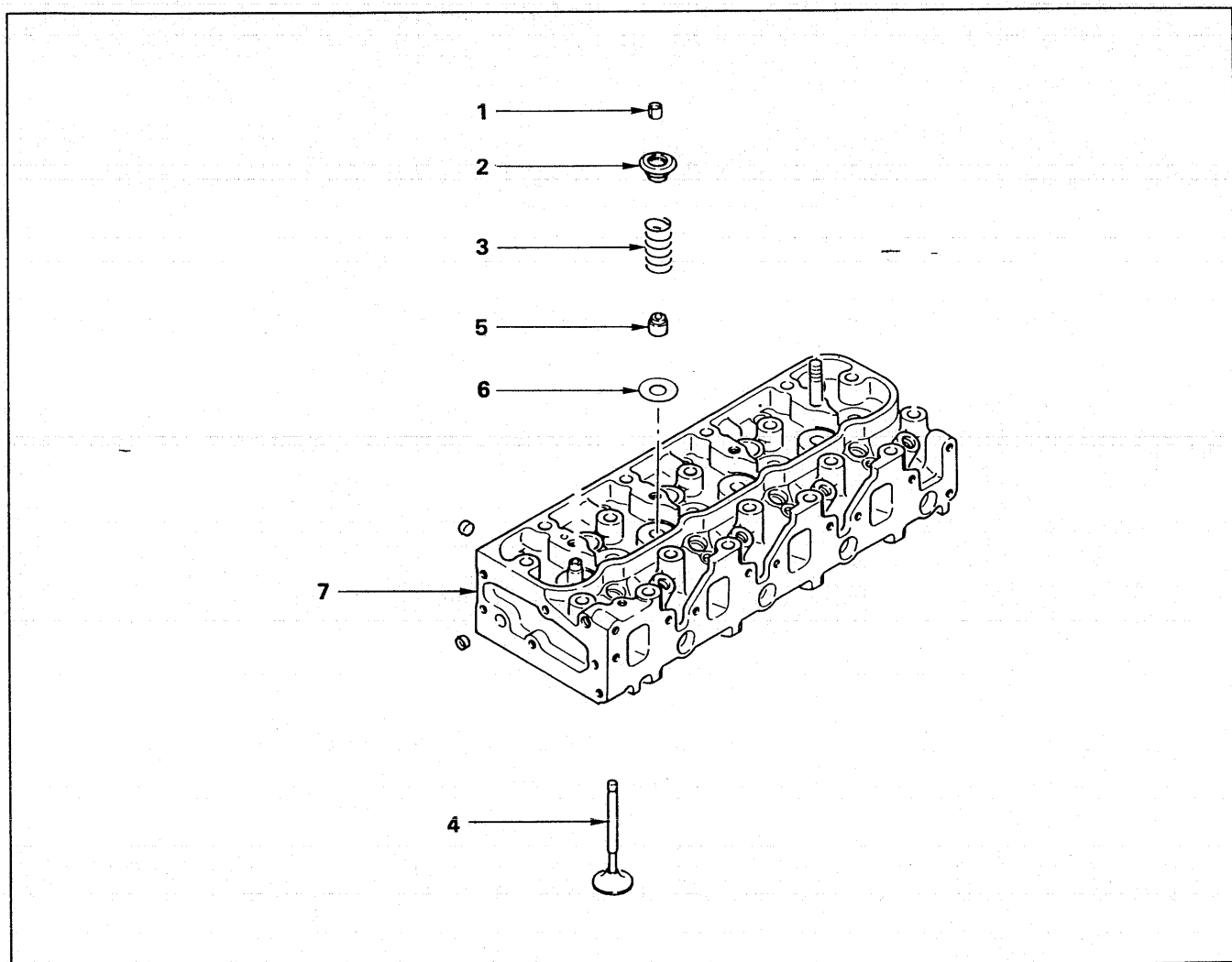
#### **2. Rocker Arm**

#### **3. Rocker Arm Shaft Bracket**

- 1) Use a pair of snap ring pliers to remove the snap rings.
- 2) Remove the rocker arms.
- 3) Remove the rocker arm shaft bracket.

If the rocker arms and rocker arm shaft brackets are to be reinstalled, mark their installation positions by tagging each rocker arm and rocker arm shaft bracket with the cylinder number from which it was removed.

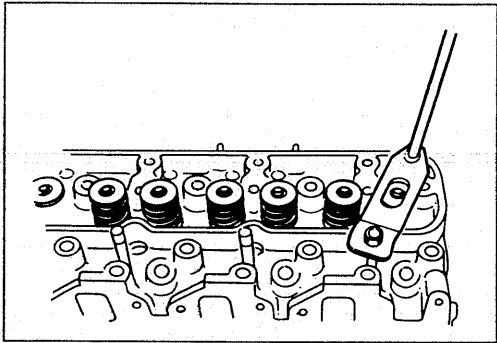
## CYLINDER HEAD

**Disassembly Steps**

- ▲ 1. Split collar
- 2. Valve spring upper seat
- 3. Valve spring
- ▲ 4. Intake and exhaust valves
- 5. Valve stem oil seal
- 6. Valve spring lower seat
- 7. Cylinder head



## Important Operations

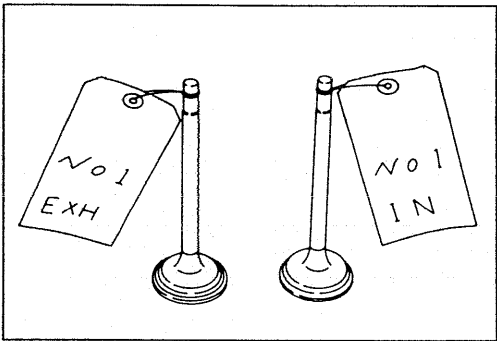


### 1. Split Collar

- 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



### 4. Intake and Exhaust Valve

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 there is excessive valve wear or damage, the valve must be replaced.

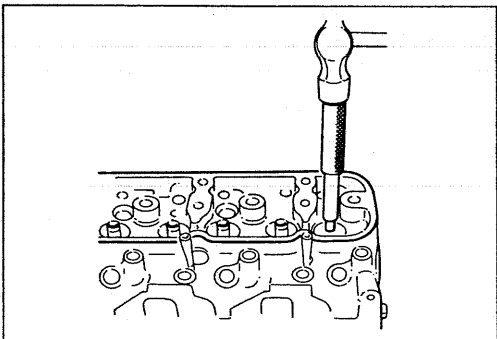
Refer to Page 54 of "Inspection and Repair" for the valve and valve seat insert procedure.

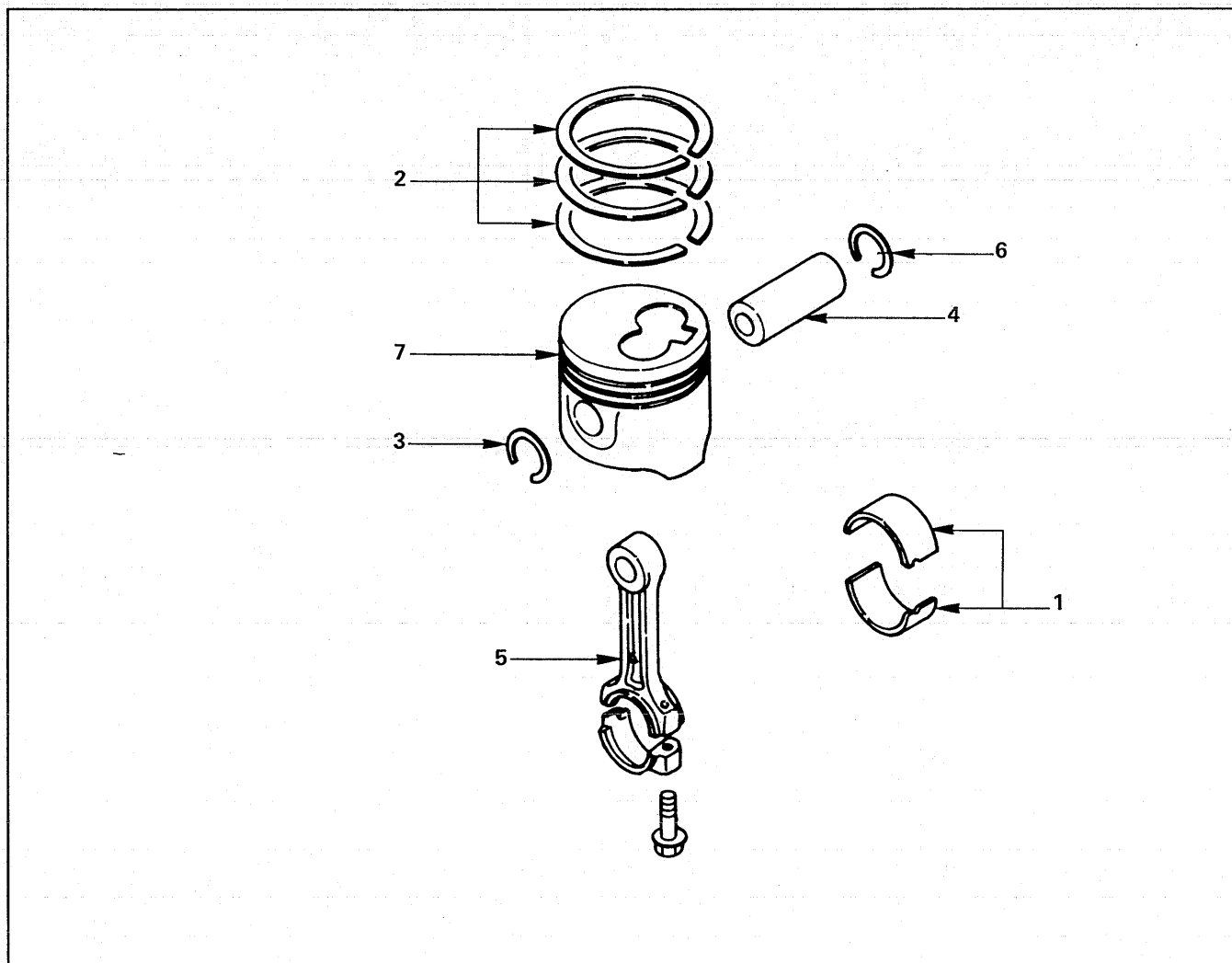
#### Note:

If there is excessive valve guide wear or damage, the valve guide must be replaced.

Refer to Page 53 of "Inspection and Repair" for the valve guide replacement procedure.

The valve and the valve guides must be replaced as a set. Never replace only one or the other.

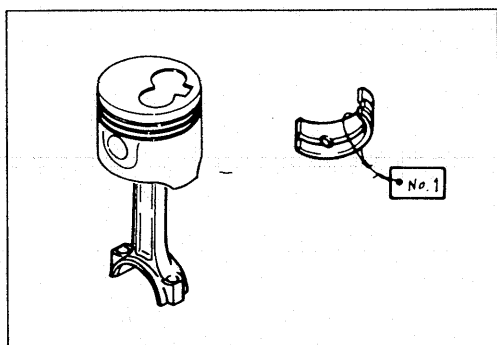


**PISTON AND CONNECTING ROD****Disassembly Steps**

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

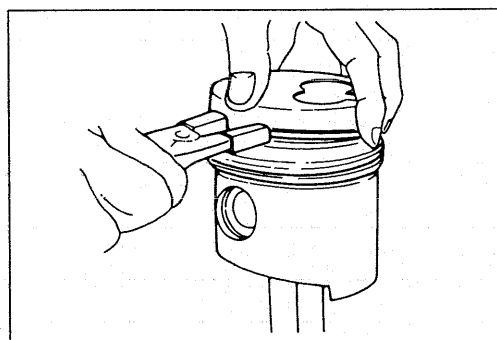


## Important Operations



### 1. Connecting Rod Bearing

If the connecting rod bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



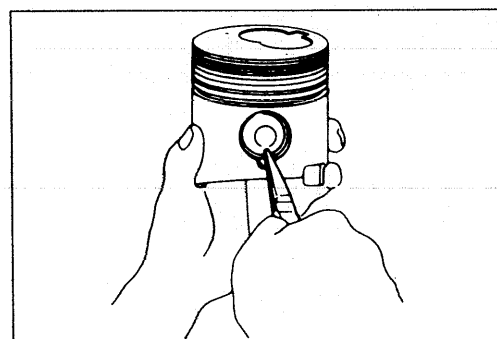
### 2. Piston Ring

- 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

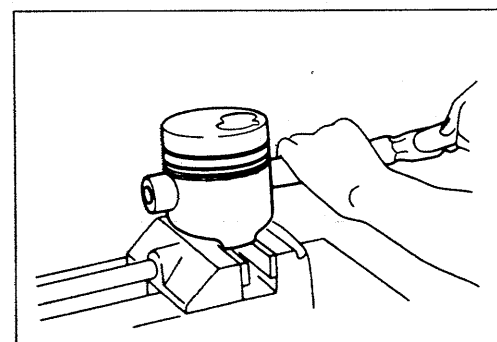
Do not attempt to use some other tool to remove the piston rings. Piston ring stretching will result in reduced piston ring tension.



### 3. Piston Pin Snap Ring

### 4. Piston Pin

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

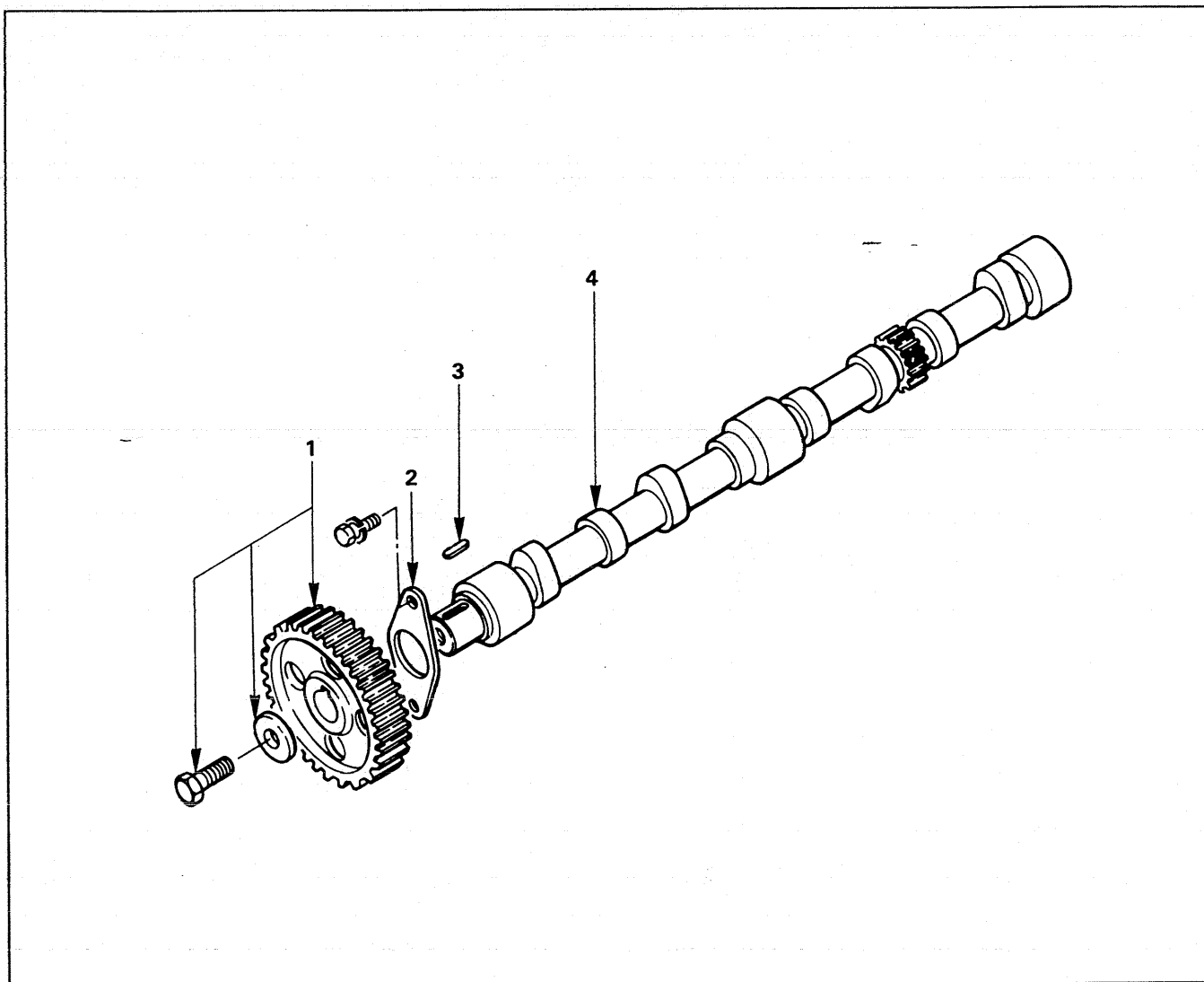


### 5. Connecting Rod

### 7. Piston

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

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

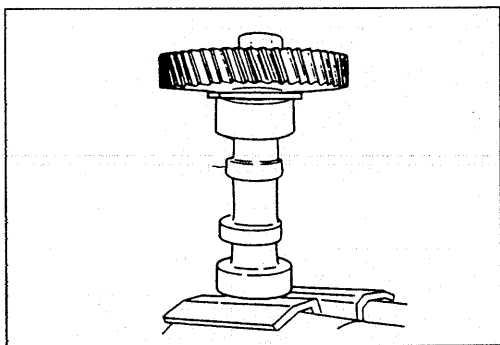
**CAMSHAFT, CAMSHAFT TIMING GEAR, AND THRUST PLATE****Disassembly Steps**

- ▲ 1. Camshaft timing gear
- ▲ 2. Thrust plate

- 3. Feather key
- 4. Camshaft



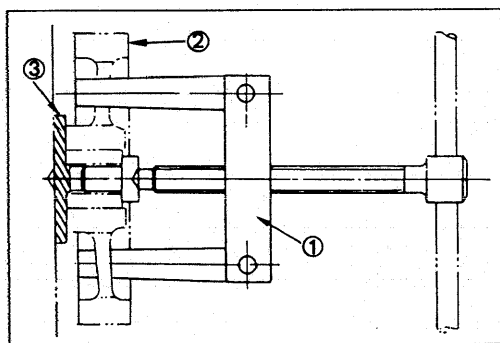
## Important Operations



### 1. Camshaft Timing Gear

### 2. Thrust Plate

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



- 2) Use the universal puller ① to pull out the camshaft timing gear ② .

Universal Puller: 5-8840-0086-0

- 3) Remove the thrust plate ③ .

SECTION 4

ENGINE ASSEMBLY ( 2 )

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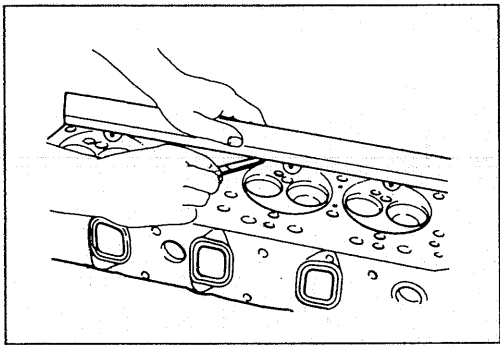
| ITEM                        | PAGE |
|-----------------------------|------|
| Inspection and repair ..... | 50   |





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)

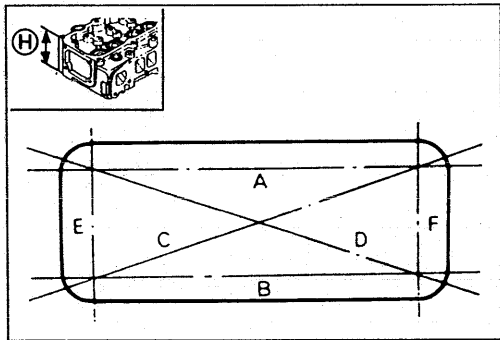
| Standard             | Limit       | Maximum Grinding Allowance |
|----------------------|-------------|----------------------------|
| 0.05 (0.002) or less | 0.2 (0.008) | 0.3 (0.012)                |

Cylinder Head Height (Reference) mm(in)

| Standard                      | Limit        |
|-------------------------------|--------------|
| 91.95 (3.620) – 92.05 (3.624) | 91.65 (3.60) |

Note:

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



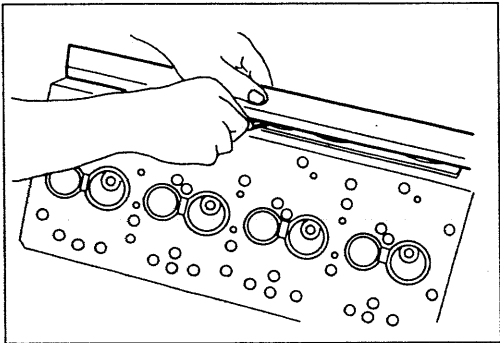
Exhaust Manifold Fitting Face Warpage



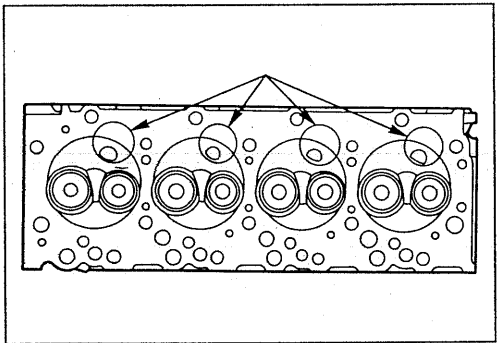
Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.

Regrind the manifold cylinder head fitting faces 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.



| Manifold Fitting Face Warpage |             | mm (in)                    |
|-------------------------------|-------------|----------------------------|
| Standard                      | Limit       | Maximum Grinding Allowance |
| 0.05<br>(0.002) or less       | 0.2 (0.008) | 0.4 (0.016)                |

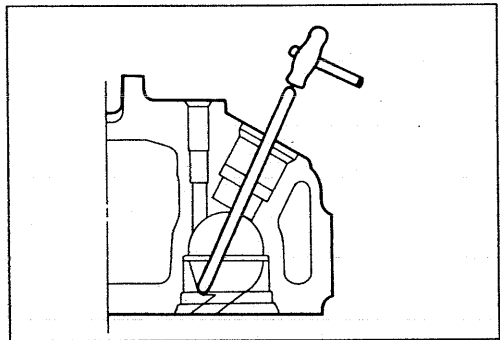


## HOT PLUG

### Hot plug depression

1. Clean the cylinder head lower side, taking care not to damage the hot plug surfaces.
2. Use a straight edge and feeler gauge to measure 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 limit, the hot plugs must be replaced.

| Depression Limit | mm (in) |
|------------------|---------|
| 0.02 (0.0008)    |         |



### Hot plug removal

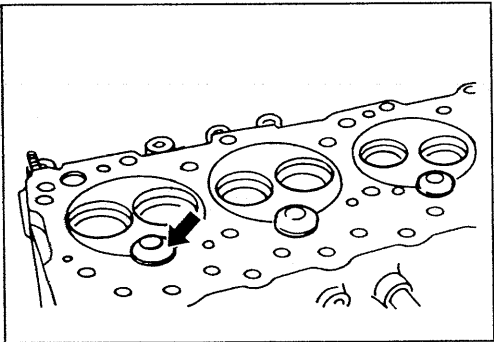
1. Insert a 3.0 – 5.0 (0.12 – 0.20 in.) diameter bar into the nozzle holder fitting hole unit it makes contact with the hot plug.
2. Lightly tap the bar with a hammer to drive the hot plug free.  
If the measured value exceeds the limit, the hot plugs must be replaced.

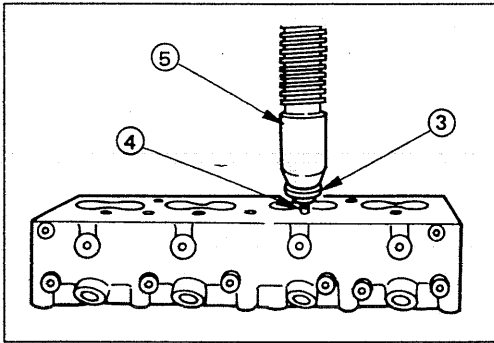
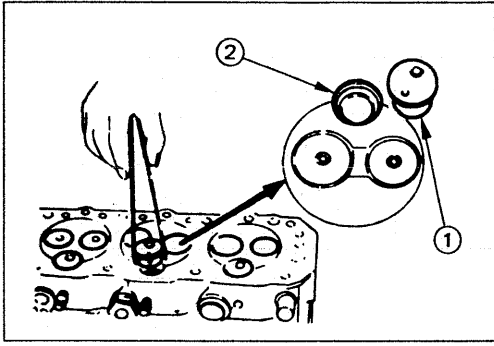
### Combustion chamber inspection

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 inside of 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 not scratches or protuberance on the combustion chamber surfaces which will be in contact with the hot plug after it is installed. There flaws will prevent the hot plug from seating correctly.





### Hot plug installation

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

1. Align the hot plug knock ball ① with the cylinder head groove ② and tap it temporarily into position with a plastic hammer.
2. Place an appropriate metal plate ③ thick over the hot plug upper surface ④.
3. Use a press ⑤ to exert a pressure of 44000 – 54000N (4500 – 5500 kg) (9923 – 12128 lbs.) on the metal plate covering the hot plug upper surface. This will drive the hot plug into position.
4. Lightly tap the hot plug heads to make sure that they are firmly seated.
5. Repeat the procedure Steps 1–4 for the remaining hot plugs.

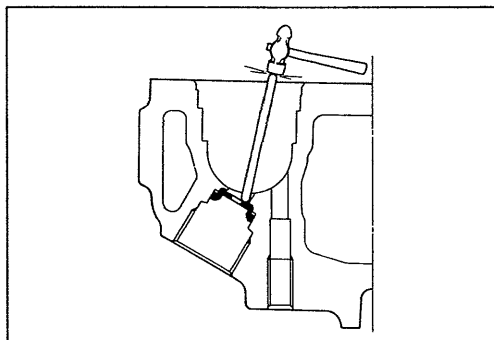
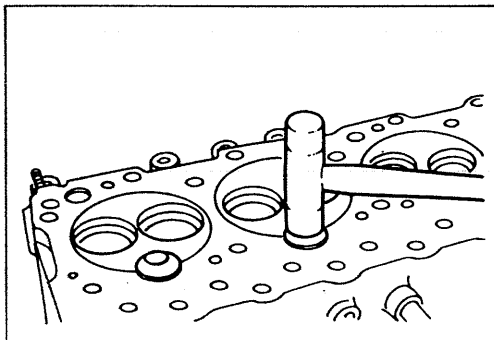


### CAUTION:

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

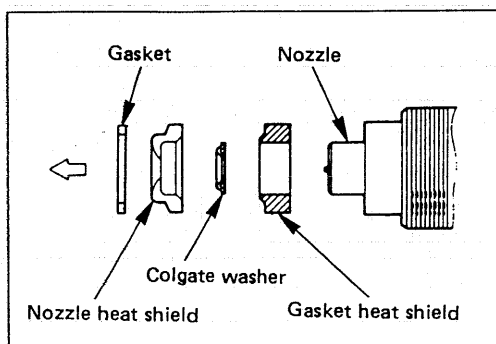
6. Use a surface grinder to grind off any hot plug surface protuberances. The hot plug surfaces must be perfectly flush with the cylinder head.
7. After grinding, make sure that the hot plug surfaces are completely free of protuberances. The hot plug surfaces must also be free of depressions.

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



### Heat shield removal

After removing the hot plugs, use a hammer ① and a brass bar ② to lightly tap the lower side of the seat shield ③ and drive it free.



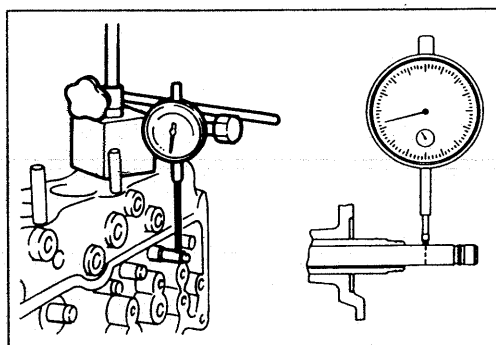
### Heat shield installation

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

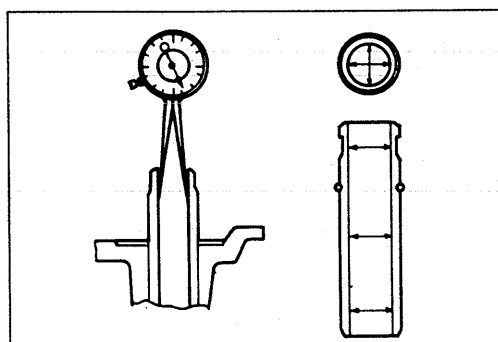
Read the dial indicator.

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.

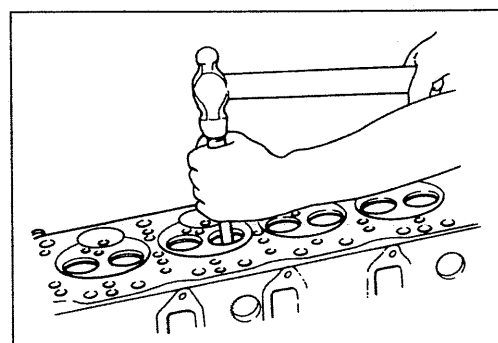
#### Valve Stem Clearance mm(in)

|               | Standard                           | Limit            |
|---------------|------------------------------------|------------------|
| Intake Valve  | 0.039 – 0.071<br>(0.0015 – 0.0028) | 0.20<br>(0.008)  |
| Exhaust Valve | 0.064 – 0.096<br>(0.0025 – 0.0038) | 0.25<br>(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.



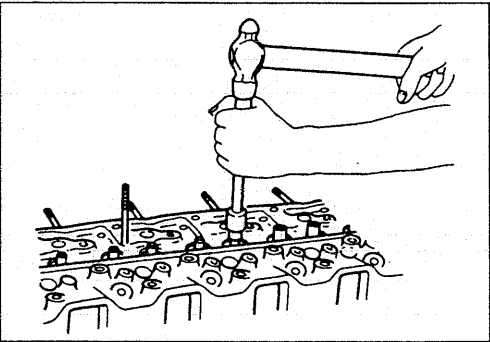
### Valve Guide Replacement

#### Valve Guide Removal

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



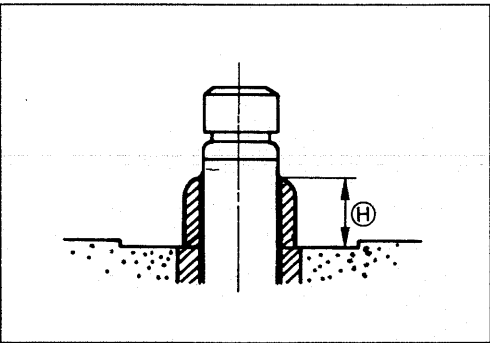
Valve Guide Replacer: 9-8523-1212-0



**Valve Guide Installation**

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

Valve Guide Replacer: 9-8523-1212-0



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

Valve Guide Upper End Height (H)

(Reference)

mm(in)

13.0 (0.51)

**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**

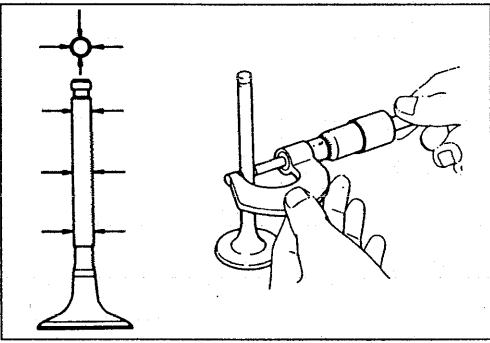
Measure the valve stem diameter at three points.

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  | 7.946 – 7.961<br>(0.3128 – 0.3134) | 7.88<br>(0.3102)  |
| Exhaust Valve | 7.921 – 7.936<br>(0.3118 – 0.3124) | 7.850<br>(0.3099) |



**Valve Thickness**

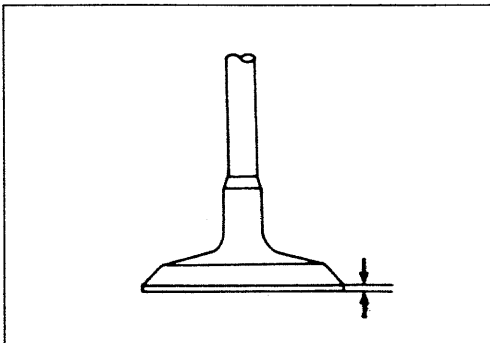
Measure the valve thickness

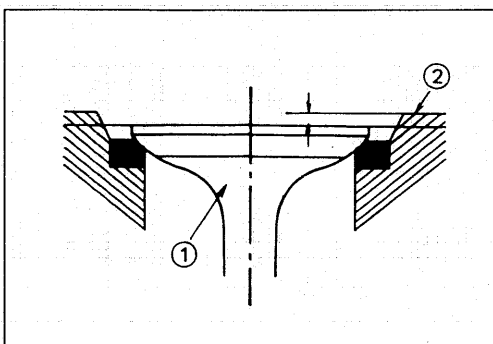
If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Intake and Exhaust Valve Thickness

mm(in)

|         | Standard | Limit       |
|---------|----------|-------------|
| Inlet   | 1.41     | 1.1 (0.043) |
| Exhaust | 1.39     | 1.1 (0.043) |





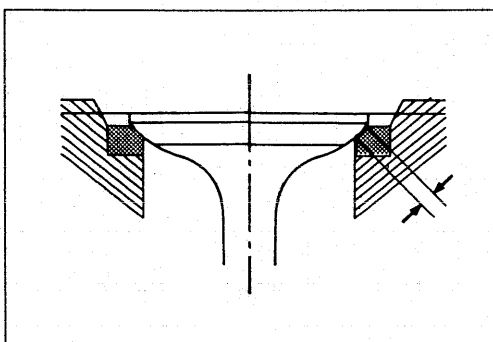
### Valve Depression

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        |
|---------|--------------|--------------|
| Intake  | 0.73 (0.029) | 1.28 (0.050) |
| Exhaust | 0.70 (0.028) | 1.20 (0.047) |



### Valve Contact Width

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

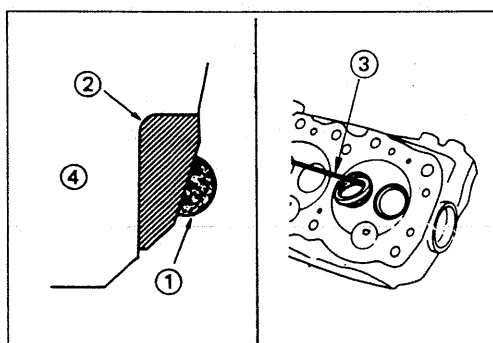
Make smooth the valve contact surfaces.

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       |
|---------|-------------|-------------|
| Intake  | 1.7 (0.067) | 2.2 (0.087) |
| Exhaust | 2.0 (0.079) | 2.5 (0.078) |

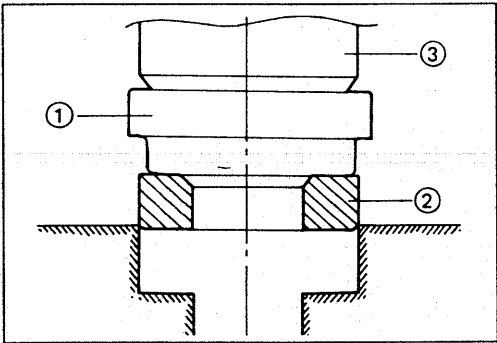


### Valve Seat Insert Replacement

#### 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 .

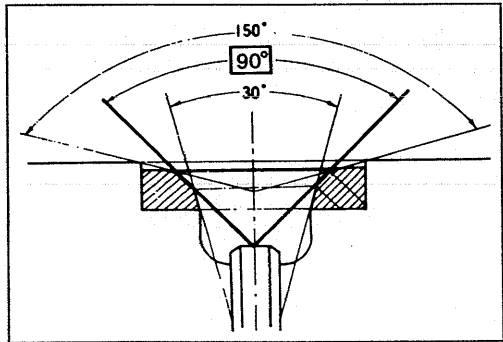
**Note:**

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.

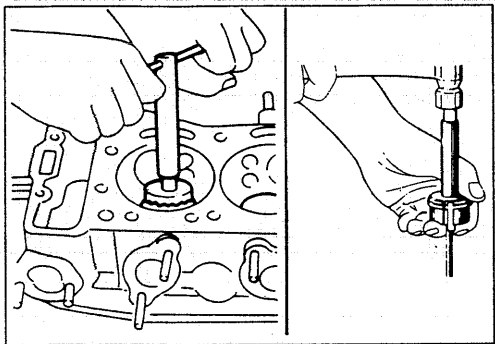
|                  |     |
|------------------|-----|
| Valve Seat Angle | 45° |
|------------------|-----|

**Note:**

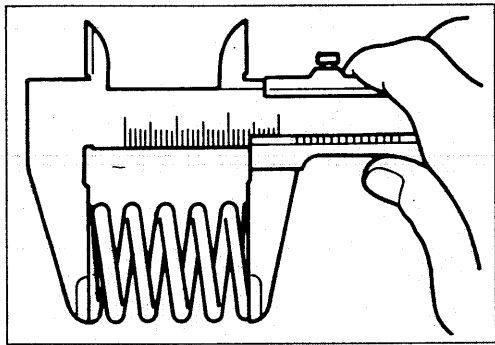


Use an adjustable valve cutter pilot.

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

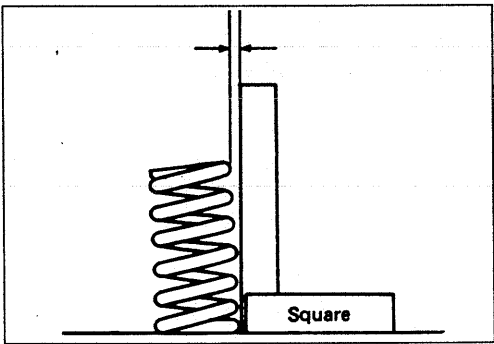


Use a vernier caliper to measure the valve spring free height.

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

Valve Spring Free Height mm(in)

| Standard    | Limit       |
|-------------|-------------|
| 49.7 (1.96) | 48.2 (1.90) |



Valve Spring Inclination

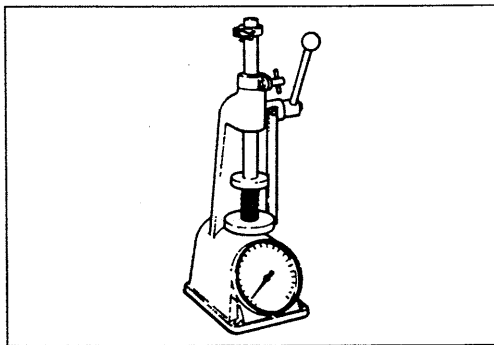


Use a surface plate and a square to measure the valve spring inclination.

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

Valve Spring Inclination mm(in)

| Standard           | Limit               |
|--------------------|---------------------|
| 1.5 (0.06) or less | 2.5 (0.984) or more |



Valve Spring Tension



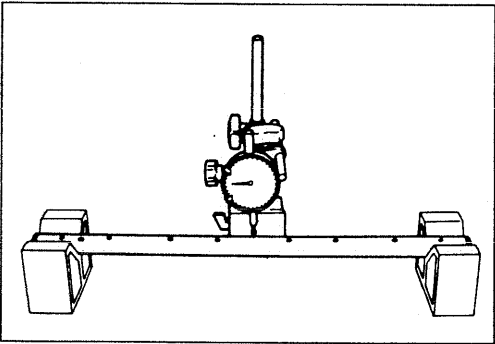
Use a spring tester to measure the valve spring tension.

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

Valve Spring Tension kg(lb)

| Compressed Height | Standard    | Limit       |
|-------------------|-------------|-------------|
| 38.9 mm (1.53 in) | 32.6 (71.7) | 29.0 (63.8) |





ROCKER ARM SHAFT AND ROCKER ARM

Rocker Arm Shaft Run-Out

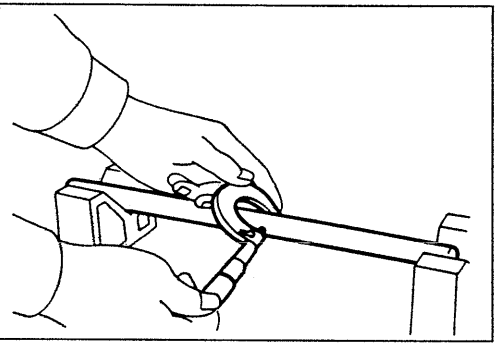


- 1. Place the rocker arm shaft on a V-block.
- 2. Use a dial indicator to measure the rocker arm shaft central portion run-out.

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) |
|--------------------------|-------------|--------|
| Standard                 | Limit       |        |
| 0.2 (0.008)              | 0.6 (0.024) |        |



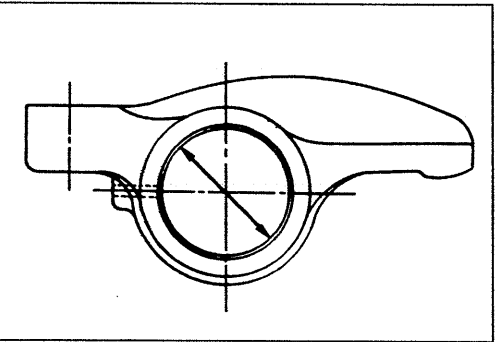
Rocker Arm Shaft Outside Diameter



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 (0.747 – 0.748)     | 18.85 (0.742) |        |



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.

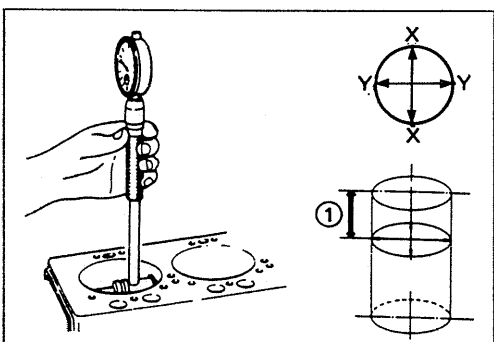
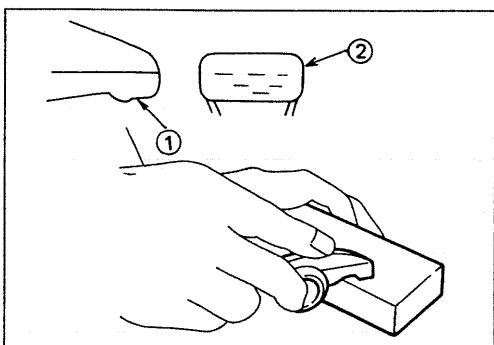
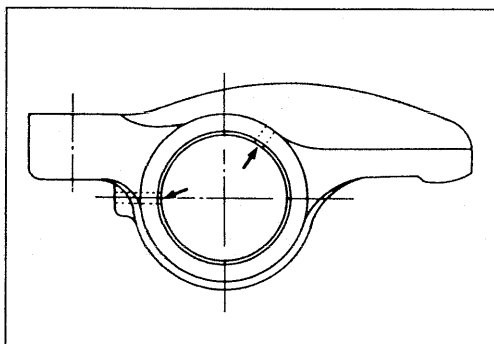
| Rocker Arm Bushing Inside Diameter |               | mm(in) |
|------------------------------------|---------------|--------|
| Standard                           | Limit         |        |
| 19.01 – 19.03 (0.748 – 0.749)      | 19.05 (0.750) |        |



- 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       |        |
| 0.01 – 0.05 (0.0004 – 0.002)              | 0.2 (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 Liner Bore Measurement



Use a cylinder indicator to measure the cylinder bore at measuring point ① in the thrust X – X and axial Y – Y directions of the crankshaft.

Measuring Point ① : Maximum wear portion

[11 ~ 15 mm (0.43 ~ 0.59 in)]

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

Cylinder Liner Bore mm(in)

| Standard                             | Limit            |
|--------------------------------------|------------------|
| 95.421 – 95.460<br>(3.7567 – 3.7583) | 95.5<br>(3.7598) |

### 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

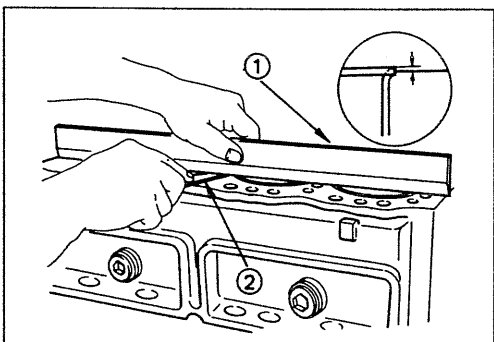
1. Hold a straight edge ① along the top edge of the cylinder liner to be measured.
2. Use a feeler gauge ② to measure each cylinder liner projection.

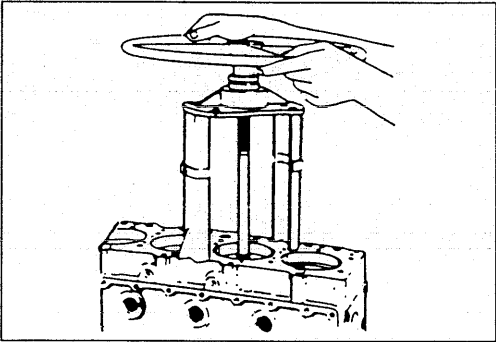


Cylinder Liner Projection mm(in)

| 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

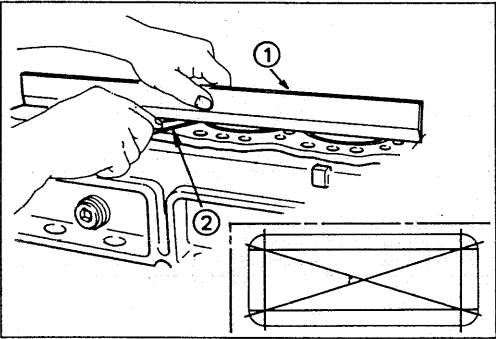
- 1. Remove the cylinder body dowel.
- 2. Set the cylinder liner remover to the cylinder liner.
- 3. Check that the remover shaft ankle is firmly gripping the cylinder liner bottom edge.
- 4. Slowly turn the remover shaft handle counterclockwise to pull the cylinder liner free.



