

MTUDDC 16V 4000  
Series

**W5 Mid-Life  
Overhaul/Tune-up**

Mobile Maintenance Truck Shop

Boron Operations

# Engine Maintenance Supplement for W5 Overhaul and Tune-up

Refer to the Series 4000 Service Manual for additional information

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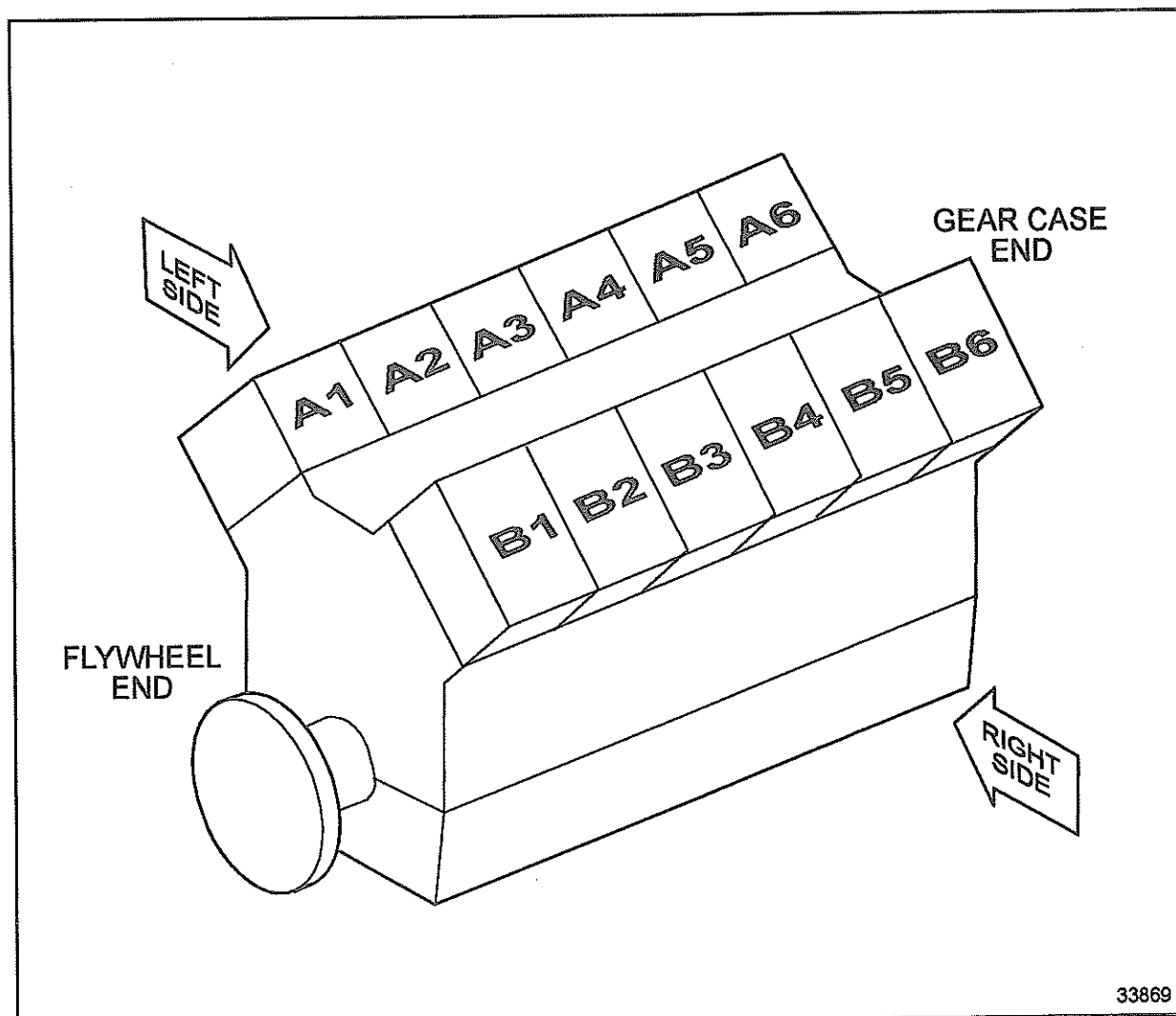
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## A 002 – CYLINDER DESIGNATION

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## Cylinder Designation

See Figure 1 for designation of engine sides and cylinders.



**Figure 1** Cylinder Designation

- Engine side(s) are always designated as viewed from the rear (flywheel end).
- The cylinders on the left engine side are designated "A" and those of the right engine side "B" (as per DIN ISO 1204).
- Each cylinder bank is numbered consecutively from No. 1, starting at the rear of the block.
- Other components and assemblies are also numbered consecutively starting at No. 1 at the rear of the engine.

# A 003 – TORQUE SPECIFICATIONS FOR BOLTS AND NUTS

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## Torque Specifications for Bolts and Nuts

Listed in Table 2 are the torque specifications for bolts and nuts for the cylinder block.

Description	Size	Category	Usage Description	Torque (Nm)
Bolt	—	A	ECM Strain Relief Comb	0.8-1.5
Bolt	M3	A	Injector Terminal	1.4-2.0
Bolt, Class 8.8	M6	A	Standard	9-10
Bolt, Class 8.8	M8	A	Standard	21-24
Bolt, Class 8.8	M10	A	Standard	42-47
Bolt, Class 8.8	M12	A	Standard	74-82
Bolt, Class 8.8	M14	A	Standard	115-127
Bolt, Class 8.8	M16	A	Standard	180-198
Bolt, Class 8.8	M18	A	Standard	250-275
Bolt, Class 8.8	M20	A	Standard	350-385
Bolt, Class 8.8	M22	A	Standard	480-528
Bolt, Class 9.8	M8	A	Standard	31-35
Bolt, Class 9.8	M10	A	Exhaust Outlet Mounting	42-47
Bolt, Class 10.9	M6	A	Standard	12-14
Bolt, Class 10.9	M8	A	Standard	31-35
Bolt, Class 10.9	M10	A	Standard	60-66
Bolt, Class 10.9	M10	A	Oil Pan/Block, Front 4 Bolts (Reference Category F)	60-66*
Bolt, Class 10.9	M10	A	Oil Pan/Block (Reference Category F)	30-33*
Bolt, Class 10.9	M12	A	Standard	100-110
Bolt, Class 10.9	M12	A	Standard	100-110
Bolt, Class 10.9	M12	A	Oil Pan to Gear Case (Reference Category F)	65-75*
Bolt, Class 10.9	M14	A	Standard	160-176
Bolt, Class 10.9	M16	A	Standard	250-275
Bolt, Class 10.9	M16	H	Flywheel/Flex Plate (Reference F and H)*	130 60 Degrees
Bolt, Class 10.9	M18	A	Standard	350-385
Bolt, Class 10.9	M18	A	Main Bearing Stabilizer (Reference Category F)*	80* 280*
Bolt, Class 10.9	M20	A	Standard	500-550
Bolt, Class 10.9	M20 X 1.5	H	Rod Joint (Reference Category F and H)*	240* 90 Degrees

Plug, Copper Washer in Steel/Cast Iron	M56 X 1.5	A	Standard	190-209
Plug, Copper Washer in Steel/Cast Iron	M64 X 1.5	A	Standard	205-226
Plug, Copper Washer in Aluminum	M10 X 1.0	A	Standard	15-17
Plug, Copper Washer in Aluminum	M12 X 1.5	A	Standard	25-28
Plug, Copper Washer in Aluminum	M14 X 1.5	A	Standard	25-28
Plug, Copper Washer in Aluminum	M16 X 1.5	A	Standard	30-33
Plug, Copper Washer in Aluminum	M18 X 1.5	A	Standard	35-39
Plug, Copper Washer in Aluminum	M20 X 1.5	A	Standard	45-50
Plug, Copper Washer in Aluminum	M22 X 1.5	A	Standard	50-55
Plug, Copper Washer in Aluminum	M24 X 1.5	A	Standard	60-66
Plug, Copper Washer in Aluminum	M26 X 1.5	A	Standard	70-77
Plug, Copper Washer in Aluminum	M27 X 2.0	A	Standard	70-77
Plug, Copper Washer in Aluminum	M30 X 1.5	A	Standard	90-99
Plug, Copper Washer in Aluminum	M30 X 2.0	A	Standard	85-94
Plug, Copper Washer in Aluminum	M33 x 2.0	A	Standard	110-121
Plug, Copper Washer in Aluminum	M36 X 1.5	A	Standard	115-127
Plug, Copper Washer in Aluminum	M38 X 1.5	A	Standard	120-132
Plug, Copper Washer in Aluminum	M42 X 1.5	A	Standard	130-143
Plug, Copper Washer in Aluminum	M45 X 1.5	A	Standard	140-154
Plug, Copper Washer in Aluminum	M48 X 1.5	A	Standard	145-160
Plug, Copper Washer in Aluminum	M52 X 1.5	A	Standard	150-165
Plug, Fitting, Sensor - ISO 6149	M10 X 1.0	A	Standard	10-12

Clamp	—	C	Turbo Compressor V-Band Clamp* (F)	12.4-14.7
Clamp	—	C	Turbo Turbine V-Band Clamp* (F)	
Nut - Hex Jam	1 - 14	A	Nut to Isolator Washer	603 - 617
Nut	M10	A	Turbo Mounting (Dry Exhaust)	60 - 66
Nut	M12	B	Nut, Gear Case to Block Joint	110-120*
Nut	M16 X 1.5	A	Valve Bridge and Rocker Arm Nut*	90-100
Nut	M24 X 2.0	E	Main Bearing Cap (Reference Category F and H)*	**
Stud	M10	A	Stud Installation, Turbo Oil Drain Flange	10-15
Stud	M12	A	Stud Installation, Gear Case/Block Joint	10-15
Stud	M24 X 2.0	A	Main Bearing Cap Stud	80-90
Fuel Line	M24 X 1.5	C	Nut, High-Pressure Fuel Lines (Reference Category F)*	10-110*
Fuel Line	M40 X 1.5	C	Nut, High-Pressure Fuel Lines (Reference Category F)*	100-110*
Fuel Line	M42 X 1.5	A	Fuel Rail Nut	550-605

\* Additional information in assembly drawing referenced in the respective UPC group.

\*\* Main bearing cap stud stretching detailed in assembly referenced in 6A1 Group.

Category A — Load within design capability. Process verification controlled by correct tooling. Verification — to minimum torque value.

Category B — Load required at or near yield. Process controlled by special torque equipment or process. Verification — to minimum torque value.

Category C — Load required sensitive to both low and high values. Process controlled by special torque equipment or process. Verification — to given range of torque values.

Category D — Load at yield. Process controlled by special torque equipment or process. Fasteners require lubricant 7Y2 or equivalent. Verification — to minimum torque value.

Category E — Load, both high and low critical. Process controlled by special torque equipment. Verification — to equipment capability.

Category F — Joint sensitive to torque sequence. See engine build instructions.

Category G — Gasket eliminator used as a sealant. Joint sensitive to bolt removal.

Category H — Critical joint. Torque plus angle required.

## Table 2 Fastener Torque Specifications

### NOTE:

Torque specification does not apply to hot engines. Re-check of torque at room temperature to be not less than 90 percent of minimum assembly values.

## A 004 - SETTINGS

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## Firing Order

- 8V: A1-B4-A4-A2-B3-A3-B2-B1
- 12V: A1 - B2 - A5 - B4 - A3 - B1 - A6 - B5 - A2 - B3 - A4 - B6
- 16V: A1 - A7 - B4 - B6 - A4 - B8 - A2 - A8 - B3 - B5 - A3 - A5 - B2 - A6 - B1 - B7

## Direction of Rotation

Listed in Table 3 are the directions of rotation when viewed towards the flywheel end.

Component Description	Direction
Crankshaft	Counterclockwise
Camshaft	Clockwise
High-Pressure Fuel Pump	Counterclockwise
Oil Pump	Counterclockwise
Engine Coolant Pump	Counterclockwise
Charge Air Coolant Pump	Counterclockwise
Air Conditioner Compressor	Counterclockwise

**Table 3** Direction of Rotation

## Valve Clearance with Engine Cold

Listed in Table 4 are the valve clearances with engine cold, 20°C (68°F.)

Component Description	Dimension
Inlet	0.20 mm (0.008 in.)
Exhaust	0.50 mm (0.02 in.)

**Table 4** Valve Clearance

# A 006 – GENERAL DESCRIPTION OF SERIES 4000 OPERATION

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## General Description of Series 4000 Operation

The Series 4000 Diesel Engine is a four stroke, direct injected engine. The engine is available in 8V, 12V, or 16V configurations, ranging from 850 to 2700 hp (634–2013 kW). The Series 4000 is the result of a strategic partnership between MTU Motoren-und Turbinen-Union (MTU) and Detroit Diesel Corporation (DDC) to design, produce and distribute an engine for applications requiring 850–2700 hp (634–2013 kW).

Vital features of the Series 4000 include:

- Electronic engine control through the Detroit Diesel Electronic Control (DDEC®) IV System
- A common rail fuel injection system
- A single casting cylinder block
- Individual cylinder liners
- Individual cylinder heads

The *Series 4000 Application and Installation* manual, is a compilation of the installation drawings, component sketches and technical information required for proper application and installation of the engine.

# B 002 – W5 MAINTENANCE OPERATIONS

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## W5 Maintenance Operations

Listed in Table 2 for W5 Maintenance Operations.

### NOTE:

The following table is based on maintenance work, always use the valid maintenance schedule corresponding to the affected engine.

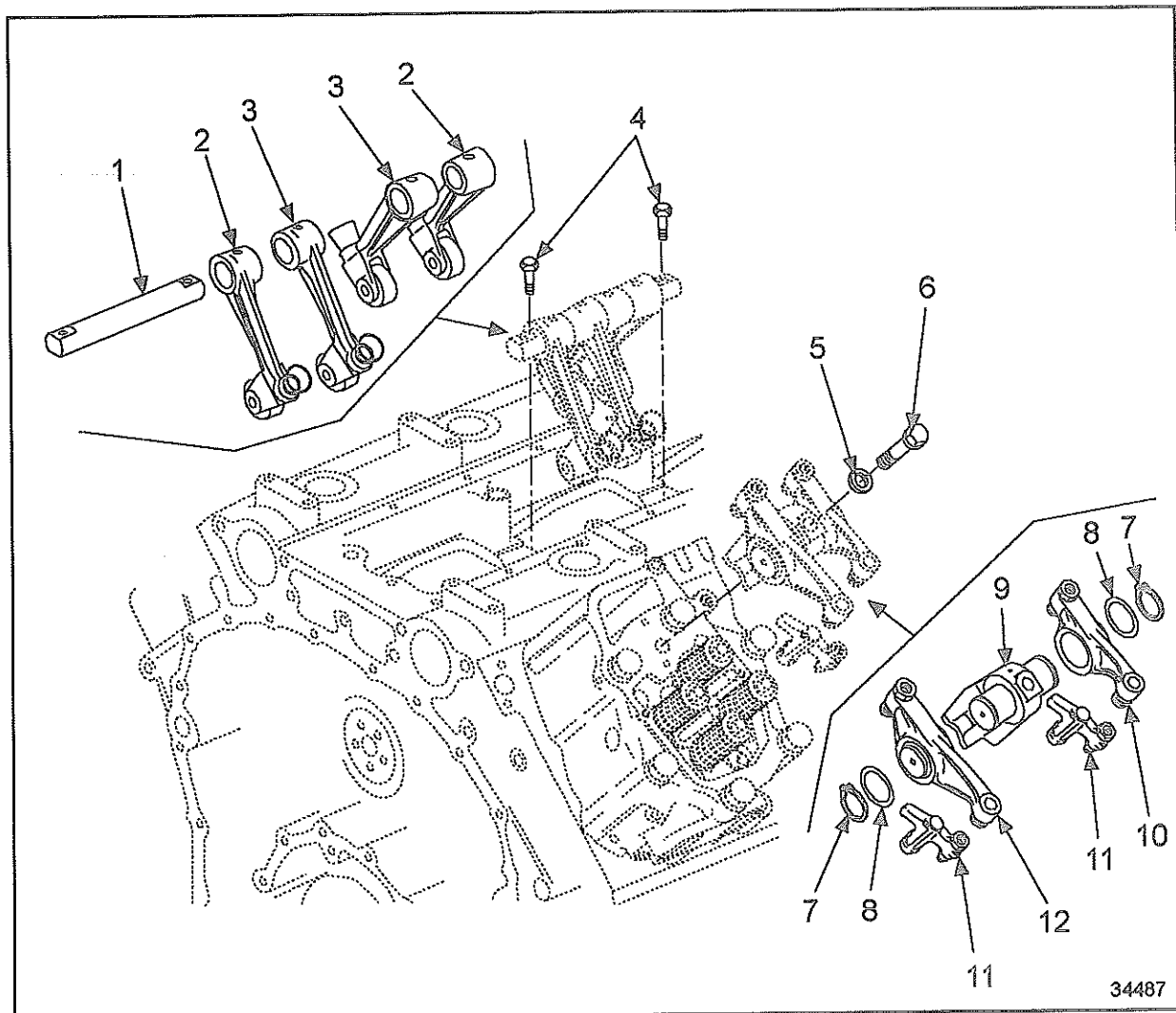
Operations to be performed	Refer to section
Shut off fuel supply line	Operators Guide
Switch off monitoring system	Operators Guide
Switch off battery main switch	Operators Guide
Wash plant, without using chemical cleaning agents	Operators Guide
Drain engine coolant, take sample and analyze (MTU test kit), change coolant if necessary	Operators Guide
Whenever possible, drain engine oil while the engine is warm, take sample and analyze	Operators Guide
Fuel prefilter, drain water and contaminants, replace filter elements	Operators Guide
Replace fuel filter	Operators Guide
Clean air filter, replace if necessary. Empty dust collection box	Operators Guide
Replace exhaust turbocharger	C 101.05.05
Intake air system, remove lines, clean, replace gaskets	-
Drain exhaust system, check security of securing bolts	Operators Guide
Remove charge air cooler, clean and check for leaks	C 111.05.05
Clean coolant cooler, check for leaks	-
Clean charge air coolant cooler, check for leaks	-
Check coolant thermostat (high-temperature circuit), replace if necessary	C 208.05.08
Check coolant thermostat (low-temperature circuit), replace if necessary	C 208.05.08
Replace engine coolant pump	C 202.05.05
Replace charge air coolant pump	C 206.05.05
Check condition of engine control system and wiring and check for security	-
Check starter, wiring and connections for corrosion and loose connections, check wiring	-
Check generator and contacts for corrosion and loose connections, check wiring	-
Generator drive, check tension and condition of drive belt	Operators Guide
Fan, check tension and condition of drive belt	Operators Guide
Air conditioner compressor, check tension and condition of drive belt	Operators Guide
Replace high-pressure fuel pump and high-pressure sensor	C 073.05.05
Replace low-pressure fuel pump	C 081.05.05
Remove and check valve gear, swing arms and valve bridges	C 055.05

## C 055.05 – VALVE OPERATING MECHANISM

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C 055.05.01 – GENERAL VIEW

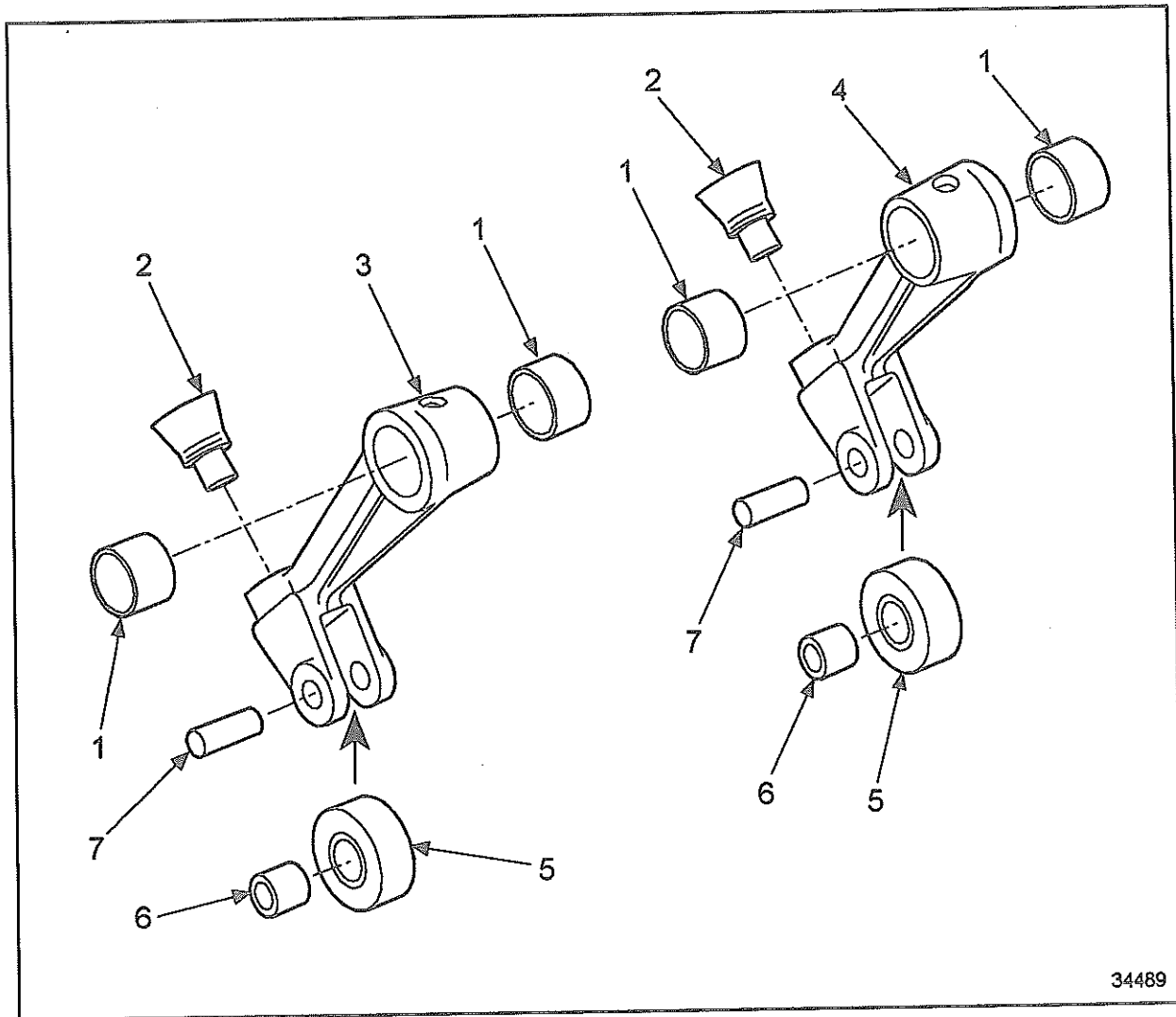
See Figure 451 for a general view of valve operating mechanism.



- |                       |                         |
|-----------------------|-------------------------|
| 1. Swing Shaft        | 7. Snap Ring            |
| 2. Swing Arm, Intake  | 8. Adjusting Shim       |
| 3. Swing Arm, Exhaust | 9. Rocker Shaft Bracket |
| 4. Hex Bolt           | 10. Rocker Arm, Exhaust |
| 5. Washer             | 11. Valve Bridge        |
| 6. Rocker Bolt        | 12. Rocker Arm, Intake  |

Figure 451 Valve Operating Mechanism

See Figure 453 for a general view of swing arm.



- |                        |            |
|------------------------|------------|
| 1. Bushing             | 5. Roller  |
| 2. Ball Socket         | 6. Bushing |
| 3. Roller Arm, Exhaust | 7. Pin     |
| 4. Roller Arm Intake   |            |

**Figure 453** Swing Arm

**C 055.05.02 – SPECIAL TOOLS**

Listed in Table 48 are the special tools required for maintenance on the valve drive.

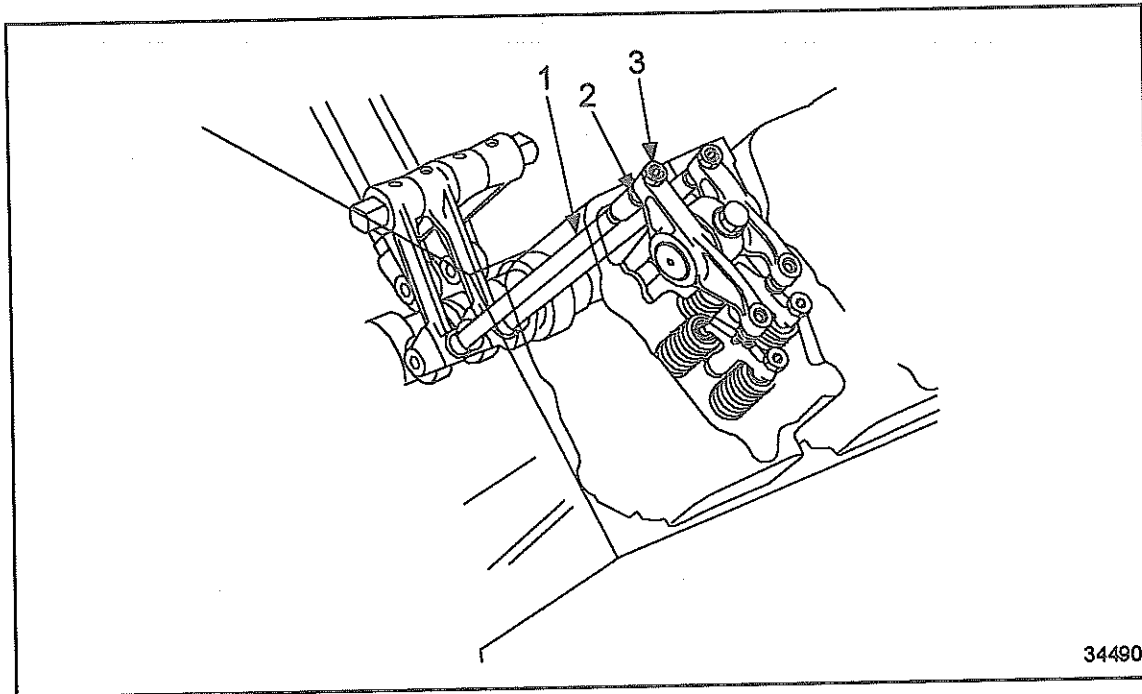
Application	Number
Valve clearance adjustment gage 0.2 mm/0.5 mm	—
Allen key, 8 A/F, for valve clearance adjustment	—
Engine barring tool	—

**Table 48 Special Tools**

**C 055.05.05 – REMOVAL OF VALVE OPERATING MECHANISM****Removing Rocker Arm Assembly**

Perform the following steps to remove rocker arm assembly:

1. Release nuts (3) of adjusting bolts (2) on rocker arm, and back off adjusting bolts. See Figure 455.



1. Pushrod
2. Adjusting Bolt

3. Nut

**Figure 455** Releasing Adjusting Bolts to Remove Pushrods

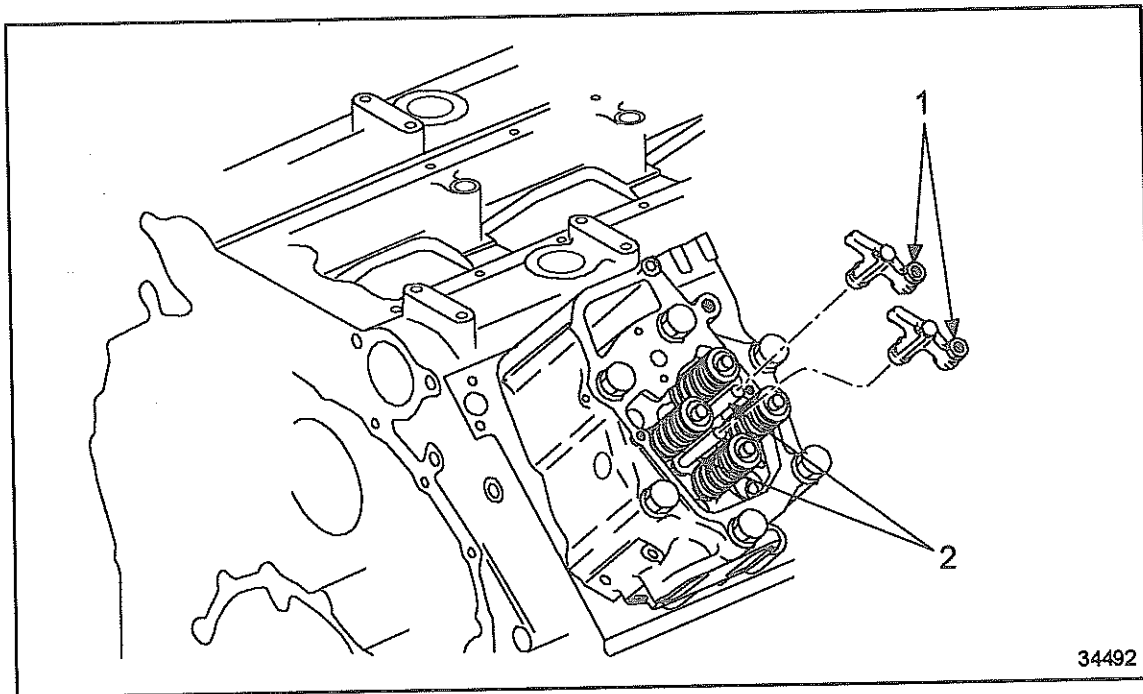
2. Remove pushrods (1) from ball sockets of rocker arms.

**NOTE:**

Ensure not to drop pushrod into oil pan.

3. Mark pushrods.

5. Mark valve bridges (1) and remove from bridge guide in cylinder head. See Figure 457.



1. Valve Bridges

2. Bridge Pin

**Figure 457** Marking Valve Bridges and Removing from Bridge Pin

6. Remove pushrods.

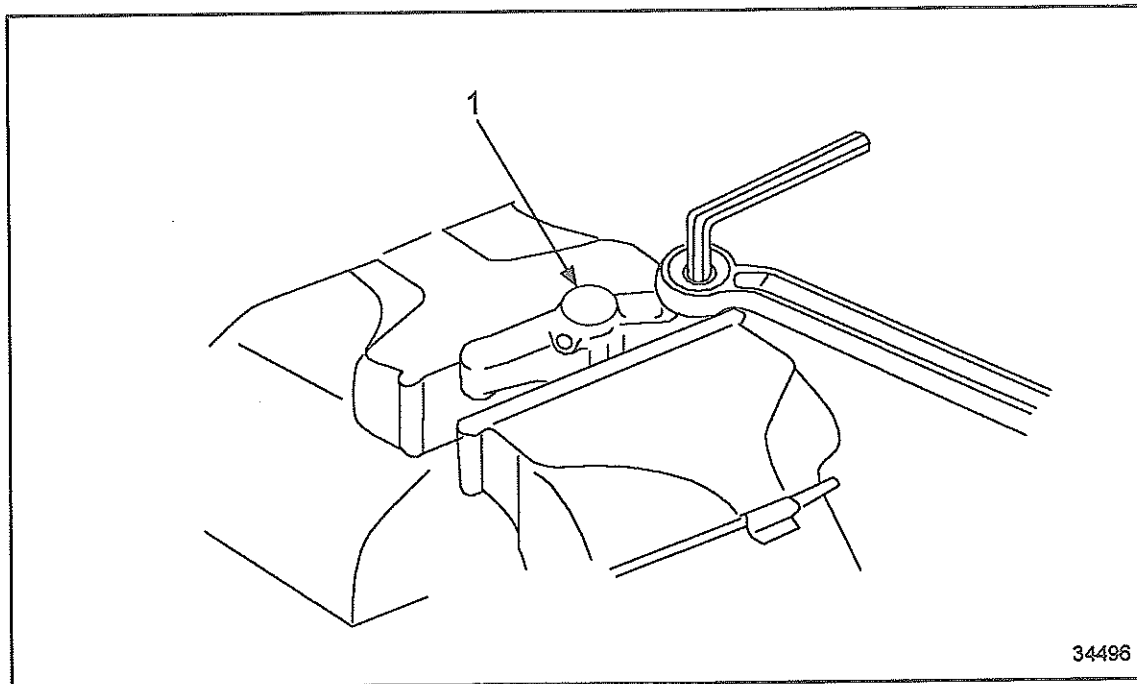
## C 055.05.11 – INSTALLATION OF VALVE DRIVE

### Adjusting and Installing Valve Bridges

Perform the following steps to adjust and install valve bridges:

**NOTE:**

Ensure parts are perfectly clean. Make adjustment only when engine is cold or heated to 40°C. See Figure 476.



