

## ORGANIZATION – GROUP CLASSIFICATION

### 1. GROUP CLASSIFICATION

This manual is organized into several groups classified according to the engine basic elements.

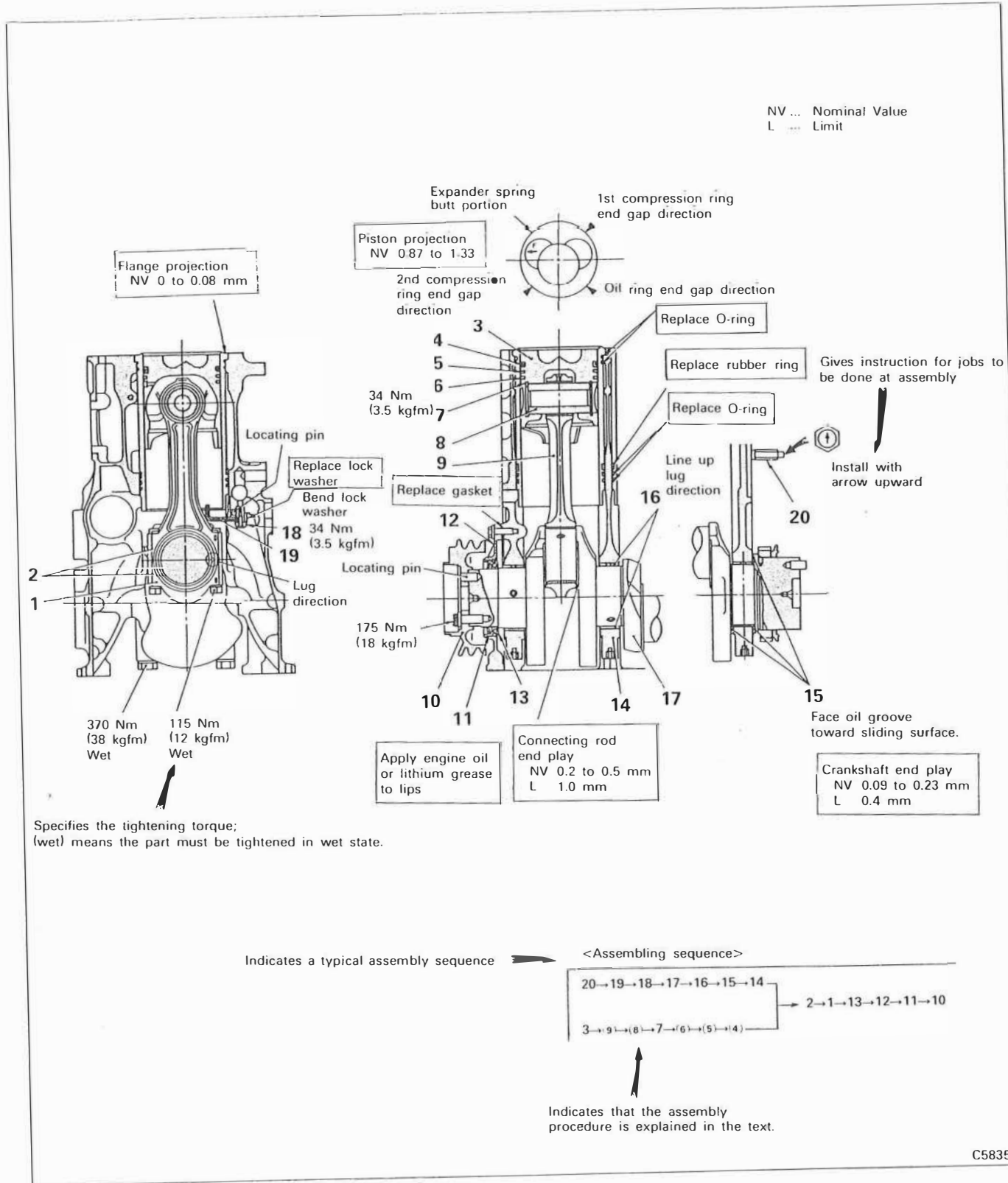
| No. | Group name              | Description   |
|-----|-------------------------|---|
| 00  | General                 | External view, major specifications, engine outputs classified by application, engine numbers, caution plate, general precautions for servicing, general bolts and nuts tightening torque table |
| 11  | Engine                  | Engine proper (cylinder head, valve mechanism, camshaft, piston, crankshaft, timing gear, flywheel), specifications, service standards, special tool, troubleshooting                           |
| 12  | Lubrication             | Lubrication system (oil pump, oil filter, oil cooler), specifications, service standards, special tool, troubleshooting   |
| 13  | Fuel and engine control | Fuel system (injection pump, injection nozzle, fuel filter, pump drive case, water separator), specifications, service standards, special tool, troubleshooting                                 |
| 14  | Cooling                 | Cooling system (water pump, thermostat, radiator, cooling system cleaning procedures, fan), specifications, service standards, special tool, troubleshooting                                    |
| 15  | Intake and exhaust      | Air cleaner, turbocharger, after cooler, specifications, service standards, special tool, troubleshooting   |
| 16  | Engine electrical       | Starter, alternator, preheating system, relays, automatic stop device, specifications, service standards, special tool, troubleshooting   |
| 21  | Clutch                  | Clutch proper, bearing case, specifications, service standards, special tool, troubleshooting   |
| 61  | Special equipment       | Air compressor, air pressure governor, specification, service standards, special tool   |

**NOTE:**

**Each group starts with page 1.**

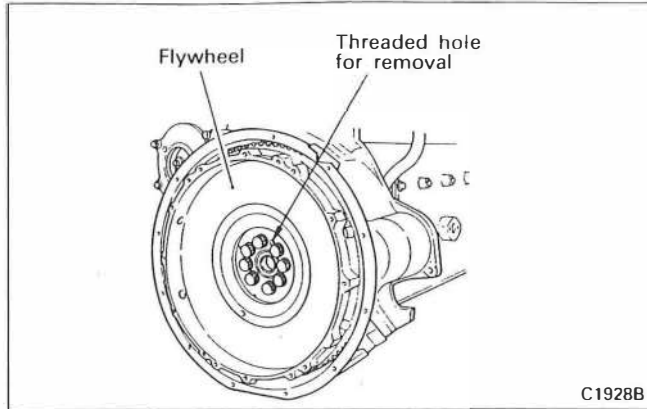
# ORGANIZATION – READING THE ILLUSTRATION

(Ex. 2: Reassembly)

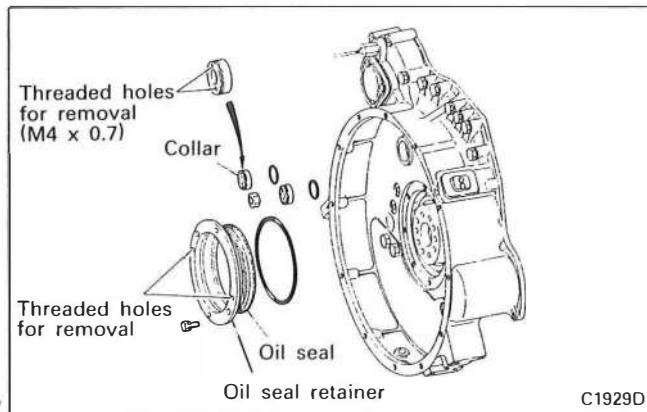


(1) Illustrations (exploded views and assembly drawings) show a typical service procedures if it is