Cylinder Liner Remover Ankle: 5-8840-2304-0

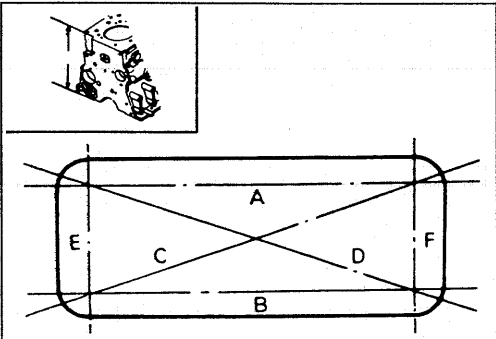
Cylinder Liner Remover: 9-8523-1169-0

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



Cylinder Body Upper Face Warpage

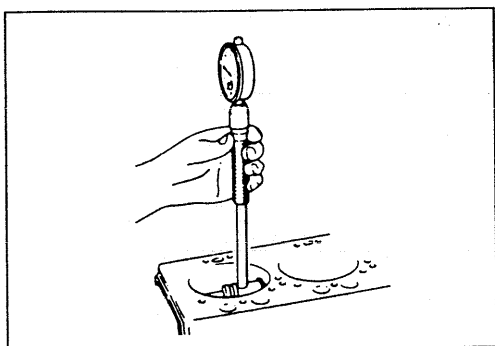
Use a straight edge ① and a feeler gauge ② to measure the four sides and the two diagonals of the cylinder body upper face.



| Cylinder Body Upper Face Warpage |             | mm(in) |
|----------------------------------|-------------|--------|
| Standard                         | Limit       |        |
| 0.05 (0.002) or less             | 0.2 (0.008) |        |

If the measured value is more than the limit, the cylinder body must be replaced.

| Cylinder Body Height (Reference)      | mm(in) |
|---------------------------------------|--------|
| Standard                              |        |
| 272.945 – 273.105 (10.7458 – 10.7521) |        |



### Cylinder Liner Grade Selection

Measure the cylinder body inside diameter and select the appropriate cylinder liner grade.

| Standard Fitting Interference | mm(in)             |
|-------------------------------|--------------------|
| 0.001 – 0.019                 | (0.0004 – 0.00075) |

If the cylinder liner fitting interference is too small, engine cooling efficiency will be adversely affected.

If the cylinder liner fitting interference is too large, it will be difficult to insert the cylinder liner into the cylinder body.

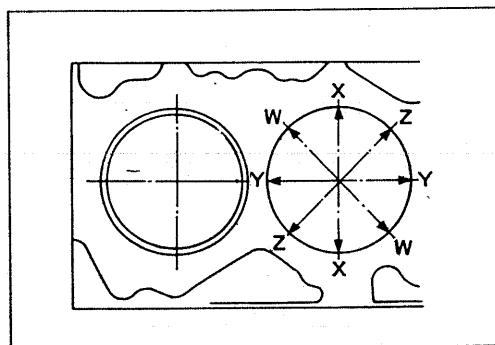
### Cylinder Body Bore Measurement



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

Measuring Point ① : 88 mm (3.46 in)

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



### Cylinder Liner Outside Diameter Measurement



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

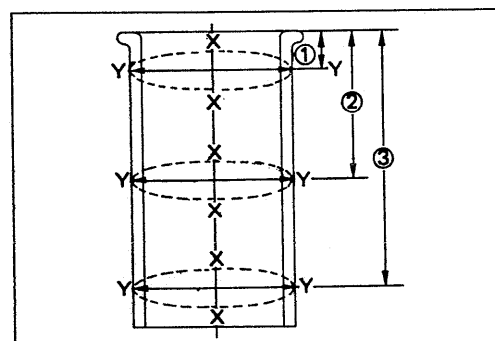
Measuring Point ① : 20 mm (0.79 in)

Measuring Point ② : 50 mm (1.97 in)

Measuring Point ③ : 150 mm (5.90 in)



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





### Cylinder Liner Installation

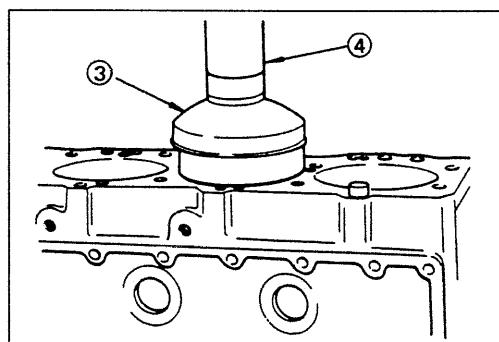
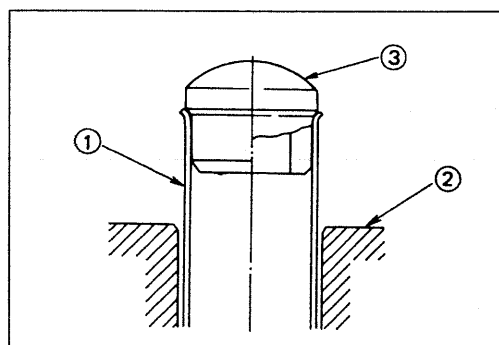


#### 1. Cylinder Liner Installation Using The Special Tool.

- 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: 5-8840-2313-0

- 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

If the cylinder liner is a chrome plated dry type, it is advisable to use dry ice during the installation procedure.

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.

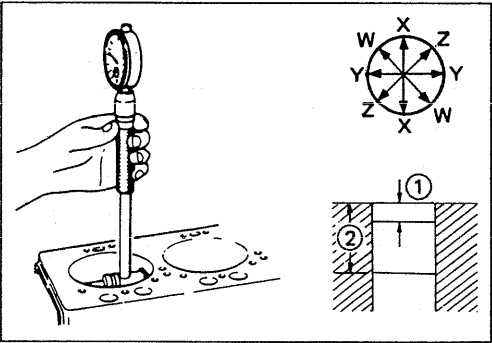
**WARNING:**

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

**Cylinder Bore and Cylinder Liner Outside Diameter Combination (Reference)**

mm(in)

|   | Cylinder Bore                        | Cylinder Liner<br>Outside Diameter   |
|---|--------------------------------------|--------------------------------------|
| 1 | 97.001 – 97.010<br>(3.8189 – 3.8193) | 97.011 – 97.020<br>(3.8193 – 3.8197) |
| 2 | 97.011 – 97.020<br>(3.8193 – 3.8197) | 97.021 – 97.030<br>(3.8197 – 3.8201) |
| 3 | 97.021 – 97.030<br>(3.8197 – 3.8201) | 97.031 – 97.040<br>(3.8201 – 3.8205) |
| 4 | 97.031 – 97.040                      | 97.041 – 97.050                      |



**Piston Grade Selection**

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.

There are two measuring points ( ① and ② ).

Measure the cylinder liner bore in four different direction (W – W, X – X, and Z – Z) at both measuring points.

Calculate the average value of the eight measurements to determine the correct cylinder liner bore.

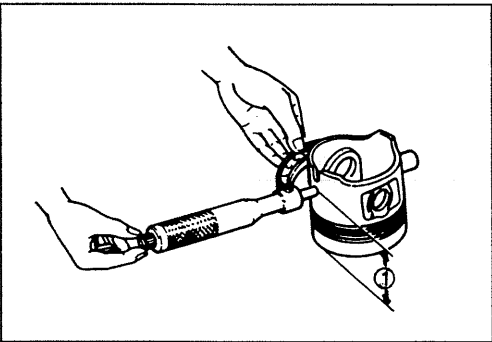
Measuring Points ① : 20 mm (0.79 in)

② : 160 mm (6.30 in)

| Cylinder Liner Bore                  |                  | mm(in) |
|--------------------------------------|------------------|--------|
| Standard                             | Limit            |        |
| 95.421 – 95.460<br>(3.7567 – 3.7583) | 95.5<br>(3.7598) |        |

**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.



2. Measure the piston outside diameter.

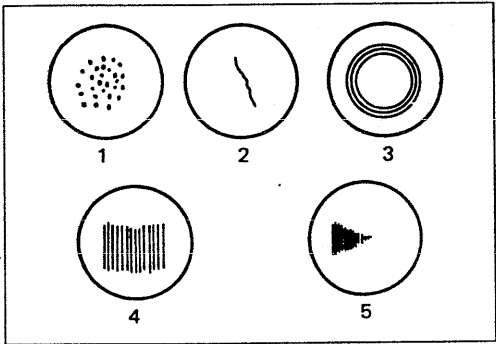
Piston Measuring Point ① : 71 mm (2.80 in)

| Piston Grade                         |                                      | mm(in) |
|--------------------------------------|--------------------------------------|--------|
| Grade Ⓐ                              | Grade Ⓒ                              |        |
| 95.365 – 95.384<br>(3.7545 – 3.7553) | 95.385 – 95.404<br>(3.7553 – 3.7561) |        |

| Cylinder Liner and Piston Clearance | mm(in) |
|-------------------------------------|--------|
| 0.037 – 0.075 (0.0015 – 0.0030)     |        |

**Note:**

Cylinder liner kit clearances are preset. However, the cylinder liner installation procedure may result in slight decreases in cylinder liner clearances. Always measure the cylinder liner clearance after installation to be sure that it is correct.



**TAPPET AND PUSH ROD**

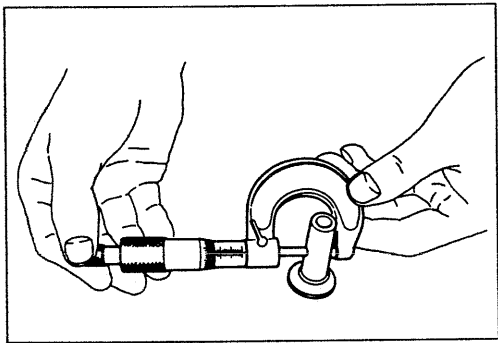
Visually inspect the tappet camshaft contact surfaces for pitting, cracking, and other abnormal conditions. The tappet must be replaced if any of these conditions are present.

Refer to the illustration at the left.

- 1 Normal contact
- 2 Cracking
- 3 Pitting
- 4 Irregular contact
- 5 Irregular contact

**Note:**

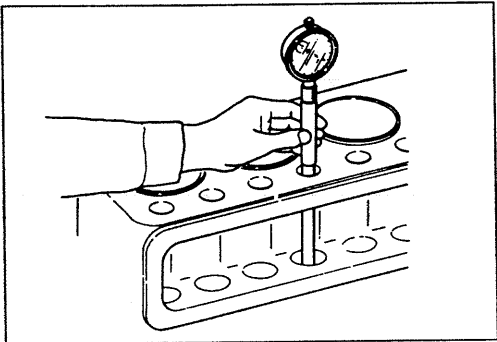
The tappet surfaces are spherical. Do not attempt to grind them with an oil stone or similar tool in an effort to repair the tappet. If the tappet is damaged, it must be replaced.



**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.

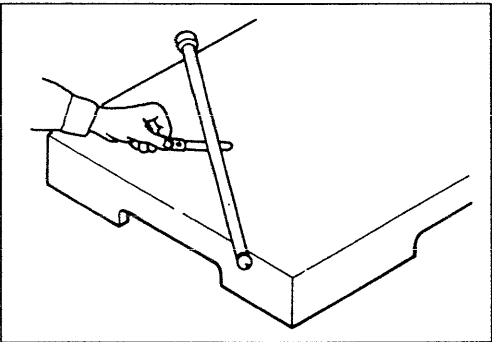
| Tappet Outside Diameter       |               | mm(in) |
|-------------------------------|---------------|--------|
| Standard                      | Limit         |        |
| 12.97 – 12.99 (0.510 – 0.511) | 12.95 (0.509) |        |



**Tappet and Cylinder Body Clearance** mm(in)

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





**Push Rod Curvature**

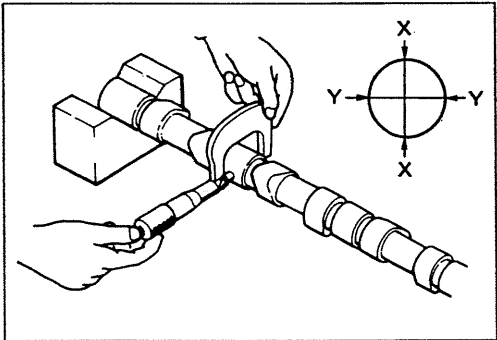
1. Lay the push rod on a surface plate.
2. Roll the push rod along the surface plate and measure the push rod curvature with a thickness gauge.  
If the measured value exceeds the specified limit, the push rod must be replaced.

| Push Rod Curvature | mm(in) |
|--------------------|--------|
| Limit              |        |
| 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**

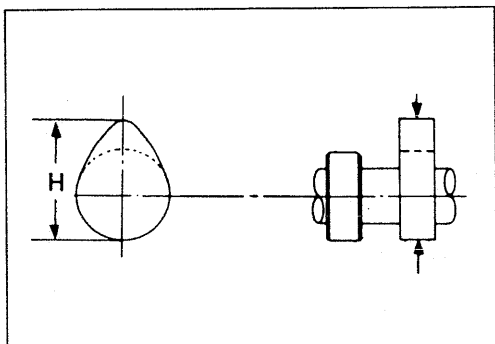
Visually inspect the journals, the cams, the oil pump drive gear, and the camshaft bearings for excessive wear and damage. The camshaft and the camshaft bearings must be replaced if these conditions are discovered during inspection.



**Camshaft Journal Diameter**

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

| Camshaft Journal Diameter          | mm(in)           |
|------------------------------------|------------------|
| Standard                           | Limit            |
| 49.945 – 49.975<br>(1.966 – 1.968) | 49.60<br>(1.953) |

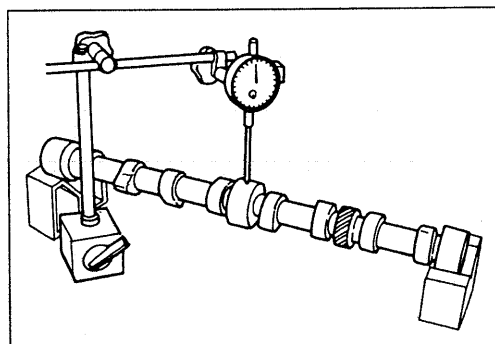


### Cam Height

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

Cam Height (H) mm(in)

| Standard     | Limit        |
|--------------|--------------|
| 42.08 (1.65) | 41.65 (1.64) |



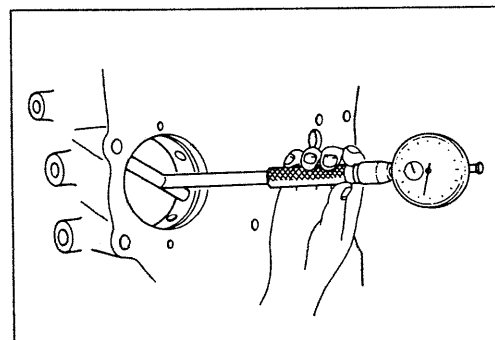
### Camshaft Run-Out

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        |
|---------------|--------------|
| 0.02 (0.0008) | 0.10 (0.004) |



### Camshaft and Camshaft Bearing Clearance

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

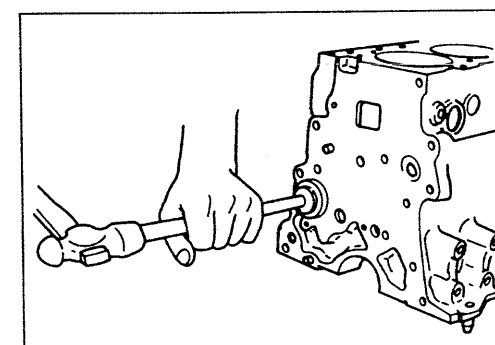
Camshaft Bearing Inside Diameter mm(in)

| Standard                          | Limit             |
|-----------------------------------|-------------------|
| 50.0 – 50.03<br>(1.9685 – 1.9696) | 50.08<br>(1.9716) |

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        |
|--------------------------------------|--------------|
| 0.025 – 0.085 –<br>(0.0010 – 0.0033) | 0.12 (0.005) |

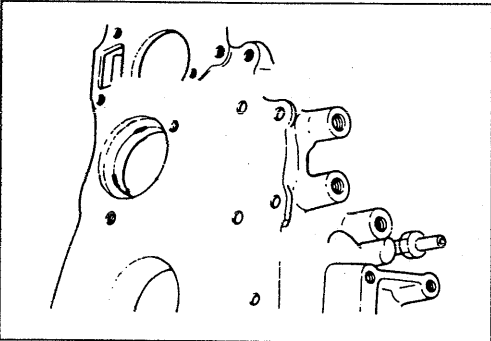


### Camshaft Bearing Replacement

#### Camshaft Bearing Removal

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

Bearing Replacer: 5-8840-2038-0

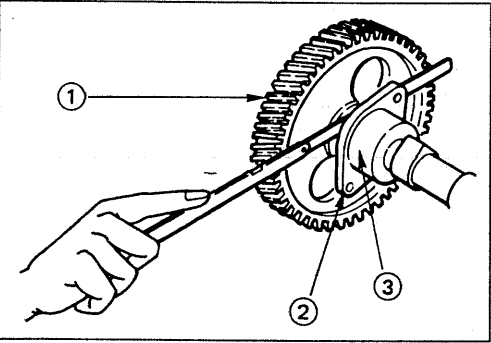


**Camshaft Bearing Installation**

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



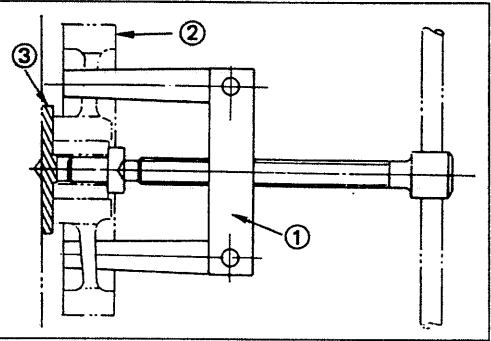
Bearing Replacer: 5-8840-2038-0



**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.
- 2. Use a feeler gauge 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**

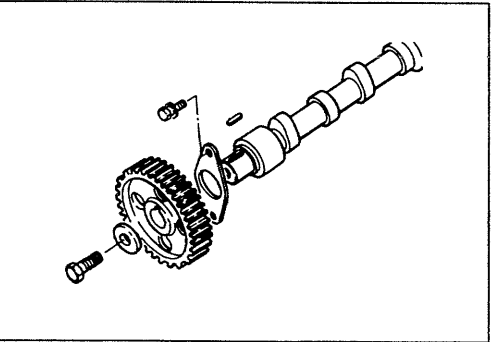
**Thrust Plate Removal**

- 1. Use the universal puller ① to remove the camshaft timing gear ② .



Universal Puller: 5-8840-0086-0

- 2. Remove the thrust plate ③ .



**Thrust Plate Installation**

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



| Camshaft Gear Torque           | kg·m(lb.ft/N·m) |
|--------------------------------|-----------------|
| 10.0 – 12.0 (72 – 87/98 – 118) |                 |

## CRANKSHAFT AND BEARING

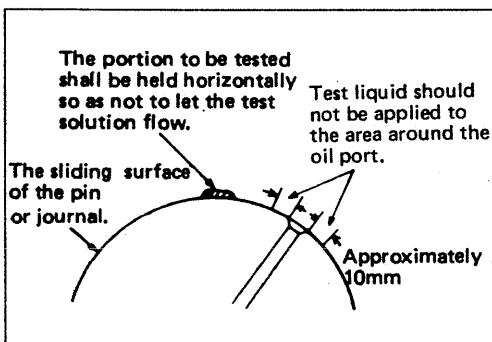
Inspect the surface of the crankshaft journals and crankpins for excessive wear and damage.

Inspect the oil seal fitting surfaces for excessive wear and damage.

Inspect the oil ports for obstructions.

### Note:

To increase crankshaft strength, tufftriding (Nitriding Treatment) has been applied. Because of this, it is not possible to grind the crankshaft surfaces.



### Crankshaft Tufftriding Inspection

1. Use an organic cleaner to thoroughly clean the crankshaft. There must be no traces of oil on the surfaces to be inspected.
2. Prepare a 5 – 10% solution of ammonium cuprous chloride (dissolved in distilled water).
3. Use a syringe to apply the solution to the surface to be inspected.

Hold the surface to be inspected perfectly horizontal to prevent the solution from running.

### Note:

Do not allow the solution to come in contact with the oil ports and their surrounding area.

### Judgement

1. Wait for thirty to forty seconds.

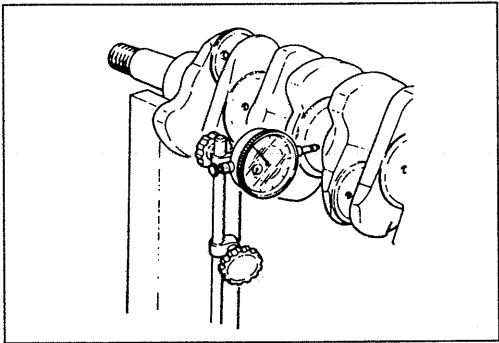
If there is no discoloration after thirty or forty seconds, the crankshaft is usable.

If discoloration appears (the surface being tested will become the color of copper), the crankshaft must be replaced.



2. Steam clean the crankshaft surface immediately after completing the test.

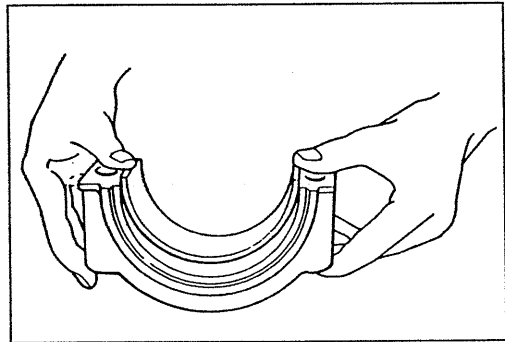
**Note:**  
The ammonium cuprous chloride solution is highly corrosive. Because of this, it is imperative that the surfaces being tested be cleaned immediately after completing the test.



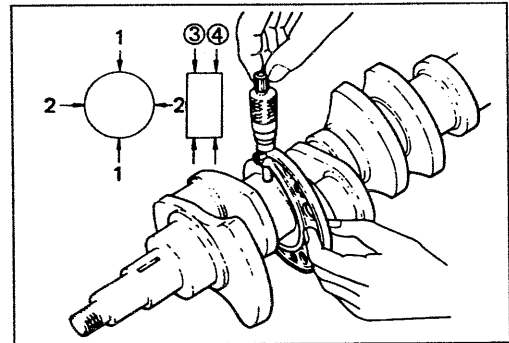
**Crankshaft Run-Out**

- 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        |        |
| 0.05 (0.002) or less | 0.08 (0.003) |        |



**Bearing Tension**  
Check to see if the bearing has enough tension, so that a good finger pressure is needed to fit the bearing into position.



**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)

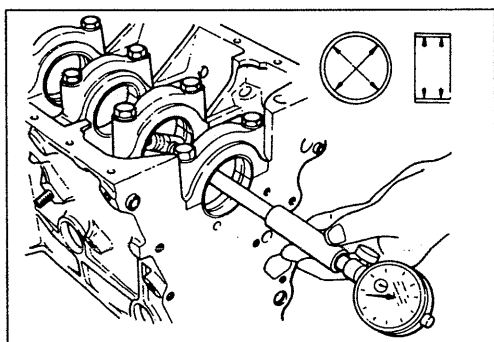
| Standard                             | Limit              |
|--------------------------------------|--------------------|
| 69.917 – 69.932<br>(2.7526 – 2.7531) | 69.910<br>(2.7524) |

## Crankpin Diameter mm(in)

| Standard                             | Limit              |
|--------------------------------------|--------------------|
| 52.915 – 52.930<br>(2.0833 – 2.0839) | 52.906<br>(2.0829) |

## Crankshaft Journal and Crankpin Uneven Wear mm(in)

| Standard             | Limit        |
|----------------------|--------------|
| 0.05 (0.002) or less | 0.08 (0.003) |

**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.

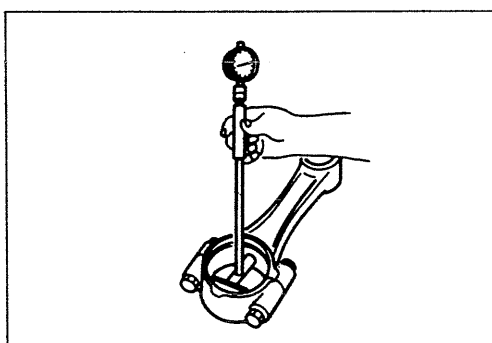
**Crankshaft Bearing Cap Bolt**

Torque kg·m(lb.ft./N·m)

16.0 – 18.0 (116 – 130/157 – 177)

## Crankshaft Journal and Bearing Clearance mm(in)

| Standard                        | Limit         |
|---------------------------------|---------------|
| 0.031 – 0.063 (0.0012 – 0.0025) | 0.11 (0.0043) |

**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)

2.8 – 3.2 → 45° – 60°  
(20 – 23/727 – 31)

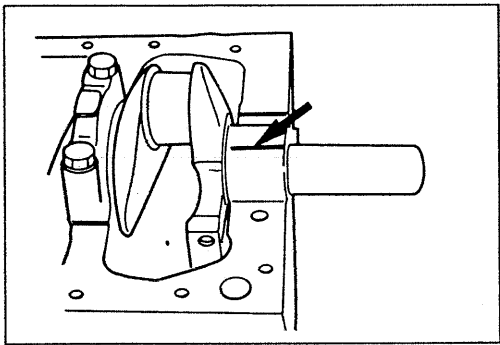
3. Use a inside dial indicator to measure the connecting rod bearing inside diameter.



**Crankpin and Bearing Clearance**

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

| Crankpin and Bearing Clearance  |               | mm(in) |
|---------------------------------|---------------|--------|
| Standard                        | Limit         |        |
| 0.029 – 0.083 (0.0011 – 0.0033) | 0.10 (0.0039) |        |

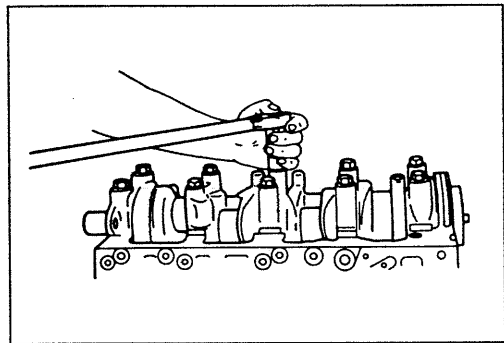


**Clearance Measurements (With Plastigage)**

**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.

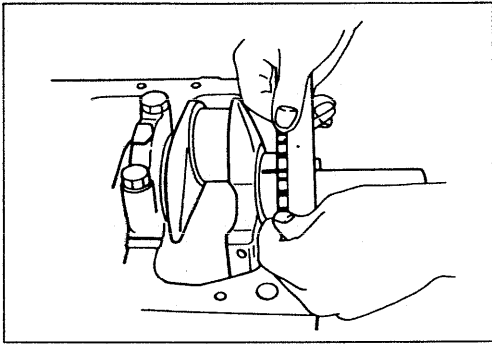


7. Tighten the bearing caps to the specified torque.

| Crankshaft Bearing Cap Bolt Torque | kg·m(lb.ft/N·m) |
|------------------------------------|-----------------|
| 16.0 – 18.0 (116 – 130/157 – 177)  |                 |

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            |        |
| 0.031 – 0.063<br>(0.0012 – 0.0025)       | 0.11<br>(0.0043) |        |

#### Crankshaft Bearing Selection

When installing new crankshaft bearings or replacing old bearings, select and install bearing part No. 897063-2590 (Identification color: **"Black"**)

#### 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) |
|------------------------------------------|-----------------|
| 2.8 – 3.2 (20 – 23/727 – 31) → 45° – 60° |                 |



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.



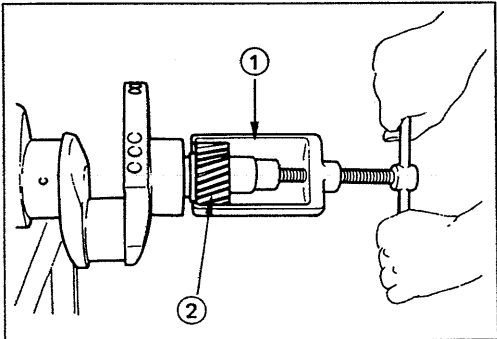
- 1) Use a micrometer to measure the crankpin outside diameter.



- 2) Use an inside dial indicator to measure the bearing inside diameter.

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

| Crankpin and Bearing Clearance     |                  | mm(in) |
|------------------------------------|------------------|--------|
| Standard                           | Limit            |        |
| 0.029 – 0.066<br>(0.0011 – 0.0026) | 0.10<br>(0.0039) |        |



#### Crankshaft Timing Gear Replacement

##### Crankshaft Timing Gear Removal

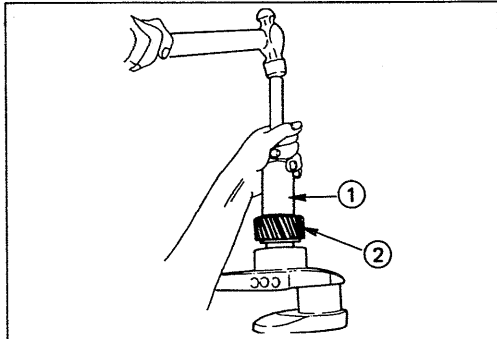


1. Use the crankshaft gear remover ① to remove the crankshaft gear ②.



2. Remove the crankshaft feather key.

Crankshaft Timing Gear Remover: 9-8840-2057-0



##### Crankshaft Timing Gear Installation



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



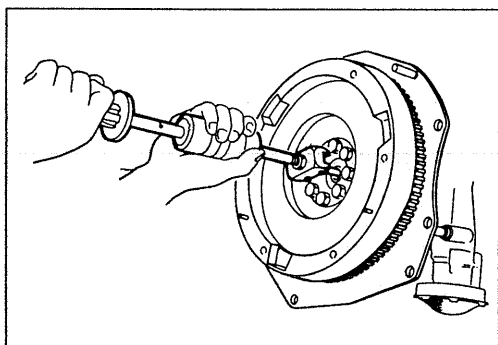
The crankshaft gear timing mark ("X – X") must be facing outward.



Crankshaft Gear Installer: 9-8522-0020-0

## CRANKSHAFT PILOT BEARING

Check the crankshaft pilot bearing for excessive wear and damage and replace it if necessary.



### Crankshaft Pilot Bearing Replacement

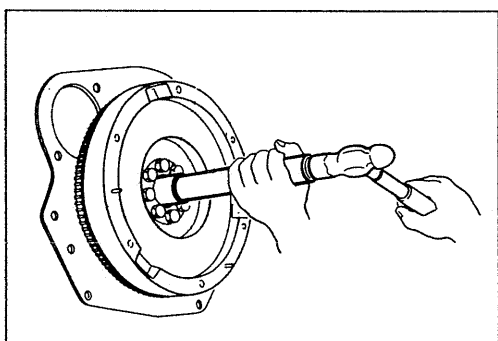
#### Crankshaft Pilot Bearing Removal

Use the pilot bearing remover to remove the pilot bearing.



Pilot Bearing Remover: 5-8840-2000-0

Sliding Hammer: 5-8840-0019-0



### Crankshaft Pilot Bearing Installation

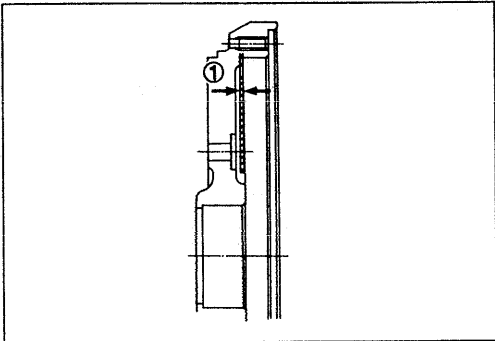
1. Place the crankshaft pilot bearing horizontally across the crankshaft bearing installation hole.
2. Tap around the edges of the crankshaft pilot bearing outer races with a brass hammer to drive the bearing into the crankshaft bearing installation hole.



Pilot Bearing Installer: 5-8522-0024-0

#### Note:

Strike only the crankshaft pilot bearing outer races with the hammer. Do not strike the bearing inner races. Bearing damage and reduced bearing service life will result.



**FLYWHEEL AND RING GEAR**

**Flywheel**

- 1. Inspect the flywheel friction surface for excessive wear and heat cracks.
- 2. Measure the flywheel friction surface wear amount (depth)

The flywheel friction surface area actually making contact with the clutch driven plate (the shaded area in the illustration) will be smaller than the original machined surface area.

There will be a ridge on the flywheel surface area. Be sure to measure the surface wear in the area inside the ridge.

If the measured value is between the standard and the specified limit, the flywheel may be reground.

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

| Flywheel Friction Surface Depth ① | mm(in) |
|-----------------------------------|--------|
| Limit                             |        |
| 1.0 (0.04) or more                |        |

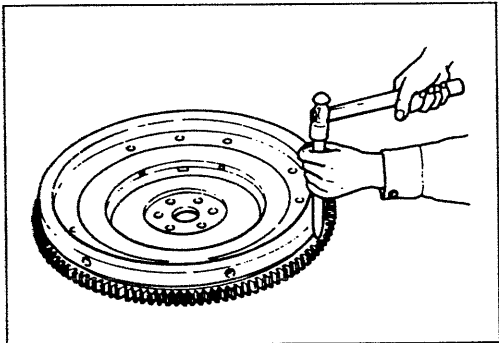
**Note:**

Because a ridge is produced at the flywheel friction surface as illustrated, do not measure the friction surface wear amount at the non-ridge area but be sure to measure it at the rear-friction surface which is shown in the illustration by shaded area.

**Ring Gear**

Inspect the ring gear.

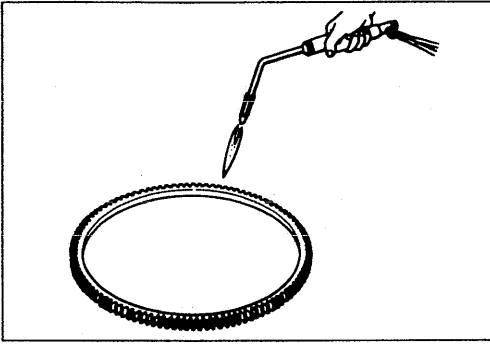
If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.



**Ring Gear Replacement**

**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:

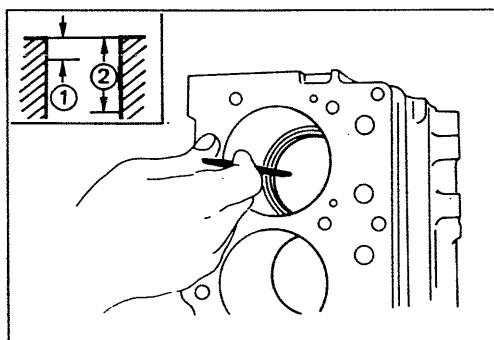
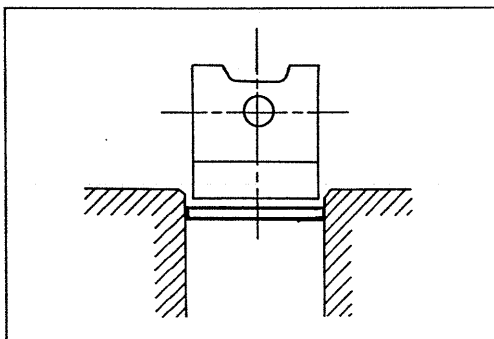
Another method of heating the ring gear to invite thermal expansion is to soak a rag in diesel fuel, wrap the diesel fuel soaked rag around the rim of the ring gear, and then light the rag.

## PISTON

### Piston Grade Selection and Cylinder Liner Bore Measurement



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



## PISTON RING

### Piston Ring Gap

1. Insert the piston ring horizontally into the cylinder liner.
2. Use a piston inserted upside down to push the piston ring into the cylinder liner until it reaches either measuring point ① or measuring point ②. Cylinder liner diameter is the smallest at these two points.

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

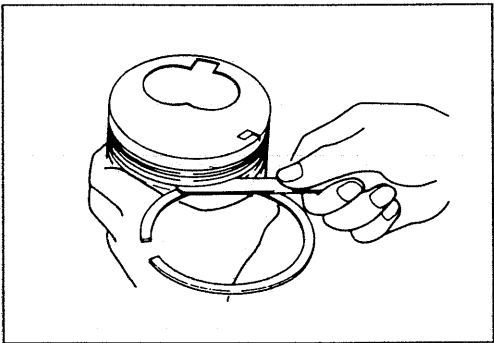
3. Use a feeler gauge to measure the piston ring gap.

Measuring Point ① : 10 mm (0.39 in)      or  
Measuring Point ② : 120 mm (4.72 in)

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



| Piston Ring Gap      |                                | mm(in)         |
|----------------------|--------------------------------|----------------|
|                      | Standard                       | Limit          |
| 1st Compression Ring | 0.2 – 0.35<br>(0.008 – 0.014)  | 1.5<br>(0.059) |
| 2nd Compression Ring | 0.37 – 0.52<br>(0.015 – 0.020) |                |
| Oil Ring             | 0.2 – 0.4<br>(0.008 – 0.016)   |                |



**Piston Ring and Piston Ring Groove Clearance**

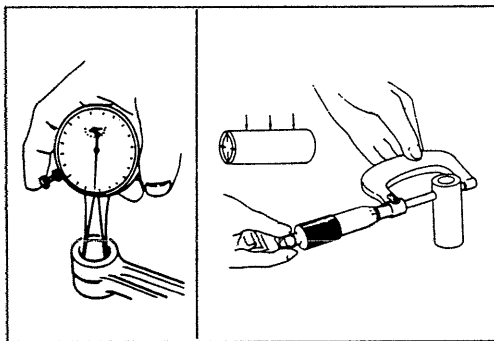
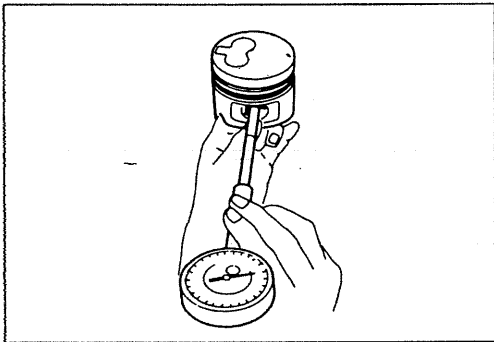
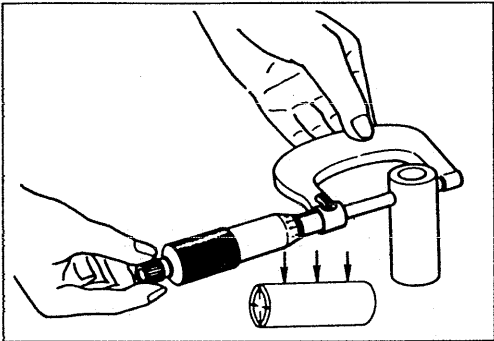
Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.

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

| Piston Ring and Piston Ring Groove Clearance |                                   | mm(in)          |
|----------------------------------------------|-----------------------------------|-----------------|
|                                              | Standard                          | Limit           |
| 1st Compression Ring                         | 0.09 – 0.130<br>(0.0035 – 0.0051) | 0.15<br>(0.006) |
| 2nd Compression Ring                         | 0.05 – 0.090<br>(0.002 – 0.0035)  |                 |
| Oil Ring                                     | 0.03 – 0.07<br>(0.0012 – 0.0028)  |                 |



Visually inspect the piston. 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           |
| 33.995 – 34.000 (1.3384 – 1.3386) |  | 33.970 (1.3374) |

### 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                          |  |        |
| 34.004 – 34.012 (1.3387 – 1.3391) |  |        |

| Piston Pin and Piston Pin Hole Clearance |  | mm(in) |
|------------------------------------------|--|--------|
| 0.004 – 0.015 (0.0002 – 0.0006)          |  |        |

### Piston Pin and Connecting Rod Small End Bushing Clearance



Use a caliper calibrator and a dial indicator to measure the piston pin and connecting rod small end bushing clearance.

If the clearance between the piston pin and the connecting rod small end bushing exceeds the specified limit, replace the piston pin and/or the connecting rod bushing.

| Piston Pin and Connecting Rod Small End Bushing Clearance |  | mm(in)          |
|-----------------------------------------------------------|--|-----------------|
| Standard                                                  |  | Limit           |
| 0.008 – 0.019<br>(0.0003 – 0.0007)                        |  | 0.05<br>(0.002) |

## Connecting Rod Bushing Replacement

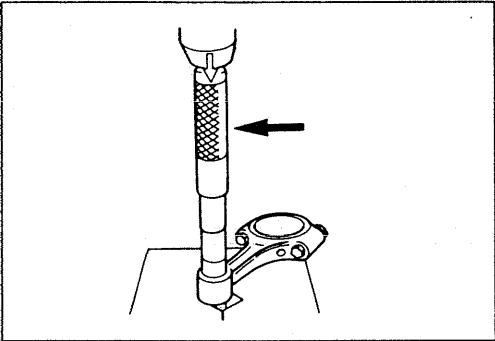


### Connecting Rod Bushing Removal



1. Clamp the connecting rod in a vise.
2. Use the connecting rod bushing remover to remove the connecting rod bushing.

### Connecting Rod Bushing Replacer

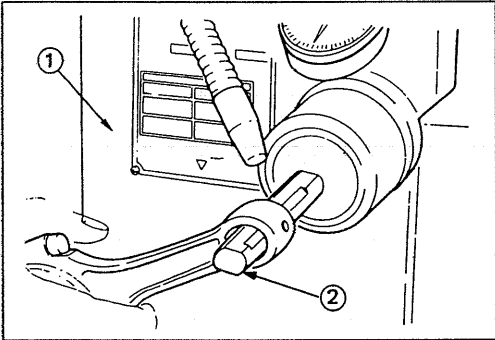


**Connecting Rod Bushing Installation**

1. Clamp the connecting rod in a vice.
2. Use the connecting rod bushing installer to install the connecting rod bushing.

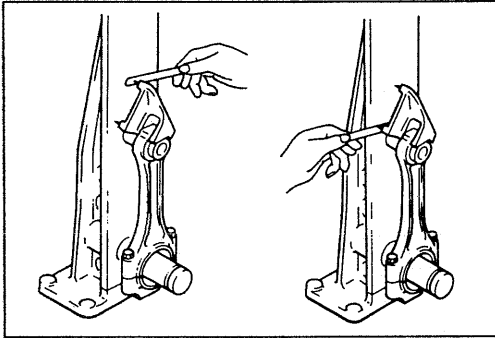


Connecting Rod Bushing Replacer:



3. Use a piston pin hole grinder ① fitted with a reamer ② to ream the piston pin hole.

| Inner Diamter of Small End Bushing | mm(in) |
|------------------------------------|--------|
| Standard                           |        |
| 34.008 – 34.015 (1.3389 – 1.3392)  |        |



**CONNECTING ROD**

**Connecting Rod Alignment**

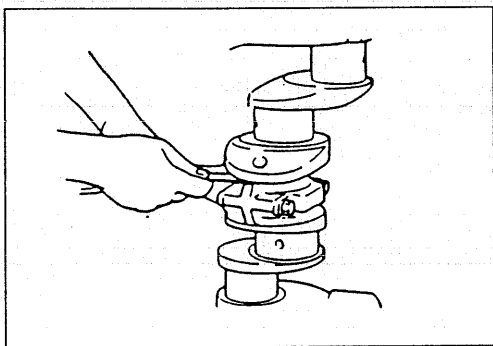


Use a connecting rod aligner to measure the distortion and the parallelism between the connecting rod big end hole and the connecting rod small end hole.

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                     | 0.05 or Less<br>(0.0020) | 0.20<br>(0.008) |
| Parallelism                    |                          | 0.15<br>(0.006) |



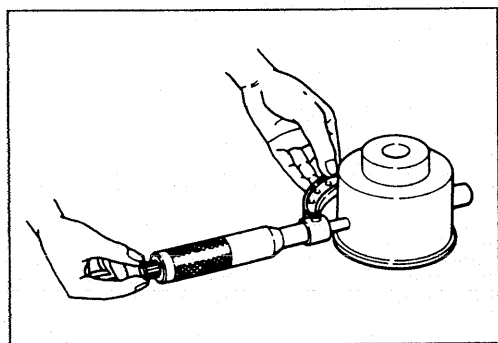
### Connecting Rod Side Face Clearance

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 side face.

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

#### Connecting Rod and Crankpin Side Face Clearance

|                                 |  | mm(in)       |
|---------------------------------|--|--------------|
| Standard                        |  | Limit        |
| 0.175 – 0.290 (0.0069 – 0.0114) |  | 0.35 (0.014) |



### IDLER GEAR SHAFT AND IDLER GEAR

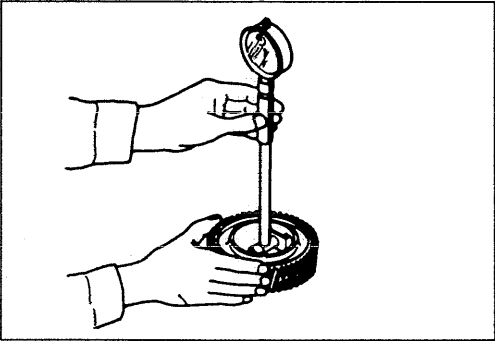
#### Idler Gear Shaft Outside Diameter

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.

|                                    |  | mm(in)           |
|------------------------------------|--|------------------|
| Standard                           |  | Limit            |
| 44.945 – 44.975<br>(1.769 – 1.771) |  | 44.90<br>(1.767) |





**Idler Gear “A” Inside Diameter**

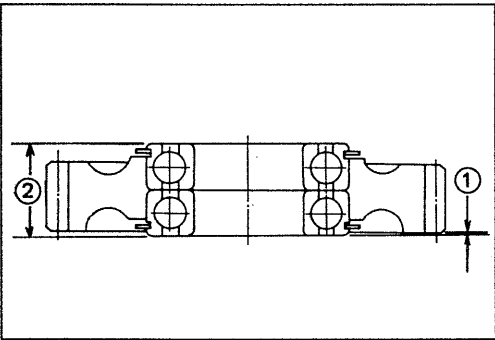


1. Use an inside dial indicator to measure the idler gear

| Idler Gear Inside Diameter        |                   | mm(in) |
|-----------------------------------|-------------------|--------|
| Standard                          | Limit             |        |
| 45.0 – 45.03<br>(1.7717 – 1.7718) | 45.10<br>(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<br>(0.008) |        |



**Idler Gear “B”**



**Bearing replacement**

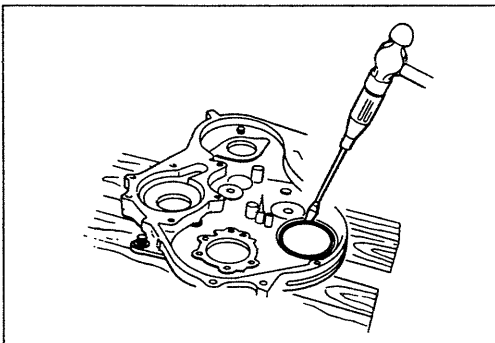
Use a suitable bar and a bench press or hammer.

Bearing projection amount should be within the specified height.

|              |                             | mm(in) |
|--------------|-----------------------------|--------|
| Projection ① | 0.4 – 0.6 (0.016 – 0.024)   |        |
| Height ②     | 23.7 – 24.0 (0.933 – 0.945) |        |

**TIMING GEAR CASE COVER**

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

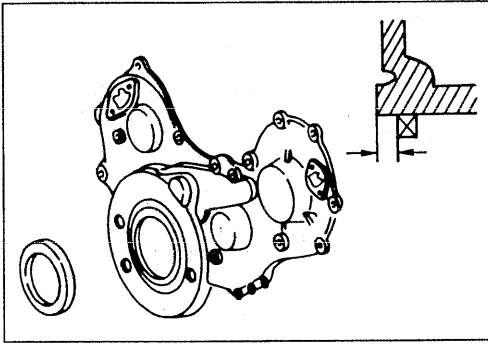


**Crankshaft Front Oil Seal Replacement**

**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

1. Apply a coat of engine oil to the oil seal lip circumference.
2. Use the oil seal installer and the installer grip to insert the oil seal 1 mm (0.039 in) into the front portion of the timing gear case.

