



Disassembly and Assembly

3500B Engines

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Disassembly and Assembly Section

i01929453

Air Starting Motor - Remove

SMCS Code: 1451-011

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Several different air starting motors are available for use. The starting motors can have different configurations for the air tube assemblies. Examples of removing two different air starting motors are described below.

Removal of an Air Starting Motor Without the Air Tube Assemblies Attached

1. Turn off the supply of pressurized air. Purge the pressurized air from the air tube assemblies and the starting motor.

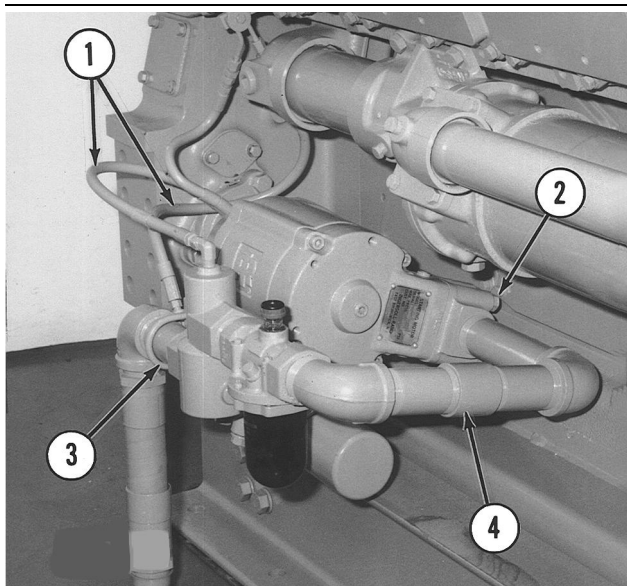


Illustration 1

g00597642

2. Disconnect hose assemblies (1).
3. Remove bolts (2).
4. Remove U-bolt (3) and tube assemblies (4).

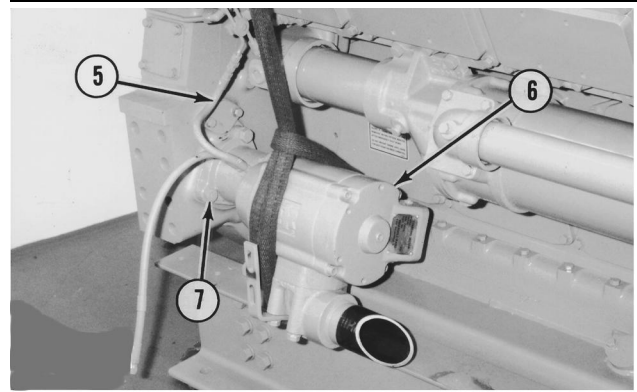


Illustration 2

g00597643

5. Disconnect hose assembly (5).
6. Attach a suitable lifting device onto air starting motor (6). The weight of air starting motor (6) is approximately 48 kg (106 lb).
7. Remove bolts (7). Remove air starting motor (6). Remove the gasket from the joint between the cover of air starting motor (6) and the flywheel housing.

Removal of an Air Starting Motor With the Air Tube Assemblies Attached

1. Turn off the supply of pressurized air. Purge the pressurized air from the air tube assemblies and the starting motor.

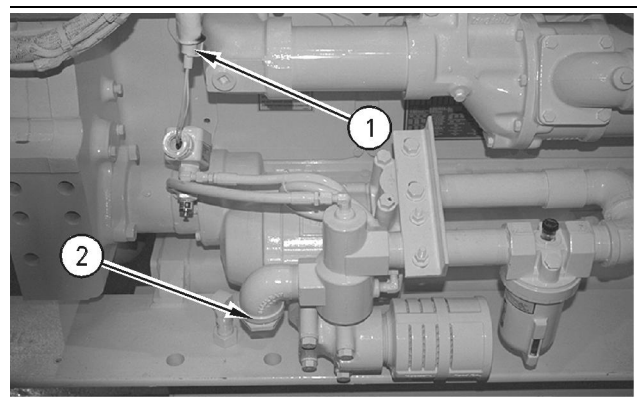


Illustration 3

g00615939

2. Disconnect harness assembly (1).
3. Disconnect the tube assembly from elbow (2).

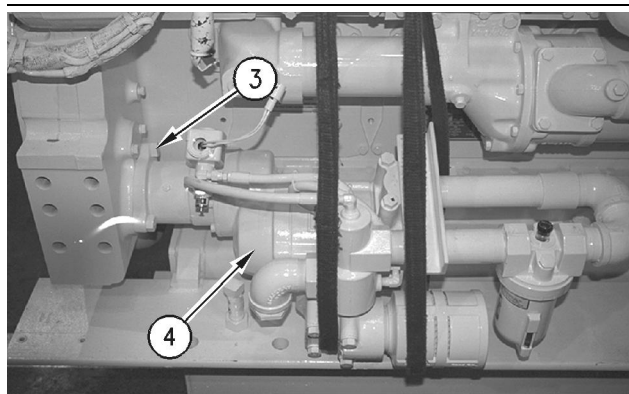


Illustration 4

g00615940

4. Attach a suitable lifting device onto air starting motor (4). The weight of air starting motor (4) is approximately 86 kg (190 lb).
5. Remove bolts (3). Remove air starting motor (4). Remove the gasket from the joint between the cover of air starting motor (4) and the flywheel housing.

i01929516

Air Starting Motor - Disassemble

SMCS Code: 1451-015

Disassembly Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-1854	Retaining Ring Pliers	1
B		Plate 50.8 mm (2 inches) x 102 mm (4 inches) x 6 mm (0.25 inches)	1
C	1P-1857	Retaining Ring Pliers	1

Start By:

- a. Remove the air starting motor. Refer to Disassembly and Assembly, "Air Starting Motor - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Several different air starting motors are available for use. An example of disassembling a typical air starting motor is described below.

Note: Before you disassemble the air starting motor, obtain a complete set of these parts: gaskets, O-ring seals, seals, and vanes.

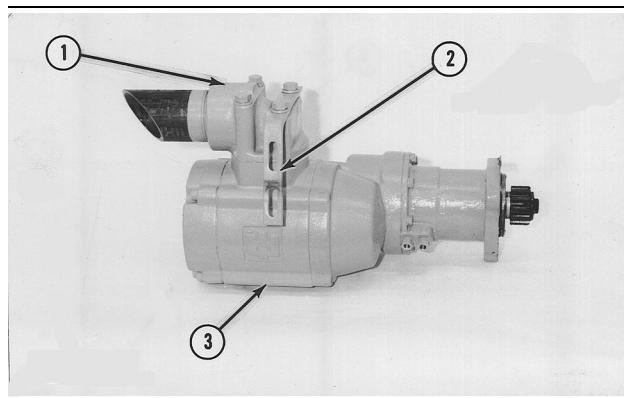


Illustration 5

g00597693

1. Remove elbow (1) and bracket (2) from motor housing (3).

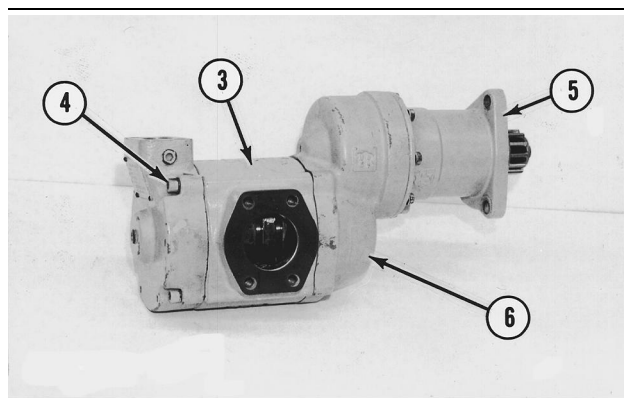


Illustration 6

g00597694

2. To ensure correct assembly, mark the position of motor housing (3) in relation to gear case (6). Remove bolts (4). Remove gear case (6) and drive housing (5) as a unit.

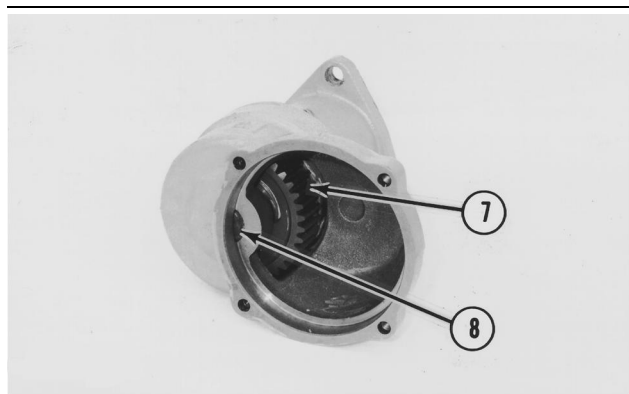


Illustration 7

g00597696

3. Use Tooling (A) in order to remove ring (8) from drive gear (7).

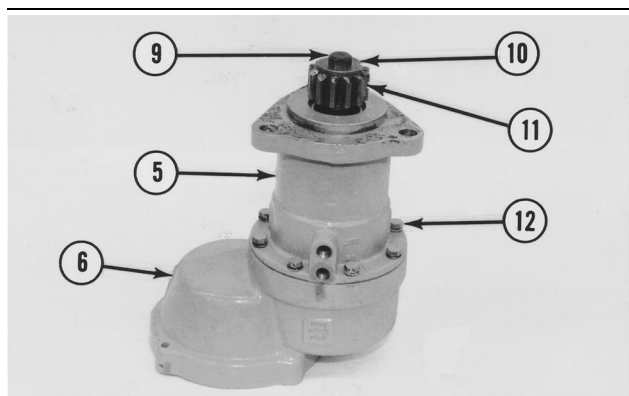


Illustration 8

g00597697

Note: Bolt (9) has left hand threads.

4. Remove bolt (9) and washer (10). Remove pinion (11), the sleeve, and the spring.

To ensure correct assembly, mark the position of drive housing (5) in relation to gear case (6). Remove bolts (12) and drive housing (5) from gear case (6).

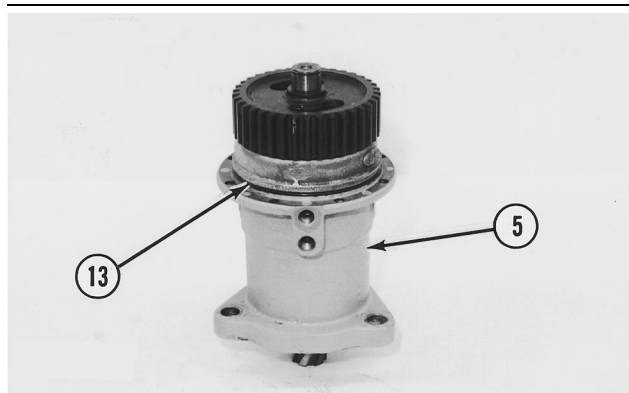


Illustration 9

g00597698

5. Remove O-ring seal (13) from drive housing (5).

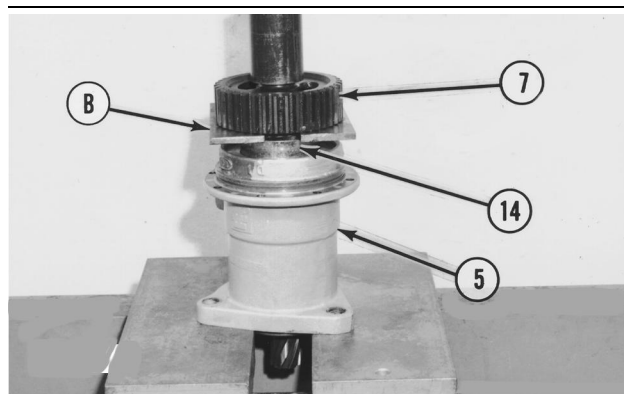


Illustration 10

g00597701

WARNING

The drive shaft, the piston, and the drive gear are under a spring force. Slowly release the spring force before you remove these components.

6. Position Tooling (B) between drive gear (7) and piston (14). Use a suitable press in order to compress the return spring. Remove the ring that holds the drive shaft and the piston in drive housing (5).

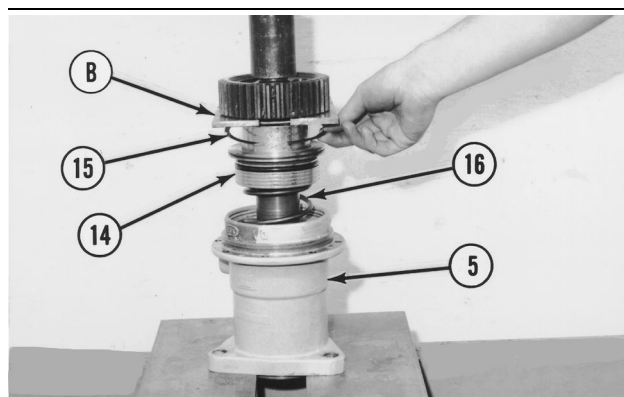


Illustration 11

g00597709

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.

7. Slowly release the press in order to remove the force of return spring (16). Remove Tooling (B). Remove ring (15). Remove the drive gear, the piston, and the drive shaft from drive housing (5) as a unit. Remove return spring (16).

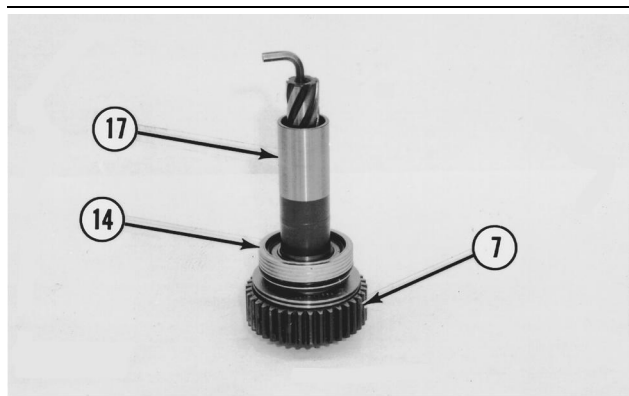


Illustration 12

g00597711

8. Loosen the bolt (not shown) until the bolt moves freely. Remove drive shaft (17) and piston (14) from drive gear (7) as a unit.

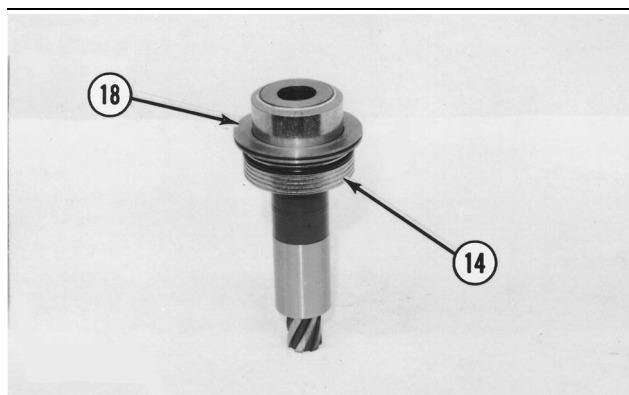


Illustration 13

g00597712

9. Remove bulkhead (18) from piston (14).

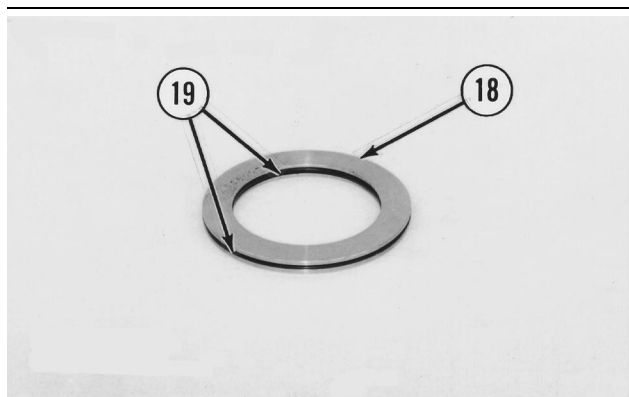


Illustration 14

g00597713

10. Remove O-ring seals (19) from bulkhead (18).

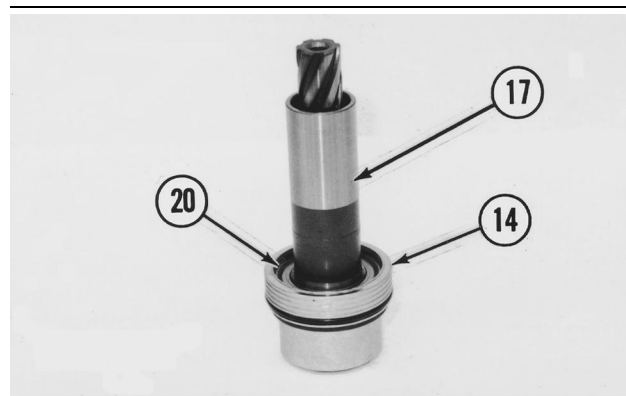


Illustration 15

g00597714

11. Remove ring (20) from piston (14). Remove the piston from drive shaft (17).

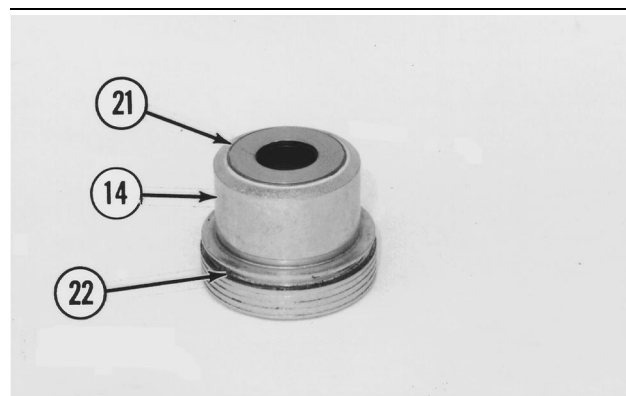


Illustration 16

g00597715

12. Remove O-ring seal (22) and seal (21) from piston (14).

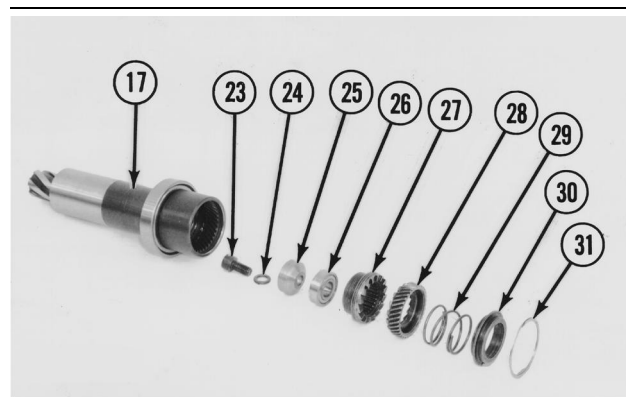


Illustration 17

g00597716

⚠ 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.

13. Remove the following parts from drive shaft (17): ring (31), cup (30), spring (29), driven clutch jaw (28), driving clutch jaw (27), bearing (26), washer (25), lockwasher (24), and bolt (23).

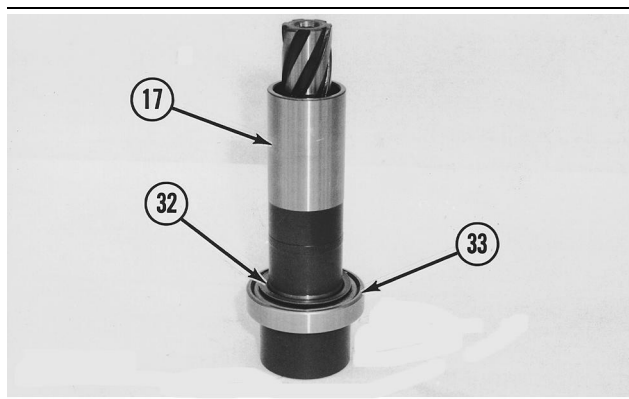


Illustration 18

g00597717

Note: A new ring is always required for assembly when ring (32) is removed.

14. Remove ring (32) and bearing (33) from drive shaft (17).

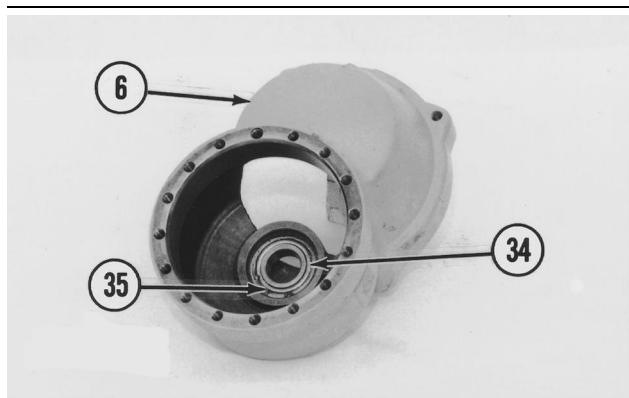


Illustration 19

g00597719

15. Use Tooling (C) to remove ring (35). Remove bearing (34) from gear case (6).

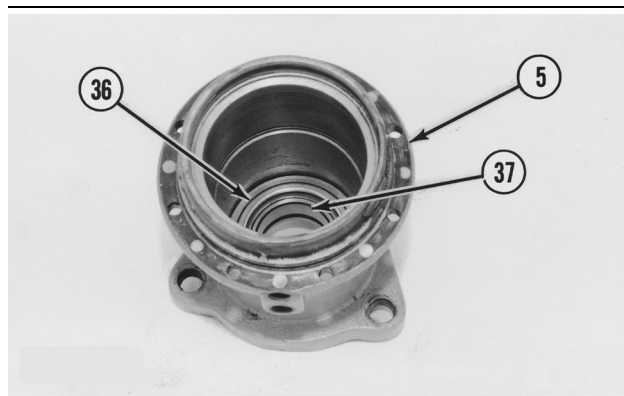


Illustration 20

g00597722

16. Remove spring seat (36) and bearing (37) from drive housing (5).

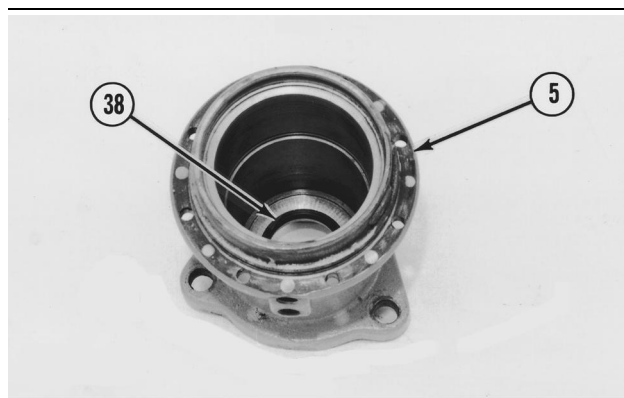


Illustration 21

g00597723

17. Remove seal (38) from drive housing (5).

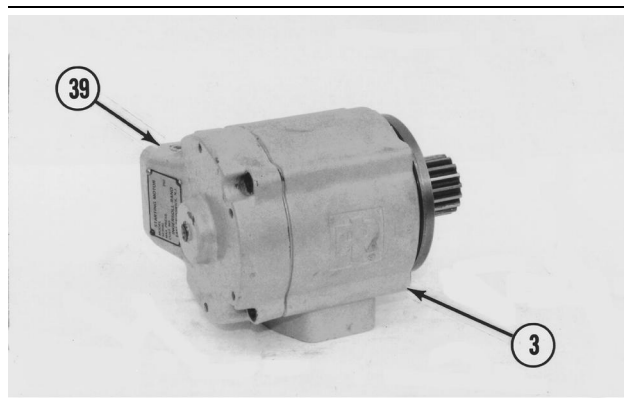


Illustration 22

g00597724

18. To ensure correct assembly, mark the position of cover (39) in relation to motor housing (3). Remove cover (39) and remove the O-ring seal from motor housing (3).

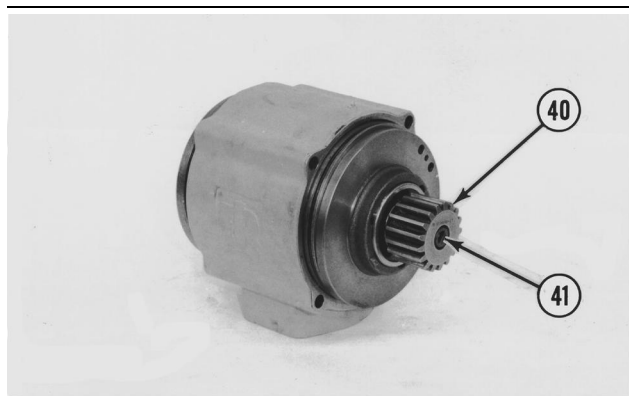


Illustration 23

g00597725

- 19.** Remove bolt (41) and rotor pinion (40) from the rotor in the motor housing.

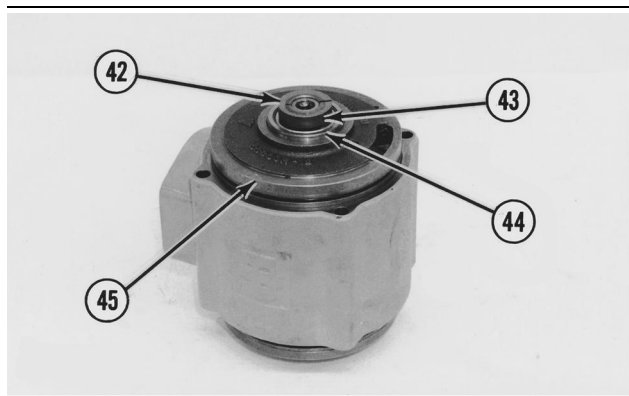


Illustration 24

g00597726

- 20.** Loosen bolt (43) and remove nut (42). Remove bearing (44) from rear end plate (45).

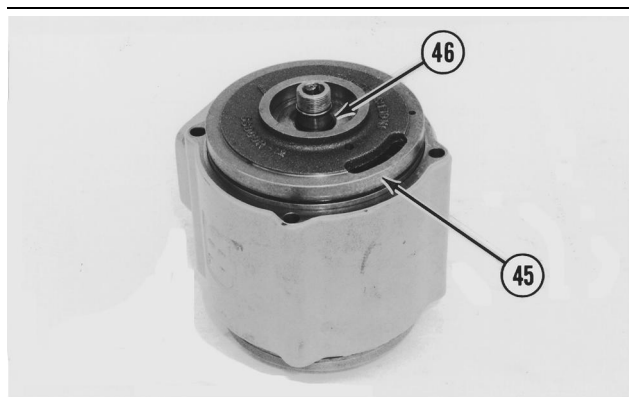


Illustration 25

g00597727

- 21.** Remove O-ring seal (46) and rear end plate (45).

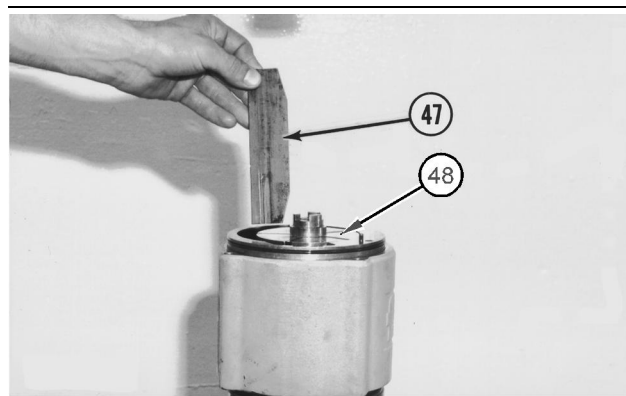


Illustration 26

g01054297

- 22.** Remove vanes (47) from rotor (48).

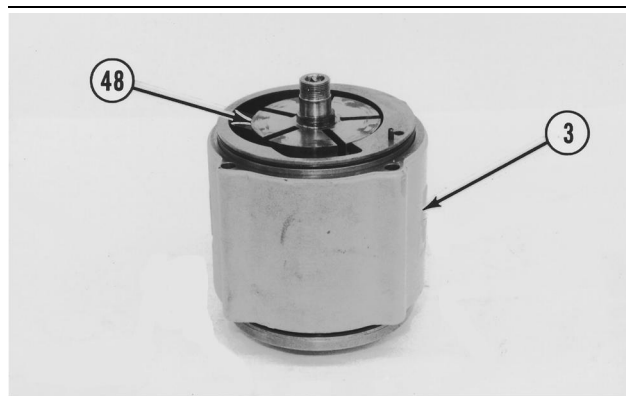


Illustration 27

g00597729

- 23.** Remove rotor (48) from motor housing (3).

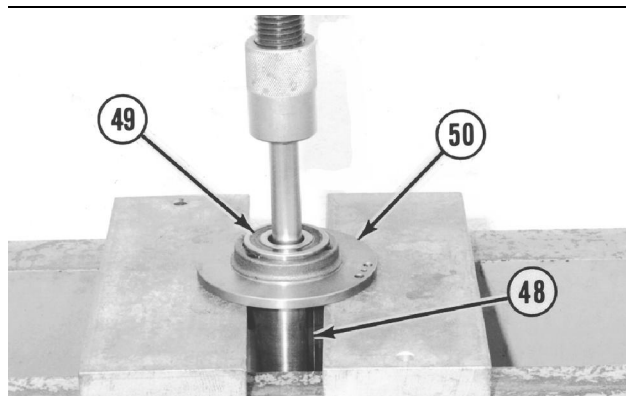


Illustration 28

g00597730

- 24.** Use a suitable press in order to remove bearing (49) and front end plate (50) from rotor (48) as a unit.

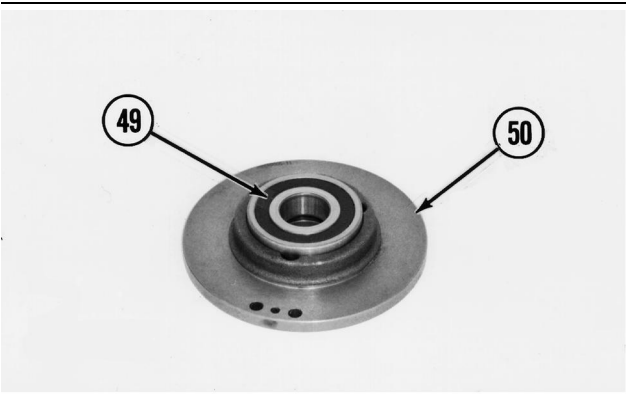


Illustration 29 g00597731

25. Remove bearing (49) from front end plate (50).

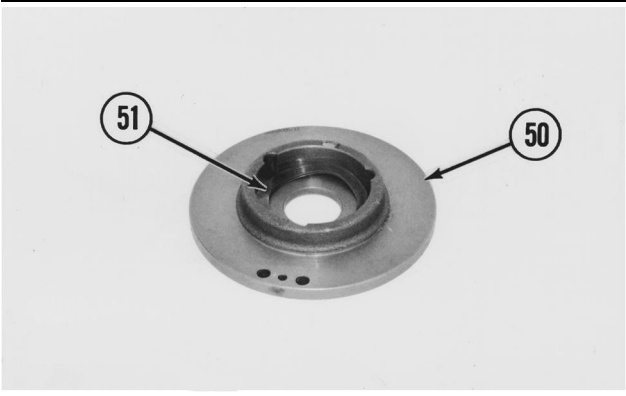


Illustration 30 g00597732

26. Remove washers (51) from front end plate (50).

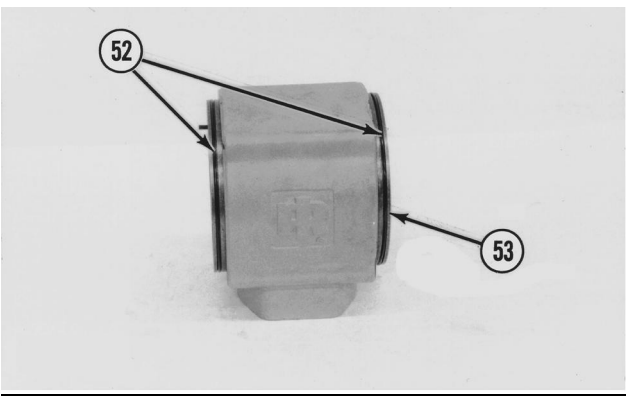


Illustration 31 g00597734

27. Remove O-ring seals (52) from rotor cylinder (53).

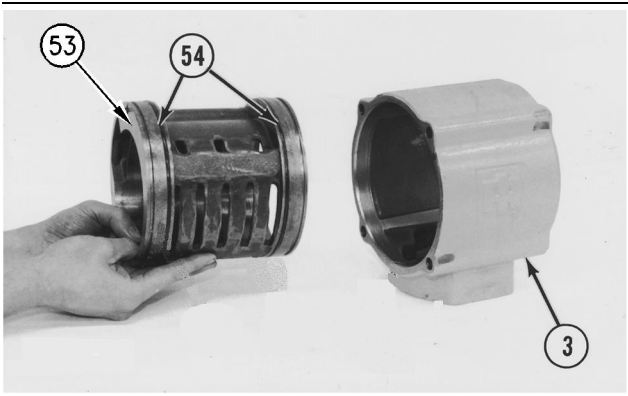


Illustration 32 g01005075

28. Remove rotor cylinder (53) from motor housing (3). Remove O-ring seals (54) from rotor cylinder (53).

i01929517

Air Starting Motor - Assemble

SMCS Code: 1451-016

Assembly Procedure

Table 2

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P - 1854	Retaining Ring Pliers	1
B		Plate 50.8 mm (2 inches) x 102 mm (4 inches) x 6 mm (0.25 inches)	2
C	1P - 1857	Retaining Ring Pliers	1
D		Tube 57 mm (2.25 inch) diameter x 6 mm (0.25 inch) thick wall x 203 mm (8 inches) long	1
E	1P - 0510	Driver Group	1
F	2S - 3230	Bearing Lubricant	

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Thoroughly clean all of the parts. Apply Tooling (F) to all of the bearings and the drive assembly. Before assembly, coat all of the other parts with an SAE 10 grade of oil.

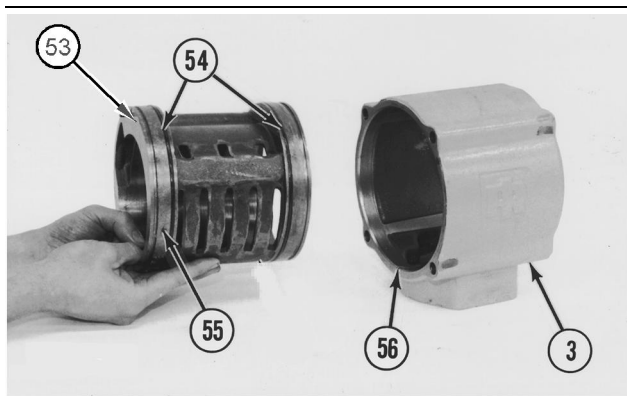


Illustration 33

g01054313

Note: Check the O-ring seals for wear or for damage. If necessary, replace the O-ring seals.

1. Install O-ring seals (54) on rotor cylinder (53).
Install rotor cylinder (53) into motor housing (3).
Orient pin (55) of rotor cylinder (53) with slot (56) in motor housing (3).

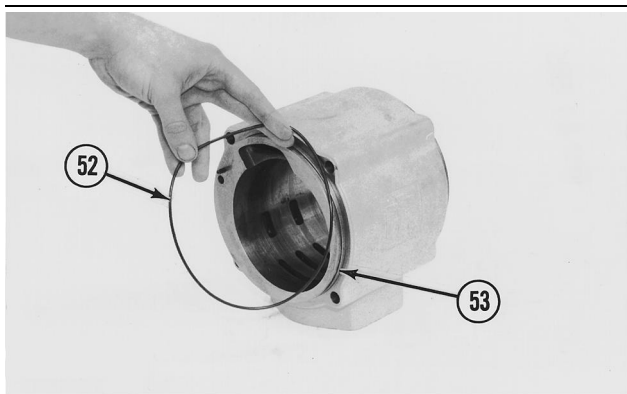


Illustration 34

g00598181

2. Install O-ring seal (52) onto rotor cylinder (53).



Illustration 35

g00598221

3. Install rear end plate (45) on the shaft of rotor (48).

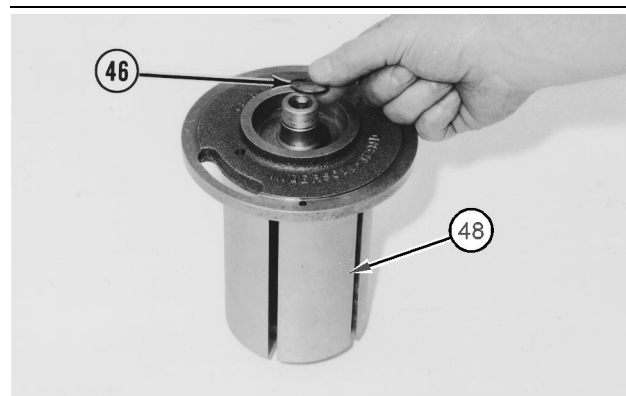


Illustration 36

g01054318

Note: Check the O-ring seal for wear or for damage. If necessary, replace the O-ring seal.

4. Install O-ring seal (46) over the shaft of rotor (48).

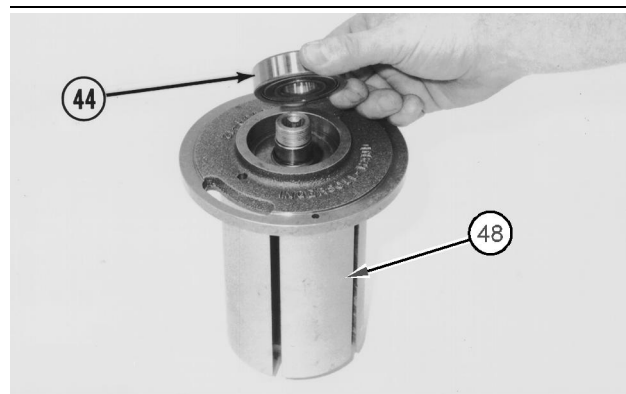


Illustration 37

g01054320

5. Install bearing (44) over the shaft of rotor (48). The bearing will fit into the rear end plate.

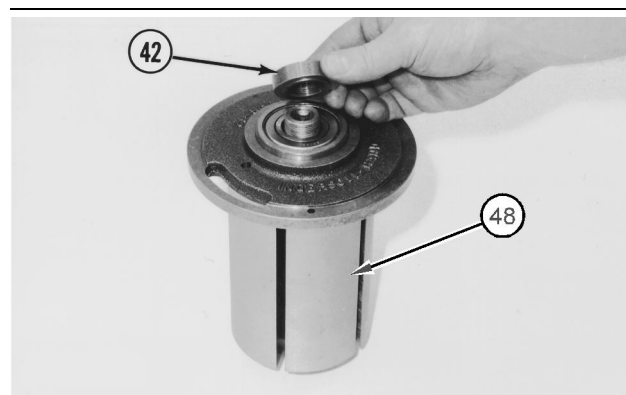


Illustration 38

g01054321

6. Install rotor clamp nut (42) on the shaft of rotor (48). Orient the shoulder of nut (42) toward the bearing.

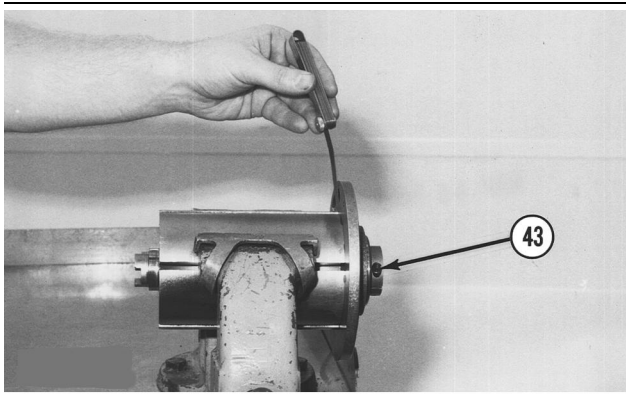


Illustration 39

g00598201

7. Tighten the rotor clamp nut in order to obtain a clearance of 0.03 to 0.08 mm (0.001 to 0.003 inch) between the rear end plate and the rotor. Measure the clearance with a feeler gauge. Tighten hex socket head bolt (43) into the rotor clamp nut. Measure the clearance again.

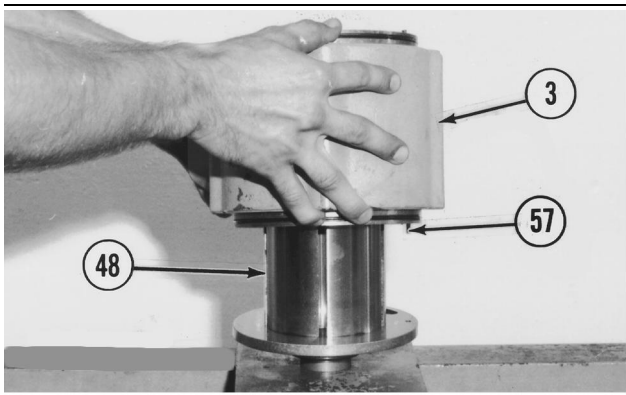


Illustration 40

g00598207

8. Install rotor (48) into motor housing (3). Align pin (57) into the slot of the rear end plate.

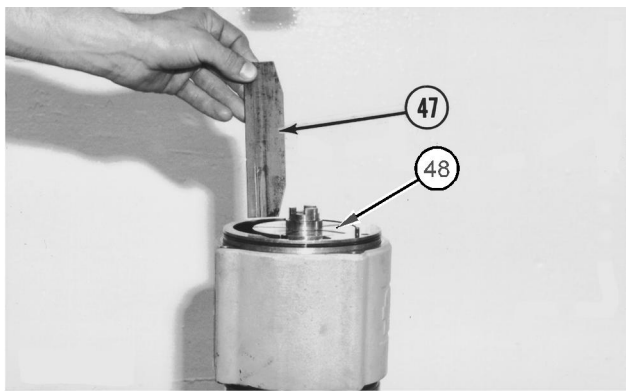


Illustration 41

g01054297

9. Install vanes (47) into rotor (48).

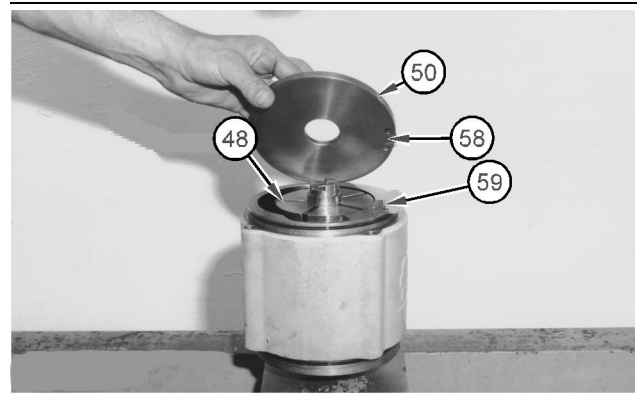


Illustration 42

g01054327

10. Install front end plate (50) onto rotor (48). Align small hole (58) of front end plate (50) onto rotor pin (59).

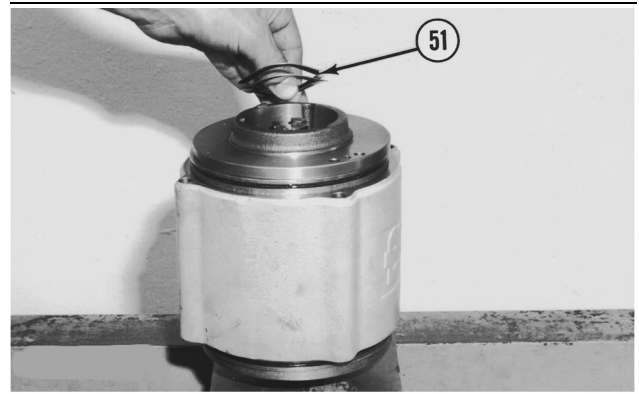


Illustration 43

g00598420

11. Install washers (51) over the shaft of the rotor onto the front end plate.

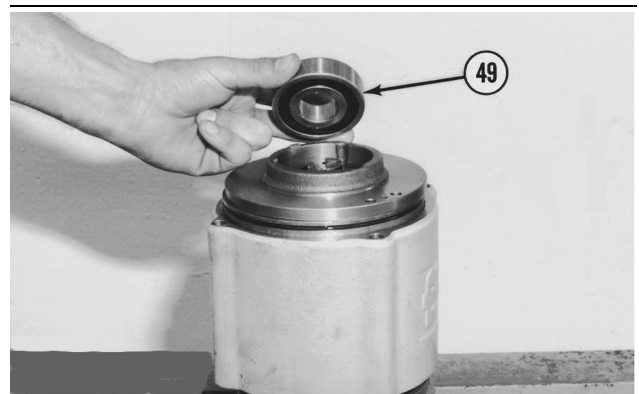


Illustration 44

g00598225

12. Place bearing (49) onto the front end plate.

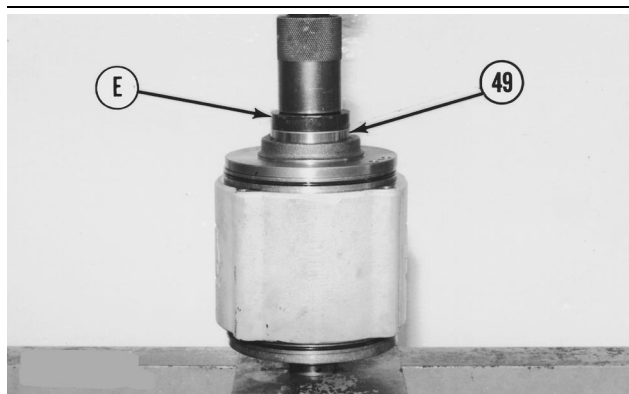


Illustration 45

g00598445

- 13.** Use Tooling (E) and a suitable press in order to complete the installation of bearing (49).

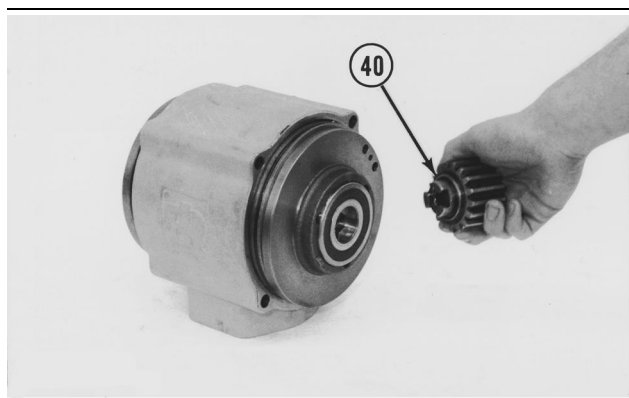


Illustration 46

g00598227

- 14.** Install rotor pinion (40) with the hex head bolt. Tighten the bolt to a torque of 120 N·m (90 lb ft).

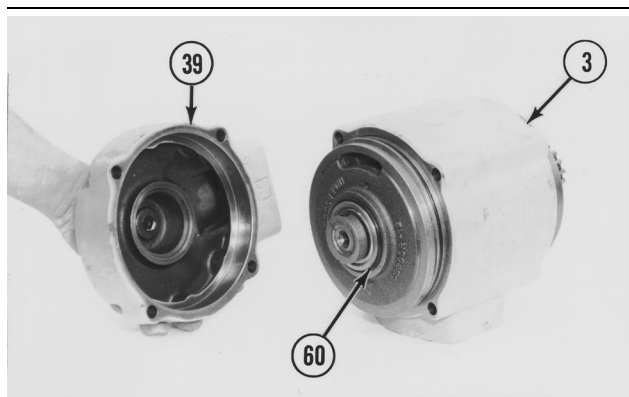


Illustration 47

g00598230

Note: Check the O-ring seal for wear or for damage. If necessary, replace the O-ring seal.

- 15.** Install O-ring seal (60) onto the rotor bearing that is on the rear end plate. Install cover (39) onto motor housing (3).

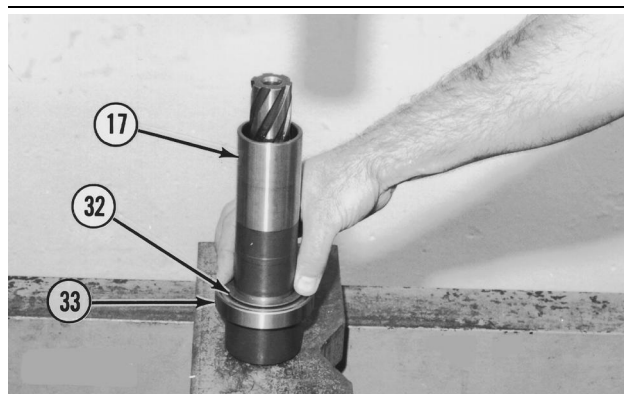


Illustration 48

g00598232

- 16.** Install bearing (33) and new ring (32) onto drive shaft (17).

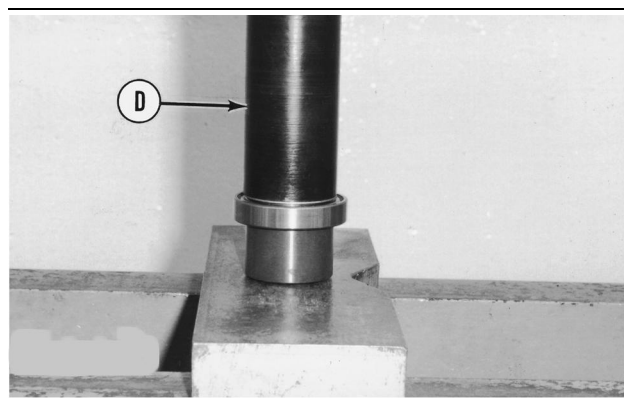


Illustration 49

g00598234

- 17.** Use Tooling (D) with a suitable press in order to complete the installation of the new ring.

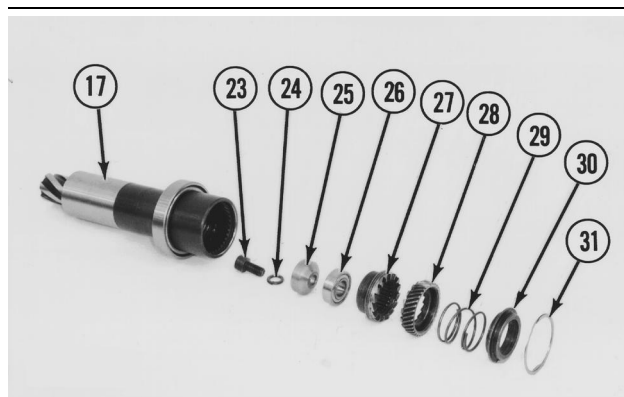


Illustration 50

g00598241

⚠ 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.

18. Install these parts into drive shaft (17): bolt (23), lockwasher (24), washer (25), bearing (26), driving clutch jaw (27), driven clutch jaw (28), spring (29), and cup (30). Install ring (31).

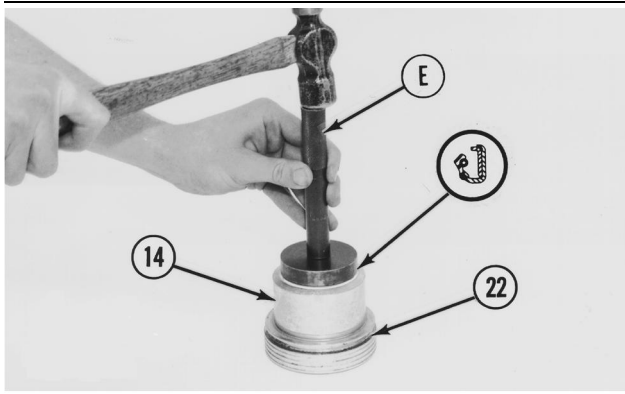


Illustration 51

g00598242

Note: Check the O-ring seal for wear or for damage. If necessary, replace the O-ring seal.

19. Use Tooling (E) in order to install the seal into piston (14). Ensure that the lip of the seal is oriented toward the outside of the piston. Install O-ring seal (22).

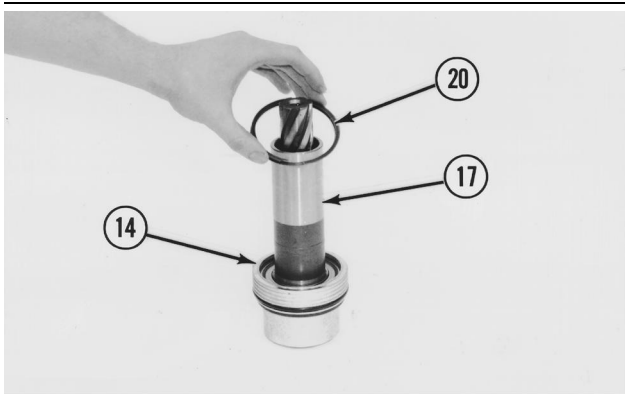


Illustration 52

g00598244

20. Install piston (14) onto the drive shaft (17). Install ring (20) onto the piston.

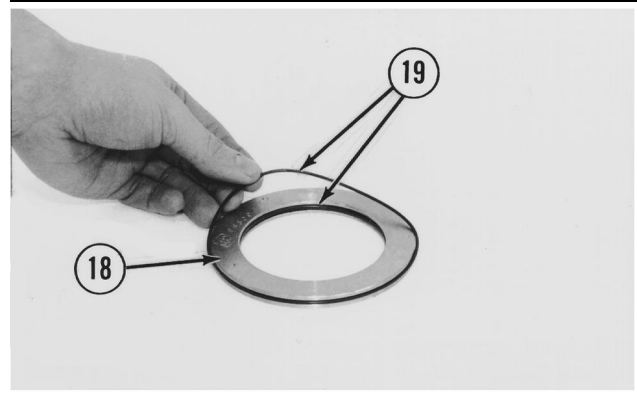


Illustration 53

g00598246

Note: Check the O-ring seals for wear or for damage. If necessary, replace the O-ring seals.

21. Install O-ring seals (19) onto bulkhead (18).

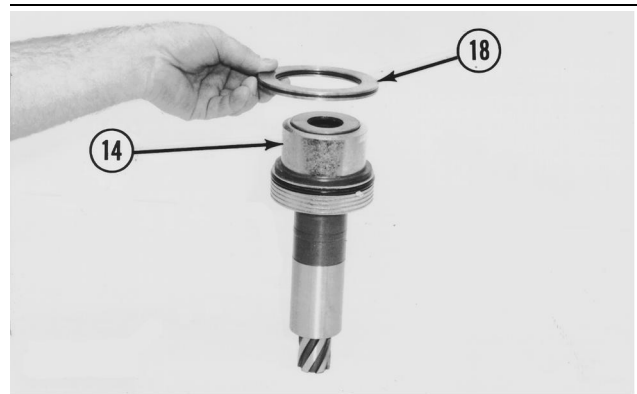


Illustration 54

g00598261

22. Install bulkhead (18) onto piston (14).

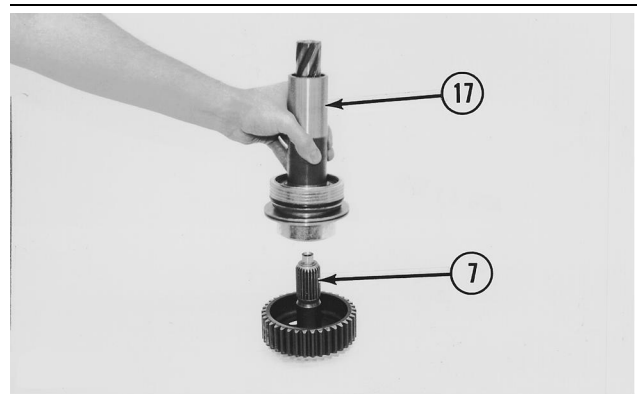


Illustration 55

g00598263

23. Install drive gear (7) onto drive shaft (17). Tighten the bolt (not shown) of the drive gear to a torque of 77 N·m (57 lb ft).

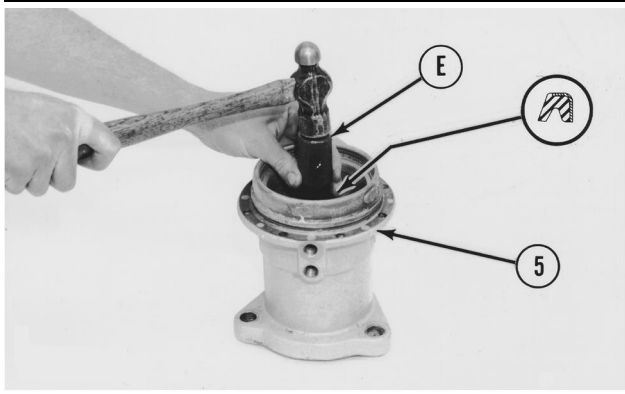


Illustration 56

g00598264

- 24.** Use Tooling (E) in order to install the seal into drive housing (5). Ensure that the lip of the seal is oriented toward the outside of the housing.

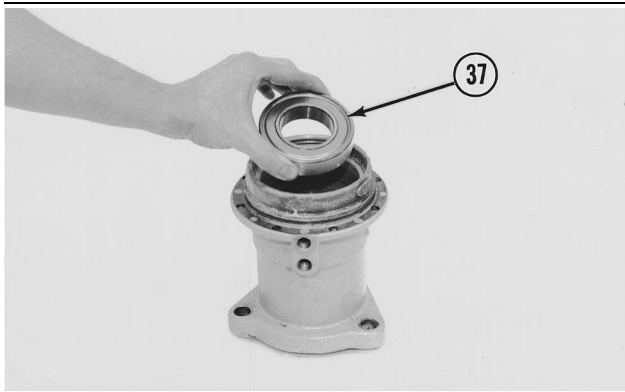


Illustration 57

g00598267

- 25.** Install bearing (37) into the drive housing.



Illustration 58

g00598268

- 26.** Install spring seat (36) into the drive housing.

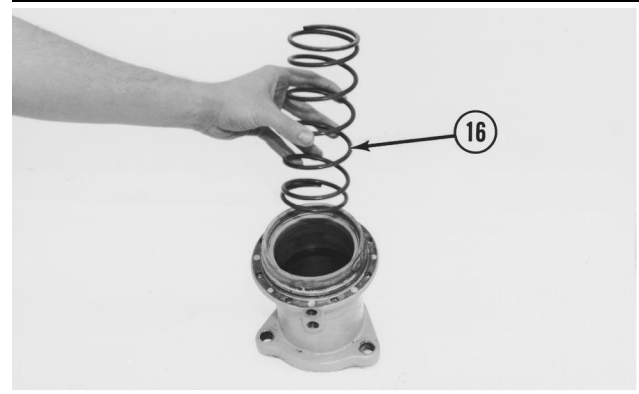


Illustration 59

g00598269

- 27.** Install return spring (16) onto the spring seat inside the drive housing.

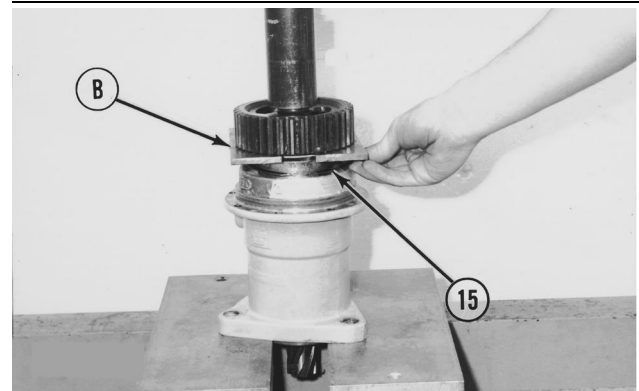


Illustration 60

g00598270

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.

- 28.** Install the drive gear, the piston, and the drive shaft onto the return spring as a unit.

Install ring (15) over the piston. Place Tooling (B) between the drive gear and the piston. Use a suitable press in order to compress the return spring. Install ring (15) into the groove of the drive housing. Slowly release the press. Remove Tooling (B).

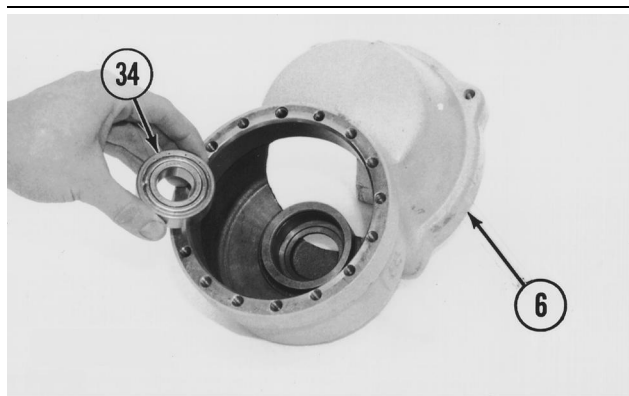


Illustration 61

g00598272

- 29.** Install bearing (34) into gear case (6). Use Tooling (C) in order to install the ring that retains the bearing in the gear case.

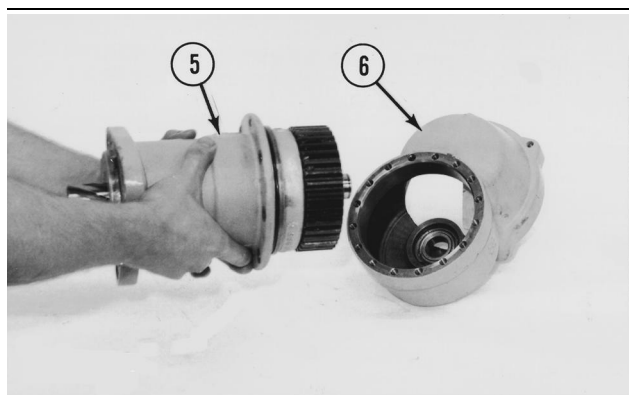


Illustration 62

g00598274

- 30.** Install drive housing (5) in gear case (6). Make sure that the shaft on the end of the drive gear is correctly engaged with the bearing in the gear case. Tighten the bolts to a torque of 36 N·m (27 lb ft).

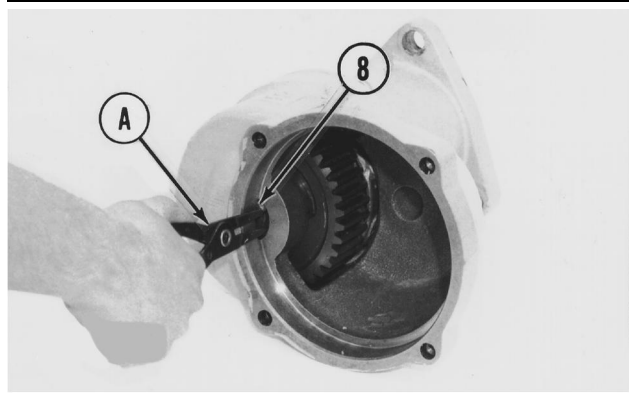


Illustration 63

g00598276

- 31.** Use Tooling (A) and install ring (8).

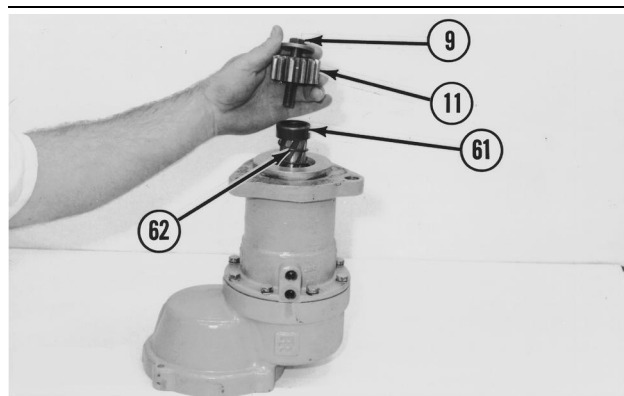


Illustration 64

g00598277

Note: Bolt (9) has left hand threads.

- 32.** Install these parts on the end of the drive shaft: pinion spring (62), spring sleeve (61), drive pinion (11), bolt (9), and the washer. Tighten bolt (9) to a torque of 110 N·m (80 lb ft).

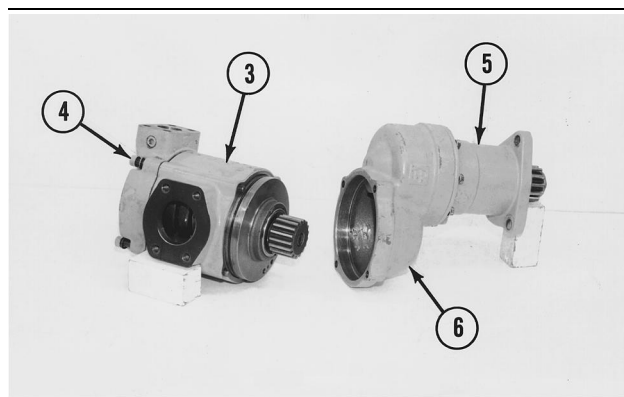


Illustration 65

g00598278

- 33.** Install gear case (6) and drive housing (5) onto cover (3) as a unit. Tighten bolts (4) evenly to a torque of 80 N·m (60 lb ft).

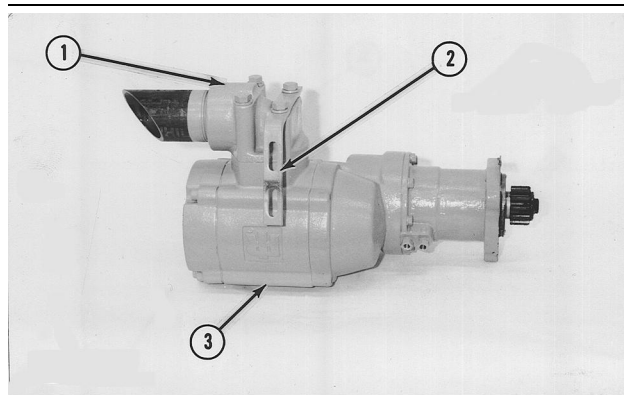


Illustration 66

g00597693

- 34.** Install the gasket, elbow (1), and bracket (2) on motor housing (3).

35. After you verify that the starting motor operates properly, attach the air lines to the starting motor.

Verify the Operation of the Air Starting Motor

Use the following procedure to verify that the air starting motor is operating correctly:

1. Turn the drive pinion by hand in the direction of the rotation of the starting motor. The drive clutch must operate smoothly with a clicking sound.
2. Turn the drive pinion in the opposite direction of the rotation of the starting motor. The drive pinion must turn by hand.
3. Apply 345 kPa (50 psi) of air pressure in the inlet of the drive housing. The drive pinion must move away from the drive housing and air must come out of the outlet of the drive housing.
4. Plug the outlet of the drive housing. Apply 1034 kPa (150 psi) in the inlet of the drive housing. Ensure that no air is leaking. Measure the dimension from the face of the drive pinion to the mounting face of the drive housing. The dimension must be 73.00 ± 2.0 mm (2.874 ± 0.08 inch). Remove the air pressure. Measure the dimension again. The dimension must be 44.5 ± 2.0 mm (1.75 ± 0.08 inch).
5. Apply 620 kPa (90 psi) of air pressure in the inlet of the drive housing. The starting motor must run smoothly.

End By:

- a. Install the air starting motor. Refer to Disassembly and Assembly, "Air Starting Motor - Install".

i01929504

Air Starting Motor - Install

SMCS Code: 1451-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Several different air starting motors are available for use. The starting motors can have different configurations for the air tube assemblies. Examples of installing two different air starting motors are provided below.

Installation of an Air Starting Motor Without the Air Tube Assemblies Attached

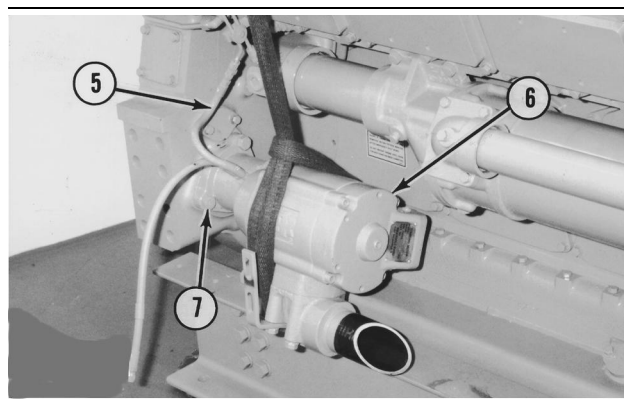


Illustration 67

g00597643

1. Attach a suitable lifting device to air starting motor (6). The weight of air starting motor (6) is approximately 48 kg (106 lb).
2. Install a new gasket for the joint between the cover of air starting motor (6) and the flywheel housing. Position air starting motor (6). Install bolts (7).
3. Connect hose assembly (5).

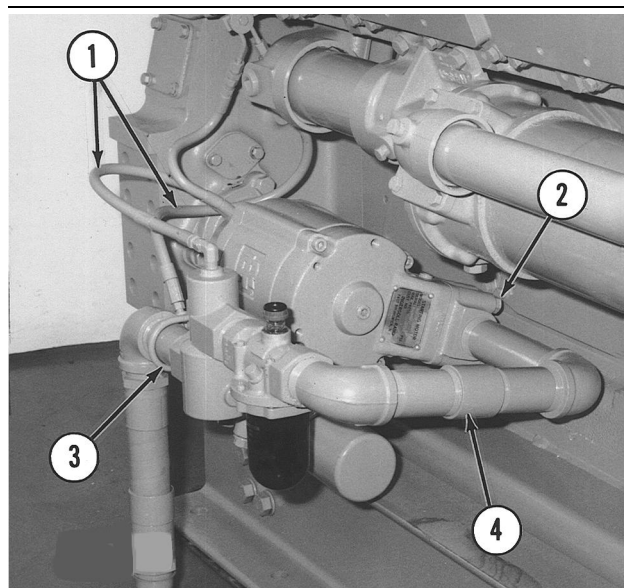


Illustration 68

g00597642

4. Install tube assemblies (4) and U-bolt (3).

i01128256

5. Install bolts (2).
6. Connect hose assemblies (1).

Installation of an Air Starting Motor With the Air Tube Assemblies Attached

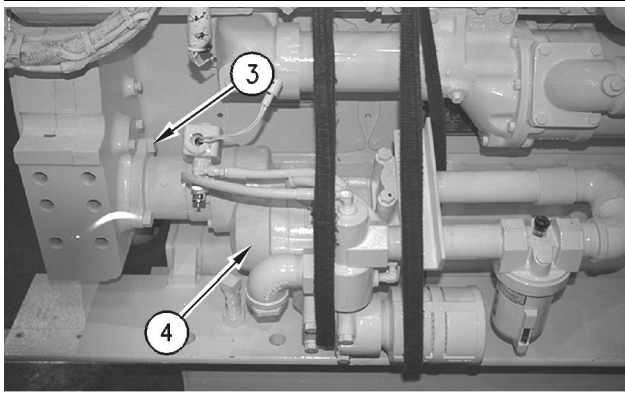


Illustration 69

g00615940

1. Attach a suitable lifting device to air starting motor (4). The weight of air starting motor (4) with the air tube assemblies is approximately 86 kg (190 lb).
2. Install a new gasket for the joint between the cover of air starting motor (4) and the flywheel housing. Position air starting motor (4). Install bolts (3).

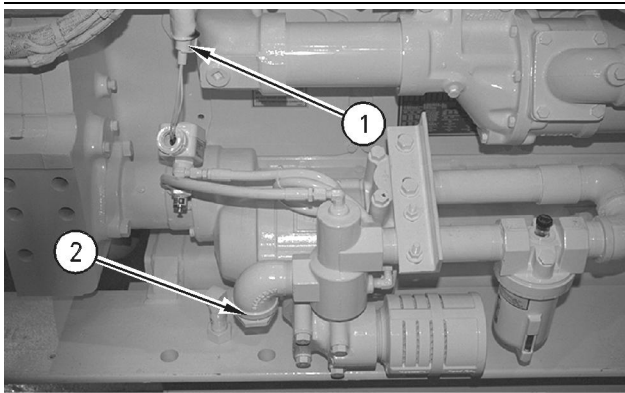


Illustration 70

g00615939

3. Connect the tube assemblies to elbow (2).
4. Connect harness assembly (1).

Electric Starting Motor - Remove and Install

SMCS Code: 1453-010

Removal Procedure

⚠ WARNING

Disconnect batteries before performance of any service work.

Note: Before disconnecting the wires and electrical cables, mark the items for the proper connections in order to ensure correct assembly.

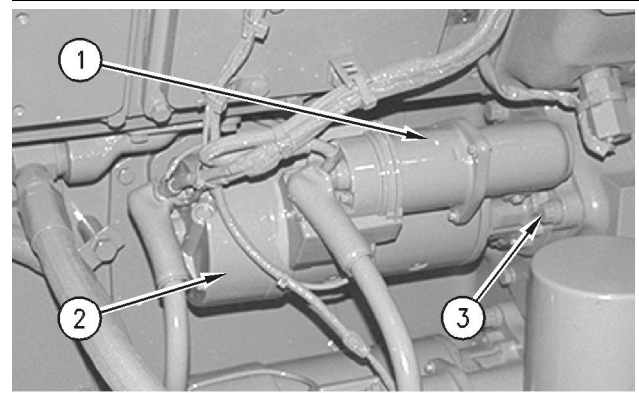


Illustration 71

g00597378

1. Disconnect the wires and electrical cables from solenoid (1) and starting motor (2).

If the engine has two starting motors, disconnect the wires between the two solenoids and starting motors.
2. Attach a suitable hoist to the starting motor. The starting motor weighs approximately 30 kg (66 lb).
3. Remove three bolts (3). Remove the starting motor. Remove the gasket from the joint between the starting motor and the flywheel housing.

Installation Procedure

1. Inspect the gasket for the joint between the starting motor and the flywheel housing. Obtain a new gasket, if necessary.
2. Attach a suitable hoist to the starting motor. The starting motor weighs approximately 30 kg (66 lb).

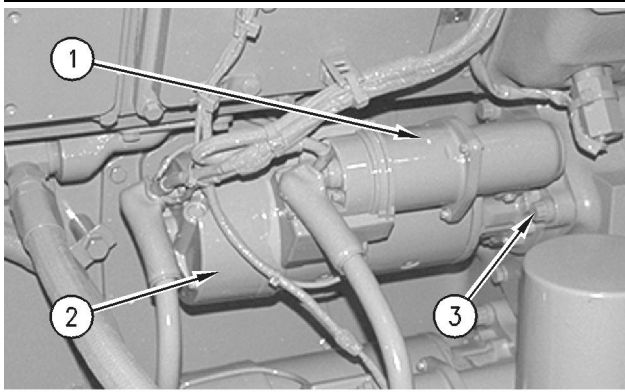


Illustration 72

g00597378

3. Place the gasket in the cover for the starting motor. Lift the starting motor onto the mounting position. Install three bolts (3).
4. Connect the wires and electrical cables to solenoid (1) and starting motor (2).

If the engine has two starting motors, connect the wires between the two solenoids and starting motors.

i02056264

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.

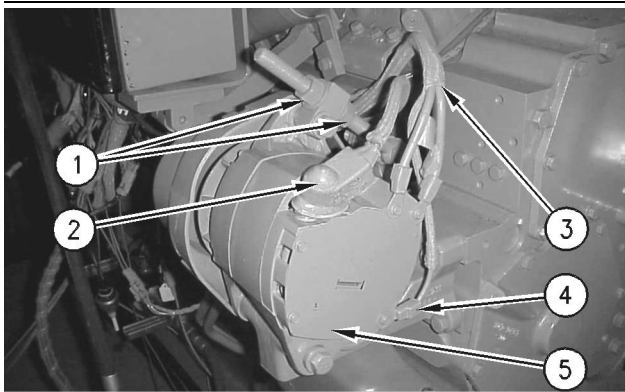


Illustration 73

g00599021

1. Disconnect harness assemblies (2), (3), and (4) from alternator (5).

2. Loosen adjusting nuts (1) in order to provide slack for the belt.

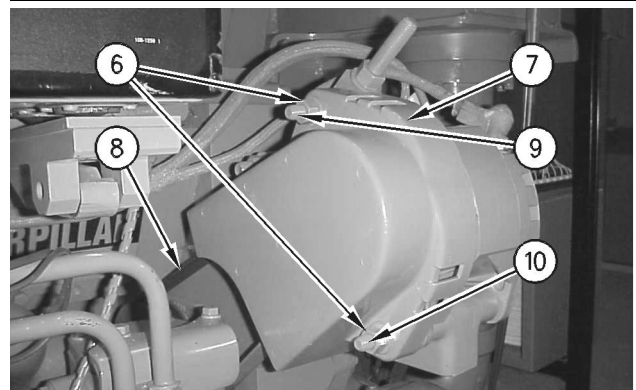


Illustration 74

g00599024

3. Remove nuts and washers (6) in order to remove belt guard (7).
4. Remove belt (8) from the pulley for the alternator.
5. Remove bolt (9) in order to disconnect the alternator from the adjusting rod.
6. Remove bolt (10) in order to disconnect the alternator from the support. Remove alternator (5).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

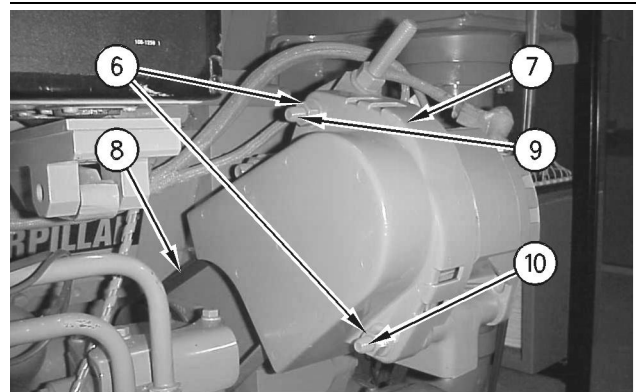


Illustration 75

g00599024

1. Position alternator (5) on the support. Install bolts (9) and (10) in order to hold alternator (5) in place. Do not tighten the bolts at this time.
2. Install belt (8) on the pulley for the alternator.

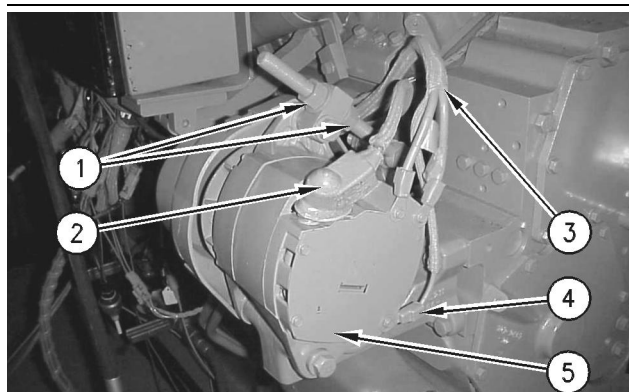


Illustration 76

g00599021

3. Adjust the belt tension. Refer to Specifications, "Belt Tension Chart". In order to adjust the belt tension, turn adjusting nuts (1). Tighten adjusting nuts (1).
4. After the belt tension has been adjusted, install belt guard (7). Secure the belt guard to bolts (9) and (10) with nuts and washers (6).
5. Connect harness assemblies (2), (3), and (4).

i02044217

Electronic Control Module (Engine) - Remove and Install

SMCS Code: 1900-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: If the ECM is being replaced, download the personality module before you remove the ECM. Refer to Troubleshooting, "Replacing the ECM".

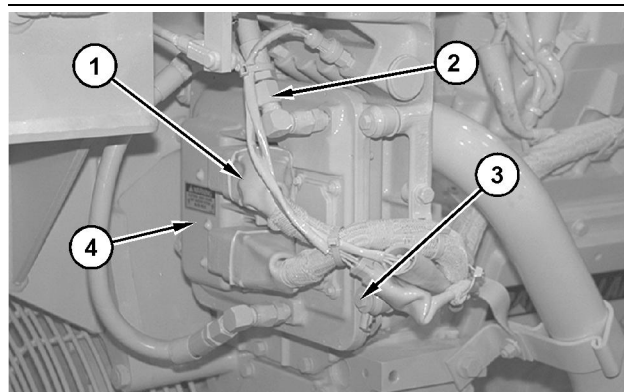


Illustration 77

g01049870

1. Disconnect harness assemblies (1).
2. Disconnect fuel hose assemblies (2). Immediately place caps or plugs on the openings.
3. Support ECM (4). Remove bolts (3).
4. Remove ECM (4).