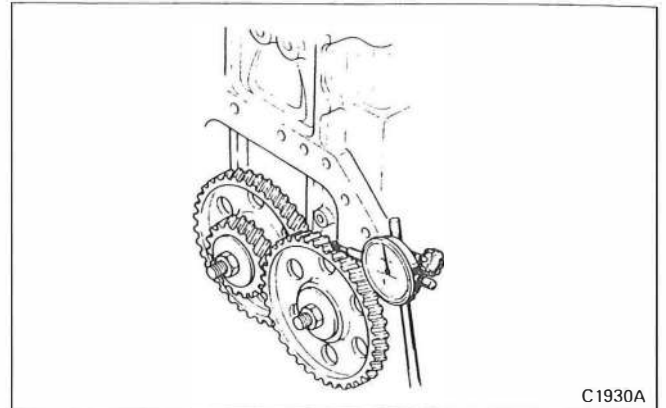
identical among various types of available systems and units.

**Disassembly Procedure****(1) Removal of Flywheel**

Thread the mounting bolt into the removing threaded hole to remove the flywheel.

**(2) Removal of Oil Seal Retainer and Collar**

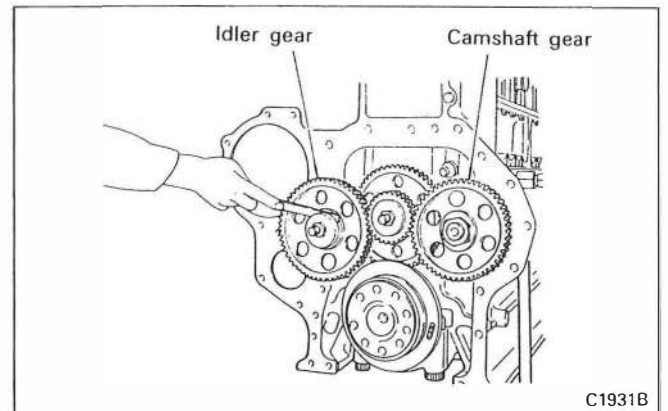
- To remove the oil seal retainer, turn down the attaching bolts into the removing threaded holes evenly, while making sure that the oil seal retainer does not have eccentricity, remove the retainer with the oil seal attached.
- Remove the collar by screwing M4 x 0.7 bolts into the removing threaded holes.

**(3) Measurement of Gear Backlash**

If the backlash exceeds the limit, check idler gear bushing and gears and replace parts as necessary.

**NOTE:**

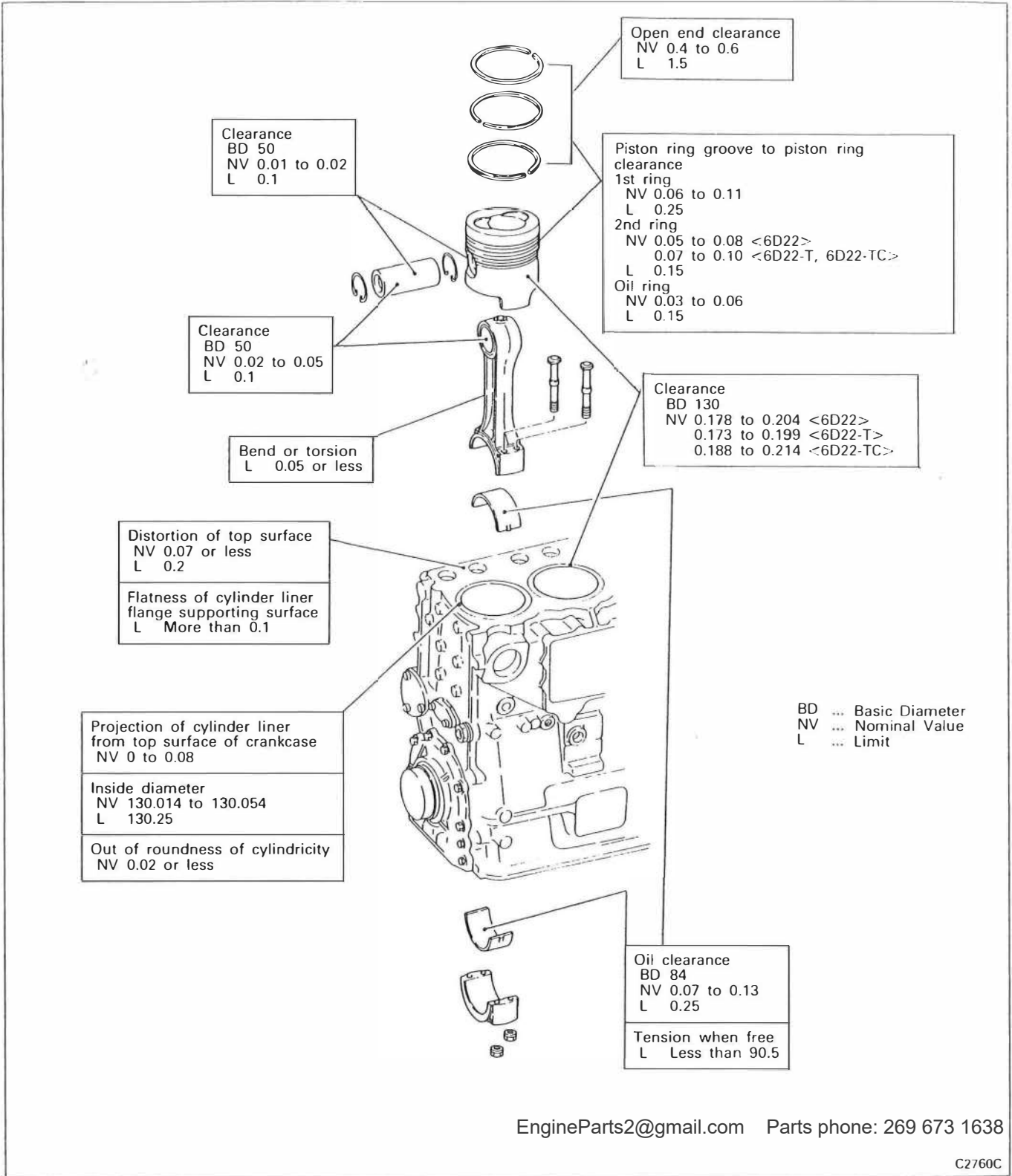
**For a pair of gears, the backlash should be measured at more than three points to determine whether it is acceptable.**

**(4) Measurement of End Play in Idler Gear and Camshaft Gear**

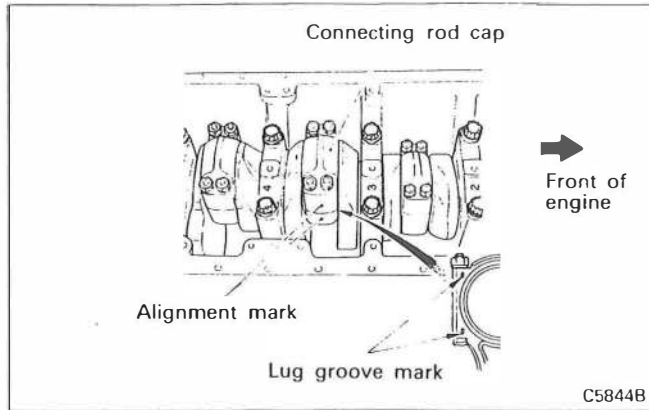
If the end play exceeds the limit, replace the thrust plate.