Oil Seal Installer: 5-8840-2061-0

MEMO

Handwriting practice area consisting of 20 sets of horizontal dotted lines.

SECTION 5

ENGINE ASSEMBLY ( 3 )

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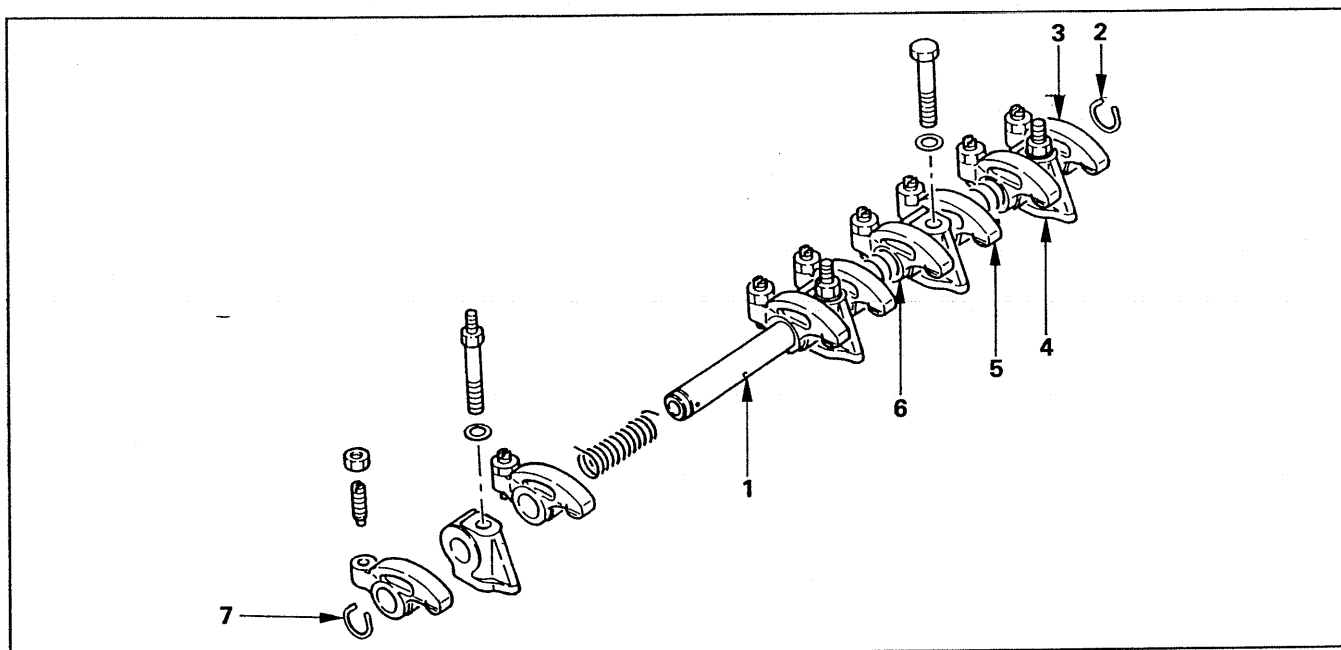
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## REASSEMBLY

### SINGLE UNIT

#### ROCKER ARM SHAFT AND ROCKER ARM

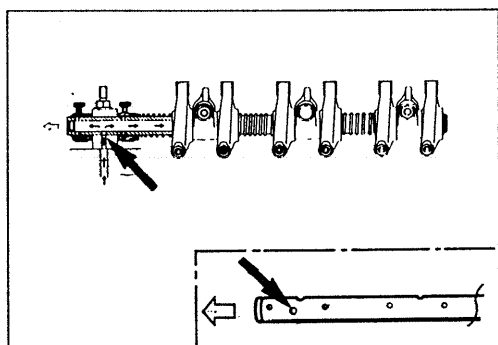


#### Reassembly Steps

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



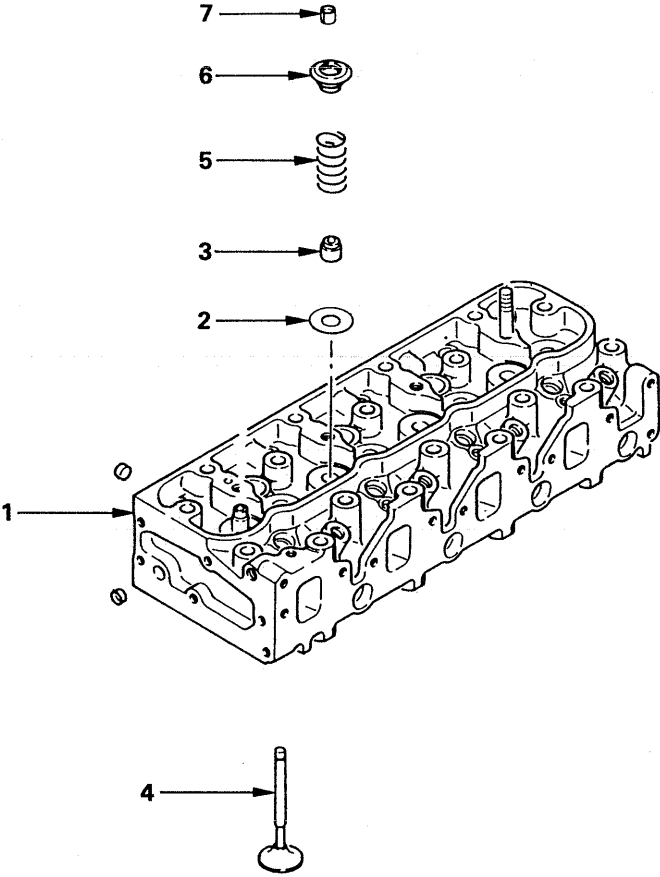
## Important Operations



### 1. Rocker Arm Shaft

- 1) Position the rocker arm shaft with the large oil hole (4ø) facing the front of the engine.
- 2) Install the rocker arm shaft together with the rocker arm, the rocker arm shaft bracket, and the spring.

CYLINDER HEAD

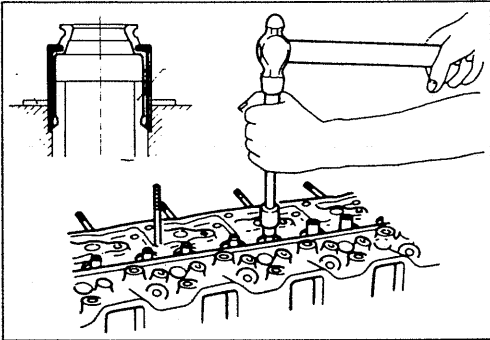


Reassembly Steps

- 1. Cylinder head
- 2. Valve spring lower seat
- ▲ 3. Valve stem oil seal
- ▲ 4. Intake and exhaust valve
- ▲ 5. Valve spring
- 6. Valve spring upper seat
- ▲ 7. Split collar



## Important Operations



### 3. Valve Stem Oil Seal

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

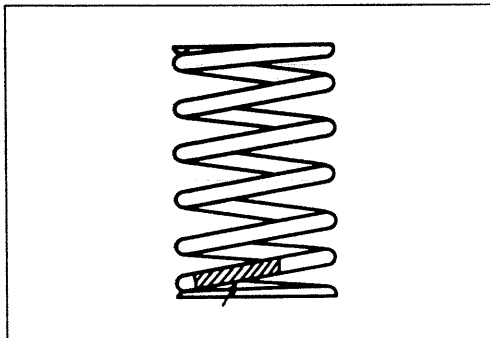
Oil Seal Installer: 5-8840-2033-0

### 4. Intake and Exhaust Valve



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

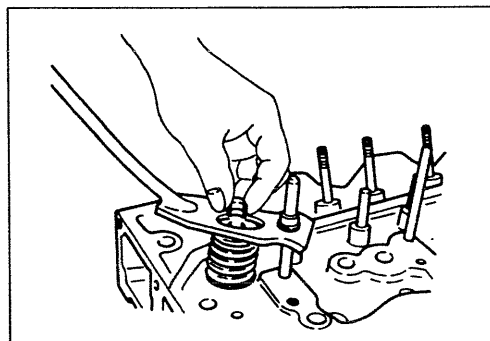
Take care not to allow the installed valves to fall free.



### 5. Valve Spring

- 1) Turn the cylinder head up to install the valve springs.
- 2) Install the valve springs with the fine pitched end (painted pink) facing down.

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



### 7. Split Collar

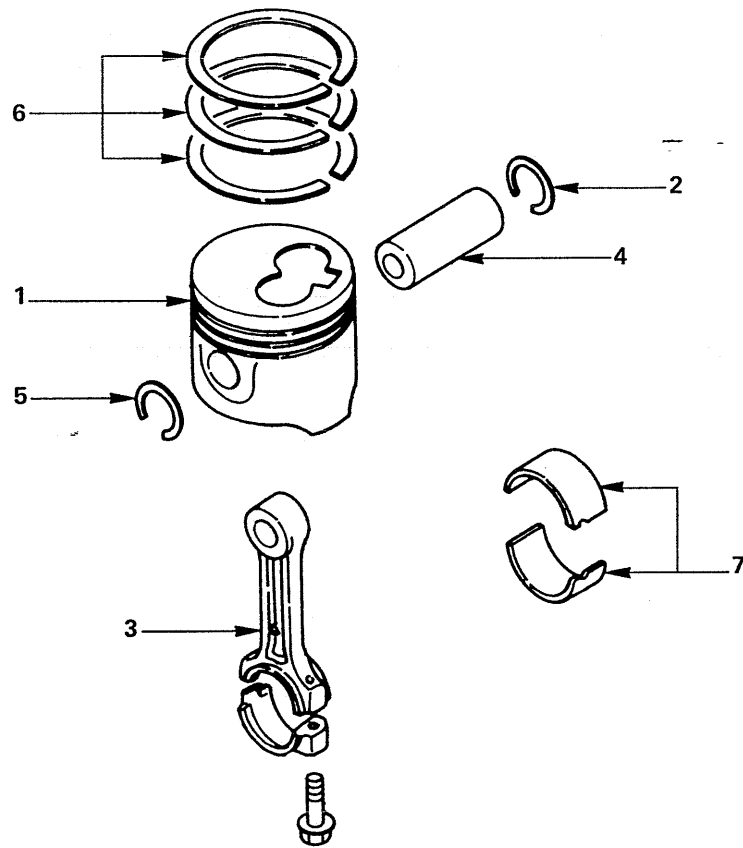
- 1) Use the spring compressor to push the valve spring into position.

Spring Compressor: 9-8523-1423-0

- 2) Install the split collar to the valve stem.
- 3) Set the split collar by tapping around the bead of the collar with a rubber hammer.



## PISTON AND CONNECTING ROD

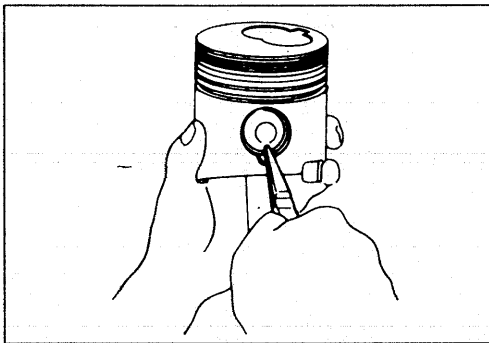


### Reassembly Steps

- ▲ 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



### 1. Piston

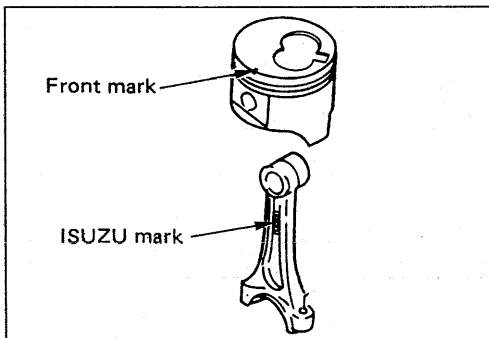
### 2. Piston pin snap ring

### 3. Connecting rod

- 1) Clamp the connecting rod in a vise.

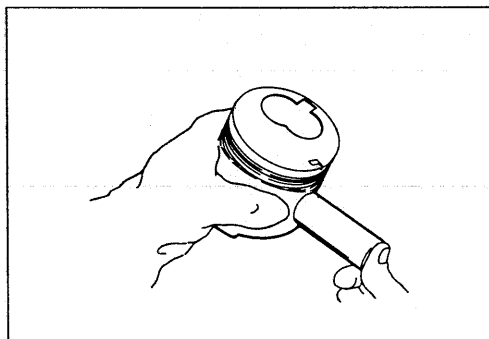
Take care not to damage the connecting rod.

- 2) Use a pair of snap ring pliers to install the piston pin snap ring to the piston.



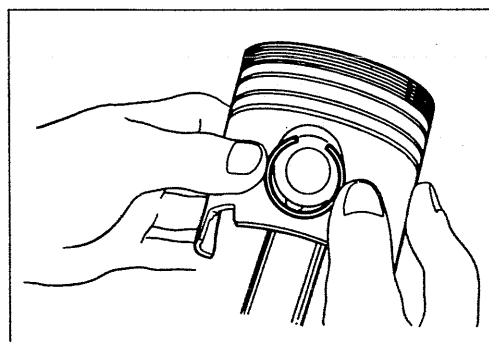
- 3) Install the piston to the connecting rod.

The piston head front mark and the connecting rod "ISUZU" casting mark must be facing the same direction.

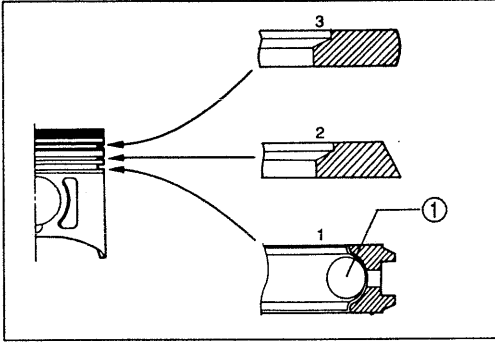


### 4. Piston pin

- 1) Apply a coat of engine oil to the piston pin and the piston pin hole.
- 2) Use your fingers to force the piston pin into the piston until it makes contact with the snap ring.



- 3) Use your fingers to force the piston pin snap ring into the piston snap ring groove.
- 4) Check that the connecting rod moves smoothly on the piston pin.



## 6. Piston Ring



- 1) Use a piston ring replacer to install the three piston rings.

Piston Ring Replacer:

Install the piston rings in the order shown in the illustration.

- ① Oil ring (Coil expander type)
- ② 2nd compression ring (Taper type)
- ③ 1st compression ring (Barrel face type)

### Note:

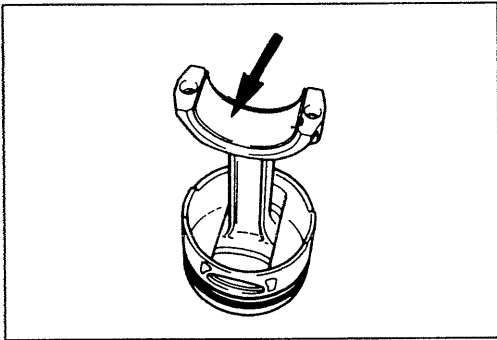


Install the compression rings with the stamped side facing up.

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.

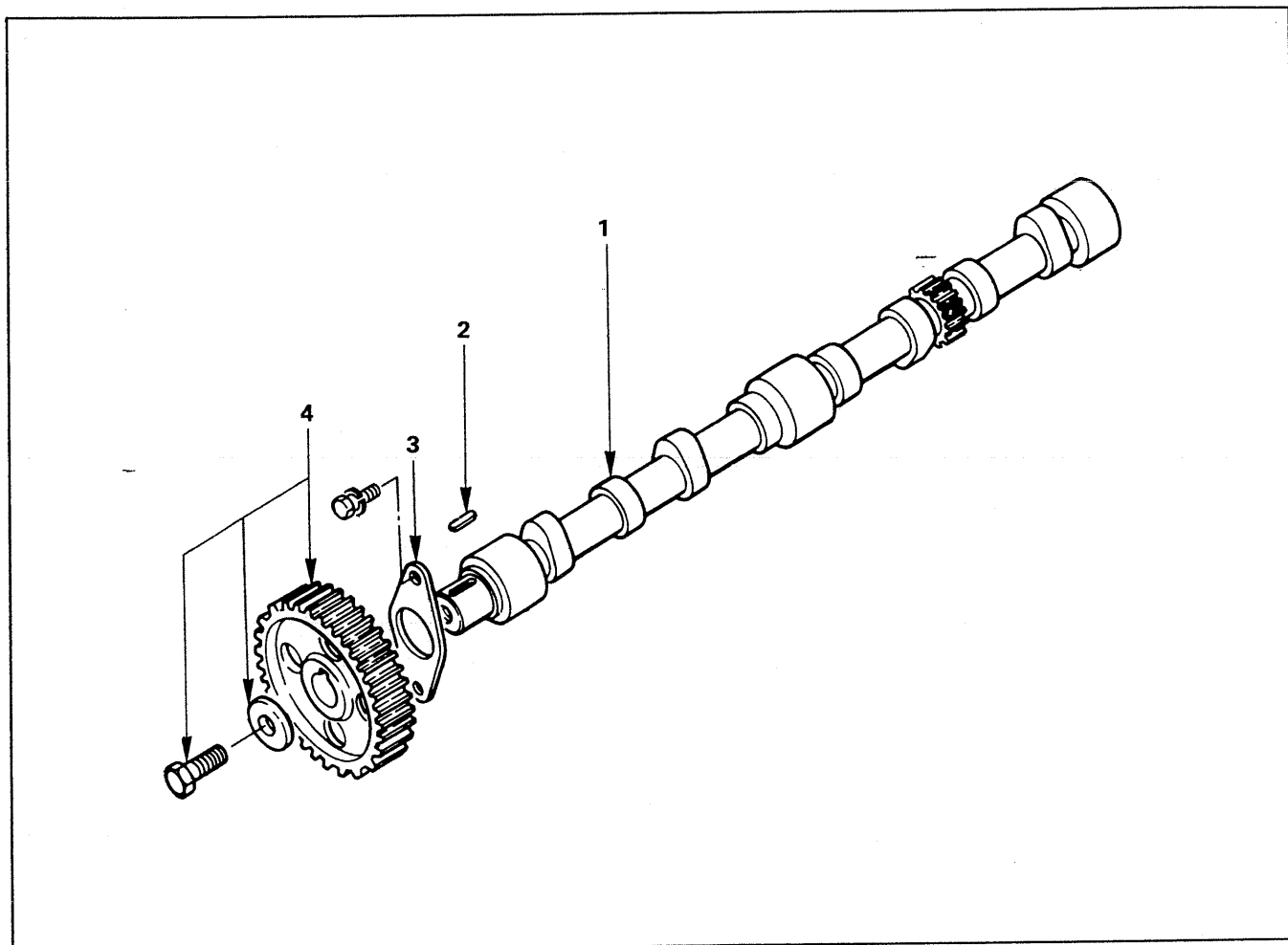


- 2) Apply engine oil to the piston ring surfaces.
- 3) Check that the piston rings rotate smoothly in the piston ring grooves.



## 7. 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.

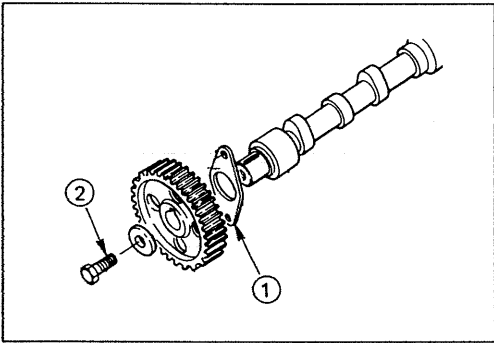
**CAMSHAFT, CAMSHAFT TIMING GEAR, AND THRUST PLATE****Reassembly Steps**

1. Camshaft
2. Feather key

3. Thrust plate
- ▲ 4. Camshaft timing gear



Important Operations



4. 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.



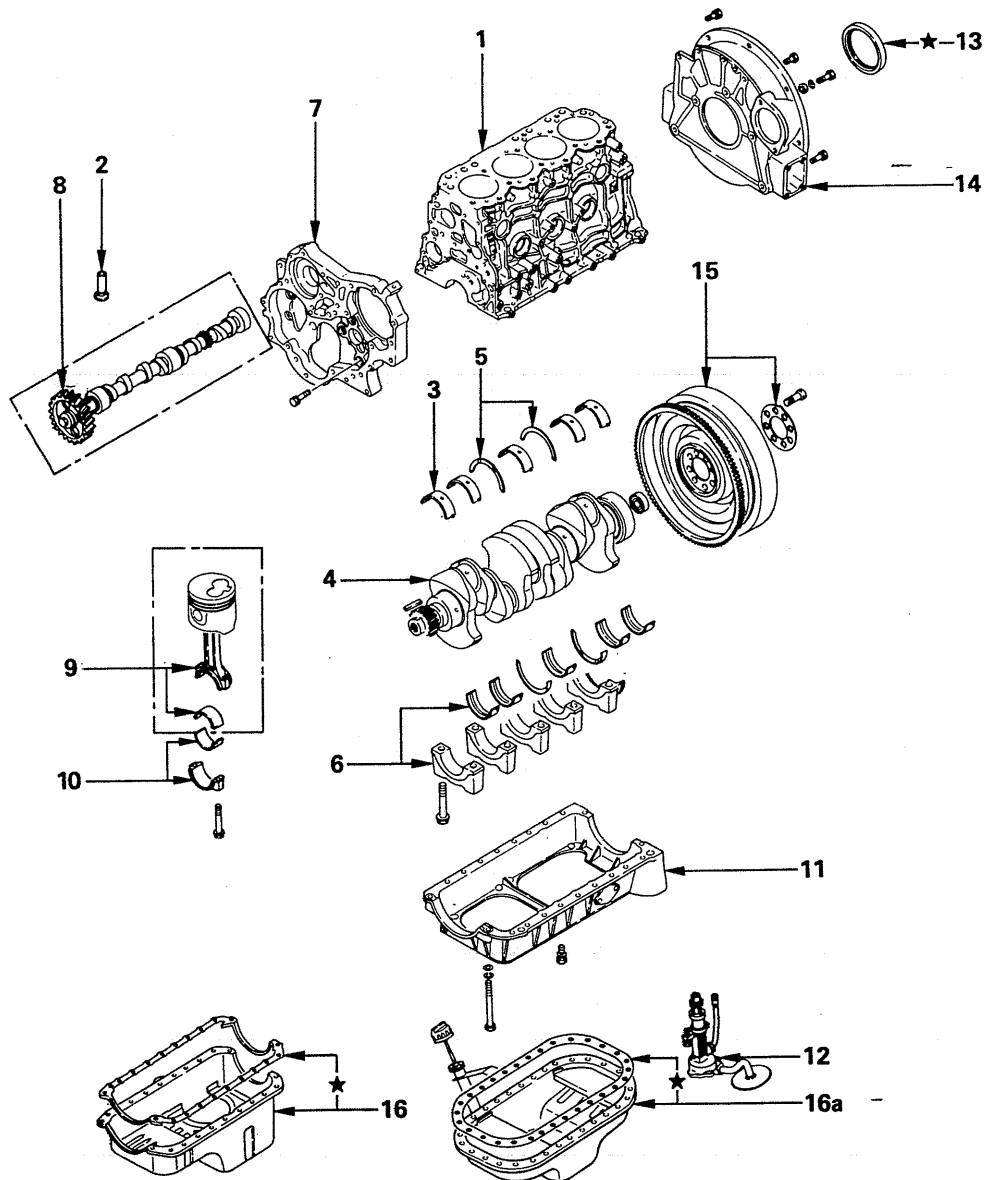
Camshaft Timing Gear Bolt Torque                      kg·m(lb.ft/N·m)

10.0 – 12.0 (72 – 87/98 – 118)

**MEMO**



## REASSEMBLY

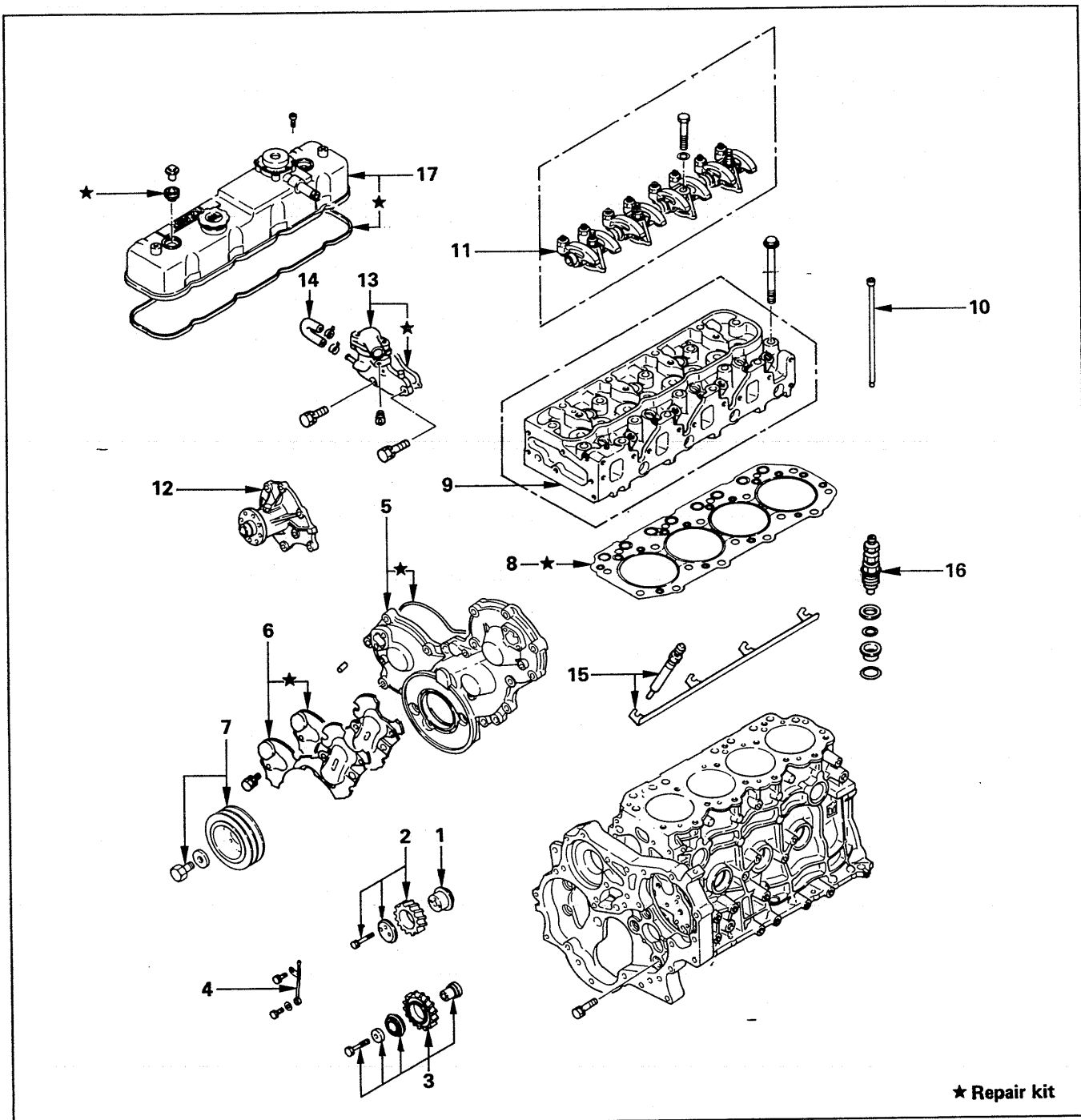


★ Repair kit

## Reassembly Steps - 1

- ▲ 1. Cylinder body
- ▲ 2. Tappet
- ▲ 3. Crankshaft upper bearing
- ▲ 4. Crankshaft with crankshaft timing gear
- ▲ 5. Crankshaft thrust bearing
- ▲ 6. Crankshaft bearing cap with lower bearing
- ▲ 7. Timing gear case
- ▲ 8. Camshaft with camshaft timing gear and thrust plate
- ▲ 9. Piston and connecting rod with upper bearing
- ▲ 10. Connecting rod cap with lower bearing
- ▲ 11. Crankcase (If so equipped)
- ▲ 12. Oil pump with oil pipe
- ▲ 13. Crankshaft rear oil seal
- ▲ 14. Flywheel housing
- ▲ 15. Flywheel
- ▲ 16. Oil pan
- ▲ 16a Oil pan (If so crankcase equipped)

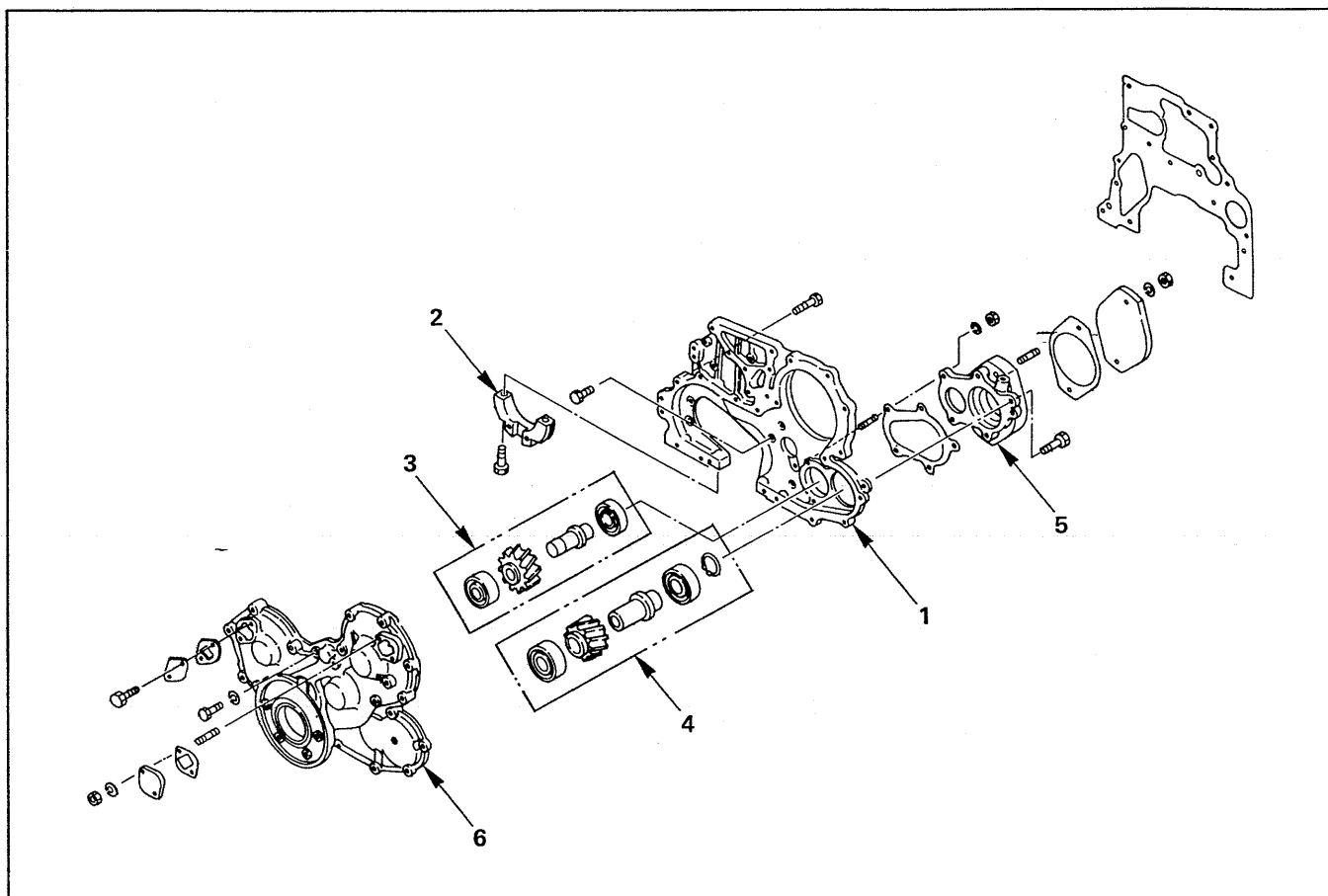
**Inverted Engine**



### Reassembly Steps – 2

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



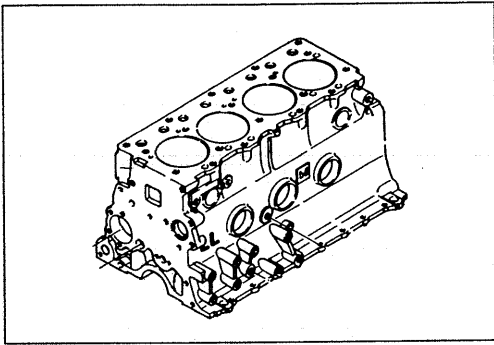


**Reassembly Steps – 2a: Timing Gear Case PTO**

- |                     |                      |
|---------------------|----------------------|
| 1. Timing gear case | 4. PTO Gear          |
| 2. Under plate      | 5. Adapter : PTO     |
| 3. PTO Idle gear    | 6. Timing case cover |

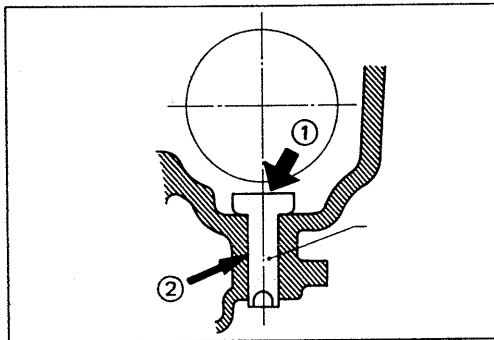


## Important Operations (Reassembly Steps-1)



### 1. Cylinder Body

Use compressed air to thoroughly clean the inside and outside surfaces of the cylinder body, the oil holes, and the water jackets.

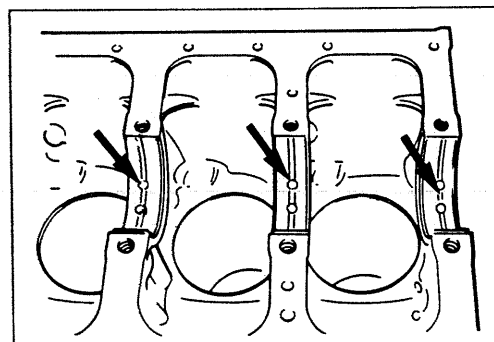


### 2. Tappet

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

#### Note:

The tappet must be installed before installing the camshaft.



### 3. Crankshaft Upper Bearing

The crankshaft upper bearings have an oil hole and an oil groove. The lower bearings do not.

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

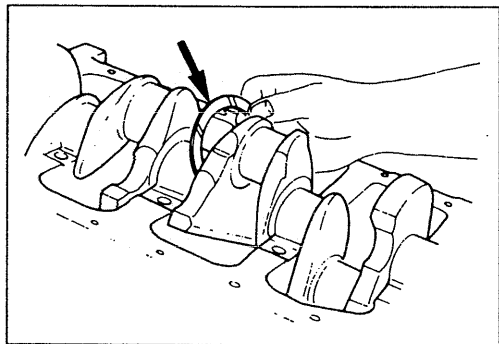
### 4. Crankshaft with Crankshaft Timing Gear



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

#### Note:

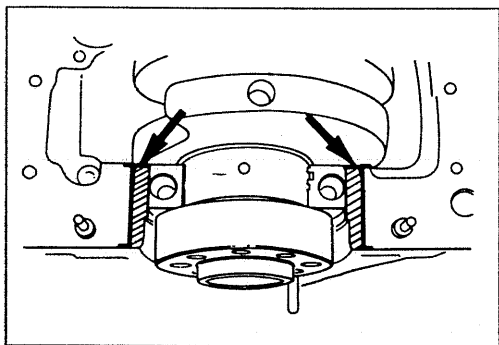
Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surfaces.



## 5. Crankshaft Thrust Bearing

- 1) Apply an ample coat of engine oil to the crankshaft thrust bearings.
- 2) Install the crankshaft thrust bearings to the crankshaft center journal.

The crankshaft thrust bearing oil groove must be facing the sliding face.



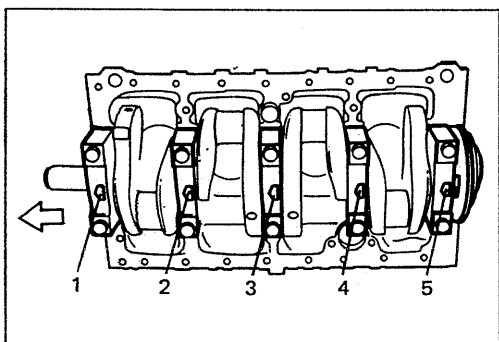
## 6. Crankshaft Bearing Cap with Lower Bearing

- 1) Apply silicon adhesive to the cylinder body No. 5 bearing cap fitting surface at the points shown in the illustration.

### Note:

Be sure that the bearing cap fitting surface is completely free of oil before applying the silicon adhesive.

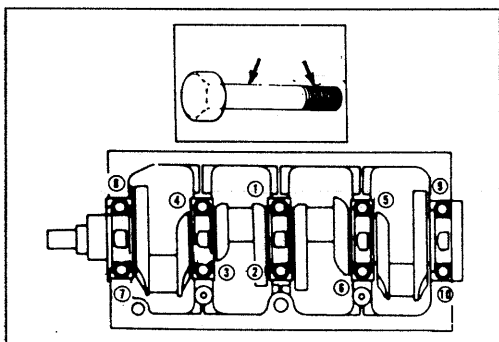
Do not allow the silicon adhesive to obstruct the cylinder thread holes and bearings.



- 2) Install the bearing caps.

The bearing cap arrow marks must be facing the front of the engine.

The arrow mark journal number must correspond to the journal to which the bearing cap is installed.

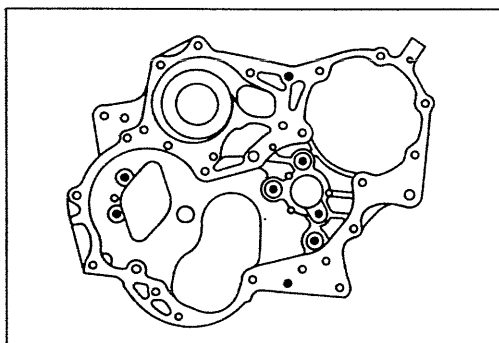


- 3) Apply a coat of engine oil to the bearing cap bolts.

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

| Crankshaft Bearing Cap Torque     | kg·m(lb.ft/N·m) |
|-----------------------------------|-----------------|
| 16.0 – 18.0 (116 – 130/157 – 177) |                 |

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

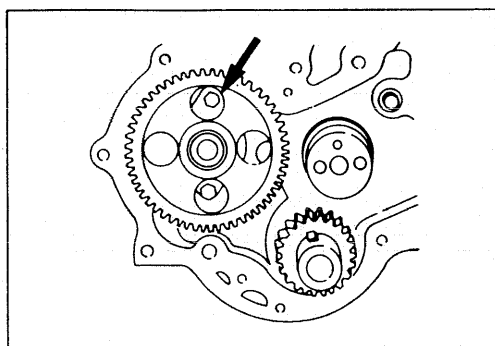


## 7. Timing Gear Case

- 1) Tighten the timing gear case with timing gear case gasket to the specified torque.

| Timing Gear Case Bolt Torque | kg·m(lb.ft/N·m) |
|------------------------------|-----------------|
| 1.4 – 2.4 (10 – 17/14 – 24)  |                 |

- 2) Cut away any excessive flash from the timing gear gasket.



### 8. Camshaft with Camshaft Timing Gear and Thrust Plate



- 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.

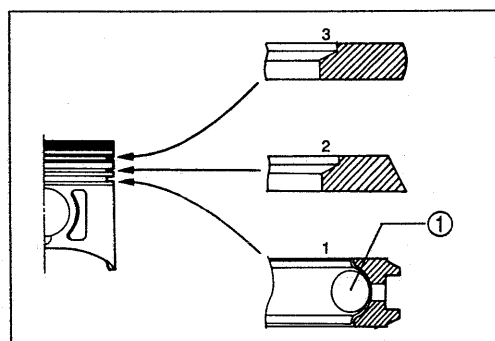


- 3) Tighten the thrust plate to the specified torque.

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

1.4 – 2.4 (10 = 17/14 – 24)

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

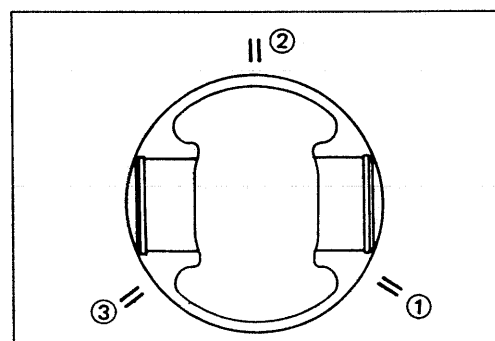


### 9. Piston and Connecting Rod with Upper Bearing

### 10. Connecting Rod Bearing Cap with Lower Bearing



- 1) Apply a coat of engine oil to the circumference of each piston ring and piston.

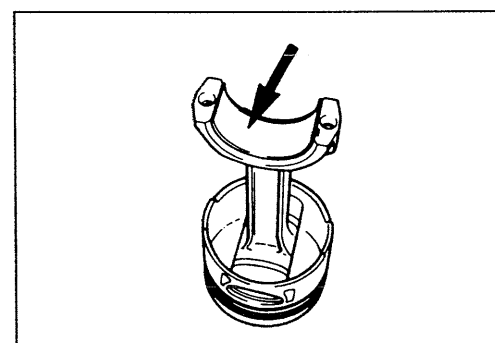


- 2) Position the piston ring gaps as shown in the illustration.

- ① 1st compression ring
- ② 2nd compression ring
- ③ Oil ring

- 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.



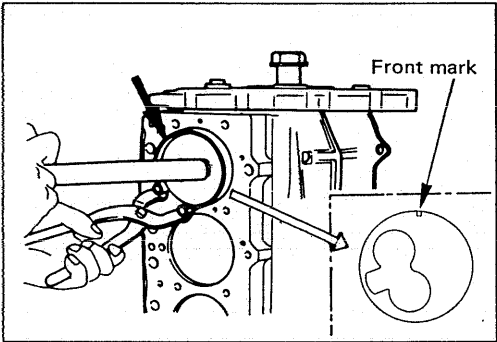
- 4) Apply a coat of engine oil to the upper bearing surfaces.

#### Note:



Do not apply engine oil to the bearing back faces and the connecting rod bearing fitting surfaces.

- 5) Apply a coat of engine oil to the cylinder wall.

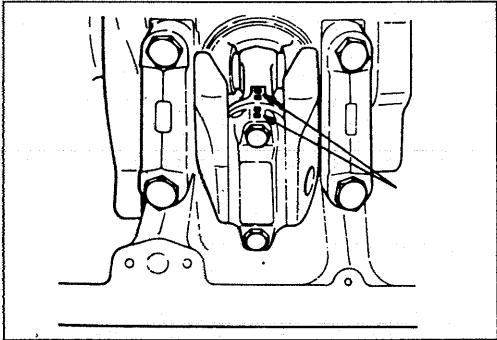


- 6) Position the piston head front mark so that it is facing the front of the cylinder body.
- 7) Use a piston ring compressor to compress the piston rings.

Piston Ring Compressor

- 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.



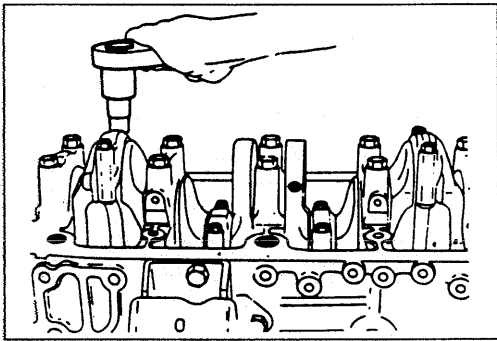
- 9) Install the connecting rod bearing caps.

The bearing cap front marks must be facing the front of the engine.

The bearing cap number (at the side of the bearing cap) and the connecting rod number must be the same.

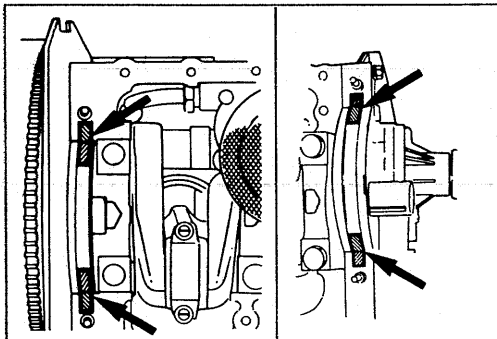
**Note:**

It is absolutely essential that the bearing caps be installed in the correct direction. Reversing the bearing cap direction will result in serious engine damage.



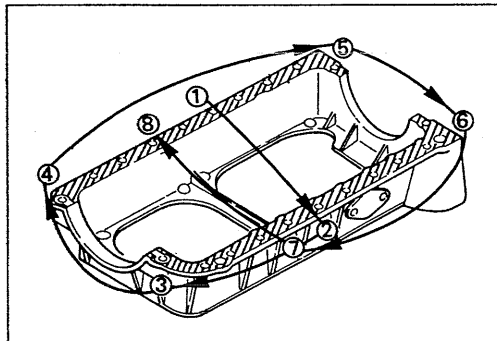
- 10) Apply a coat of engine oil to the threads and setting faces of each connecting rod cap bolt.
- 11) Tighten the connecting rod caps to the specified torque.

| Connecting Rod Cap Bolt Torque             | kg-m(lb.ft/N-m) |
|--------------------------------------------|-----------------|
| 2.8 – 3.2 → 45° – 60°<br>(20 – 23/27 – 31) |                 |



**11. Crankcase (if so equipped)**

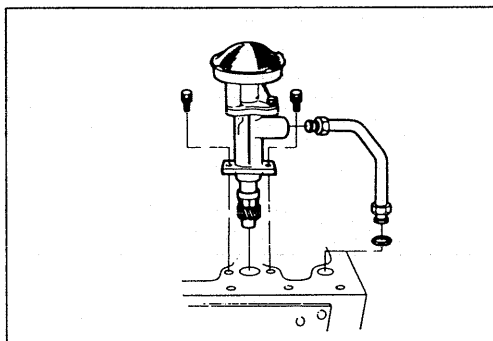
- 1) Apply sealant to the No. 5 bearing cap arches, the bearing grooves, and the timing gear case arches at the positions shown in the illustration.



- 2) Apply sealant to the crankcase cylinder body fitting area.

- 3) Tighten the crankcase bolts to the specified torque a little at a time in the sequence shown in the illustration.