Installation Procedure

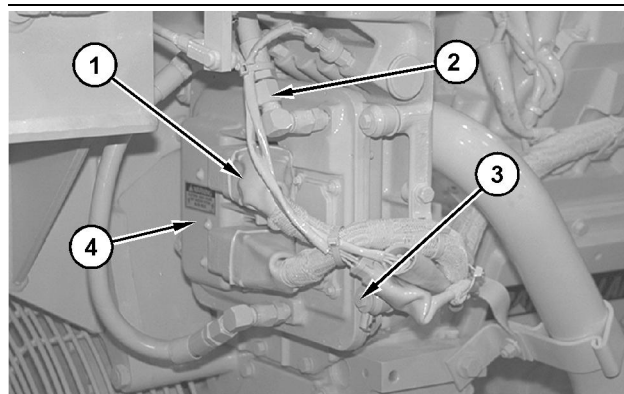


Illustration 78

g01049870

1. Position ECM (4) on the engine.
2. Install bolts (3).
3. Connect fuel hose assemblies (2).
4. Connect harness assemblies (1).

i02044890

Fuel Filter Housing - Remove (Spin-on Filter)

SMCS Code: 1262-011

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. Shut OFF the fuel supply to the engine.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

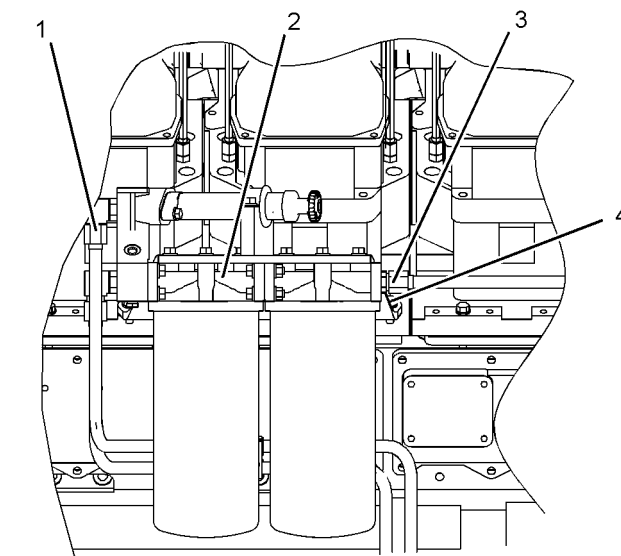


Illustration 79

g01050681

2. Disconnect tube assemblies (1) and tube assembly (3) from fuel filter housing (2).
3. Remove bolts (4) that are located behind the fuel filter housing.
4. Remove fuel filter housing (2).

i02741443

Fuel Filter Housing - Remove

SMCS Code: 1262-011

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i02046946

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 Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Shut OFF the fuel supply to the engine.
2. Drain the fuel filter housing into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, "Fuel System Secondary Filter - Replace".

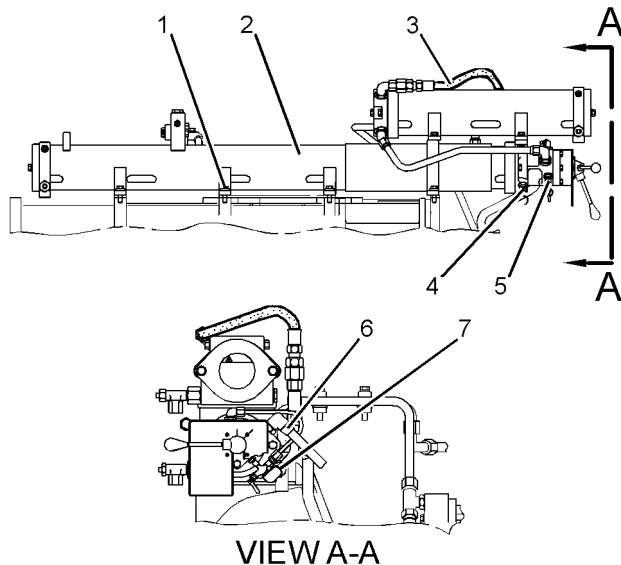


Illustration 80

g01373948

3. Disconnect sensor (4) and sensor (5).
4. Disconnect hose assembly (3).
5. Disconnect tube assembly (6) and tube assembly (7).
6. Attach a suitable lifting device onto fuel filter housings (2). The weight of fuel filter housings (2) is approximately 30 kg (66 lb). Remove bolts (1).
7. Remove fuel filter housings (2).

Fuel Filter Housing - Remove

SMCS Code: 1262-011

Removal Procedure**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Shut OFF the fuel supply to the engine.

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.

2. Drain the fuel filter housing into a suitable container for storage or for disposal.

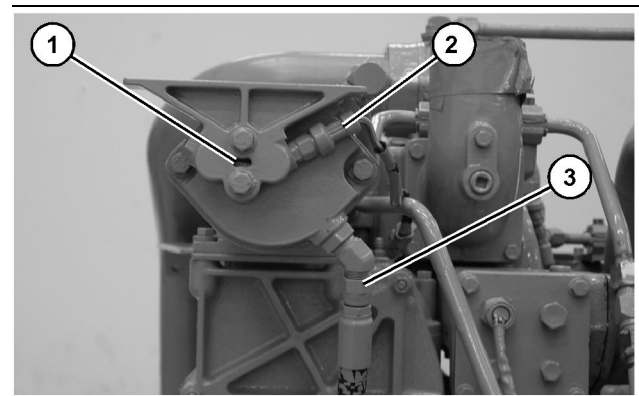


Illustration 81

g01050833

⚠ 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. Disconnect fuel pressure sensor (2).
4. Disconnect hose assembly (3).
5. Remove cover (1).

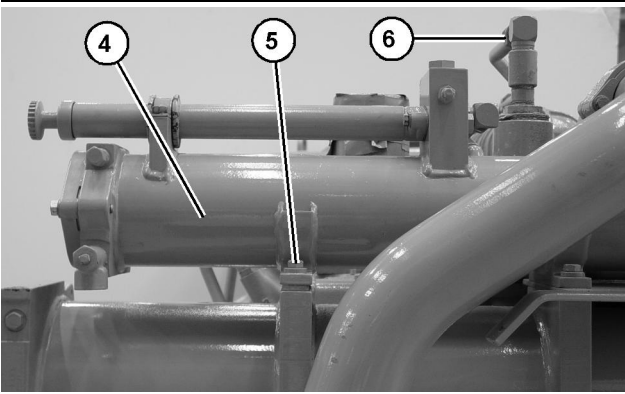


Illustration 82

g01050834

6. Disconnect tube assemblies (6).
7. Remove bolts (5).
8. Attach a suitable lifting device onto fuel filter housing (4). The weight of fuel filter housing (4) is approximately 30 kg (66 lb). Remove fuel filter housing (4).

Fuel Filter Housing - Disassemble (Spin-on Filters)

SMCS Code: 1262-015

Disassembly Procedure

Table 3

Required Tools			
Tool	Part Number	Part Description	Qty
A	187-2718	Filter Wrench	1

Start By:

- a. Remove the fuel filter housing. Refer to Disassembly and Assembly, "Fuel Filter Housing - Remove".
- b. Remove the fuel priming pump, if equipped. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

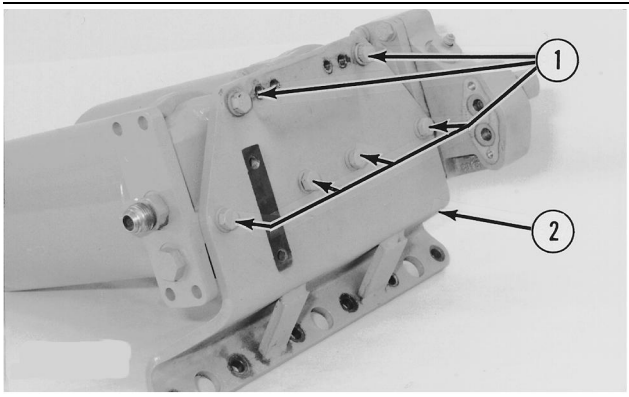


Illustration 83

g00599245

1. Remove bolts (1). Remove bracket (2) from the fuel filter housing.

i02057034

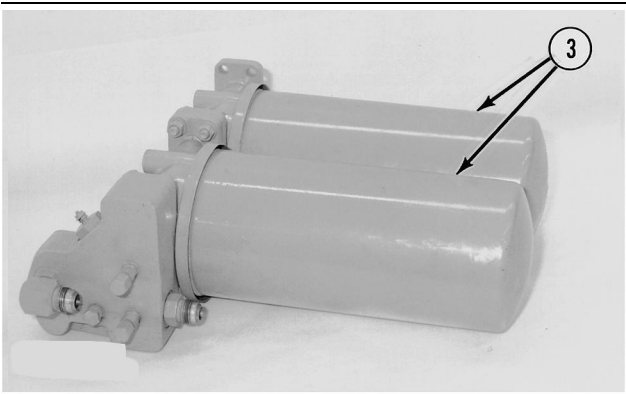


Illustration 84 g00599246

2. Use Tooling (A) and remove filter filters (3).

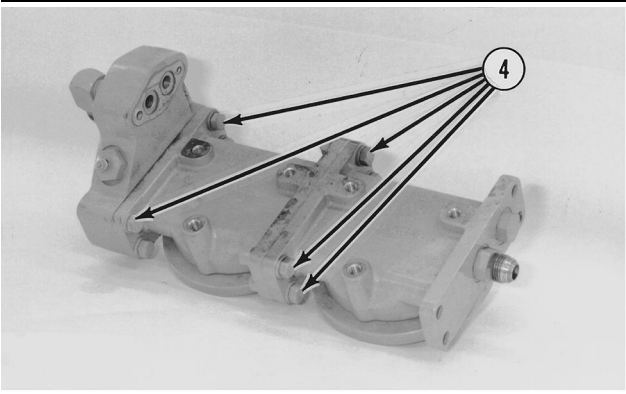


Illustration 85 g00599247

3. Remove bolts and nuts (4).

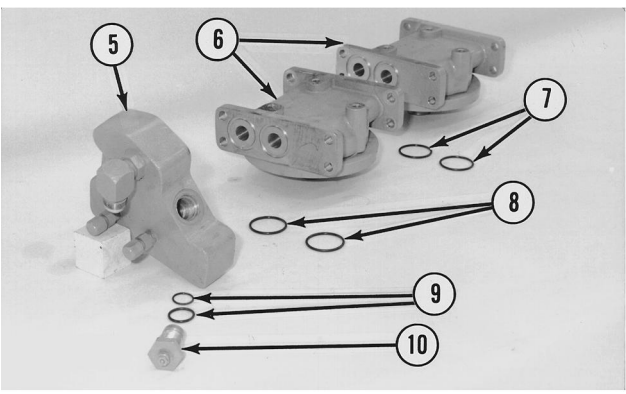


Illustration 86 g00599248

4. Separate adapter (5) and bases (6). Remove O-ring seals (7) and (8) from each base.

Note: Do not disassemble valve (10). Do not change the setting of valve (10).

5. Remove valve (10) and O-ring seals (9) from adapter (5).

Fuel Filter Housing - Assemble (Spin-on Filters)

SMCS Code: 1262-016

Assembly Procedure

Table 4

Required Tools			
Tool	Part Number	Part Description	Qty
A	187-2718	Filter Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Inspect the O-ring seals before installation. If a seal is cut, scratched, or cracked, obtain a new seal for installation. To make installation easier, coat the bores for the seals with clean diesel fuel.

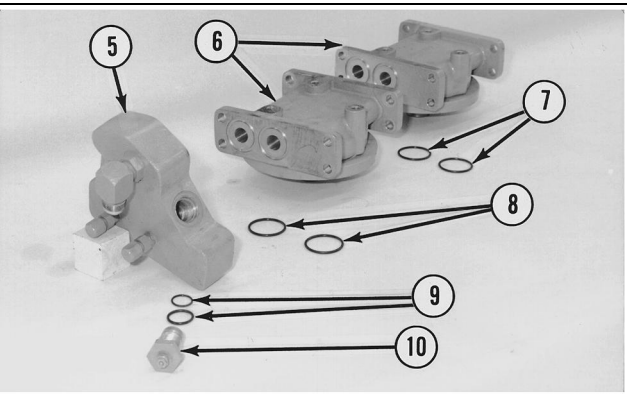


Illustration 87 g00599248

1. Install O-ring seals (9) and valve (10) into adapter (5).

2. Install O-ring seals (7) and (8) into each base (6).

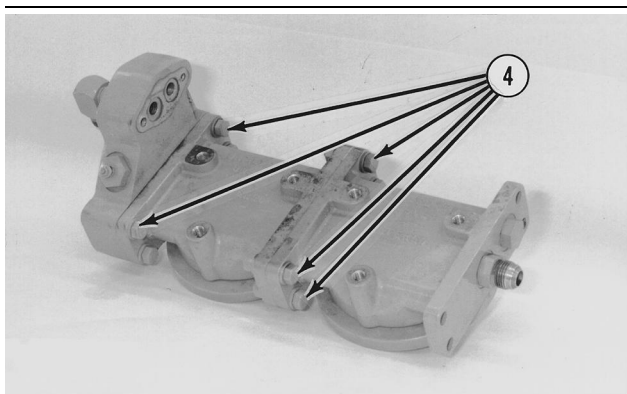


Illustration 88

g00599247

3. Assemble the fuel filter housing. Install bolts and nuts (4).

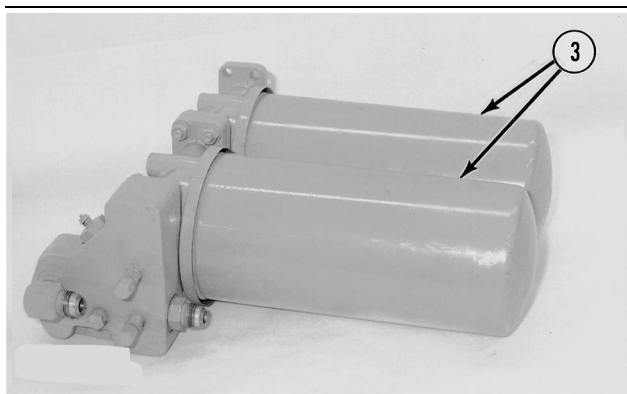


Illustration 89

g00599246

4. Ensure that the sealing surface of the mounting base is clean. Apply clean diesel fuel to the gaskets of new fuel filters (3). Position fuel filters (3). Use Tooling (A) and tighten fuel filters (3) until the gaskets contact the bases. Tighten fuel filters (3) for an additional one full turn (360 degrees). Do not overtighten fuel filters (3).

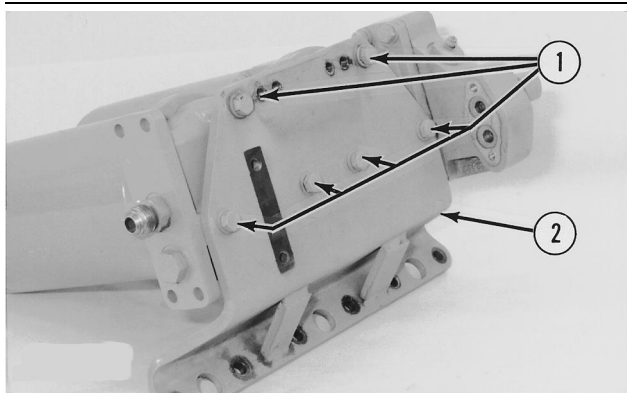


Illustration 90

g00599245

5. Position bracket (2) onto the fuel filter housing. Install bolts (1).

End By:

- a. Install the fuel priming pump, if equipped. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".
- b. Install the fuel filter housing. Refer to Disassembly and Assembly, "Fuel Filter Housing - Install".

i02741453

Fuel Filter Housing - Install

SMCS Code: 1262-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

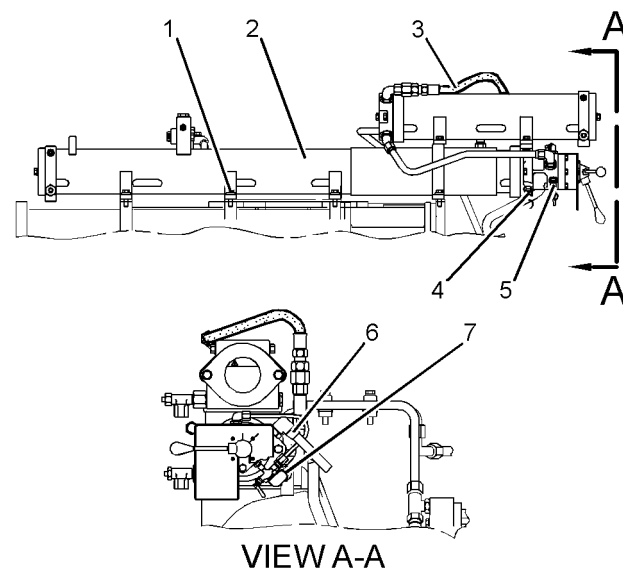


Illustration 91

g01373948

1. Attach a suitable lifting device to fuel filter housings (2). The weight of fuel filter housings (2) is approximately 30 kg (66 lb). Position fuel filter housings (2) and install bolts (1).
2. Connect tube assembly (7) and tube assembly (6).
3. Connect hose assembly (3).
4. Connect sensor (5) and sensor (4).

5. Turn ON the fuel supply to the engine.
6. Remove the air from the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime".

i02057113

Fuel Filter Housing - Install (Spin-on Filters)

SMCS Code: 1262-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

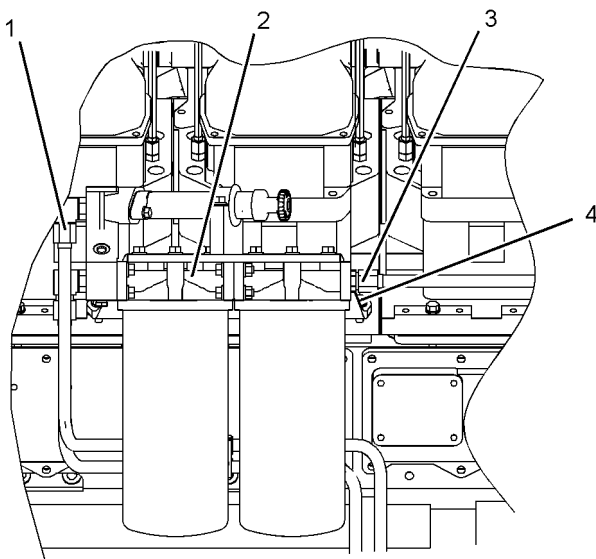


Illustration 92

g01050681

1. Position fuel filter housing (2).
2. Install bolts (4) that are located behind fuel filter housing (2).
3. Connect tube assemblies (1) and tube assembly (3).
4. Turn ON the fuel supply to the engine.

i02724002

Fuel Filter Housing - Install

SMCS Code: 1262-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

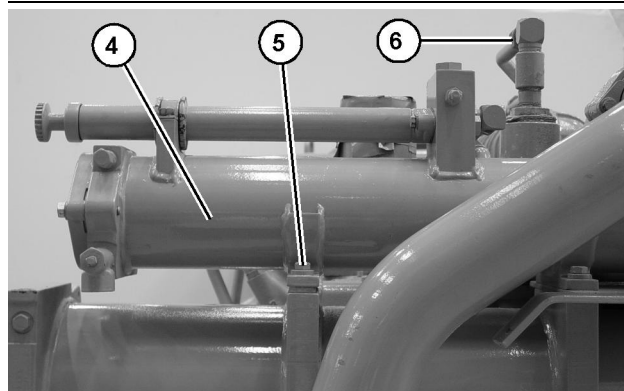


Illustration 93

g01050834

1. Attach a suitable lifting device to fuel filter housing (4). The weight of fuel filter housing (4) is approximately 30 kg (66 lb). Position fuel filter housing (4) and install bolts (5).
2. Connect tube assemblies (6).

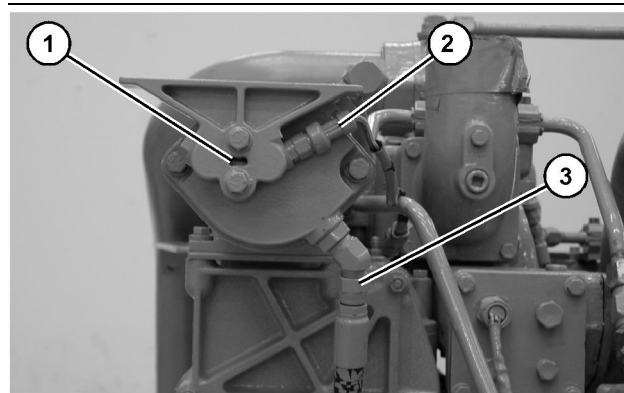


Illustration 94

g01050833

3. Install cover (1).
4. Connect hose assembly (3).
5. Connect fuel pressure sensor (2).
6. Turn ON the fuel supply to the engine.

7. Remove the air from the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime".

i01929735

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.

1. Turn the fuel supply to the OFF position.

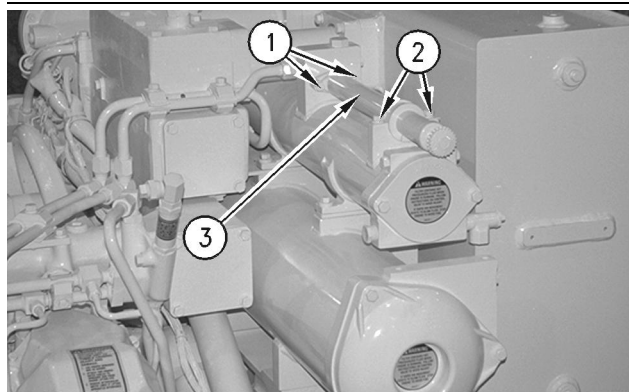


Illustration 95

g00599551

2. Remove bolts (1).
3. Remove bolts (2).
4. Remove fuel priming pump (3).

5. Remove the gasket.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

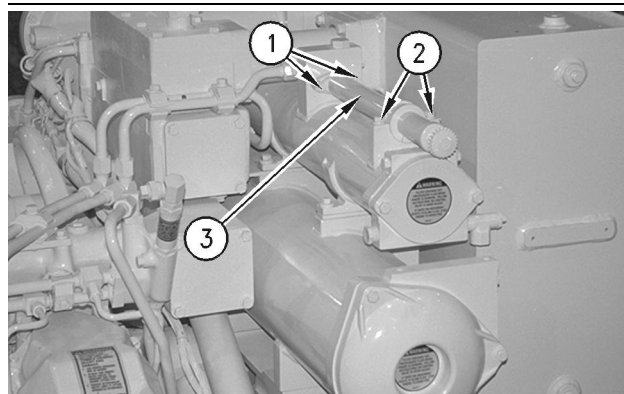


Illustration 96

g00599551

1. Position a new gasket and fuel priming pump (3).
2. Install bolts (2).
3. Install bolts (1).
4. Turn the fuel supply to the ON position.

i02059104

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.

i01929748

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. Turn OFF the fuel supply to the engine.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

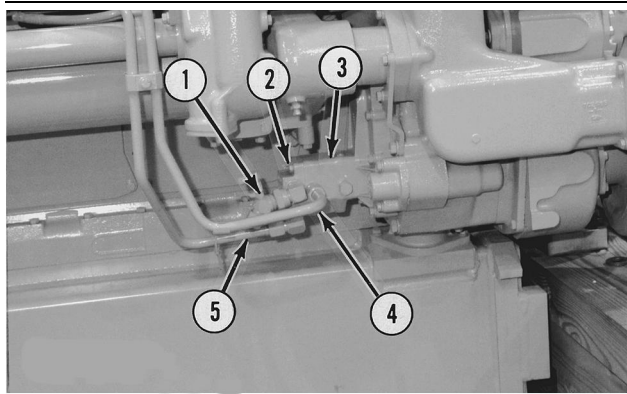


Illustration 97

g00599571

2. Disconnect tube assembly (1).
3. Disconnect tube assembly (5). Disconnect tube assembly (4) that is between fuel transfer pump (3) and the fuel priming pump (if equipped) and/or the fuel filters.
4. Remove bolts (2) that hold fuel transfer pump (3) to the cover of the oil pump.
5. Remove fuel transfer pump (3), the O-ring seal, and the drive coupling.

Fuel Transfer Pump - Disassemble

SMCS Code: 1256-015

Disassembly Procedure

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

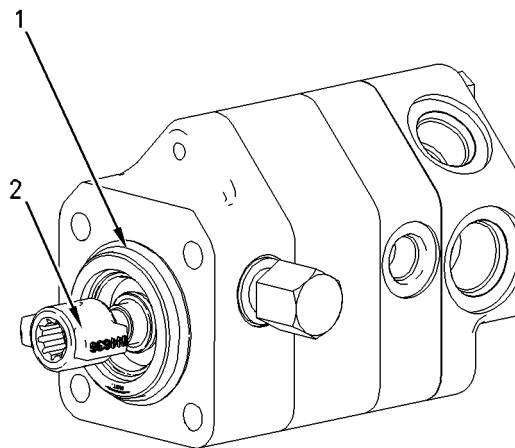


Illustration 98

g01007133

1. Remove drive coupling (2) from the drive shaft. Remove O-ring seal (1).

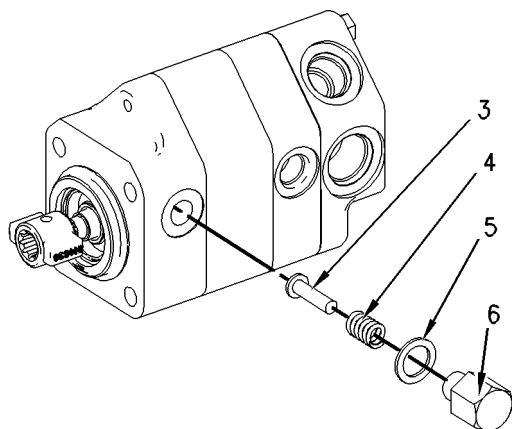


Illustration 99

g01007139

⚠ 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.

2. Remove the following items from the bracket: cap (6), washer (5), valve spring (4), and poppet valve (3).

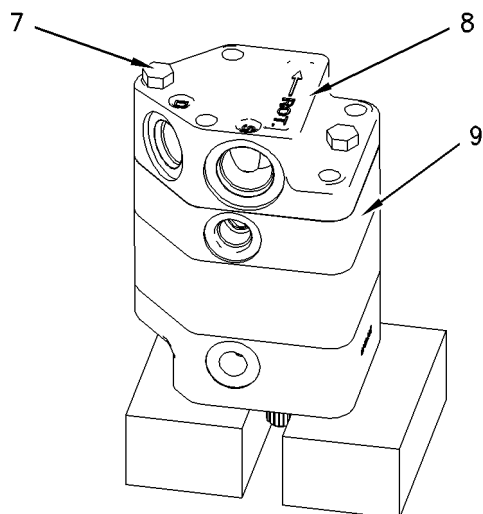


Illustration 100

g01007146

3. Remove bolts (7). Remove head (8) from plate (9).

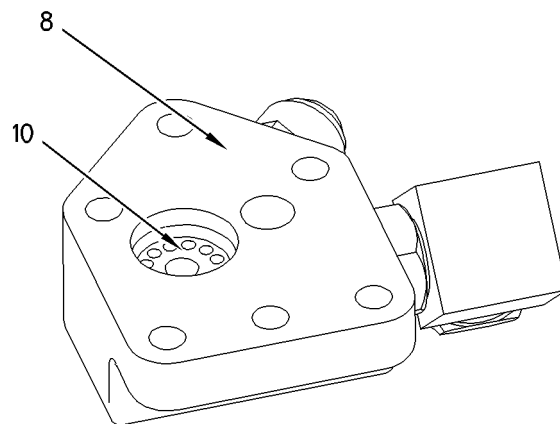


Illustration 101

g01007154

4. If check valve (10) will be replaced, remove the check valve from head (8).

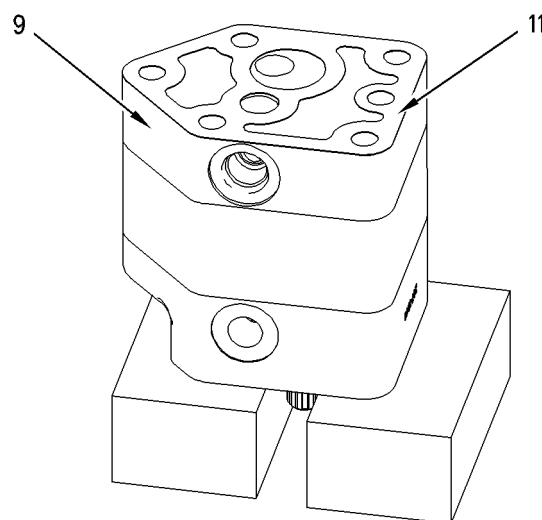


Illustration 102

g01007155

5. Remove plate (9). Remove gasket (11). Remove the O-ring seal from the side of the plate that is opposite of gasket (11).

If the bearings in plate (9) are damaged, the plate must be replaced. The bearings are nonserviceable separately.

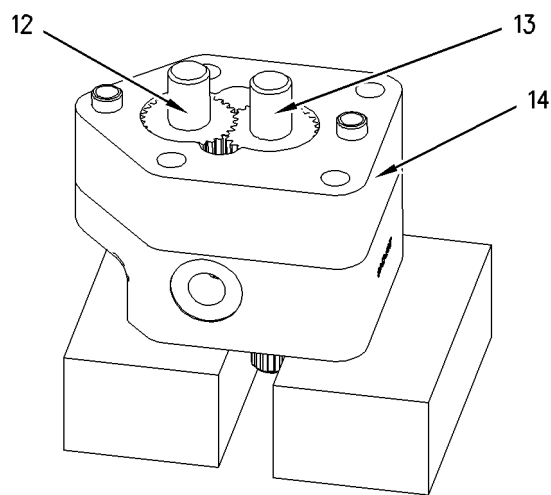


Illustration 103

g01007191

6. Remove idler gear (12) and drive shaft (13) from casing (14).

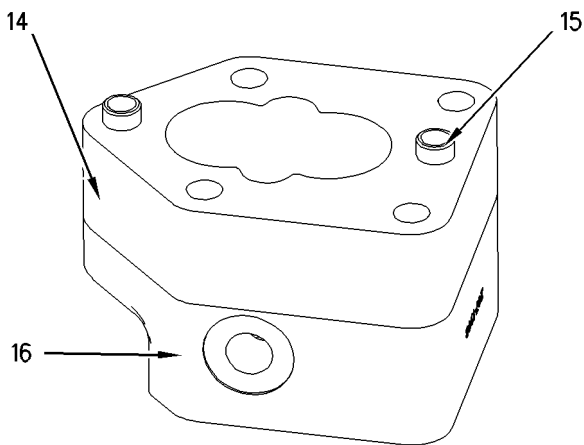


Illustration 104

g01007192

7. Remove casing (14) and sleeves (15) from bracket (16). Remove the O-ring seal from casing (14).

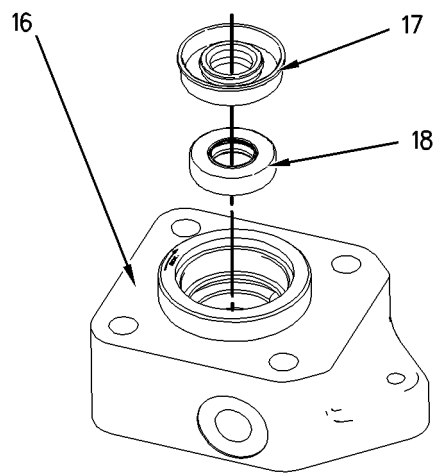


Illustration 105

g01007193

8. Remove outer lip seal (17) and inner lip seal (18) from bracket (16).

Note: If the bearings in bracket (16) are damaged, the bracket must be replaced. The bearings are nonserviceable separately.

i01929749

Fuel Transfer Pump - Assemble

SMCS Code: 1256-016

Assembly Procedure

Table 5

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

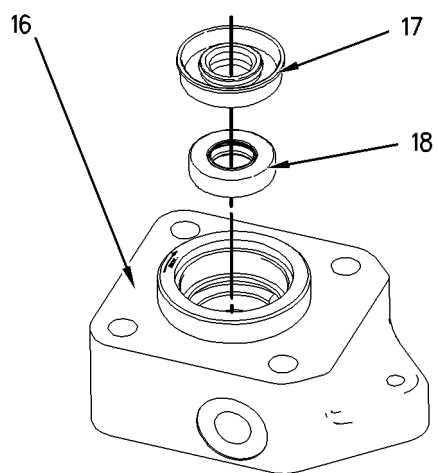


Illustration 106

g01007193

1. Coat the lip seals for bracket (16) with clean engine oil.
2. Use Tooling (A) in order to install inner lip seal (18) and outer lip seal (17) into bracket (16).

Note: If the bearings in bracket (16) are damaged, the bracket must be replaced. The bearings are nonserviceable separately.

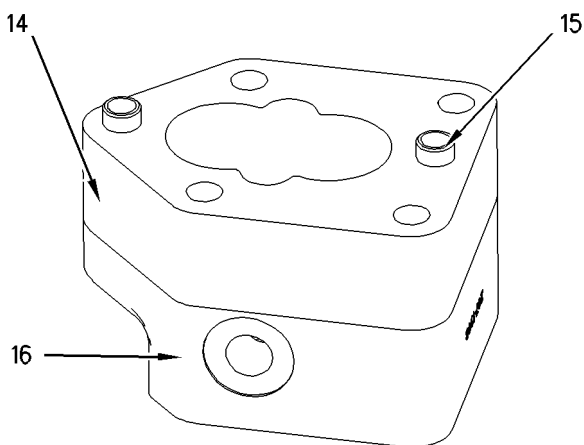


Illustration 107

g01007192

3. Install the O-ring seal onto casing (14). Install casing (14) and sleeves (15) onto bracket (16).

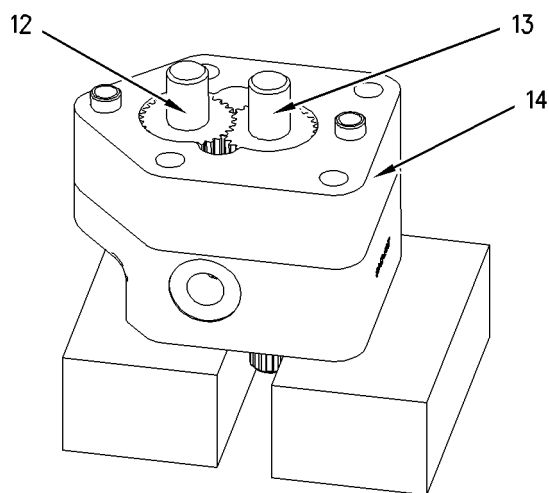


Illustration 108

g01007191

4. Install idler gear (12) and drive shaft (13) into casing (14).

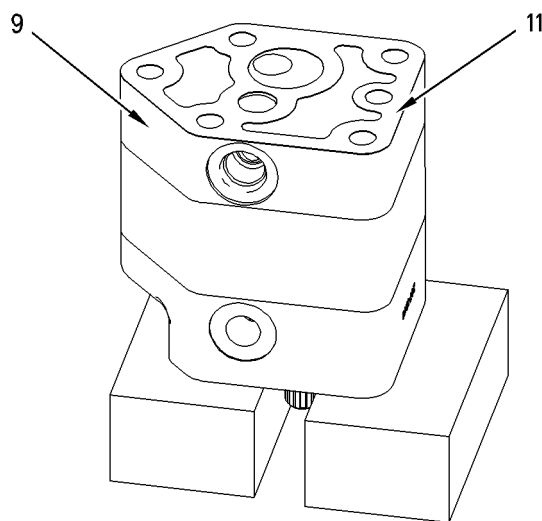


Illustration 109

g01007155

Note: If the bearings in plate (9) are damaged, the plate must be replaced. The bearings are nonserviceable separately.

5. Install the O-ring seal into the side of the plate that is opposite of gasket (11). Install plate (9). Install gasket (11).

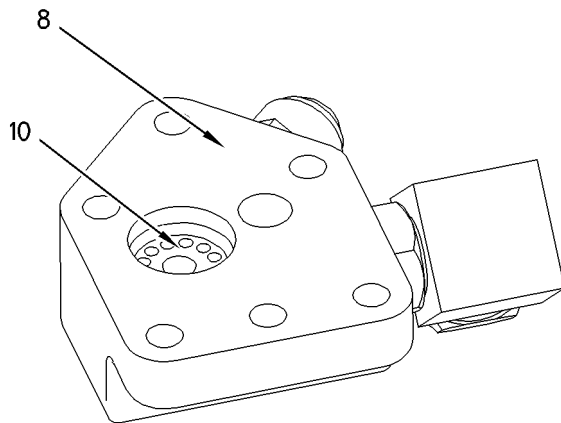


Illustration 110

g01007154

Note: Before you install check valve (10) in head (8), make sure that the spring on the check valve is oriented toward the inside.

6. Install check valve (10) into head (8).

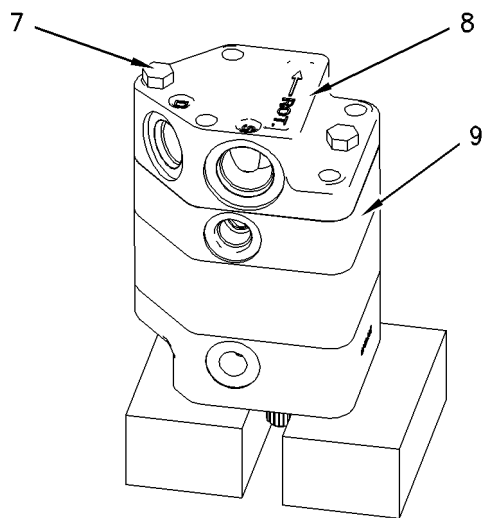


Illustration 111

g01007146

7. Install head (8) onto plate (9).
8. Install bolts (7).

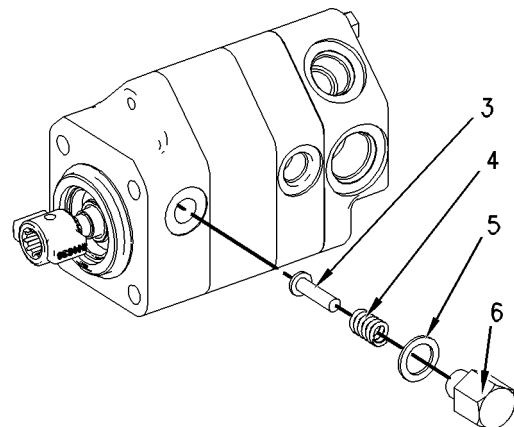


Illustration 112

g01007139

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.

9. Install the following items into the bracket: cap (6), washer (5), valve spring (4), and poppet valve (3).

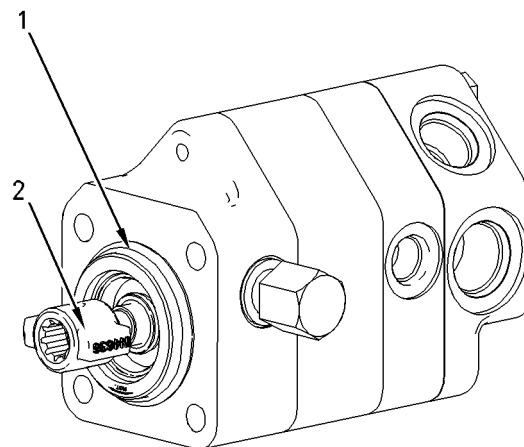


Illustration 113

g01007133

10. Install O-ring seal (1).

11. Install drive coupling (2) onto the drive shaft.

End By:

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

i02059131

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.

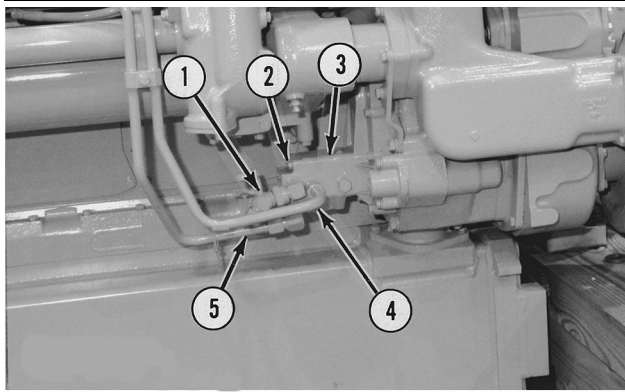


Illustration 114

g00599571

1. Make sure that the O-ring seal is installed on fuel transfer pump (3). Position fuel transfer pump (3) onto the engine. Make sure that the drive coupling is correctly engaged with the shaft of the engine oil pump.
2. Install bolts (2) that secure fuel transfer pump (3) to the cover of the engine oil pump.
3. Connect tube assembly (4) that is between fuel transfer pump (3) and the fuel priming pump (if equipped) and/or the fuel filters.
4. Connect tube assembly (5).
5. Connect tube assembly (1).
6. Turn ON the fuel supply to the engine.

i02838615

Fuel Cooler - Remove and Install

SMCS Code: 1712-010

Removal Procedure

Start By:

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

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 Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Note: The cooling system components and weights may vary depending on your arrangement.

1. Turn the fuel supply to the OFF position.

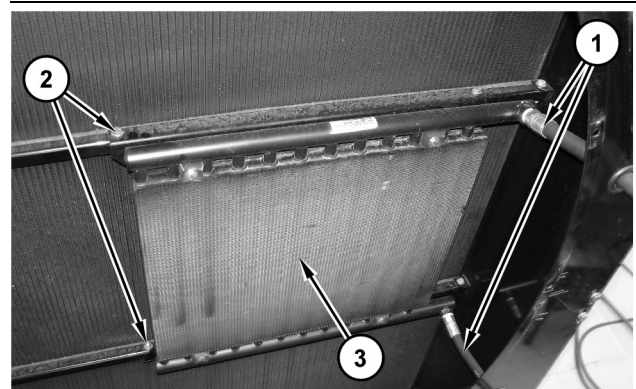


Illustration 115

g01415713

2. Disconnect hose assemblies (1).
3. Remove bolts (2) and fuel cooler (3).

Installation Procedure

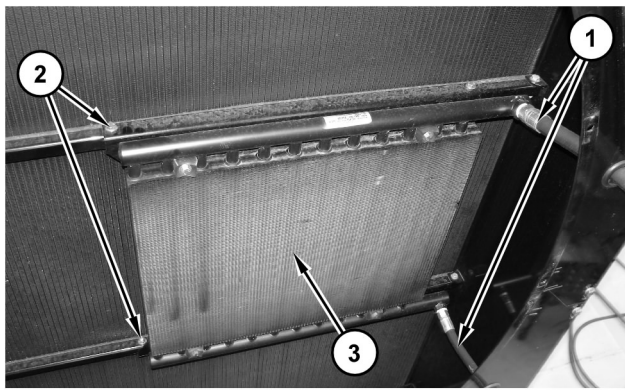


Illustration 116

g01415713

1. Place fuel cooler (3) into position and install bolts (2).
2. Connect hose assemblies (1).
3. Turn the fuel supply to the ON position.

End By:

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

i02059227

Air Cleaner - Remove and Install

SMCS Code: 1051-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Several different types of air cleaners are available. The following procedures describe the removal and installation of a typical air cleaner.

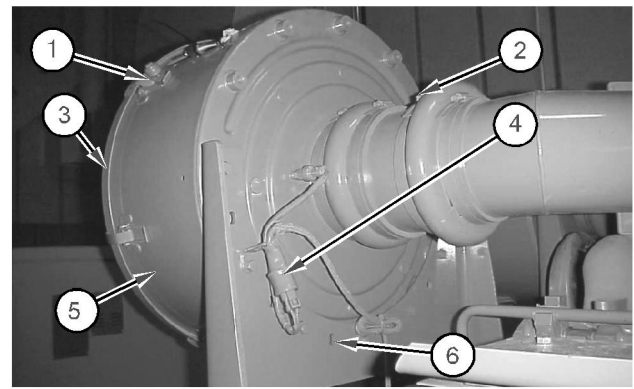


Illustration 117

g01055403

1. Loosen clamps (1). Remove cover (23) and the seal for the cover.

Note: For information on servicing the air cleaner elements, Refer to the Operation and Maintenance Manual for the engine that is being serviced.

2. Remove the air cleaner element.
3. Loosen clamp (2).
4. Disconnect harness assembly (4).
5. Attach a lifting device to air cleaner housing (5). The weight of air cleaner housing (5) is approximately 27 kg (60 lb).
6. Remove bolts and washers (6) that attach air cleaner housing (5) to the bracket.
7. Remove air cleaner housing (5).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

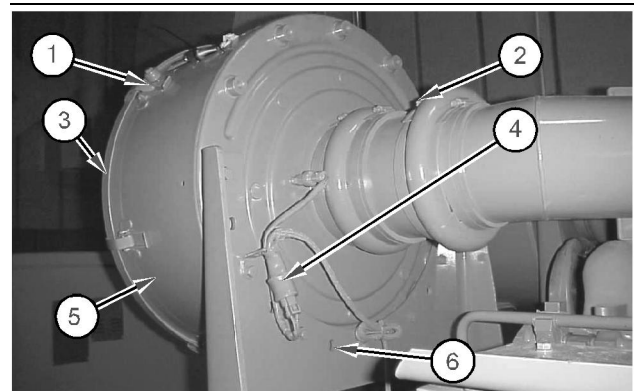


Illustration 118

g01055403

1. Attach a suitable lifting device to air cleaner housing (5). The weight of air cleaner housing (5) is approximately 27 kg (60 lb).
2. Position air cleaner housing (5) on the air inlet of the turbocharger. Install bolts and washers (6) that attach air cleaner housing (5) to the bracket.
3. Install clamp (2).
4. Connect harness assembly (4).

Note: Before you install the air cleaner element, inspect the air cleaner element for cleanliness and good condition.

5. Install the air cleaner element.
6. Inspect the seal of cover (3) for cleanliness and good condition. Install cover (3) with the seal. Fasten clamps (1).

i02059307

Turbocharger - Remove (Center Mounted Turbocharger)

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.

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

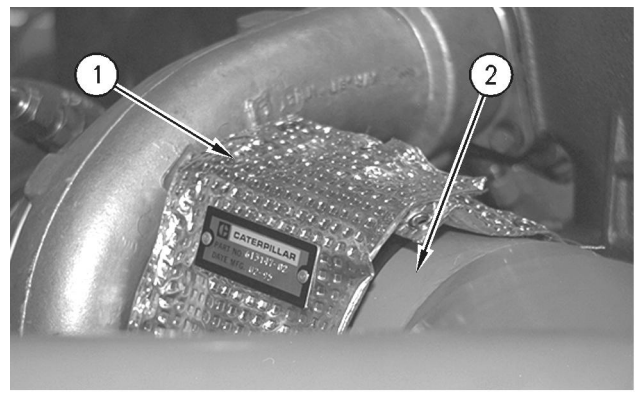


Illustration 119

g00619521

2. Cut the wires in order to remove shield (1) from the connection of air inlet tube (2) and the turbocharger. Also, remove shield (1) from the connection of air inlet tube (2) and the air cleaner.

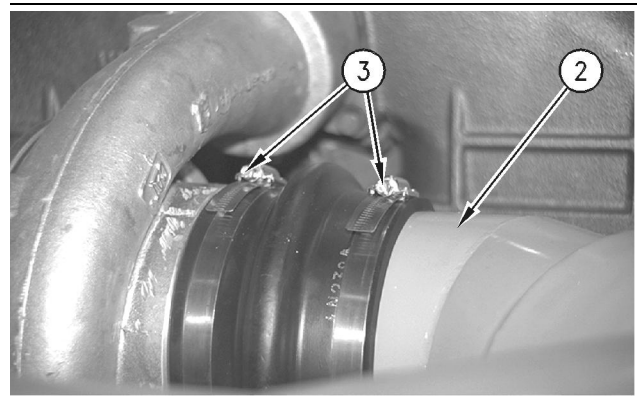


Illustration 120

g00619523

3. Loosen clamps (3) at both ends of air inlet tube (2).

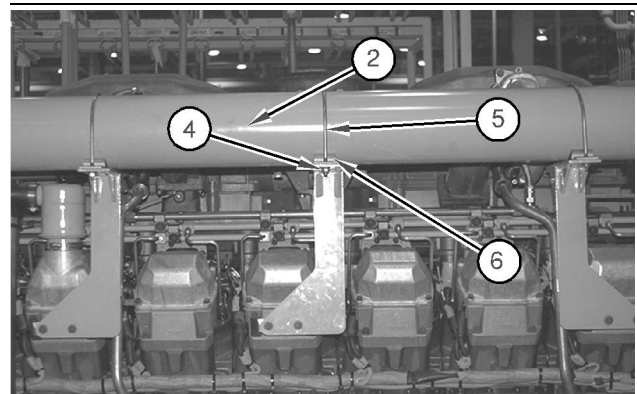


Illustration 121

g01055525

4. Remove nuts (4) and the washers.

5. Attach a suitable lifting device onto air inlet tube (2). The weight of air inlet tube (2) is approximately 23 kg (50 lb).
6. Remove U-bolts (5) and supports (6).
7. Remove air inlet tube (2) from the turbocharger and from the air cleaner.

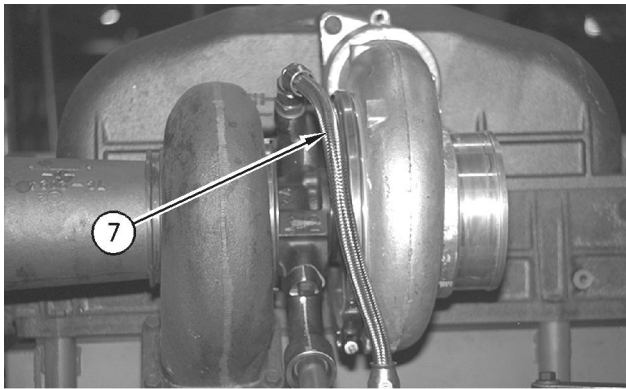


Illustration 122

g00619529

8. Remove hose assembly (7).

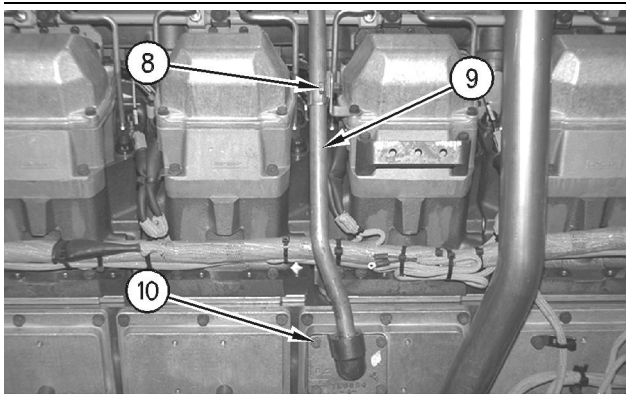


Illustration 123

g00619531

9. Remove clamp (8) that attaches tube assembly (9) to the cylinder head.
10. Remove bolts (10). Remove tube assembly (8).

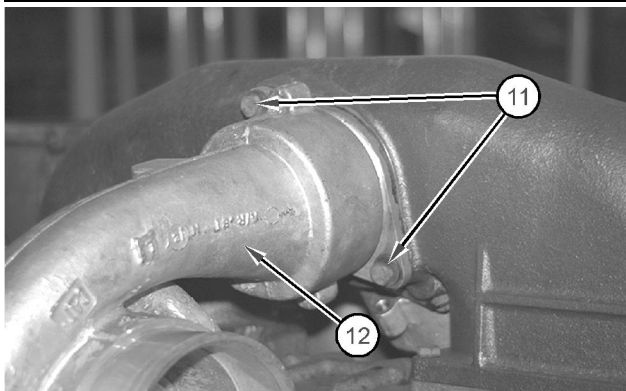


Illustration 124

g01055526

11. Remove bolts (11) that attach turbocharger (12) to the aftercooler housing.
12. Attach a lifting device onto turbocharger (12). The weight of turbocharger (12) is approximately 61 kg (134 lb).

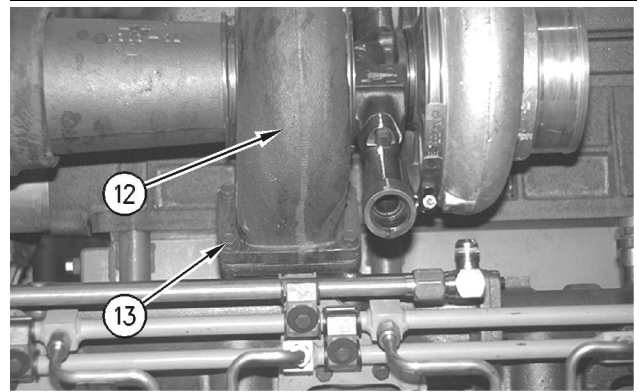


Illustration 125

g00619586

13. Remove the nuts, the washers, and bolts (13).
14. Remove turbocharger (12). Remove the gasket from the exhaust manifold.

i02060042

Turbocharger - Remove (Rear Mounted Turbocharger)

SMCS Code: 1052-011

Removal Procedure

Start By:

- a. Remove the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - 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. Drain the coolant from the cooling system into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

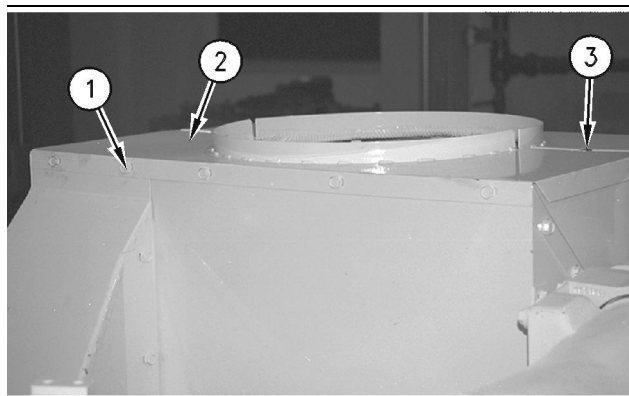


Illustration 126

g00619378

2. Remove bolts (1) and (3). Remove top of shield (2).

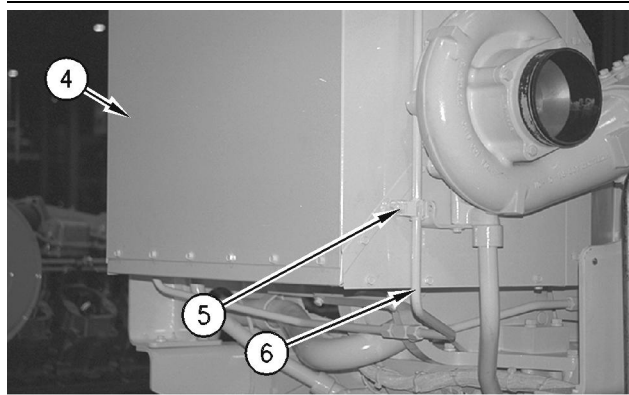


Illustration 127

g00619397

3. Remove clamp (5). Remove tube assembly (6) from both turbochargers.

4. Remove shield (4).

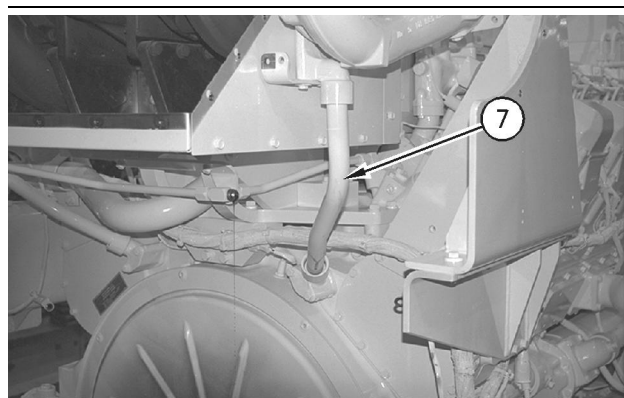


Illustration 128

g00619404

5. Remove tube assembly (7) from the turbocharger.

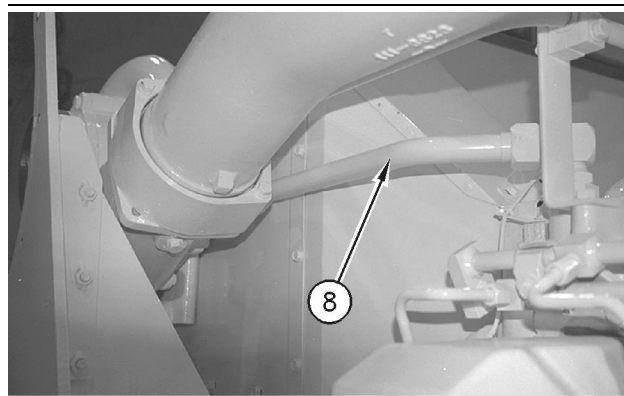


Illustration 129

g00619423

6. Remove tube assembly (8).

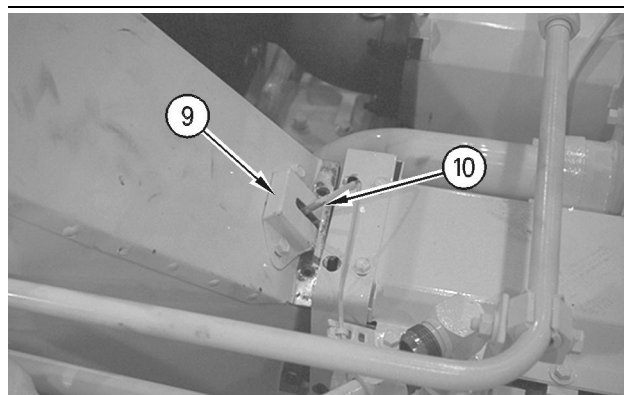


Illustration 130

g00619426

7. Remove cover (9). Disconnect thermocouple (10).

8. Remove the remaining shields from the turbochargers.

i02402749

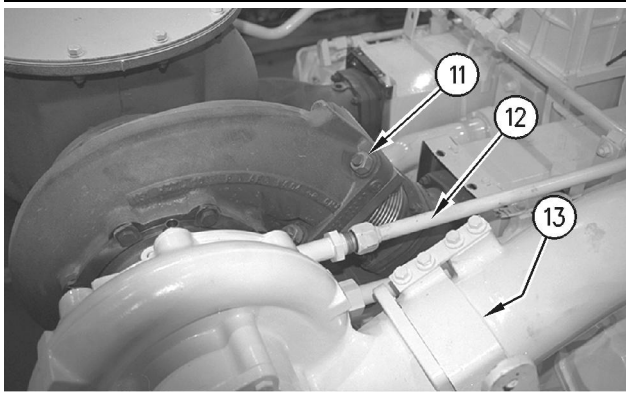


Illustration 131

g00619429

9. Remove bolts (11) from the exhaust inlet to the turbocharger.
10. Disconnect tube assembly (12).
11. Remove bolts (13) from the air outlet of the turbocharger.

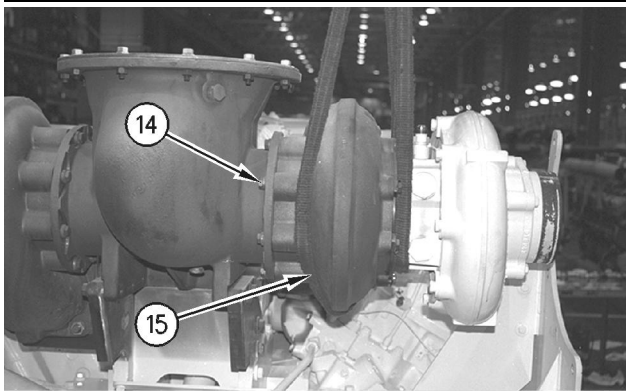


Illustration 132

g00619432

12. Attach a suitable lifting device onto turbocharger (15). The weight of turbocharger (15) is approximately 65 kg (143 lb).
13. Remove bolts (14) that attach turbocharger (15) to the exhaust elbow. Remove turbocharger (15).

Turbocharger - Remove (Rear Mounted Turbocharger)

SMCS Code: 1052-011**S/N:** PTA1-Up**S/N:** PTB1-Up**S/N:** BPD1-Up**S/N:** YAD1-Up**S/N:** PTE1-Up**S/N:** PWG1-Up**S/N:** YAH1-Up**S/N:** YAJ1-Up**S/N:** BLM1-Up**S/N:** PTM1-Up**S/N:** PTN1-Up**S/N:** BNR1-Up**S/N:** 3ZW1-Up

Removal Procedure

Start By:

- a. Remove the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - 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 Dealer Service Tool Catalog" 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 cooling system into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

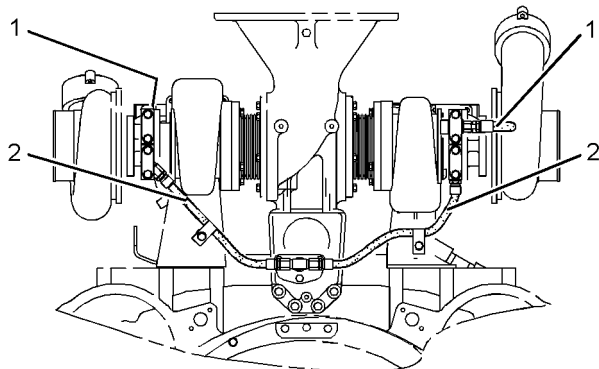


Illustration 133

g01199984

2. Disconnect hose assemblies (1) and (2).

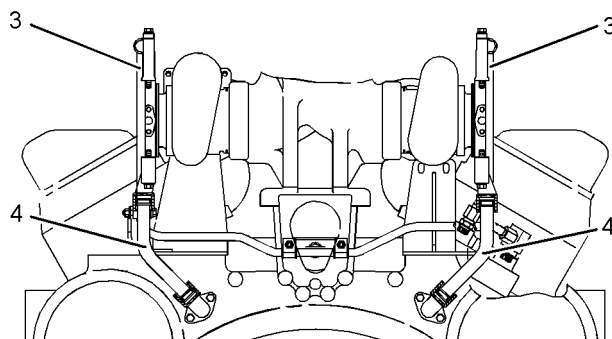


Illustration 134

g01199987

3. Disconnect tube assemblies (4). Remove tube assemblies (3).

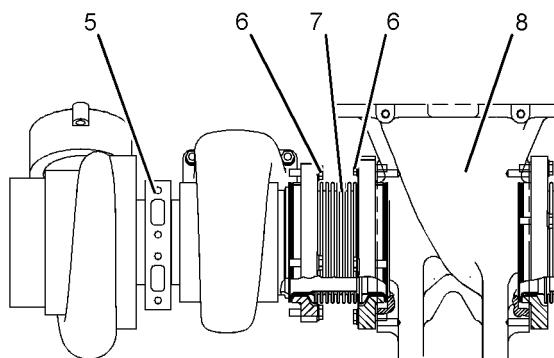


Illustration 135

g01199989

4. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 35 kg (77 lb). Remove bolts (6).

5. Remove bellows assembly (7) from exhaust elbow (8) and turbocharger (5).

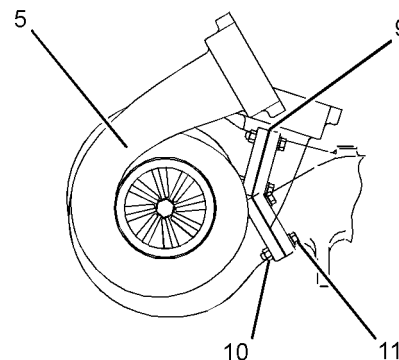


Illustration 136

g01199991

6. Remove bolts (11) and nuts (10).
7. Remove turbocharger (5) and gasket (9).

i02431148

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.

Note: Different turbochargers are available for use with 3500B Engines. For some of the turbochargers, only the cartridge is serviced. Further disassembly is not possible.

i02431715

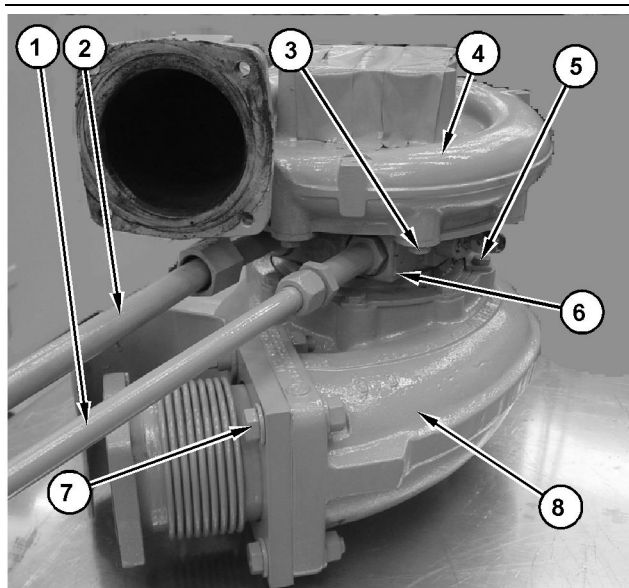


Illustration 137

g01054902

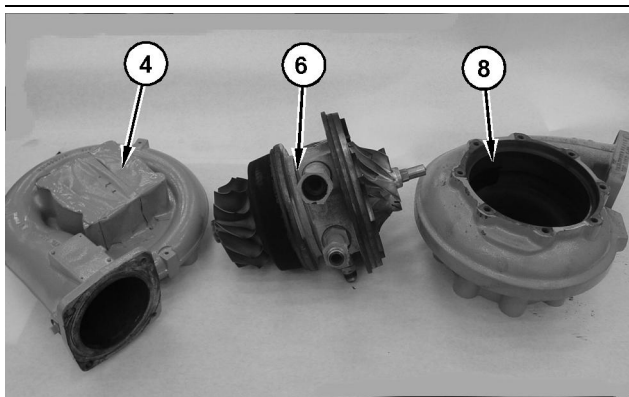


Illustration 138

g01054903

1. Mark the three turbocharger housings for alignment upon assembly.
2. Disconnect tube assemblies (1) and (2).
3. Remove bolts (3) and (5).
4. Remove turbine housing (4).
5. Use two people in order to remove cartridge assembly (6) from compressor housing (8). The weight of cartridge assembly (6) is approximately 30 kg (70 lb).
6. Remove bolts (7).

Turbocharger - Assemble

SMCS Code: 1052-016

Assembly Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Different turbochargers are available for use with 3500B Engines. For instructions and torques for your specific turbocharger, see the Specifications, "Turbocharger" topic. The following procedure describes the assembly of a typical turbocharger.

Note: Obtain new seals for assembly. Thoroughly clean all of the parts. Unless other instructions are provided, coat the parts of the cartridge with clean engine oil.

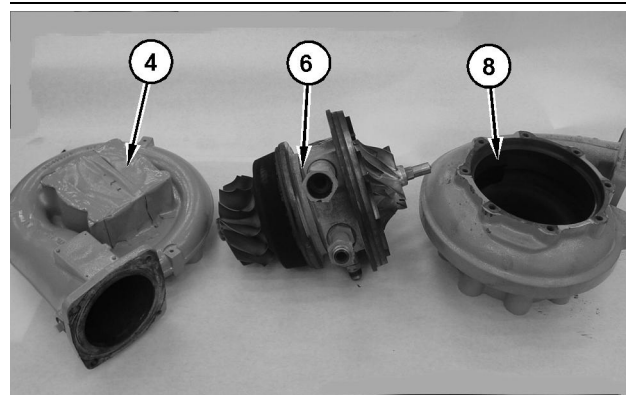


Illustration 139

g01054903

1. Ensure that the following parts are aligned correctly upon assembly: turbine housing (4), cartridge assembly (6), and compressor housing (8).

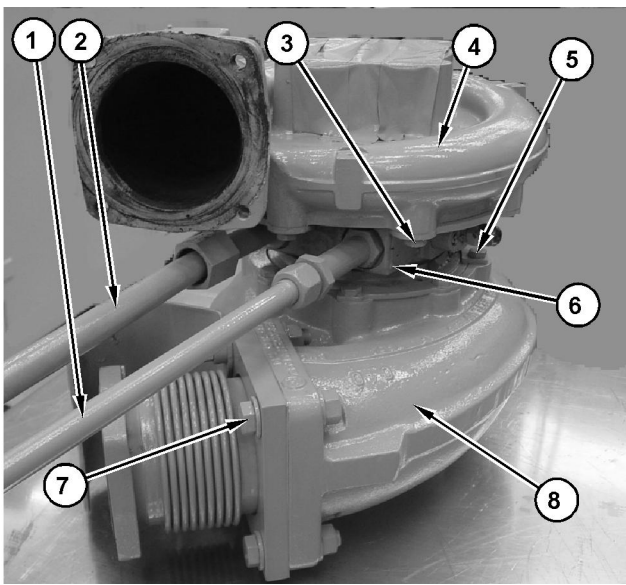


Illustration 140 g01054902

2. Install bolts (7).
3. Use two people in order to install cartridge assembly (6) in compressor housing (8). The weight of cartridge assembly (6) is approximately 30 kg (70 lb).
4. Install turbine housing (4).
5. Install bolts (3) and (5). Refer to Specifications, "Turbocharger" for the correct torque.
6. Connect tube assemblies (1) and (2).

End By:

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

i02242028

Turbocharger - Install (Rear Mounted Turbocharger)

SMCS Code: 1052-012

Installation Procedure

Table 6

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-5597	Anti-Seize Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Inspect the O-ring seals before installation. If a seal is cut, scratched, or cracked, obtain a new seal for installation.

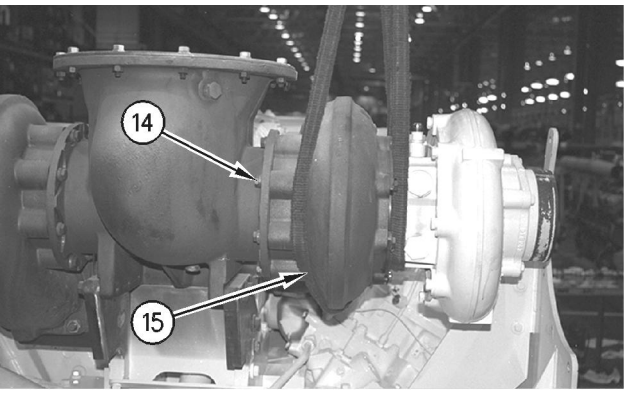


Illustration 141 g00619432

1. Attach a suitable lifting device onto turbocharger (15). The weight of turbocharger (15) is approximately 65 kg (143 lb). Apply Tooling (A) to bolts (14). Position turbocharger (15) and install bolts (14). Tighten bolts (14) to a torque of $54 \pm 5 \text{ N}\cdot\text{m}$ ($40 \pm 4 \text{ lb}\cdot\text{ft}$).

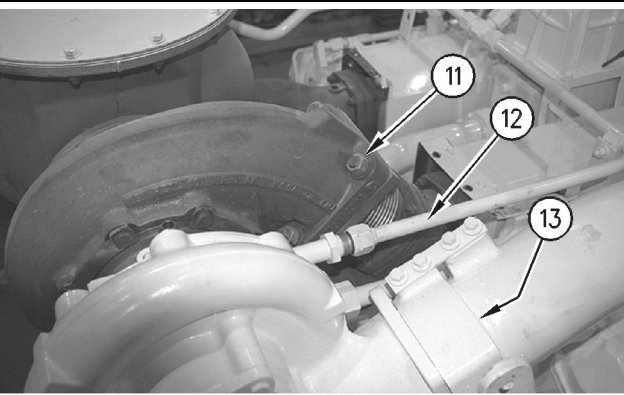


Illustration 142 g00619429

2. Install bolts (13).
3. Connect tube assembly (12).
4. Apply Tooling (A) to bolts (11). Install bolts (11) and tighten bolts (11) to a torque of $54 \pm 5 \text{ N}\cdot\text{m}$ ($40 \pm 4 \text{ lb}\cdot\text{ft}$).

5. Install the shield assemblies for the turbocharger and start the bolts. However, do not tighten the bolts until the shield assemblies are properly aligned.

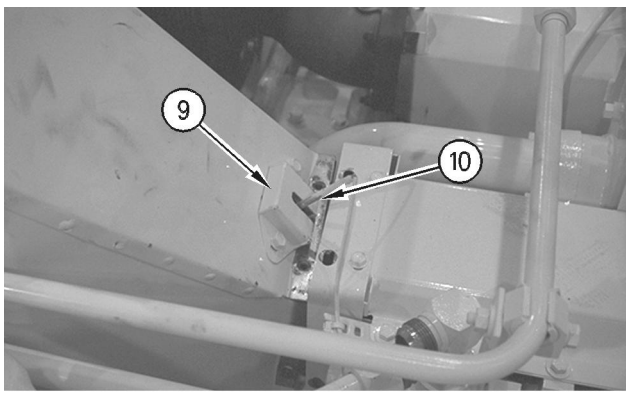


Illustration 143

g00619426

6. Connect thermocouple (10). Install cover (9).

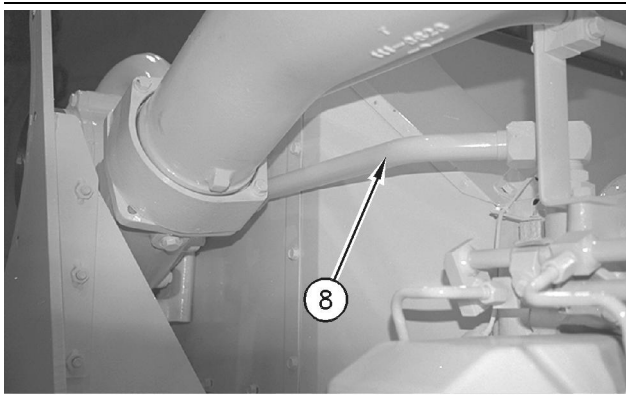


Illustration 144

g00619423

7. Install tube assembly (8).

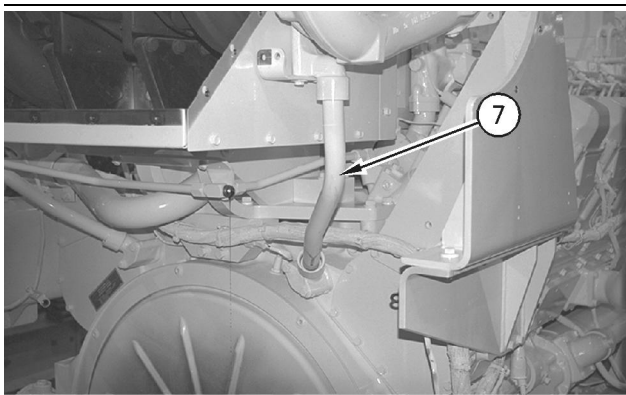


Illustration 145

g00619404

8. Install tube assembly (7).

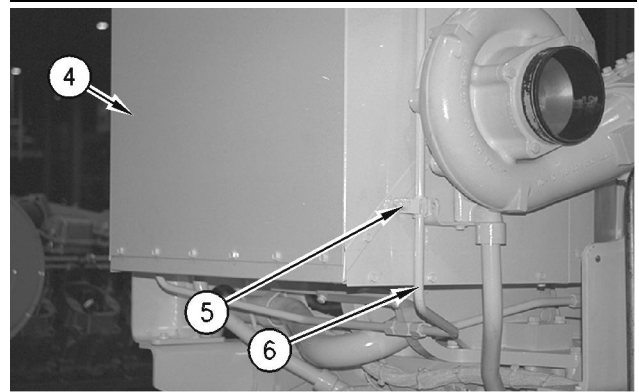


Illustration 146

g00619397

9. Install shield (4).

10. Attach tube assembly (6) to both of the turbochargers. Install clamp (5).

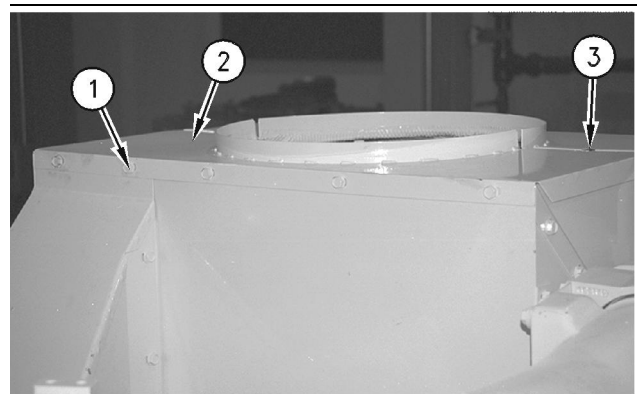


Illustration 147

g00619378

11. Position top of shield (2). Install bolts (1) and (3).

12. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

- a. Install the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".

i02242029

Turbocharger - Install (Center Mounted Turbocharger)

SMCS Code: 1052-012

Installation Procedure

Table 7

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-5597	Anti-Seize Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Inspect the O-ring seals before installation. If a seal is cut, scratched, or cracked, obtain a new seal for installation.

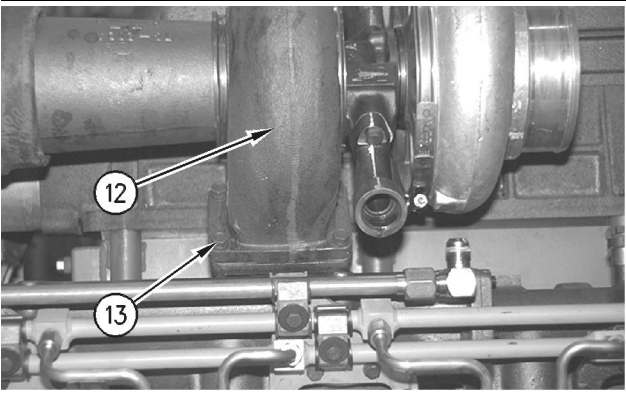


Illustration 148

g00619586

1. Apply Tooling (A) to bolts (13). Attach a lifting device to turbocharger (12). The weight of turbocharger (12) is approximately 61 kg (134 lb). Position turbocharger (12) and install bolts (13). Tighten bolts (13) to a torque of 54 ± 5 N·m (40 ± 4 lb ft).

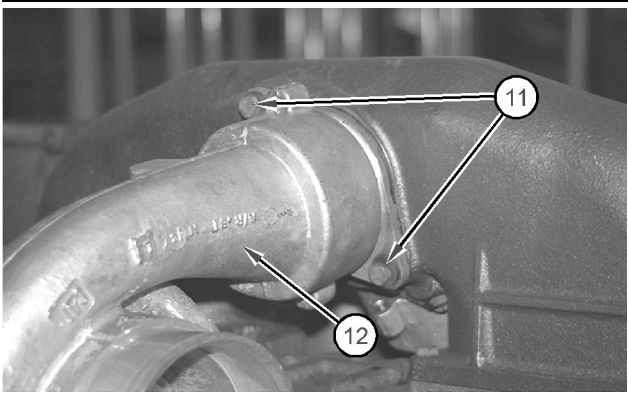


Illustration 149

g01055526

2. Install bolts (11) that attach turbocharger (12) to the aftercooler housing.

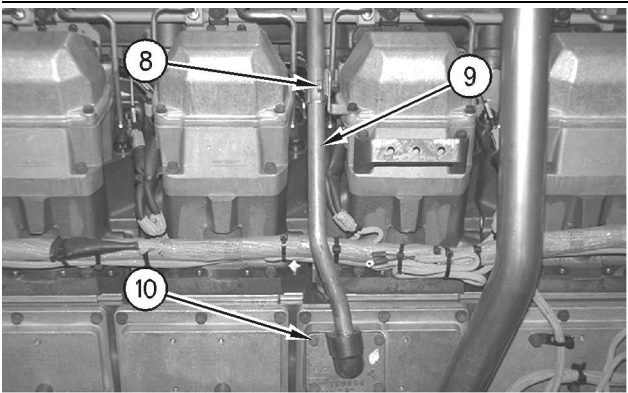


Illustration 150

g00619531

3. Install tube assembly (9). Install bolts (10). Install clamp (8) that attaches tube assembly (9) to the cylinder head.