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### 5.4.2 Inspection



### (13) Installation of Connecting Rod Caps



Make sure that the alignment marks and lug groove marks on the connecting rod cap and connecting rod are aligned.

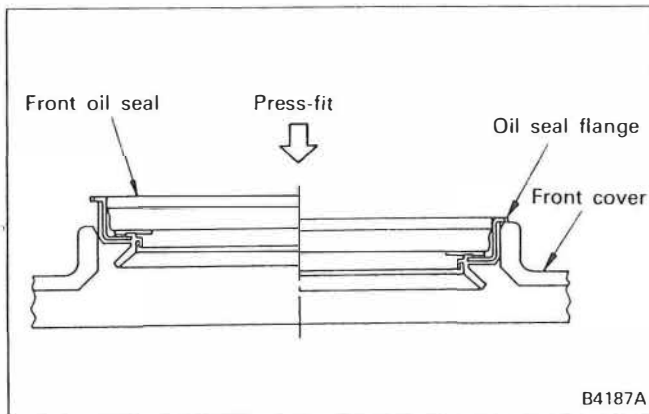
### (14) Check the connecting rod end play.

[Refer to Item (2), Section 5.4.1.]

### (15) Check the projection of the piston.

[Refer to Item (1), Section 5.4.1.]

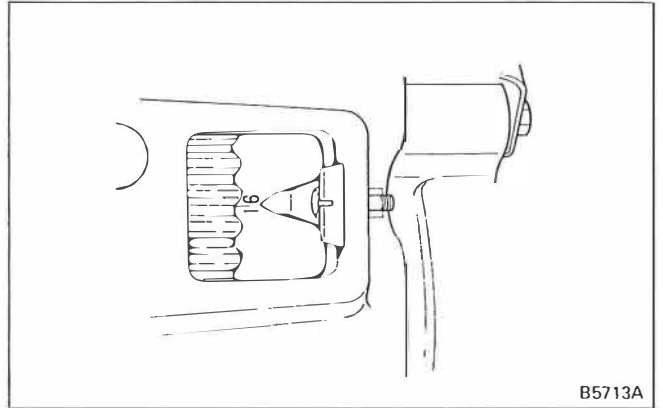
### (16) Installation of Front Oil Seal



Evenly press the oil seal throughout its entire periphery to prevent it from tilting. Press-fit the oil seal into the front cover until the oil seal flange is held tight up against the front cover.

### 5.5 INSPECTION AND ADJUSTMENT OF VALVE CLEARANCE

The valve clearance should be checked and adjusted as described below while the engine is cold.



(1) Crank the engine to align the pointer of the inspection window of the flywheel housing with the inscribed mark 1.6 of the flywheel. Check the push rods, and the piston whose push rod is not pushing up the rocker is at the top dead center of the compression stroke.

(2) When the No. 1 cylinder piston is at the top dead center on the compression stroke, check and adjust the clearance of valves marked "o" in the following table.

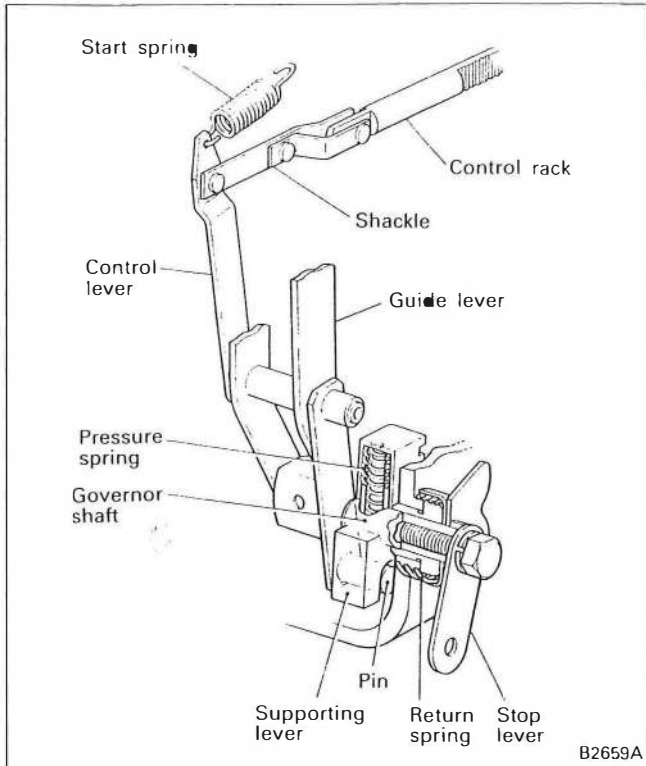
When the No. 6 cylinder piston is at the top dead center on the compression stroke, check and adjust the clearances of valve marked "x". Turn the crankshaft through a rotation, and make sure that valve clearance inspection and adjustment are performed for all of the six cylinders.

| Valve arrangement                      | Cylinder No. 1 |     | Cylinder No. 2 |     | Cylinder No. 3 |     | Cylinder No. 4 |     | Cylinder No. 5 |     | Cylinder No. 6 |     |   |
|--|----------------|-----|----------------|-----|----------------|-----|----------------|-----|----------------|-----|----------------|-----|---|
|  | In.            | Ex. | In.            | Ex. | In.            | Ex. | In.            | Ex. | In.            | Ex. | In.            | Ex. |   |
| No. 1 at TDC on the compression stroke | o              | o   | o              |     |                |     | o              | o   |                |     | o              |     |   |
| No. 6 at TDC on the compression stroke |                |     |                | x   | x              |     |                | x   | x              |     |                | x   | x |

