CATERPILLAR®

RENR2304-02
May 2004

Disassembly and Assembly

3406E and 3456 Industrial Engines

3PG1-Up (Engine)
7WG1-Up (Engine)
1DZ1-Up (Engine)
1MZ1-Up (Engine)

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Disassembly and Assembly Section

i02022754

Fuel Priming Pump - Remove and Install

SMCS Code: 1258-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

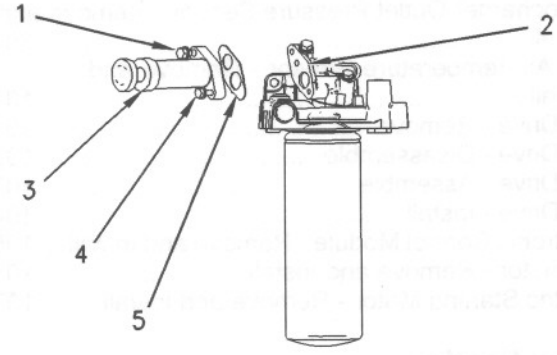

Illustration 1 g01002542

1. Remove bolt (1) and bolt (4). Remove fuel priming pump (3) from fuel filter base (2).
2. Remove gasket (5) for the fuel priming pump and the fuel filter base.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

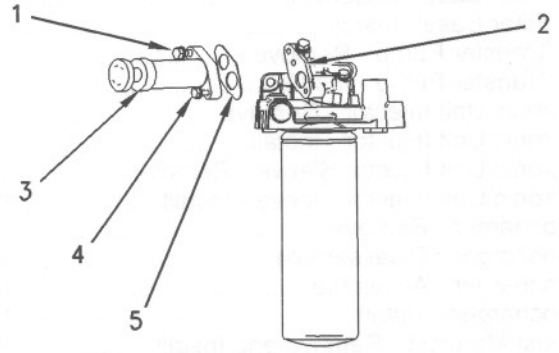

Illustration 2 g01002542

1. Ensure that gasket (5) is in position for the fuel priming pump.
2. Put fuel priming pump (3) in position on fuel filter base (2). Install bolt (1) and bolt (4).

i01988510

Fuel Filter Base - Remove

SMCS Code: 1262-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench	1
ZZ	9U-7072	Tapered Cap/Plug	3
	9U-7070	Tapered Cap/Plug	3

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

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Dispose of all fluids according to local regulations and mandates.

1. Turn the fuel supply to the "OFF" position.

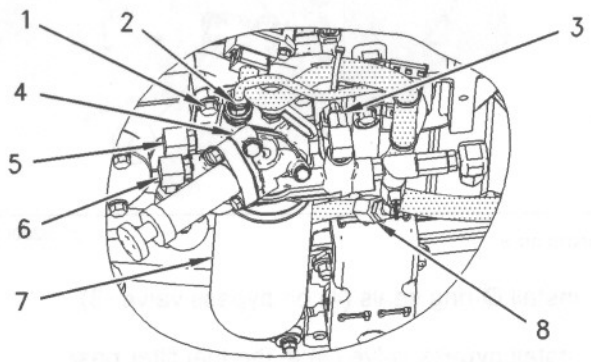

Illustration 3 g01002631

2. Disconnect harness assembly (2) from the fuel temperature sensor.
3. Disconnect hose assembly (3), (6), and (8) from fuel filter base (4).
4. Disconnect tube assembly (5) from fuel filter base (4).
5. Use Tooling (A) to remove fuel filter (7) from fuel filter base (4).
6. Remove bolts (1) that fasten the fuel filter base to the cylinder block. Remove fuel filter base (4).

i01805883

Fuel Filter Base - Disassemble

SMCS Code: 1262-015

Disassembly Procedure

Start By:

a. Remove the fuel filter base. Refer to Disassembly and Assembly, "Fuel Filter Base - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

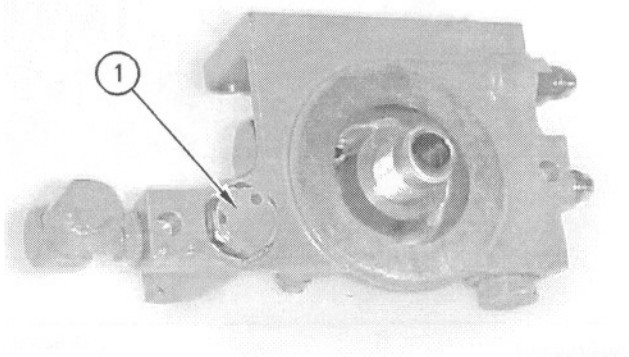

Illustration 4 g00628020

1. Remove check valve (1) from the fuel filter base.

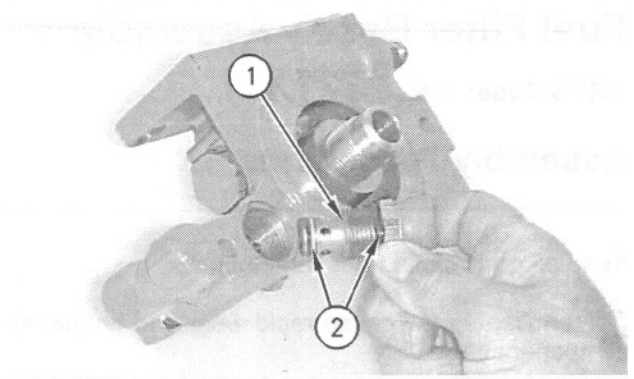

Illustration 5 g00628032

2. Remove O-ring seals (2) from check valve (1).

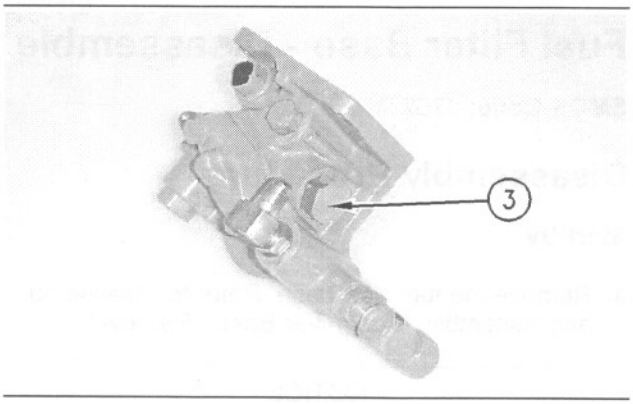

Illustration 6 g00628036

3. Remove bypass valve (3) from the fuel filter base.

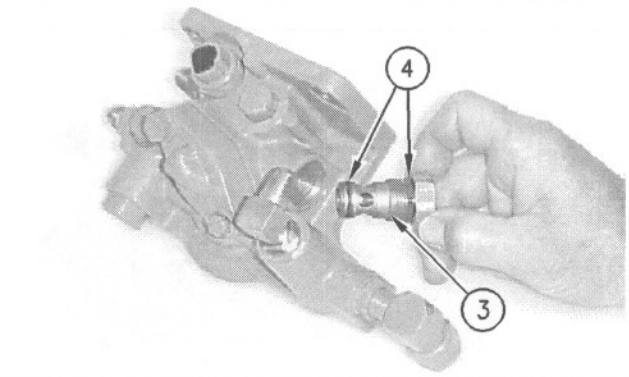

Illustration 7 g00628092

4. Remove O-ring seals (4) from bypass valve (3).

i01175496

Fuel Filter Base - Assemble

SMCS Code: 1262-016

Assembly Procedures

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Check the condition of the O-ring seals. If the O-ring seals are worn or damaged use new parts for replacement.

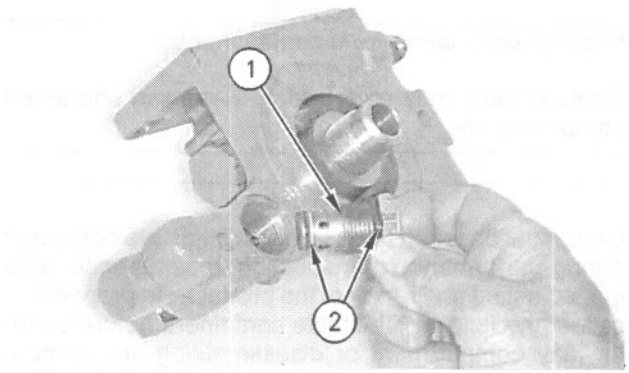

Illustration 8 g00628032

1. Install O-ring seals (2) on check valve (1).

2. Install check valve (1) in the fuel filter base.

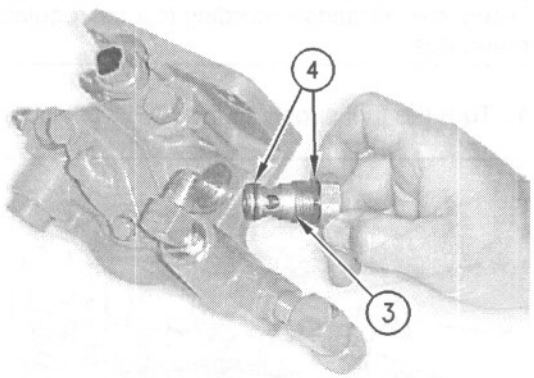

Illustration 9 g00628092

3. Install O-ring seals (4) on bypass valve (3).

4. Install bypass valve (3) in the fuel filter base.

End By:

a. Install the fuel filter base. Refer to Disassembly and Assembly, "Fuel Filter Base - Install".

i01926168

Fuel Filter Base - Install

SMCS Code: 1262-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

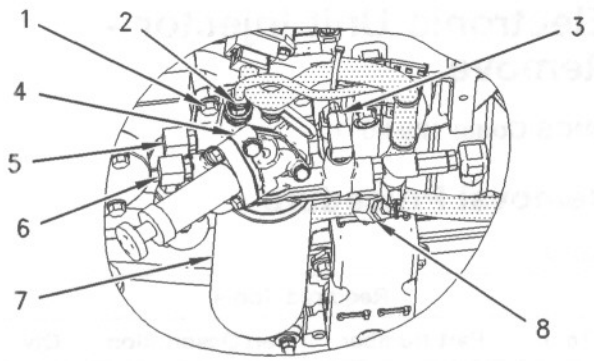

Illustration 10 g01002631

1. Install fuel filter base (4) with bolts (1).
2. Install fuel filter (7) on fuel filter base (4). Follow the direction on the fuel filter for the correct installation procedure.
3. Connect tube assembly (5) to the fuel filter base.
4. Connect hose assembly (3), (6), and (8) to the fuel filter base.
5. Connect harness assembly (2) to the fuel temperature sensor.
6. Turn the fuel supply to the "ON" position.
7. Remove the air from the system. Refer to Testing and Adjusting, "Fuel System - Prime".

i02110363

Fuel Transfer Pump - Remove

SMCS Code: 1256-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

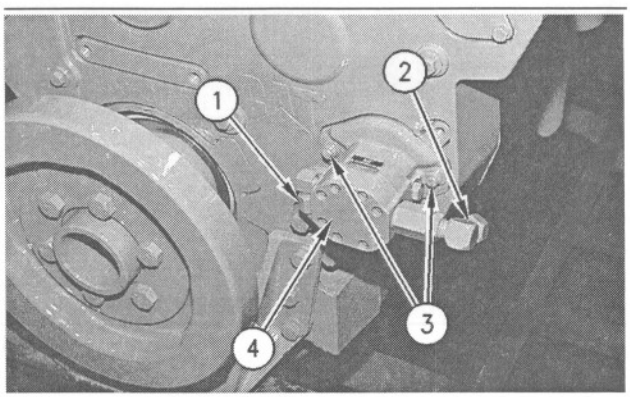

Illustration 11 g00488104

1. Disconnect hose assemblies (1) and (2). Plug and cap all openings in order to prevent debris and contamination from entering the system.
2. Remove bolts (3) and fuel transfer pump (4).

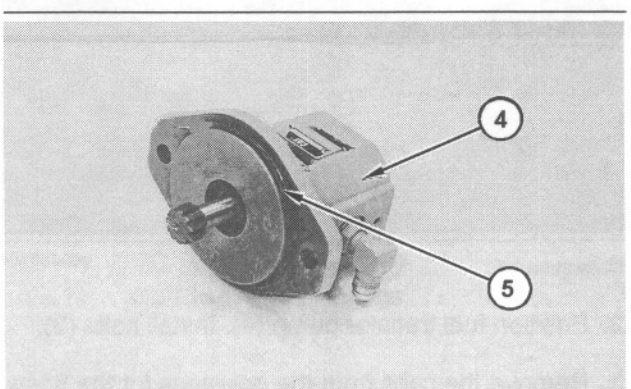

Illustration 12 g01039865

3. Check the condition of O-ring seal (5) on fuel transfer pump (4). If the O-ring seal is worn or damaged, use a new part for replacement.

i01990706

Fuel Transfer Pump - Install

SMCS Code: 1256-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

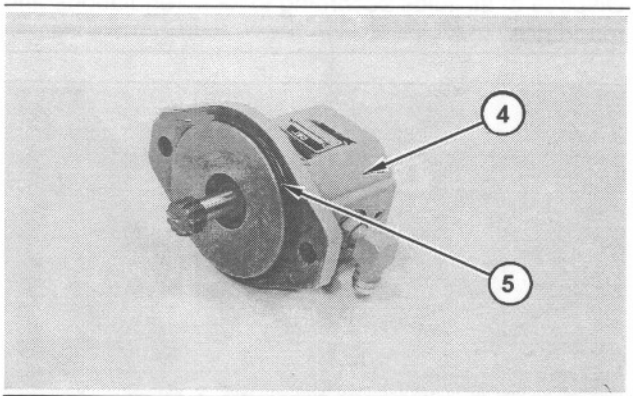

Illustration 13 g01039865

1. Install O-ring seal (5) on fuel transfer pump (4). Apply clean engine oil to O-ring seal (5).

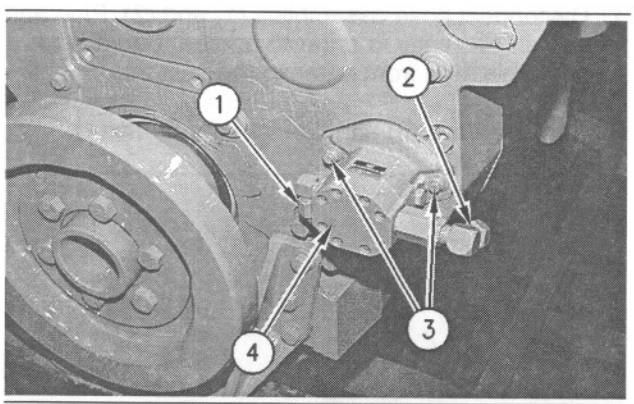

Illustration 14 g00488104

2. Position fuel transfer pump (4). Install bolts (3).

3. Remove the caps from the openings for the hose assemblies. Connect hose assemblies (1) and (2).

i02097659

Electronic Unit Injector - Remove

SMCS Code: 1290-011

Removal Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5F-4764	Pry Bar	1

Start By:

a. Remove the rocker arms and the rocker arm shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

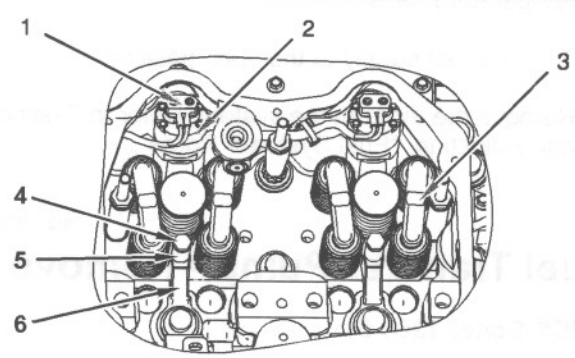

Illustration 15 g01026993

1. Disconnect harness assembly (1) from electronic unit injector (2).

2. Remove bridge assemblies (3).

NOTICE
Do not reuse the injector hold down bolts. New injector hold down bolts must be used.

NOTICE
If the injector hold down bolt is loose during the removal procedure, inspect the injector bore for wear and debris. Replace the clamp and spacer.

3. Remove bolt (4), spacer (5), and clamp (6).

4. Place an identification mark on the electronic unit injectors for installation purposes. Each electronic unit injector must be reinstalled in the original electronic unit injector sleeve.

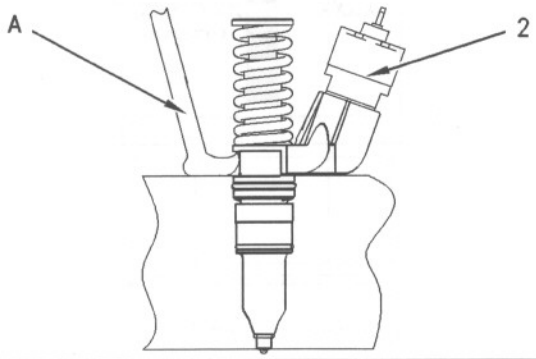

Illustration 16 g00996395

5. Use Tooling (A) in order to pry beneath the base and free electronic unit injector (2).

6. Remove electronic unit injector (2) from the cylinder head.

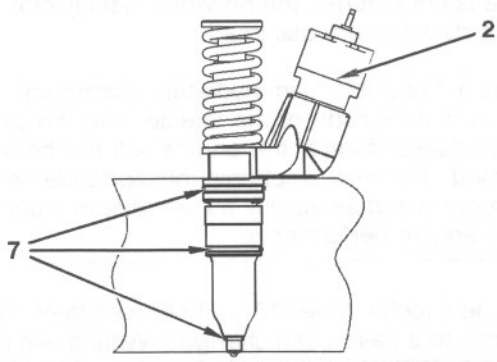

Illustration 17 g01039929

7. Remove O-ring seals (7) from electronic unit injector (2).

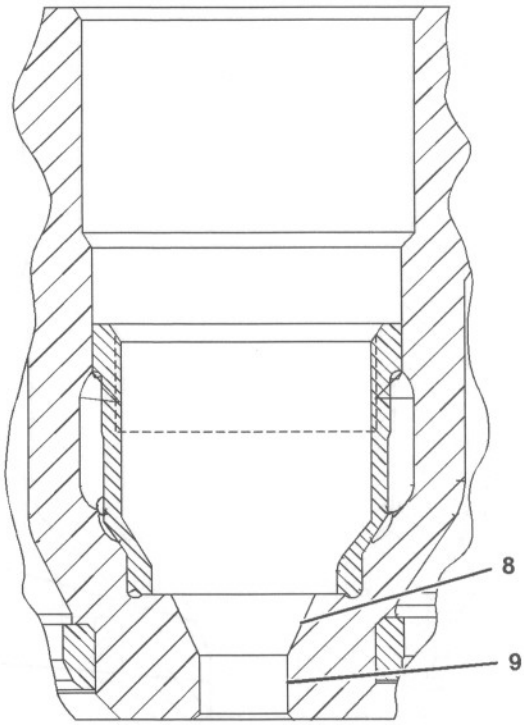

Illustration 18 g01054374

8. Inspect electronic unit injector seat (8) and electronic unit injector bore (9).

i02095281

Electronic Unit Injector - Install

SMCS Code: 1290-012

Installation Procedure

Table 3

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	9U-6862	Tapered Brush	1
C	9U-6863	Small Bore Brush	1
D	9U-7237	Brush Extension	1
E	8T-2998	Lubricant	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

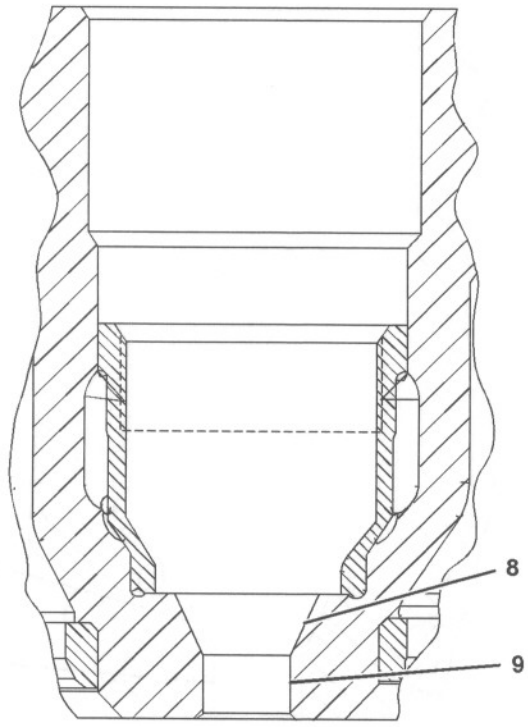

Illustration 19 g01054374

1. Use Tooling (B) and Tooling (D) in order to clean electronic unit injector seat (8).

2. Use Tooling (C) and Tooling (D) in order to clean electronic unit injector bore (9).

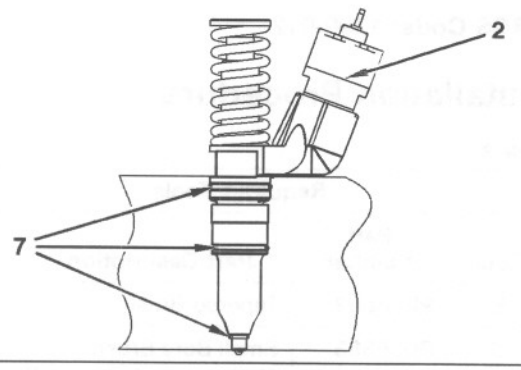

Illustration 20 g01039929

NOTICE
Do not reuse O-ring seals. New O-ring seals must be used.

3. Install O-ring seals (7). Lubricate the top two O-ring seals with a 50/50 mixture of clean engine oil and Tooling (E).

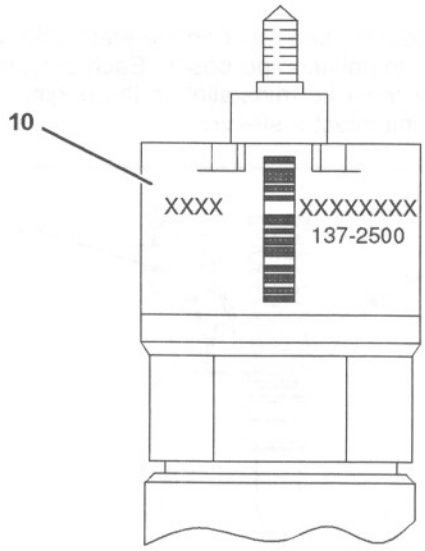

Illustration 21 g01019373

NOTICE
When a fuel injector group is serviced, the new fuel injector group's electronic injector code must be programmed into the engine's personality module software by using the calibration menu on the Electronic Service Tool. If the new fuel injector group's electronic code is not entered, the previous fuel injector group's characteristics are assumed.

If it is not possible to immediately reprogram the electronic injector code of the injector into the personality module software, the engine will not be severely harmed. The new electronic injector code should be reprogrammed as quickly as possible in order to optimize engine performance.

4. The injector code (10) will be used later if the injectors have been changed. Write down injector code (10) which is located on the solenoid.

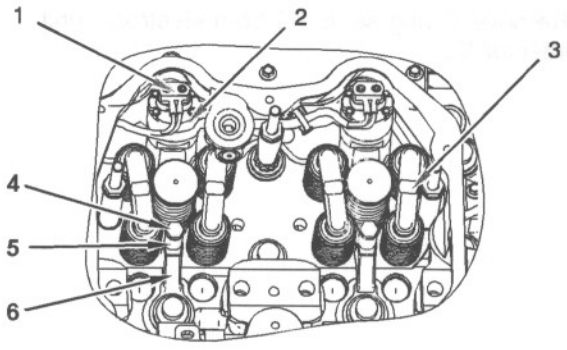

Illustration 22 g01026993

5. Install electronic unit injector (2) into the original location in the cylinder head.

6. Install clamp (6) and spacer (5).

NOTICE
Do not reuse the injector hold down bolts. New injector hold down bolts must be used.

NOTICE
If the injector hold down bolt is loose during the removal procedure, inspect the injector bore for wear and debris. Replace the clamp and spacer.

7. Install bolt (4). Tighten bolt (4) according to the following procedure.

   a. Tighten the bolt for the electronic unit injector to 50 ± 10 N·m (37 ± 7 lb ft).

   b. Loosen the bolt until you can turn the bolt by hand.

   c. Tighten the bolt for the electronic unit injector again to 50 ± 10 N·m (37 ± 7 lb ft).

8. Install bridge assemblies (3) in the respective locations.

9. Connect harness assembly (1) on electronic unit injector (2). Install the nuts. Tighten the nuts to a torque of 2.5 ± 0.25 N·m (22 ± 2 lb in).

10. Install the rocker arms and the rocker arm shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

11. Adjust the height of the electronic unit injector. Refer to Testing and Adjusting, "Electronic Unit Injector - Adjust" for information on adjusting the height of the injector.

12. Calibrate the electronic unit injector.

   a. Connect Cat ET to the service tool connector.

   b. Turn the keyswitch to the ON position.

   c. Open the "Injector Codes Calibration" in "Calibrations" under the "Service" menu on Cat ET.

   d. Enter the new injector trim code for the electronic unit injector in each cylinder.

i01983465

Electronic Unit Injector Sleeve - Remove

SMCS Code: 1713-011

Removal Procedure

Table 4

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	128-7889	Bridge Puller	1
	221-9778	Puller Stud	1
	9U-6877	Thrust Bearing	1
	5P-8247	Hard Washer	1
	4K-0367	Nut	1

(1) Part of the 9U-6891 Injector Tool Group

Start By:

a. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the engine. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

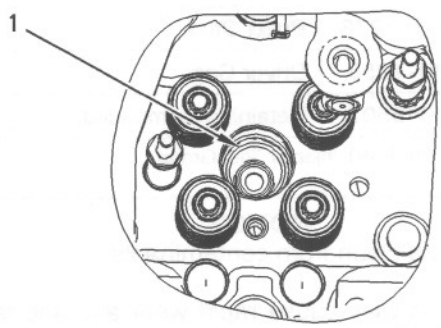

Illustration 23 g01002969

2. Use Tooling (A) to remove unit injector sleeve (1).

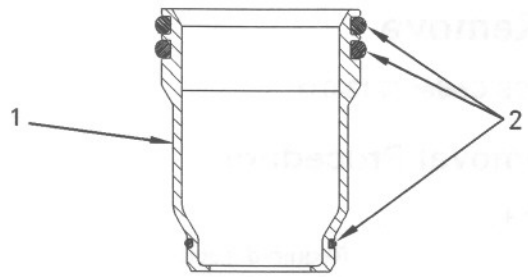

Illustration 24 g00948616

3. Remove O-ring seals (2) from unit injector sleeve (1).

i02015805

Electronic Unit Injector Sleeve - Install

SMCS Code: 1713-012

Installation Procedure

Table 5

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	9U-6862	Tapered Brush	1
	9U-6863	Small Bore Brush	1
	9U-7244	End Brush	1
	9U-7237	Brush Extension	1
	4C-5552	Large Bore Brush	1
C(1)	221-9778	Puller Stud	1
D(1)	9U-7258	Driver Cap	1
E	4C-9507	Retaining Compound	-

(1) Part of the 9U-6891 Injector Tool Group

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (B) to clean the bore in the cylinder head for the unit injector sleeve.

NOTICE
Before starting installation ensure that the unit injector sleeve and the cylinder head bore for the unit injector sleeve are completely free of oil, dirt, and sealant debris.

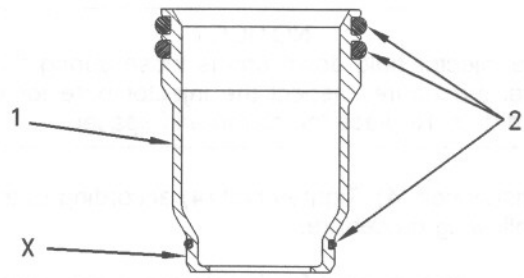

Illustration 25 g01003258

2. Install new O-ring seals (2) on unit injector sleeve (1).

Note: Do not apply Tooling (E) to the cylinder head surfaces. Apply Tooling (E) on the unit injector sleeve only.

3. Apply Tooling (E) to the contact surface of unit injector sleeve (1) on the surface that is marked "X".

4. Lubricate O-ring seals (2) with clean engine oil.

5. Install Tooling (C) into the threads of unit injector sleeve (1).

6. Position Tooling (C) and unit injector sleeve (1) in the cylinder head. Use care not to damage the O-ring seals on the unit injector sleeve.

NOTICE
Ensure that the unit injector sleeve is properly seated in the cylinder head. The tool and the unit injector sleeve will "RING" when the unit injector sleeve is fully seated in the bore in the cylinder head.

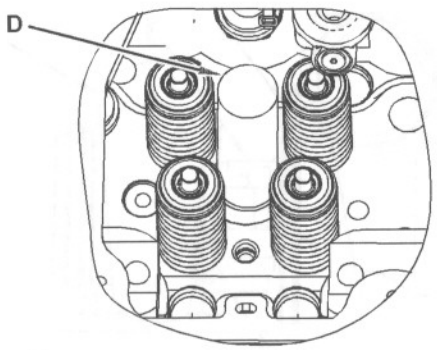

Illustration 26 g01027804

7. Use Tooling (D) and a hammer to install the unit injector sleeve.

8. Use a clean towel to remove any excessive retaining compound.

9. Fill the cooling system with coolant. Refer to Operation and Maintenance, "Refill Capacities" for the cooling system capacity.

End By:

a. Install the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".

i01973670

Turbocharger - Remove

SMCS Code: 1052-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

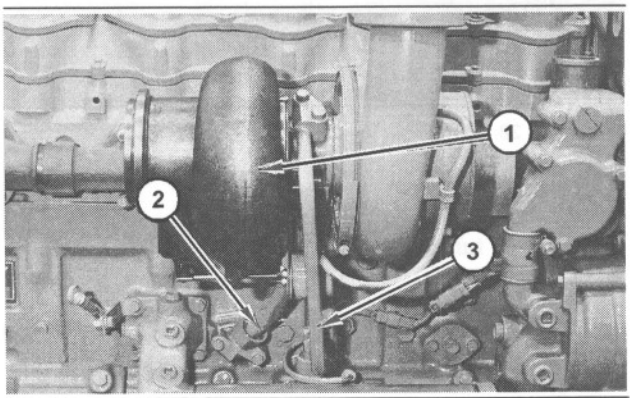

Illustration 27 g01029881

1. Remove tube assemblies (2) and (3) from the turbocharger. Check the condition of the O-ring seals on tube assemblies (2) and (3). Use new parts for replacement if the O-ring seals are worn or damaged.

2. Use a suitable lifting device. The turbocharger weighs approximately 34 kg (75 lb).

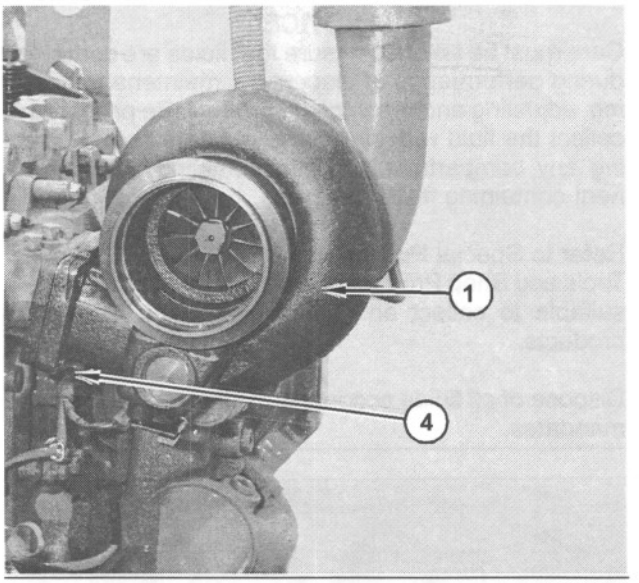

Illustration 28 g01029884

3. Remove bolts (4).

4. Remove turbocharger (1).

i01066656

Turbocharger - Disassemble

SMCS Code: 1052-015

Disassembly Procedure

Start By:

a. Remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

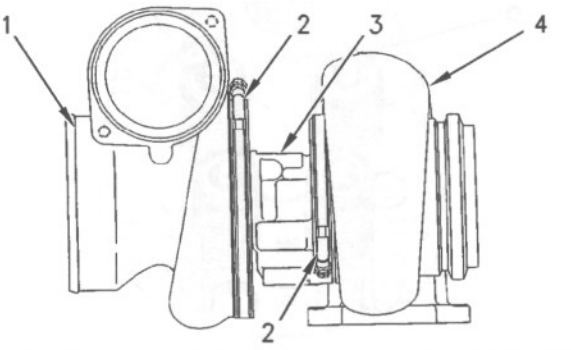

Illustration 29 g00555701

1. Loosen the nuts on V-band clamps (2).

NOTICE
The compressor housing must remain straight with the turbocharger cartridge during disassembly and assembly. Tilting may cause damage to the tips of the compressor wheel and the compressor shaft.

2. Separate compressor housing (1) and turbine housing (4) from turbocharger cartridge (3).

3. Check the condition of all components. Use new parts to replace worn parts or damaged parts.

i01988526

Turbocharger - Assemble

SMCS Code: 1052-016

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

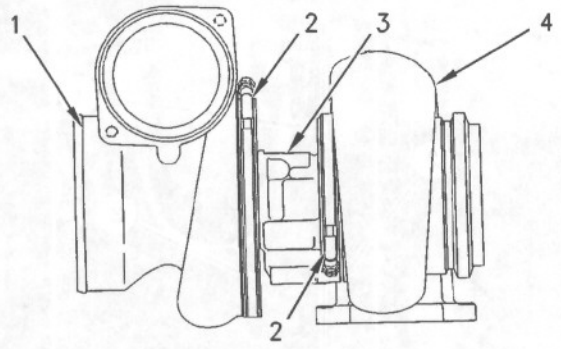

Illustration 30 g00555701

1. Check condition of all components. Use new parts to replace worn parts or damaged parts.

NOTICE
The compressor housing must remain straight with the turbocharger cartridge during disassembly and assembly. Tilting may cause damage to the tips of the compressor wheel and the compressor shaft.

2. Connect compressor housing (1) and turbine housing (4) to turbocharger cartridge (3).

3. Tighten the nuts on V-band clamps (2) to a torque of 14 ± 1 N·m (10 ± 1 lb ft). Lightly tap around the diameter of band clamps (2) with a soft hammer.

4. Tighten the nuts on V-band clamps (2) again. Tighten to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

End By:

a. Install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

i01988584

Turbocharger - Install

SMCS Code: 1052-012

Installation Procedure

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

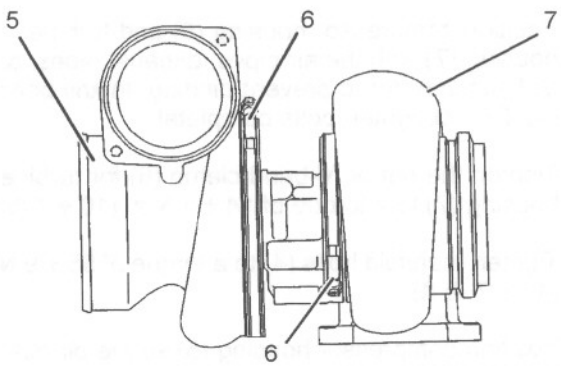

Illustration 31 g01029915

1. Loosen the nuts on V-band clamps (6) enough to allow compressor housing (5) and turbine housing (7) to rotate.

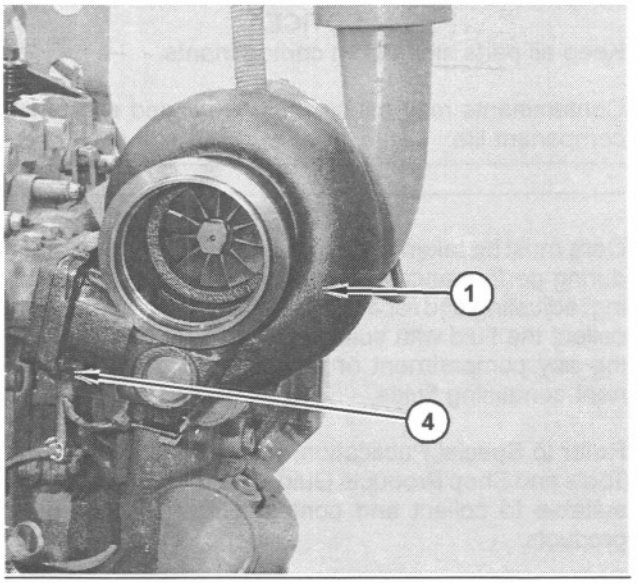

Illustration 32 g01029884

2. Apply Tooling (A) on bolts (4).

3. Position compressor housing (5) and turbine housing (7) with the air pipes, exhaust pipes, and oil lines in order to prevent binding. Install bolts (4). Do not tighten bolts completely.

4. Tighten the nut on V-band clamp (6) for turbine housing (7) to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

5. Tighten manifold bolts (4) to a torque of 55 ± 9 N·m (41 ± 7 lb ft).

6. Position compressor housing (5) so the air outlet is zero degrees from top vertical.

7. Tighten the nut on V-band clamp (6) for compressor housing (5) to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

8. Lightly tap around the diameter of both V-band clamps (6) with a soft hammer. Tighten the nuts on both V-band clamps (6) to a torque of 14 ± 1 N·m (10 ± 1 lb ft).

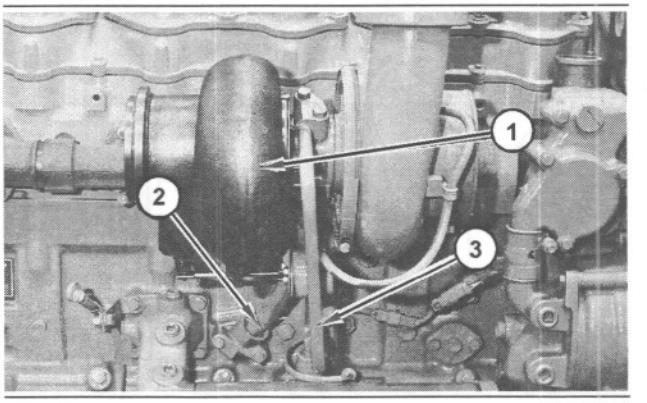

Illustration 33 g01029881

9. Install tube assemblies (2) and (3).

i01806198

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

Start By:

a. Remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

b. Remove the water temperature regulator. Refer to Disassembly and Assembly, "Water Temperature Regulator - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

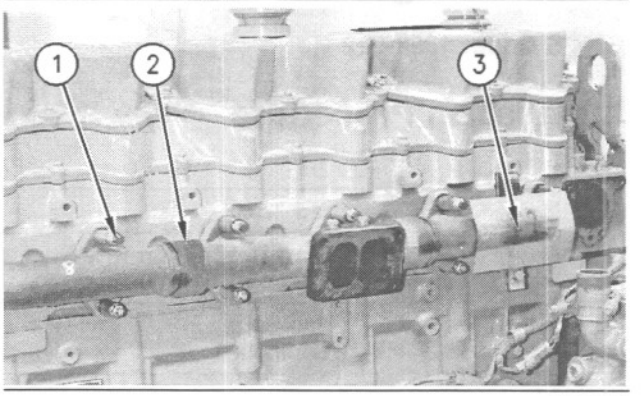

Illustration 34 g00619289
Typical example

1. Remove exhaust manifold shield (3). Remove the nuts and spacers from studs (1). Remove exhaust manifold (2).

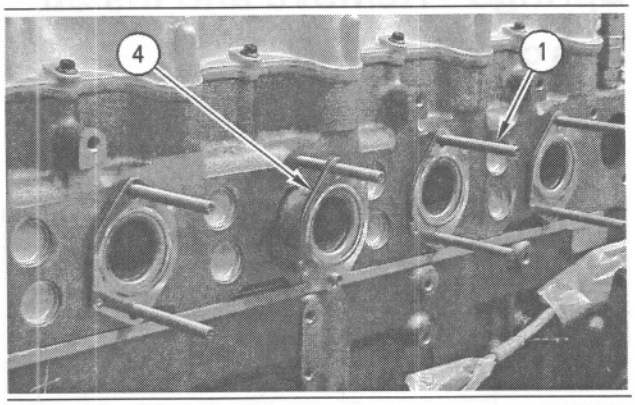

Illustration 35 g00632595
Typical example

2. Remove sleeve assemblies (4) from the cylinder head.

Installation Procedure

Table 7

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	1
B	2P-2333	High Temperature Sealer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Before assembly, check the condition of the sleeve assemblies, the studs, and the nuts. If the part is worn or damaged, use new parts for replacement.

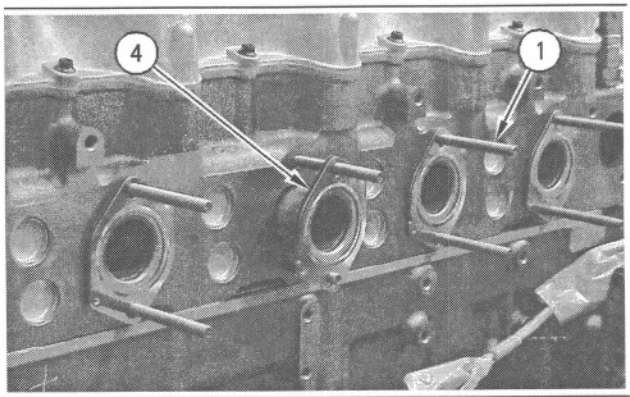

Illustration 36 g00632595
Typical example

1. Apply Tooling (A) to studs (1). If the studs were removed from the cylinder head, install the studs in the cylinder head. Tighten the studs to a torque of 35 ± 5 N·m (26 ± 4 lb ft).

2. Install sleeve assemblies (4) in the cylinder head.

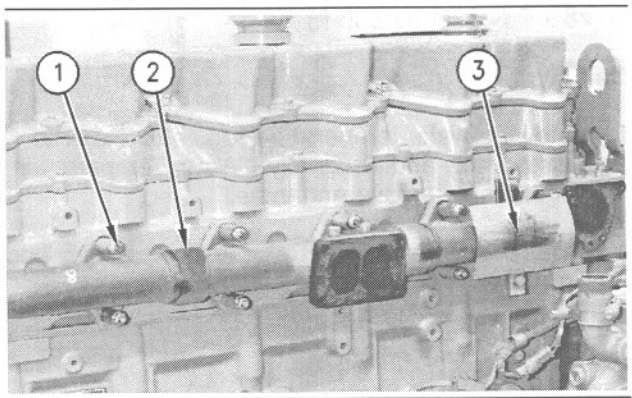

Illustration 37 g00619289
Typical example

3. Apply Tooling (B) to the outside diameter of the male ends of exhaust manifold (2). Put clean engine oil on the female ends of the exhaust manifold.