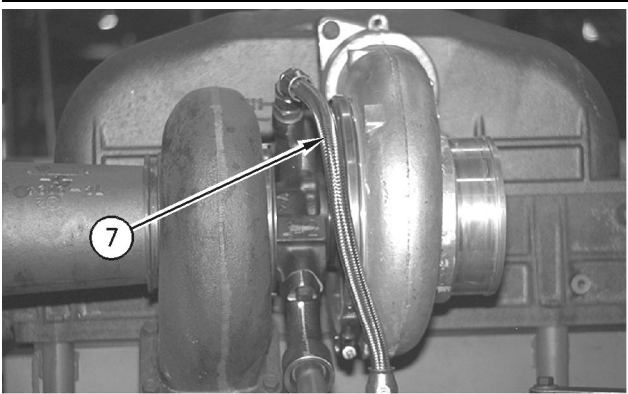


Illustration 151

g00619529

NOTICE

A damaged hose assembly will reduce the service life of the turbocharger. Do not twist the hose assembly. To help prevent damage to the hose assembly, orient the position of the hose assembly fitting on the turbocharger before you install the hose assembly.

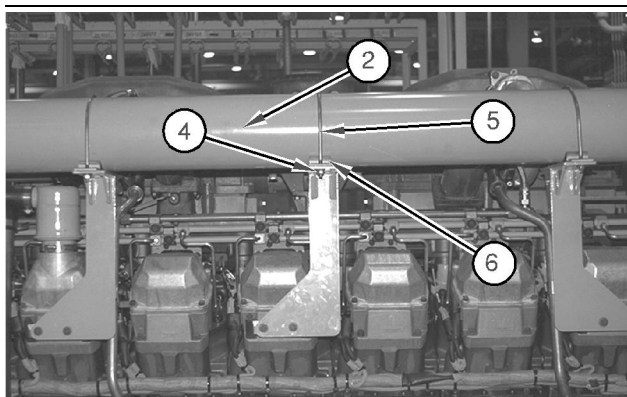
4. Install hose assembly (7).

Illustration 152

g01055525

5. Attach a suitable lifting device to air inlet tube (2). The weight of air inlet tube (2) is approximately 23 kg (50 lb). Position air inlet tube (2) between the turbocharger and the air cleaner.
6. Install supports (6). Install U-bolts (5), nuts (4) and the washers.

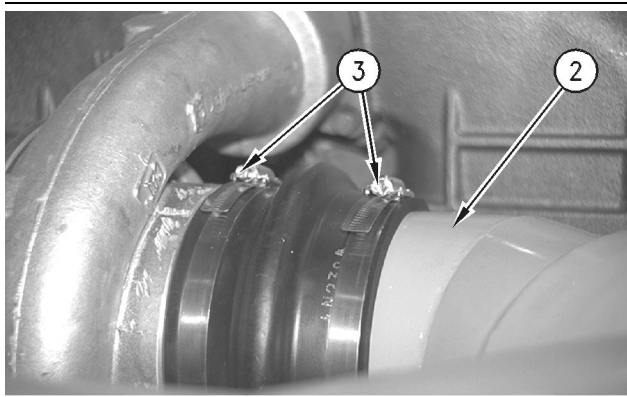


Illustration 153

g00619523

7. Install clamps (3) that attach air inlet tube (2) to the turbocharger.

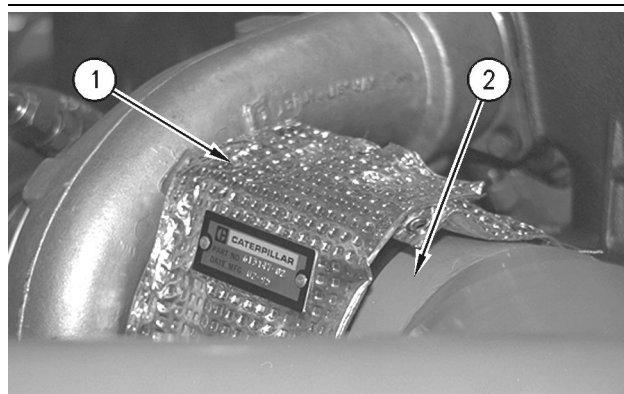


Illustration 154

g00619521

8. Use wires to install shield (1) around the connection of air inlet tube (2) and the turbocharger.
9. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02402975

Turbocharger - Install (Rear Mounted Turbocharger)

SMCS Code: 1052-012

- S/N:** PTA1-Up
S/N: PTB1-Up
S/N: BPD1-Up
S/N: YAD1-Up
S/N: PTE1-Up
S/N: PWG1-Up
S/N: YAH1-Up
S/N: YAJ1-Up
S/N: BLM1-Up
S/N: PTM1-Up
S/N: PTN1-Up
S/N: BNR1-Up
S/N: 3ZW1-Up

Installation Procedure

Table 8

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

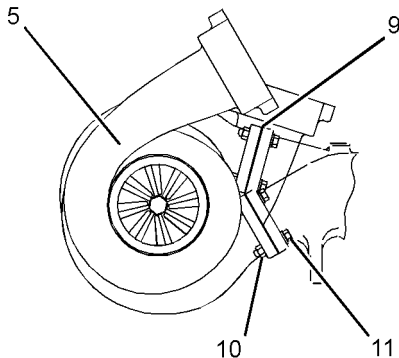


Illustration 155

g01199991

1. Attach a suitable lifting device to turbocharger (5). The weight of turbocharger (5) is approximately 35 kg (77 lb). Apply Tooling (A) to the threads of bolts (11) and the bearing surfaces. Install gasket (9). Position turbocharger (5) on the engine. Install bolts (11) and nuts (10). Use the following procedure in order to tighten nuts (10):
 - a. Tighten all of the nuts on the joint to a snug fit.
 - b. Tighten one nut to a torque of 54 ± 5 N·m (40 ± 4 lb ft).
 - c. Tighten the diagonally opposed nut to a torque of 54 ± 5 N·m (40 ± 4 lb ft).
 - d. Tighten the remaining nuts to a torque of 54 ± 5 N·m (40 ± 4 lb ft).
 - e. Repeat Steps 1.b to 1.d.

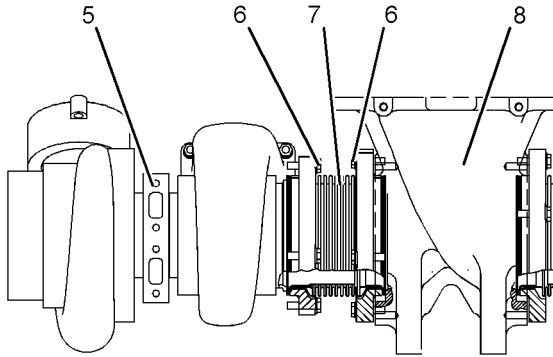


Illustration 156

g01199989

2. Apply Tooling (A) to the threads of bolts (6) and the bearing surfaces. Position bellows assembly (7) on exhaust elbow (8) and turbocharger (5).
3. Install bolts (6) and tighten the bolts to a torque of 54 ± 5 N·m (40 ± 4 lb ft).

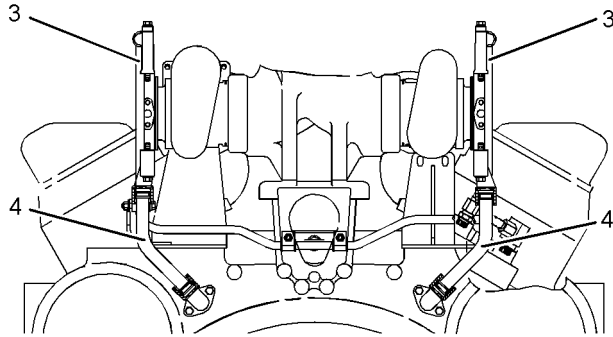


Illustration 157

g01199987

4. Install tube assemblies (3). Connect tube assemblies (4).

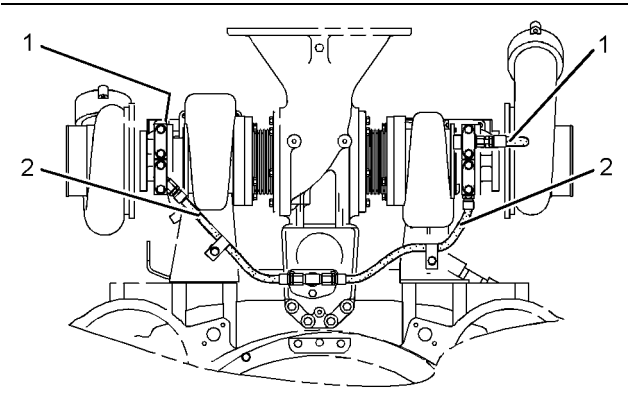


Illustration 158

g01199984

5. Connect hose assemblies (2) and (1).
6. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Coolong System Coolant - Change".

End By:

- a. Install the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".

i02060189

Aftercooler - Remove and Install

SMCS Code: 1063-010

Removal Procedure

Table 9

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

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: Different designs of aftercoolers are available for different applications. The following procedures describe the removal and installation of a typical aftercooler.

Note: The 3508B and 3512B Engines have one aftercooler. The 3516B Engines have two aftercoolers. The following procedures describe the removal and installation of only one aftercooler.

1. Drain the coolant from the cooling system into a suitable container for storage or for disposal. Refer to Disassembly and Assembly, "Cooling System Coolant - Change".

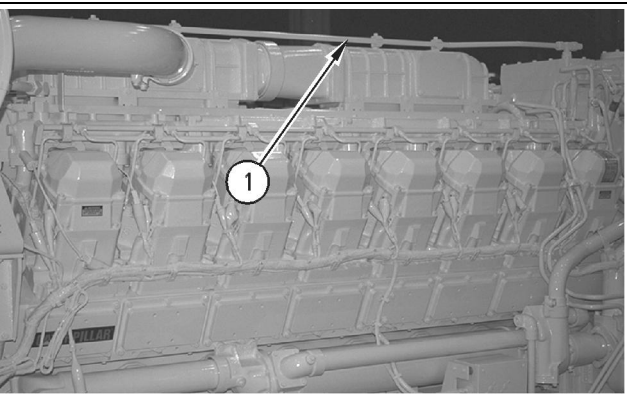


Illustration 159

g00601406

2. Remove tube assembly (1). Cap the openings and/or plug of the openings.

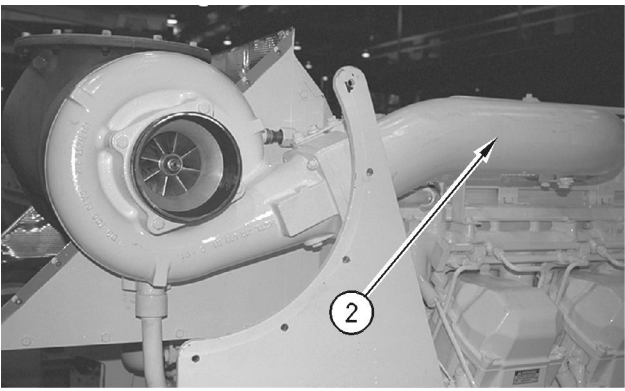


Illustration 160 g00601408

3. Remove tube assemblies (2) that are between the air inlet cover of the aftercooler and the turbochargers.

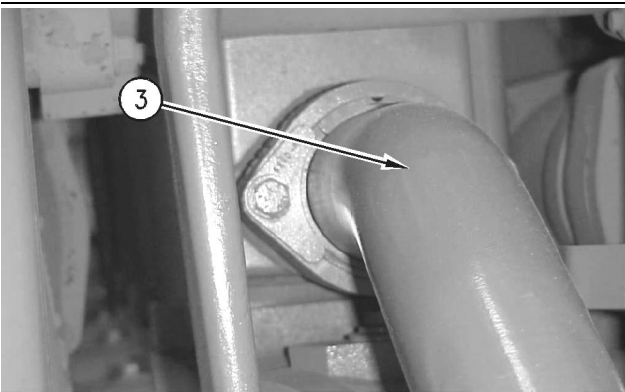


Illustration 161 g00616450

4. Disconnect tube assemblies (3) from the ends of the aftercooler core. One tube is at the front and one tube is for the rear.

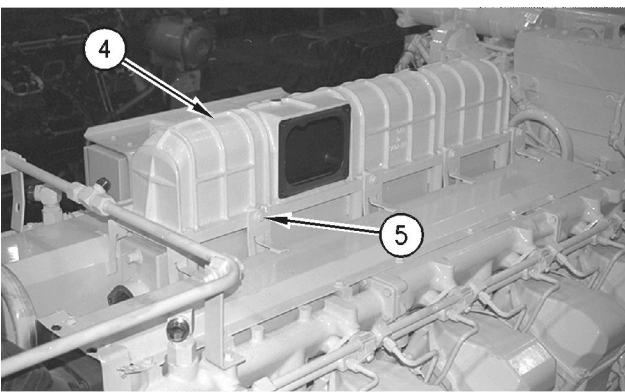


Illustration 162 g00601409

5. Install Tooling (A) into the top of air inlet cover (4).

6. Attach a suitable lifting device onto Tooling (A). The weight of air inlet cover (4) is approximately 11 kg (24 lb). Remove bolts (5). Remove air inlet cover (4).

Note: Be careful not to damage the fins of the aftercooler core.

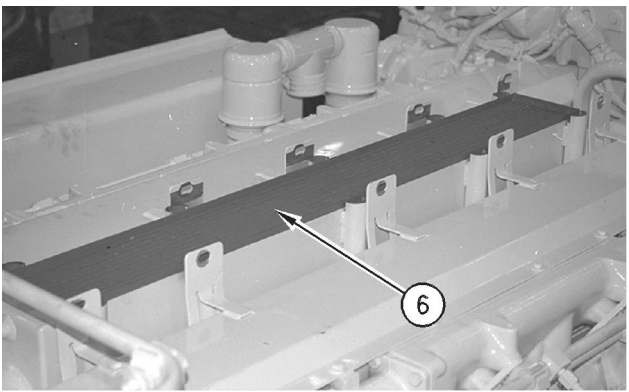


Illustration 163 g00601411

7. Attach a suitable lifting device onto aftercooler core (6). The weight of aftercooler core (6) is approximately 37 kg (82 lb). Lift aftercooler core (6) from the air inlet manifold.

Installation Procedure

Table 10

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Be careful not to damage the fins of the aftercooler core.

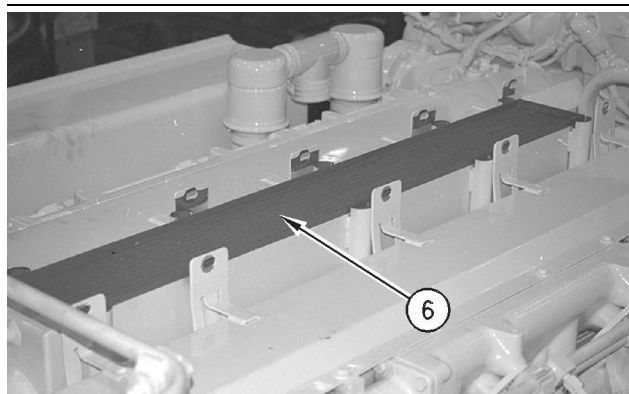


Illustration 164

g00601411

1. Inspect the top O-ring seal and the bottom O-ring seal of aftercooler core (6). If a seal is cut, scratched, or cracked, install a new seal. Temporarily secure the bottom seal with tape. Make sure that the tape can be removed after the aftercooler core is installed. Do not use an adhesive, a silicone lubricant, or any other lubricant for retention of the seal.
2. Attach a suitable lifting device onto aftercooler core (6). The weight of aftercooler core (6) is approximately 37 kg (82 lb). Position aftercooler core (6) onto the air inlet manifold.

Ensure that the bottom seal is properly seated.

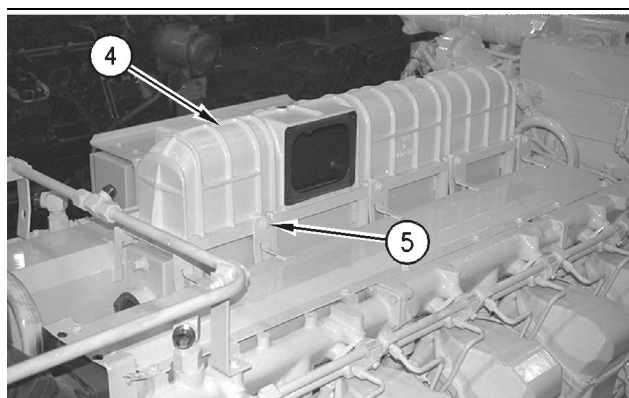


Illustration 165

g00601409

3. Install Tooling (A) in the top of air inlet cover (4). Attach a suitable lifting device onto Tooling (A). The weight of air inlet cover (4) is approximately 11 kg (24 lb).
4. Position air inlet cover (4) onto the aftercooler core.

Ensure that the seal is seated between air inlet cover (4) and the aftercooler core.

5. Install bolts (5). Hand tighten bolts (5).

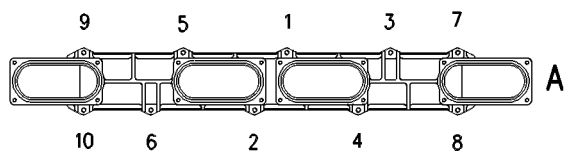


Illustration 166

g00747427

Bolt tightening sequence for engines with one aftercooler
(A) Front of the engine

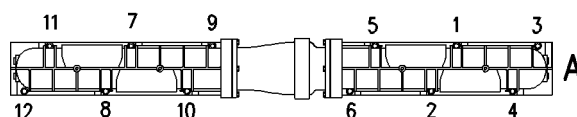


Illustration 167

g00747429

Bolt tightening sequence for engines with two aftercoolers
(A) Front of the engine

6. Tighten the bolts in the numerical sequence to a torque of 24 N·m (18 lb ft).
7. Tighten the bolts in the numerical sequence to a torque of 47 N·m (35 lb ft).
8. Remove the tape from the bottom seal.

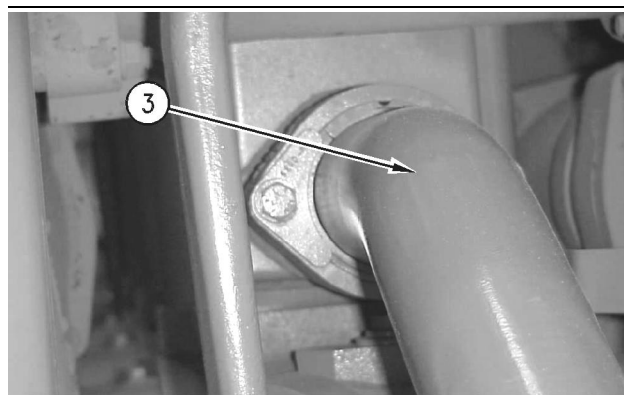


Illustration 168

g00616450

9. Inspect the O-ring seals for tube assemblies (3). If a seal is cut, scratched, or cracked, install a new seal. Connect tube assemblies (3) to the ends of the aftercooler core. One tube is for the front and one tube is for the rear.

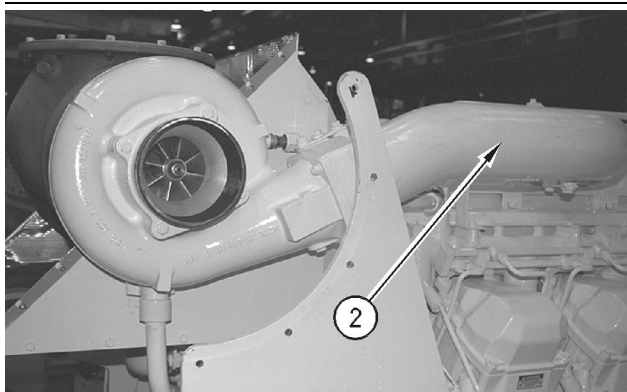


Illustration 169

g00601408

- 10.** Inspect the O-ring seals for tube assemblies (2). If a seal is cut, scratched, or cracked, install a new seal. Install tube assemblies (2) between the air inlet cover of the aftercooler and the turbochargers.

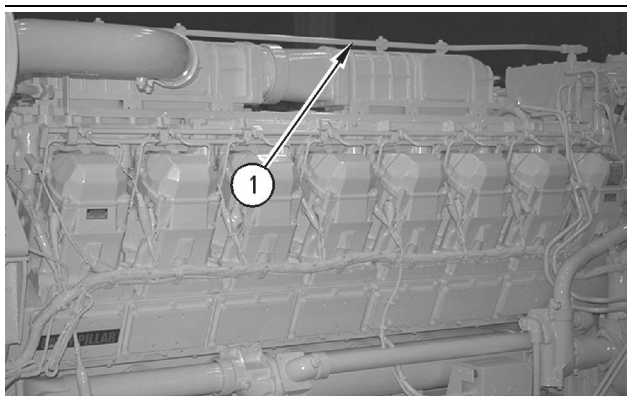


Illustration 170

g00601406

- 11.** Inspect the O-ring seals for tube assembly (1). If a seal is cut, scratched, or cracked, install a new seal. Install tube assembly (1).
- 12.** Fill the cooling system with coolant. Refer to the Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02060212

Air Inlet Manifold - Remove and Install

SMCS Code: 1058-010

Removal Procedure

Start By:

- a.** Remove the aftercooler. Refer to Disassembly and Assembly, "Aftercooler - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

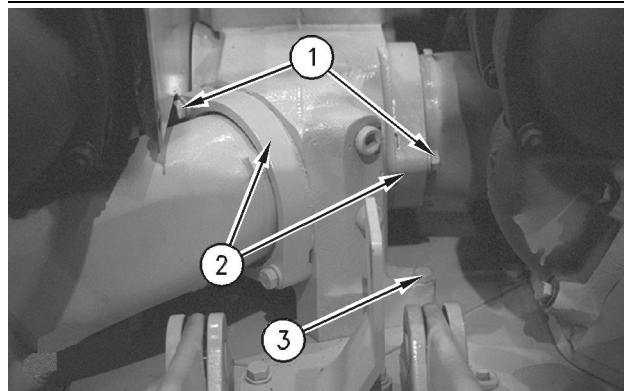


Illustration 171

g00598884

The exhaust heat shield has been removed for photographic purposes.

- 1.** Remove bolts (1) and the washers. Pry flanges (2) on the elbows away from the air inlet manifold. Each cylinder has one elbow for inlet air.
- 2.** Remove bolts (3).

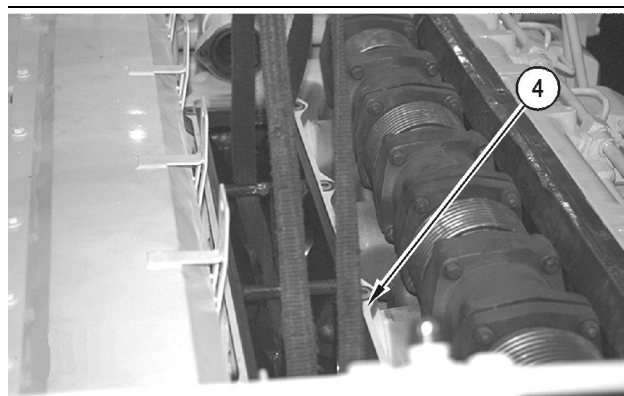


Illustration 172

g00598890

- 3.** Attach a suitable lifting device to air inlet manifold (4).
 - Air inlet manifold (4) for a 3508B Engine weighs approximately 49 kg (108 lb).
 - Air inlet manifold (4) for a 3512B Engine weighs approximately 55 kg (121 lb).
 - Air inlet manifold (4) for a 3516B Engine weighs approximately 94 kg (207 lb).

Remove air inlet manifold (4).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

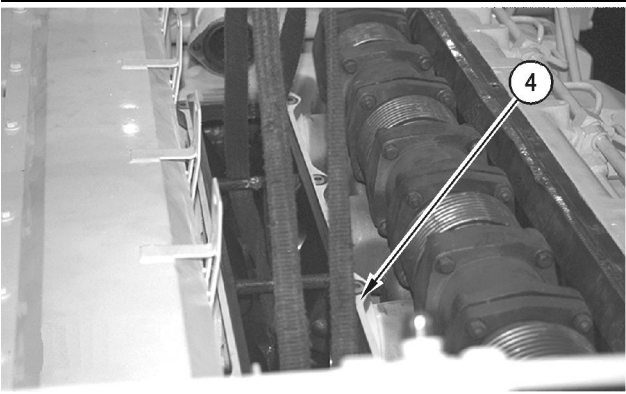


Illustration 173

g00598890

1. Attach a suitable lifting device to air inlet manifold (4).
- Air inlet manifold (4) for a 3508B Engine weighs approximately 49 kg (108 lb).
 - Air inlet manifold (4) for a 3512B Engine weighs approximately 55 kg (121 lb).
 - Air inlet manifold (4) for a 3516B Engine weighs approximately 94 kg (207 lb).

Position air inlet manifold (4) onto the engine.

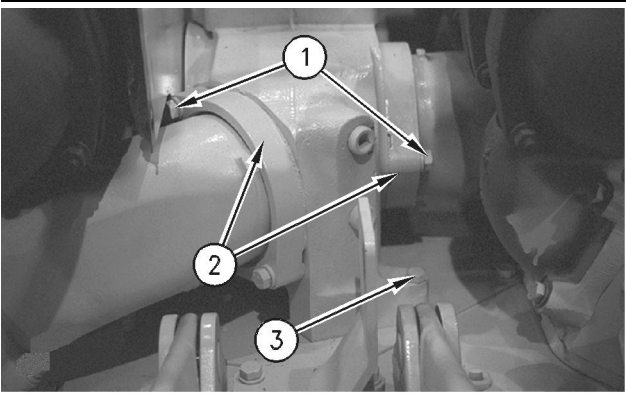


Illustration 174

g00598884

Typical example

2. Install bolts (3).
3. Inspect the O-ring seals for flanges (2). If a seal is cut, scratched, or cracked, install a new seal.

1. Use washers and bolts (1) to install flanges (2) for the elbows. Each cylinder has one elbow for inlet air.

End By:

- a. Install the aftercooler. Refer to Disassembly and Assembly, “Aftercooler - Remove and Install”.

i02060336

Exhaust Elbow - Remove and Install

SMCS Code: 1060-010

Removal Procedure

Table 11

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

Start By:

- a. Remove the turbochargers. Refer to Disassembly and Assembly, “Turbocharger - Remove”.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

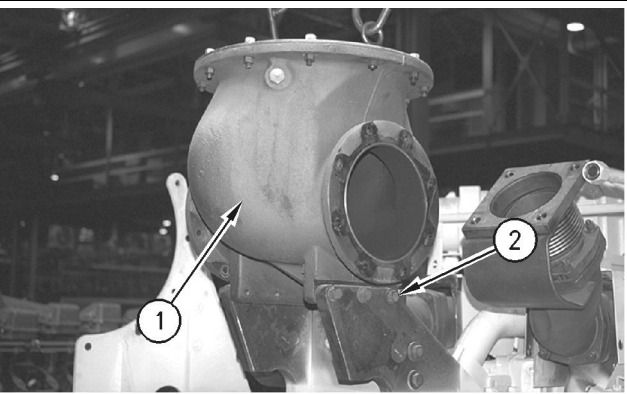


Illustration 175

g00615014

1. Install Tooling (A) in the top of exhaust elbow (1). Attach a suitable lifting device onto Tooling (A). The weight of exhaust elbow (1) is approximately 48 kg (106 lb).
2. Remove bolts (2). Lift exhaust elbow (1) from the engine.

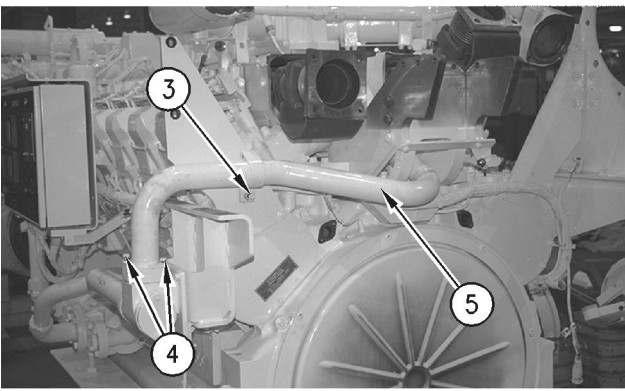


Illustration 176

g00615016

3. Remove the bolt and clamp (3). Remove bolts and clamps (4) from each end of tube assembly (5). Remove tube assembly (5). Inspect the seals at the end of tube assembly (5). If the seals are damaged or deteriorated, obtain new seals for assembly.

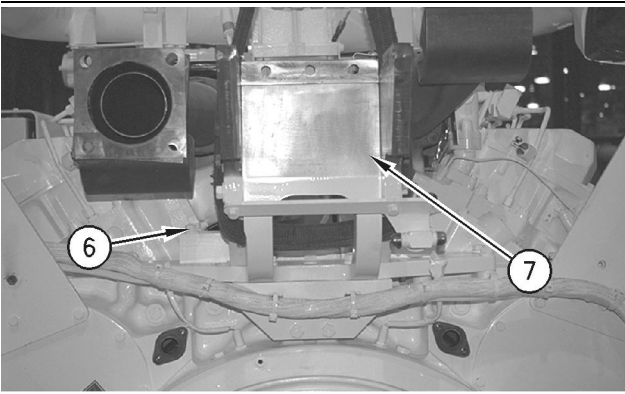


Illustration 177

g00615017

4. Attach a suitable lifting device onto support bracket (7). The weight of support bracket (7) is approximately 117 kg (257 lb).
5. Remove bolts (6). Remove support bracket (7).

Installation Procedure

Table 12

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

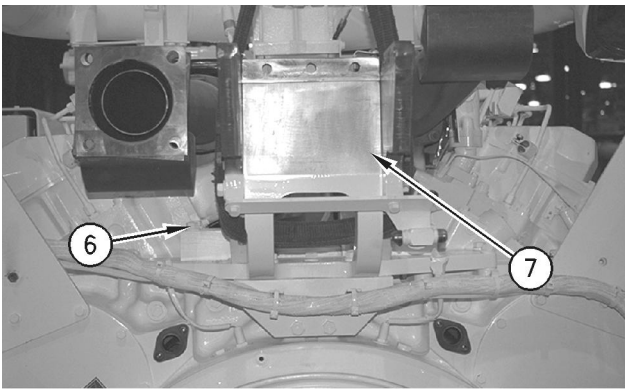


Illustration 178

g00615017

1. Attach a suitable lifting device onto support bracket (7). The weight of support bracket (7) is approximately 117 kg (257 lb). Position support bracket (7) onto the engine.
2. Install bolts (6).

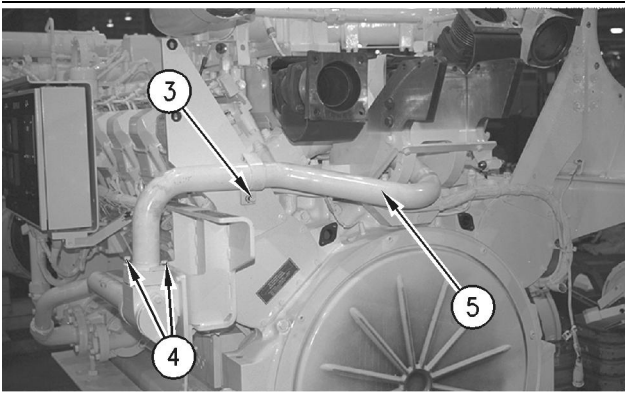


Illustration 179

g00615016

- Note:** Ensure that the seals are installed in the ends of tube (5).
3. Position tube assembly (5) and install bolts and clamps (4) onto each end of tube assembly (5). Install the bolt and clamp (3).

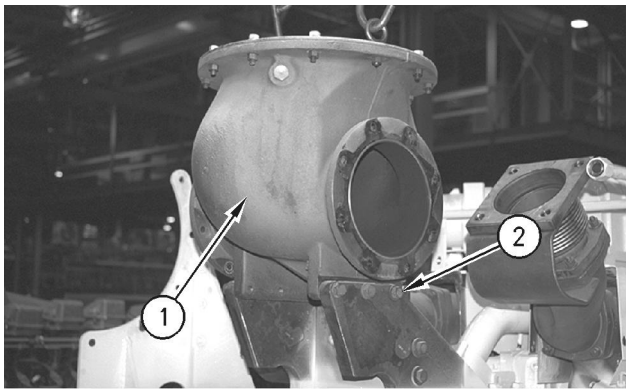


Illustration 180

g00615014

4. Install Tooling (A) in the top of exhaust elbow (1). Attach a suitable lifting device onto Tooling (A). The weight of exhaust elbow (1) is approximately 48 kg (106 lb). Position exhaust elbow (1).

5. Install bolts (2).

End By:

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

i02242030

Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

Start By:

- a. Remove the aftercooler. Refer to Disassembly and Assembly, "Aftercooler - Remove and Install".
- b. Remove the air inlet manifold. Refer to Disassembly and Assembly, "Air Inlet Manifold - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: It is possible to remove the exhaust manifolds without removing the air inlet manifold first. However, the procedure is more difficult. The aftercooler must be removed before the exhaust manifolds are removed.

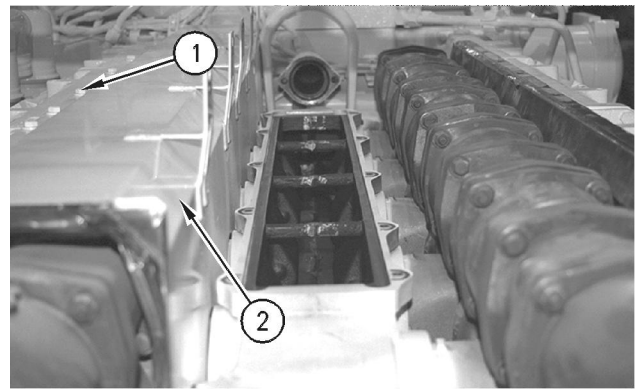


Illustration 181

g00616579

1. Remove bolts (1) and the washers from heat shield (2).
2. Remove heat shield (2).

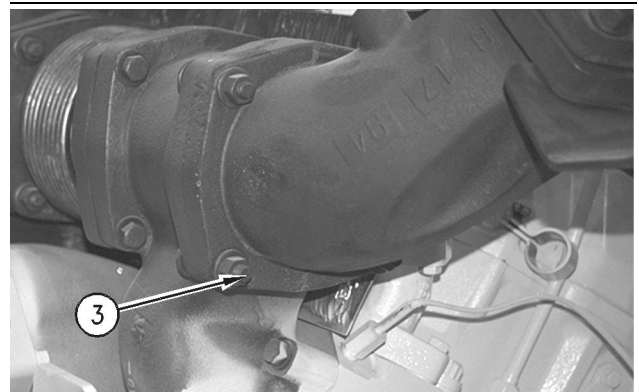


Illustration 182

g00616580

3. Remove nuts (3) and the bolts that attach the exhaust manifold to the elbow for the turbocharger. Remove the gasket.

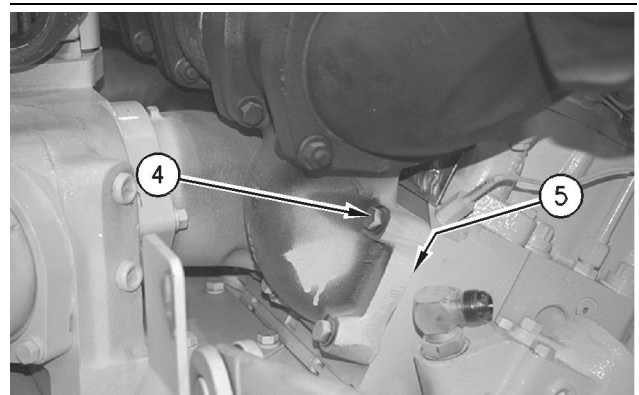


Illustration 183

g00616613

4. Remove bolts (4), the nuts, and the washers that attach the exhaust manifold to the cylinder heads. Remove gaskets (5).

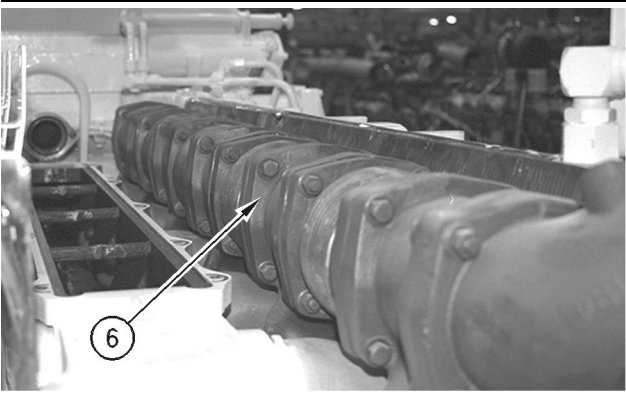


Illustration 184 g00616615

5. Attach a suitable lifting device to exhaust manifold (6).

Exhaust manifold (6) for 3508B Engines weighs approximately 78 kg (170 lb). Exhaust manifold (6) for 3512B Engines weighs approximately 125 kg (275 lb). Exhaust manifold (6) for 3516B Engines weighs approximately 154 kg (340 lb).

6. Lift exhaust manifold (6) from the engine.

Installation Procedure

Table 13

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-5597	Anti-Seize Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

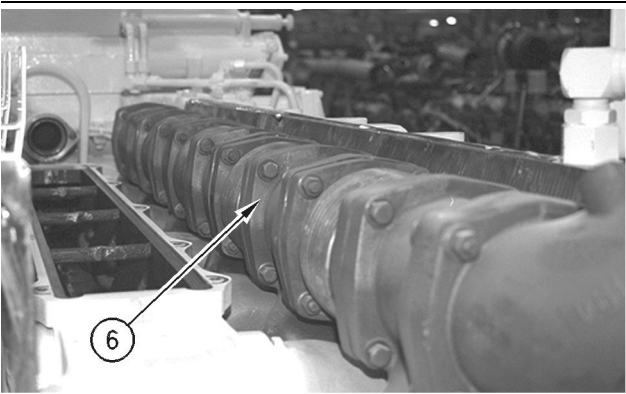


Illustration 185 g00616615

1. Attach a suitable lifting device to exhaust manifold (6).

Exhaust manifold (6) for 3508B Engines weighs approximately 78 kg (170 lb). Exhaust manifold (6) for 3512B Engines weighs approximately 125 kg (275 lb). Exhaust manifold (6) for 3516B Engines weighs approximately 154 kg (340 lb).

2. Position exhaust manifold (6) onto the engine.

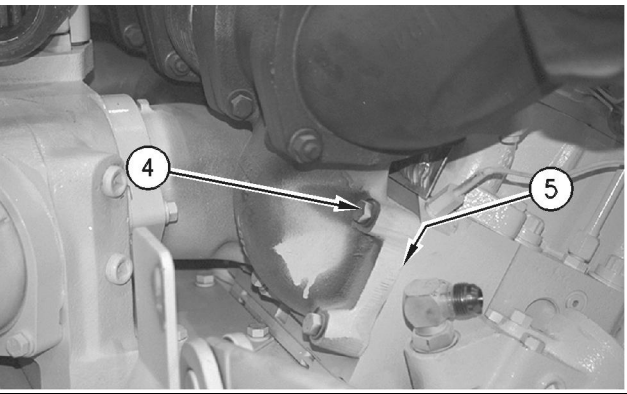


Illustration 186 g00616613

3. Install new gaskets (5) for the joints between the exhaust manifold and the cylinder heads. Apply Tooling (A) to bolts (4). Install bolts (4), the nuts, and the washers that attach the exhaust manifold to the cylinder head. Tighten bolts (4) to a torque of 55 ± 5 N·m (41 ± 4 lb ft).

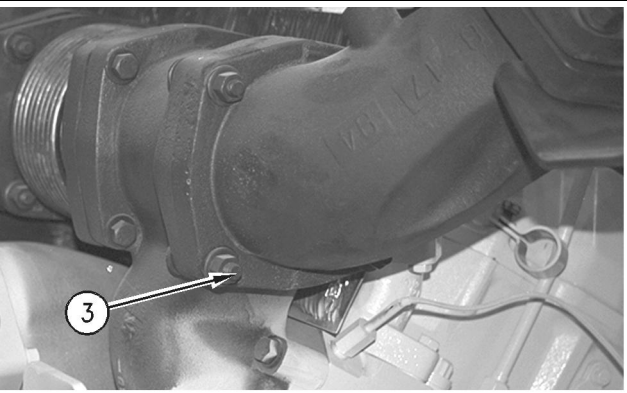


Illustration 187 g00616580

4. Install a new gasket for the joint between the exhaust manifold and the elbow for the turbocharger. Apply Tooling (A) to bolts (3). Install bolts(3) and the nuts. Tighten bolts (3) in a diagonal pattern simultaneously to a torque of 55 ± 5 N·m (41 ± 4 lb ft).

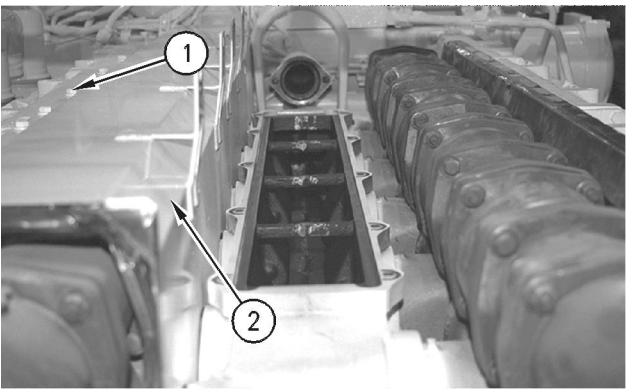


Illustration 188 g00616579

- 5. Install heat shield (2).
- 6. Install bolts (1) and the washers for heat shield (2).

End By:

- a. Install the air inlet manifold. Refer to Disassembly and Assembly, “Air Inlet Manifold - Remove and Install”.
- b. Install the aftercooler. Refer to Disassembly and Assembly, “Aftercooler - Remove and Install”.

i02060737

Expansion Tank - Remove and Install

SMCS Code: 1354-010

Removal Procedure

Table 14

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

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 expansion tank into a suitable container for storage or for disposal.

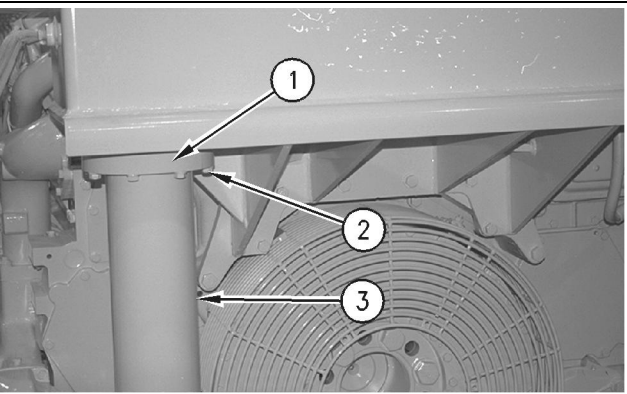


Illustration 189 g00599053

- 2. Remove bolts (2) and the washers. Carefully slide flange (1) down tube (3).

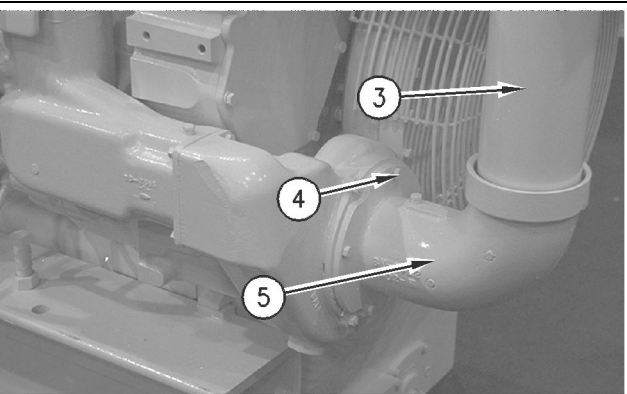


Illustration 190 g00599054

- 3. Remove bolts (4), elbow (5), and tube (3).

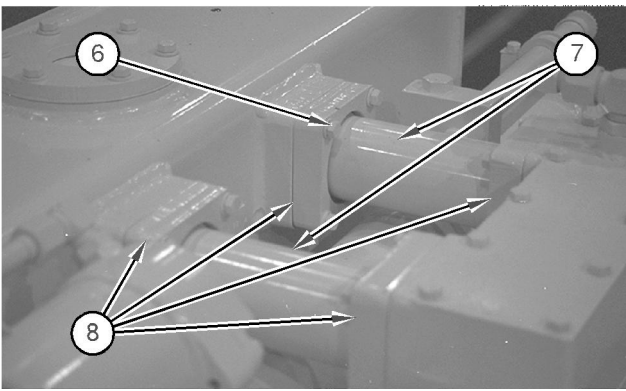


Illustration 191 g01055978

4. Remove bolts and washers (6). Remove flanges (8) and tubes (7).

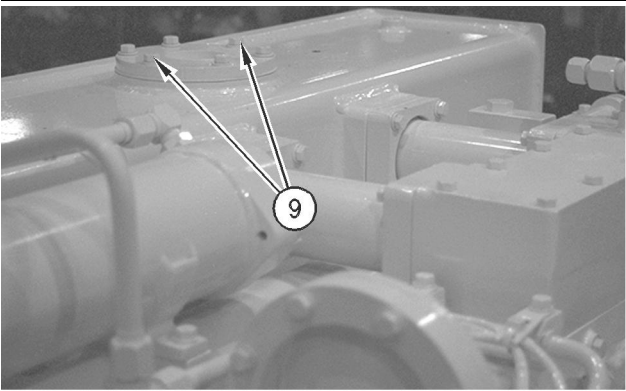


Illustration 192 g00599056

5. Remove bolts (9) from the top of the expansion tank. Install Tooling (A) in the holes.
6. Attach a suitable lifting device onto Tooling (A). The weight of the expansion tank is approximately 209 kg (460 lb).

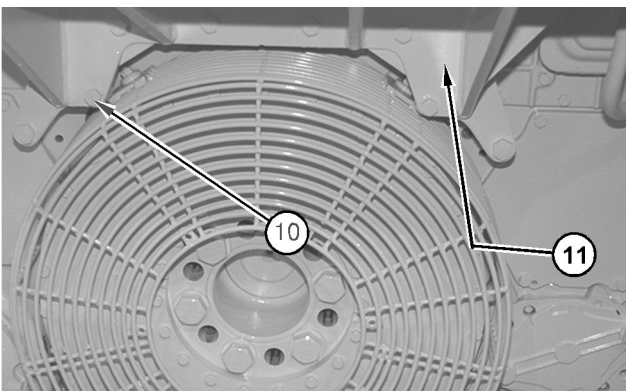


Illustration 193 g01056904

7. Remove bolts (10) and the washers. Remove expansion tank (11).

Installation Procedure

Table 15

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

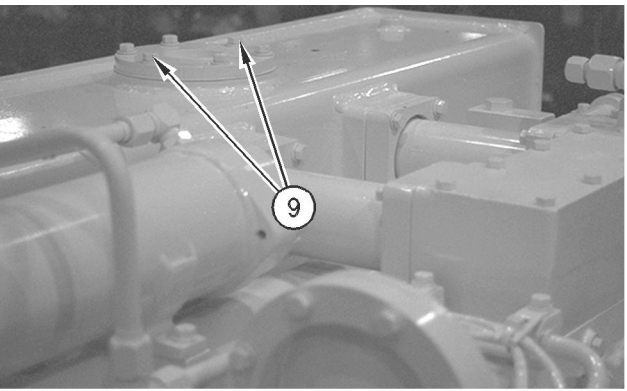


Illustration 194 g00599056

1. Remove bolts (9) from the top of the expansion tank. Install Tooling (A) in the holes.
2. Attach a suitable lifting device onto Tooling (A). The weight of the expansion tank is approximately 209 kg (460 lb).

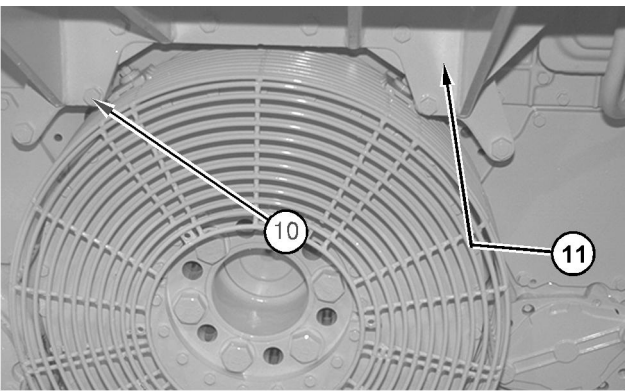


Illustration 195 g01056904

3. Position expansion tank (11) and install bolts (10) and the washers .

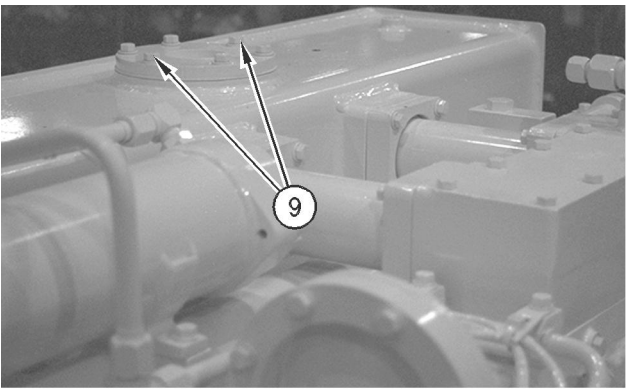


Illustration 196 g00599056

4. Remove Tooling (A). Install bolts (9) in the holes.

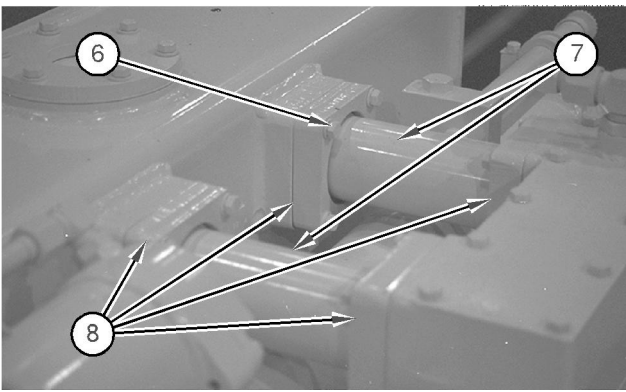


Illustration 197 g01055978

5. Inspect the seals for flanges (8). Obtain new seals, if necessary. Lubricate the bores of flanges (8) lightly with glycerin. Insert the seals into flanges (8). Install flanges (8) and tubes (7) with bolts (6).

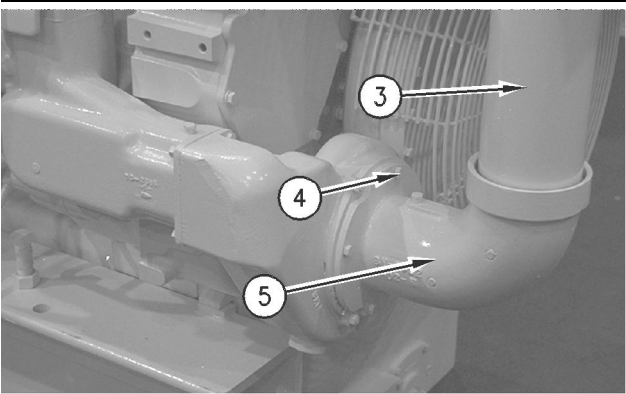


Illustration 198 g00599054

6. Inspect the O-ring seal for tube (3). Obtain a new O-ring seal, if necessary. Lubricate the bore of elbow (5) lightly with glycerin. Insert the O-ring seal into the bore of elbow (5). Insert tube (3) into the bore of elbow (5).

7. Inspect the seal for the joint between elbow (5) and the water pump. Obtain a new seal, if necessary. Place the seal onto the flange of elbow (5). Fasten elbow (5) to the water pump with bolts (4).

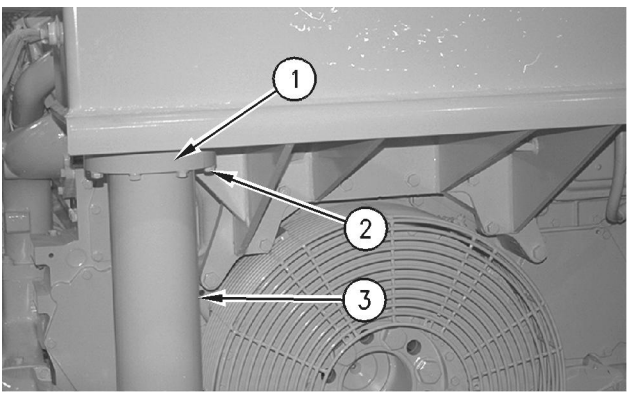


Illustration 199 g00599053

8. Inspect the gasket for the joint between flange (1) and the expansion tank. Obtain a new gasket, if necessary. Insert the gasket into flange (1). Carefully slide flange (1) up tube (3). Fasten flange(1) with bolts (2) and the washers.

9. Fill the expansion tank to the correct level. For the proper coolant to use, refer to the Operation and Maintenance Manual for the engine that is being serviced.

i02061660

Water Temperature Regulators - Remove

SMCS Code: 1355-011

Removal Procedure

Table 16

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

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 cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change". Drain the cooling system until the level of the coolant is below the exhaust manifolds.

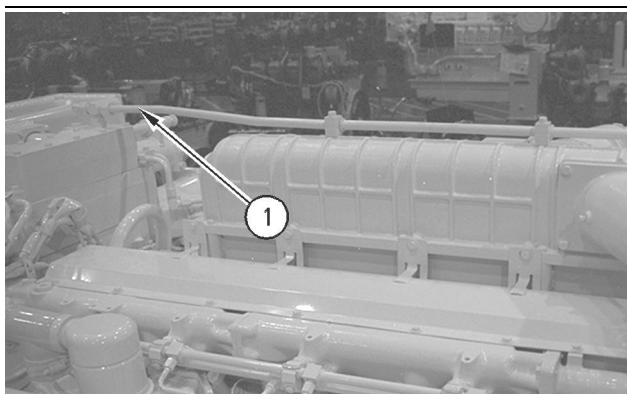


Illustration 200

g00602193

2. Disconnect tube assembly (1) from the water temperature regulator housing.

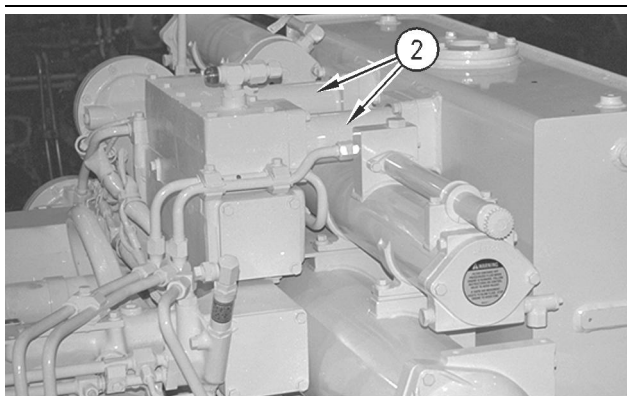


Illustration 201

g00602196

3. Disconnect tube assemblies (2) from the water temperature regulator housing.

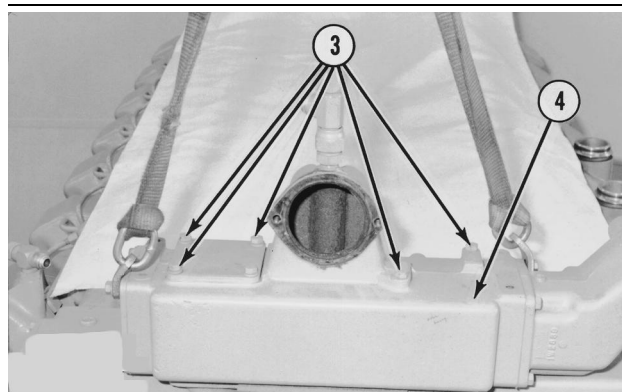


Illustration 202

g00602197

Typical example

4. Attach Tooling (A) and a suitable lifting device to water temperature regulator housing (4). Remove bolts (3). Remove water temperature regulator housing (4).

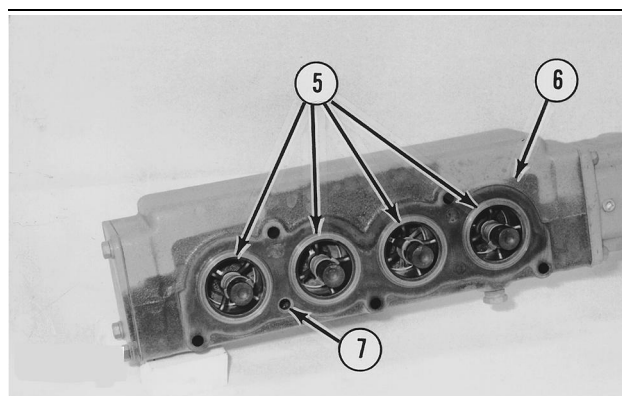


Illustration 203

g00602198

5. Remove water temperature regulators (5). Remove gasket (6).

Visually inspect ferrule (7) and the seals for water temperature regulators (5). Obtain new parts for assembly, if necessary.

i02061675

Water Temperature Regulators - Install

SMCS Code: 1355-012

Installation Procedure

Table 17

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2
B	221 - 8647	Seal Installer Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

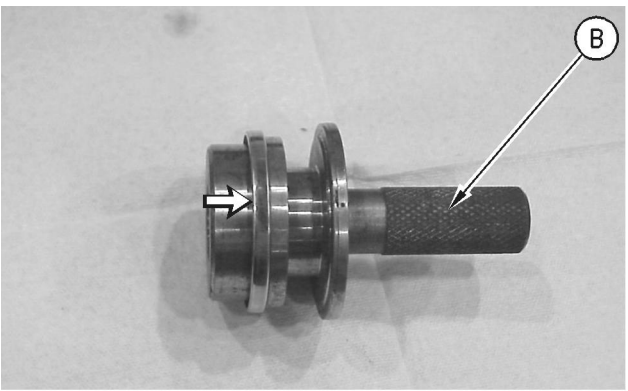


Illustration 204

g00911612

1. Use Tooling (B) to install the seals.

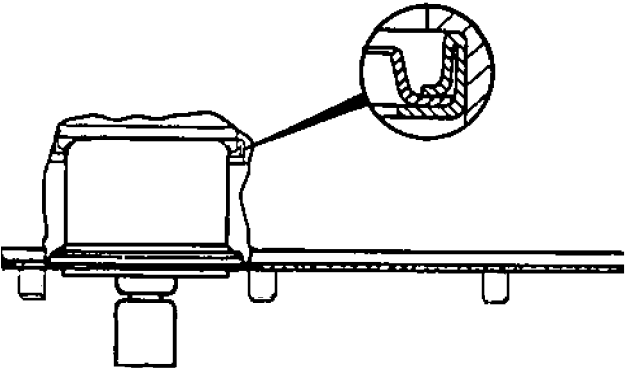


Illustration 205

g00602328

2. Ensure that the lip of the seal is toward the inside of the housing.

NOTICE

If the water temperature regulator is installed incorrectly, it will cause the engine to overheat.

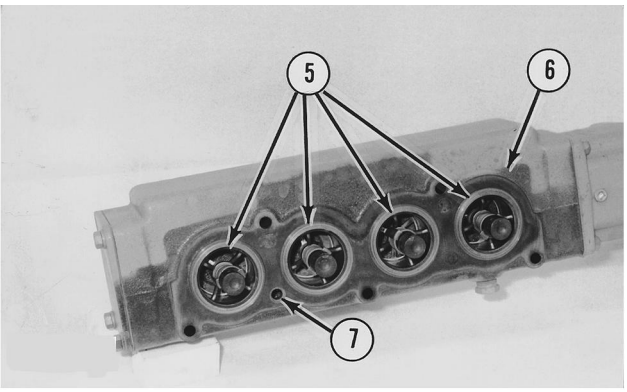


Illustration 206

g00602198

3. Install water temperature regulators (5). Install gasket (6).

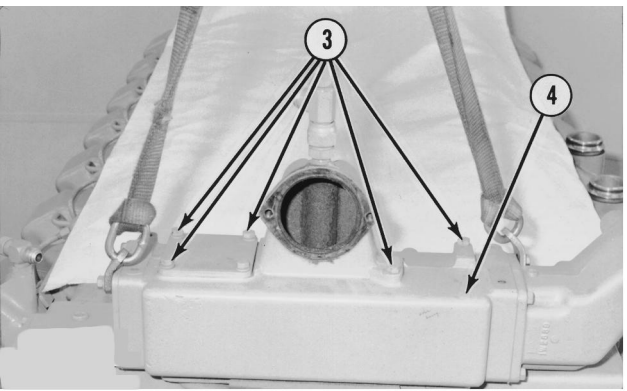


Illustration 207

g00602197

4. Use Tooling (A) and a suitable lifting device to position water temperature regulator housing (4) on the engine. Install bolts (3).

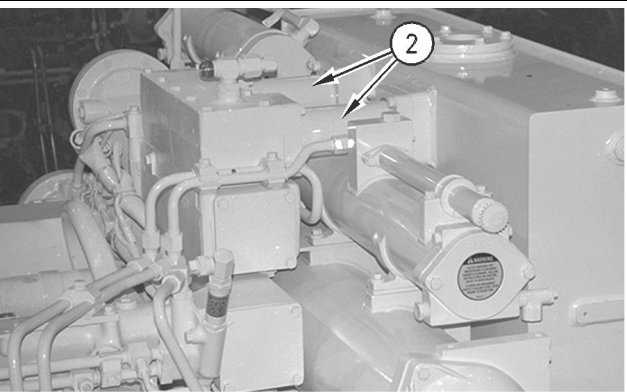


Illustration 208

g00602196

5. Connect tube assemblies (2) to the water temperature regulator housing.

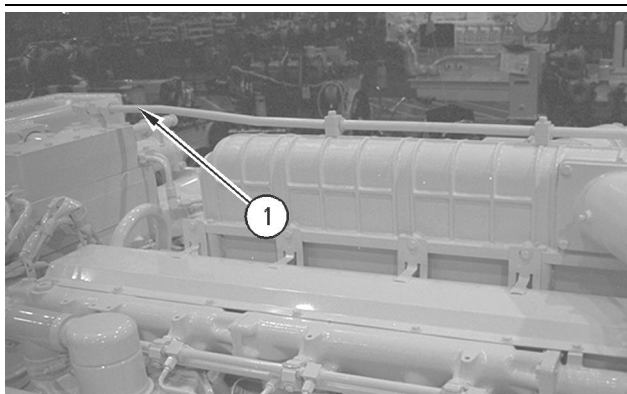


Illustration 209

g00602193

6. Connect tube assembly (1) to the water temperature regulator housing.
7. Fill the cooling with coolant to the correct level. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02061698

Water Pump - Remove

SMCS Code: 1361-011

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

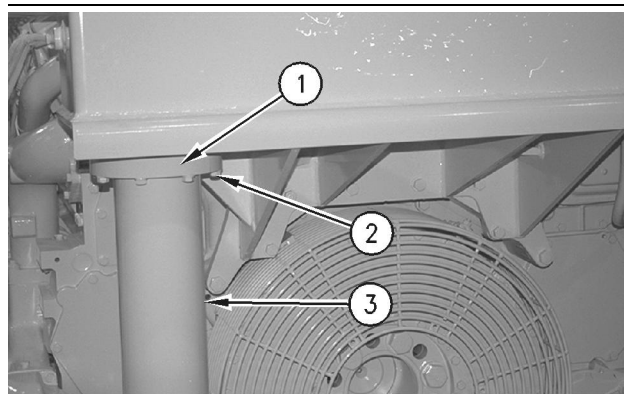


Illustration 210

g00599053

2. Remove bolts (2) and the washers. Carefully slide flange (1) down tube (3).

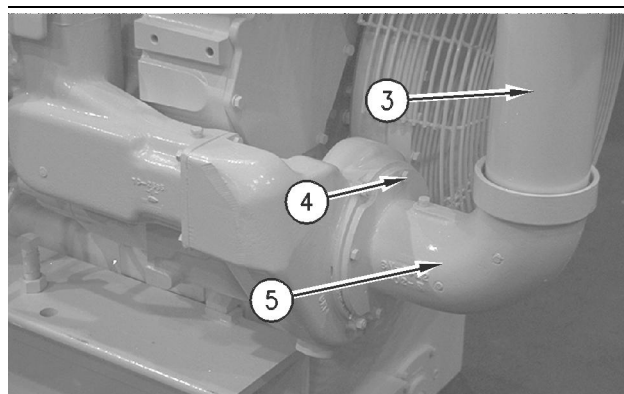


Illustration 211

g00599054

3. Remove bolts (4), elbow (5), and tube (3).

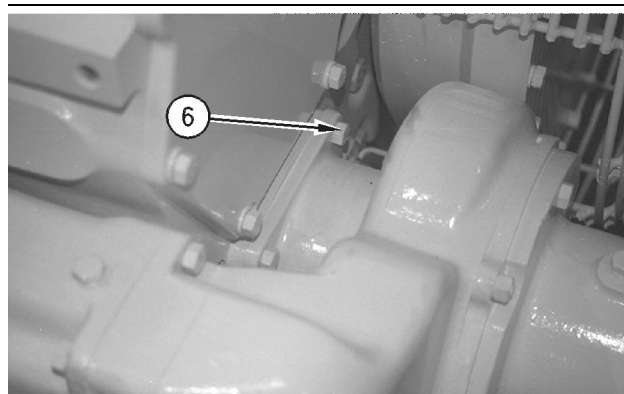


Illustration 212

g00602365

4. Remove bolts (6).

i01929566

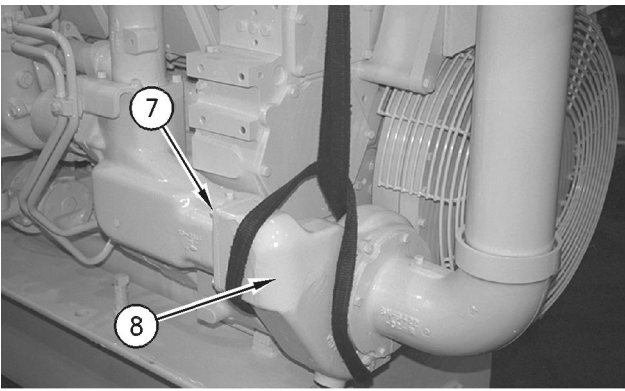


Illustration 213 g00602366

5. Attach a suitable lifting device onto water pump (8). The weight of water pump (8) is approximately 27 kg (60 lb). Remove bolts (7). Remove water pump (8).

Handling the Water Pump

NOTICE

Radial movement of the pump drive shaft can allow the shaft to contact the ceramic seals in the water pump. This can damage the ceramic seals. Damage to the seals will cause leaks and failure of the pump. Do not cause radial movement of the pump drive shaft.

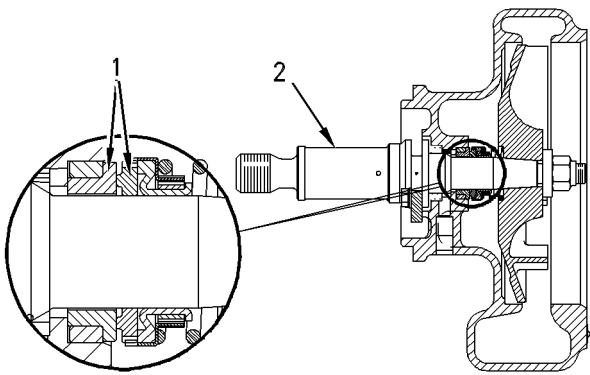


Illustration 214 g00616674

Section view of the water pump

- (1) Ceramic seals
- (2) Pump drive shaft

Use the following guidelines for handling the water pump:

- Do not cause radial movement of the pump drive shaft. Never use any tooling that will cause radial movement of the shaft.
- Never place the water pump on a surface so the shaft rests on the surface.
- Never handle the water pump by the shaft.

Water Pump - Disassemble

SMCS Code: 1361-015

Disassembly Procedure

Table 18

Required Tools			
Tool	Part Number	Part Description	Qty
A	5F - 7465	Puller	1
	8S - 4728	Bolt	2
	4B - 5270	Washer	2
	4B - 5271	Washer	2
	4B - 5273	Washer	2
	1P - 0458	Drive Plate	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.

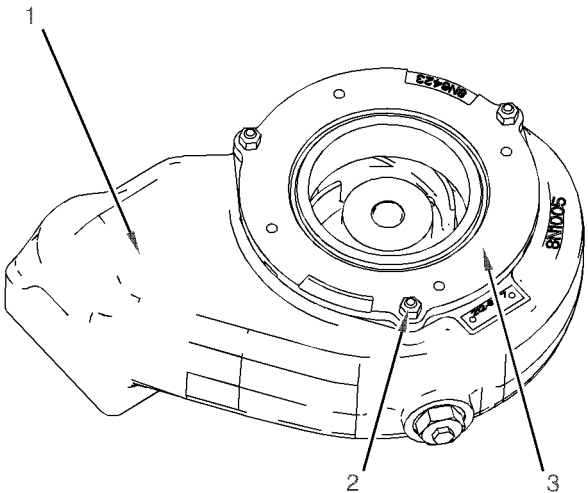


Illustration 215

g01057112

- 1. Remove nuts (2) from cover (3). Remove cover (3) and the O-ring seal from housing (1).

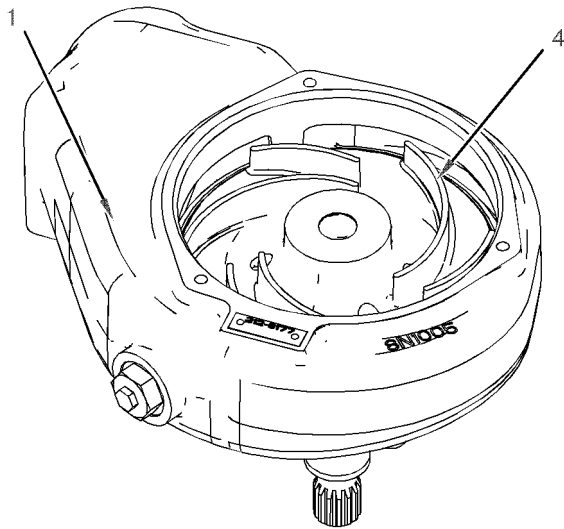


Illustration 216

g01057046

2. Use Tooling (A) to remove impeller (4).
3. Remove impeller (4) from housing (1). Remove Tooling (A) from impeller (4).

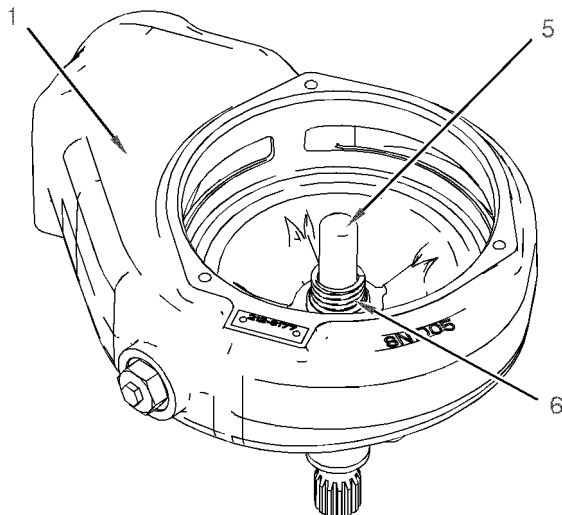


Illustration 217

g01057047

⚠ 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.

4. Remove spring (6) from shaft assembly (5) in housing (1).

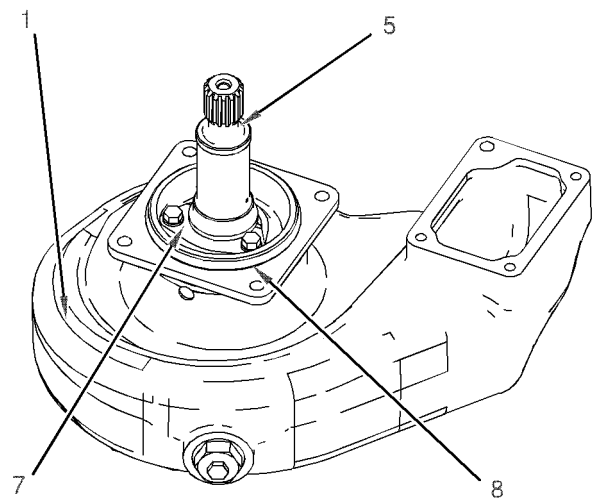


Illustration 218

g01057049

5. Remove O-ring seal (8) from the rear of housing (1).
6. Remove washer (7) that holds shaft assembly (5) in housing (1).
7. Use a soft hammer to push shaft assembly (5) out of housing (1).

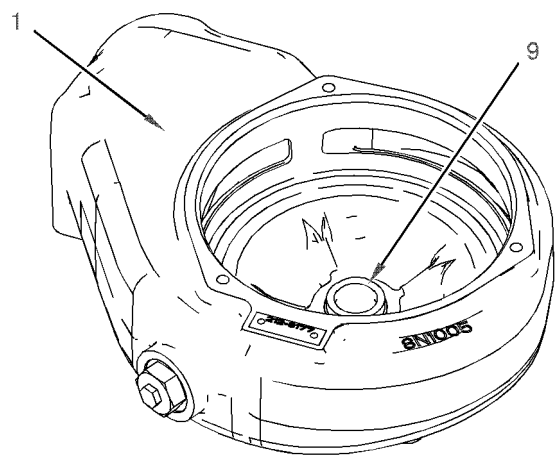


Illustration 219 g01057050

8. Remove seal assembly (9) from housing (1).

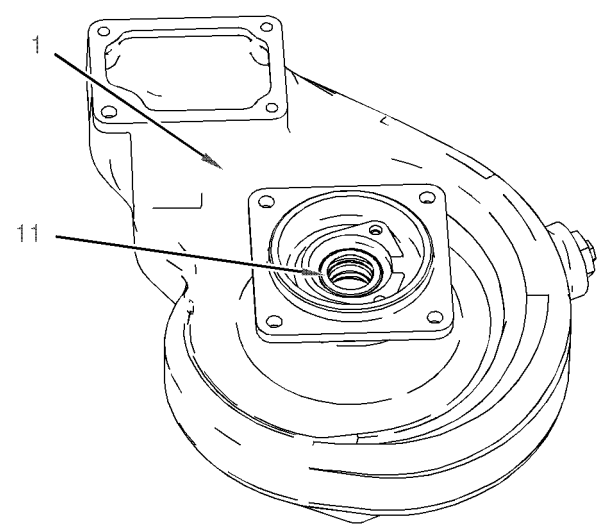


Illustration 221 g01057053

10. Remove seal (11) from the rear of housing (1).

i01929552

Water Pump - Assemble

SMCS Code: 1361-016

Assembly Procedure

Table 19

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

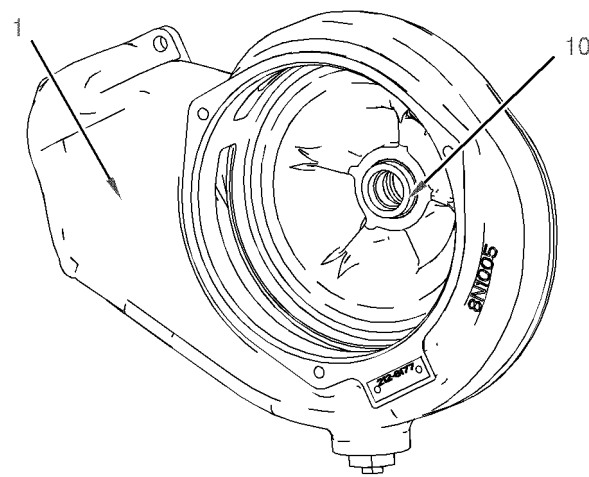


Illustration 220 g01057052

9. Remove ceramic seal (10) and the rubber ring from housing (1).

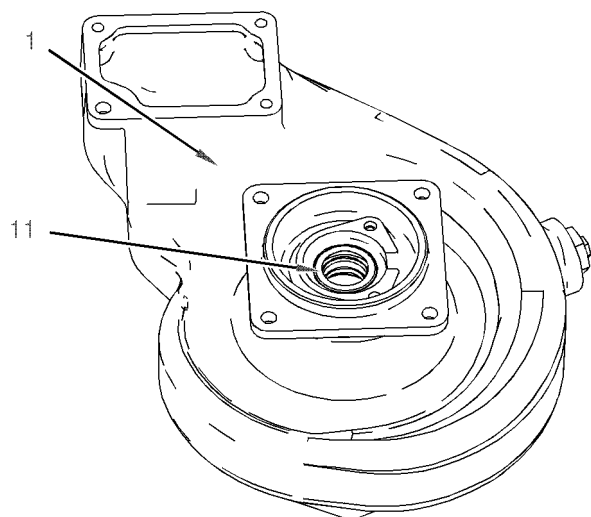


Illustration 222

g01057053

1. Use Tooling (B) to install seal (11) into housing (1). Ensure that the lip of seal (11) is toward the outside. Install seal (11).

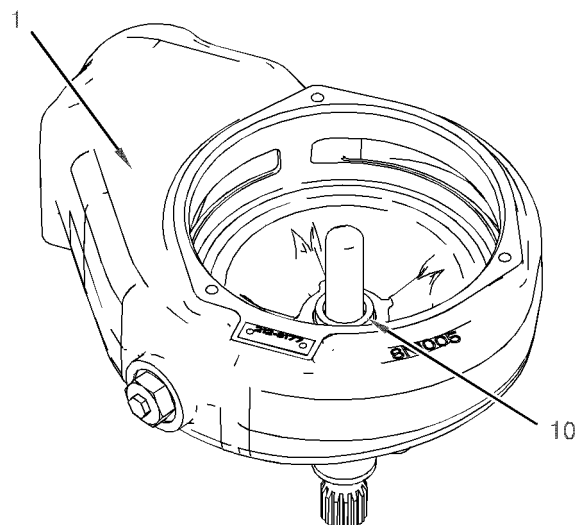


Illustration 224

g01057124

5. Install the rubber ring and ceramic seal (10) into housing (1).

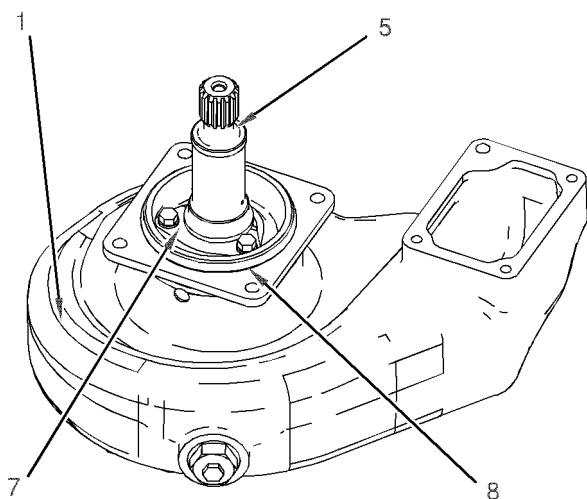


Illustration 223

g01057049

2. Install shaft assembly (5) into housing (1).
3. Install washer (7) into housing (1).

Note: Check the O-ring seal for wear or for damage. If necessary, replace the O-ring seal.