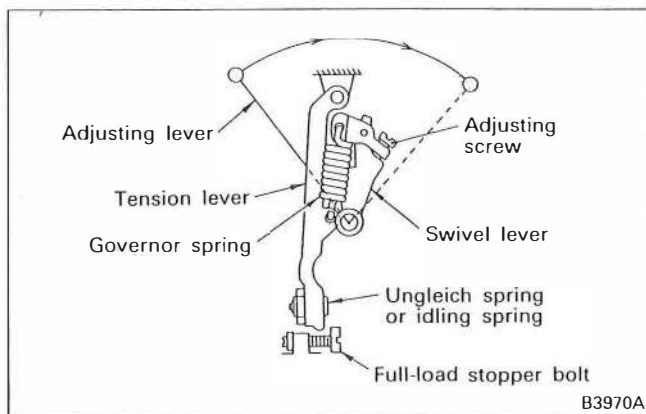
| Description  |  | Nominal value<br>(Basic diameter)                   | Limit | Correction and remarks |
|--|--|---|-------|------------------------|
| Oil pump   | Relief valve<br>valve opening pressure               | 1180 kPa<br>(12 kgf/cm <sup>2</sup> )               |       | Replace spring.        |
|  | Relief valve spring load<br>(Installed length: 46.3) | 150 to 165 N<br>(15.3 to 16.9 kgf)                  |       |                        |
| Oil bypass alarm valve opening pressure<br>(ON start pressure) |  | 345 to 390 kPa<br>(3.5 to 4 kgf/cm <sup>2</sup> )   |       | Replace.               |
| Oil cooler bypass valve opening pressure                       |  | 175 to 215 kPa<br>(1.8 to 2.2 kgf/cm <sup>2</sup> ) |       | Replace.               |
| Regulator<br>valve   | Valve opening pressure                               | 360 to 420 kPa<br>(3.7 to 4.3 kgf/cm <sup>2</sup> ) |       | Replace.               |
|  | Spring load<br>(Installed length: 48.3)              | 76 to 80 N<br>(7.8 to 8.2 kgf)                      |       |                        |
| Check valve opening pressure                                   |  | 265 to 325 kPa<br>(2.7 to 3.3 kgf/cm <sup>2</sup> ) |       | Replace.               |

### 3.2 TIGHTENING TORQUE TABLE

| Description                   | Thread size<br>O.D. x Pitch mm | Tightening torque<br>Nm (kgfm) | Remarks                   |
|-------------------------------|--------------------------------|--------------------------------|---------------------------|
| Oil pump idler gear shaft nut | M12 x 1.25                     | 59 to 78<br>(6 to 8)           | Apply LOCTITE<br>No. 262. |
| Oil bypass alarm              | M20 x 1.5                      | 44 to 54<br>(4.5 to 5.5)       |                           |
| Oil filter center bolt        | M16 x 1.5                      | 59 to 69<br>(6 to 7)           |                           |
| Oil cooler bypass valve       | M27 x 1.5                      | 15 to 20<br>(1.5 to 2.0)       |                           |
| Regulator valve               | M27 x 1.5                      | 98 to 115<br>(10 to 12)        |                           |
| Oil pan drain plug            | M18 x 1.5                      | 69 (7)                         |                           |
| Oil jet check valve           | M12 x 1.75                     | 34 (3.5)                       |                           |



The control lever is mounted to the middle of the guide lever by the shaft with the bottom end as the fulcrum, whereas the top of the lever is coupled through the shackle to the control rack. The start spring, attached to the top end of the control lever, always pulls the control rack in the direction that fuel is increased.



The turning shaft of the swivel lever is fitted into the bushing of the governor cover and its center is eccentric with respect to the mounting position of the governor spring installed to the tension lever. The governor spring is installed to the end of the swivel lever.

When the governor spring receives tension, the bottom end of the tension lever touches the adjustable full-load stopper bolt.

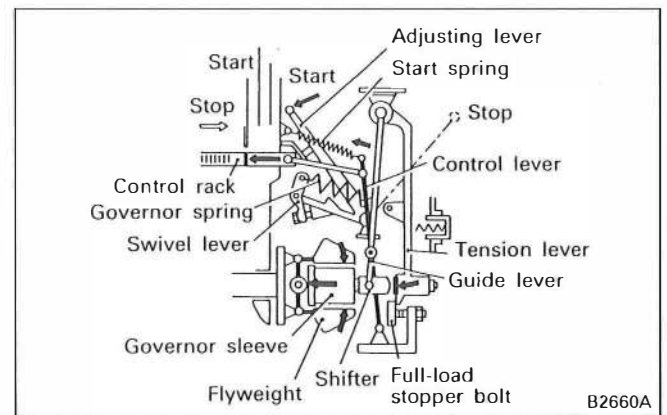
When the angle of the adjusting lever is changed, the angle of the swivel lever is also changed and the tension of the governor spring changed. This is because the turning center of the swivel lever and the mounting position of the governor spring installed to the tension lever are eccentric to each other as mentioned above.

An adjusting screw is also mounted to the swivel lever. Adjustment of the screw changes the tension of the governor spring, thereby making it possible to adjust the speed regulation.

An Ungleich spring is provided in the bottom portion of the tension lever. Adjust the tension of the spring by adding or removing shims.

An idling sub spring adjustable from outside is provided in the middle of the governor cover. During idling, the spring always keeps in contact with the tension lever to maintain a constant idling speed. The stop lever, mounted through the supporting lever to the bottom end of the control lever, returns the control rack to the stop position with a slight pressure irrespective of the adjusting lever position.

**1) Start of engine**



When the adjusting lever is moved to the start position (until it touches the maximum speed stopper), the swivel lever which moves with the adjusting lever pulls the governor spring and moves the tension lever until it touches the full-load stopper bolt.

Unit: mm

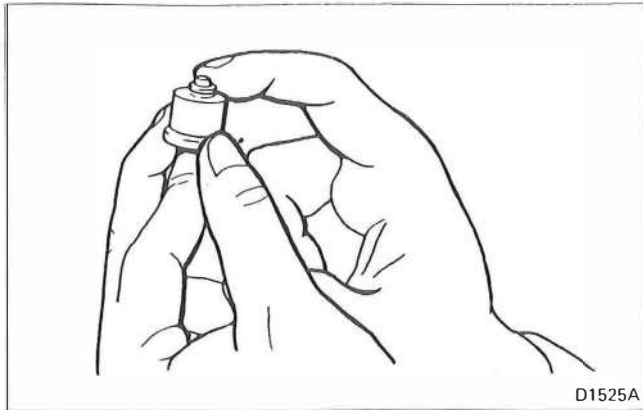
| Description  |  | Nominal value<br>(Basic diameter)  | Limit              | Correction and<br>remarks |          |
|--------------|--|--|--------------------|---------------------------|----------|
| Feed<br>pump | Tightness (when 195 kPa (2 kgf/cm <sup>2</sup> ) of air pressure is applied) | 0 cc/min.  | —                  | Replace.                  |          |
|              | Lifting capacity   | No. of strokes required before lifting when operated at 60 to 100 strokes per minute | 25 strokes or less |                           |          |
|              | Delivery<br>(min.)<br>for 15<br>seconds<br>cc                                | 100 rpm  | KE type            | 60                        | Replace. |
|              |  |  | K type             | 60                        |          |
|              |  | 500 rpm  | KE type            | 340                       |          |
|              |  |  | K type             | 260                       |          |
|              |  | 1000 rpm   | KE type            | 405                       |          |
|              |  |  | K type             | 530                       |          |
| 1500 rpm     | KE type  | 430  |                    |                           |          |
|              | K type   | 520  |                    |                           |          |