1. Valve Bridge

**Figure 476** Clamping Valve Bridge in Vice and Removing Nut and Adjusting Bolt

1. Measure projection of sliding pins with respect to cylinder head.  
Refer to section C 041.05.08.

**NOTE:**

If valve seats in cylinder head or valves have been machined, valve bridges must be adjusted.

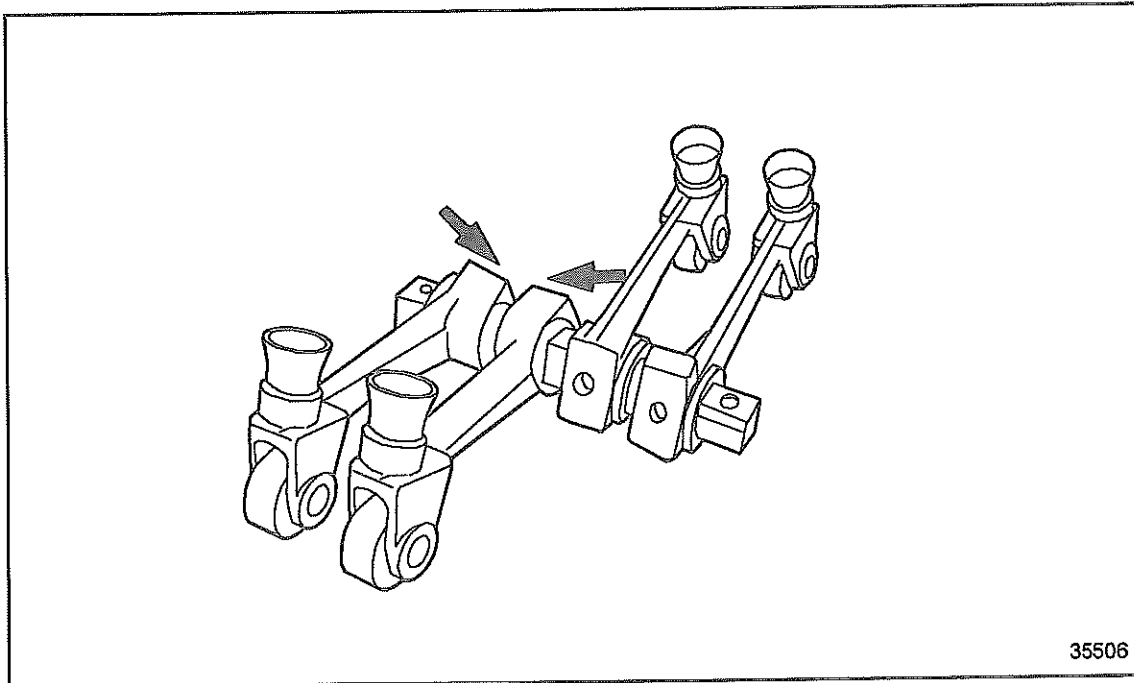
2. Secure valve bridge (1) in vice with aluminum jaws, release locknut and back off adjusting bolt by approximately 3 revolutions.
3. Ensure oil bore is perfectly clean.

9. Turn adjusting bolt further, approximately 20 degrees to compensate clearance.

**NOTE:**

Valve bridges are set and must not be interchanged during installation.

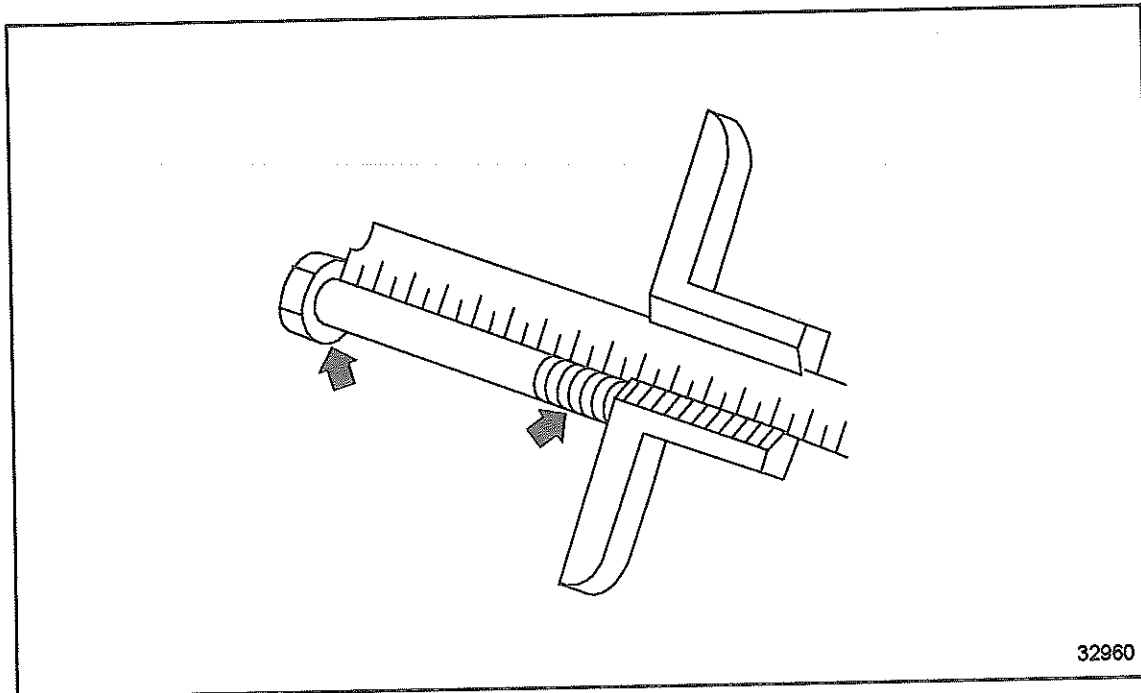
10. Hold adjusting bolt firmly with Allen wrench and tighten locknut (4) by hand to valve bridge.
11. Remove valve bridge from valve head and place in vice with aluminum jaws.
12. Torque bridge nut to specifications.
13. The Allen wrench must not turn. For tightening torque, refer to section A 003.
14. Re-install valve bridge on valve head.
15. Inspect clearance with 0.1 mm feeler gage under each locknut. If equal drag does not occur, readjust bridge.
16. Coat shaft and bushings of swing arm with engine oil. See Figure 478.



35506

**Figure 478** Installing Swing Roller Arms on Swing Shaft

22. Coat ball sockets of pushrods with engine oil and insert pushrods.
23. Measure shaft length of hex bolt; for maximum shaft length, refer to section A 003.
24. Coat thread and mating surface of hex bolts (arrows) with engine oil. See Figure 480.

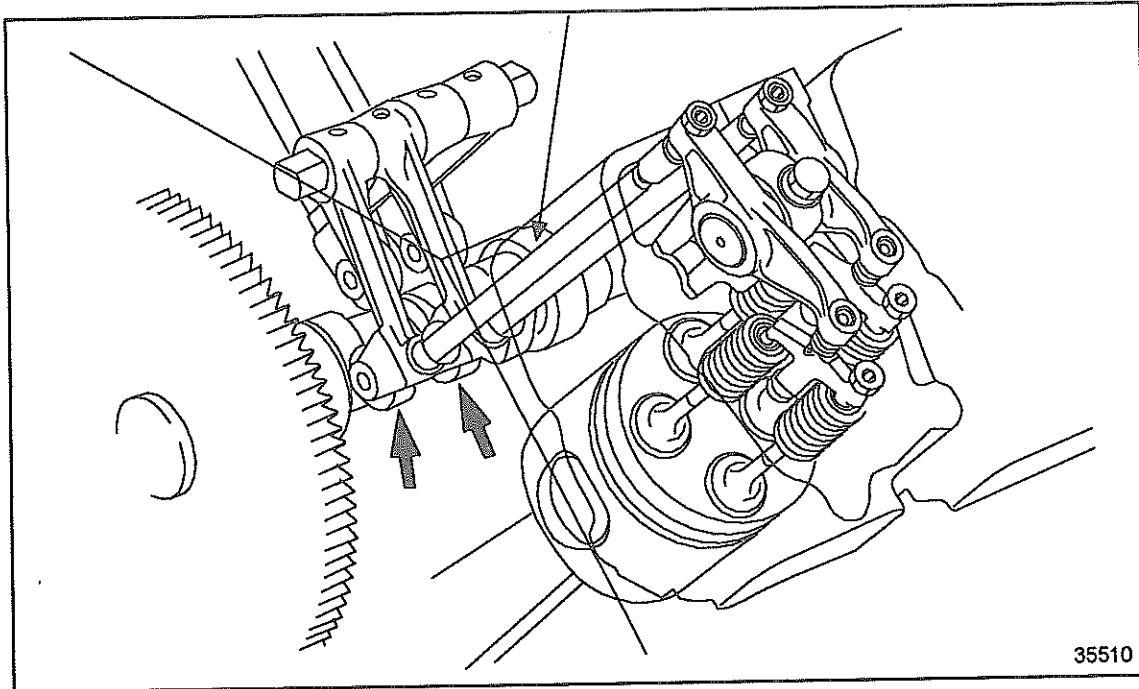


**Figure 480**    **Measuring Shaft Length of Hex Bolt**

**CAUTION:**

To avoid personal injury when barring the engine over, stand clear so that the crankshaft will not unexpectedly rotate and cause loss of control of barring tool.

29. Using the barring tool, set piston of cylinder to be checked to firing TDC. See Figure 482.



**Figure 482** Position of Swing Arm Rollers at Firing TDC

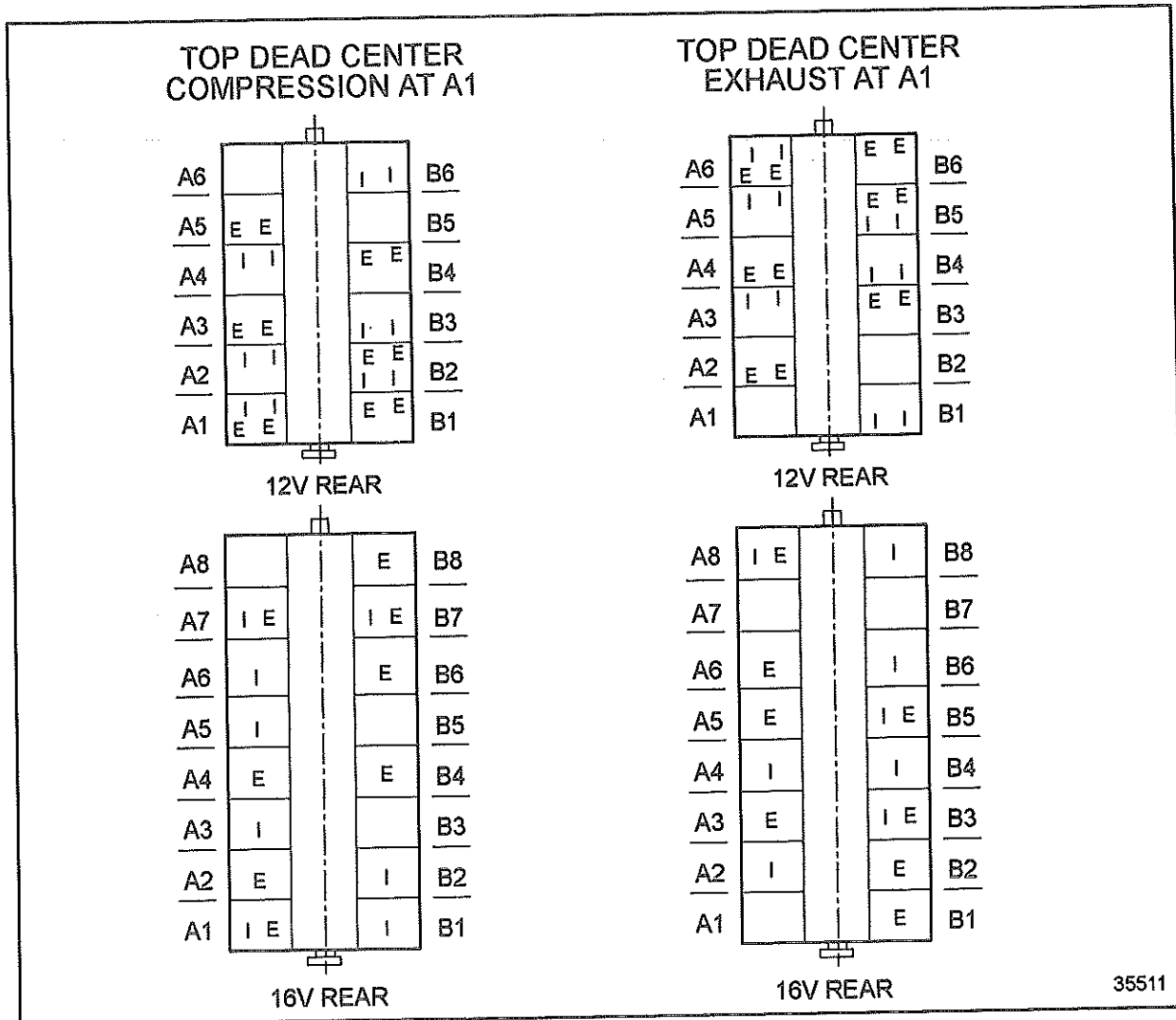
**NOTE:**

At firing TDC, both rollers of swing arm of respective cylinder are in base circle (arrow) of camshaft.

## Adjusting Valve Clearance in Two Crankshaft Positions

Perform the following steps to adjust valve clearance in two crankshaft positions:

1. If swing arms on cylinder A1 are unloaded, the piston is in firing TDC. See Figure 484.



**Figure 484 Adjusting Valve Clearance in Two Crankshaft Positions**

2. If swing arms on cylinder A1 are loaded, the piston is in overlap TDC.
3. Check all valve clearances at two crankshaft positions (firing TDC and overlap TDC, cylinder A1) in accordance with Figure .
4. Turn crankshaft in direction of engine rotation.
5. 1 = Firing TDC at cylinder A1; 2 = Overlap TDC at cylinder A1; X = Exhaust value; 0 = Inlet valve.

### Inspecting Valve Clearance in Two Positions

Perform the following steps to inspect valve clearance in two crankshaft positions:

1. If swing arms on cylinder A1 are unloaded, the piston is in firing TDC. See Figure 486.

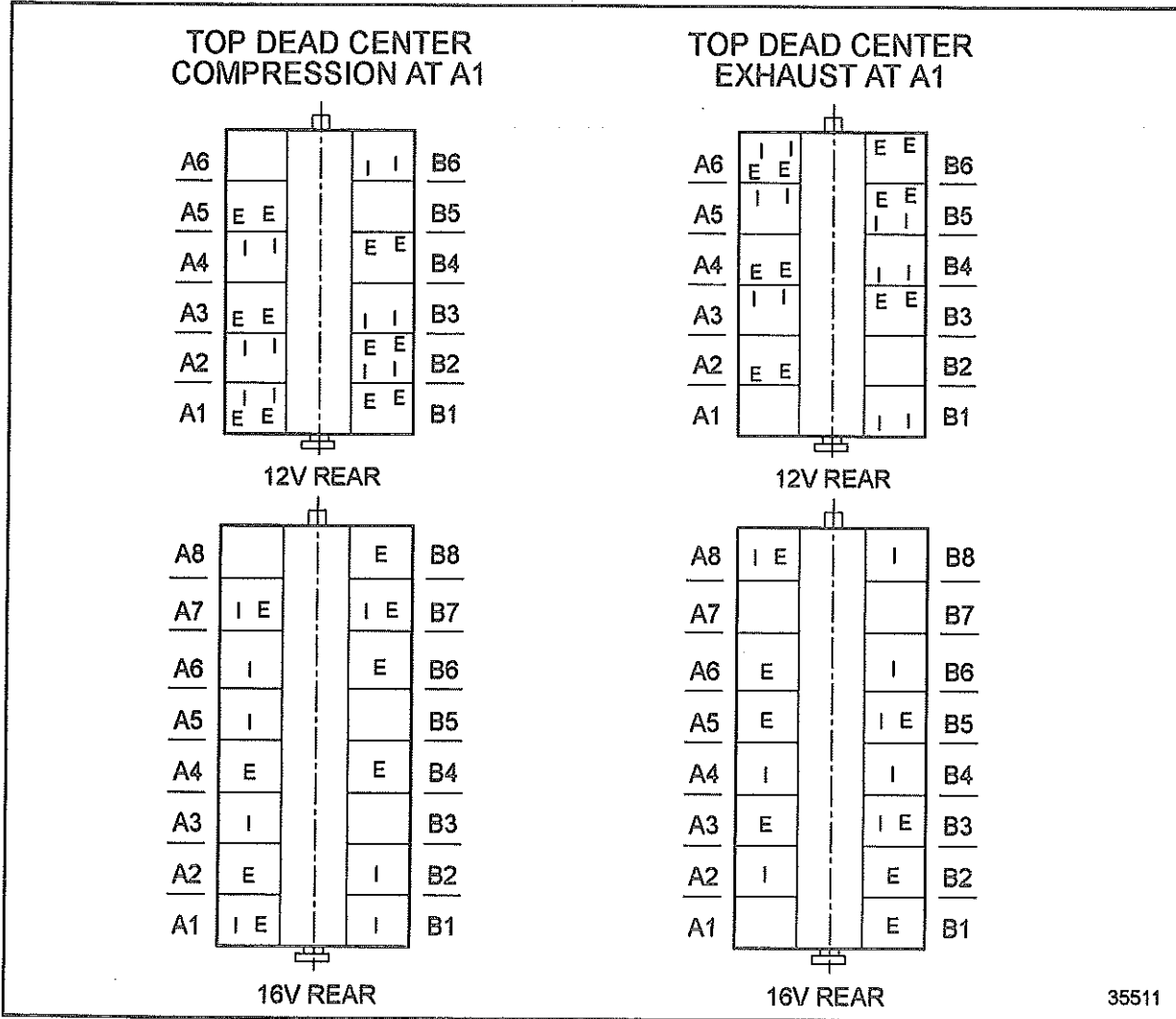
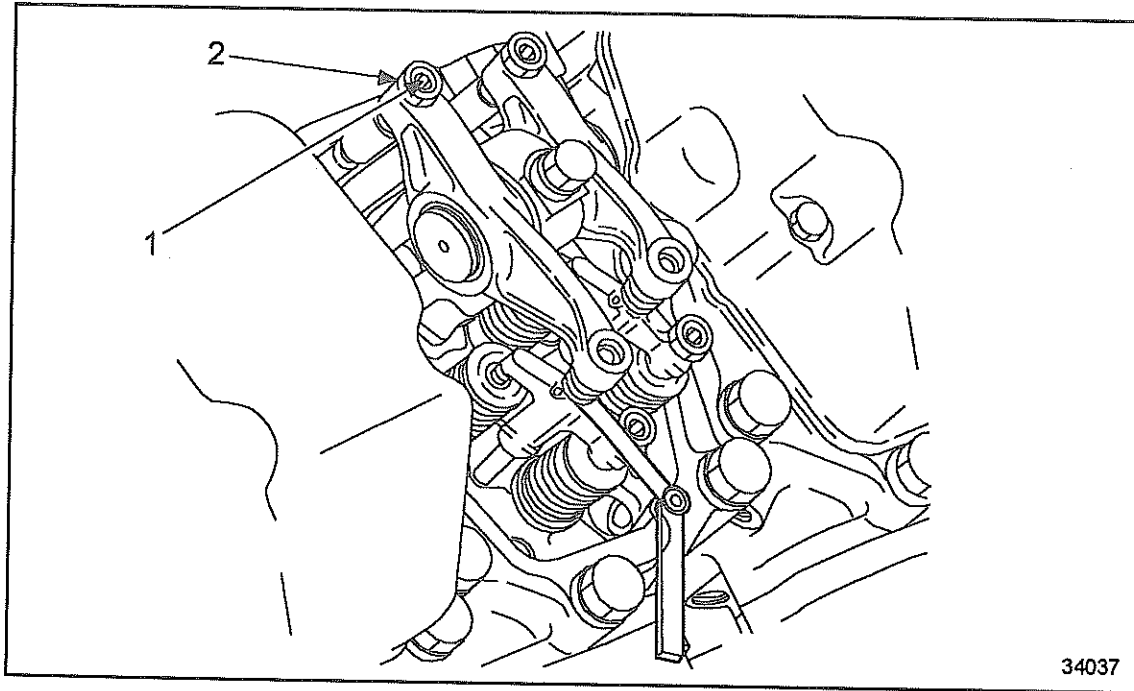


Figure 486 Inspecting Valve Clearance in Two Crankshaft Positions

9. If deviation from specified value is more than 0.1 mm, adjust valve clearance.
10. Release locknut (1) and readjust adjusting bolt (2) with Allen key until feeler gage can be pulled through. See Figure 488.



1. Locknut

2. Adjusting Bolt

**Figure 488**     **Readjusting Adjusting Bolt**

11. Valve clearance on inlet valve (long swing arm) = 0.2 mm (cold engine).
12. Valve clearance on exhaust valve (short swing arm) = 0.5 mm (cold engine).
13. Holding adjusting bolt firmly, again tighten locknut to specified torque.
14. For tightening torque, refer to section A 003.
15. Again check valve clearance.

## C 055.05.12 – AFTER-INSTALLATION OPERATIONS

Listed in Table 50 are the After-Installation Operations for the valve drive.

Level of Maintenance	Operation	Reference
1, 2, 3	Install valve covers	Refer to section C 055.05.11
1, 2, 3	Install charge air coolant lines (low temperature)	Refer to section C 207.05.11
1, 2, 3	Install turbocharger	Refer to section C 101.05.11
1, 2, 3	Install oil supply line for turbochargers	Refer to section C 187.05.11
1, 2, 3	Install oil return lines for turbochargers	Refer to section C 188.05.11
1, 2, 3	Install coolant lines (high temperature)	Refer to section C 203.05.11
1, 2, 3	Install charge air coolant vent lines (low temperature)	Refer to section C 205.05.01
1, 2, 3	Install engine coolant vent lines (high temperature)	Refer to section C 205.05.01
1, 2, 3	Install intake air system from turbocharger to charge air cooler	Refer to section C 125.05.11
1, 2, 3	Install Y-pipe at exhaust outlet housing	Refer to section C 141.05.11
1, 2, 3	Add charge air coolant (low temperature)	Refer to section C 206.05.11
1, 2, 3	Add engine coolant (high temperature)	Refer to Operators Guide
1, 2, 3	Enable engine power	Refer to Operators Guide

1 = The engine is to be completely disassembled.

2 = The engine is to be removed but not completely disassembled.

3 = The engine is to remain installed.

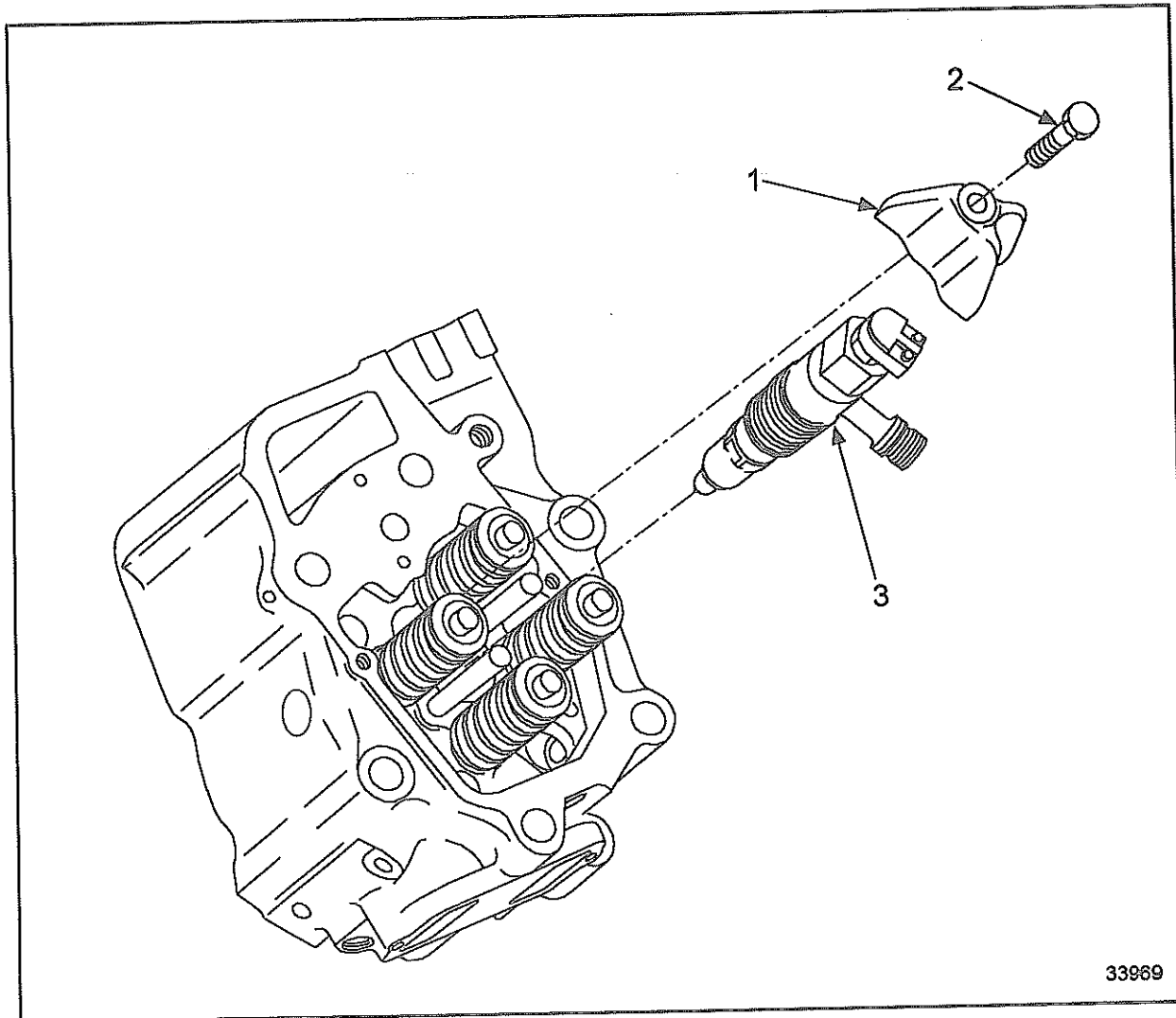
**Table 50** After-Installation Operations

## C 075.05 – INJECTOR

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C 075.05.11	Installation of the Injector ..... C -727
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C 075.05.01 – GENERAL VIEW

See Figure 525 for a general view of the injector.



33989

- 1. Injector Hold-Down Clamp
- 2. Injector Hold Down Clamp Bolt
- 3. Injector

Figure 525 General View of the Injector

**C 075.05.04 – BEFORE-REMOVAL OPERATIONS**

Listed in Table 59 are the Before-Removal Operations for the injector.

Level of Maintenance	Operation	Reference
1, 2, 3	Disable engine power	Refer to Operators Guide
1, 2, 3	Remove rocker cover	Refer to section C 056.05.05
1, 2, 3	Remove high-pressure fuel line	Refer to section C 083.05.05

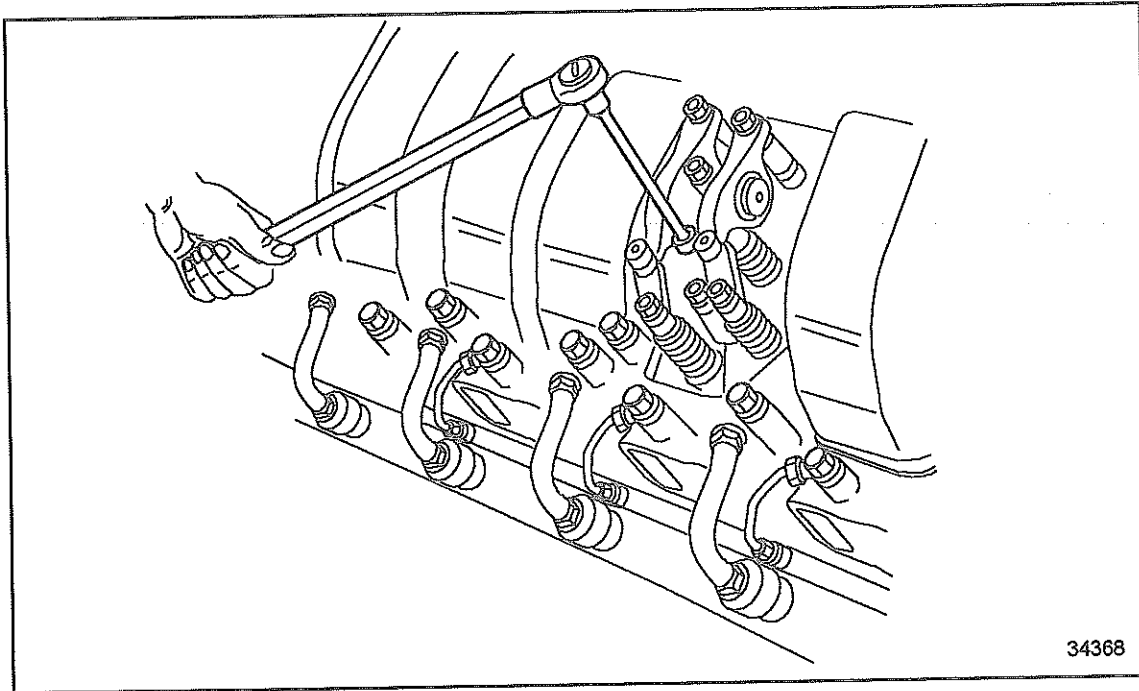
1 = The engine is to be completely disassembled.

2 = The engine is to be removed but not completely disassembled.

3 = The engine is to remain installed.

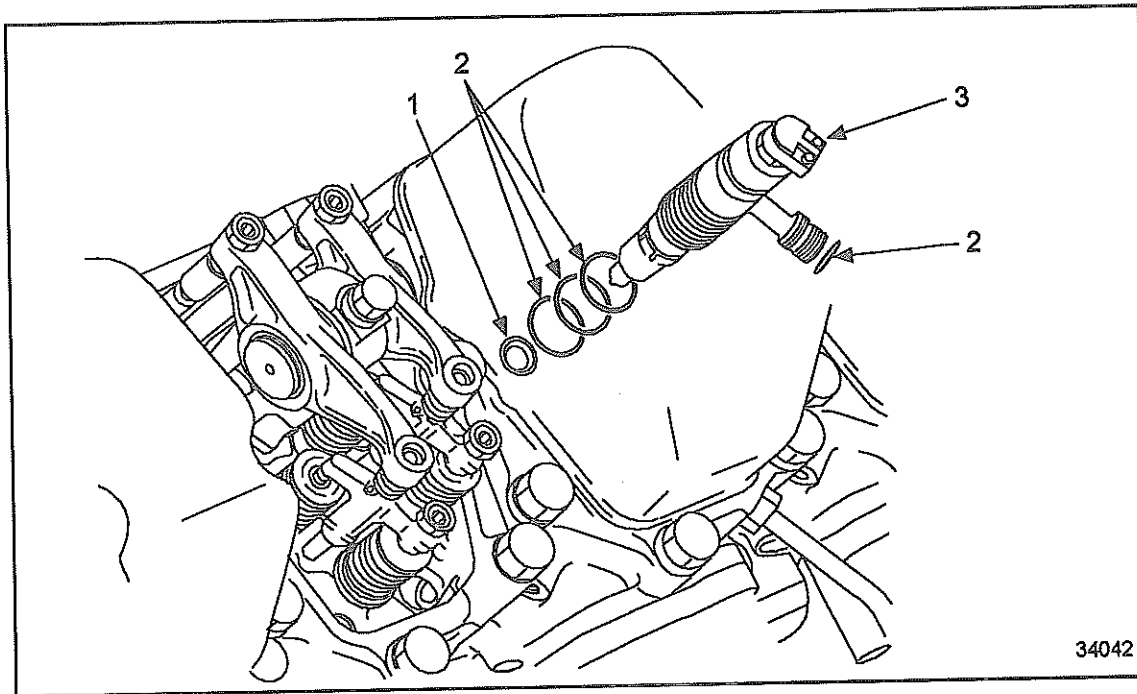
**Table 59 Before-Removal Operations**

8. Use a torque wrench to break bolt torque and note breaking torque. Remove bolt from hold-down clamp and take off hold-down clamp. See Figure 527.