4. Install O-ring seal (8) into housing (1).

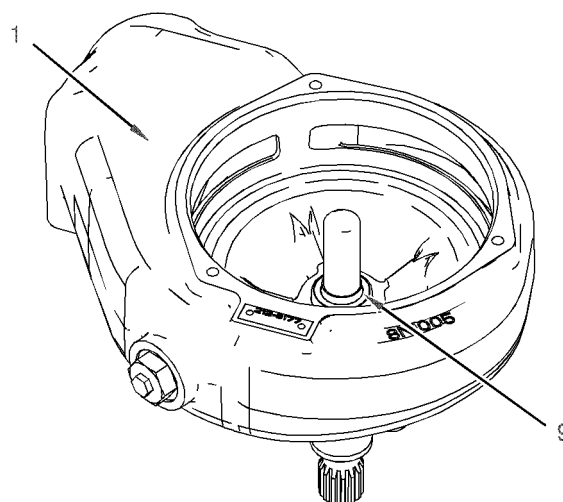


Illustration 225

g01057129

6. Install seal assembly (9) into housing (1).

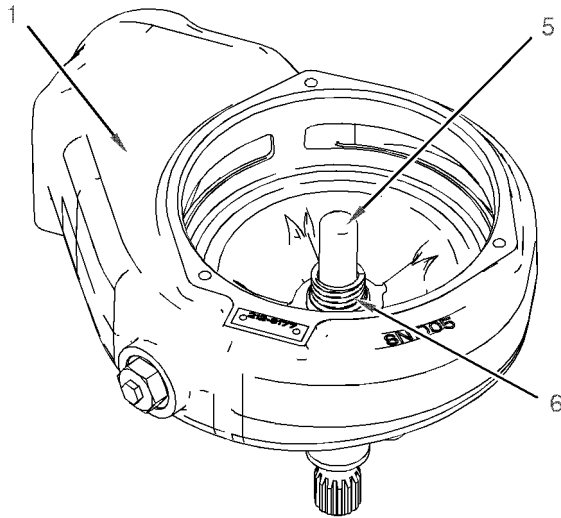


Illustration 226

g01057047

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.

7. Install spring (6) onto shaft assembly (5) in housing (1).

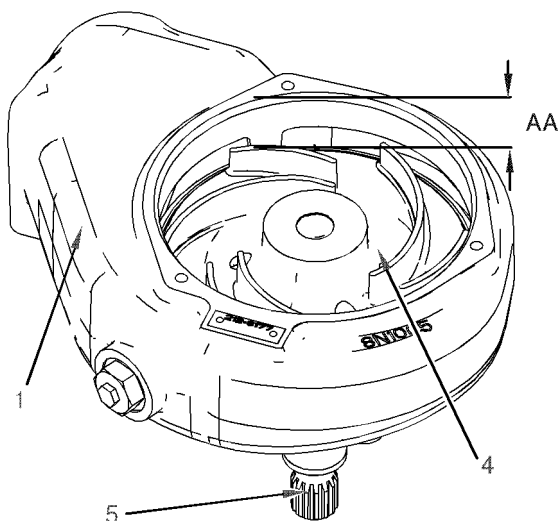


Illustration 227

g01057142

8. Install impeller (4) onto shaft assembly (5) in housing (1). Use a suitable press to install impeller (4) onto shaft assembly (5).

9. Dimension (AA) should measure 31.58 ± 0.44 mm (1.243 ± 0.017 inch).

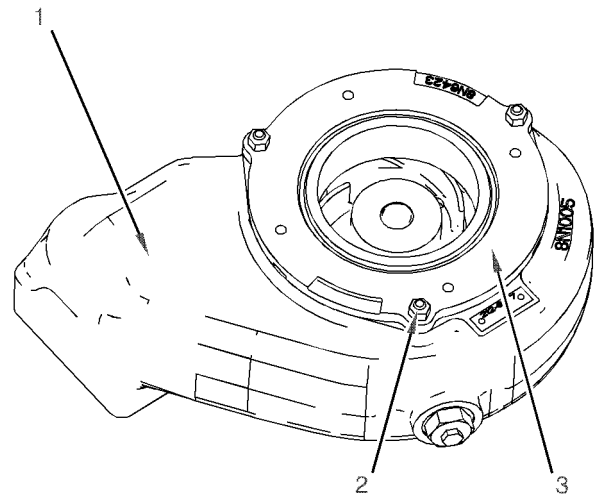


Illustration 228

g01057112

Note: Check the O-ring seal for wear or for damage. If necessary, replace the O-ring seal.

10. Install the O-ring seal and cover (3) into housing (1). Install nuts (2) onto cover (3). Tighten nuts (2) to a torque of 27 ± 4 N·m (20 ± 3 lb ft).

End By:

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

i02061712

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.

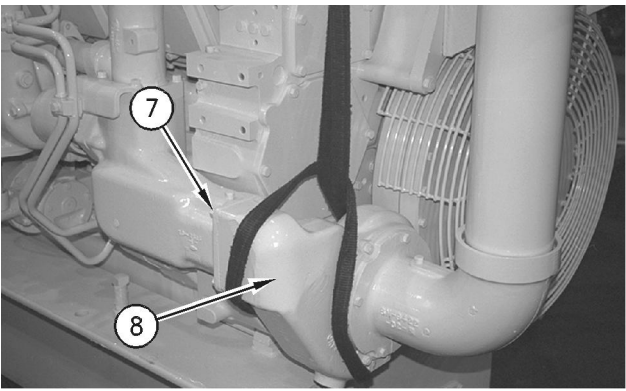


Illustration 229 g00602366

1. Attach a suitable lifting device onto water pump (8). The weight of water pump (8) is approximately 27 kg (60 lb). Position water pump (8) onto the engine. Install bolts (7).

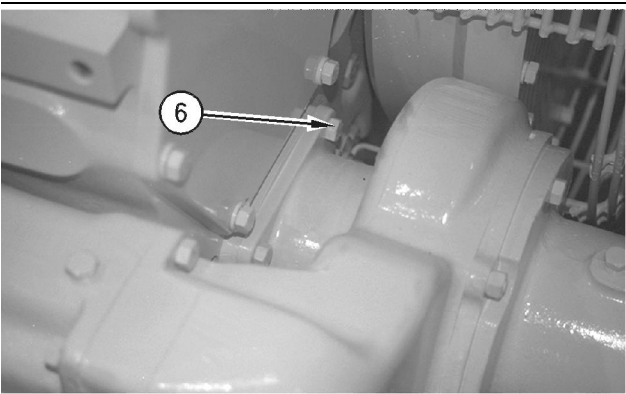


Illustration 230 g00602365

2. Install bolts (6).

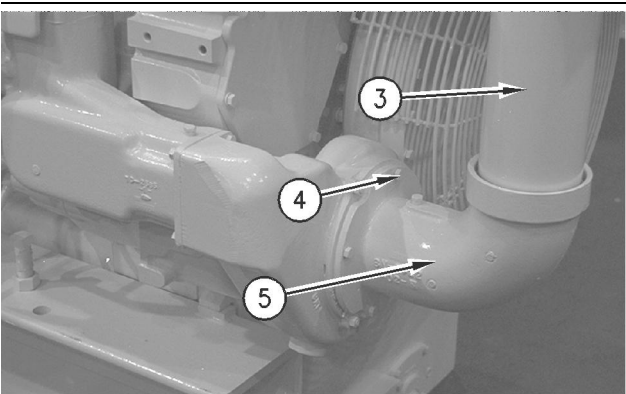


Illustration 231 g00599054

3. Inspect the O-ring seal for tube (3). Obtain a new O-ring seal, if necessary. Lubricate the bore of elbow (5) lightly with glycerin. Insert the O-ring seal into the bore of the elbow. Insert tube (3) into the bore of the elbow.

Inspect the seal for the joint between elbow (5) and the water pump. Obtain a new seal, if necessary. Place the seal onto the flange of the elbow. Fasten elbow (5) to the water pump with bolts (4).

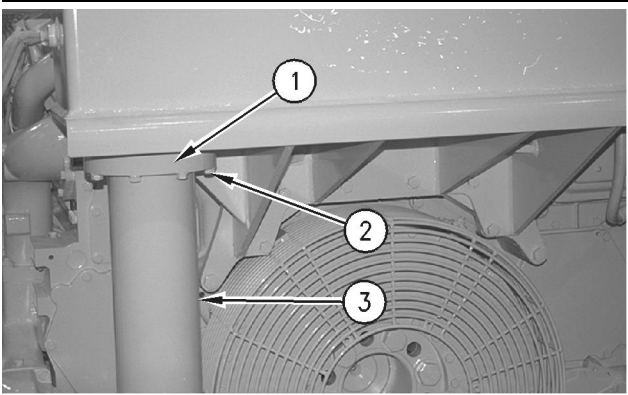


Illustration 232 g00599053

4. Inspect the gasket for the joint between flange (1) and the expansion tank. Obtain a new gasket, if necessary. Insert the gasket into flange (1). Carefully slide flange (1) up tube (3). Fasten flange (1) with bolts (2) and the washers.
5. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

i02061799

Water Pump (Separate Circuit Aftercooler) - Remove

SMCS Code: 1363-011

Removal Procedure

Table 20

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	3/8 x 3 in guide pin	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i02061863

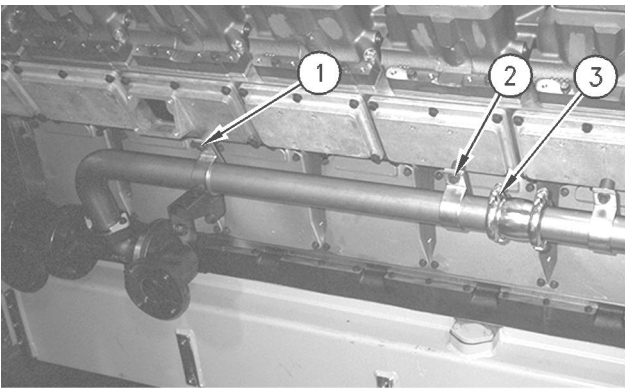


Illustration 233 g00602642

1. Remove bolts (1) and (2). Loosen bolts (3).

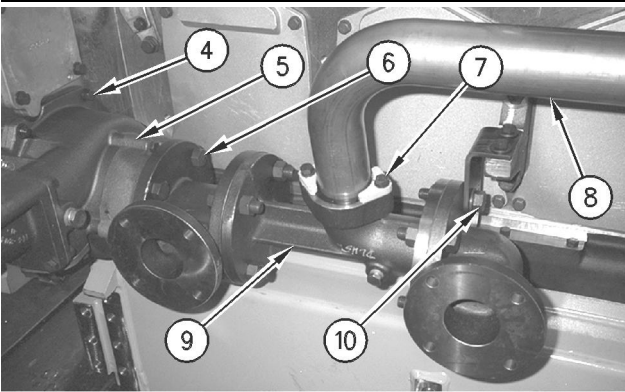


Illustration 234 g00602645

2. Remove bolts and retainers (7). Remove tube (8).
3. Remove bolt (10), the nut, and the washer. Remove bolts (6). Remove connector assembly (9).
4. Remove two of the mounting bolts (4). Install Tooling (A) into the holes. Remove the remaining mounting bolts (4).
5. Attach a suitable lifting device onto water pump (5). The weight of water pump (5) is approximately 39 kg (86 lb). Carefully move water pump (5) on Tooling (A) away from the engine. Lift pump (5) from Tooling (A).

Water Pump (Separate Circuit Aftercooler) - Disassemble

SMCS Code: 1363-015

Disassembly Procedure

Table 21

Required Tools			
Tool	Part Number	Part Description	Qty
A	5F - 7465	Puller	1
	4B - 3903	Bolt	2
	9M - 1974	Hard Washer	2
	5P - 8245	Hard Washer	2
	1P - 0458	Drive Plate	1

Start By:

- a. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump (Separate Circuit Aftercooler) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

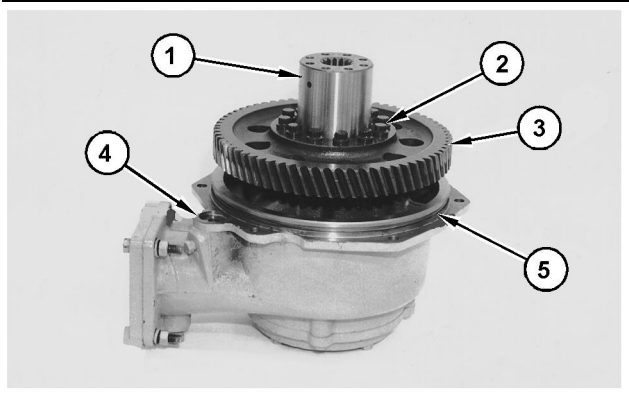


Illustration 235 g01056506

1. Remove O-ring seals (4) and (5).
2. Remove bolts (2) and gear (3) from shaft (1).

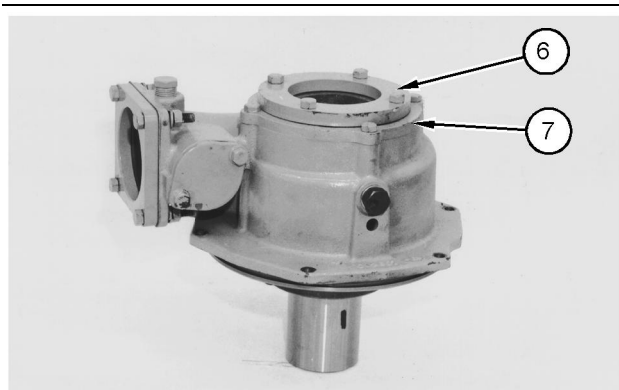


Illustration 236

g01056534

3. Remove adapter (6) and adapter (7) from the housing. Remove the O-ring seal from adapter (7).

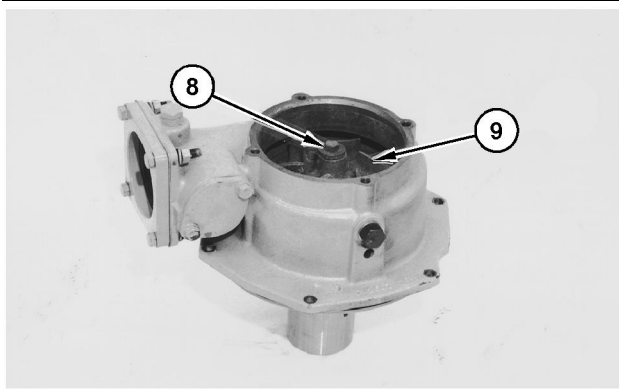


Illustration 237

g01056544

4. Remove bolt (8) that holds impeller (9) on the shaft.

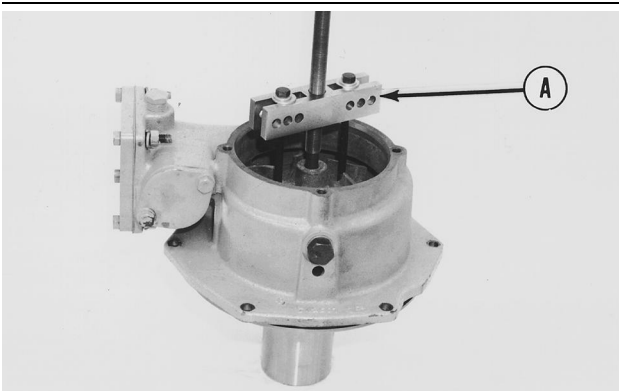


Illustration 238

g00592357

⚠ 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.

5. Use Tooling (A) in order to remove impeller (9) from the shaft.

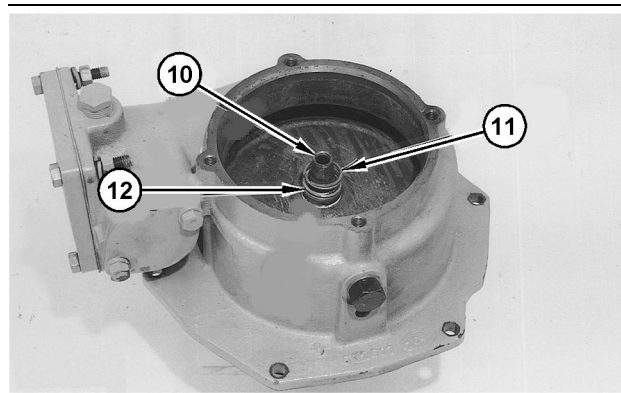


Illustration 239

g01056561

6. Remove spring (11) from carbon seal assembly (12). Remove carbon seal assembly (12) from shaft (10).

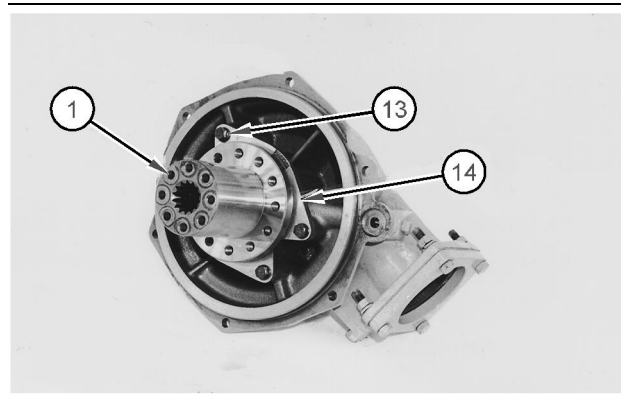


Illustration 240

g01056615

7. Remove bolts (13) that hold retaining washers (14) on the housing. Remove shaft (1) and washers (14).

i02062365

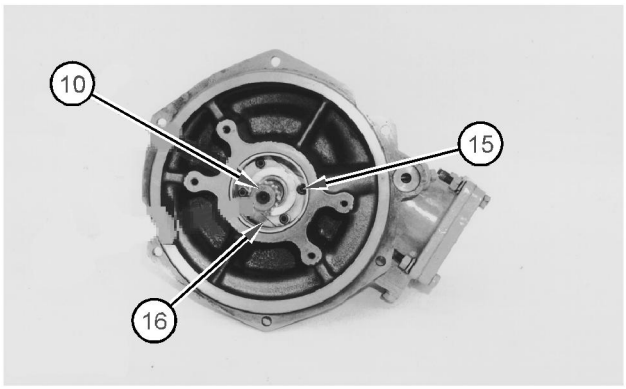


Illustration 241 g01056621

8. Remove bolts (15) that hold the shims and retaining washers (16) on the housing. Remove shaft (10), the shims, and washers (16).

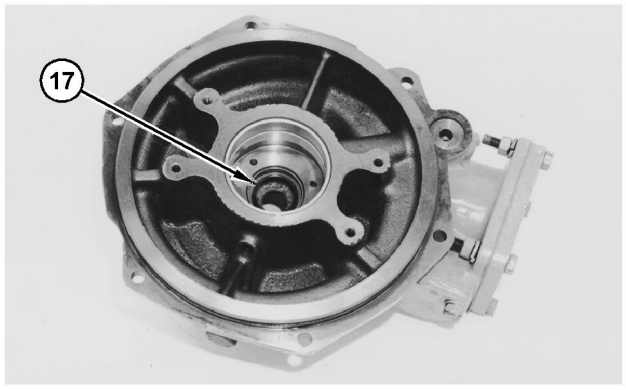


Illustration 242 g01056633

9. Remove lip seal (17) from the housing.

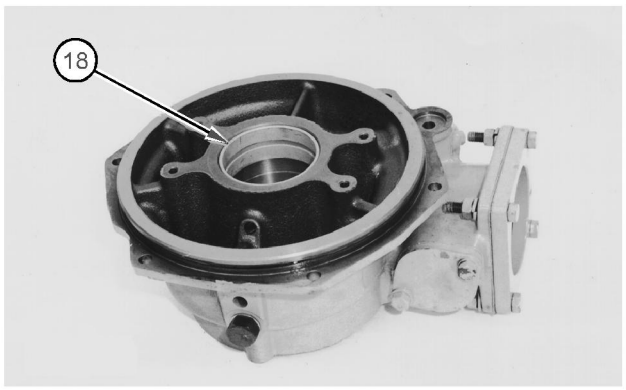


Illustration 243 g01056641

10. Remove bearing (18).

Water Pump (Separate Circuit Aftercooler) - Assemble

SMCS Code: 1363-016

Assembly Procedure

Table 22

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

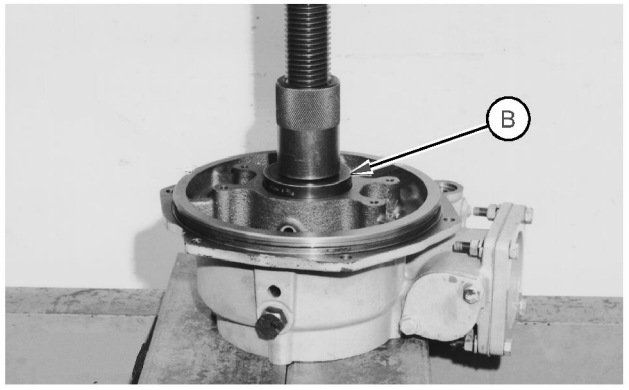


Illustration 244 g01056783

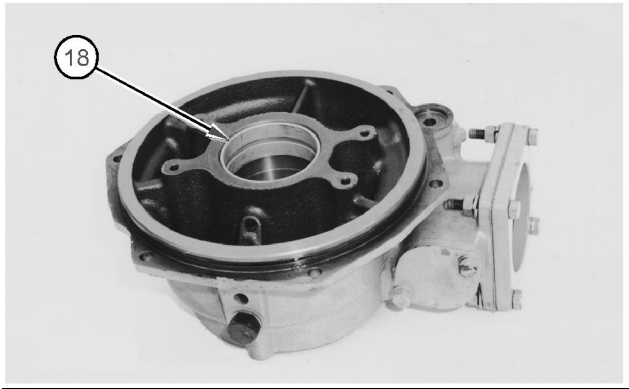


Illustration 245 g01056641

1. Ensure that the oil hole in bearing (18) is aligned with the oil passage in the housing. Use Tooling (B) and a suitable press in order to install bearing (18) in the housing. Bearing (18) must be 1.5 ± 0.5 mm (0.06 ± 0.02 inch) below the surface of the housing. The diameter of bearing (18) must be 75.000 ± 0.055 mm (2.9527 ± 0.0022 inch) after installation.

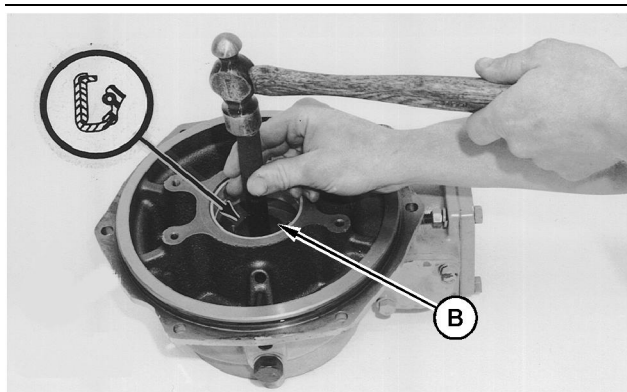


Illustration 246

g01056788

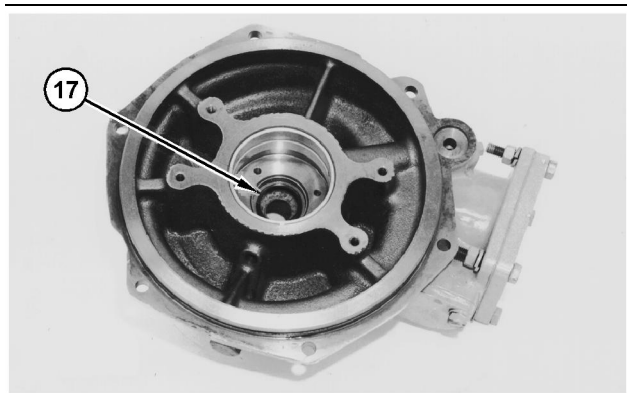


Illustration 247

g01056633

2. Lubricate the bore for lip seal (17) with clean engine oil. Use Tooling (B) in order to install lip seal (17) into the housing. Ensure that the lip of seal (17) is toward the bearing.

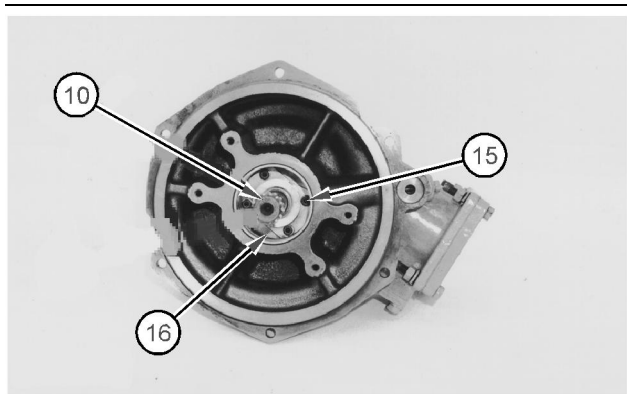


Illustration 248

g01056621

3. Install shaft (10). Install retaining washers (16), the shims, and bolts (15) that hold shaft (10) in the housing.

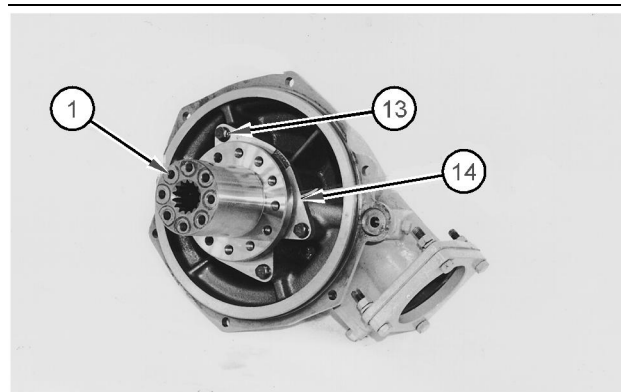


Illustration 249

g01056615

4. Lubricate the bearing in the housing with clean engine oil. Install shaft (1) and retaining washers (14). Install bolts (13).

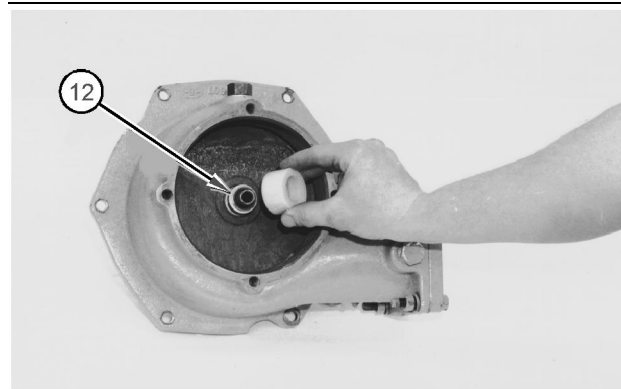


Illustration 250

g01056794

5. Place clean water on the inside diameter of carbon seal assembly (12) for lubrication. Use hand pressure and the tool that is supplied with the seal group in order to install carbon seal assembly (12). The face of carbon seal assembly (12) should make light contact with the shaft.

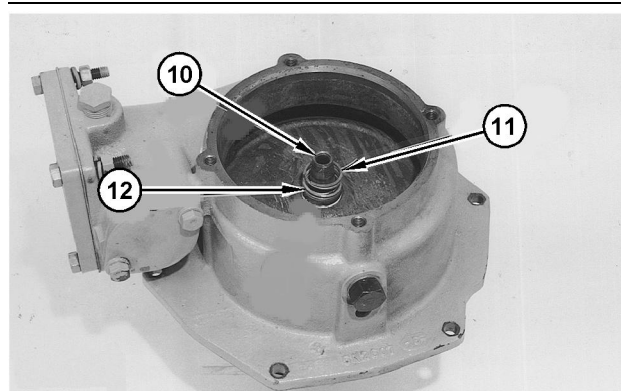


Illustration 251

g01056561

6. Install spring (11) on shaft (10) and on carbon seal assembly (12).

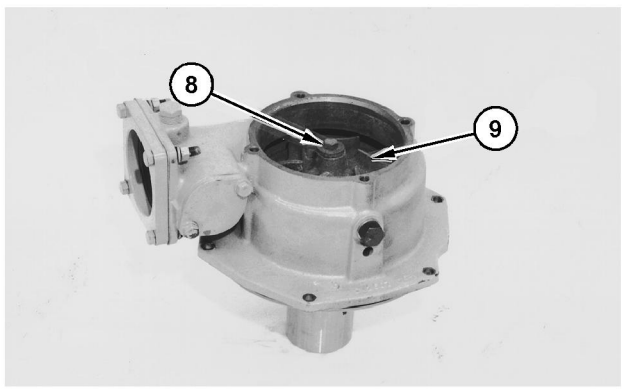


Illustration 252

g01056544

⚠ 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.

7. Install impeller (9). Install bolt (8) and the washer. Tighten bolt (8) to a torque of $38 \pm 4 \text{ N}\cdot\text{m}$ ($28 \pm 3 \text{ lb ft}$).

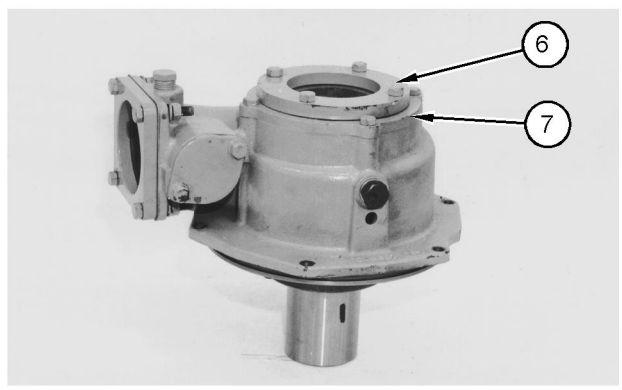


Illustration 253

g01056534

Note: Check the O-ring seal for wear or for damage. If necessary, replace the O-ring seal.

8. Lubricate the bore for the O-ring seal with glycerin. Install the O-ring seal on adapter (7). Position adapter (7) in the housing and install adapter (6).

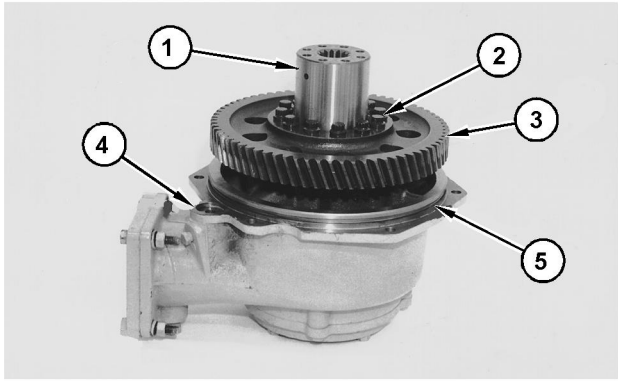


Illustration 254

g01056506

Note: Check the O-ring seals for wear or for damage. If necessary, replace the O-ring seals.

9. Position gear (3) on shaft (1) and install bolts (2). Lubricate the bores for O-ring seals (4) and (5) with clean engine oil. Install O-ring seals (4) and (5) in the housing.

End By:

- a. Install the water pump. Refer to Disassembly and Assembly, "Water Pump (Separate Circuit Aftercooler) - Install".

i02061845

Water Pump (Separate Circuit Aftercooler) - Install

SMCS Code: 1363-012

Installation Procedure

Table 23

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	3/8 x 3 in guide pin	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i02060129

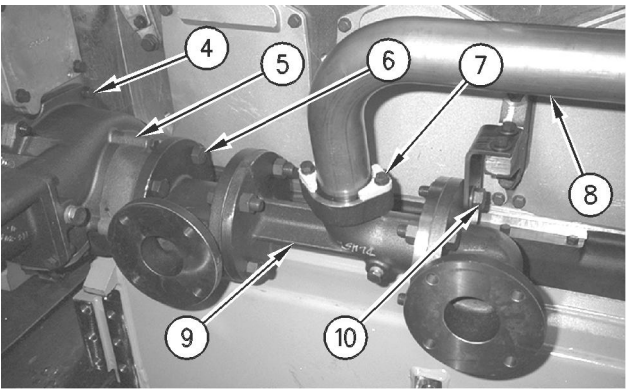


Illustration 255

g00602645

1. Install Tooling (A) in the holes for mounting bolts (4).
2. Attach a suitable lifting device onto water pump (5). The weight of water pump (5) is approximately 39 kg (86 lb). Carefully lift water pump (5) onto Tooling (A). Position water pump (5) onto the engine.
3. Install mounting bolts (4). Remove Tooling (A) and install the remaining mounting bolts (4).
4. Install connector assembly (9). Install bolts (6). Install bolt (10), the nut, and the washer.
5. Position tube (8). Install bolts (7) and the retainers.

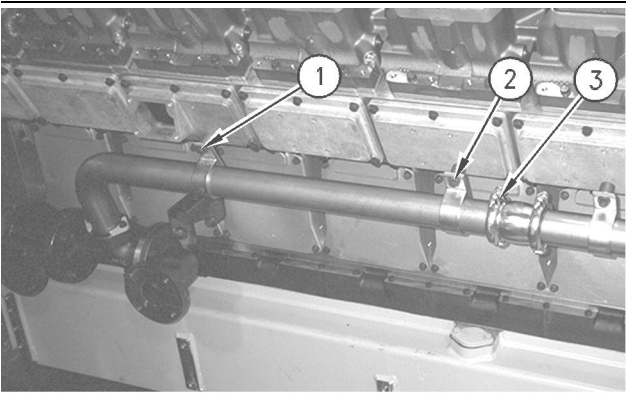


Illustration 256

g00602642

6. Tighten bolts (3). Install bolts (1) and (2).

Auxiliary Water Pump - Remove (Auxiliary Pump)

SMCS Code: 1371-011

Removal Procedure

Table 24

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.

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.

Remove the Check Valve

1. Drain the sea water from the system.
2. Disconnect the water lines from the check valve and from the auxiliary water pump. Remove the gaskets from the joints between the water lines, the check valve, and the auxiliary water pump.

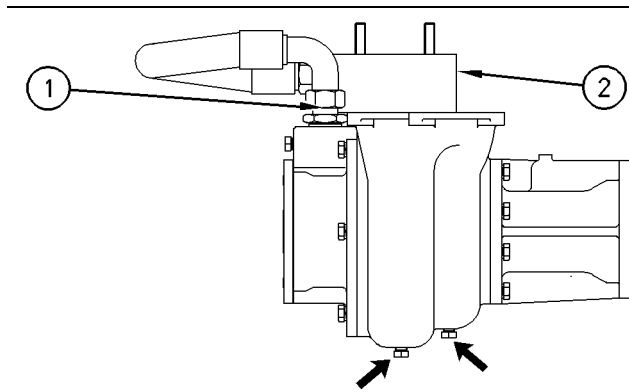


Illustration 257

g00714933

3. Remove the plugs from the bottom of the auxiliary water pump in order to drain the remaining water from the auxiliary water pump. After the water has drained, install the plugs.
4. Disconnect hose assembly (1) from the auxiliary water pump.
5. Remove check valve (2) and hose assembly (1) as a unit.
6. Remove the gasket from the joint between the check valve and the auxiliary water pump.
7. Remove the studs for the check valve from the holes around the outlet of the auxiliary water pump.

Remove the Pump

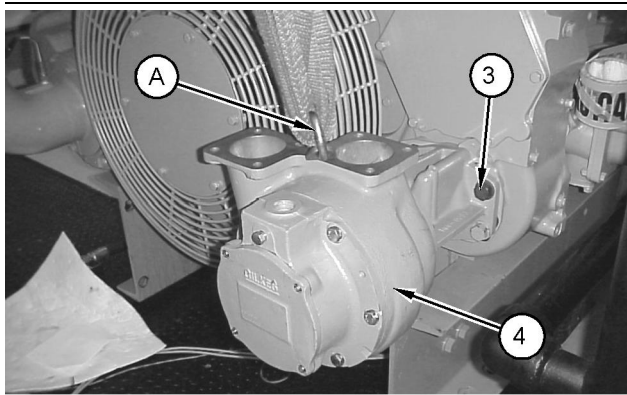


Illustration 258

g01055719

1. Attach Tooling (A) and a suitable lifting device to auxiliary water pump (4). The weight of the auxiliary water pump is approximately 64 kg (140 lb). Remove the slack from the suitable lifting device. The auxiliary water pump must be supported during removal.

2. While the auxiliary water pump is supported by the suitable lifting device, remove bolts (3) and the washers. Carefully move the shaft of the auxiliary water pump out of the front drive in order to remove the auxiliary water pump from the front housing.

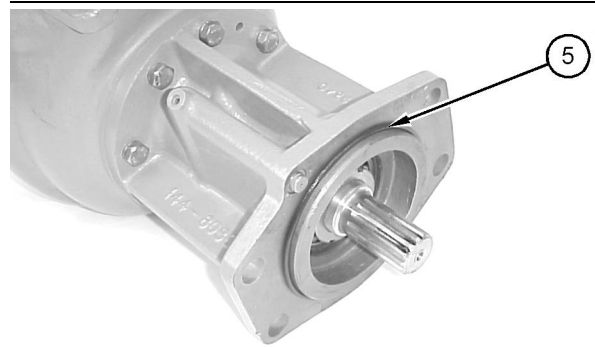


Illustration 259

g01057277

3. Remove O-ring seal (5).

i02060168

Auxiliary Water Pump - Remove (Auxiliary Sea Water Pump)

SMCS Code: 1371-011

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

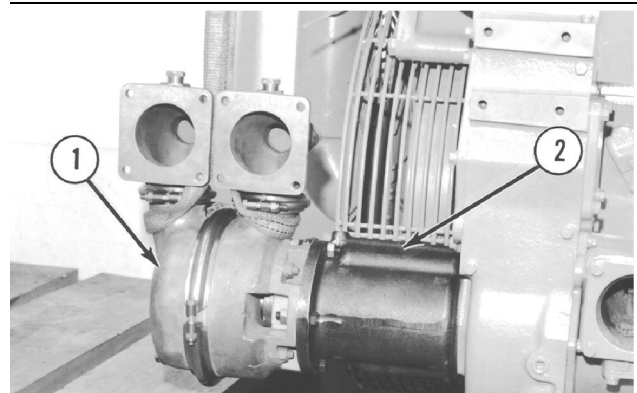


Illustration 260

g00602815

1. Remove the water lines from auxiliary water pump (1).

i02060196

2. Attach a suitable lifting device to auxiliary water pump (1). The weight of the auxiliary water pump is approximately 59 kg (130 lb).
3. Remove the nuts and bolts that fasten auxiliary water pump (1) to housing (2). Remove auxiliary water pump (1).

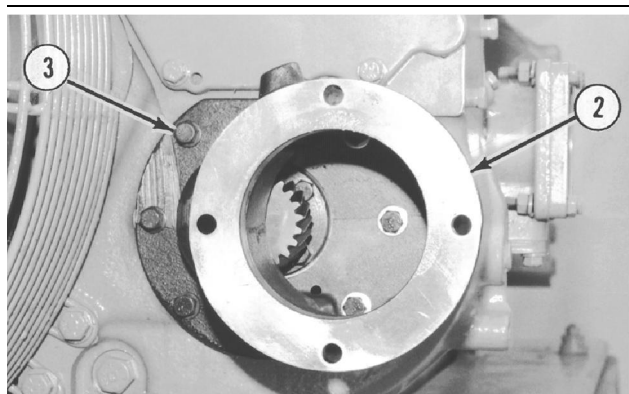


Illustration 261

g00602816

4. Remove bolts and washers (3) in order to remove housing (2). If necessary, remove the bearing from the housing.

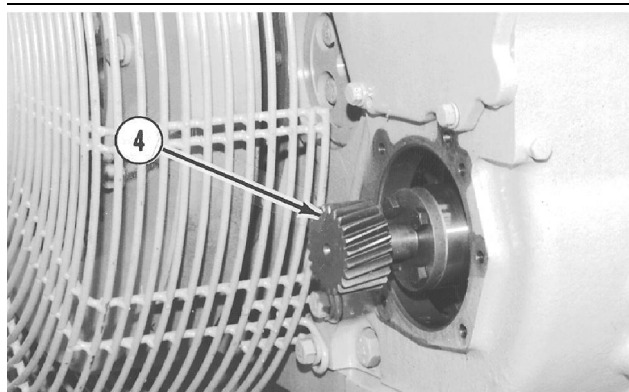


Illustration 262

g00602821

5. Remove the bolts and remove gear (4) from the accessory drive shaft.

Auxiliary Water Pump - Disassemble (Auxiliary Pump)

SMCS Code: 1361-015

Disassembly Procedure

Table 25

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-2320	Combination Puller (Two Jaw or Three Jaw)	1
B	193-8094	Spline Socket	1
C	193-8100	Socket (Impeller Nut)	1
D	1P-0510	Driver Gp	1
E	136-1452	Retaining Ring Pliers As	1
F	152-7159	Socket As (Water Pump Shaft)	1
G	1U-7600	Slide Hammer Puller Gp	1
H	1P-0074	Slide Hammer Puller Gp	1
J	-	M10 x 125 Forcing Bolts	2
K	-	M8 x 1.25 Bolts	2

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Disassemble the Check Valve

Note: If the hose assembly is leaking, the entire hose assembly must be replaced.

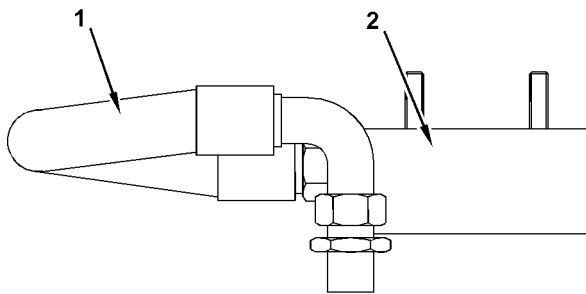


Illustration 263

g01056041

1. Remove hose assembly (1) from the body of check valve (2).

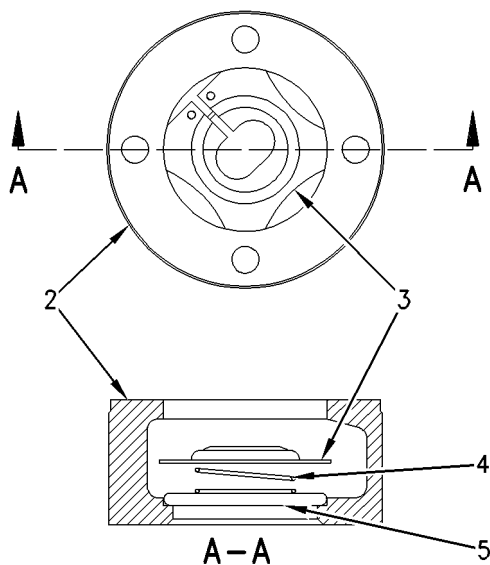


Illustration 264

g00714974

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.

2. Use Tooling (E) in order to remove retainer (3) from the body of check valve (2).
3. Remove spring (4) and disc (5) from the body of check valve (2).

Disassemble the Pump

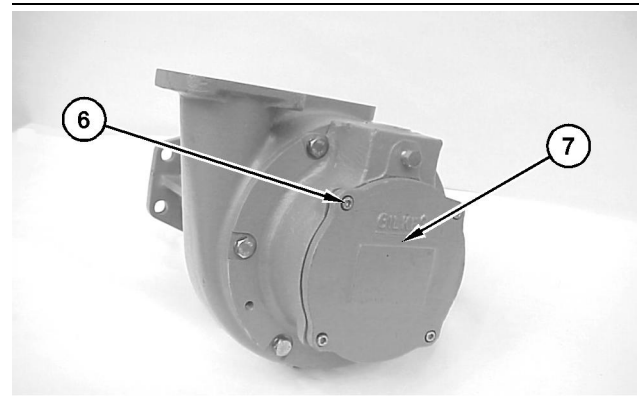


Illustration 265

g01055763

1. Remove bolts (6) in order to remove cover (7).

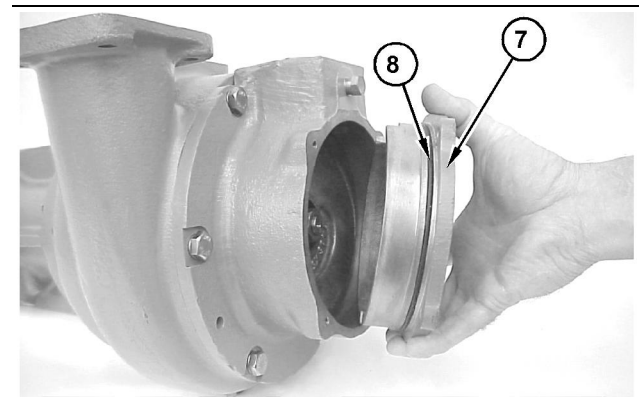


Illustration 266

g01055766

2. Remove O-ring seal (8) from cover (7).

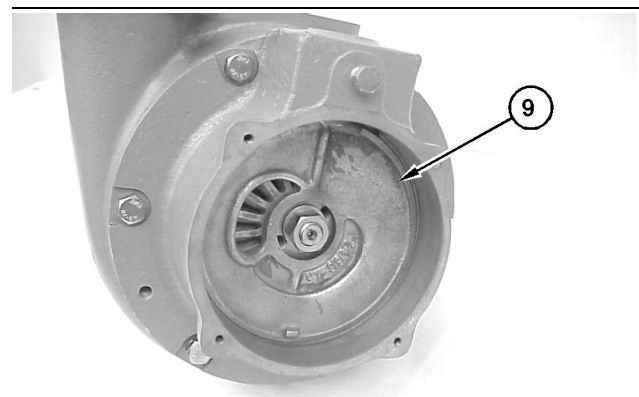


Illustration 267

g01055768

3. Remove port plate (9).

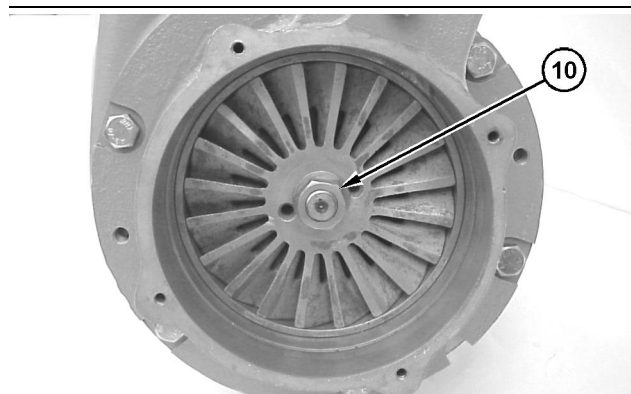


Illustration 268

g01055769

4. Remove nut (10) and the washer.

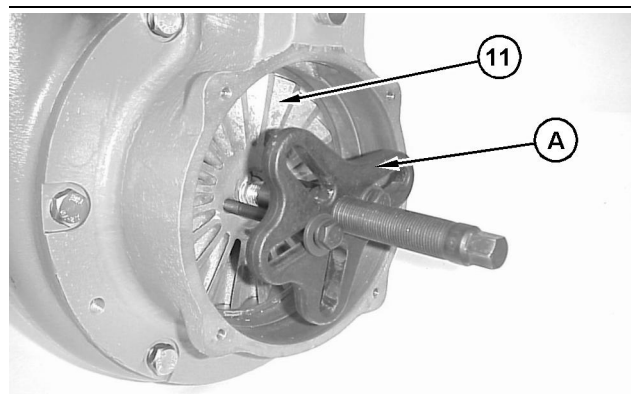


Illustration 269

g01055770

5. Use Tooling (A) in order to remove impeller (11).

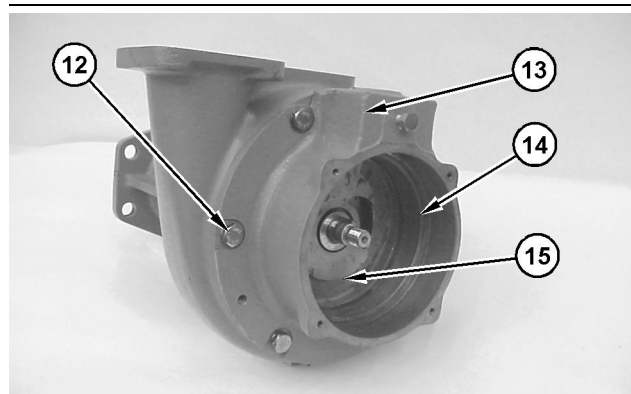


Illustration 270

g01055773

6. Remove bolts (12) from body (13).

Note: Ring (14) and port plate (15) will remain inside when the body is removed.

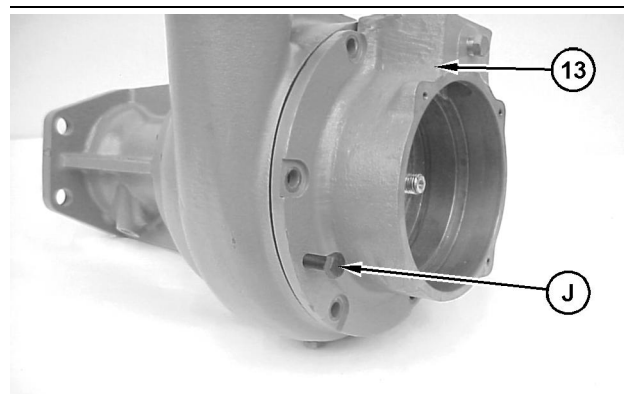


Illustration 271

g01055775

7. Use Tooling (J) in order to remove body (13).

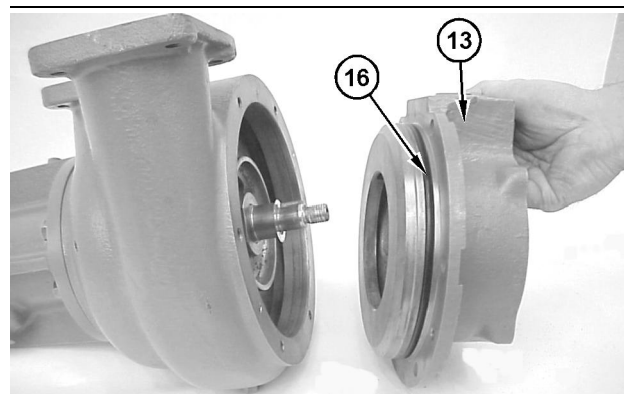


Illustration 272

g01055781

8. Remove O-ring seal (16) from body (13).

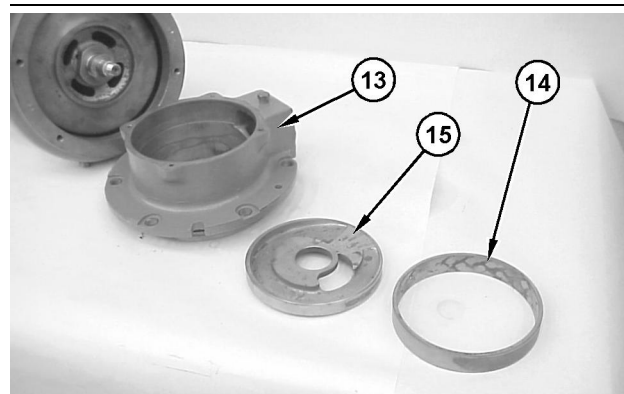


Illustration 273

g01055783

9. Remove ring (14) and port plate (15) from body (13).

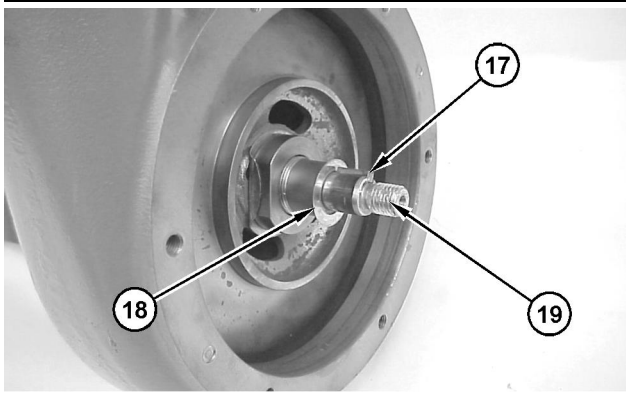


Illustration 274

g01055786

10. Remove key (17) and shim (18) from shaft (19).

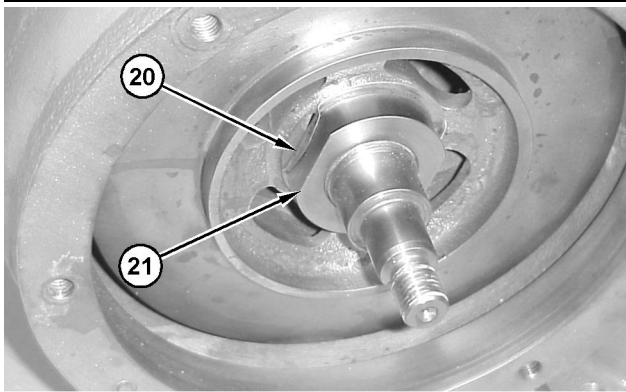


Illustration 275

g01055789

11. Bend the tabs of lockwasher (20) away from the flats of locknut (21).

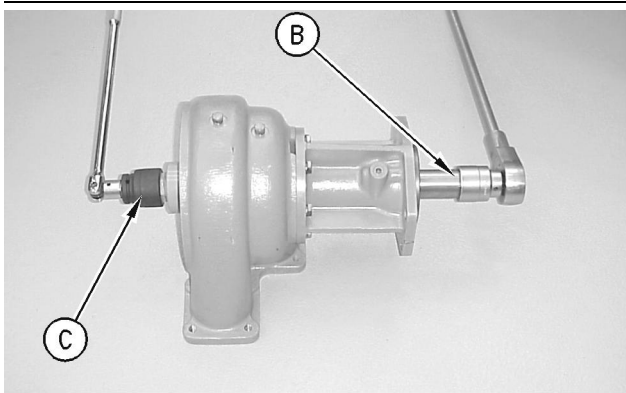


Illustration 276

g00705829

12. Hold the driven end of the shaft with Tooling (B).
Use Tooling (C) in order to loosen the locknut.

Remove the locknut and the lockwasher from the shaft. Use a new lockwasher upon assembly.

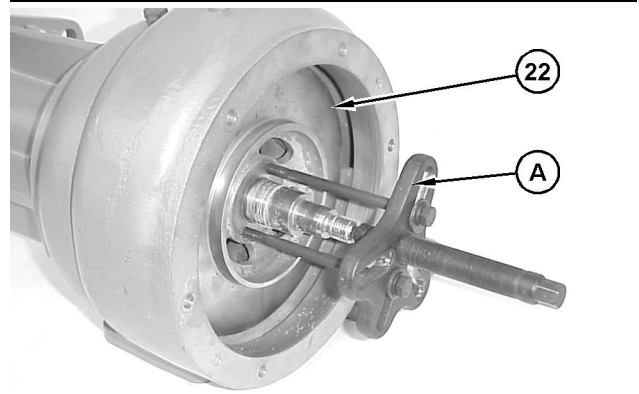


Illustration 277

g01055791

13. Use Tooling (A) in order to remove impeller (22).

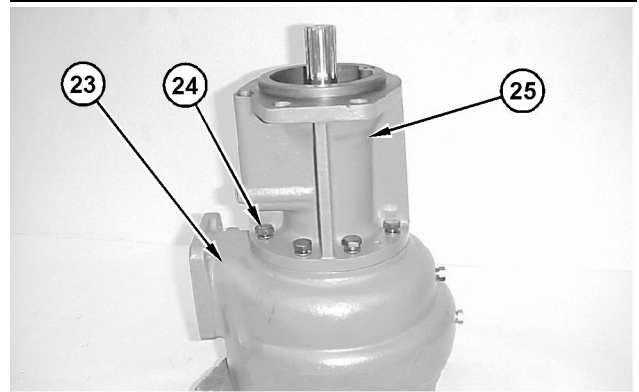


Illustration 278

g01055793

14. Place body (23) in the downward position.
Remove bolts and washers (24) that attach bearing housing (25) to the body.

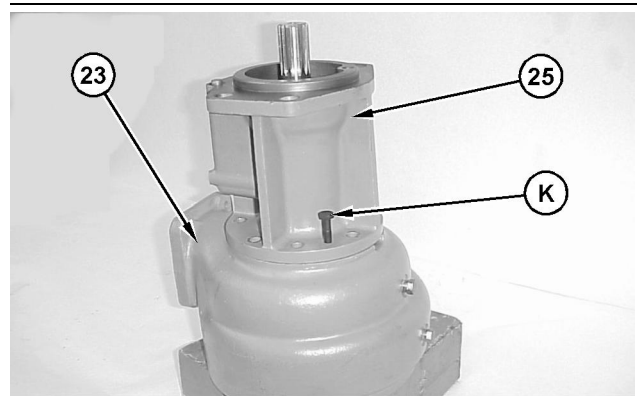


Illustration 279

g01055795

15. Use Tooling (K) in order to force bearing housing (25) from body (23).

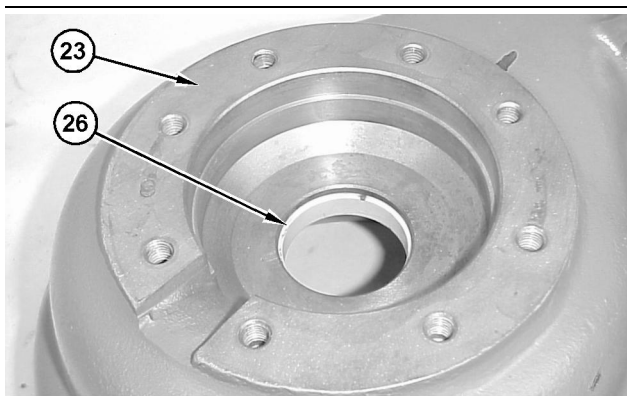


Illustration 280

g01055796

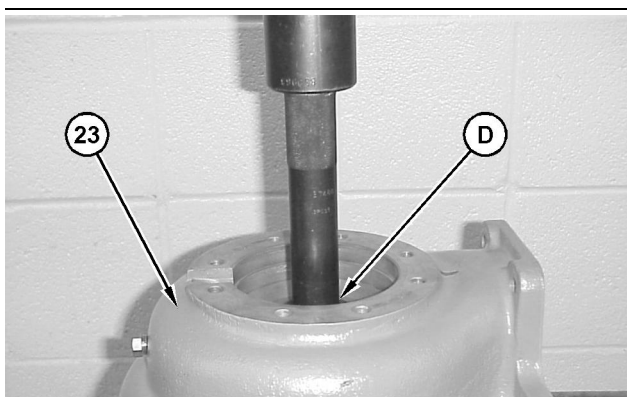


Illustration 281

g01055798

16. Use Tooling (D) and a suitable press in order to remove the stationary segment of ceramic seal (26) from body (23).

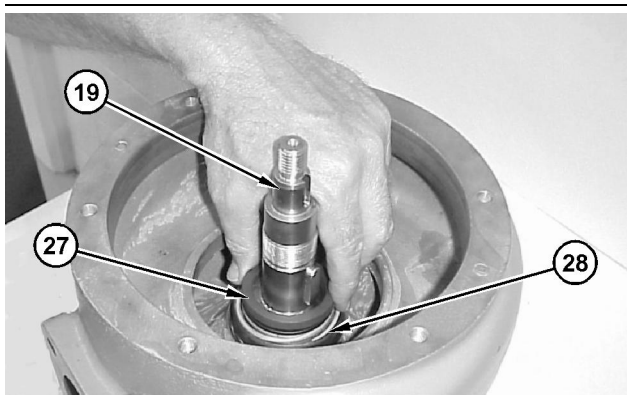


Illustration 282

g01055799

17. Remove ring (27) and the rotating segment of ceramic seal (28) from shaft (19).

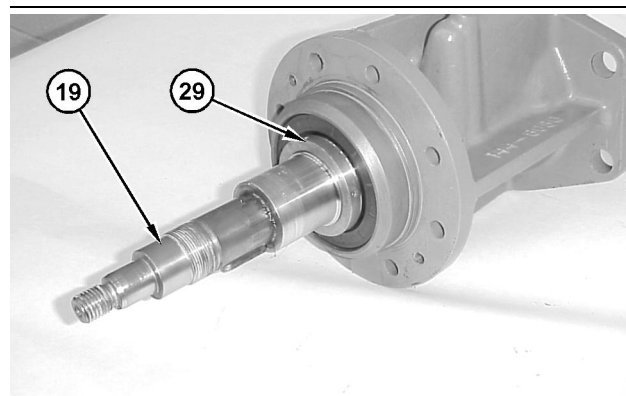


Illustration 283

g01055802

18. Use an allen wrench to loosen the screws that hold ring (29) to shaft (19). Remove the ring.

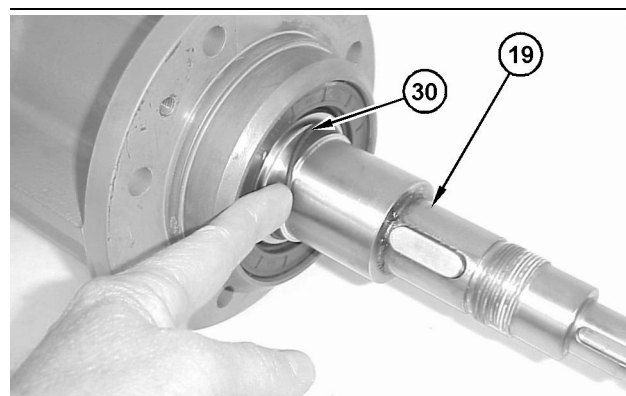


Illustration 284

g01055803

19. Remove O-ring seal (30) from shaft (19).

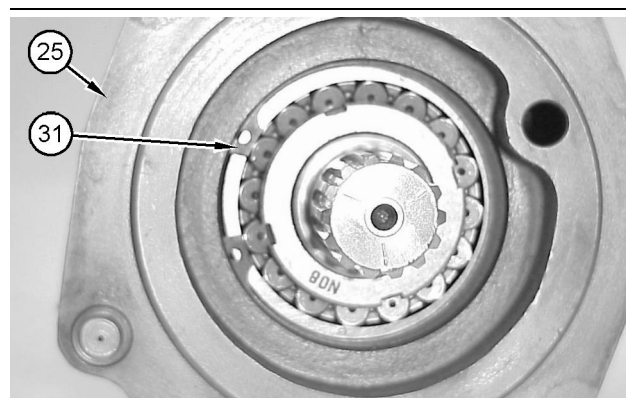


Illustration 285

g01055804

20. Place bearing housing (25) in a vise with the driven end of the shaft in the upward position. Use Tooling (E) in order to remove retaining ring (31).

NOTICE

Do not allow the shaft to fall when the shaft is removed from the bearing housing.

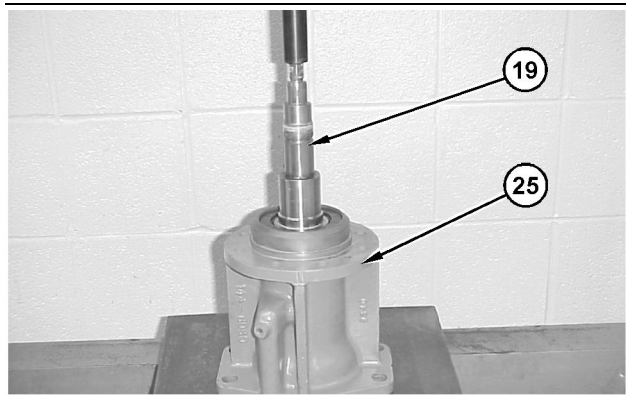


Illustration 286

g01055806

21. Place bearing housing (25) and shaft (19) in a suitable press. Orient the impeller end of the shaft in the upward position. Press the shaft out of the bearing housing.

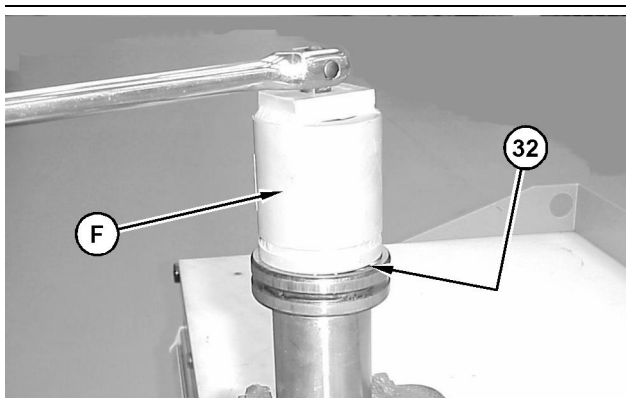


Illustration 287

g01055810

22. Place the shaft in a vise. Orient the driven end of the shaft in the upward position. Use Tooling (F) in order to remove nut (32) (not shown) from the shaft.

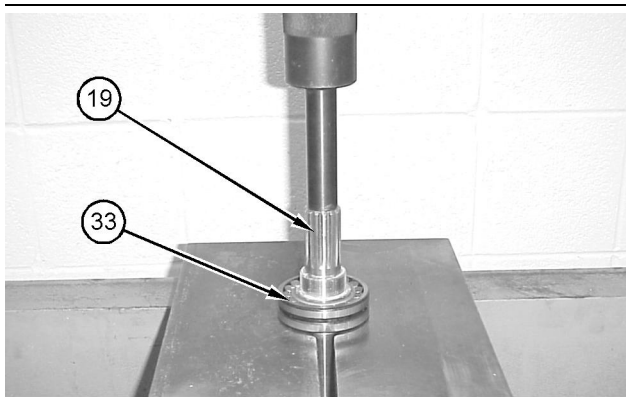


Illustration 288

g01055815

23. Place shaft (19) and bearing (33) in a suitable press. Orient the driven end of the shaft in the upward position. Press the shaft out of the bearing.

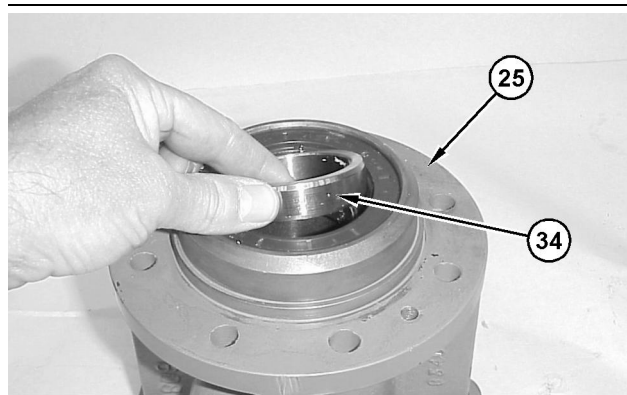


Illustration 289

g01055814

24. Remove collar (34) from bearing housing (25).

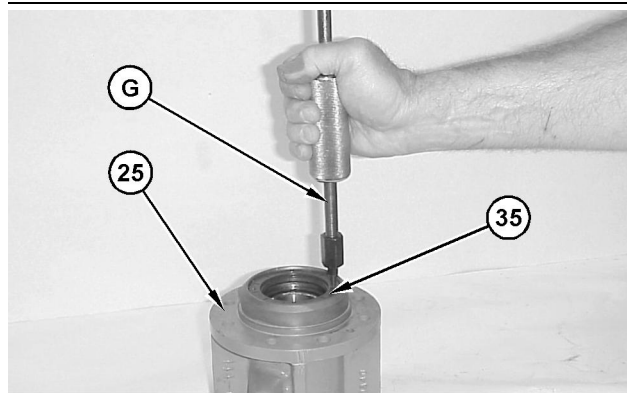


Illustration 290

g01055816

25. Use Tooling (G) in order to remove oil seal (35) from bearing housing (25).

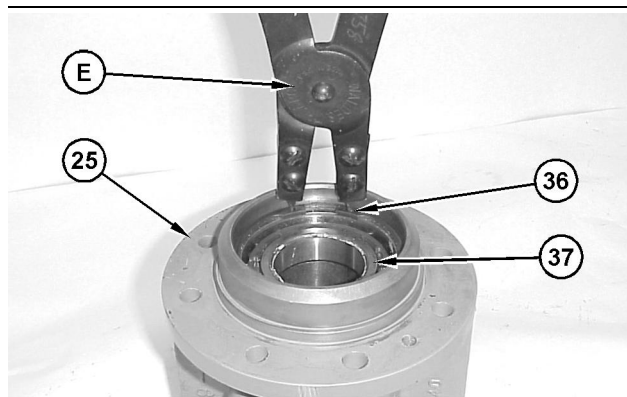


Illustration 291

g01055817

26. Use Tooling (E) in order to remove retaining ring (36) from bearing housing (25).

27. Remove bearing (37) from bearing housing (25).

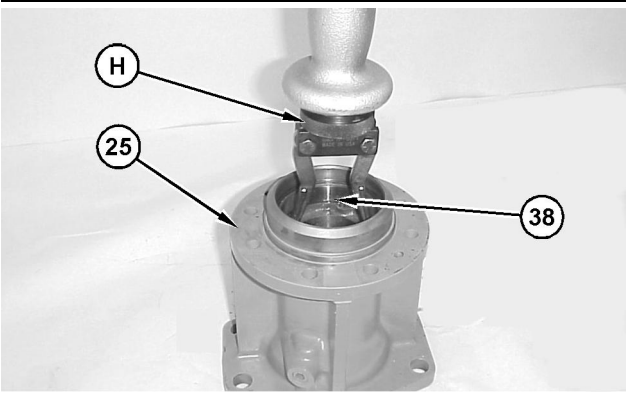


Illustration 292

g01055821

28. Use Tooling (H) in order to remove bearing race (38) from bearing housing (25).

i02060956

Auxiliary Water Pump - Disassemble (Auxiliary Sea Water Pump)

SMCS Code: 1361-015

Disassembly Procedure

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P - 2320	Combination Puller	1
	8B - 7560	Step Plate	1
B	8S - 2264	Puller Group	1
	-	5/16 inch Bolt 18 NC 76.2 mm (3 inch) length	2
	4B - 5270	Washer (5/16 inch)	2
C	136 - 1452	Retaining Ring Pliers As	1
D	152 - 7159	Socket As (Water Pump Shaft)	1
E	1U - 7600	Slide Hammer Puller	1
F	1P - 0074	Slide Hammer Puller	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

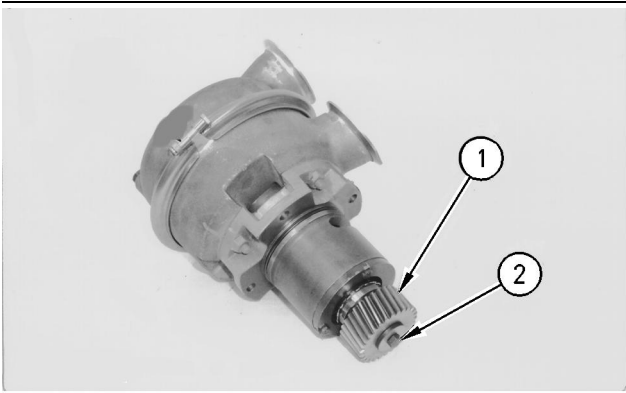


Illustration 293

g00603001

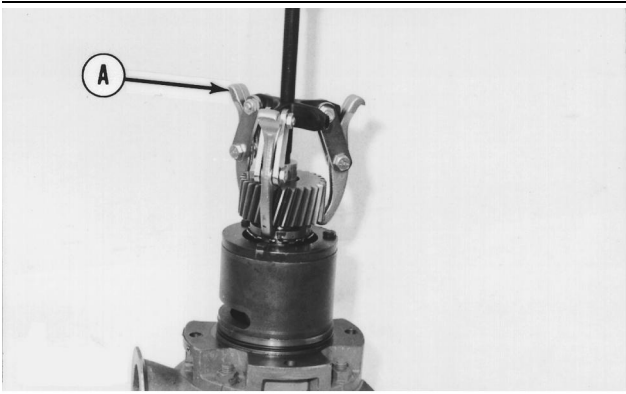


Illustration 294

g00603003

- Loosen bolt (2) by approximately 3.0 mm (0.12 inch). Use Tooling (A) in order to pull gear (1) from the shaft. Remove Tooling (A), bolt (2), the washer, and gear (1) from the end of the shaft.



Illustration 295

g00690875

- Remove clamp (3).

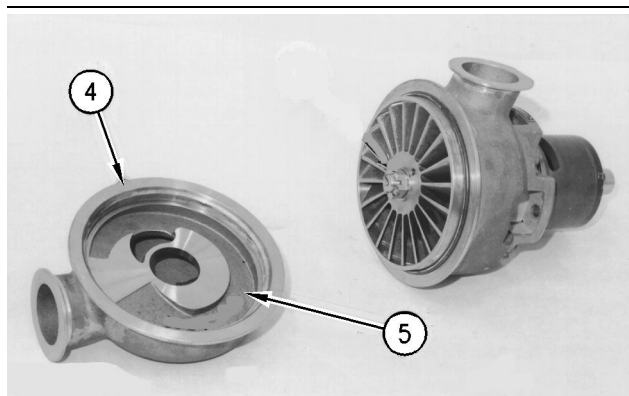


Illustration 296

g00603007

3. Remove body (4). Remove port plate (5) from the body.

Note: Be careful not to damage the threads of the nut and/or the shaft when you remove the cotter pin. Be sure that all of the cotter pin is completely removed before you remove the nut.

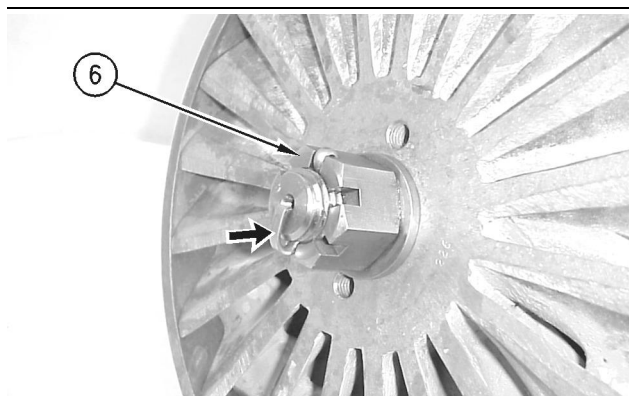


Illustration 297

g00690890

4. Remove the cotter pin. Remove nut (6) and the washer from the shaft.

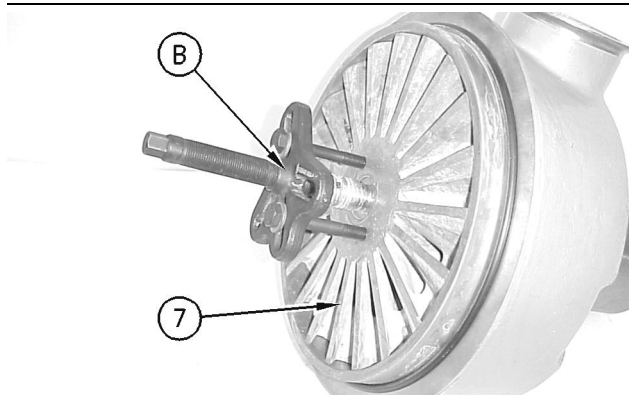


Illustration 298

g00603009

5. Use Tooling (B) in order to remove impeller (7) from the shaft.

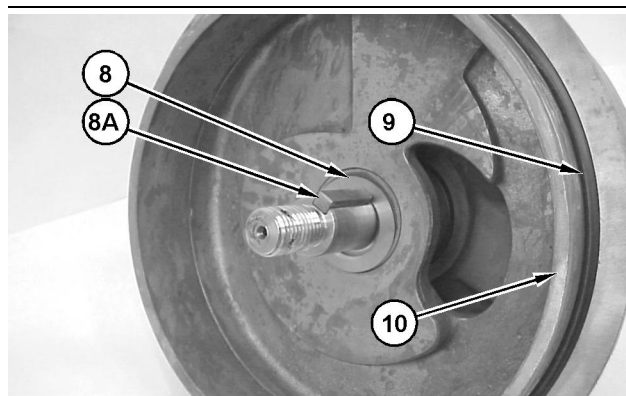


Illustration 299

g01058029

6. Remove key (8A). Remove shims (8), O-ring seal (9), and ring (10).

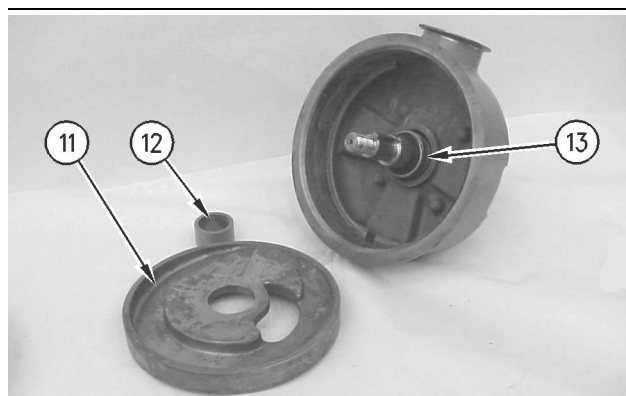


Illustration 300

g00603011

Note: It may be necessary to clean the inside of the body before the port plate can be removed.

7. Remove port plate (11) and spacer (12) from the drive housing.

Note: The ceramic seal has two sections. One section is stationary and one section rotates. Do not remove the ceramic seal unless it is necessary. The ceramic seal can be easily damaged.

8. Lubricate the shaft and the rotating section of ceramic seal (13) with a solution of water and five percent soap. Carefully pry the rotating section of the seal away from the drive housing. Remove the rotating section of the seal from the shaft.

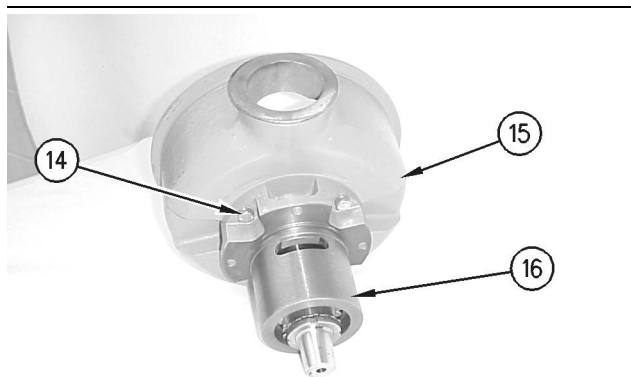


Illustration 301

g00603013

- 9.** Remove bolts (14) that hold drive housing (15) to bearing housing (16). Separate the drive housing from the bearing housing.

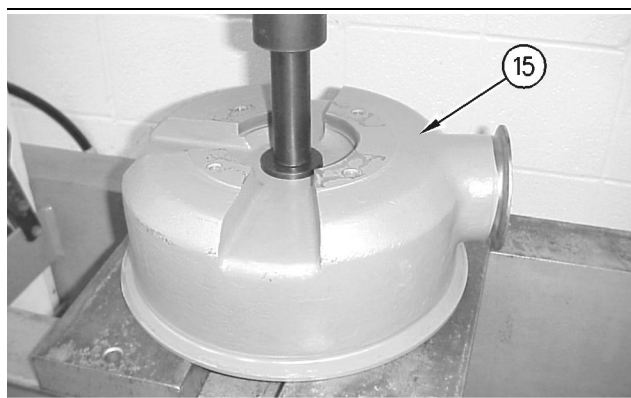


Illustration 302

g00690951

- 10.** Use a suitable press in order to remove the stationary section of the ceramic seal from drive housing (15).

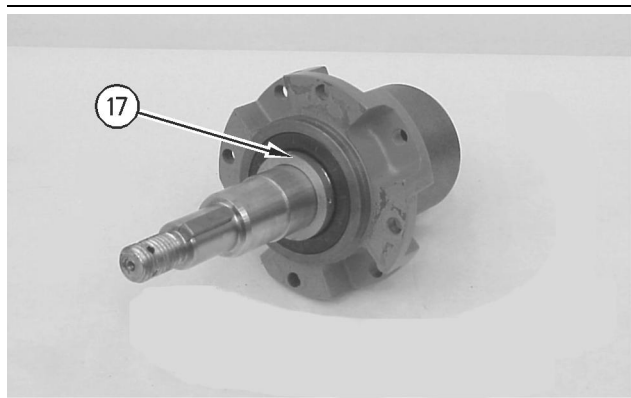


Illustration 303

g00690988

- 11.** Use an allen wrench to loosen the screws that hold ring (17) to the shaft. Remove the ring.