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



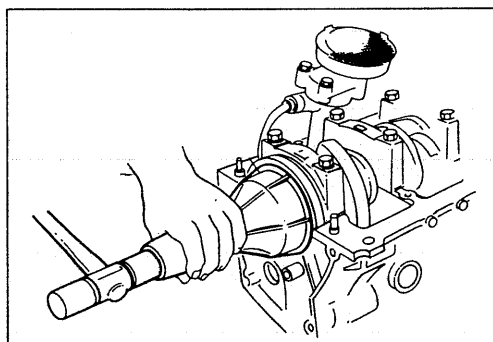
## 12. Oil Pump with Oil Pipe

Install the oil pump with the oil pipe and tighten the bolts to the specified torque.

| Oil Pump Bolt Torque | kg·m(lb.ft/N·m)             |
|----------------------|-----------------------------|
|                      | 1.4 – 2.4 (10 – 17/14 – 24) |

### Note:

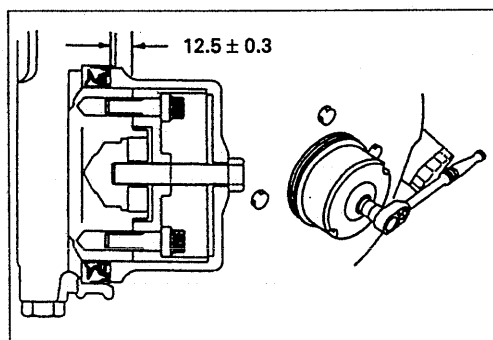
Take care not to damage the O-rings when tightening the oil pipe bolts.



## 13. Crankshaft Rear Oil Seal (TYPE I)

- 1) Apply engine oil to the oil seal lip circumference and the oil seal outer circumference.
- 2) Use the oil seal installer to install the oil seal to the cylinder body.

Oil Seal Installer: 5-8840-0141-0

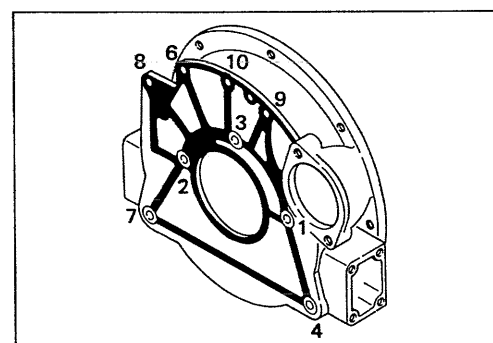


## 13. Crankshaft Rear Oil Seal (TYPE II)

- 1) Tighten the adapter to the crankshaft rear and section with 2 bolts.
- 2) Insert the oil seal into the peripheral section of adapter.
- 3) Insert the sleeve into the adapter section, and 1) tighten it with a bolt (M12 x 1.75L = 70) until the adapter section hits the sleeve.
- 4) Remove the adapter and the sleeve.
- 5) With the seal pressed in, check the dimension of the oil seal section.

Standard Dimension =  $12.5 \pm 0.3$  mm

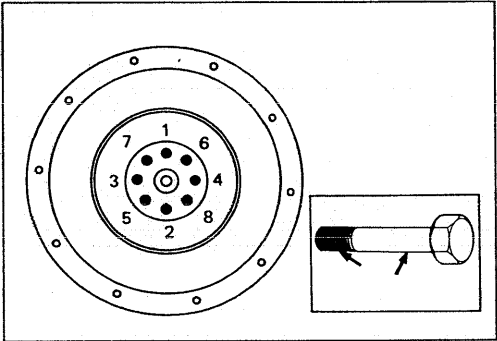
Oil Seal Installer: 5-8840-2359-0



## 14. Flywheel Housing

- 1) Apply sealant 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)             |
|------------------------------|-----------------------------|
| M10x1.25                     | 3.6 – 4.6 (26 – 33/35 – 45) |
| M12x1.5                      | 7.5 – 9.3 (54 – 67/74 – 91) |

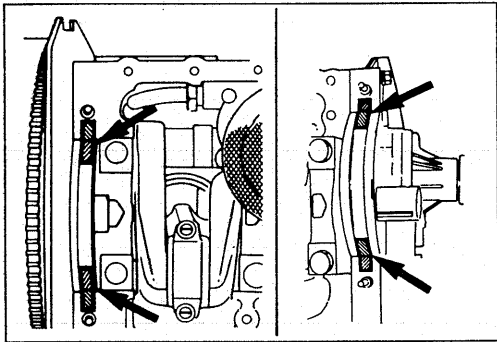


15. Flywheel

- 1) Block the flywheel with a piece of wood to prevent it from turning.
- 2) Apply a coat of engine oil to the threads of the flywheel bolts.
- 3) Tighten the flywheel bolts in the numerical order shown in the illustration.



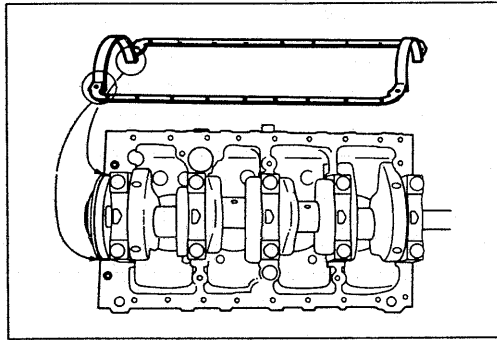
| Flywheel Bolt Torque            | kg·m(lb.ft/N·m) |
|---------------------------------|-----------------|
| 11.5 – 12.5 (83 – 90/113 – 123) |                 |



16. Oil Pan

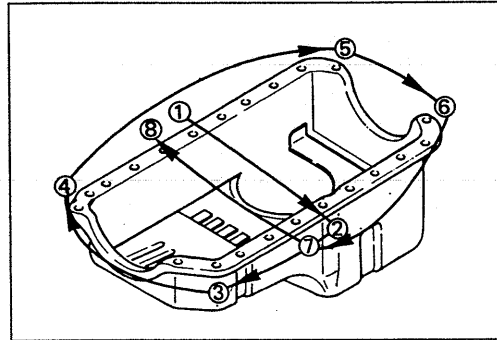


- 1) Apply sealant to the No. 5 bearing cap arches, the bearing grooves, and the timing gear case arches at the positions shown in the illustration.



- 2) Fit the gasket rear lipped portion into the No. 5 bearing cap groove.

Be absolutely sure that the lipped portion is fitted snugly in the groove.

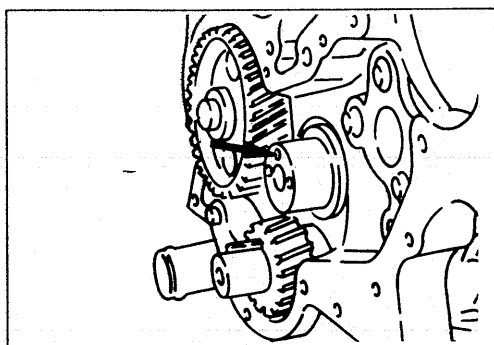


- 3) Tighten the oil pan bolts to the specified torque a little at a time in the sequence shown in the illustration.

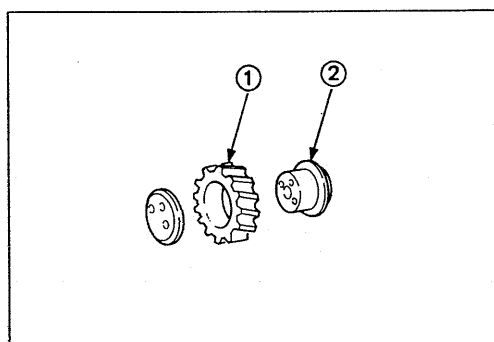
| Oil Pan Bolt Torque          | kg·m(lb.ft/N·m) |
|------------------------------|-----------------|
| 0.6 – 1.0 (4.3 – 7.2/6 – 10) |                 |



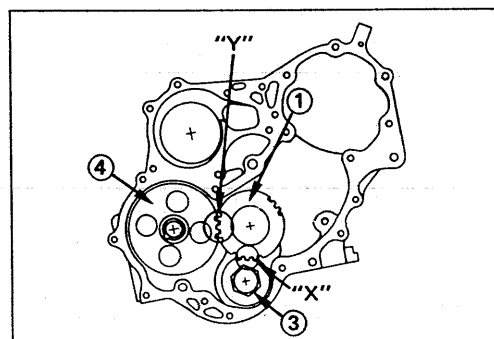
## Important Operations (Reassembly Steps-2)

**1. Idler Gear Shaft**

The idler gear shaft oil hole must be facing up.

**2. Idler Gear "A"**

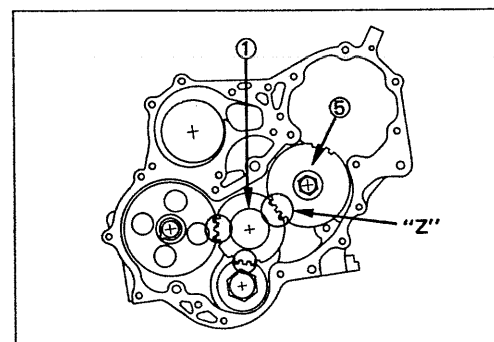
- 1) Apply engine oil to the idler gear ① and the idler gear shaft ②.
- 2) Position the idler gear setting marks "X" and "Y" so that they are facing the front of the engine.



- 3) Align the idler gear "X - X" setting mark with the crankshaft timing gear ③ "X" setting mark.
- 4) Align the idler gear "Y - Y" setting mark with the camshaft timing gear ④ "Y" setting mark.
- 5) Tighten the idler gear bolt to the specified torque.

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

2.1 - 3.1 (15 - 22/21 - 30)

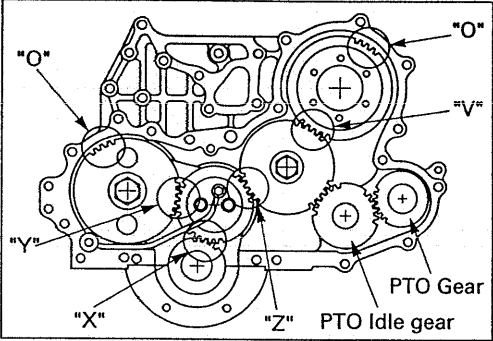
**3. Idler Gear "B"**

- 1) Apply engine oil to the idler gear and the idler gear shaft.
- 2) Align the idler gear ⑤ "Z" setting mark with the idler gear ① "Z - Z" setting mark.

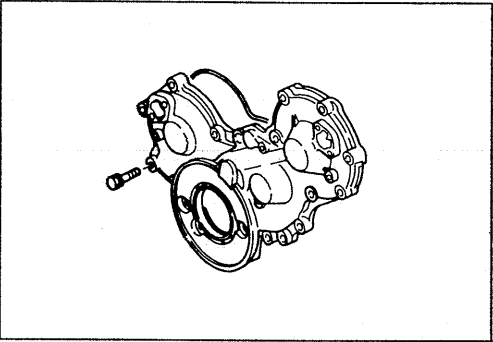
Idler Gear "B" Bolt Torque kg·m(lb.ft/N·m)

9.5 - 11.5 (69 - 83/93 - 113)





3. Idler Gear "B" and PTO Gear

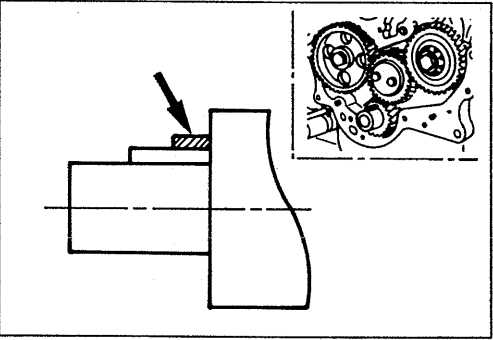


5. Timing Case Cover

- 1) Before installing the timing gear case, apply a 3 mm x 5 mm (0.12 in x 0.20 in) strip of sealant to the portion of the feather key indicated by the arrow in the illustration.
- 2) Check that the timing case cover O-ring is firmly inserted into the gear case groove.
- 3) Tighten the timing case cover bolts to the specified torque.



| Timing Case Cover Bolt Torque |  | kg·m(lb.ft/N·m)             |
|-------------------------------|--|-----------------------------|
| M 8x1.25 (0.31x0.05)<br>Bolt  |  | 1.4 – 2.4 (10 – 17/14 – 24) |



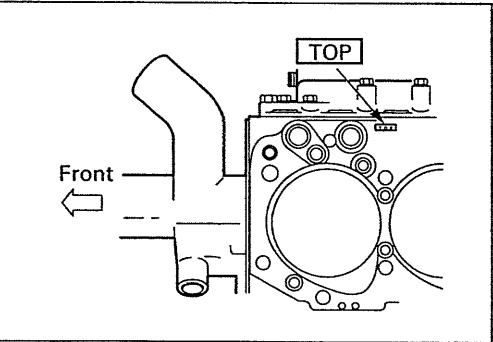
7. Crankshaft Damper Pulley

- 1) Block the flywheel ring gear with a piece of wood to prevent it from turning.
- 2) Tighten the crankshaft damper pulley to the specified torque.



| Crankshaft Damper Pulley Bolt Torque | kg·m(lb.ft/N·m) |
|--------------------------------------|-----------------|
| 20.1 – 24.5 (145 – 177/197 – 240)    |                 |

Take care not to damage the crankshaft damper pulley boss.



8. Cylinder Head Gasket

The cylinder gasket "TOP" mark must be facing up.  
Use the head gasket of the thickness 1.65 mm.  
(Part No. 897066-1970)



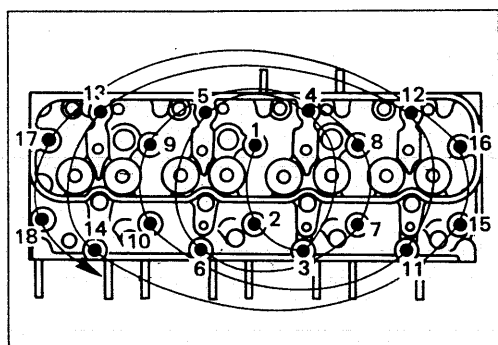
**9. Cylinder Head**

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

Carefully set the cylinder head to the cylinder head gasket.

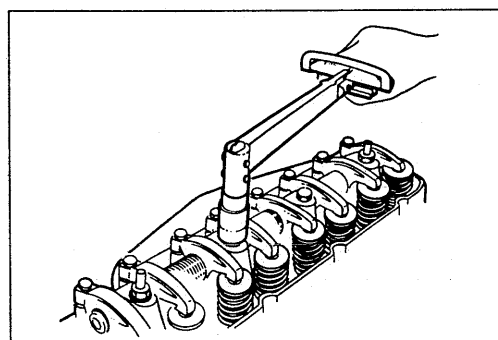


- 2) Apply engine oil to the cylinder head fixing bolt threads and setting faces.



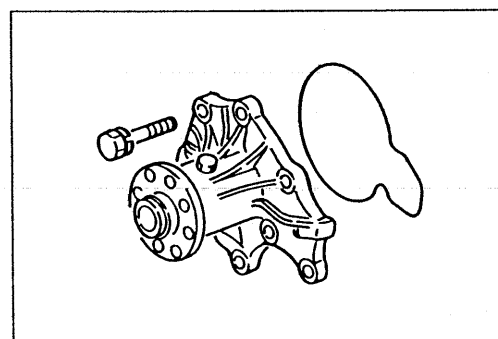
- 3) Tighten the cylinder head bolts to the specified torque in two steps following the numerical order shown in the illustration.

| Cylinder Head Bolt Torque      |          | kg·m(lb.ft/N·m) |
|--------------------------------|----------|-----------------|
| 1st stop                       | 2nd stop | 3rd stop        |
| 4.5 – 5.5<br>(33 – 40/44 – 54) | 60 – 75° | 60 – 75°        |

**11. Rocker Arm Shaft and Rocker Arm**

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

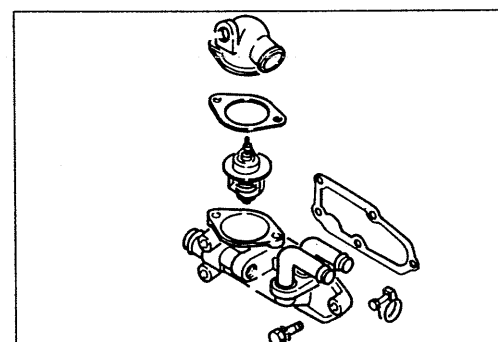
| Rocker Arm Shaft Bracket Bolt Torque | kg·m(lb.ft/N·m) |
|--------------------------------------|-----------------|
| 5.0 – 6.0 (36 – 43/49 – 59)          |                 |

**12. 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) |
|-----------------------------|-----------------|
| 1.4 – 2.4 (10 – 17/14 – 24) |                 |

**13. 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 – 17/14 – 24)    |                 |

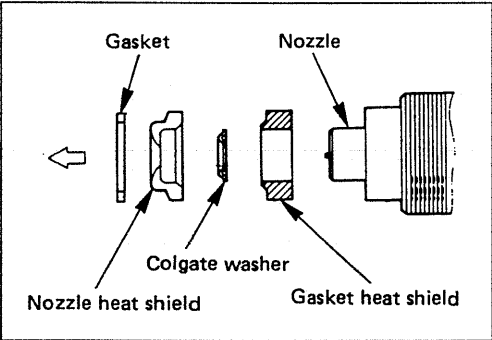
15. Glow Plug and Glow Plug Connector



1) Tighten the glow plugs to the specified torque.

| Glow Plug Torque            | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 1.5 – 2.0 (11 – 14/15 – 20) |                 |

2) Install the glow plug connectors.



16. Injection Nozzle Holder

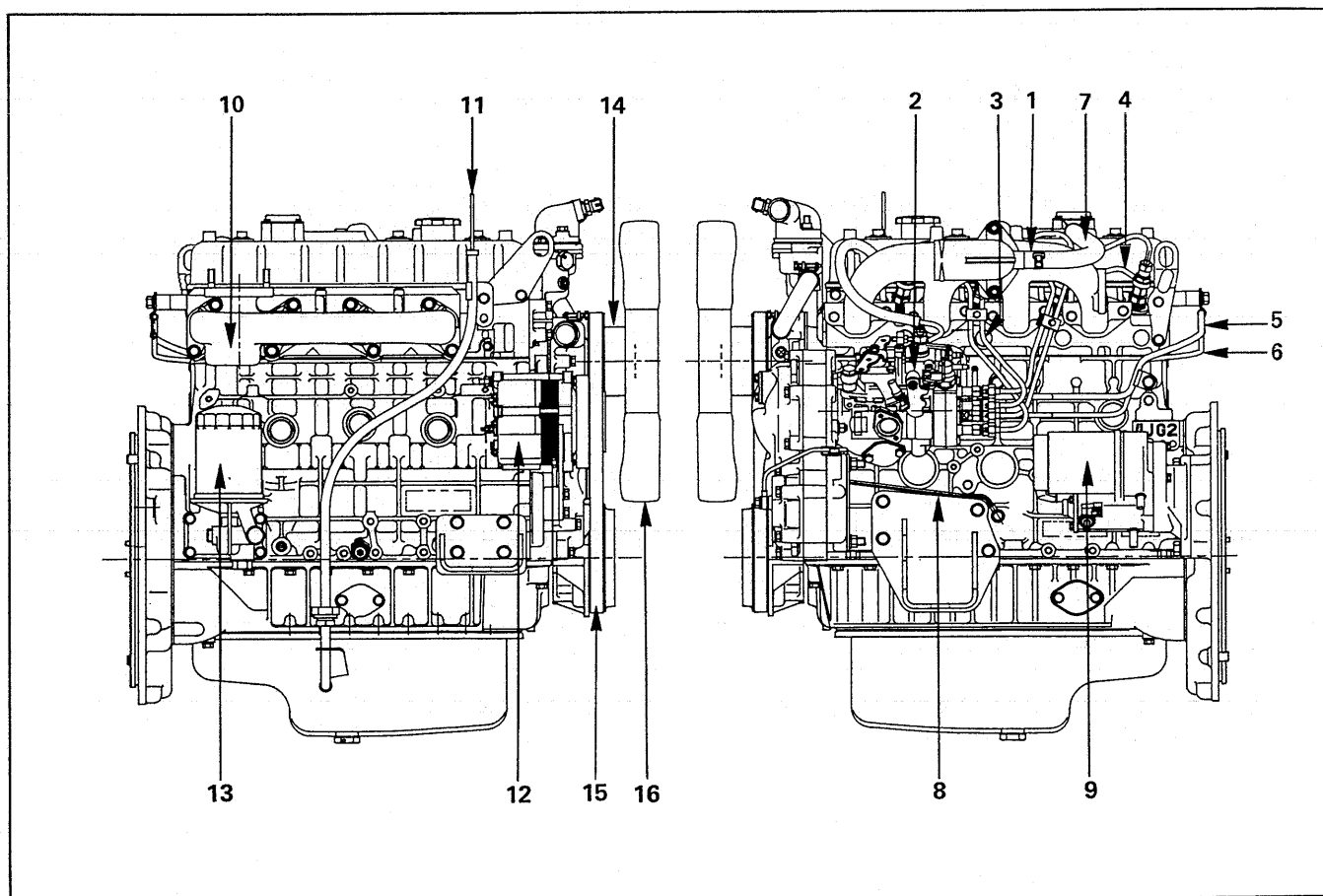
1) Install the heat shield washer and the heat shield to the cylinder head from the nozzle holder installation hole side. Lightly tap the flange into place with a brass bar.

The heat shield flange side must be facing up.

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

2) Tighten the holder nut to the specified torque.

|                             | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 6.0 – 7.0 (43 – 51/59 – 69) |                 |

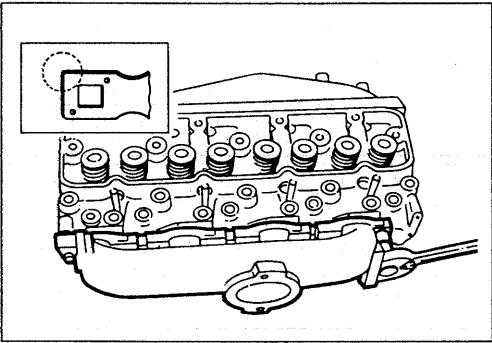


### Reassembly Steps – 3

- |                                    |                             |
|------------------------------------|-----------------------------|
| ▲ 1. Intake manifold               | 11. Dipstick and guide tube |
| ▲ 2. Injection pump                | ▲ 12. Alternator            |
| ▲ 3. Fuel injection pipe with clip | ▲ 13. Oil filter            |
| 4. Fuel leak off pipe              | 14. Fan pulley              |
| 5. Fuel pipe (IN)                  | 15. Cooling fan belt        |
| 6. Fuel pipe (OUT)                 | 16. Cooling fan and spacer  |
| 7. Breather hose                   |                             |
| 8. Oil pipe                        |                             |
| ▲ 9. Starter motor                 |                             |
| ▲ 10. Exhaust manifold             |                             |



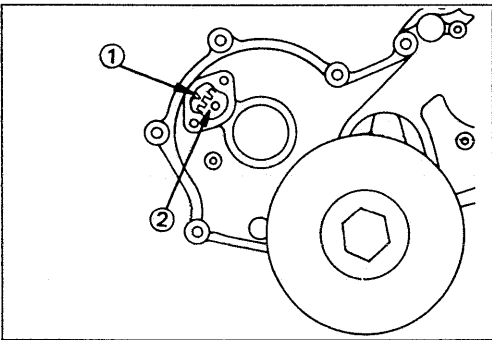
Important Operations (Reassembly Steps-3)



1. Intake Manifold



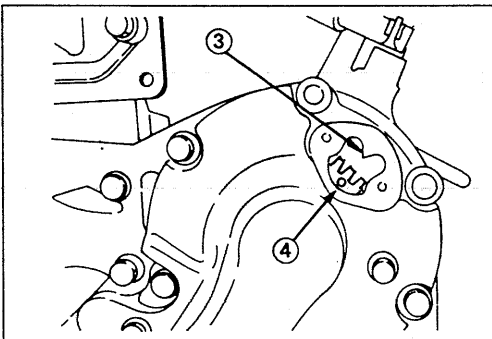
Install the intake manifold gasket with the end having the sharp corners facing the front of the engine.



2. Injection Pump Installation



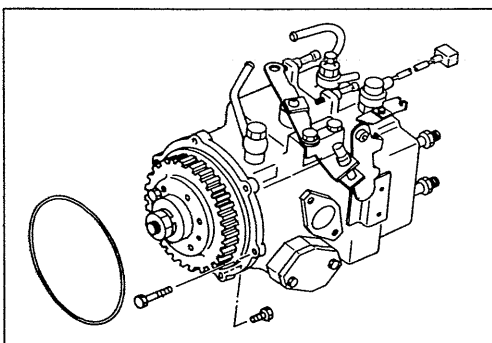
1) Turn the crankshaft slowly clockwise to align the camshaft timing check hole pointer ① with the camshaft timing gear "O" mark ② .



2) Install the injection pump to the timing gear case.

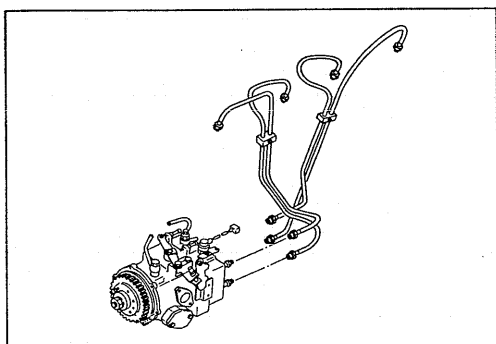
Align the injection pump timing check hole pointer ③ with the timing gear "O" mark ④ .

3) Tighten the injection pump bracket bolt ⑤ to the specified torque.



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

1.4 -2.4 (10 - 1714 - 24)



### 3. Fuel Injection Pipe with Clip

- 1) Temporarily tighten the injection pipe sleeve nut.
- 2) Set the clip in the prescribed position.

#### Note:

Make absolutely sure that the clip is correctly positioned. An improperly positioned clip will result in injection pipe breakage and fuel pulsing noise.



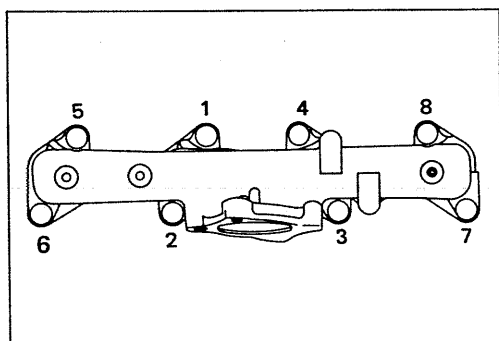
- 3) Tighten the injection pipe sleeve nut to the specified torque.

| Injection Pipe Sleeve Nut Torque | kg·m(lb.ft/N·m) |
|----------------------------------|-----------------|
| 2.0 – 4.0(14 – 29/20 – 39)       |                 |

### 9. Starter motor

Tighten the starter bolts to the specified torque.

| Starter Bolt Torque         | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 6.7 – 8.7 (48 – 63/60 – 85) |                 |



### 10. Exhaust Manifold

Tighten the exhaust manifold bolts to the specified torque a little at a time in the numerical order shown in the illustration.

| Exhaust Manifold Bolt Torque | kg·m(lb.ft/N·m) |
|------------------------------|-----------------|
| 1.4 – 2.4 (10 – 17/14 – 24)  |                 |

### 12. Alternator and Adjusting Plate



Tighten the alternator bolts and the adjusting plate bolts to the specified torque.

| Alternator Bolt Torque      | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 1.4 – 2.4 (10 – 17/14 – 24) |                 |



Tighten the adjusting plate bolts to the specified torque after cooling drive belt installation.

| Adjusting Plate Bolt Torque | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 1.4 – 2.4 (10 – 17/14 – 24) |                 |

13. Oil Filter



Tighten the oil filter bolts to the specified torque.

| Oil Filter Bolt Torque      | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 1.4 – 2.4 (10 – 17/14 – 24) |                 |

SECTION 6

LUBRICATING SYSTEM

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| ITEM                                      | PAGE |
|-------------------------------------------|------|
| Main data and specifications .....        | 114  |
| General description .....                 | 115  |
| Oil pump .....                            | 118  |
| Oil filter with built-in oil cooler ..... | 121  |

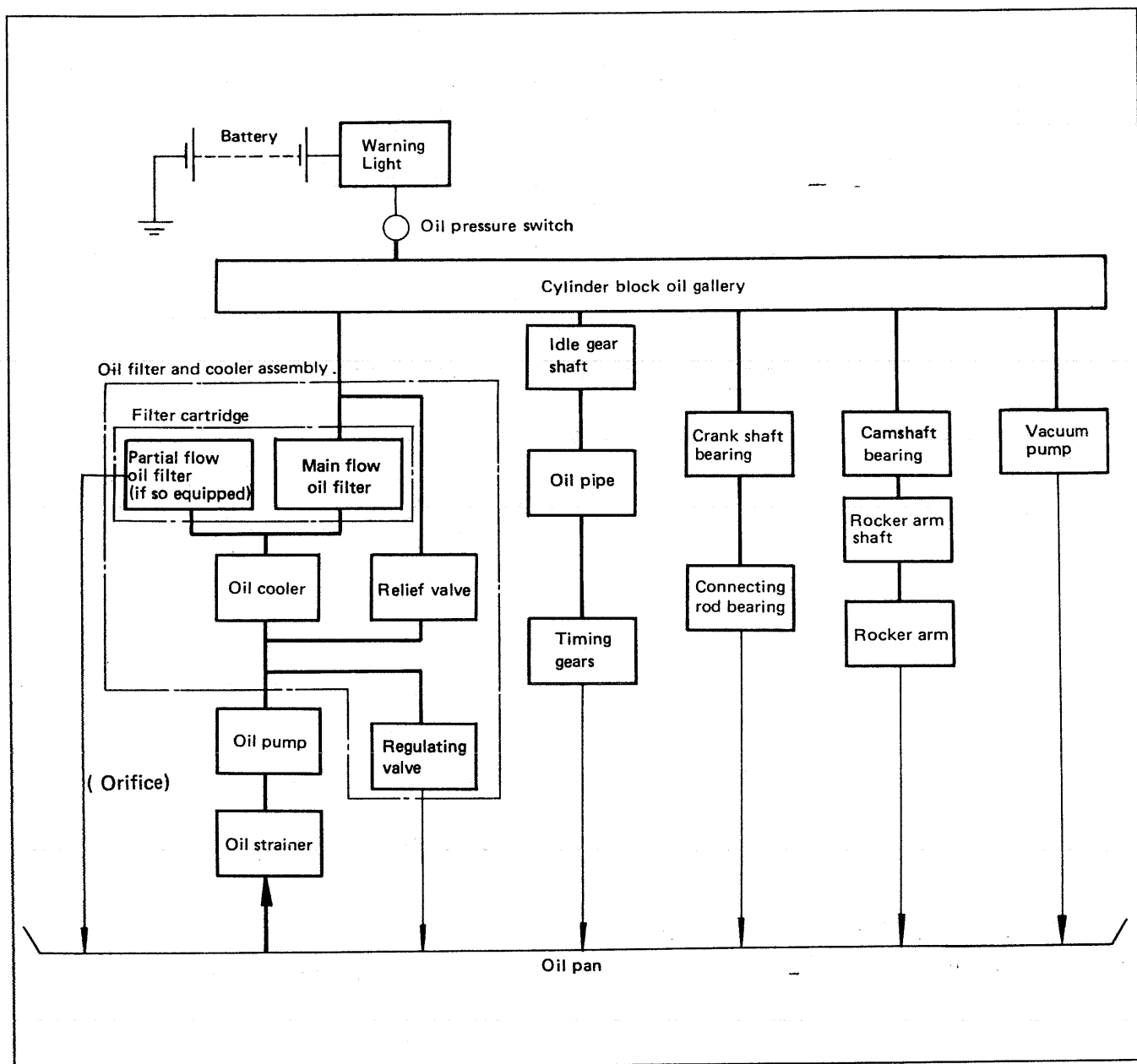


MAIN DATA AND SPECIFICATIONS

| Item                                                       | 4JG2                                   |
|------------------------------------------------------------|----------------------------------------|
| Oil pump type                                              | Trochoid                               |
| Delivery volume Lit(US/UK gal)/min.                        | 17.5 (4.61/3.85)                       |
| Pump speed rpm                                             | 1000                                   |
| Delivery pressure kg/cm <sup>2</sup> (psi/kPa)             | 4.0 (57/392)                           |
| Oil temperature °C(°F)                                     | 47 – 53 (116.6 – 127.4)                |
| Engine oil                                                 | SAE 30                                 |
| Oil filter type                                            | Full flow with cartridge paper element |
| Relief valve opening pressure kg/cm <sup>2</sup> (psi/kPa) | 4.3 – 4.7 (61 – 67/422 – 461)          |
| Safety valve opening pressure kg/cm <sup>2</sup> (psi/kPa) | 0.8 – 1.2 (11 – 17/78 – 118)           |
| Oil cooler type (if so equipped)                           | Water-cooled                           |
| Safety valve opening pressure kg/cm <sup>2</sup> (psi/kPa) | 2.3 – 2.7 (33 – 38/225 – 265)          |

## GENERAL DESCRIPTION

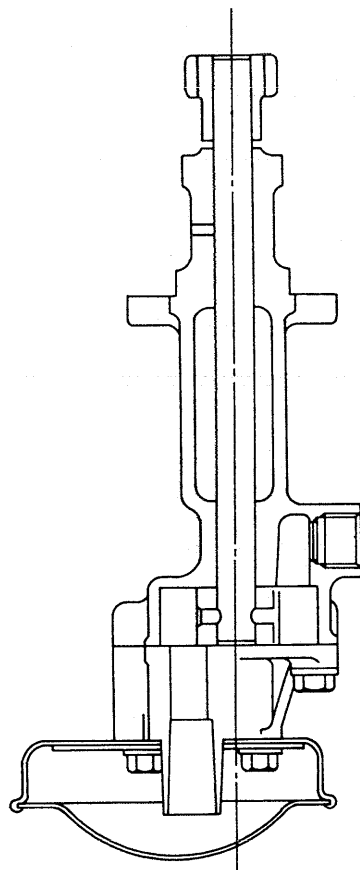
## LUBRICATING OIL FLOW



The 4J Series engine lubricating system is a full flow type.

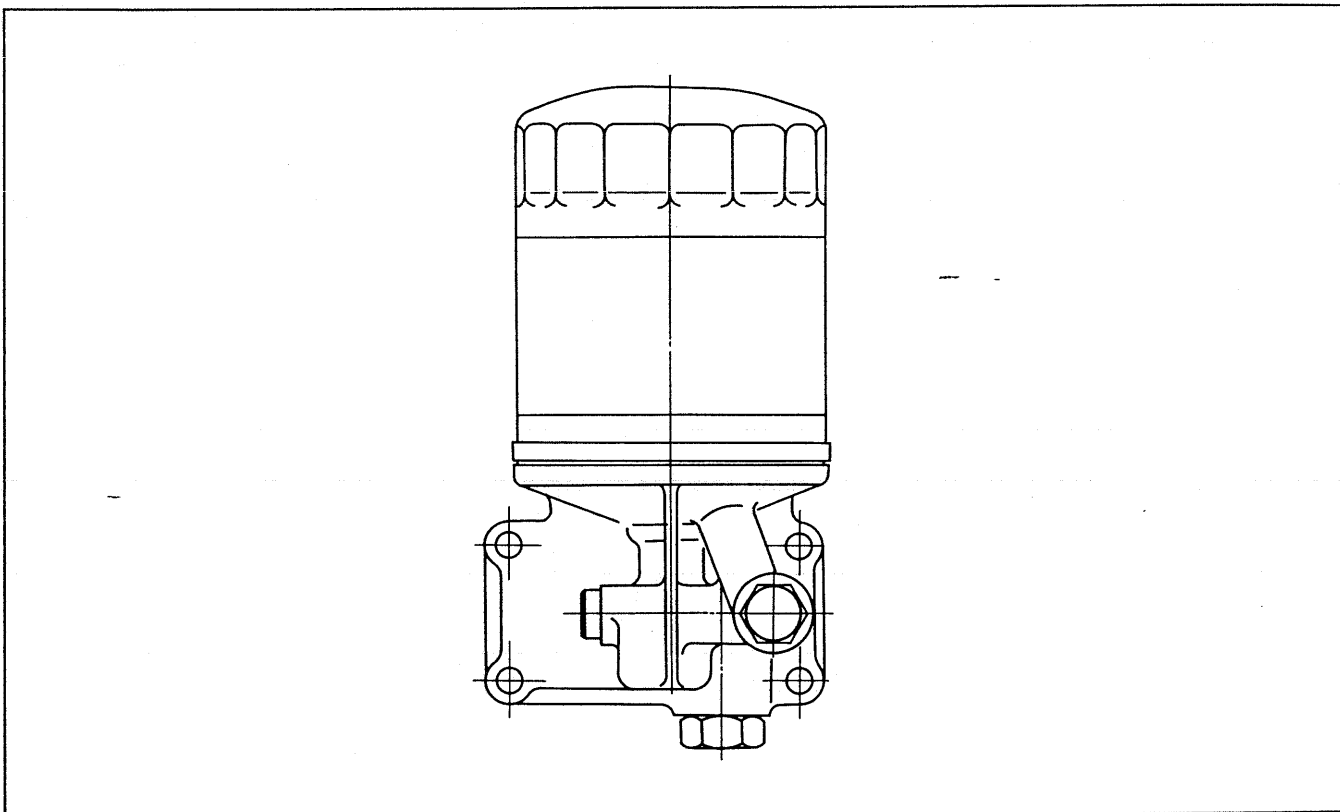
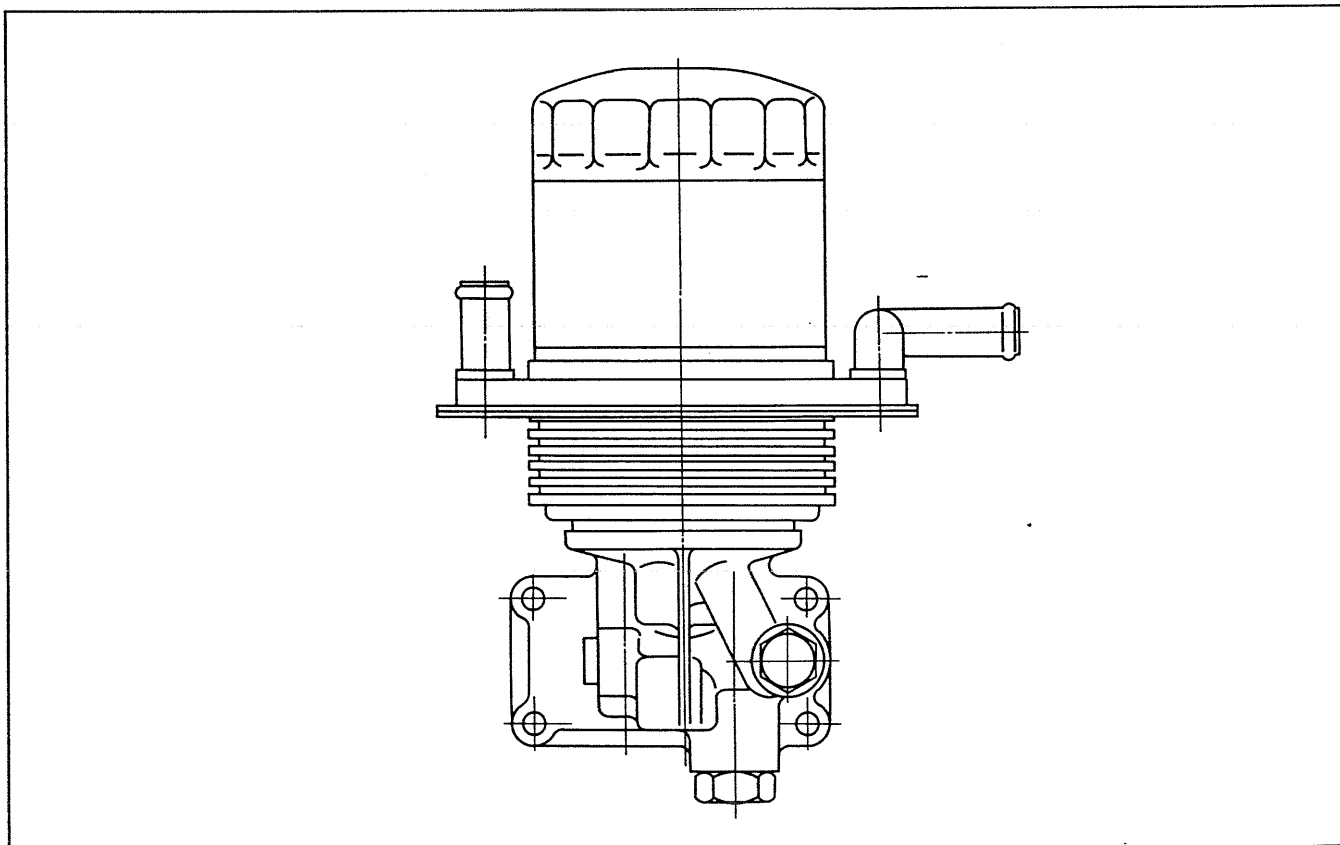
Lubricating oil is pumped from the oil pump to the cylinder body oil gallery through the oil cooler and the oil filter. It is then delivered to the vital parts of the engine from the cylinder body oil gallery.

OIL PUMP



4J Series engine are equipped with a trochoid type oil pump.

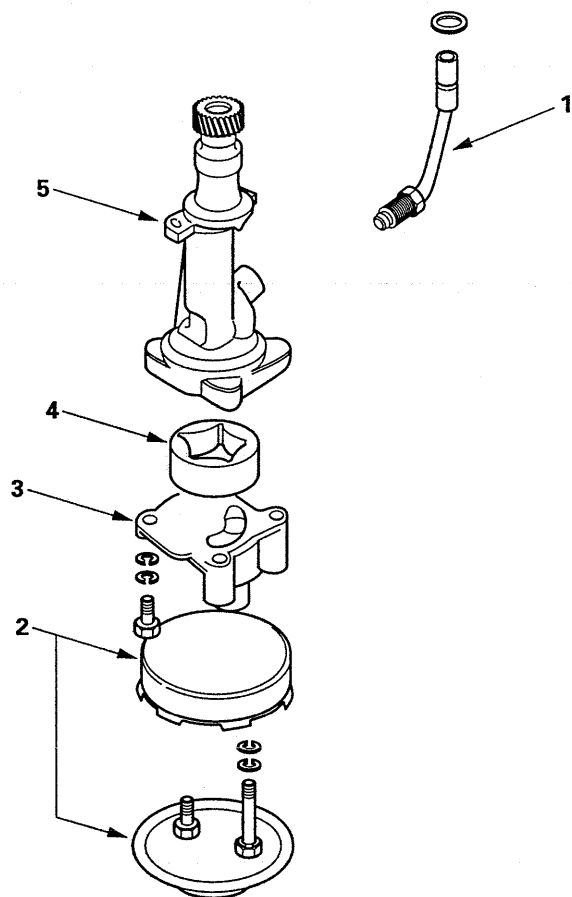
The oil filter and the water cooled oil cooler are a single unit to increase the cooling effect.

**MAIN OIL FILTER****OIL FILTER WITH BUILT-IN OIL COOLER (Option)**

## OIL PUMP



### DISASSEMBLY



051ET001

#### Disassembly Steps

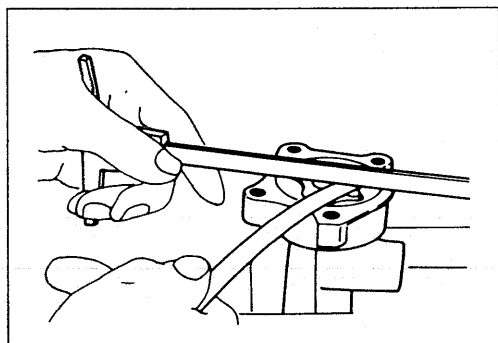
1. Oil pipe
2. Strainer case
3. Pump cover

4. Vane
- ▲ 5. Pump body with rotor and pinion



## INSPECTION AND REPAIR

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



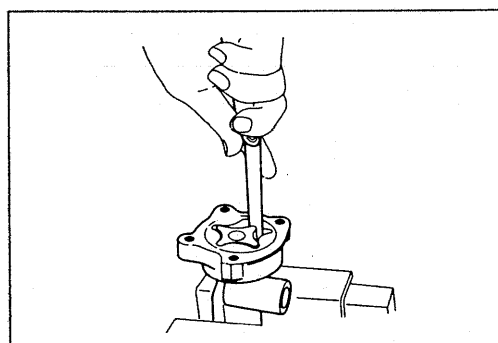
### Vane, Rotor, and Cover Clearance

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 (0.0008 – 0.0026) | 0.15 (0.006) |



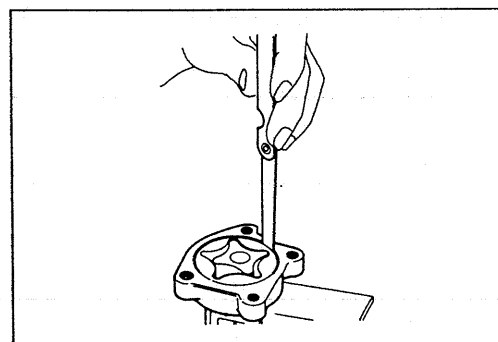
### Rotor and Vane Clearance

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

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

Rotor and Vane Clearance mm(in)

| Standard             | Limit        |
|----------------------|--------------|
| 0.14 (0.006) or less | 0.20 (0.008) |



### Vane and Pump Body Clearance

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

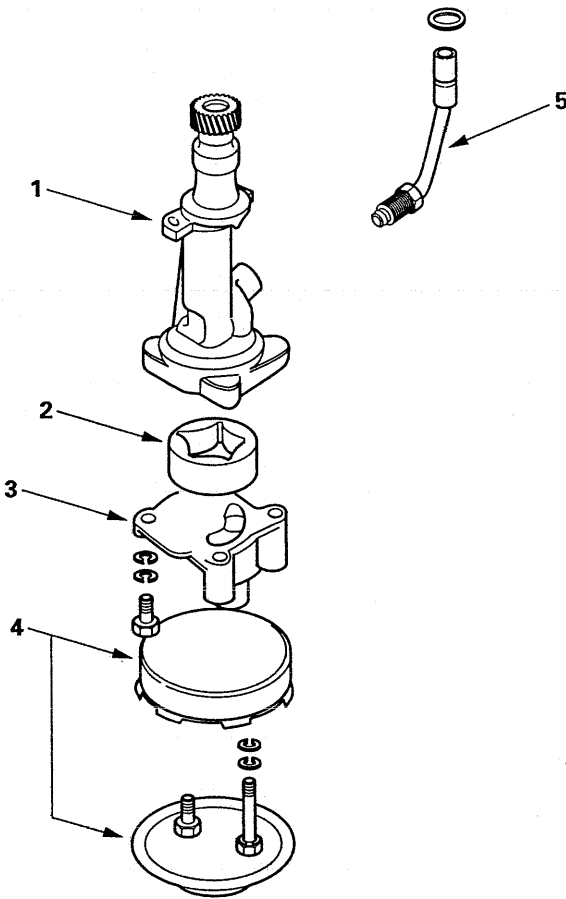
If the clearance between the vane and the pump body exceeds the specified limit, the entire pump assembly must be replaced.