**Figure 527** Removing Hold-Down Clamp

10. Remove injector (2) manually from bore.
11. Remove O-ring (2) from injector (3). See Figure 529.



1. CE Ring
2. O-ring

3. Injector

**Figure 529** Removing O-ring and C-E Ring from Injector

**NOTE:**

After removing injector, ensure that no C-E support ring remains in bore for injector in cylinder head.

**C 075.05.08 – INSPECTION AND REPAIR**

Perform the following steps for the inspection and repair of the injector:

1. Clean all components.
2. Using the magnetic crack-testing method with fluorescent magnetic powder, inspect injector hold down bolt and clamping element for cracks.
  - [a] If injector hold down bolt and clamping element are cracked, replace as necessary.
  - [b] If injector hold down bolt and clamping element are not cracked, continue inspection.
3. Inspect threads on injector hold down bolt and injector for ease of movement.
  - [a] If threads on injector hold down bolt or injector do not show ease of movement, replace component as necessary.
  - [b] If threads on injector hold down bolt and injector show ease of movement, continue inspection.

**NOTE:**

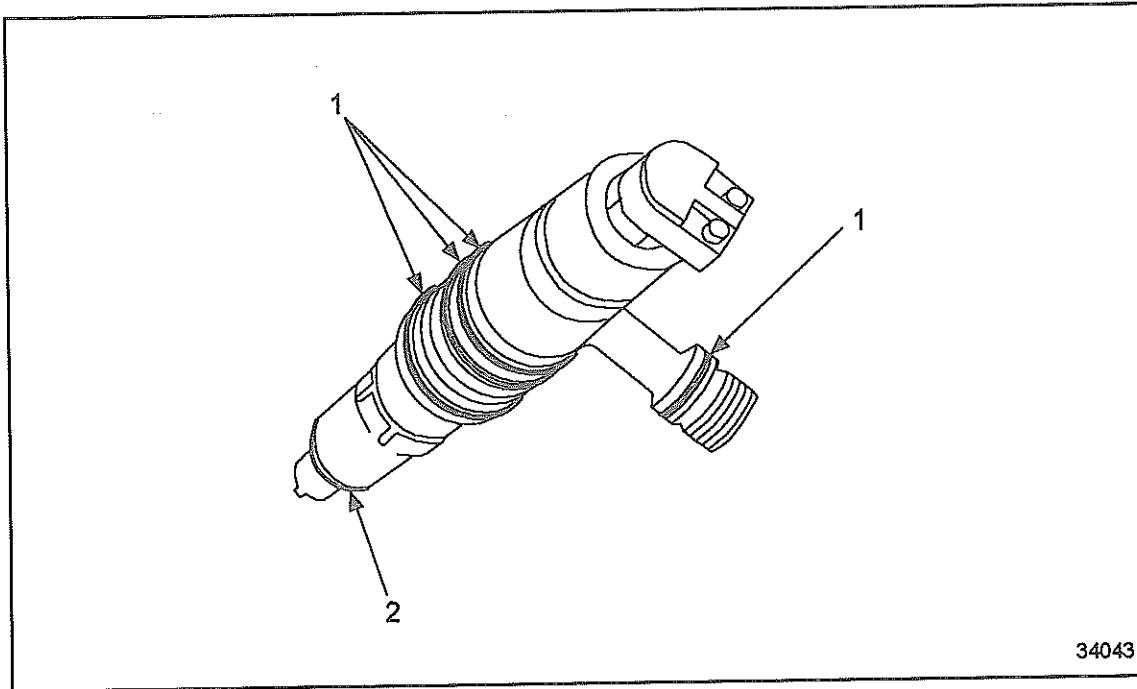
When inspecting injector, ensure that it is perfectly clean.

4. Visually inspect mating surfaces of hold-down clamp for wear or damage.
  - [a] If mating surfaces of hold-down clamp are worn or damaged, rub down with emery cloth or oilstone.
  - [b] If rubbing down with emery cloth or oilstone does not remove wear or damage, replace hold-down clamp as necessary.
  - [c] If mating surfaces of hold-down clamp are not worn or damaged, continue inspection.
5. Visually inspect injector O-ring surface of injector (in cylinder head) for wear or damage.
  - [a] If O-ring sealing or cylinder head surface of injector is worn or damaged, rub down with emery cloth or oilstone.
  - [b] If rubbing down with emery cloth or oilstone does not remove wear or damage, replace injector as necessary.
  - [c] If O-ring sealing and cylinder head surface of injector are not worn or damaged, continue inspection.
6. Visually inspect DDEC injector harness connections for damage.
  - [a] If DDEC injector harness connections are damaged, replace as necessary.
  - [b] If DDEC injector harness connections are not damaged, continue inspection.
7. Visually inspect injector hole tube for wear and damage.
  - [a] If injector hole tube is worn or damaged, replace as necessary.
  - [b] If injector hole tube is not worn or damaged, continue inspection.
8. Replace C-E rings and O-rings at every assembly.

## C 075.05.11 – INSTALLATION OF THE INJECTOR

Perform the following steps for installation of the injector:

1. Coat new O-rings (1) with petroleum jelly and install on injector. See Figure 530



1. O-ring

2. C-E Ring

**Figure 530**     **Installing O-rings and CE Support Rings on Injector**



**CAUTION:**

To avoid personal injury when working on the fuel system, do not smoke, use open flame, or electrical equipment. Diesel fuel is a combustible fluid. Risk of a fire from sparks is probable. Perform maintenance in a well ventilated work area with access to a fire extinguisher.

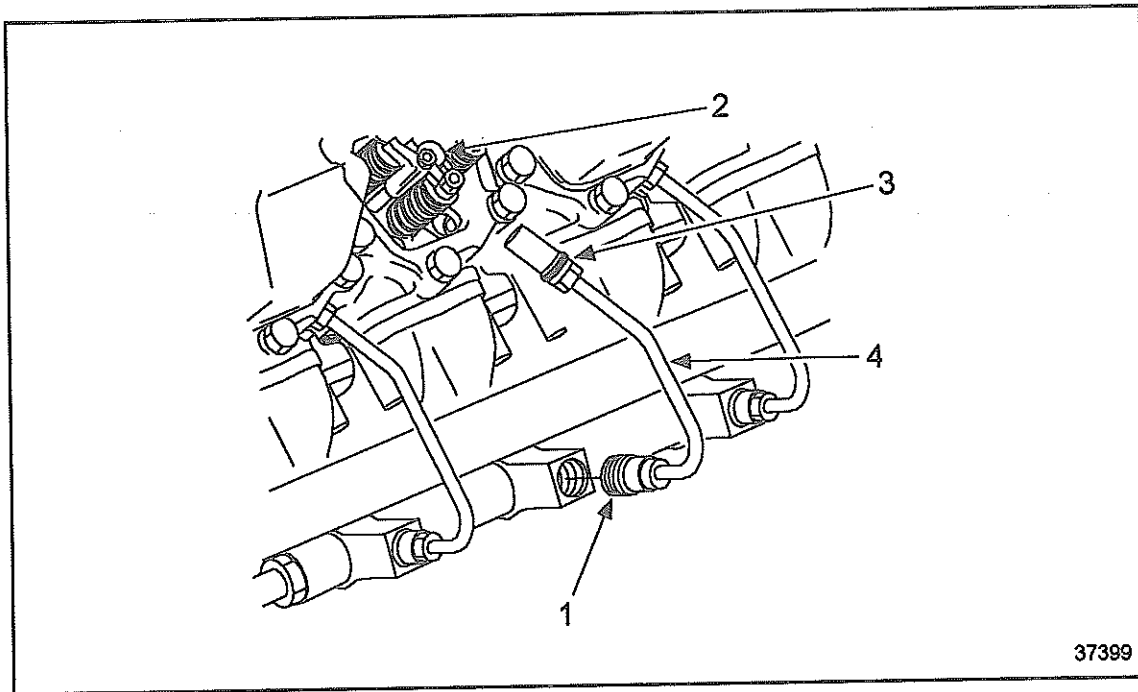


**CAUTION:**

To avoid personal injury when barring the engine over, stand clear so that the crankshaft will not unexpectedly rotate and cause loss of control of barring tool.

3. bar engine several times to blow out any remaining fuel.
4. Inspect sealing surface on cylinder head and injector hole tube.
  - [a] Clean sealing surface on cylinder head or hole tube if necessary.
  - [b] If sealing surface on cylinder head or hole tube does not require cleaning, continue inspection.

9. Install new O-rings (3) at each end of high-pressure jumper line and coat with petroleum jelly See Figure 533.



- |                                  |                              |
|----------------------------------|------------------------------|
| 1. Flow Limiting Valve Connector | 3. O-ring                    |
| 2. Injector                      | 4. High-Pressure Jumper Line |

**Figure 533**     **Installing High-Pressure Jumper Line**

10. Install flow limiting valve in high-pressure rail.
11. Install high-pressure jumper line (4) at injector (2) and connector (flow limiting valve) (1).

**NOTE:**

The high-pressure jumper line must not be bent. Ensure that the installation position is correct.

**NOTE:**

For ease of installation, connect both ends of high-pressure jumper line before tightening.

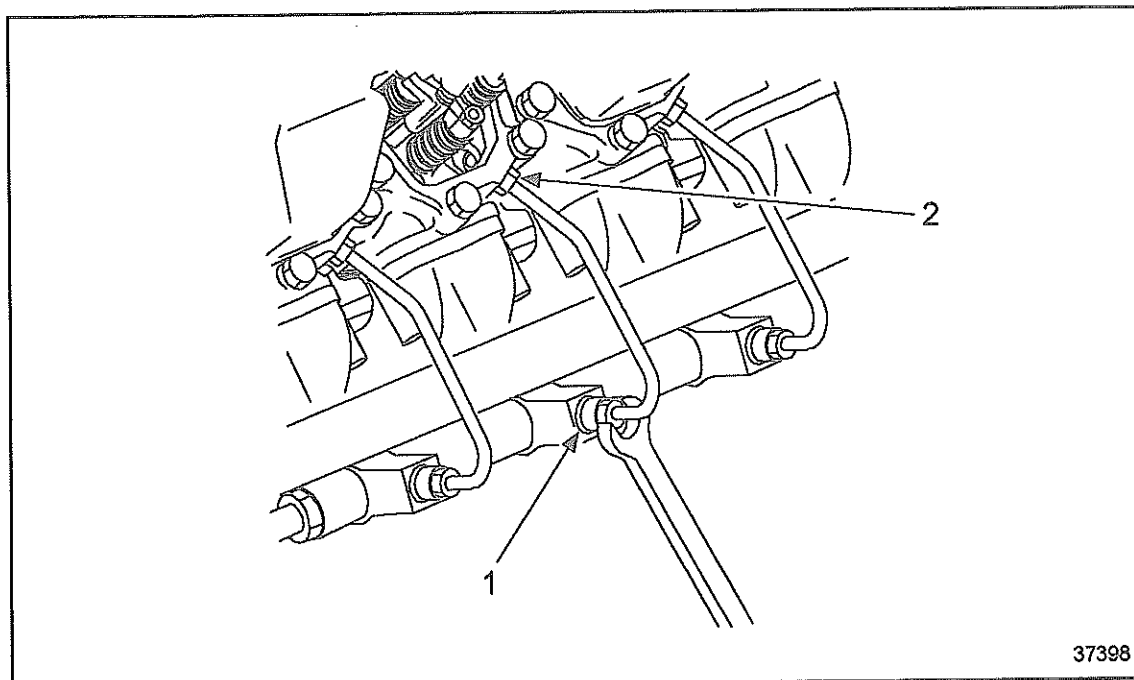
14. Using torque wrench, tighten connector of high-pressure jumper line at injector (2) and flow limiting valve connector (1) to specification. Refer to section A 003. See Figure 535

**NOTE:**

Use engine oil as lubricant.

**NOTE:**

The high-pressure jumper line must not be bent. Ensure that the installation position is correct.

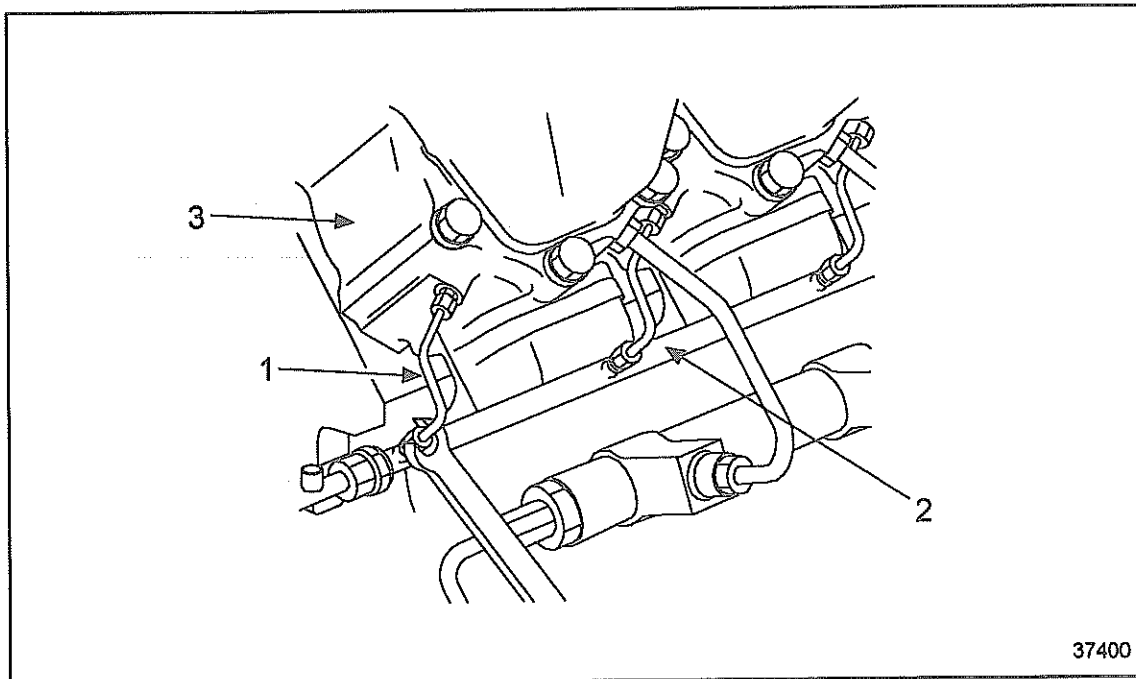


1. Flow Limiting Valve Connector

2. Injector

**Figure 535** Tightening Threaded Connection of High-Pressure Jumper Line at Injector

16. Attach fuel return line (1) between cylinder head and return rail and tighten. 537



- |                     |                  |
|---------------------|------------------|
| 1. Fuel Return Line | 3. Cylinder Head |
| 2. Fuel Return Rail |                  |

**Figure 537 Attaching Fuel Return Line Between Cylinder Head and Fuel Return Rail**

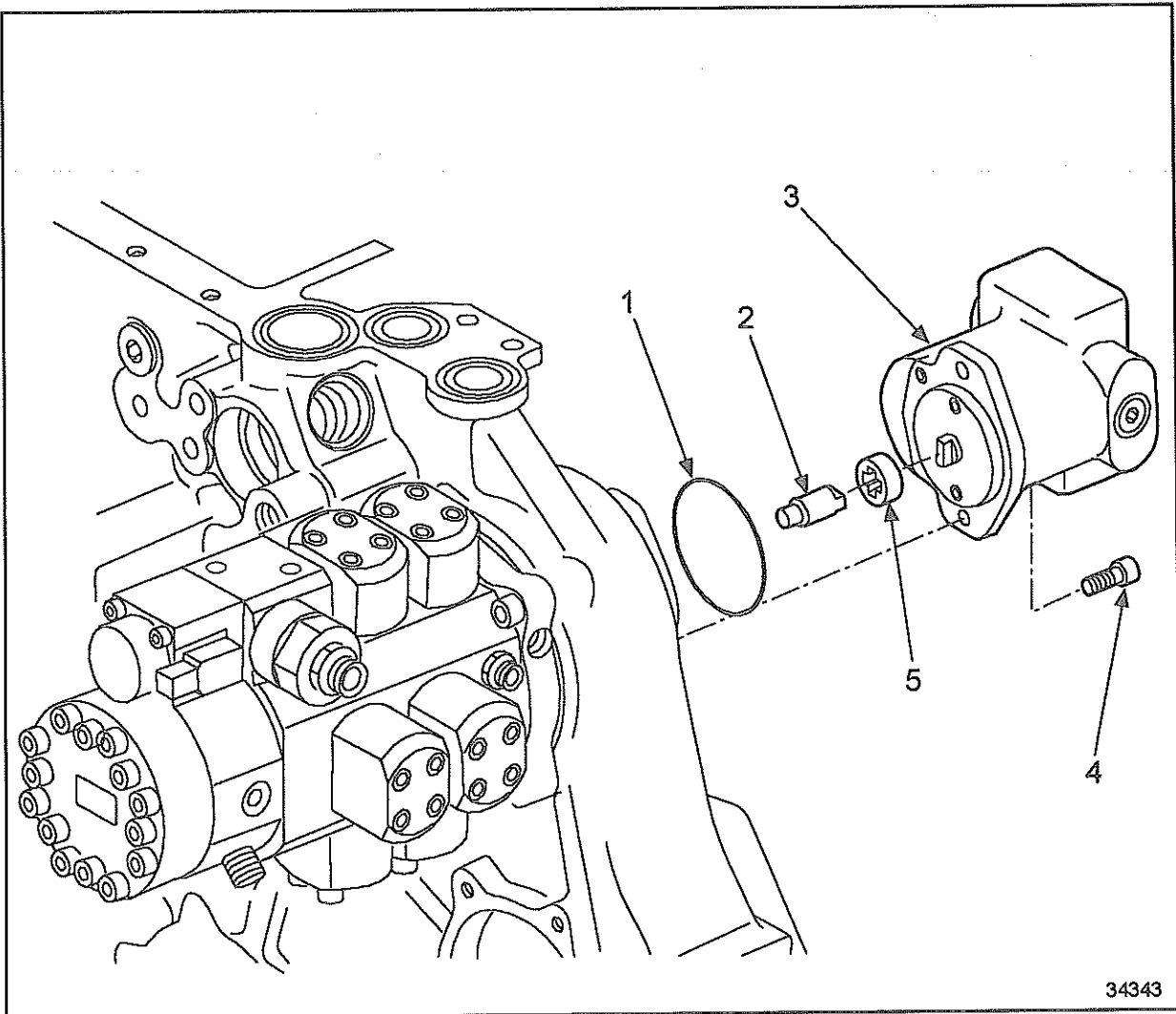
17. Open fuel supply to engine. Prime fuel system. Refer to Operators Guide.
18. Release engine start.
19. Inspect for leaks.

## C 081.05 – FUEL PUMP

Section		Page
C 081.05.01	General View .....	C -789
C 081.05.04	Before-Removal Operations .....	C -790
C 081.05.05	Removal of Low-Pressure Fuel Pump .....	C -791
C 081.05.06	Disassembly of Low-Pressure Fuel Pump .....	C -793
C 081.05.08	Inspection and Repair .....	C -794
C 081.05.10	Assembly of Low-Pressure Fuel Pump .....	C -795
C 081.05.11	Installation of Low-Pressure Fuel Pump .....	C -796
C 081.05.12	After-Installation Operations .....	C -798

**C 081.05.01 – GENERAL VIEW**

See Figure 581 for a general view of the fuel pump assembly.




- 1. O-ring
- 2. Drive Adaptor

- 3. Fuel Pump
- 4. Socket-Head Bolt

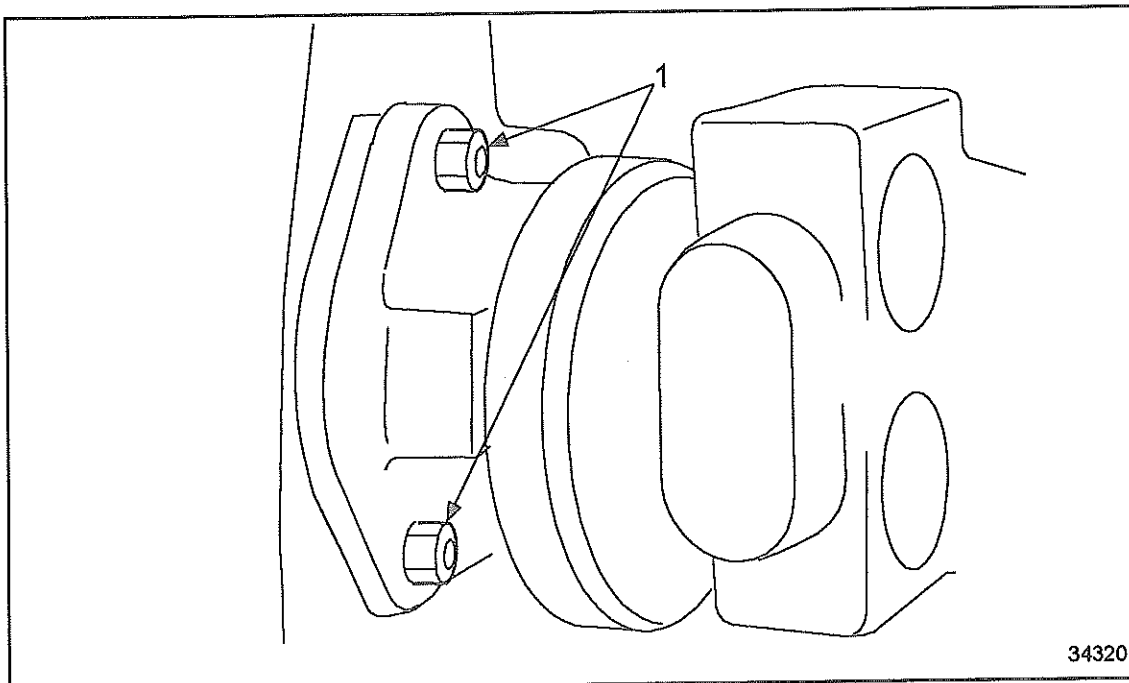
**Figure 581 Fuel Pump Assembly**

## C 081.05.05 – REMOVAL OF LOW-PRESSURE FUEL PUMP

Perform the following steps to remove the low-pressure fuel pump:

	<b>CAUTION:</b>
<p>To avoid personal injury when working on the fuel system, do not smoke, use open flame, or electrical equipment. Diesel fuel is a combustible fluid. Risk of a fire from sparks is probable. Perform maintenance in a well ventilated work area with access to a fire extinguisher.</p>	

1. Remove Allen-head bolts (1). See Figure 582.



1. Allen-Head Bolt

**Figure 582**      Removing Allen-Head Bolts

## C 081.05.06 – DISASSEMBLY OF LOW-PRESSURE FUEL PUMP

Low-pressure fuel pumps are serviced only as an assembly by your authorized Detroit Diesel Distributor.

## C 081.05.10 – ASSEMBLY OF LOW-PRESSURE FUEL PUMP

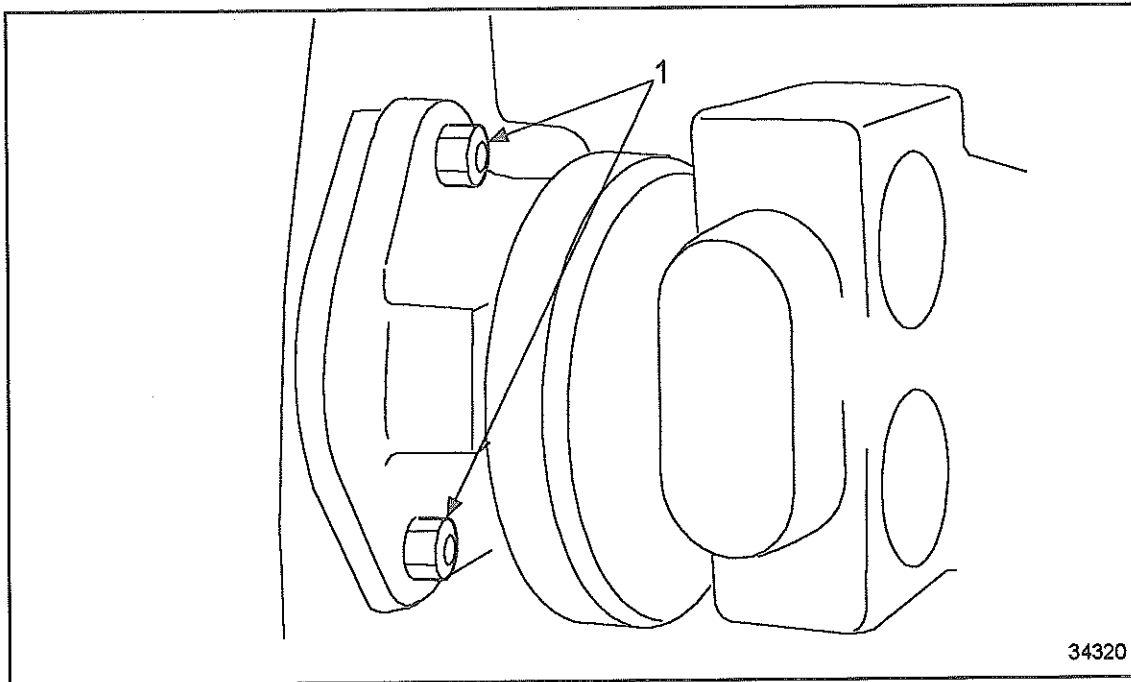
Low-pressure fuel pumps are serviced only as an assembly by your authorized Detroit Diesel Distributor.

4. Install fuel delivery pump (1) into gear case bore. See Figure 584.

**NOTE:**

If the pump does not move in as far as the stop, withdraw the pump and check the position of the driver with regard to the coupling.

5. Secure with Allen-head bolts and torque socket-head bolts (1) to specification. Refer to section A 003. See Figure 585.



1. Allen-Head Bolts

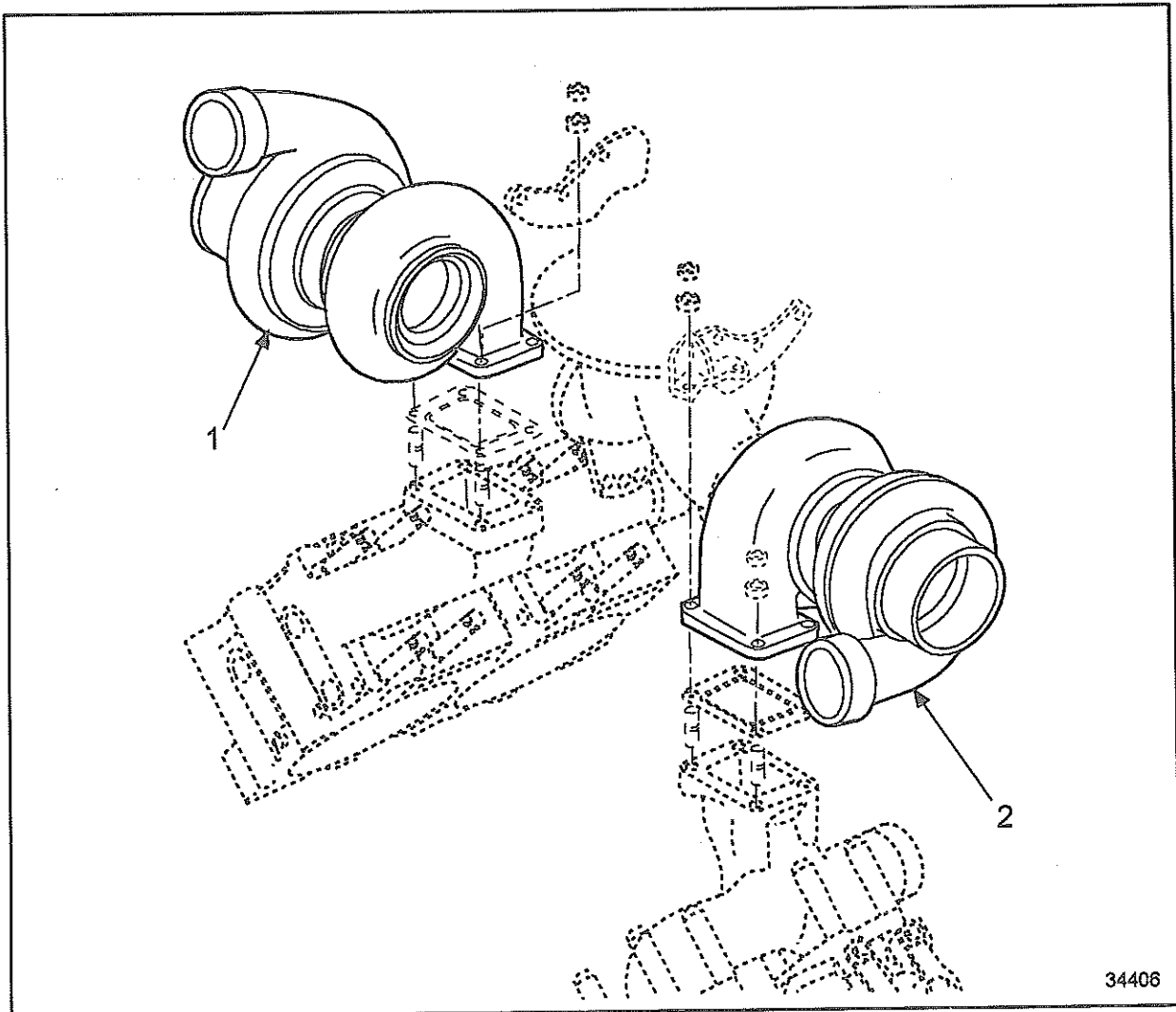
**Figure 585**      **Installation of Allen-Head Bolts**

## C 101.05 – TURBOCHARGER

Section		Page
C 101.05.01	General View .....	C -853
C 101.05.04	Before-Removal Operations .....	C -854
C 101.05.05	Removal of the Exhaust Turbocharger .....	C -855
C 101.05.06	Disassembly of the Exhaust Turbocharger .....	C -857
C 101.05.08	Inspection and Repair .....	C -858
C 101.05.10	Assembly of Turbocharger .....	C -859
C 101.05.11	Installation of the Turbocharger .....	C -860
C 101.05.12	After-Installation Operations .....	C -863

**C 101.05.01 – GENERAL VIEW**

See Figure 616 for a general view of the turbocharger.