**(2) Injection nozzle**

Unit: mm

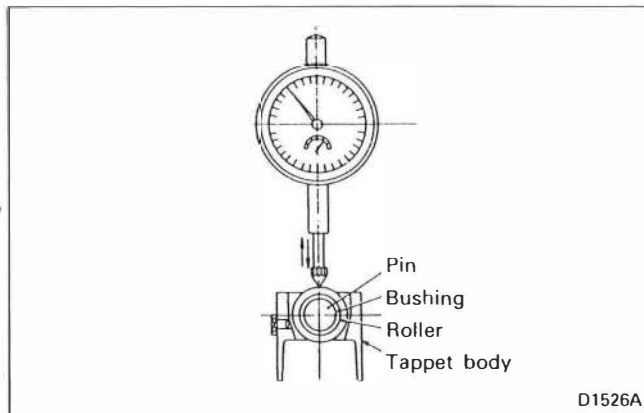
| Description  |                   | Nominal value<br>(Basic diameter)                     | Limit | Correction and<br>remarks |
|--|-------------------|---|-------|---------------------------|
| Injection nozzle injection pressure  | One-spring nozzle | 21.6 MPa (220 kgf/cm <sup>2</sup> )                   |       | Adjust or replace nozzle. |
|  | Two-spring nozzle | 17.7 MPa (180 kgf/cm <sup>2</sup> )                   |       |                           |
| Prelift  |                   | 0.10 ± 0.02   |       | Adjust.                   |
| 2-spring regulated pressure (open pressure)                                |                   | 24.8 to 25.4 MPa<br>(253 to 259 kgf/cm <sup>2</sup> ) |       | Adjust.                   |
| 2-spring regulated pressure (cover pressure) with a 0.05 needle valve lift |                   | 23 to 23.5 MPa<br>(235 to 240 kgf/cm <sup>2</sup> )   |       | Adjust.                   |



**(b) Delivery valve**

D1525A

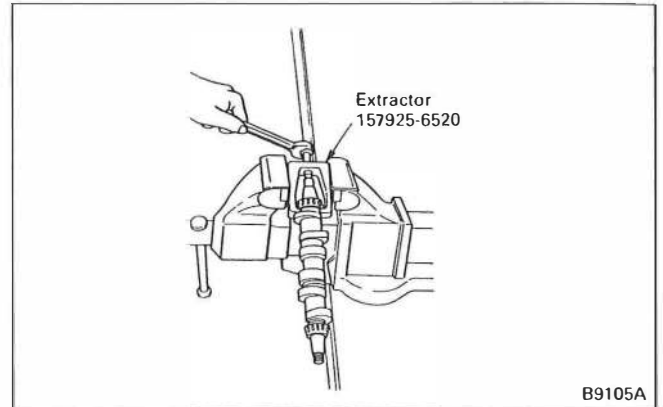
Clean the valve and valve seat portions of the delivery valve in gas oil and check worn condition. Seal off the bottom of the valve seat portion with a finger tip and press down the valve portion with a finger. If the valve portion bounces back when released, the valve portion is good. If it does not bounce back, the valve portion is badly worn. Replace the delivery valve.

**(c) Tappet**

D1526A

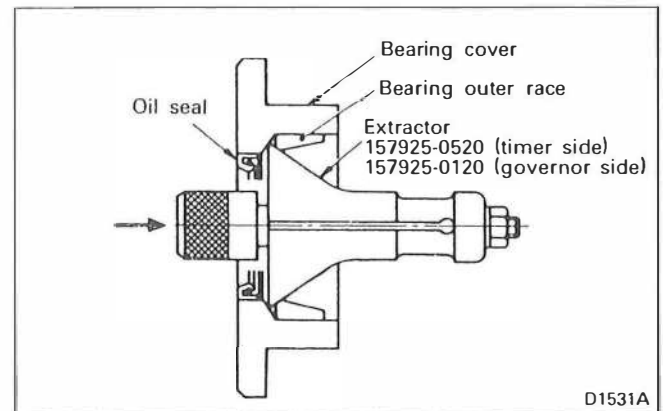
Hold a dial gauge to the roller portion of tappet and check the overall clearance by moving the roller up and down.

If the overall clearance is in excess of the limit, replace the tappet assembly.

**(d) Replacement of taper roller bearing****Inner race**

B9105A

To remove, use Extractor (special tool). To install, put the ring and shims and then install the taper roller bearing.

**Outer race**

D1531A

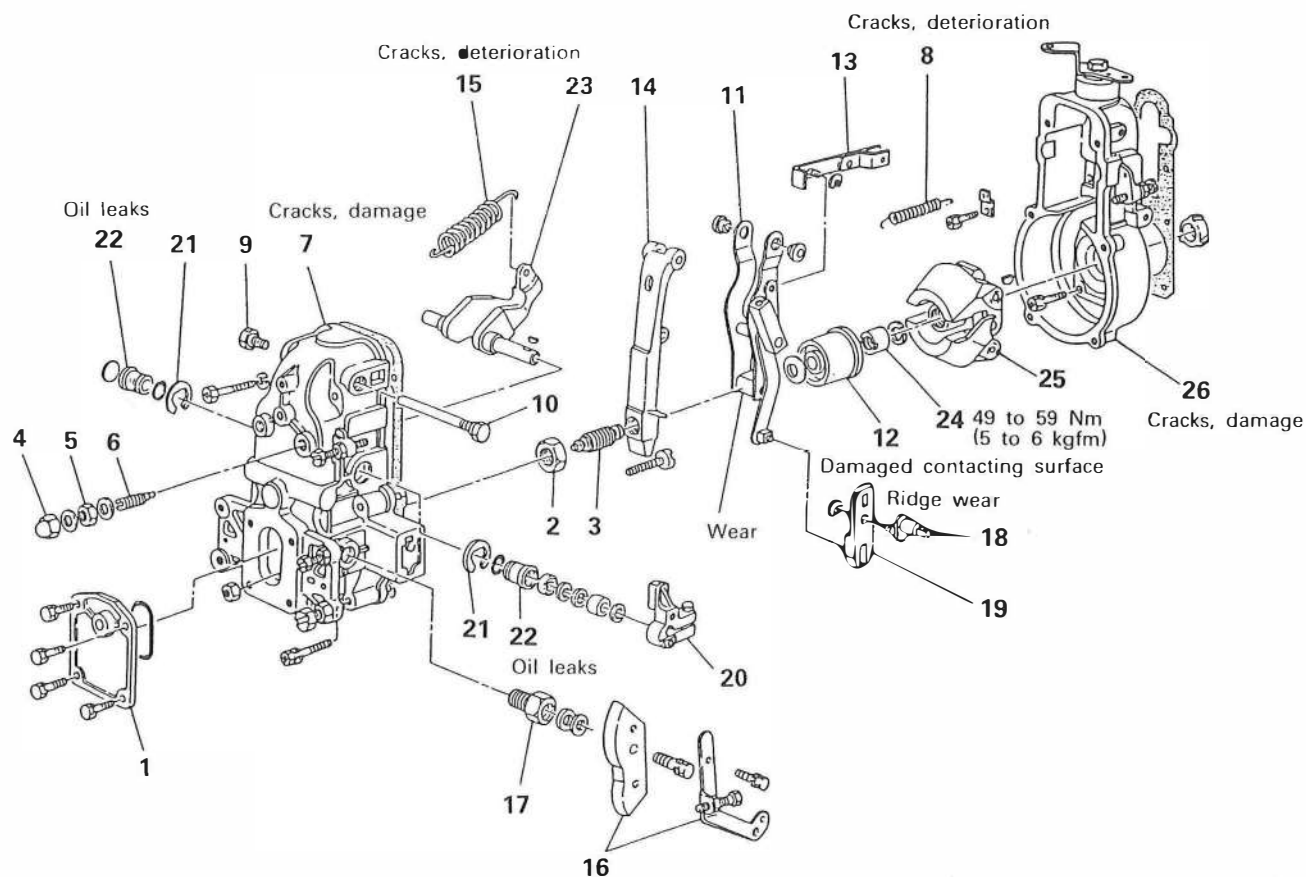
The bearing cover side outer race should be removed by use of Outer Race Extractor (special tool).