Vane and Pump Body Clearance mm(in)

| Standard                    | Limit        |
|-----------------------------|--------------|
| 0.20 – 0.27 (0.008 – 0.011) | 0.40 (0.016) |



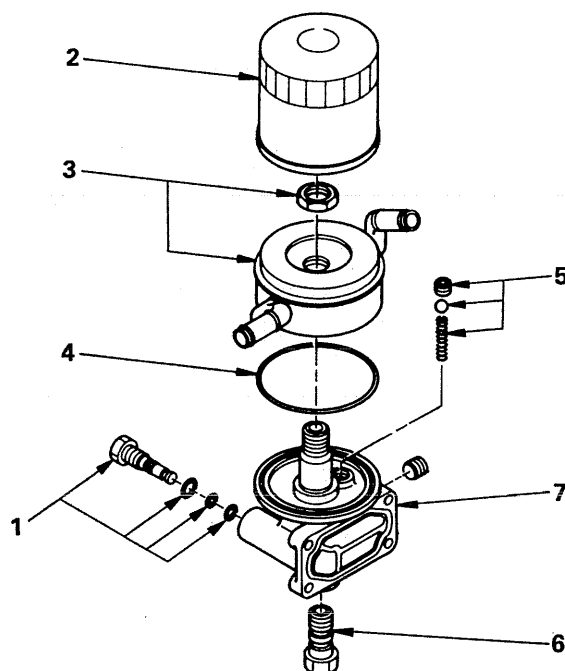
REASSEMBLY



051ET002

**Reassembly Steps**

- |                                    |                  |
|------------------------------------|------------------|
| 1. Pump body with rotor and pinion | 4. Strainer case |
| 2. Vane                            | 5. Oil pipe      |
| 3. Pump cover                      |                  |

**OIL FILTER WITH BUILT-IN OIL COOLER (Option)****DISASSEMBLY****Disassembly Steps**

1. Drain plug
2. Cartridge oil filter
3. Oil cooler
4. O-ring

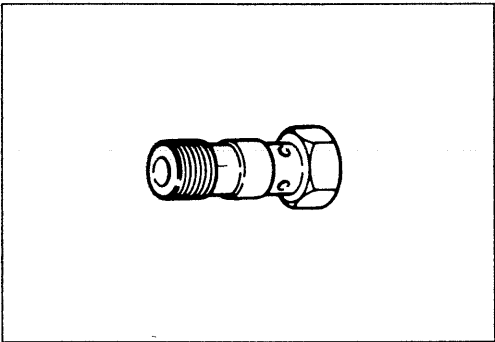
5. Safety valve
6. Relief valve
7. Oil filter body





INSPECTION AND REPAIR

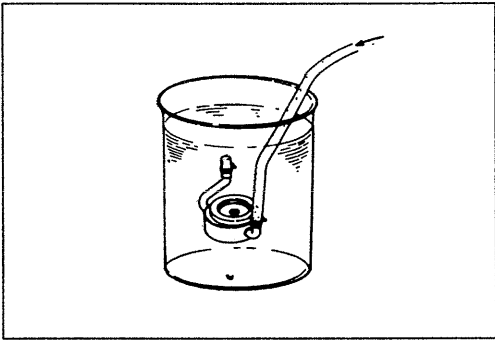
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



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/cm <sup>2</sup> (psi/kPa) |
|-------------------------------|------------------------------|
| 5.8 – 6.2 (82 – 88/569 – 608) |                              |

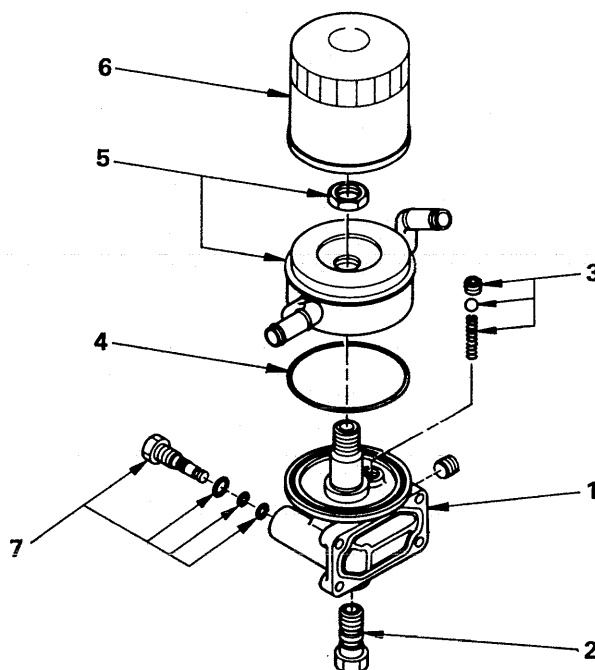


Oil Cooler

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/cm<sup>2</sup> (28 psi/196 kPa)) to the other side of the oil cooler water passage.

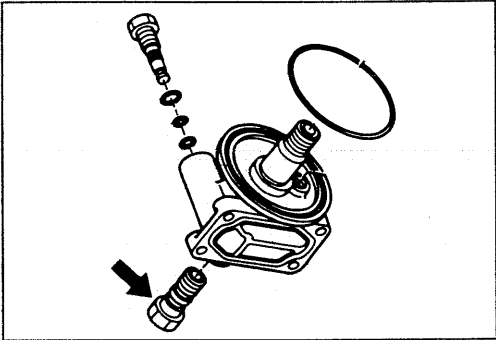
If air bubbles rise to the surface, there is water leakage.

**REASSEMBLY****Reassembly Steps**

- |                    |                           |
|--------------------|---------------------------|
| 1. Oil filter body | ▲ 5. Oil cooler           |
| ▲ 2. Relief valve  | ▲ 6. Oil filter cartridge |
| ▲ 3. Safety valve  | ▲ 7. Drain plug           |
| 4. O-ring          |                           |



Important Operations

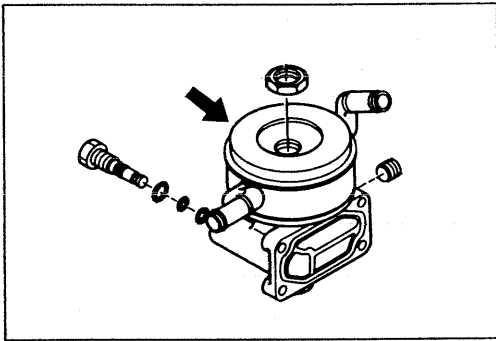


2. Relief Vale



Tighten the relief valve to the specified torque.

| Relief Valve Torque         | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 2.5 – 3.5 (18 – 25/25 – 34) |                 |



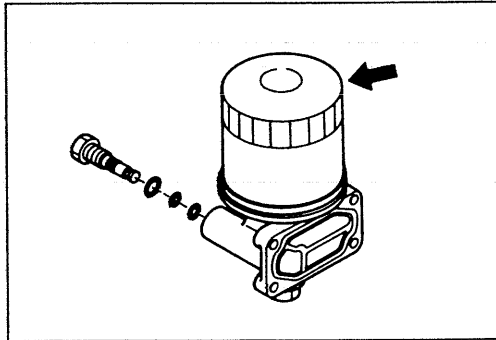
5. Oil Cooler



- 1) Align the oil filter holes with the body knock pins at installation.

- 2) Tighten the oil cooler to the specified torque.

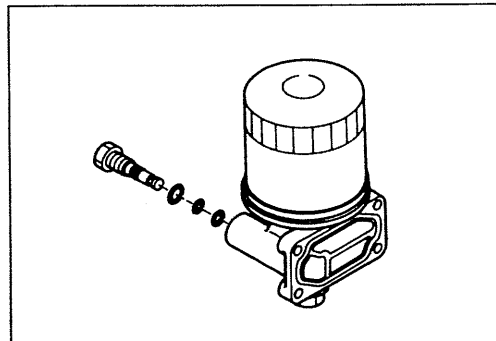
| Oil Cooler Torque           | kg·m(lb.ft/N·m) |
|-----------------------------|-----------------|
| 2.5 – 3.5 (18 – 25/25 – 34) |                 |



6. 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 and 1/4 of a turn.



7. Drain Plug



Tighten the drain plug to the specified torque.

| Drain Plug Torque             | kg·m(lb.ft/N·m) |
|-------------------------------|-----------------|
| 1.0 – 2.0 (7.2 – 14/9.8 – 20) |                 |

SECTION 7

COOLING SYSTEM

TABLE OF CONTENTS

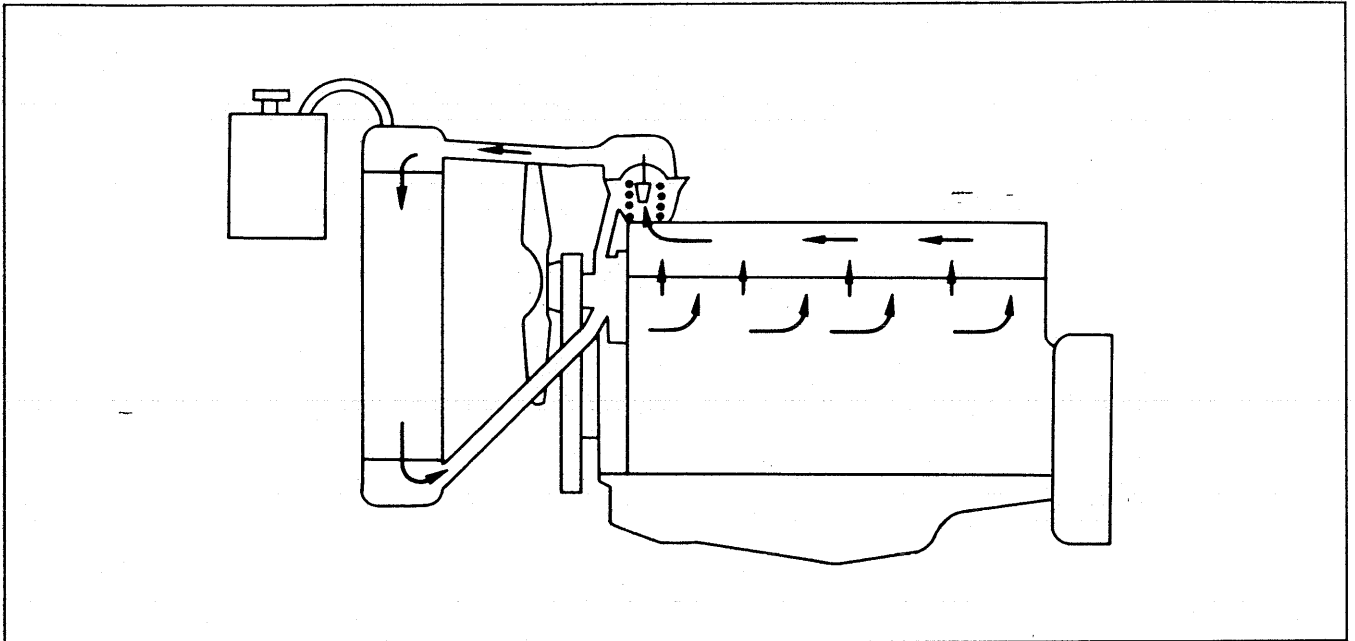
| ITEM                               | PAGE |
|------------------------------------|------|
| Main data and specifications ..... | 126  |
| General description .....          | 127  |
| Water pump .....                   | 129  |
| Thermostat .....                   | 134  |

MAIN DATA AND SPECIFICATIONS

| Item                                      |                              |
|-------------------------------------------|------------------------------|
| Water pump type                           | Centrifugal impeller         |
| Pump to crankshaft speed ratio (To 1)     | 1.1                          |
| Delivery volume Lit(US/UK gal)/min.       | 100 (26.3/22.2)              |
| Pump speed at 3000 rpm                    |                              |
| Water temperature at 30°C (86°F)          |                              |
| Pump bearing type                         | Double row shaft             |
| Thermostat type                           | Wax pellet with jiggle valve |
| Valve initial opening temperature °C(°F)  | 76.5 (170)                   |
| Valve full opening temperature °C(°F)     | 90 (194)                     |
| Valve lift at fully open position mm(in.) | 8.0 (0.31)                   |

## GENERAL DESCRIPTION

### COOLANT FLOW



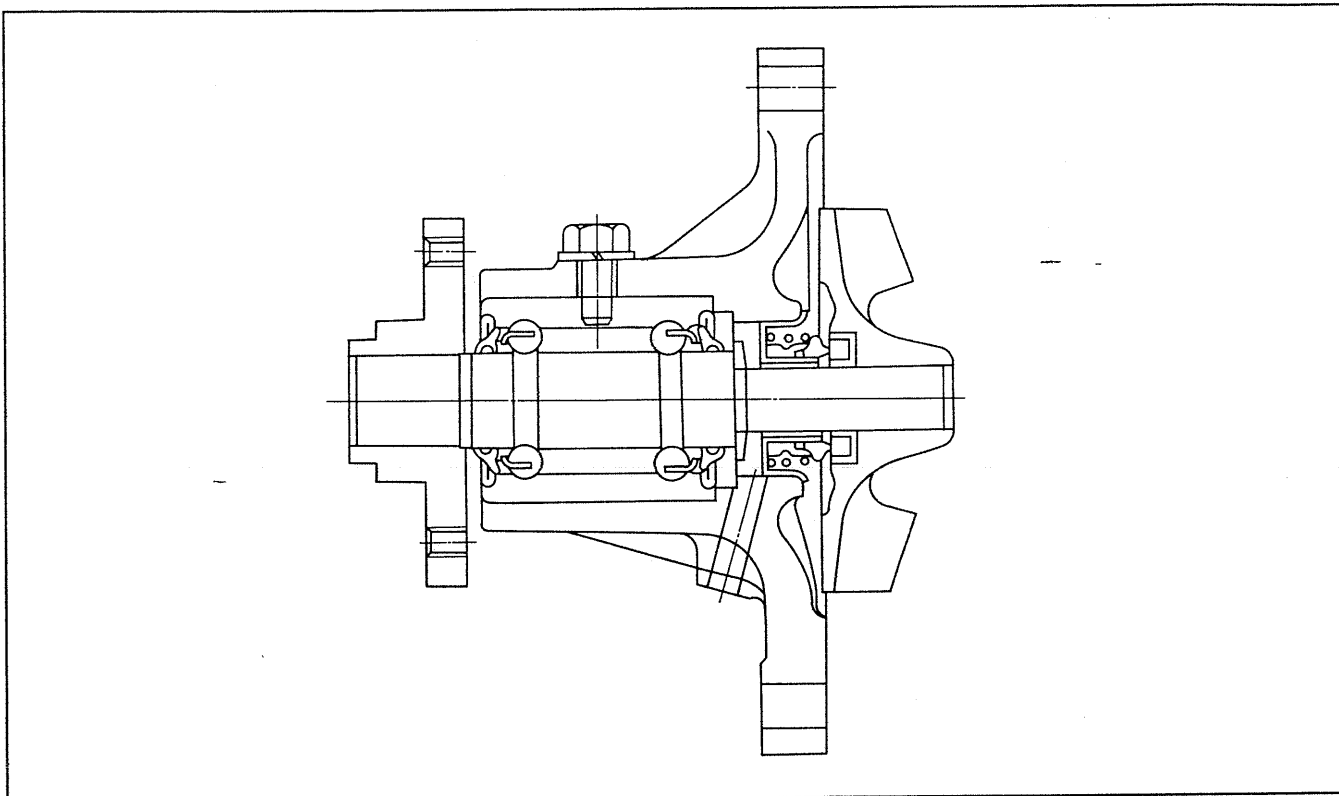
The engine cooling system consists of the radiator, the water pump, the cooling fan, and the thermostat.

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.

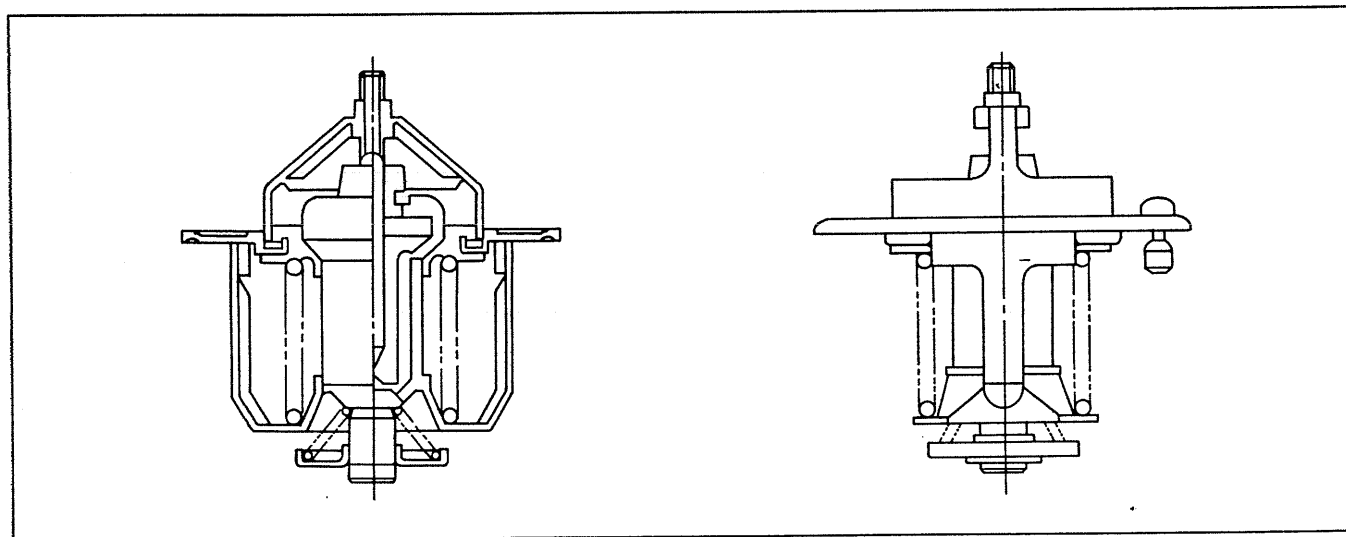
When the coolant temperature reaches  $76.5^{\circ}\text{C}$  ( $170^{\circ}\text{F}$ ), the thermostat will begin to open and a gradually increasing amount of coolant will circulate through the radiator.

The thermostat will be fully open when the coolant temperature reaches  $90^{\circ}\text{C}$  ( $194^{\circ}\text{F}$ ). All of the coolant is now circulating through the radiator for effective engine coolant.

**WATER PUMP**



**THERMOSTAT**



A centrifugal type water pump forcefully circulates the coolant through the cooling system.

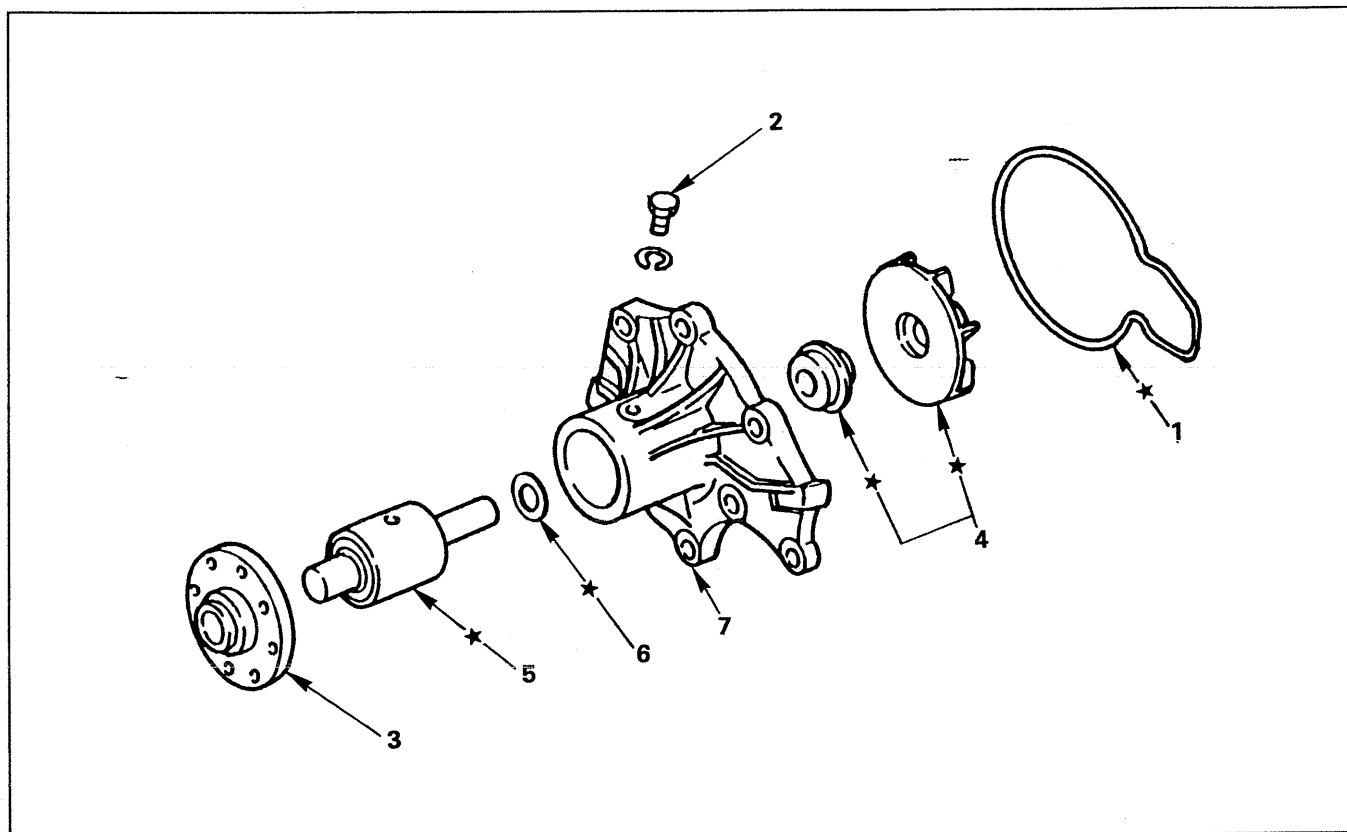
A wax pellet type thermostat is used.

The jiggle valve accelerates engine warm-up.

## WATER PUMP



### DISASSEMBLY



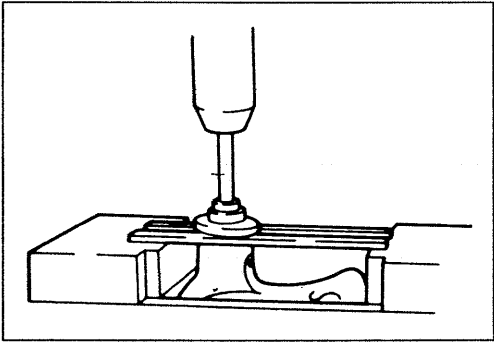
#### Disassembly Steps

- ▲ 1. O-ring
- ▲ 2. Set screw
- ▲ 3. Cooling fan center
- ▲ 4. Impeller and seal unit
- ▲ 5. Bearing unit
- ▲ 6. Thrower
- ▲ 7. Water pump body



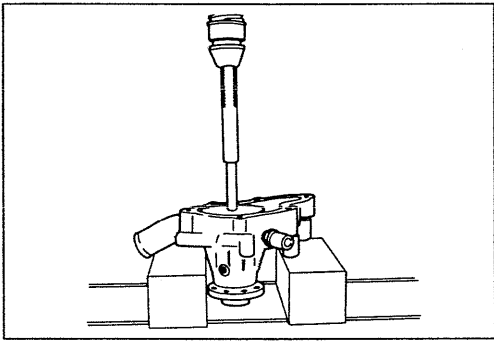


**Important Operations**



**3. Cooling Fan Center**

Remove the fan center with a bench press and a bar.



**4. Impeller and Seal Unit**

Remove the impeller and seal unit with a bench press and bar.

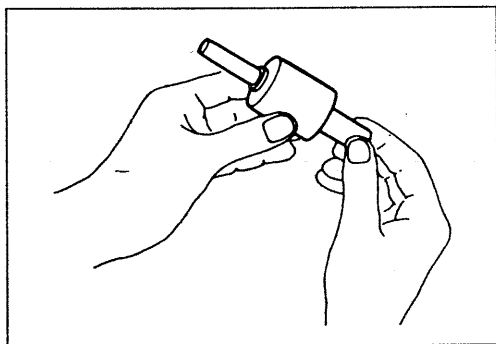
**Note:**

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.

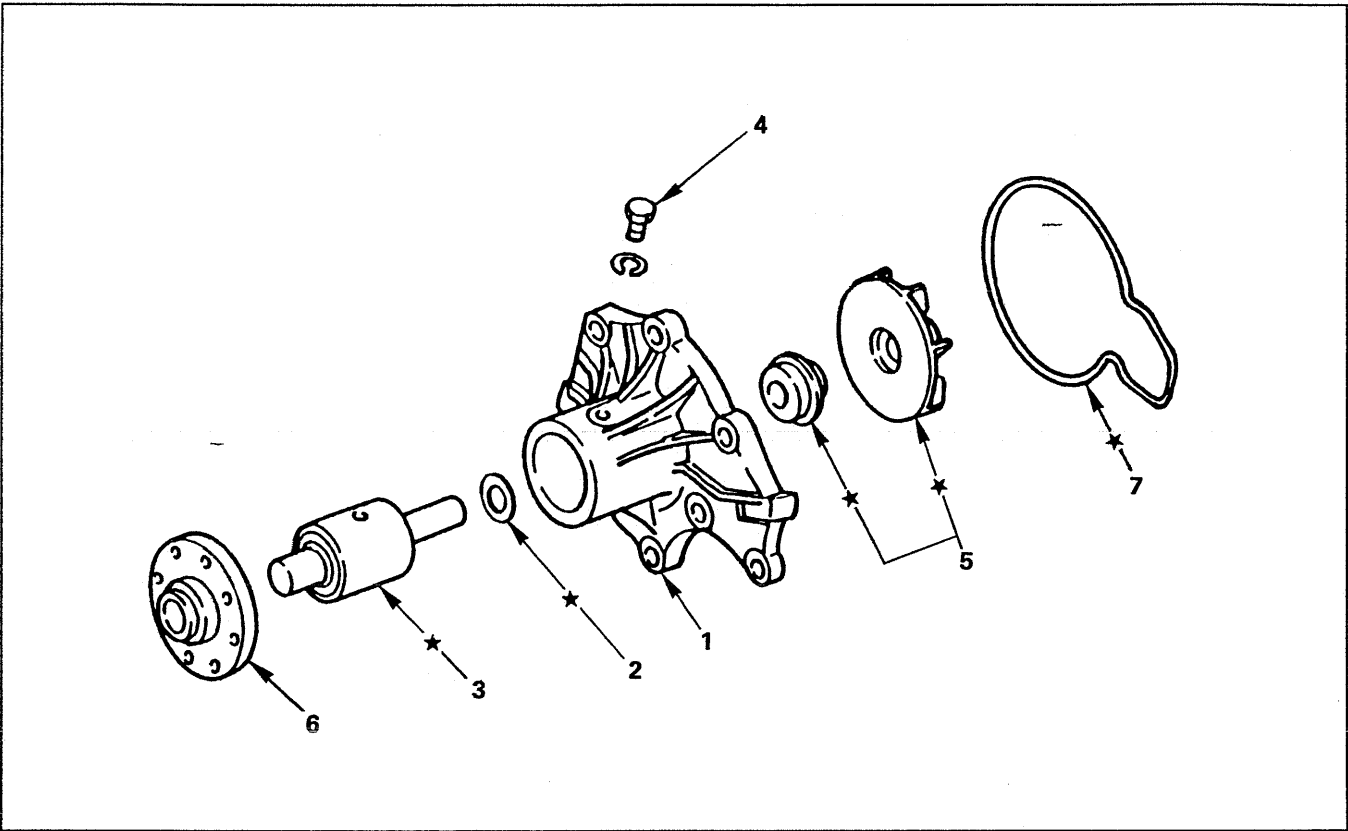


### Bearing Unit

Check the bearing for abnormal noise, binding, and other abnormal conditions.



REASSEMBLY



Reassembly Steps

1. Water pump body

2. Thrower

▲ 3. Bearing unit

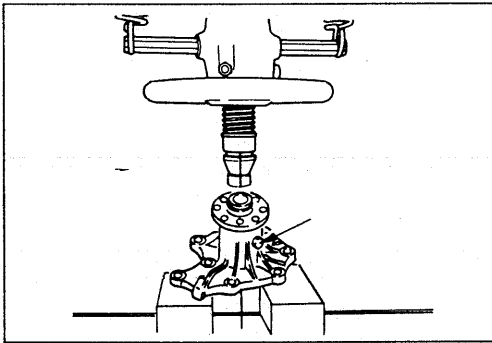
▲ 4. Set screw
- ▲ 5. Impeller and seal unit

▲ 6. Cooling fan center

7. O-ring



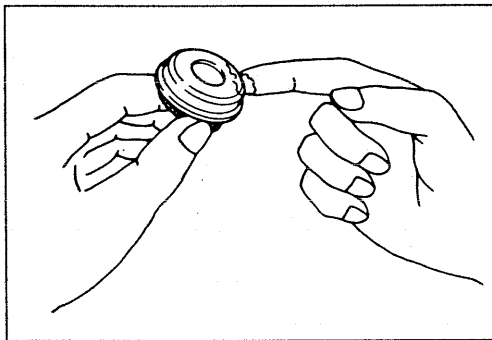
## Important Operations



### 3. Bearing Unit

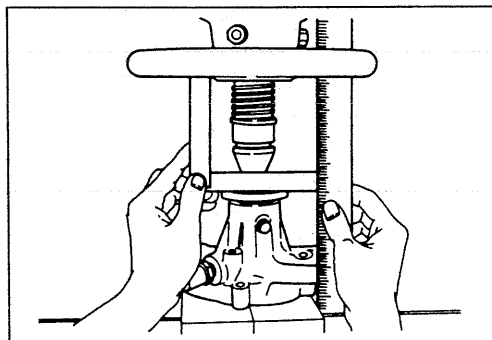
#### 4. Set Screw

- 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.



### 5. Impeller and Seal Unit

- 1) Apply a thin coat of liquid gasket to the seal unit outer periphery.
- 2) Install the seal unit.



#### Note:

1. The fan center and the impeller are 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 breakdown of the water pump during engine operation and subsequent serious overheating problems.

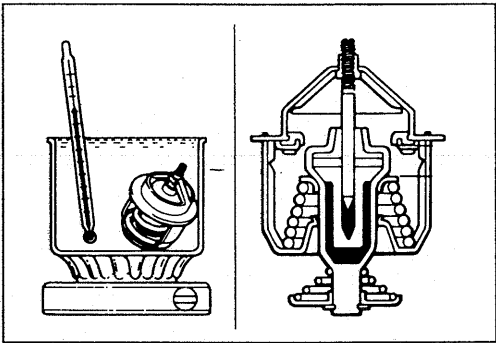
2. The water pump assembly must be replaced whenever the fan center and impeller pressure force falls below 200 kg.
3. Do not attempt to strike the bearing into position with a hammer or similar object. Damage to the bearing will result.

THERMOSTAT



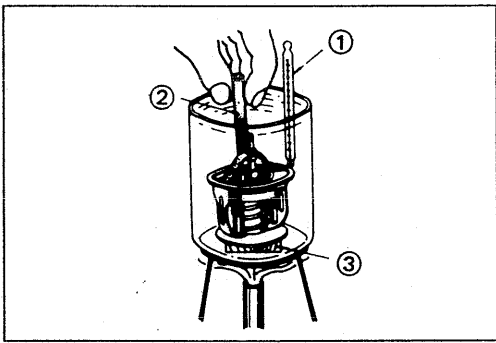
INSPECTION AND REPAIR

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



Operating 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) |
|----------------------------------------|--------|
| 76.5 (170)                             |        |



- 4. Check the thermostat full opening temperature.

| Thermostat Full Opening Temperature | °C(°F) |
|-------------------------------------|--------|
| 90 (194)                            |        |



| Valve Lift at Fully Open Position | mm(in.) |
|-----------------------------------|---------|
| 8.0 (0.31)                        |         |

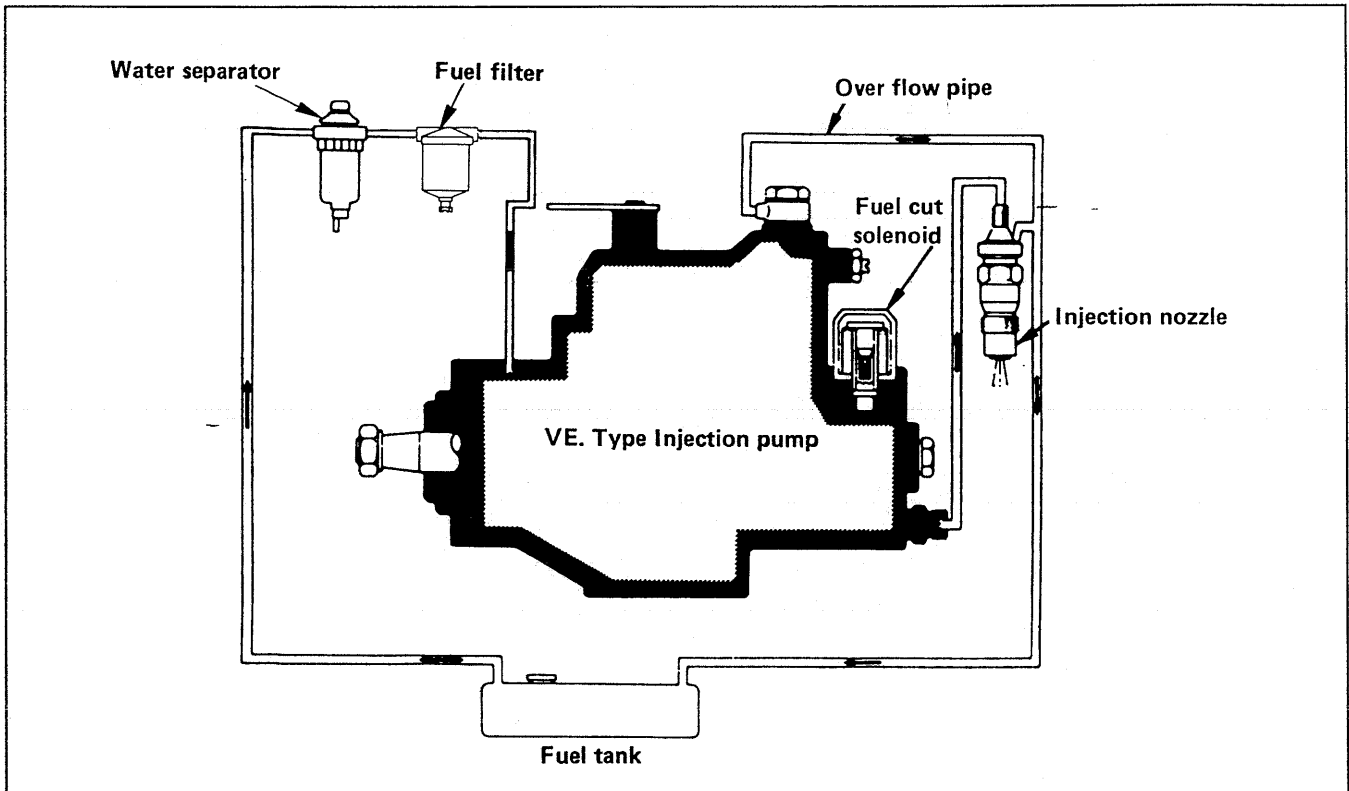
- ① Thermostat
- ② Agitating Rod
- ③ Wooden Piece

SECTION 8

FUEL SYSTEM

TABLE OF CONTENTS

| ITEM                      | PAGE |
|---------------------------|------|
| General description ..... | 136  |
| Injection nozzle .....    | 137  |
| Injection pump data ..... | 144  |

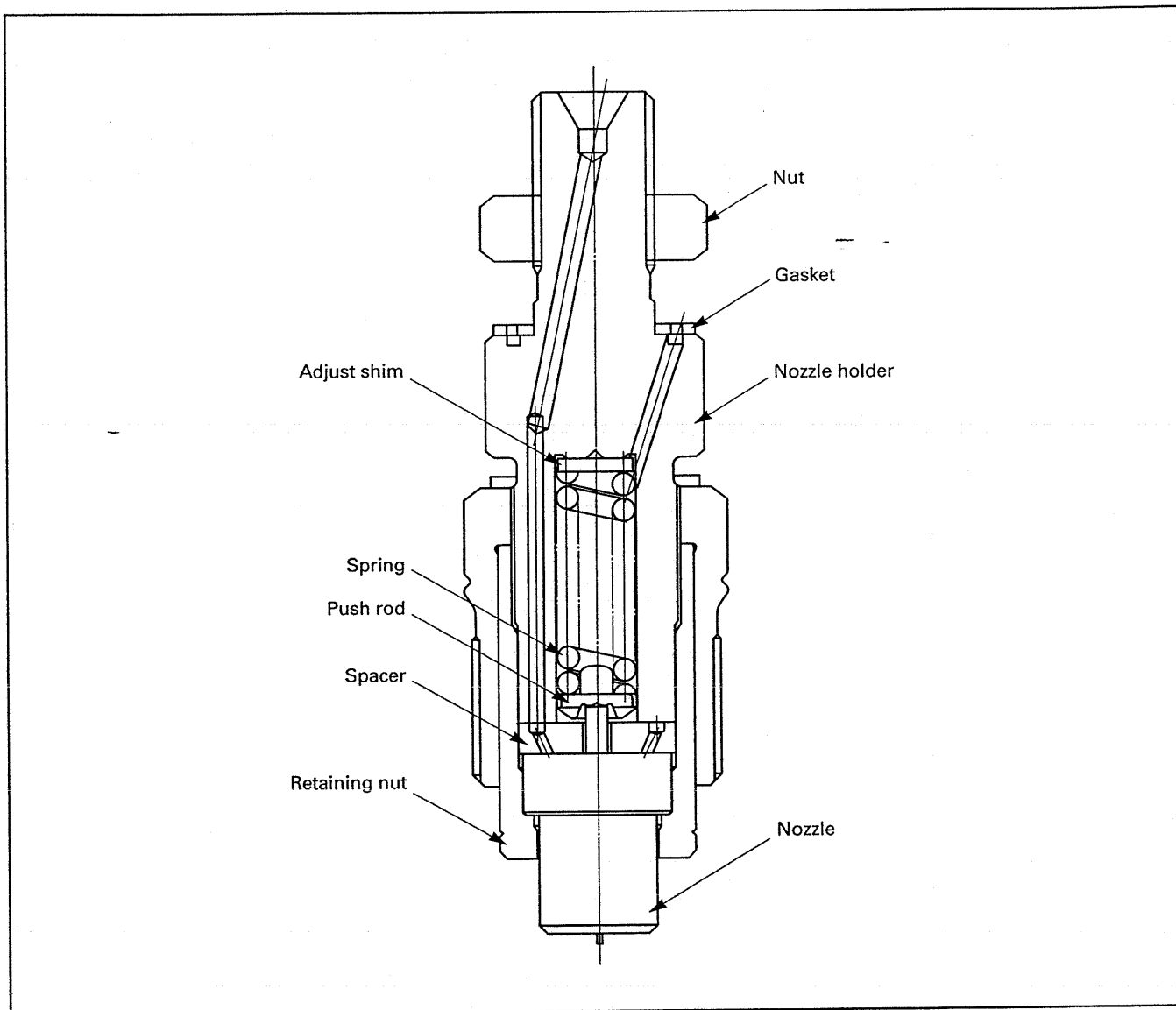
**GENERAL DESCRIPTION****FUEL FLOW**

The fuel system consists of the fuel tank, the water separator (if so equipped), the fuel filter, the injection pump, and the injection nozzle.

The fuel from the fuel tank passes through the water separator 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 efficient engine operation.

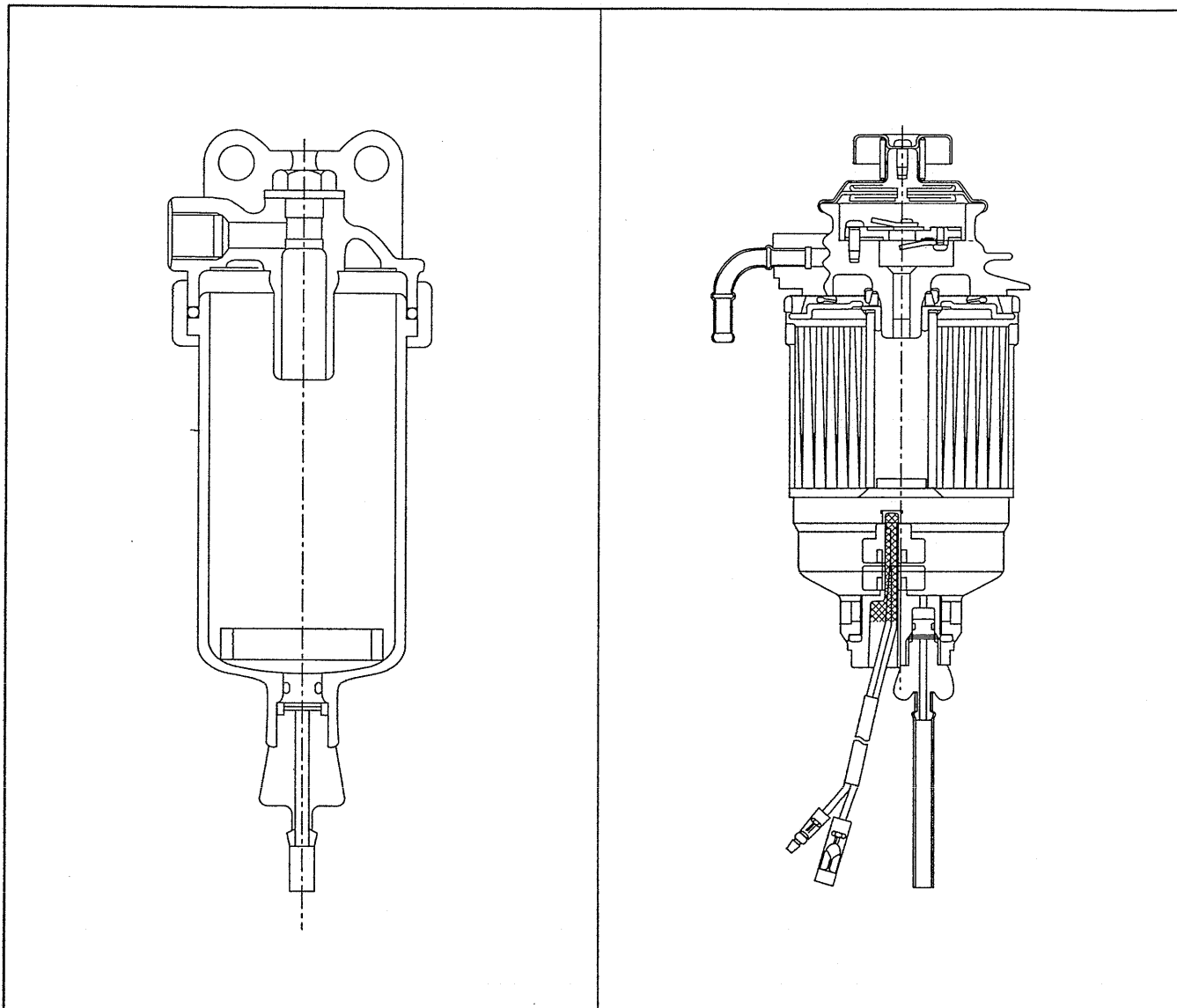
## INJECTION NOZZLE



The injection nozzle sprays pressurized fuel from the injection pump through the injection nozzle orifices and into the combustion chamber.



## FUEL FILTER AND WATER SEPARATOR



041ET003

041ET004

A cartridge type fuel filter and a water separator are used.

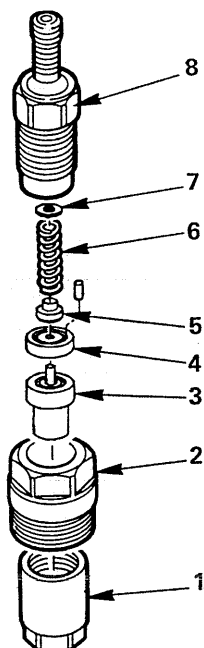
As the inside of the injection pump is lubricated by the fuel which it is pumping, the fuel must be perfectly clean. The fuel filter and the water separator remove water particles and other foreign material from the fuel before it reaches the injection pump.

The water separator has an internal float. When the float reaches the drain level, remind you to drain the water from the water separator.

## INJECTION NOZZLE



## DISASSEMBLY

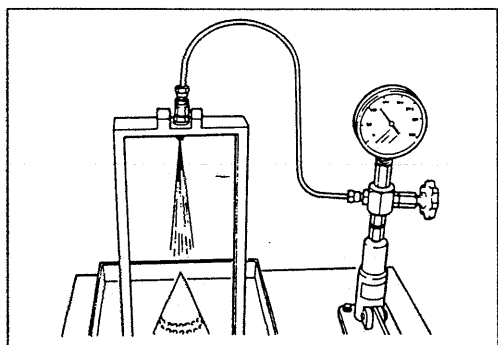
**Disassembly Steps**

1. Retaining nut
2. Holder nut
- ▲ 3. Injection nozzle
4. Spacer

5. Push rod
6. Spring
7. Adjusting shim
8. Nozzle holder



## Important Operations



Perform this test before disassembling the injection nozzle.

- 1) Install the injection nozzle to the nozzle tester.
- 2) Use the nozzle tester to apply compressed fuel at 14.7 MPa (150 kg/cm<sup>2</sup>/2,130 psi) to the injection nozzle.

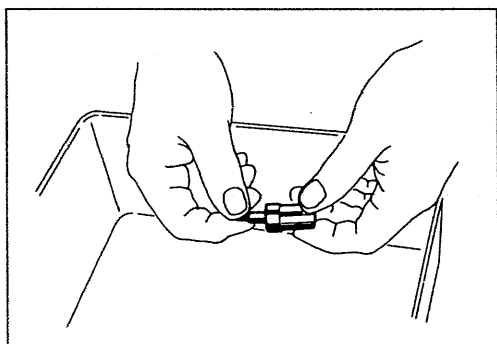


- 3) Check the area around the nozzle seat for fuel leakage.

If there is fuel leakage, the injection nozzle and the injection body must be replaced as a set.

### 3. Injection Nozzle

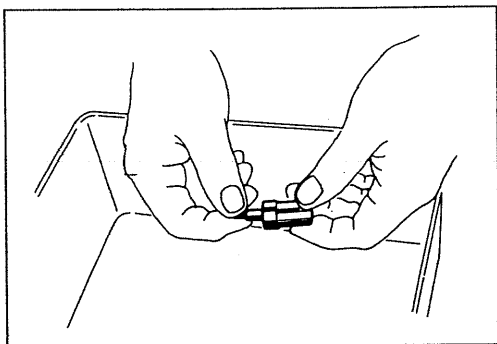
- 1) Remove the injection nozzles from the nozzle holders.  
The nozzle needle valve and nozzle body combinations must be interchangeable.
- 2) Immerse the injection nozzles in a tool tray filled with clean diesel fuel to protect them from dust.





## INSPECTION AND REPAIR

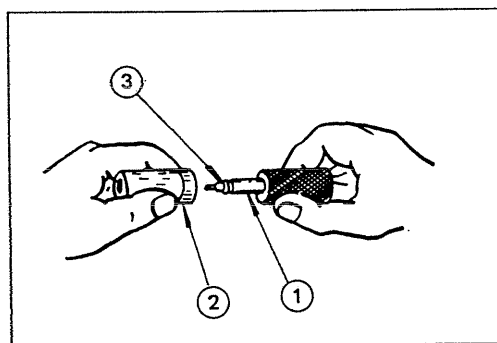
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



### 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 repaired (See "Nozzle Lapping Procedure" below.)



### Nozzle Lapping Procedure

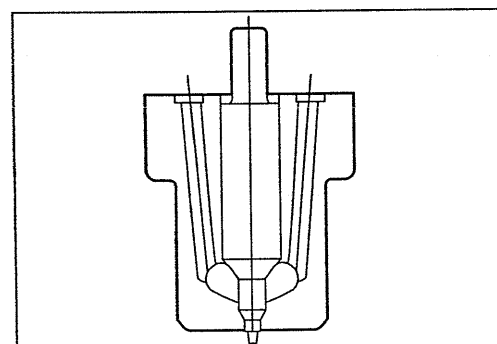
1. Lap the nozzle needle (1) and the nozzle body (2) by applying a compound of oxidized chrome and animal oil (3).