1. "A" Bank Turbocharger (2X)

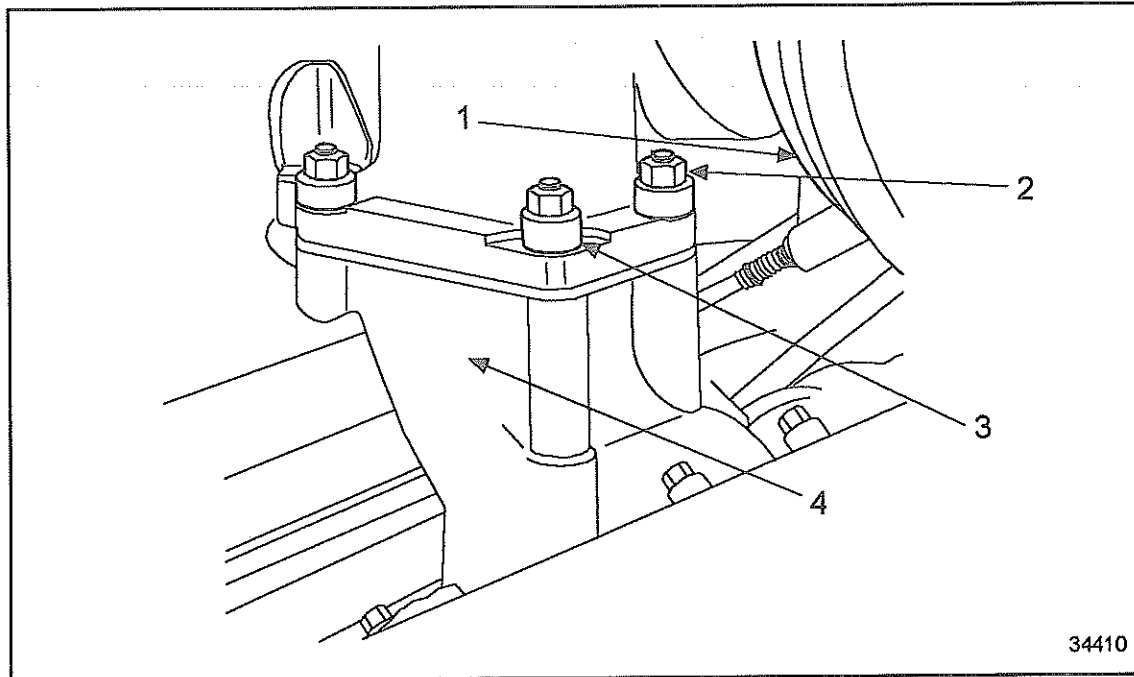
2. "B" Bank Turbocharger (2X)

**Figure 616 General View of Turbocharger**

## C 101.05.05 – REMOVAL OF THE EXHAUST TURBOCHARGER

Perform the following steps to remove the turbocharger:

1. To remove turbocharger, remove hex nuts (1) from flange on both turbochargers (2). See Figure 617.



- |                 |                     |
|-----------------|---------------------|
| 1. Hex Nut      | 3. Spacer Bushing   |
| 2. Turbocharger | 4. Exhaust Manifold |

**Figure 617** Exhaust Turbocharger

2. Remove spacer sleeves (3).

**NOTE:**

Two different length of spacers are used.



**CAUTION:**

To avoid personal injury while using a lifting device, never stand beneath a suspended load. Use a suitable lifting device and review all manufacturer's cautionary notes.

3. Attach turbocharger with lifting device to crane and carefully lift from studs.

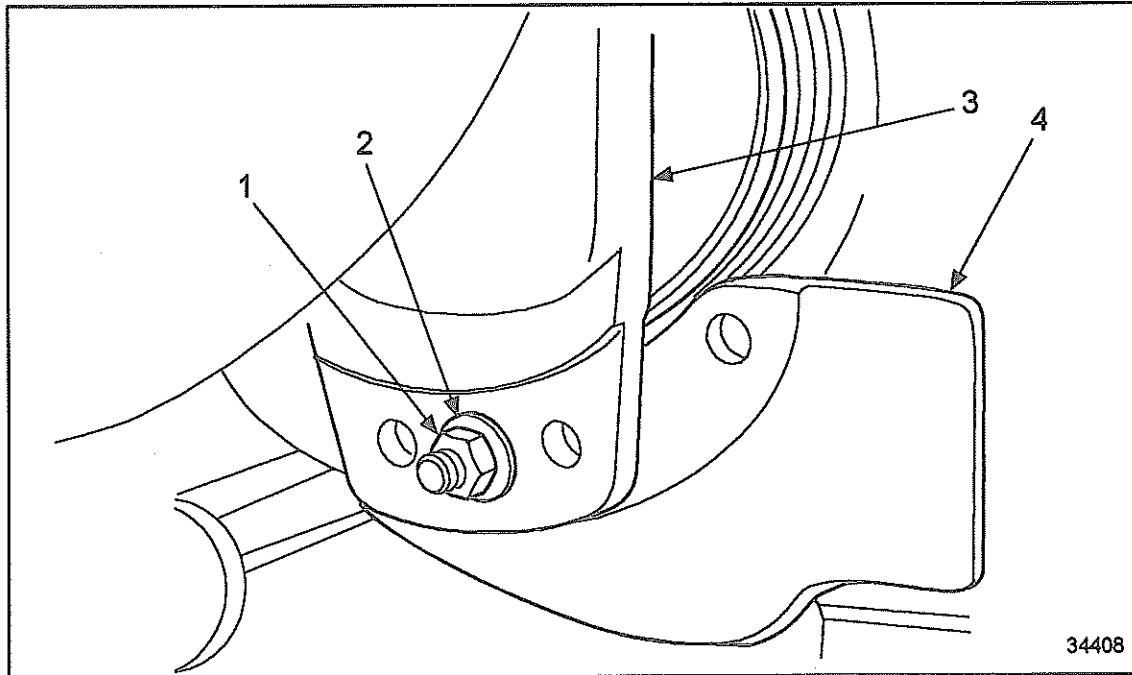
## C 101.05.06 – DISASSEMBLY OF THE EXHAUST TURBOCHARGER

At present, no provision is made for turbocharger disassembly on site.

**C 101.05.10 – ASSEMBLY OF TURBOCHARGER**

Refer to section C 101.05.06.

3. Install exhaust outlet (Y-pipe) (3) into turbocharger exhaust outlet. See Figure 620.



- |             |            |
|-------------|------------|
| 1. Hex Bolt | 3. Y-pipe  |
| 2. Washer   | 4. Bracket |

**Figure 620** Installing Exhaust Outlet (Y-pipe) into Turbocharger Exhaust Outlet

4. Bolt bracket (4) and (Y-pipe) (3) together with hex bolt (1) and washer (2).

**NOTE:**

Join retainers on exhaust outlet (Y-pipe) and bracket at central bores. Final alignment on exhaust outlet (Y-pipe) with vehicle exhaust system can be carried out after installation.

**NOTE:**

Secure exhaust outlet (Y-pipe) to prevent from falling.

**C 101.05.12 – AFTER-INSTALLATION OPERATIONS**

Listed in Table 73 are the After-Installation Operations for the exhaust turbocharger.

Level of Maintenance	Operation	Reference
1, 2, 3	Enable engine start	Refer to Operators Guide
1, 2, 3	Install oil supply lines for turbochargers	Refer to section C 187.05.11
1, 2, 3	Install oil return lines for turbochargers	Refer to section C 188.05.11
1, 2, 3	Install intermediate charge air element of manifold on exhaust turbocharger.	Refer to section C 124.05.11
1, 2, 3	Install exhaust system after exhaust outlet (Y-pipe)	Refer to section C 141.05.11
1, 2, 3	install air system before exhaust turbocharger	Refer to section C 101.05.11

- 1 = The engine is to be completely disassembled.
- 2 = The engine is to be removed but not completely disassembled.
- 3 = The engine is to remain installed.

**Table 73 After-Installation Operations**

## C 202.05 – HIGH-TEMPERATURE WATER PUMP WITH ATTACHMENTS

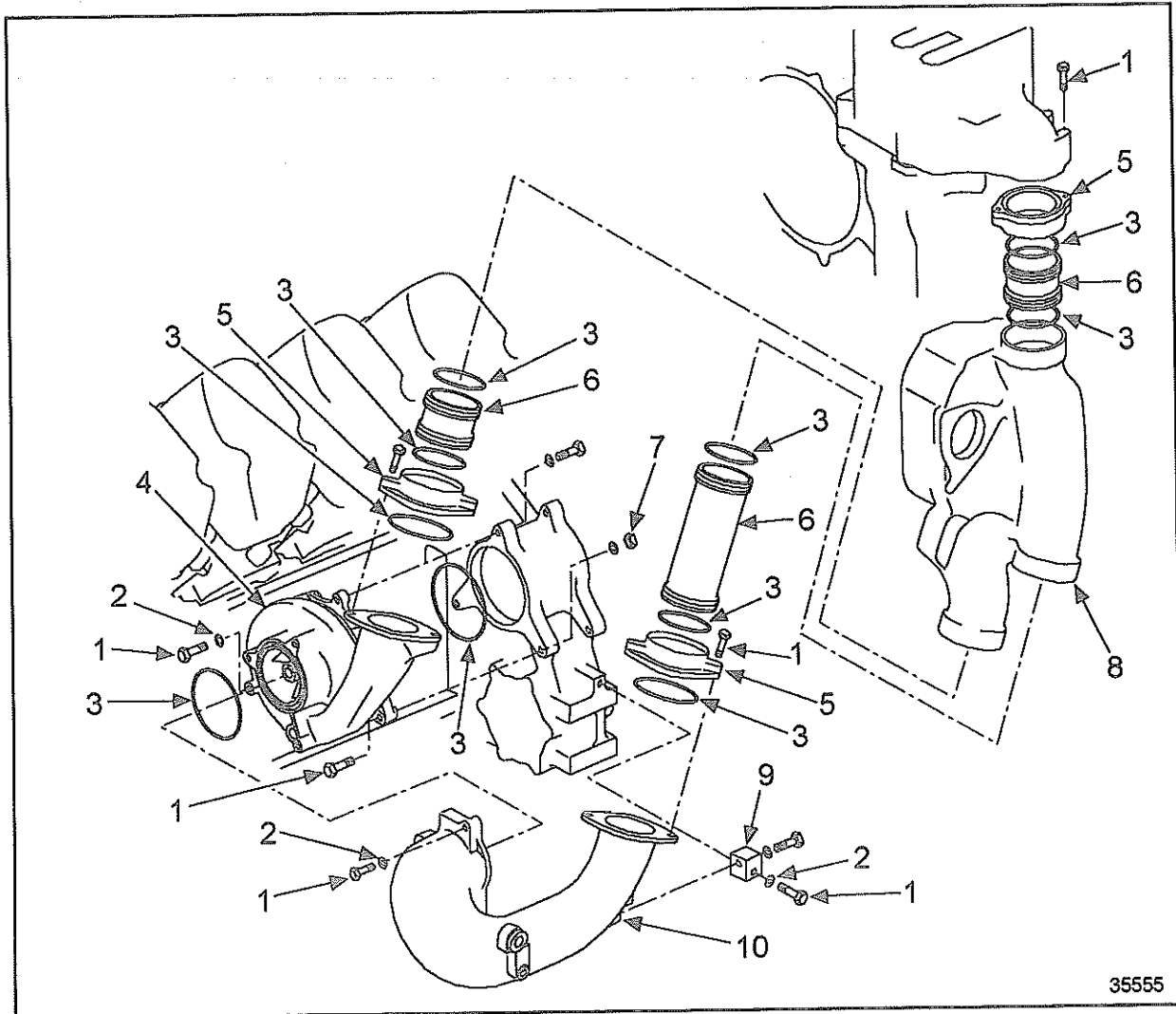
Section	Page
C 202.05.01    General View .....	C -1287
C 202.05.02    Special Tools .....	C -1290
C 202.05.04    Before-Removal Operations .....	C -1291
C 202.05.05    Removal of High—Temperature Water Pump .....	C -1292
C 202.05.06    Disassembly of High-Temperature Pump .....	C -1294
C 202.05.08    Inspection and Repair .....	C -1301
C 202.05.10    Assembly of High-Temperature Water Pump .....	C -1303
C 202.05.11    Installation of High-Temperature Water Pump .....	C -1328
C 202.05.12    After-Installation Operations .....	C -1330

C 202.05.01 – GENERAL VIEW

**NOTE:**

Refer to section before beginning any work in the cooling system.

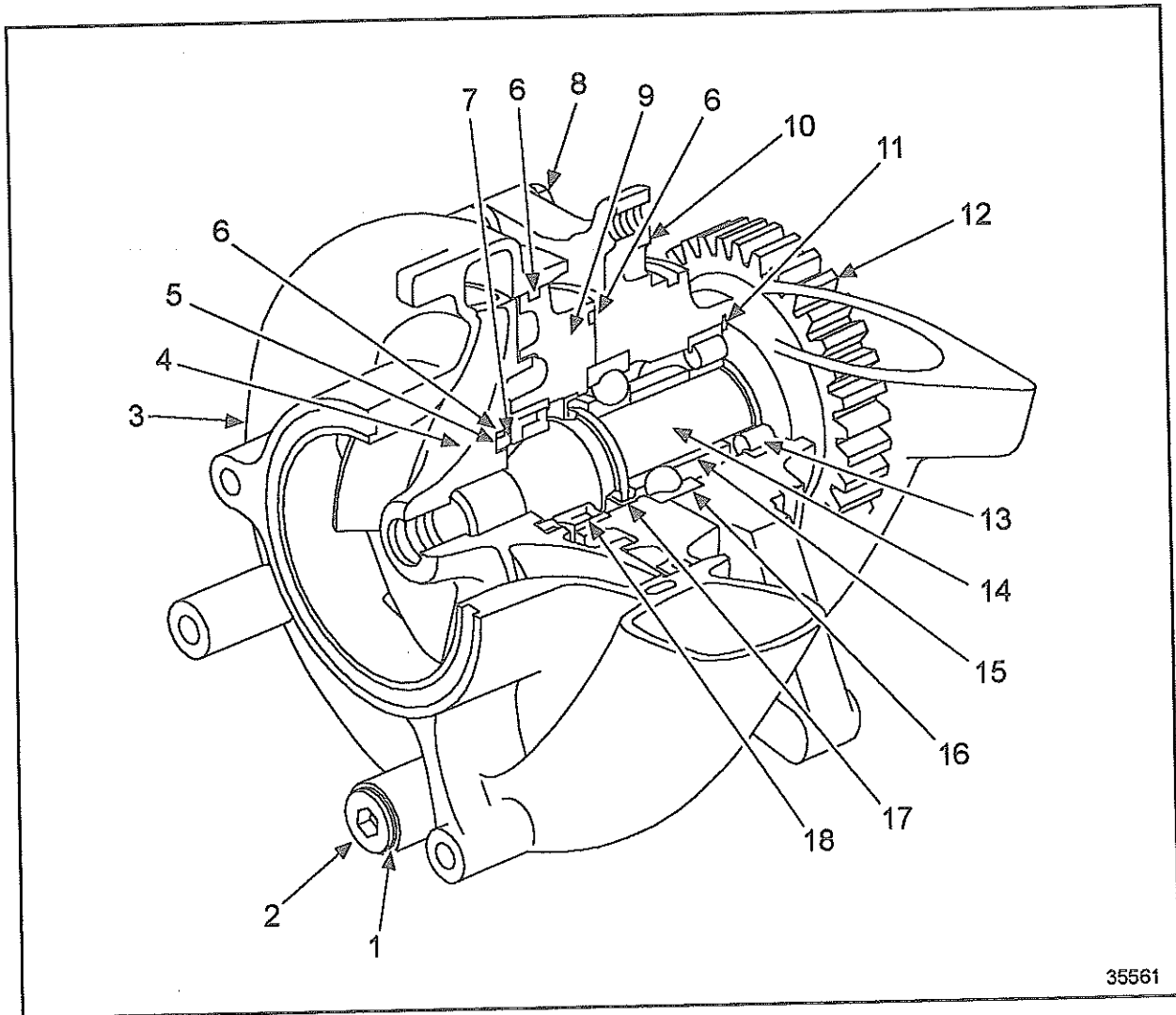
See Figure 843 for a general view of the coolant high-temperature water with attachments.



- |                                |                       |
|--------------------------------|-----------------------|
| 1. Hex Bolt                    | 6. Plug-in Pipe       |
| 2. Washer                      | 7. Nut                |
| 3. O-ring                      | 8. Thermostat Housing |
| 4. High-Temperature Water Pump | 9. Bracket            |
| 5. Flange                      | 10. Elbow             |

**Figure 843** General View of High—Temperature Water Pump with Attachments

See Figure 845 for a three-dimensional overview of the high-temperature water pump.



- 1. Washer
- 2. Plug
- 3. Impeller Housing
- 4. Impeller
- 5. Metal Ring
- 6. O-Ring
- 7. Thrust Ring
- 8. Hex Bolt
- 9. Seal Carrier

- 10. Bearing Housing
- 11. Circlip
- 12. Gear
- 13. Cylindrical Roller Bearing
- 14. Water Pump Shaft
- 15. Spacer Sleeve
- 16. Angular-Contact Ball Bearing
- 17. Shaft Seal
- 18. Rotary Seal

**Figure 845** Three-Dimensional Overview of High-Temperature Water Pump

**C 202.05.04 – BEFORE-REMOVAL OPERATIONS**

Listed in Table 126 are the Before-Removal Operations for the high-temperature water pump.

Level of Maintenance	Operation	Reference
1, 2, 3	Disable engine power	Refer to Operators Guide
1, 2, 3	Drain engine coolant	Refer to Operators Guide

1 = The engine is to be completely disassembled.

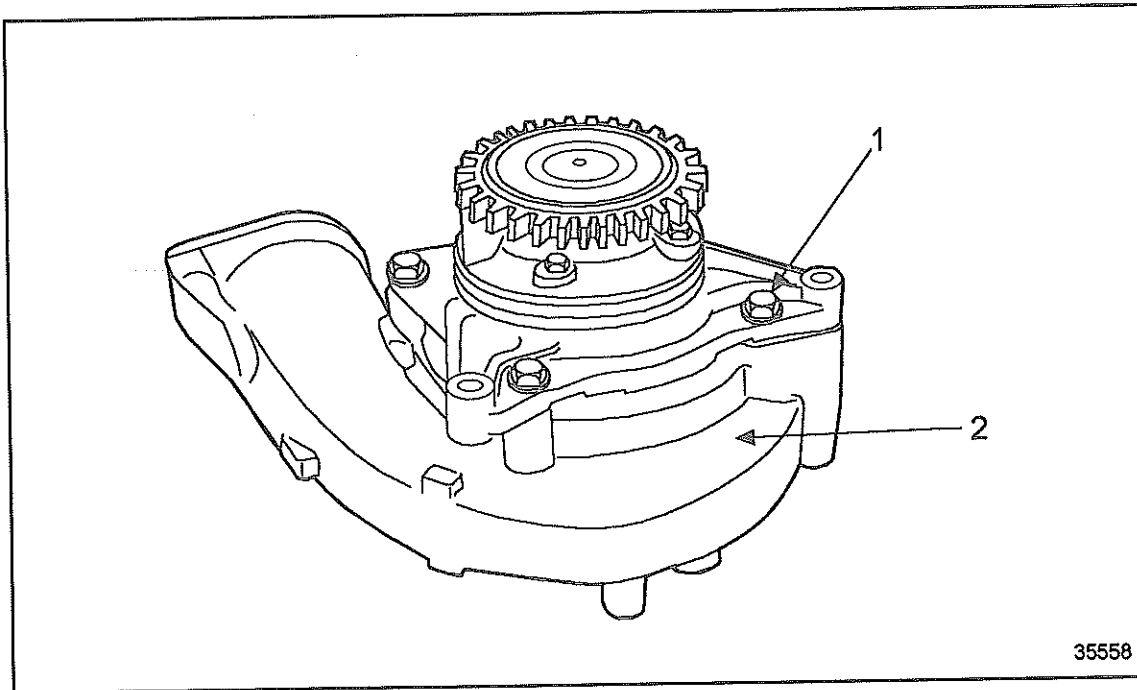
2 = The engine is to be removed but not completely disassembled.

3 = The engine is to remain installed.

**Table 126 Before-Removal Operations**

2. Remove charge cooler pipe flange hex bolts and remove charge air cooler pipe (6).
3. Remove flange hex bolts at pump inlet (4).
4. Remove flange hex bolts on elbow (1).
5. Remove elbow (1).

4. Remove securing bolts (1) from pump housing to seal carrier. See Figure 848.

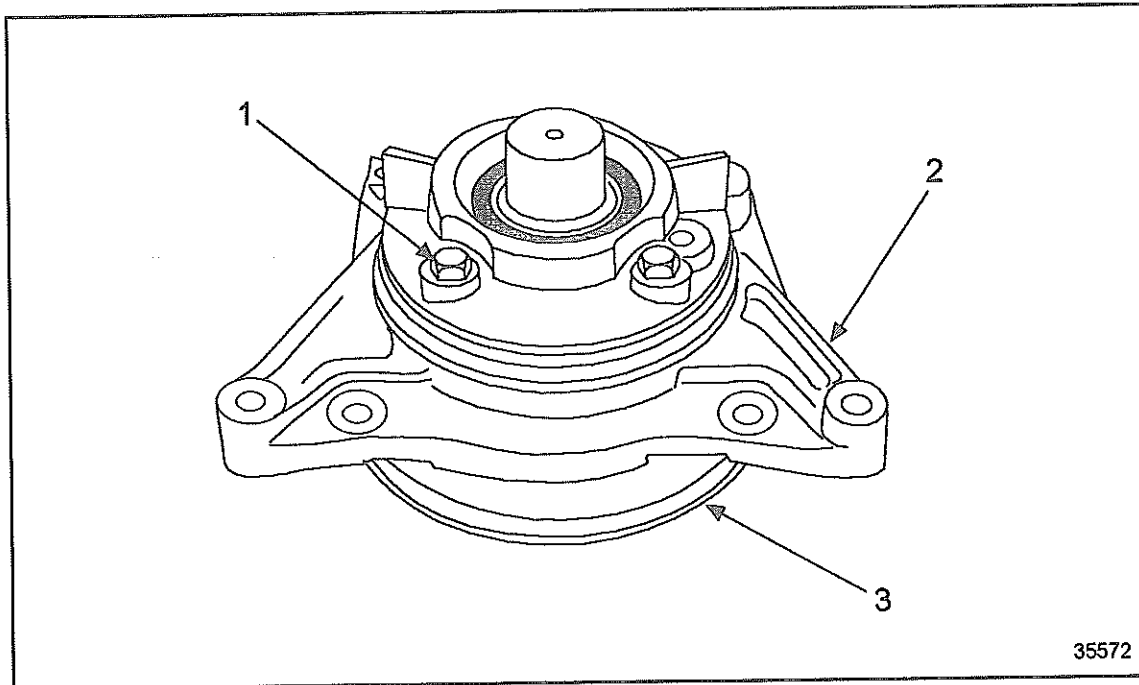


1. Securing Bolt

2. Coolant Pump Housing

**Figure 848** Removing Attaching Bolts from Pump Housing to Seal Carrier and Removing Pump Housing

8. Use a suitable removal tool to remove gear from coolant pump shaft. See Figure 850.



1. Securing Bolt  
2. Seal Carrier

3. Bearing Housing

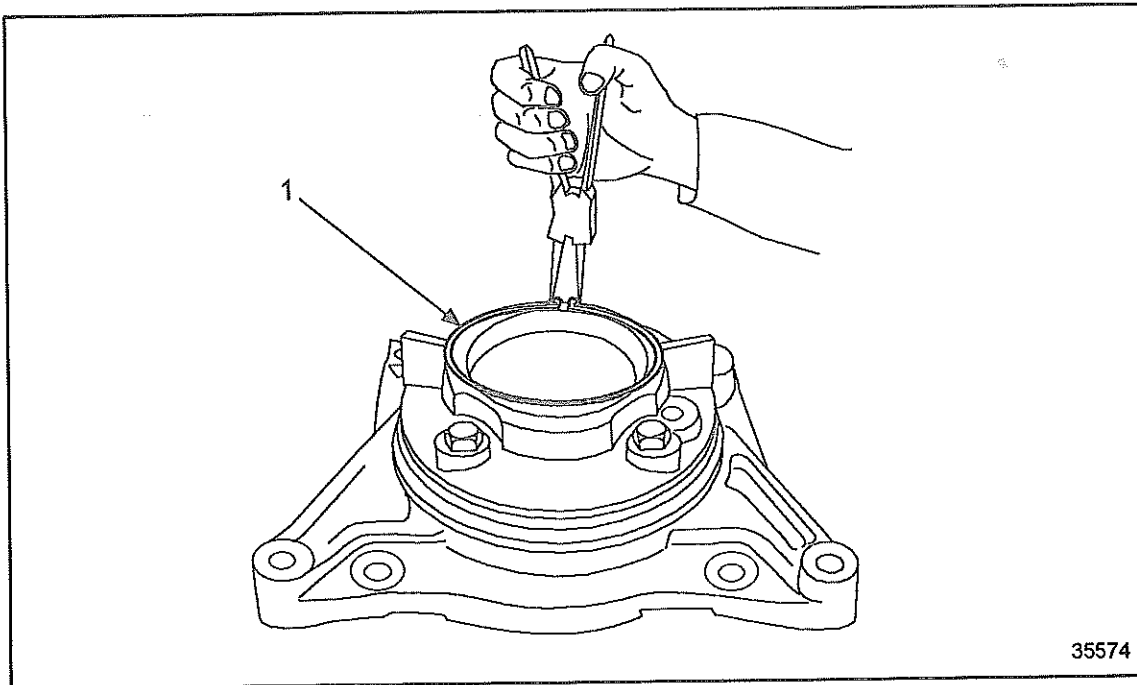
**Figure 850 Removing Securing Bolt between Seal Carrier and Bearing Housing**

9. Remove thrust ring with inserted O-ring and metal ring from groove on back of impeller.

**NOTE:**

Due to the interference fit of gear hub and shaft, the shaft will be heavily scored when the gear is removed.

13. Remove O-rings from seal carrier.
14. Use a suitable tool to remove bearing inner race, spacer sleeve and roller bearing from pump shaft.
15. Remove snap ring (1) from bearing housing. See Figure 852.



1. Snap Ring

**Figure 852**      **Removing Snap Ring from Bearing Housing**

**C 202.05.08 – INSPECTION AND REPAIR**

Perform the following steps for inspection and repair of the high-temperature water pump:

1. Clean all components.
2. Using surface crack-testing method and red penetrant dye, inspect impeller for cracks.
  - [a] If cracks are found, repair or replace impeller.
  - [b] If no cracks are found, continue inspection.
3. Using the magnetic crack-testing method with fluorescent magnetic powder, inspect pump shaft and gear for cracks.
  - [a] If pump shaft or gear is cracked, repair or replace components as necessary.
  - [b] If pump shaft or gear is not cracked, continue inspection.
4. Visually inspect sealing surfaces and/or annular grooves on elbow, housing, impeller and inlet connection for wear, indentations and pitting.
  - [a] If sealing surfaces and/or annular grooves are worn, indented or pitted, rub down with emery cloth or an oilstone.
  - [b] If damage is beyond repair, replace component.
  - [c] If sealing surfaces and/or annular grooves are not worn or damaged, continue inspection.
5. Visually inspect elbow, housing, impeller and inlet adaptor for pitting.
  - [a] If pitting is over 1 mm in depth, replace component.
  - [b] If pitting is under 1 mm in depth, continue inspection.

**CAUTION:**

To avoid an eye injury when using compressed air, wear adequate eye protection (safety glasses or faceplate) and do not exceed 276 kPa (40 lb/in.<sup>2</sup>) air pressure.

6. Visually inspect elbow, inlet adaptor and housing for leaks with compressed air under water.
  - [a] If elbow, inlet adaptor or housing show leaks, repair or replace components as necessary.
  - [b] If elbow, inlet adaptor or housing do not show leaks, continue inspection.

**NOTE:**

Water temperature should be within a minimum of 30 °C (86 °F) to a maximum of 40 °C (104 °F).

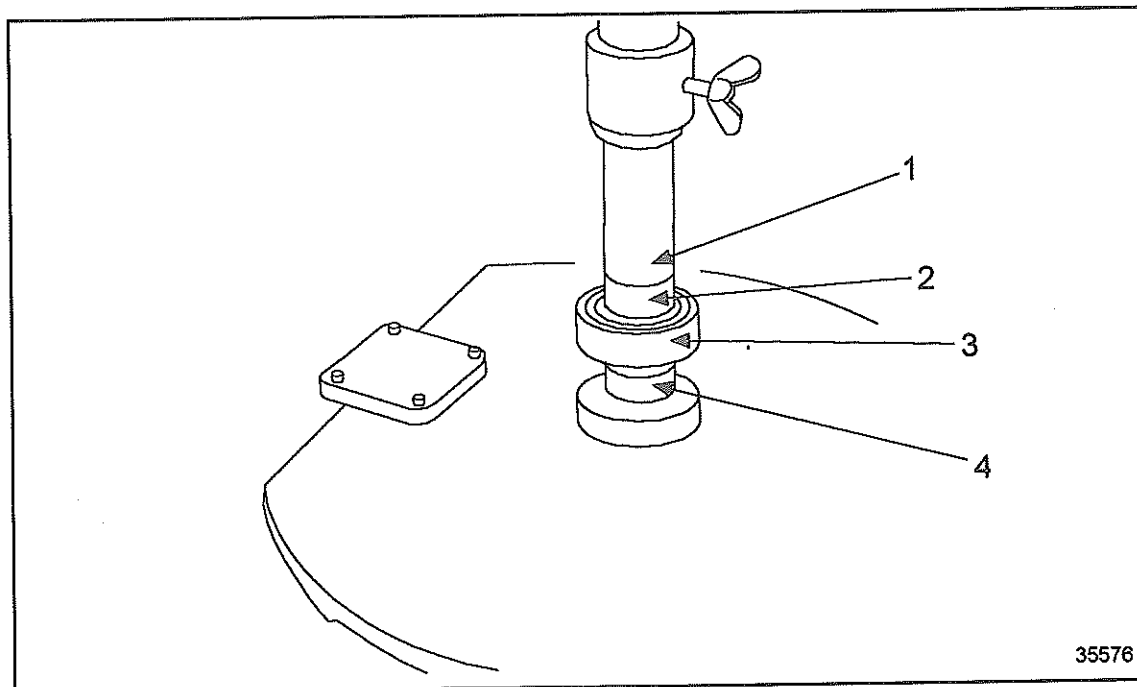
**C 202.05.10 – ASSEMBLY OF HIGH-TEMPERATURE WATER PUMP**

Perform the following steps to assemble the high-temperature water pump.

**NOTE:**

Ensure that oil-retaining parts are perfectly clean.

1. To prepare pump shaft, degrease contact surfaces of pump shaft (4), angular-contact ball bearing (3), spacer sleeve (2) and inner race (1) of cylindrical roller bearing. See Figure 854.