4. Apply Tooling (A) to the ends of studs (1). Put exhaust manifold (2) in position on the studs. Install the spacers and nuts on studs (1).

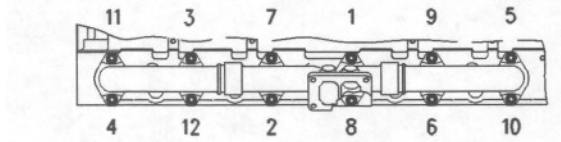

Illustration 38 g00498448

Tightening sequence for the exhaust manifold

5. Tighten the nuts for the exhaust manifold in a numeric sequence to a torque of 38 ± 5 N·m (28 ± 4 lb ft).

6. Install exhaust manifold shield (3). Apply Tooling (A) to the nuts for the exhaust manifold shield. Tighten the nuts for the shield to a torque of 25 ± 7 N·m (18 ± 5 lb ft).

End By:

a. Install the water temperature regulator. Refer to Disassembly and Assembly, "Water Temperature Regulator - Remove and Install".

b. Install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

i02111105

Inlet and Exhaust Valve Springs - Remove and Install

SMCS Code: 1108-010

Removal Procedure

Table 8

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	1U-8826	Thrust Bearing	1
	9U-7242	Compressor Plate	1
	9U-7548	Compressor Base	1
	2J-3506	Full Nut	1
	5P-8248	Hard Washer	1
	0L-1143	Bolt	1
B	8S-2263	Spring Tester	1

(1) Part of the 9U-7241 Valve Spring Compressor

Start By:

a. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Place the piston at the top of the compression stroke (TC). Remove the valve springs for that cylinder. If the valves fall into the cylinder liner, then the cylinder head must be removed.

1. Position the piston at the top of the compression stroke (TC) of the cylinder.

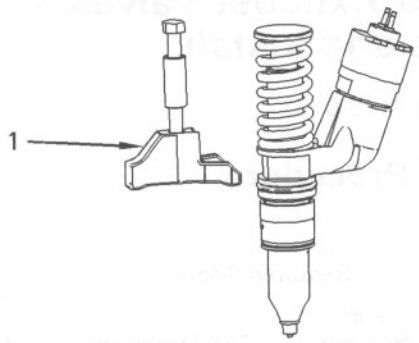

Illustration 39 g01003285

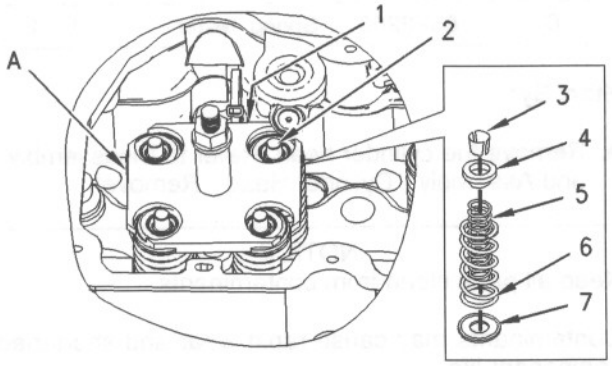

Illustration 40 g01003311

2. Secure Tooling (A) with unit injector clamp (1).

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

3. Tighten full nut until valve spring retainers (3) are loose on valve (2).

4. Remove valve spring retainers (3) from valve (2).

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

5. Carefully remove Tooling (A) from valves (2).

6. Remove valve rotator (4).

7. Remove outer valve spring (6) and inner valve spring (5) from valve (2).

8. Remove washer (7) from the valve guide.

9. Use Tooling (B) to check the valve springs (spring force). Refer to Specifications, "Cylinder Head Valves" for additional information on the valve springs.

10. Repeat Steps 1 through 9 for the remaining valve springs.

Installation Procedure

Table 9

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	1U-8826	Thrust Bearing	1
	9U-7242	Compressor Plate	1
	9U-7548	Compressor Base	1
	2J-3506	Full Nut	1
	5P-8248	Hard Washer	1
	0L-1143	Bolt	1

(1) Part of the 9U-7241 Valve Spring Compressor

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Lubricate the valve stems with clean engine oil.

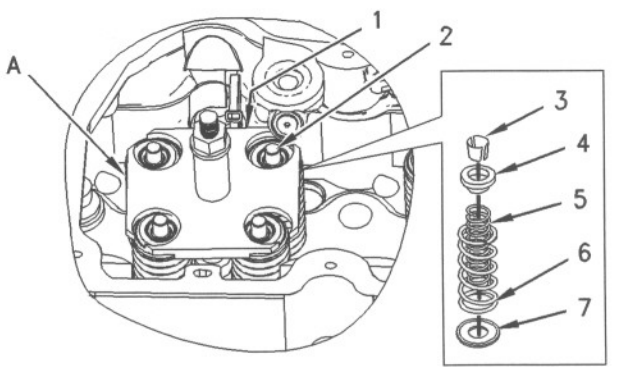

Illustration 41 g01003311

2. Ensure that washer (7) is installed on the valve guide.

3. Install inner valve spring (5) and outer valve spring (6) on valve (2).

4. Install valve rotator (4) on valve (2).

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

5. Secure Tooling (A) with unit injector clamp (1). Use Tooling (A) to compress the valve springs. Install valve spring retainers (3) on each valve (2).

⚠ WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

6. Carefully remove Tooling (A). Strike the top of the valve with a soft faced hammer in order to ensure that valve spring retainers (3) are properly installed.

7. Repeat Steps 3 through 6 for the remaining valve springs.

End By:

a. Install the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".

i02015976

Inlet and Exhaust Valves - Remove and Install

SMCS Code: 1105-010

Removal Procedure

Table 10

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5S-1330	Valve Spring Compressor	1
B	8S-2263	Spring Tester	1

Start By:

a. Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

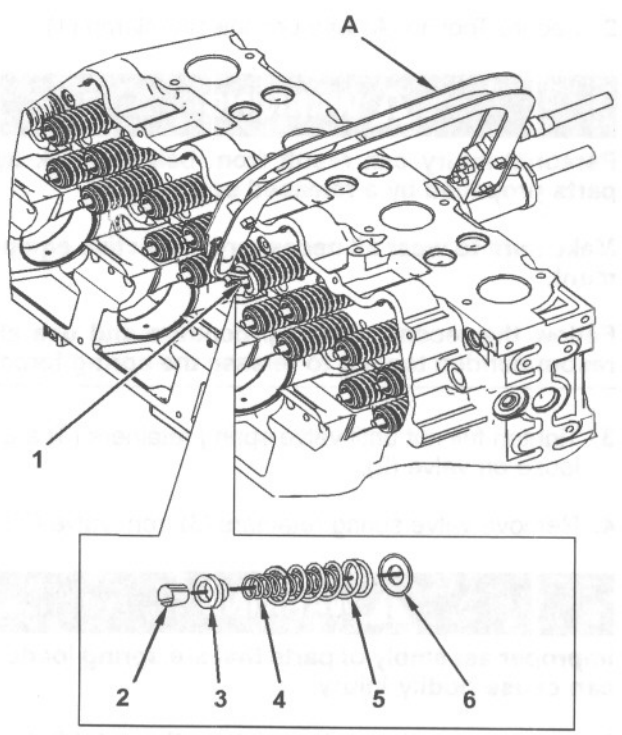

Illustration 42 g01042281

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Install Tooling (A) and compress the valve springs. Remove valve spring retainers (2) from valve (1).
2. Carefully remove Tooling (A) from valve (1).
3. Remove valve rotator (3).
4. Remove outer valve spring (5) and inner valve spring (4) from valve (1).
5. Remove washer (6) and the valve from the valve guide.
6. Use Tooling (B) to check the valve springs (spring force). Refer to Specifications, "Cylinder Head Valves" for additional information on the valve springs.
7. Inspect the valve and the exhaust valves. Refer to Specifications, "Cylinder Head Valves" for additional information on the inlet and exhaust valves.

Installation Procedure

Table 11

Required Tools			
Tool	Part Number	Part Description	Qty
A	5S-1330	Valve Spring Compressor	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Lubricate the inlet valves and the exhaust valves with clean engine oil. Install the inlet valves and the exhaust valves in the cylinder head.

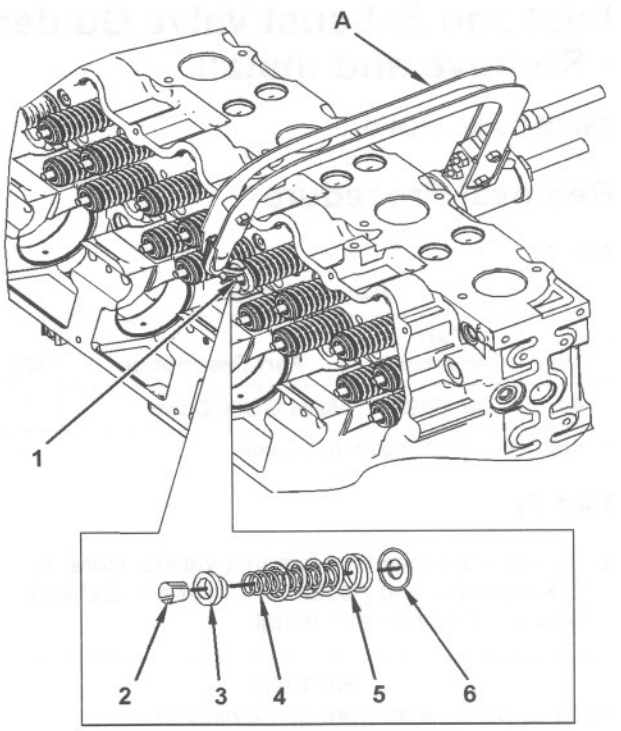

Illustration 43 g01042281

2. Ensure that washer (6) is installed on the valve guide.
3. Install inner valve spring (4) and outer valve spring (5) on valve (1).
4. Install valve rotator (3) on valve (1).
5. Use Tooling (A) to compress inner valve spring (4) and outer valve spring (5). Install valve spring retainers (2) on valve (1).

⚠ WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

6. Carefully remove Tooling (A). Strike the top of the valve with a soft faced hammer in order to ensure that valve spring retainers (2) are properly installed.

End By:

a. Install the cylinder head. Refer to Disassembly and Assembly, " Cylinder Head - Install".

i02015995

Inlet and Exhaust Valve Guides - Remove and Install

SMCS Code: 1104-010

Removal Procedure

Table 12

Required Tools			
Tool	Part Number	Part Description	Qty
A(1)	9U-6895	Valve Guide Driver	1

(1) Part of 9U-7530 Engine Tool Group

Start By:

a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

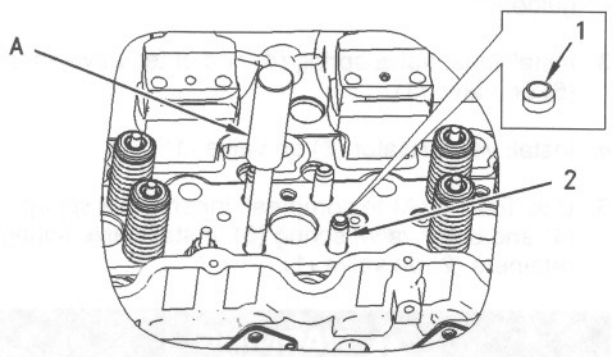

Illustration 44 g01003942

1. Remove valve stem seal (1) from valve guide (2).

2. Use Tooling (A) and a hammer to remove the valve guide from the cylinder head.

Installation Procedure

Table 13

Required Tools			
Tool	Part Number	Part Description	Qty
A(1)	9U-6895	Valve Guide Driver	1
B(1)	9U-6894	Guide Collar	1

(1) Part of 9U-7530 Engine Tool Group

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

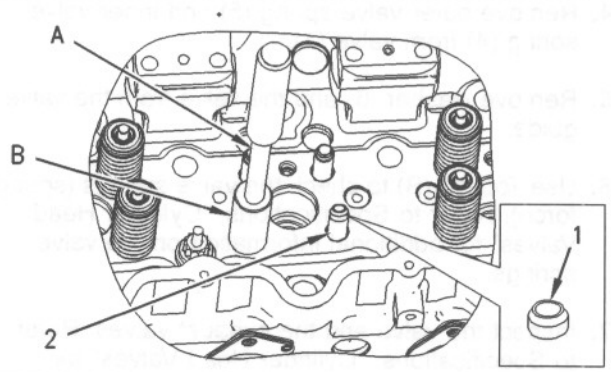

Illustration 45 g01003943

1. Lubricate the bores for the valve guides with clean engine oil.

2. Install valve guide (2) in the cylinder head with Tooling (A) and Tooling (B), as shown.

Note: Tooling (B) must be used in order to install the valve guide to the correct height.

Height to top of valve guide from cylinder head surface ..... 35.00 ± 0.50 mm (1.378 ± 0.020 inch)

Note: For more information, refer to Specifications, "Cylinder Head Valves".

3. Install valve stem seal (1) on the valve guide.

End By:

a. Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

i02016026

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS Code: 1103-010

Removal Procedure

Table 14

Required Tools			
Tool	Part Number	Part Description	Qty
A	166-7441	Valve Seat Extractor Tool Group	1

Start By:

a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

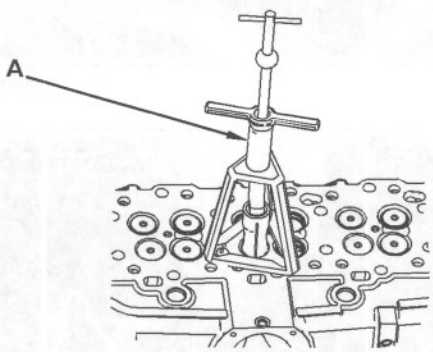

Illustration 46 g01042314

1. Use Tooling (A) to remove the valve seat inserts from the cylinder head.

2. Clean the bores in the cylinder head for the valve seat inserts. Remove any rough areas from the bores.

Installation Procedure

Table 15

Required Tools			
Tool	Part Number	Part Description	Qty
B(1)	9U-6898	Valve Seat Driver (Exhaust)	1
	9U-6897	Valve Seat Driver (Inlet)	1

(1) Part of 9U-7530 Engine Tool Group

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

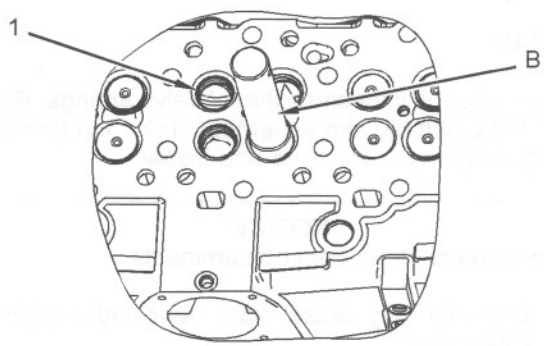

Illustration 47 g01042315

1. Lower the temperature of new valve seat inserts (1).

2. Use Tooling (B) to install the new valve seat inserts in the cylinder head.

Note: Do not machine the prefinished valve seat inserts in order to correct the valve projection. Excessive valve projection indicates that the valve seat insert is not seated or material was not cleaned from the bottom of the counterbore.

End By:

a. Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

i02110458

Inlet and Exhaust Valve Seals - Remove and Install

SMCS Code: 1104-010-SA

Removal Procedure

Table 16

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-7414	Seal Pick	1
B(1)	9U-6890	Seal Installer	1
C(1)	9U-7216	Valve Seal Pin	1

(1) Part of the 9U-7226 Seal Installer

Start By:

a. Remove the inlet and exhaust valve springs. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Springs - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The valve seals can be replaced with the cylinder head on the engine or off the engine. The valves do not need to be installed in the cylinder head in order to install the valve seals.

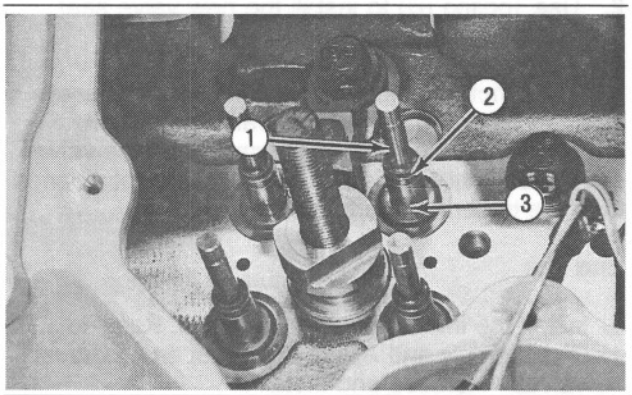

Illustration 48 g00516322

1. Use Tooling (A) to remove valve seals (2) from valves (1) and valve guides (3).

Installation Procedure

Table 17

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-7414	Seal Pick	1
B(1)	9U-6890	Seal Installer	1
C(1)	9U-7216	Valve Seal Pin	1

(1) Part of the 9U-7226 Seal Installer

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

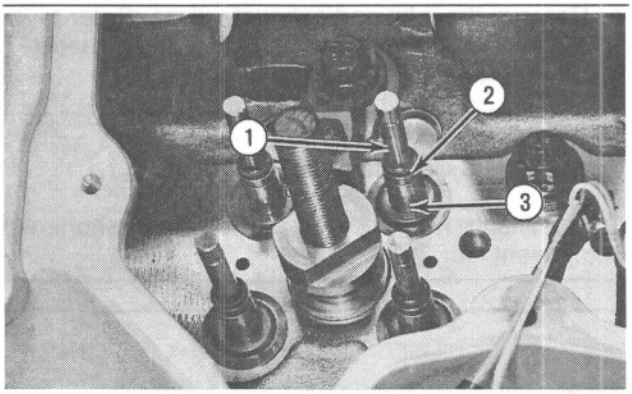

Illustration 49 g00516322

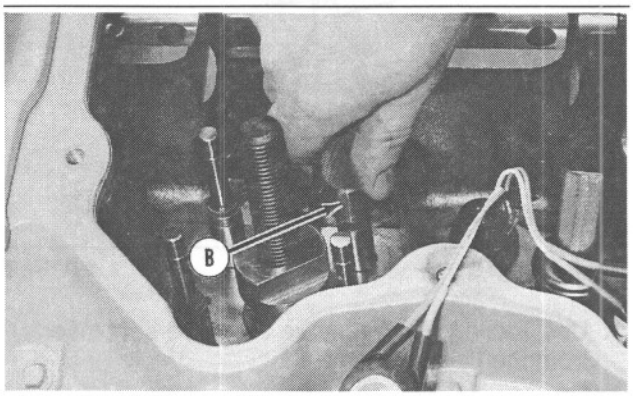

Illustration 50 g00516323

Note: Follow Steps 1 and 2 in order to install the valve seals with the valves in the cylinder head.

1. Apply a thin coat of clean engine oil on the valve stems. Position valve seals (2) on valves (1).

2. Use Tooling (B) to press valve seals (2) onto valve guides (3).

Note: Follow Steps 3 through 7 in order to install the valve seals when the valves are removed from the cylinder head. Use Tooling (C) instead of the valve stem to correctly position the new valve seal.

3. Position valve seal (2) on Tooling (B).
4. Insert Tooling (C) through Tooling (B) and the new valve seal.
5. Position Tooling (C) in the valve guide bore.
6. Use Tooling (B) to push valve seal (2) in position on valve guide (3).
7. Remove Tooling (B) and Tooling (C) from valve guide (3).
8. Repeat Steps 3 through 7 in order to install the remaining valve seals.

End By:

a. Install the inlet and exhaust valve springs. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Spring - Remove and Install".

i01973975

Engine Oil Filter Base - Remove

SMCS Code: 1306-011

Removal Procedure

Table 18

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench Assembly	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

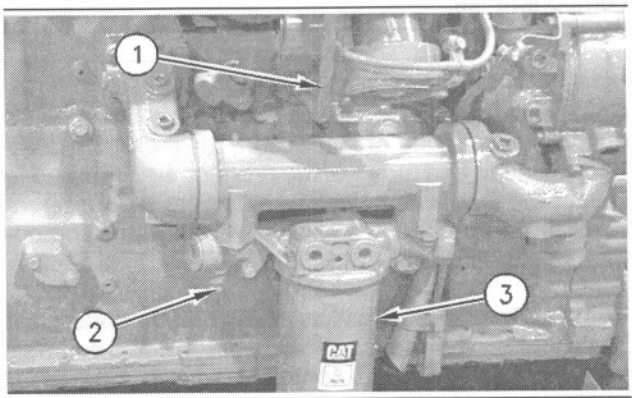

Illustration 51 g00594540

1. Remove plug (2) and drain the oil from the engine oil filter base into a suitable container for storage or disposal.
2. Use Tooling (A) to remove oil filter (3).
3. Disconnect oil tube assembly for the turbocharger (1).

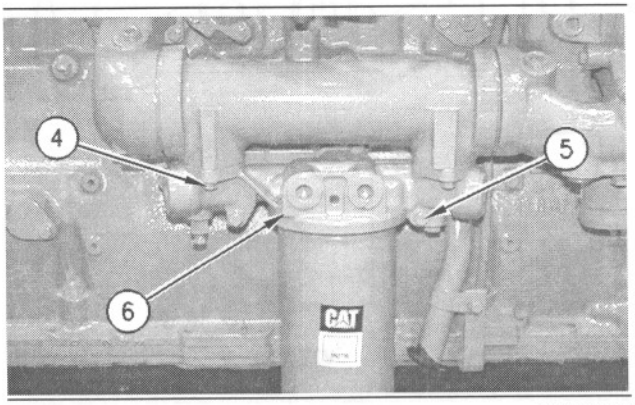

Illustration 52 g00594549

4. Remove nuts (4) and the bolts that hold the engine oil filter base to the engine oil cooler and bolts (5) that hold the engine oil filter base to the cylinder block.

5. Remove engine oil filter base (6).

i01924925

Engine Oil Filter Base - Disassemble

SMCS Code: 1306-015

Disassembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

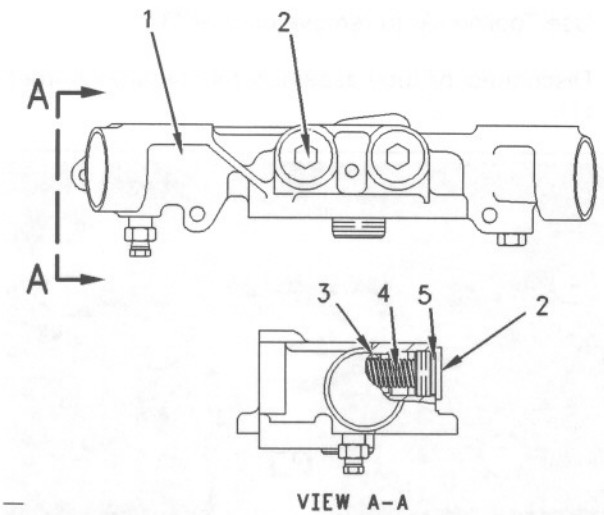

Illustration 53 g01001860

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Remove plugs (2) that hold the valves in engine oil filter base (1).
2. Remove spring (4).
3. Remove plunger (3).

i01989932

Engine Oil Filter Base - Assemble

SMCS Code: 1306-016

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

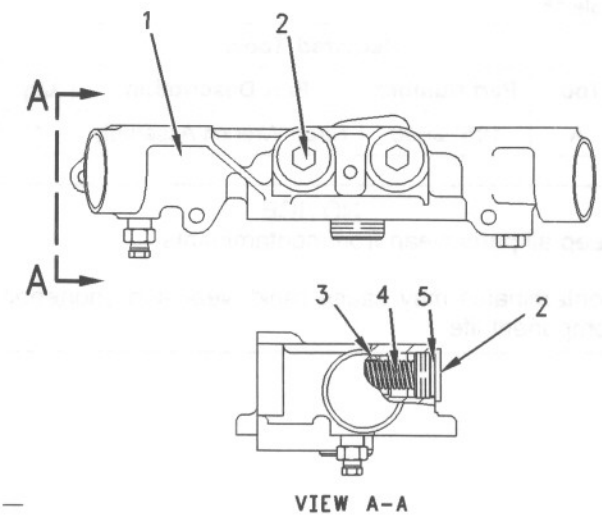

Illustration 54 g01001860

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

1. Install plunger (3).
2. Install spring (4).
3. Install plugs (2) that hold the valves in engine oil filter base (1). Tighten plugs (2) to a torque of 100 ± 15 N·m (74 ± 11 lb ft).

i01973979

Engine Oil Filter Base - Install

SMCS Code: 1306-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Before assembly, check the condition of the O-ring seals. If the O-ring seals are worn or damaged, use new parts for replacement.

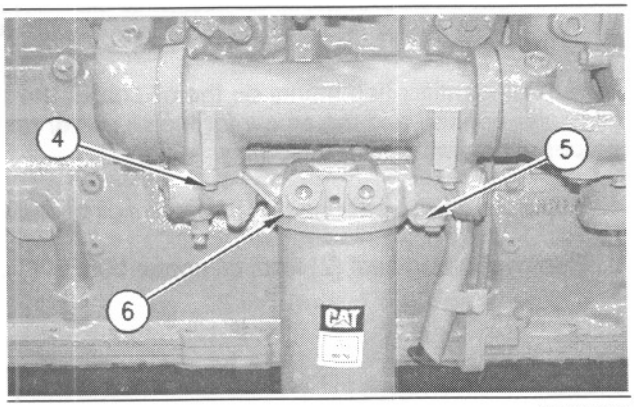

Illustration 55 g00594549

1. Ensure that the O-ring seals are in position on the engine oil filter base. Put engine oil filter base (6) in position on the engine oil cooler and the cylinder block.
2. Install bolts (5) that hold the engine oil filter base to the cylinder block.
3. Install the bolts and nuts (4) that hold the engine oil filter base to the engine oil cooler.

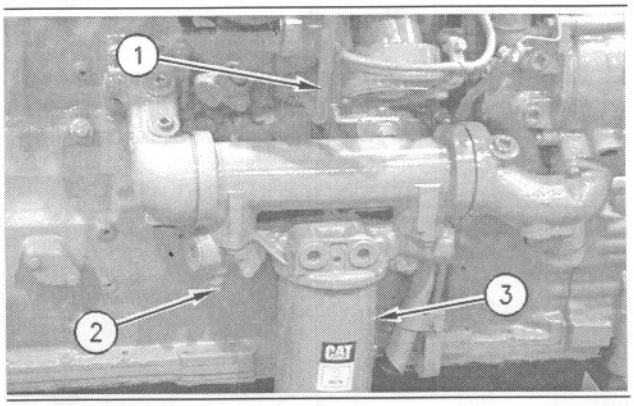

Illustration 56 g00594540

4. Connect oil tube assembly for the turbocharger (1).
5. Install plug (2).
6. Install oil filter (3). Follow directions on the oil filter.
7. Fill the engine crankcase with oil. Refer to Operation and Maintenance Manual, "Refill Capacities" in the Maintenance Section.

i01973982

Engine Oil Cooler - Remove

SMCS Code: 1378-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the oil from the engine oil filter base into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".

2. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

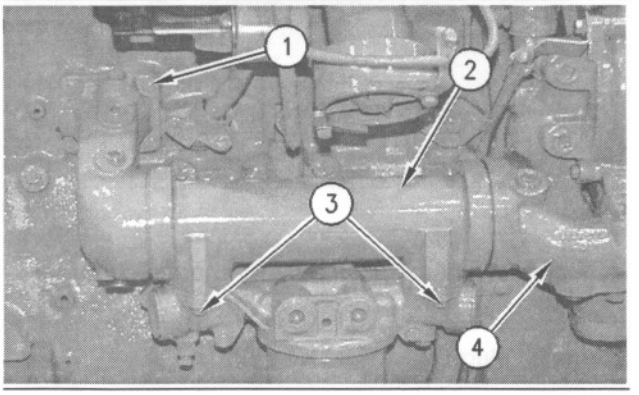

Illustration 57 g00593892

3. Remove the bolts that hold oil cooler bonnet (4) of the engine oil cooler to the water pump.

4. Remove bolts (3) that hold the engine oil cooler to the engine oil filter base.

5. Remove bolts (1) that hold the engine oil cooler to the cylinder block. Remove engine oil cooler (2).

i01973990

Engine Oil Cooler - Disassemble

SMCS Code: 1378-015

Disassembly Procedure

Table 19

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A		Rod 457 X 3.81 mm (18 X 0.150 inch)	1

Start By:

a. Remove the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

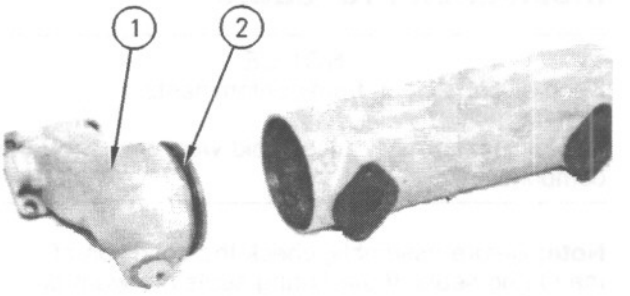

Illustration 58 g00594166

Note: Put identification marks on the oil cooler, the oil cooler bonnet, and the elbow for the oil cooler for proper alignment during assembly.

1. Separate oil cooler bonnet (1) from the oil cooler.

2. Remove O-ring seal (2) from oil cooler bonnet (1).

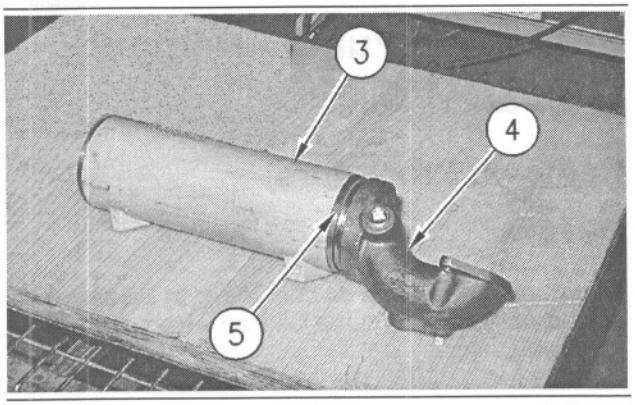

Illustration 59 g00594036

3. Separate oil cooler bonnet (4) from oil cooler (3).
4. Remove O-ring seals (5) from oil cooler bonnet (4) for the oil cooler.

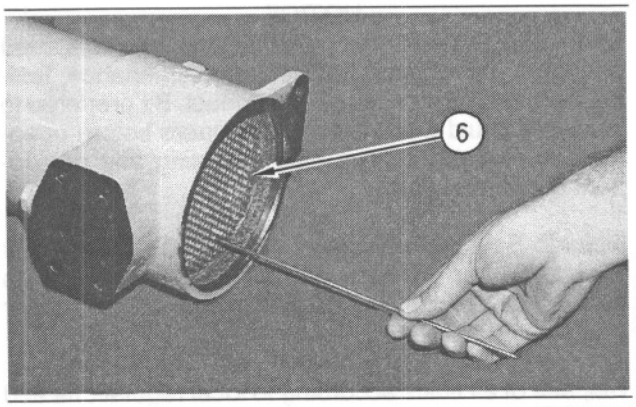

Illustration 60 g00594125

5. Clean tubes (6) for the oil cooler core with Tooling (A).

i01973999

Engine Oil Cooler - Assemble

SMCS Code: 1378-016

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Before assembly, check the condition of the gaskets and the O-ring seals. If the gaskets or the O-ring seals are worn or damaged, use new parts for replacement.

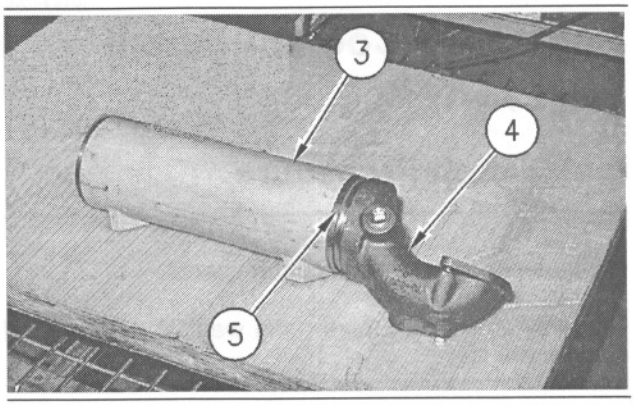

Illustration 61 g00594036

1. Lubricate the bore of oil cooler (3) with glycerin.
2. Install O-ring seals (5) on oil cooler bonnet (4) of the oil cooler. Put clean engine oil on the O-ring seals. Lubricate the bore of oil cooler (3) with glycerin. Install oil cooler bonnet (4) into the oil cooler.

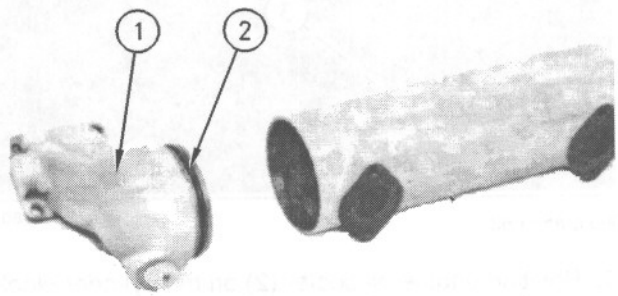

Illustration 62 g00594166

3. Put O-ring seal (2) in position on oil cooler bonnet (1). Align oil cooler bonnet (1) with oil cooler (3). Put clean engine oil on the O-ring seal.

End By:

a. Install the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Install".

i01974003

Engine Oil Cooler - Install

SMCS Code: 1378-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Check the condition of the gaskets. If the gaskets are worn or damaged, use new parts for replacement.

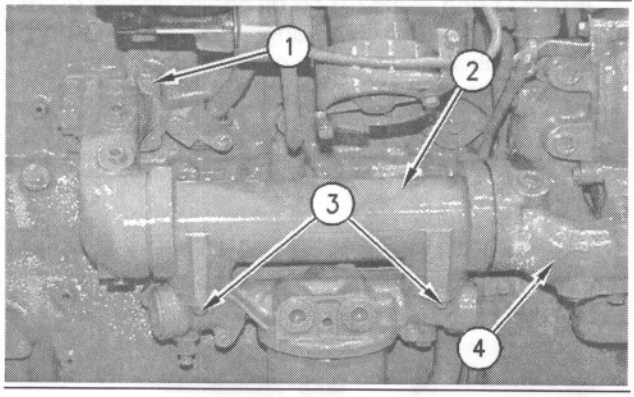

Illustration 63 g00593892

1. Position engine oil cooler (2) on the cylinder block and install bolts (1).
2. Install bolts (3) that hold the engine oil cooler to the oil filter base.
3. Install the bolts that hold oil cooler bonnet (4) to the water pump.
4. Fill the cooling system with coolant. Fill the engine with oil. Refer to Operation and Maintenance Manual, "Refill Capacities".

i02009149

Engine Oil Pump - Remove

SMCS Code: 1304-011

Removal Procedure

Start By:

a. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

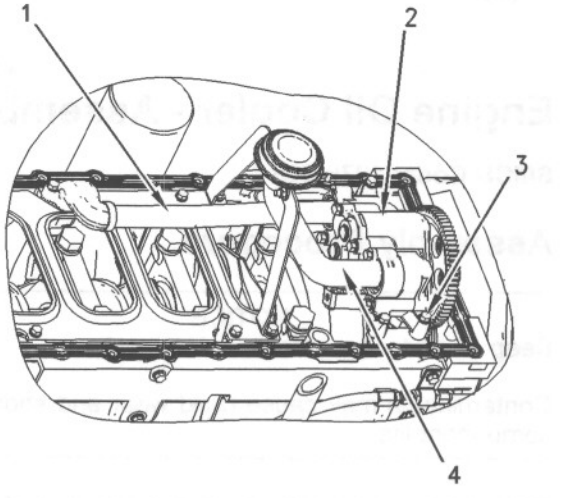

Illustration 64 g01001911

1. Remove oil supply tube assembly (1). Remove suction bell and tube assembly (4).

2. Remove bolts (3) and remove engine oil pump (2) from the cylinder block.

i02110543

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Table 20

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2321	Combination Puller	1
B	1P-0510	Driver Group	1

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

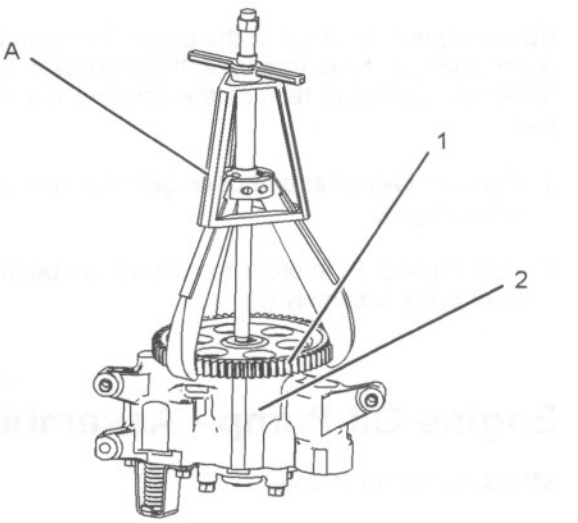

Illustration 65 g01001918

1. Remove the bolt that holds drive gear (1) to the shaft of body assembly (2).

2. Use Tooling (A) in order to remove drive gear (1) from the shaft. Remove the key from the shaft.

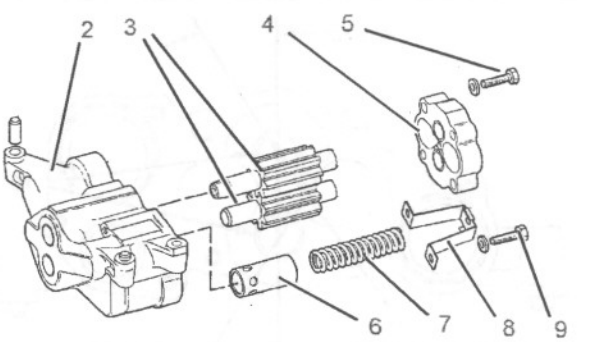

Illustration 66 g01001929

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

3. Remove bolts (9) that hold retainer (8) to body assembly (2).

4. Remove retainer (8), spring (7), and bypass valve (6) from the body assembly.

5. Remove bolts (5) and cover (4) from body assembly (2).

Note: Inspect the bores in the cover. The aluminum cover does not have bearings. If the bores in the cover are damaged, replace the cover with a new part.

6. Remove idler gear and drive gear (3) from body assembly (2).

7. Use Tooling (B) in order to remove the bearings from body assembly (2).

i02110558

Engine Oil Pump - Assemble

SMCS Code: 1304-016

Assembly Procedure

Table 21

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	1P-0510	Driver Group	1

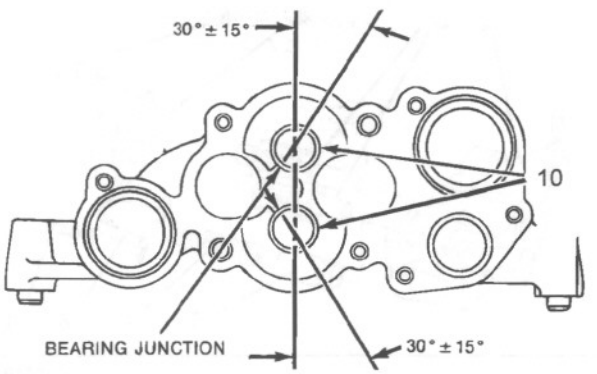

Illustration 67 g01017356

1. Install bearings (10) in the body assembly with Tooling (B). The bearing joint should be 30 ± 15 degrees from the center line of the two bearing bores. Install the bearings so the bearings are even with the outside of the body assembly.

2. Before final assembly, check the condition and specifications of all of the parts of the engine oil pump. Refer to Specification, "Engine Oil Pump".

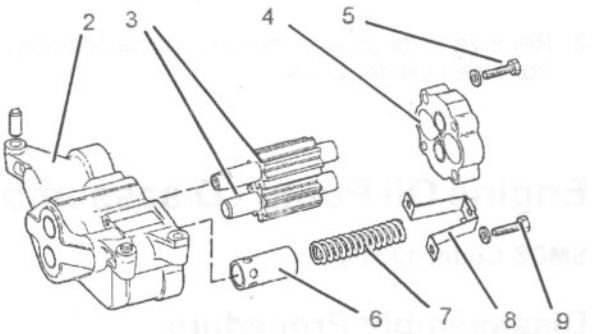

Illustration 68 g01001929

⚠ WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

3. Lubricate the bearings and idler gear and drive gear (3) with clean engine oil. Install the idler gear and drive gear in body assembly (2).

4. Install cover (4). Install bolts (5) in order to secure the cover to body assembly (2).

Note: The engine oil pump must turn freely after assembly. Turn the engine oil pump by hand. Reposition cover (4) if the pump does not turn freely.

5. Install bypass valve (6), spring (7), retainer (8), and bolts (9).

6. Install the key on the shaft.

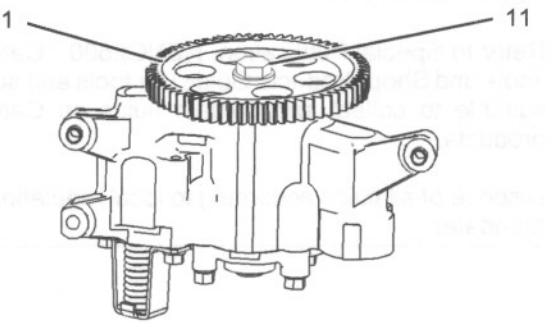

Illustration 69 g01017258

7. Install drive gear (1). Install bolt (11). Tighten the bolt to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i01984303

Engine Oil Pump - Install

SMCS Code: 1304-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

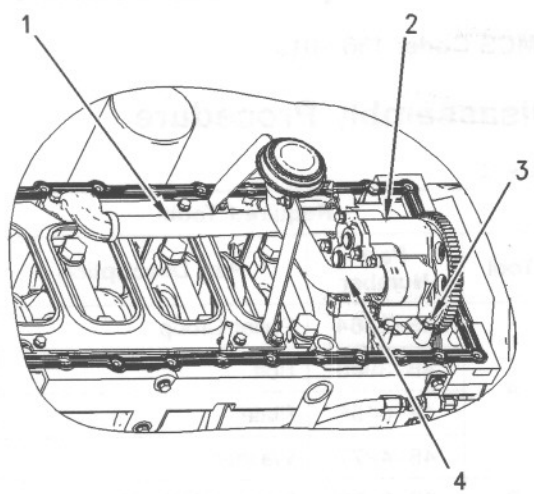

Illustration 70 g01001911

Note: Ensure that engine oil pump (2) is seated on the dowels before bolts (3) are tightened.