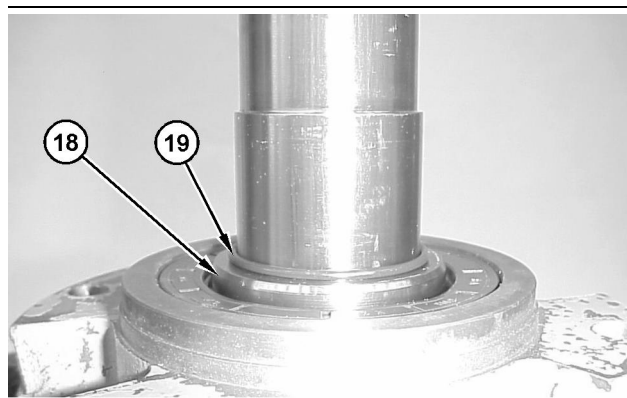


Illustration 304

g01057040

- 12.** Remove O-ring seal (19) and collar (18).

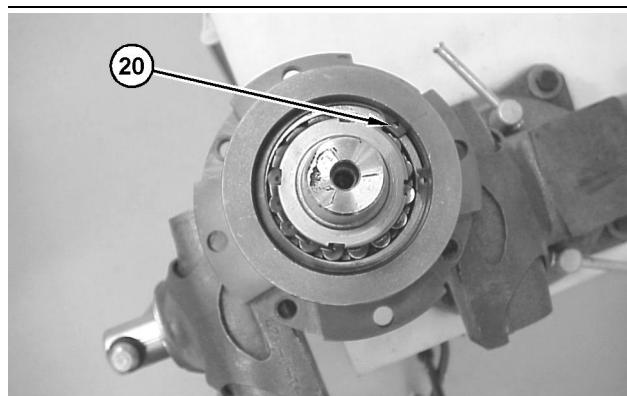


Illustration 305

g01057042

- 13.** Place the bearing housing in a vise. Use Tooling (C) in order to remove retaining ring (20).

NOTICE

Do not allow the shaft to fall when the shaft is removed from the bearing housing.

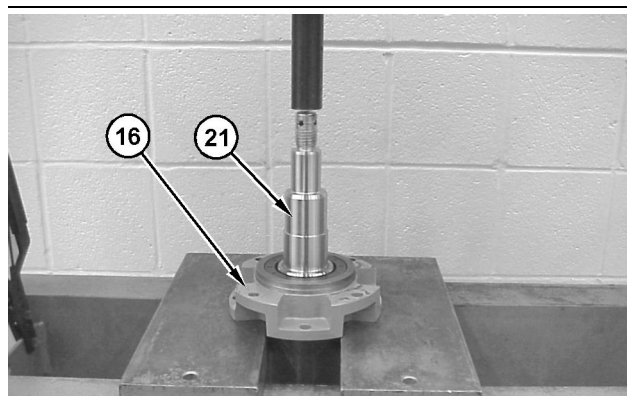


Illustration 306

g01057043

- 14.** Place bearing housing (16) and shaft (21) in a press. Orient the impeller end of the shaft in the upward position. Press the shaft out of the bearing housing.

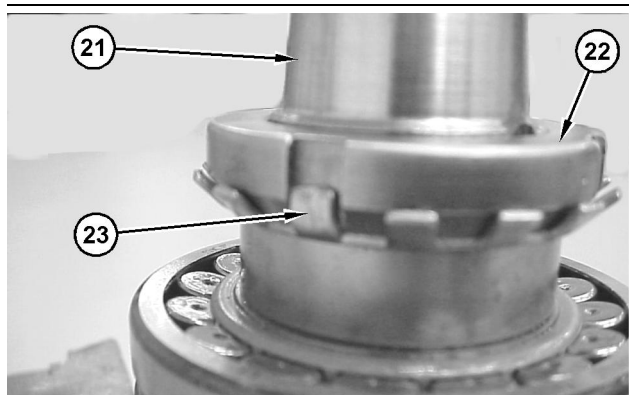


Illustration 307

g01057045

- 15.** Place shaft (21) in a vise. Orient the driven end of the shaft in the upward position. Pry the tab of lock ring (23) out of the slot in nut (22).

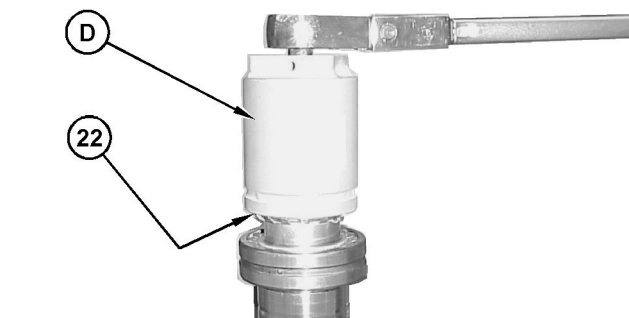


Illustration 308

g01057048

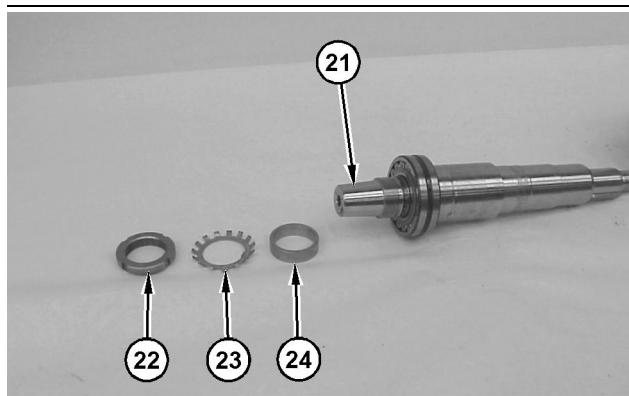


Illustration 309

g01057051

- 16.** Use Tooling (D) in order to remove nut (22) from shaft (21). Remove lock ring (23) and spacer (24).

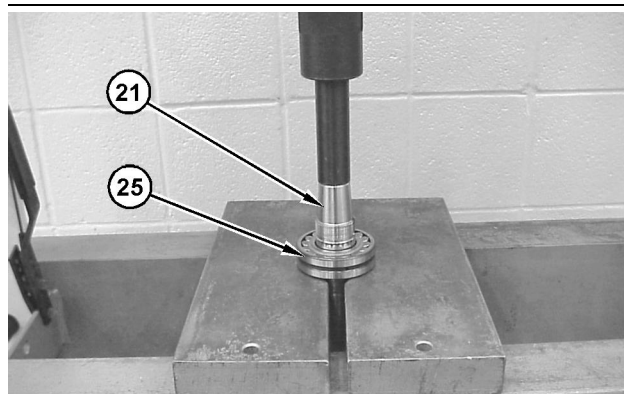


Illustration 310

g01057054

- 17.** Place shaft (21) in a suitable press. Press the shaft out of bearing (25).

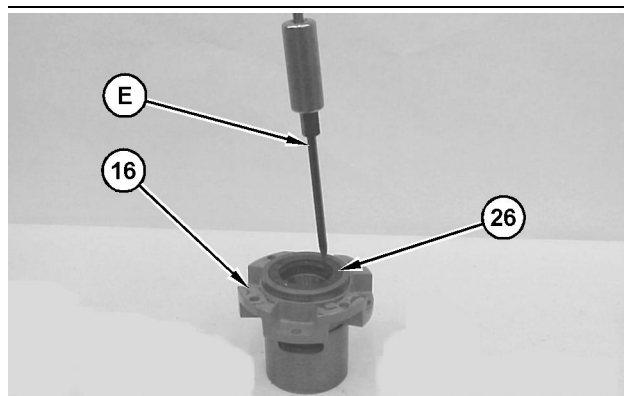


Illustration 311

g01057055

- 18.** Use Tooling (E) in order to remove oil seal (26) from bearing housing (16).

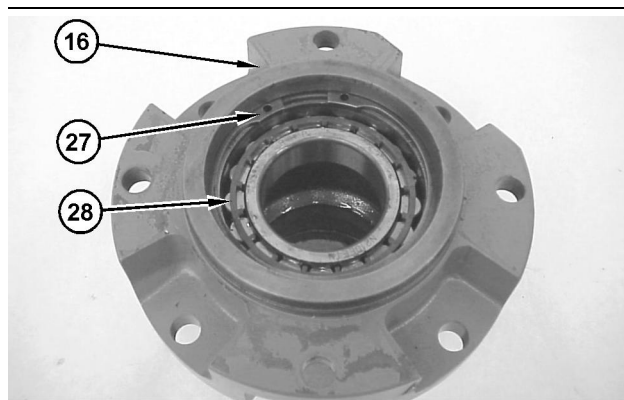


Illustration 312

g01057058

- 19.** Use Tooling (C) in order to remove retaining ring (27) from bearing housing (16).

- 20.** Remove bearing (28) from the bearing housing.

i02061100

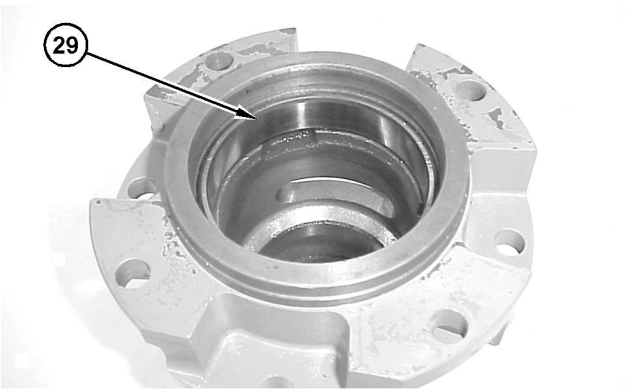


Illustration 313

g01057060

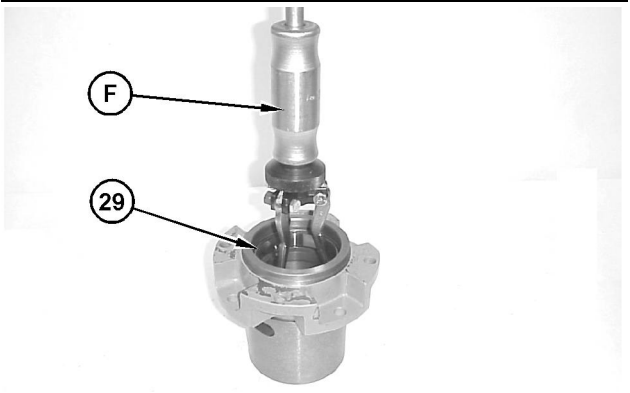


Illustration 314

g01057062

21. Use Tooling (F) in order to remove bearing race (29) from the bearing housing.

Auxiliary Water Pump - Assemble (Auxiliary Pump)

SMCS Code: 1361-016

Assembly Procedure

Table 27

Required Tools			
Tool	Part Number	Part Description	Qty
B	193 - 8094	Spline Socket	1
C	193 - 8100	Socket (Impeller Nut)	1
E	136 - 1452	Retaining Ring Pliers As	1
F	152 - 7159	Socket As (Water Pump Shaft)	1
L	1P - 0520	Driver Group (Bearing and Seal)	1
M	5P - 4197	Spacer	1
N	4C - 4030	Thread Lock Compound	1
P	4C - 4032	Bearing Mount Compound	1
Q	9S - 3263	Thread Lock Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Assemble the Check Valve

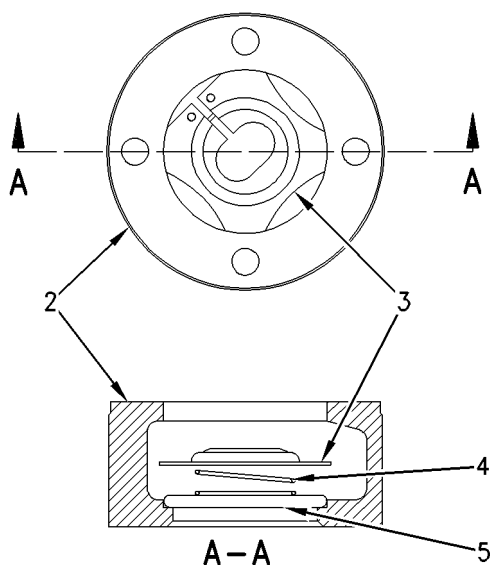


Illustration 315

g00714974

1. Install disc (5) and spring (4) into the body of check valve (2).
2. Use Tooling (E) in order to install retainer (3) into the body of check valve (2). After the retainer is installed, strike the retainer in order to ensure that the retainer is properly seated.

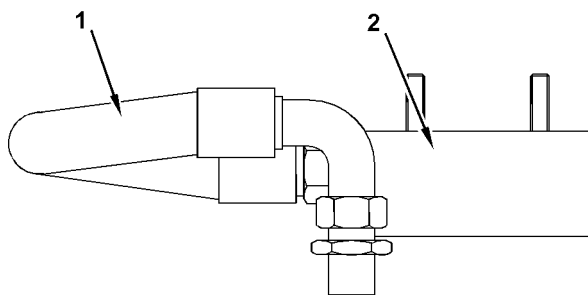


Illustration 316

g01056041

3. Install hose assembly (1) to the body of check valve (2).

Assemble the Pump

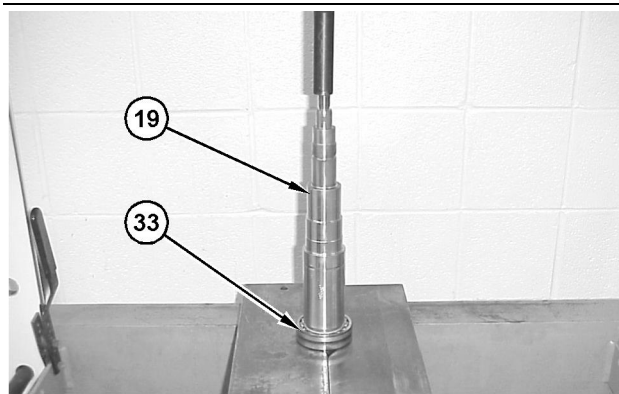


Illustration 317

g01056378

1. Place shaft (19) and bearing (33) in a suitable press. Make sure that the serial number on the bearing is toward the driven end of the shaft. Insert the driven end of the shaft into the bearing. Press the shaft into the bearing until the shoulder of the shaft contacts the bearing.

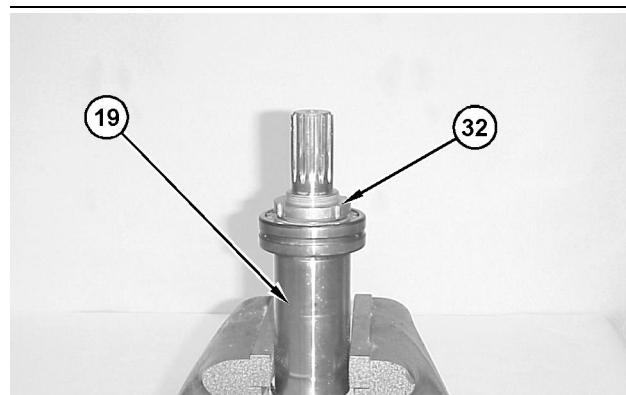


Illustration 318

g01056379

Note: Thoroughly clean the threads of shaft (19) and nut (32) with solvent before assembly.

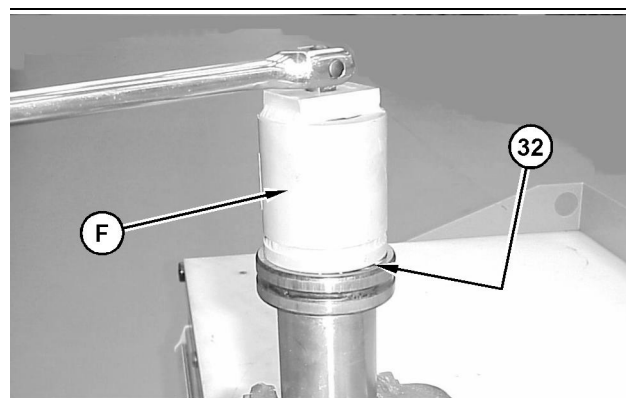


Illustration 319

g01055810

2. Secure the shaft in a vise with the driven end of the shaft in the upward position. Apply Tooling (N) to the threads of the shaft. Orient the tapered end of nut (32) (not shown) toward the bearing. Use Tooling (F) in order to tighten the nut to a torque of $135 \pm 15 \text{ N}\cdot\text{m}$ ($100 \pm 10 \text{ lb}\cdot\text{ft}$).

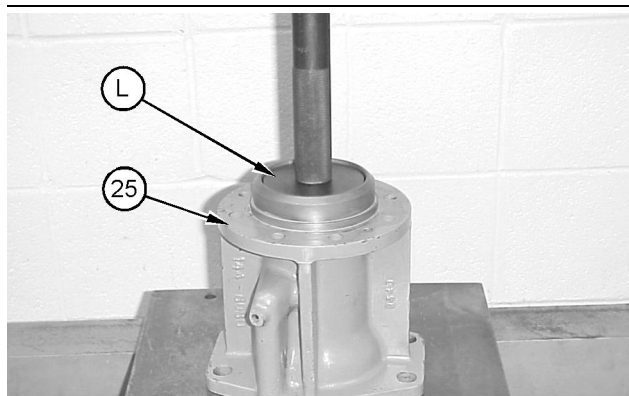


Illustration 320

g01056412



Illustration 321

g01056415

3. Use a suitable press and Tooling (L) in order to install bearing race (38) into bearing housing (25).

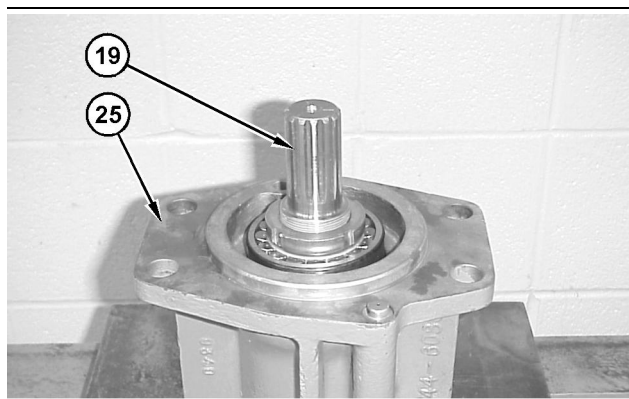


Illustration 322

g01056417

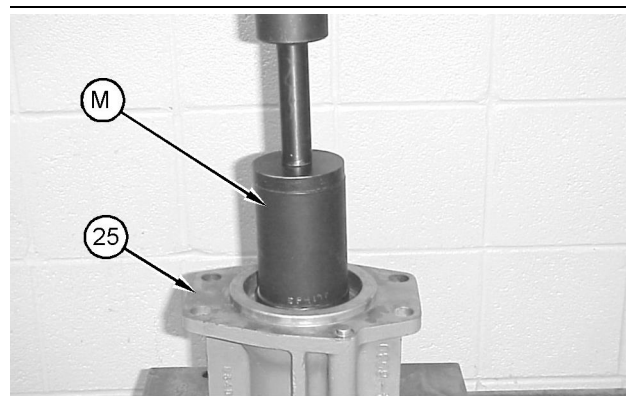


Illustration 323

g01056418

4. Place shaft (19) into bearing housing (25) with the driven end of the shaft in the upward position. Use a suitable press and Tooling (M) in order to install the shaft into the bearing housing.

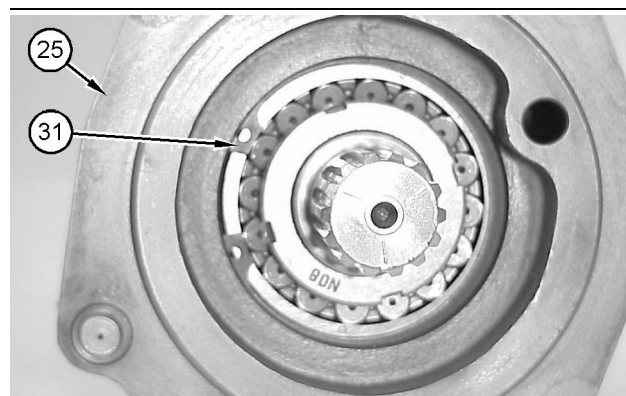


Illustration 324

g01055804

5. Place bearing housing (25) into a vise with the driven end of the shaft in the upward position. Use Tooling (E) in order to install retaining ring (31) into the bearing housing. After the retaining ring is installed, strike the ring with a punch in order to ensure that the ring is properly seated.

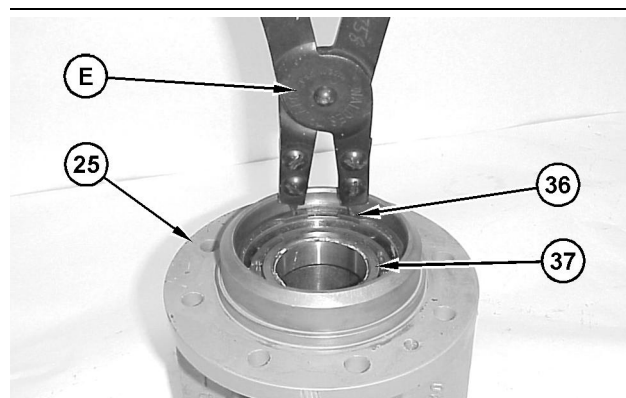


Illustration 325

g01055817

6. Place bearing housing (25) into a vise with the impeller end of the shaft in the upward position. Place bearing (37) into position with the serial number in the upward position. Use a hammer and a brass driver to install the bearing into the bearing housing.

Alternatively, use a suitable press with an appropriate sleeve to press the bearing into the housing.

7. Use Tooling (E) in order to install retaining ring (36) into bearing housing (25). Make sure that the side of the retaining ring with the bevel is upward. After the retaining ring is installed, strike the ring with a punch in order to ensure that the ring is properly seated.

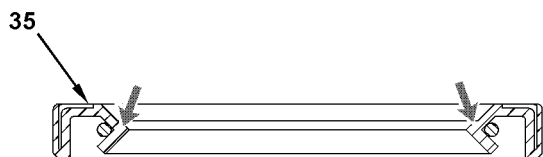


Illustration 326

g01056429

8. Lubricate the inner diameter (lip) of oil seal (35) with clean engine oil.

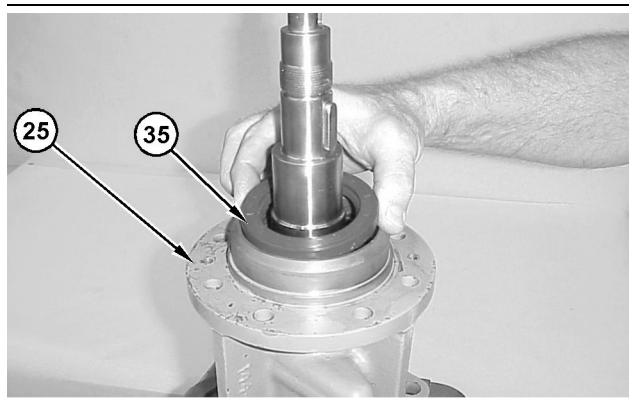


Illustration 327

g01056434

9. Lubricate the outer diameter of oil seal (35) with a solution of water and five percent soap. Install the oil seal into bearing housing (25).

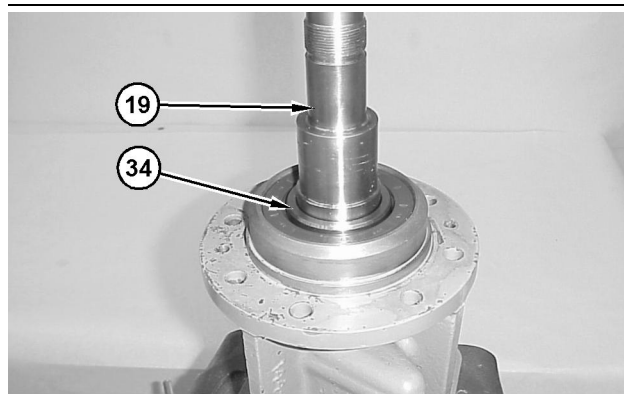


Illustration 328

g01056485

10. Thoroughly clean shaft (19) and collar (34) with solvent. Apply Tooling (P) to the shaft for 15 mm (0.6 inch) from the shoulder of the shaft at the bearing diameter. Install the collar onto the shaft. Rotate the collar for 180 degrees in both directions. Allow the compound to cure for 30 minutes.

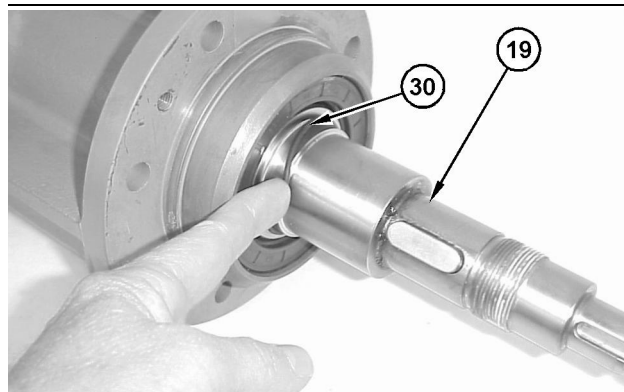


Illustration 329

g01055803

11. Install O-ring seal (30) on shaft (19) and install the O-ring seal over the collar.

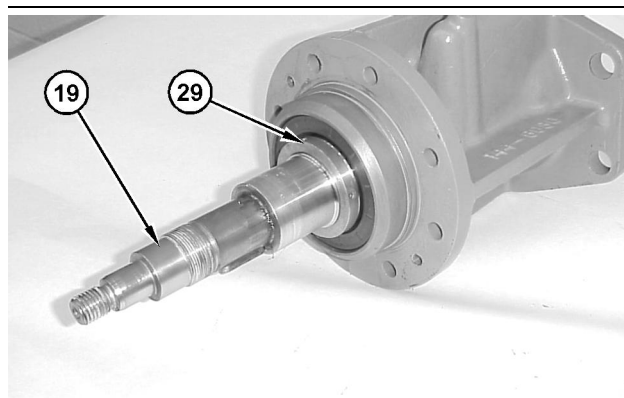


Illustration 330

g01055802

- 12.** Install ring (29) on shaft (19) and install the ring over the O-ring seal. Make sure that the side of the ring with the step is oriented toward the O-ring seal. Maintain approximately 490 ± 45 N (110 ± 10 lb) of pressure on ring (29) and use an allen wrench to tighten the screws to a torque of 0.9 ± 0.1 N·m (7.97 ± 0.10 lb in). After the screws are tightened, use a small center punch to peen the threads in the ring.

Note: Carefully inspect the surface of the ceramic seal. If the surface is cracked or scratched, discard the seal and obtain a new seal for installation. Ensure that the faces of the seal are clean.

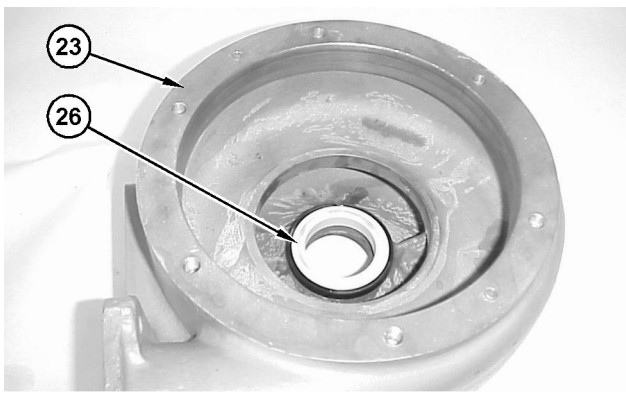


Illustration 331

g01056491

- 13.** Orient the inside of body (23) to the upward position. Lubricate the stationary segment of ceramic seal (26) with a solution of water and five percent soap. Place the marked side of the segment in the downward position. Use hand pressure to install the segment into body (23). After the seal is installed, wipe the surface dry.

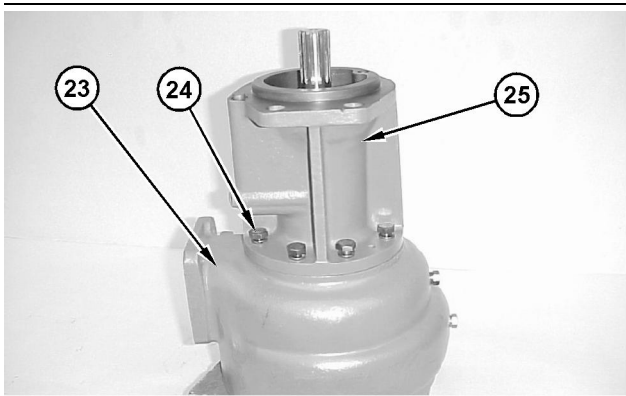


Illustration 332

g01055793

- 14.** Place body (23) on blocks. Orient the inside of the body to the downward position. Place bearing housing (25) onto the body. Attach the bearing housing to the body with bolts and washers (24). Tighten the bolts to a torque of 22 ± 4 N·m (16 ± 3 lb ft).

Note: Carefully inspect the surface of the ceramic seal. If the surface is cracked or scratched, discard the seal and obtain a new seal for installation. Ensure that the faces of the seal are clean.



Illustration 333

g01055799

- 15.** Place the body with the inside of the body in the upward position. Lubricate the rotating segment of ceramic seal (28) with a solution of water and five percent soap. Orient the side of the segment with the spring to the upward position. Use hand pressure to install the rotating segment of ceramic seal (28) over shaft (19).

- 16.** Install ring (27) onto shaft (19). If the key was removed from the shaft, install the key.

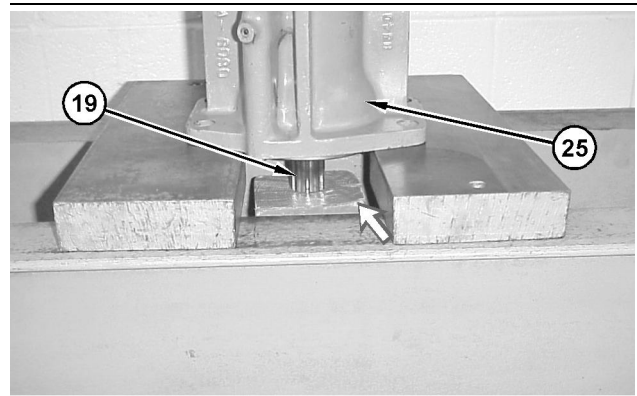


Illustration 334

g01056519

- 17.** Place bearing housing (25) onto a suitable press. Orient the driven end of shaft (19) in the downward position. Use a jack and/or blocking in order to help prevent damage to the shaft when the impeller is installed.

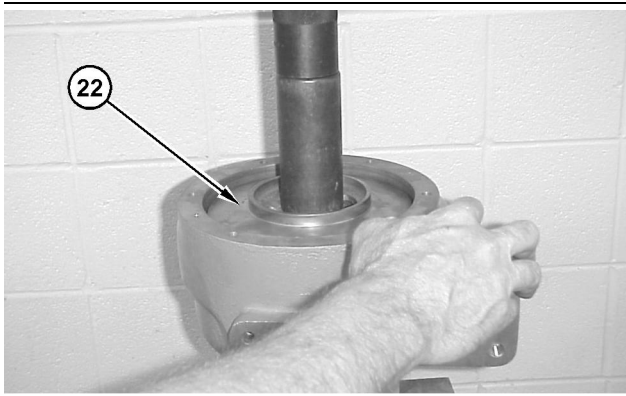


Illustration 335

g01056529

18. Press impeller (22) onto the shaft.

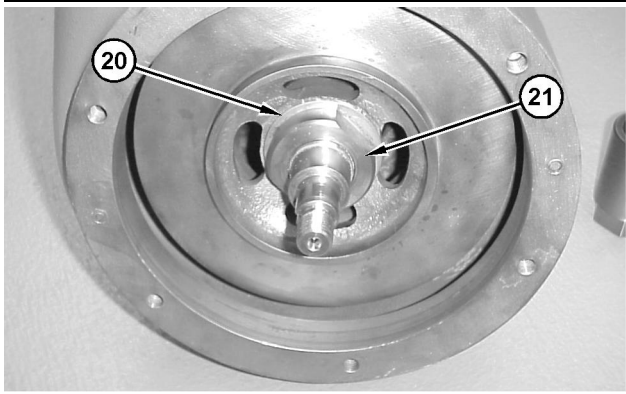


Illustration 336

g01056531

19. Thoroughly clean the threads of the shaft and locknut (21) with solvent. Install lockwasher (20) onto the shaft. Coat the threads of the shaft with Tooling (Q). Install locknut (21) onto the shaft.

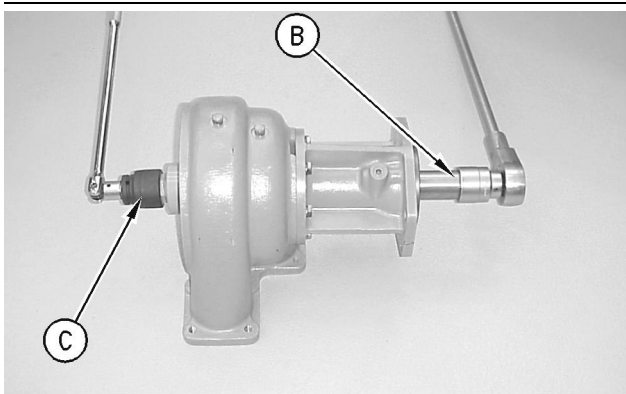


Illustration 337

g00705829

20. Hold the driven end of the shaft with Tooling (B). Tighten the locknut with Tooling (C). Tighten the locknut to a torque of $271 \pm 15 \text{ N}\cdot\text{m}$ ($200 \pm 10 \text{ lb}\cdot\text{ft}$).

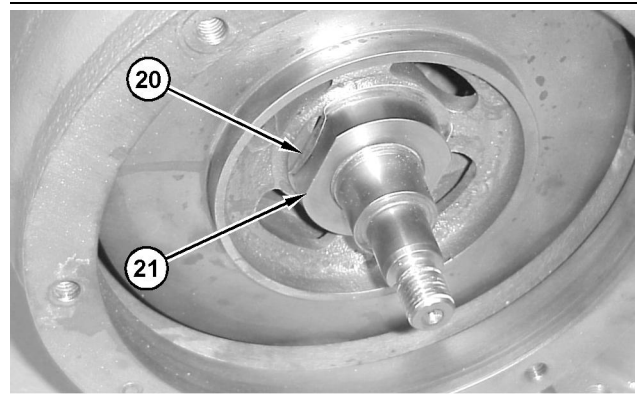


Illustration 338

g01055789

21. Bend the edges of lockwasher (20) against the flats of locknut (21).

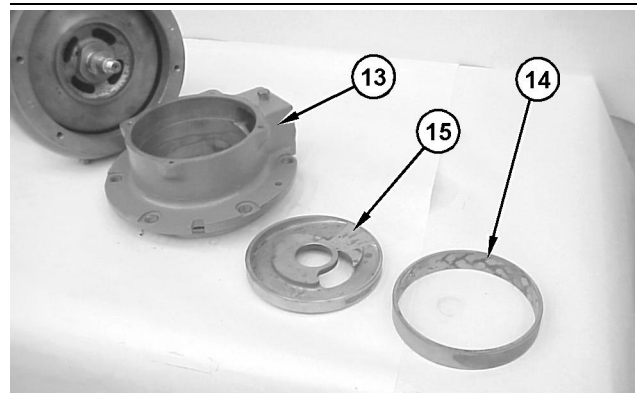


Illustration 339

g01055783

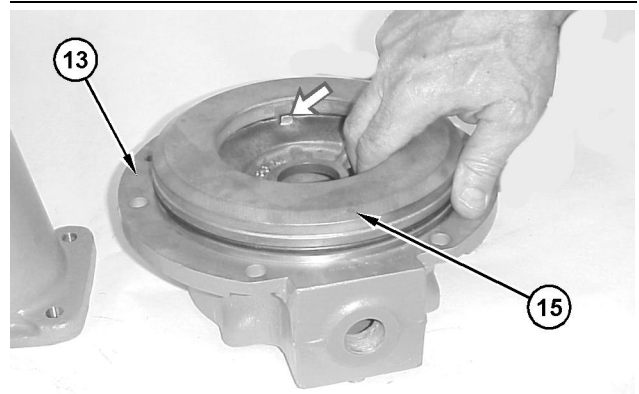


Illustration 340

g01056549

22. Lubricate port plate (15) with a solution of water and five percent soap. Install port plate (15) and ring (14) into body (13). Make sure that the lug on the port plate fits into the slot in the body.

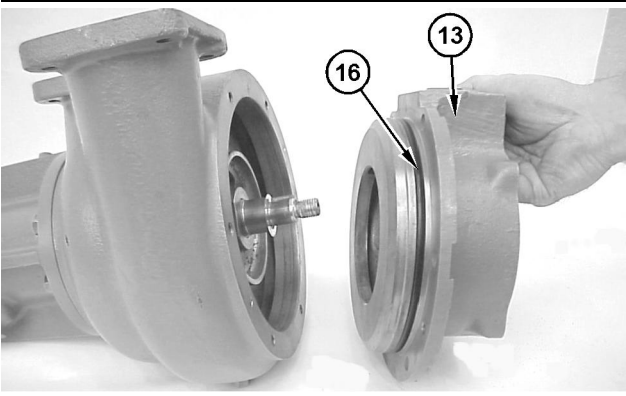


Illustration 341

g01055781

23. Make sure that O-ring seal (16) is in good condition. Coat the O-ring seal with a solution of water and five percent soap in order to make installation easier. Install the O-ring seal onto body (13).

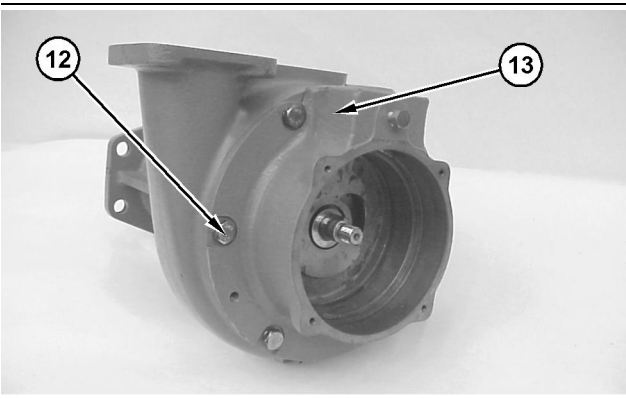


Illustration 342

g01056553

24. Install body (13). Install washers and bolts (12) in body (13). Tighten the bolts to a torque of $22 \pm 4 \text{ N}\cdot\text{m}$ ($16 \pm 3 \text{ lb}\cdot\text{ft}$).

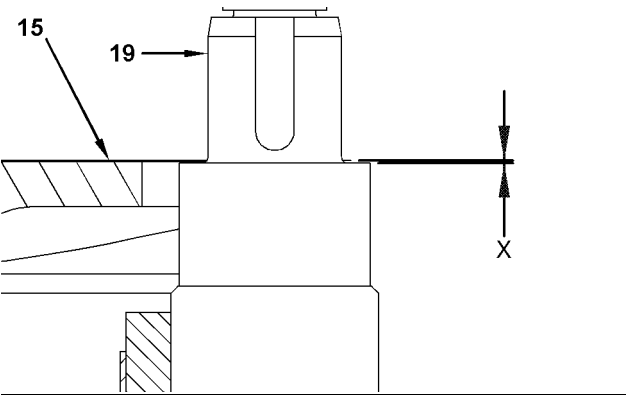


Illustration 343

g01056558

25. Determine the thickness of the shims for the impeller.

The shims will be used in order to obtain a clearance of 0.10 to 0.15 mm (0.004 to 0.006 inch) on each side of the impeller.

Place a straight edge on the face of the port plate (15) across the opening for shaft (19). Use a feeler gauge to measure Dimension (X) between the shoulder of the shaft and the face of the port plate.

The correct thickness of the shims is Dimension (X) plus the specification of the clearance. Table 28 is an example of the calculation.

Table 28

Example of the Calculation for Determining the Thickness of the Shims			
Dimension (X)		Clearance Specification	Thickness of the Shims
0.56 mm (0.022 inch)	+	0.125 mm (0.005 inch)	= 0.685 mm (0.0270 inch)

In the example, the proper thickness for the shims is 0.685 mm (0.0269 inch).

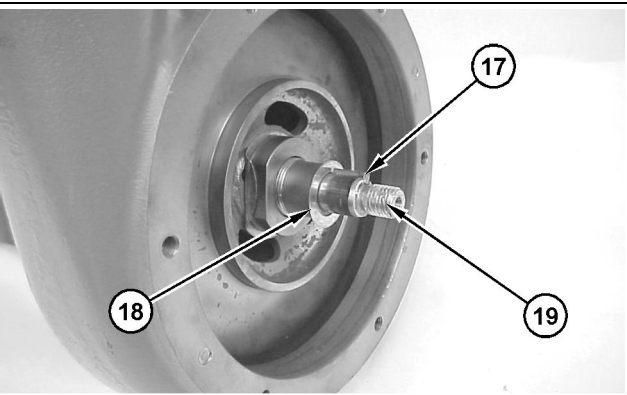


Illustration 344

g01055786

26. Install shim (18) and key (17) onto shaft (19).

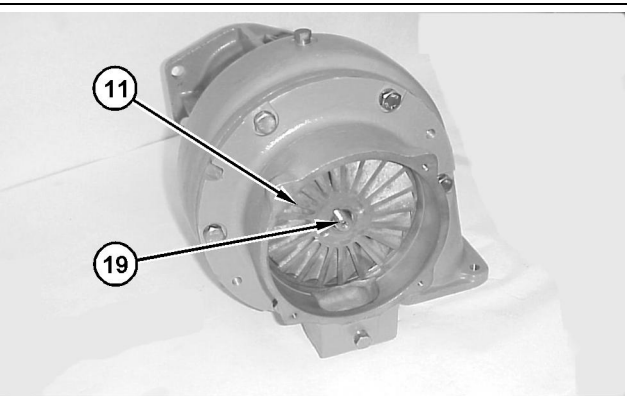


Illustration 345

g01056577

27. Fit the keyway of impeller (11) onto the key of shaft (19). Install the impeller onto the shaft. If you use a suitable press in order to install the impeller, be sure to support the shaft with a jack and/or blocks.

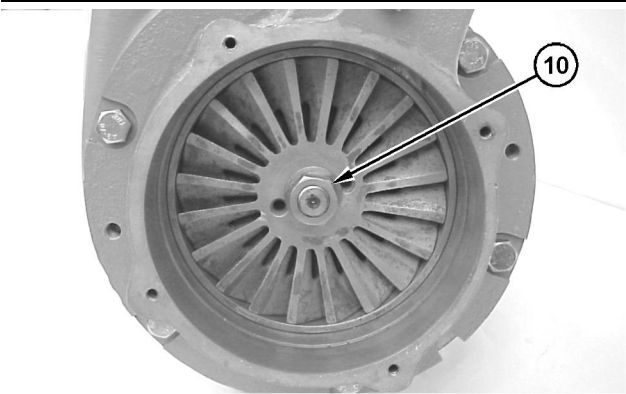


Illustration 346 g01055769

28. Thoroughly clean the threads of the shaft and nut (10) with solvent. Coat the threads of the shaft with Tooling (Q). Install the washer and nut (10) onto the shaft. Tighten the nut to a torque of 70 ± 5 N·m (52 ± 4 lb ft).

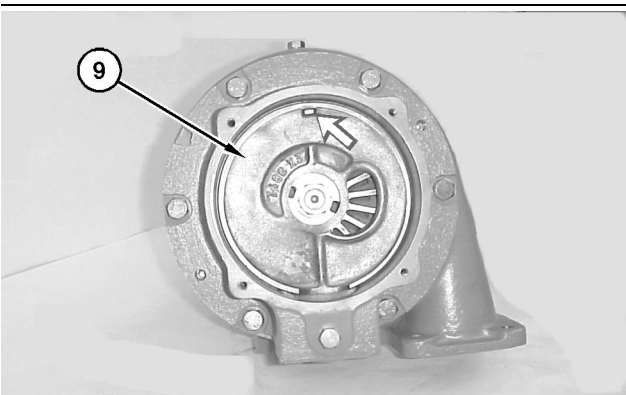


Illustration 347 g01056579

29. Lubricate port plate (9) with a solution of water and five percent soap. Install port plate (9). Note the position of the lug on the port plate.

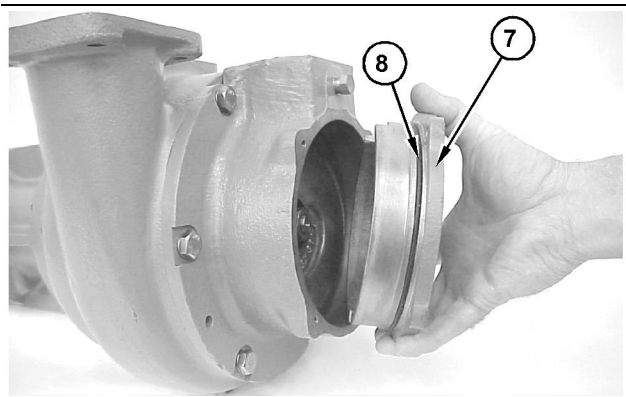


Illustration 348 g01055766

30. Ensure that O-ring seal (8) is in good condition. Install the O-ring seal onto cover (7). Install the cover. Fit the slot of the cover over the lug on the port plate.

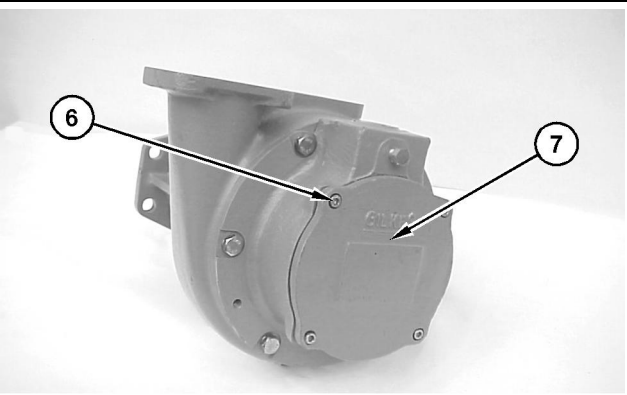


Illustration 349 g01055763

31. Thoroughly clean the threads of bolts (6) with solvent. Coat the threads of bolts (6) with Tooling (Q). Install the bolts in cover (7). Tighten the bolts to a torque of 5 ± 1 N·m (4 ± 1 lb ft).

End By:

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

i02062541

Auxiliary Water Pump - Assemble (Auxiliary Sea Water Pump)

SMCS Code: 1361-016

Assembly Procedure

Table 29

Required Tools			
Tool	Part Number	Part Description	Qty
C	136-1452	Retaining Ring Pliers As	1
D	152-7159	Socket As (Water Pump Shaft)	1
G	1P-0520	Driver Gp (Bearing and Seal)	1
H	5P-4197	Spacer	1
J	4C-4032	Bearing Mount Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

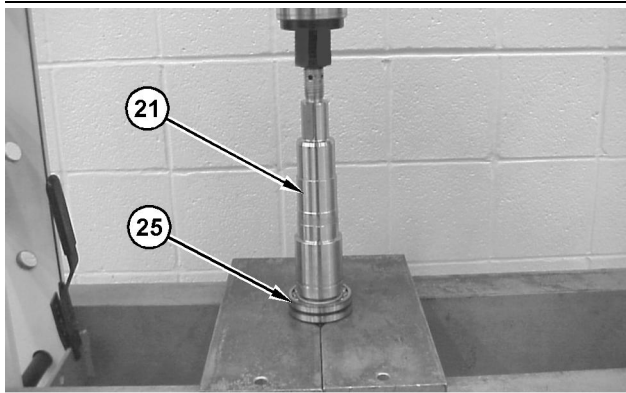


Illustration 350

g01057093

1. Place shaft (21) and bearing (25) in a suitable press. Make sure that the serial number on the bearing is toward the driven end of the shaft. Insert the driven end of the shaft into the bearing. Press the shaft into the bearing until the shoulder of the shaft contacts the bearing.

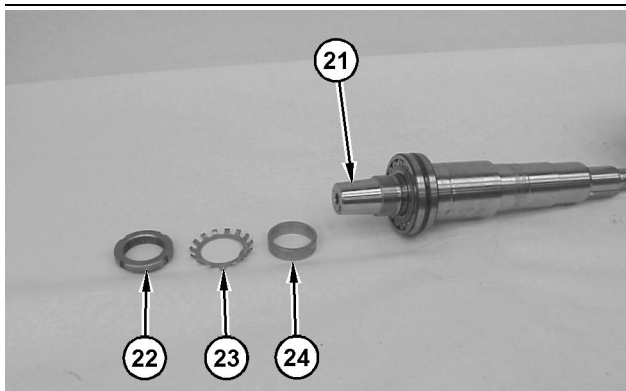


Illustration 351

g01057051

2. Install spacer (24), lock ring (23), and nut (22) onto the end of shaft (21). Place the shaft into a vise with the bearing upward.

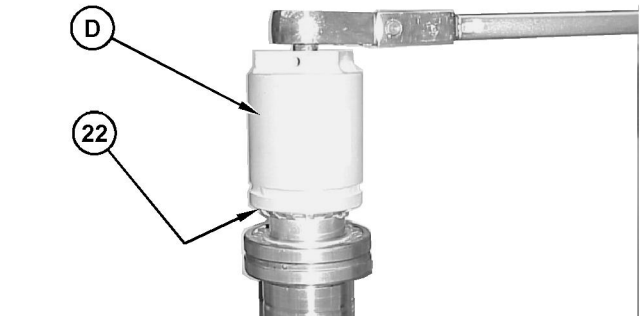


Illustration 352

g01057048

3. Use Tooling (D) in order to tighten nut (22) to a torque of $167 \pm 33 \text{ N}\cdot\text{m}$ ($125 \pm 25 \text{ lb ft}$).

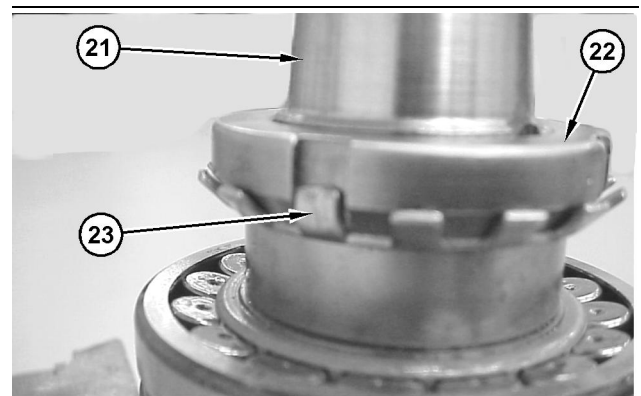


Illustration 353

g01057045

4. Place shaft (21) in a vise. Bend a tab of lock ring (23) into a slot of nut (22).

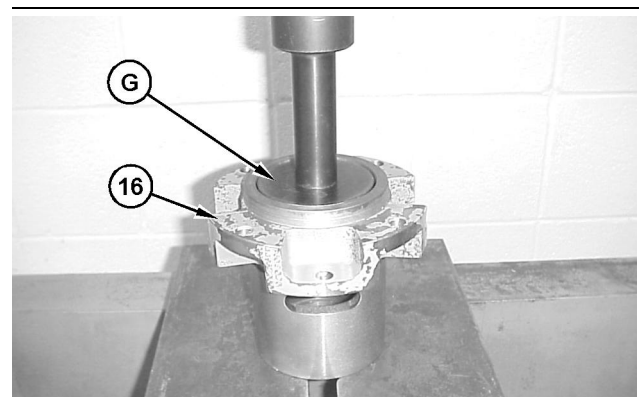


Illustration 354

g01057103

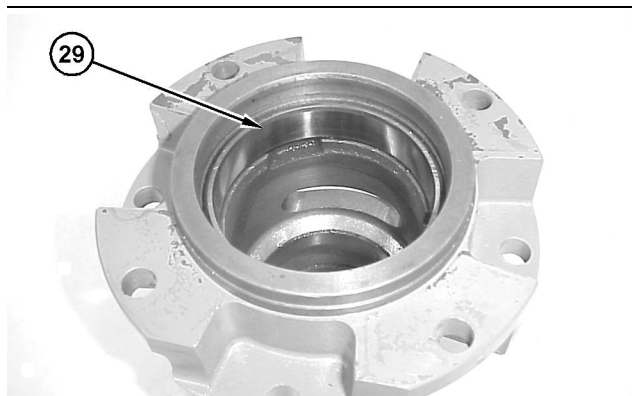


Illustration 355

g01057060

5. Use a suitable press and Tooling (G) in order to install bearing race (29) into bearing housing (16).

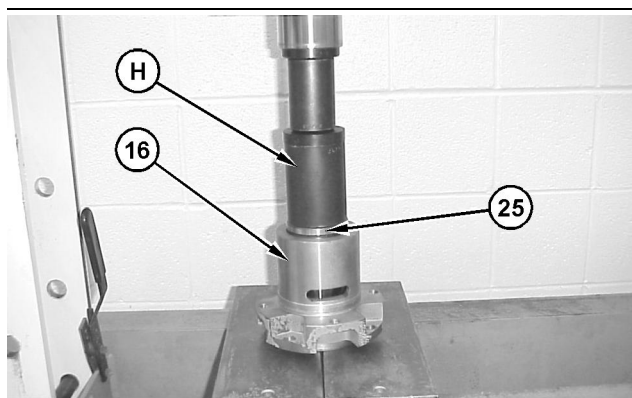


Illustration 356

g01057115

6. Use a suitable press and Tooling (H) in order to install the shaft and bearing (25) into bearing housing (16).

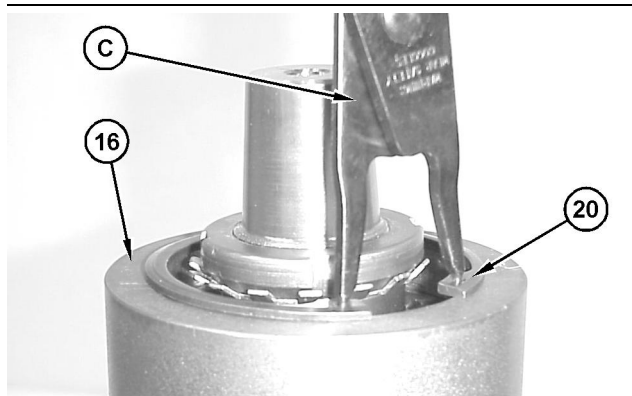


Illustration 357

g01057118

7. Use Tooling (C) in order to install retaining ring (20) into bearing housing (16). Make sure that the side of the ring with the bevel is upward. After the ring is installed, strike the ring with a punch in order to ensure that the ring is properly seated.

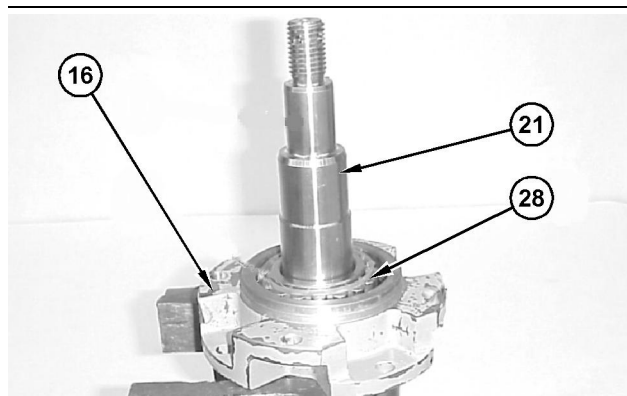


Illustration 358

g01057120

8. Place bearing housing (16) and shaft (21) into a vise with the impeller end of the shaft in the upward position. Place bearing (28) into position with the serial number in the upward position. Use a hammer and a brass driver to install the bearing into the bearing housing.

Alternatively, use a suitable press with an appropriate sleeve to press the bearing into the housing.

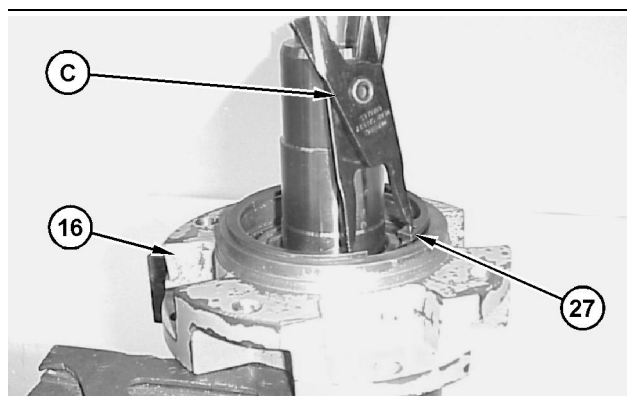


Illustration 359

g01057123

9. Use Tooling (C) in order to install retaining ring (27) into bearing housing (16). After the retaining ring is installed, strike the ring with a punch in order to ensure that the ring is properly seated.

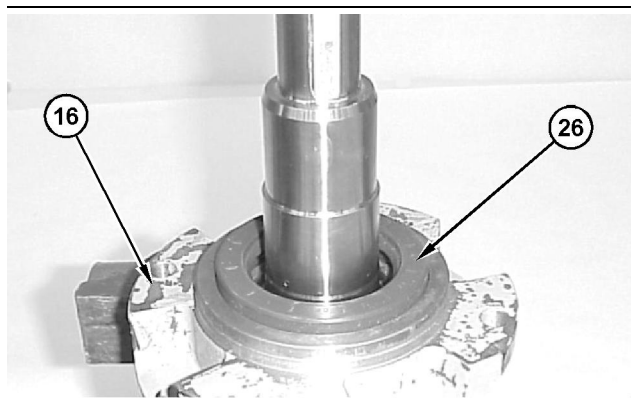


Illustration 360

g01057128

- 10.** Lubricate oil seal (26) with a solution of water and five percent soap. Install the oil seal into bearing housing (16).

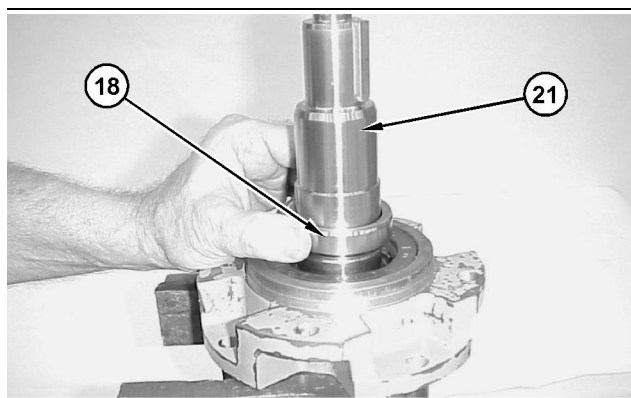


Illustration 361

g01057132

- 11.** Thoroughly clean shaft (21) and collar (18) with solvent. Apply Tooling (J) to the inside diameter of the collar. Install the collar onto the shaft. Rotate the collar for 180 degrees in both directions. Allow the compound to cure for 30 minutes.

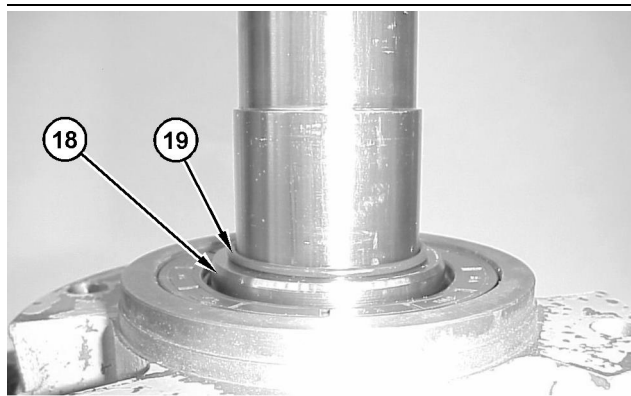


Illustration 362

g01057040

- 12.** Install O-ring seal (19) over collar (18).

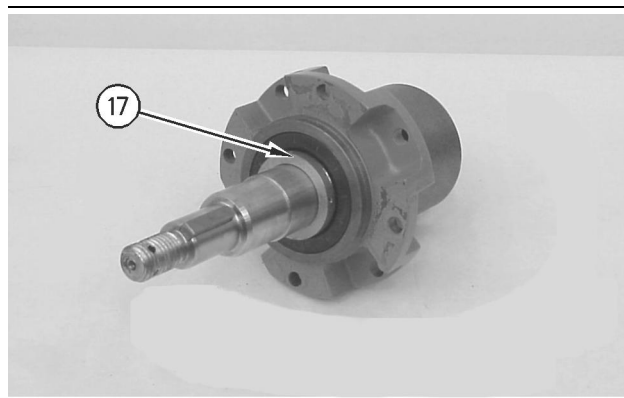


Illustration 363

g00690988

- 13.** Install ring (17) over the O-ring seal. Compress the O-ring seal with ring (17). Maintain approximately 490 ± 45 N (110 ± 10 lb) of pressure on ring (17) and use an allen wrench in order to tighten the screws to a torque of 0.9 ± 0.1 N·m (7.97 ± 0.10 lb in). After the screws are tightened, use a small center punch topeen the threads in the ring.

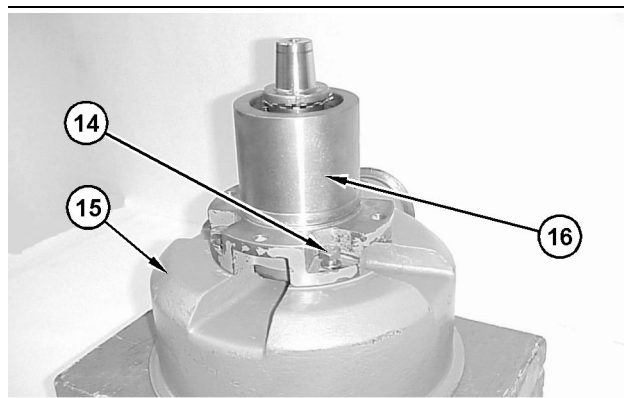


Illustration 364

g01057139

- 14.** Place drive housing (15) on blocks. Install bearing housing (16) onto the body. Attach the bearing housing to the body with washers and bolts (14).

Note: Carefully inspect the surface of the ceramic seal. If the surface is cracked or scratched, discard the seal and obtain a new seal for installation. Ensure that the faces of the seal are clean.

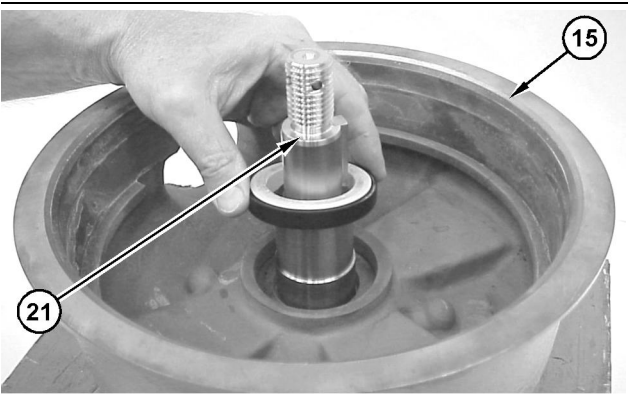


Illustration 365 g01057143

15. Orient the impeller end of shaft (21) to the upward position. Lubricate the stationary segment of the ceramic seal with a solution of water and five percent soap. Place the side of the segment with the bevel in the downward position. Use hand pressure in order to install the segment into drive housing (15). After the seal is installed, wipe the surface dry.

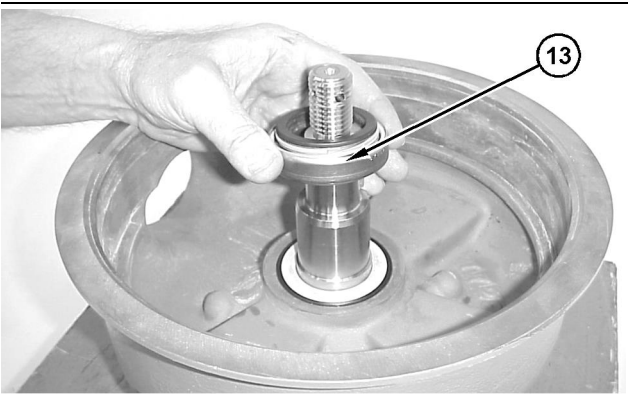


Illustration 366 g01057146

16. Lubricate the rotating segment of ceramic seal (13) with a solution of water and five percent soap. Orient the side of the segment with the spring to the upward position. Use hand pressure in order to install the rotating segment of ceramic seal (13) onto the stationary segment of the ceramic seal. After the seal is installed, wipe the surface dry.

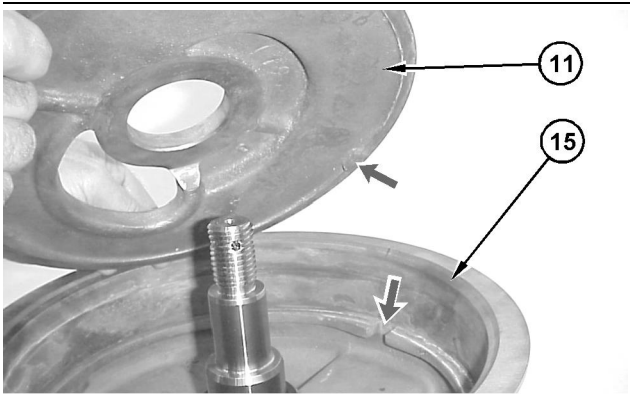


Illustration 367 g01057149

17. Lubricate port plate (11) with a solution of water and five percent soap. Align the tabs of the port plate with the notches in the body. Install the port plate into drive housing (15).

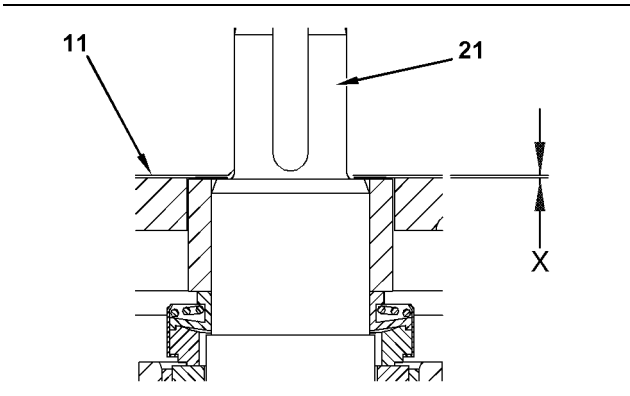


Illustration 368 g01057151

18. Determine the thickness of the shims for the impeller.

The shims will be used in order to obtain a clearance of 0.18 to 0.23 mm (0.007 to 0.009 inch) on each side of the impeller.

Place a straight edge on the face of the port plate (11) across the opening for shaft (21). Use a feeler gauge to measure Dimension (X) between the shoulder of the shaft and the face of the port plate.

The correct thickness of the shims is Dimension (X) plus the specification of the clearance. Table 30 is an example of the calculation.

Table 30

Example of the Calculation for Determining the Thickness of the Shims			
Dimension (X)		Clearance Specification	Thickness of the Shims
0.56 mm (0.022 inch)	+	0.20 mm (0.008 inch)	= 0.76 mm (0.03 inch)

In the example, the proper thickness for the shims is 0.76 mm (0.030 inch).

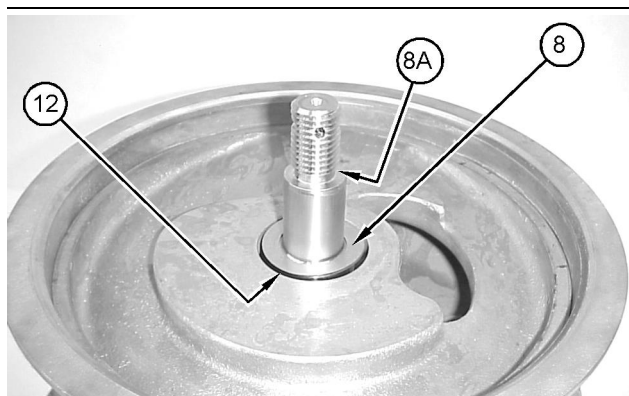


Illustration 369

g01057154

- 19.** Install spacer (12) (not shown). Install shims (8). Install key (8A).

Note: The spacer and the shims will protrude slightly above the port plate. This is normal. When the impeller is installed, the spring in the ceramic seal will be compressed and the spacer and the shims will be pushed down.

Note: The impeller has threaded holes for the puller. Install the impeller with the holes toward the outside.

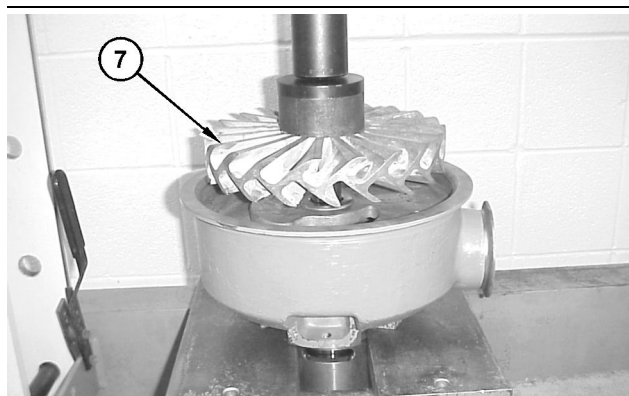


Illustration 370

g01057157

- 20.** Use a suitable press to install impeller (7) onto the shaft. Be sure to support the shaft with a jack and/or blocks.

After the impeller is installed, rotate the impeller in order to make sure that the impeller does not rub.

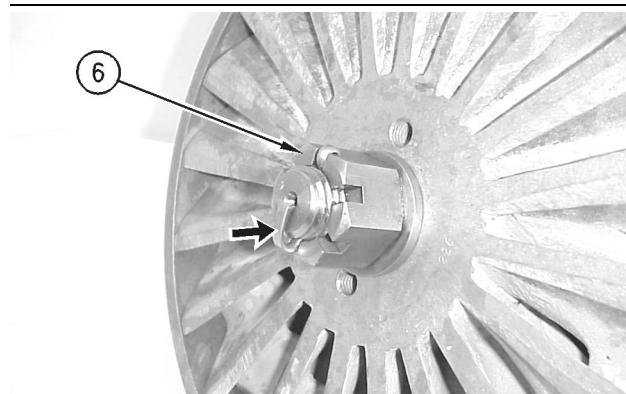


Illustration 371

g00690890

- 21.** Install the washer. Thoroughly clean the threads of the shaft and nut (6) with solvent. Apply Tooling (J) to the threads of nut (6). Install the nut. Tighten the nut to a torque of 155 ± 20 N·m (115 ± 15 lb ft). Install the cotter pin in order to secure the nut.

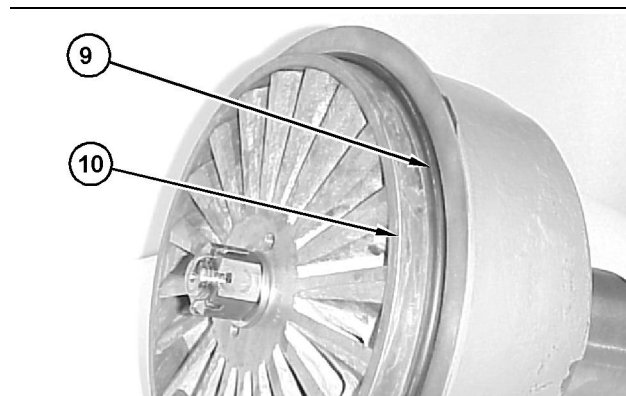


Illustration 372

g01057162

- 22.** Install ring (10). Ensure that O-ring seal (9) is in good condition. Install O-ring seal (9).

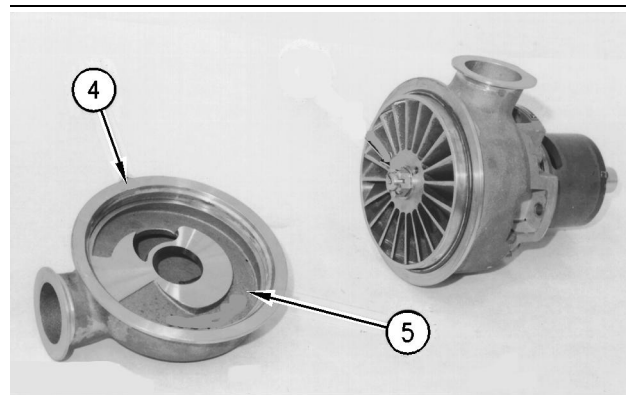


Illustration 373

g00603007

- 23.** Lubricate port plate (5) with a solution of water and five percent soap. Install the port plate into body (4).

i02063177

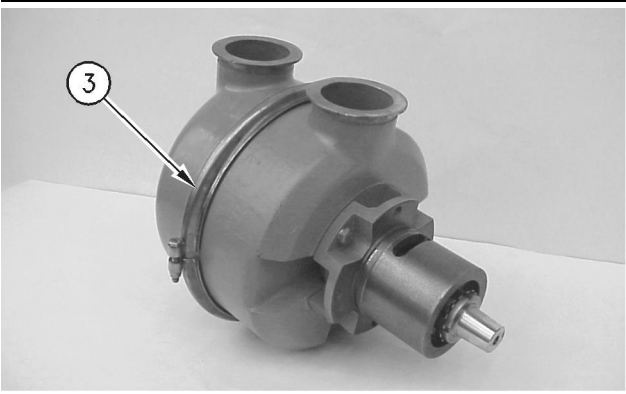


Illustration 374 g00690875

24. Install the body onto the auxiliary water pump. Attach the body to the auxiliary water pump with clamp (3). Tap the clamp while you tighten the bolt in order to ensure that the clamp seats properly.

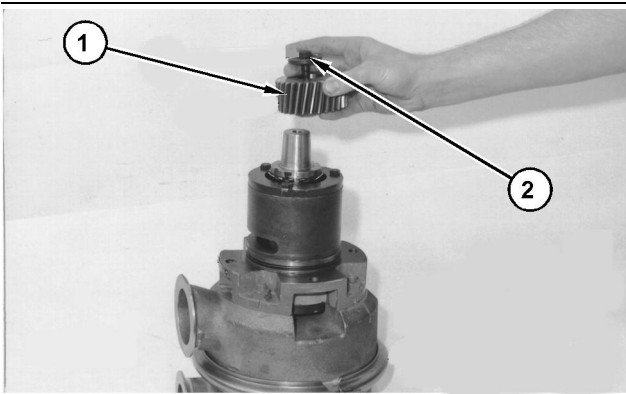


Illustration 375 g01057164

25. Install gear (1) onto the shaft with the washer and bolt (2). Tighten the bolt to a torque of $55 \pm 7 \text{ N}\cdot\text{m}$ ($41 \pm 5 \text{ lb}\cdot\text{ft}$). Strike the bolt with a hammer and a punch. Tighten the bolt again to the same torque.

End By:

- a. Install the auxiliary water pump. Refer to Disassembly and Assembly, “Auxiliary Water Pump - Install”.

Auxiliary Water Pump - Install (Auxiliary Pump)

SMCS Code: 1371-012

Installation Procedure

Table 31

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	1
B	-	5/8 in x 11 NC x 4 in Guide Bolts	2
C	4C - 4030	Thread Lock Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Install the Pump

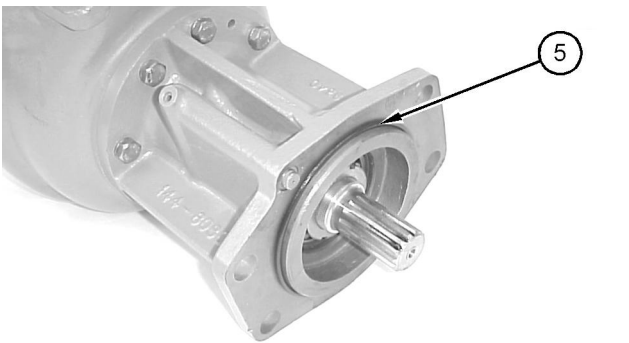


Illustration 376 g01057277

- 1. Lubricate the bore for O-ring seal (5) with clean engine oil. Install the O-ring seal onto the mounting flange of the auxiliary water pump.

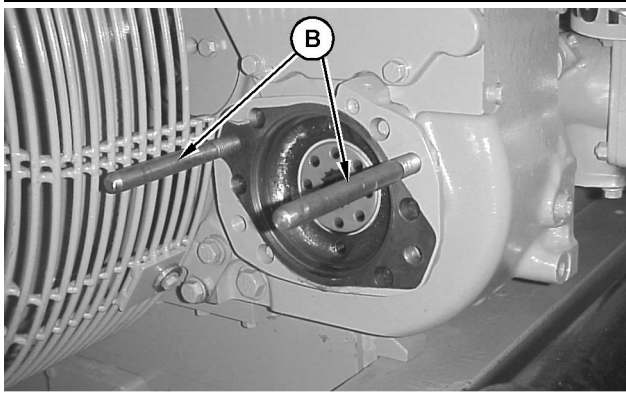


Illustration 377

g01057279

2. Install Tooling (B) into the upper bolt holes for the auxiliary water pump on the front housing.

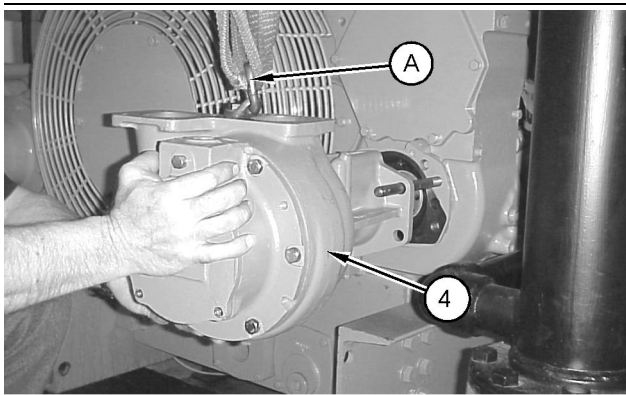


Illustration 378

g01057284

3. Attach Tooling (A) and a suitable lifting device to auxiliary water pump (4). The weight of the auxiliary water pump is approximately 64 kg (140 lb). Use a suitable lifting device in order to lift the auxiliary water pump onto Tooling (B). Carefully move the auxiliary water pump toward the front housing.

If the shaft of the auxiliary water pump does not fit into the drive gear, move the auxiliary water pump slightly away from the front housing. Rotate the shaft slightly until the splines of the shaft will fit properly into the drive gear.

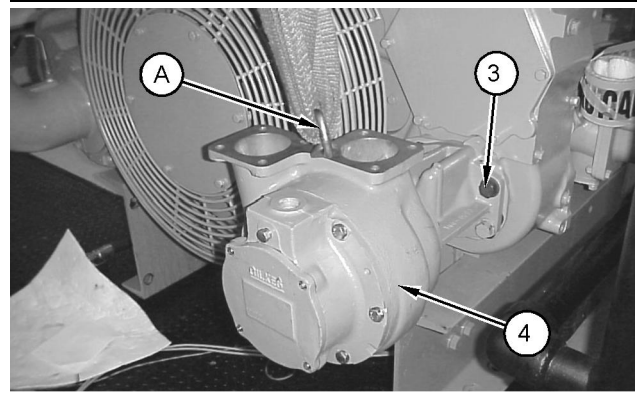


Illustration 379

g01055719

4. Continue to provide support for the auxiliary water pump. After the shaft of the auxiliary water pump is fully engaged in the drive gear, install two bolts (3) and the washers into the lower bolt holes for the auxiliary water pump on the front housing. Remove Tooling (B) from the front housing. Install the other two bolts (3) and the washers. Remove Tooling (A) from the auxiliary water pump.

Install the Check Valve

1. Install the studs for the check valve into the holes around the outlet of the auxiliary water pump.
2. Inspect the gasket for the joint between the check valve and the auxiliary water pump. If the gasket is damaged and/or deteriorated, obtain a new gasket. Install the gasket onto the outlet of the auxiliary water pump.

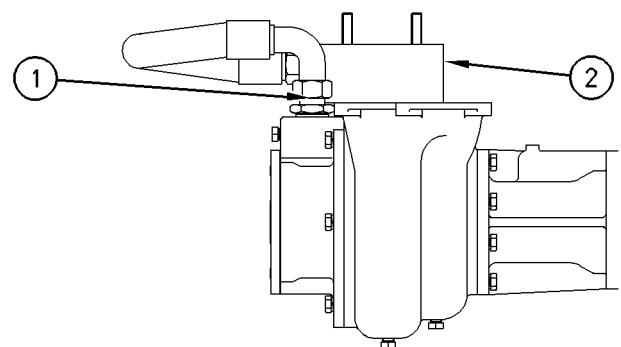


Illustration 380

g00715046

3. Place the body of check valve (2) onto the studs at the outlet of the auxiliary water pump.
4. Ensure that the threads of hose assembly (1) are thoroughly clean. Coat the threads of the hose assembly with Tooling (C). Attach the hose assembly to the check valve and the auxiliary water pump.