#### Note:

Do not apply an excessive amount of the oxidized chrome and animal oil compound to the injection needle valve seat area.



2. Carefully wash the needle valve and the nozzle body in clean diesel fuel after lapping.



080ET003

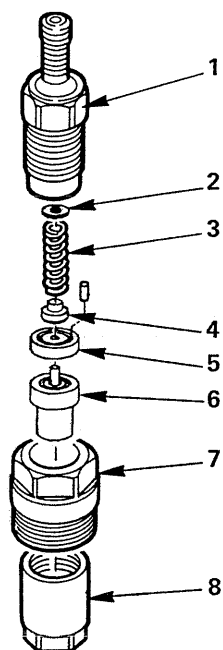
### Nozzle Body and Needle Valve Inspection

Check the nozzle body and the needle valve for damage and deformation.

The nozzle and body must be replaced if either of these two conditions are discovered during inspection.



## REASSEMBLY



### Reassembly Steps

- |                     |                     |
|---------------------|---------------------|
| 1. Nozzle holder    | 5. Spacer           |
| ▲ 2. Adjusting shim | 6. Injection nozzle |
| 3. Spring           | 7. Holder nut       |
| 4. Push rod         | ▲ 8. Retaining nut  |

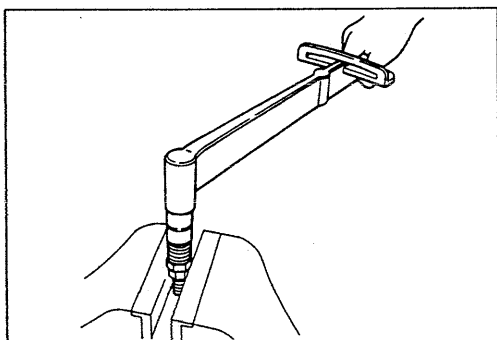


## Important Operations

### 2. Adjust Shim

Adjust Shim Availability mm(in.)

|           |                             |
|-----------|-----------------------------|
| Range     | 0.10 – 0.50 (0.004 – 0.020) |
| Increment | 0.1 (0.004)                 |

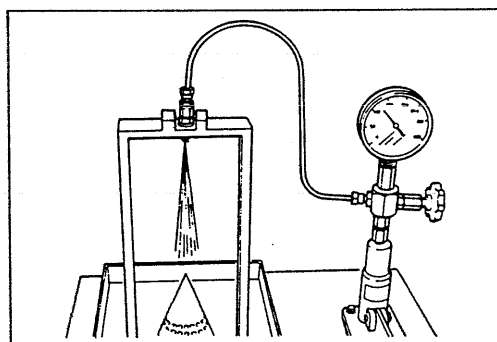


### 8. Retaining Nut

Tighten to the retaining nut to the specified torque.

Retaining Nut Torque kg·m(lbs.ft./N·m)

4 (35/39)



### Injection Nozzle Adjustment

1. Attach the injection nozzle holder to the injection nozzle tester.
2. Apply pressure to the nozzle tester to check that the injection nozzle opens at the specified pressure.

If the injection nozzle does not open at the specified pressure, install or remove the appropriate number of adjusting shims to adjust it.

### 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 TESTER AT ALL TIMES.

## INJ. PUMP CALIBRATION DATA

ISUZU Part No. : 897136-6800  
 Injection pump No. : 104646-1910 (NP-VE4/11F1200LNP1593)  
 Pump rotation : Counterclockwise-viewed from drive side

ZEXEL No. 104746-1910  
 Date : 15 FEB. 1996  
 Company : ISUZU  
 Maker No. : 8-97136-680-0

Refer to the service manual (VE pump B.I.S; Pub. No. EE14E-11041) for all procedures and details other than the following.

### 1. Test condition

|                                                                                     |                                                                      |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| 1-1 Nozzle : 105780-0060 (NP-DN0SD1510)                                             | Injection pipe : 157805-7320 ( $\phi 2 \times \phi 6-450\text{mm}$ ) |
| 1-2 Nozzle holder : 105780-2150                                                     | Fuel oil temperature : $45^{+5}\text{ }^{\circ}\text{C}$             |
| 1-3 Nozzle opening pressure : $13.0^{+3}\text{ MPa}$ ( $133^{+3}\text{ kgf/cm}^2$ ) | Supply pump pressure : $20\text{ kPa}$ ( $0.2\text{ kgf/cm}^2$ )     |
| 1-4 Joint ass'y : 157641-4720                                                       | Tube ass'y : 157641-4020                                             |
| 1-5 Test oil : ISO4113 or SAE J967d                                                 |                                                                      |

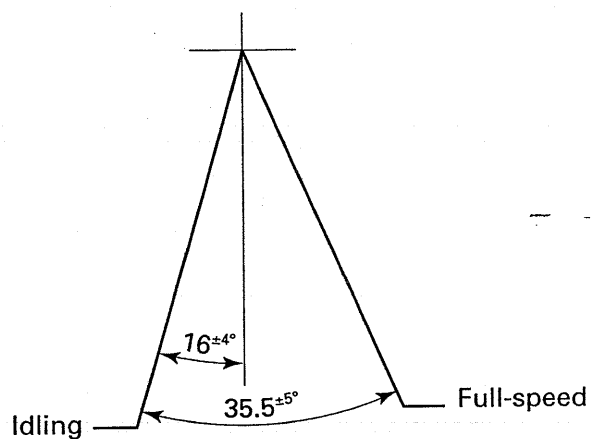
| 2. Adjustment |                      | Pump speed<br>(r/min) | Settings                       |                               | Charge air press.<br>kPa (mmHg) | Difference in<br>delivery ( $\text{cm}^3$ ) |
|---------------|----------------------|-----------------------|--------------------------------|-------------------------------|---------------------------------|---------------------------------------------|
| 2-1           | Full-load adjustment | 900                   | $58.1 \pm 0.5$                 | $\text{cm}^3/1,000\text{ st}$ |                                 | 3.5                                         |
| 2-2           | Supply pump          | 900                   | $392 \pm 20$ ( $4.0 \pm 0.2$ ) | kPa ( $\text{kgf/cm}^2$ )     |                                 |                                             |
| 2-3           | Timing device travel | 900                   | $0.6 \pm 0.2$                  | mm                            |                                 |                                             |
| 2-4           | Idling adjustment    | 350                   | $21.8 \pm 2.0$                 | $\text{cm}^3/1,000\text{ st}$ |                                 | 4.5                                         |
| 2-5           | Start fuel adj.      | 100                   | $68.0 \pm 3.0$                 | $\text{cm}^3/1,000\text{ st}$ | FULL                            |                                             |
| 2-6           | Maximum speed adj.   | 1,320                 | $16.5 \pm 3.0$                 | $\text{cm}^3/1,000\text{ st}$ |                                 | 5.5                                         |

| 3. Test specification |                   |                                        |                                                                                                                                                                                              |
|-----------------------|-------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3-1                   | Timing device     | N = r/min<br>mm                        | <div style="display: flex; justify-content: space-around;"> <div>           900<br/> <math>0.6 \pm 0.2</math> </div> <div>           1,325<br/> <math>1.2^{+0.4}_{-0.3}</math> </div> </div> |
| 3-2                   | Supply pump       | N = r/min<br>kPa(kgf/cm <sup>2</sup> ) | <div style="display: flex; justify-content: space-around;"> <div>           900<br/> <math>392 \pm 29</math><br/>           (4.0 <math>\pm</math> 0.3)         </div> </div>                 |
| 3-3                   | Overflow delivery | N = r/min<br>$\text{cm}^3/\text{min}$  | <div style="display: flex; justify-content: space-around;"> <div>           900<br/>           (360 <math>\pm</math> 130)         </div> </div>                                              |

### 3-4 Fuel injection quantities

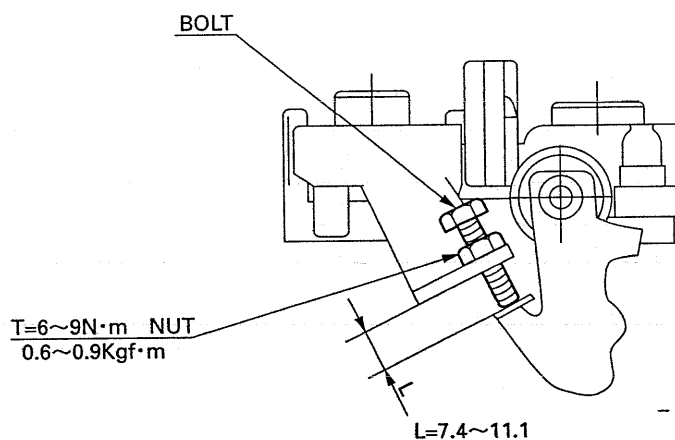
| Control lever position     | Pump speed<br>(r/min)                               | Fuel delivery<br>( $\text{cm}^3/1,000\text{ st}$ ) | Charge air press.<br>kPa (mmHg) |
|----------------------------|-----------------------------------------------------|----------------------------------------------------|---------------------------------|
| Max. speed                 | 500                                                 | (58.1)                                             |                                 |
|                            | 600                                                 | (60.4)                                             |                                 |
|                            | 900                                                 | $58.1 \pm 1.0$                                     |                                 |
|                            | 1,000                                               | (58.5)                                             |                                 |
|                            | 1,200                                               | (58.5)                                             |                                 |
|                            | 1,320                                               | $16.5 \pm 3.0$                                     |                                 |
|                            | 1,400                                               | Below 5.0                                          |                                 |
| Idling                     | 350                                                 | $21.8 \pm 2.0$                                     |                                 |
|                            | 450                                                 | Below 5.0                                          |                                 |
| Switch OFF<br>Magnet valve | 350                                                 | 0                                                  | IDLE                            |
| Solenoid                   | Max. cut-in voltage : 8 V, Test voltage : 12 ~ 14 V |                                                    |                                 |

#### 4. Control lever angle



#### Starting injection quantity adjustment

Adjust the specified starting injection quantity (Item 2-5) using the adjusting bolt and then lock the nut.





# MEMO

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

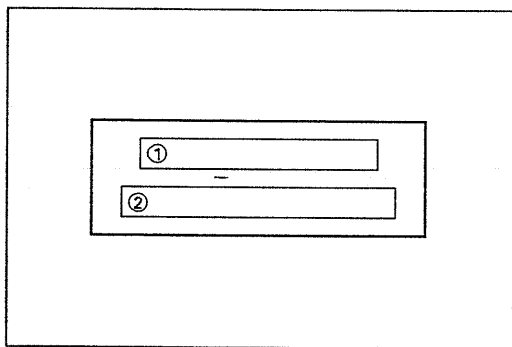
SECTION 9

ENGINE ELECTRICALS

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| ITEM             | PAGE |
|------------------|------|
| Starter .....    | 148  |
| Alternator ..... | 161  |

## STARTER



### STARTER IDENTIFICATION

NIPPON DENSO starter are identified by name plate attached to the yoke. (Illustration)

- ① Isuzu part number
- ② NIPPON DENSO part number

**Note:**

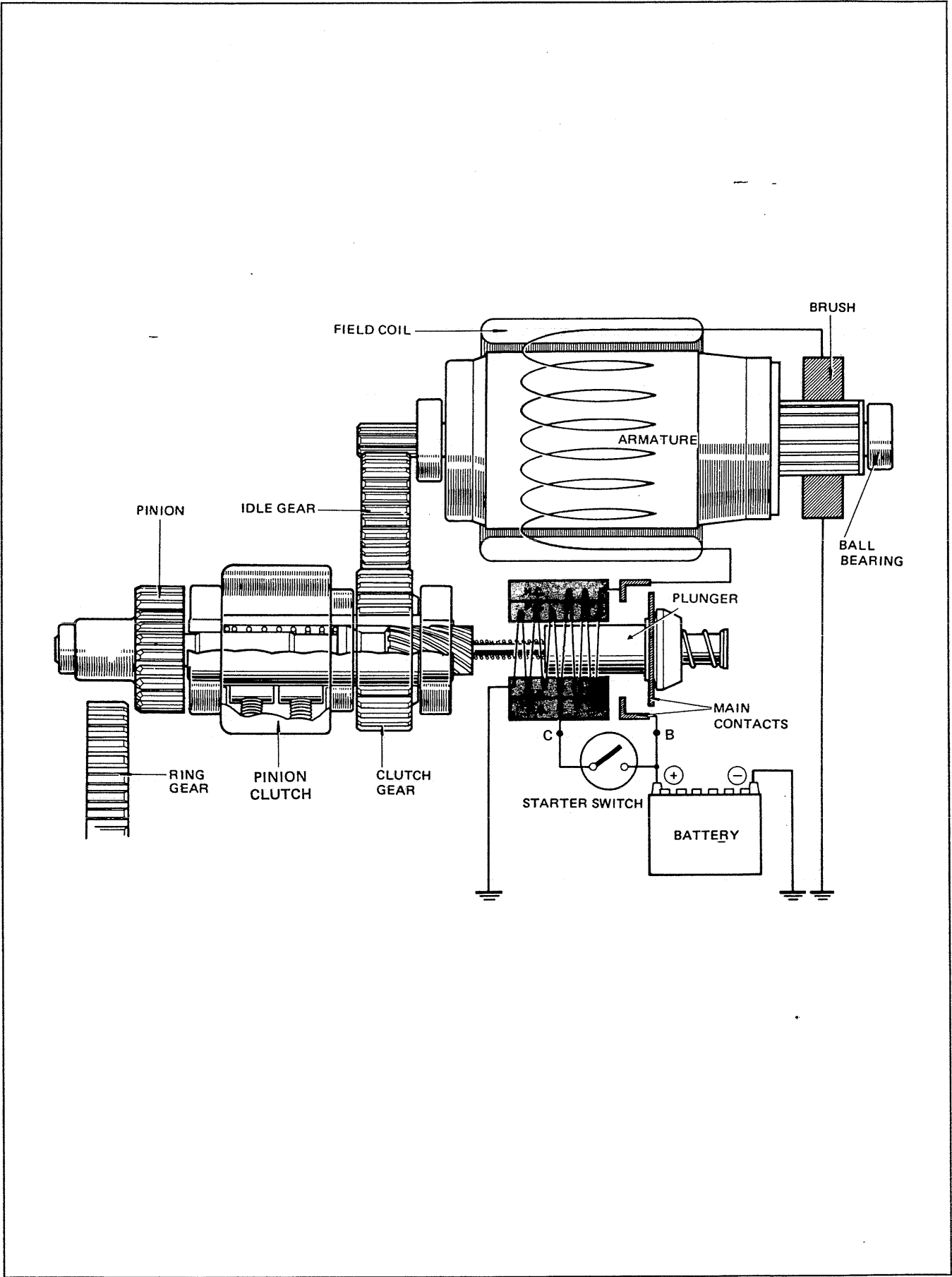
Always check the identification number before beginning a service operation.

Applicable service data will vary according to the identification number. Use of the wrong service data will result in starter damage.

## MAIN DATA AND SPECIFICATION

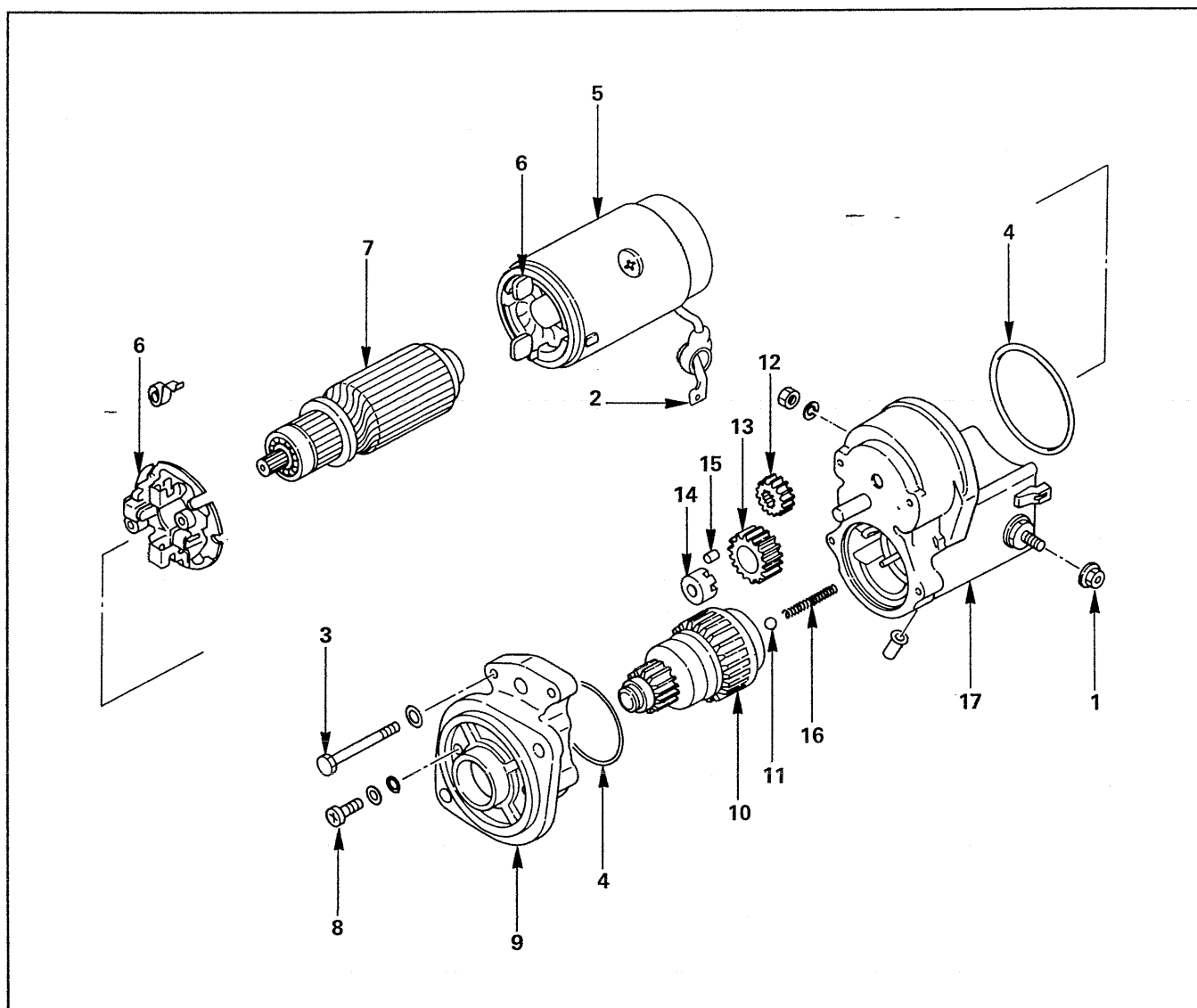
|                                                        |           |                           |
|--------------------------------------------------------|-----------|---------------------------|
| Isuzu Part No.                                         |           | 8-97042-997-0             |
| NIPPON DENSO Part No.                                  |           | 228000-1890               |
| Rated voltage                                          | V         | 12                        |
| Rated output                                           | kW        | 2.2                       |
| Rating                                                 |           |                           |
| Direction of rotation<br>(Viewed from the pinion side) |           | Clockwise                 |
| Clutch type                                            |           | Roller                    |
| Terminal voltage (No. Load)                            | V         | 11.5                      |
| Minimum current (No. Load)                             | A         | 120                       |
| Starter motor minimum operating speed<br>(No. Load)    | rpm       | 4000                      |
| Pinion gear                                            |           |                           |
| Modules                                                |           | 2.75                      |
| Number of teeth                                        |           | 9                         |
| Outside diameter                                       | mm(in.)   | 33.0 (4.3)                |
| Travel distance                                        | mm(in.)   | 1.51 (0.059)              |
| Yoke outside diameter                                  | mm(in.)   | 83.0 (3.27)               |
| Number of poles                                        |           | 4                         |
| Brush length                                           |           |                           |
| Standard                                               | mm(in.)   | 16.5 (0.65)               |
| Limit                                                  | mm(in.)   | 13.0 (0.51)               |
| Brush spring standard fitting load                     | kg(lb./N) | (3.52/15.7–4.4/19.6)      |
| Commutator                                             |           |                           |
| Outside diameter                                       |           |                           |
| Standard                                               | mm(in.)   | 35.0 (1.38)               |
| Limit                                                  | mm(in.)   | 34.0 (1.34)               |
| Depth of undercut mica                                 |           |                           |
| Standard                                               | mm(in.)   | 0.7 – 0.9 (0.027 – 0.035) |
| Limit                                                  | mm(in.)   | 0.2 (0.008)               |

CIRCUIT ARRANGEMENT





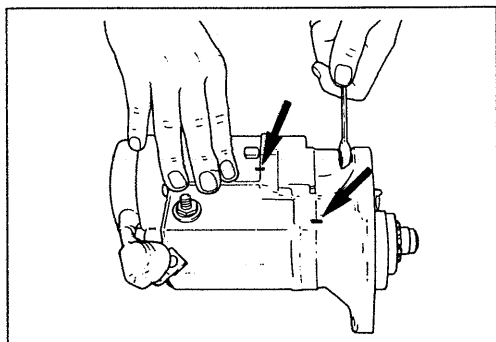
## DISASSEMBLY

**Disassembly Steps**

- |                         |                               |
|-------------------------|-------------------------------|
| 1. Hexagon nut          | ▲ 11. Steel ball              |
| 2. Connecting lead wire | ▲ 12. Starter pinion          |
| 3. Through bolt         | ▲ 13. Idle gear               |
| 4. Starter seal         | ▲ 14. Retainer                |
| ▲ 5. Yoke               | ▲ 15. Clutch roller           |
| ▲ 6. Brush holder       | 16. Compression return spring |
| ▲ 7. Armature           | ▲ 17. Magnetic switch body    |
| 8. Screw                |                               |
| ▲ 9. Starter housing    |                               |
| ▲ 10. Pinion clutch     |                               |



## Important Operations



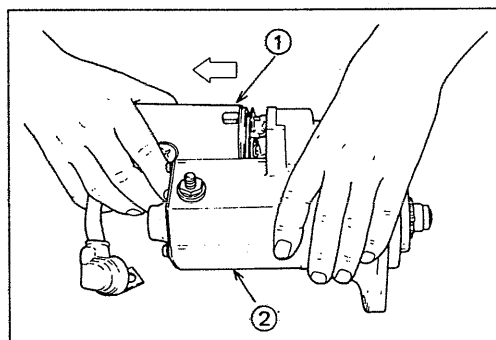
### 5. Yoke

### 9. Starter Housing

### 17. Magnetic Switch Body

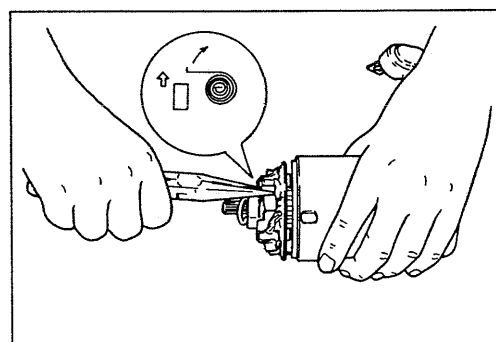
Apply setting marks across the end frame, the yoke, and the magnetic switch body.

This will ensure reassembly of the parts in their original positions.



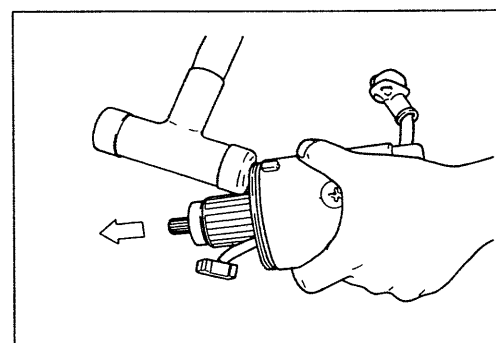
### 5. Yoke

Remove the yoke ① from the magnetic switch ②.



### 6. Brushes and Brush Holder

Use a pair of long nose pliers to remove the brushes and pull out the brush holder.

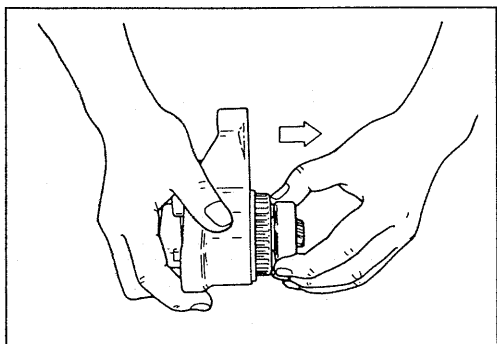


### 7. Armature

Remove the armature from the yoke.

#### Note:

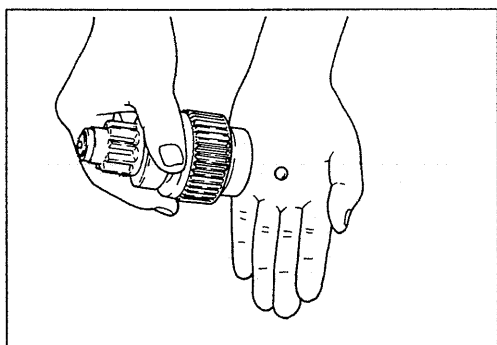
If necessary, tap the yoke end with a plastic hammer to remove the armature.

**10. Pinion Clutch**

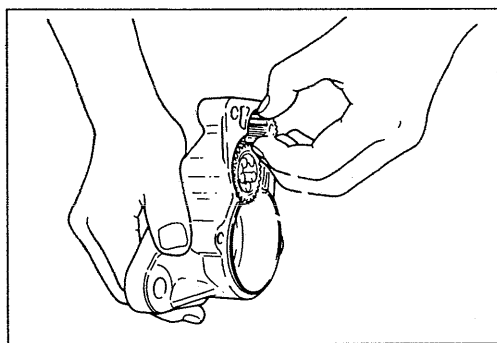
Remove the magnetic sub-switch from the starter housing.

**Note:**

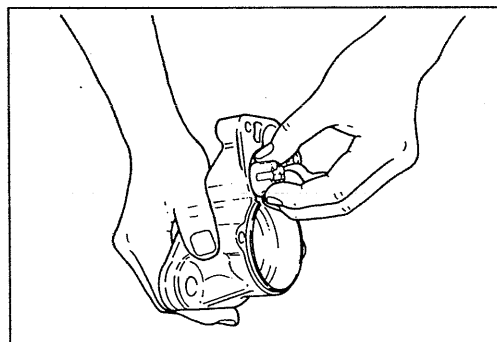
If the pinion is installed to the starter housing (externally attached to the magnetic sub-switch shaft, it must be removed before the magnetic sub-switch.

**11. Steel Ball**

Remove the steel ball from the pinion clutch.

**12. Starter Pinion****13. Idler gear**

Remove the starter pinion and the idler gear from the starter housing.

**14. Retainer****15. Clutch Roller**

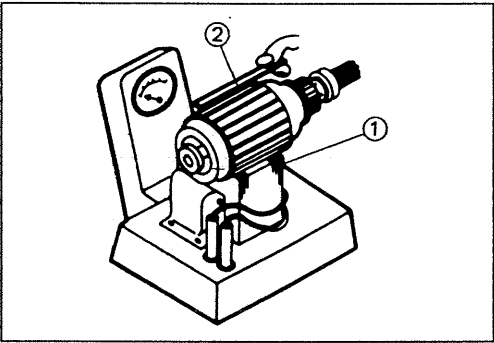
Remove the retainer and clutch roller from the starter housing.





## INSPECTION AND REPAIR

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



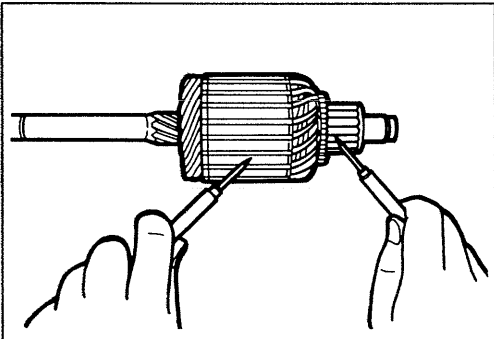
### ARMATURE

#### Armature Short Circuit Test

1. Place the armature on a growler tester ①.
2. Hold a hack saw blade ② against the armature core while slowly rotating the armature.

If the armature is short circuited, the hack saw blade will vibrate and will be attracted to the armature core.

A short circuited armature must be replaced.

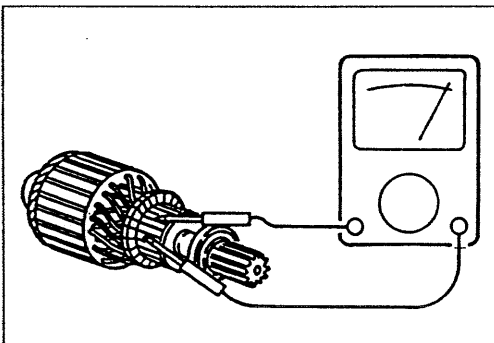


#### Armature Winding Ground Test



Check for continuity across the commutator segments and the core.

If there is continuity, the armature is internally grounded due to insulation failure and must be replaced.

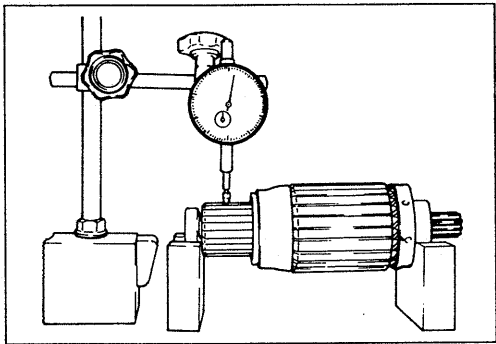


#### Armature Winding Continuity Test



Check for continuity across the commutator segment.

If there is no continuity, the armature coil is open and must be replaced.

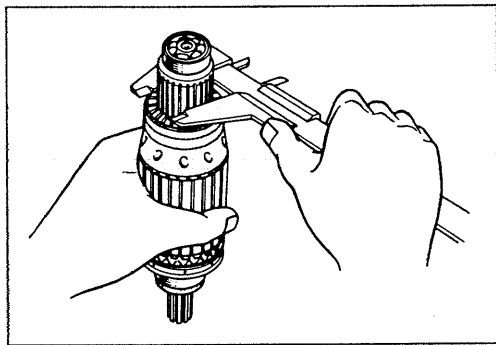


**Commutator Run-Out Test**



Use a dial indicator and a V-block to measure the commutator runout.  
If the measured value exceeds the limit, the commutator must be replaced.

| Commutator Run-Out mm(in.) |              |
|----------------------------|--------------|
| Standard                   | Limit        |
| 0.02 (0.0008)              | 0.05 (0.002) |

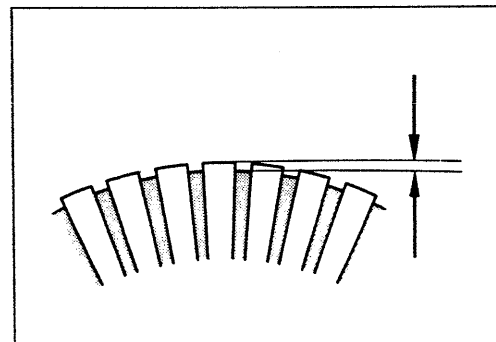


**Commutator Outside Diameter Measurement**



Use a vernier caliper to measure the commutator outside diameter.  
If the measured value exceeds the limit, the armature must be replaced.

| Commutator Outside Diameter mm(in.) |             |
|-------------------------------------|-------------|
| Standard                            | Limit       |
| 35.0 (1.38)                         | 34.0 (1.34) |

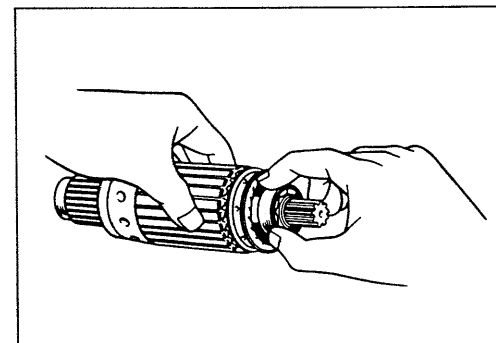


**Segment Mica Depth Measurement**



Use a depth gauge to measure the segment mica depth.  
If the measured value exceeds the limit, the segment mica must be undercut.

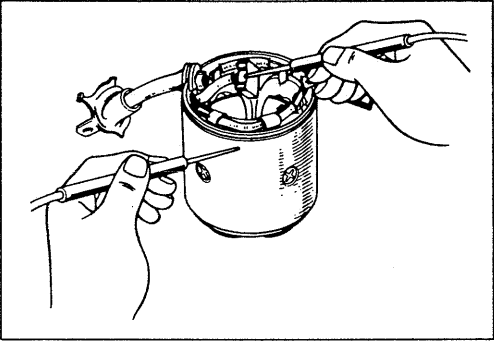
| Segment Mica Depth mm(in.) |             |
|----------------------------|-------------|
| Standard                   | Limit       |
| 0.5 – 0.8<br>(0.02 – 0.03) | 0.2 (0.008) |



**Bearing Inspection**



Visually inspect the bearing.  
If the bearing is worn or damaged, it must be replaced.



**YOKE**

**Field Winding Ground Test**

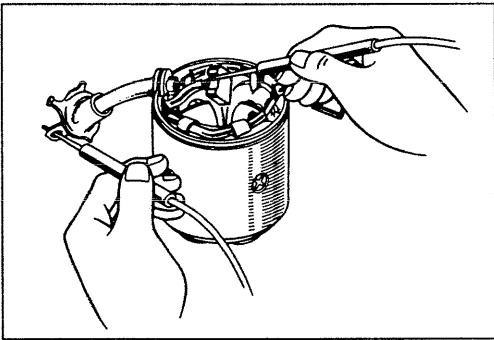
Use a circuit tester to check the field winding ground.

1. Touch one probe to the brush field winding end.
2. Touch the other probe to the bare surface of the yoke body.

There should be no continuity.

If there is continuity, the field windings are grounded.

Repair or replace the field windings.



**Field Winding Continuity Test**

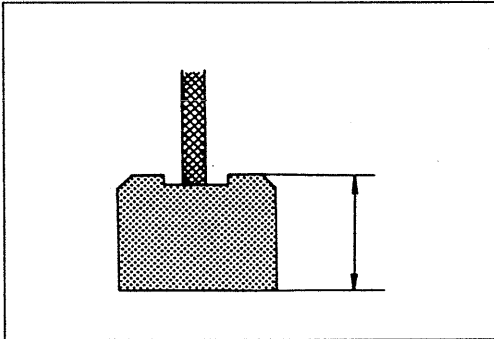
Use a circuit tester to check the field winding continuity.

1. Touch one probe to the field winding lead wire.
2. Touch the other probe to the brush.

There should be continuity.

If there is no continuity, the field windings are open.

Repair or replace the field windings.



**BRUSH AND BRUSH HOLDER**

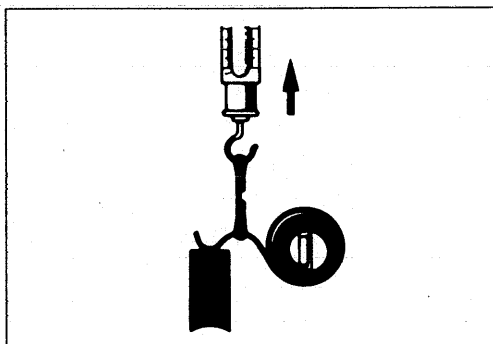


**Brush Length Measurement**

Use a vernier caliper to measure the brush length.

If the measured value exceeds the limit, the brush and/or the yoke must be replaced.

| Brush Length |             | mm(in.) |
|--------------|-------------|---------|
| Standard     | Limit       |         |
| 16.5 (0.65)  | 13.0 (0.51) |         |



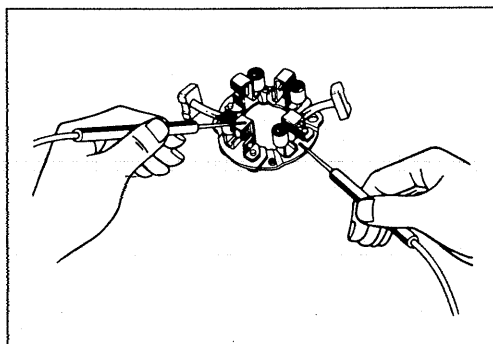
### Brush Spring Inspection

Visually check the brush spring for weakness and rusting.

Replace the brush spring if it is weak or rusted.

Use a spring balancer to measure the spring tension.

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



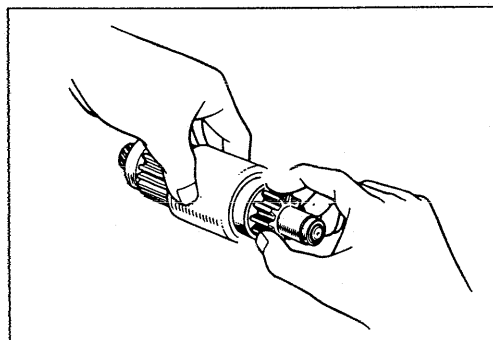
### Brush Holder Insulation Test

Use a circuit tester to check the brush holder insulation.

1. Touch one probe to the field winding lead wire.
2. Touch the other probe to the brush.

There should be no continuity.

If there is continuity, the brush holder must be repaired or replaced.



### PINION CLUTCH

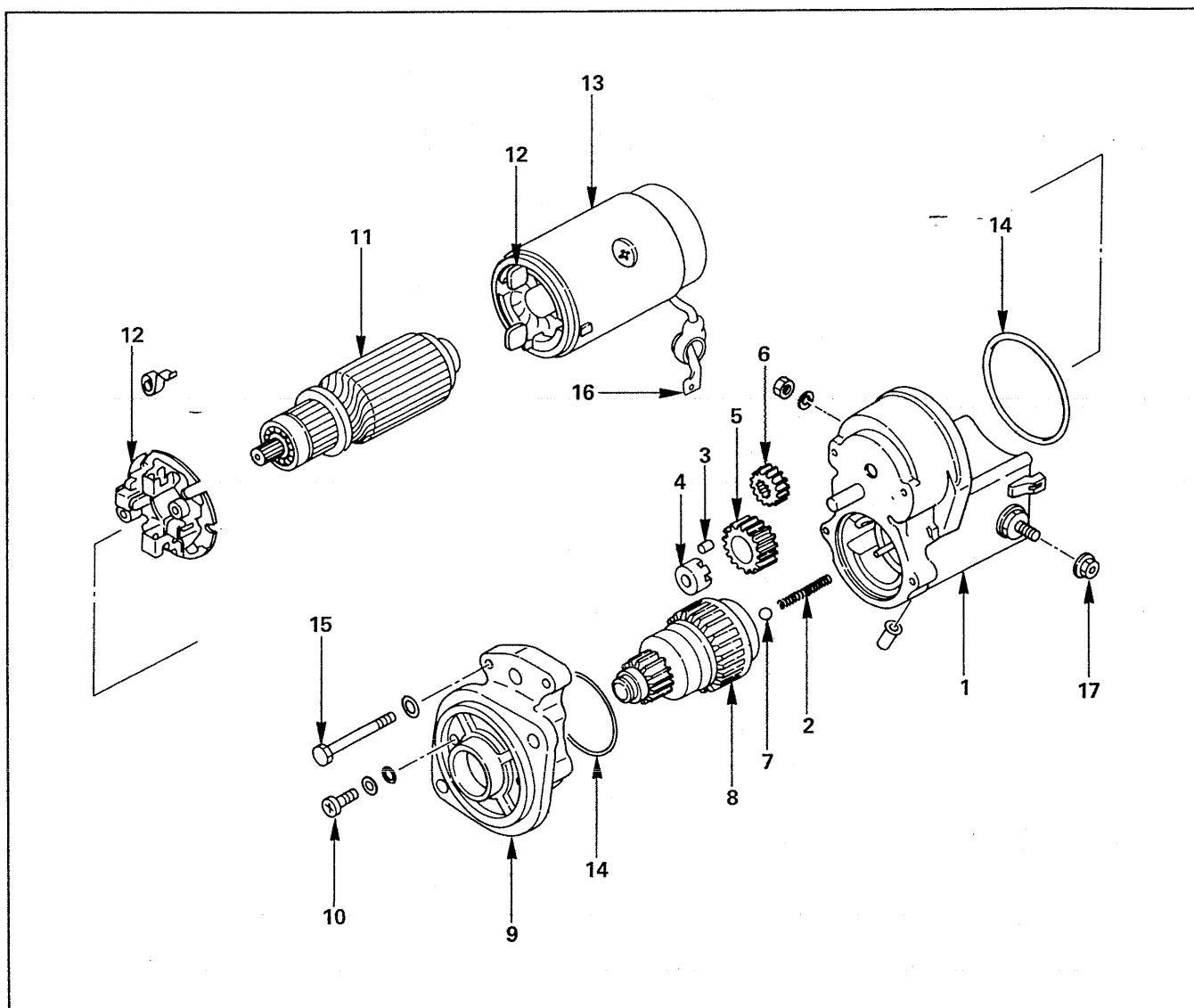
#### Pinion Inspection

Use your hand to turn the pinion in the direction of starter motor rotation. The pinion should turn freely.

Try to turn the pinion in the opposite direction. The pinion should lock.



## REASSEMBLY

**Reassembly Steps**

- |                                |                            |
|--------------------------------|----------------------------|
| 1. Magnetic switch body        | 11. Armature               |
| ▲ 2. Compression return spring | ▲ 12. Brush holder         |
| ▲ 3. Clutch roller             | ▲ 13. Yoke                 |
| ▲ 4. Retainer                  | 14. Starter seal           |
| 5. Idler gear                  | ▲ 15. Through bolt         |
| 6. Starter pinion              | ▲ 16. Connecting lead wire |
| 7. Steel ball                  | 17. Hexagon nut            |
| 8. Pinion clutch               |                            |
| 9. Starter housing             |                            |
| 10. Screw                      |                            |



## Important Operations



### 2. Compression Return Spring

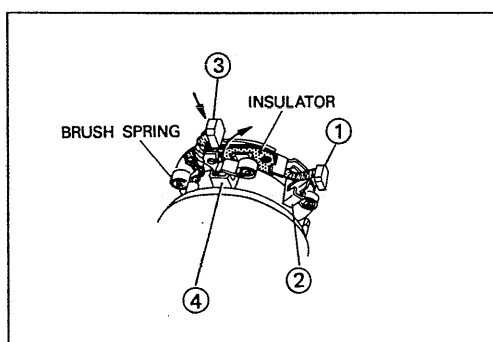
Apply a coat of engine oil to the compression return spring.

### 3. Clutch Roller

### 4. Retainer

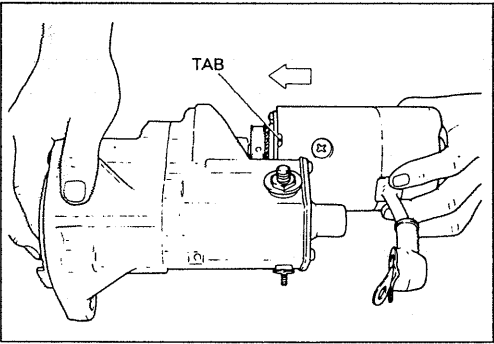


Apply a coat of engine oil to the clutch roller and the retainer.



## 12. Brushes and Brush Holder

- 1) Install the negative brush ① on the brush holder side to the brush holder negative hole ②.  
The brush holder negative hole is not insulated.
- 2) Install the positive brush ③ on the yoke side to the brush holder positive hole ④.  
The brush holder positive hole is separated from the plate with the insulator.
- 3) Check that the positive brush lead wires are not grounded.
- 4) Install the brush holder to the yoke.  
Take care not to damage the brush holder or the yoke.  
Do not spill oil on the brush holder or the yoke.



**13. Yoke**

- 1) Install the yoke to the magnetic switch.  
The yoke must engage the notch on the magnetic switch.
- 2) Securely set the rubber boot to the magnetic switch C-terminal.

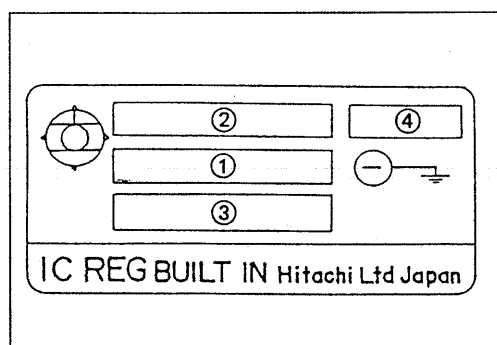
**15. Throttle Bolt**

Tighten the through bolt to the specified torque.



| Through Bolt Torque            | kg·m(lb.ft./N·m) |
|--------------------------------|------------------|
| 1.1 – 1.5 (8.0 – 10.8/11 – 15) |                  |

## ALTERNATOR



### ALTERNATOR IDENTIFICATION

Hitachi generators are identified by name plate attached to the rear cover. (Illustration)

- ① Isuzu part number
- ② Manufacturer's code number
- ③ Rated output
- ④ Manufacturer's production mark

**Note:**

Always check the identification number before beginning a service operation.