To install, put a new oil seal in position, and then install the outer race.

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5.2.2 RFD Type Governor

(1) Disassembly, Inspection and Reassembly



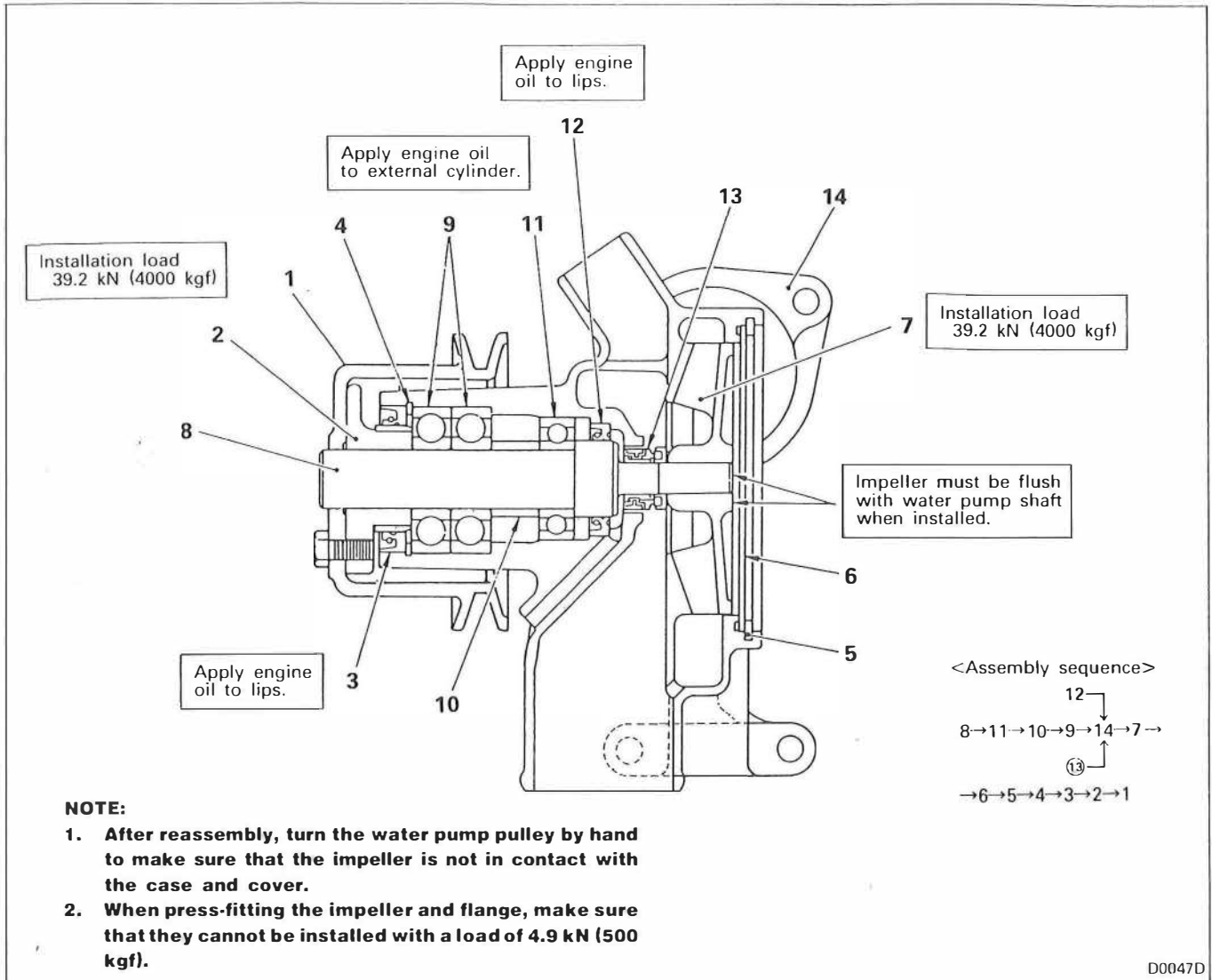
<Disassembly sequence>

- |                          |                        |
|--------------------------|------------------------|
| 1 Governor cover         | 15 Governor spring     |
| ② Lock nut               | 16 Load control lever  |
| ③ Idling spring assembly | 17 Bushing             |
| 4 Cap nut                | 18 Lever shaft         |
| 5 Lock nut               | 19 Sliding lever       |
| 6 Damper spring          | 20 Speed control lever |
| 7 Governor cover         | 21 Snap ring           |
| 8 Start spring           | 22 Bushing             |
| 9 Tension lever plug     | 23 Swivel lever        |
| 10 Tension lever shaft   | ②④ Round nut           |
| ⑪ Guide lever assembly   | ②⑤ Flyweight           |
| ⑫ Sleeve                 | ②⑥ Governor housing    |
| 13 Floating lever link   |                        |
| 14 Tension lever         |                        |

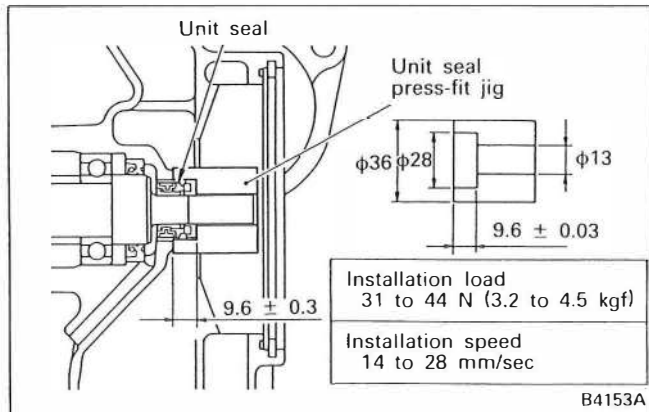
For disassembly and reassembly of parts with an encircled number, see following items.  
For reassembly, reverse the order of disassembly.