Note: After the auxiliary water pump has been drained, the auxiliary water pump must be filled with water before use.

5. Inspect the gasket for the joint between the check valve and the water line. If the gasket is damaged and/or deteriorated, obtain a new gasket. Install the gasket onto the outlet of the check valve.
6. Install the water line to the outlet of the check valve. Use nuts and washers to attach the flange of the water line to the check valve. Tighten the nuts to a torque of $29 \pm 4 \text{ N}\cdot\text{m}$ ($21 \pm 3 \text{ lb ft}$).
7. Inspect the gasket for the joint between the water line and the inlet of the auxiliary water pump. If the gasket is damaged and/or deteriorated, obtain a new gasket. Install the gasket onto the inlet of the auxiliary water pump.
8. Install the water line to the inlet of the auxiliary water pump. Use bolts and washers to attach the flange of the water line to the auxiliary water pump. Tighten the bolts to a torque of $29 \pm 4 \text{ N}\cdot\text{m}$ ($21 \pm 3 \text{ lb ft}$).

i02063224

Auxiliary Water Pump - Install (Auxiliary Sea Water Pump)

SMCS Code: 1371-012

Installation Procedure

Table 32

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Group	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

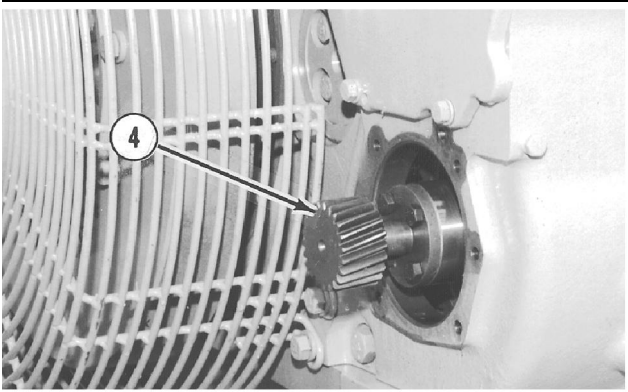


Illustration 381

g00602821

1. Install gear (4) with the bolts that hold the gear to the accessory drive shaft.

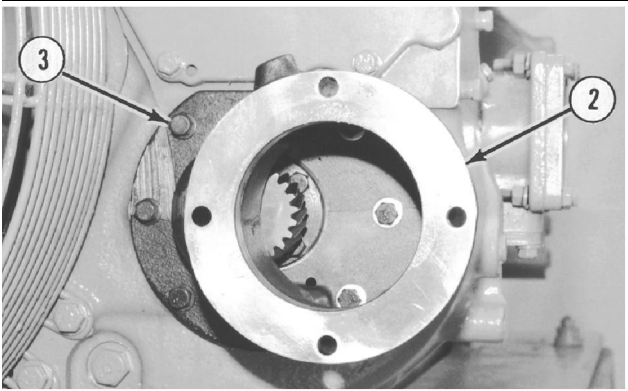


Illustration 382

g00602816

2. Use the following Steps if the bearing was removed from housing (2):
 - a. Reduce the temperature of the bearing.
 - b. Use Tooling (A) in order to install the bearing. Install the bearing to $1.5 \pm 0.5 \text{ mm}$ ($0.06 \pm 0.02 \text{ inch}$) below the surface of the housing. Make sure that the hole in the bearing for oil is aligned with the passage for oil in the housing.
 - c. After the bearing is installed, measure the bore of the bearing. The bore must be $75 \pm 0.055 \text{ mm}$ ($2.9528 \pm 0.0022 \text{ inch}$).
3. Ensure that the O-ring seals are in position on housing (2). Coat the O-ring seals and the bearing with clean engine oil.
4. Install the housing with bolts and washers (3).

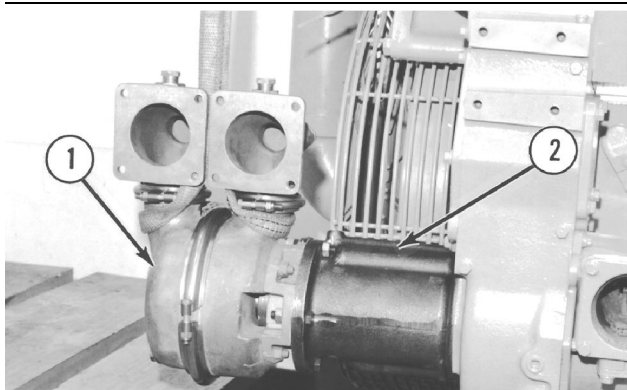


Illustration 383

g00602815

5. Attach a suitable lifting device to auxiliary water pump (1). The weight of the auxiliary water pump is approximately 59 kg (130 lb).
6. Lift the auxiliary water pump into position on housing (2). Install the mounting bolts and nuts.
7. Install the water lines to the auxiliary water pump.

i02063331

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 coolant into a suitable container for storage or for disposal. Refer to the Operation and Maintenance Manual, "Refill Capacities".

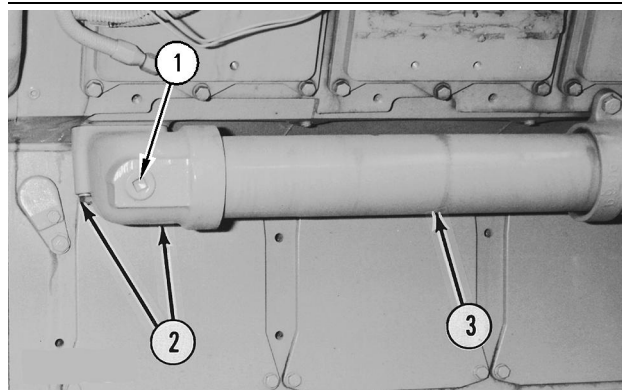


Illustration 384

g00603770

2. Remove hose (not shown) from connection (1) for the jacket water heater (if equipped).
3. Remove bolts (2). Remove the elbow and tube (3).

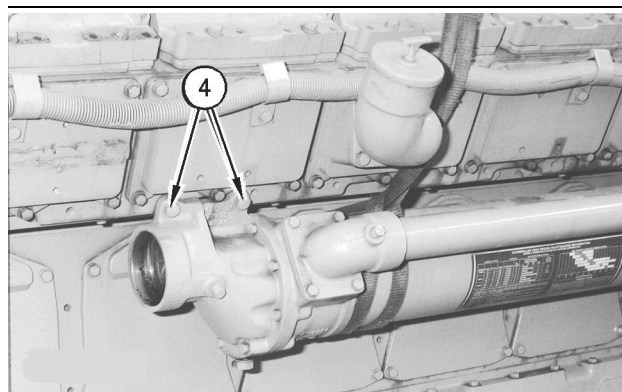


Illustration 385

g00747906

4. Attach a suitable lifting device to the oil cooler. For 3508B Engines, the weight of the oil cooler is approximately 45 kg (100 lb). For 3512B Engines, the weight of the oil cooler is approximately 65 kg (143 lb). For 3516B Engines, the weight of the oil cooler is approximately 78 kg (172 lb). Remove bolts (4).

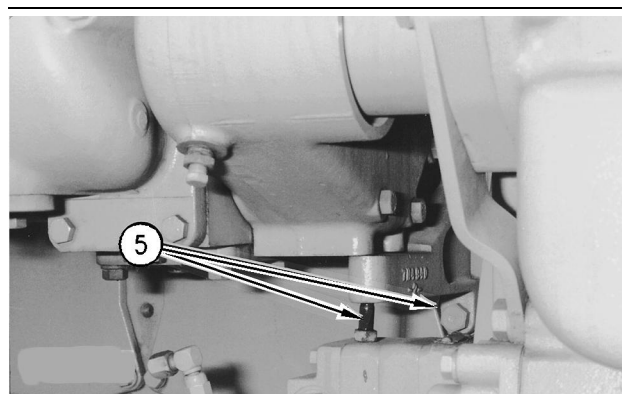


Illustration 386

g00747911

5. Remove bolts (5) from the bottom of the oil cooler. The bolts are directly above the fuel transfer pump.

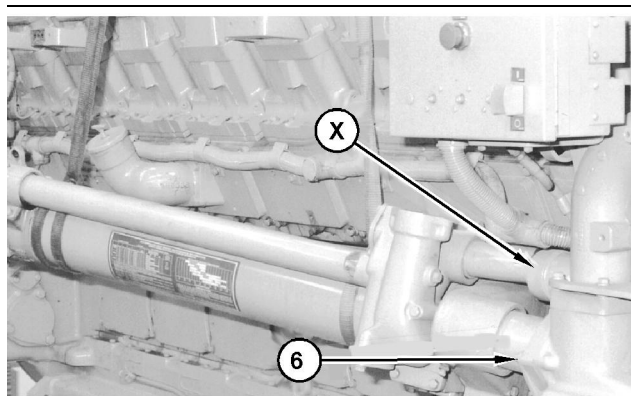


Illustration 387

g01057407

6. Remove bolts from flange (6). Remove the gasket from the flange.
7. Slowly lift the oil cooler away from the engine. The oil cooler will separate at Point (X) (slip fit). Remove the O-ring seal from the slip fit.

i02503929

Engine Oil Cooler - Disassemble

SMCS Code: 1378-015

Disassembly Procedure

Start By:

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

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

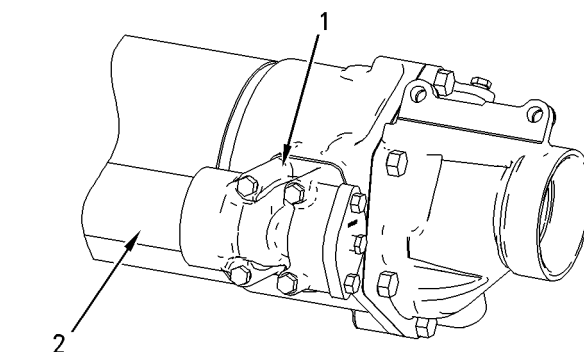


Illustration 388

g01004313

1. Remove the bolts from elbow (1). Remove elbow (1) and tube (2) from the engine oil cooler.
2. Remove tube (2) and the O-ring seals from elbow (1).

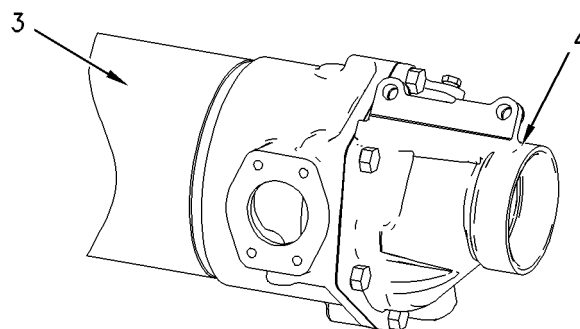


Illustration 389

g01004559

3. Place an identification mark on bonnet (4) and on engine oil cooler core (3) for assembly purposes. Remove bonnet (4) from engine oil cooler core (3).

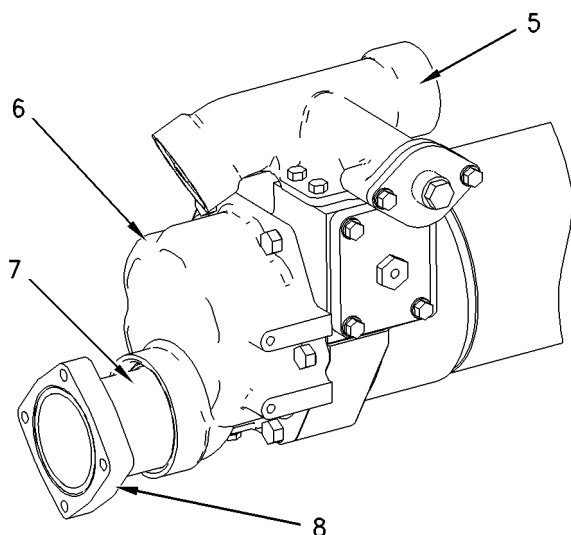


Illustration 390

g01004658

4. Remove the bolts and elbow (5) from the engine oil cooler bypass. Remove the O-ring seals from elbow (5).
5. Remove flange (8) and tube (7) from bonnet (6). Remove the O-ring seals from tube (7).

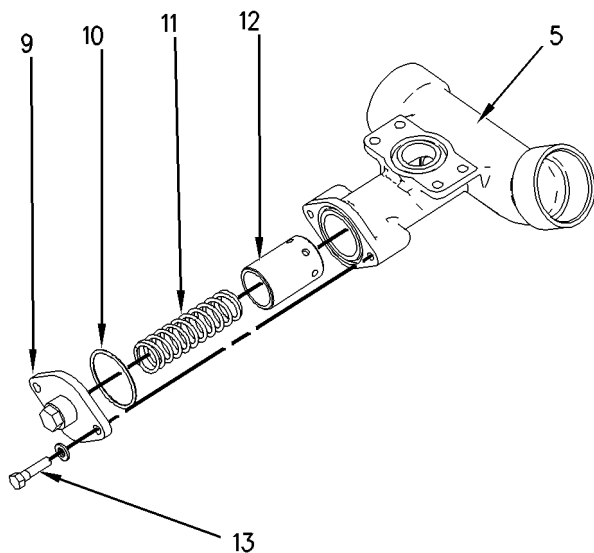


Illustration 391

g01004704

⚠ 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.

6. Remove bolts (13), cover (9), O-ring seal (10), spring (11), and bypass valve (12) from elbow (5).

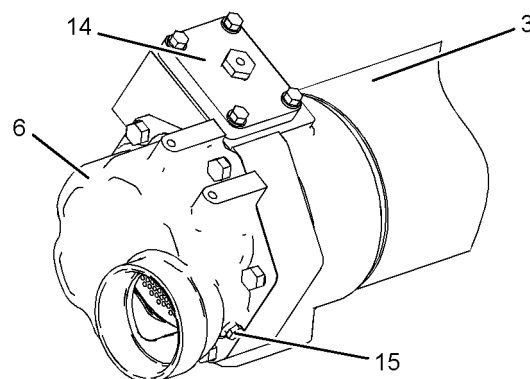


Illustration 392

g01253217

7. Place an identification mark on bonnet (6) and on engine oil cooler core (3) for assembly purposes. Remove bonnet (6) and the gasket.
8. Remove drain plug (15) and the O-ring seal, if necessary.
9. Remove cover (14) and the O-ring seal, if necessary.

i02503999

Engine Oil Cooler - Assemble

SMCS Code: 1378-016

Assembly Procedure

Note: Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

Note: Lubricate the O-ring seals with the oil that is being used.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

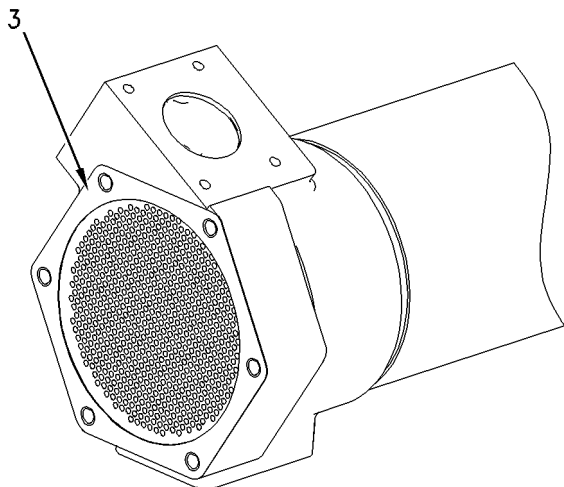


Illustration 393

g01004839

Note: Make sure that you do not damage the tubes in engine oil cooler core (3) during the cleaning.

1. Make sure that the tubes in engine oil cooler core (3) are clean.

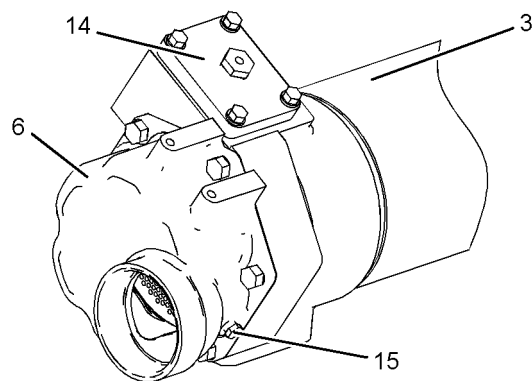


Illustration 394

g01253217

2. Install the O-ring seal and cover (14), if necessary.
3. Install the O-ring seal and drain plug (15), if necessary.
4. Install the gasket and bonnet (6) on engine oil cooler core (3) in the orientation that was noted during the disassembly procedure. Install the bolts.

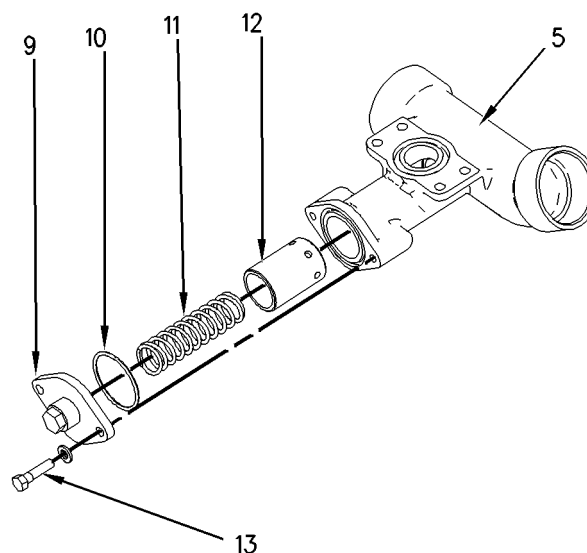


Illustration 395

g01004704

**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. Install bypass valve (12) and spring (11) in elbow (5). Install O-ring seal (10) and lubricate the O-ring seal with clean engine oil. Install cover (9) and bolts (13).

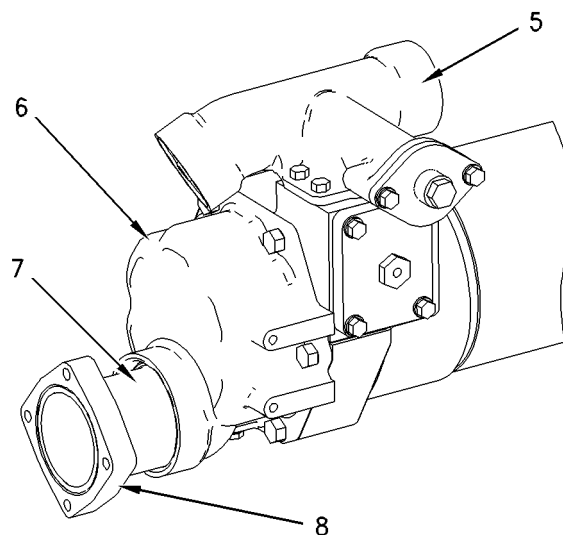


Illustration 396

g01004658

6. Install the O-ring seals on tube (7) and lubricate the O-ring seals with clean engine oil. Install tube (7) and flange (8) on bonnet (6).
7. Install the O-ring seal on elbow (5) and install elbow (5) on the engine oil cooler with the bolts.

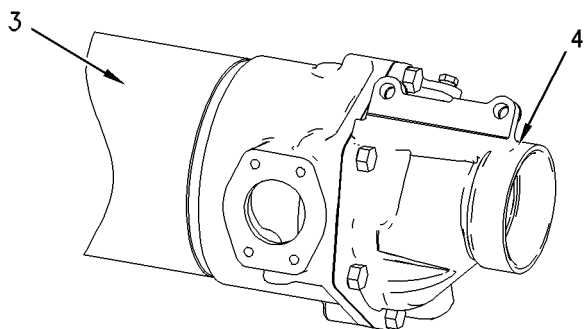


Illustration 397

g01004559

8. Install the gasket and bonnet (4) on engine oil cooler core (3) in the location that was marked during the disassembly procedure. Install the bolts in bonnet (4).

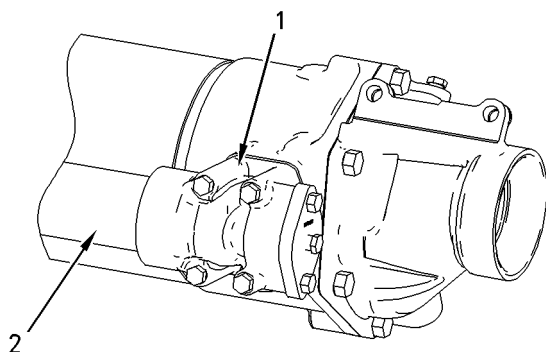


Illustration 398

g01004313

9. Install the O-ring seals on both ends of tube (2). Lubricate the O-ring seals with clean engine oil. Install tube (2) in elbow (1).
10. Install the O-ring seal on elbow (1) and lubricate the O-ring seal with clean engine oil. Install elbow (1) and tube (2) with the bolts on the engine oil cooler core.

End By:

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

i02063446

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.

1. Attach a suitable lifting device to the oil cooler.
For 3508B Engines, the weight of the oil cooler is approximately 45 kg (100 lb). For 3512B Engines, the weight of the oil cooler is approximately 65 kg (143 lb). For 3516B Engines, the weight of the oil cooler is approximately 78 kg (172 lb).

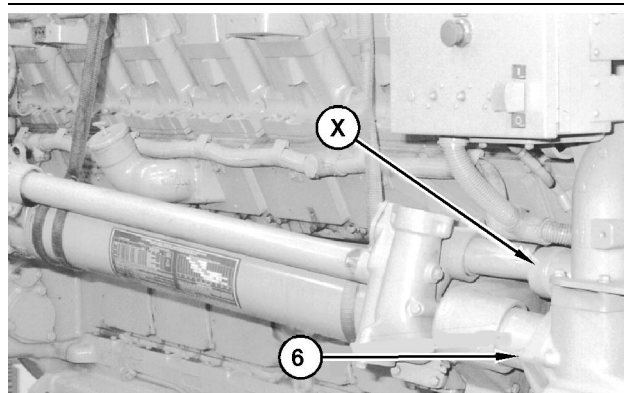


Illustration 399

g01057407

2. Lubricate the bore for the O-ring at Point (X) with clean engine oil. Install the seal. Install a new gasket for flange (6). Lift the oil cooler into position on the engine. Point (X) is a slip fit. Install the bolts for flange (6).

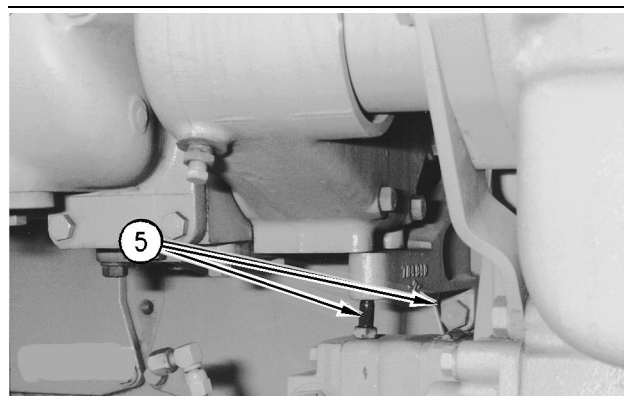


Illustration 400

g00747911

i02063518

3. Install bolts (5) at the bottom of the oil cooler. The bolts are directly above the fuel transfer pump.

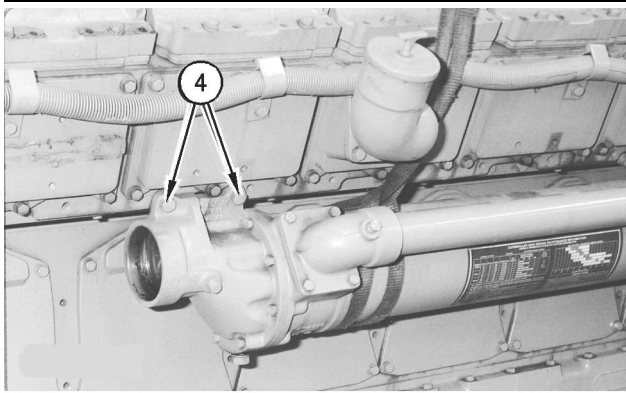


Illustration 401

g00747906

4. Install bolts (4).

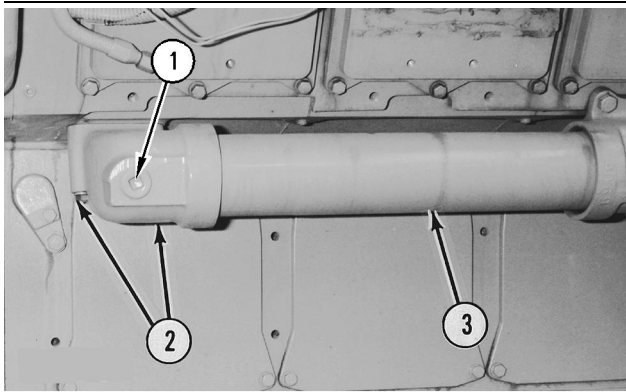


Illustration 402

g00603770

5. Install a new gasket for the joint between the elbow and the cylinder block. Use glycerin to lubricate the new O-ring seal for the slip fit of tube (3). Fit tube (3) into the bonnet of the oil cooler. Install bolts (2).
6. Connect the hose (not shown) of connection (1) for the jacket water heater.
7. Fill the cooling system with coolant. Refer to the Operation and Maintenance Manual, "Refill Capacities".

Engine Oil Pump - Remove

SMCS Code: 1304-011

Removal Procedure

Start By:

- a. Remove the fuel transfer pump. Refer to Disassembly and Assembly, "Fuel Transfer 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. Drain the coolant into a suitable container for storage or for disposal. Refer to the Operation and Maintenance Manual, "Refill Capacities".

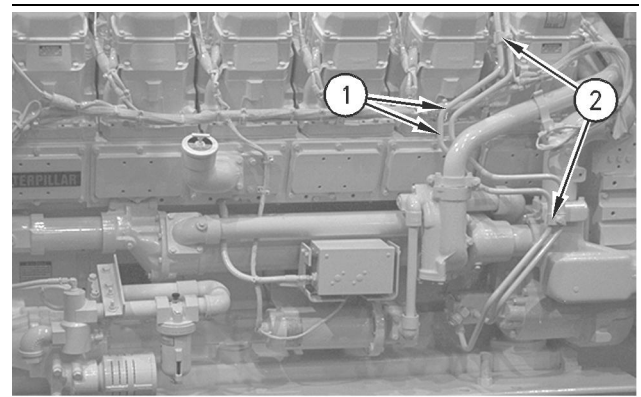


Illustration 403

g00603899

2. Remove tube assemblies (1) and brackets (2).

i02077619

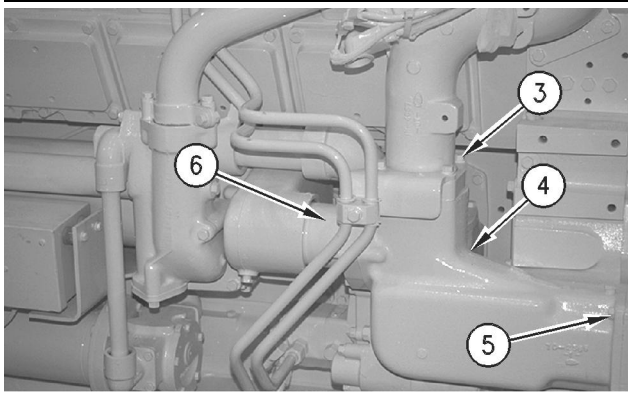


Illustration 404 g00603902

3. Remove bolts (3) and (5) in order to remove adapter (4) and tube (6).

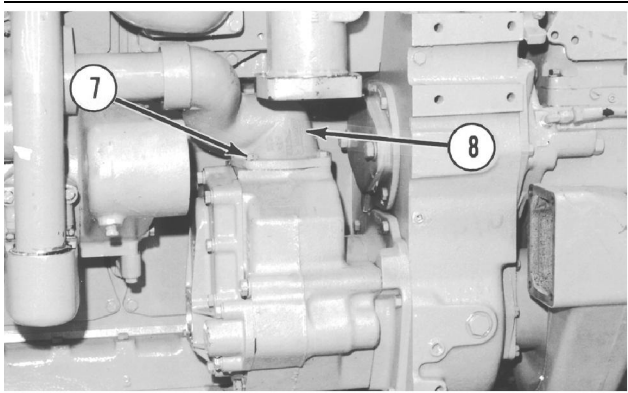


Illustration 405 g00603903

4. Remove bolts (7) in order to disconnect elbow (8) from the engine oil pump.

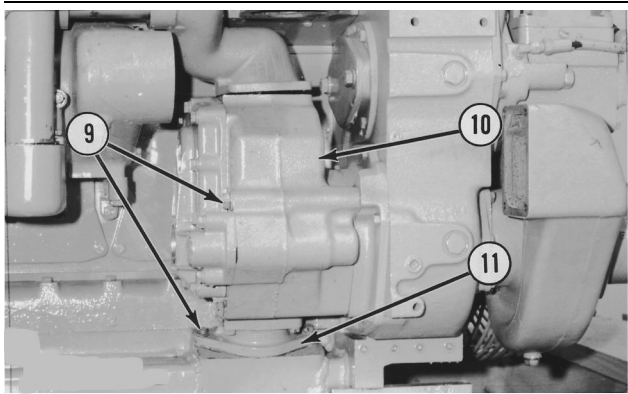


Illustration 406 g00603905

5. The weight of the engine oil pump is approximately 39 kg (86 lb). Use two people in order to remove the engine oil pump. Remove bolts (9) in order to remove engine oil pump (10) and adapter (11).

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Table 33

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P - 0510	Driver Gp	1
B	156 - 7100	Slide Hammer Puller Gp	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

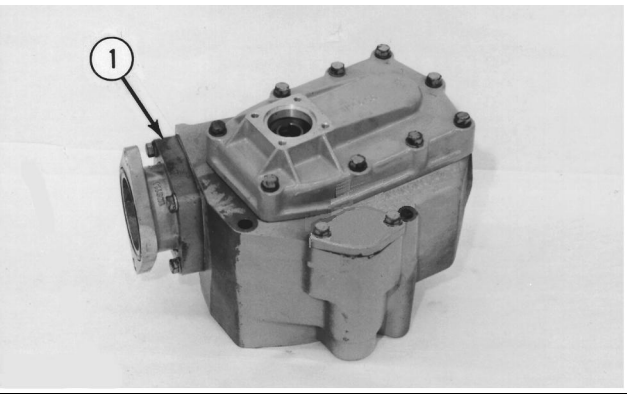


Illustration 407 g01005273

1. Remove adapter (1).

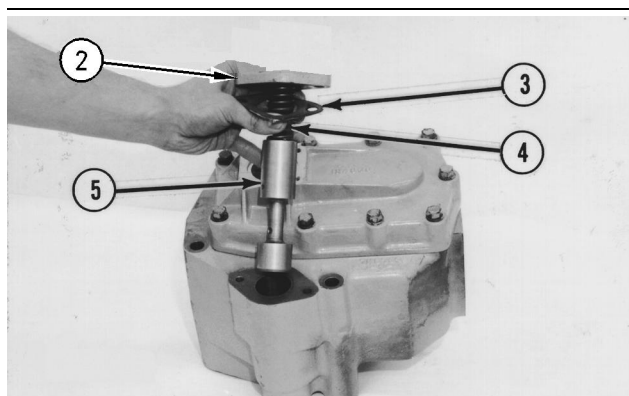


Illustration 408

g01005318

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.

2. Remove cover (2). Remove gasket (3), spring (4), and valve spool (5).

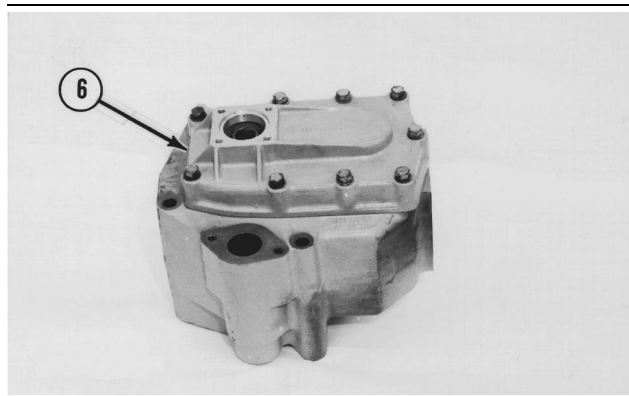


Illustration 409

g00591932

3. Remove cover assembly (6) and the gasket.

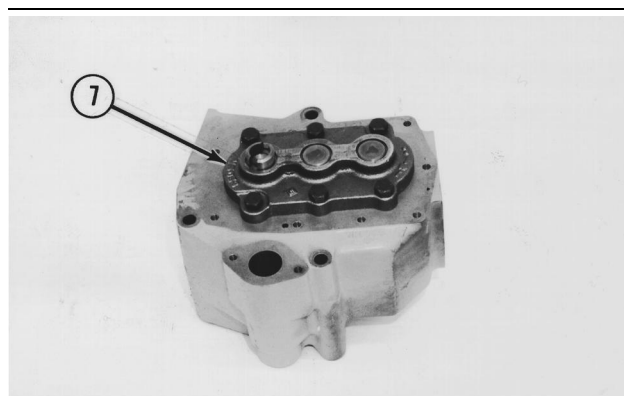


Illustration 410

g00591936

4. Remove cover assembly (7).

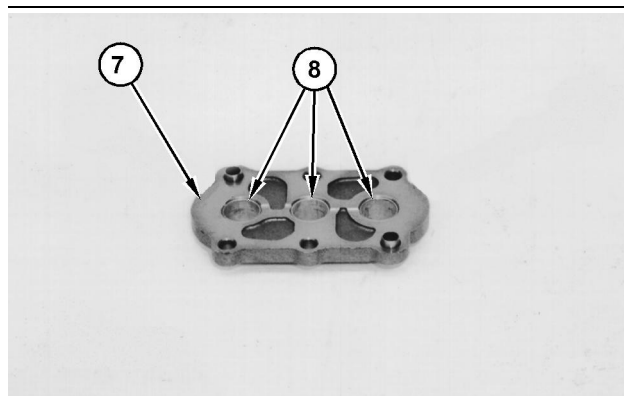


Illustration 411

g01050749

5. Use Tooling (A) in order to remove bearings (8) from cover assembly (7).

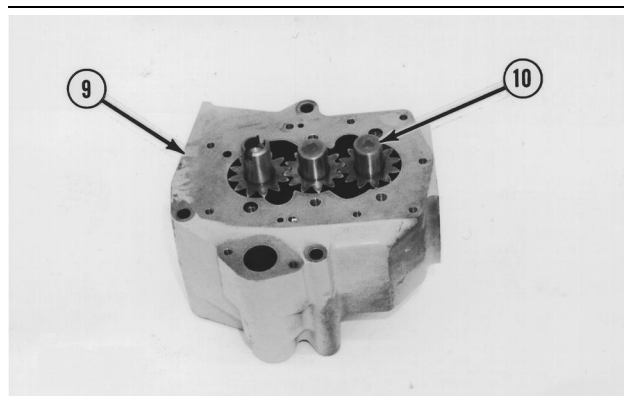


Illustration 412

g00591963

6. Remove shaft assemblies (10) from body (9).

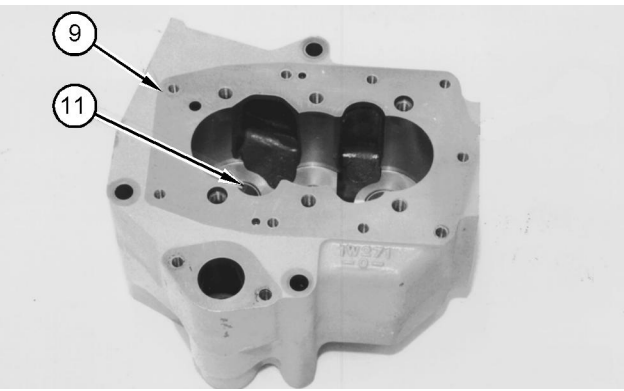


Illustration 413

g01057505

7. Use Tooling (A) in order to remove two of the three bearings (11) from body (9).
8. Use Tooling (B) in order to remove the remaining bearing.

i02063530

Engine Oil Pump - Assemble

SMCS Code: 1304-016

Assembly Procedure

Table 34

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

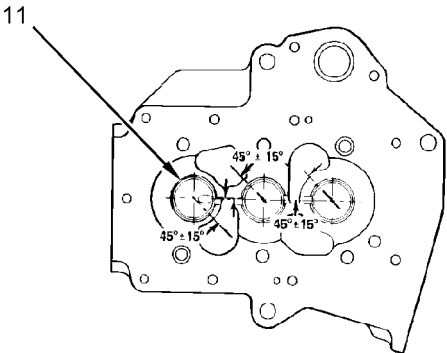


Illustration 414

g01057511

1. Align bearings (11) in the body of the engine oil pump. Align the joints of the bearings to 45 ± 15 degrees from the centerline of the bearing bores.
2. Use Tooling (A) in order to install bearings (11). The bearings must be 1.5 ± 0.5 mm (0.06 ± 0.02 inch) below the gear bore.

Measure the inside diameter of the bearings after installation. The inside diameter of the bearings must be 31.811 ± 0.013 mm (1.2524 ± 0.0005 inch) after installation. Machine the bearing, if necessary.

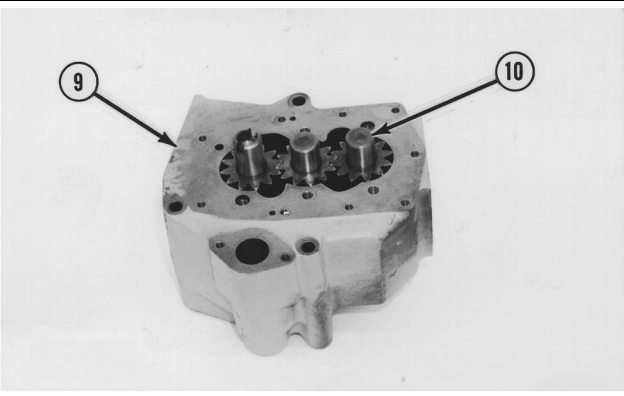


Illustration 415

g00591963

3. Install shaft assemblies (10) in body (9).

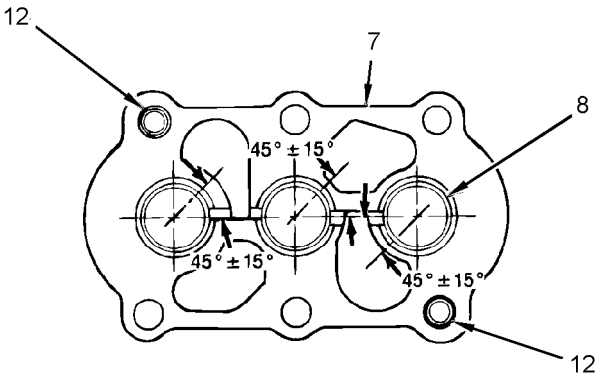


Illustration 416

g01057514

4. Ensure that dowels (12) are installed in cover assembly (7) at a distance of 6.0 ± 0.5 mm (0.24 ± 0.02 inch) above the surface of the cover.
5. Use Tooling (A) in order to install bearings (8) in cover assembly (7) with the bearing joints in the correct position.

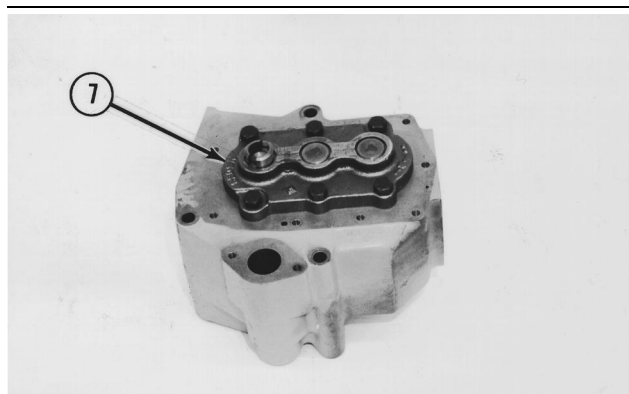


Illustration 417

g00591936

6. Place cover assembly (7) into position and install the bolts.

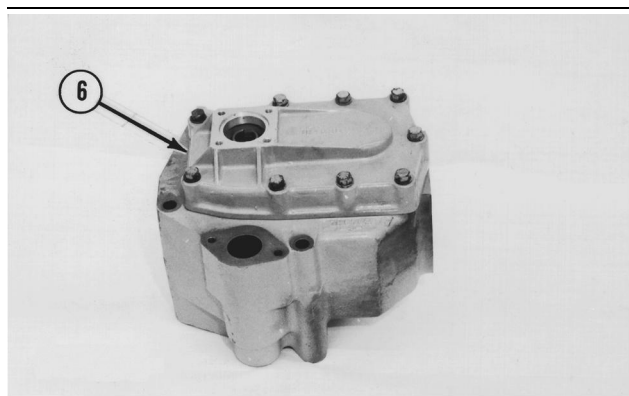


Illustration 418

g00591932

7. Ensure that the two pins in cover assembly (6) are installed at a distance of 6.0 ± 1.0 mm (0.24 ± 0.04 inch) above the surface of the cover. Install cover assembly (6).

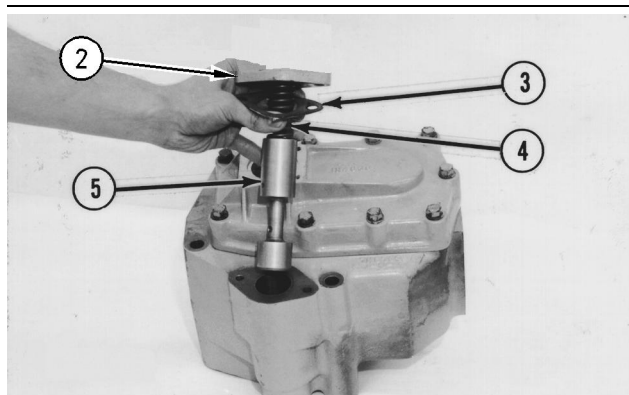


Illustration 419

g01005318

⚠ 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.

8. Place clean engine oil on valve spool (5). Install valve spool (5), spring (4), gasket (3), cover (2), and the bolts.

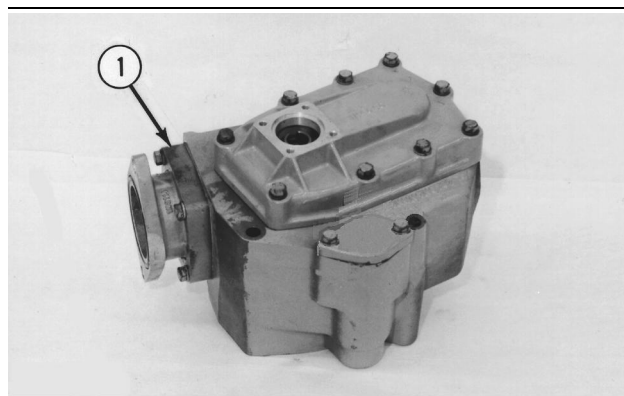


Illustration 420

g01005273

9. Install the gasket and adapter (1).

Note: Refer to Specifications, "Engine Oil Pump" for more information.

End By:

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

i02063556

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.

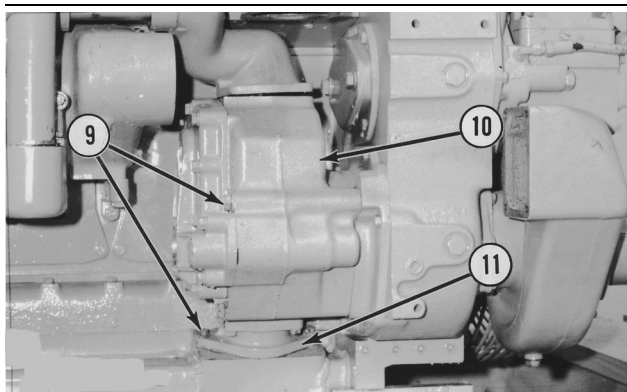


Illustration 421

g00603905

1. Ensure that the O-ring seal is in position on adapter (11). Coat the O-ring seal with clean engine oil.

Note: Before you install the engine oil pump, make sure that the shaft of the pump will turn by hand. The pump must have oil for lubrication before the pump is installed.

2. Use two people in order to install the engine oil pump. The weight of the engine oil pump is approximately 39 kg (86 lb). Place engine oil pump (10) and adapter (11) into position. Make sure that the splines of the engine oil pump are properly meshed with the splines of the drive for the engine oil pump. Install bolts (9) that secure engine oil pump (10) and adapter (11).

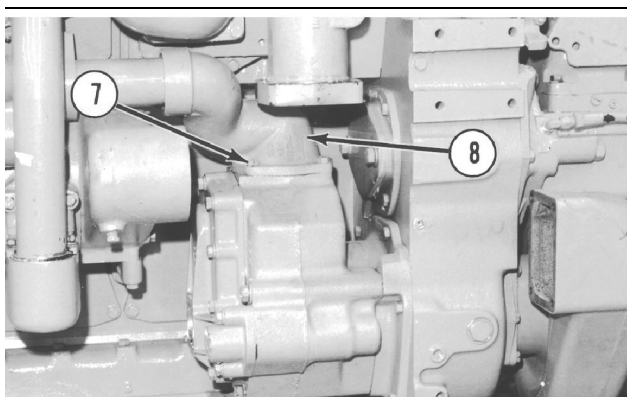


Illustration 422

g00603903

3. Install bolts (7) that connect elbow (8) to the engine oil pump.

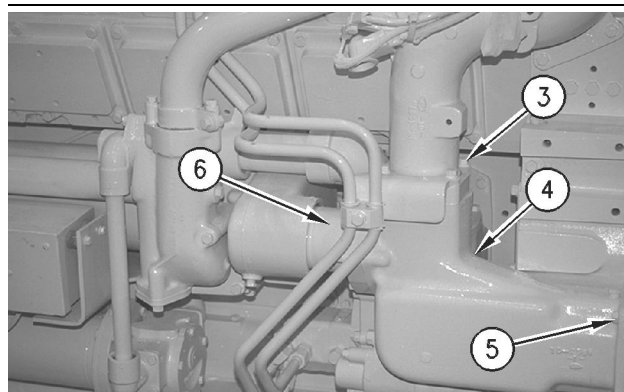


Illustration 423

g00603902

4. Make sure that the O-ring seal is in position on tube (6). Coat the O-ring seal with clean engine oil.
5. Ensure that the gaskets for tube (6) and the water pump are in place. Place tube (6) and adapter (4) into position. Install bolts (3) and (5).

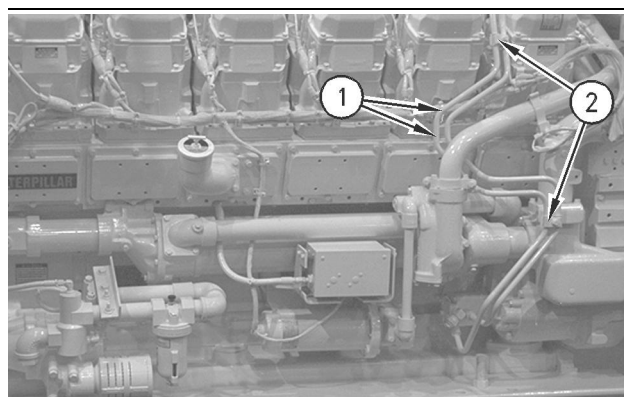


Illustration 424

g00603899

6. Install tube assemblies (1) and brackets (2).
7. Fill the cooling system. Refer to the Operation and Maintenance Manual, "Refill Capacities".

End By:

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

i02063661

Engine Oil Filter Housing - Remove

SMCS Code: 1306-011

Removal Procedure

Table 35

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2

Start By:

- a. Remove the expansion tank (if equipped). Refer to Disassembly and Assembly, "Expansion Tank - Remove and Install".
- b. Remove the fuel filter housing. Refer to Disassembly and Assembly, "Fuel Filter Housing - 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.

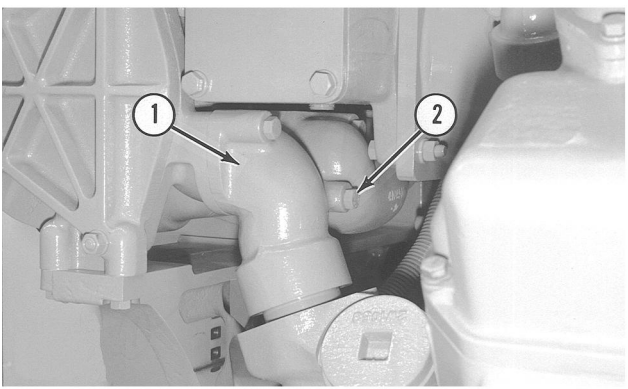


Illustration 425

g00590926

1. Remove bolts (2) that attach adapter (1) to the oil inlet and the outlet of the oil filter housing.

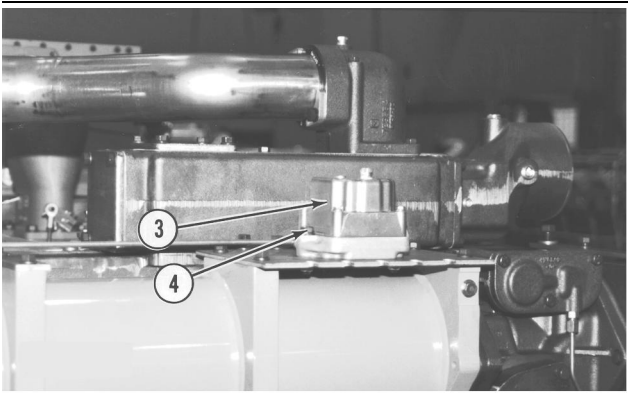


Illustration 426

g00604111

2. Remove bolts (4) from electronic control (3). Place electronic control (3) away from the oil filter housing.

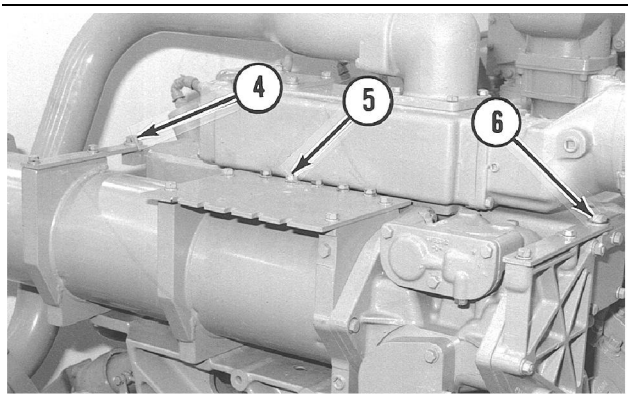


Illustration 427

g00604112

3. Remove bolts (4) and (5). Remove adapter plate (6) from both ends of the oil filter housing.

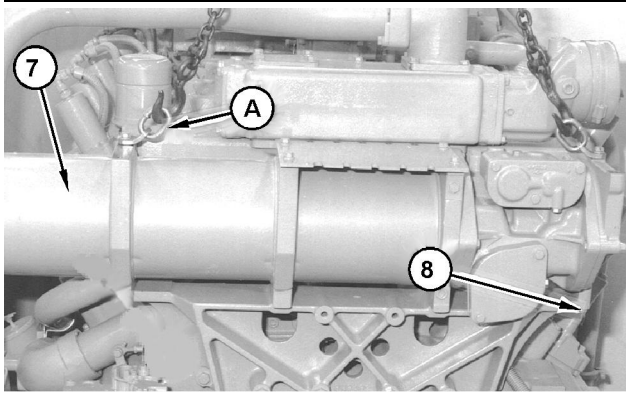


Illustration 428

g01057545

4. Install Tooling (A) onto oil filter housing (7). Attach a suitable lifting device to Tooling (A). The weight of the oil filter housing is approximately 95 kg (210 lb).
5. Remove bolts (8). Remove the oil filter housing from the engine.
6. Remove the seals from the joint between the adapter and the oil inlet and the outlet of the oil filter housing.

i02504298

Engine Oil Filter Housing - Disassemble

SMCS Code: 1306-015

Disassembly Procedure

Start By:

- a. Remove the engine oil filter housing. Refer to Disassembly and Assembly, "Engine Oil Filter Housing - 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 Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

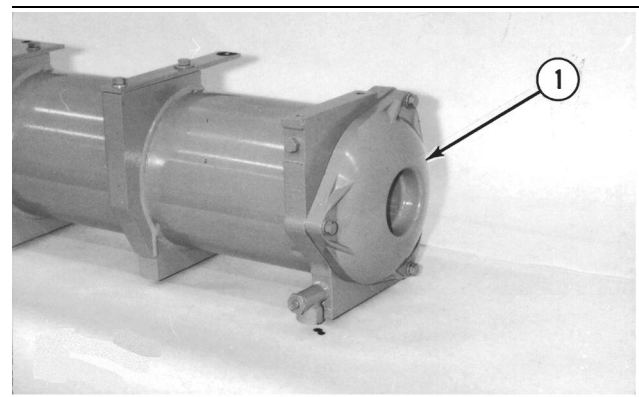


Illustration 429

g00591497

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.

1. Remove the bolts and cover (1).

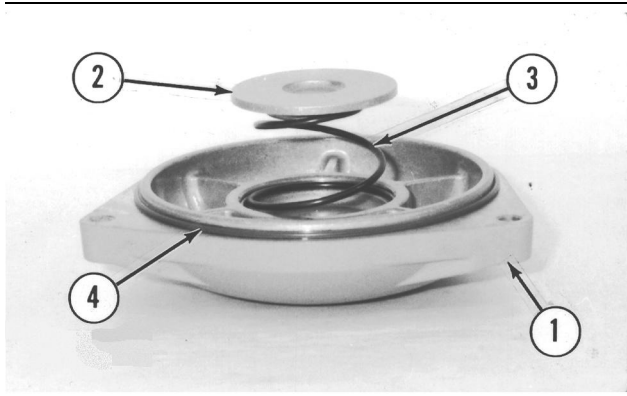


Illustration 430

g00591498

2. Remove retainer (2), spring (3), and O-ring seal (4) from cover (1).

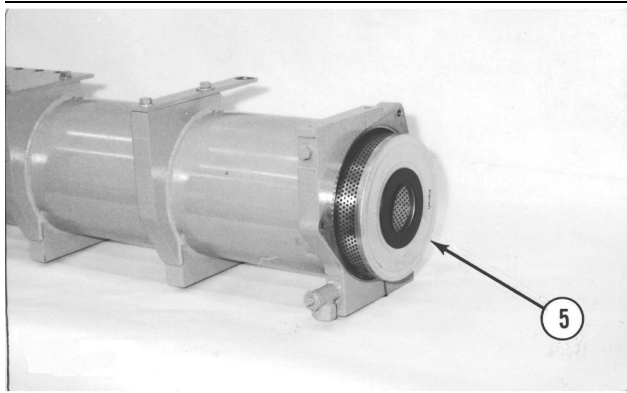


Illustration 431

g00591500

3. Remove engine oil filter elements (5).

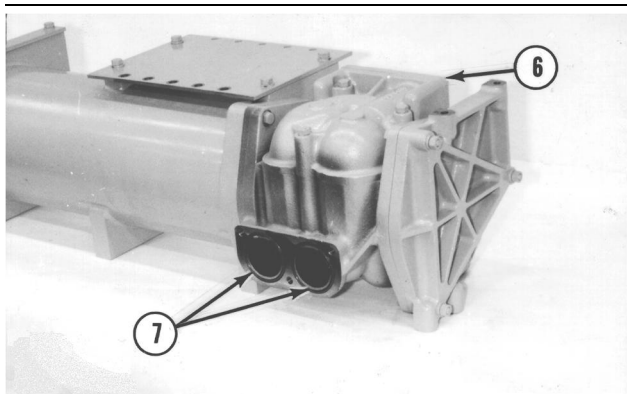


Illustration 432

g00591502

4. Remove O-ring seals (7).
5. Remove the bolts and bypass valve housing (6). The weight of bypass valve housing (6) is approximately 43 kg (95 lb).

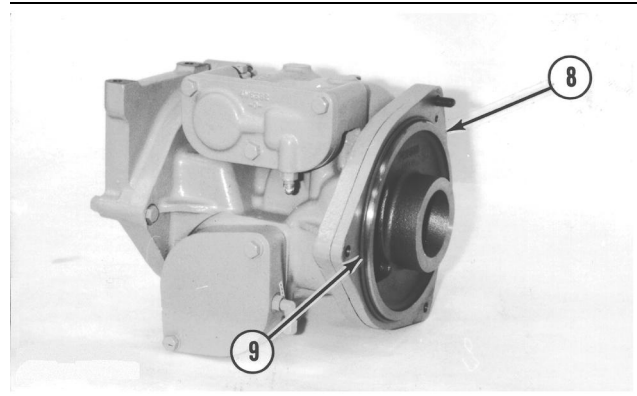


Illustration 433

g00591504

6. Remove adapter (8). Remove O-ring seal (9) from the adapter.

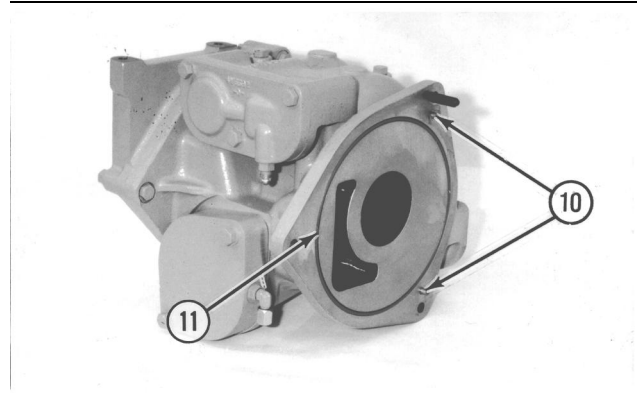


Illustration 434

g00591541

7. Remove O-ring seal (11) and pins (10), if necessary.

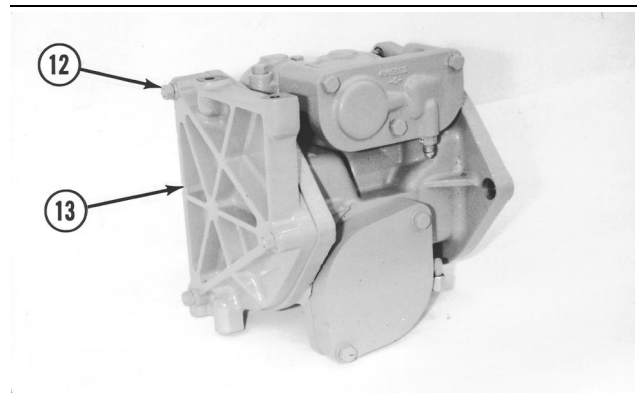


Illustration 435

g00591544

8. Remove nuts (12) and the bolts from support (13).

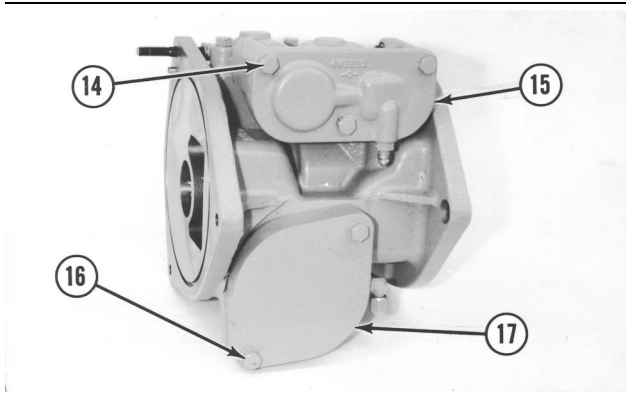


Illustration 436

g00591545

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.

9. Remove bolts (14) and (16). Also remove covers (15) and (17).

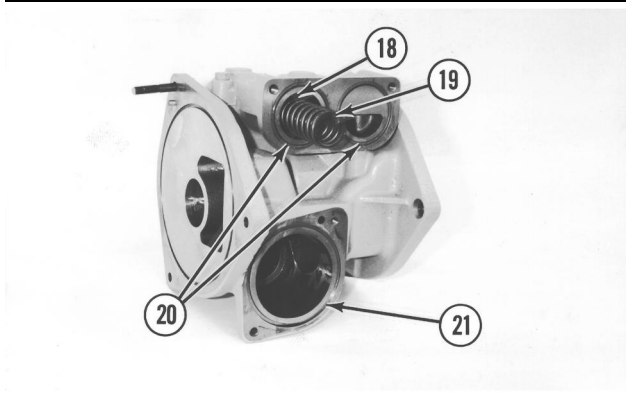


Illustration 437

g00591546

10. Remove O-ring seals (20) and (21).

11. Remove spring (19) and bypass valve (18).

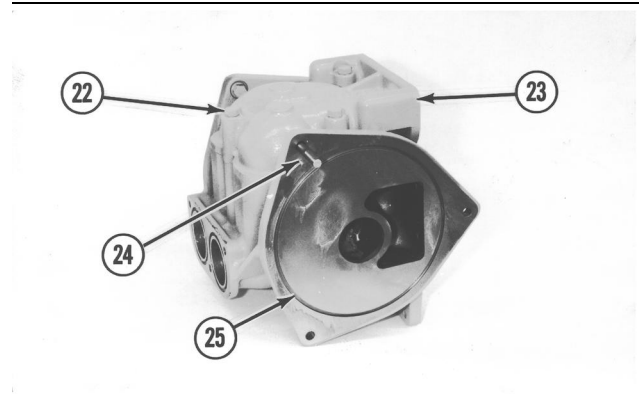


Illustration 438

g00591547

12. Remove bolts (22), cover (23), and the O-ring seals from the housing.

13. Remove O-ring seal (25) and pin (24), if necessary.

i02505235

Engine Oil Filter Housing - Assemble

SMCS Code: 1306-016

Assembly Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

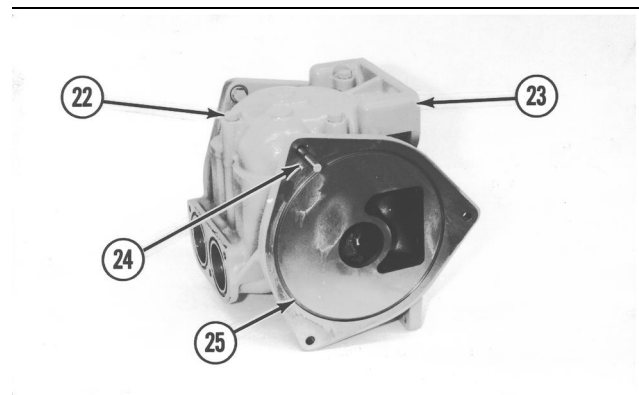


Illustration 439

g00591547

1. Install the O-ring seals on the housing. Install cover (23) and bolts (22).
2. Install O-ring seal (25).

3. Install pin (24), if necessary. The pin must be 6.50 ± 1.00 mm (0.256 ± 0.040 inch) above the surface of the housing.

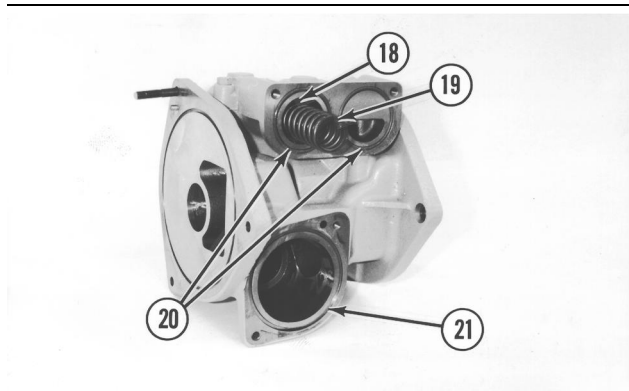


Illustration 440

g00591546

4. Install bypass valve (18) and spring (19).
5. Install O-ring seals (20) and (21).

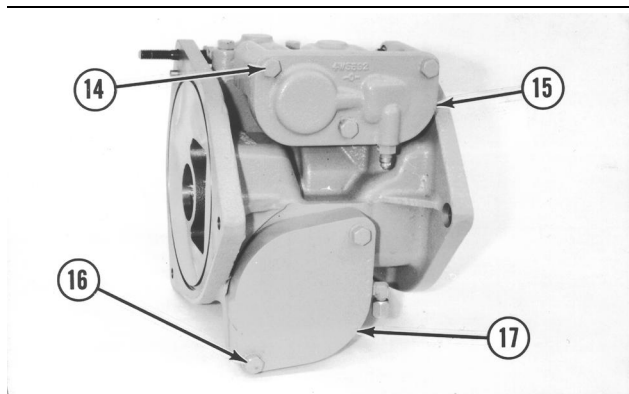


Illustration 441

g00591545

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.

6. Install covers (15) and (17). Install bolts (14) and (16).

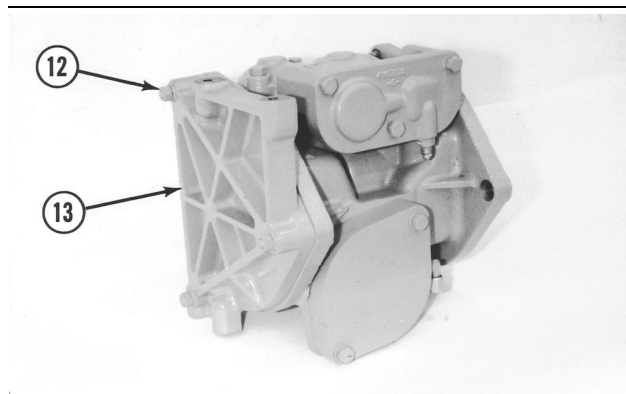


Illustration 442

g00591544

7. Install support (13), the bolts, and nuts (12). Tighten the nuts to a torque of 55 ± 7 N·m (41 ± 5 lb ft).

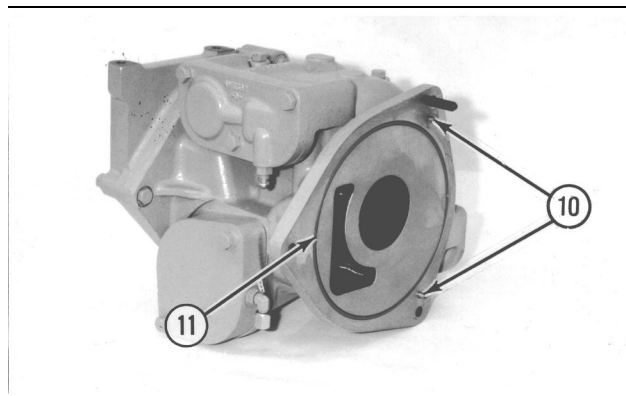


Illustration 443

g00591541

8. Install O-ring seal (11).
9. Install new pins (10) in the bypass valve housing, if necessary. The pins must be 6.50 ± 1.00 mm (0.256 ± 0.040 inch) above the surface of the housing.

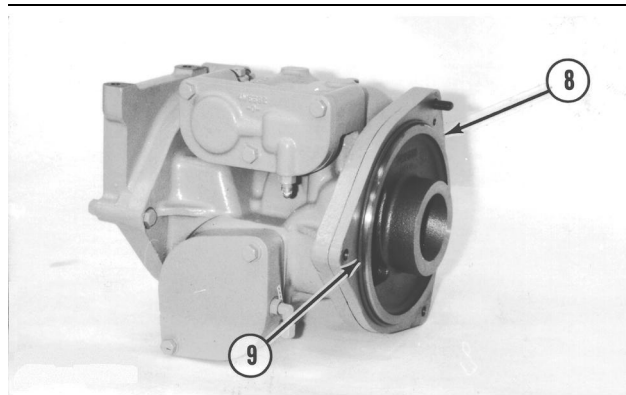


Illustration 444

g00591504

10. Install adapter (8). Install O-ring seal (9) on adapter (8) and lubricate the seal with clean engine oil.

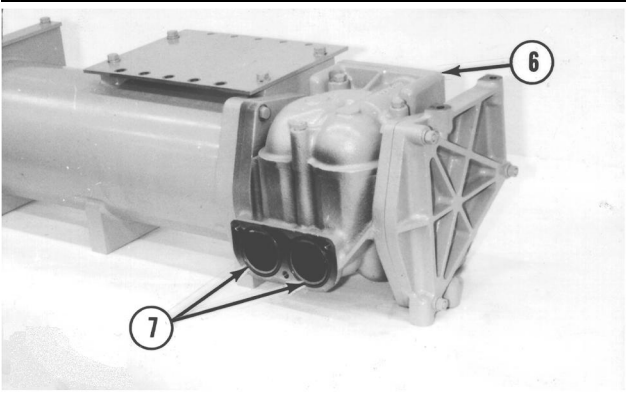


Illustration 445 g00591502

11. Install bypass valve housing (6). The weight of bypass valve housing (6) is approximately 43 kg (95 lb). Tighten the bolts to a torque of 55 ± 7 N·m (41 ± 5 lb ft).

12. Install O-ring seals (7).

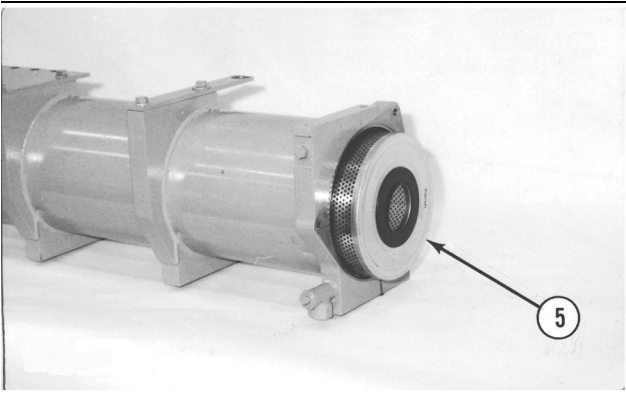


Illustration 446 g00591500

13. Install new engine oil filter elements (5).

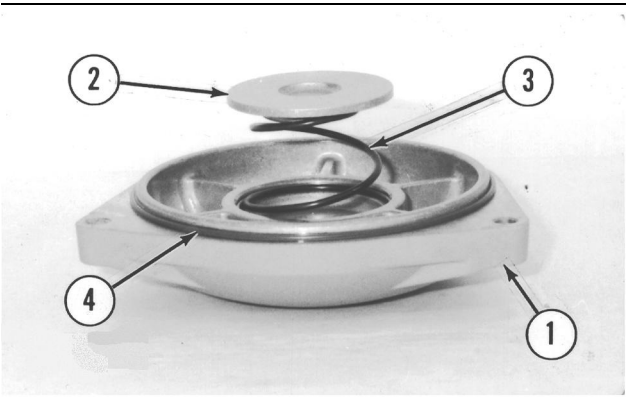


Illustration 447 g00591498

14. Install O-ring seal (4), spring (3), and retainer (2) on cover (1).

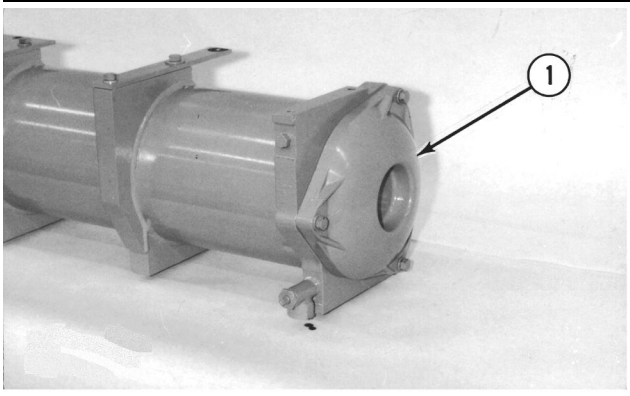


Illustration 448 g00591497

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.

15. Install cover (1) and the bolts.

End By:

- a. Install the engine oil filter housing. Refer to Disassembly and Assembly, "Engine Oil Filter Housing - Install".

i02063727

Engine Oil Filter Housing - Install

SMCS Code: 1306-012

Installation Procedure

Table 36

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the seals for the adapter to the oil inlet and the outlet of the oil filter housing. If a seal is cut, scratched, or cracked, obtain a new seal for assembly.

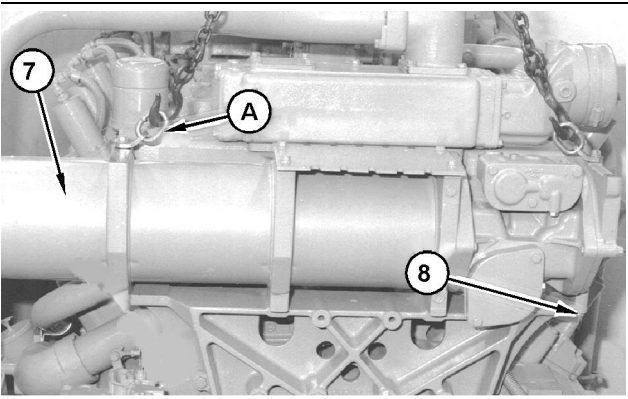


Illustration 449 g01057545

2. Install Tooling (A) onto oil filter housing (7). Attach a suitable lifting device to Tooling (A). The weight of the oil filter housing is approximately 95 kg (210 lb).
3. Lift the oil filter housing into position on the engine. Install bolts (8).

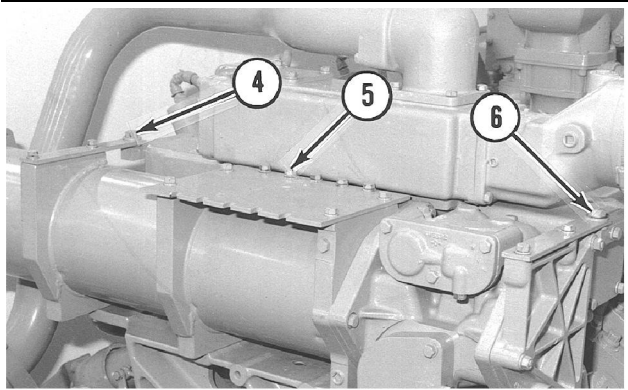


Illustration 450 g00604112

4. Remove Tooling (A). Install adapter plate (6) on both ends of the oil filter housing. Install bolts (4) and (5).

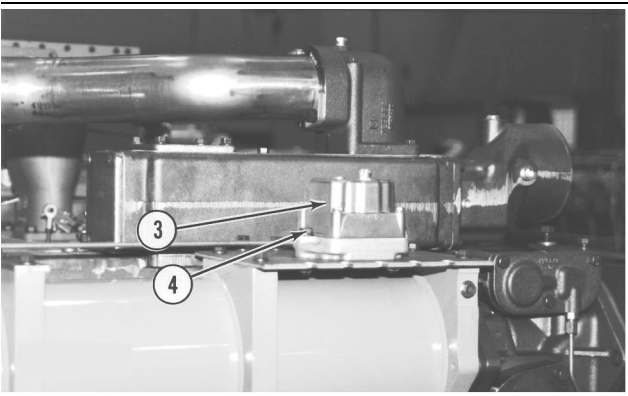


Illustration 451 g00604111

5. Install electronic control (3) with bolts (4).

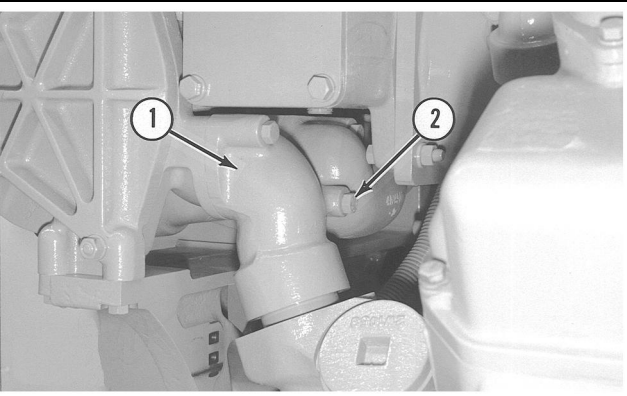


Illustration 452 g00590926

6. Install adapter (1) and bolts (2).

End By:

- a. Install the fuel filter housing. Refer to Disassembly and Assembly, “Fuel Filter Housing - Install”.
- b. Install the expansion tank (if equipped). Refer to Disassembly and Assembly, “Expansion Tank - Remove and Install”.

i02063760

Engine Oil Filter Base - Remove (Spin-on Filters)

SMCS Code: 1306-011

Removal Procedure

Table 37

Required Tools			
Tool	Part Number	Part Description	Qty
A	2P-8250	Strap Wrench Assembly	1
B	138-7575	Link Bracket	2

1. Remove the bolts that hold the clips for the harness assembly. Move the harness assembly out of the way.

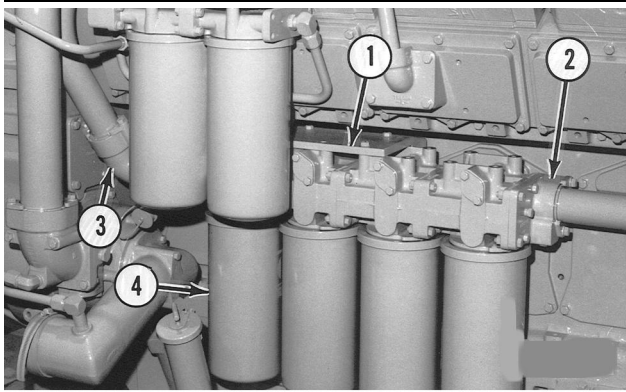


Illustration 453

g00604291

2. Remove filters (4) with Tooling (A).
3. Remove the bolts that hold elbow (2) and adapter (3) to the oil filter base. Move the elbow and the adapter away from the oil filter base.
4. Attach Tooling (B) to the oil filter base. Attach a suitable lifting device to Tooling (B). The weight of the oil filter base is approximately 39 kg (86 lb). Remove bolts (1) that hold the oil filter base to the engine. Remove the oil filter base.

i02063765

Engine Oil Filter Base - Disassemble (Spin-on Filters)

SMCS Code: 1306-015

Disassembly Procedure

Start By:

- a. Remove the oil filter base. Refer to Disassembly and Assembly, "Engine Oil Filter Base - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

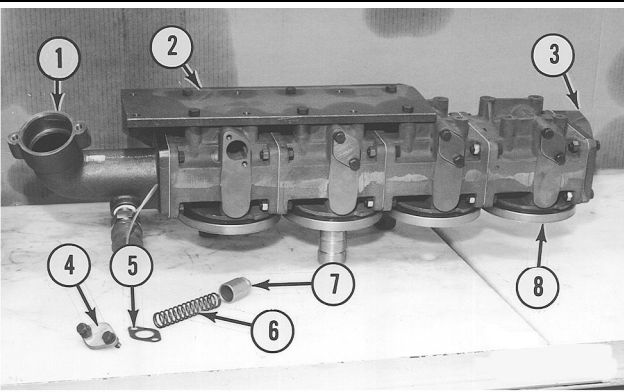


Illustration 454

g00604316



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.

1. Remove elbow (1), support (2), and adapter (3).
2. Remove cover (4), gasket (5), spring (6), and plunger (7) from each base assembly.
3. Remove the bolts that hold base assemblies (8) together.
4. If necessary, remove the stud from each of the base assemblies.

i02063771

Engine Oil Filter Base - Assemble (Spin-on Filters)

SMCS Code: 1306-016

Assembly Procedure

Table 38

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-3263	Thread Lock Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

- 1. Use the following procedure if the filter element studs were removed from the base assemblies:
 - a. Apply Tooling (A) to the tapered end of the studs for a distance of 10.2 ± 1.5 mm (0.40 ± 0.06 inch).
 - b. Install the studs in the base assemblies. Tighten the studs to a torque of 80 ± 14 N·m (60 ± 10 lb ft).