1. Position engine oil pump (2) on the dowels in the cylinder block. Install bolts (3).
2. Install oil supply tube assembly (1). Install suction bell and tube assembly (4).

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

i01989816

Water Pump - Remove

SMCS Code: 1361-011

Removal Procedure

Start By:

a. Remove the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Intermittent leakage of a small amount of coolant from the weep hole is not an indication of water pump seal failure. Seepage is normal to ensure proper lubrication of the face of the water pump seal. Replace the water pump if excessive leakage is observed from the weep hole in the water pump housing.

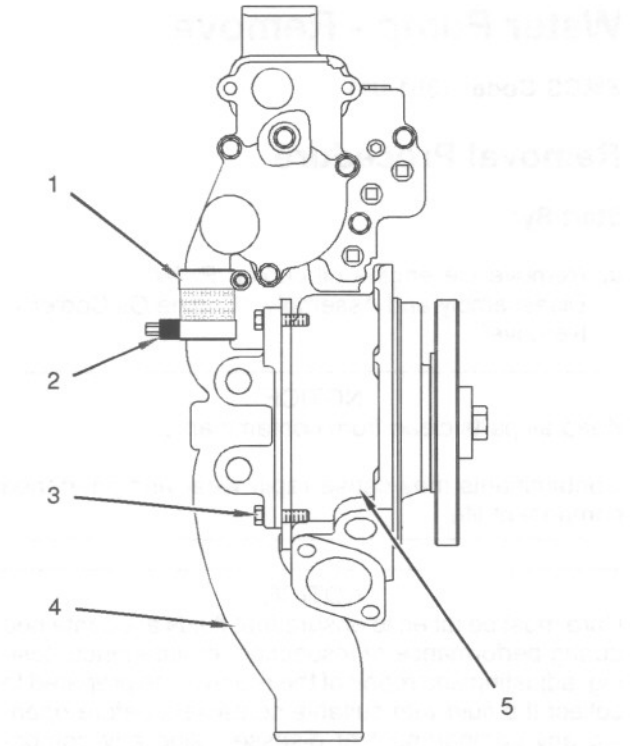

Illustration 71 g01030503

1. Identify the orientation of the bolts for the hose clamps for installation purposes. Loosen hose clamps (1) and (2). Slide the hose from cover (4).

2. Remove bolts (3) and cover (4).

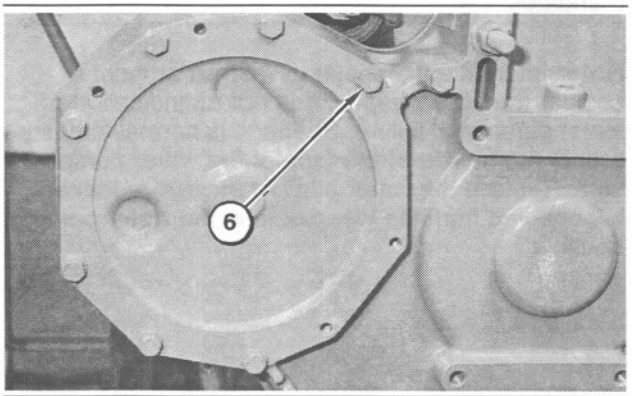

Illustration 72 g01030504

3. Remove bolts (6) from the front housing. Remove water pump (5).

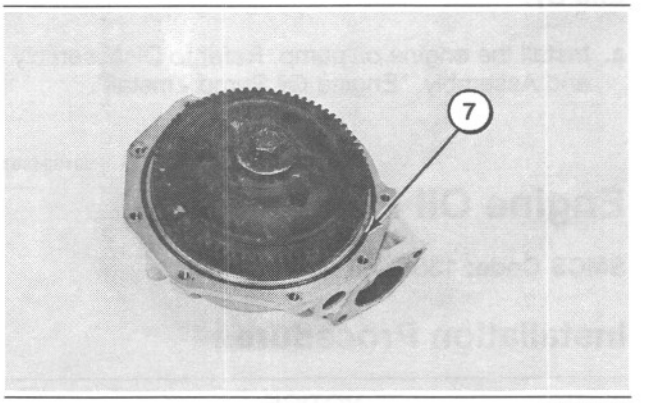

Illustration 73 g01030505

4. Remove O-ring seal (7) from the water pump.

i02006613

Water Pump - Disassemble

SMCS Code: 1361-015

Disassembly Procedure

Table 22

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2264	Puller Group	1
	4B-3903	Bolt	2
	1P-0456	Plate	1
	4B-4277	Washer	2
B	9S-9152	Bearing Puller Gp	1

Start By:

a. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The water pump seal can be replaced without removing the water pump from the engine.

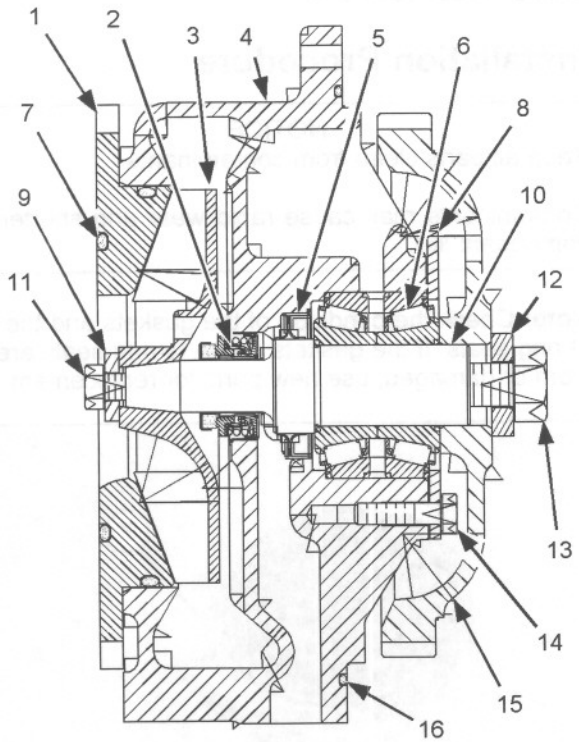

Illustration 74 g01009122

1. Remove O-ring seal (7) from adapter (1). Remove adapter (1) from housing (4). Remove the O-ring seal from the outside of adapter (1).
2. Remove bolt (11) and washer (9). Use Tooling (A) to remove impeller (3) from shaft (10).
3. Remove bolt (13) and washer (12) from shaft (10). Remove gear (15) from shaft (10).
4. Remove bolts (14) from bearing retainer (8). Remove bearing retainer (8). Remove bearing cone (6) and shaft (10) from housing (4) by inverting the pump assembly.
5. Invert the pump and drive or press seal (2) and oil seal (5) out of the housing.
6. Use a press and Tooling (B) to remove bearing assembly (6) from shaft (10).
7. Remove O-ring seal (16) from housing (4).

i01993259

Water Pump - Assemble

SMCS Code: 1361-016

Assembly Procedure

Table 23

Required Tools			
Tool	Part Number	Part Description	Qty
C	1P-0510	Driver Group	1
D	138-9299	Oil Seal Tool	1
E	139-0088	Seal Tool	1
F	4C-9500	Quick Cure Primer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

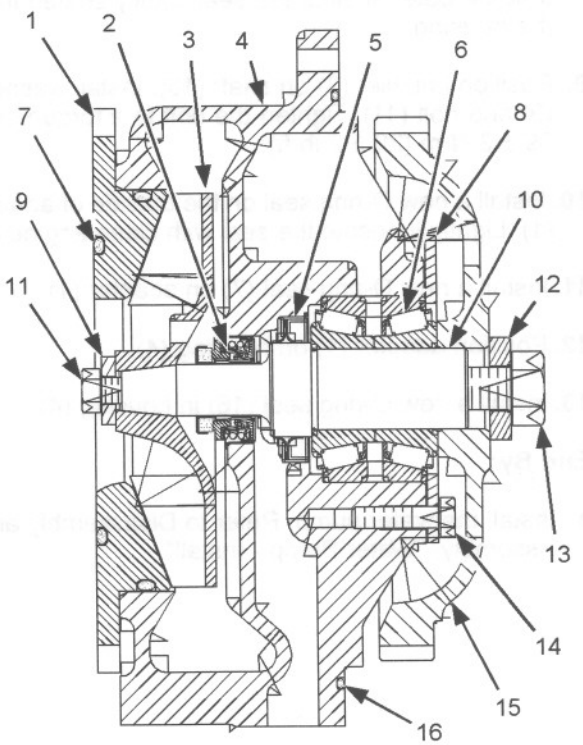

Illustration 75 g01009122

1. Use Tooling (F) to clean shaft (10) and the counterbore for oil seal (5) in housing (4).

2. Use Tooling (C) to install a new oil seal (5) in housing (4). Install the seal with the part number on the metal face of the seal toward the housing. Ensure that the oil seal is flush with the front edge of the counterbore of the housing. Do not lubricate the oil seal.

3. Install bearing cone (6) on shaft (10).

4. Position bearing retainer (8) with "this side out" markings toward the gear end of shaft (10). Install gear (15). Install washer (12) and bolt (13) on shaft (10). Tighten bolt (13) to a torque of 215 ± 40 N·m (159 ± 30 lb ft).

5. Slide Tooling (D) over shaft (10). The tapered edge will be facing outward.

6. Install the gear and shaft assembly into housing (4). Use care not to damage the oil seal. Install bolts (14) that hold bearing retainer (8) to the housing.

7. Remove Tooling (D) from shaft (10).

8. Use a press and Tooling (E) to install a new seal (2) over shaft (10) and into housing (4). Ensure that the outer shell of the seal is fully seated in the housing.

9. Position impeller (3) on shaft (10). Install washer (9) and bolt (11). Tighten the bolt to a torque of 39 ± 3 N·m (29 ± 2 lb ft).

10. Install a new O-ring seal on the outside of adapter (1). Lightly lubricate the seal with clean engine oil.

11. Install a new O-ring seal (7) on adapter (1).

12. Position adapter (1) on housing (4).

13. Install a new O-ring seal (16) in housing (4).

End By:

a. Install the water pump. Refer to Disassembly and Assembly, "Water Pump - Install".

i01989874

Water Pump - Install

SMCS Code: 1361-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Check the condition of the gaskets and the O-ring seals. If the gaskets or the O-ring seals are worn or damaged, use new parts for replacement.

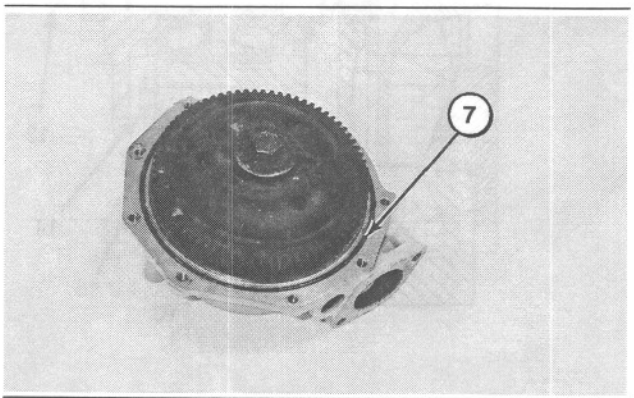

Illustration 76 g01030505

1. Install O-ring seal (7) on the water pump.

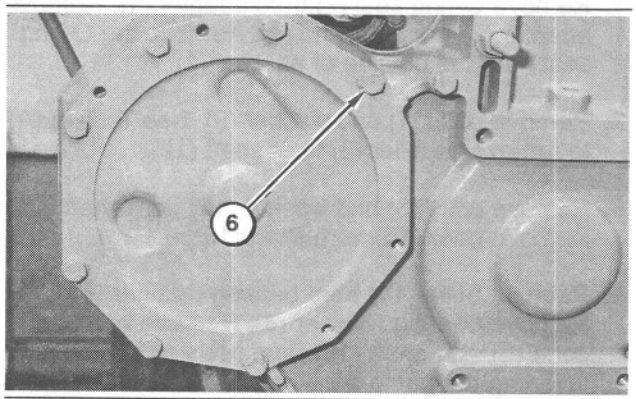

Illustration 77 g01030504

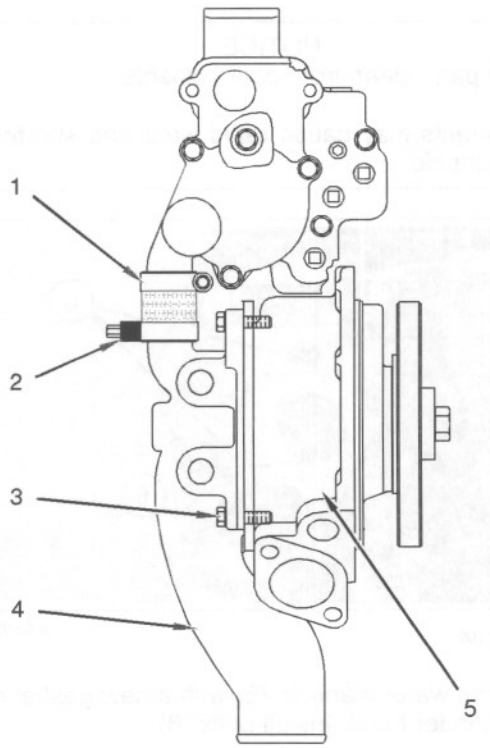

Illustration 78 g01030503

2. Put water pump (5) in position and install bolts (6).
3. Install cover (4) and bolts (3).
4. Slide the hose in position on cover (4). Install hose clamps (1) and (2).

End By:

a. Install the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Install".

i01989913

Water Temperature Regulator - Remove and Install

SMCS Code: 1355-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant from the engine into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".
2. Disconnect the upper radiator hose from the water manifold.

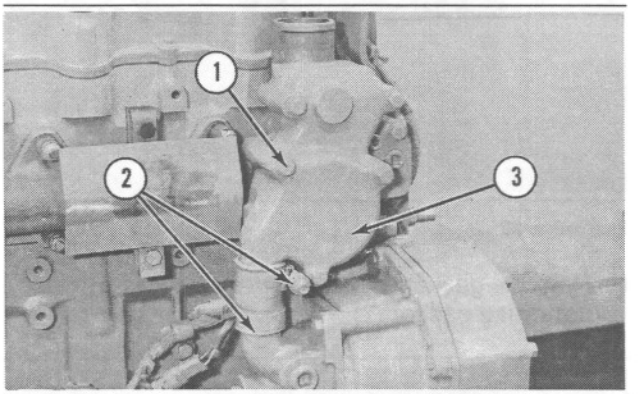

Illustration 79 g00559394

3. Loosen hose clamps (2). Remove bolts (1). Remove regulator housing (3).

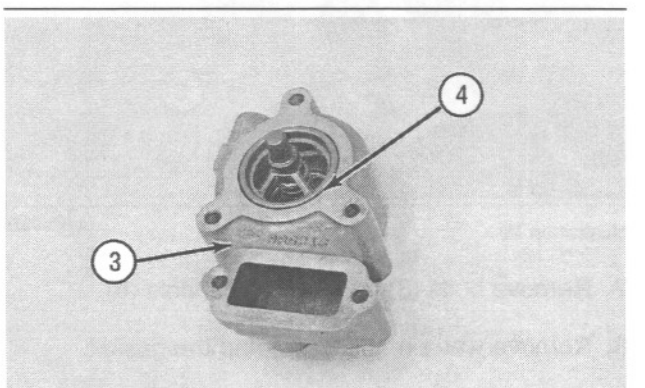

Illustration 80 g00559396

4. Remove water temperature regulator (4) from regulator housing (3).

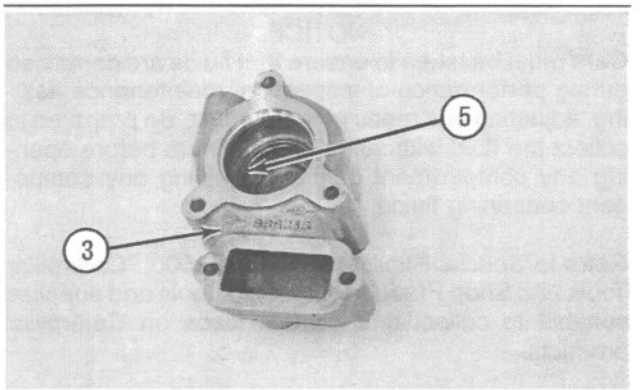

Illustration 81 g00559403

5. Remove lip seal (5) from regulator housing (3).

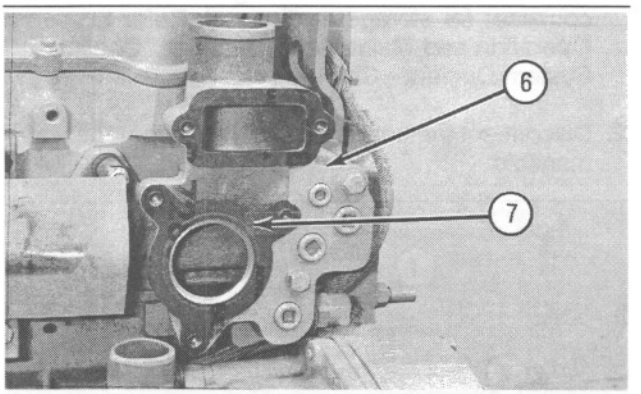

Illustration 82 g00593365

6. Remove gasket (7) from water manifold (6). Do not reuse gasket (7).

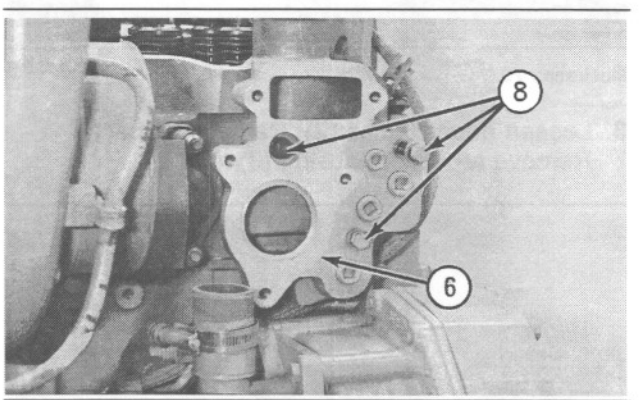

Illustration 83 g00593375

7. Remove bolts (8) from water manifold (6).

8. Remove water manifold (6) and the gasket.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

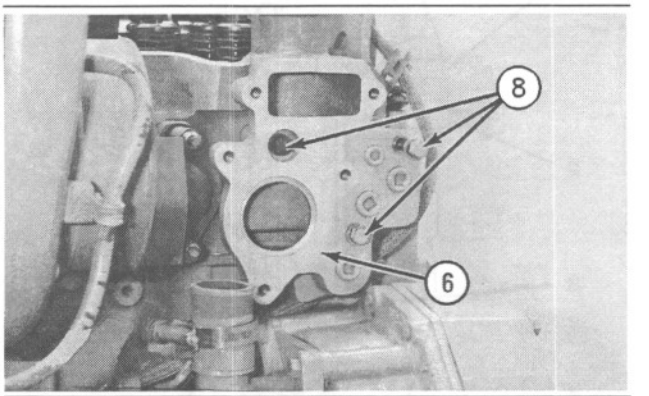

Illustration 84 g00593375

1. Position water manifold (6) with a new gasket on the cylinder head. Install bolts (8).

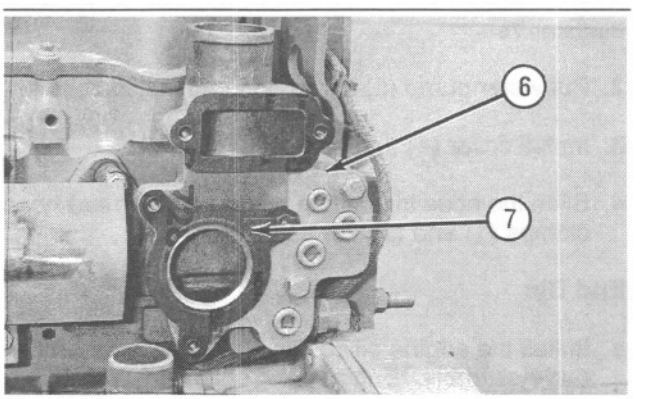

Illustration 85 g00593365

2. Position a new gasket (7) on water manifold (6).

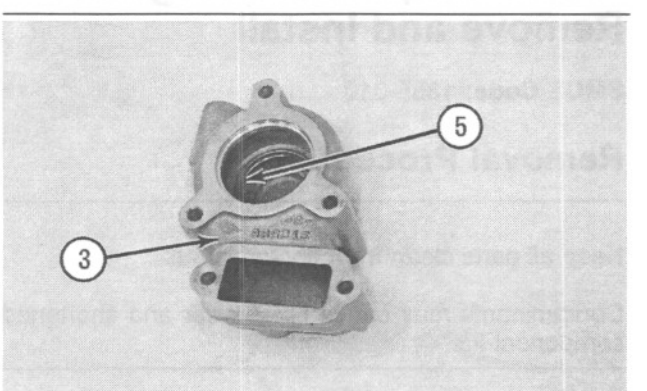

Illustration 86 g00559403

3. Install lip seal (5) in regulator housing (3). Ensure that lip seal (5) is fully seated in the counterbore of regulator housing (3).

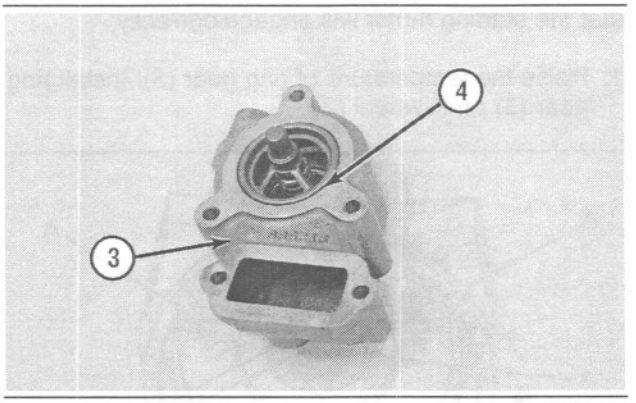

Illustration 87 g00559396

4. Install water temperature regulator (4) in regulator housing (3).

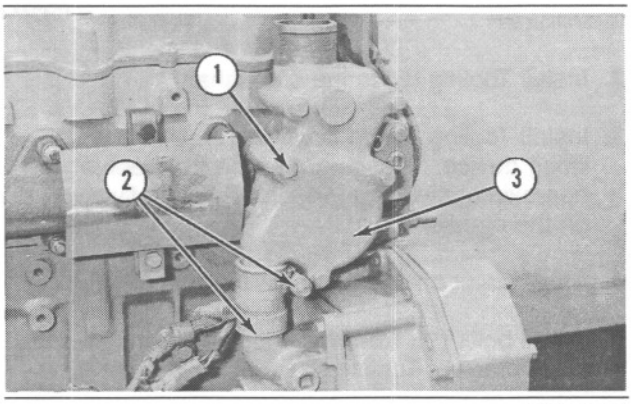

Illustration 88 g00559394

5. Position regulator housing (3) with a new gasket on the water manifold. Install bolts (1). Tighten bolts (1) to a torque of 50 ± 9 N·m (37 ± 7 lb ft).

6. Position hose clamps (2) and tighten the clamps to a torque of 9 ± 3 N·m (80 ± 27 lb in).

Note: Refer to Specifications, "Water Lines" for more information on the position of hose clamps (3).

7. Connect the upper radiator hose to the water manifold.

8. Fill the cooling system to the correct coolant level. Refer to Operation and Maintenance Manual, "Refill Capacities" in the Maintenance Section for more information.

i02110602

Flywheel - Remove

SMCS Code: 1156-011

Removal Procedure

Table 24

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Lifting Bracket	2
B	FT2712	Guide Stud	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

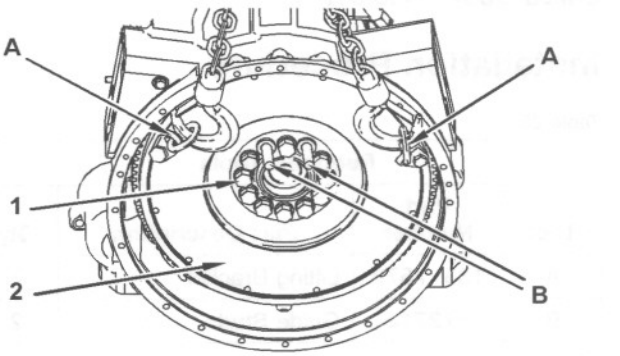

Illustration 89 g01042414

1. Install Tooling (A) on the flywheel. Use a suitable lifting device. The weight of the flywheel is approximately 65 kg (143 lb).

2. Remove two bolts (1). Install Tooling (B).

3. Remove remaining bolts (1) that hold the flywheel to the crankshaft . Remove flywheel (2).

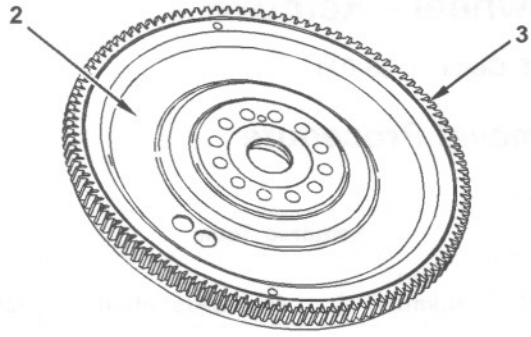

Illustration 90 g01042415

4. If necessary, use a hammer and a punch in order to remove ring gear (3) from flywheel (2).

i02016230

Flywheel - Install

SMCS Code: 1156-012

Installation Procedure

Table 25

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Lifting Bracket	2
B	FT2712	Guide Stud	2

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

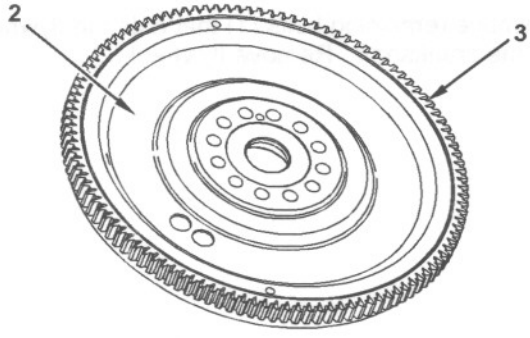

Illustration 91 g01042415

Note: Ring gear (3) must be installed with the chamfered side of the teeth upward. The chamfered side of the gear teeth will be facing toward the starting motor when the flywheel is installed. This will ensure that the starting motor will engage correctly.

1. Raise the temperature of ring gear (3). Install ring gear (3) on flywheel (2).

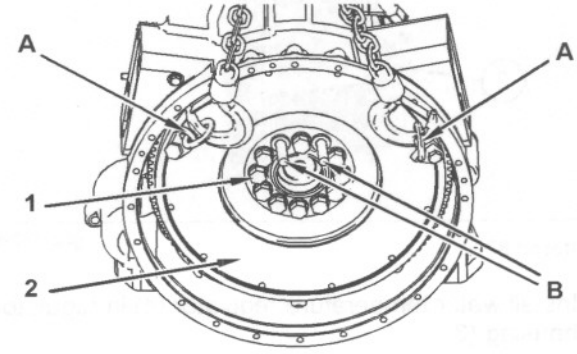

Illustration 92 g01042414

2. Install Tooling (B) in the crankshaft.
3. Install Tooling (A) on flywheel (2). Use a suitable lifting device. The weight of the flywheel is approximately 65 kg (143 lb). Position flywheel (2) on the crankshaft.
4. Apply clean engine oil to the threads of bolts (1).
5. Install bolts (1). Remove Tooling (B). Install bolts (1) in place of Tooling (B).
6. Tighten bolts (1) to a torque of 270 ± 40 N·m (200 ± 30 lb ft).
7. Remove Tooling (A) from the flywheel.
8. Check the flywheel runout. Refer to Testing and Adjusting, “Flywheel - Inspect”.

i02016240

Crankshaft Rear Seal - Remove

SMCS Code: 1161-011

Removal Procedure

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7600	Slide Hammer Puller	1

Start By:

a. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The rear seal and the wear sleeve must be replaced at the same time. Once the crankshaft rear seal and the wear sleeve are separated, these components can not be used again.

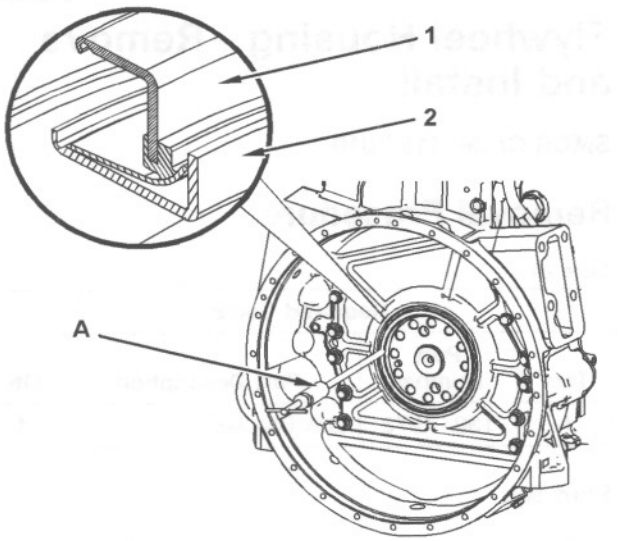

Illustration 93 g01042446

1. Use Tooling (A) to remove wear sleeve (2).

2. Use Tooling (A) to remove crankshaft rear seal (1).

i02113020

Crankshaft Rear Seal - Install

SMCS Code: 1161-012

Installation Procedure

Table 27

Required Tools			
Tool	Part Number	Part Description	Qty
B	5P-7301	Seal Locator	1
C	5P-7309	Bolts	2
D	8T-2683	Rear Seal Installer	1
E	9S-8858	Nut (Seal Installer)	1
F	4C-9500	Quick Cure Primer	1
G	4C-9507	Retaining Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The rear seal and the wear sleeve must be replaced at the same time. Once the seal and the wear sleeve are separated, these components cannot be used again. Refer to Special Instruction, SMHS8508, "Special Handling Information and Installation Instructions for Crankshaft Seal Groups that Have Hydrodynamic Grooves In the Sealing Lip" before the seal is serviced.

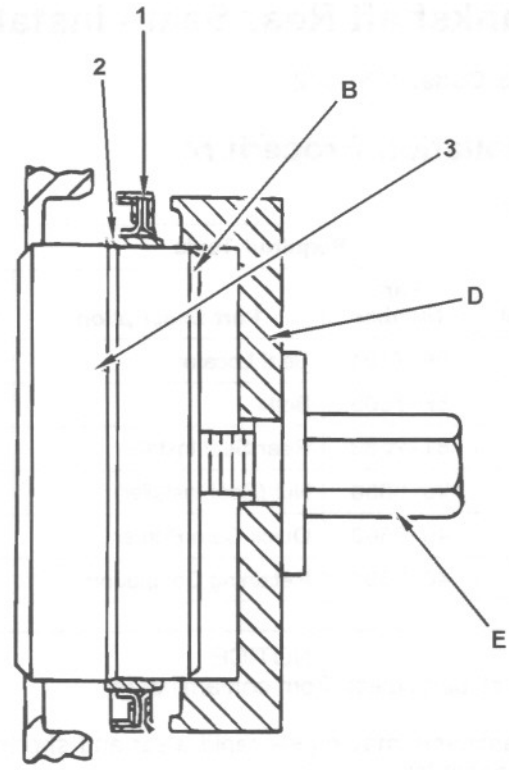

Illustration 94 g01076371

Note: Do not use any type of lubricant during the installation of the crankshaft rear seal and wear sleeve.

1. Before installation of the crankshaft rear seal and the wear sleeve, inspect the crankshaft for scratches. Also, inspect the crankshaft for any distortion on the surface that may lead to an out of round condition. Use a polishing cloth in order to remove any imperfections on the crankshaft.

2. Use Tooling (F) to clean the outside diameter of crankshaft (3) and the inside diameter of wear sleeve (2).

3. Apply Tooling (G) to the outside diameter of crankshaft (3). Apply Tooling (G) to the inside diameter of wear sleeve (2).

4. Fasten Tooling (B) to crankshaft (3) with Tooling (C).

NOTICE
The front and rear seals and wear sleeves have different spiral grooves in the seal. Because of this type of design, the front seal group for an engine is different from the rear seal group. If a seal group is installed on the wrong end of the engine, oil can actually be taken out of the engine instead of moving oil back into the engine.

Note: Install the crankshaft rear seal with the arrow that shows the direction of crankshaft rotation toward the rear of the engine.

5. Position wear sleeve (2) and crankshaft rear seal (1) on Tooling (B). Install Tooling (D) on Tooling (B). Lubricate the face of the washer on Tooling (E). Install Tooling (E) on Tooling (B).

6. Tighten Tooling (E) until Tooling (D) contacts Tooling (B).

7. Remove Tooling (B), Tooling (C), Tooling (D), and Tooling (E). Check the crankshaft rear seal and the wear sleeve for the correct installation.

End By:

a. Install the flywheel. Refer to Disassembly and Assembly, "Flywheel - Install".

i01974146

Flywheel Housing - Remove and Install

SMCS Code: 1157-010

Removal Procedure

Table 28

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	1

Start By:

a. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove".

b. Remove the electric starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove".

c. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

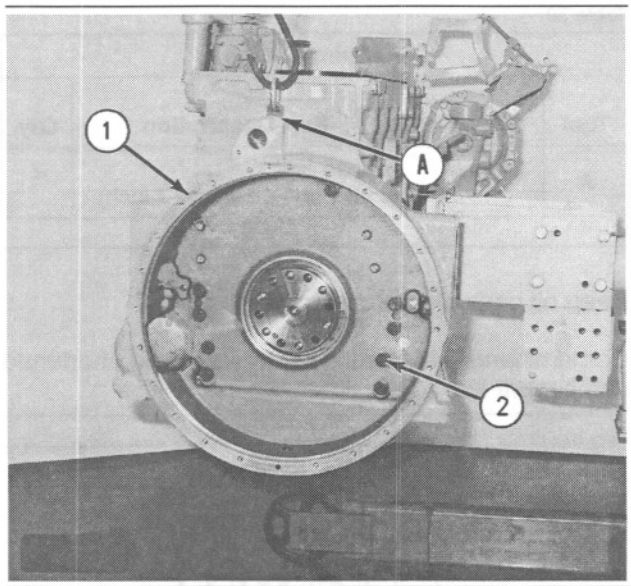

Illustration 95 g00516618
Typical example

1. Install Tooling (A) on flywheel housing (1). Use a suitable lifting device. The weight of the flywheel housing is approximately 111 kg (245 lb).

2. Remove bolts (2). Remove flywheel housing (1) from the dowels in the cylinder block.

Installation Procedure

Table 29

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7573	Link Bracket	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

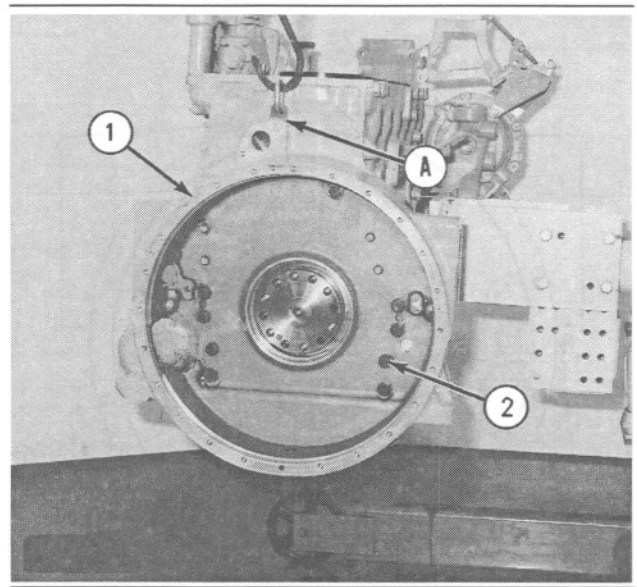

Illustration 96 g00516618
Typical example

Note: During assembly, inspect the following components for any foreign materials: the front face of the flywheel housing, both sides of the flywheel housing gasket, and the rear face of the cylinder block. These components must be free of the following substances: oil, fuel, water, gasket adhesive, assembly compounds, and any other foreign material.

1. Install Tooling (A) on the flywheel housing (1). Use a suitable lifting device. The weight of the flywheel housing is approximately 111 kg (245 lb).

2. Position flywheel housing (1) on the dowels in the cylinder block. Install bolts (2) and remove Tooling (A).

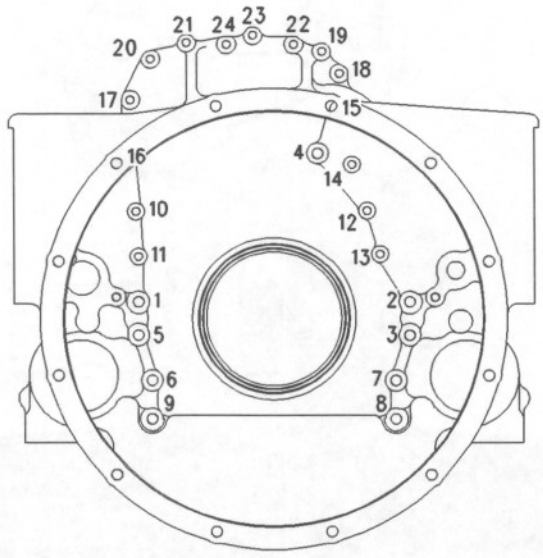

Illustration 97 g00551652

Bolt tightening sequence

3. Tighten the bolts, as follows:

   a. In a numerical sequence, tighten bolt 1 through bolt 9.

      Torque for bolts .... 100 ± 20 N·m (74 ± 15 lb ft)

   b. In a numerical sequence, tighten bolt 10 through bolt 24.

      Torque for bolts ..... 40 ± 10 N·m (30 ± 7 lb ft)

   c. In a numerical sequence, again tighten bolt 1 through bolt 9.

      Torque for bolts .. 135 ± 20 N·m (100 ± 15 lb ft)

   d. In a numerical sequence, again tighten bolt 10 through bolt 24.

      Torque for bolts ..... 55 ± 10 N·m (41 ± 7 lb ft)

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

b. Install the electric starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

c. Install the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

i01936106

Vibration Damper and Pulley - Remove and Install

SMCS Code: 1205-010

Removal Procedure

Table 30

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Bolt (5/8 inch - 18 NF by 7 inch)	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

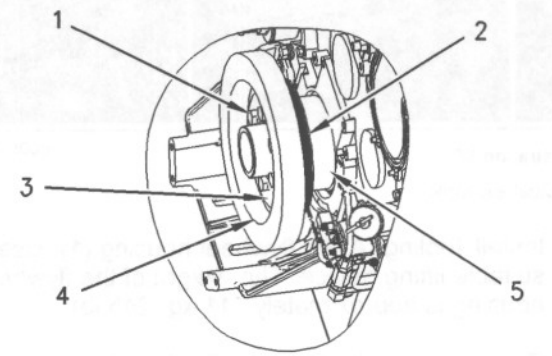

Illustration 98 g01007776

Typical example

1. Remove two bolts (1). Install Tooling (A).

2. Remove remaining bolts (1). Remove plate (3). Remove vibration damper (4) from adapter (5) and pulley (2). The weight of the vibration damper is approximately 15 kg (33 lb).

3. Remove pulley (2) and adapter (5) from the crankshaft.

4. Remove Tooling (A) from the crankshaft.

Installation Procedure

Table 31

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolt (5/8 inch - 18 NF by 7 inch)	2
B	4C-5593	Anti-Seize Compound	-

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Thoroughly inspect the viscous damper for signs of leakage or for signs of a dented (damaged) case. Either of these conditions can cause the weight to make contact with the case. This can affect the viscous damper's operation.

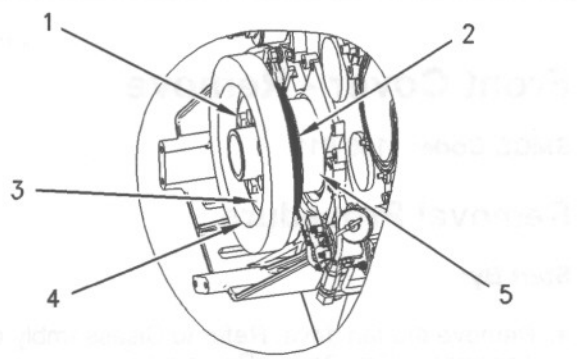

Illustration 99 g01007776
Typical example

1. Install Tooling (A) in the crankshaft.
2. Install adapter (5) and pulley (2) on Tooling (A).
3. Install vibration damper (4) on Tooling (A). The weight of the vibration damper is approximately 15 kg (33 lb).
4. Install plate (3) on Tooling (A).
5. Apply Tooling (B) to bolts (1). Install the bolts. Remove Tooling (A) and install the remaining bolts.

i02016277

Crankshaft Front Seal - Remove

SMCS Code: 1160-011

Removal Procedure

Table 32

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7600	Slide Hammer Puller	1

Start By:

a. Remove the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The crankshaft front seal and the wear sleeve must be replaced at the same time. Once the crankshaft front seal and the wear sleeve are separated, these components can not be used again.

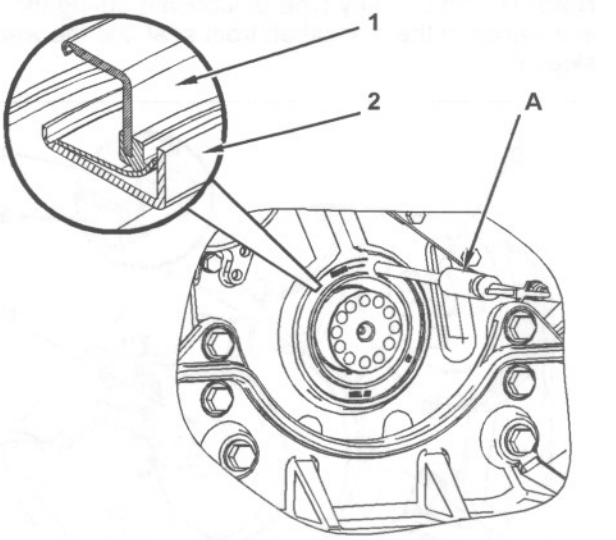

Illustration 100 g01042474

1. Use Tooling (A) or a punch and hammer in order to puncture three or more holes in wear sleeve (2) and crankshaft front seal (1).

2. Use Tooling (A) to remove the wear sleeve and the crankshaft front seal.

i02016329

Crankshaft Front Seal - Install

SMCS Code: 1160-012

Installation Procedure

Table 33

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	5P-1733	Seal Locator	1
C	5P-1737	Bolt	3
D	9S-8858	Nut (Seal Installer)	1
E	6V-6142	Seal Installer	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The crankshaft front seal and the wear sleeve must be replaced at the same time. Once the crankshaft front seal and the wear sleeve are separated, these components cannot be used again.