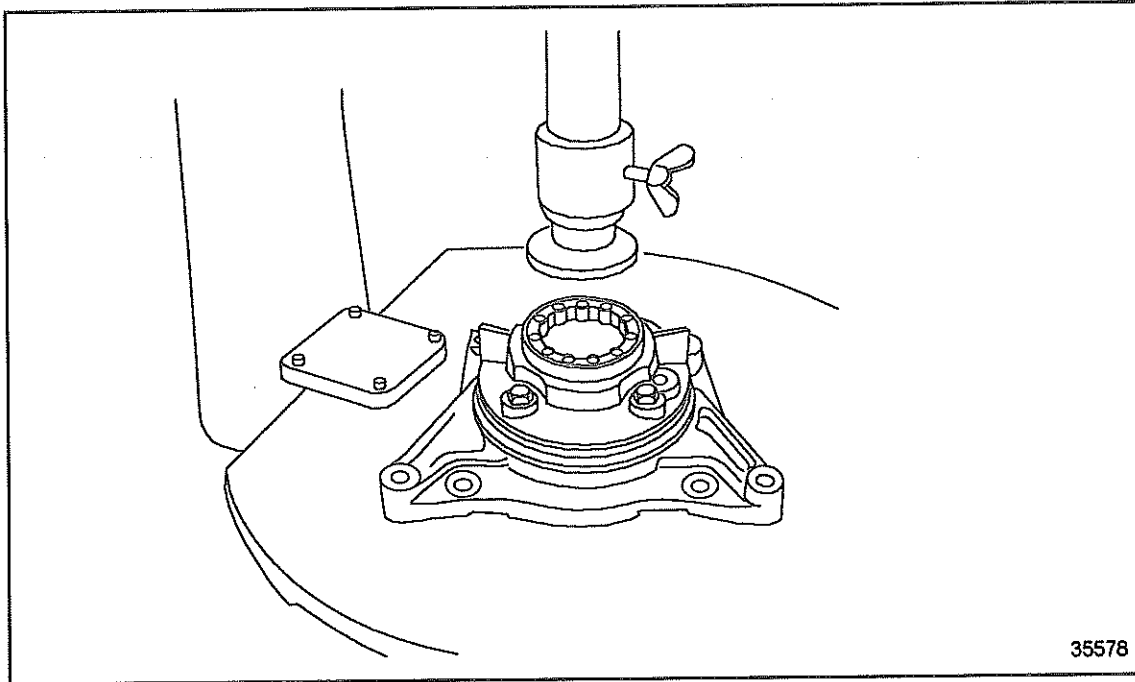
1. Inner Race
2. Spacer Sleeve

3. Angular-Contact Ball Bearing
4. Pump Shaft

**Figure 854 Pressing Angular-Contact Ball Bearing, Spacer Sleeve and Inner Race of Cylindrical Roller Bearing on Pump Shaft**

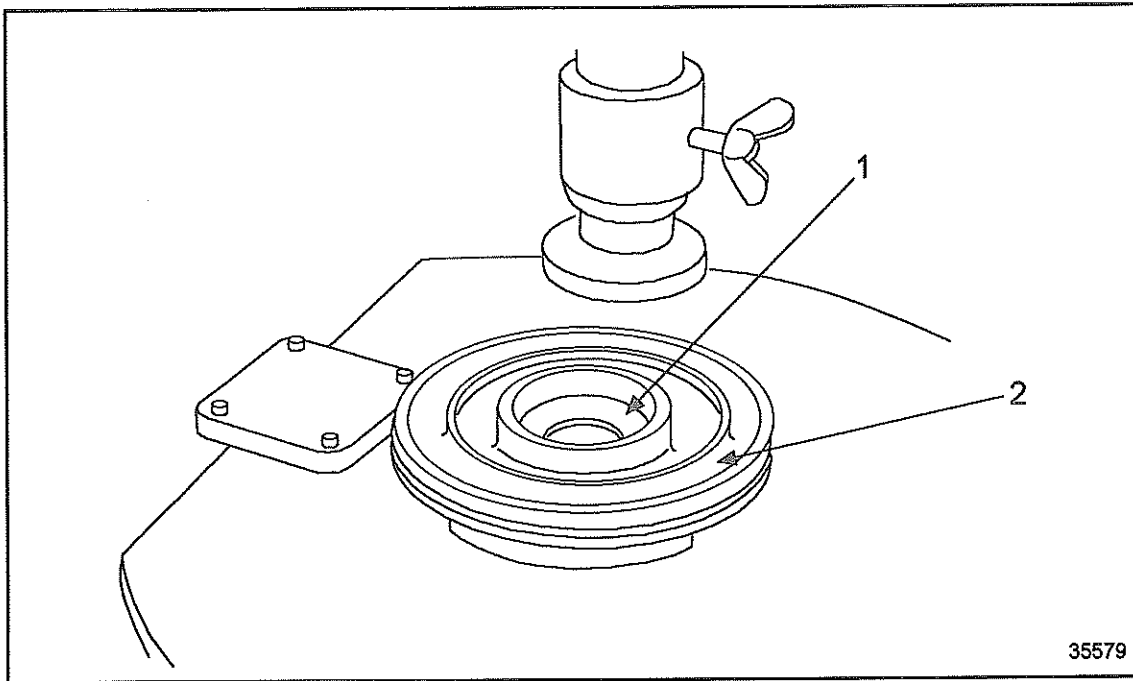
2. Place shaft contact washer in manual press.
3. Place pump shaft so that mating surface for angular-contact ball bearing surfaces up.
4. Press the angular-contact ball bearing, spacer sleeve and inner race of cylindrical roller bearing on pump shaft.

6. To prepare bearing housing, degrease contact surfaces of cylindrical roller bearing in bearing housing.
7. Install cylindrical roller bearing evenly to the stop. See Figure 856.



**Figure 856**     **Installing Cylindrical Roller Bearing**

9. To prepare seal carrier, degrease contact surfaces of shaft seal.
10. Insert shaft seal (1) evenly in seal carrier (2). See Figure 858.

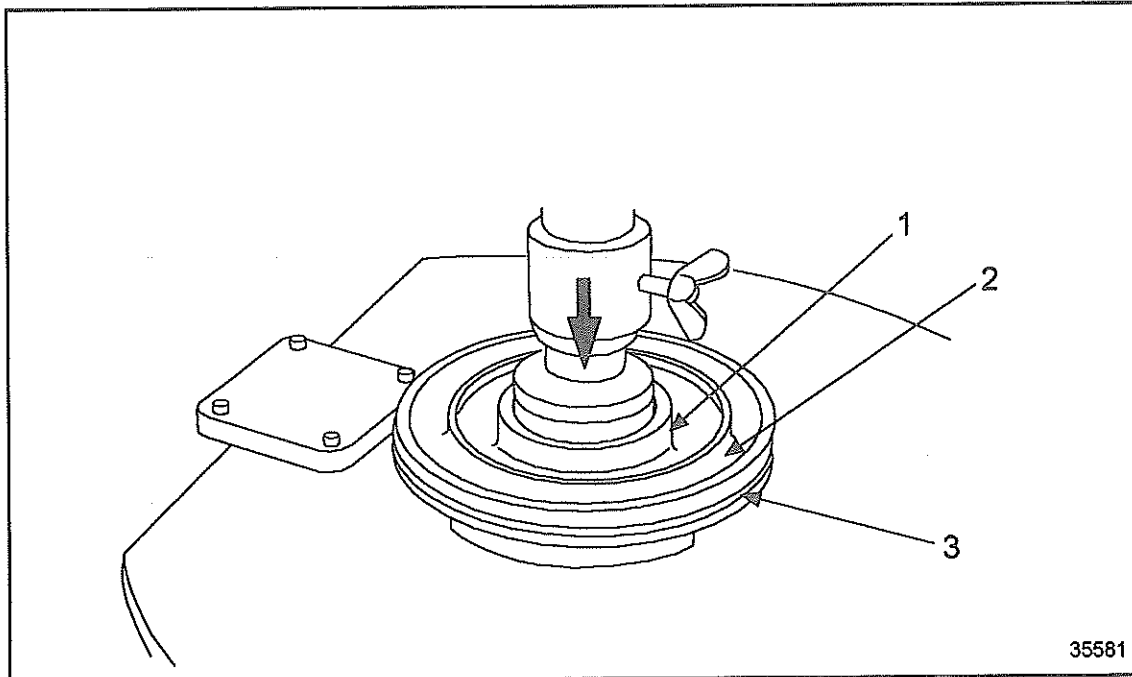


1. Shaft Seal

2. Seal Carrier

**Figure 858**     **Inserting Shaft Seal in Seal Carrier**

13. Install rotary seal (1) evenly in seal carrier. See Figure 860.

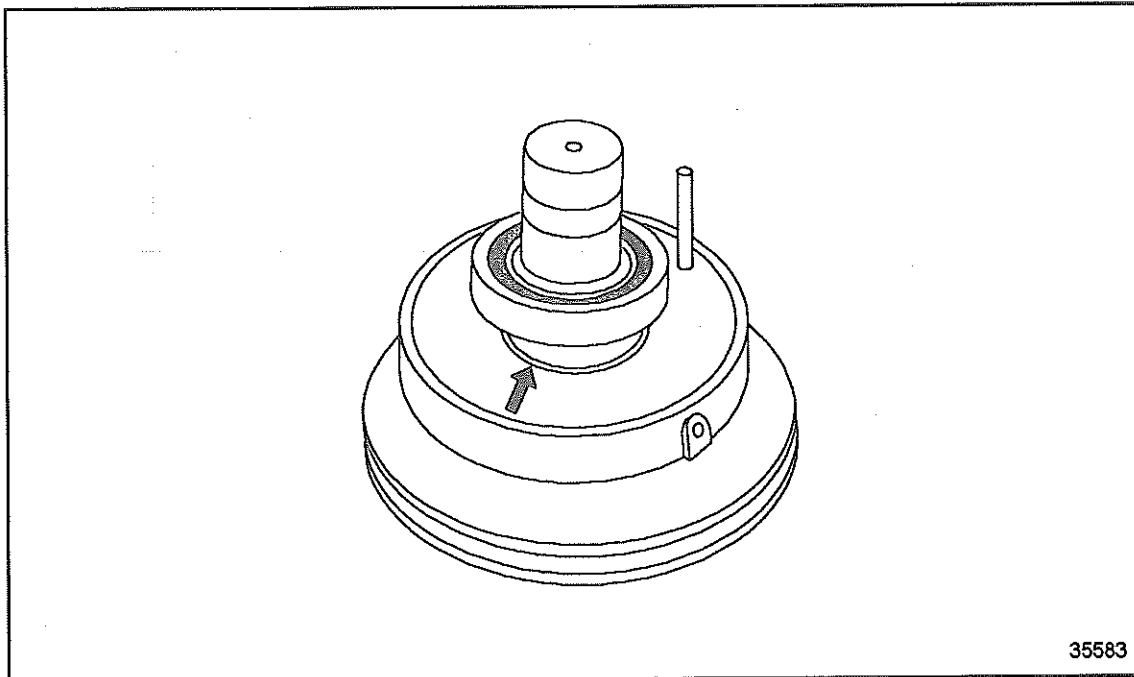


- 1. Rotary Seal
- 2. Seal Carrier

3. O-ring

**Figure 860**     **Inserting Rotary Seal in Seal Carrier**

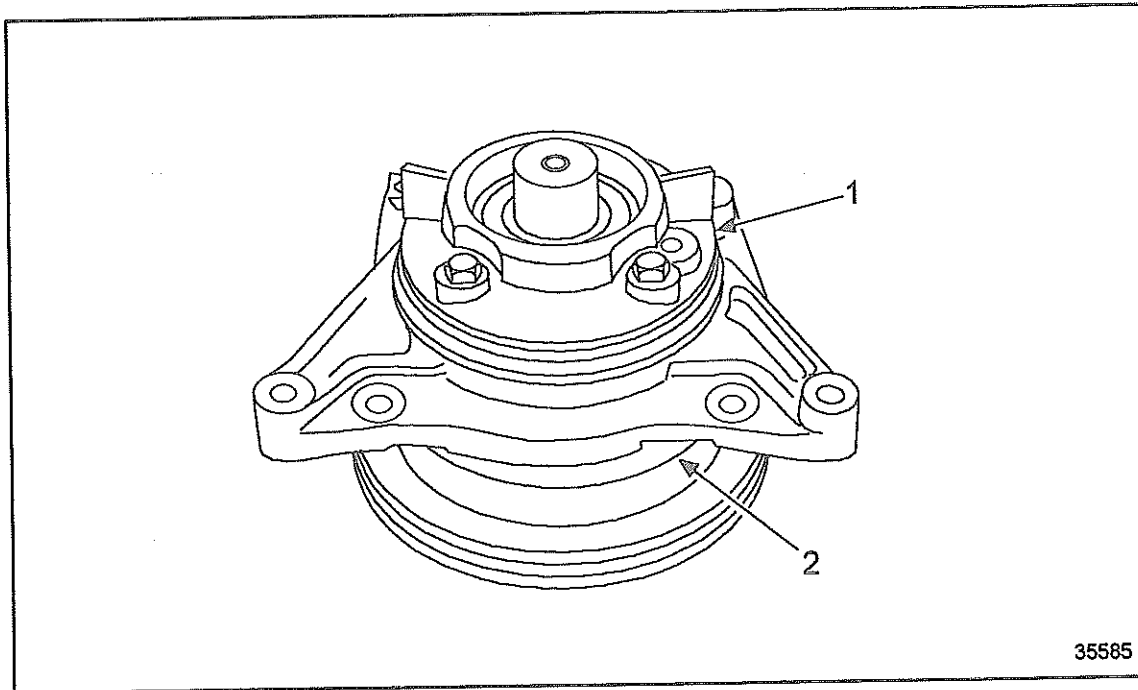
18. Install prepared pump shaft in seal carrier. See Figure 862.



35583

**Figure 862**     **Installing Pump Shaft**

22. Angular-contact ball bearing (2) must be flat.
23. Install bearing housing (1) on guide pins and place loosely on sealing ring flange (2).  
See Figure 864.

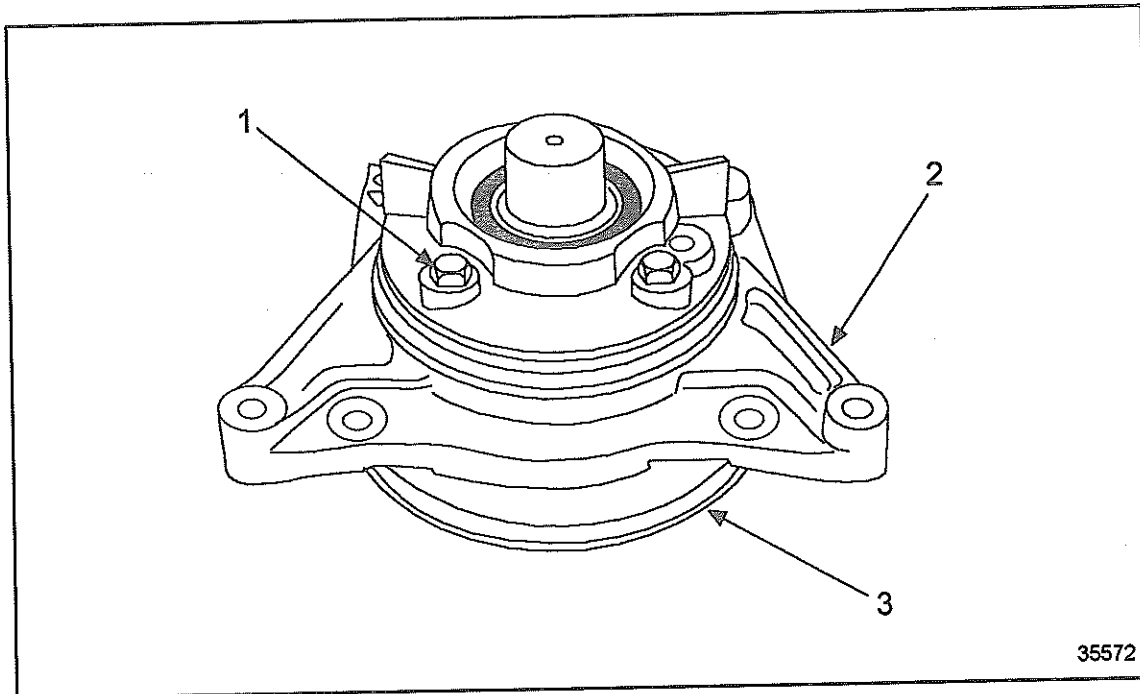


1. Bearing Housing

2. Sealing Ring Flange

**Figure 864** Installing Bearing Housing on Guide Pin and Placing Loosely on Sealing Ring Flange

25. Use press to press bearing housing (2) onto seal carrier (3) to the stop.
26. Remove guide pin and locate bearing housing (2) with hex bolt (1) against seal carrier (3). See Figure 866.



1. Hex Bolt

3. Seal Carrier

2. Bearing Housing

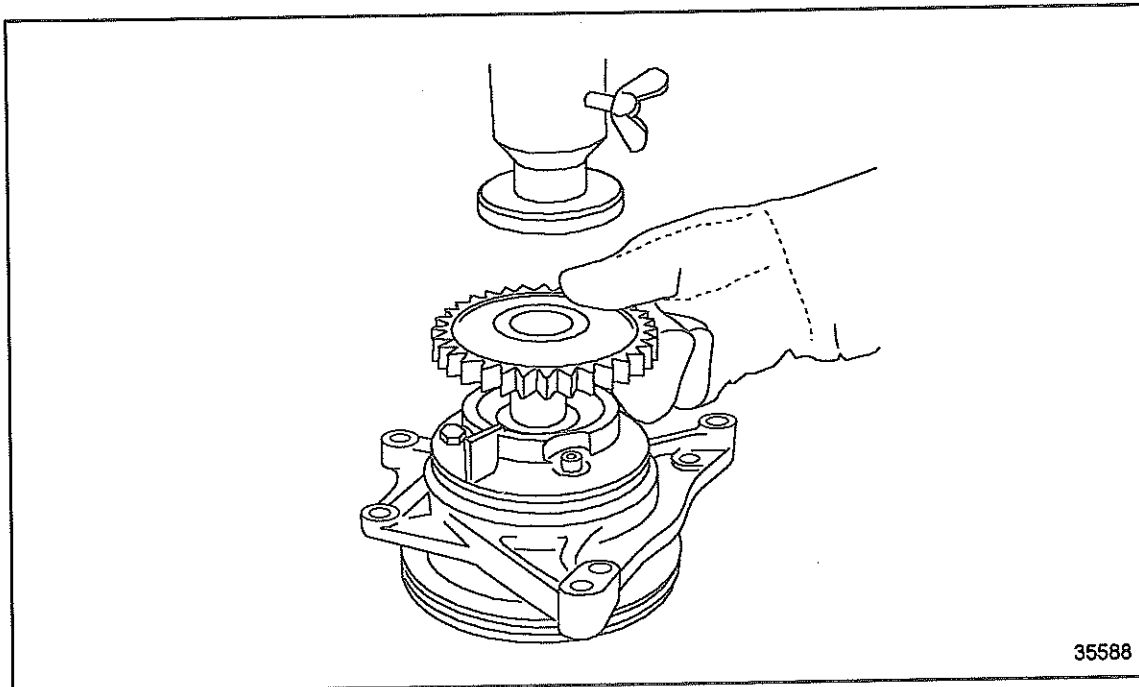
**Figure 866**      **Locating Bearing Housing with Hex Bolt against Seal Carrier**



**CAUTION:**

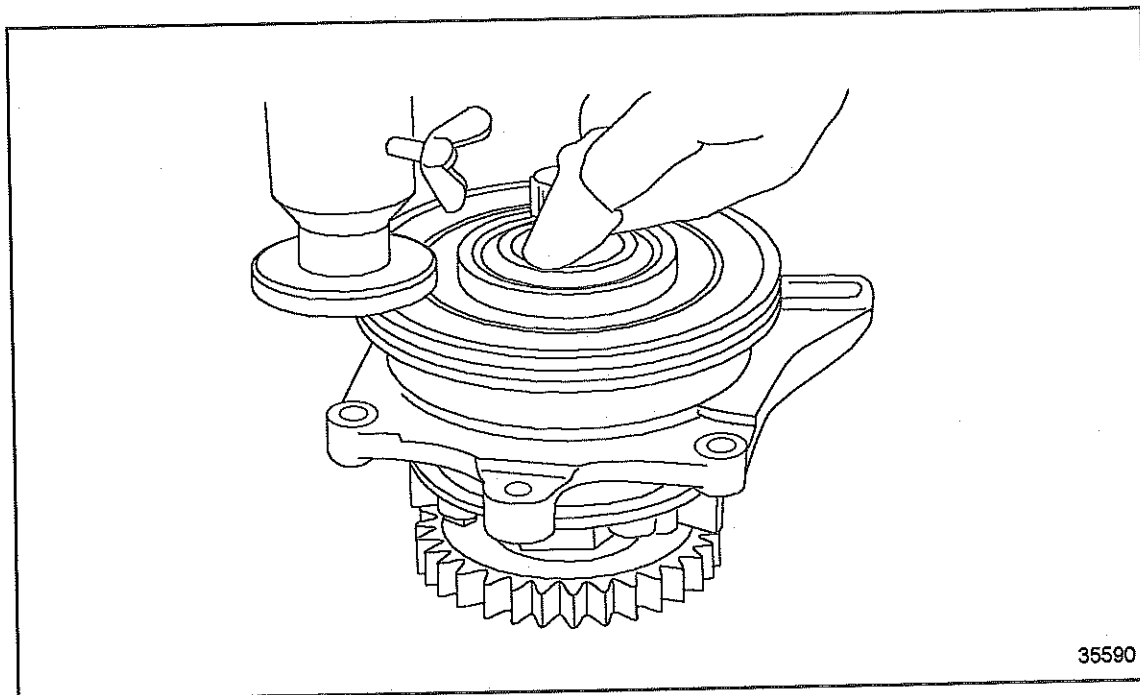
**To avoid personal injury while handling 'HOT' components, wear protective gloves and clothing.**

29. Preheat drive gear uniformly to 180°C.
30. Degrease contact surfaces on drive gear and pump shaft.
31. Place brass drift adapter for pump shaft in manual press. See Figure 868.



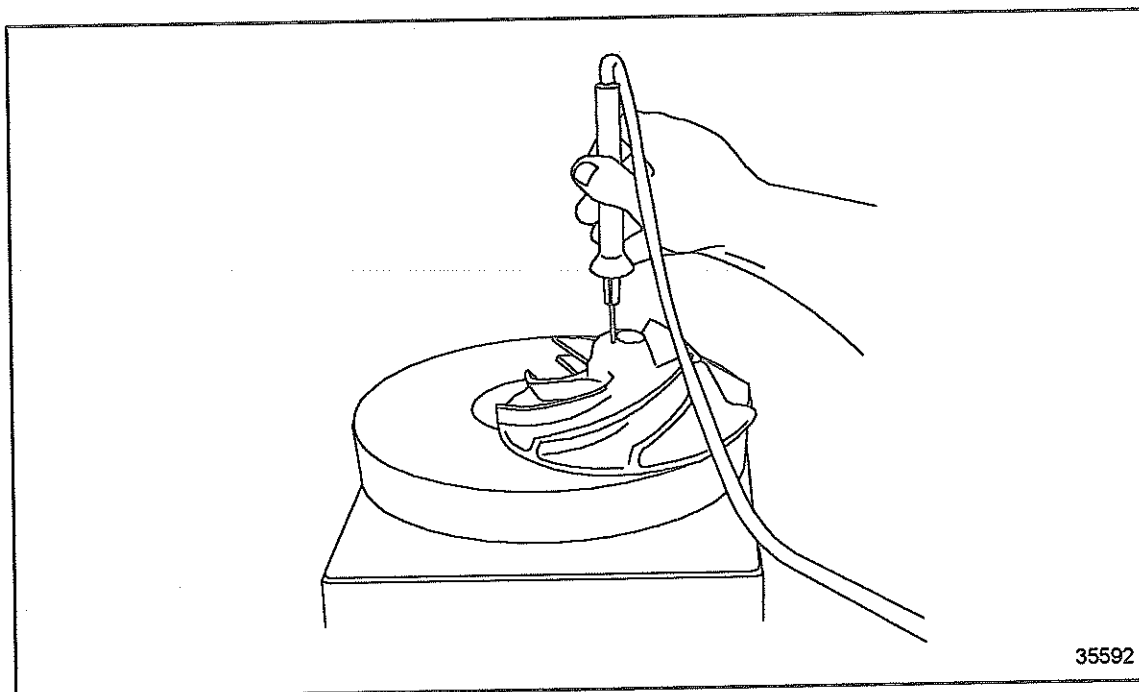
**Figure 868**     **Installing Drive Gear**

35. Turn pump assembly over to complete the installation.
36. To install impeller, first degrease contact surface between pump shaft and impeller.
37. Place pump on manual press with drive gear facing down. See Figure 870.



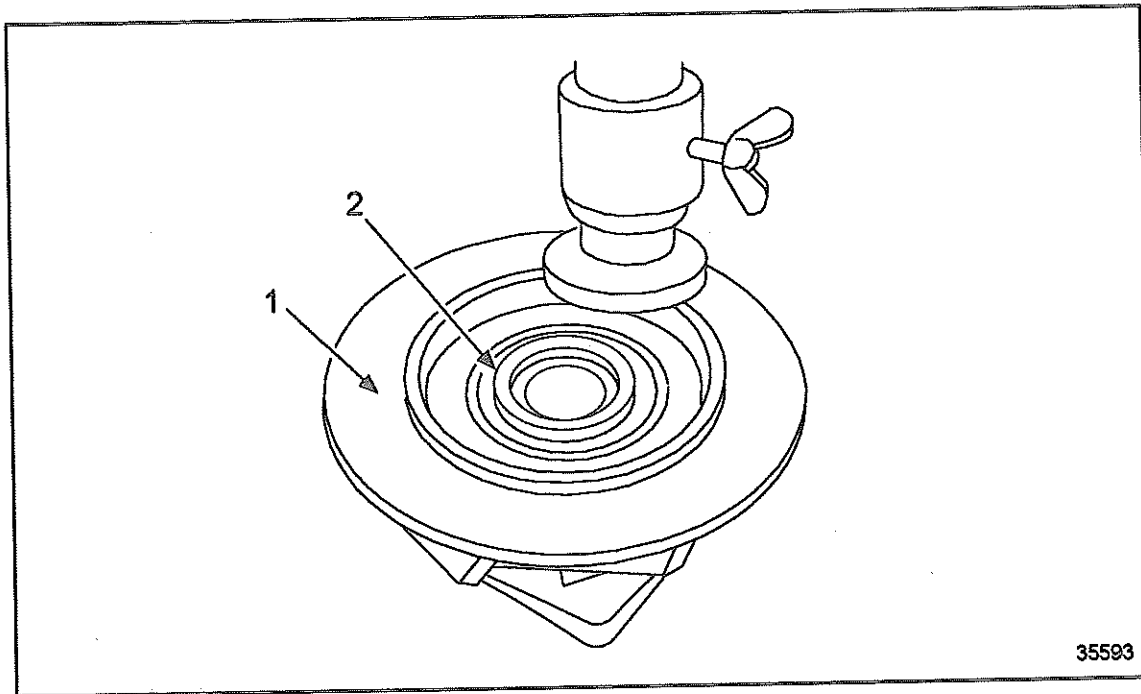
**Figure 870**     **Installing Impeller and Cleaning Rotary Seal Surface**

40. Degrease impeller in area of shaft bore and mating surface of thrust ring. See Figure 872.



**Figure 872**    **Degreasing Impeller**

43. Press thrust ring (2) (with fitted O-ring) into groove on back of impeller (1).  
See Figure 874.



1. Impeller

2. Thrust Ring

**Figure 874 Pressing Thrust Ring into Groove on Back of Impeller**

44. Clean inside surface of thrust ring with ethanol.

47. To install pump housing, first coat pump housing with petroleum jelly at contact surface to O-ring (arrow). See Figure 877.

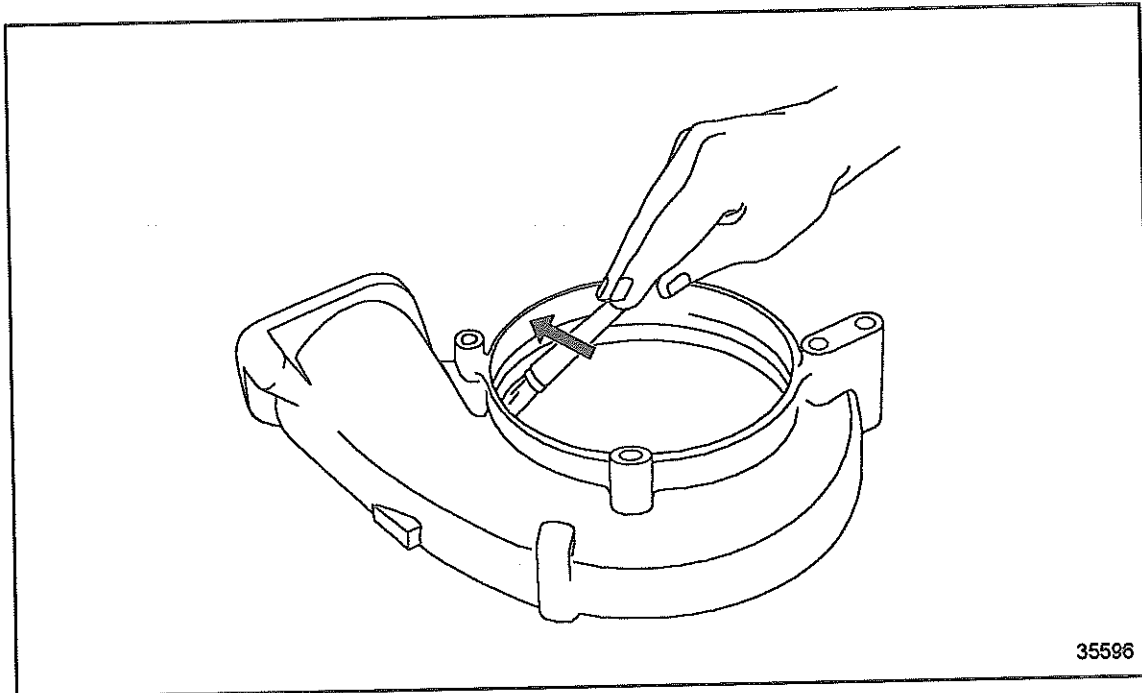
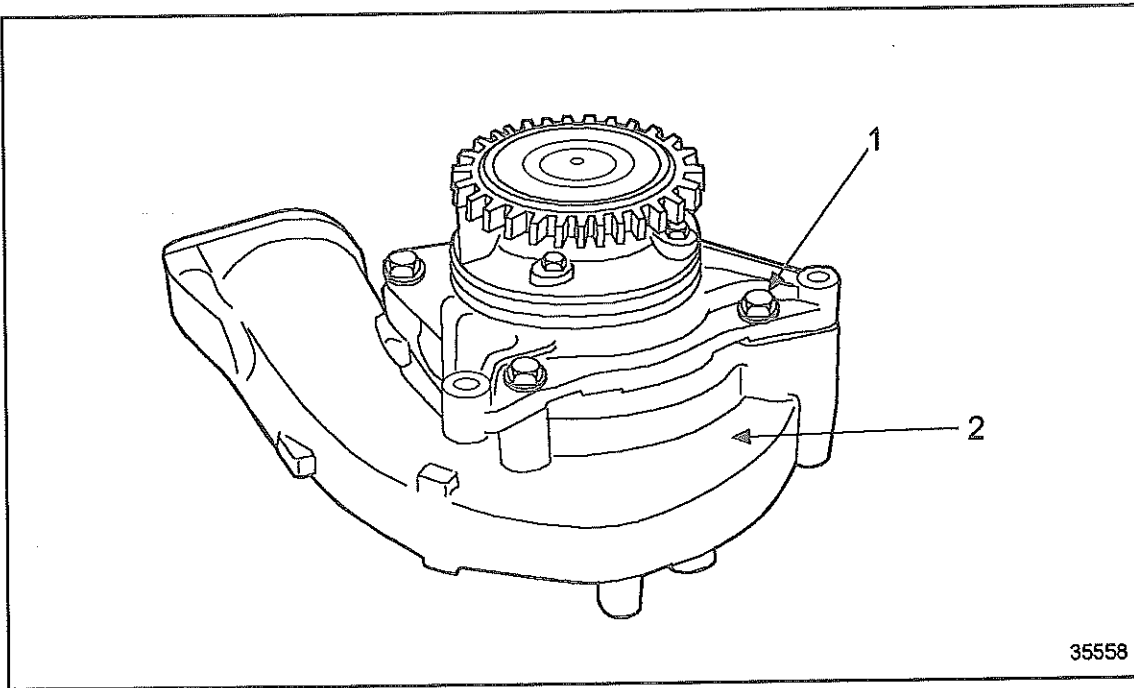


Figure 877 Coating Pump Housing

50. Ensure that O-ring (arrow) is not damaged.
51. Install pump housing to seal carrier with hex bolts (1). See Figure 879.