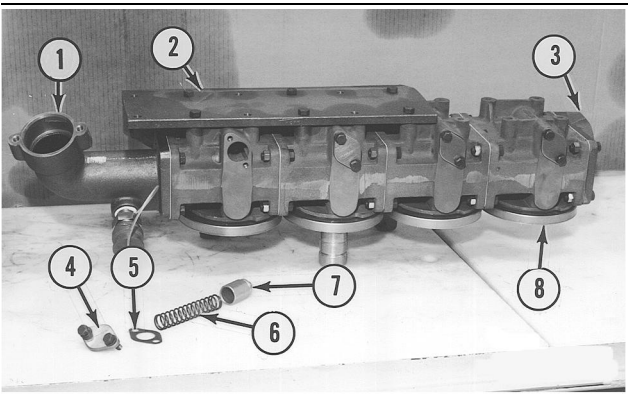


Illustration 455 g00604316

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.

- 2. Place the gaskets in position between base assemblies (8). Install the bolts that hold the base assemblies together.
- 3. Place the gaskets, elbow (1), and adapter (3) into position. Install the bolts that hold the parts.
- 4. Install plunger (7) and spring (6) into each of the base assemblies.
- 5. Place gaskets (5) and covers (4) into position. Install the bolts that hold the parts.
- 6. Install support (2) with the bolts.

End By:

- a. Install the oil filter base. Refer to Disassembly and Assembly, "Engine Oil Filter Base - Install".

i02063779

Engine Oil Filter Base - Install
(Spin-on Filters)

SMCS Code: 1306-012

Installation Procedure

Table 39

Required Tools			
Tool	Part Number	Part Description	Qty
B	138-7575	Link Bracket	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

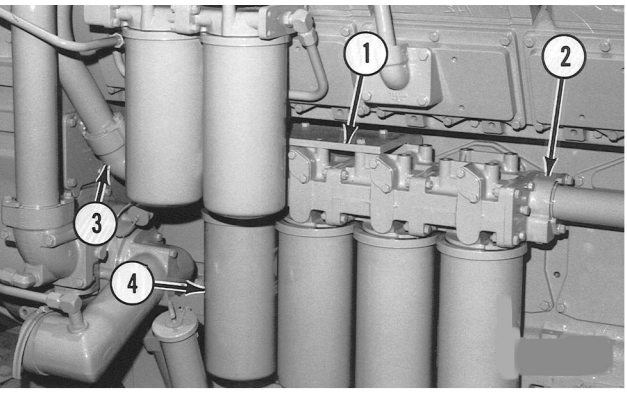


Illustration 456 g00604291

- 1. Attach Tooling (B) and a suitable lifting device to the oil filter base. The weight of the oil filter base is approximately 39 kg (86 lb). Lift the oil filter base into position. Install bolts (1) that hold the oil filter base to the engine.
- 2. Install gaskets for elbow (2) and adapter (3). Install elbow (2) and adapter (3) with the bolts.
- 3. Ensure that the mounting surface for the oil filters is clean. Apply clean engine oil to the seals of the filters. Install filters (4) according to the instructions that are shown on the filters. Do not overtighten the filters.
- 4. Place the clips for the harness assembly into position. Install the bolts into the clips.

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

i02047059

Engine Oil and Water Pump Drive - Remove

SMCS Code: 1313-011

Removal Procedure

Start By:

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

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.

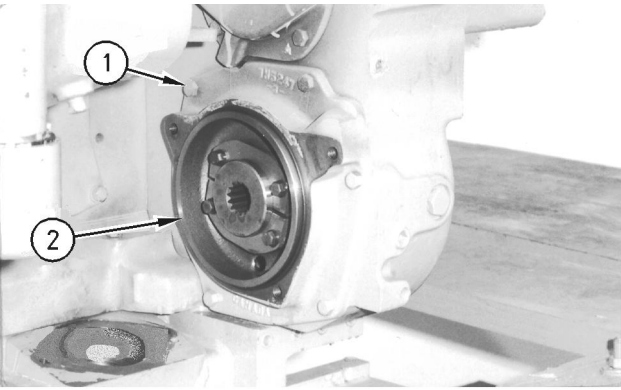


Illustration 457

g00921410

1. Remove bolts (1) and rear adapter assembly (2).

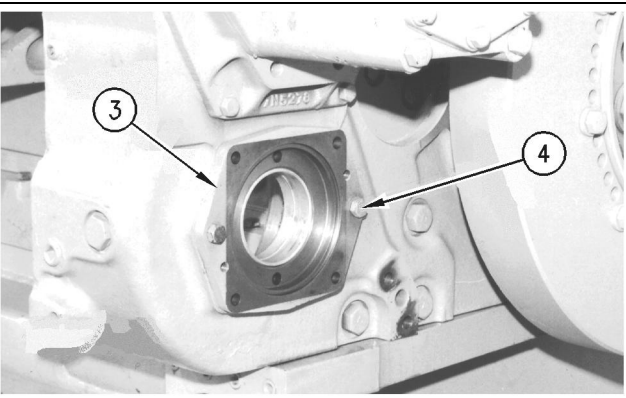


Illustration 458

g00921411

2. Remove bolts (4) and front adapter assembly (3).

i02411968

Engine Oil and Water Pump Drive - Disassemble

SMCS Code: 1313-015

Disassembly Procedure

Table 40

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Group	1

Start By:

- Remove the engine oil and water pump drive. Refer to Disassembly and Assembly, "Engine Oil and Water Pump Drive - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

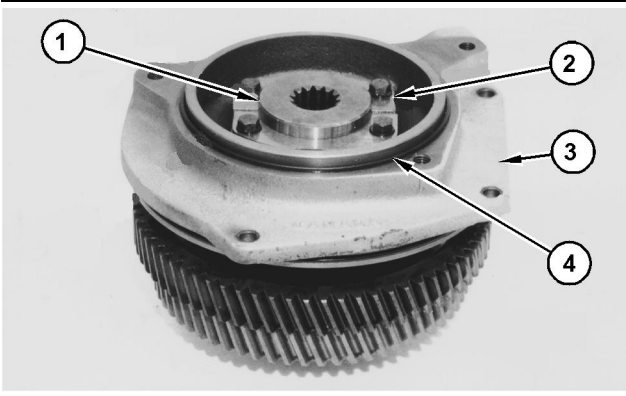


Illustration 459 g01052078

- 1. Remove O-ring seal (4).
- 2. Remove bolts and thrust washers (2). Remove rear adapter assembly (3) from shaft assembly (1).

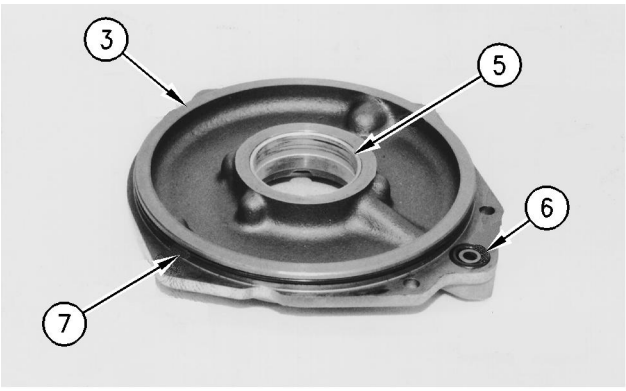


Illustration 460 g00921559

- 3. Remove O-ring seals (6) and (7) from rear adapter assembly (3).
- 4. Use Tooling (A) and a suitable press to remove bearing (5).

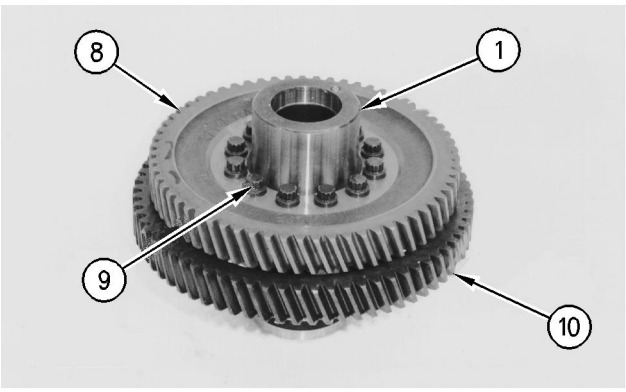


Illustration 461 g00921574

- 5. Remove bolts (9) from shaft assembly (1). Remove gears (8) and (10) from shaft assembly (1).

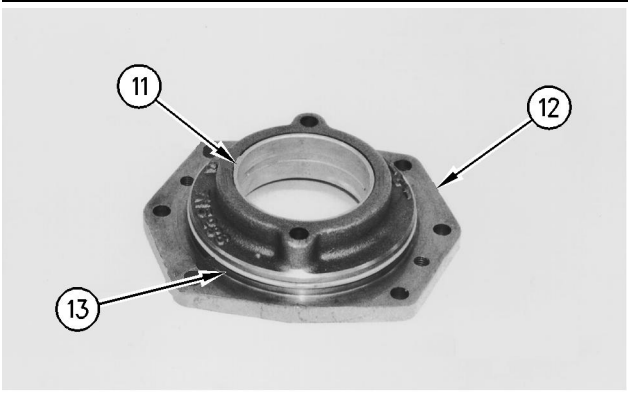


Illustration 462 g00921575

- 6. Remove O-ring seal (13) from front adapter assembly (12).
- 7. Use Tooling (A) and a suitable press to remove bearing (11) from front adapter assembly (12).

i02411970

Engine Oil and Water Pump Drive - Assemble

SMCS Code: 1313-016

Assembly Procedure

Table 41

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Group	1

Note: Check the O-ring seals for wear or damage. Replace the O-ring seals, if necessary.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

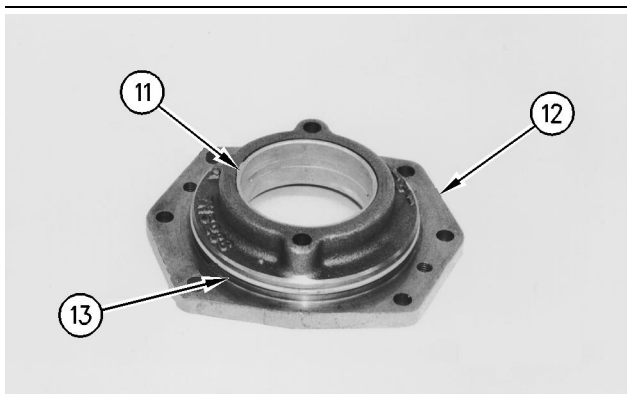


Illustration 463

g00921575

1. Lower the temperature of bearing (11). Use Tooling (A) and a suitable press to install bearing (11) in front adapter assembly (12). The bore in bearing (11) must be 75.00 ± 0.06 mm (2.953 ± 0.002 inch) after installation.
2. Install O-ring seal (13).

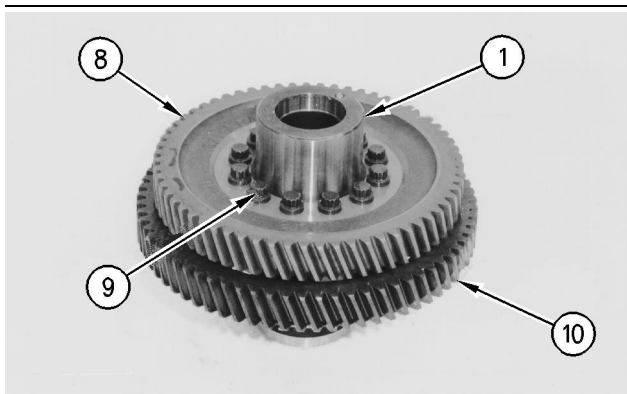


Illustration 464

g00921574

3. Install gears (8) and (10) on shaft assembly (1).
4. Install bolts (9).

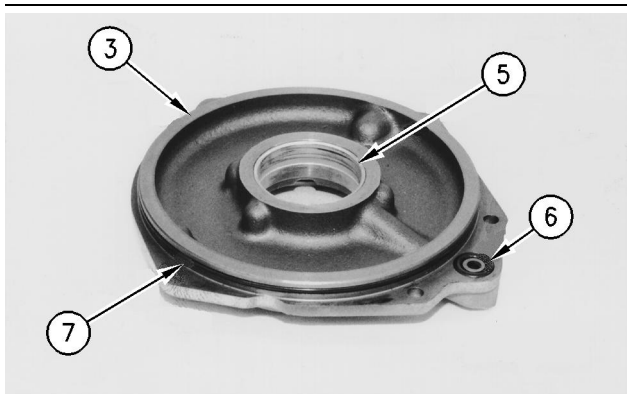


Illustration 465

g00921559

5. Lower the temperature of bearing (5). Align the oil hole in bearing (5) with the oil hole that is in rear adapter assembly (3). Use Tooling (A) and a suitable press to install bearing (5).
6. Ensure that bearing (5) does not extend above the surface of rear adapter assembly (3). The bore in bearing (5) must be 75.00 ± 0.06 mm (2.953 ± 0.002 inch) after installation.
7. Install O-ring seals (6) and (7) on rear adapter assembly (3).

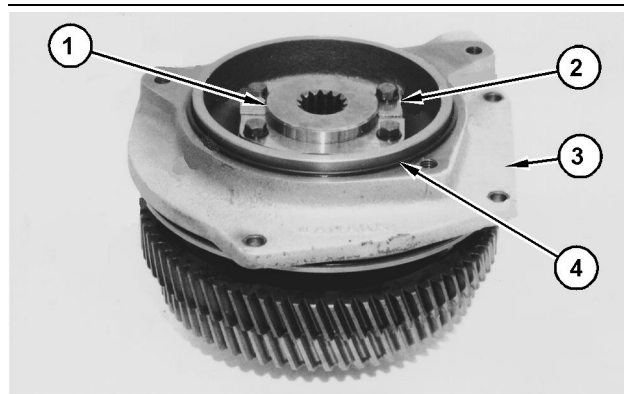


Illustration 466

g01052078

8. Install rear adapter assembly (3) on shaft assembly (1).
9. Install bolts and thrust washers (2).
10. Install O-ring seal (4) on rear adapter assembly (3).

End By:

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

i02047064

Engine Oil and Water Pump Drive - Install

SMCS Code: 1313-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the O-ring seals are installed in the grooves of the adapter assemblies. Also apply clean engine oil to the seals.

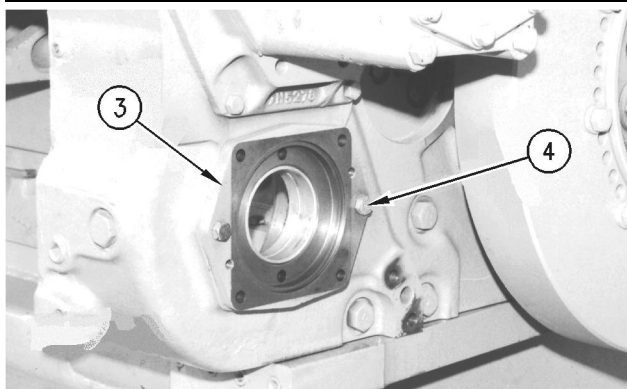


Illustration 467

g00921411

2. Install front adapter assembly (3) and bolts (4).

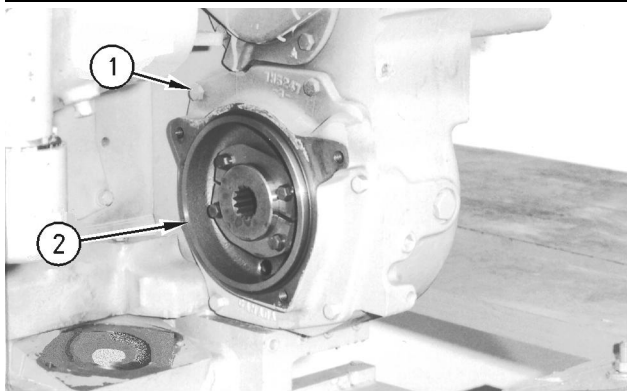


Illustration 468

g00921410

3. Install rear adapter assembly (2) and bolts (1).

End By:

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

i02047077

Engine Oil Pan - Remove

SMCS Code: 1302-011

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 engine oil into a suitable container for storage or for disposal. Refer to the Operation and Maintenance Manual, "Capacities (Refill)" for the oil capacity.

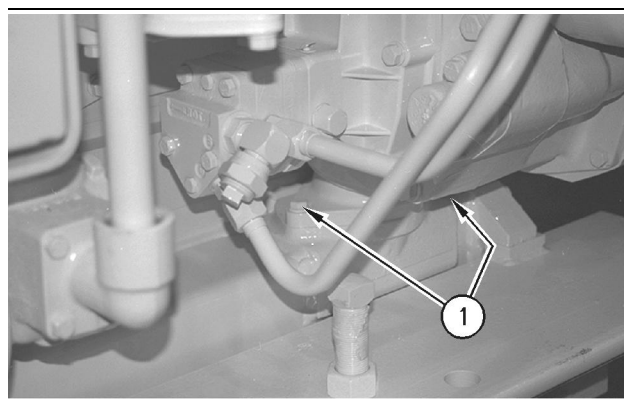


Illustration 469

g00921655

2. Remove bolts (1) that hold the connector for the oil pump to the oil pan.

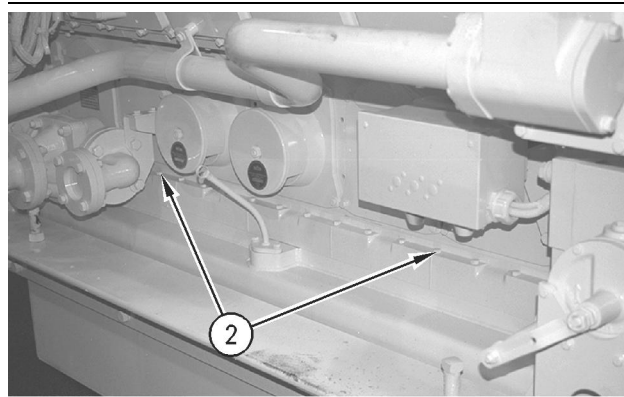


Illustration 470

g00921656

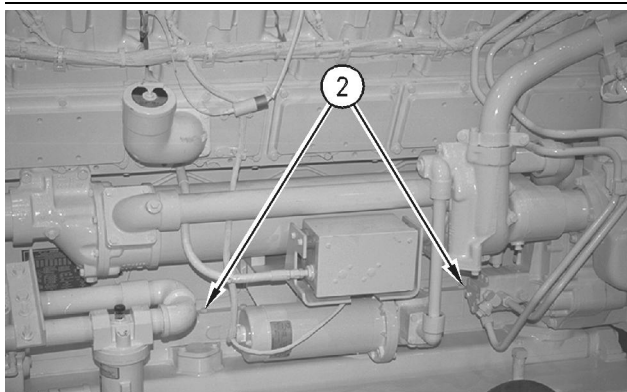


Illustration 471

g00604419

3. Remove bolts (2) that connect the oil pan to the engine.

WARNING

Improper lift rigging can allow unit to tumble causing injury and damage.

Note: If improper equipment is used to lift the engine, injury and damage can occur. Use cables or chains that are properly rated for the weight. Use a spreader bar and attach the cables or chains according to the information that is on the lifting film for the engine.

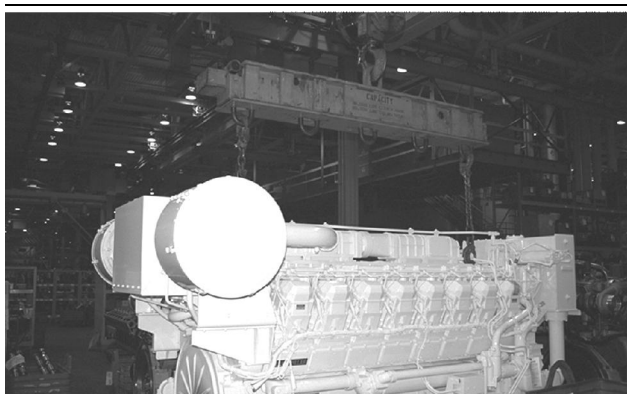


Illustration 472

g00604420

4. Attach a suitable lifting device to the engine lifting eyes.
 - The weight of the 3508 Engine is approximately 4445 kg (9800 lb). The weight of the oil pan is approximately 240 kg (530 lb).
 - The weight of the 3512 Engine is approximately 5900 kg (13,000 lb). The weight of the oil pan is approximately 295 kg (650 lb).

- The weight of the 3516 Engine is approximately 7711 kg (17,000 lb). The weight of the oil pan is approximately 409 kg (900 lb).

5. Lift the engine from the oil pan.

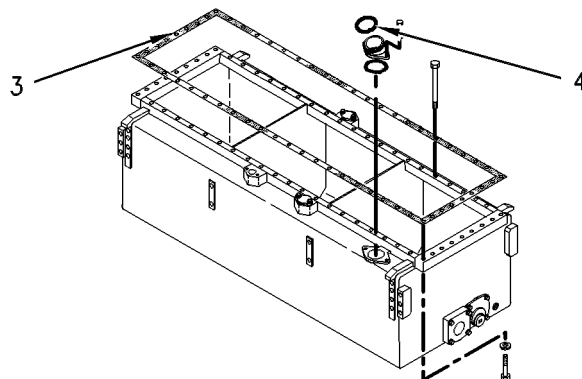


Illustration 473

g00604494

6. Remove gasket (3) and O-ring seal (4).

i02047084

Engine Oil Pan - Disassemble

SMCS Code: 1302-015

Disassembly Procedure

Start By:

- a. 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.

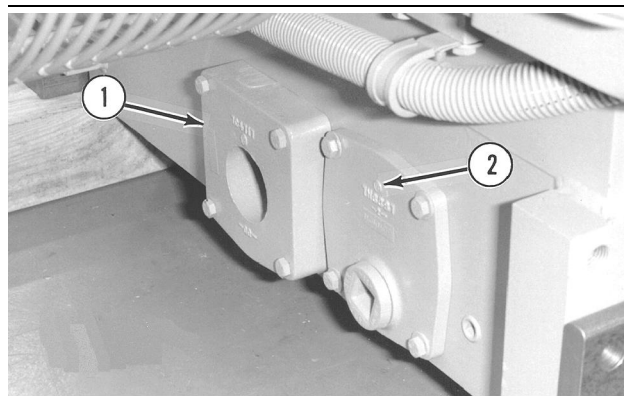


Illustration 474

g00590183

1. Remove covers (1) and (2). Also remove the O-ring seals.

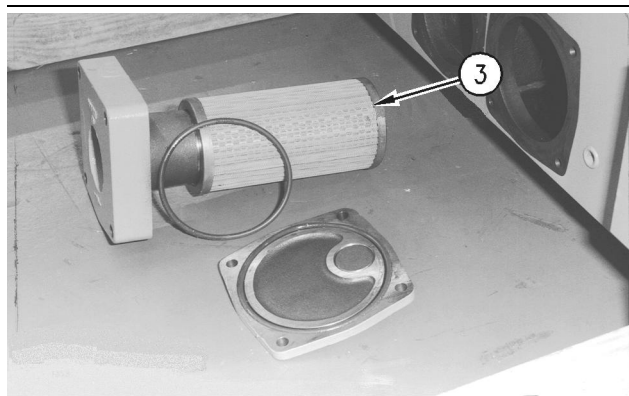


Illustration 475

g00921661

2. Remove screen assembly (3).

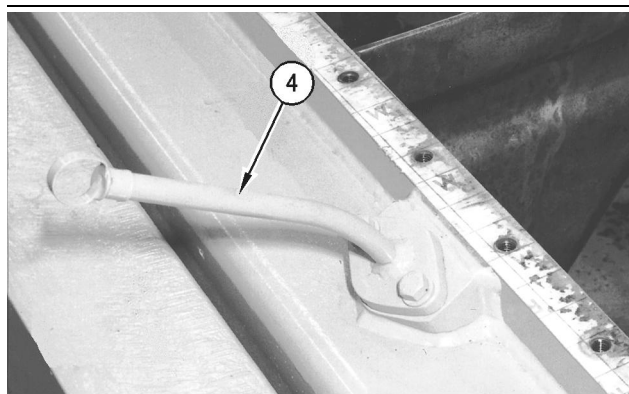


Illustration 476

g00921665

3. Remove the bolts and engine oil level gauge (4).

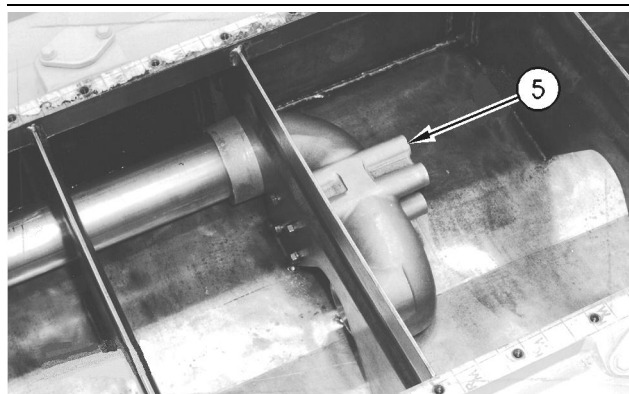


Illustration 477

g00921672

4. Remove the bolts that hold bell (5) on the engine oil pan. Remove bell (5) from the tube assembly.

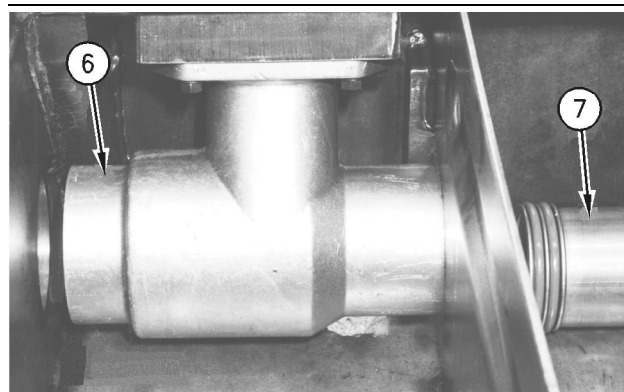


Illustration 478

g00921673

5. Pull tube assembly (7) from housing (6).
6. Remove the bolts and housing (6).
7. Remove tube assembly (7) and the O-ring seals.

i02047087

Engine Oil Pan - Assemble

SMCS Code: 1302-016

Assembly Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

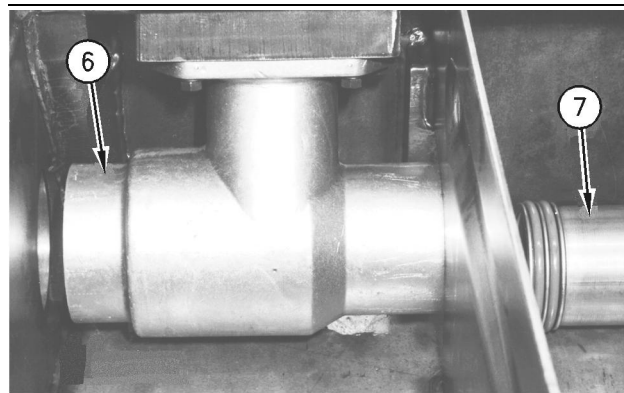


Illustration 479

g00921673

1. Install tube assembly (7) and the O-ring seals.
2. Install housing (6) with the bolts.
3. Insert tube assembly (7) into housing (6).

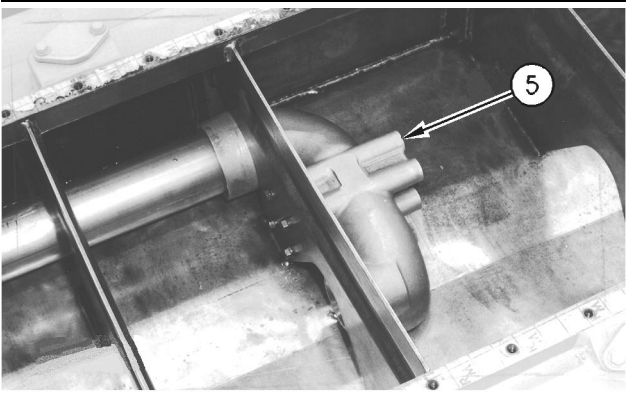


Illustration 480 g00921672

4. Position bell (5) on the tube assembly. Install the bolts that hold bell (5) on the engine oil pan.

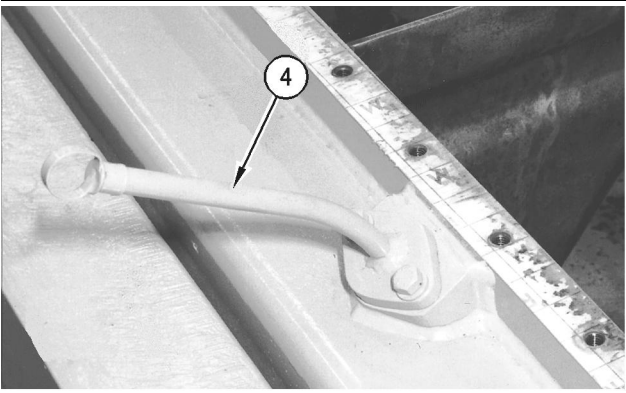


Illustration 481 g00921665

5. Install engine oil level gauge (4) and the bolts.

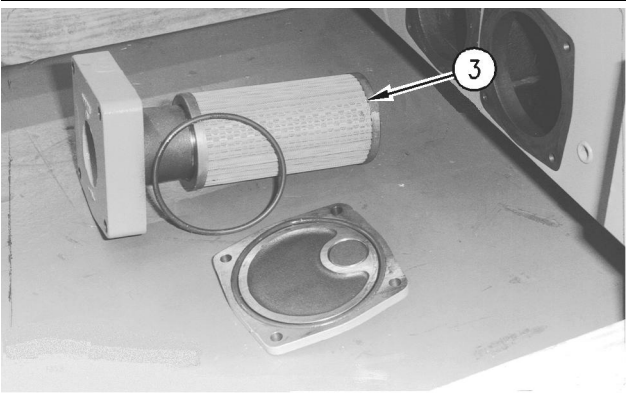


Illustration 482 g00921661

6. Install screen assembly (3).

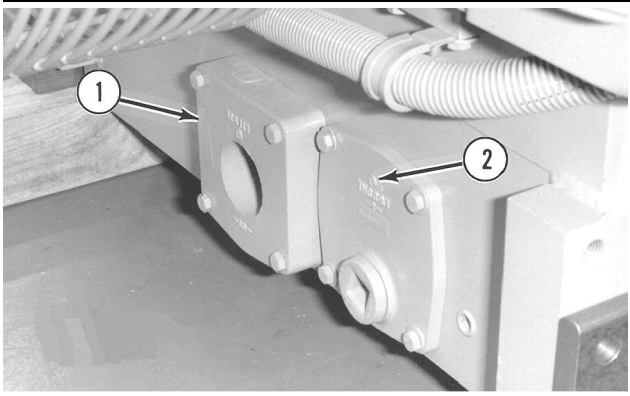


Illustration 483 g00590183

7. Install the O-ring seals on covers (1) and (2). Install covers (1) and (2).

End By:

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

i02047093

Engine Oil Pan - Install

SMCS Code: 1302-012

Installation Procedure

Table 42

Required Tools			
Tool	Part Number	Part Description	Qty
A	7M-7260	Liquid Gasket	1
B	-	3/8 - 16 NC Guide Bolts	4

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

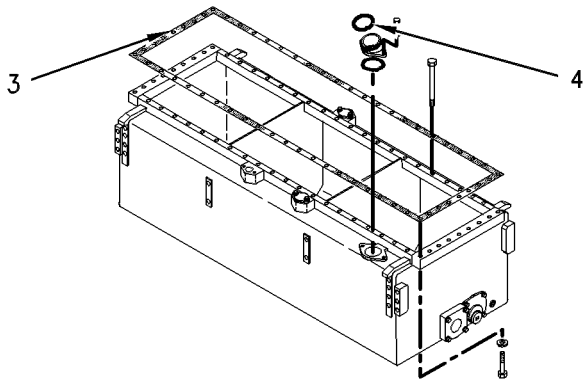


Illustration 484

g00604494

1. Inspect O-ring seal (4) for the connector to the oil pump. If the seal is cut, scratched, or cracked, obtain a new seal for assembly. Lubricate the bore for the seal with clean engine oil. Install the seal.
2. Make sure that the surface for gasket (3) is clean. Apply Tooling (A) to gasket (3). Install Tooling (B) in the oil pan. Place the gasket into position.

WARNING

Improper lift rigging can allow unit to tumble causing injury and damage.

Note: If improper equipment is used to lift the engine, injury and damage can occur. Use cables or chains that are properly rated for the weight. Use a spreader bar and attach the cables or chains according to the information that is on the lifting film for the engine.

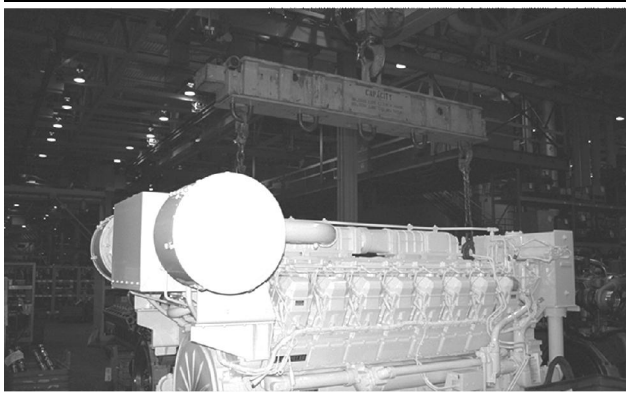


Illustration 485

g00604420

3. Attach a suitable lifting device to the engine lifting eyes.
 - The weight of the 3508 Engine is approximately 4445 kg (9800 lb). The weight of the oil pan is approximately 240 kg (530 lb).

- The weight of the 3512 Engine is approximately 5900 kg (13,000 lb). The weight of the oil pan is approximately 295 kg (650 lb).
- The weight of the 3516 Engine is approximately 7711 kg (17,000 lb). The weight of the oil pan is approximately 409 kg (900 lb).

4. Lift the engine. Place the engine onto the oil pan or place the oil pan in position under the engine. Remove Tooling (B) from the oil pan.

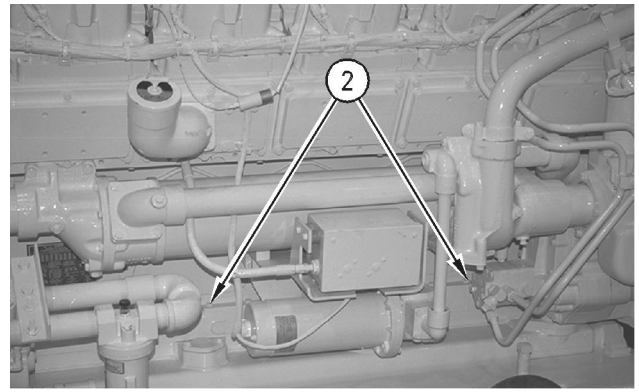


Illustration 486

g00604419

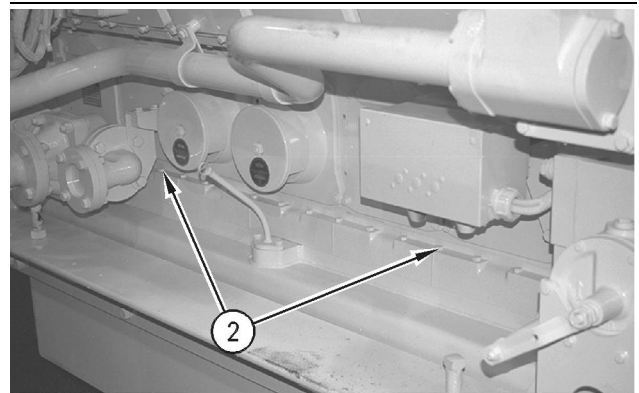


Illustration 487

g00604418

5. Install bolts (2) that hold the engine and the oil pan together.

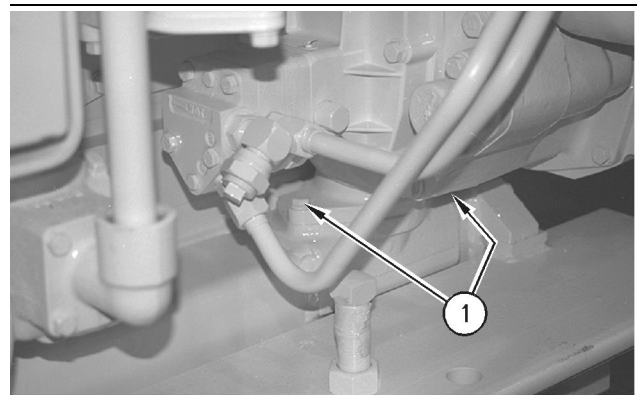


Illustration 488

g00604417

6. Install bolts (1) that hold the connector for the oil pump to the oil pan.
7. Fill the engine crankcase with oil. Refer to the Operation and Maintenance Manual, "Capacities (Refill)" for the oil capacity.

i02052160

Engine Oil Scavenge Pump - Remove

SMCS Code: 1312-011

Removal Procedure

Start By:

- a. 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.

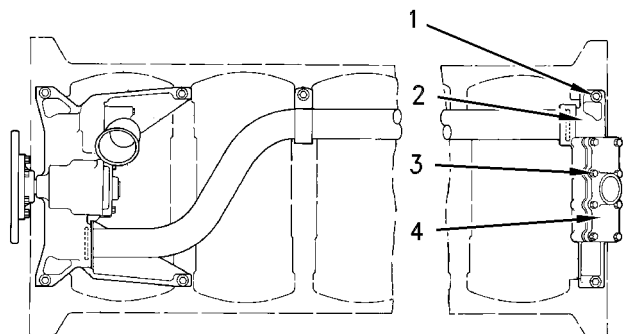


Illustration 489

g00604551

1. Remove bolts (1) in order to remove housing (2).
2. Remove bolts (3) and the washers in order to remove cover (4). Two screens are inside of the housing. Remove the screens.

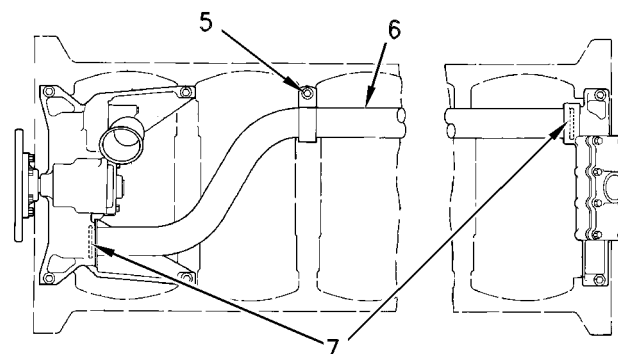


Illustration 490

g00604595

3. Remove bolts, washers, and clips (5) in order to remove tube (6).
4. Remove O-ring seals (7) from the tube.

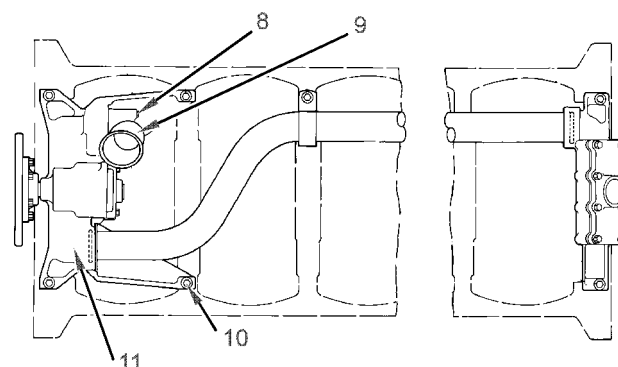


Illustration 491

g01052645

5. Remove bolts (8) in order to remove elbow (9).
6. Attach a suitable lifting device to oil scavenge pump (11). The weight of the oil scavenge pump is approximately 32 kg (71 lb). Remove bolts (10) in order to remove the oil scavenge pump.

i02412825

Engine Oil Scavenge Pump - Disassemble

SMCS Code: 1312-015

Disassembly Procedure

Table 43

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-2321	Combination Puller	1
	9S-9155	Spacer	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

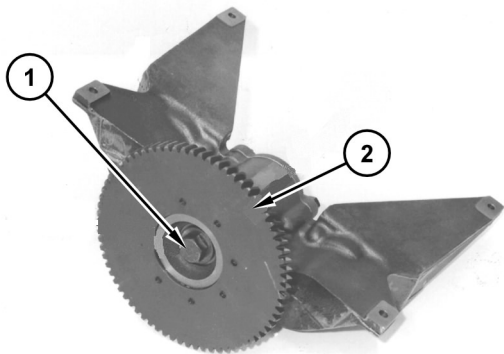


Illustration 492

g01205956

- 1. Remove bolt (1).
- 2. Use Tooling (A) to remove gear (2).

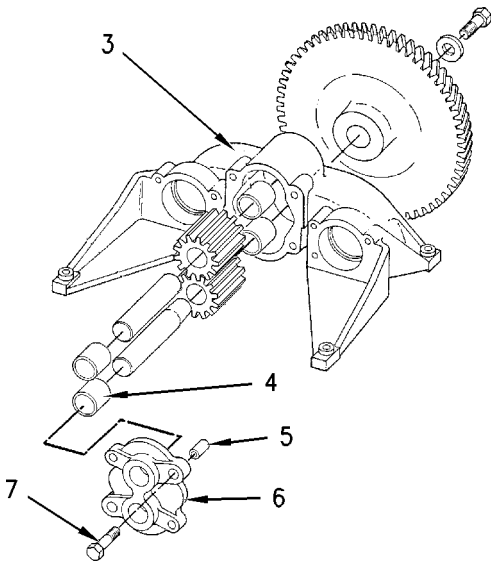


Illustration 493

g00923147

- 3. Mark body (3) and cover (6) for assembly purposes.
- 4. Remove bolts (7) and cover (6).
- 5. Remove dowels (5) and sleeve bearings (4) from cover (6).

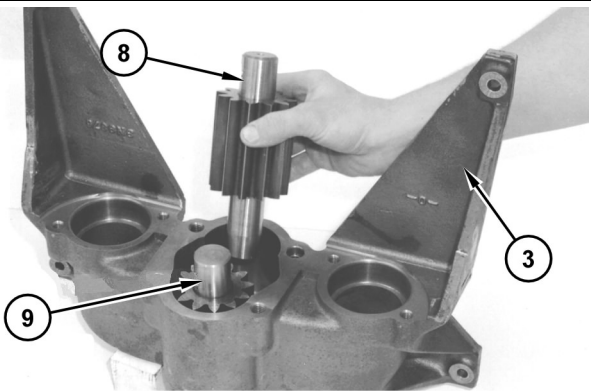


Illustration 494

g01205955

- 6. Remove drive shaft assembly (8) and idler shaft assembly (9) from body (3).

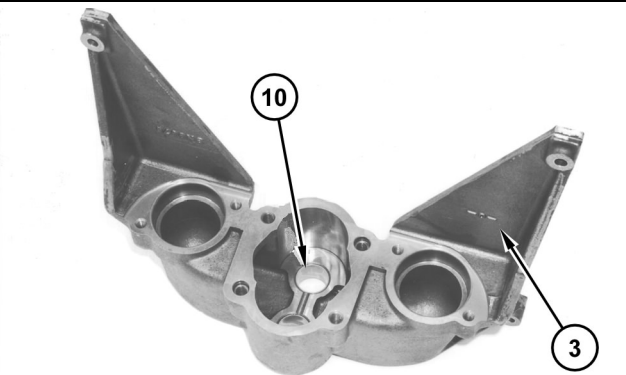


Illustration 495

g01205958

7. Remove sleeve bearings (10) from body (3).

i02412840

Engine Oil Scavenge Pump - Assemble

SMCS Code: 1312-016

Assembly Procedure

Table 44

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

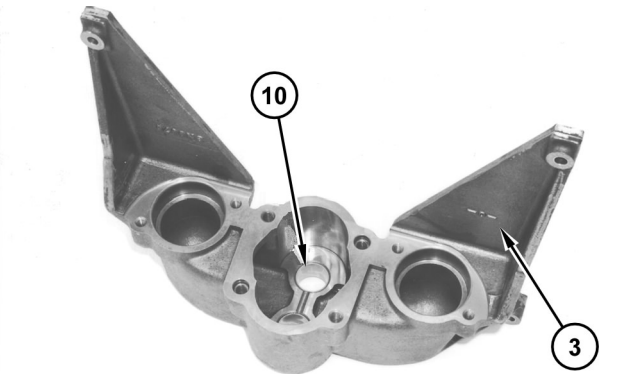


Illustration 496

g01205958

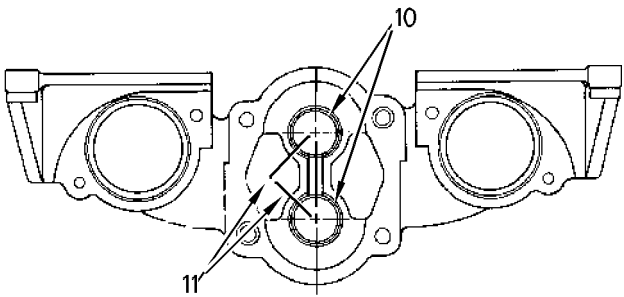


Illustration 497

g00604752

1. Apply clean engine oil to sleeve bearings (10). Use Tooling (B) to install sleeve bearings (10) to body (3).
2. Position the joints in sleeve bearings (10) for 45 ± 15 degrees from the center of the bearing bore. See Item (11) in Illustration 497.

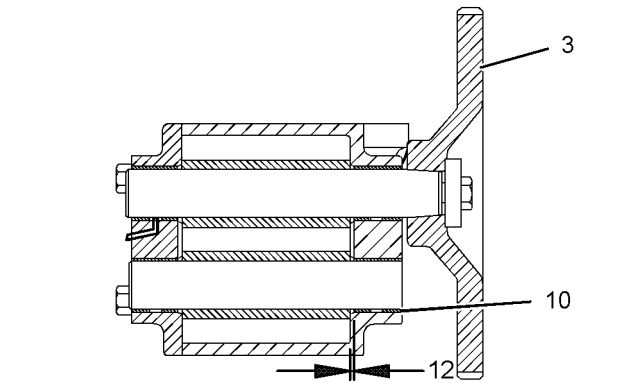


Illustration 498

g01206054

3. Install sleeve bearings (10) to a depth of 1.5 ± 0.5 mm (0.06 ± 0.02 inch) in body (3). See Item (12) in Illustration 498.

After installing sleeve bearings (10), measure the inner diameter of sleeve bearings (10). The inner diameter must be 31.837 ± 0.070 mm (1.2534 ± 0.0028 inch).

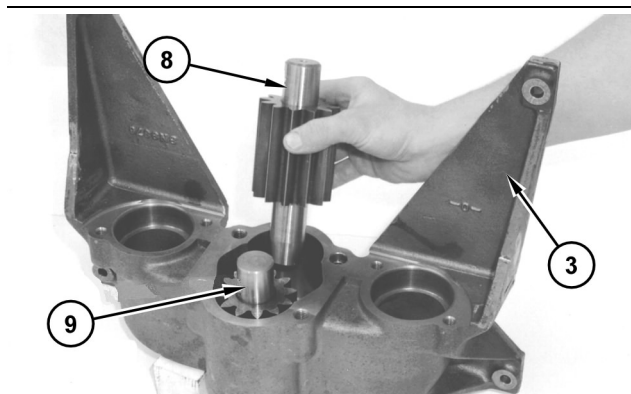


Illustration 499

g01205955

4. Apply clean engine oil to idler shaft assembly (9) and drive shaft assembly (8). Install idler shaft assembly (9) and drive shaft assembly (8) into body (3).

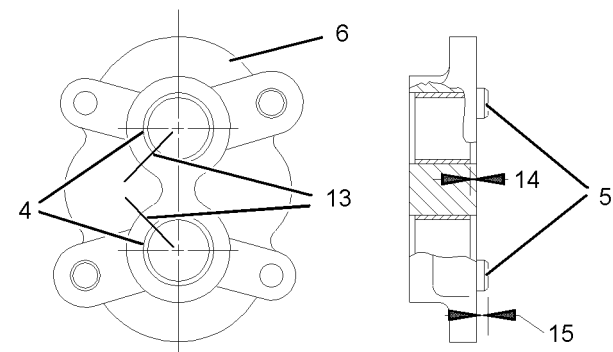


Illustration 500

g01206056

5. Apply clean engine oil to sleeve bearings (4). Use Tooling (B) to install sleeve bearings (4) in cover (6). Position the joints in sleeve bearings (4) for 45 ± 15 degrees from the center of the bearing bore. See Item (13) in Illustration 500.

Install sleeve bearings (4) to a depth of 1.5 ± 0.5 mm (0.06 ± 0.02 inch). See Item (14) in Illustration 500.

After installing sleeve bearings (4), measure the inner diameter of sleeve bearings (4). The diameter must be 31.837 ± 0.070 mm (1.2534 ± 0.0028 inch).

6. Install dowels (5) into cover (6). Install dowels (5) so that dowels (5) protrude 6.4 ± 0.5 mm (0.25 ± 0.02 inch) from the surface of cover (6). See Item (15) in Illustration 500.

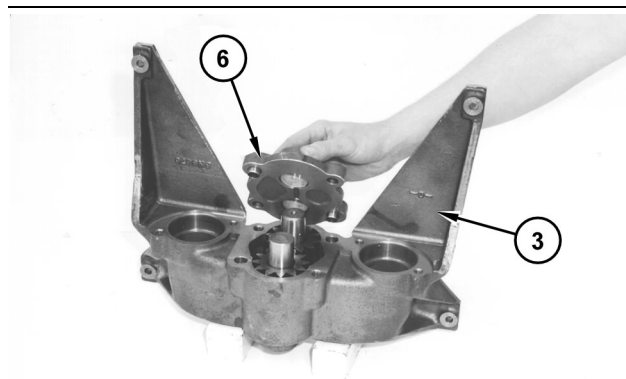


Illustration 501

g01206142

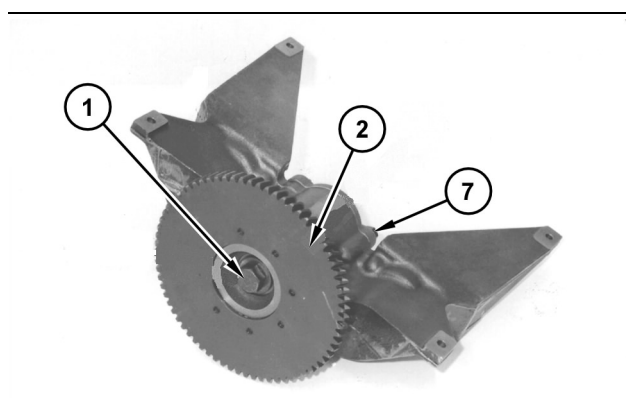


Illustration 502

g01206144

7. Align the marks on cover (6) and body (3) and position cover (6). Install bolts (7).

8. Install gear (2).

Tap on gear (2) in order to seat the taper onto the shaft. Install bolt (1). Tighten bolt (1) to a torque of 100 ± 20 N·m (75 ± 15 lb ft). Repeat this procedure until the torque does not change.

End By:

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

i02052188

Engine Oil Scavenge Pump - Install

SMCS Code: 1312-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

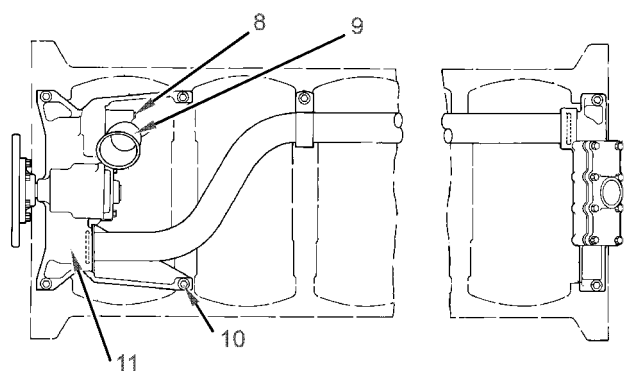


Illustration 503

g01052645

1. Attach a suitable lifting device to oil scavenge pump (11). The weight of the oil scavenge pump is approximately 32 kg (71 lb). Lift the oil scavenge pump into position. Install bolts (10) in order to secure the pump.
2. Install elbow (9) with bolts (8).

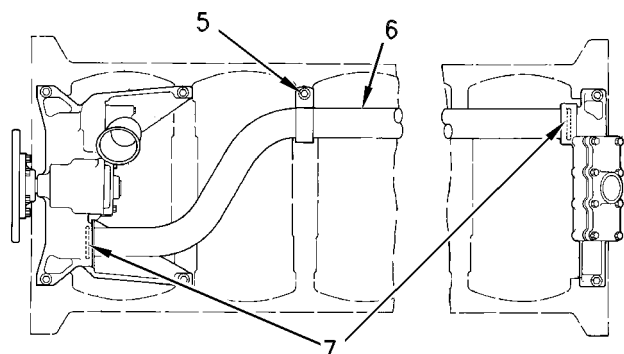


Illustration 504

g00604595

3. Inspect O-ring seals (7). If a seal is cut, scratched, or cracked, obtain a new seal for assembly. Coat the bores for the O-ring seals with clean engine oil. Install the O-ring seals into tube (6).

4. Install tube (6) onto the pump. Secure the tube with clips, washers, and bolts (5).

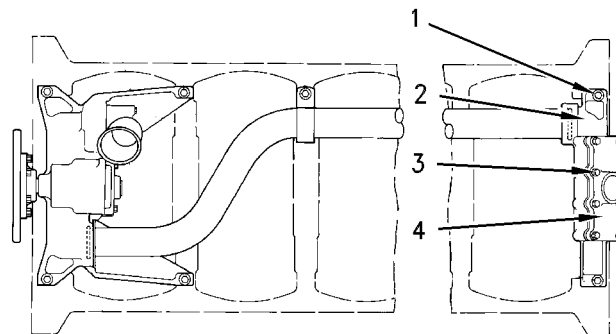


Illustration 505

g00604551

5. Clean the two screens from inside housing (2). Inspect the screens for good condition. Obtain new parts, if necessary. Place the screens into the housing.
6. Place cover (4) onto the housing. Secure the cover with bolts (3) and the washers.
7. Place the housing into position on the tube. Install the housing with bolts (1).

End By:

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

i01932610

Crankcase Breather - Remove and Install

SMCS Code: 1317-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

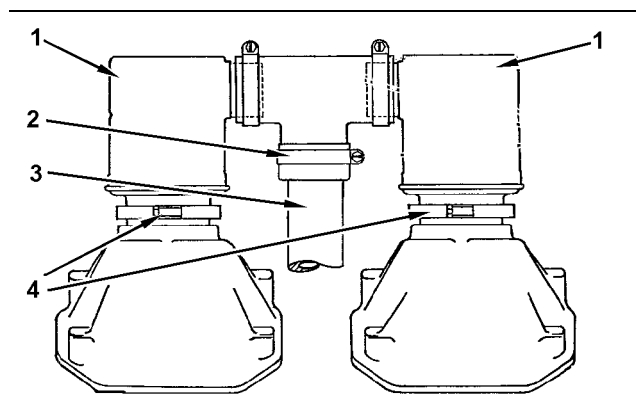


Illustration 506

g01057823

1. Loosen clamp (2). Remove the clamp and tube (3).
2. Loosen clamps (4). Remove both breathers (1) as a unit.

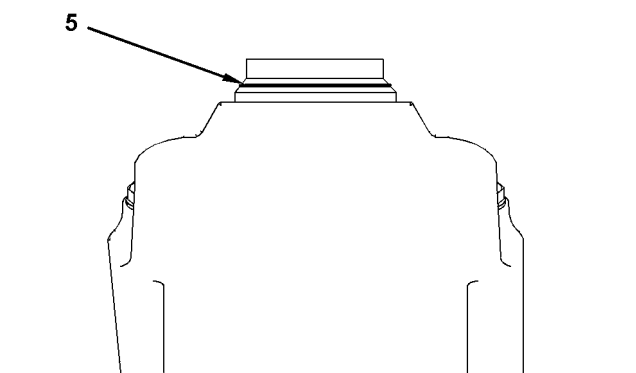


Illustration 507

g01057824

3. Remove O-ring seals (5) from the valve covers. Discard the O-ring seals.

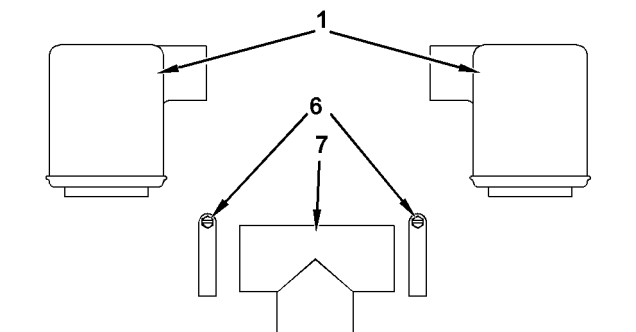


Illustration 508

g01057825

4. Remove clamps (6). Remove both breathers (1) from tee assembly (7).

Inspect the tee assembly for cracks. If the tee assembly is cracked, discard the old tee assembly and obtain a new tee assembly for installation.

5. Turn the breathers upside-down in order to inspect the condition of the breather elements.

Clean the breather elements with clean, nonflammable solvent. If the breather elements remain contaminated after the cleaning, discard the breathers and obtain new breathers. Do not attempt to disassemble the breathers.

Allow the breather elements to dry before installation.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

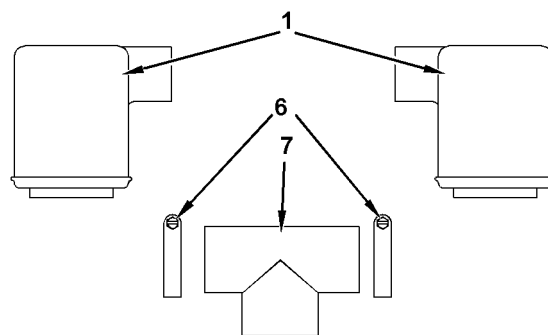


Illustration 509

g01057825

Note: Coat the rubber parts with clean engine oil or petroleum jelly in order to make installation easier.

1. Place clamps (6) over the parts of tee assembly (7) that will receive breathers (1). Install breathers (1) into the tee assembly. Tighten the clamps to a torque of 3.0 ± 0.5 N·m (27 ± 4 lb in).

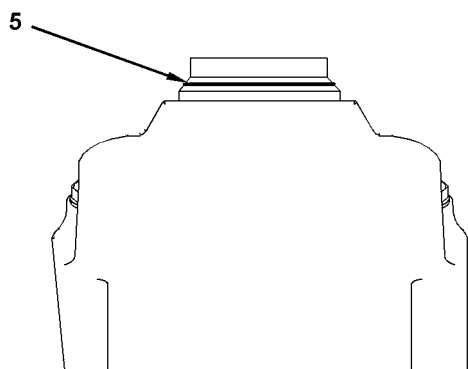


Illustration 510

g01057824

2. Coat new O-ring seals (5) with clean engine oil. Place the O-ring seals on the valve covers.

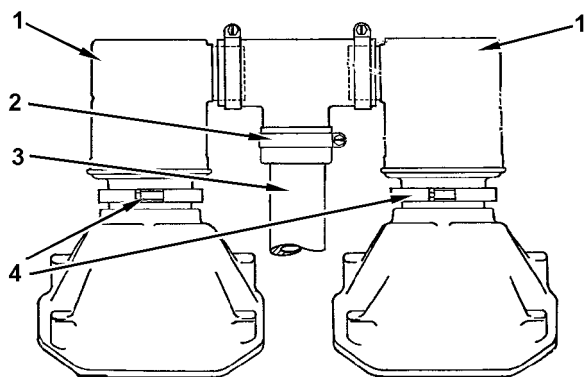


Illustration 511

g01057823

3. Place clamps (4) around the parts of the breathers that will be attached to the valve covers. Install both breathers (1) as a unit. Tighten the clamps.
4. Place clamp (2) on the part of the tee assembly that will receive tube (3). Install the tube. Tighten the clamp to a torque of $3.0 \pm 0.5 \text{ N}\cdot\text{m}$ ($27 \pm 4 \text{ lb in}$).

i02413993

Valve 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.

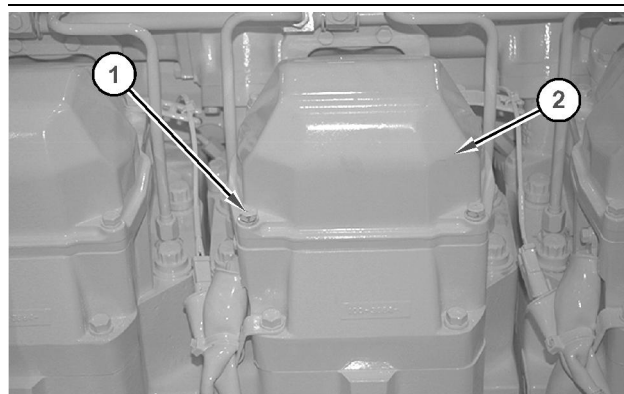


Illustration 512

g01052600

1. Remove bolts (1). Remove valve cover (2).

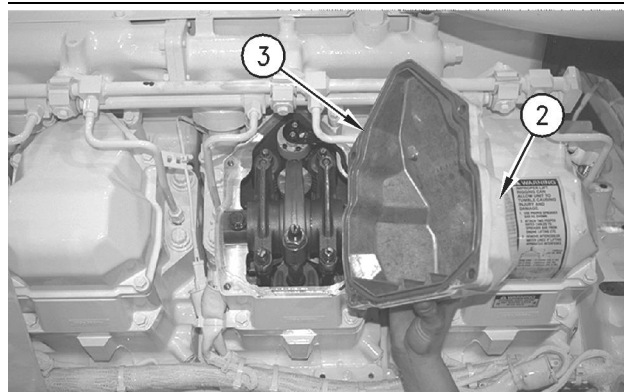


Illustration 513

g00923171

2. If necessary, remove O-ring seal (3) from valve cover (2).

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

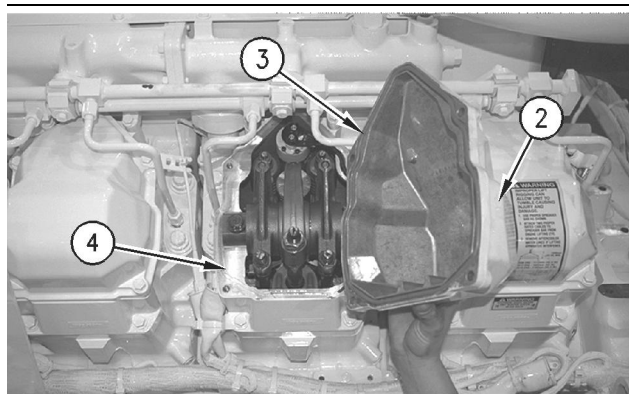


Illustration 514

g00605124

1. Install O-ring seal (3) in the groove of valve cover (2). Position valve cover (2) onto rocker arm base (4).

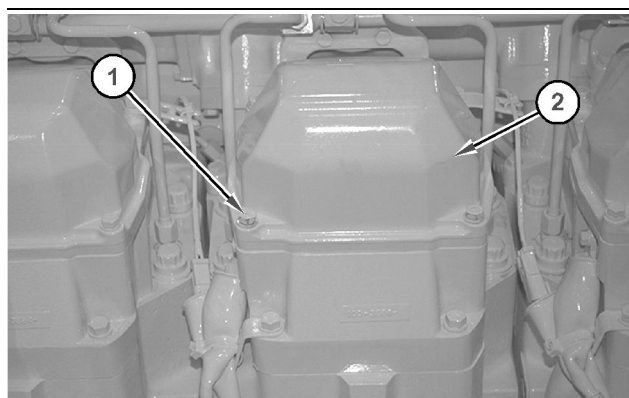


Illustration 515

g01052600

2. Install bolts (1) in valve cover (2). Tighten bolts (1) to a torque of 10 N·m (89 lb in). Tighten bolts (1) again to a torque of 20 ± 3 N·m (177 ± 27 lb in).

i02467510

Valve Cover Base - Remove and Install

SMCS Code: 1120-010

Removal Procedure

Start By:

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

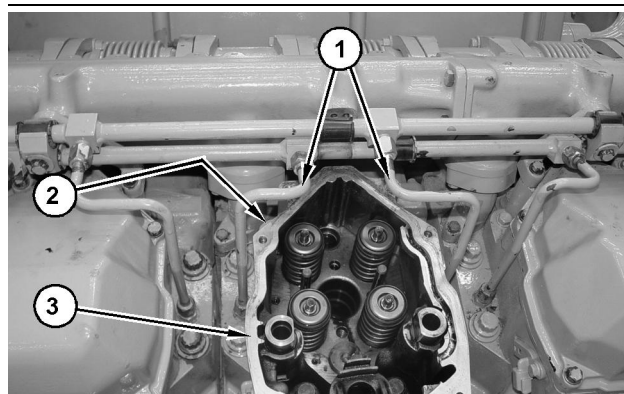


Illustration 516

g01052887

1. Remove tube assemblies (1).
2. Remove bolts (2) (not shown) and valve cover base (3).

Installation Procedure

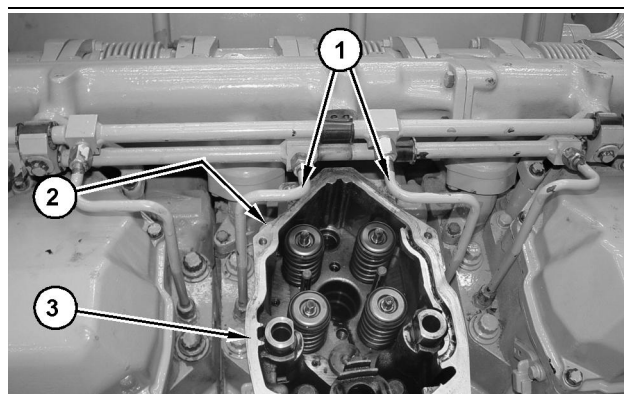


Illustration 517

g01052887

1. Position valve cover base (3) and install bolts (2) (not shown).
2. Install tube assemblies (1).

End By:

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

i02047270

Rocker Shaft and Push Rods - Remove

SMCS Code: 1102-011

Removal Procedure

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

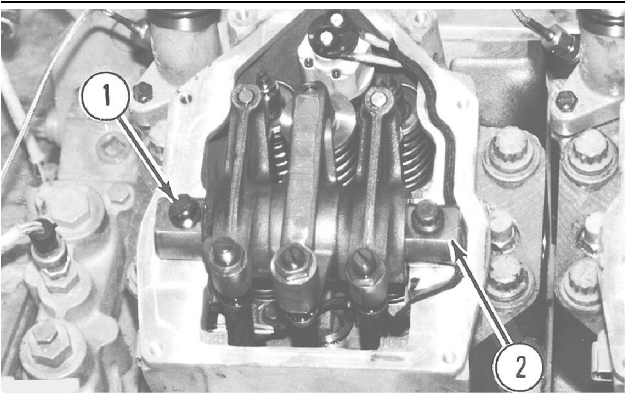


Illustration 518

g00605234

- 1. Remove bolts (1). Remove rocker shaft assembly (2) from the rocker arm base.

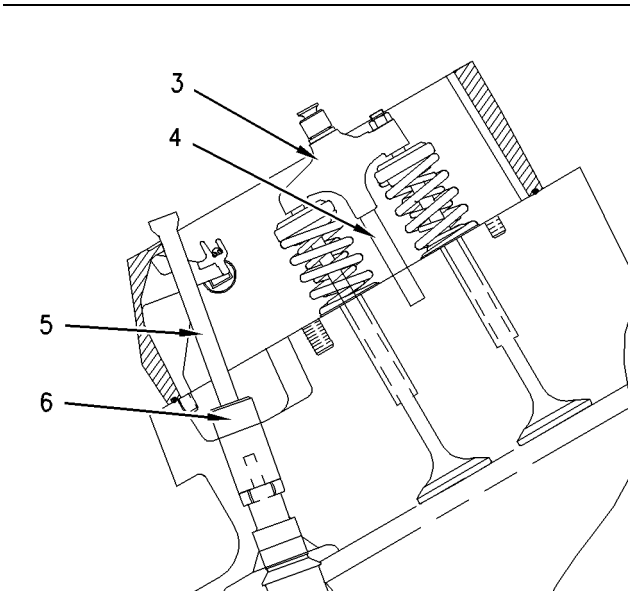


Illustration 519

g00636958

Note: Mark the pushrods for identification of location upon assembly.

- 2. Remove bridge assemblies (3) from dowels (4).
- 3. Remove pushrods (5) from the cup of valve lifters (6).

i02084784

Rocker Shaft - Disassemble

SMCS Code: 1102-015

Disassembly Procedure

Table 45

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

Start By:

- a. Remove the rocker shaft assemblies. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Remove".

i02084785

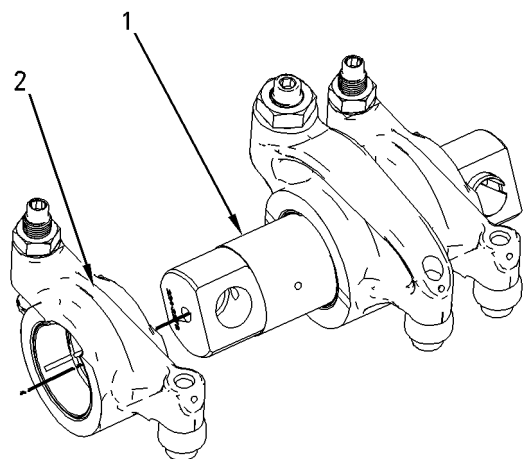


Illustration 520

g01004533

1. Slide shaft (1) out of rocker arms (2). If necessary, remove the dowel from the shaft.

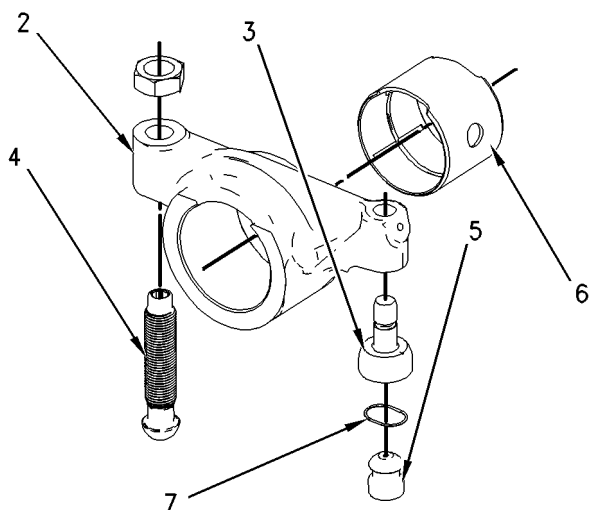


Illustration 521

g01004548

2. Remove adjustment screw (4) and the nut from rocker arm (2).
3. Use a hammer and a punch in order to remove socket (3) from rocker arm (2).
4. Remove button (5) from socket (3). Remove retaining ring (7) from button (5).
5. Use Tooling (A) in order to remove sleeve bearing (6) from rocker arm (2).

Rocker Shaft - Assemble

SMCS Code: 1102-016

Assembly Procedure

Table 46

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

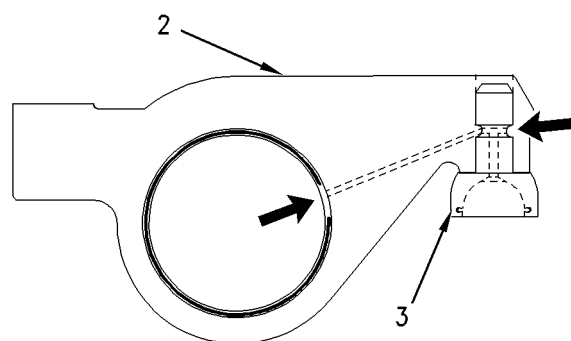


Illustration 522

g01004555

Oil holes

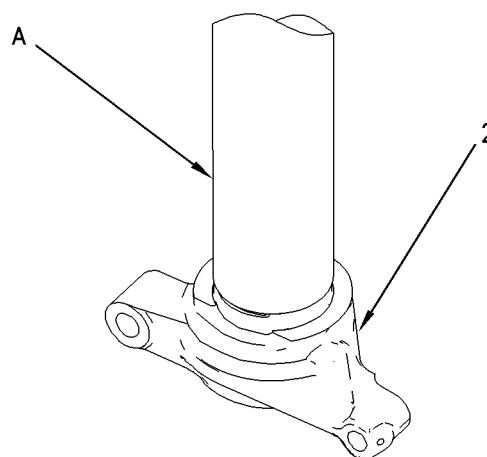


Illustration 523

g01004558

Note: Make sure that the bore of the rocker arm and the sleeve bearing are thoroughly clean.

1. The sleeve bearing and the rocker arm have oil supply holes. The holes must be aligned when the bearing is installed in the rocker arm. Align the joint of the bearing toward the top of the rocker arm. Align the oil hole in the bearing with the oil hole in the rocker arm. Use Tooling (A) in order to install the sleeve bearing in rocker arm (2).

After the bearing is installed, measure the bore of the bearing. The bore must be 45.056 ± 0.015 mm (1.7740 ± 0.0006 inch).

2. Align the scribe mark on socket (3) with the scribe mark on rocker arm (2). Press socket (3) fully into rocker arm (2).

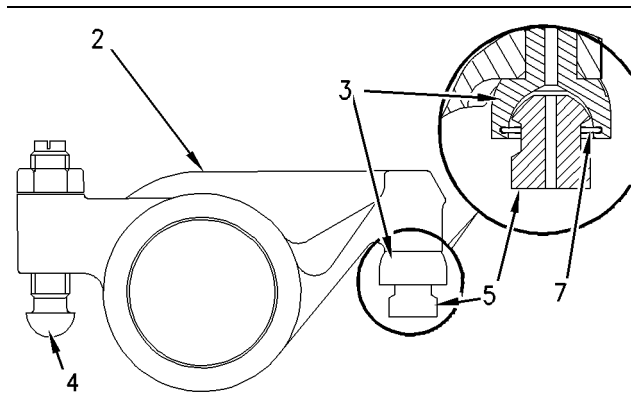


Illustration 524

g01004562

3. Place retaining ring (7) on button (5). Install button (5) in socket (3).
4. Install adjustment screw (4) and the nut on rocker arm (2).

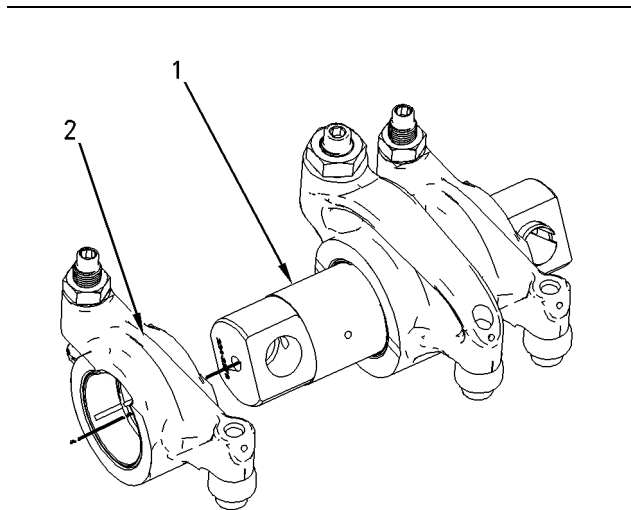


Illustration 525

g01004533

5. If the dowel was removed from shaft (1), install a new dowel. The dowel must project 6.0 mm (0.24 inch) above the surface of shaft (1).
6. Coat the bearings of rocker arms (2) and coat shaft (1) with clean engine oil. Install rocker arms (2) on shaft (1).

End By:

- a. Install the rocker shaft assemblies. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Install".

i02047291

Rocker Shaft and Push Rods - Install

SMCS Code: 1102-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

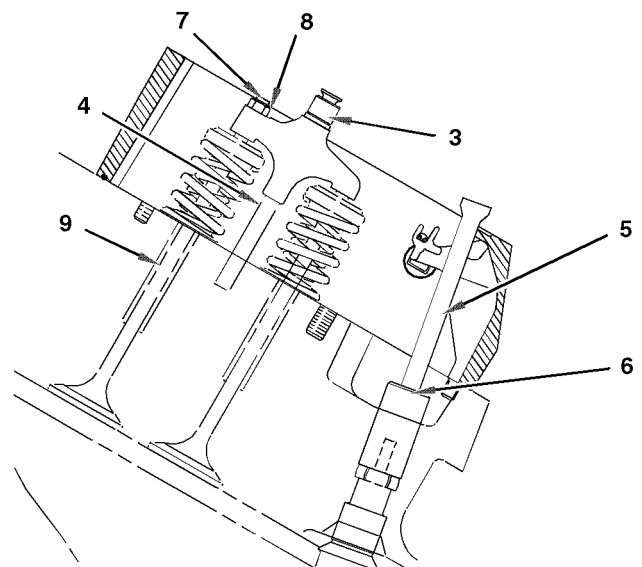


Illustration 526

g01051014

1. Loosen adjustment screw (7) and jam nut (8) on the bridge assembly.
2. Coat these items with clean engine oil: dowels (4), the receptacle of the bridge for the dowels, and the uppermost contact surface of bridge assembly (3).

3. Place the bridge assembly into position on the dowel. Apply 1 to 14 N·m (1 to 10 lb ft) of downward force on the uppermost contact surface of bridge assembly (3). While you apply the force, turn adjustment screw (7) until the screw contacts valve stem (9).

Turn the adjustment screw for an additional 20 to 30 degrees (1/3 to 1/2 of the hex). This will straighten the dowel in the guide. This will also compensate for a lack of clearance (slack) in the threads.

4. Hold the adjustment screw in position and tighten jam nut (8) to a torque of 30 ± 4 N·m (22 ± 3 lb ft).

Note: It is very important to install each pushrod in the original location.

5. Coat pushrods (5) and the cups of the valve lifters (6) with clean engine oil. Place the pushrods into position on the valve lifters.

NOTICE

Ensure that the crankshaft and the camshafts are in time with each other. Also ensure that the adjustment screws in the rocker arms are loosened completely before the bolts on the rocker shaft are tightened or damage to the valves and the pistons may occur.

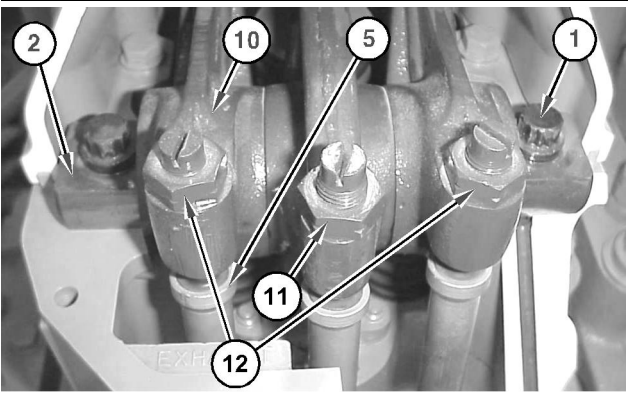


Illustration 527

g01051017

NOTICE

If the rocker shaft is not positioned correctly, the oil supply to the sleeve bearings in the rocker arm will be shut off. This will cause seizure of the bearings and severe damage to the engine.

Be sure to orient the rocker shaft in the correct position.

6. Place rocker shaft assembly (2) in position on the rocker arm base. Make sure that rocker arms (10) and pushrods (5) are aligned. Install bolts (1). Tighten the bolts to a torque of 215 ± 40 N·m (159 ± 30 lb ft).

7. Adjust the valve bridge and the valve lash according to Testing and Adjusting, “Valve Lash and Valve Bridge Adjustment”.
8. Adjust the fuel injection pump according to Testing and Adjusting, “Fuel Injector Adjustment”.
9. Tighten nuts (12) to a torque of 70 ± 15 N·m (52 ± 11 lb ft).
10. Tighten nut (11) for the rocker arm of the fuel injection pump to a torque of 120 ± 15 N·m (89 ± 11 lb ft).