B9155A

5.2.3 Reassembly



Installation of Unit Seal

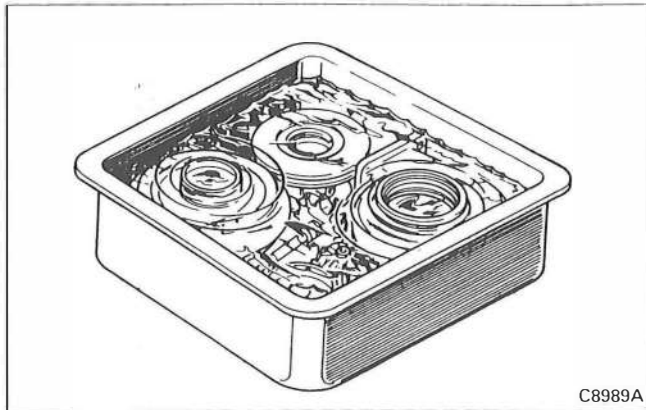


To install the unit seal, use the press-fit jig as shown and press-fit the unit seal until the installed dimensions shown are obtained.

**(a) Cleaning**

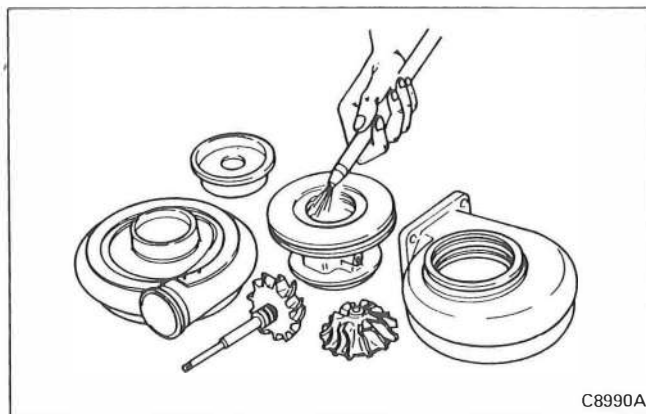
Turbocharger manufacturers use a blasting equipment for cleaning parts at their workshops. As an alternative effective method for overhaul at the dealer's workshop, use the following procedures. When a commercially available neutral detergent is used for cleaning, make sure that it does not contain corrosive component.

1) Before cleaning, visually check the condition of the parts. Check for burns, wear, etc. which could not be identified after washing.



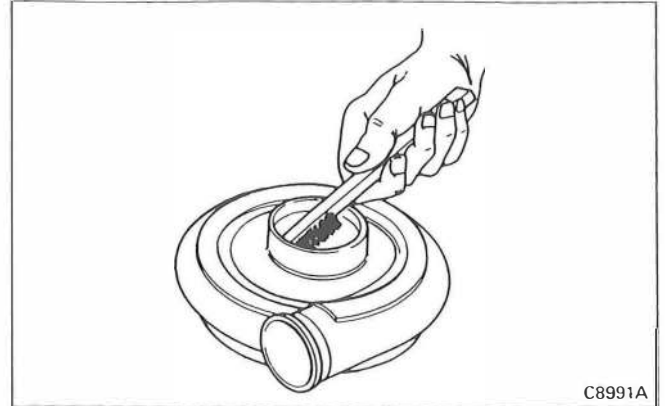
C8989A

2) Immerse all the parts in a non-inflammable solvent (Daido kagaku Kogyo's Dai Cleaner T-30 or equivalent) to clean oily contamination.



C8990A

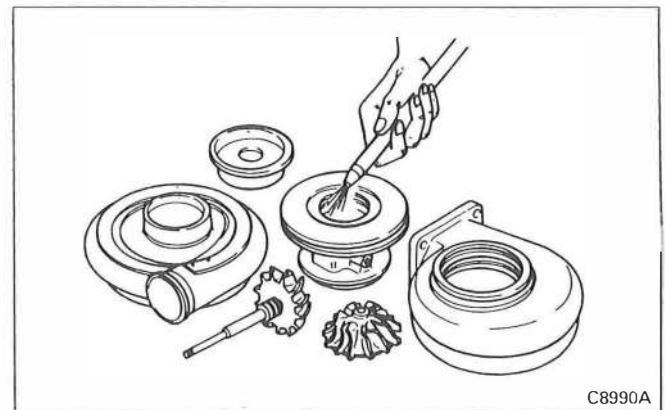
3) Blow clean compressed air against the entire internal and external surfaces.



C8991A

4) Clean deposits, using a plastic scraper or bristle brush.

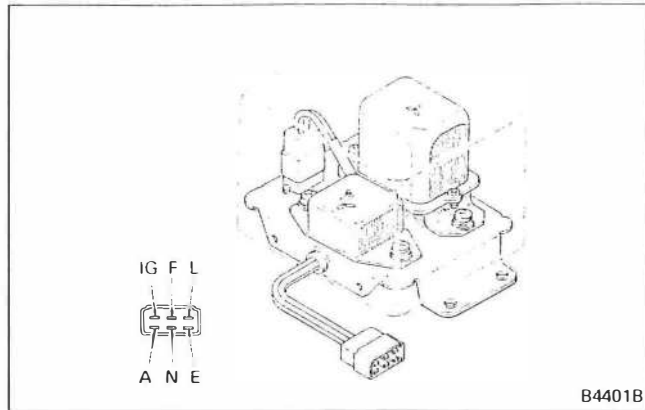
**NOTE:**  
Use care to prevent damage to parts.



C8990A

5) Blow clean compressed air again against the entire internal and external surfaces.

**NOTE:**  
The bearing housing and turbine wheel shaft should be re-immersed in a non-inflammable detergent after Step 4). After deposits have been removed, blow compressed air.

**5.6 REGULATOR [Model R7T01071]****Inspection****(1) Regulated Voltage of Voltage Regulator**

Nominal value (between A and E terminals) ... 28 to 29V with alternator at 4 000 rpm

Battery overcharged ... Voltage too high

Battery discharged ... Voltage too low

**NOTE:**

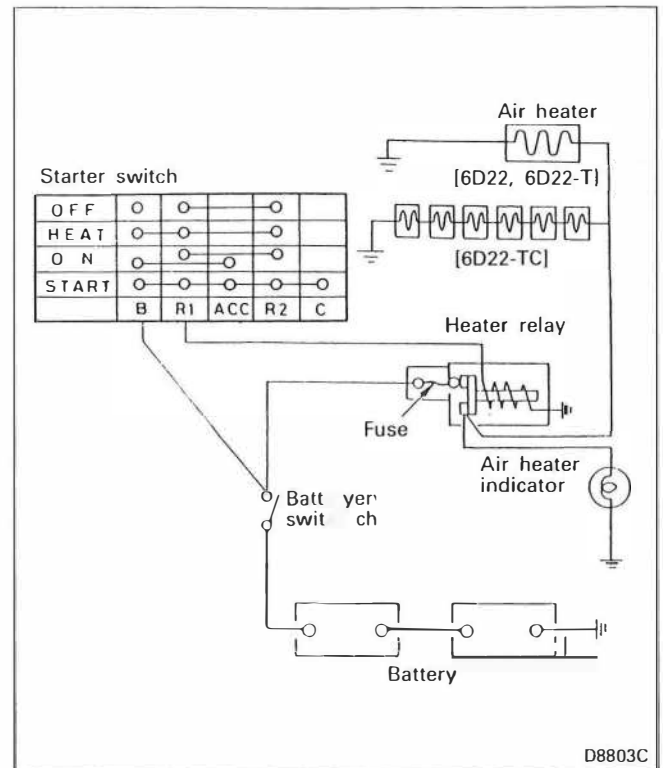
**This regulator uses a transistor type voltage regulator, so the regulated voltage cannot be changed. If the regulated voltage is out of the nominal value, replace the regulator.**

**(2) Voltage Regulator Regulated Voltage Measuring Procedure**

- (a) Increase the engine speed until the alternator reaches the specified speed.
- (b) Continue charging until the charging current to the battery falls to less than 10 A (the battery fully charged).
- (c) Measure the voltage across the A and E terminals.
- (d) Measure the voltage across the A terminal and the negative terminal of the battery and check to ensure that there is no difference between the value and the value measured under Item (c).