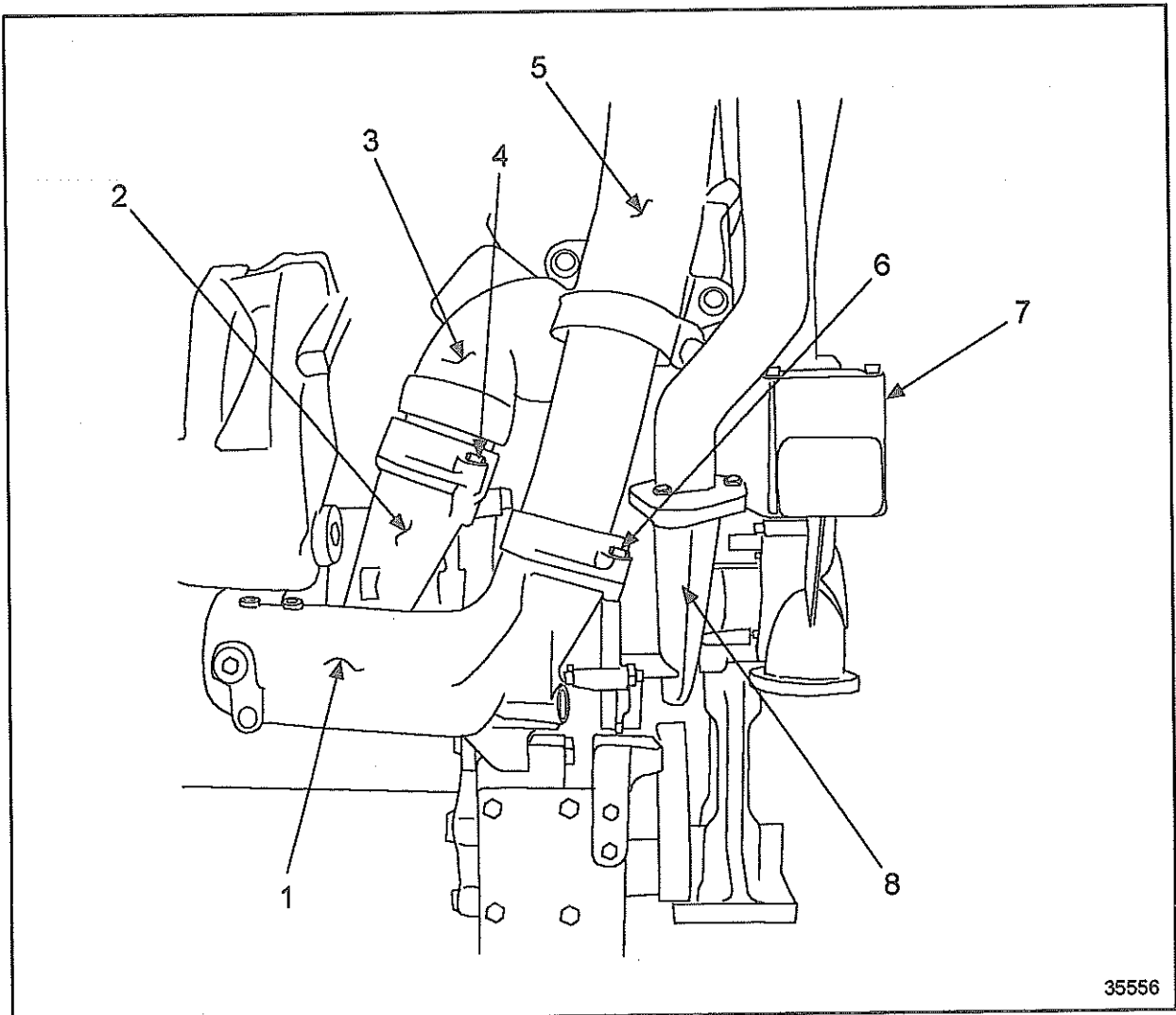


1. Hex Bolt

2. Coolant Pump Housing

**Figure 879**     **Installing Pump Housing to Seal Carrier**

4. Install hex bolts (2) with washers and tighten uniformly to specification.  
Refer to section A 003.
5. Install charge air cooler pipe (6). See Figure 881.



- |                                |  |
|--------------------------------|--|
| 1. Water Pump Outlet Elbow     | 5. High Temperature Thermostat Housing |
| 2. High Temperature Water Pump | 6. Bolt                                |
| 3. Water Pump Inlet Elbow      | 7. Low Temperature Thermostat Housing  |
| 4. Bolt                        | 8. Low Temperature Water Pump          |

**Figure 881**     **Installing Charge Air Cooler Pipe, Flange to Elbow and Bracket to Elbow**

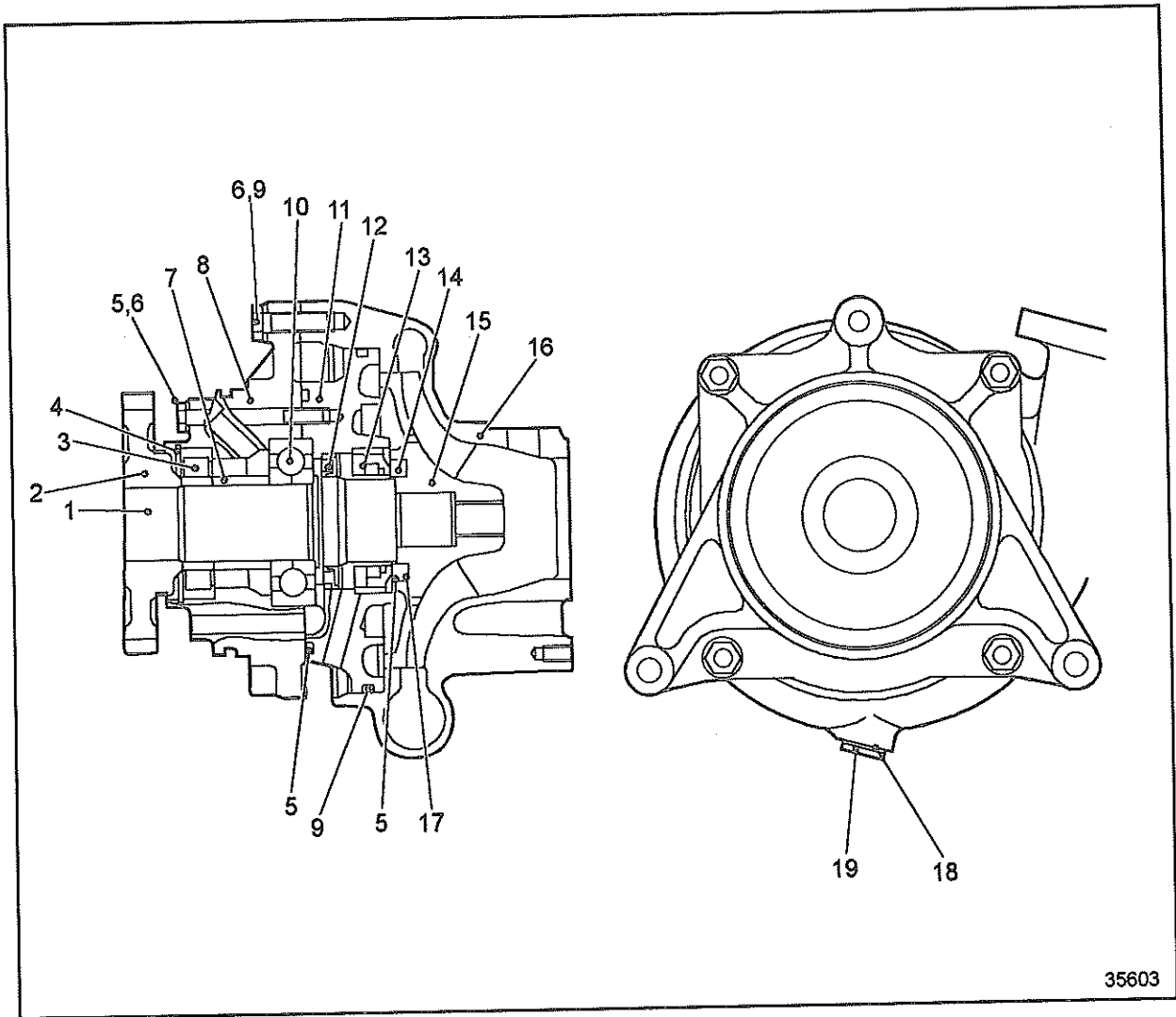
## C 206.05 – CHARGE AIR COOLING SYSTEM (LOW-TEMPERATURE)

Section		Page
C 206.05.01	General View .....	C -1393
C 206.05.02	Special Tools .....	C -1397
C 206.05.04	Before-Removal Operations .....	C -1398
C 206.05.05	Removal of Charge Air Cooling System (Low-Temperature) .....	C -1399
C 206.05.06	Disassembly of Charge Air Cooling System (Low-Temperature) ..	C -1402
C 206.05.08	Inspection and Repair .....	C -1408
C 206.05.10	Assembly of Charge Air Cooling System (Low-Temperature) .....	C -1410
C 206.05.11	Installation of Charge Air Cooling System (Low-Temperature) ....	C -1435
C 206.05.12	After-Installation Operations .....	C -1439

## C 206.05.01 – GENERAL VIEW

### NOTE:

Refer to section before beginning any work in the charge air cooling system (low-temperature).



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- |                                  |                      |
|----------------------------------|----------------------|
| 1. Pump Shaft                    | 11. Seal Carrier     |
| 2. Gear                          | 12. Shaft Seal       |
| 3. Cylindrical Roller Bearing    | 13. Rotary Seal      |
| 4. Snap Ring                     | 14. Counter Ring     |
| 5. O-ring                        | 15. Impeller         |
| 6. Washer                        | 16. Impeller Housing |
| 7. Spacer Sleeve                 | 17. Metal Ring       |
| 8. Bearing Housing               | 18. Sealing Ring     |
| 9. Hex Bolt                      | 19. Plug             |
| 10. Angular-contact Ball Bearing |                      |

**Figure 913** Cutaway View of Charge Air Cooling System (Low-Temperature)

**C 206.05.02 -- SPECIAL TOOLS**

Listed in Table 132 are the special tools required for maintenance on the charge air cooling system (low-temperature).

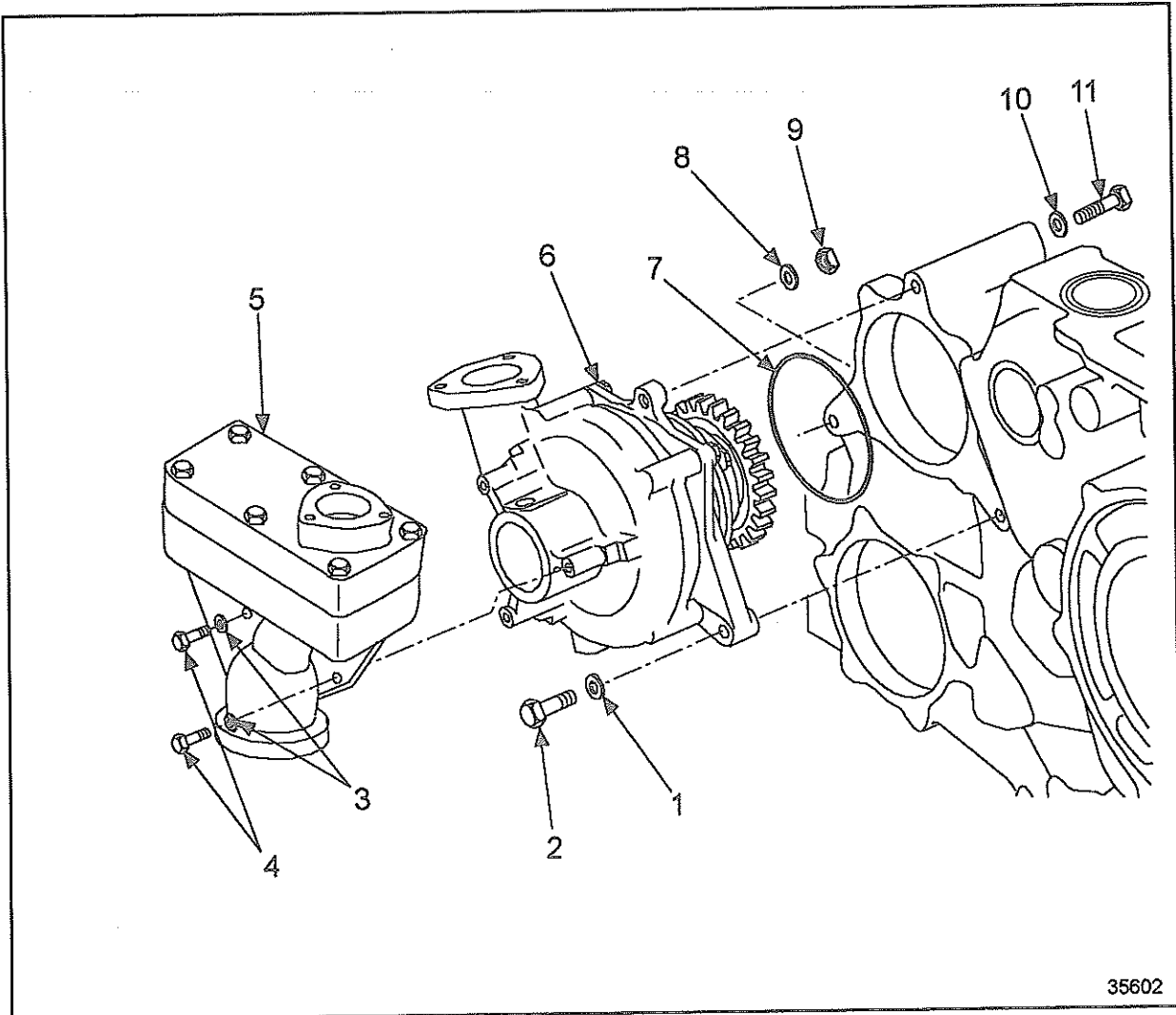
Application	Number
Removal tool for impeller	—
Washer for shaft	—
Washer for housing	—
Press-fit sleeve for pump shaft	—
Installation tool for drive gear/impeller	—

**Table 132 Special Tools**

## C 206.05.05 – REMOVAL OF CHARGE AIR COOLING SYSTEM (LOW-TEMPERATURE)

Perform the following steps to remove the charge air cooling system (low-temperature).

1. Loosen pipe connections on charge air coolant outlet (1) and return (2). See Figure 915.

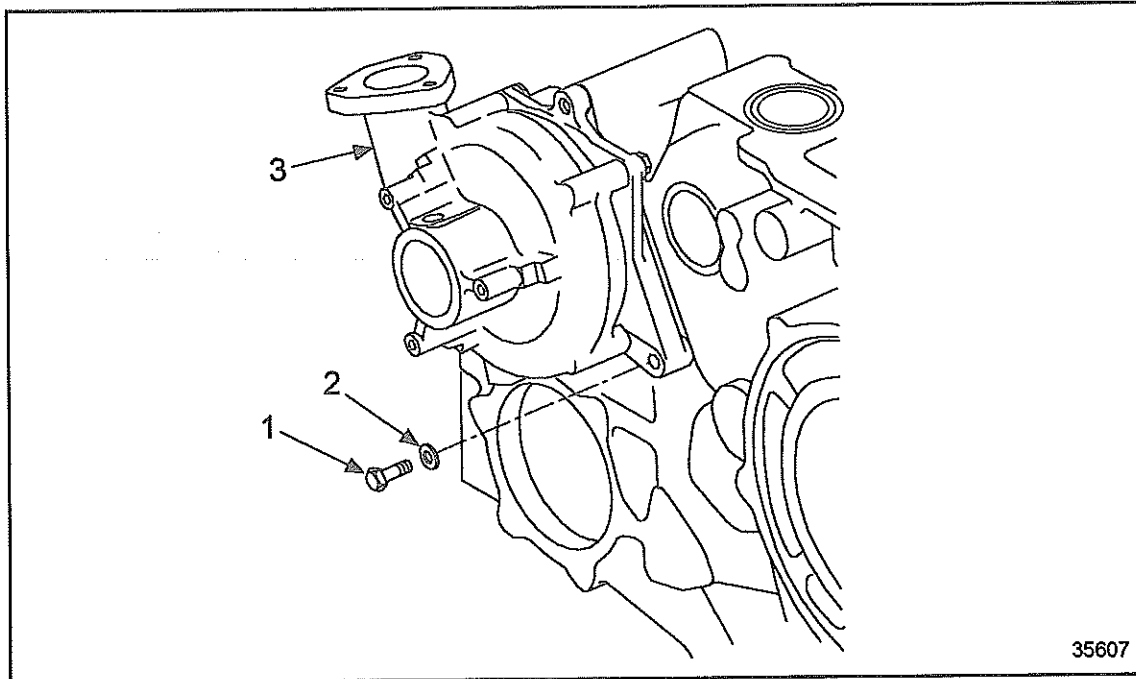


- |                     |                    |
|---------------------|--------------------|
| 1. Pump Outlet Pipe | 3. Coolant Supply  |
| 2. Coolant Return   | 4. Pump Inlet Pipe |

**Figure 915** Loosening Pipe Connections on Charge Air Coolant Supply and Return

2. Loosen coolant pipes at pump inlet (4) and supply (3) and couplings on charge air coolant pipes.

4. Loosen securing bolts (2). See Figure 917.



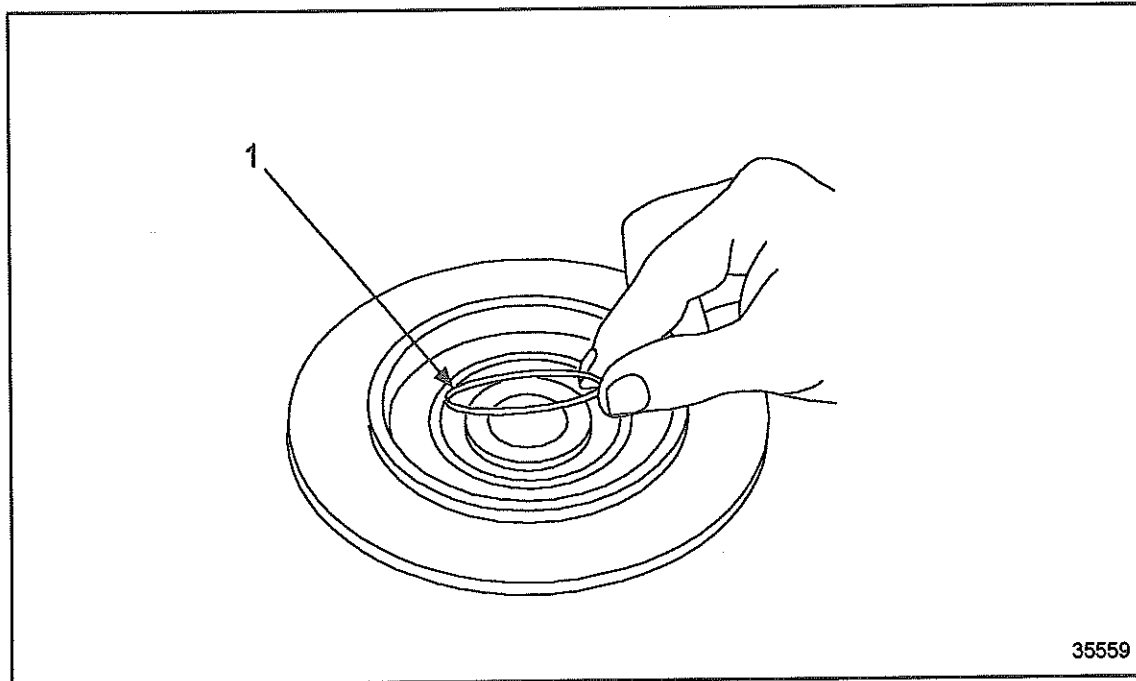
1. Low-Temperature Thermostat Housing

2. Bolt

**Figure 917 Removing Charge Air Coolant Pump from Gear Case**

5. Carefully loosen charge air coolant pump (3) from gear case and remove.
6. Remove O-ring from charge air coolant pump.

4. Remove thrust ring with inserted O-ring and metal ring (1) from groove on back on impeller. See Figure 919.



1. Metal Ring

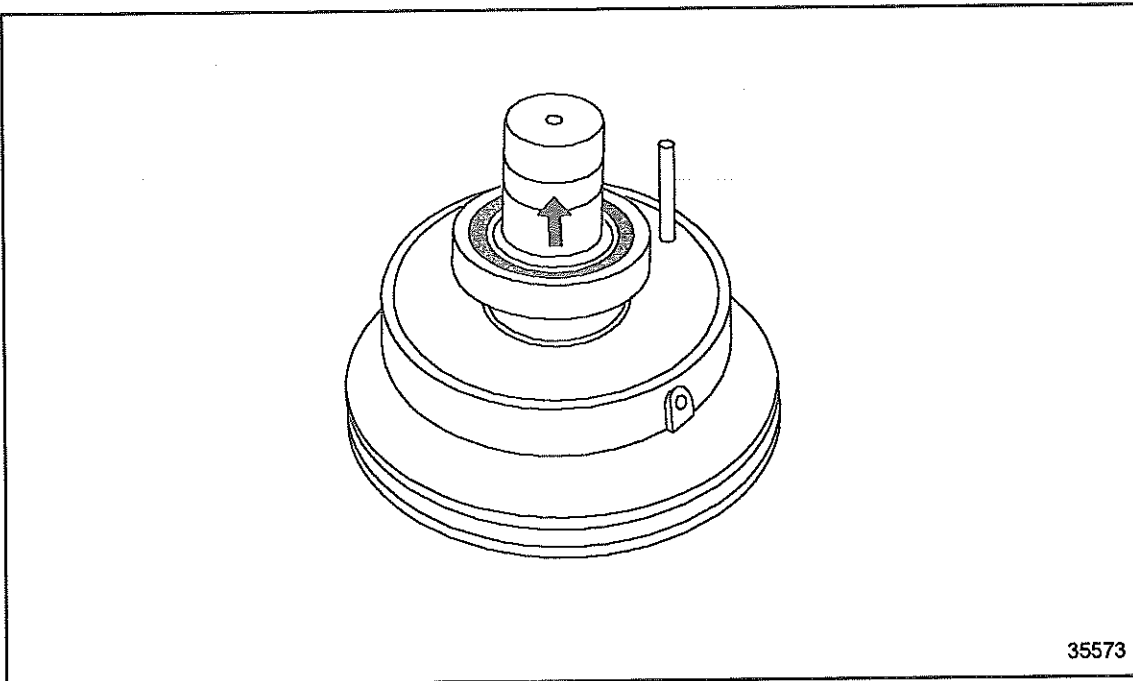
**Figure 919** Removing Metal Ring from Groove on Back of Impeller

5. Use a suitable removal tool to remove gear from charge air coolant pump shaft.

**NOTE:**

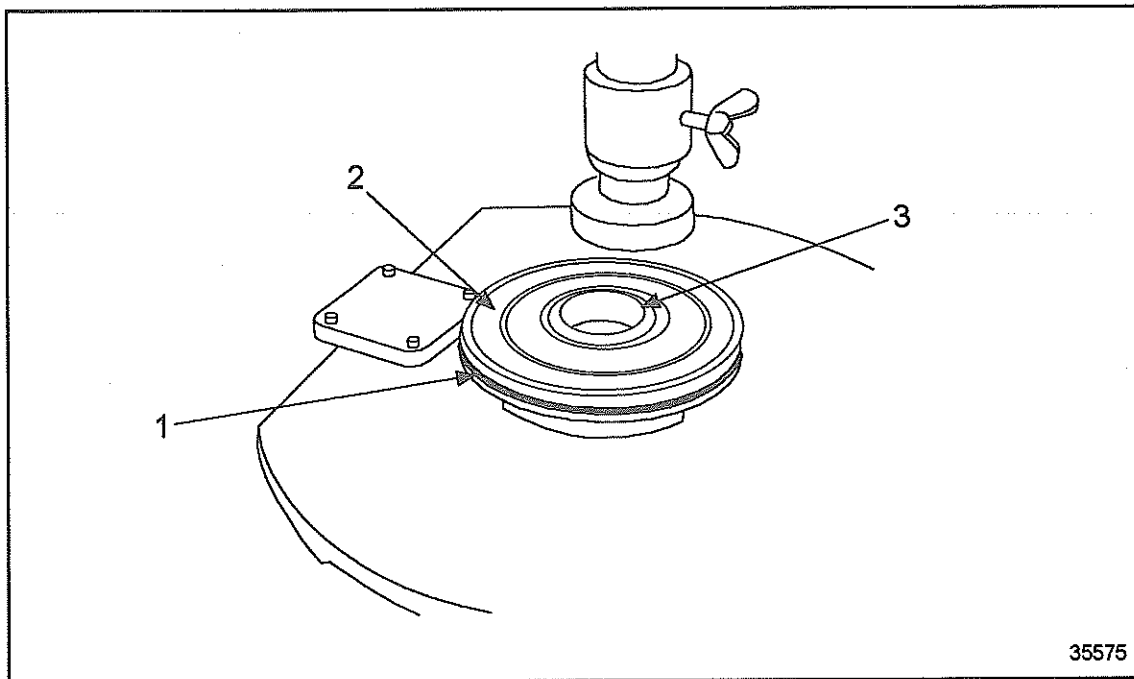
Due to interference fit of gear hub and shaft, shaft will be heavily scored when gear is removed.

7. Using a pry bar, carefully remove bearing housing (3) from seal carrier.
8. Remove pump shaft with roller bearing, spacer sleeve and bearing inner race from seal carrier. See Figure 921.



**Figure 921** Removing Pump Shaft from Seal Carrier

12. Remove bearing cage with outer race of cylindrical roller bearing from bearing housing.
13. Remove rotary seal (3) and thermostat seal behind it from seal carrier (2). See Figure 923.



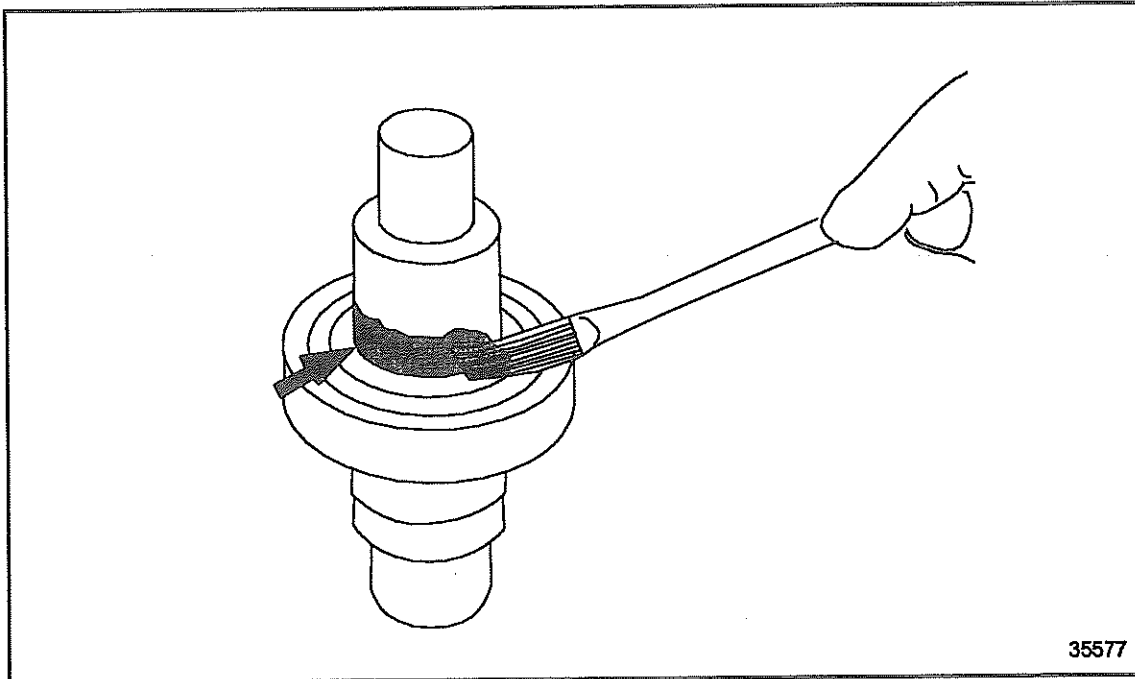
- |                 |                |
|-----------------|----------------|
| 1. O-ring       | 3. Rotary Seal |
| 2. Seal Carrier |                |

**Figure 923 Removing Rotary Seal and Shaft Seal from Seal Carrier**

14. Remove O-ring (1) from outer collar.

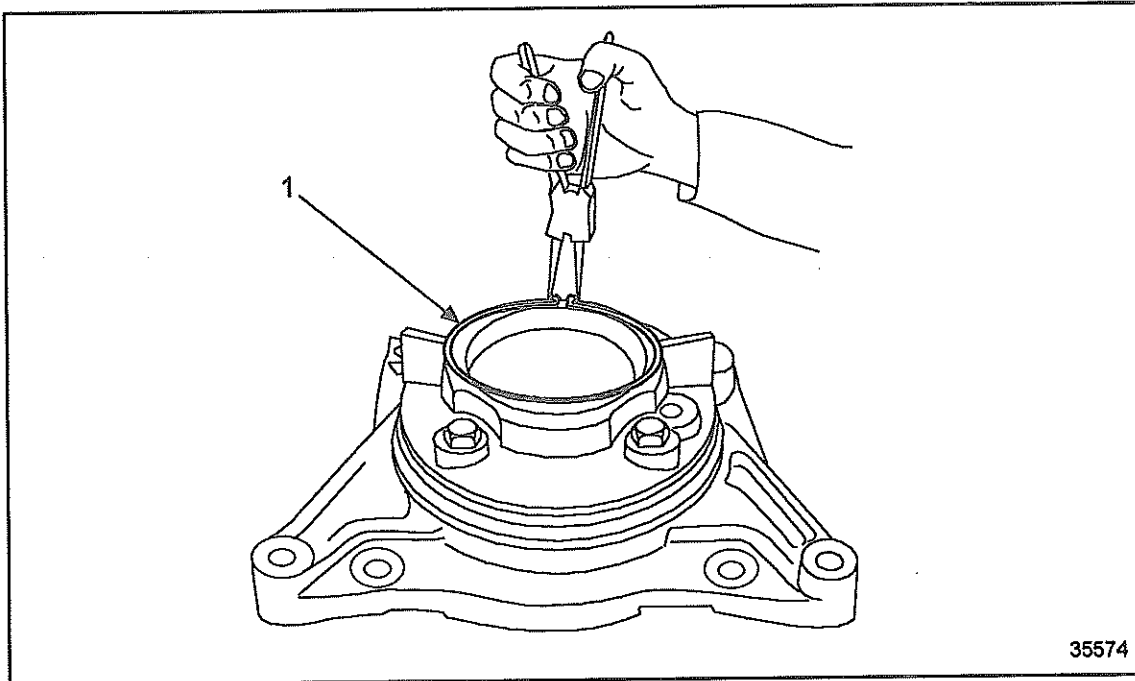
7. Visually inspect shaft for wear and damage.
  - [a] If shaft is worn or damaged, smooth out slight wear and damage with an emery cloth.
  - [b] If damage is beyond repair, replace shaft.
  - [c] If no wear or damage is found, continue inspection.
8. Visually inspect gear for indentations and wear.
  - [a] If gear is indented or worn, rub down with an oilstone or an emery cloth.
  - [b] If damage is beyond repair, replace gear.
  - [c] If gear is not worn or indented, continue inspection.
9. Visually inspect threads for wear and damage.
  - [a] If threads are worn or damaged, rechase components.
  - [b] If damage is beyond repair, replace component.
  - [c] If threads are not worn or damaged, continue inspection.
10. Adjust bore gage and measure bearing bores in housing.
  - [a] If bearing bores are not within specified limits, replace components as necessary.
  - [b] If bearing bores are within specified limits, continue inspection.
11. Using micrometer, measure bearing seat on shaft.
  - [a] If limit values are exceeded, replace components as necessary.
  - [b] If limit values are not exceeded, continue inspection.
12. Replace cylindrical roller bearing and grooved ball bearing as part of every W6 overhaul.
13. After every pump disassembly, replace gaskets, O-rings, rotary seal and radial-lip shaft seal.