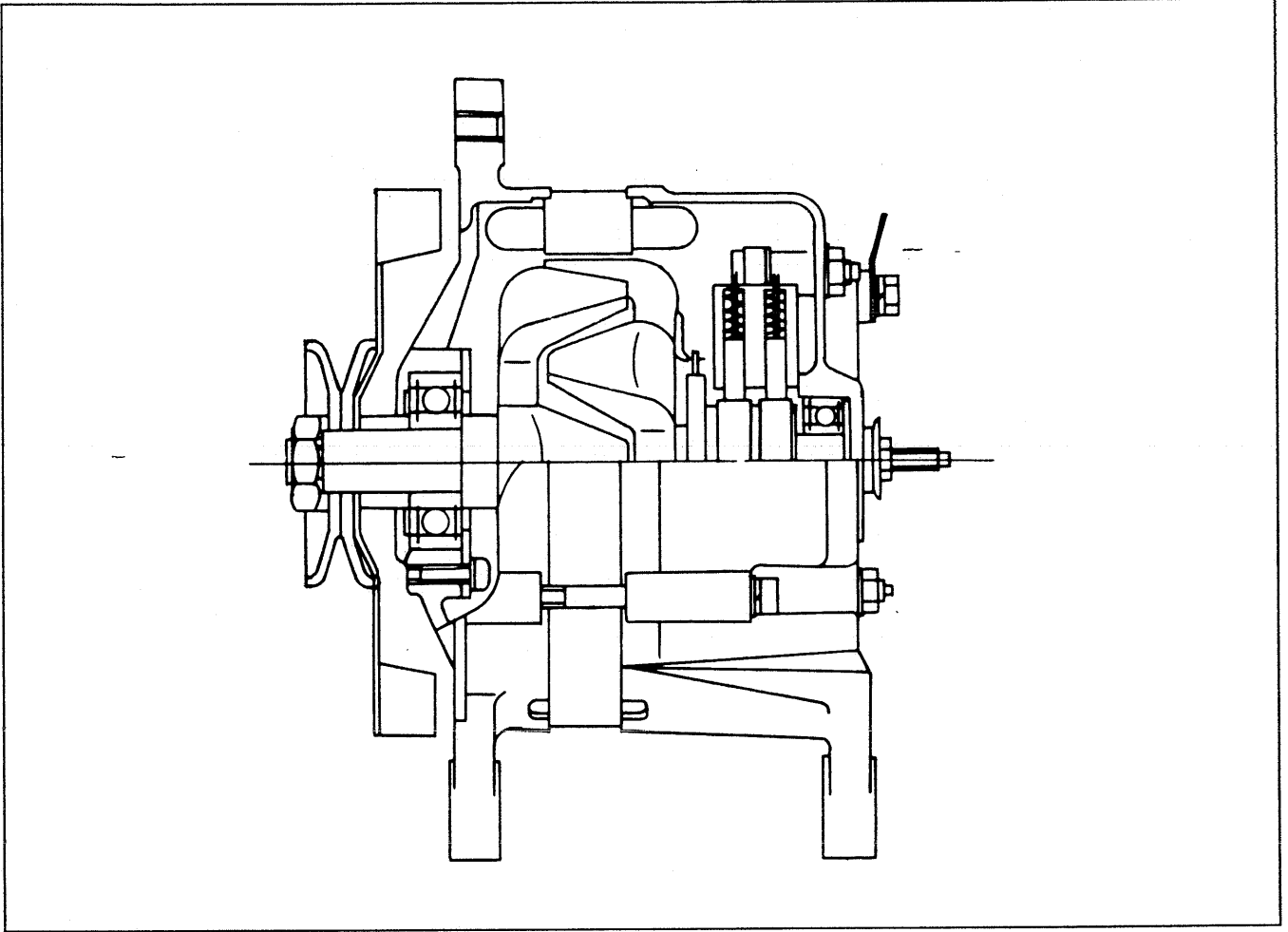
Applicable service data will vary according to the identification number. Use of the wrong service data will result alternator damaged.



MAIN DATA AND SPECIFICATION

|                                                     |                   |
|-----------------------------------------------------|-------------------|
| Engine Model to be Equipped                         | 4JG2              |
| Manufacturer's name                                 | HITACHI           |
| Isuzu Part No.                                      | 8-94423-756-0     |
| Manufacturer's Code No.                             | LR135-127         |
| Rated voltageV                                      | 12                |
| Rated outputA                                       | 35                |
| Operating speedrpm                                  | 1000-13500        |
| Rated output at rpmA/V/rpm                          | 33-37/13.5/5000   |
| No-load output at 0 amperesV/rpm                    | 13.5/1000 or less |
| Direction of rotation (viewed from the pulley side) | Clockwise         |
| Polarity grounded                                   | Negative          |
| Pulley diameter (P.C.D.)mm(in.)                     | 80 (3.15)         |
| Coil resistance at 20°C                             |                   |
| Rotor coilΩ                                         | 3.11              |
| Stator coilΩ                                        | 0.13              |
| Brush length                                        |                   |
| Standardmm(in.)                                     | 14.5 (0.57)       |
| Limitmm(in.)                                        | 7.5 (0.30)        |
| Slip ring diameter:                                 |                   |
| Standardmm(in.)                                     | 31.6 (1.24)       |
| Limitmm(in.)                                        | 30.6 (1.20)       |
| Shaft diameter                                      |                   |
| Frontmm(in.)                                        | 15.0 (0.59)       |
| Rearmm(in.)                                         | 12.0 (0.47)       |
| Regulator(s) applicable                             | Built-in          |
| Isuzu Part No.                                      | 5-81270-004-0     |
| Manufacturer(s) code No.                            | TR1Z-63           |

## GENERAL DESCRIPTION



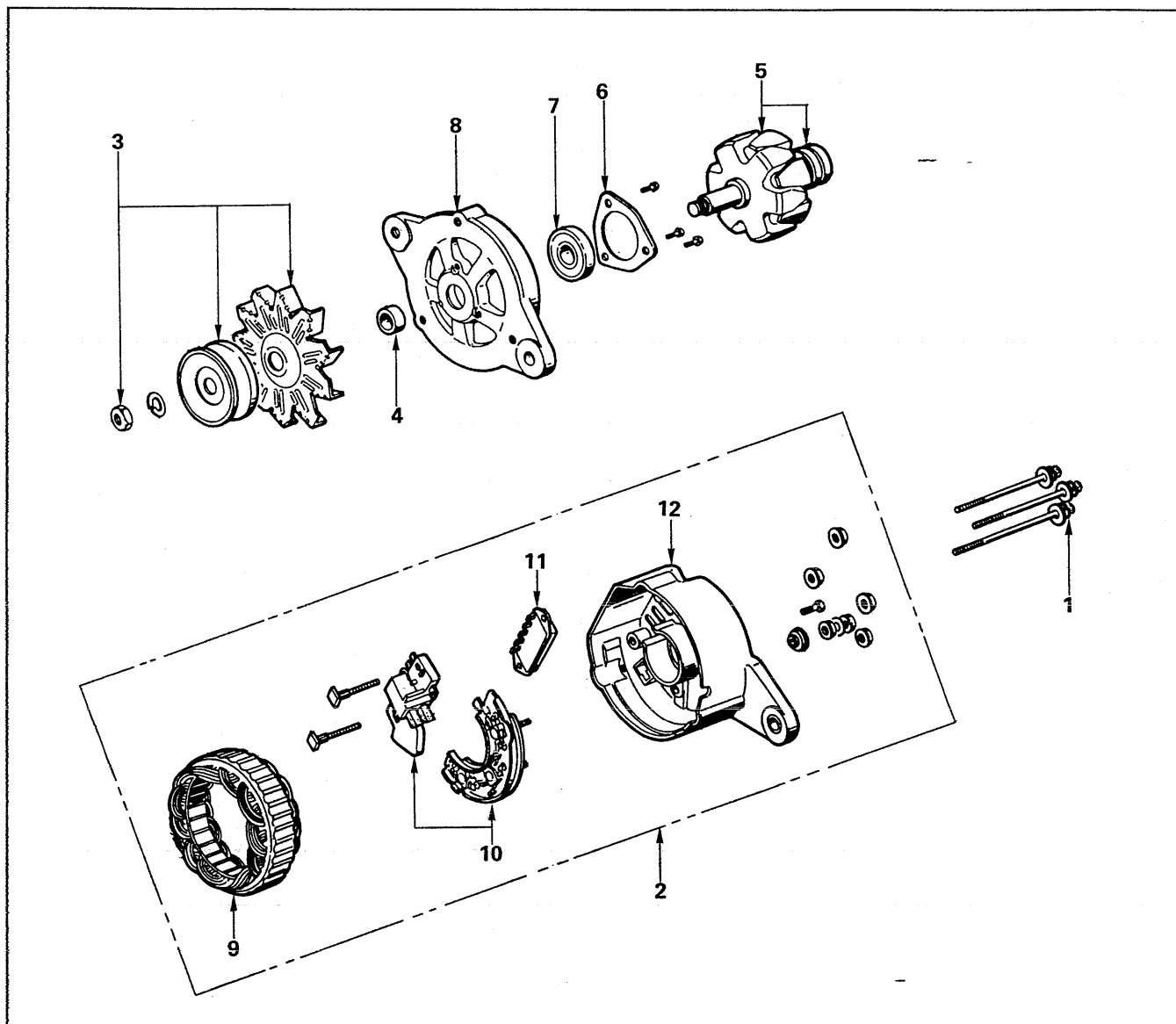
The alternator consists of the front cover, the rotor, the stator, the built-in IC regulator (some engines use a Tirrell alternator with separate regulator), and the rear cover.

This small size and light weight alternator provides excellent reliability. Its simple construction makes it very easy to service. The built-in IC regulator minimizes circuit wiring.



## DISASSEMBLY

These disassembly steps are based on the built-in IC regulator type.

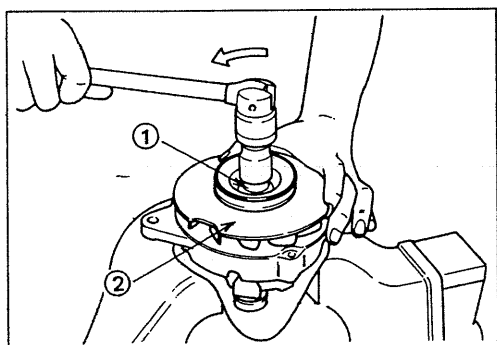


## Disassembly Steps

- |                          |                                   |
|--------------------------|-----------------------------------|
| 1. Through bolt          | 7. Ball bearing                   |
| 2. Rear cover and stator | 8. Front cover                    |
| ▲ 3. Pulley and fan      | ▲ 9. Stator                       |
| ▲ 4. Spacer collar       | ▲ 10. Rectifier with brush holder |
| 5. Rotor with bearing    | 11. IC regulator                  |
| 6. Bearing retainer      | 12. Rear cover                    |

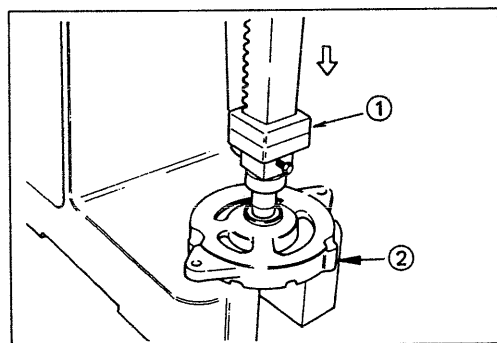


## Important Operations



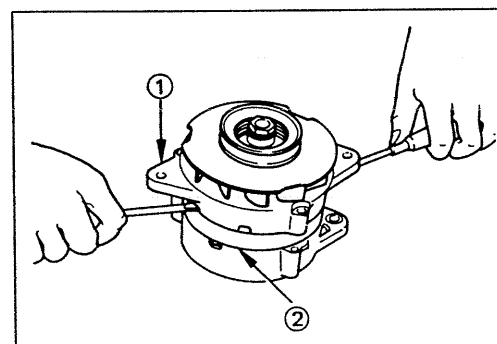
### 3. Pulley and Fan

- (1) Clamp the rotor shaft in a soft jaw vise.
- (2) Loosen the pulley lock nut ①.
- (3) Remove the pulley ② along with the spacer collar.



### 4. Rotor and Bearing

- (1) Use a plastic hammer or a press ① to remove the rotor from the front cover ②.
- (2) Remove the spacer collar.

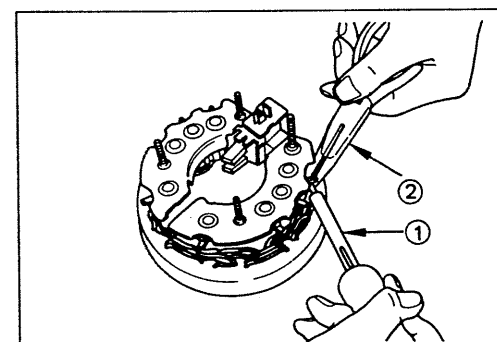


### 8. Front Cover

Use screwdrivers to pry the front cover ① from the stator ②.

#### Note:

**Do not attempt to pry the coil wires from the stator.**



### 9. Stator

#### 10. Rectifier with Brush Holder

Use a soldering iron ① and a pair of long nose pliers ② to remove the rectifiers.

#### Note:

**Hold the rectifier leads between the rectifier and the soldering iron with the long nose pliers. This will protect the rectifier from the heat.**

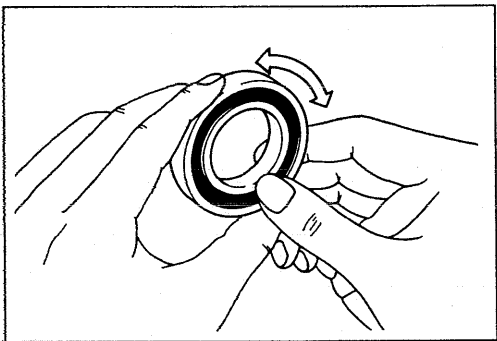


INSPECTION AND REPAIR

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

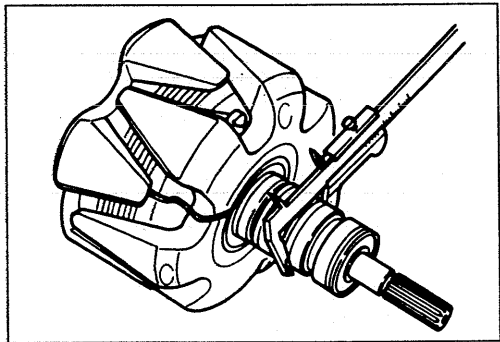
ROTOR AND BEARING

Check the face of the slip rings for contamination and roughness. If found to be roughened, dress with a fine sand paper (#500 – 600). If found to be contaminated, clean with a cloth saturated with alcohol.



Ball Bearing

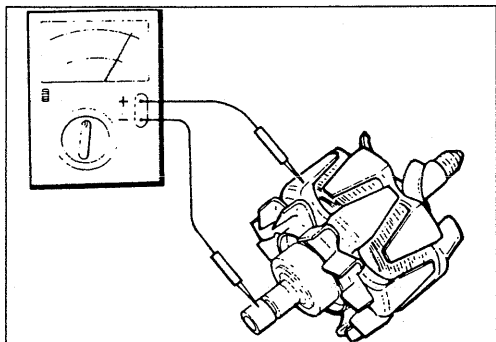
Check that the ball bearings rotate smoothly.  
If the ball bearings are noisy, they must be replaced.



Use a vernier caliper to measure the slip ring outside diameter.

If the measured value exceeds the limit, the rotor must be replaced.

| Slip Ring Outside Diameter |             | mm(in.) |
|----------------------------|-------------|---------|
| Standard                   | Limit       |         |
| 31.6 (1.24)                | 30.6 (1.20) |         |



### Rotor Coil Continuity Test

Use an circuit tester to test the rotor coil continuity.

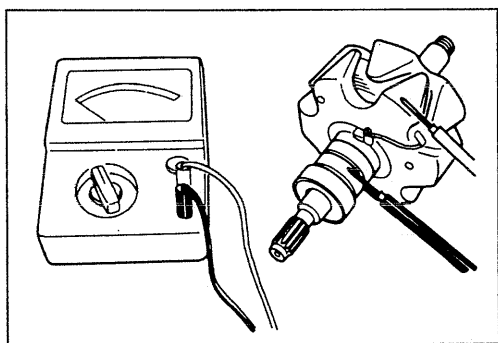
1. Touch both circuit tester probes to the rotor coil slip rings.
2. Note the circuit tester reading.

The circuit tester should register approximately 9 ohms.

3. If the circuit tester does not show continuity, check the connections between the lead wire and the slip rings.

If breaks are founded, repair and repeat the rotor coil continuity test.

If there is still no rotor coil continuity, the rotor must be replaced.



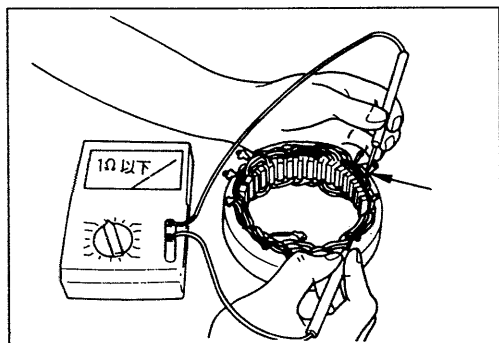
### Rotor Coil Ground Test

Use an circuit tester to test the rotor coil for grounding.

1. Touch one of the circuit tester probes to the rotor shaft.
2. Touch the other circuit tester probe to one of slip rings.
3. Note the circuit tester reading.
4. Touch the circuit tester probe to the other slip ring.
5. Note the circuit tester reading.

The circuit tester should show infinity (no needle movement) at both measuring points.

If the circuit tester does not show infinity (the needle moves) at both measuring points, the rotor is grounded and must be replaced.



## STATOR COIL

### Stator Coil Continuity Test

Use an circuit tester to test the stator coil continuity.

1. Touch the circuit tester probes to two of the bare stator wires.
2. Note the circuit tester reading.
3. Move one of the circuit tester probes to a third wire.

## 4. Note the circuit tester reading.

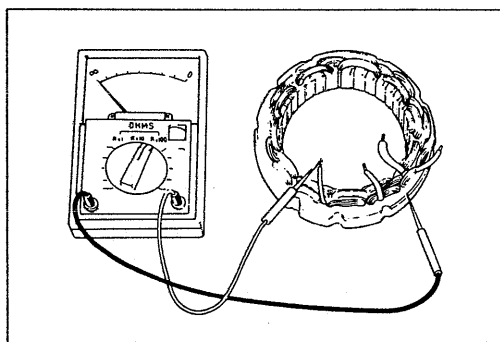
If the two readings (Steps 2 and 4) are identical, the stator coil has continuity.

If the two circuit tester readings are different, there is no stator continuity.

## 5. Check the neutral junction (arrow mark) for breaks.

If breaks are found, repair and repeat the stator coil continuity test.

If there is still no stator coil continuity, the stator must be replaced.



## Stator Coil Ground Test

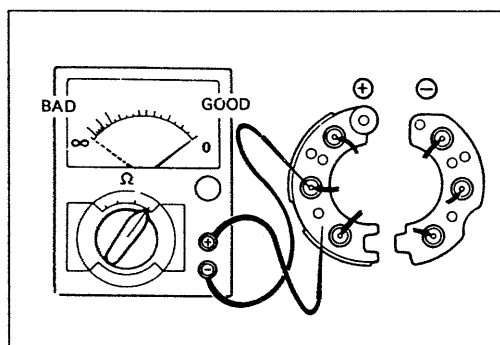


Use an circuit tester to test the stator coil for grounding.

1. Touch one circuit tester probe to the bare metal surface of the stator.
2. Touch the other circuit tester probe to a bare stator lead wire.
3. Note the circuit tester reading.

The circuit tester should show infinity (no needle movement).

If the circuit tester shows a value other than infinity (the needle moves), the stator is grounded and must be replaced.



## RECTIFIER

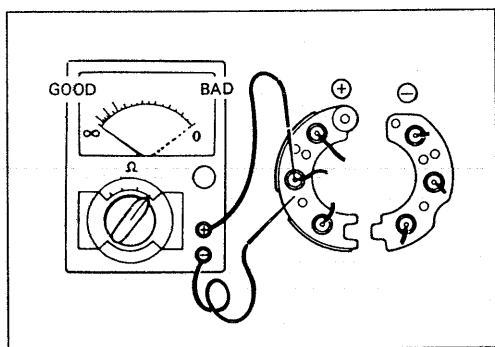
### Rectifier (Positive Diode) Continuity Test



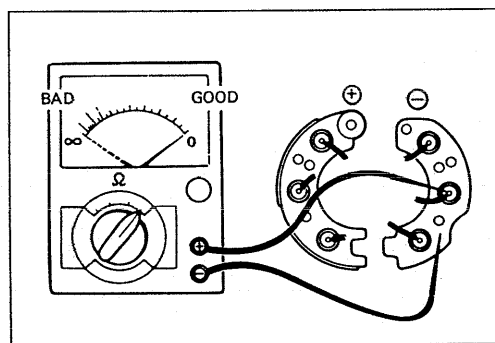
Use an circuit tester to test rectifier continuity.

1. Touch the circuit tester positive probe to the rectifier holder.
2. Touch the circuit tester negative probe to each of the diode terminals in turns.

3. Note the meter reading for each diode terminal.  
All of the diode should show continuity.  
If a diode shows no continuity, it is open circuit. The rectifier assembly must be replaced.



4. Touch the circuit tester negative probe to the rectifier holder.
5. Touch the circuit tester positive probe to each of the diode terminals in turn.
6. Note the meter reading for each diode terminal.  
None of the diodes should show continuity.  
If a diode shows continuity, it is shorted. The rectifier assembly must be replaced.

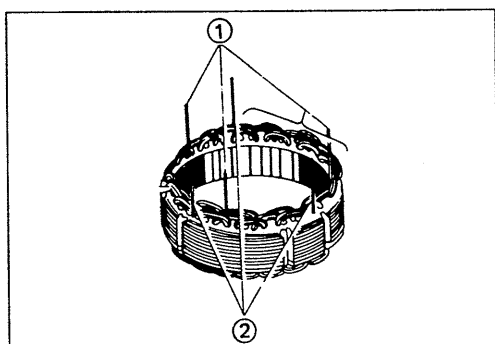
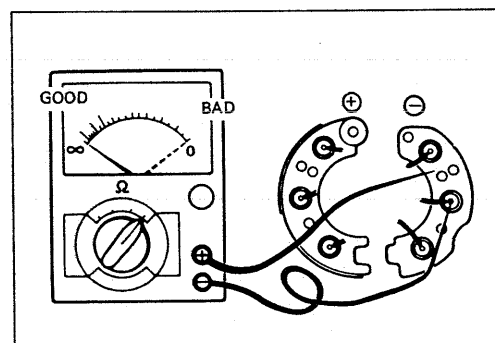


### Rectifier (Negative Diode) Continuity Test



Use a circuit tester to test the rectifier continuity.

1. Touch the circuit tester negative probe to the rectifier holder.
2. Touch the circuit tester positive probe to each of the diode terminals in turn.
3. Note the meter reading for each diode terminal.  
All of the diode should show continuity.  
If a diode shows no continuity, it is open. The rectifier assembly must be replaced.
4. Touch the circuit tester positive probe to the rectifier holder.
5. Touch the circuit tester negative probe to each of the diode terminals in turn.
6. Note the meter reading for each diode terminal.  
None of the diode should show continuity.  
If a diode shows continuity, it is shorted. The rectifier assembly must be replaced.



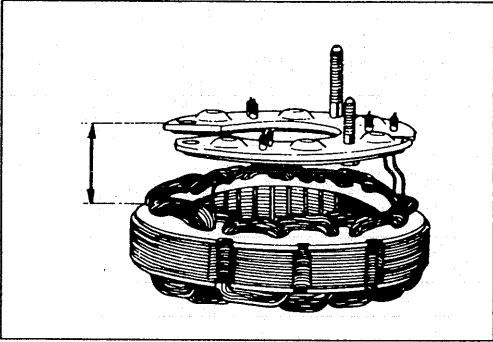
### Rectifier Assembly Replacement Procedure



Use the Rectifier Service Kit to replace the rectifier assembly in the following steps.

1. Connect the three inside lead wires to the "N" terminals ①.
2. Connect the three outside lead wires ② to the outside terminals.
3. Wind the stator lead wires around the rectifier lead wires (included in the Rectifier Service Kit) and solder them.





**Note:**



1. The stator lead wires must be cut to the proper length before they are connected to the rectifier lead wires. If the stator lead wires are too long or too short, trouble may occur.

| Stator Lead Wire Length | mm(in.) |
|-------------------------|---------|
| 33.5 (1.32)             |         |

2. Take care not to damage the rectifier paint surfaces.



**BRUSH**

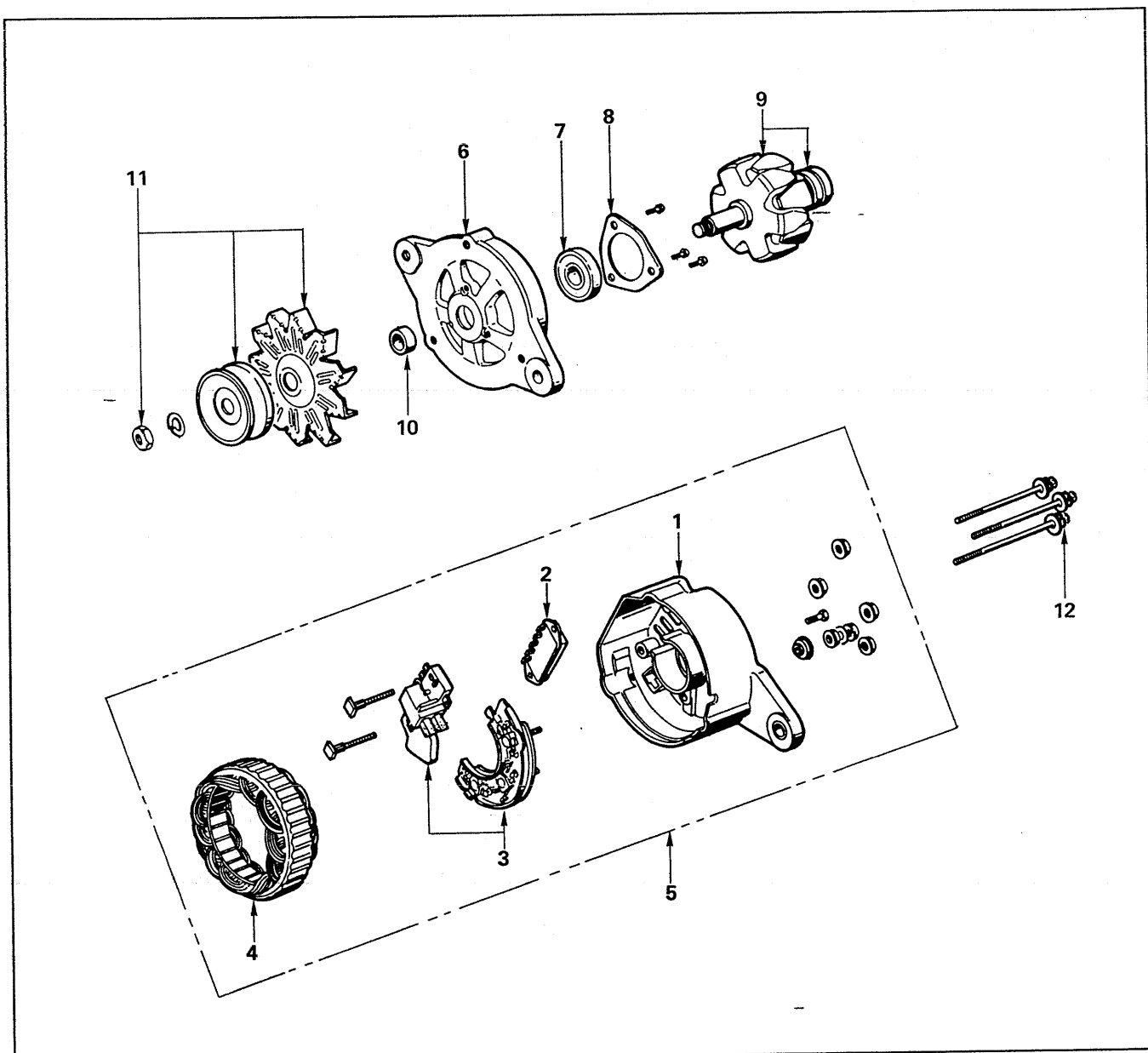
Use a vernier caliper to measure the brush.  
If the measured value exceeds the limit, the brush must be replaced.

| Brush Length  | mm(in.)     |            |
|---------------|-------------|------------|
|               | Standard    | Limit      |
| 8-94423-756-0 | 14.5 (0.57) | 7.5 (0.30) |

Brushes are provided with a line which indicates the limit of usage.



## REASSEMBLY

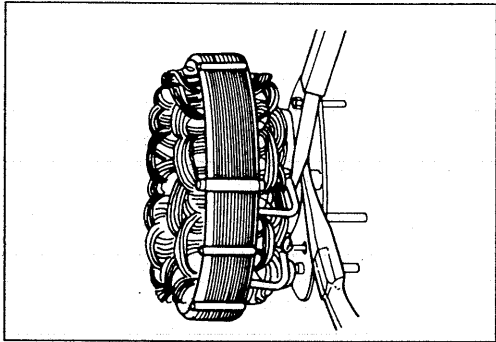


## Reassembly Steps

- |                                  |                       |
|----------------------------------|-----------------------|
| 1. Rear cover                    | ▲ 7. Ball bearing     |
| 2. IC regulator                  | 8. Bearing retainer   |
| ▲ 3. Rectifier with brush holder | 9. Rotor with bearing |
| ▲ 4. Stator                      | 10. Spacer collar     |
| 5. Rear cover and stator         | ▲ 11. Pulley and fan  |
| 6. Front cover                   | 12. Through bolt      |



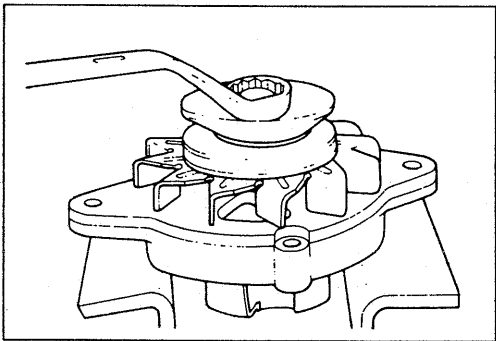
Important Operations



3. Rectifier with Brush Holder

4. Stator

When connecting stator coil leads and diode leads using solder, use long-nose pliers and finish the work as quickly as possible to prevent the heat from being transferred to the diodes.



11. Pulley and Fan

Tighten the pulley and fan to the specified torque.



Pulley and Fan Nut Torque kg·m(lb.ft./N·m)

5.0 – 6.5 (36 – 47/49 – 64)

## SECTION 10

# TROUBLESHOOTING

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| ITEM                             | PAGE |
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## **TROUBLESHOOTING**

Refer to this Section to quickly diagnose and repair engine problems.

Each troubleshooting chart has three headings arranged from left to right.

(1) Checkpoint (2) Trouble Cause (3) Countermeasure

This Section is divided into ten sub-sections:

1. Hard Starting
  - 1) Starter inoperative
  - 2) Starter operates but engine does not turn over
  - 3) Engine turns over but does not start
2. Unstable Idling
3. Insufficient Power
4. Excessive Fuel Consumption
5. Excessive Oil Consumption
6. Overheating
7. White Exhaust Smoke
8. Dark Exhaust Smoke
9. Oil Pressure Does Not Rise
10. Abnormal Engine Noise

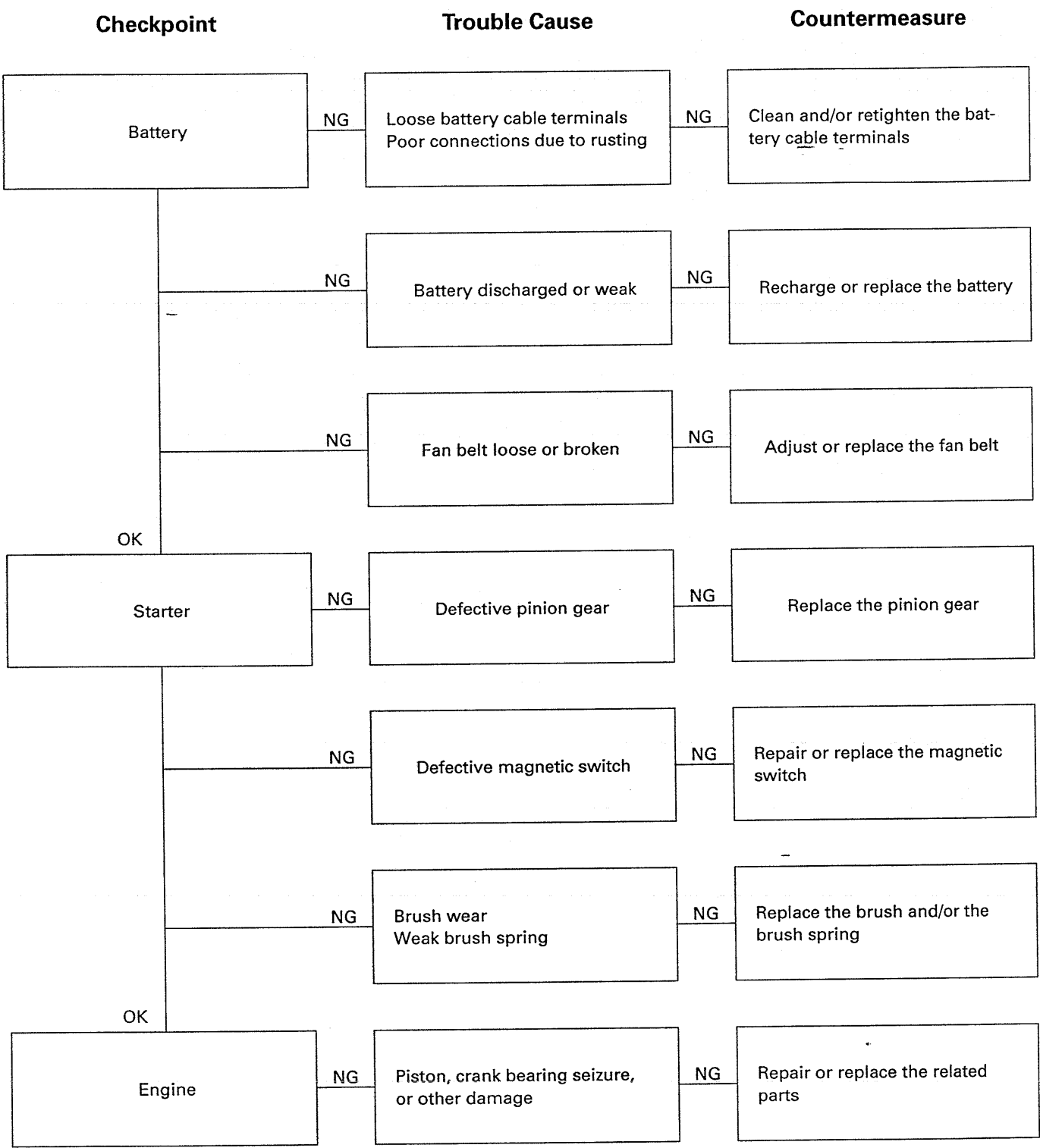
# 1. HARD STARTING

## 1. STARTER INOPERATIVE

| Checkpoint                      |    | Trouble Cause                                                    |    | Countermeasure                                     |
|---------------------------------|----|------------------------------------------------------------------|----|----------------------------------------------------|
| Neutral switch (If so equipped) | NG | Defective neutral switch                                         | NG | Replace the neutral switch                         |
| Battery                         | NG | Loose battery cable terminals<br>Poor connections due to rusting | NG | Clean and/or retighten the battery cable terminals |
|                                 | NG | Battery discharged or weak                                       | NG | Recharge or replace the battery                    |
|                                 | NG | Fan belt loose or broken                                         | NG | Adjust or replace the fan belt                     |
|                                 | OK |                                                                  |    |                                                    |
| Fusible link                    | NG | Fusible link shorted                                             | NG | Replace the fusible link                           |
| Starter switch                  | NG | Defective starter switch or starter relay                        | NG | Replace the starter switch or the starter relay    |
|                                 | OK |                                                                  |    |                                                    |
| Starter                         | NG | Defective magnetic switch or starter relay                       | NG | Repair or replace the magnetic switch              |
| Starter                         | NG | Defective starter                                                | NG | Repair or replace the starter motor                |
|                                 | OK |                                                                  |    |                                                    |

1. HARD STARTING

2. STARTER OPERATES BUT ENGINE DOES NOT TURN OVER



# 1. HARD STARTING

## 3. ENGINE TURNS OVER BUT DOES NOT START

| Checkpoint            |    | Trouble Cause                                                                   |    | Countermeasure                                               |
|-----------------------|----|---------------------------------------------------------------------------------|----|--------------------------------------------------------------|
| Engine stop mechanism | NG | Defective engine stop mechanism 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            |
| Fuel system | OK |                                                              |    |                                                                         |
|             | NG | Air in the fuel system                                       | NG | Bleed the air from the fuel system                                      |

Continued on the next page



1. HARD STARTING

3. ENGINE TURNS OVER BUT DOES NOT START

FUEL IS BEING DELIVERED TO THE INJECTION PUMP

| Checkpoint                       |    | Trouble Cause                                                                    |    | Countermeasure                                    |
|----------------------------------|----|----------------------------------------------------------------------------------|----|---------------------------------------------------|
| Continued from the previous page |    |                                                                                  |    |                                                   |
| OK                               |    |                                                                                  |    |                                                   |
| Injection nozzle                 | NG | Injection nozzle injection starting pressure too low<br>Improper spray condition | NG | Adjust or replace the injection nozzle            |
| OK                               |    |                                                                                  |    |                                                   |
| Injection pump                   | NG | Defective fuel injection nozzle resulting in fuel drippage after fuel injection  | NG | Replace the delivery valve                        |
|                                  | NG | Defective injection pump control rack operation                                  | NG | Repair or replace the injection pump control rack |
|                                  | NG | Injection pump plunger worn or stuck                                             | NG | Replace the injection pump plunger assembly       |
| OK                               |    |                                                                                  |    |                                                   |
| Injection pump (VE pump)         | NG | Injection pump drive shaft seizure or other damage                               | NG | Replace the injection pump drive shaft            |
|                                  | NG | Injection pump governor spring seizure                                           | NG | Replace the injection pump governor spring        |

## 2. UNSTABLE IDLING

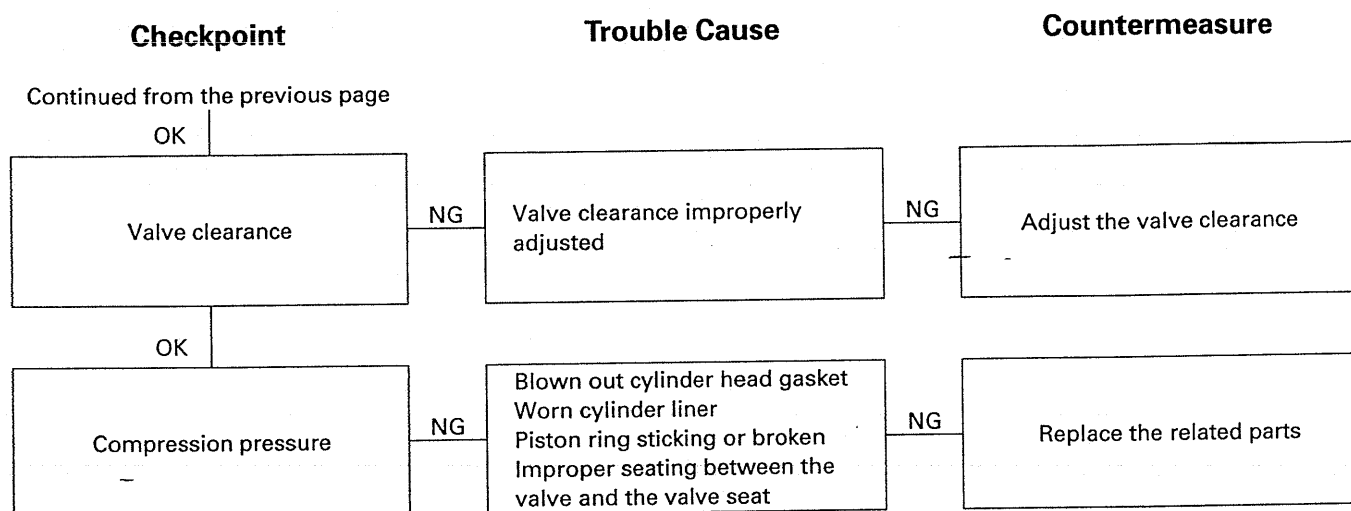
| Checkpoint                       |    | Trouble Cause                                  |    | Countermeasure                                               |
|----------------------------------|----|------------------------------------------------|----|--------------------------------------------------------------|
| Idling system                    | NG | Idling improperly adjusted                     | NG | Adjust the idling                                            |
| OK                               |    |                                                |    |                                                              |
| Fast idling speed control device | NG | Defective fast idling speed control device     | NG | Repair or replace the fast idling speed control device       |
| OK                               |    |                                                |    |                                                              |
| Accelerator control system       | NG | Accelerator control system improperly adjusted | NG | Adjust the accelerator control system                        |
| OK                               |    |                                                |    |                                                              |
| Fuel system                      | NG | Fuel system leakage or blockage                | NG | Repair or replace the fuel system                            |
|                                  | NG | Air in the fuel system                         | NG | Bleed the air from the fuel system                           |
|                                  | NG | Water particles in the fuel system             | NG | Change the fuel                                              |
| OK                               |    |                                                |    |                                                              |
| Fuel filter                      | NG | Clogged fuel filter element                    | NG | Replace the fuel filter element or the fuel filter cartridge |

Continued on the next page

2. UNSTABLE IDLING

| Checkpoint                       | Trouble Cause |                                                    | Countermeasure |                                       |
|----------------------------------|---------------|----------------------------------------------------|----------------|---------------------------------------|
| Continued from the previous page |               |                                                    |                |                                       |
| OK                               |               |                                                    |                |                                       |
| Injection pump                   | NG            | Defective governor lever operation                 | NG             | Repair or replace the governor lever  |
|                                  | NG            | Regulator valve improperly adjusted (VE pump only) | NG             | Adjust or replace the regulator valve |
|                                  | NG            | Broken plunger spring                              | NG             | Replace the plunger spring            |
|                                  | NG            | Worn plunger                                       | NG             | Replace the plunger assembly          |
|                                  | NG            | Worn camshaft (In-line pump only)                  | NG             | Replace the camshaft                  |
|                                  | NG            | Worn roller tappet (In-line pump only)             | NG             | Replace the roller tappet             |
|                                  | NG            | Worn cam disc (VE pump only)                       | NG             | Replace the cam disc                  |
| Continued on the next page       |               |                                                    |                |                                       |

## 2. UNSTABLE IDLING



3. INSUFFICIENT POWER

| Checkpoint           |    | Trouble Cause                                                                    |    | Countermeasure                                               |
|----------------------|----|----------------------------------------------------------------------------------|----|--------------------------------------------------------------|
| Air cleaner          | NG | Clogged air cleaner element                                                      | NG | Clean or replace the air cleaner element                     |
| OK                   |    |                                                                                  |    |                                                              |
| Fuel                 | NG | Water particles in the fuel                                                      | NG | Replace the fuel                                             |
| OK                   |    |                                                                                  |    |                                                              |
| Fuel filter          | NG | Clogged fuel filter element                                                      | NG | Replace the fuel filter element or the fuel filter cartridge |
| OK                   |    |                                                                                  |    |                                                              |
| Fuel feed pump       | NG | Defective fuel feed pump                                                         | NG | Repair or replace the fuel feed pump                         |
| OK                   |    |                                                                                  |    |                                                              |
| Injection nozzle     | NG | Injection nozzle sticking                                                        | NG | Replace the injection nozzle                                 |
|                      | NG | Injection nozzle injection starting pressure too low<br>Improper spray condition | NG | Adjust or replace the injection nozzle                       |
| OK                   |    |                                                                                  |    |                                                              |
| Fuel injection pipes | NG | Fuel injection pipes damaged or obstructed                                       | NG | Replace the fuel injection pipes                             |

Continued on the next page

### 3. INSUFFICIENT POWER

#### Checkpoint

#### Trouble Cause

#### Countermeasure

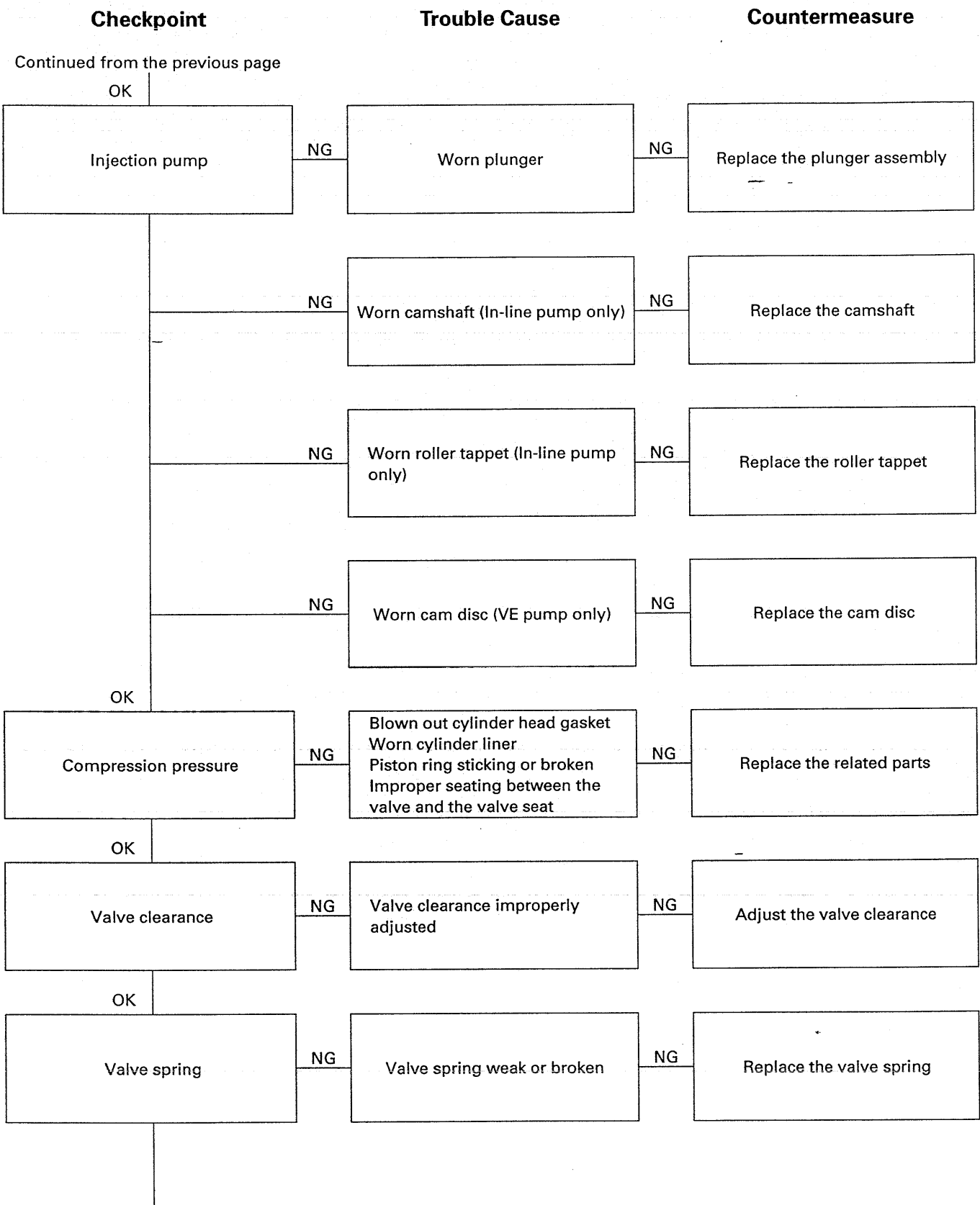
Continued from the previous page

OK

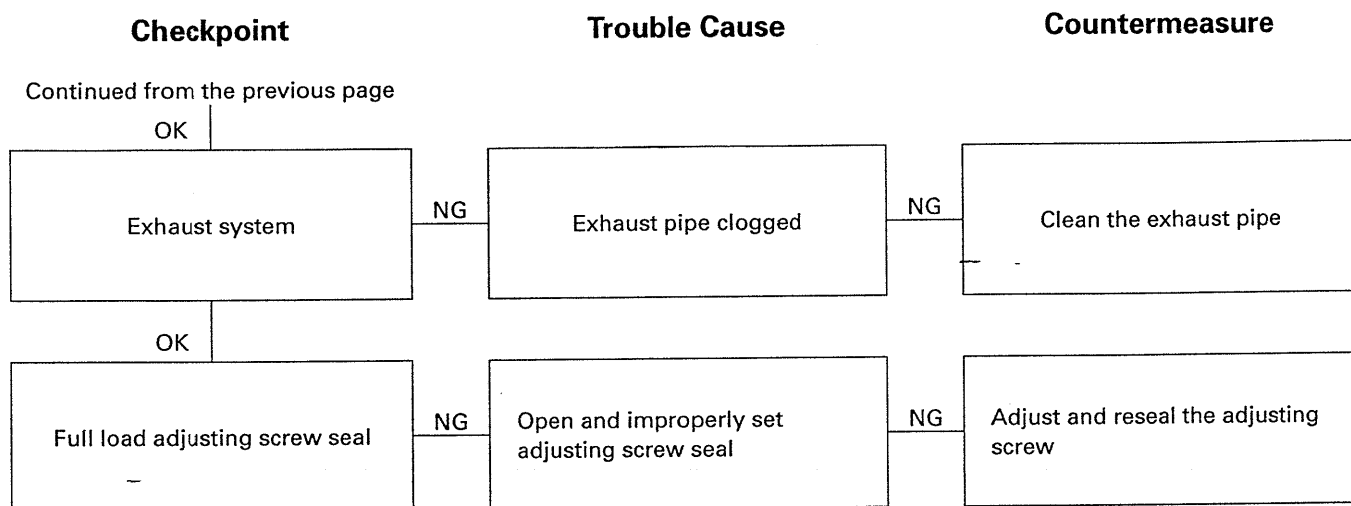
|                |    |                                              |    |                                                                           |
|----------------|----|----------------------------------------------|----|---------------------------------------------------------------------------|
| Injection pump | NG | Defective regulating valve<br>(VE pump only) | NG | Repair or replace the regulating valve                                    |
|                | NG | Defective delivery valve                     | NG | Replace the delivery valve                                                |
|                | NG | Defective timer                              | NG | Repair or replace the timer                                               |
|                | NG | Worn cam disc (VE pump only)                 | NG | Replace the cam disc                                                      |
|                | NG | Improper control lever operation             | NG | Adjust or replace the control lever                                       |
|                | NG | Defective injection timing                   | NG | Adjust the injection timing<br>Repair or replace the injection pump timer |
|                | NG | Weak governor spring                         | NG | Replace the governor spring                                               |