**5.7 PREHEATER****5.7.1 Intake Air Heater****(1) Removal and Installation**

[Refer to Group 15 Intake and Exhaust]

**(2) Inspection**

Perform the following inspection and check the function of each part or the wiring if necessary.

- (a) Time required before indicator becomes red-hot:

Standard time

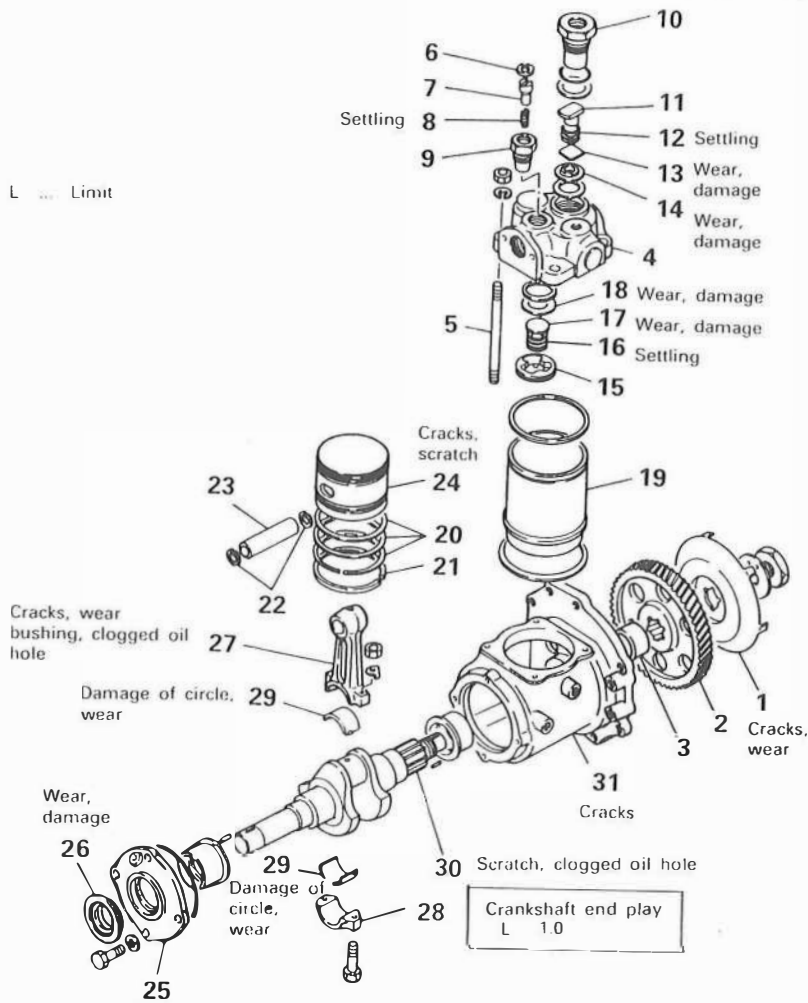
40 to 60 seconds

- (b) Check each terminal of the air heater for looseness and the heater element for damage and contact with other parts.

5.1.2 Disassembly

[1-cylinder Type]

L ... Limit



<Disassembly sequence>

- |                          |                          |                           |
|--------------------------|--------------------------|---------------------------|
| 1 Sensor plate           | 11 Spring holder         | 21 Oil ring               |
| 2 Injection pump gear    | 12 Delivery valve spring | 22 Snap ring              |
| 3 Collar                 | 13 Delivery valve        | 23 Piston pin             |
| 4 Cylinder head          | 14 Delivery valve seat   | 24 Piston                 |
| 5 Stud bolt              | 15 Suction valve holder  | 25 Bearing holder         |
| 6 Snap ring              | 16 Suction valve spring  | 26 Oil seal               |
| 7 Unloader valve         | 17 Suction valve         | 27 Connecting rod         |
| 8 Valve spring           | 18 Suction valve seat    | 28 Connecting rod cap     |
| 9 Valve guide            | 19 Cylinder liner        | 29 Connecting rod bearing |
| 10 Delivery valve holder | 20 Compression ring      | 30 Crankshaft             |
|                          |                          | 31 Crankcase              |

For parts with an encircled number, refer to Disassembly Procedure that follows.

D9252A

**NOTE:**

**Do not remove the stud bolt unless trouble is evident.**

3126106400 Gasket, 6D22 Injection Pump  
ME704044 Gasket, 6D22 Injection Pump  
ME704083 Gasket, 6D22 Injection Pump  
ME704096 Gasket, 6D22 Injection Pump  
ME704101 Gasket, 6D22 Injection Pump  
ME705151 Gasket, 6D22 Injection Pump  
ME705209 Gasket, 6D22 Injection Pump  
ME705218 Gasket, 6D22 Injection Pump  
ME705289 Gasket, 6D22 Injection Pump  
ME727376 Gasket, 6D22 Injection Pump  
ME727378 Gasket, 6D22 Injection Pump  
ME970401 Gasket, 6D22 Injection Pump Drive  
ME969962 Gasket, 6D22 Intake Heater  
ME969849 Gasket, 6D22 Intercooler  
ME969904 Gasket, 6D22 Intercooler  
ME969501 Gasket, 6D22 Oil Cooler  
ME998604 Gasket, 6D22 Oil Pump  
ME969310 Gasket, 6D22 PTO Drive  
ME977028 Gasket, 6D22 Turbo Oil Return Line  
ME980061 Gasket, 6D22 Turbocharger to Manifold  
ME977602 Gasket, 6D22 Water Manifold to Head  
3003232100 Gasket, Exhaust Pipe  
ME063680 Gasket, Exhaust Pipe  
ME063737 Gasket, Exhaust Pipe  
ME068375 Gasket, Exhaust Pipe  
ME120385 Gear and Case 6D22 Oil Pump  
3123500044 Gear, 6D22 Oil Pump  
ME054703 Gear, 6D22 Oil Pump  
ME150506 Gear, Cam Idler  
ME151298 Gear, camshaft  
ME091034 Gear, Crankshaft  
ME052996 Gear, Inj Pump Drive  
ME150689 Gear, Inj Pump Idler  
ME051515 Head Bolt 6D22