Note: Do not use any type of lubricant during the installation of the crankshaft front seal and the wear sleeve.

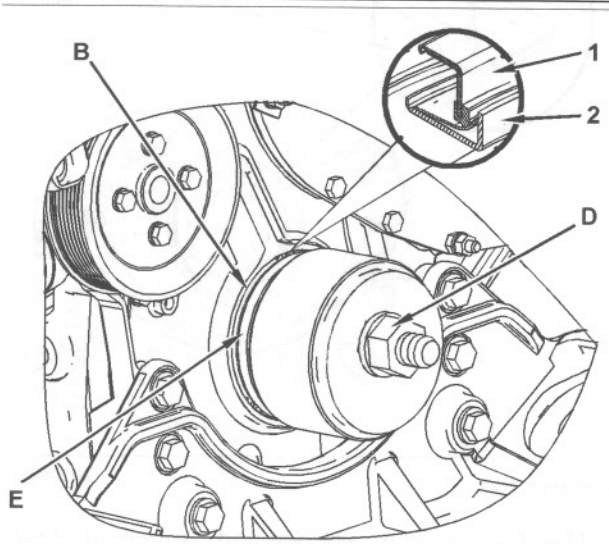

Illustration 101 g01042507

1. Fasten Tooling (B) to the crankshaft with Tooling (C).

Note: Install the crankshaft front seal with the arrow that shows the direction of crankshaft rotation toward the front of the engine.

2. Position wear sleeve (2) and crankshaft front seal (1) on Tooling (B). Install Tooling (E) on Tooling (B). Lubricate the face of the washer on Tooling (D). Install Tooling (D) on Tooling (B).

3. Tighten Tooling (D) until Tooling (E) contacts Tooling (B).

4. Remove Tooling (D), and Tooling (E) from Tooling (B).

5. Remove Tooling (C) and Tooling (B) from the crankshaft.

End By:

a. Install the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

i01119495

Front Cover - Remove

SMCS Code: 1166-011

Removal Procedure

Start By:

a. Remove the fan drive. Refer to Disassembly and Assembly, "Fan Drive - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

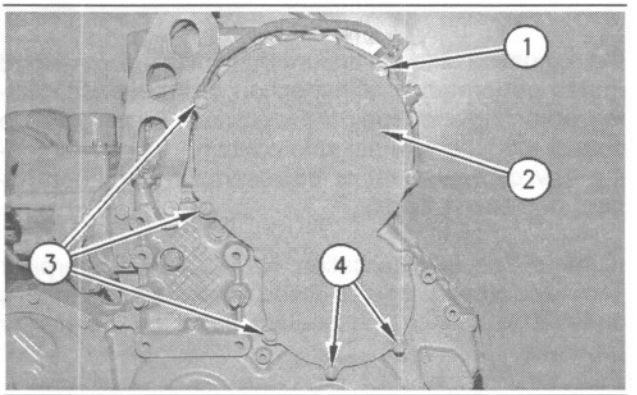

Illustration 102 g00591716

1. Remove button head screws (3), bolts (1), and nuts (4).
2. Remove front cover (2).

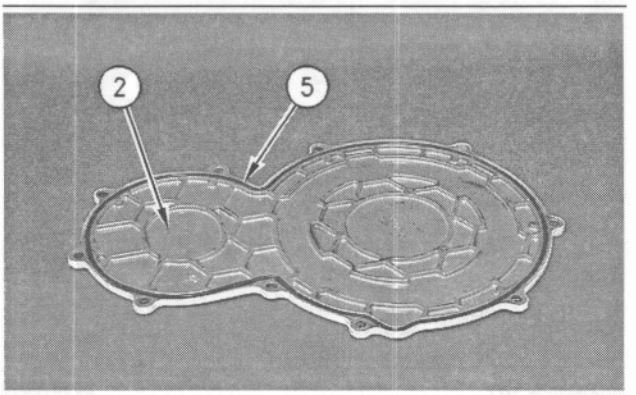

Illustration 103 g00579317

3. Remove seal (5) from front cover (2).

i01119966

Front Cover - Install

SMCS Code: 1166-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

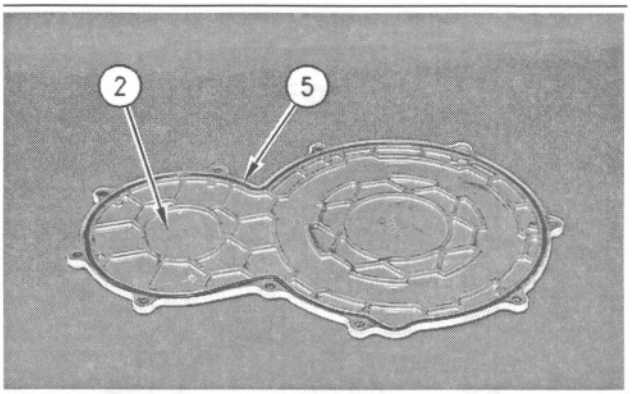

Illustration 104 g00579317

1. Inspect seal (5). If seal (5) is worn or damaged, replace the seal. Install seal (5) in front cover (2).

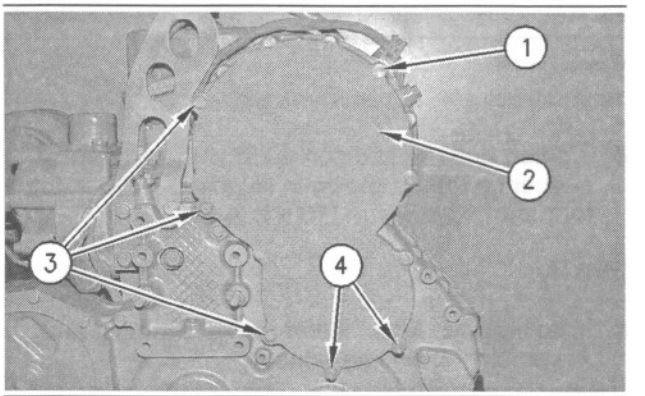

Illustration 105 g00591716
Typical example

2. Install front cover (2), button head screws (3), bolts (1), and nuts (4).

Note: Do not tighten button head screws (3) until bolts (1) and nuts (4) have been properly tightened.

3. Tighten bolts (1) and nuts (4).

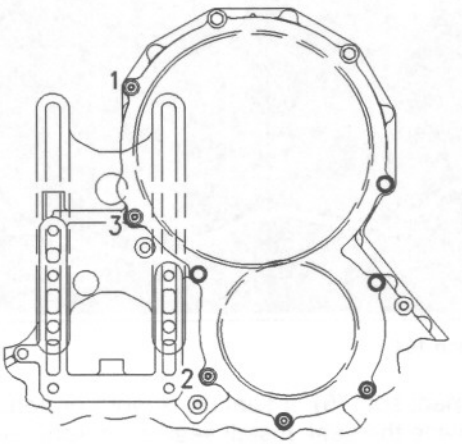

Illustration 106 g00563307

Tightening sequence for button head screws

4. Tighten button head screw (3) in the numerical sequence that is shown in Illustration 136 to the torque of 13 ± 3 N·m (10 ± 2 lb ft).

End By:

a. Install the fan drive. Refer to Disassembly and Assembly, "Fan Drive - Install".

i01974263

Gear Group (Front) - Remove

SMCS Code: 1206-011

Removal Procedure

Table 34

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Group	1

Start By:

a. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Be sure to mark the orientation of each of the gears for installation purposes.

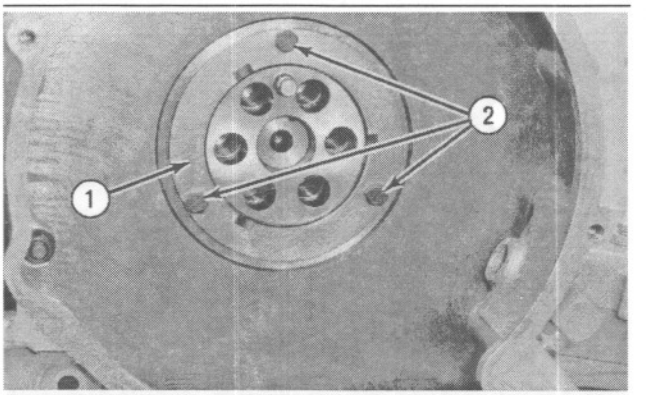

Illustration 107 g00515929

Typical example

1. Remove bolts (2) and thrust plate (1).

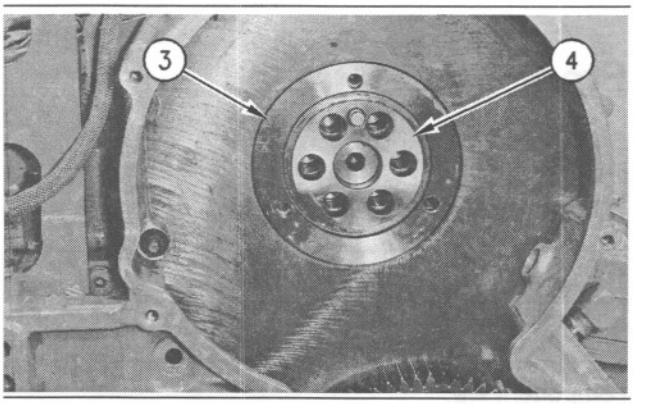

Illustration 108 g00576209

Typical example

2. Remove seal assembly (3) and adapter (4).

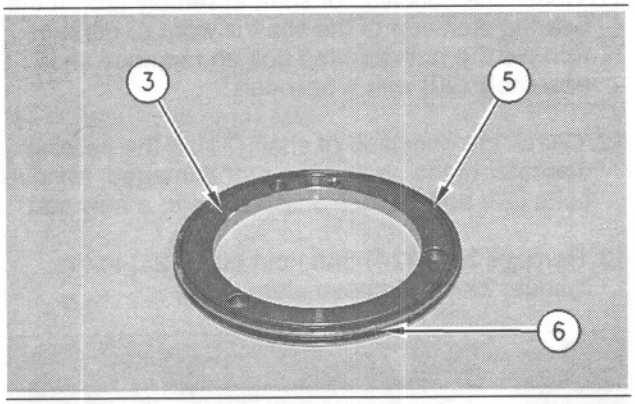

Illustration 109 g00576240

3. Remove O-ring seals (5) and (6) from seal assembly (3).

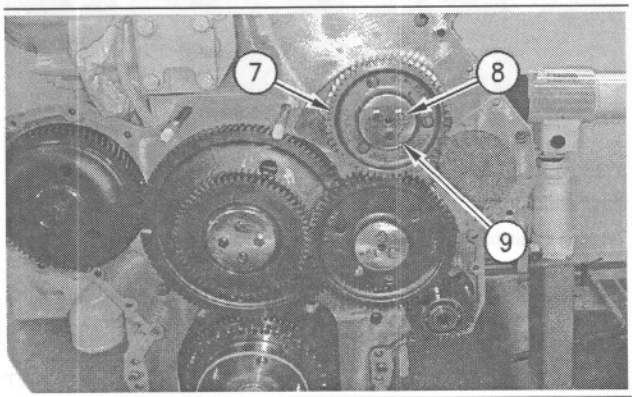

Illustration 110 g00596172

Typical example

4. Remove bolts (8), plate (9), and adjustable idler gear (7).

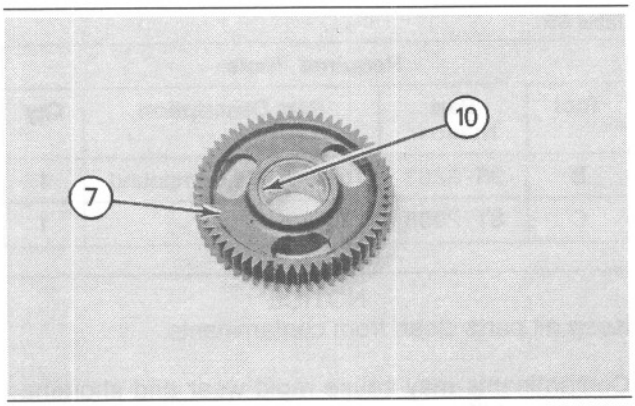

Illustration 111 g00576201

5. Check the condition of bearing (10) in adjustable idler gear (7). If bearing (10) is worn or damaged, use a new part for replacement. Use Tooling (A) to replace bearing (10) in adjustable idler gear (7).

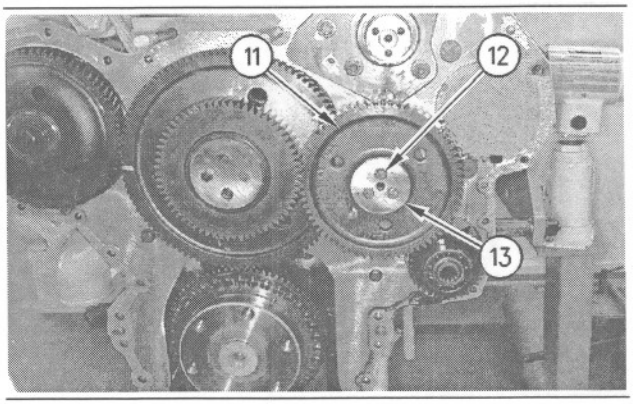

Illustration 112 g00596214

Typical example

6. Remove bolts (12), plate (13), and idler gear (11).

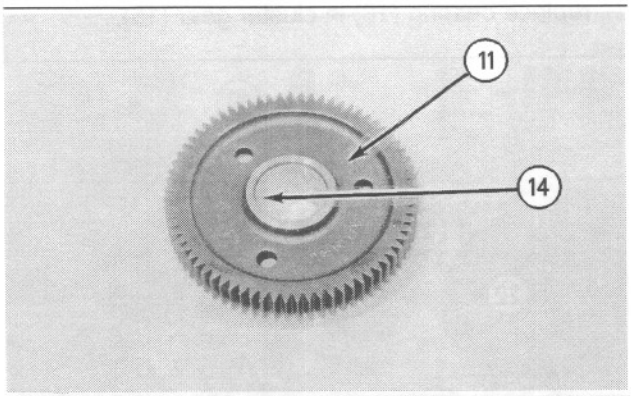

Illustration 113 g00576204

7. Check the condition of bearing (14) in idler gear (11). If bearing (14) is worn or damaged, use a new part for replacement. Use Tooling (A) to replace bearing (14) in idler gear (11).

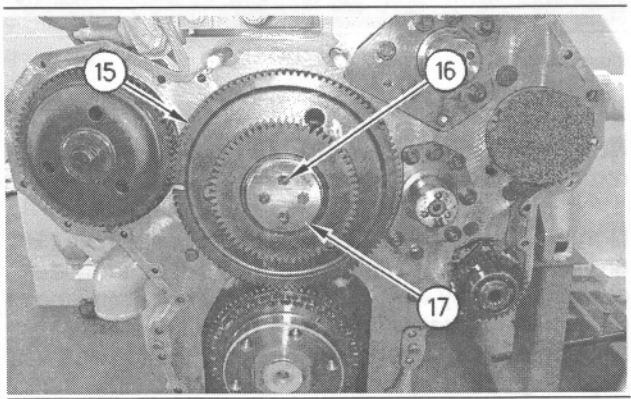

Illustration 114 g00596255

Typical example

8. Remove bolts (16), plate (17), and cluster gear (15).

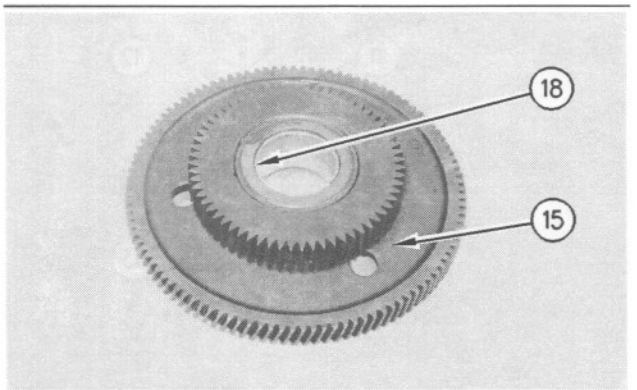

Illustration 115 g00576207

9. Check the condition of bearing (18) in cluster gear (15). If bearing (18) is worn or damaged, use a new part for replacement. Use Tooling (A) to replace bearing (18) in cluster gear (15).

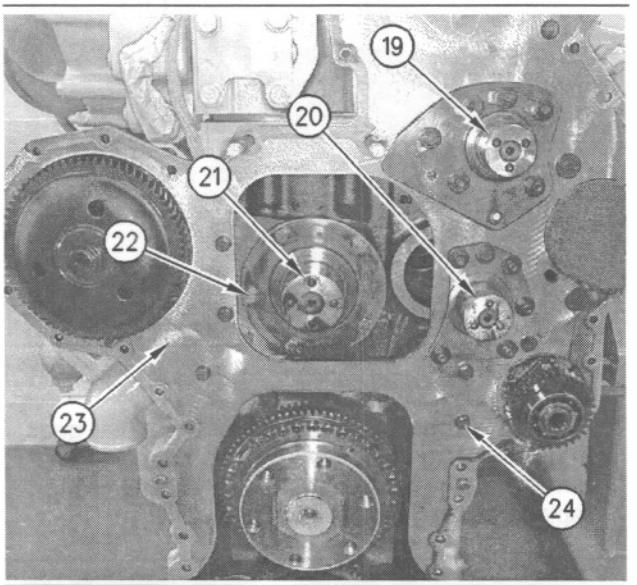

Illustration 116 g00596260
Typical example

Note: Shaft assemblies (19) and (20) must be removed in order to remove plate (23).

Note: If the nuts and the bolt for shaft assembly (19) are loosened, or if shaft assembly (19) is removed or moved in any way, the backlash for the camshaft gear and adjustable idler gear (7) will need to be readjusted at assembly. Refer to Testing and Adjusting, "Fuel System".

10. Check the condition of shaft assembly (19). If the bearing diameter of the shaft is worn or damaged, remove the nuts and the bolt and replace shaft assembly (19) with a new part.

11. Check the condition of shaft assembly (20). If the bearing diameter of the shaft is worn or damaged, remove the nuts and the bolt and replace shaft assembly (20) with a new part.

12. Check the condition of shaft (21). If the bearing diameter of the shaft is worn or damaged, remove bolts (22) and replace shaft (21) with a new part.

13. Remove bolts (24) that hold plate (23) to the cylinder block. Remove plate (23).

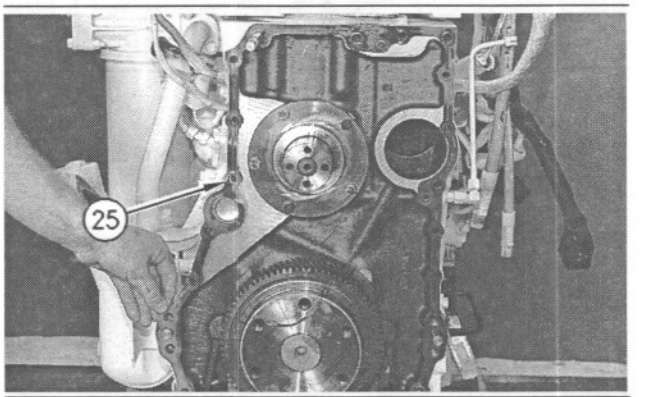

Illustration 117 g00576241
Typical example

14. Remove gasket (25) from the cylinder block.

i01974267

Gear Group (Front) - Install

SMCS Code: 1206-012

Installation Procedure

Table 35

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	9S-3263	Thread Lock Compound	1
C	8T-2998	Lubricant	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the gasket material from the cylinder block and both sides of plate (19).

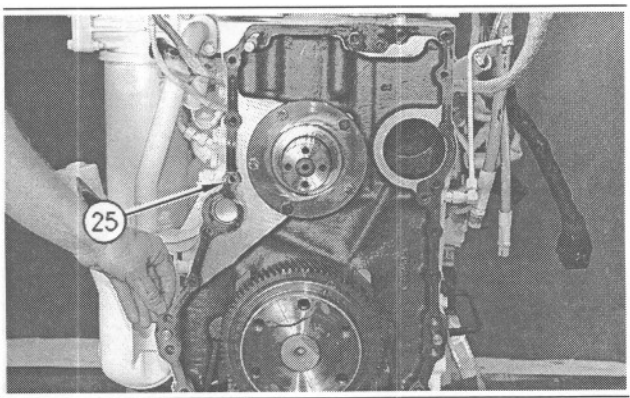

Illustration 118 g00576241
Typical example

2. Install a new gasket (25) on the cylinder block.

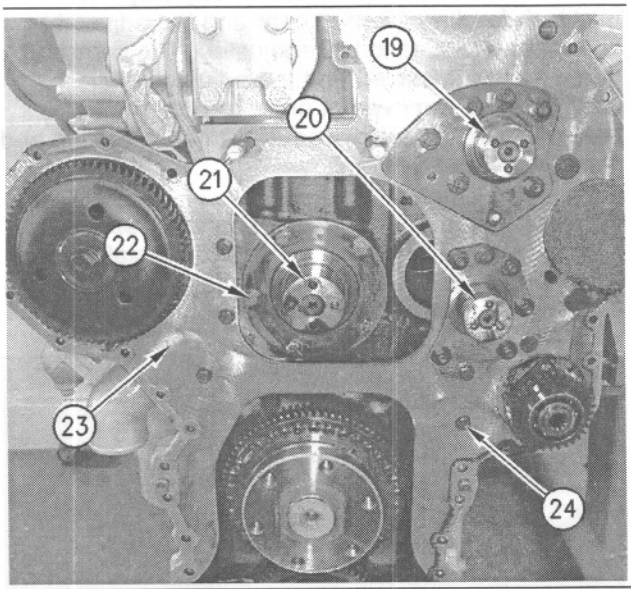

Illustration 119 g00596260
Typical example

3. Install plate (23) and bolts (24).

4. Tighten bolts (24) to 55 ± 10 N·m (41 ± 7 lb ft).

5. Tighten bolts (24) to 55 ± 10 N·m (41 ± 7 lb ft) again.

6. Install shaft assembly (20). Apply Tooling (B) to the studs and the bolt for the shaft assembly. Tighten the nuts and the bolt for the shaft assembly to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

7. Hand tighten the nuts and the bolt for shaft assembly (20) to a torque of 55 ± 10 N·m (41 ± 7 lb ft) again.

Note: The backlash for the camshaft gear and the adjustable idler gear will need to be readjusted if shaft assembly (19) has been removed, loosened, or moved in any way. The camshaft gear must be installed and the adjustable idler gear must be removed in order to perform the backlash adjustment procedure. Refer to Testing and Adjusting, "Fuel System".

8. Install shaft assembly (19). Do not tighten the nuts and the bolt for shaft assembly (19) at this time. The nuts and the bolt for shaft assembly (19) will need to be tightened when the backlash is adjusted.

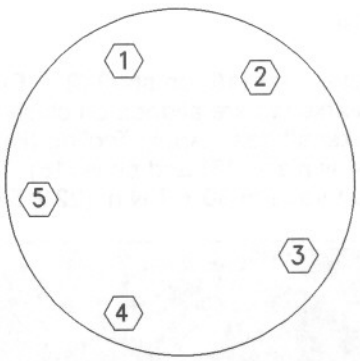

Illustration 120 g00537659
Bolt tightening sequence for shaft (21)

9. Apply Tooling (B) to bolts (22). Install shaft (21). Tighten bolts (22) to a torque of 55 ± 10 N·m (41 ± 7 lb ft) in a sequence (1, 3, 4, 5, 2, 1, 2, 3, 4, 5, 1).

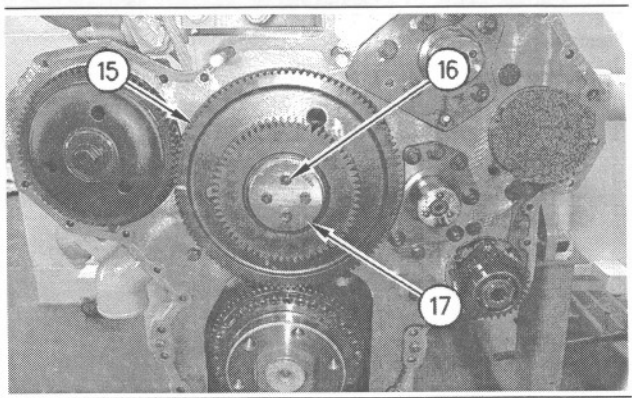

Illustration 121 g00596255
Typical example

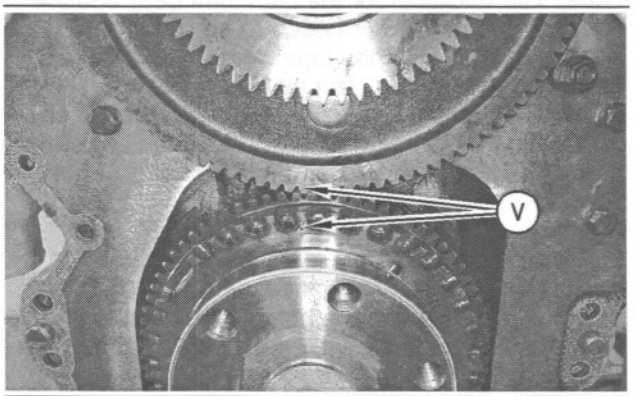

Illustration 122 g00516404
Typical example

10. Put cluster gear (15) on shaft (21). Ensure that timing Marks (V) are aligned on cluster gear and the crankshaft gear. Apply Tooling (B) to bolts (17). Install plate (17) and bolts (16). Tighten bolts (16) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

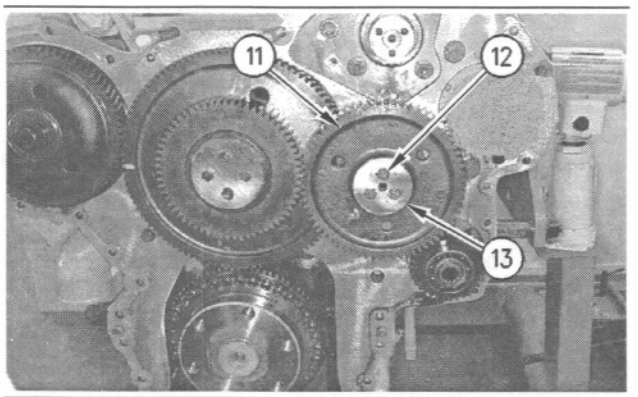

Illustration 123 g00596214
Typical example

11. Put idler gear (11) on shaft (20). Apply Tooling (B) to bolts (12). Install plate (13) with the oil groove toward the gear face. Install bolts (12) and tighten to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

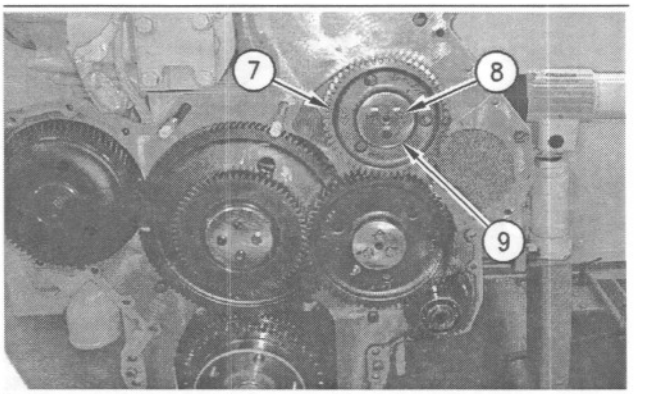

Illustration 124 g00596172
Typical example

Note: Skip Step 12 if shaft assembly (19) has been removed, loosened, or moved in any way. The backlash for the camshaft gear and the adjustable idler gear will need to be readjusted. The camshaft gear must be installed and the adjustable idler gear must be removed in order to perform the backlash adjustment procedure. Refer to Testing and Adjusting, "Fuel System".

12. Put adjustable idler gear (7) on shaft assembly (19). Apply Tooling (B) to bolts (8). Install plate (9) and bolts (8). Tighten bolts (8) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

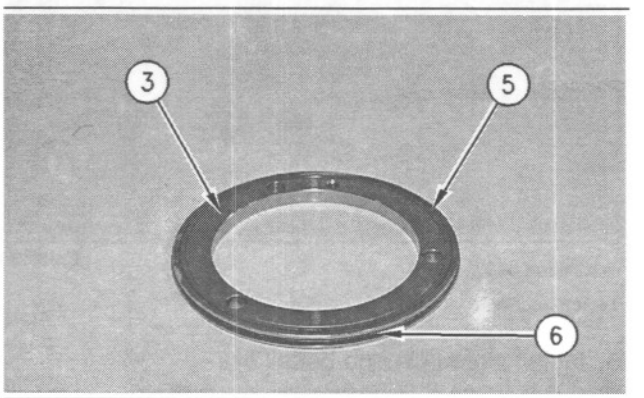

Illustration 125 g00576240

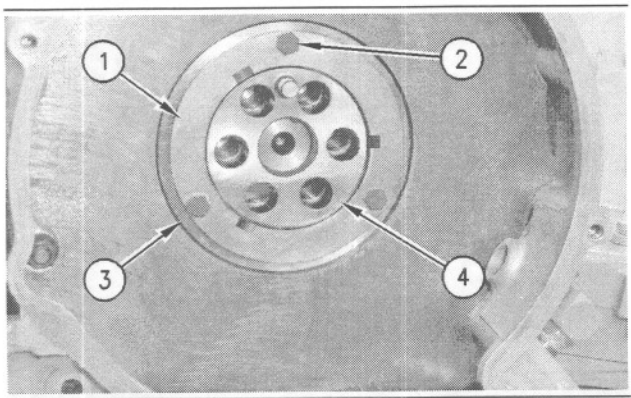

Illustration 126 g00576839

Typical example

13. Install O-ring seals (5) and (6) in seal assembly (3). Lightly lubricate the O-ring seal (5) with a 50/50 mixture of Tooling (C) and clean engine oil.

14. Assemble thrust plate (1) and seal assembly (3). Apply Tooling (B) to bolts (2). Hold the assembly in position and install bolts (2). Evenly tighten bolts (2) until seal assembly (3) and O-ring seal (5) are seated against the cylinder head.

Note: Be careful in order to ensure that O-ring seal (5) stays in the groove in seal assembly (3).

15. Install adapter (4). Ensure that the dowel in adapter (4) engages the hole in the camshaft.

16. Adjust the backlash for the camshaft gear and the adjustable idler gear, if necessary. Refer to Testing and Adjusting, "Fuel System".

Note: The camshaft gear must be installed and the adjustable idler gear must be removed in order to perform the backlash adjustment procedure.

End By:

a. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

i01121261

Housing (Front) - Remove

SMCS Code: 1151-011

Removal Procedure

Start By:

a. Remove the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

b. Remove the crankshaft front seal and the wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Remove".

c. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

d. Remove the fan drive. Refer to Disassembly and Assembly, "Fan Drive - Remove".

e. Remove the fuel transfer pump. Refer to Disassembly and Assembly, "Fuel Transfer Pump - Remove".

f. Remove the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

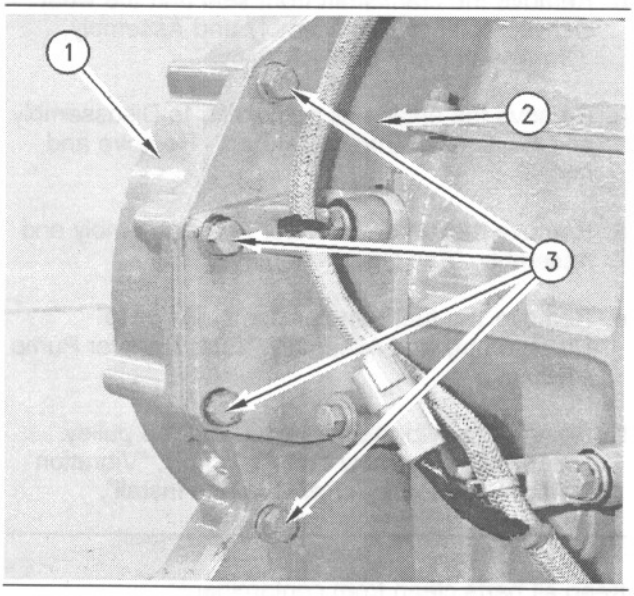

Illustration 127 g00592550
Typical example

1. Remove bolts (3) that fasten front plate (2) to front housing (1).

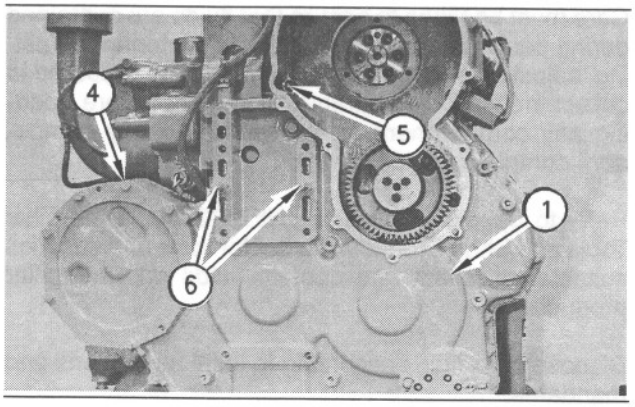

Illustration 128 g00592633
Typical example

2. Remove bolts (4), nut (5), and nuts (6) from front housing (1).

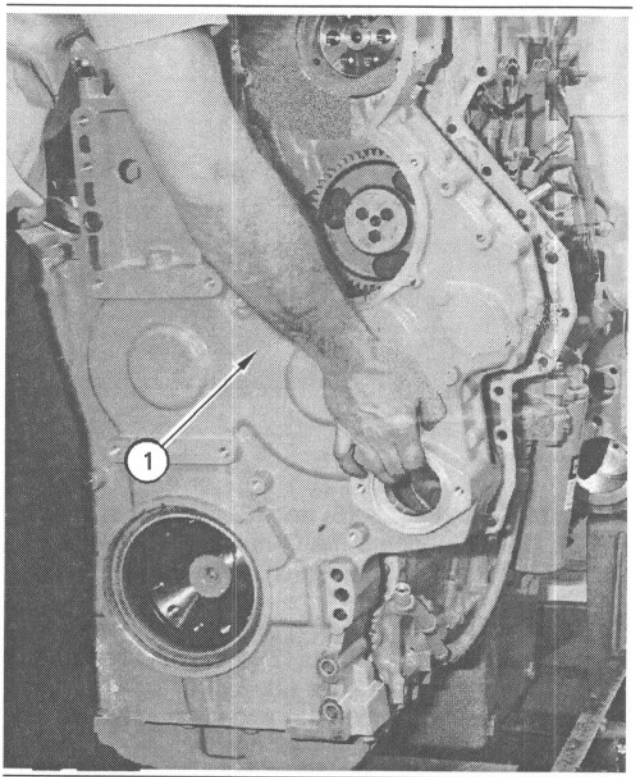

Illustration 129 g00592668
Typical example

3. Remove front housing (1).

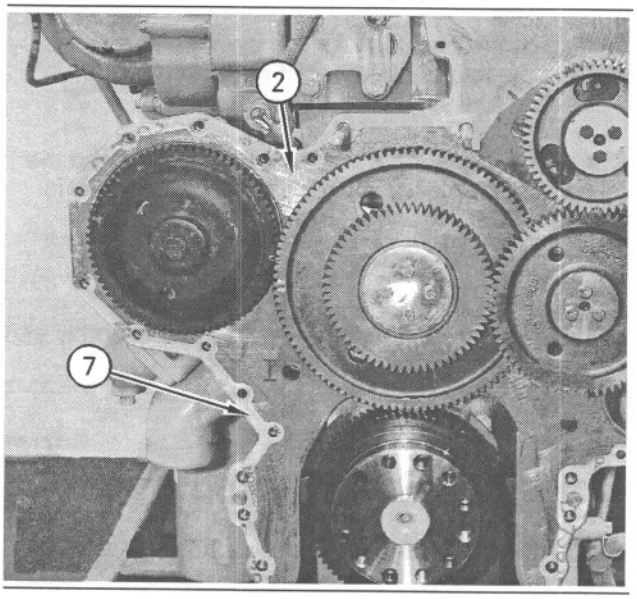

Illustration 130 g00592672
Typical example

4. Remove gasket (7) from front plate (2).

i01985440

Housing (Front) - Install

SMCS Code: 1151-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

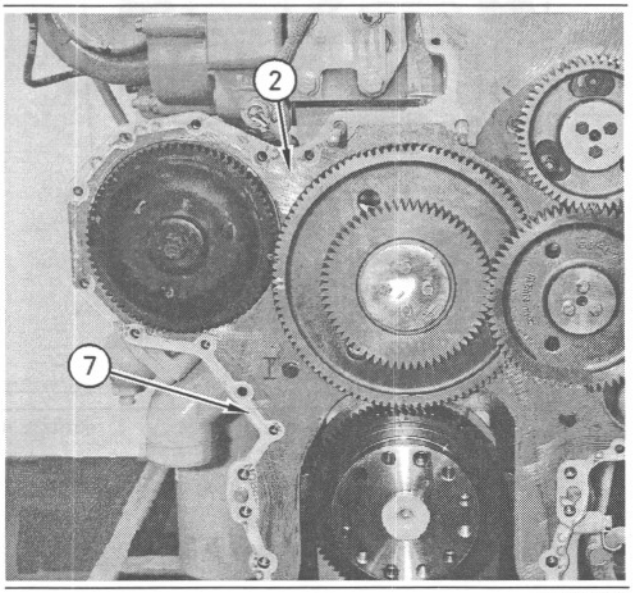

Illustration 131 g00592672
Typical example

1. Thoroughly clean the old gasket material from front plate (2). Install a new gasket (7) on front plate (2).

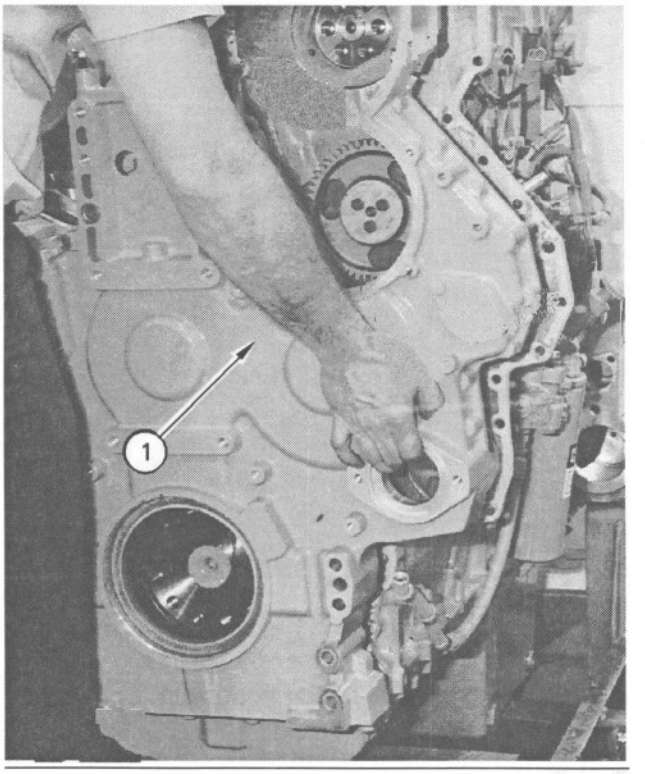

Illustration 132 g00592668
Typical example

2. Thoroughly clean the old gasket material from front housing (1) and install front housing (1) on the two dowel pins.

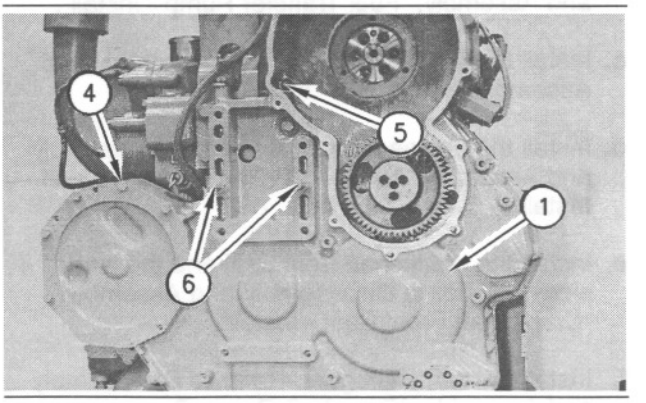

Illustration 133 g00592633
Typical example

3. Install bolts (4), nut (5), and nuts (6) on front housing (1).

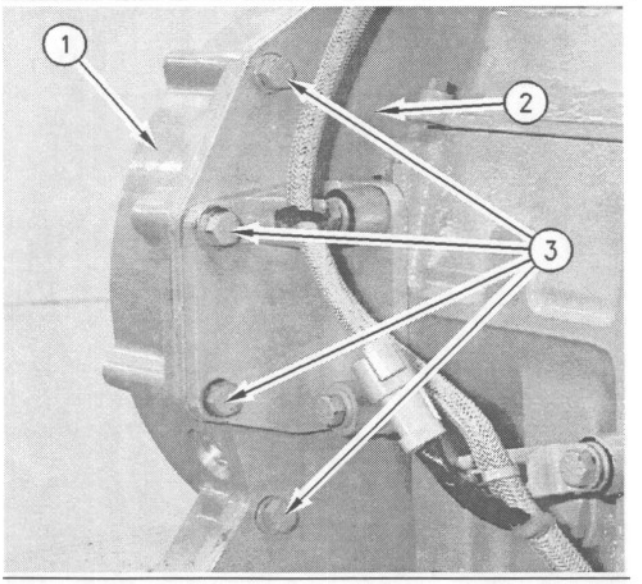

Illustration 134 g00592550

Typical example

4. Install bolts (3) that fasten front plate (2) to front housing (1).

End By:

a. Install the vibration damper and the pulley. Refer to Disassembly and Assembly, "Vibration Damper and Pulley - Remove and Install".

b. Install the fuel transfer pump. Refer to Disassembly and Assembly, "Fuel Transfer Pump - Install".

c. Install the fan drive. Refer to Disassembly and Assembly, "Fan Drive - Install".

d. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

e. Install the crankshaft front seal and the wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Install".

f. Install the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

i01994409

Valve Mechanism Cover - Remove and Install

SMCS Code: 1107-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

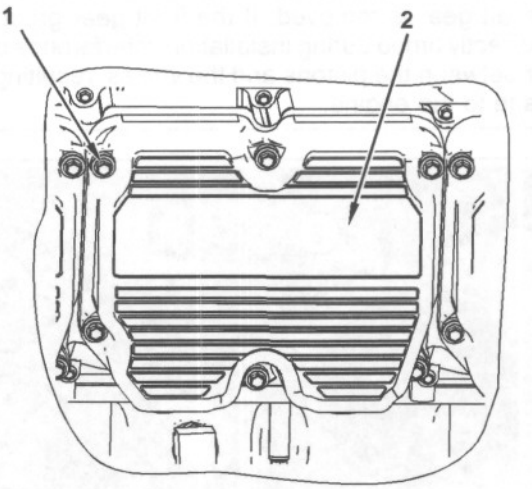

Illustration 135 g01033224

1. Remove bolts (1).

2. Remove valve mechanism cover (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

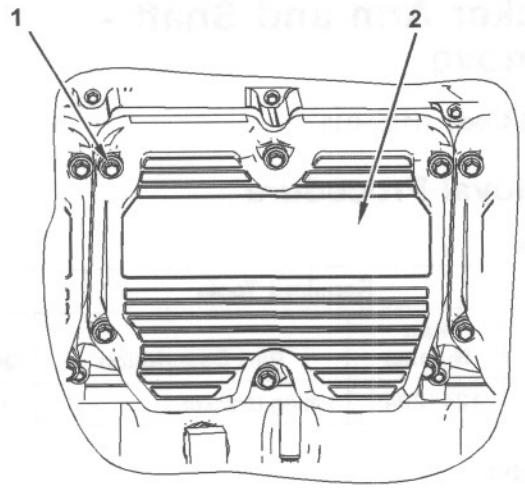

Illustration 136 g01033224

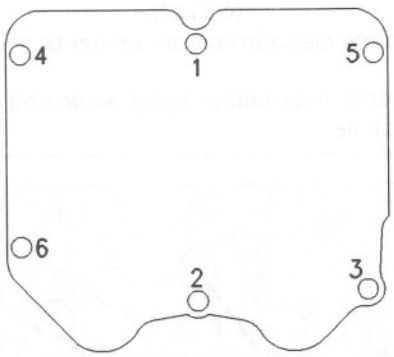

Illustration 137 g00579295

1. Position valve mechanism cover (2) on the valve cover base. Tighten bolts (1) to a torque of 18 ± 3 N·m (13 ± 2 lb ft) in the numerical sequence that is shown in Illustration 137.

i01985327

Valve Mechanism Cover Base - Remove and Install

SMCS Code: 1120-010

Removal Procedure

Start By:

a. Remove the valve mechanism covers. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

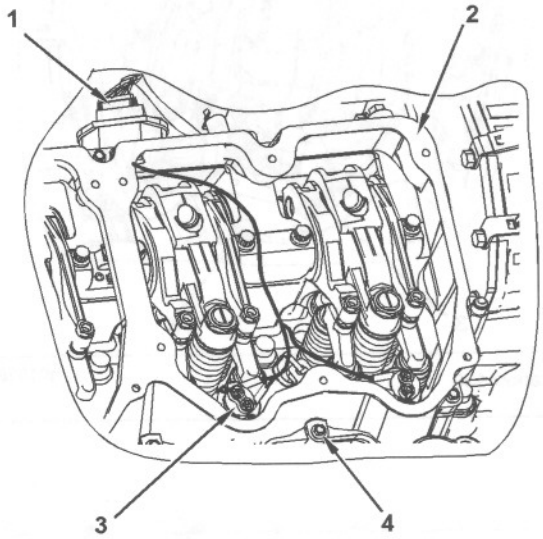

Illustration 138 g01028794

1. Disconnect harness assembly (3) from the electronic unit injector.
2. Disconnect harness assembly (1) from valve cover base (2).
3. Remove bolts (4).
4. Remove valve cover base (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Before assembly, check the condition of the seal. If the seal is worn or damaged, use a new part for replacement.