5. Coat pump shaft in running area of shaft seal (arrow) with Molykote. See Figure 925.



**Figure 925**     **Coating Pump Shaft with Molykote**

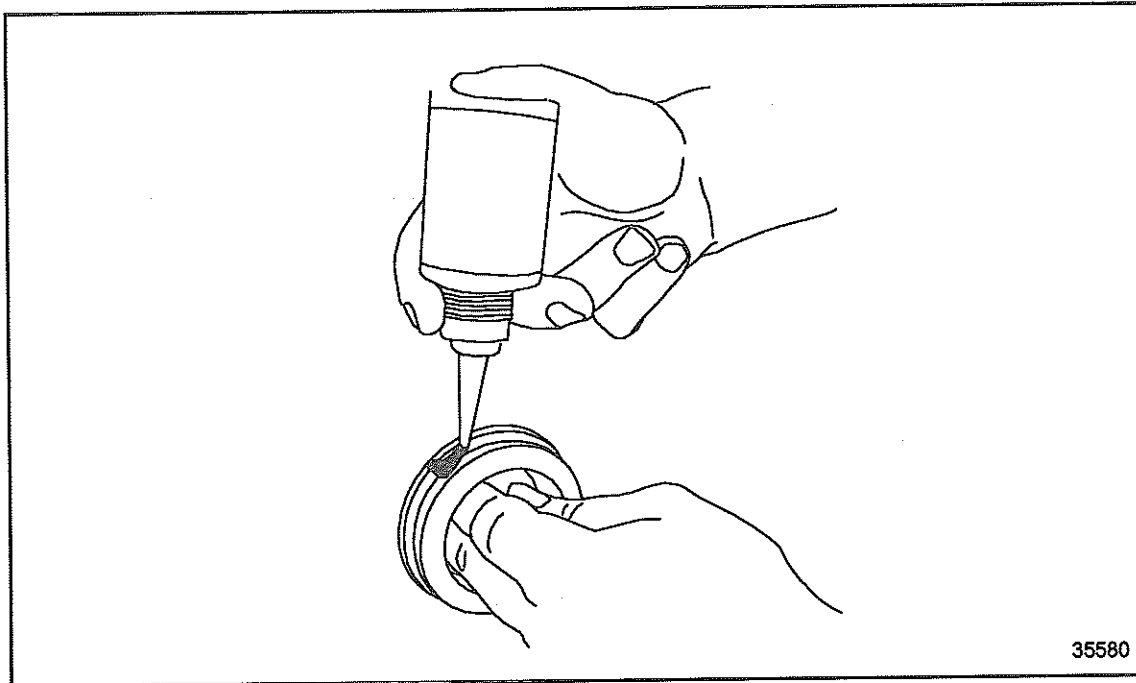
8. Insert snap ring (1) for cylindrical roller bearing in bearing housing. See Figure 927.



1. Snap Ring

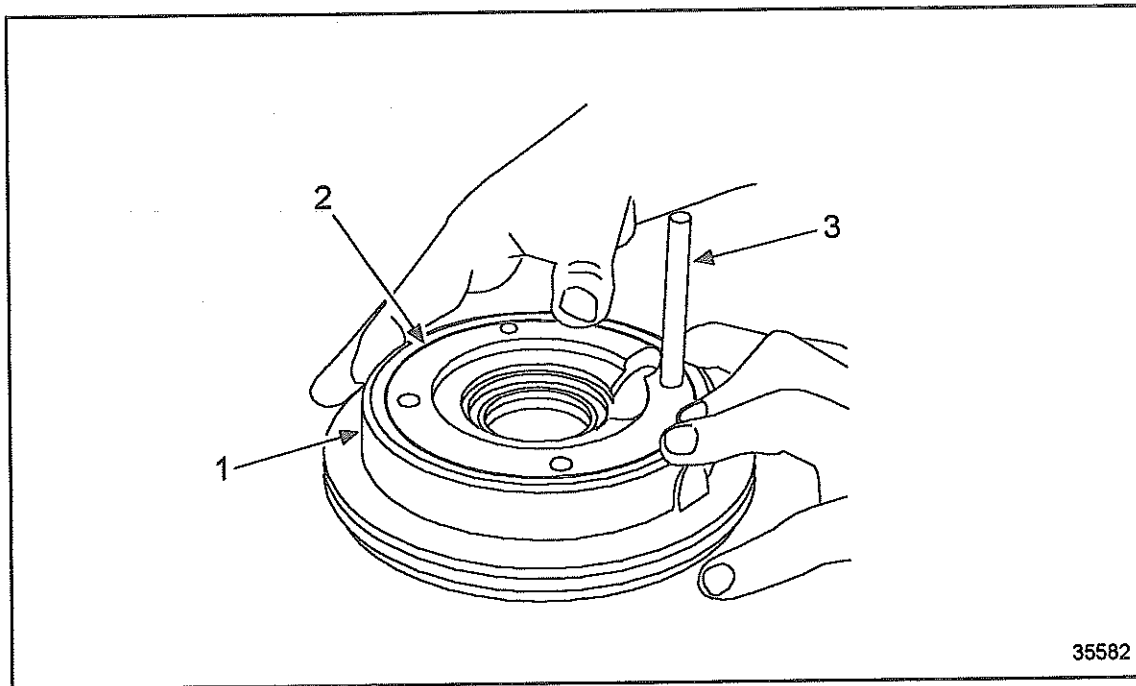
**Figure 927**     **Inserting Snap Ring into Bearing Housing**

11. Clean bore and bearing surfaces with ethanol.
12. Coat outer surface of rotary seal with sealant. See Figure 929.



**Figure 929**      **Coating Outer Surface of Rotary Seal with Sealant**

14. Coat O-ring (3) with petroleum jelly and install into groove in seal carrier (2).
15. Turn seal carrier over to work on the other side. See Figure 931.



1. Seal Carrier
2. O-ring

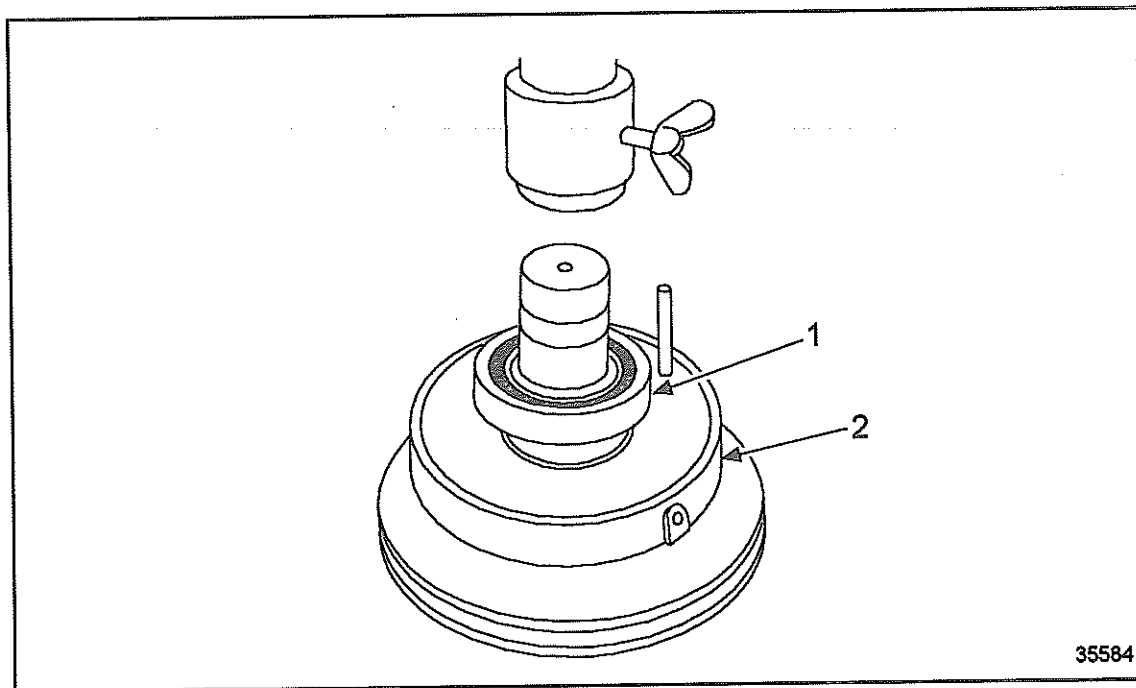
3. Guide Pin

**Figure 931** Turning Seal Carrier Over

**NOTE:**

Ensure that bore of seal carrier comes to rest over an opening in working plate, so that pump shaft is not obstructed during subsequent installation.

19. Install part of shaft coated with Molykote (arrow) first.
20. Ensure that lip of shaft seal is not damaged.
21. Verify that pump shaft with angular-contact ball bearing is correctly positioned in seal carrier (1). See Figure 933.

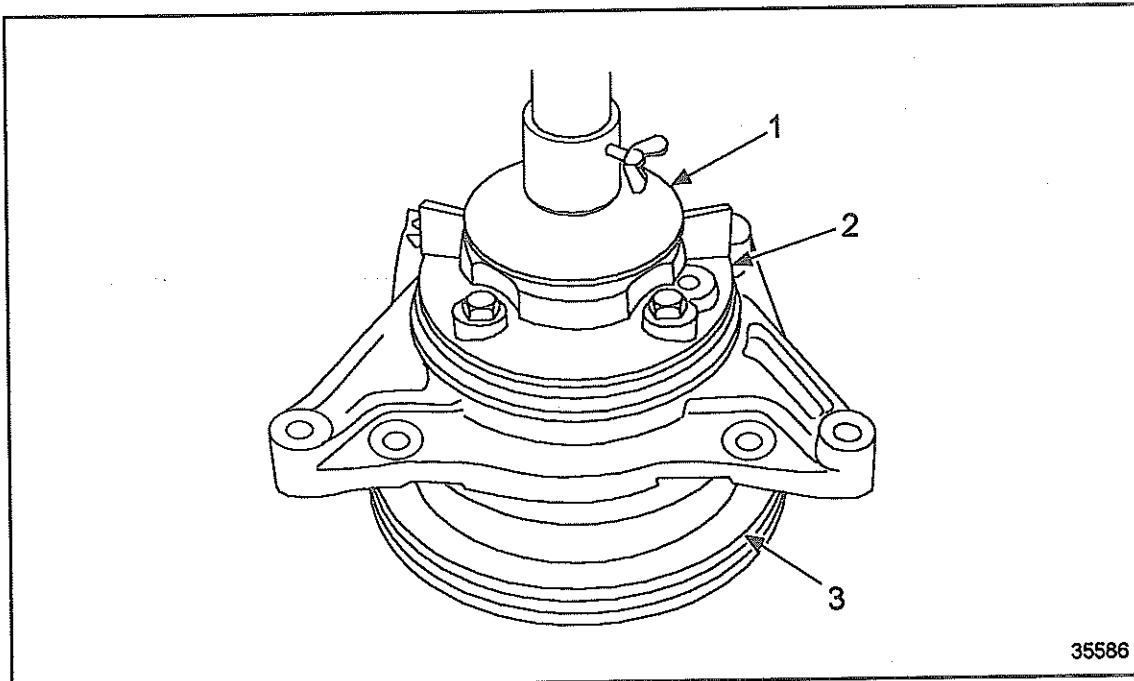


1. Seal Carrier

2. Ball Bearing

**Figure 933 Verifying Pump Shaft Positioning**

24. Place brass drift adapter (1) for seal carrier (3) in manual press. See Figure 935.



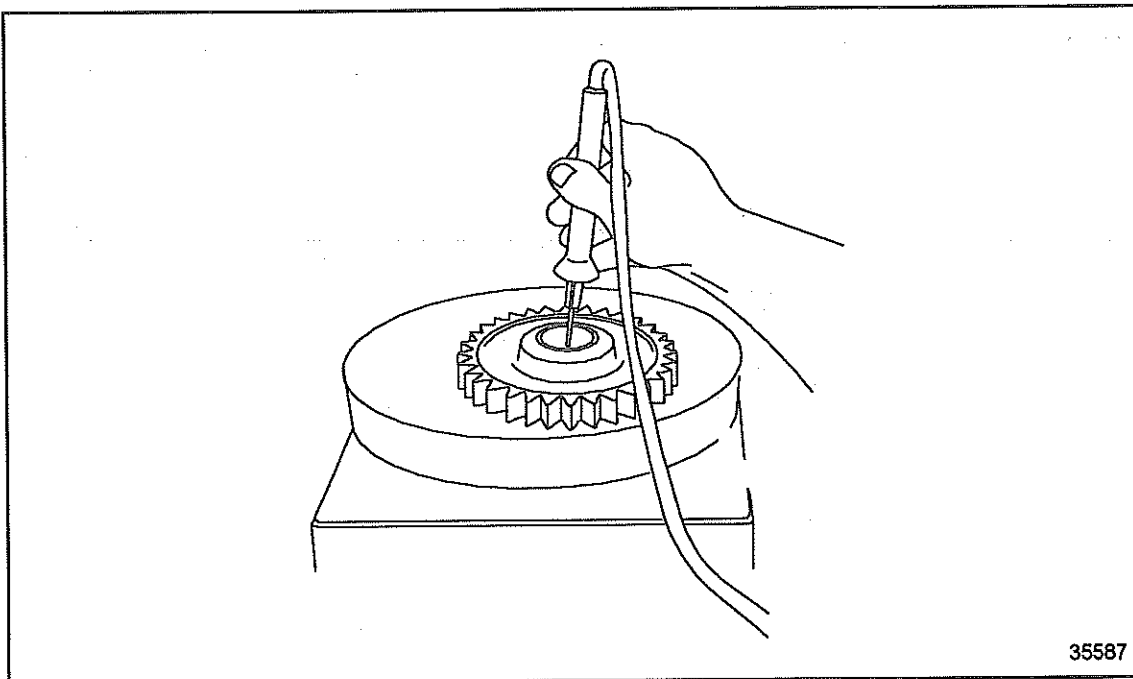
1. Brass Drift Adapter

3. Seal Carrier

2. Bearing Housing

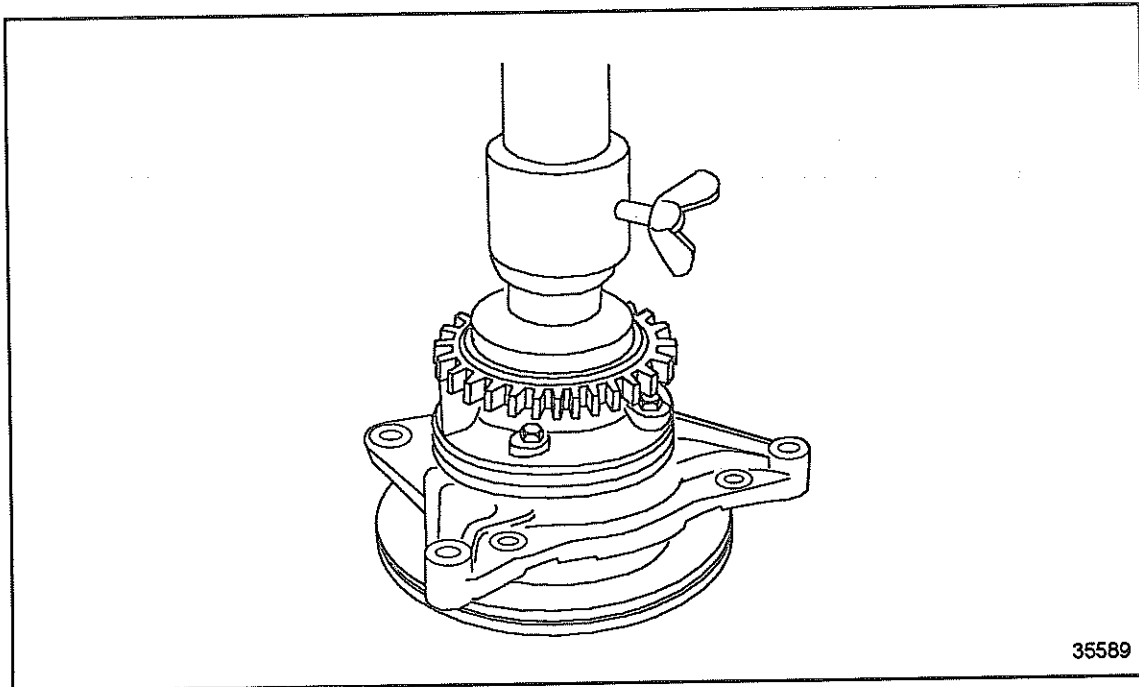
**Figure 935 Pressing Bearing Housing onto Seal Carrier**

27. Tighten hex bolt to specification. Refer to section A 003.
28. To install drive gear, first degrease contact surface on drive gear. See Figure 937.



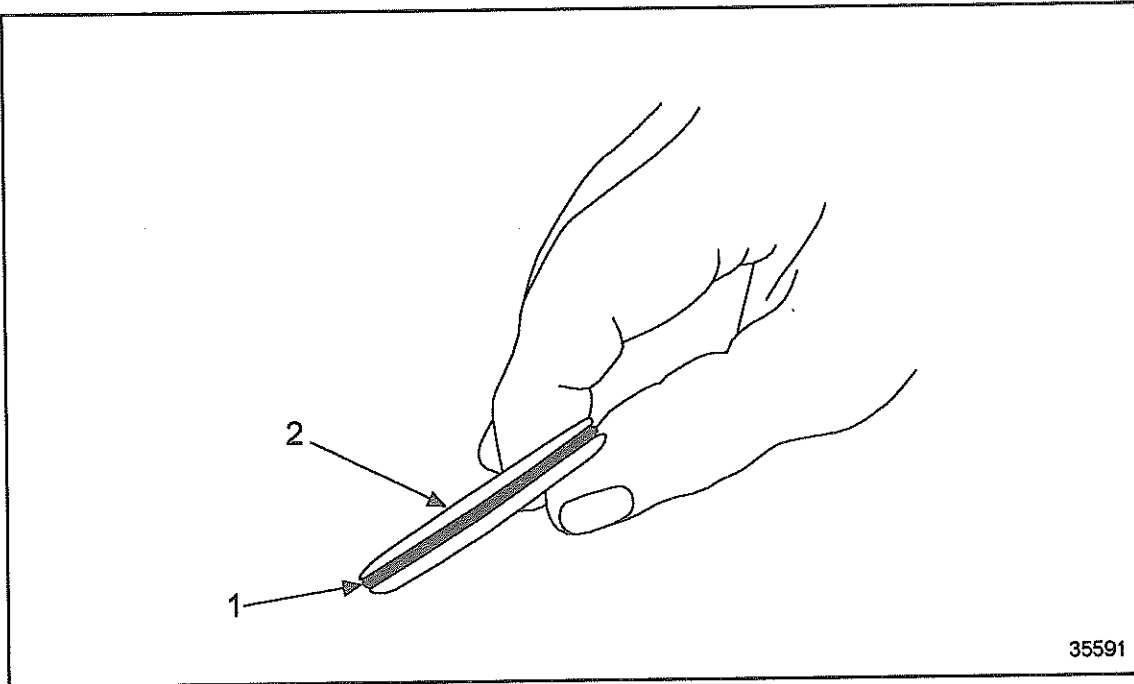
**Figure 937**      **Degreasing Drive Gear**

32. Place installed pump shaft on adapter so that bearing housing faces up.
33. Place preheated gear on pump shaft and press into place to the stop.
34. Maintain pressure until shaft-gear (shrink-on) connection is firm. See Figure 939.



**Figure 939 Press-Fitting Drive Gear**

38. Clean rotary seal surface with ethanol.
39. Coat O-ring (1) with petroleum jelly and install on thrust ring (2). See Figure 941.



1. O-ring

2. Thrust Ring

**Figure 941**     **Coating O-ring**

**NOTE:**

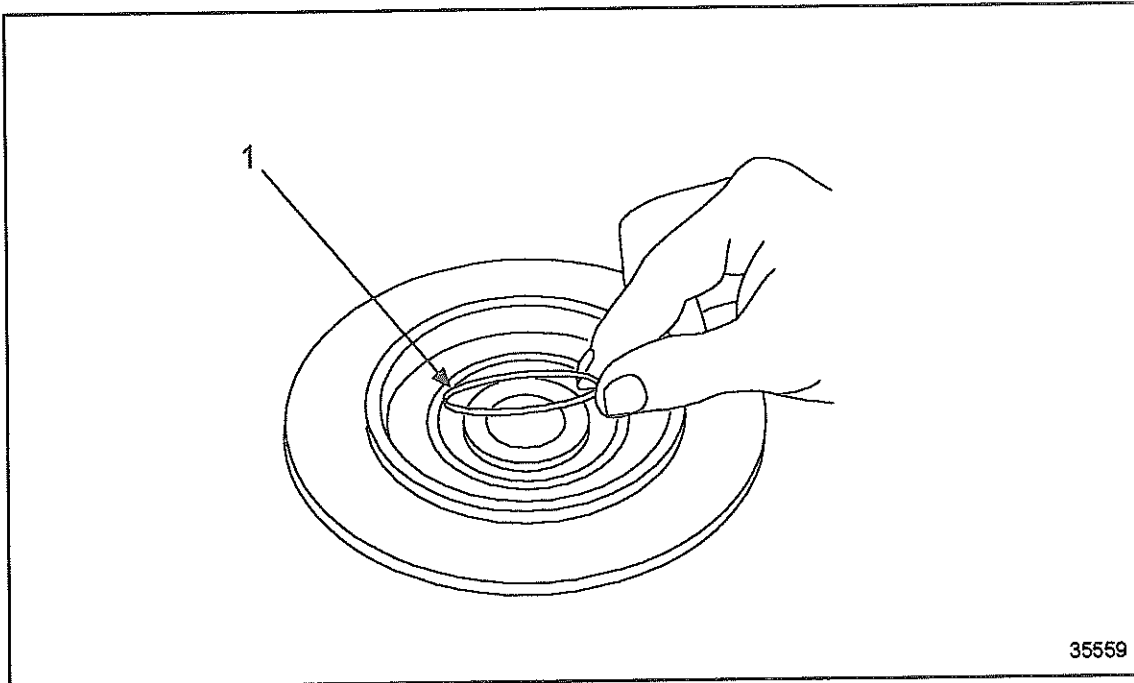
Ensure that O-ring is perfectly seated against shoulder of thrust ring.



**CAUTION:**

**To avoid personal injury while handling 'HOT' components, wear protective gloves and clothing.**

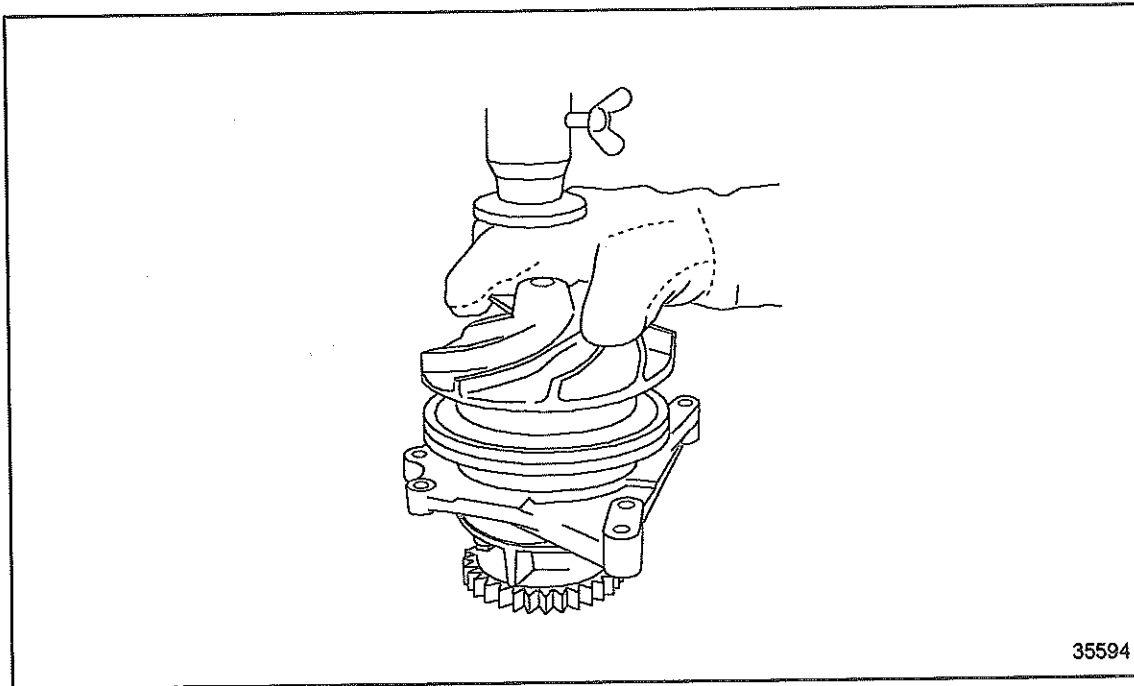
41. Preheat impeller uniformly to 210°C.
42. Install metal ring (1) in groove on back of impeller. See Figure 943.



1. Metal Ring

**Figure 943**     **Installing Metal Ring in Groove on Back of Impeller**

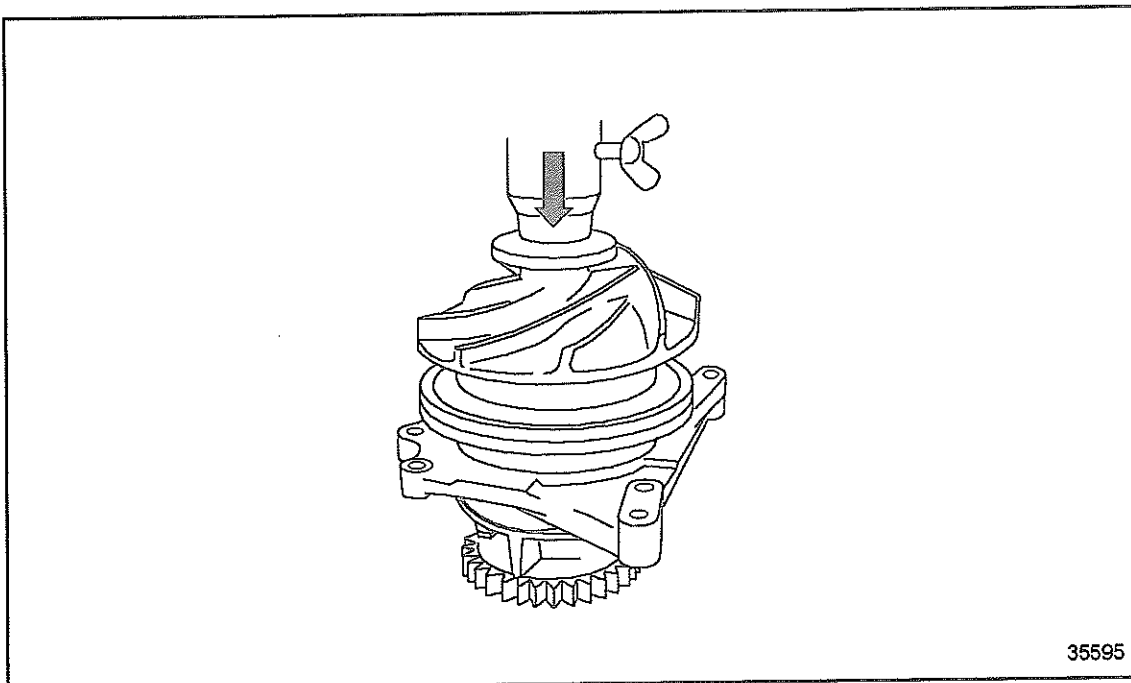
45. Place preheated impeller on pump shaft. See Figure 945.



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**Figure 945** Placing Preheated Impeller on Pump Shaft

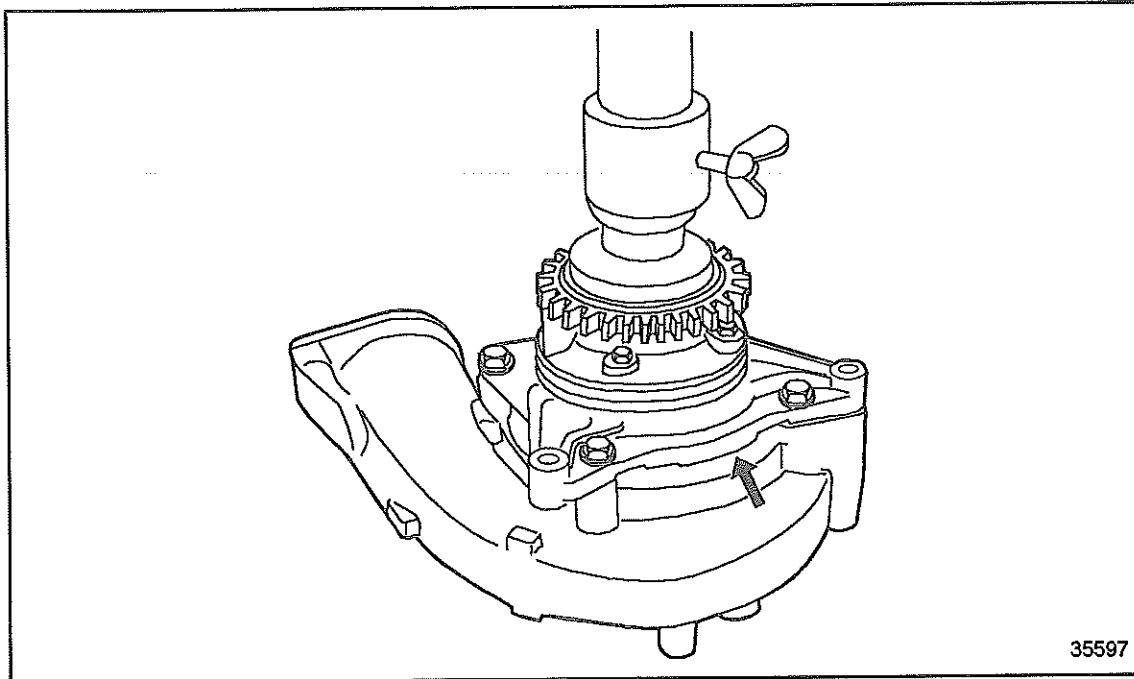
46. Use manual press to press impeller to stop and maintain pressure until shaft to gear (shrink-on) connection is secure. See Figure 946.



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**Figure 946** Installing Impeller

48. Carefully place seal carrier with impeller side on pump housing.
49. Position pump housing on bearing housing, tapping lightly with hammer or by means of light press pressure. See Figure 948.

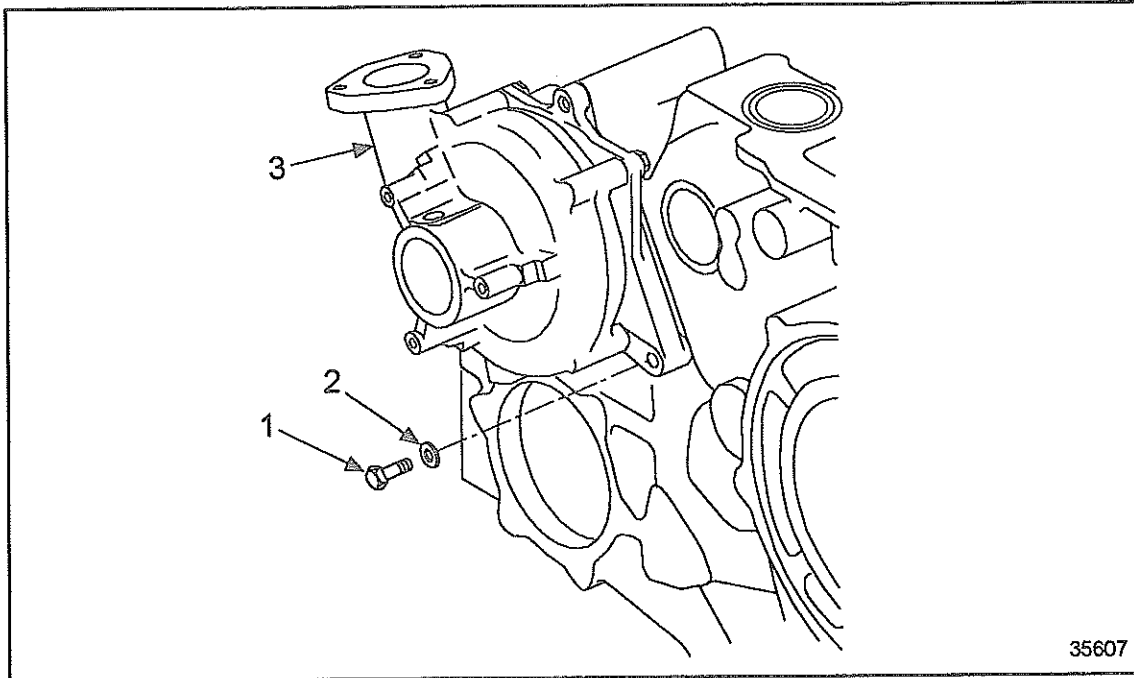


**Figure 948** Positioning Pump Housing on Bearing Housing

## C 206.05.11 – INSTALLATION OF CHARGE AIR COOLING SYSTEM (LOW-TEMPERATURE)

Perform the following steps for the installation of the charge air cooling system (low-temperature):

1. Coat O-ring with petroleum jelly and insert in groove on pump housing of charge air coolant pump.
2. Install charge air coolant pump (2) into bore in gear case, ensuring that gear engages. See Figure 950.