Continued on the next page

3. INSUFFICIENT POWER



### 3. INSUFFICIENT POWER



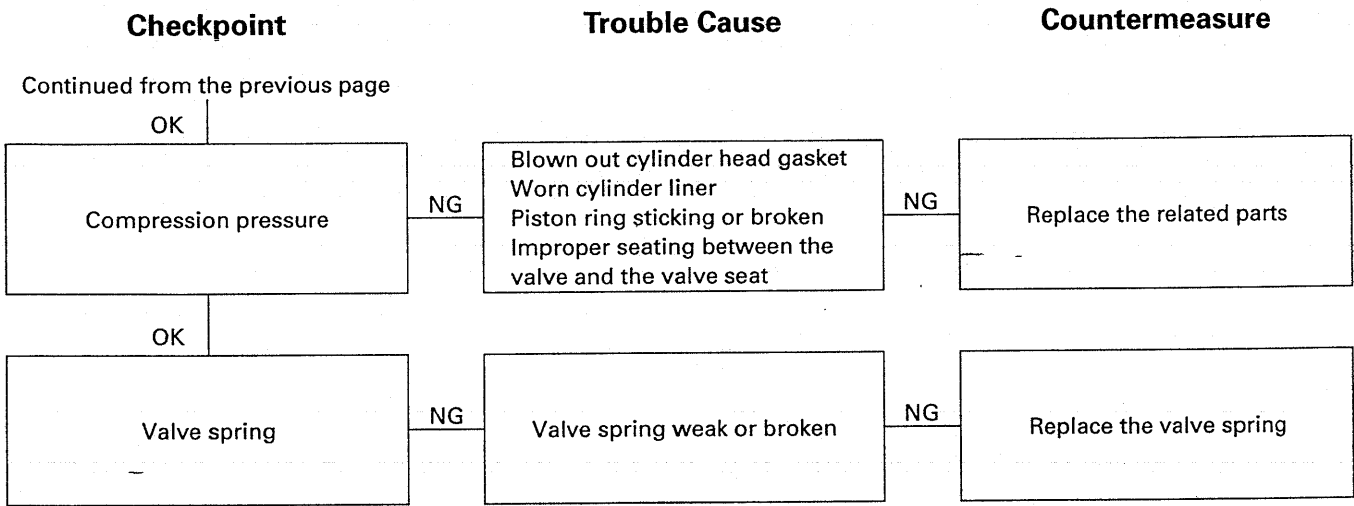


4. EXCESSIVE FUEL CONSUMPTION

| Checkpoint            |    | Trouble Cause                                                                    |    | Countermeasure                                  |
|-----------------------|----|----------------------------------------------------------------------------------|----|-------------------------------------------------|
| Fuel system           | NG | Fuel leakage                                                                     | NG | Repair or replace the fuel system related parts |
| OK                    |    |                                                                                  |    |                                                 |
| Air cleaner           | NG | Clogged air cleaner element                                                      | NG | Clean or replace the air cleaner element        |
| OK                    |    |                                                                                  |    |                                                 |
| Idling speed          | NG | Poorly adjusted idling speed                                                     | NG | Adjust the idling speed                         |
| OK                    |    |                                                                                  |    |                                                 |
| Injection nozzle      | NG | Injection nozzle injection starting pressure too low<br>Improper spray condition | NG | Adjust or replace the injection nozzle          |
| OK                    |    |                                                                                  |    |                                                 |
| Fuel injection timing | NG | Fuel injection timing improperly adjusted                                        | NG | Adjust the fuel injection timing                |
| OK                    |    |                                                                                  |    |                                                 |
| Injection pump        | NG | Defective delivery valve resulting is fuel drippage after fuel injection         | NG | Replace the delivery valve                      |
| OK                    |    |                                                                                  |    |                                                 |
| Valve clearance       | NG | Valve clearance improperly adjusted                                              | NG | Adjust the valve clearance                      |

Continued on the next page

4. EXCESSIVE FUEL CONSUMPTION



5. EXCESSIVE OIL CONSUMPTION

| Checkpoint                              |    | Trouble Cause                                                  |    | Countermeasure                                               |
|-----------------------------------------|----|----------------------------------------------------------------|----|--------------------------------------------------------------|
| Engine oil                              | NG | Engine oil unsuitable<br>Too much engine oil                   | NG | Replace the engine oil<br>Correct the engine oil volume      |
| OK                                      |    |                                                                |    |                                                              |
| Oil seal and gasket                     | NG | Oil leakage from the oil seal<br>and/or the gasket             | NG | Replace the oil seal and/or the<br>gasket                    |
| OK                                      |    |                                                                |    |                                                              |
| Air breather                            | NG | Clogged air breather                                           | NG | Clean the air breather                                       |
| OK                                      |    |                                                                |    |                                                              |
| Inlet and exhaust valves<br>Valve seals | NG | Defective valve seals<br>Worn valves stems and valve<br>guides | NG | Replace the valve seals, the<br>valves, and the valve guides |
| OK                                      |    |                                                                |    |                                                              |
| Piston rings                            | NG | Piston rings worn, broken or<br>improperly installed           | NG | Replace the piston rings or<br>properly install              |
| OK                                      |    |                                                                |    |                                                              |
| Cylinder liners                         | NG | Cylinder lines scored or<br>worn                               | NG | Replace the cylinder liners                                  |

## 6. OVERHEATING

| Checkpoint                                  |    | Trouble Cause                                    |    | Countermeasure                                      |
|---------------------------------------------|----|--------------------------------------------------|----|-----------------------------------------------------|
| Cooling water                               | NG | Insufficient cooling water                       | NG | Replenish the cooling water                         |
| OK                                          |    |                                                  |    |                                                     |
| Fan coupling (if so equipped)               | NG | Oil leakage from the fan coupling                | NG | Replace the fan coupling                            |
| 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                              |

Continued on the next page

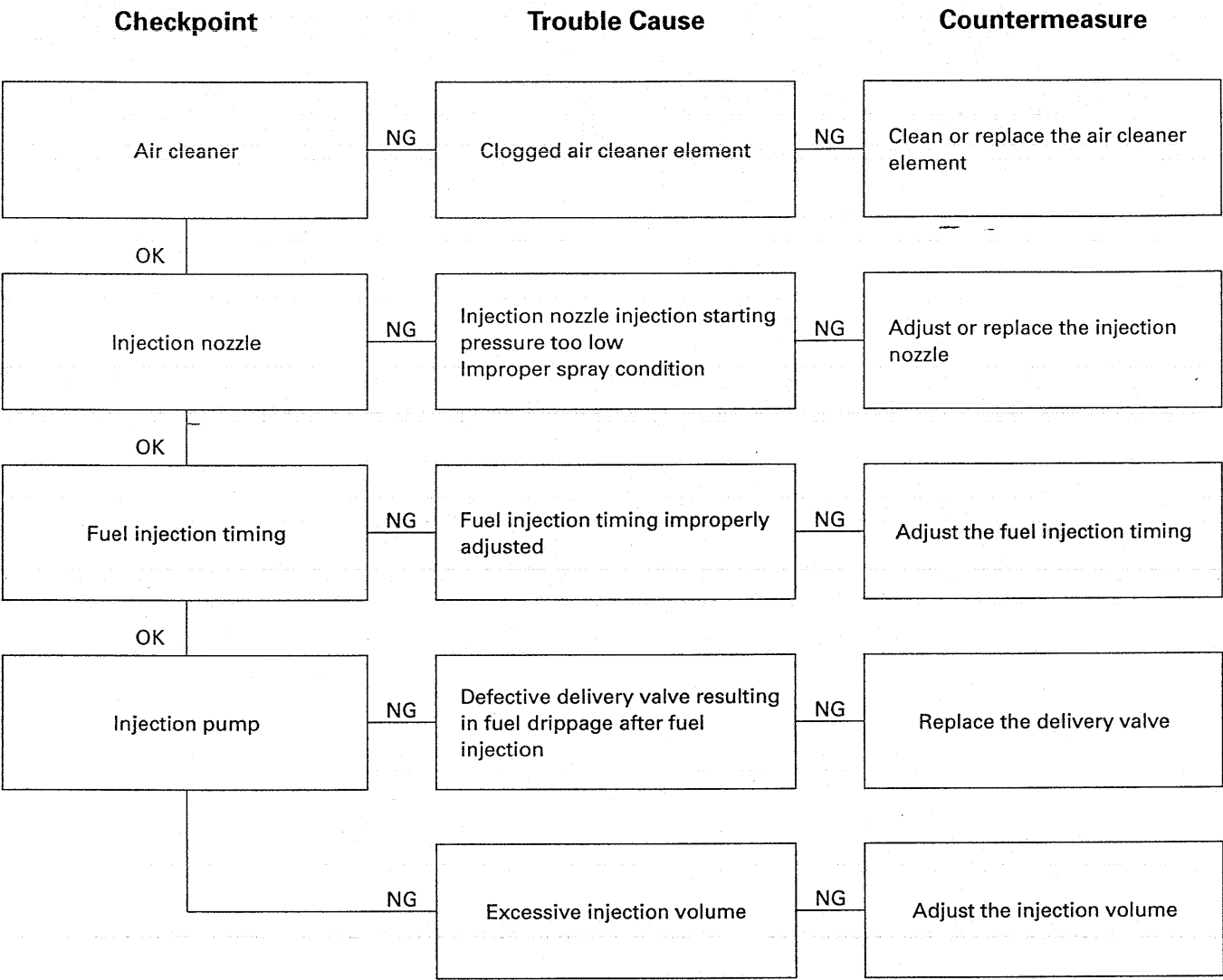
6. OVERHEATING

| Checkpoint                       | Trouble Cause |                                            | Countermeasure                                           |
|----------------------------------|---------------|--------------------------------------------|----------------------------------------------------------|
| Continued from the previous page |               |                                            |                                                          |
| OK                               |               |                                            |                                                          |
| Cooling system                   | NG            | Cooling system clogged by foreign material | NG<br>Clean the foreign material from the cooling system |
| OK                               |               |                                            |                                                          |
| Fuel injection timing            | NG            | Fuel injection timing improperly adjusted  | NG<br>Adjust the fuel injection timing                   |

## 7. WHITE EXHAUST SMOKE

| Checkpoint                              |    | Trouble Cause                                                                                                                                    |    | Countermeasure                                            |
|-----------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------|----|-----------------------------------------------------------|
| Fuel                                    | NG | Water particles in the fuel                                                                                                                      | NG | Replace the fuel                                          |
| OK                                      |    |                                                                                                                                                  |    |                                                           |
| Fuel injection timing                   | NG | Delayed fuel injection timing                                                                                                                    | NG | Adjust the fuel injection timing                          |
| OK                                      |    |                                                                                                                                                  |    |                                                           |
| Compression pressure                    | NG | Blown out cylinder head gasket<br>Worn cylinder liner<br>Piston ring sticking or broken<br>Improper seating between the valve and the valve seat | NG | Replace the related parts                                 |
| OK                                      |    |                                                                                                                                                  |    |                                                           |
| Inlet and exhaust valves<br>Valve seals | NG | Defective valve seals<br>Worn valves stems and valve guides                                                                                      | NG | Replace the valve seals, the valves, and the valve guides |
| OK                                      |    |                                                                                                                                                  |    |                                                           |
| Piston rings                            | NG | Piston rings worn, broken or improperly installed                                                                                                | NG | Replace the piston rings or properly install              |
| OK                                      |    |                                                                                                                                                  |    |                                                           |
| Cylinder liners                         | NG | Cylinder lines scored or worn                                                                                                                    | NG | Replace the cylinder liners                               |

8. DARK EXHAUST SMOKE



## 9. OIL PRESSURE DOES NOT RISE

| Checkpoint                                                 |    | Trouble Cause                                                     |    | Countermeasure                                                                  |
|------------------------------------------------------------|----|-------------------------------------------------------------------|----|---------------------------------------------------------------------------------|
| Engine oil                                                 | NG | Improper viscosity engine oil<br>Too much engine oil              | NG | Replace the engine oil<br>Correct the engine oil volume                         |
| OK                                                         |    |                                                                   |    |                                                                                 |
| Oil pressure gauge or unit<br>Oil pressure indicator light | NG | Defective oil pressure gauge or unit<br>Defective indicator light | NG | Repair or replace the oil pressure gauge or unit<br>Replace the indicator light |
| OK                                                         |    |                                                                   |    |                                                                                 |
| Oil filter                                                 | NG | Clogged oil filter element                                        | NG | Replace the oil filter element or the oil filter cartridge                      |
| OK                                                         |    |                                                                   |    |                                                                                 |
| Relief valve and by-pass valve                             | NG | Relief valve sticking and/or weak by-pass valve spring            | NG | Replace the relief valve and/or the by-pass valve spring                        |
| OK                                                         |    |                                                                   |    |                                                                                 |
| Oil pump                                                   | NG | Clogged oil pump strainer                                         | NG | Clean the oil pump strainer                                                     |
|                                                            | NG | Worn oil pump related parts                                       | NG | Replace the oil pump related parts                                              |
| OK                                                         |    |                                                                   |    |                                                                                 |
| Rocker arm shaft                                           | NG | Worn rocker arm bushing                                           | NG | Replace the rocker arm bushing                                                  |

Continued on the next page



9. OIL PRESSURE DOES NOT RISE

| Checkpoint                       |    | Trouble Cause                      |    | Countermeasure                                 |
|----------------------------------|----|------------------------------------|----|------------------------------------------------|
| Continued from the previous page |    |                                    |    |                                                |
| OK                               |    |                                    |    |                                                |
| Camshaft                         | NG | Worn camshaft and camshaft bearing | NG | Replace the camshaft and the camshaft bearings |
| OK                               |    |                                    |    |                                                |
| Crankshaft and bearings          | NG | Worn crankshaft and bearings       | NG | Replace the crankshaft and/or the bearings     |

## 10. ABNORMAL ENGINE NOISE

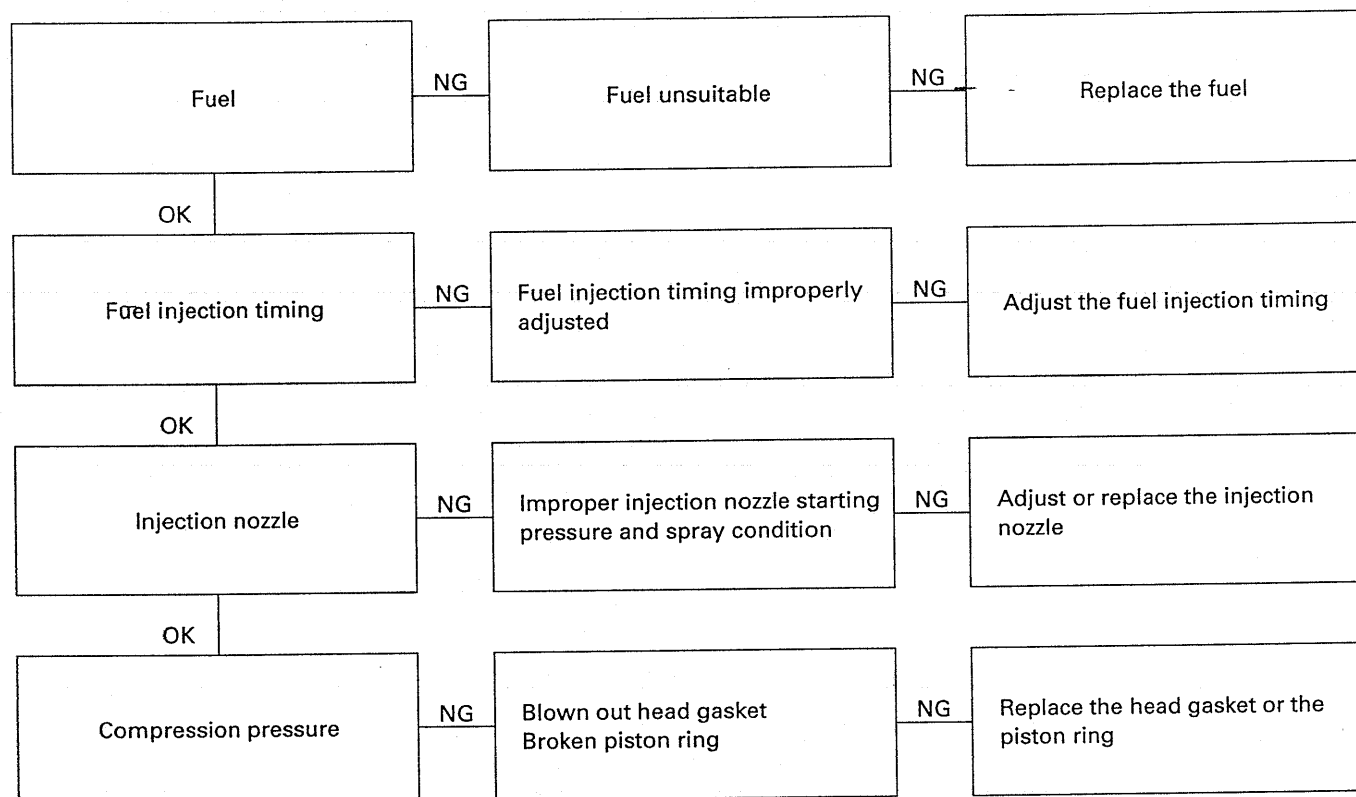
### 1. Engine Knocking

#### Checkpoint

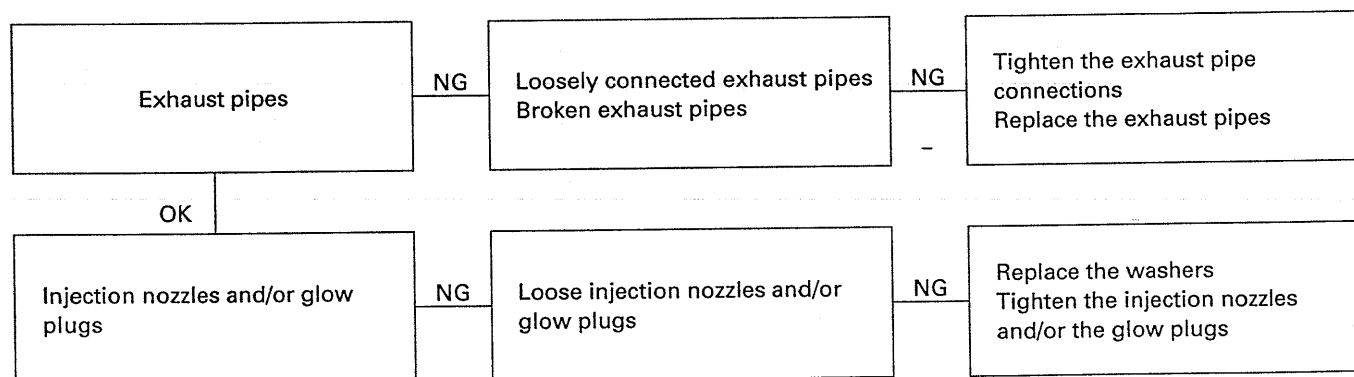
#### Trouble Cause

#### Countermeasure

Check to see that the engine has been thoroughly warmed up before beginning the troubleshooting procedure.



### 2. Gas Leakage Noise



Continued on the next page

10. ABNORMAL ENGINE NOISE

2. Gas Leakage Noise

| Checkpoint                       |    | Trouble Cause                                        |    | Countermeasure                           |
|----------------------------------|----|------------------------------------------------------|----|------------------------------------------|
| Continued from the previous page |    |                                                      |    |                                          |
| OK                               |    |                                                      |    |                                          |
| Exhaust manifold                 | NG | Loosely connected exhaust manifold and/or glow plugs | NG | Tighten the exhaust manifold connections |
| OK                               |    |                                                      |    |                                          |
| Cylinder head gasket             | NG | Damaged cylinder head gasket                         | NG | Replace the cylinder head gasket         |

3. Continuous Noise

|                           |    |                                     |    |                                                     |
|---------------------------|----|-------------------------------------|----|-----------------------------------------------------|
| Fan belt                  | NG | Loose fan belt                      | NG | Readjust the fan belt tension                       |
| OK                        |    |                                     |    |                                                     |
| Cooling fan               | NG | Loose cooling fan                   | NG | Retighten the cooling fan                           |
| OK                        |    |                                     |    |                                                     |
| Water pump bearing        | NG | Worn or damaged water pump bearing  | NG | Replace the water pump bearing                      |
| OK                        |    |                                     |    |                                                     |
| Alternator or vacuum pump | NG | Defective alternator or vacuum pump | NG | Repair or replace the alternator or the vacuum pump |
| OK                        |    |                                     |    |                                                     |
| Valve clearance           | NG | Valve clearance improperly adjusted | NG | Adjust the valve clearance                          |

## 10. ABNORMAL ENGINE NOISE

### 4. Slapping Noise

| Checkpoint                             |    | Trouble Cause                                                                 |    | Countermeasure                                            |
|----------------------------------------|----|-------------------------------------------------------------------------------|----|-----------------------------------------------------------|
| 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                 |

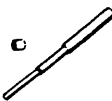
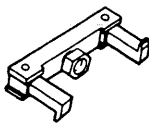
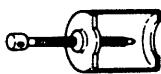
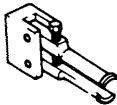
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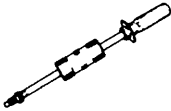
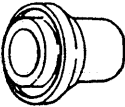
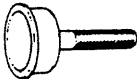
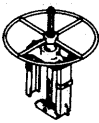
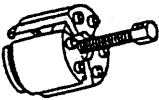
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**SECTION 11**

**SPECIAL TOOL LIST**

SPECIAL TOOL LIST

| ITEM NO. | ILLUSTRATION                                                                        | PART NO.      | PARTS NAME                               | PAGE     |
|----------|-------------------------------------------------------------------------------------|---------------|------------------------------------------|----------|
| 1        |    | 5-8840-2008-1 | Compression Gauge                        | 27       |
| 2        |    | 5-8531-7001-0 | Compression Gauge Adaptor                | 27       |
| 3        |    | 9-8523-1423-0 | Valve Spring Compressor                  | 44<br>89 |
| 4        |    | 9-8523-1212-0 | Valve Guide Replacer                     | 53<br>54 |
| 5        |  | 5-8840-2313-0 | Cylinder Liner Installer                 | 62       |
| 6        |  | 5-8840-2038-0 | Camshaft Bearing Replacer                | 67<br>68 |
| 7        |  | 5-8840-0086-0 | Camshaft Timing Gear<br>Universal Puller | 48<br>68 |
| 8        |  | 9-8840-2057-0 | Crankshaft Timing Gear<br>Remover        | 74       |
| 9        |  | 9-8522-0020-0 | Crankshaft Timing Gear<br>Installer      | 74       |
| 10       |  | 9-8840-2000-0 | Crankshaft Pilot Bearing<br>Remover      | 75       |

| ITEM NO. | ILLUSTRATION                                                                        | PART NO.      | PARTS NAME                          | PAGE |
|----------|-------------------------------------------------------------------------------------|---------------|-------------------------------------|------|
| 11       |    | 5-8840-0019-0 | Sliding Hammer                      | 75   |
| 12       |    | 5-8522-0024-0 | Crankshaft Pilot Bearing Installer  | 75   |
| 13       |    | 5-8840-2061-0 | Crankshaft Front Oil Seal Installer | 83   |
| 14       |    | 5-8840-2033-0 | Valve Stem Oil Seal Installer       | 89   |
| 15       |   | 5-8840-0141-0 | Crankshaft Rear Oil Seal Installer  | 102  |
| 16       |  | 5-8840-2304-0 | Cylinder Liner Remover Ankle        | 60   |
| 17       |  | 9-8523-1169-0 | Cylinder Liner Remover              | 60   |
| 18       |  | 5-8840-2362-0 | Rear Oil Seal Remover               | 40   |
| 19       |  | 5-8840-2359-0 | Rear Oil Seal Installer             | 103  |



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## SECTION 12

## CONVERSION TABLES

## INDEX

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| Length .....      | 203  |
| Area .....        | 205  |
| Volume .....      | 205  |
| Mass .....        | 207  |
| Pressure .....    | 208  |
| Torque .....      | 209  |
| Temperature ..... | 210  |

## 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 |

CONVERSION TABLE

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 | 157.4803 | 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 | 57.787 | 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 <sup>2</sup> | 0               | 1               | 2               | 3               | 4               | 5               | 6               | 7               | 8               | 9               | in <sup>2</sup> |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>2</sup> |                 |
| —               |                 | 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 <sup>2</sup> | 0               | 1               | 2               | 3               | 4               | 5               | 6               | 7               | 8               | 9               | cm <sup>2</sup> |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> | in <sup>2</sup> |                 |
| —               |                 | 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 <sup>3</sup> | 0                    | 1                    | 2                    | 3                    | 4                    | 5                    | 6                    | 7                    | 8                    | 9                    | in <sup>3</sup> |
|-----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------|
|                 | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (cc) | cm <sup>3</sup> (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              | 409.677              | 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 <sup>3</sup> (cc) | 0               | 1               | 2               | 3               | 4               | 5               | 6               | 7               | 8               | 9               | cm <sup>3</sup> (cc) |
|----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------------|
|                      | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> | in <sup>3</sup> |                      |
| —                    |                 | 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          | 2.3189          | 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                  |

# CONVERSION TABLE

## 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 | 336.3966 | 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  | 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 |

**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 |

**CONVERSION TABLE**

**PRESSURE**

**POUNDS PER SQUARE INCHES TO KILOGRAMS PER SQUARE CENTIMETERS**

| lb/in <sup>2</sup> | 0                  | 1                  | 2                  | 3                  | 4                  | 5                  | 6                  | 7                  | 8                  | 9                  | lb/in <sup>2</sup> |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| (psi)              | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | (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/cm <sup>2</sup> | 0                        | 1                        | 2                        | 3                        | 4                        | 5                        | 6                        | 7                        | 8                        | 9                        | kg/cm <sup>2</sup> |
|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------|
|                    | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) | lb/in <sup>2</sup> (psi) |                    |
| —                  |                          | 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                   | 796.49                   | 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/cm <sup>2</sup> | 0      | 1      | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | kg/cm <sup>2</sup> |
|--------------------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|--------------------|
|                    | KPa    | KPa    | KPa     | KPa     | KPa     | KPa     | KPa     | KPa     | KPa     | KPa     |                    |
| —                  | —      | 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                  | 100                | 200                | 300                | 400                | 500                | 600                | 700                | 800                | 900                | KPa   |
|-------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------|
|       | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> | kg/cm <sup>2</sup> |       |
| —     | —                  | 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 |



CONVERSION TABLE

TEMPERATURE

FAHRENHEIT TO CENTIGRADE

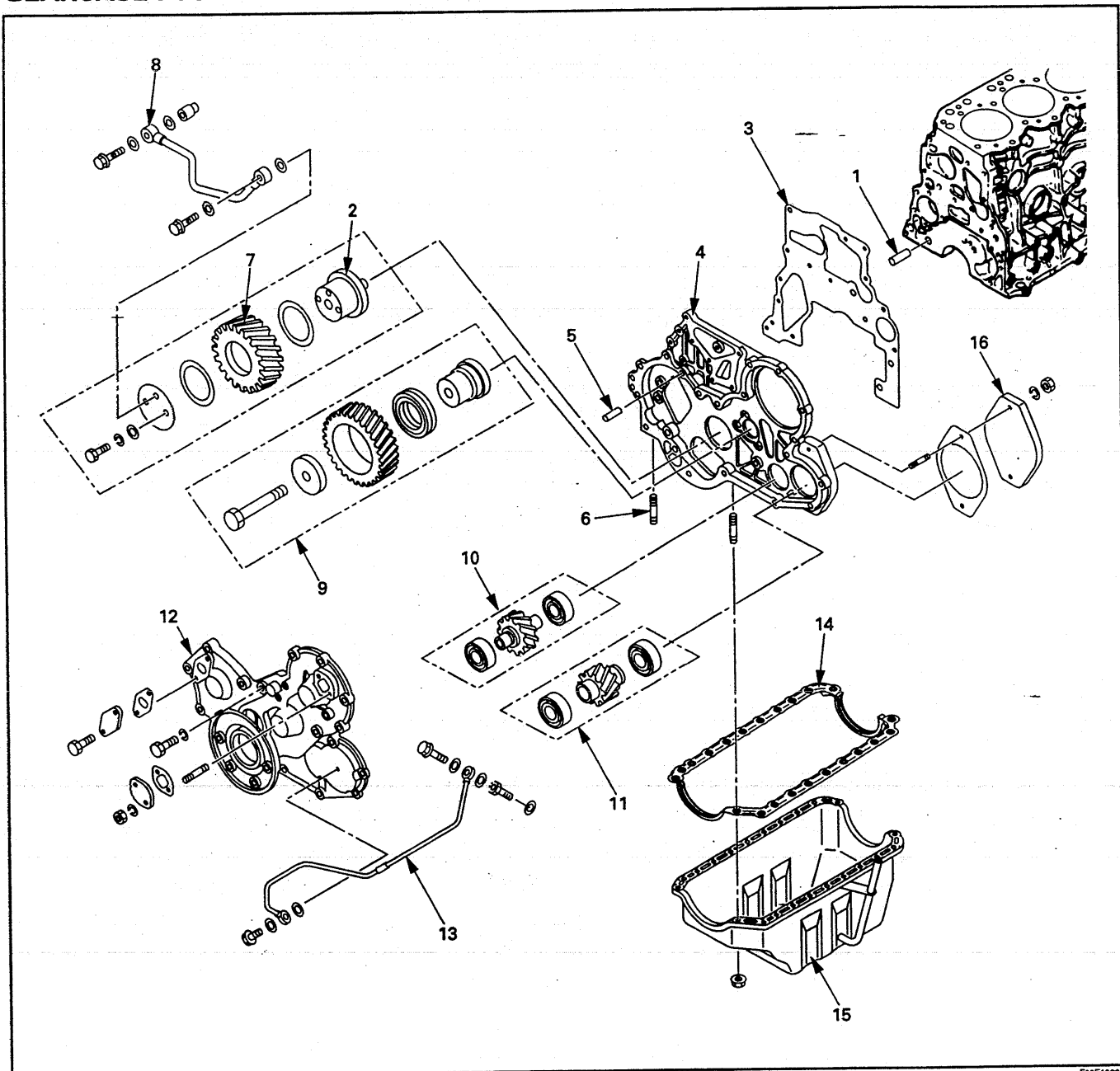
| °F  | °C    | °F | °C    | °F  | °C   | °F  | °C   | °F  | °C    | °F  | °C    | °F  | °C    | °F  | °C    |
|-----|-------|----|-------|-----|------|-----|------|-----|-------|-----|-------|-----|-------|-----|-------|
| -60 | -51.1 | -2 | -18.9 | 56  | 13.3 | 114 | 45.6 | 172 | 77.8  | 230 | 110.0 | 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 |

# ALUMINUM DYECAST TYPE TIMING GEARCASE PTO INSTALLATION PROCEDURE

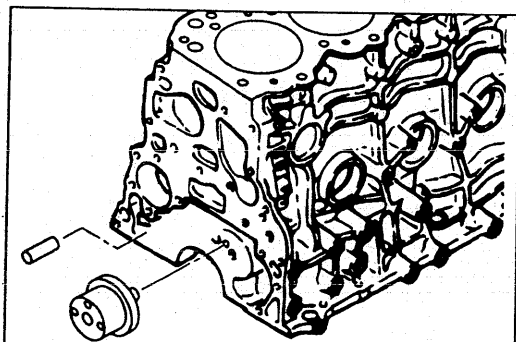
## GEARCASE PTO AND RELATED PARTS



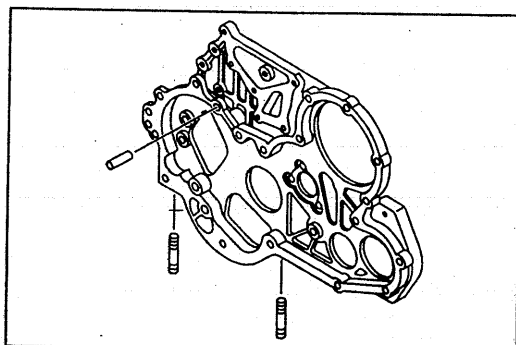
F06E100046

### Reassembly Steps – 2b: Timing Gearcase PTO

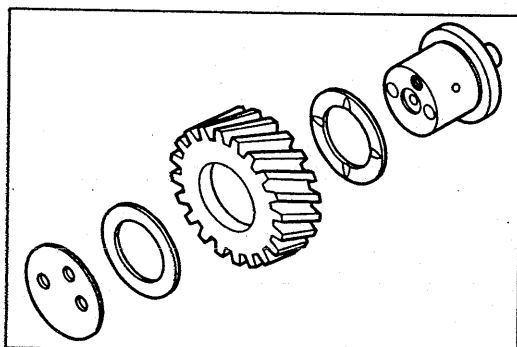
- |                       |                    |
|-----------------------|--------------------|
| 1. Locating pin       | 9. Idler gear B    |
| 2. Idler gear shaft A | 10. Idler gear C   |
| 3. Gasket             | 11. PTO gear       |
| 4. Gearcase           | 12. Gearcase cover |
| 5. Locating pin       | 13. Oil feed pipe  |
| 6. Stud bolt          | 14. Gasket         |
| 7. Idler gear A       | 15. Oil pan        |
| 8. Oil pipe           | 16. Cover          |



014E100055



020E100018



014E100066

### Idler gear shaft

1. Install the idler gear shaft A with facing up oil hole to the cylinder block.
2. Install the locating pin to the cylinder block.

### Note:

The gearcase is positioned by the locating pin and idler gear shaft A.

### Gearcase

1. Install the gearcase with new gasket to the cylinder block. Tighten the bolts to the specified torque.

N·m (kgf·m/lb.ft)

|                      |                             |
|----------------------|-----------------------------|
| Gearcase Bolt Torque | 14 – 24 (1.4 – 2.4/10 – 17) |
|----------------------|-----------------------------|

2. Install the locating pin to the gearcase.
3. Install the stud bolts to the gearcase.
  - Apply Loctite 262 or equivalent to the thread portion of stud bolt.

### Idler gear A

1. Install the camshaft with cam gear.
2. Install the idler gear and thrust washer to the idler gear shaft.
  - Apply engine oil to the idler gear shaft.
  - Install the thrust washers with the dimple of thrust washer facing to gear side.
  - Tighten the bolts to the specified torque.

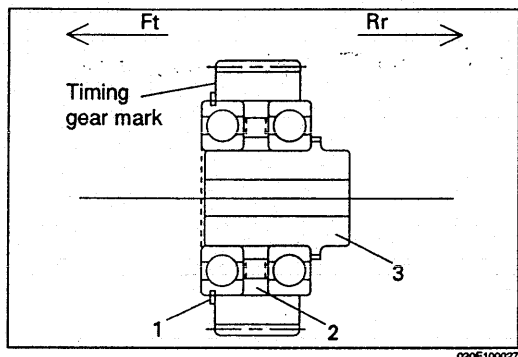
N·m (kgf·m/lb.ft)

|             |                             |
|-------------|-----------------------------|
| Bolt Torque | 14 – 24 (1.4 – 2.4/10 – 17) |
|-------------|-----------------------------|

3. Install the oil pipe (gearcase to idler gear shaft). Tighten the bolts to the specified torque.

N·m (kgf·m/lb.ft)

|             |                              |
|-------------|------------------------------|
| Bolt Torque | 10 – 15 (1.0 – 1.5/7.2 – 11) |
|-------------|------------------------------|

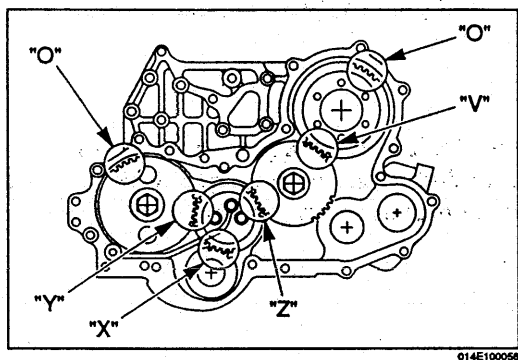


### Idler gear B

1. Press the bearing to the idler gear until the gear contacts into bearing stopper (1).
  - Use the bearing with spacers (2).
  - Apply load only on the outer race of bearing, when the bearing will be pressed to the gear.
2. Install the idler gear shaft (3) to the gear.
3. Install the idler gear asm to the gearcase.
4. Tighten the bolt to the specified torque.

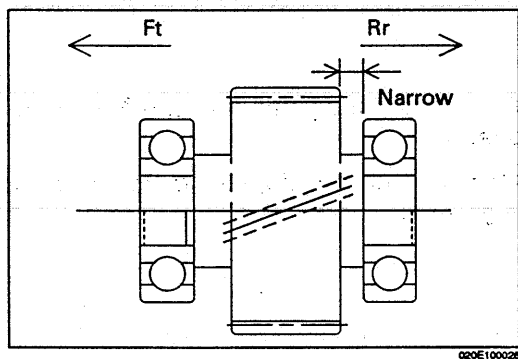
N·m (kgf·m/lb.ft)

|             |                                |
|-------------|--------------------------------|
| Bolt Torque | 98 – 118 (10.0 – 12.0/72 – 87) |
|-------------|--------------------------------|



### Timing gear mark

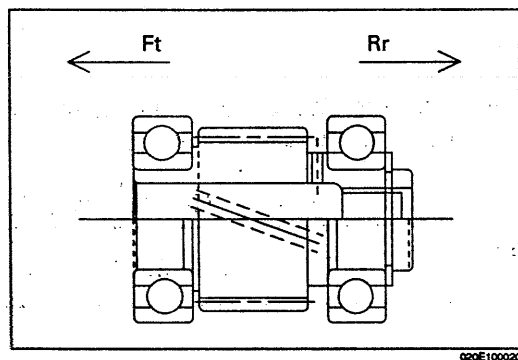
Align the timing mark X, Y, Z.



### Idler gear C

Sub-assemble the bearing to the gear.

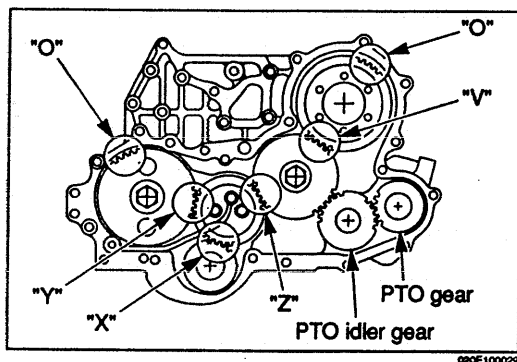
- Apply load only on the inner race of bearing, when the bearing will be pressed to the gear.



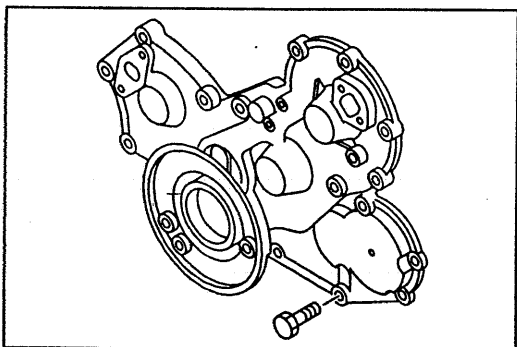
### PTO gear

Sub-assemble the bearing to the gear.

- Apply load only on the inner race of bearing, when the bearing will be pressed to the gear.



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080E100022

### Gearcase PTO

Install the idler gear C and PTO gear to the gearcase.

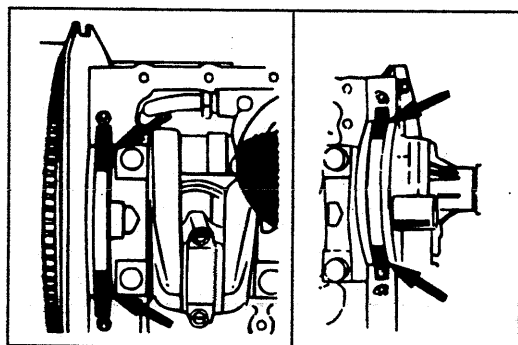
### Gearcase cover

1. Apply sealant to the gearcase.
2. Install the gearcase cover to the gearcase.
3. Tighten the bolts to the specified torque.

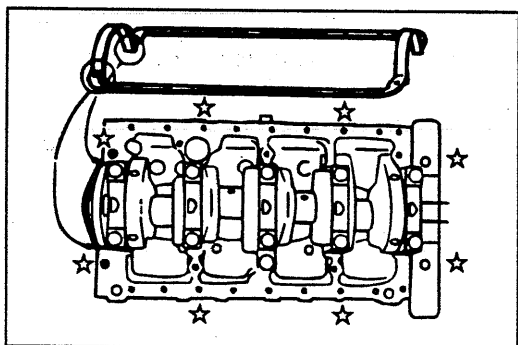
N-m (kgf-m/lb.ft)

| Bolt Torque | M8  | 14-24 (1.4-2.4/10-17) |
|-------------|-----|-----------------------|
|             | M12 | 75-91 (7.6-9.3/55-67) |

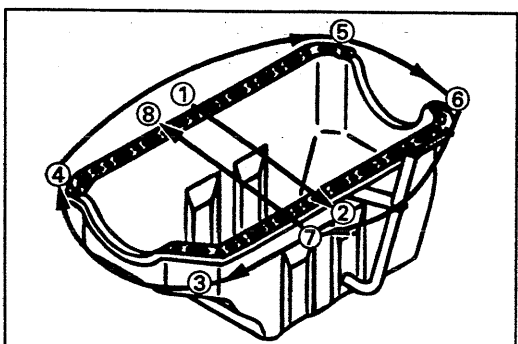
4. Install the oil feed pipe to the gearcase cover.



013E100004



013E100005



013E100007

### Oil pan

1. Apply sealant TB1207B or equivalent to the No.5 bearing cap arches, the bearing grooves, and the timing gearcase arches as shown in the illustration.

2. Fit the gasket rear lipped portion into the No.5 bearing cap groove.

Be absolutely sure that the lipped portion is fitted snugly in the groove.

3. Tighten the oil pan nuts and bolts to the specified torque a little at a time in the sequence shown in the illustration.

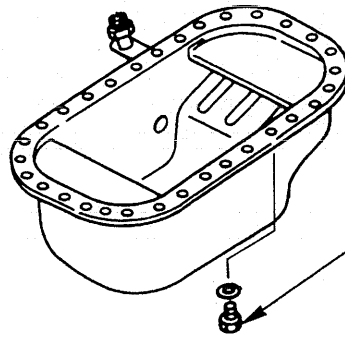
N-m (kgf-m/lb.ft)

| Oil Pan Nut and Bolt Torque | 14 - 24 (1.4 - 2.4/10 - 17) |
|-----------------------------|-----------------------------|
|-----------------------------|-----------------------------|

# ERRATA

## 1. 4JG2 (IDE-2290, PAGE 12)

### CORRECTION



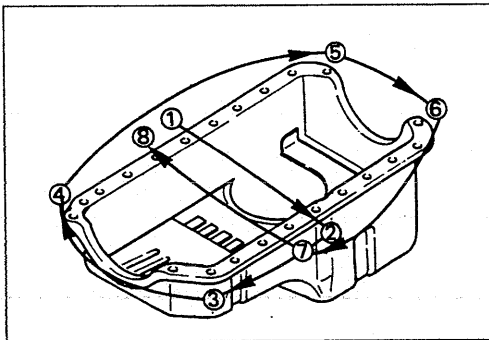
~~0.6 – 1.0~~  
~~(4.3 – 7.2/6 – 10)~~

0.6 – 1.0  
(4.4 – 7.2/5.9 – 9.8)

## 2. 4JG2 (IDE-2290, PAGE 104)

Oil pan fixing torque in case of the engine specification which is not equipped with the crankcase.

### CORRECTION



3) Tighten the oil pan bolts to the specified torque a little at a time in the sequence shown in the illustration.

Oil Pan Bolt Torque kgf·m(lb.ft/N·m)

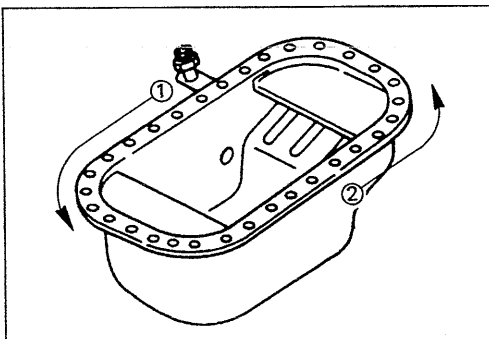
~~0.6 – 1.0(4.3 – 7.2/6 – 10)~~

1.4 – 2.4(10.1 – 17.3/13.7 – 23.5)

## 3. 4JG2 (IDE-2290, PAGE 104)

Oil pan fixing torque in case of the engine specification which is equipped with the crankcase.

### ADDITION



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 kgf·m (lb.ft/N·m)

0.6– 1.0(4.4 – 7.2/5.9 – 9.8)

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**WORKSHOP MANUAL (INDUSTRIAL)**

**4JG2**

(IDE-2290)

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**ISUZU MOTORS LIMITED**

ENGINE SALES PLANNING OFFICE

6-26-1, Minami-oi, Shinagawa-ku, Tokyo, 140, Japan

TEL 03-5471-1111

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