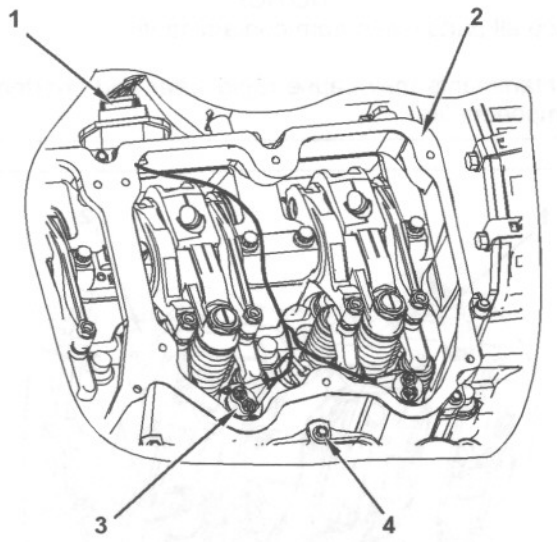

Illustration 139 g01028794

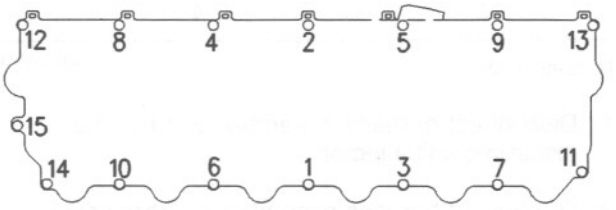

Illustration 140 g00579307

1. Position valve cover base (2) on the cylinder head and install bolts (4). Tighten bolts (4) to a torque of 18 ± 3 N·m (13 ± 2 lb ft) in the numerical sequence that is shown in Illustration 140.

2. Connect harness assembly (1).

3. Position harness assembly (3) on the electronic unit injector. Tighten the cap nuts to a torque of 2.5 ± 0.25 N·m (22 ± 2 lb in).

End By:

a. Install the valve mechanism covers. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

i01974349

Rocker Arm and Shaft - Remove

SMCS Code: 1102-011

Removal Procedure

Table 36

Required Tools			
Tool	Part Number	Part Description	Qty
A	124-2946	Lifting Bracket	1

Start By:

a. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

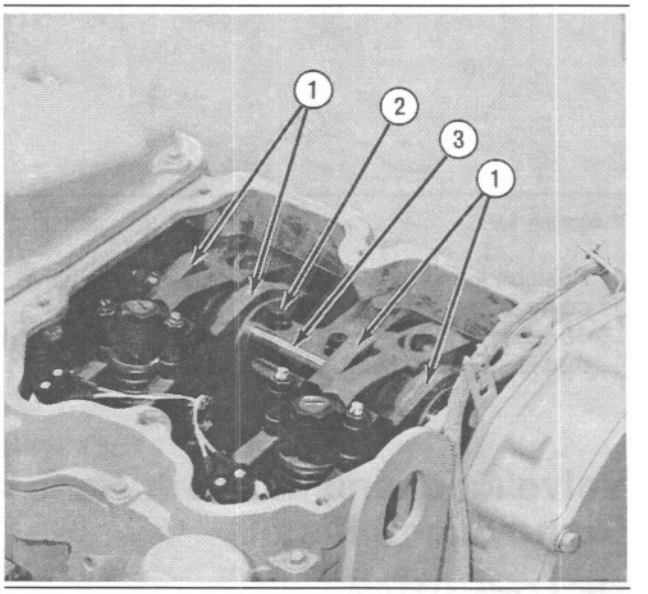

Illustration 141 g00517442
Typical example

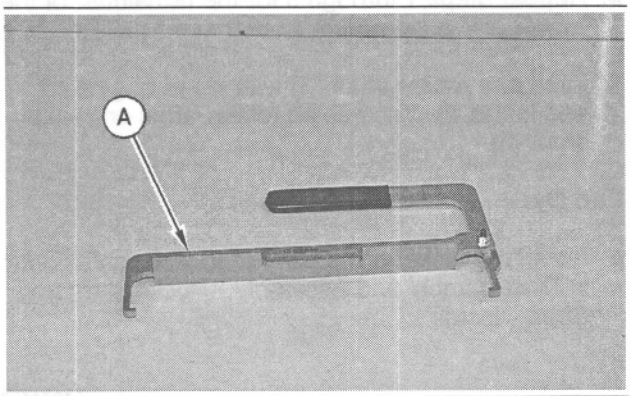

Illustration 142 g00517462

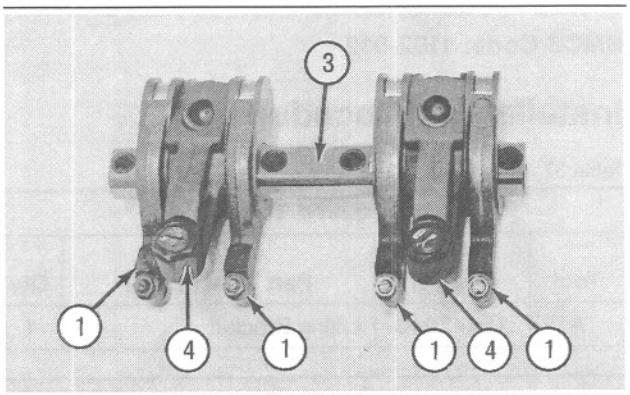

Illustration 143 g00517457

⚠ WARNING

Valve rocker arms and unit injector rocker arms can move on the shaft after the bolts have been removed. The shaft should be kept level when removed from the cylinder head. To avoid possible personal injury, keep fingers clear of the valve rocker arms and the unit injector rocker arms when lifting the assembly from the cylinder head.

1. Remove bolts (2).
2. Remove shaft (3), valve rocker arms (1), and unit injector rocker arms (4) as a unit with Tooling (A).
3. Repeat Steps 1 and 2 for the remainder of the rocker arm assemblies.

i01985468

Rocker Arm - Disassemble

SMCS Code: 1123-015

Disassembly Procedure

Start By:

a. Remove the rocker arms and the rocker shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

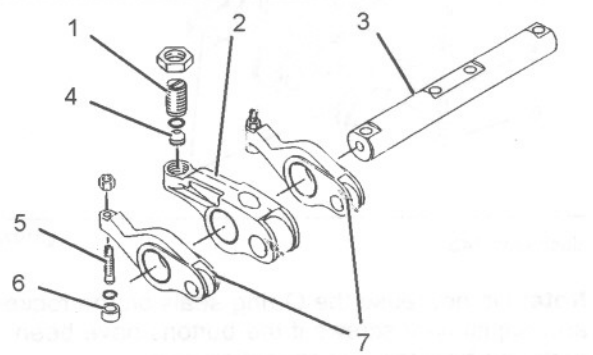

Illustration 144 g01028860

1. Remove valve rocker arms (7) and unit injector rocker arm (2) from rocker shaft (3).

Note: Check the condition of all components. Replace any worn components or damaged components with new parts.

Note: Do not reuse the O-ring seals on the rocker arm adjustment screws if the buttons have been removed from the adjustment screws.

2. Remove button (6) from adjuster screw (5) in valve rocker arm (7).
3. Remove button (4) from adjuster screw (1) in unit injector rocker arm (2).
4. Repeat Steps 1 through 3 for the remaining rocker arm assemblies.

i01985507

Rocker Arm - Assemble

SMCS Code: 1123-016

Assembly Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

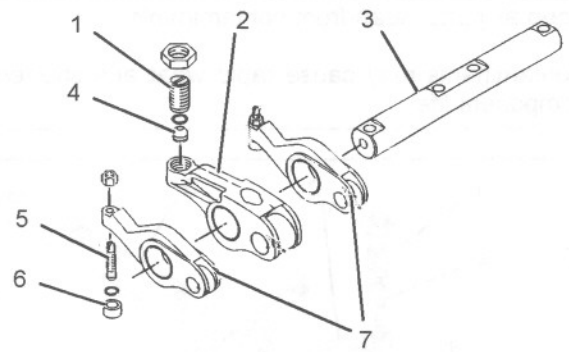

Illustration 145 g01028860

Note: Do not reuse the O-ring seals on the rocker arm adjustment screws if the buttons have been removed from the adjustment screws.

1. Install the O-ring seals in button (6) and button (4).
2. Install the O-ring seals and the buttons on the valve rocker arms, as follows:
   a. Support valve rocker arm (7) in a vise with soft jaws.
   b. Position the O-ring seal and button (6) on the round end of adjustment screw (5).
   c. Use a soft hammer to seat button (6) on adjustment screw (5).
3. Install the O-ring seals and the buttons on the unit injector rocker arms, as follows:
   a. Support unit injector rocker arms (2) in a vise with soft jaws.
   b. Put the O-ring seal and button (4) in position on the end of adjustment screw (1).
   c. Use a soft hammer to seat button (4) on adjustment screw (1).
4. Repeat Steps 1 through 3 for the remainder of the rocker arm assemblies.
5. Lubricate rocker shaft (3) with clean engine oil and install the assembled rocker arms on rocker shaft (3).

End By:

a. Install the rocker arms and the rocker shaft. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

i01974400

Rocker Arm and Shaft - Install

SMCS Code: 1102-012

Installation Procedure

Table 37

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	124-2946	Lifting Bracket	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Valve rocker arms and unit injector rocker arms can move on the shaft after the bolts have been removed. The shaft should be kept level when removed from the cylinder head. To avoid possible personal injury, keep fingers clear of the valve rocker arms and the unit injector rocker arms when lifting the assembly from the cylinder head.

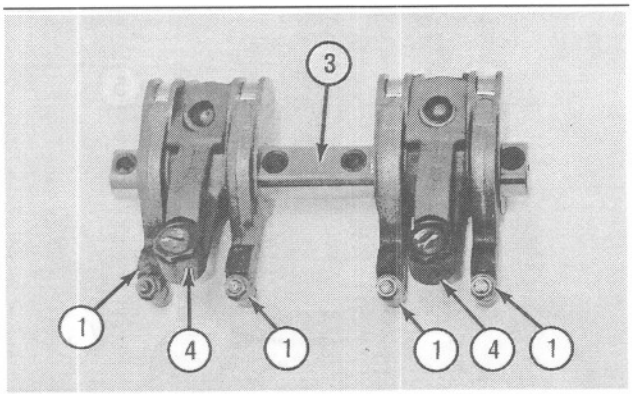

Illustration 146 g00517457

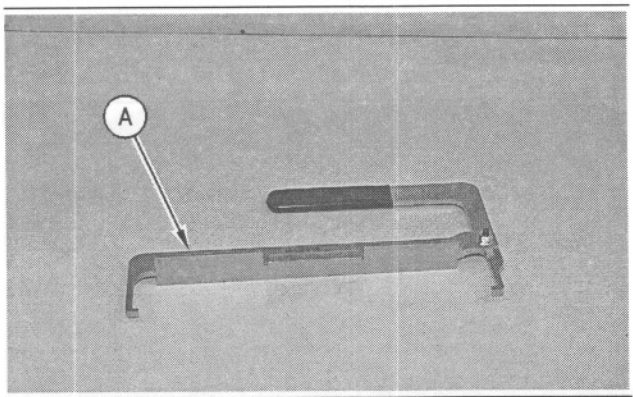

Illustration 147 g00517462

1. Install rocker shaft (3), valve rocker arms (1), and unit injector rocker arms (4) as a unit with Tooling (A).

Note: Install rocker shaft (3) with the flat side facing upward.

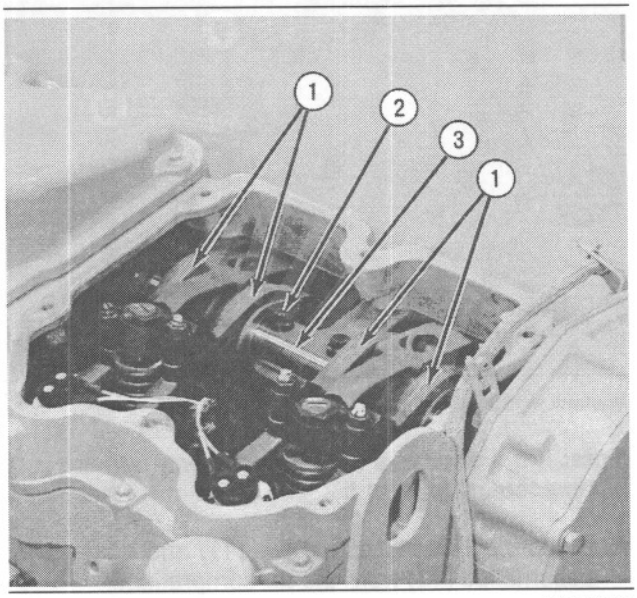

Illustration 148 g00517442

2. Install bolts (2). Tighten bolts (2) to a torque of 109 ± 15 N·m (80 ± 11 lb ft).

3. Repeat Steps 1 and 2 for the remainder of the rocker arm assemblies.

End By:

a. Install the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

i01974407

Cylinder Head - Remove

SMCS Code: 1100-011

Removal Procedure

Start By:

a. Remove the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

b. Remove the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".

c. Remove the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".

d. Remove the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

e. Remove the valve mechanism cover base. Refer to Disassembly and Assembly, "Valve Mechanism Cover Base - Remove and Install".

f. Remove the water temperature regulator. Refer to Disassembly and Assembly, "Water Temperature Regulator - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

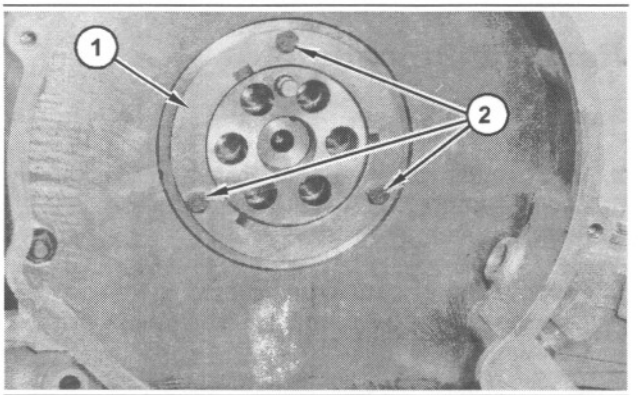

Illustration 149 g01028806

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

1. Remove bolts (2) and thrust plate (1).

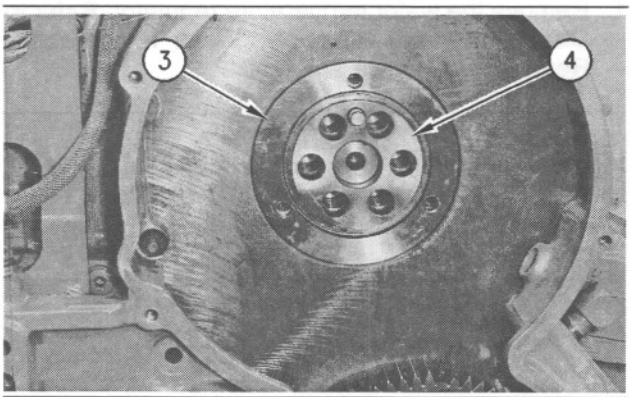

Illustration 150 g00576209

2. Remove seal assembly (3) and adapter (4).

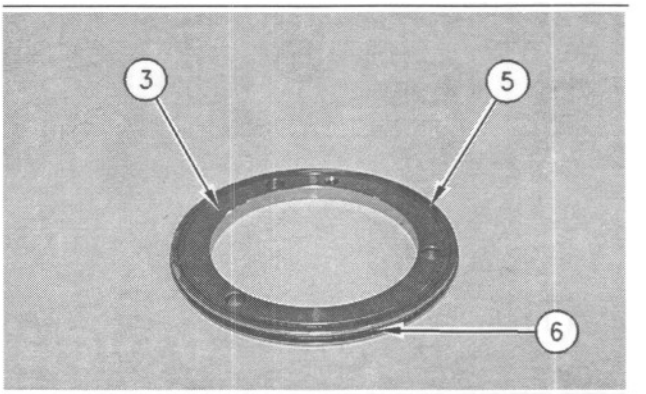

Illustration 151 g00576240

3. Remove O-ring seals (5) and (6) from seal assembly (3).

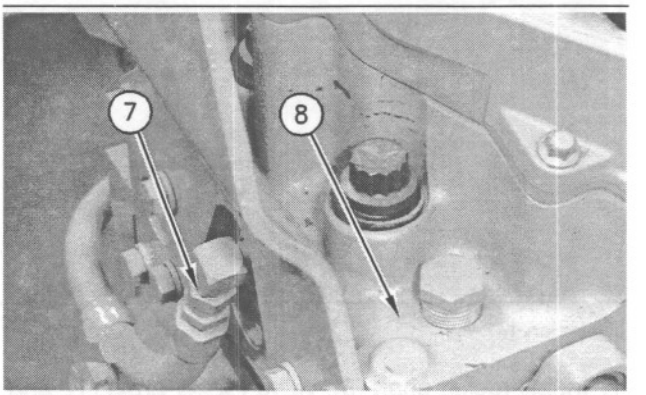

Illustration 152 g00580805

4. Disconnect hose assembly (7) from cylinder head (8).

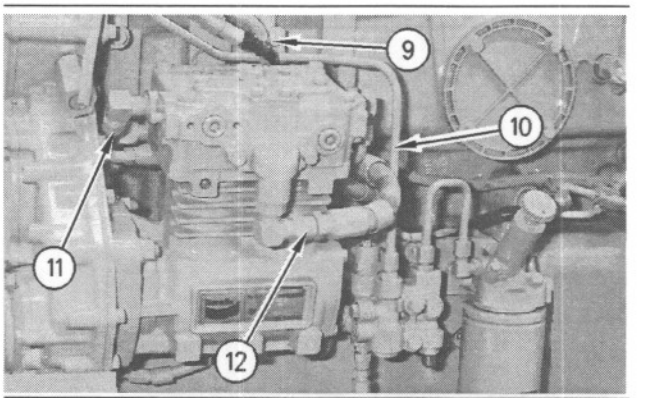

Illustration 153 g00580807

Note: If the engine is not equipped with an air compressor, skip Step 5.

5. Disconnect hose assemblies (11) and hose assemblies (12) from the air compressor.

6. Remove the bolt and clamp (9) from the hose assembly. Remove hose assembly (10).

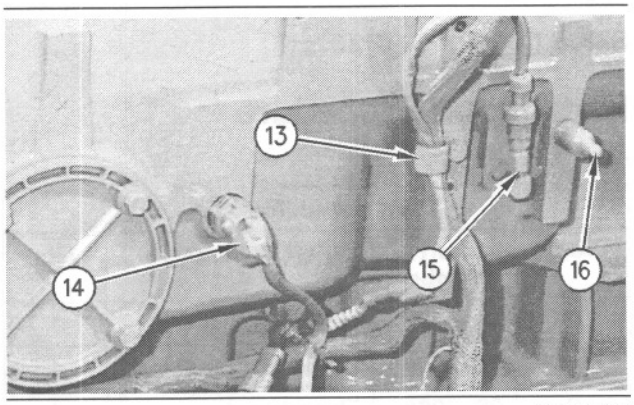

Illustration 154 g00580808

7. Remove the bolt and support clip (13) for the harness assembly.

8. Disconnect the harness assembly from sensor (14), sensor (15), and ground stud (16).

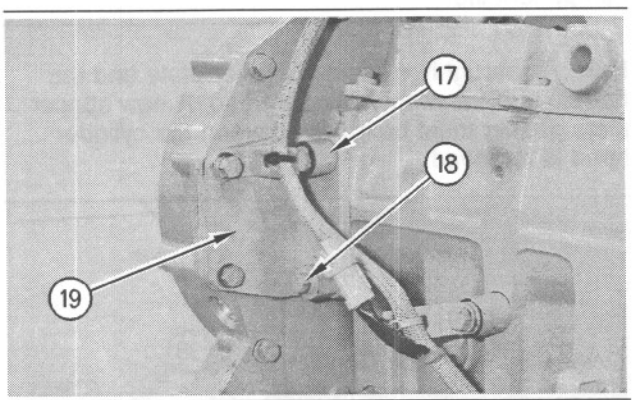

Illustration 155 g00580810

9. Remove bolts (18) and spacers (17) that fasten bracket (19) to the cylinder head.

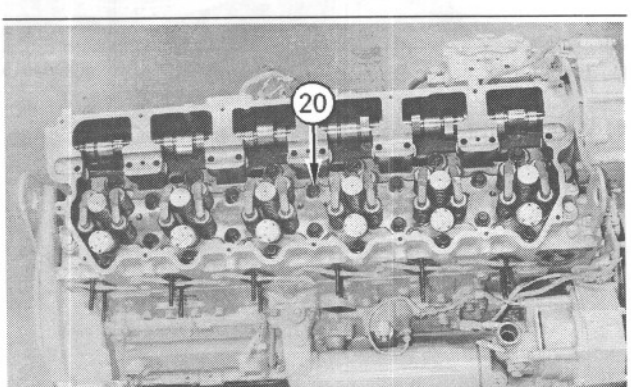

Illustration 156 g00580811

10. Remove cylinder head bolts (20).

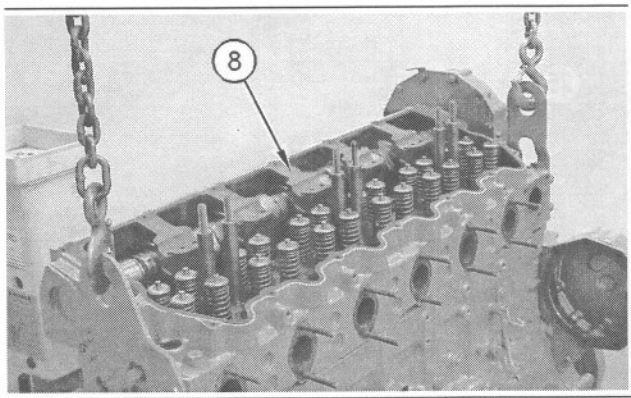

Illustration 157 g00580812

11. Attach a suitable lifting device to cylinder head (8). Ensure that all of the following items are clear from the cylinder head: harness assemblies, tube assemblies, and hose assemblies.

12. Carefully remove cylinder head (8). The weight of the cylinder head is approximately 235 kg (518 lb).

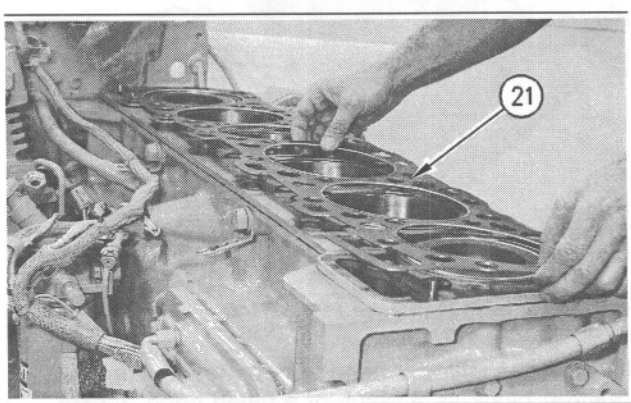

Illustration 158 g00580833

13. Remove cylinder head gasket (21).

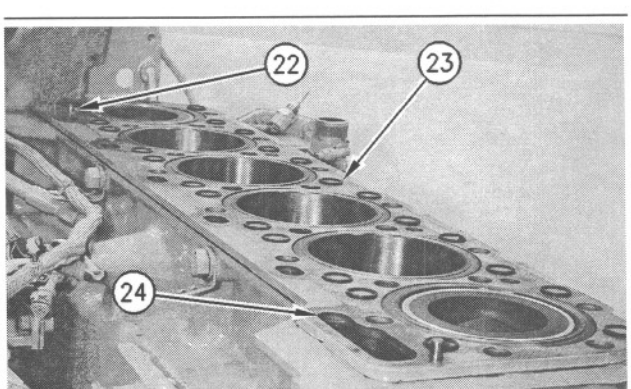

Illustration 159 g00632047

14. Remove O-ring seal (22) and water seals (23). Remove seal (24).

15. Remove the spacer plate from the engine.

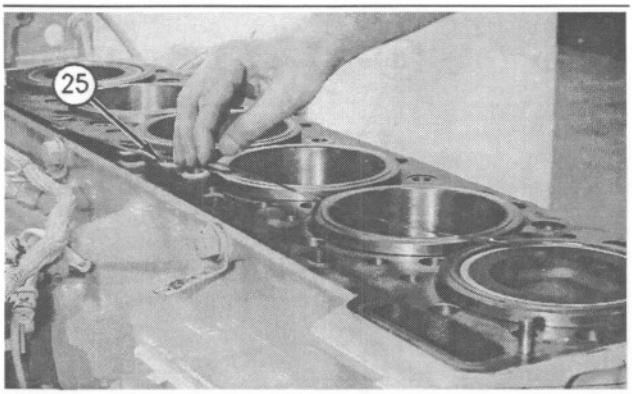

Illustration 160 g00632048

16. Remove spacer plate gasket (25).

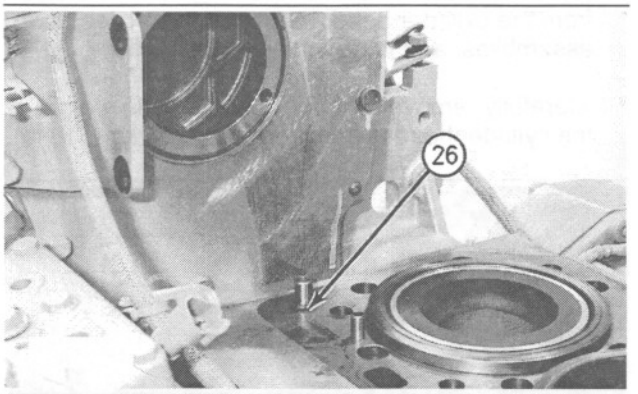

Illustration 161 g00632049

17. Remove O-ring seal (26).

Note: If the cylinder head was removed from the cylinder block as a result of a failed head gasket, refer to Special Instruction, SEHS9564, "3400 Cylinder Head Joint Repair Procedure" for additional information.

i01985424

Cylinder Head - Install

SMCS Code: 1100-012

Installation Procedure

Table 38

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-4876	Lubricant	1
B	8T-2998	Lubricant	1
C	9S-3263	Thread Lock Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Thoroughly clean the spacer plate and the bottom surface of the cylinder head. A new spacer plate gasket must be installed when the cylinder head is removed.

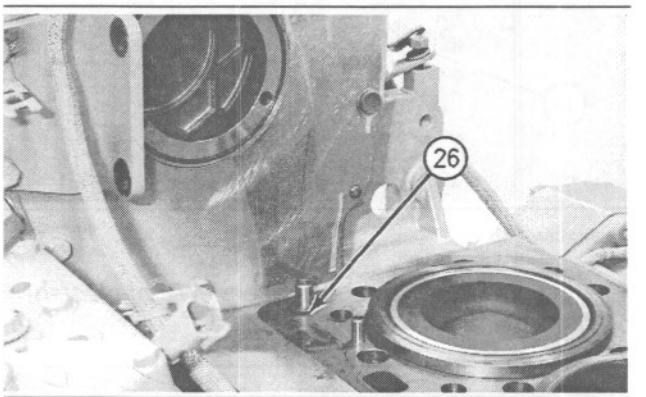

Illustration 162 g00632049

1. Apply a thin film of clean engine oil to O-ring seal (26). Install O-ring seal (26).

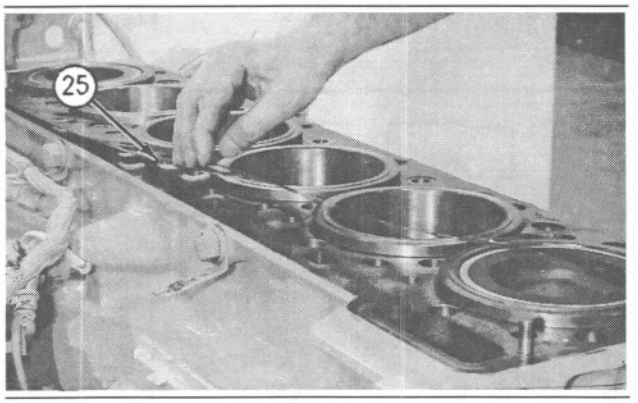

Illustration 163 g00632048

2. Install a new spacer plate gasket (25).

3. Install the spacer plate on the engine.

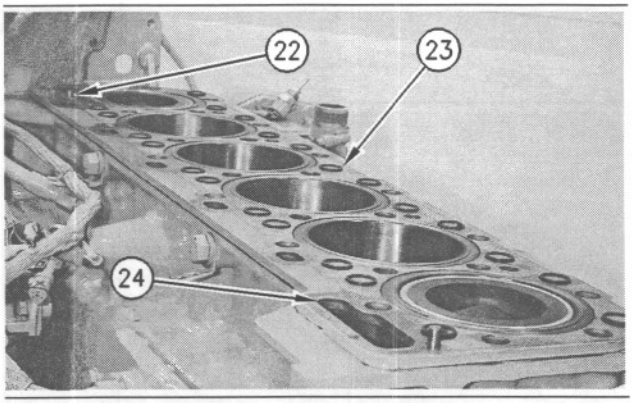

Illustration 164 g00632047

4. Apply a thin film of clean engine oil to O-ring seal (22). Install O-ring seal (22).

5. Install water seals (23) dry.

6. Install seal (24) in the spacer plate.

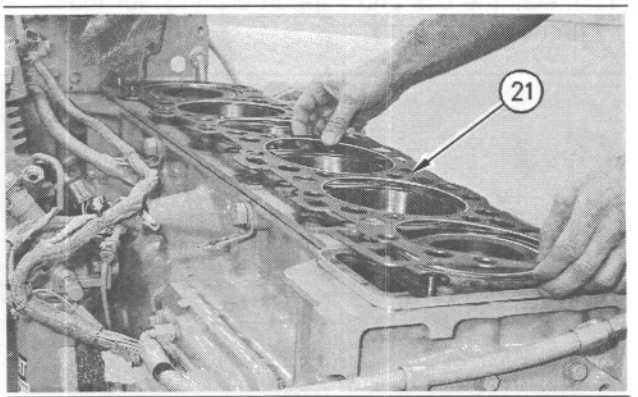

Illustration 165 g00580833

7. Install a new cylinder head gasket (21).

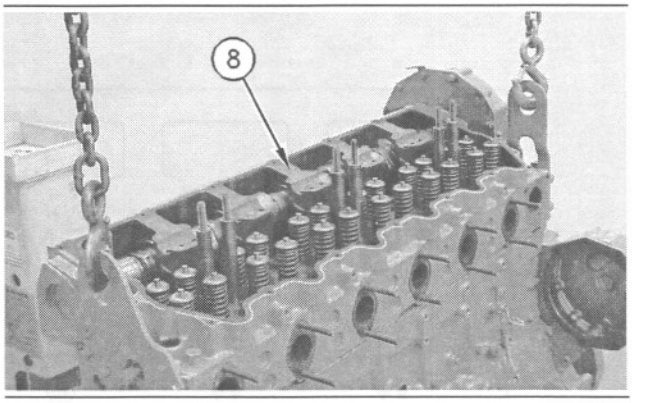

Illustration 166 g00580812

8. Attach a suitable lifting device to cylinder head (8). Carefully position cylinder head (8) on the spacer plate. The weight of the cylinder head is approximately 235 kg (518 lb).

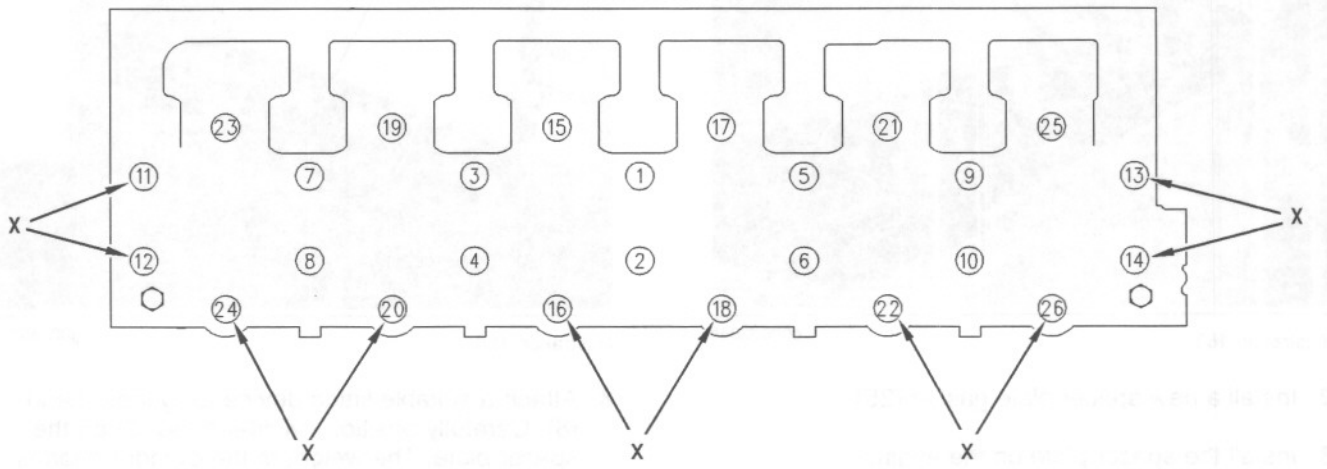

Illustration 167 g00513934

Note: The bolts that are Marked "X" are 216 mm (8.5 inch) long. The remainder of the bolts are 194 mm (7.6 inch) in length.

9. Apply Tooling (A) to the bolt threads and both sides of the washers. Install the cylinder head bolts. Tighten the cylinder head bolts, as follows.

a. In a numerical sequence, tighten bolts 1 through 26 to a torque of 270 ± 15 N·m (200 ± 11 lb ft).

b. In a numerical sequence, tighten bolts 1 through 26 to a torque of 450 ± 15 N·m (330 ± 11 lb ft).

c. In a numerical sequence, again tighten bolts 1 through 26 to a torque of 450 ± 15 N·m (330 ± 11 lb ft).

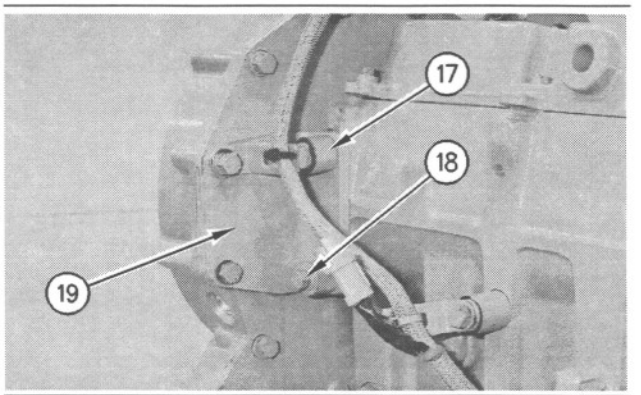

Illustration 168 g00580810

10. Install spacers (17) and bolts (18) that fasten bracket (19) to the cylinder head.

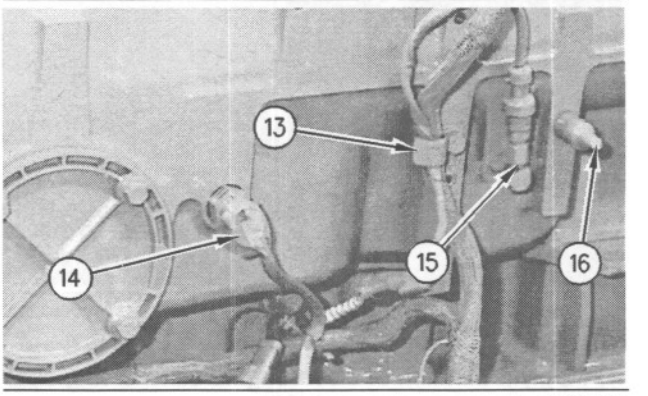

Illustration 169 g00580808

11. Connect the harness assembly to sensor (14), sensor (15), and ground stud (16).

12. Install the bolt and support clip (13) for the harness assembly.

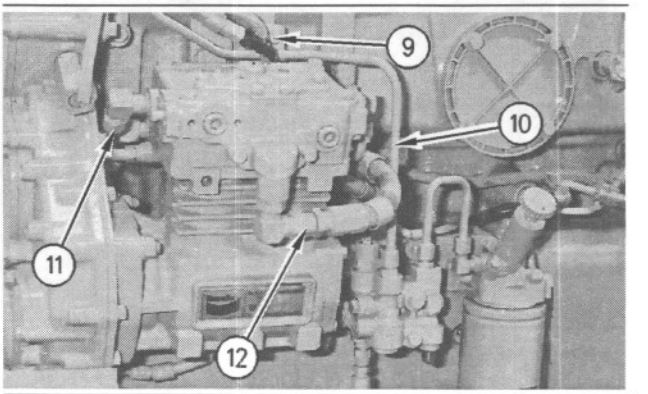

Illustration 170 g00580807

13. Install hose assemblies (10). Install the bolt and clamp (9).

Note: If the engine is not equipped with an air compressor, skip Step 14.

14. Connect hose assemblies (11) and hose assemblies (12) to the air compressor.

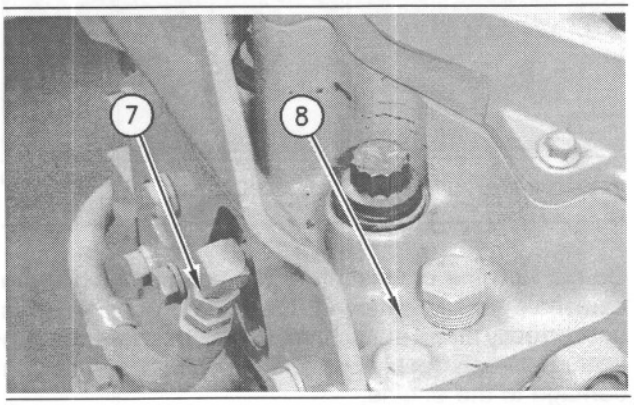

Illustration 171 g00580805

15. Connect hose assembly (7) to cylinder head (8).

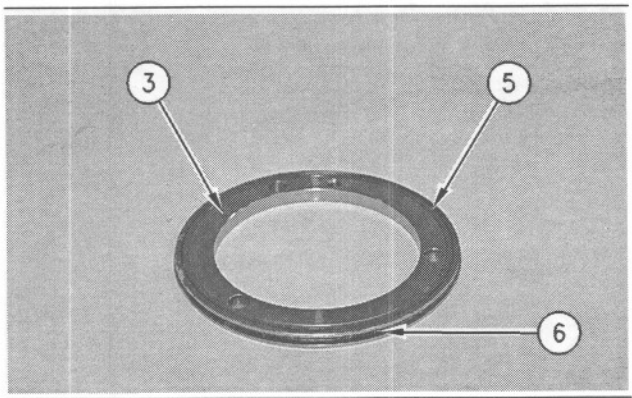

Illustration 172 g00576240

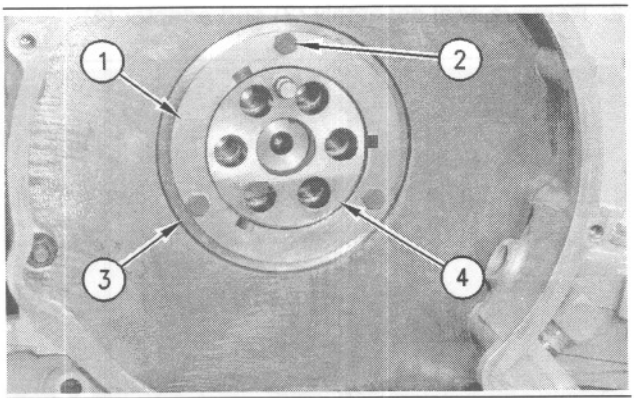

Illustration 173 g00576839

16. Install O-ring seals (5) and (6) in seal assembly (3). Lubricate seal (6) with Tooling (B).

17. Assemble thrust plate (1) and seal assembly (3). Apply Tooling (C) to bolts (2). Hold the assembly in position and install bolts (2). Evenly tighten bolts (2) until seal assembly (3) and O-ring seal (5) are seated against the cylinder head.