1. Bolt

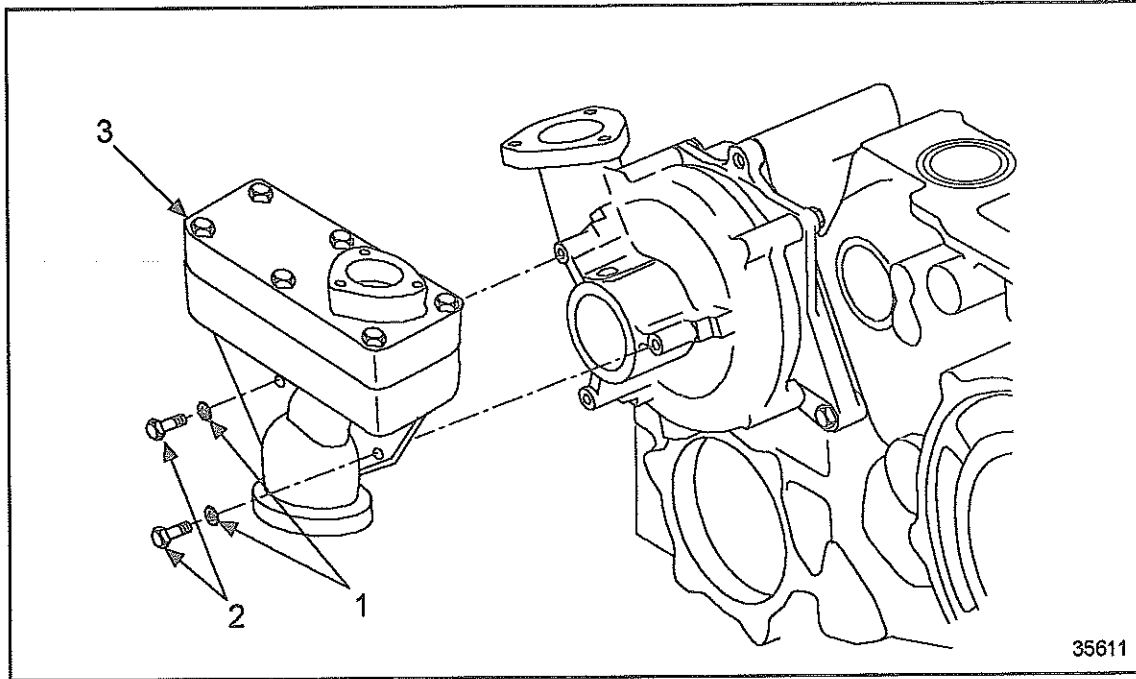
2. Charge Air Coolant Pump

2. Washer

**Figure 950** Installing Charge Air Coolant Pump into Gear Case

3. Inspect gear lash.
4. Install hex bolts (2) with washers and tighten uniformly to specification. Refer to section A 003.

6. Install thermostat housing on charge air coolant pump housing. See Figure 952.



- 1. Washer
- 2. Bolt

3. Thermostat Housing

**Figure 952**      **Installing Thermostat Housing on Charge Air Coolant Pump Housing**

**C 206.05.12 – AFTER-INSTALLATION OPERATIONS**

Listed in Table 134 are the After-Installation Operations for the charge air cooling system (low-temperature).

Level of Maintenance	Operation	Reference
1, 2, 3	Secure flange, charge air coolant pipe to pump inlet	Refer to section C 202.05.11
1, 2, 3	Secure flange, charge air coolant pipe to pump outlet	Refer to section C 202.05.11
1, 2, 3	Install temperature switch	Refer to section C 208.05.11
1, 2, 3	Connect coolant supply to cooler	Refer to section C 204.05.11
1, 2, 3	Connect coolant return from cooler	Refer to section C 204.05.11
1, 2, 3	Fill engine coolant system	Refer to Operators Guide
1, 2, 3	Inspect for leaks	Refer to Operators Guide
1, 2, 3	Enable engine power	Refer to Operators Guide

1 = The engine is to be completely disassembled.

2 = The engine is to be removed but not completely disassembled.

3 = The engine is to remain installed.

**Table 134 After-Installation Operations**

## C 208.05 – COOLANT PIPEWORK WITH THERMOSTAT

<b>Section</b>		<b>Page</b>
C 208.05.01	General View .....	C -1487
C 208.05.02	Special Tools .....	C -1489
C 208.05.04	Before-Removal Operations .....	C -1490
C 208.05.05	Removal of Cooling System Thermostat and Distribution Housings .....	C -1491
C 208.05.08	Inspection and Repair .....	C -1498
C 208.05.11	Installation of Cooling System Thermostat and Distribution Housings .....	C -1501
C 208.05.12	After-Installation Operations .....	C -1509

## C 208.05.01 – GENERAL VIEW

### NOTE:

Refer to section before beginning any work in the coolant chambers.

See Figure 971 for a general view of the cooling system thermostat and distribution housings.

**C 208.05.02 – SPECIAL TOOLS**

Listed in Table 139 are the special tools required for maintenance on the cooling system distribution housing and thermostat.

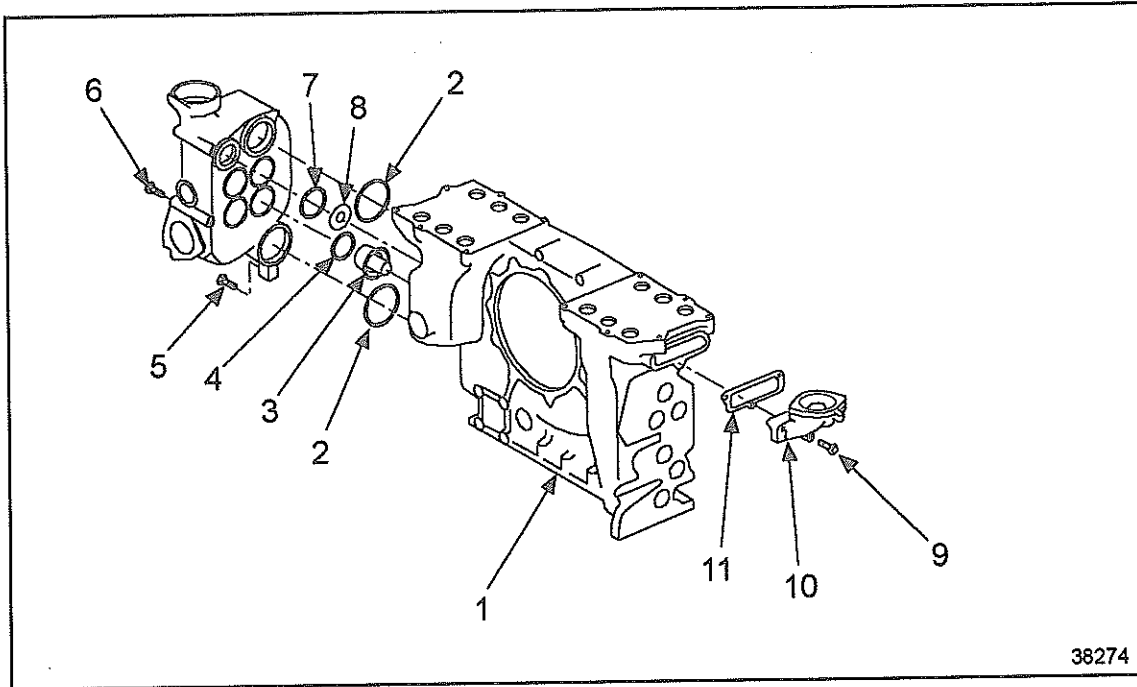
Application	Number
Installation tool, restrictor installation/removal, coolant distribution housing	—
Guide journal for restrictor	—
Guide journal for restrictor	—
Guide journal for restrictor	—
Guide journal for restrictor	—

**Table 139 Special Tools**

## C 208.05.05 – REMOVAL OF COOLING SYSTEM THERMOSTAT AND DISTRIBUTION HOUSINGS

Perform the following steps for the removal of the coolant pipework and thermostat:

1. To remove high-temperature thermostat housing, remove hex bolts (not shown). See Figure 972.

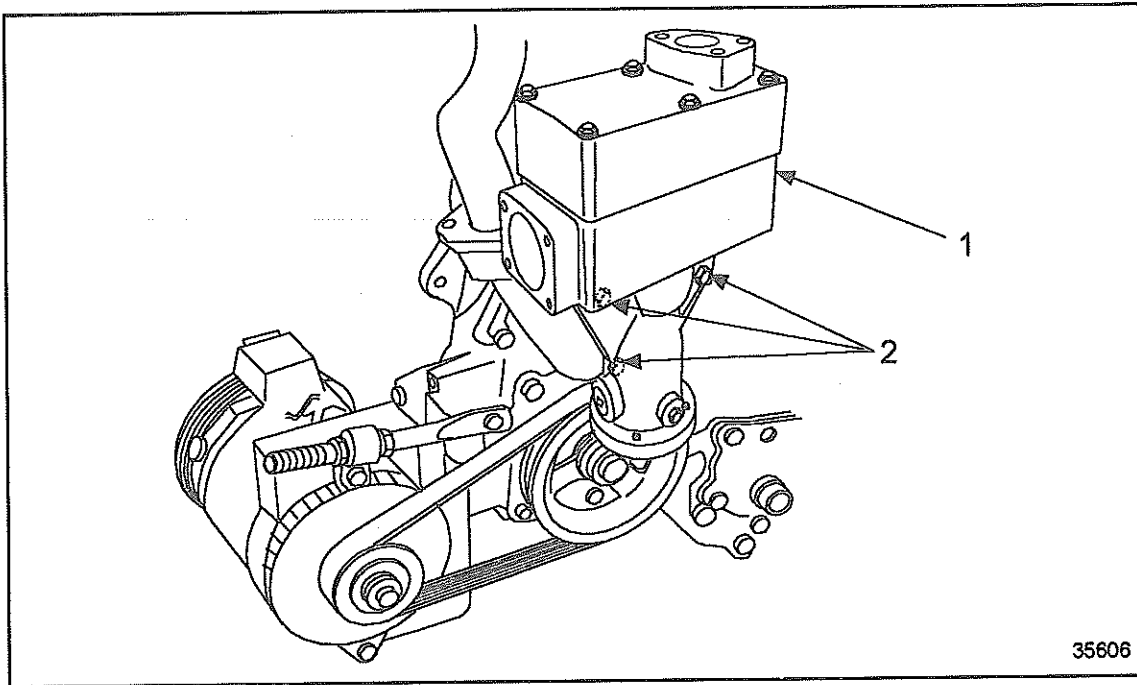


1. Thermostat Housing

**Figure 972** Removing High-temperature Thermostat Housing

2. Remove thermostat housing (1).

4. To remove low-temperature thermostat housing remove hex bolts (3) attaching thermostat housing (2) to water pump (1) of the low-temperature circuit. See Figure 974.



1. Low-Temperature Thermostat Housing

2. Bolt

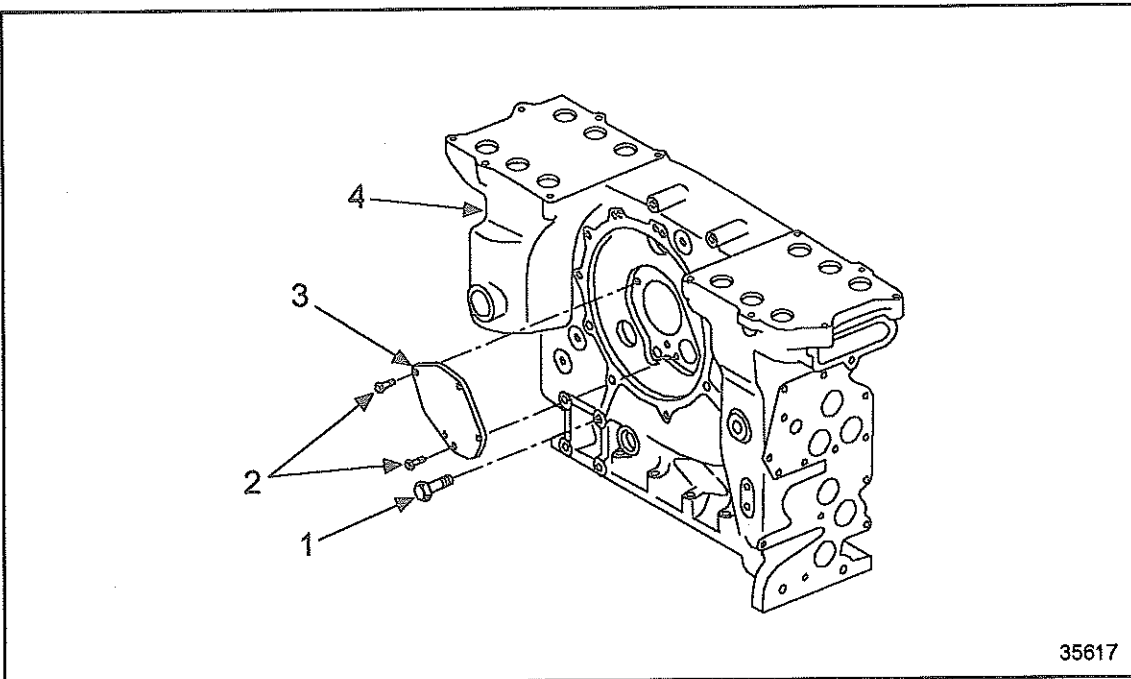
**Figure 974** Removing Low-temperature Thermostat Housing



**CAUTION:**

To avoid personal injury while using a lifting device, never stand beneath a suspended load. Use a suitable lifting device and review all manufacturer's cautionary notes.

7. To remove distribution housing, attach housing (4) with a lifting device, slightly tensioned, to crane. See Figure 976.



1. Hex Bolts
2. Hex Bolts

3. Cover
4. Distribution Housing

**Figure 976 Removing Distribution Housing**

8. Remove hex bolts (2) and cover (3).
9. Remove hex bolts (1).

11. Remove O-rings.
12. Remove elbow. (Not shown. Refer to section C 208.05.01.)

**CAUTION:**

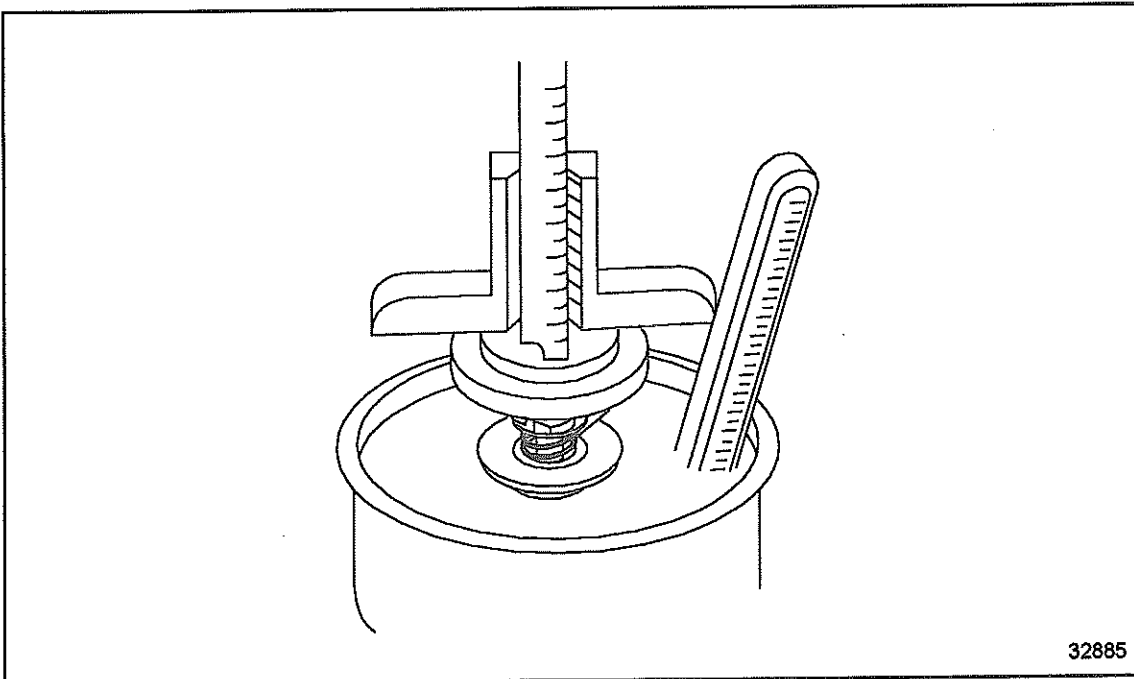
To avoid an eye injury when using compressed air, wear adequate eye protection (safety glasses or faceplate) and do not exceed 276 kPa (40 lb/in.<sup>2</sup>) air pressure.

10. Pressure test coolant and lube oil passages of distribution housing for leaks with compressed air in water bath (with corrosion inhibitor).
  - [a] If lube oil passages or coolant passages in the distribution housing show leaks, repair or replace the housing as necessary.
  - [b] If lube oil passages or coolant passages in the distribution housing do not show leaks, continue inspection.

### Inspection of Thermostats

Perform the following steps for inspection of thermostats:

1. Measure distance from thermostat collar to main valve head. See Figure 978.



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**Figure 978** Inspection of Thermostats

2. Hang thermostat on a wire in a container filled with water.

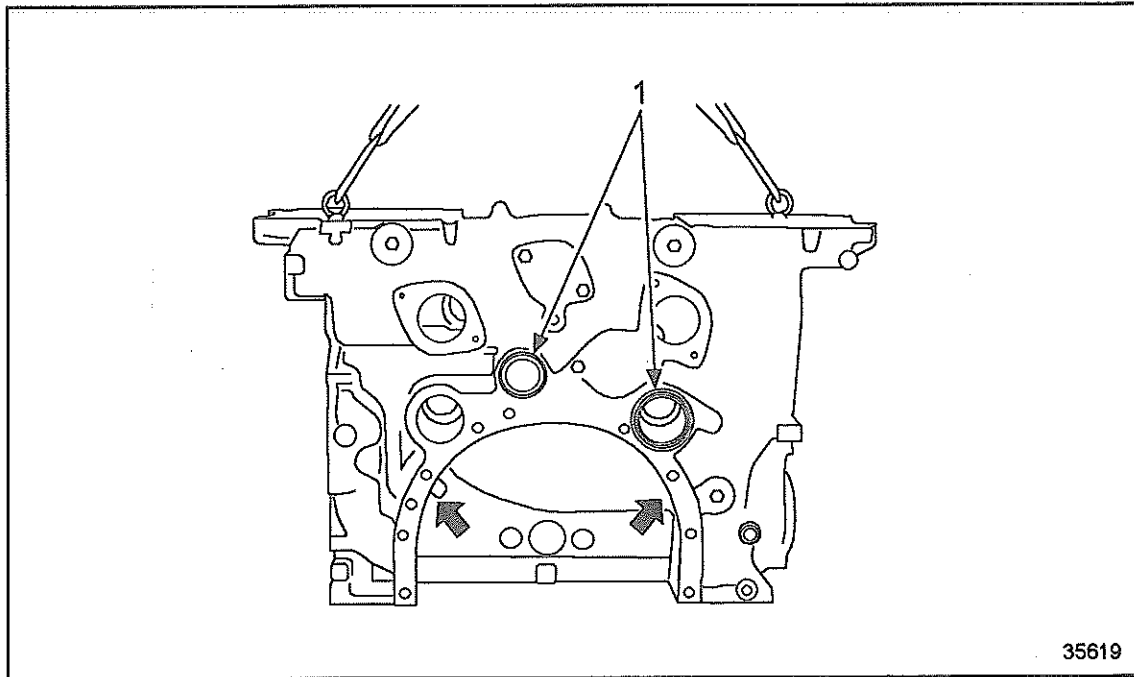
**NOTE:**

Thermostat must not contact container.

## C 208.05.11 – INSTALLATION OF COOLING SYSTEM THERMOSTAT AND DISTRIBUTION HOUSINGS

Perform the following steps for the installation of the cooling system thermostat and distribution housings:

1. To assemble and install distribution housing, install elbow (Not shown. Refer to section C 208.05.01) on distribution housing. See Figure 979.



1. O-ring

**Figure 979** Installing O—rings on Distributor Housing

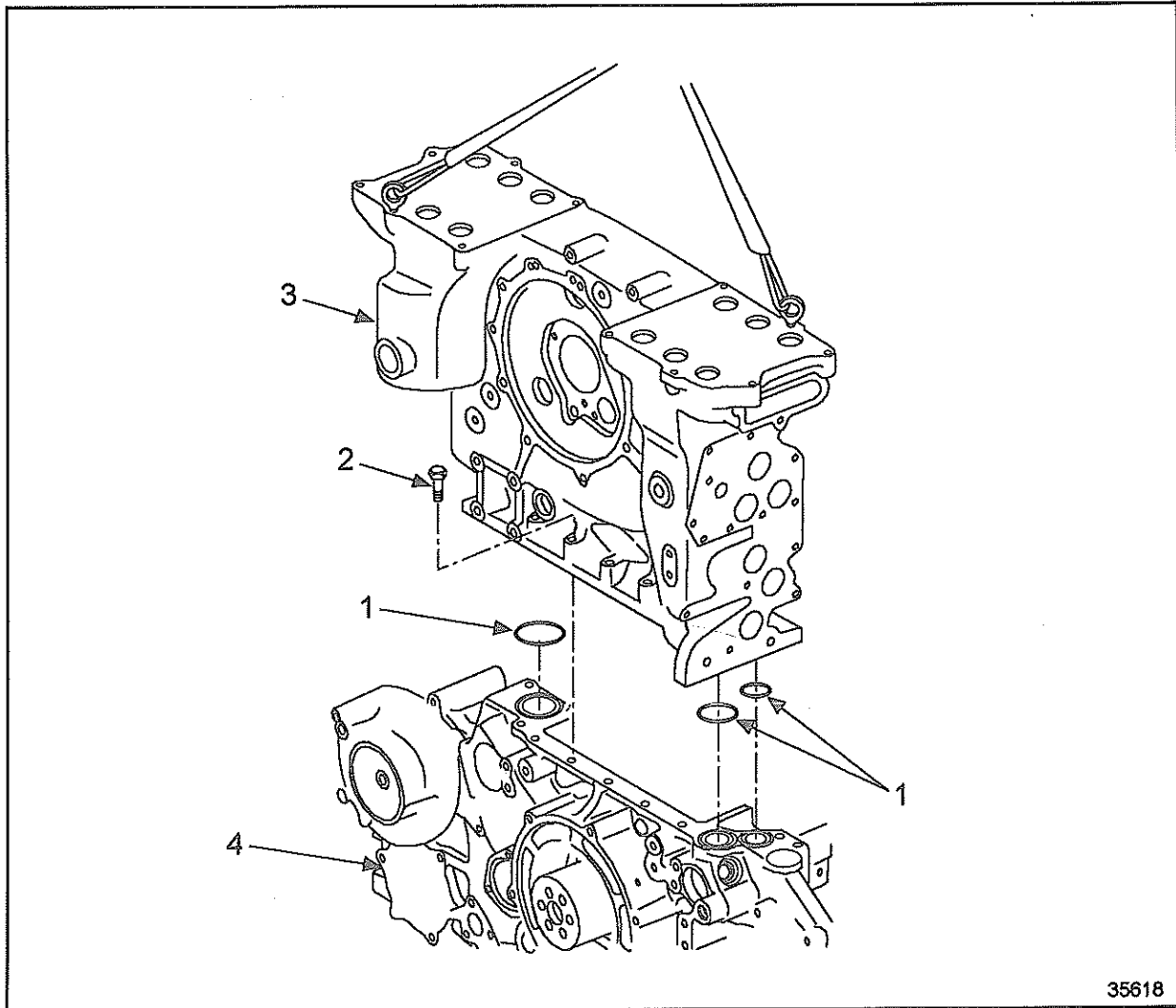
2. Bolt cap plugs onto distribution housing and tighten.
3. Coat O-rings (1) with petroleum jelly and install on back of distribution housing.
4. Coat mating surface (arrow) between rear of distribution housing and cylinder block with gasket eliminator.



**CAUTION:**

To avoid personal injury while using a lifting device, never stand beneath a suspended load. Use a suitable lifting device and review all manufacturer's cautionary notes.

8. Install lifting eyes into distribution housing. See Figure 981.

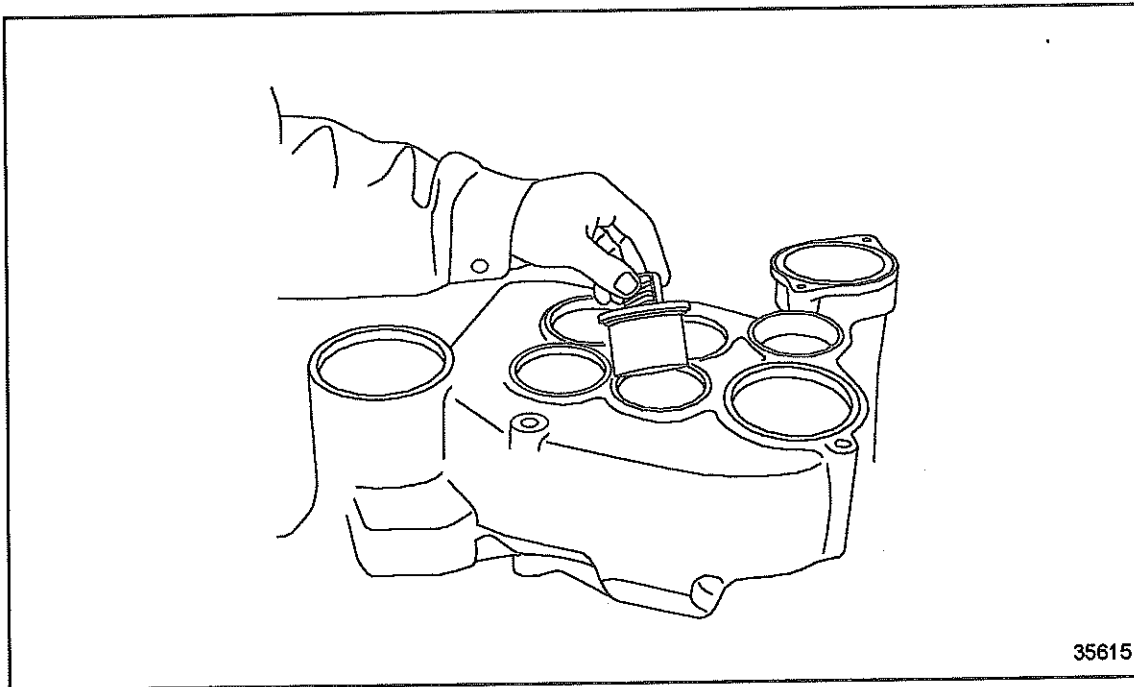


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- |             |                                 |
|-------------|---------------------------------|
| 1. O-ring   | 3. Coolant Distribution Housing |
| 2. Hex Bolt | 4. Gear Case                    |

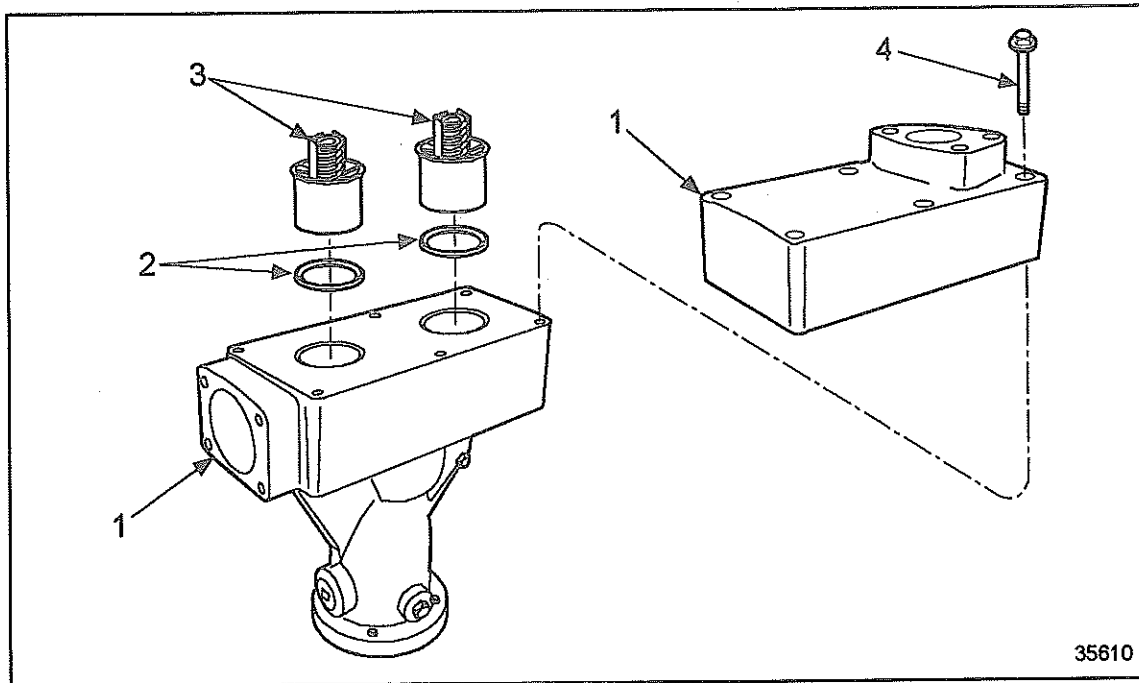
**Figure 981** Placing Housing on Gear Case

12. Install distribution housing cover (2).
13. Tighten hex bolts (1) to specification. Refer to section A 003.
14. To install high-temperature thermostat, inspect sealing and mating surfaces for contamination.
  - [a] If sealing or mating surfaces are contaminated, clean as necessary.
  - [b] If sealing or mating surfaces are not contaminated, continue installation.
15. Install thermostats in thermostat housing bores. See Figure 983.



**Figure 983**     **Installing Thermostats into Thermostat Housing**

18. Install thermostat housing on coolant distribution housing by means of guide pins.
19. Remove guide pins.
20. Install hex bolts to secure thermostat housing. Refer to section C 208.05.01.
21. Tighten hex bolts to specification. Refer to section A 003.
22. To install low-temperature thermostat install sealing ring and thermostat element dry in thermostat housing. See Figure 985.



1. Thermostat Housing

2. Sealing Ring

3. Thermostat

4. Mounting Bolt

**Figure 985**     **Installing Sealing Ring and Thermostat Element in Thermostat Housing**

**C 208.05.12 – AFTER-INSTALLATION OPERATIONS**

Listed in Table 141 are the After-Installation Operations for the coolant distribution housing.

Level of Maintenance	Operation	Reference
1, 2, 3	Install oil filter	Refer to section C 183.05.11
1, 2, 3	Install engine oil heat exchanger	Refer to section C 185.05.05
1, 2, 3	Connect coolant lines	Refer to section C 204.05.11
1, 2, 3	Connect coolant vent lines	Refer to section C 205.05.11
1, 2, 3	Install oil centrifuge	Refer to section C 184.05.11
1, 2, 3	Connect electric cables	Refer to section C 500
1, 2, 3	Install engine mounts (KGS)	Refer to section C 231.05.11
1, 2, 3	Install fan drive	Refer to section C 221.05.11
1, 2, 3	Fill oil system with engine oil	Refer to Operators Guide
1, 2, 3	Fill engine coolant system	Refer to Operators Guide
1, 2, 3	Release engine start	Refer to Operators Guide
1, 2, 3	Vent fuel system	Refer to Operators Guide
1, 2, 3	Check for leaks	Refer to Operators Guide
1, 2, 3	Enable engine power	Refer to Operators Guide

1 = The engine is to be completely disassembled.

2 = The engine is to be removed but not completely disassembled.

3 = The engine is to remain installed.

**Table 141 After-Installation Operations**