Note: Be careful in order to ensure that O-ring seal (5) stays in the groove in seal assembly (3).

18. Install adapter (4). Ensure that the dowel in adapter (4) engages the hole in the camshaft.

End By:

a. Install the water temperature regulator. Refer to Disassembly and Assembly, "Water Temperature Regulator - Remove and Install".

b. Install the valve mechanism cover base. Refer to Disassembly and Assembly, "Valve Mechanism Cover Base - Remove and Install".

c. Install the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

d. Install the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".

e. Install the electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".

f. Install the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

i02110801

Camshaft - Remove

SMCS Code: 1210-011

Removal Procedure

Table 39

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7257	Cradle	1
B	9U-7256	Guide	1
C	9U-7225	Camshaft Pilot	2
D	9U-7240	Camshaft Hook	2

Start By:

a. Remove the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

b. Remove the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

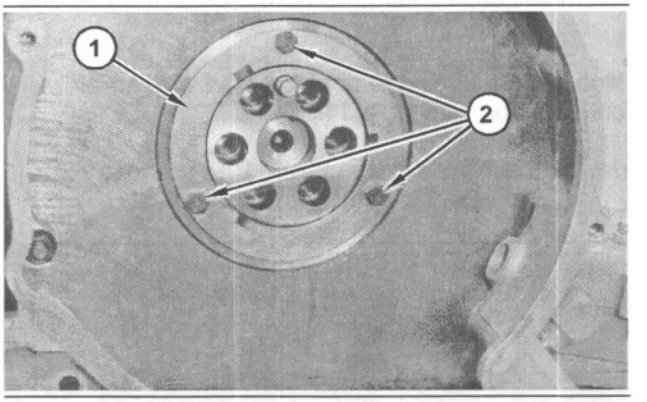

Illustration 174 g01028806

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

1. Remove bolts (2) and thrust plate (1).

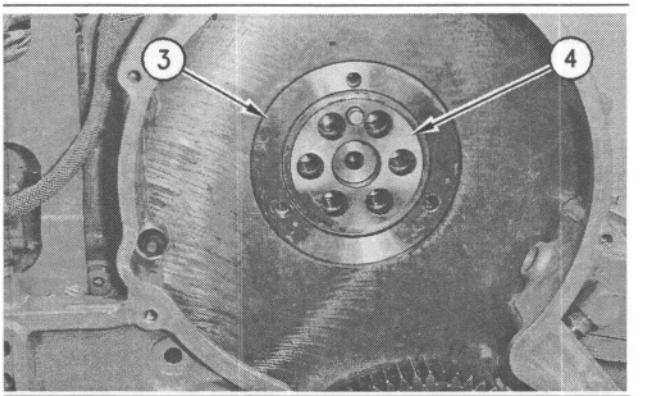

Illustration 175 g00576209

2. Remove seal assembly (3) and adapter (4).

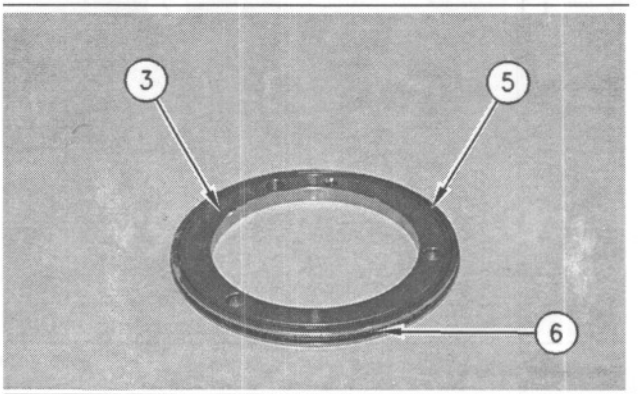

Illustration 176 g00576240

3. Remove O-ring seals (5) and (6) from seal assembly (3).

NOTICE
Care must be used when removing the camshaft to not damage the highly finshed surfaces of both the camshaft and camshaft bearings

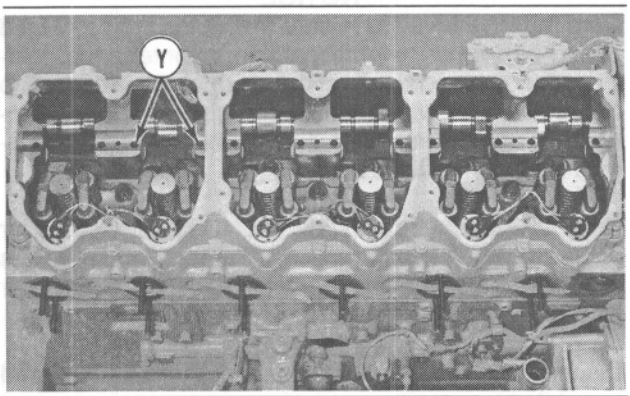

Illustration 177 g00509797

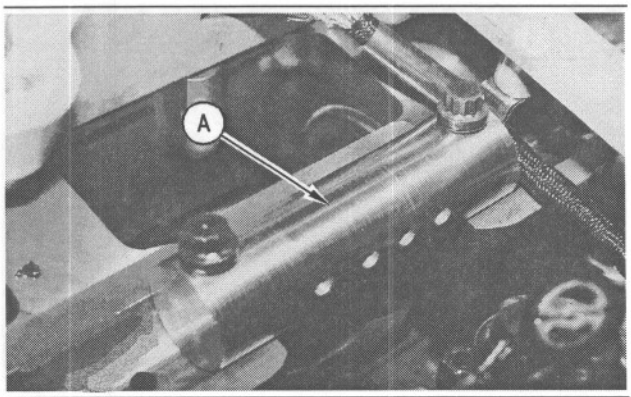

Illustration 178 g00581441

4. Use the bolts for the rocker arm shaft assembly to install Tooling (A) at Location (Y).

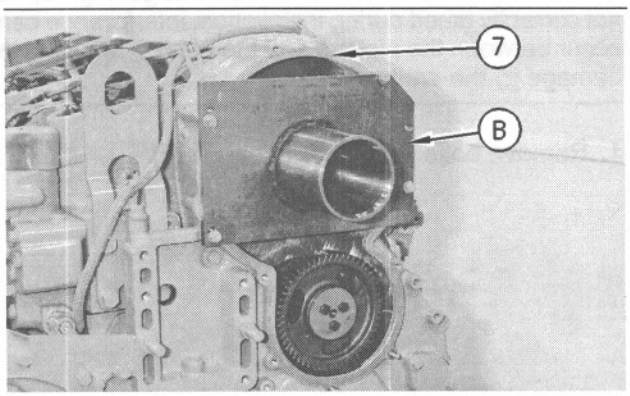

Illustration 179 g00581442

5. Install Tooling (B) on front housing (7). Do not tighten the bolts for Tooling (B) at this time.

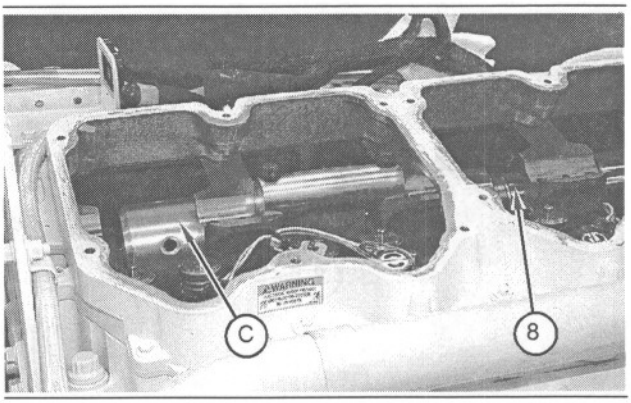

Illustration 180 g01074729

Note: It is necessary to install Tooling (C) on the camshaft. Tooling (C) will support the rear of camshaft (8) as the camshaft is moved out of the cylinder head and into Tooling (B).

6. Move camshaft (8) forward and install one Tooling (C) in the end of camshaft (8). Again, move the camshaft forward and install remaining Tooling (C) into the back of first Tooling (C).

7. Position camshaft (8) into the bore of Tooling (B). Tighten the bolts that hold Tooling (B) to the front housing.

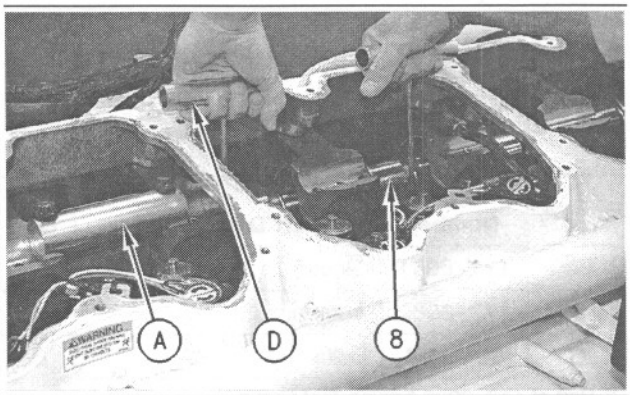

Illustration 181 g00581444

Note: Avoid lifting camshaft (8) with Tooling (D). The camshaft should rest on Tooling (A). Lifting of the camshaft can cause misalignment as the camshaft is removed, resulting in damage to the camshaft bearings.

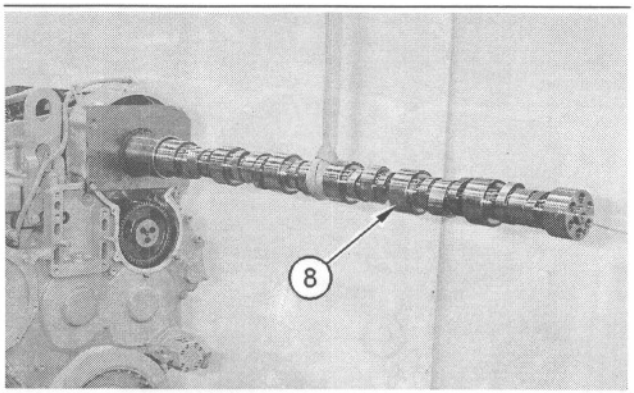

Illustration 182 g00581445

8. Remove camshaft (8), as follows:

   a. Use Tooling (D) to move camshaft (8) toward the front of the engine. Reposition Tooling (D), as needed.

   b. Move camshaft (8) far enough out of the cylinder head in order to attach a suitable lifting device.

   c. Keep the camshaft level while the camshaft is being removed from the cylinder head. The weight of the camshaft is approximately 39 kg (86 lb).

Alternative Removal Procedure

Table 40

Required Tools			
Tool	Part Number	Part Description	Qty
E(1)	177-8001	Sleeve	1
F	177-8002	Adapter	1
G	6L-4697	Bolts	3

(1) Part of 177-8003 Engine Tool Group

Start By:

a. Remove the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

b. Remove the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Remove".

Note: This is an optional procedure to remove the camshaft. The preceding tool list shows the required tooling for removing the camshaft from the front of the engine or the rear of the engine.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

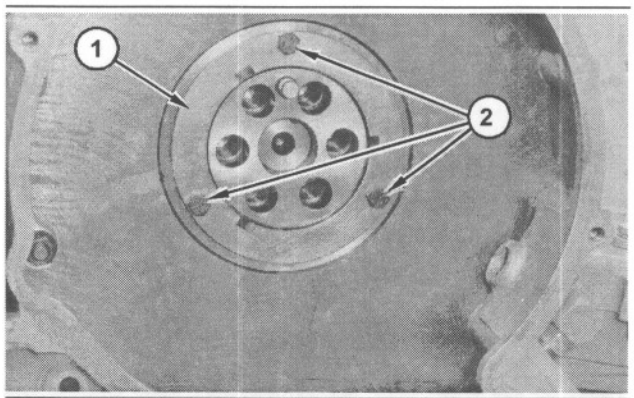

Illustration 183 g01028806

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

1. Remove bolts (2) and thrust plate (1).

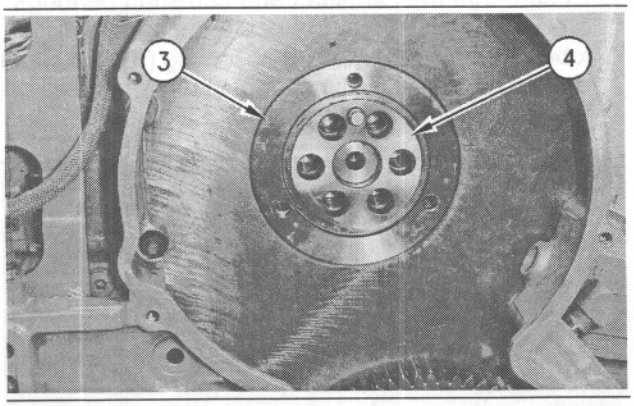

Illustration 184 g00576209

2. Remove seal assembly (3) and adapter (4).

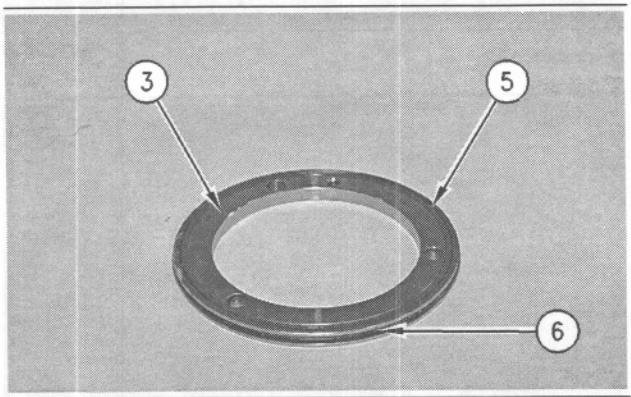

Illustration 185 g00576240

3. Remove O-ring seals (5) and (6) from seal assembly (3).

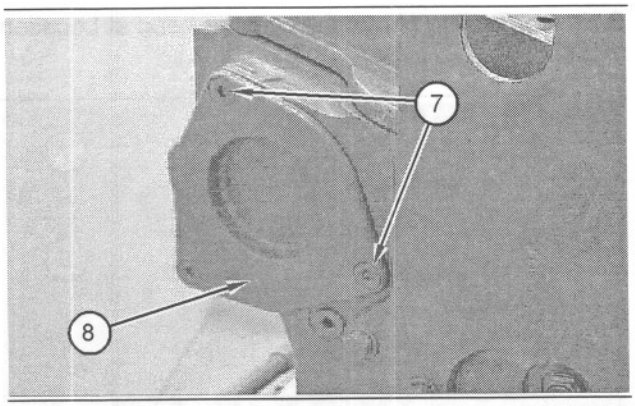

Illustration 186 g01043575

4. Remove screws (7) and cover (8).

NOTICE

Care must be used when removing the camshaft to not damage the highly finshed surfaces of both the camshaft and camshaft bearings

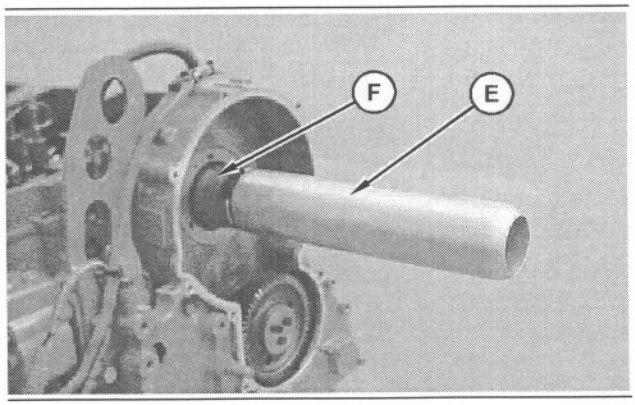

Illustration 187 g01024825

Note: Carefully align Tooling (F) with the end of the camshaft. If the adapter and the camshaft are not aligned, the camshaft may not be removed. The adapter and camshaft bearing will interfere.

5. To remove the camshaft from the rear of the engine, install Tooling (F) on the front of the camshaft with Tooling (G).

6. Install Tooling (E).

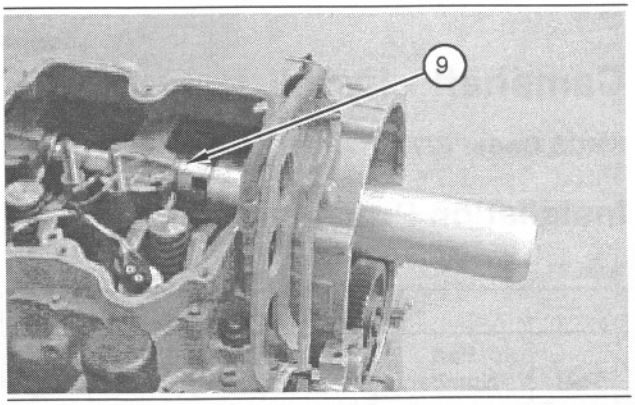

Illustration 188 g01043577

7. Carefully slide the camshaft to the rear of the engine for removal. Use two technicians to remove the camshaft. Keep the camshaft level while the camshaft is being removed from the cylinder head. The weight of the camshaft is approximately 39 kg (86 lb).

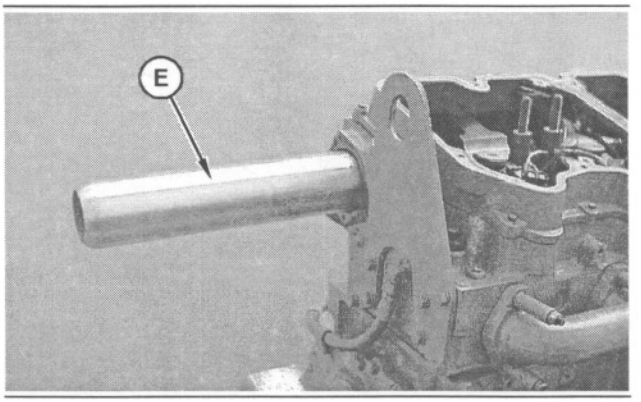

Illustration 189 g01024826

8. To remove the camshaft from the front of the engine, install Tooling (E) on the rear of the camshaft.

9. Carefully slide the camshaft to the front of the engine for removal. Use two technicians to remove the camshaft. Keep the camshaft level while the camshaft is being removed from the cylinder head. The weight of the camshaft is approximately 39 kg (86 lb).

i02020749

Camshaft - Install

SMCS Code: 1210-012

Installation Procedure

Table 41

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-7257	Cradle	1
B	9U-7256	Guide	1
C	9U-7225	Camshaft Pilot	2
D	9U-7240	Camshaft Hook	2
H	9U-7243	Alignment Sleeve	1
J	9S-3263	Thread Lock Compound	1
K	8T-2998	Lubricant	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the camshaft and camshaft bearings are thoroughly clean. Lubricate the camshaft lobes with a 50/50 mixture of Tooling (K) and clean engine oil. Apply a thin coat of clean engine oil on the camshaft bearings.

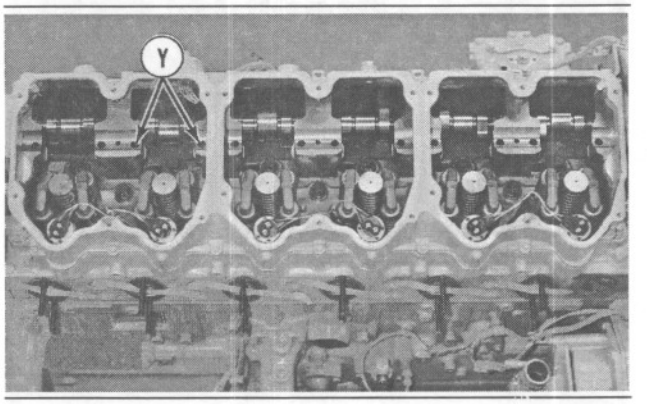

Illustration 190 g00509797

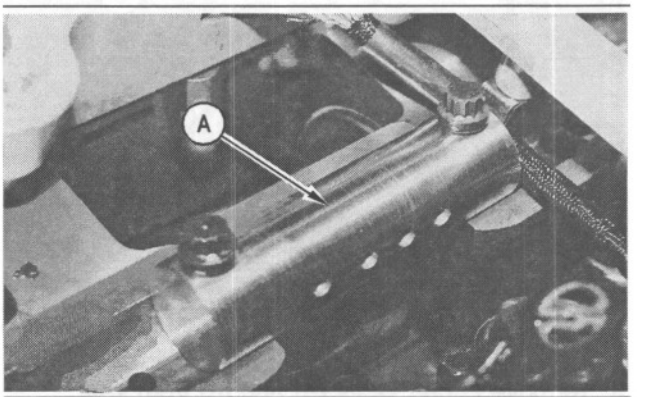

Illustration 191 g00581441

2. Install Tooling (A) on the cylinder head at Location (Y).

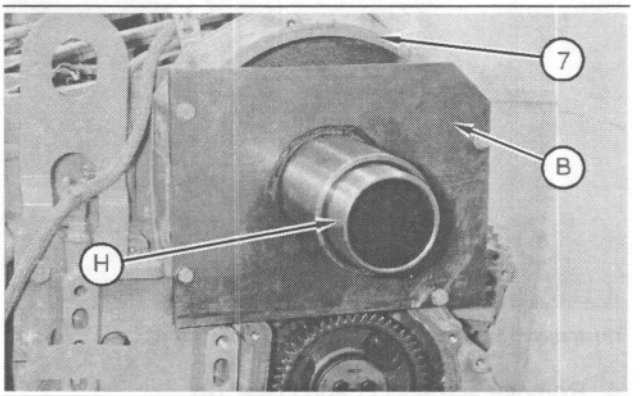

Illustration 192 g01024862

3. Install Tooling (B) on front housing (7). Do not tighten the bolts that hold Tooling (B) to front housing (7) at this time.

4. Use Tooling (H) to align Tooling (B) with the camshaft bearings. Tighten the bolts that hold Tooling (B) to front housing (7). Remove Tooling (H).

Note: Tooling (H) should move freely from the bore of Tooling (B).

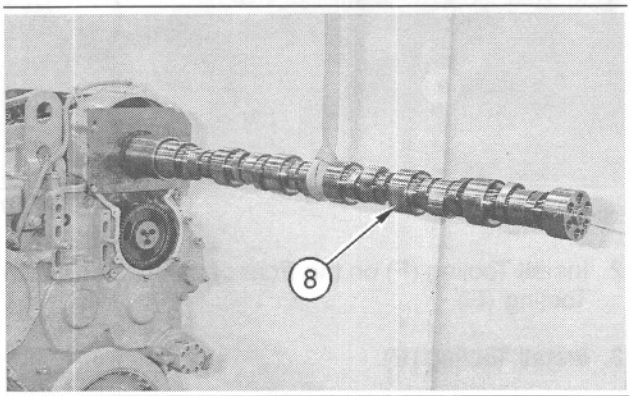

Illustration 193 g00581445

5. Install Tooling (C) in the end of camshaft (8).

Note: Rotate the camshaft during installation. This will prevent the camshaft from binding in the camshaft bearings.

6. Use a suitable lifting device in order to position camshaft (8) into Tooling (B) and the cylinder head. The weight of the camshaft is approximately 39 kg (86 lb).

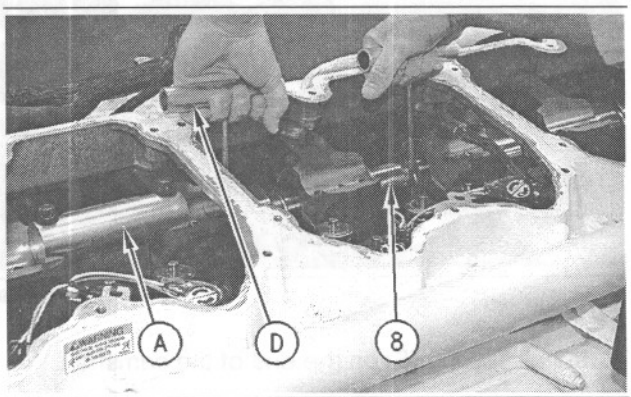

Illustration 194 g00581444

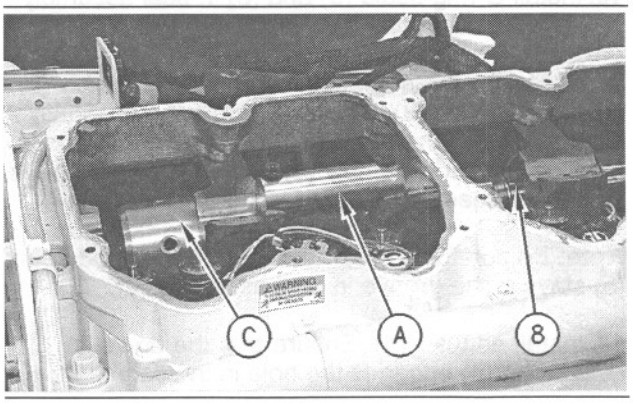

Illustration 195 g00581443

Note: Tooling (C) must be removed before the camshaft can be completely installed in the cylinder head.

7. Remove the lifting device. Rotate the camshaft during installation. Use care not to allow the end of the camshaft and Tooling (C) to drop. Use Tooling (D) to assist in aligning camshaft (8) with the camshaft bearings.

8. Remove Tooling (C) and finish installing camshaft (8) in the bore.

9. Remove Tooling (A) and Tooling (B).

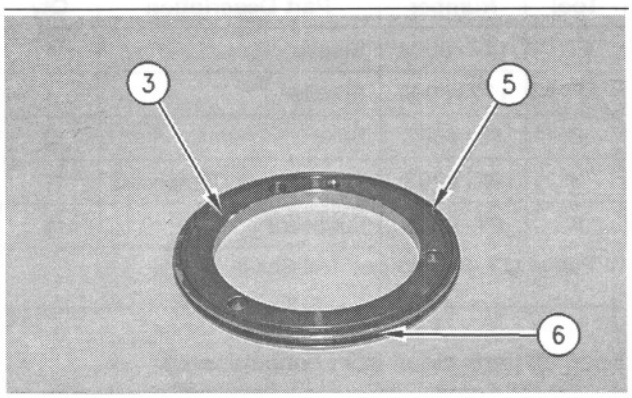

Illustration 196 g00576240

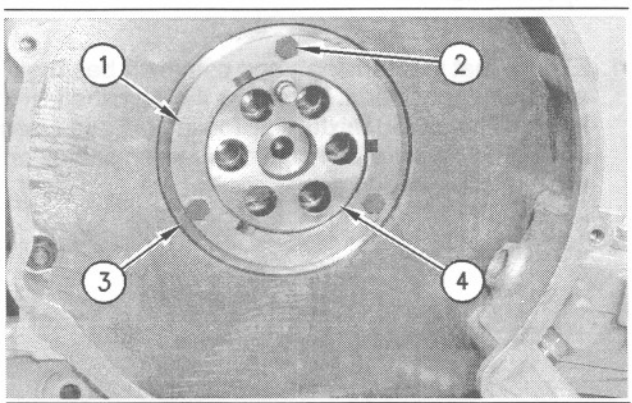

Illustration 197 g00576839

10. Install O-ring seals (5) and (6) in seal assembly (3). Lubricate seal (6) with Tooling (K).

11. Assemble thrust plate (1) and seal assembly (3). Apply Tooling (J) to bolts (2). Hold the assembly in position and install bolts (2). Evenly tighten bolts (2) until seal assembly (3) and O-ring seal (5) are seated against the cylinder head.

Note: Be careful in order to ensure that O-ring seal (5) stays in the groove in seal assembly (3).

12. Install adapter (4). Ensure that the dowel in adapter (4) engages the hole in the camshaft.

End By:

a. Install the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

b. Install the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

Alternative Installation Procedure

Table 42

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
E(1)	177-8001	Sleeve	1
F	177-8002	Adapter	1
G	6L-4697	Bolts	3
J	9S-3263	Thread Lock Compound	1
K	8T-2998	Lubricant	1

(1) Part of 177-8003 Engine Tool Group

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the camshaft and camshaft bearings are thoroughly clean. Lubricate the camshaft lobes with a 50/50 mixture of Tooling (K) and clean engine oil. Apply a thin coat of clean engine oil on the camshaft bearings.

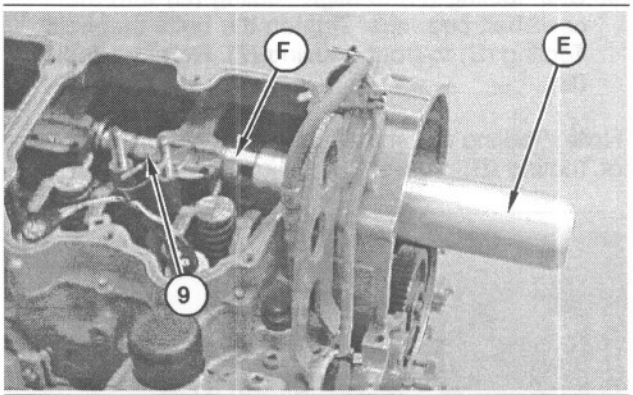

Illustration 198 g01043587

2. Install Tooling (F) on the front of camshaft (9) with Tooling (G).

3. Install Tooling (E).

4. Use two technicians to install the camshaft. Carefully slide camshaft (9) into the cylinder head from the rear of the engine. Keep the camshaft level while the camshaft is being installed in the cylinder head. The weight of the camshaft is approximately 39 kg (86 lb).

5. Remove Tooling (F).

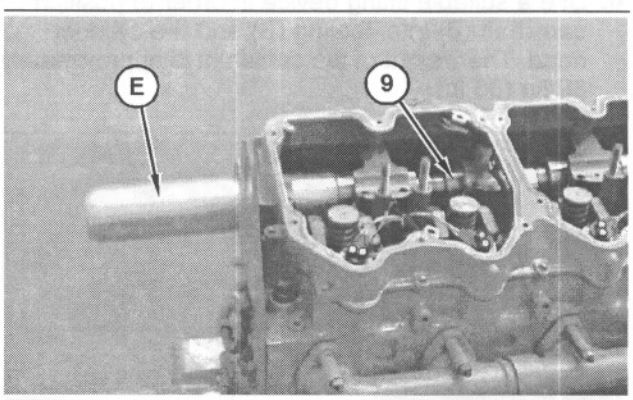

Illustration 199 g01043589

6. Install Tooling (F) on the end of the camshaft.

7. Use two technicians to install the camshaft. Carefully slide camshaft (9) into the cylinder head from the rear of the engine. Keep the camshaft level while the camshaft is being installed in the cylinder head. The weight of the camshaft is approximately 39 kg (86 lb).

8. Remove Tooling (F).

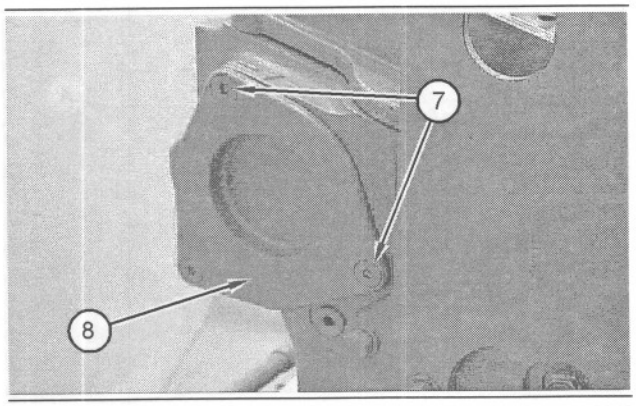

Illustration 200 g01043575

9. Position cover (8) on the rear of the cylinder head. Install bolts (7).

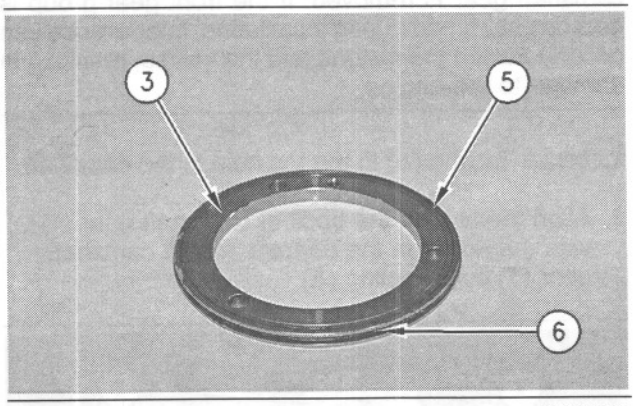

Illustration 201 g00576240

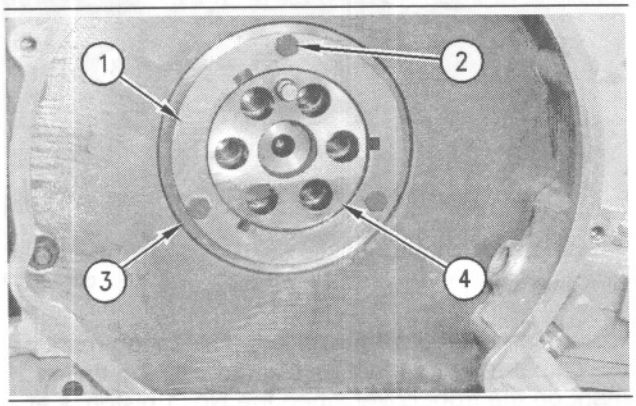

Illustration 202 g00576839

10. Install O-ring seals (5) and (6) in seal assembly (3). Lubricate seal (6) with Tooling (K).

11. Assemble thrust plate (1) and seal assembly (3). Apply Tooling (J) to bolts (2). Hold the assembly in position and install bolts (2). Evenly tighten bolts (2) until seal assembly (3) and O-ring seal (5) are seated against the cylinder head.

Note: Be careful in order to ensure that O-ring seal (5) stays in the groove in seal assembly (3).

12. Install adapter (4). Ensure that the dowel in adapter (4) engages the hole in the camshaft.

End By:

a. Install the rocker arms and the rocker shafts. Refer to Disassembly and Assembly, "Rocker Arm and Shaft - Install".

b. Install the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear - Remove and Install".

i02110882

Camshaft Gear - Remove and Install

SMCS Code: 1210-010-GE

Removal Procedure

Table 43

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-6896	Guide Bolt	1

Start By:

a. Remove the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove".

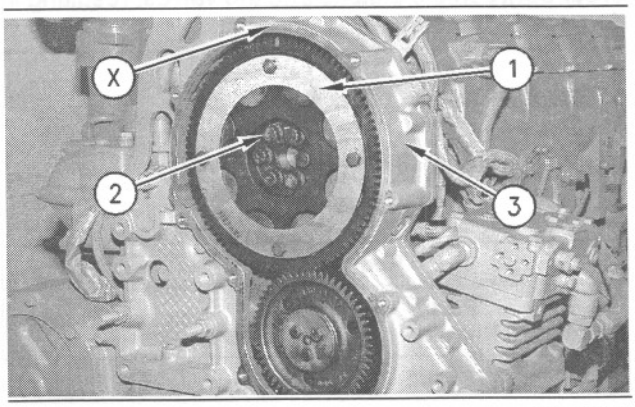

Illustration 203 g00579965

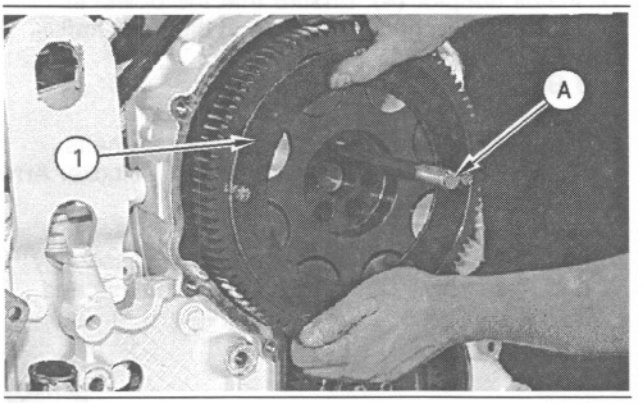

Illustration 204 g00579966

1. Position the No. 1 piston at the top center of the compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

2. Verify that the timing mark on camshaft gear (1) is aligned with Timing Mark (X) on front housing (3).

3. Remove top bolt (2) from camshaft gear (1). Install Tooling (A) in place of the bolt.

4. Remove remaining bolts (2) and remove camshaft gear (1).

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

5. Remove Tooling (A).

Installation Procedure

Table 44

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6896	Guide Bolt	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

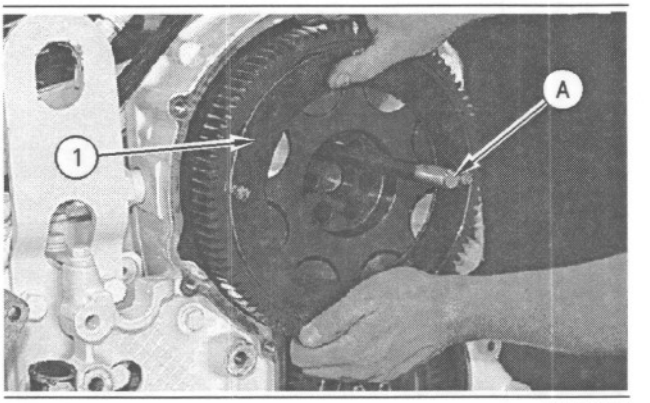

Illustration 205 g00579966

NOTICE
Do not turn the crankshaft or the camshaft while the camshaft gear is removed. If the front gear group is not correctly timed during installation, interference can occur between the pistons and the valves, resulting in damage to the engine.

1. Install Tooling (A) in the top hole in the camshaft.

2. Align the hole in the back of camshaft gear (1) with the dowel in the adapter. Install camshaft gear (1) over Tooling (A).

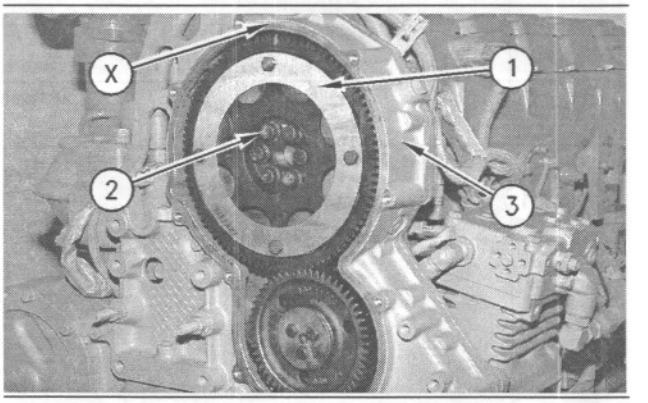

Illustration 206 g00579965

Note: Camshaft timing is critical. The timing mark on the camshaft gear must be aligned with the timing mark on the front cover when the No. 1 piston is at the top center of the compression stroke. Refer to Testing and Adjusting, "Gear Group (Front) - Time".

3. Verify that the timing mark on camshaft gear (1) is aligned with Timing Mark (X) on front housing (3).

Note: If the timing marks are not aligned, remove camshaft gear (1) and rotate the camshaft until the timing marks are aligned.

4. Install bolts (2). Remove Tooling (A) and install remaining bolt (2).

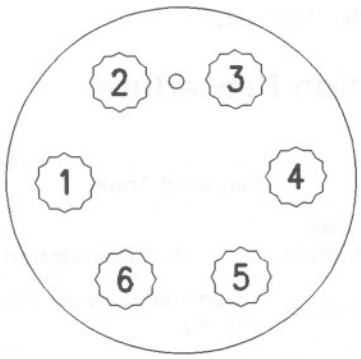

Illustration 207 g00593987

5. Tighten the bolts in a numeric sequence 1, 4, 2, 5, 3, 6, 1, 4 to a torque of 240 ± 40 N·m (180 ± 30 lb ft).

6. Check the backlash between the camshaft gear and the adjustable idler gear. The backlash should be 0.216 ± 0.114 mm (0.0085 ± 0.0045 inch). Refer to Testing and Adjusting, "Gear Group (Front) - Time" for the backlash adjustment procedure.

End By:

a. Install the front cover. Refer to Disassembly and Assembly, "Front Cover - Install".

i01995165

Camshaft Bearings - Remove

SMCS Code: 1211-011

Removal Procedure

Table 45

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	8S-2241	Camshaft Bearing Tool Group	1
	8S-8290	Nut	1
	8S-8291	Threaded Shaft	1
	8S-8287	Thrust Bearing Assembly	1
	8S-8288	Cone	1
	8S-8292	Extension (Short)	2
	8S-8293	Extension (Long)	1
B	9U-7222	Camshaft Bearing Pilot	1
	8M-8778	Taperlock Stud (1/2 inch - 13 UNC by 1 9/16 inch)	1
C	9U-7223	Alignment Bushing	1
D	9U-7210	Puller Plate	1

(1) Part of the 8S-2241 Camshaft Bearing Tool Group

Start By:

a. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

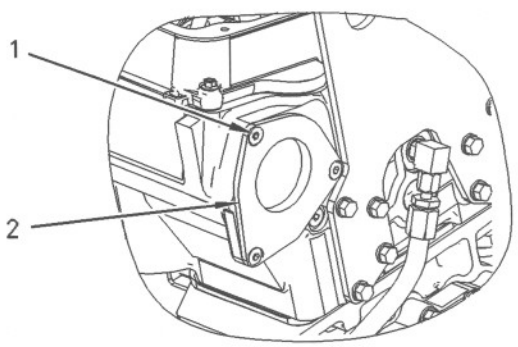

Illustration 208 g01005315

1. Remove bolts (1) from rear cover (2). Inspect the O-ring seal and replace the O-ring seal if the O-ring seal is worn or damaged.

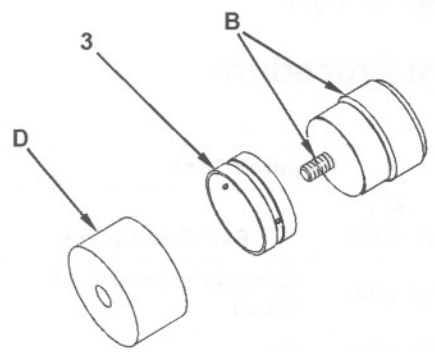

Illustration 209 g01034895

2. Remove the No. 7 camshaft bearing (rear). Work from the rear of the engine to the front of the engine.

3. Install the small end of Tooling (B) in the camshaft bearing.

4. Position Tooling (D) on Tooling (A). Install Tooling (A) on Tooling (B).

Note: Tooling (D) is installed on the outside of the cylinder head. Tooling (D) is required in order to remove the No. 7 camshaft bearing from the cylinder head.

5. Use Tooling (A) to remove camshaft bearing (3) from the cylinder head.

6. Remove Tooling (B) from Tooling (A) and remove the camshaft bearing.

7. Repeat Step 3 through Step 6 in order to remove the remaining camshaft bearings. Work from the rear of the engine to the front of the engine.

i01995166

Camshaft Bearings - Install

SMCS Code: 1211-012

Installation Procedure

Table 46

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A(1)	8S-2241	Camshaft Bearing Tool Group	1
	8S-8290	Nut	1
	8S-8291	Threaded Shaft	1
	8S-8287	Thrust Bearing Assembly	1
	8S-8288	Cone	1
	8S-8292	Extension (Short)	2
	8S-8293	Extension (Long)	1
B	9U-7222	Camshaft Bearing Pilot	1
	8M-8778	Taperlock Stud (1/2 inch - 13 UNC by 1 9/16 inch)	1
C	9U-7223	Alignment Bushing	1
D	9U-7210	Puller Plate	1
E	9U-7213	Backup Plate	1
	0S-1621	Bolt (1/2 inch - 13 UNC by 1 inch)	1
F	9U-7214	Spacer Plate	1

(1) Part of the 8S-2241 Camshaft Bearing Tool Group

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Ensure that the inside of the cylinder head is clean. Inspect the camshaft bore for metal burrs. Put a thin film of clean engine oil on the inside of the camshaft bearing bores and on each camshaft bearing prior to installation.

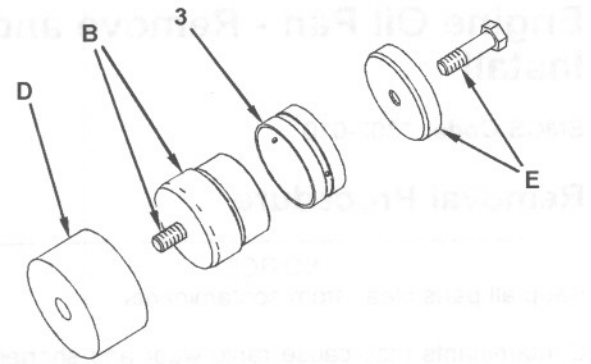

Illustration 210 g01034920

1. Install the No. 7 camshaft bearing (rear), as follows:
   a. Insert the large end of Tooling (B) into the No. 7 camshaft bore. Position camshaft bearing (3) on Tooling (B).
   b. Position Tooling (D) on Tooling (A). Install Tooling (A) in Tooling (B).
   c. Position camshaft bearing (3) on Tooling (B). Install Tooling (E) on Tooling (B).

Note: Refer to Specifications, "Cylinder Head" for appropriate information for the orientation of the camshaft bearings in the cylinder head.

   d. Use Tooling (A) in order to pull camshaft bearing (3) into the camshaft bore.

Note: When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

   e. Remove Tooling (E) from Tooling (B). Remove Tooling (A) from Tooling (B). Remove Tooling (B) from the cylinder head.

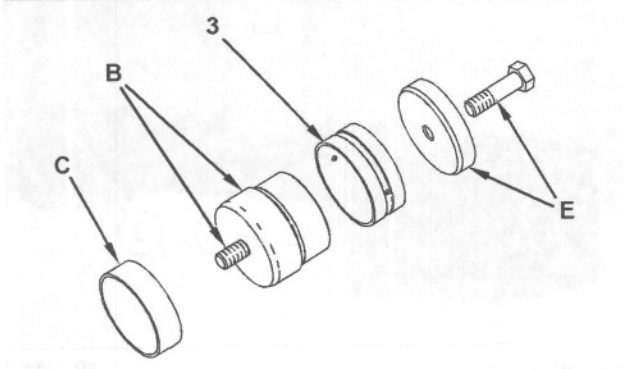

Illustration 211 g01034921

2. Install the No. 6 through No. 2 camshaft bearings, as follows:
   a. Insert the large end of Tooling (B) into the camshaft bore.

Note: Use Tooling (C) to align Tooling (A) and Tooling (B) with the camshaft bearing bores. Install Tooling (C) in the inside diameter of any installed camshaft bearing between Tooling (A) and Tooling (B).

   b. Install Tooling (A) in Tooling (B). Position camshaft bearing (3) on Tooling (B). Install Tooling (E) on Tooling (B).

Note: Refer to Specifications, "Cylinder Head" for appropriate information for the location and the orientation of the camshaft bearings in the cylinder head.

   c. Use Tooling (A) in order to pull camshaft bearing (3) into the camshaft bore.

Note: When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

   d. Remove Tooling (E) from Tooling (B). Remove Tooling (A) from Tooling (B).
   e. Remove Tooling (B) and Tooling (C) from the cylinder head.

3. Repeat Step 2 in order to install the No. 6 through No. 2 camshaft bearings.

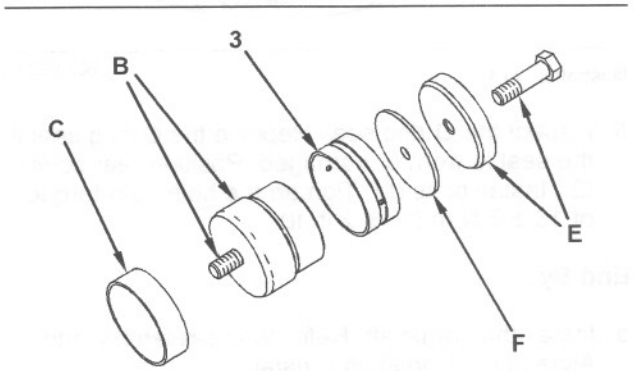

Illustration 212 g01034922

4. Install the No. 1 camshaft bearing (front), as follows:
   a. Insert the large end of Tooling (B) into the No. 1 camshaft bore. Assemble Tooling (A) and Tooling (C) on Tooling (B).
   b. Position camshaft bearing (3) on Tooling (B). Install Tooling (E) and Tooling (F) on Tooling (B).

Note: Refer to Specifications, "Cylinder Head" for appropriate information for the location and the orientation of the camshaft bearings in the cylinder head.

Note: Tooling (F) is used to seat the No. 1 camshaft bearing to the correct depth in the camshaft bore.

c. Use Tooling (A) in order to pull the No. 1 camshaft bearing into the No. 1 camshaft bore. When the chamfer of Tooling (E) contacts the face of the camshaft bore, the camshaft bearing is properly installed.

d. Remove Tooling (E) and Tooling (F) from Tooling (B). Remove Tooling (A) from Tooling (B).

e. Remove Tooling (B) and Tooling (C) from the cylinder head.

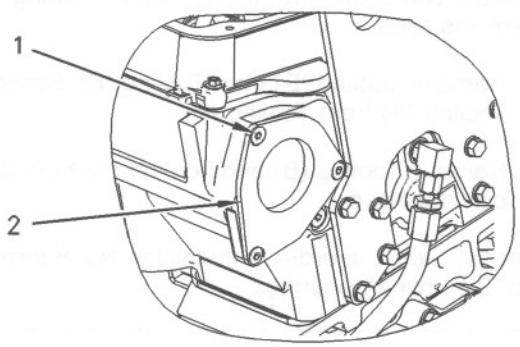

Illustration 213 g01005315

5. Inspect the O-ring seal. Replace the O-ring seal if the seal is worn or damaged. Position rear cover (2). Install bolts (1). Tighten the bolts to a torque of 13 ± 3 N·m (10 ± 2 lb ft).

End By:

a. Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Install".

i01974881

Engine Oil Pan - Remove and Install

SMCS Code: 1302-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

1. Drain the oil from the engine oil pan into a suitable container for storage or disposal.

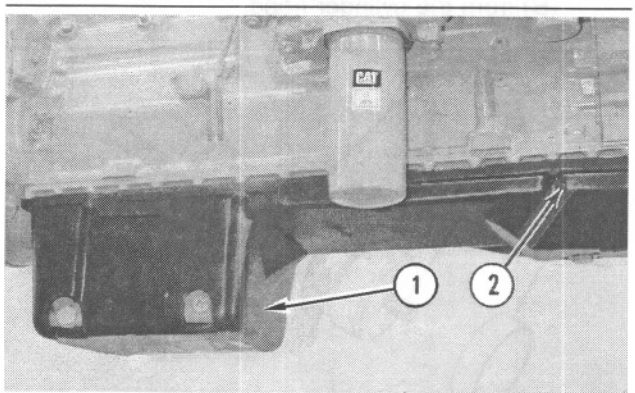

Illustration 214 g00516605

2. Remove bolts (2) and remove sound suppression panel (1), if equipped.

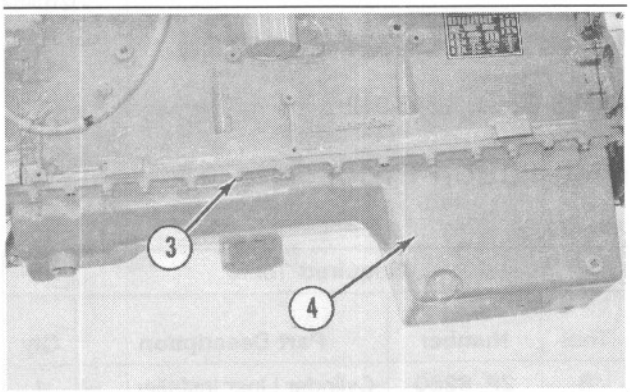

Illustration 215 g00516607

3. Remove bolts (3) that fasten engine oil pan (4) to the cylinder block.

4. Remove engine oil pan (4).

5. Some engines are equipped with a plate between the engine oil pan and the cylinder block. Remove the bolts and the plate from the cylinder block. Remove the plate gasket. The weight of the plate is approximately 24 kg (53 lb).

Installation Procedure

Table 47

Required Tools			
Tool	Part Number	Part Description	Qty
A	8T-9022	Silicone Gasket	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Apply Tooling (A) on the sealing surface of the engine oil pan and on the connecting joints of the front plate, oil pan gasket, cylinder block, and the flywheel housing. Install a new gasket on the engine oil pan.

2. Position a new gasket on the cylinder block and install the plate, if equipped. The weight of the plate is approximately 24 kg (53 lb).

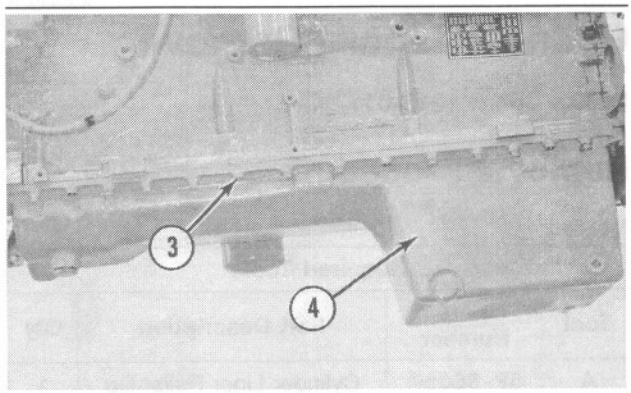

Illustration 216 g00516607

3. Position engine oil pan (4) and install bolts (3). Tighten bolts (3) to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

4. Tighten the drain plug to a torque of 70 ± 15 N·m (52 ± 11 lb ft).

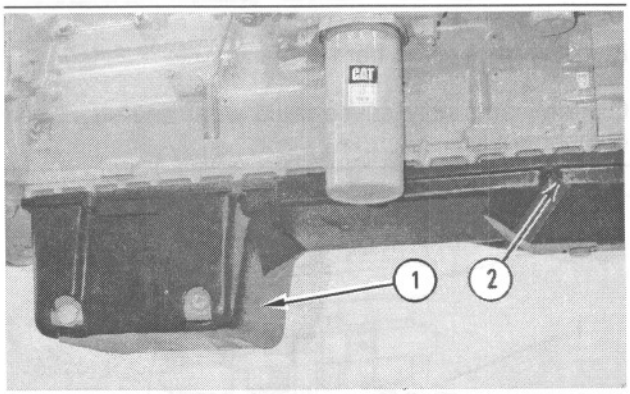

Illustration 217 g00516605

5. If the engine is equipped with a sound suppression panel, position sound suppression panel (1) and install bolts (2).

6. Fill the engine to the correct level with oil. Refer to Operation and Maintenance Manual, "Refill Capacities".

i02000204

Cylinder Liner - Remove

SMCS Code: 1216-011

Removal Procedure

Table 48

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-8665(1)	Cylinder Liner Puller Gp	1

(1) The 6V-9448 Cylinder Pack Puller is an optional Tool for removing the cylinder liner.

Start By:

a. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

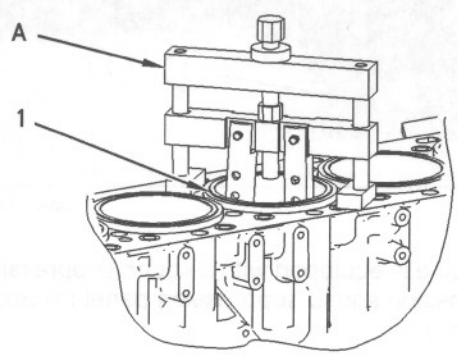

Illustration 218 g01005579

1. Remove cylinder liner (1) with Tooling (A).

i02110914

Cylinder Liner - Install

SMCS Code: 1216-012

Installation Procedure

Table 49

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	2P-8260	Cylinder Liner Installer	1
C	5P-3975	Rubber Lubricant	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Check the cylinder liner projection. Refer to Testing and Adjusting, "Cylinder Liner Projection - Inspect".

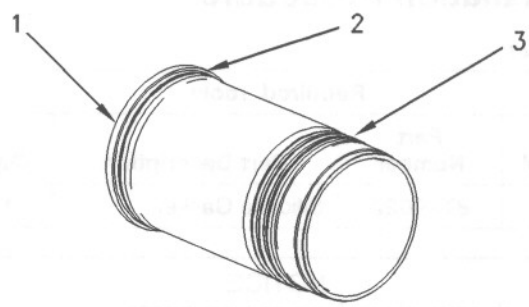

Illustration 219 g01004993

2. Install liner seals (3) in the respective grooves.

3. Apply Tooling (C) on the cylinder block liner bore surfaces and liner seals (3).

4. Dip filler band (2) in clean engine oil for a moment. Install filler band (2) and install cylinder liner (1) immediately.

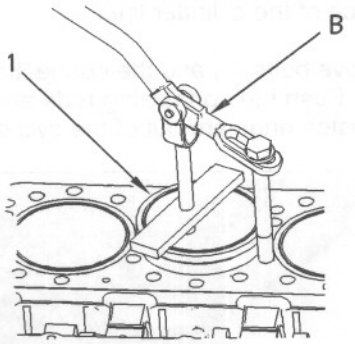

Illustration 220 g01005003

5. Use Tooling (B) to install cylinder liner (1) in the cylinder block. Ensure that any marks in relation to the cylinder liner projection are in alignment.

Note: Refer to Special Instruction, SEHS9564 for more information about cylinder liner installation.

End By:

a. Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Install".

i01974937

Piston Cooling Jets - Remove and Install

SMCS Code: 1331-010

Removal Procedure

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

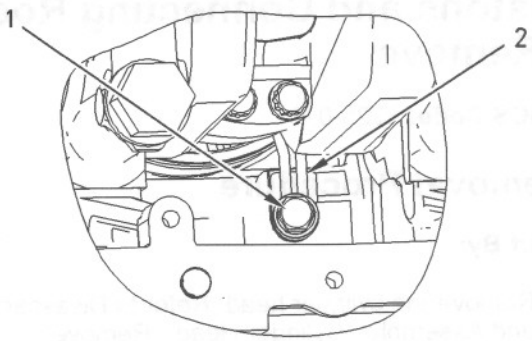

Illustration 221 g01004705

1. Remove bolt (1) and piston cooling jet (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

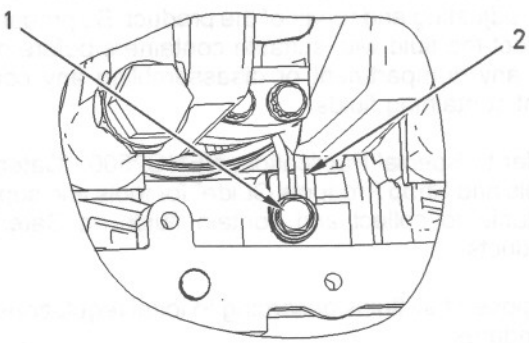

Illustration 222 g01004705

1. Install piston cooling jet (2) and bolt (1). Tighten bolt (1) to a torque of 40 ± 8 N·m (30 ± 6 lb ft).

2. Check the clearance between the piston, the piston cooling jet, and the crankshaft.

   Minimum permissible clearance between the piston, the piston cooling jet, and the crankshaft ..... 0.63 mm (0.025 inch)

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i01098970

Pistons and Connecting Rods - Remove

SMCS Code: 1225-011

Removal Procedure

Start By:

a. Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

b. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

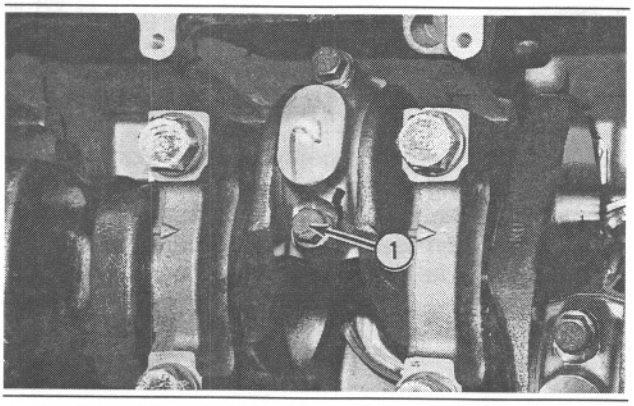

Illustration 223 g00506275

1. Turn the crankshaft until two pistons are at the bottom center.

2. Remove the carbon ridge from the top inside surface of the cylinder liner.

3. Remove bolts (1) and the connecting rod bearing caps. Push the connecting rods and pistons until the piston rings are out of the cylinder liners.

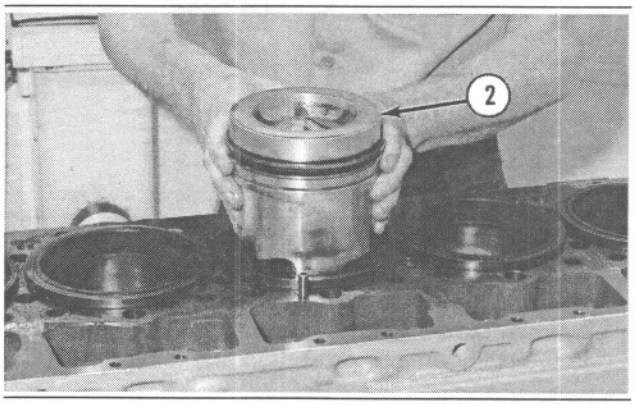

Illustration 224 g00506229

4. Remove pistons (2) and connecting rods from the cylinder liners.

5. Repeat Steps 1 through 4 in order to remove the remainder of the pistons and connecting rods.

i01974944

Pistons and Connecting Rods - Disassemble

SMCS Code: 1225-015

Disassembly Procedure

Table 50

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-1861[1] or 139-9039[2]	Retaining Ring Pliers	1
B	7M-3978[3] or 149-7179[4]	Ring Expander	1

(1) Use with one-piece piston
(2) Use with two-piece piston
(3) Use with C-15 Engines
(4) Use with C-16 Engines

Start By:

a. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Remove" for the procedure.

Note: Mark the components of each piston and connecting rod assembly. The components must be reinstalled in the original location. Do not interchange components.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

One-piece piston

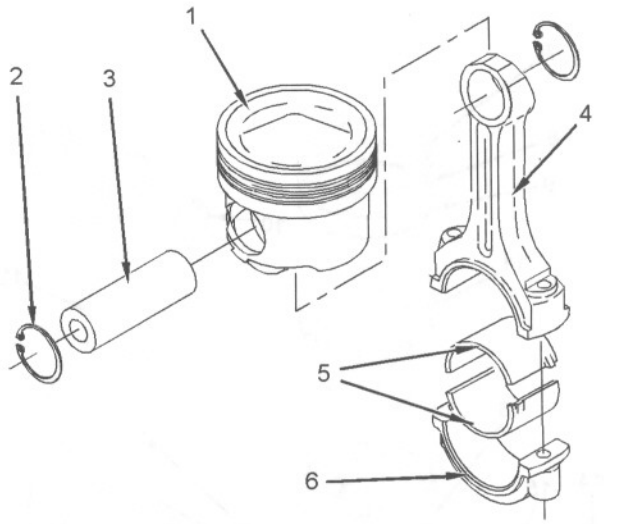

Illustration 225 g01033568

1. Remove bearings (5) from connecting rod (4) and connecting rod cap (6).

2. Use Tooling (A) to remove retaining ring (2).

3. Remove pin (3) and separate piston (1) from connecting rod (4).

4. Use Tooling (B) to remove the piston rings from piston (1).

Two-piece piston

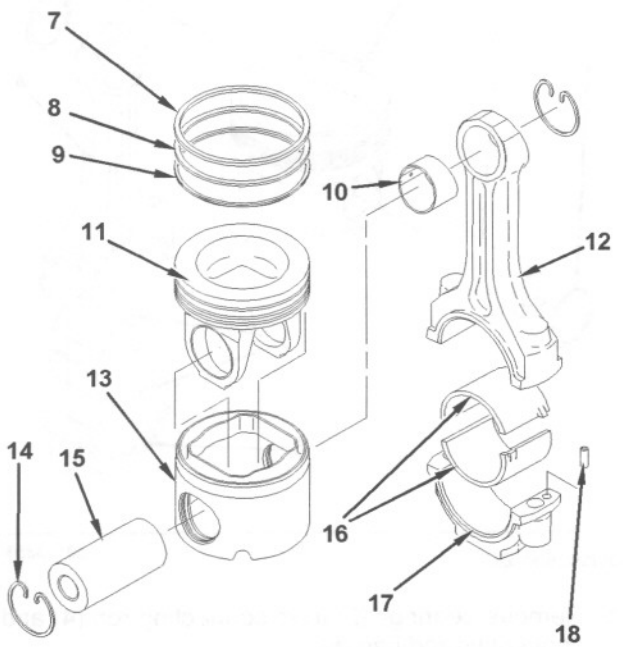

Illustration 226 g01033611

1. Remove bearings (16) from connecting rod (12) and connecting rod cap (17). Remove dowel (18) from connecting rod cap (17).
2. Use Tooling (A) to remove retaining ring (14).
3. Remove pin (15) and connecting rod (12) from the piston.
4. Use Tooling (B) to remove piston rings (7), (8), and (9) from the piston.
5. Separate piston crown (11) from piston skirt (13).

Note: Piston pin bearing (10) will be pushed out of connecting rod (12) during installation of the new bearing. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Assemble" for the procedure.

i02110984

Pistons and Connecting Rods - Assemble

SMCS Code: 1225-016

Assembly Procedure

Table 51

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1861[1] or 139-9039[2]	Retaining Ring Pliers	1
B	7M-3978[3] or 149-7179[4]	Ring Expander	1
C	5P-8639	Hydraulic Press (Connecting Rod Bearing)	1
	8F-0024	Hose Assembly	1
	1P-2375	Connecting Coupler	1
	1P-2376	Connecting Coupler	1
	5P-8651	Spacer	1
	5P-8649	Adapter	1
	8P-8650	Bushing Adapter	1
	9U-6600	Hydraulic Pump	1

(1) Use with one-piece piston
(2) Use with two-piece piston
(3) Use with C-15 Engines
(4) Use with C-16 Engines

Note: Prior to removal from the engine, the pistons and connecting rod assemblies were marked. The components must be reassembled together. The components must be installed in the original location in the engine. Do not interchange any of the components.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

One-piece piston

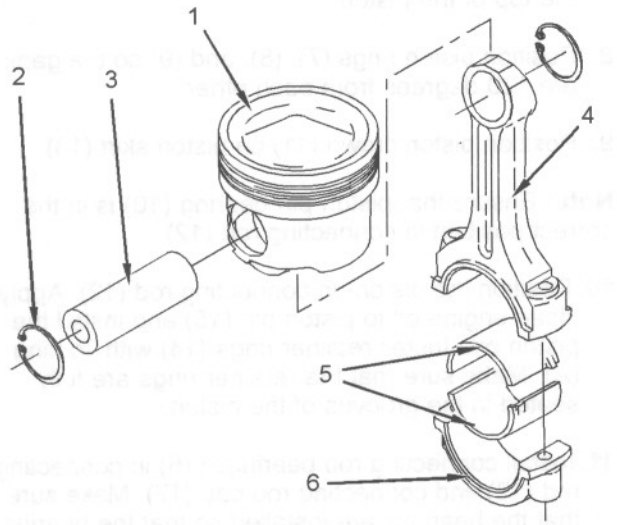

Illustration 227 g01033568

1. Use Tooling (B) to install the piston rings on piston (1). Position the rings so the gaps are 120 degrees from each other.
2. Assemble piston (1) and connecting rod (4). Install pin (3).
3. Use Tooling (A) to install retaining ring (2).
4. Install bearings (5) in connecting rod (4) and connecting rod cap (6).

Two-piece piston

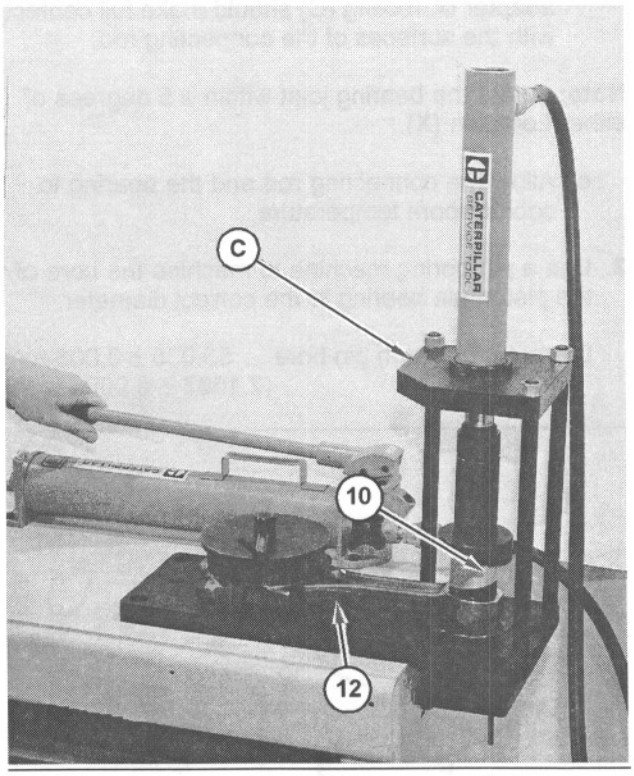

Illustration 228 g01033642

1. Install a new piston pin bearing (10) in connecting rod (12) and remove the old piston pin bearing, as follows:

NOTICE
The connecting rod must be heated for the installation of the piston pin bearing. Do not use a torch.

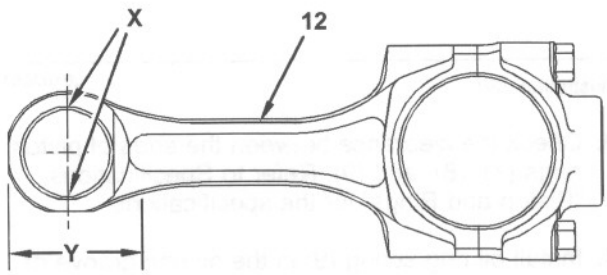

Illustration 229 g01033643

a. Heat Length (Y) of connecting rod (12) to a temperature of 175 to 260 °C (347 to 468 °F).

(Y) Maximum Length for heating the connecting rod ..... 85 mm (3.4 inch)

b. Use Tooling (C) to remove the old bearing and install the new bearing at the same time. The adapter of Tooling (C) should make full contact with the surfaces of the connecting rod.

Note: Orient the bearing joint within ± 5 degrees of either Location (X).

c. Allow the connecting rod and the bearing to cool to room temperature.

2. Use a pin boring machine to machine the bore of the piston pin bearing to the correct diameter.

Diameter of piston pin bore ... 55.035 ± 0.008 mm (2.1667 ± 0.0003 inch)

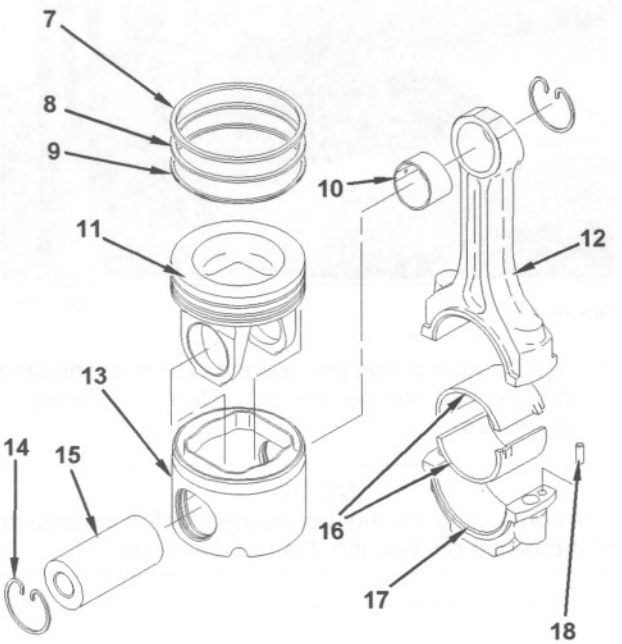

Illustration 230 g01033611

3. Check the clearance between the ends of piston rings (7), (8), and (9). Refer to Specifications, "Piston and Rings" for the specifications.

4. Install oil ring spring (9) in the oil ring groove of the piston.

5. Position oil ring (9) over the oil ring spring. Position the oil ring so that the gap is 180 degrees from the joint in the oil ring spring. Install the oil ring on the piston with Tooling (B).

6. Use Tooling (B) to install intermediate piston ring (8) with the side that has the identification "UP-2" toward the top of the piston.

7. Use Tooling (B) to install top piston ring (7) with the side that has the identification "UP-1" toward the top of the piston.

8. Position piston rings (7), (8), and (9) so the gaps are 120 degrees from each other.

9. Position piston crown (11) on piston skirt (13).

Note: Ensure that piston pin bearing (10) is in the correct position in connecting rod (12).

10. Position the piston on connecting rod (12). Apply clean engine oil to piston pin (15) and install the piston pin. Install retainer rings (14) with Tooling (A). Make sure that the retainer rings are fully seated in the grooves of the piston.

11. Install connecting rod bearings (16) in connecting rod (12) and connecting rod cap (17). Make sure that the bearings are installed so that the bearing tabs fit into the notches in the connecting rod and in the connecting rod cap.

12. Install dowel (18) in connecting rod cap (17).

End By:

a. Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Install" for the procedure.

i02113073

Pistons and Connecting Rods - Install

SMCS Code: 1225-012

Installation Procedure

Table 52

Required Tools			
Tool	Part Number	Part Description	Qty
A	5P-3526 or 149-7180	Piston Ring Compressor	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

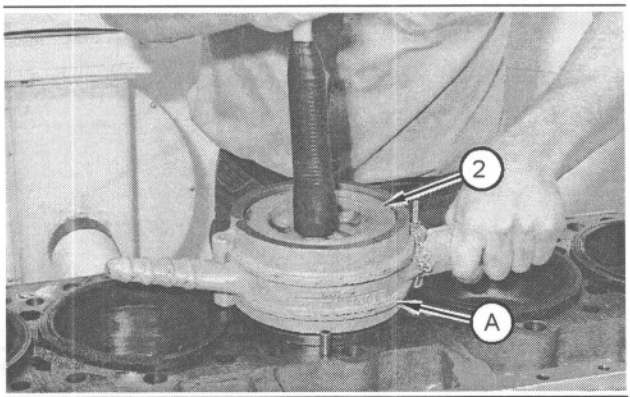

Illustration 231 g01076408

1. Apply clean engine oil to the cylinder liner bore, to the piston rings, and to the outer surface of the piston.

Note: Be careful not to damage the cylinder liners and/or the crankshaft journals during the installation of the pistons and the connecting rods.

2. Use Tooling (A) to install piston (2) and the connecting rod in the cylinder liner.

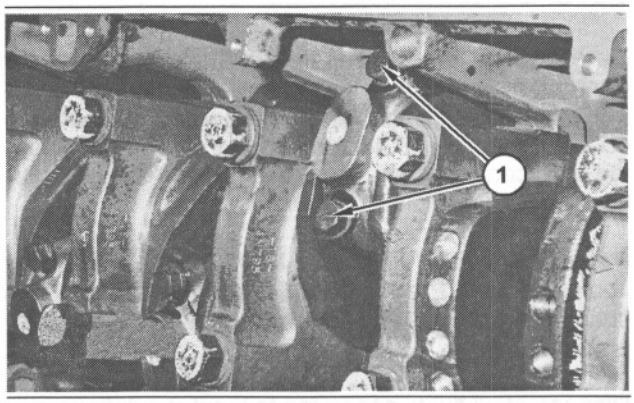

Illustration 232 g01032888

3. Install bolts (1) and the bearing caps. Refer to Specifications, "Connecting Rod" for the correct tightening procedure.

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

i01934239

Connecting Rod Bearings - Remove

SMCS Code: 1219-011

Removal Procedure

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

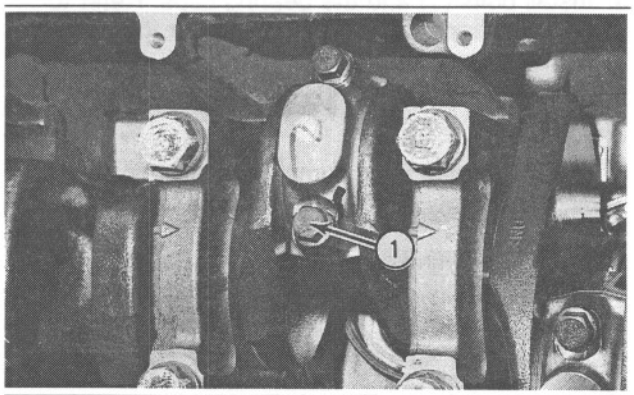

Illustration 233 g00506275

1. Turn the crankshaft until the connecting rod bearing caps are accessible.
2. Check the connecting rod and the connecting rod bearing caps for identification and for the location.
3. Remove bolts (1) and the connecting rod bearing cap from the connecting rod. Remove the lower half of the connecting rod bearing from the connecting rod bearing cap.
4. Push the connecting rod away from the crankshaft. Remove the upper half of the connecting rod bearing from the connecting rod.
5. Repeat Steps 1 through 4 for the removal of the remainder of the connecting rod bearings.

i02113102

Connecting Rod Bearings - Install

SMCS Code: 1219-012

Installation Procedure

Table 53

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3989	Anti-Seize Compound	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

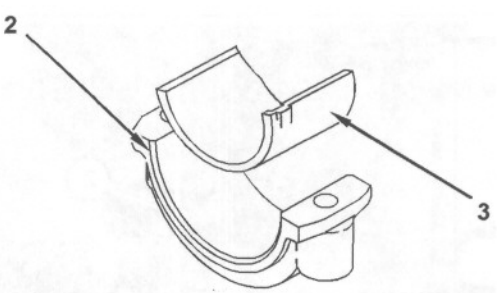

Illustration 234 g01029039

Note: Install the connecting rod bearings dry when clearance checks are performed. Apply clean engine oil on the connecting rod bearings for final assembly.

1. Install a new lower half connecting rod bearing (3) in connecting rod bearing cap (2).
2. Install a new upper half connecting rod bearing in the connecting rod.
3. Pull the connecting rod onto the crankshaft.

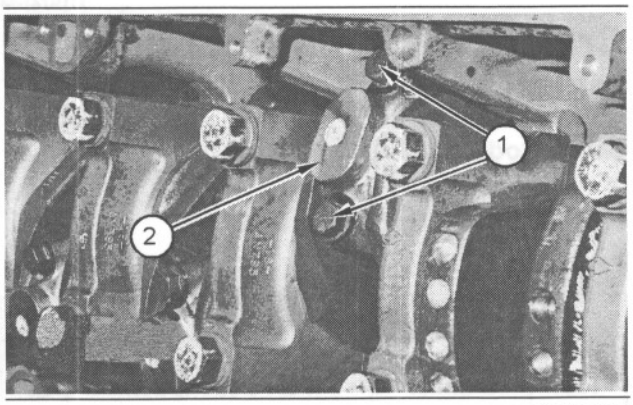

Illustration 235 g01032923

4. Check the connecting rod bearing clearances. Follow Steps 5 and 6 for the correct installation procedures and tightening procedures for the connecting rod bearing caps when the clearance check is performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check".

   Bearing clearance (new bearings) ..... 0.062 to 0.160 mm (0.0024 to 0.0063 inch)

   Maximum permissible bearing clearance (used bearings) ..... 0.20 mm (0.008 inch)

5. Lubricate the threads of bolts (1) and the seating faces of connecting rod bearing cap (2) with Tooling (A). Install connecting rod bearing cap (2) and bolts (1). Ensure that the number on the side of the connecting rod bearing cap is on the same side as the number on the connecting rod.

6. Tighten bolts (1), as follows:

   a. Tighten the bolts to a torque of 90 ± 8 N·m (65 ± 6 lb ft).

   b. Put a mark on each bolt and on each connecting rod bearing cap.

   c. Tighten each bolt for an additional 90 ± 5 degrees (1/4 turn).

7. Repeat Steps 1 through 6 in order to install the remainder of the connecting rod bearings.

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i01810421

Crankshaft Main Bearings - Remove

SMCS Code: 1203-011

Removal Procedure

Table 54

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	2P-5518	Bearing Tool	1

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Check the main bearing caps for identification of the location and check the direction of the main bearing caps in relation to the cylinder block. The main bearing caps must be installed in the original location and the original direction.

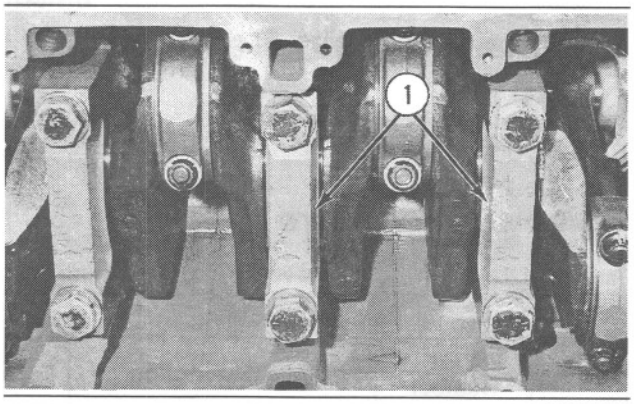

Illustration 236 g00503084

2. Remove No. 2 through No. 6 main bearing caps (1). Remove the thrust plates from the No. 4 main bearing.

Note: Remove No. 1 and No. 7 main bearing caps (1) after No. 2 through No. 6 main bearing caps have been installed.

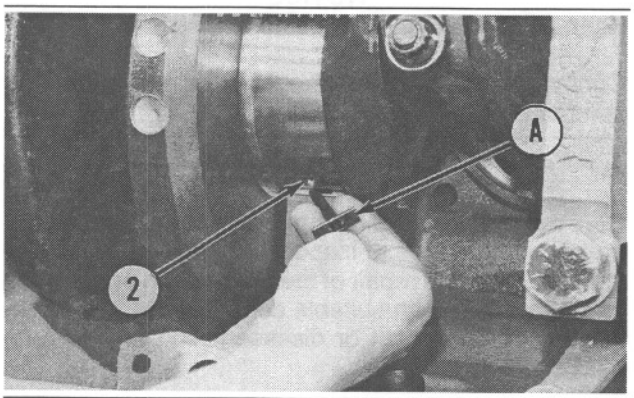

Illustration 237 g00503174

Note: If the crankshaft is turned in the wrong direction, the tab on the bearing will be pushed between the crankshaft and the bearing area of the cylinder block. This can result in damage to the cylinder block and/or the crankshaft. Turn the crankshaft so that the bearing tab is rotated out of the crankshaft.

3. Remove the upper halves of the main bearings by putting Tooling (A) in oil hole (2) in the crankshaft. Turn the crankshaft in the direction which will remove the upper halves of the main bearings.

4. Remove the lower halves of the main bearings from the main bearing caps.

i01974984

Crankshaft Main Bearings - Install

SMCS Code: 1203-012

Installation Procedure

Table 55

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	2P-5518	Bearing Tool	1
B	8T-5096	Dial Indicator	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

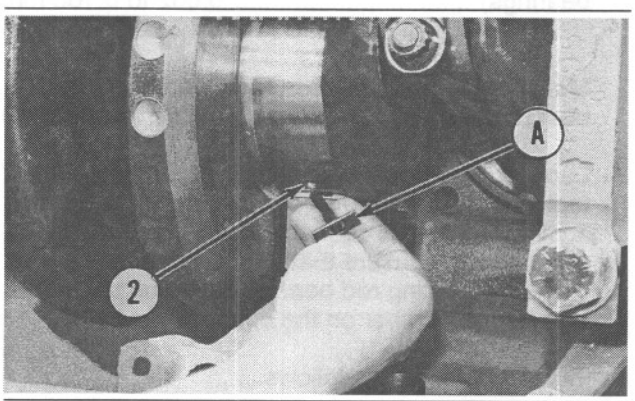

Illustration 238 g00503174

Note: Install the crankshaft main bearings dry when clearance checks are made. Put clean engine oil on the crankshaft main bearings for final assembly.

1. Install new upper main bearings by putting Tooling (A) in oil hole (2) and turning the crankshaft in order to push the main bearing into the cylinder block. Insert the end of the bearing that does not have the tab into the cylinder block first.

Note: The upper halves of the main bearings have the oil groove and the oil hole.

Note: Ensure that the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block and in the main bearing caps.

2. Install new crankshaft main bearings in the main bearing caps.

Note: Refer to Special Publication, SEBD0531, "Engine Bearings and Crankshafts" for complete details concerning measuring of bearing clearances.

3. Check the crankshaft main bearing clearances. Follow Steps 4 and 5 for the correct installation procedures and tightening procedures for the main bearing caps when the clearance check is performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check".

   Bearing clearance (new bearings) ..... 0.091 to 0.186 mm (0.0036 to 0.0073 inch)

   Maximum permissible bearing clearance (used bearings) ..... 0.25 mm (0.010 inch)

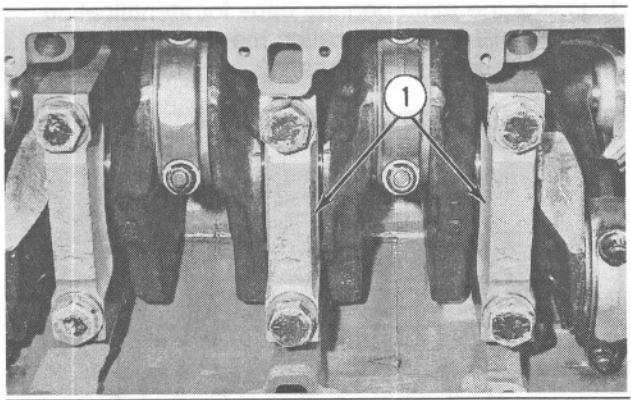

Illustration 239 g00503084

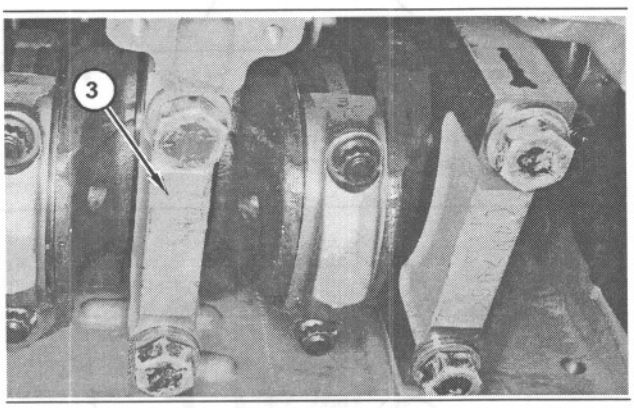

Illustration 240 g01029625

Note: Ensure that the numbers on main bearing caps (1) match the numbers on the cylinder block. Also ensure that arrows (3) on the main bearing caps are toward the front of the cylinder block.

4. Apply clean engine oil on the bolts. Install the thrust plates during installation of the No. 4 main bearing. Install the main bearing caps and the bolts.

Note: Install the thrust plates for the No. 4 main bearing with the words "Block Side" toward the cylinder block.

5. Tighten the bolts for the main bearing caps, as follows:

   a. Tighten the bolt first on the bearing tab side of the main bearing cap to a torque of 260 ± 14 N·m (190 ± 10 lb ft).

   b. Tighten the bolt opposite the bearing tab side to a torque of 260 ± 14 N·m (190 ± 10 lb ft).

   c. Put a mark on each bolt and on each main bearing cap.

   d. Tighten the bolt opposite the bearing tab side for an additional 120 ± 5 degrees (2 flats).

   e. Tighten the bolt on the bearing tab side for an additional 120 ± 5 degrees (2 flats).

6. Use Tooling (B) to check the crankshaft end play. Ensure that Tooling (B) is against a machined surface. The end play is controlled by the thrust plates of No. 4 main bearing (center).

   Crankshaft end play (new thrust plates) ..... 0.15 to 0.55 mm (0.006 to 0.022 inch)

   Maximum permissible crankshaft end play (used thrust plates) ..... 0.89 mm (0.035 inch)

End By:

a. Install the engine oil pump. Refer to Disassembly and Assembly, "Engine Oil Pump - Install".

i01988142

Crankshaft - Remove

SMCS Code: 1202-011

Removal Procedure

Table 56

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1H-3110	Bearing Puller	1
	8B-7560	Step Plate	1
	9U-6600	Hand Hydraulic Pump	1
	1H-3108	Push-Puller Leg	2
	1H-3107	Bearing Puller	1
	3H-0468	Puller Plate	5
	3H-0465	Push-Puller Plate	2
	1P-0820	Hydraulic Puller	1
	5B-0637	Nut	1
	8S-6586	Forcing Screw	1
B	5P-0944	Dowel Puller Group	1
	5P-0939	Dowel Extractor	1

Start By:

a. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

b. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Check the main bearing caps for identification marks. Place identification marks on the main bearing caps, if necessary.

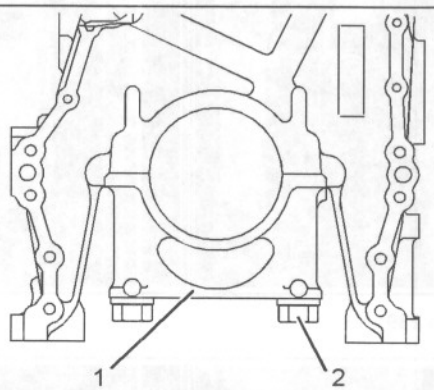

Illustration 241 g01029693

2. Remove bolts (2) for the main bearing caps. Remove main bearing caps (1).

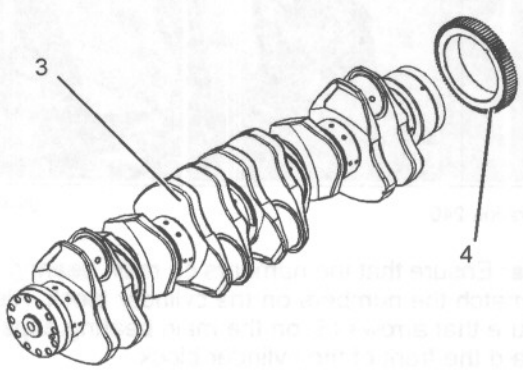

Illustration 242 g01029696

3. Remove the connecting rod caps.

4. Use a suitable lifting device. Remove the crankshaft (3) from the cylinder block. The weight of the crankshaft is approximately 159 kg (350 lb).
5. Use Tooling (A) to remove crankshaft gear (4).
6. Use Tooling (B) to remove the dowel and the pin.

i02110989

Crankshaft - Install

SMCS Code: 1202-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

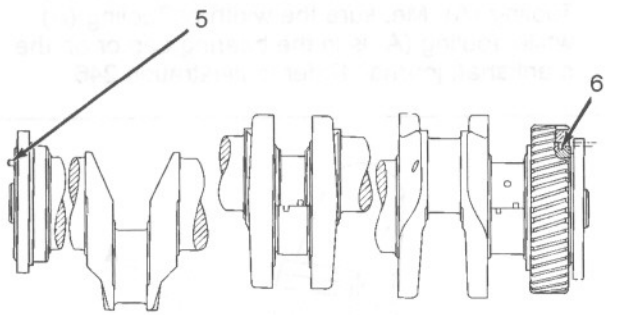

Illustration 243 g01018180

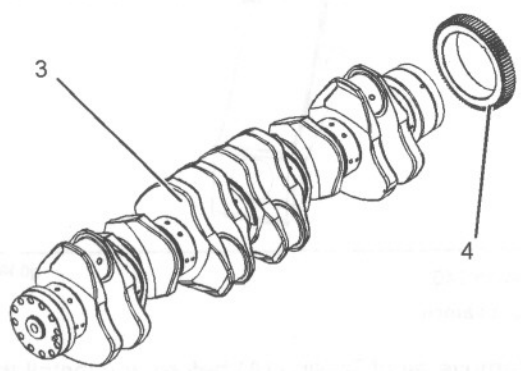

Illustration 244 g01029696

1. Install pin (5) in the crankshaft.

   The maximum length of the dowel out of the crankshaft face ..... 6.4 mm (0.25 inch)

2. Install dowel (6) in the crankshaft.

   Protrusion of dowel (6) from the crankshaft face ..... 4.1 ± 0.5 mm (0.16 ± 0.02 inch)

3. Raise the temperature of crankshaft gear (4). Install gear (4) on the crankshaft with the keyway in alignment with dowel (6). Timing Mark "V" should face away from the crankshaft.

Note: Install the main bearings dry when clearance checks are made. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Put clean engine oil on the main bearings for final assembly.

4. Install the upper halves of the main bearings in the cylinder block.
5. Fasten a suitable lifting device to crankshaft (3). Install crankshaft (3) with the "V" mark on the crankshaft gear in alignment with the "V" mark on the cluster gear. The weight of the crankshaft is approximately 159 kg (350 lb).
6. Install the connecting rod caps.

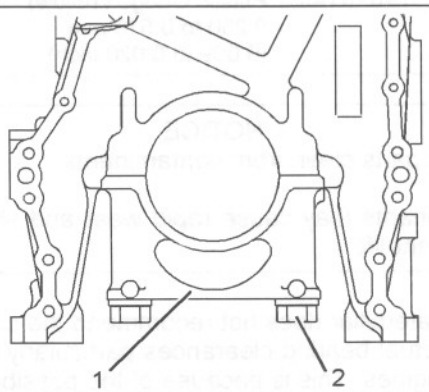

Illustration 245 g01029693

7. Place main bearing caps (1) in position. Install bolts (2) for the main bearing caps.

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

b. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

i01931507

Bearing Clearance - Check

SMCS Code: 1203-535; 1219-535

Measurement Procedure

Table 57

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE
Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A).

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A). Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 246.

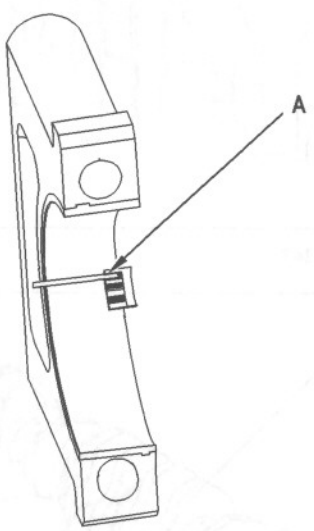

Illustration 246 g00953605
Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

i01810472

Atmospheric Pressure Sensor - Remove and Install

SMCS Code: 1923-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

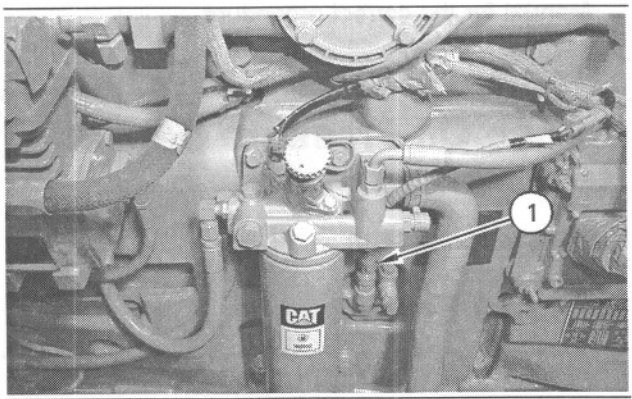

Illustration 247 g00621509
Typical example

1. Disconnect the harness assembly for atmospheric pressure sensor (1).
2. Remove atmospheric pressure sensor (1).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

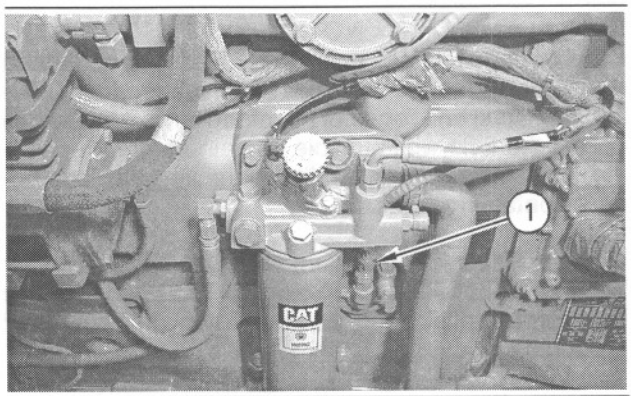

Illustration 248 g00621509
Typical example

1. Install atmospheric pressure sensor (1). Tighten the sensor to a torque of 10 ± 2 N·m (90 ± 20 lb in).
2. Connect the harness assembly for atmospheric pressure sensor (1).

i01975056

Coolant Temperature Sensor - Remove and Install

SMCS Code: 1906-010

Removal Procedure

Table 58

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-5103	Socket (Slotted)	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

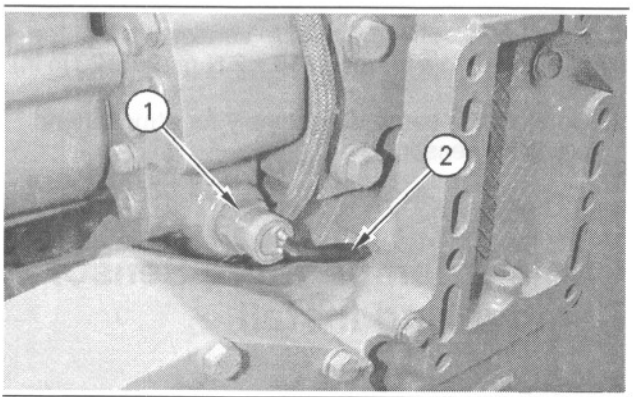

Illustration 249 g00518087

1. Drain the level of the coolant below the coolant temperature sensor. Drain the coolant into a suitable container for storage or disposal.
2. Disconnect harness assembly (2) from coolant temperature sensor (1).
3. Remove coolant temperature sensor (1) with Tooling (A).

Installation Procedure

Table 59

Required Tools			
Tool	Part Number	Part Description	Qty
A	9U-5103	Socket (Slotted)	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

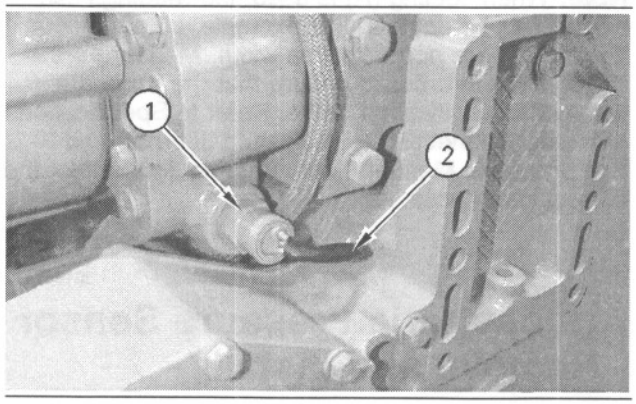

Illustration 250 g00518087

1. Install coolant temperature sensor (1) with Tooling (A). Tighten coolant temperature sensor (1) to a torque of 20 ± 3 N·m (15 ± 2 lb ft).
2. Connect harness assembly (2) to coolant temperature sensor (1).
3. Fill the cooling system with coolant to the correct level. Refer to the Operation and Maintenance Manual for the correct procedure.

i01810485

Engine Oil Pressure Sensor - Remove and Install

SMCS Code: 1924-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

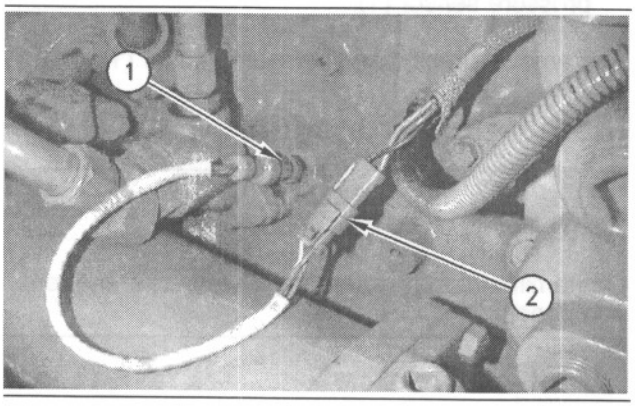

Illustration 251 g00518159

1. Disconnect harness assembly (2).
2. Remove engine oil pressure sensor (1) from the cylinder block.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

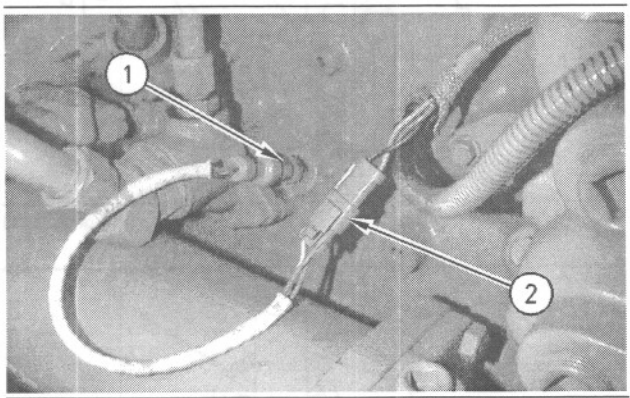

Illustration 252 g00518159

1. Install engine oil pressure sensor (1) and tighten to a torque of 10 ± 2 N·m (88 ± 18 lb in).
2. Connect harness assembly (2).

i01931558

Fuel Temperature Sensor - Remove and Install

SMCS Code: 1922-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

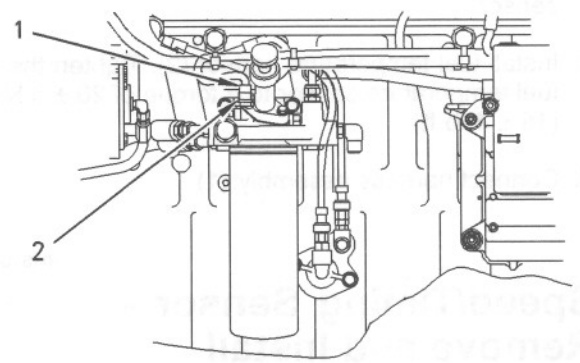

Illustration 253 g01004847

1. Disconnect harness assembly (1).
2. Remove fuel temperature sensor (2) from the fuel filter base.
3. Remove the O-ring seal from the fuel temperature sensor.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

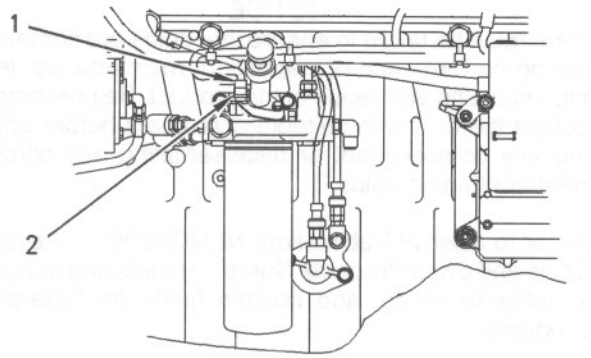

Illustration 254 g01004847

1. Install a new O-ring seal on the fuel temperature sensor.
2. Install fuel temperature sensor (2). Tighten the fuel temperature sensor to a torque of 20 ± 5 N·m (15 ± 4 lb ft).
3. Connect harness assembly (1) .

i01810494

Speed/Timing Sensor - Remove and Install

SMCS Code: 1907-010; 1912-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

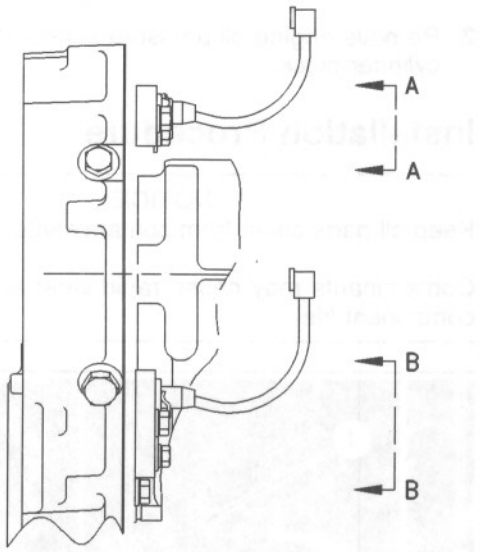

Illustration 255 g00574831

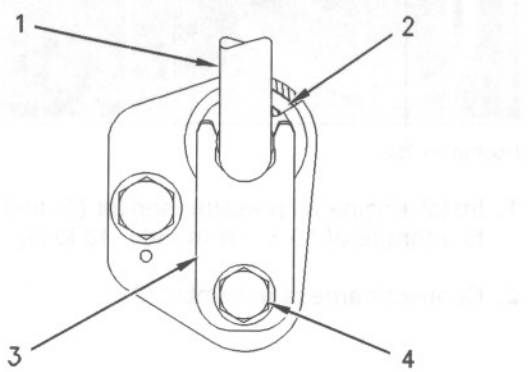

Illustration 256 g00574876
Typical example of View A-A and View B-B

Note: There are two engine speed/timing sensors. The removal procedure is identical for both of the sensors.

1. Disconnect harness assembly (1).
2. Remove bolt (4) and bracket (3). Remove engine speed/timing sensor (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
The speed/timing sensors must be installed to the proper depth for correct operation. The speed/timing sensors and the housing (front) must be free of any contaminates to ensure proper speed/timing sensors installation depth.

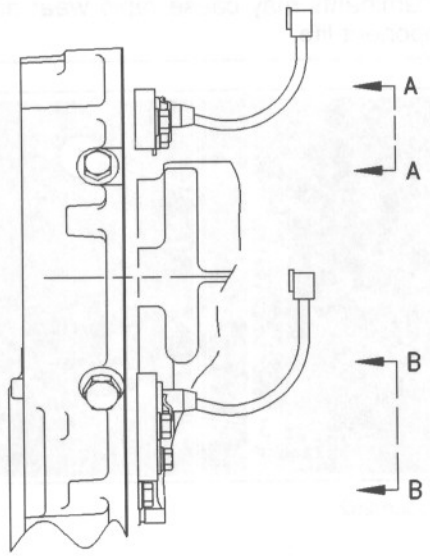

Illustration 257 g00574831

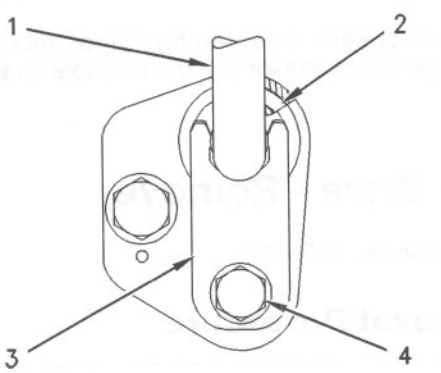

Illustration 258 g00574876
Typical example of View A-A and View B-B

Note: There are two engine speed/timing sensors. The installation procedure is identical for both sensors.

1. Install engine speed/timing sensor (2). Put bracket (3) in position and install bolt (4).
2. Connect harness assembly (1).

i01810495

Turbocharger Outlet Pressure Sensor - Remove and Install

SMCS Code: 1917-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

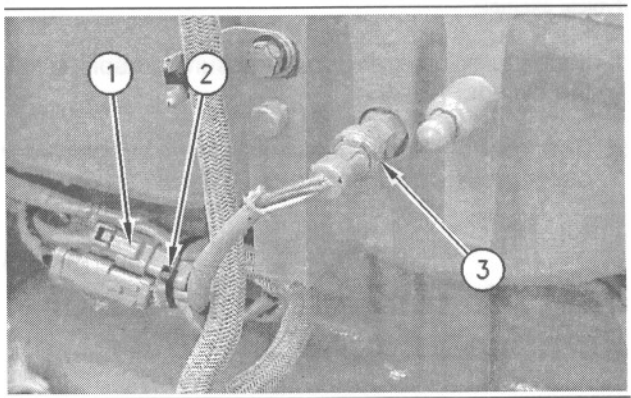

Illustration 259 g00632044
Typical example

1. Cut cable strap (2) and disconnect harness assembly (1) from the turbocharger outlet pressure sensor.
2. Remove turbocharger outlet pressure sensor (3) from the cylinder head.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

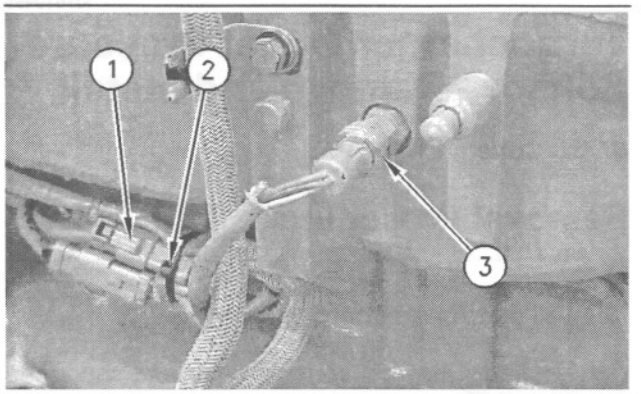

Illustration 260 g00632044

Typical example

1. Install turbocharger outlet pressure sensor (3) in the cylinder head.
2. Connect harness assembly (1) for the turbocharger outlet pressure sensor. Install cable strap (2).

i01810493

Inlet Air Temperature Sensor - Remove and Install

SMCS Code: 1921-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

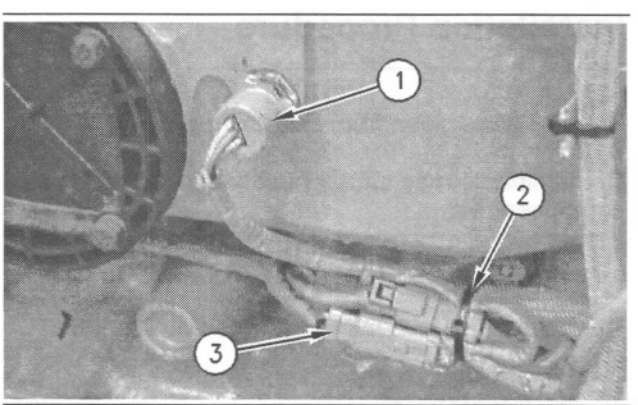

Illustration 261 g00631972

1. Cut cable strap (2) and disconnect harness assembly (3) from inlet air temperature sensor (1).
2. Remove inlet air temperature sensor (1) from the cylinder head.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

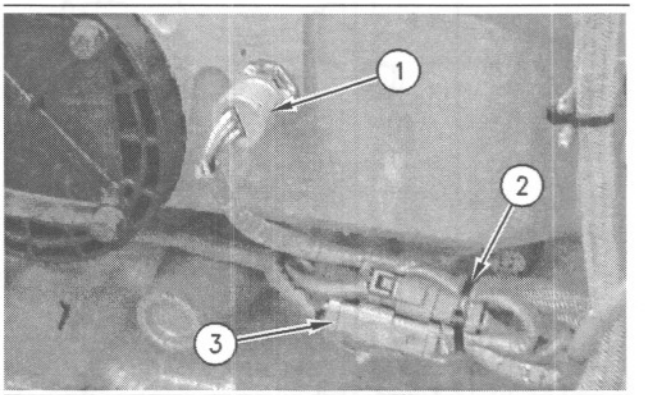

Illustration 262 g00631972

1. Install inlet air temperature sensor (1) in the cylinder head. Tighten the inlet air temperature sensor to a torque of 15 ± 3 N·m (11 ± 2 lb ft).
2. Connect harness assembly (3) for inlet air temperature sensor (1). Install cable strap (2).

i01988415

Fan Drive - Remove

SMCS Code: 1359-011

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

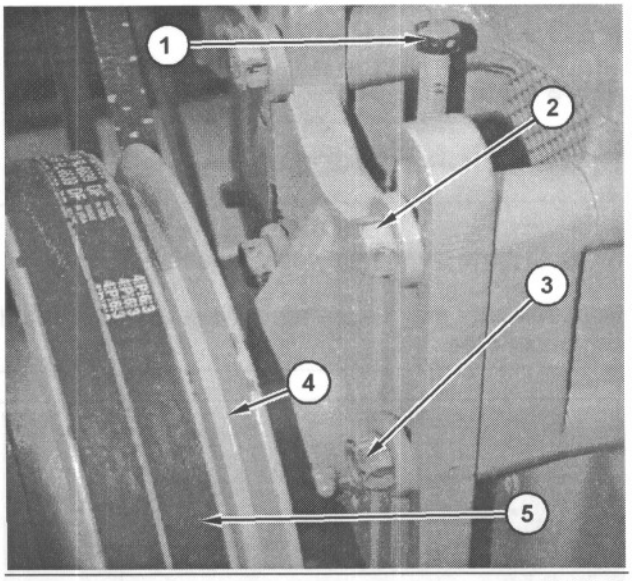

Illustration 263 g01029819

1. Loosen bolts (2) and nuts (3). Remove bolt (1), and remove fan drive belts (5).
2. Remove the nuts and the bolts that hold the fan drive. Remove fan drive (4).

i01988310

Fan Drive - Disassemble

SMCS Code: 1359-015

Disassembly Procedure

Start By:

a. Remove the fan drive. Refer to Disassembly and Assembly, "Fan Drive - Remove".

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

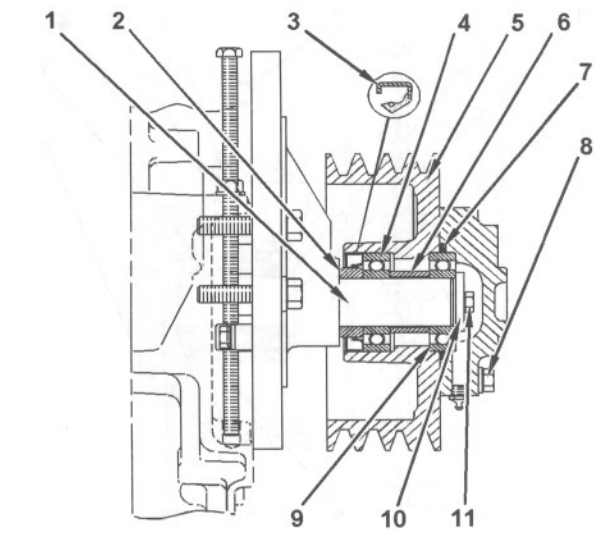

Illustration 264 g01029786

1. Remove bolts (8).
2. Remove the fan adapter from pulley (5).
3. Remove bolts (11) and retainer (10). Remove O-ring seal (7).
4. Remove pulley (5) from shaft assembly (1).
5. Remove bearing (9) and spacer (6) from pulley (5). Remove spacer (2), lip seal (3), and bearing (4) from pulley (5).

i01975124

Fan Drive - Assemble

SMCS Code: 1359-016

Assembly Procedure

Table 60

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-0510	Driver Group	1
B	2P-9065	Lubricant	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

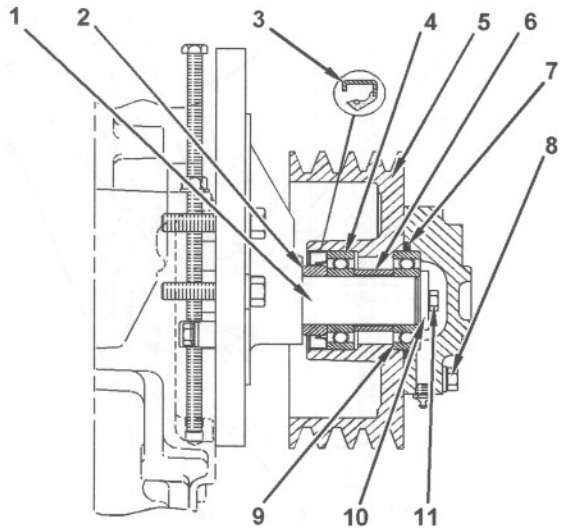

Illustration 265 g01029786

1. Install bearing (4) in pulley (5).
2. Install lip seal (3) with Tooling (A), as shown. Apply Tooling (B) to the lip of the seal.
3. Install spacer (2) so the end with the taper is toward the inside of pulley (5).
4. Install spacer (6) and bearing (9) in the front of pulley (5).
5. Position O-ring seal (7) on the front of pulley (5). Install the pulley on shaft assembly (1).
6. Install retainer (10) and bolts (11). Tighten bolts (11) to a torque of 25 ± 6 N·m (18 ± 4 lb ft).
7. Install the fan adapter on pulley (5). Tighten bolts (8) to a torque of 47 ± 9 N·m (35 ± 7 lb ft).
8. Fill the fan drive with Tooling (B).

End By:

a. Install the fan drive. Refer to Disassembly and Assembly, "Fan Drive - Install".

i01988436

Fan Drive - Install

SMCS Code: 1359-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

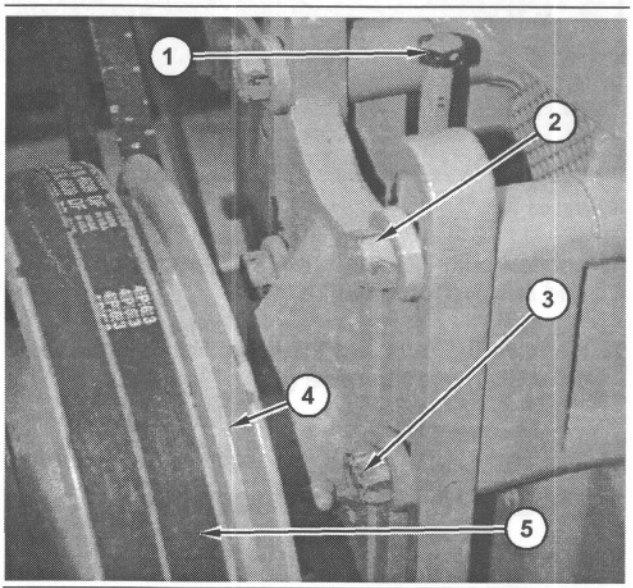

Illustration 266 g01029819

1. Position fan drive (4) on the front housing.
2. Install bolts (2) and nuts (3) loosely.
3. Install bolt (1).

Note: Install belts (5) as a set only.

4. Install the fan drive belts and adjust the belt tension. Refer to Specifications, "Belt Tension Chart".
5. Tighten bolt (2) and nuts (3) that hold the fan drive in position.

i01985537

Electronic Control Module - Remove and Install

SMCS Code: 1901-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

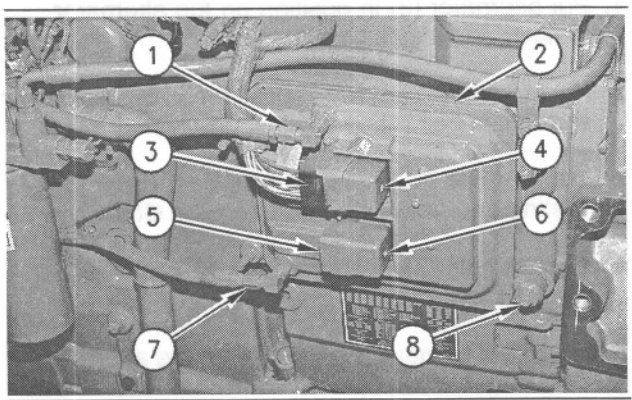

Illustration 267 g00575421

1. Disconnect fuel lines (1) and (7). Plug and cap all openings immediately.
2. Loosen allen head screw (4) until engine harness assembly (3) can be disconnected. Disconnect engine harness assembly (3) from electronic control module (2).
3. Loosen allen head screw (6) until the harness assembly for machine (5) can be disconnected. Disconnect the harness assembly for machine (5) from electronic control module (2).
4. Remove bolts, nuts, and washers (8) and remove electronic control module (2).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

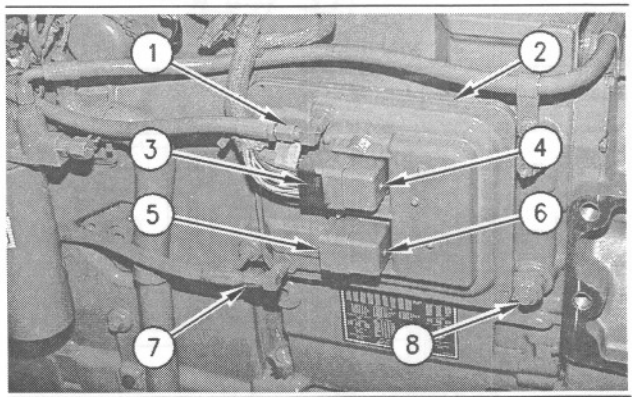

Illustration 268 g00575421

1. Position electronic control module (2) on the engine and install bolts, nuts, and washers (8).
2. Connect engine harness assembly (3). Tighten allen head screw (4) to a torque of 2.25 ± 0.25 N·m (20 ± 2 lb in).
3. Connect the harness assembly for machine (5). Tighten allen head screw (6) to a torque of 2.25 ± 0.25 N·m (20 ± 2 lb in).
4. Connect fuel lines (1) and (7).

i01810705

Alternator - Remove and Install

SMCS Code: 1405-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the battery disconnect switch to the OFF position.

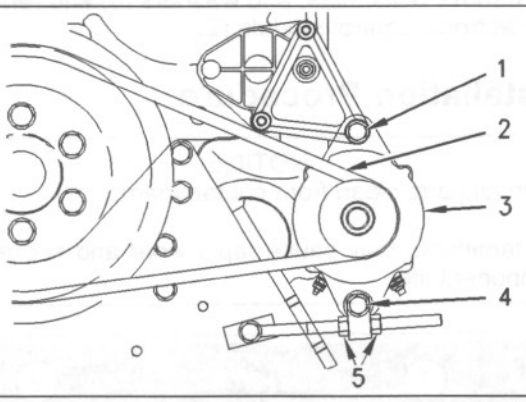

Illustration 269 g00596882

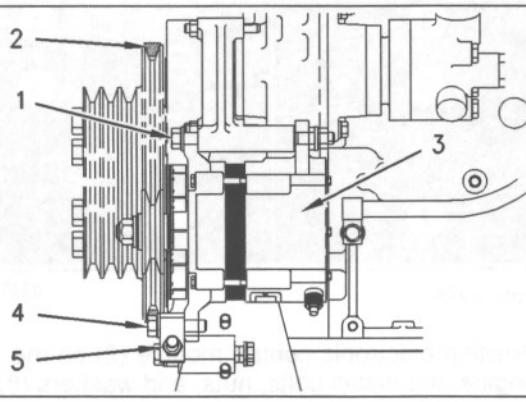

Illustration 270 g00596913

2. Put identification on the harness assemblies for installation purposes. Remove the harness assemblies from alternator (3).

3. Loosen nuts (5) on the adjustment rod.

4. Loosen the nut on bolt (1). Push the top of the alternator toward the cylinder block. Remove V-belt (2).

5. Remove bolts (1) and (4). Remove alternator (3).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

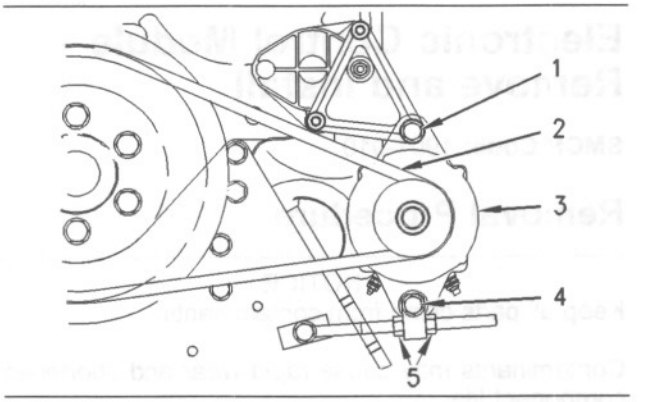

Illustration 271 g00596882

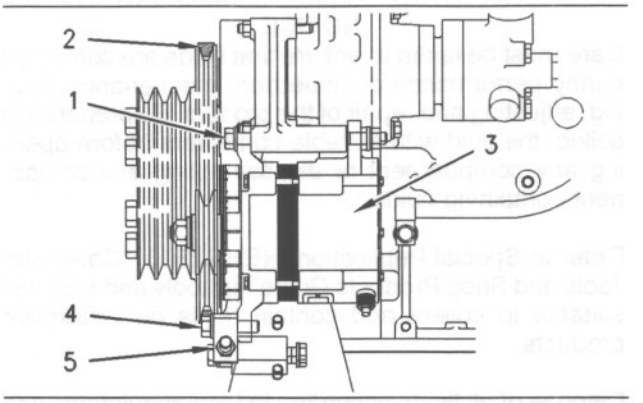

Illustration 272 g00596913

1. Put alternator (3) in position on the alternator bracket and install bolt (1).

2. Put the adjustment rod in position on the alternator and install bolt (4).

3. Install V-belt (2). Tighten the V-belt. Refer to Testing and Adjusting, "Belt Tension Chart".

4. Tighten nuts (5) to a torque of 30 ± 15 N·m (22 ± 11 lb ft).

5. Install the harness assemblies on the alternator.

6. Turn the battery disconnect switch to the ON position.

i01985628

Electric Starting Motor - Remove and Install

SMCS Code: 1453-010

Removal Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (−) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

1. Turn the battery disconnect switch to the OFF position.
2. Disconnect harness assemblies from the electric starting motor.

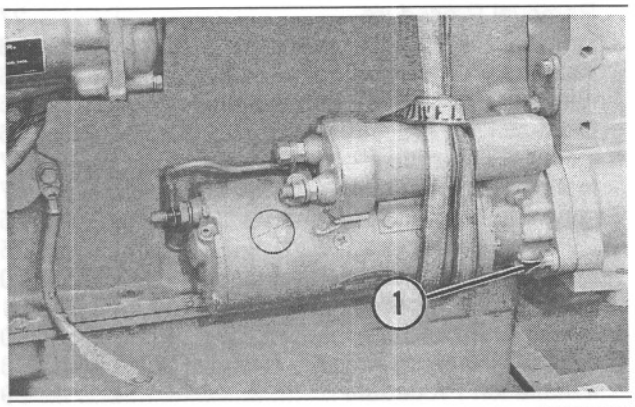

Illustration 273 g00596348

3. Fasten a suitable lifting device to the electric starting motor. Remove bolts (1) that hold the electric starting motor to the flywheel housing. Remove the electric starting motor. The weight of electric starting motor may be up to 36 kg (80 lb).

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

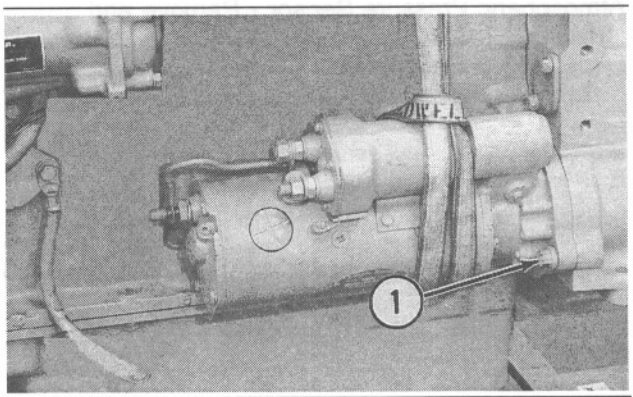

Illustration 274 g00596348

1. Fasten a suitable lifting device to the electric starting motor. Put the electric starting motor in position on the flywheel housing. Install bolts (1) that hold the electric starting motor to the flywheel housing.
2. Connect the harness assemblies to the electric starting motor.
3. Turn the battery disconnect switch to the ON position.

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