End By:

- a. Install the valve covers. Refer to Disassembly and Assembly, “Valve Cover - Remove and Install”.

i02415328

Electronic Unit Injector - Remove

SMCS Code: 1290-011

Removal Procedure

Table 47

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

Start By:

- a. Remove the rocker shaft assembly and the pushrods. Refer to Disassembly and Assembly, “Rocker Shaft Assembly and Push Rods - Remove”.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

i02415334

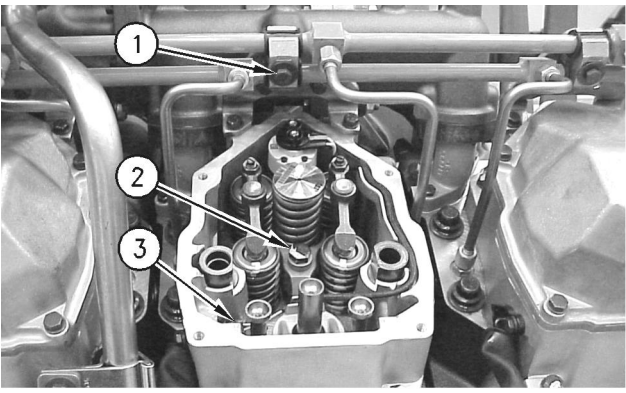


Illustration 528

g00903832

1. Remove bolt (1) and the clamp.
2. Remove bolt (2) and the clamp.
3. Disconnect harness assembly (3).

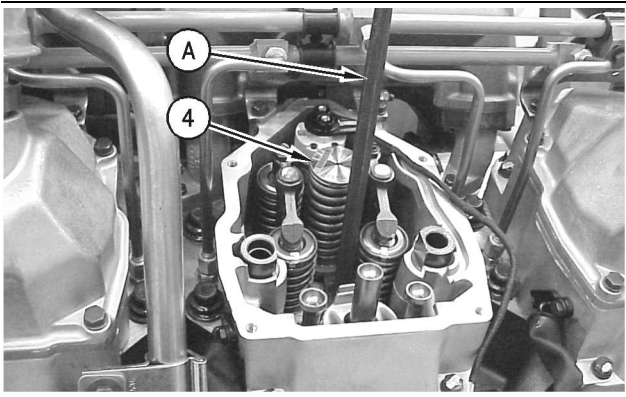


Illustration 529

g00903932

4. Use Tooling (A) to remove electronic unit injector (4).

Electronic Unit Injector - Install

SMCS Code: 1290-012

Installation Procedure

Table 48

Required Tools			
Tool	Part Number	Part Description	Qty
B	9U-6862	Tapered Brush	1
C	4C-5027	Tap Wrench	1
D	4C-6774	Vacuum Gun Kit	1
E	1P-0808	Multipurpose Grease	1
F	1U-5512 or 8T-7765	Abrasive Material or Surface Reconditioning Pad	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Remove all carbon deposits from the angled surface at the bottom of the cylinder head bore for the fuel injection pump. Failure to clean this area may prevent the fuel injection pump from seating properly. This could result in failure of the fuel injection pump due to leakage of exhaust gas into the fuel passage.

1. It is very important to clean the cylinder head bore for the electronic unit injector before you install the electronic unit injector. Use the following procedure to clean the bore.

Note: A fine grade of Scotch Brite material is recommended for cleaning the cylinder head bore for the electronic unit injector. The product is available as Tooling (F).

- a. Place a 38 mm (1.5 inch) square piece of Scotch Brite material on the end of Tooling (B).

Note: It should not be necessary to use a power tool to clean the cylinder head bore for the electronic unit injector.

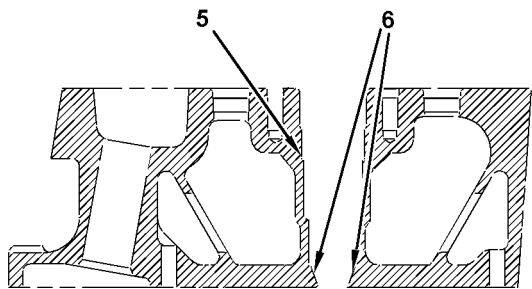


Illustration 530

g01051051

- b. Hold the brush with Tooling (C). Insert the brush into bore (5). Rotate the Scotch Brite material against the lower surface of bore (6). Continue cleaning until the surface is smooth and shiny.

Note: Tooling (D) is recommended for cleaning loose particles from the bore. The vacuum is operated with pressurized air.

- c. Remove all of the loose particles from the bore.

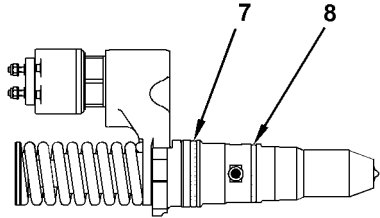


Illustration 531

g01051052

2. Inspect O-ring seals (7) and (8) for good condition. Obtain new O-ring seals, if necessary. Coat the O-ring seals and coat the cylinder head bore for the electronic unit injector with Tooling (E).
3. Press the electronic unit injector into the bore of the cylinder head. Do not strike the electronic unit injector. Center the solenoid between the valve springs.

Note: Adjust the height of the electronic unit injector according to the Service Manual, "Specifications".

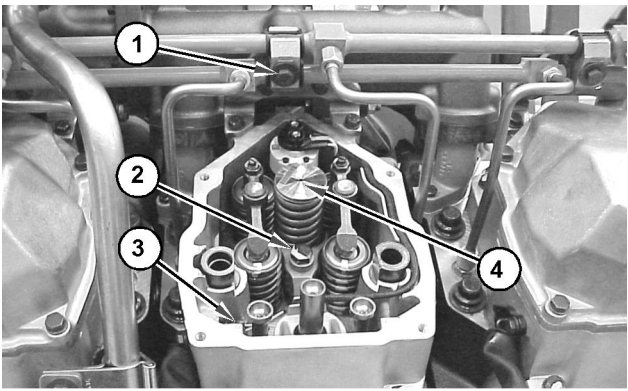


Illustration 532

g01052571

4. To seat electronic unit injector (4) into the bore, install the clamp with bolt (2) and the washer. Tighten the bolt to a torque of $65 \pm 7 \text{ N}\cdot\text{m}$ ($48 \pm 5 \text{ lb ft}$).
5. Connect harness assembly (3) to the connector. Tighten the terminal nuts to a torque of $1.70 \pm 0.25 \text{ N}\cdot\text{m}$ ($15 \pm 2 \text{ lb in}$).
6. Press the harness assembly into the groove in the valve cover base.
7. Install bolt (1) and the clamp.

End By:

- a. Install the rocker shaft assembly and the pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Install".

i02414981

Cylinder Head - Remove

SMCS Code: 1100-011

Removal Procedure

Table 49

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

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 Dealer Service Tool Catalog" 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 cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

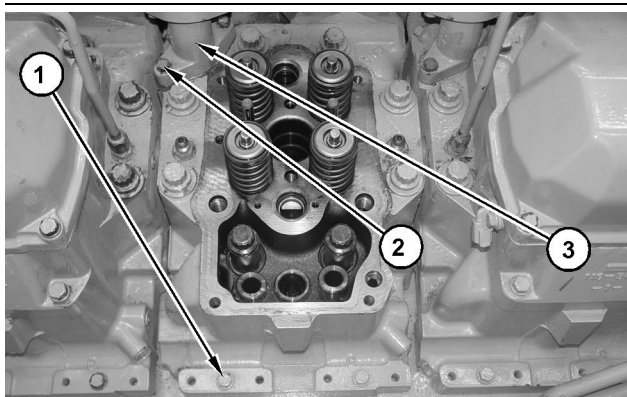


Illustration 533

g01053854

2. Remove bolts (1) and (2). Remove tube (3).

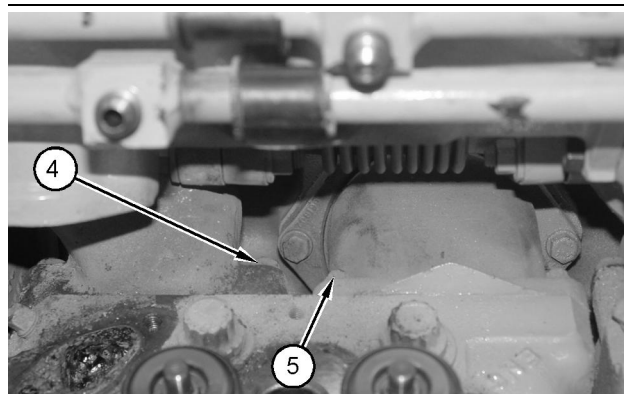


Illustration 534

g01053859

3. Remove four bolts (4) (not shown) from exhaust tube assembly and remove four bolts (5) (not shown) from inlet tube assembly.

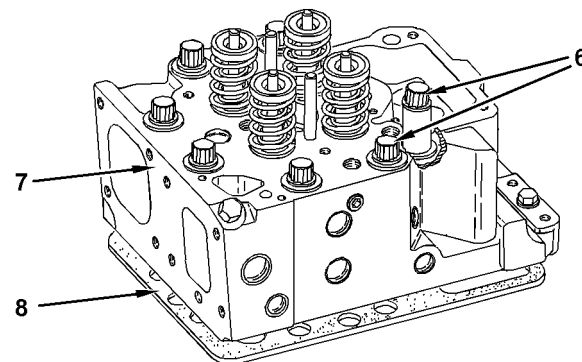


Illustration 535

g01053860

4. Remove bolts (6). Use a suitable lifting device and Tooling (A) in order to remove cylinder head assembly (7). The weight of cylinder head assembly (7) is approximately 47 kg (104 lb). Remove gasket (8).

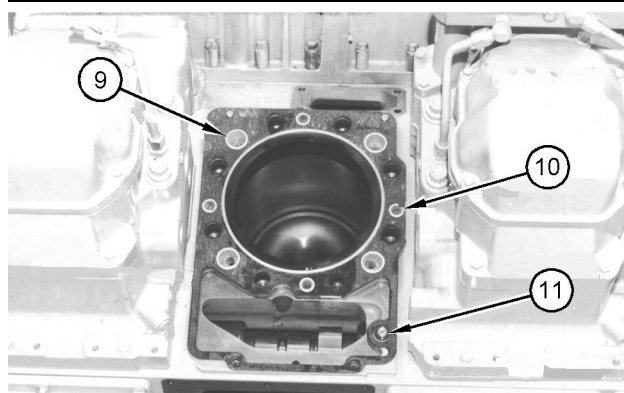


Illustration 536

g01053975

5. Remove seals (9) and (10), and O-ring seal (11) from the spacer plate.

i02048542

Cylinder Head - Disassemble

SMCS Code: 1100-015

Disassembly Procedure

Start By:

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

Inlet and Exhaust Valves

Table 50

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

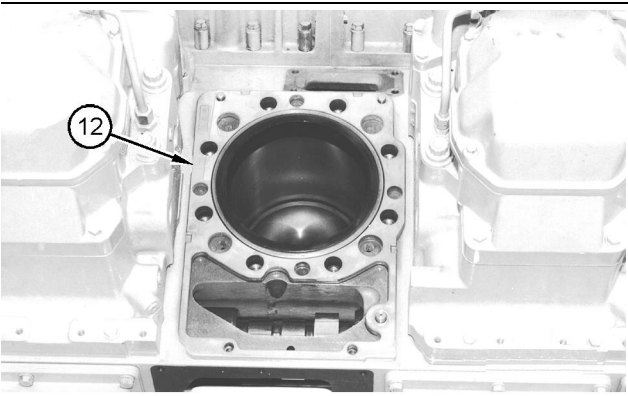


Illustration 537

g01053977

6. Remove spacer plate (12) from the dowels in the cylinder block.

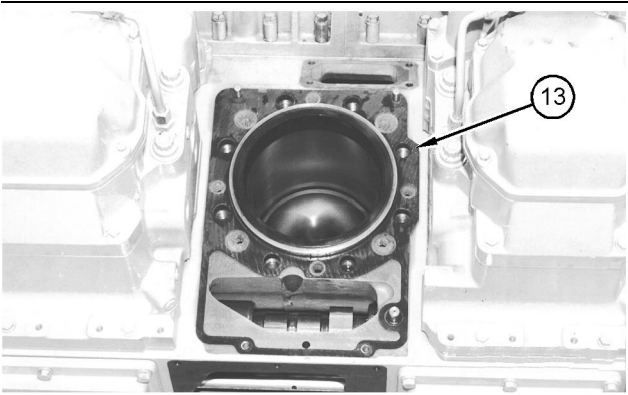


Illustration 538

g01053978

7. Remove gasket (13) from the dowels.

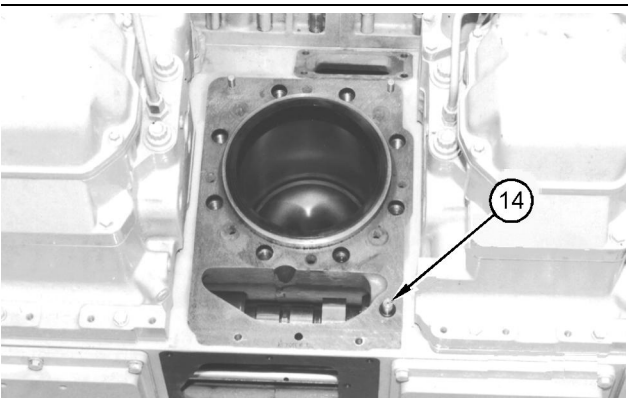


Illustration 539

g01053983

8. Remove the O-ring seal from dowel (14).

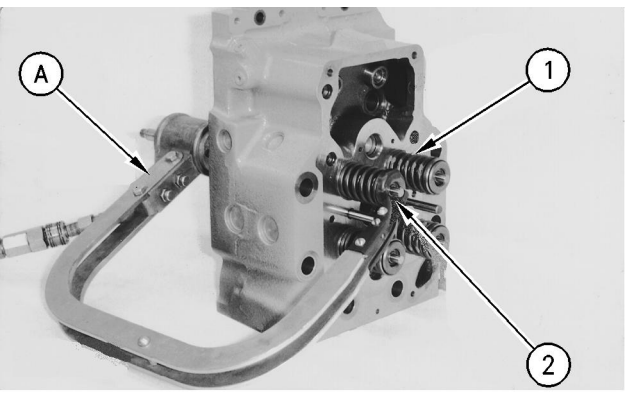


Illustration 540

g00905560

⚠ 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.

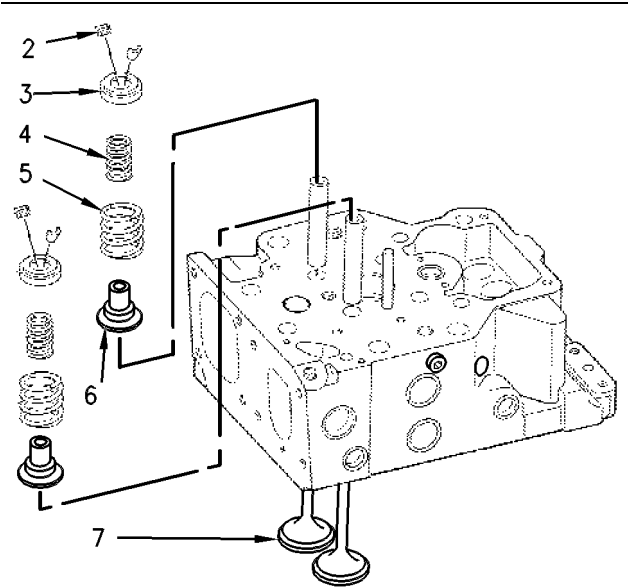


Illustration 541 g00618922

1. Use Tooling (A) to compress valve spring (1).
 2. Remove retainer lock (2).
 3. Release the tension on Tooling (A). Remove Tooling (A).
 4. Remove valve rotator (3), outer spring (5), inner spring (4), and seal (6).
- Note:** If the valves will be reused, mark the valves for identification upon assembly.
5. Remove valve (7) from the cylinder head.
 6. Use Tooling (B) to measure the force of the valve springs. Refer to Specifications for the correct spring force.
 7. Repeat Steps 1 through 6 for the remaining valves.

Bridge Dowels

Table 51

Required Tools			
Tool	Part Number	Part Description	Qty
C	5P-0944	Dowel Puller Group	1
	5P-0942	Dowel Extractor	1

NOTICE
Keep all parts clean from contaminants.
Contaminants may cause rapid wear and shortened component life.

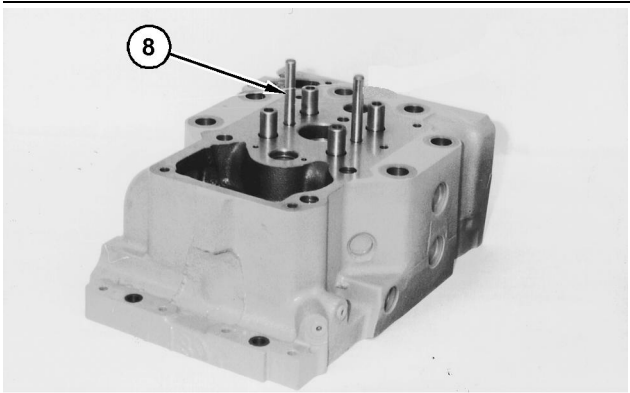


Illustration 542 g01051069

1. If the bridge dowels will be replaced, use Tooling (C) to remove bridge dowel (8) from the cylinder head.

Inlet and Exhaust Valve Seat Inserts

Table 52

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

NOTICE
Keep all parts clean from contaminants.
Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (D) to remove the valve seat inserts from the cylinder head.
2. Thoroughly clean valve seat bores in the cylinder head.

Inlet and Exhaust Valve Guides

Table 53

Required Tools			
Tool	Part Number	Part Description	Qty
E	7M-3975	Valve Guide Driver	1
	5P-1729	Valve Guide Bushing	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (E) and a hammer to remove the valve guides from the cylinder head.

Valve Lifters

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The valve lifters may also be removed with the cylinder head on the engine. Remove the camshaft and use the following steps in order to remove the valve lifters with the cylinder head on the engine.

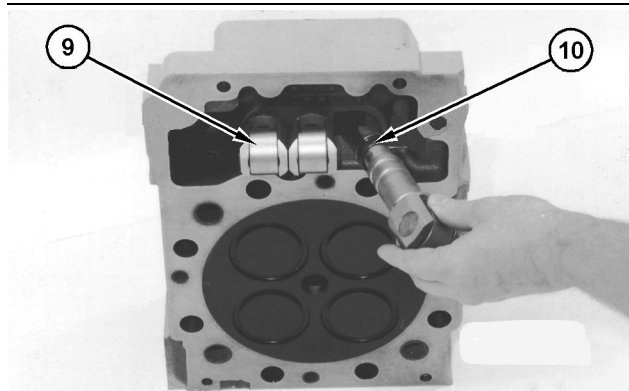


Illustration 543

g01051072

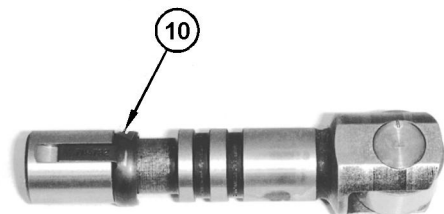


Illustration 544

g01051073

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. Pull valve lifter (9) out of the cylinder head.
2. Remove guide spring (10) from the valve lifter.

i02512530

Cylinder Head - Assemble

SMCS Code: 1100-016

Assembly Procedure

Valve Lifters

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

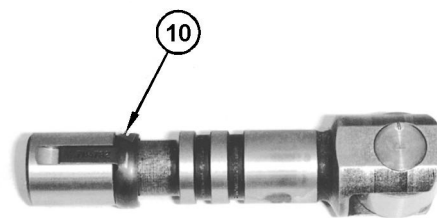


Illustration 545

g01051073

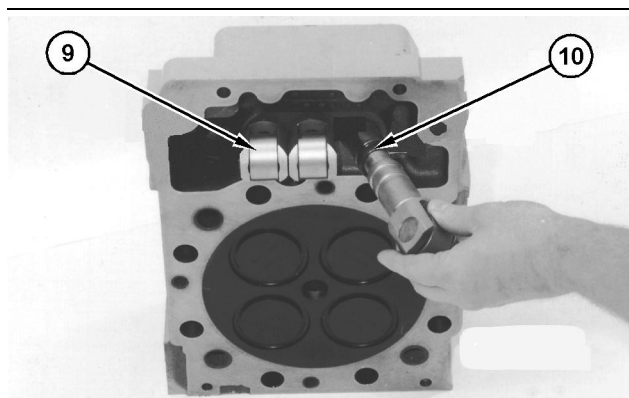


Illustration 546

g01051072

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 new guide spring (10) for valve lifter (9).
2. Place valve lifter (9) in a container of clean engine oil prior to installation.
3. Install valve lifter (9) into the cylinder head.

Note: Refer to Specifications, "Valve Mechanism".

Inlet and Exhaust Valve Guides

Table 54

Required Tools			
Tool	Part Number	Part Description	Qty
E	7M - 3975	Valve Guide Driver	1
	5P - 1729	Valve Guide Bushing	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Use new valve guides for assembly.

1. Coat the outside of the valve guides with clean engine oil prior to installation.

2. Use Tooling (E) to install the valve guides. The valve guide must extend 26.0 ± 0.50 mm (1.02 ± 0.020 inch) above the surface of the cylinder head.

Inlet and Exhaust Valve Seat Inserts

Table 55

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Use new inserts for assembly.

1. Cool the valve seat inserts. Install the valve seat inserts with Tooling (D).

Bridge Dowels

Table 56

Required Tools			
Tool	Part Number	Part Description	Qty
F	6V - 4009	Dowel Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

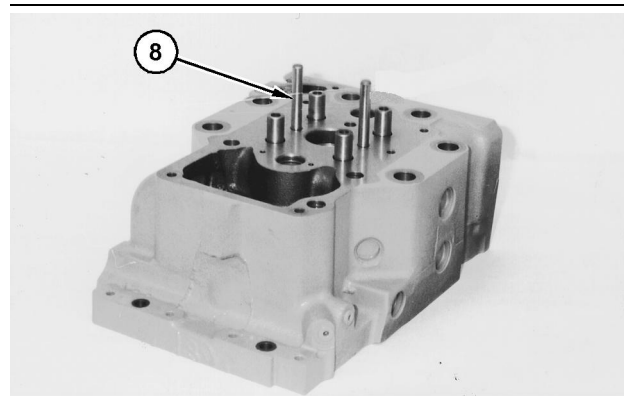


Illustration 547

g01051069

Note: Use new dowels for assembly.

1. Use Tooling (F) with a hammer to install bridge dowels (8). The bridge dowels must extend 66.5 ± 0.50 mm (2.62 ± 0.020 inch) above the surface of the cylinder head.

Inlet and Exhaust Valves

Table 57

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.

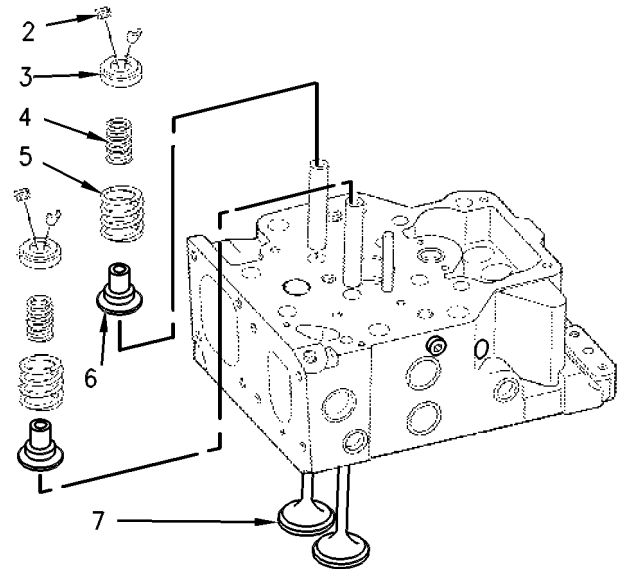


Illustration 548

g00618922

 WARNING

If the valve locks are not positioned correctly, the locks can be expelled when the spring pressure is released.

To help prevent personal injury, stay away from the front of the valve retainer and springs. Ensure that the valve locks are positioned correctly.

1. Coat valves (7) with clean engine oil. Install the valves into the cylinder head.
2. Install seal (6), inner spring (4), outer spring (5), and valve rotator (3) over the valve stem and the valve guide.

3. Compress the valve spring with Tooling (A) and install retainer lock (2).
4. Release the pressure on Tooling (A). Remove Tooling (A). Lightly tap the top of the valve with a hammer. This will ensure that the retainer locks are in the proper position.
5. Repeat Steps 1 through 4 for the remaining valves.

End By:

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

i02415073

Cylinder Head - Install

SMCS Code: 1100-012

Installation Procedure

Table 58

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the spacer plate and the surface of the cylinder block are clean.

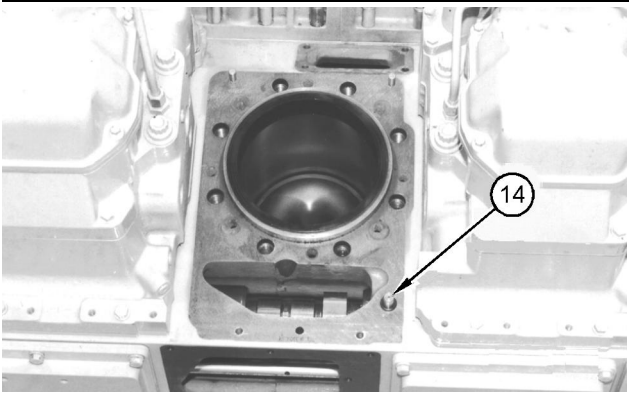


Illustration 549

g01053983

2. Install the O-ring seal on dowel (14).

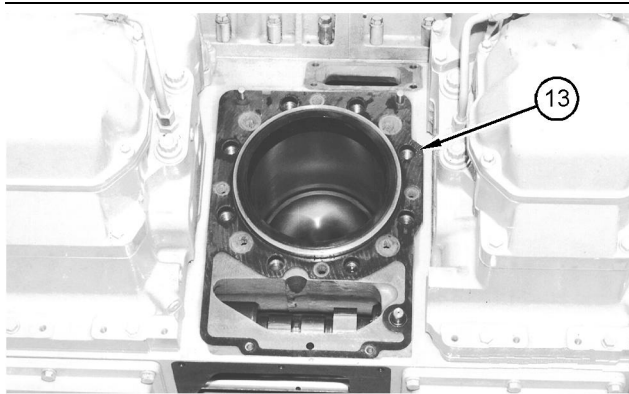


Illustration 550

g01053978

NOTICE

Ensure that the surface of the spacer plate gasket and the surface of the cylinder block are clean. **Do not** use a gasket adhesive on these surfaces.

3. Install a new gasket (13) on the dowels in the cylinder block.

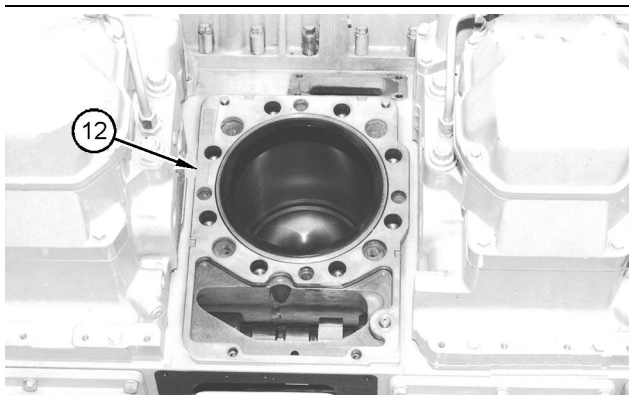


Illustration 551

g01053977

4. Install spacer plate (12) on the dowels.

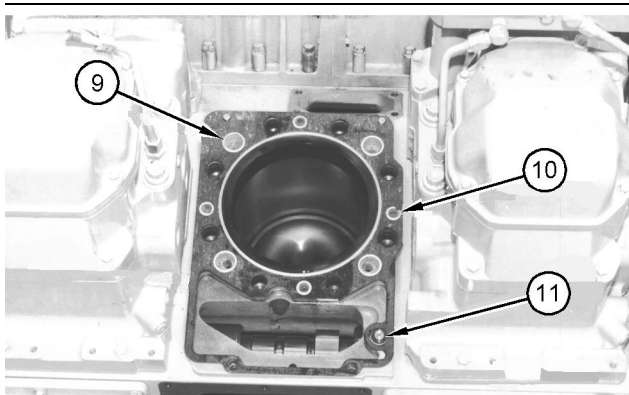


Illustration 552

g01053975

5. Install new seals (9) and (10) in the spacer plate.

6. Install a new O-ring seal (11) on the dowel.
7. Check the cylinder liner projection. Refer to Disassembly and Assembly, "Cylinder Liner - Install" for the correct procedure.
8. Ensure that the bottom of the cylinder head assembly is thoroughly clean.

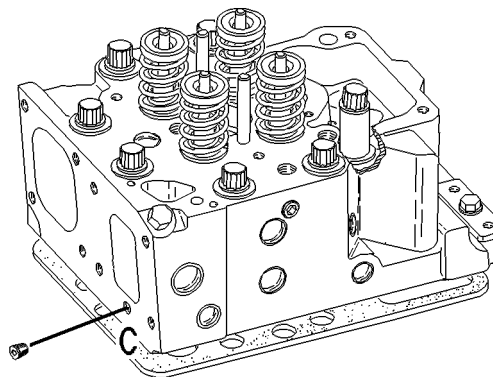


Illustration 553

g00618255

NOTICE

The plug for Location (C) **MUST** be installed in the cylinder head.

9. Install Tooling (A) into the threaded holes for the valve cover base in the cylinder head. Attach a suitable lifting device to Tooling (A).

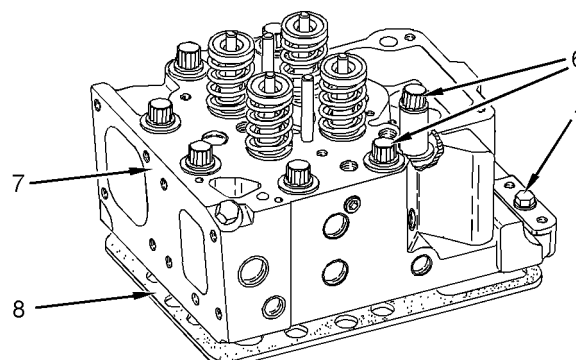


Illustration 554

g01053935

Note: The weight of cylinder head assembly (7) is approximately 47 kg (104 lb).

10. Install a new head gasket (8). Lift cylinder head assembly (7) into position on the cylinder block. Install bolts (6) and (1) according to the instructions in Step 11.

Note: Refer to Specifications, "Cylinder Head".

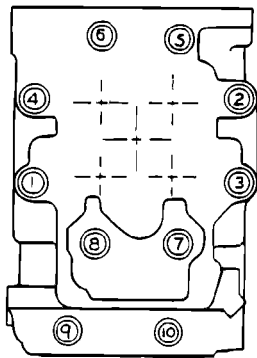


Illustration 555 g00585055

11. Coat the threads of the bolts with clean engine oil.

Note: Refer to Illustration 555 for the correct tightening sequence.

- a. Tighten Bolt (1) through Bolt (8) to a torque of $30 \pm 5 \text{ N}\cdot\text{m}$ ($22 \pm 4 \text{ lb ft}$).
- b. Tighten Bolt (1) through Bolt (8) to a torque of $200 \pm 15 \text{ N}\cdot\text{m}$ ($148 \pm 11 \text{ lb ft}$).
- c. Tighten Bolt (1) through Bolt (8) again to a torque of $200 \pm 15 \text{ N}\cdot\text{m}$ ($148 \pm 11 \text{ lb ft}$).
- d. Turn Bolt (1) through Bolt (8) again by an additional 180 degrees.
- e. Tighten Bolts (9) and (10) to a torque of $55 \pm 10 \text{ N}\cdot\text{m}$ ($40 \pm 7 \text{ lb ft}$).

12. Remove Tooling (A) from the cylinder head.

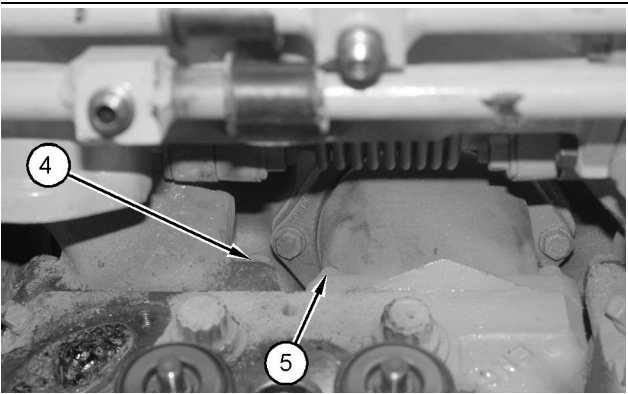


Illustration 556 g01053859

13. Install four bolts (4) (not shown) on exhaust tube assembly and install four bolts (5) (not shown) on inlet tube assembly.

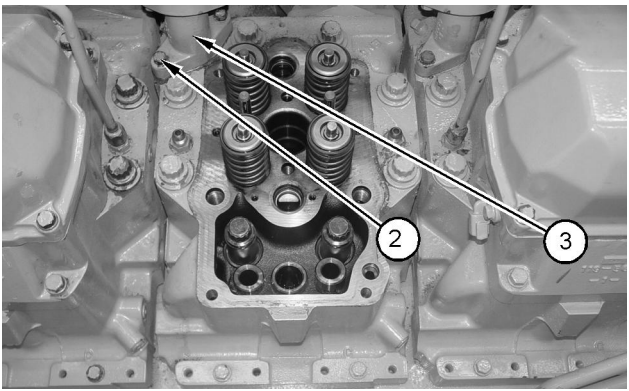


Illustration 557 g01053958

14. Position tube (3). Install bolts (2).

15. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

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

i02414673

Accessory Drive (Front) - Remove

SMCS Code: 1207-011

Removal Procedure

Table 59

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolts 1/2 in x 13 NC	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

- 1. Remove the alternator pulley (if equipped).

i02507146

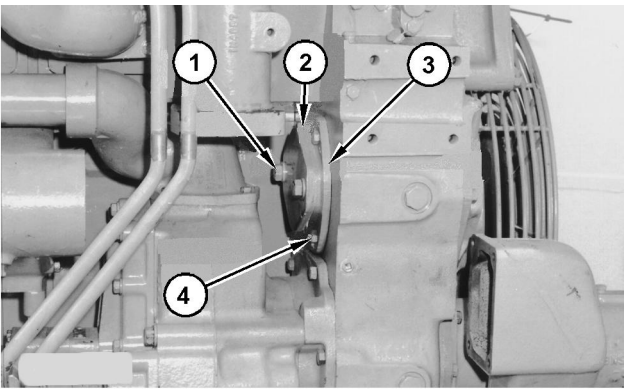


Illustration 558

g01054400

2. Remove bolts (1) in order to remove rear cover (2) from rear adapter assembly (3).
3. Remove bolts (4) from rear adapter assembly (3). Use Tooling (A) to remove rear adapter assembly (3).

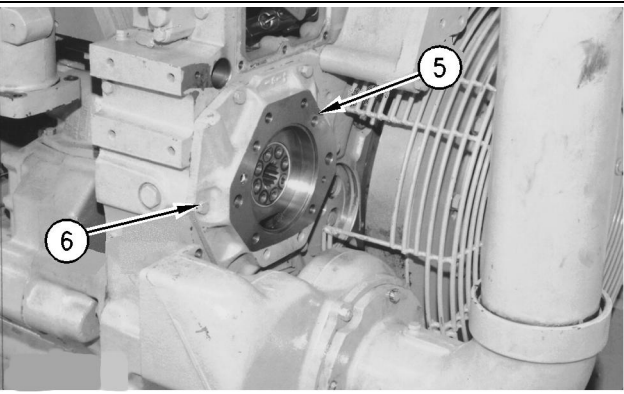


Illustration 559

g00906510

4. Remove the bolts in order to remove the front cover (not shown).
5. Remove bolts (5). Remove front adapter assembly (6), the shaft, and the drive gear as a unit from the drive housing.

Accessory Drive (Front) - Disassemble

SMCS Code: 1207-015

Disassembly Procedure

Table 60

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Group	1

Start By:

- a. Remove the accessory drive (front). Refer to Disassembly and Assembly, "Accessory Drive (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

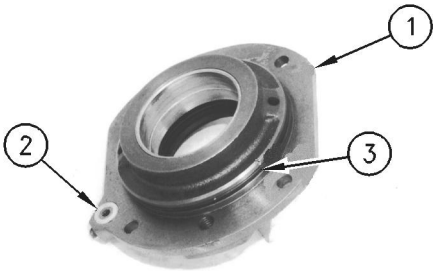


Illustration 560

g00906726

1. Remove O-ring seals (2) and (3) from rear adapter assembly (1).

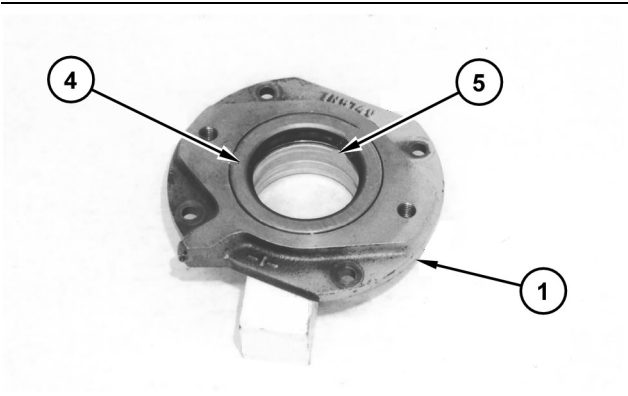


Illustration 561 g01255143

- 2. Remove seal (4) from rear adapter assembly (1).
- 3. Use Tooling (A) and a suitable press to remove bearing (5) from rear adapter assembly (1).

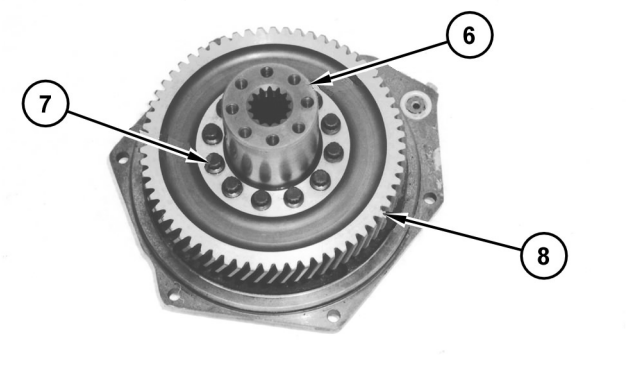


Illustration 562 g01255146

- 4. Remove bolts (7) and gear (8) from shaft (6).

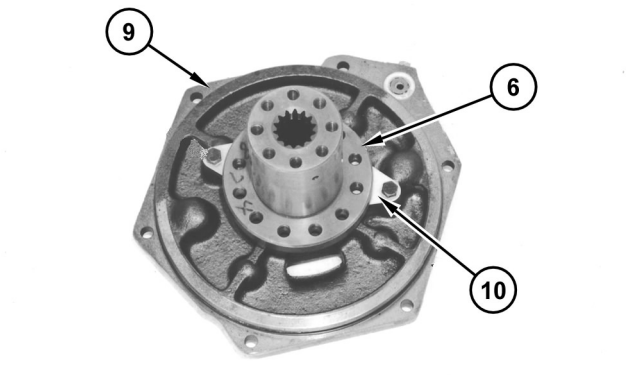


Illustration 563 g01255149

- 5. Remove the bolts and retaining washer (10).
- Note:** Later models have two retaining washers.
- 6. Remove shaft (6) from front adapter assembly (9).

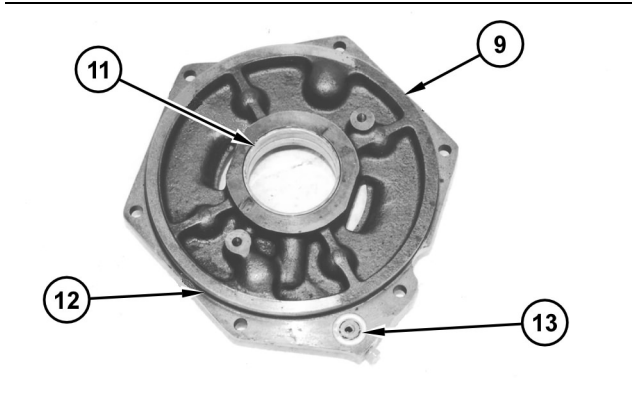


Illustration 564 g01255150

- 7. Remove O-ring seals (12) and (13) from front adapter assembly (9).
- 8. Use Tooling (A) and a suitable press to remove bearing (11) from front adapter assembly (9).

i02507201

Accessory Drive (Front) - Assemble

SMCS Code: 1207-016

Assembly Procedure

Table 61

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Group	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

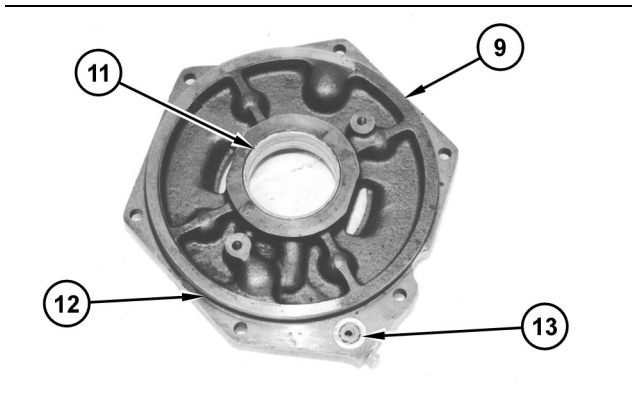


Illustration 565 g01255150

1. Align the oil hole in the bearing and the oil hole in front adapter assembly (9). Use Tooling (A) and a suitable press to install bearing (11) into front adapter assembly (9). The bore of the bearing must be 75.0 ± 0.055 mm (2.95 ± 0.0020 inch) after installation.
2. Install O-ring seals (12) and (13) into front adapter assembly (9).

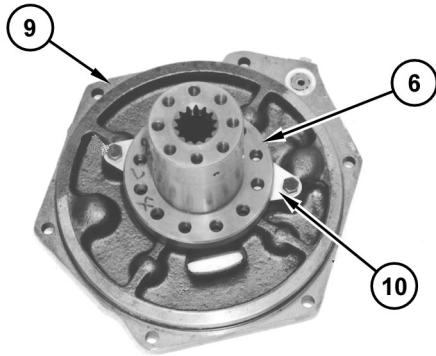


Illustration 566

g01255149

3. Place clean engine oil on the bearing and install shaft (6) in front adapter assembly (9).
4. Install retaining washer (10) and the bolts.

Note: Later models have two retaining washers.

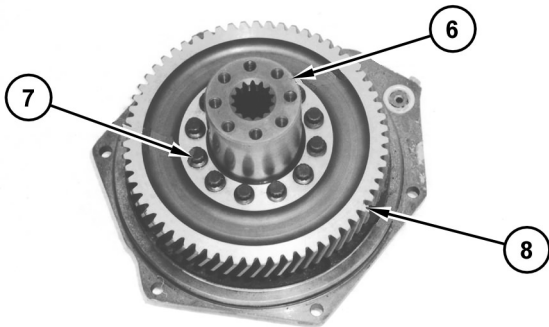


Illustration 567

g01255146

5. Position gear (8) on shaft (6) and install bolts (7).

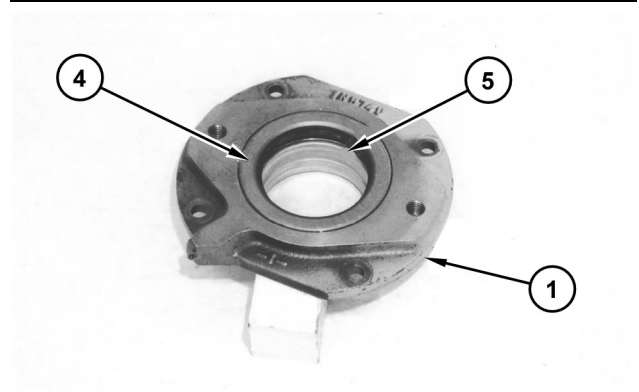


Illustration 568

g01255143

6. Align the oil hole in the bearing and the oil hole in rear adapter assembly (1). Use Tooling (A) and a suitable press to install bearing (5) into rear adapter assembly (1). The bore of the bearing must be 75.0 ± 0.055 mm (2.95 ± 0.0020 inch) after installation.
7. Use Tooling (A) to install seal (4) into rear adapter assembly (1). Ensure that the lip of the seal is toward the bearing.

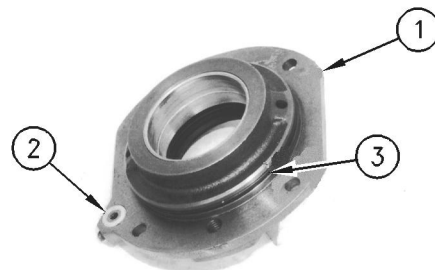


Illustration 569

g00906726

8. Install O-ring seals (2) and (3) into rear adapter assembly (1). Place clean engine oil on the O-ring seals.

End By:

- a. Install the accessory drive (front). Refer to Disassembly and Assembly, "Accessory Drive (Front) - Install".

i02049692

Accessory Drive (Front) -
Install

SMCS Code: 1207-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

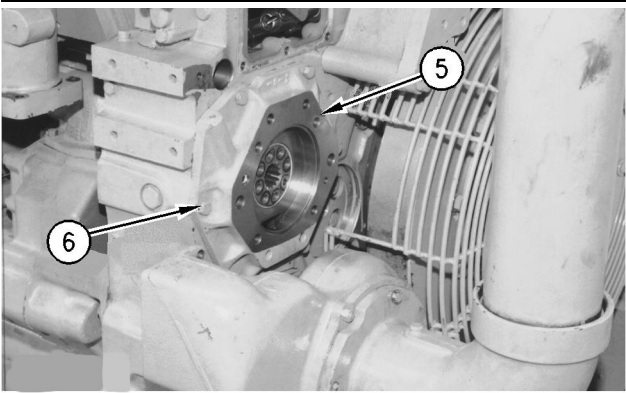


Illustration 570

g00906510

1. Coat the O-ring seals of front adapter assembly (5) with clean engine oil. Install the drive gear, the shaft, and front adapter assembly (5) as a unit. Make sure that the teeth of the drive gear are properly aligned with the teeth of the drive gear for the oil pump and the water pump. Install bolts (6) that hold front adapter assembly (5) in place.
2. Coat the O-ring seal of the front cover for the accessory drive with clean engine oil. Install the front cover with the bolts.

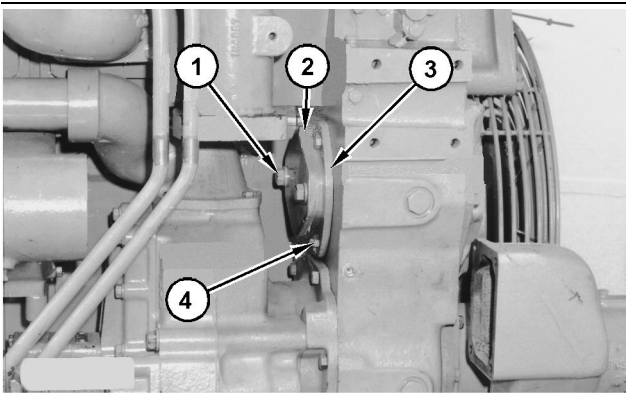


Illustration 571

g01054400

3. Coat the O-ring seals of rear adapter assembly (3) with clean engine oil. Position rear adapter assembly (3) and install bolts (4).

4. Coat the O-ring seal of rear cover (2) for the accessory drive with clean engine oil. Install rear cover (2) with bolts (1).
5. Install the alternator pulley (if equipped).

i02414945

Front Drive Housing - Remove
and Install

SMCS Code: 1151-010

Removal Procedure

Table 62

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0074	Slide Hammer Puller	1
	8B-7557	Threaded Adapter	1
B	138-7573	Link Bracket	2
C	1P-0520	Driver Group	1
D	-	Guide Bolt 3/8×16 NC	2

Start By:

- a. Remove the oil filter base. Refer to Disassembly and Assembly, "Engine Oil Filter Base - Remove".
- b. Remove the crankshaft front seal and the wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Front Seal and Wear Sleeve - Remove".
- c. Remove the accessory drive (front). Refer to Disassembly and Assembly, "Accessory Drive (Front) - Remove".
- d. Remove the engine oil and water pump drive. Refer to Disassembly and Assembly, "Engine Oil and Water Pump Drive - Remove".
- e. Remove the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

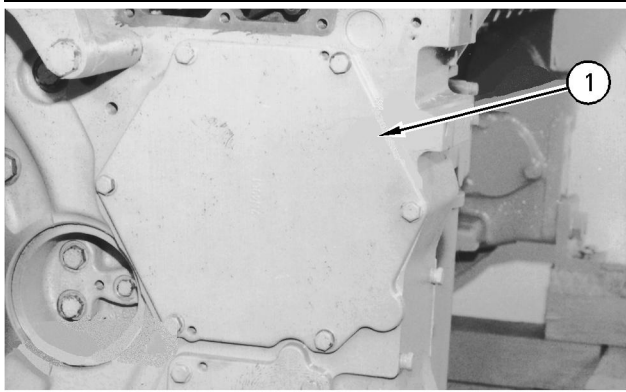


Illustration 572 g00907030

1. Remove cover (1) and the O-ring seal.

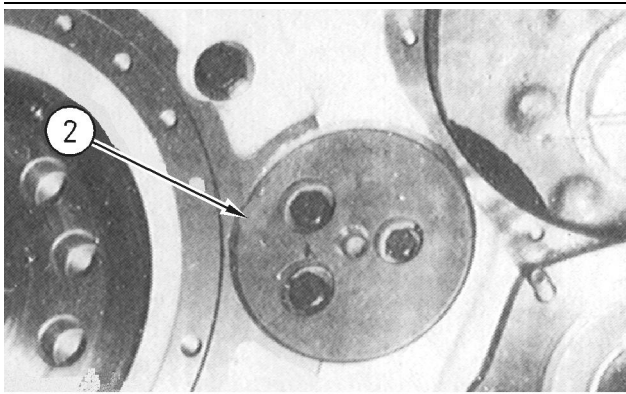


Illustration 573 g00907040

2. Remove the bolts that hold shaft (2) in the front drive housing. Use Tooling (A) to remove shaft (2). Remove the O-ring seal from shaft (2).

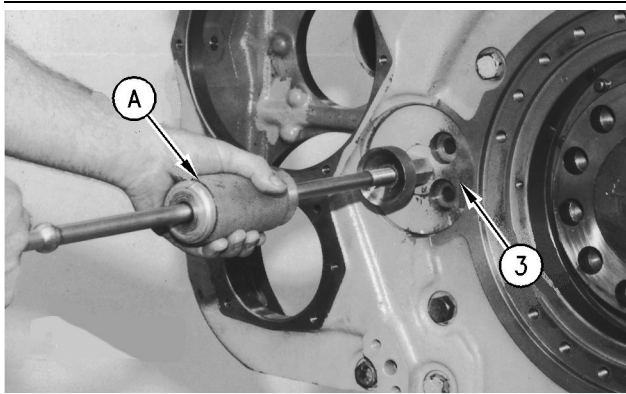


Illustration 574 g00907098

3. Remove the bolts that hold shaft (3) in the front drive housing. Use Tooling (A) to remove shaft (3), the idler gear, and the washer. Remove the O-ring seal from shaft (3).

4. Use Tooling (C) and a suitable press in order to remove the bearing from the idler gear, if necessary.

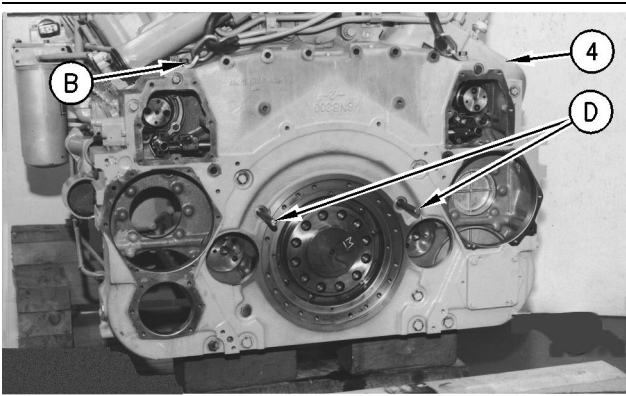


Illustration 575 g00907145

5. Install Tooling (B) and attach a suitable lifting device to front drive housing (4). The weight of front drive housing (4) is approximately 209 kg (460 lb). Remove two bolts and install Tooling (D). Remove the rest of the bolts that hold front drive housing (4) to the cylinder block. Remove front drive housing (4) and the gasket.

Installation Procedure

Table 63

Required Tools			
Tool	Part Number	Part Description	Qty
B	138 - 7573	Link Bracket	2
C	1P - 0520	Driver Group	1
D	-	Guide Bolt 3/8×16 NC	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Install the gasket for the front drive housing onto the cylinder block. Install Tooling (D) into the cylinder block.

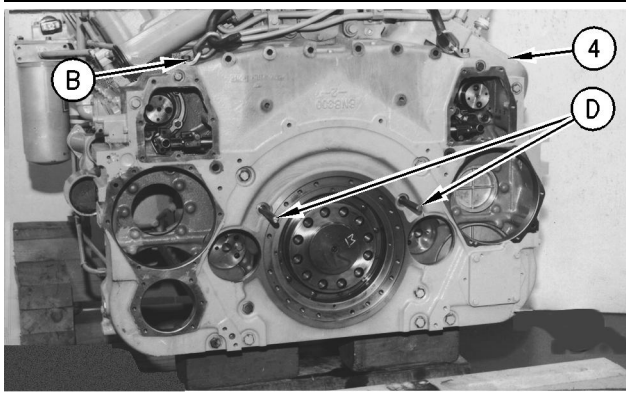


Illustration 576

g00907145

2. Install Tooling (B) and attach a suitable lifting device to front drive housing (4). The weight of front drive housing (4) is approximately 209 kg (460 lb). Position front drive housing (4) onto Tooling (D).
3. Install the bolts that attach front drive housing (4) to the cylinder block. Tighten the bolts evenly. Cut any excess gasket from the face of the cylinder block.

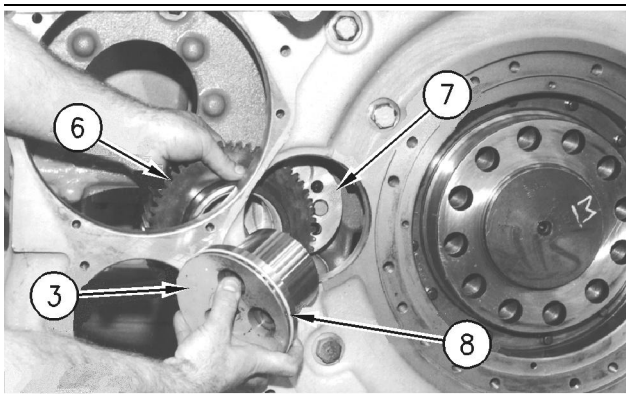


Illustration 577

g00907120

4. If the bearing was removed from gear (6), use Tooling (C) to install the bearing.

After the bearing is installed, measure the bore of the bearing. The bore of the bearing must be 90.0 ± 0.06 mm (3.54 ± 0.002 inch).
5. Coat the bore for O-ring seal (8) with clean engine oil. Install the O-ring seal on shaft (3).
6. Place washer (7) and gear (6) into position in the front drive housing. Install shaft (3). Install the bolts for shaft (3).

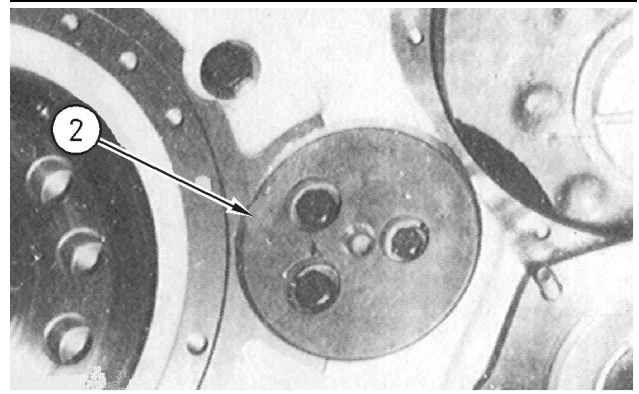


Illustration 578

g00907040

7. Coat the bore for the O-ring seal of shaft (2) with clean engine oil. Install the O-ring seal onto shaft (2).
8. Place shaft (2) into position in the front drive housing. Install the bolts for shaft (2).

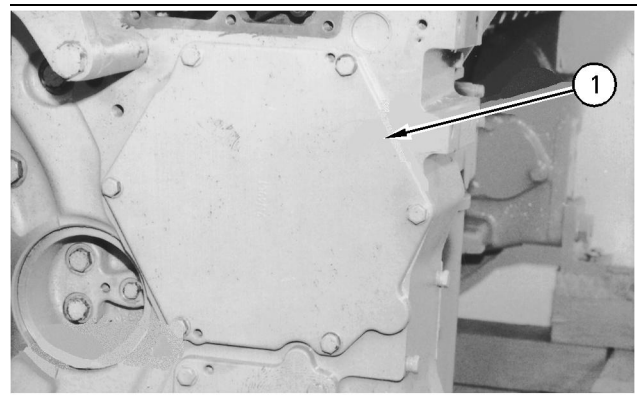


Illustration 579

g00907030

9. Install cover (1) onto the front drive housing.

End By:

- a. Install the auxiliary water pump. Refer to Disassembly and Assembly, "Auxiliary Water Pump - Install".
- b. Install the engine oil and water pump drive. Refer to Disassembly and Assembly, "Engine Oil and Water Pump Drive - Install".
- c. Install the accessory drive (front). Refer to Disassembly and Assembly, "Accessory Drive (Front) - Install".
- d. Install the crankshaft front seal and the wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Front Seal and Wear Sleeve - Install".
- e. Install the engine oil filter base. Refer to Disassembly and Assembly, "Engine Oil Filter Base - Install".

i02415383

Vibration Damper - Remove and Install

SMCS Code: 1205-010

Removal Procedure

Table 64

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolts 3/8 - 16 NC by 4 inch	2
B	-	Guide Bolts 1/2 - 13 NC by 4 inch	2
C	138 - 7575	Link Bracket	2
D	1U - 9393	Damper Guide Pin	2

Note: Some different types of vibration dampers are available for use. The following procedure describes the removal and installation of a typical vibration damper assembly and damper group.

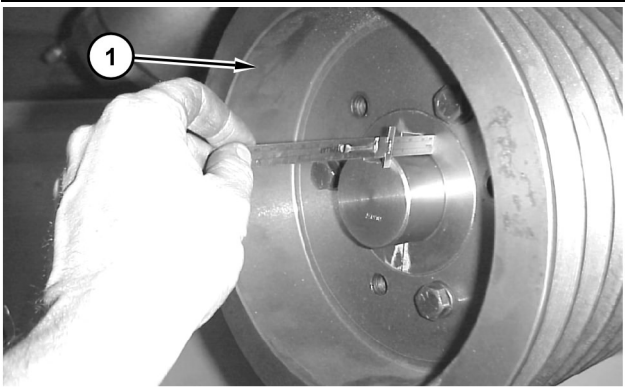


Illustration 580

g01207380

1. Before you remove pulley (1) make a note of the position of pulley (1) on the shaft.

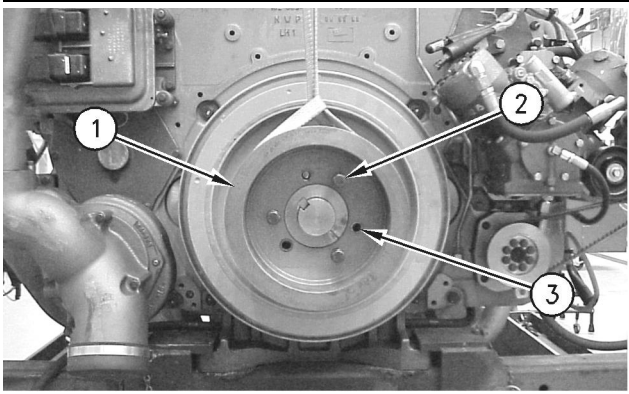


Illustration 581

g00916223

2. Install a suitable lifting device onto pulley (1). Remove bolts (2). Reinstall bolts (2) into holes (3). Tighten bolts (2) enough to remove pulley (1). The weight of pulley (1) is approximately 39 kg (85 lb).

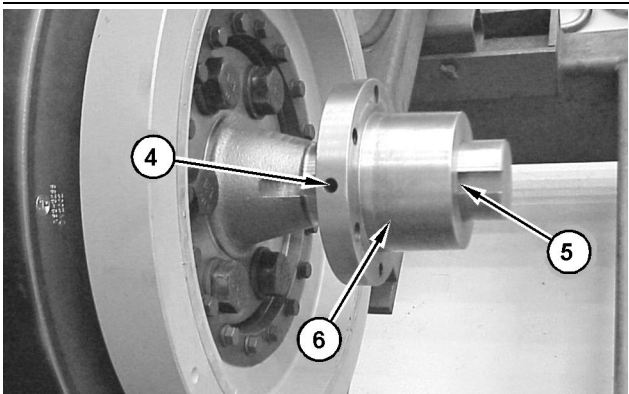


Illustration 582

g01054420

3. Loosen set screw (4) in hub (6). Remove hub (6) and key (5).

Note: If it is necessary to remove the vibration damper as an assembly, proceed to Step 8.

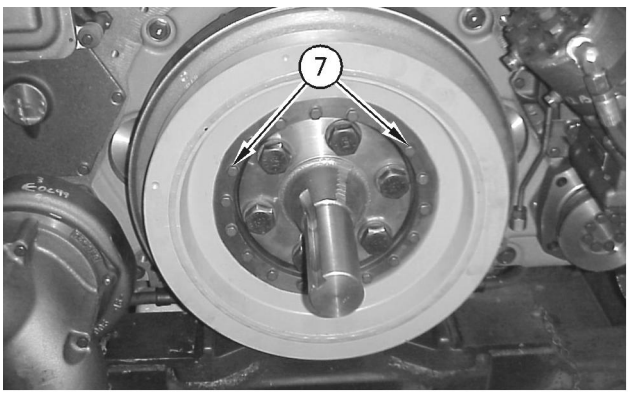


Illustration 583

g00916274

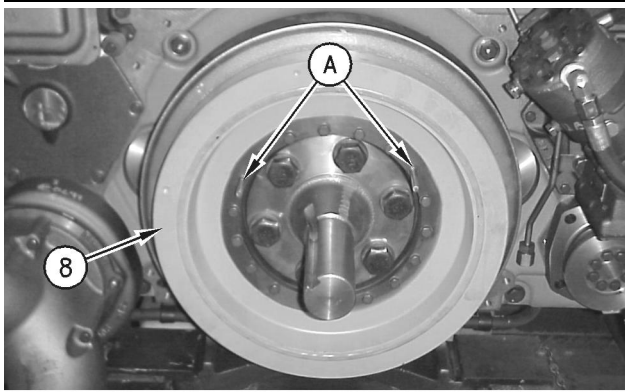


Illustration 584

g00916284

4. Remove two bolts (7) and install Tooling (A). Remove remaining bolts (7). Use two people and remove vibration damper (8). The weight of vibration damper (8) is approximately 30 kg (65 lb).

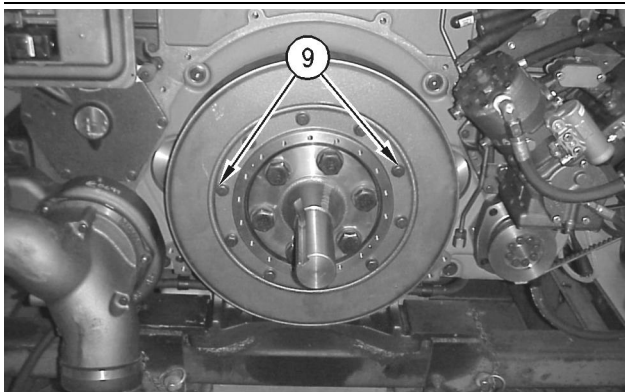


Illustration 585

g00916292

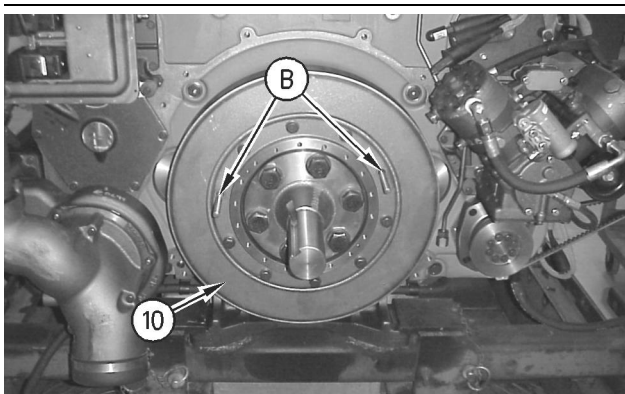


Illustration 586

g00916297

5. Remove two bolts (9) and install Tooling (B). Remove remaining bolts (9) from vibration damper (10).

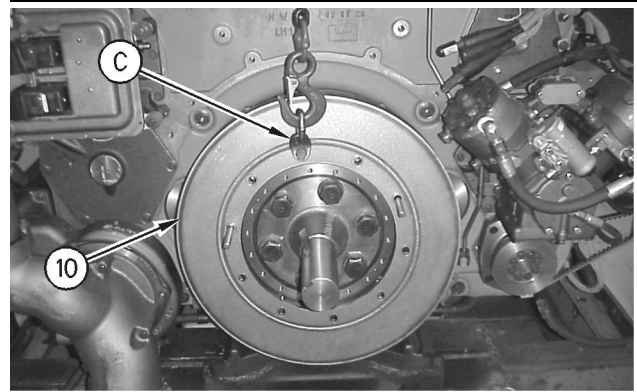


Illustration 587

g00916389

6. Slide vibration damper (10) outward. Install Tooling (C) and a suitable lifting device to vibration damper (10). Remove vibration damper (10). The weight of vibration damper (10) is approximately 50 kg (110 lb).

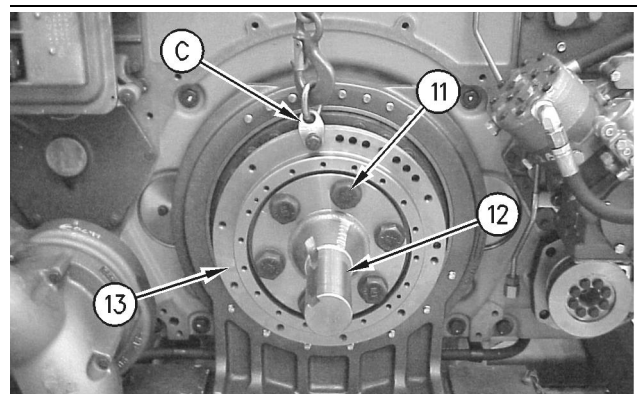


Illustration 588

g00916309

7. Install Tooling (C) and attach a suitable lifting device to hub (13). Remove bolts (11). Remove pulley hub (12) and hub (13). The weight of pulley hub (12) and hub (13) is approximately 36 kg (80 lb).
8. The following steps are for removing the vibration damper as a complete assembly.

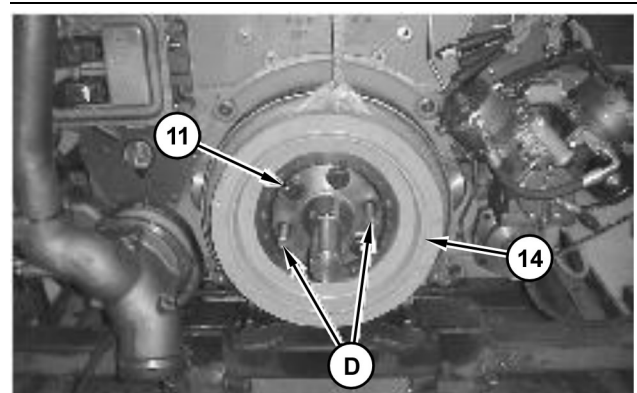


Illustration 589

g01207444

9. Remove two bolts (11). Install Tooling (D) and a suitable lifting device to vibration damper assembly (14).
10. Remove remaining bolts (11) and remove vibration damper assembly (14). The weight of vibration damper assembly (14) is approximately 116 kg (255 lb).

Installation Procedure

Table 65

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Guide Bolts 3/8 - 16 NC by 4 inch	2
B	-	Guide Bolts 1/2 - 13 NC by 4 inch	2
C	138-7575	Link Bracket	2
D	1U-9393	Damper Guide Pin	2

1. The following steps are for installation of the vibration damper as a complete assembly.

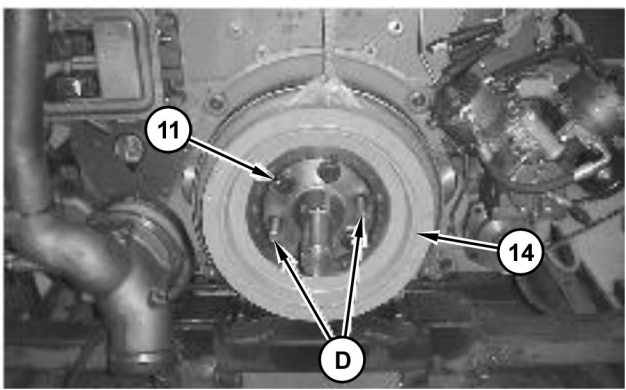


Illustration 590

g01207444

2. Install Tooling (D). Use a suitable lifting device and slide vibration damper assembly (14) onto Tooling (D). The weight of vibration damper assembly (14) is approximately 116 kg (255 lb). Install bolts (11).
3. Remove Tooling (D) and install two bolts (11).

Note: Refer to Specifications, "Vibration Damper" for the correct torque.

Note: If it was necessary to install the vibration damper as an assembly, proceed to Step 8.

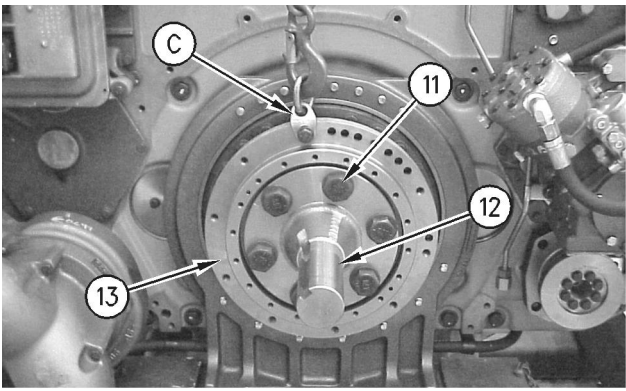


Illustration 591

g00916309

4. Install Tooling (C) and a suitable lifting device to hub (13). Install hub (13) and pulley hub (12). The weight of hub (13) and pulley hub (12) is approximately 36 kg (80 lb). Install bolts (11).

Note: Refer to Specifications, "Vibration Damper" for the correct torque.

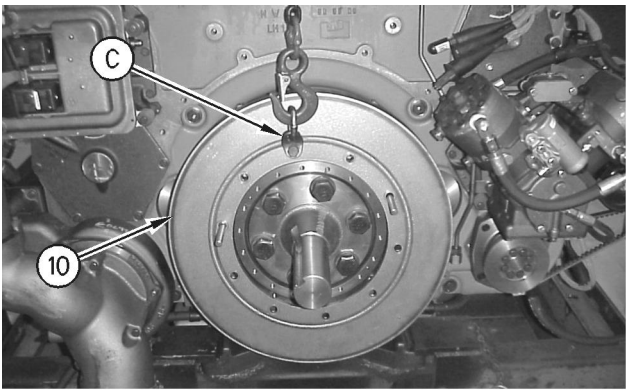


Illustration 592

g00916389

5. Install Tooling (B). Install Tooling (C) and a suitable lifting device onto vibration damper (10). Position vibration damper (10) onto Tooling (B). Install vibration damper (10). The weight of vibration damper (10) is approximately 50 kg (110 lb).

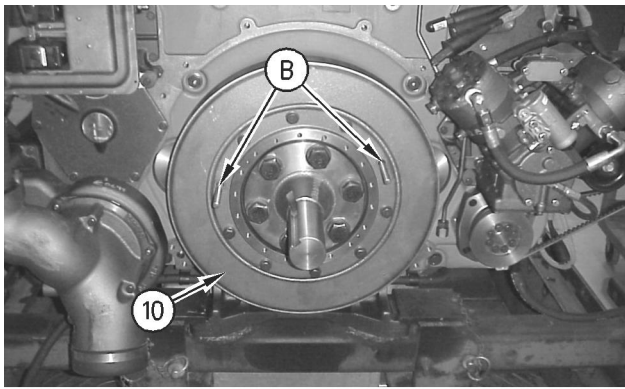


Illustration 593

g00916297

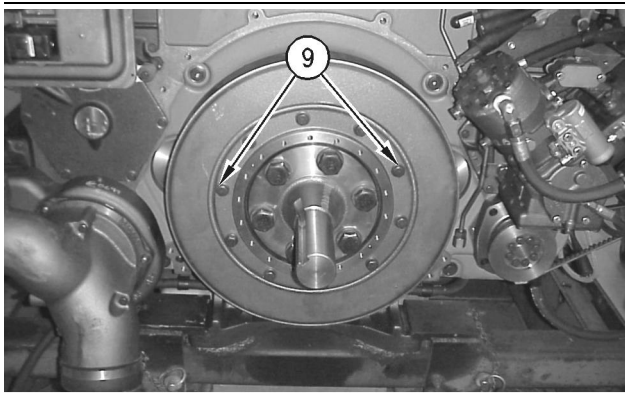


Illustration 594

g00916292

6. Install bolts (9) into vibration damper (10). Remove Tooling (B) and install two bolts (9).

Note: Refer to Specifications, "Vibration Damper" for the correct torque.

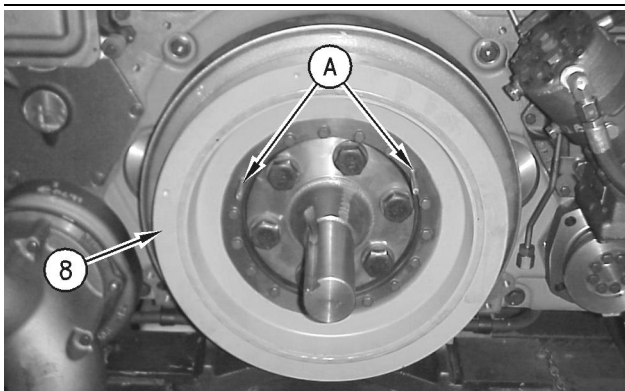


Illustration 595

g00916284

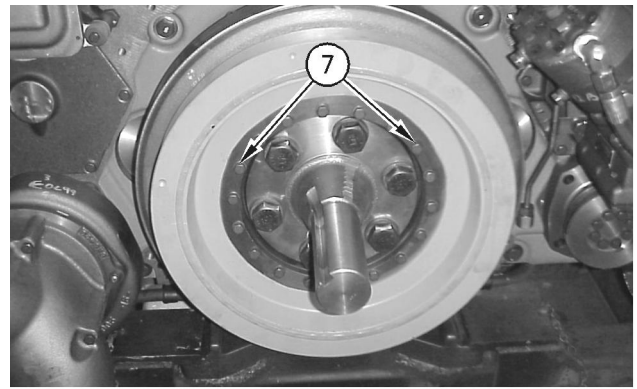


Illustration 596

g00916274

7. Install Tooling (A). Use two people and install vibration damper (8). The weight of vibration damper (8) is approximately 30 kg (65 lb). Install bolts (7). Remove Tooling (A) and install two bolts (7).

Note: Refer to Specifications, "Vibration Damper" for the correct torque.

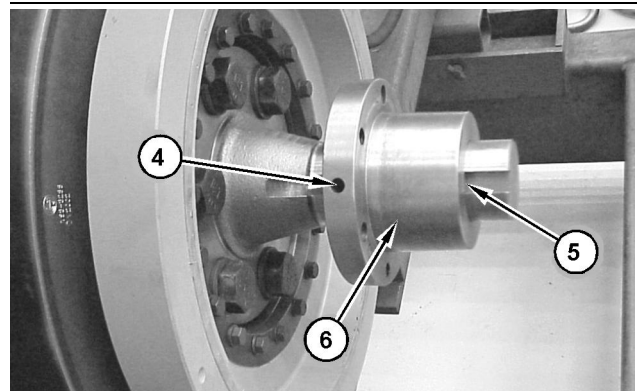


Illustration 597

g01054420

8. Install key (5) and hub (6). Tighten set screw (4) in hub (6).

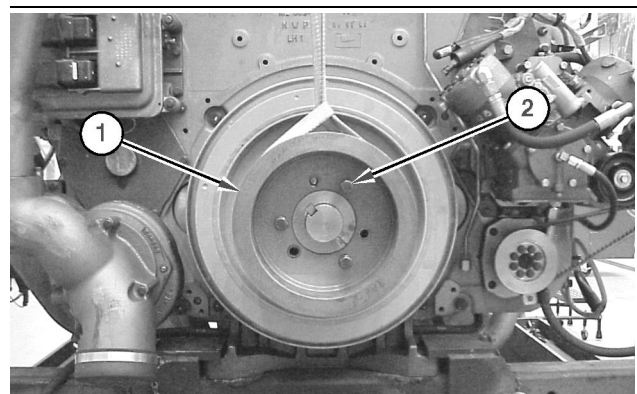


Illustration 598

g01051456

9. Install a suitable lifting device onto pulley (1). Install pulley (1). The weight of pulley (1) is approximately 39 kg (85 lb). Install bolts (2).

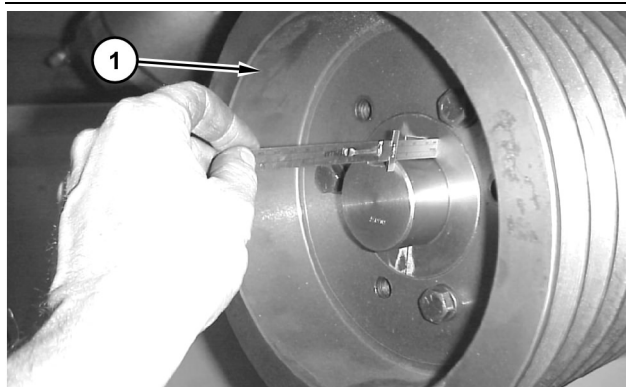


Illustration 599

g01207380

10. Check the position of pulley (1).

i02724256

Crankshaft Front Seal and Wear Sleeve - Remove

SMCS Code: 1160-011; 7558-011

Removal Procedure

Table 66

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U - 7600	Slide Hammer Puller	1
B	6V - 3143	Distorter Adapter	1
C	5P - 7409	Sleeve Distorter	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Every time that the crankshaft seal is removed from the wear sleeve, a new wear sleeve and crankshaft seal must be installed.

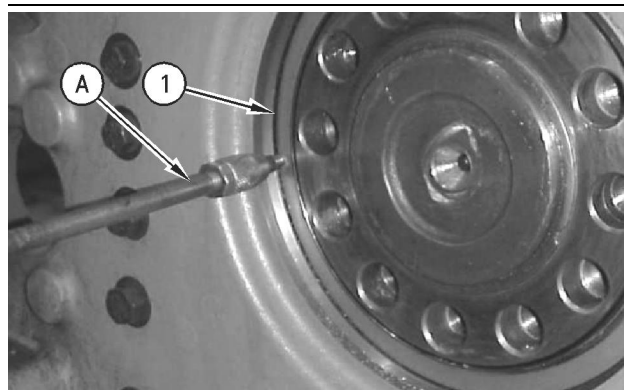


Illustration 600

g00659180

1. Drill three evenly spaced holes in crankshaft front seal (1) and use Tooling (A) to remove crankshaft front seal (1) from the front housing.

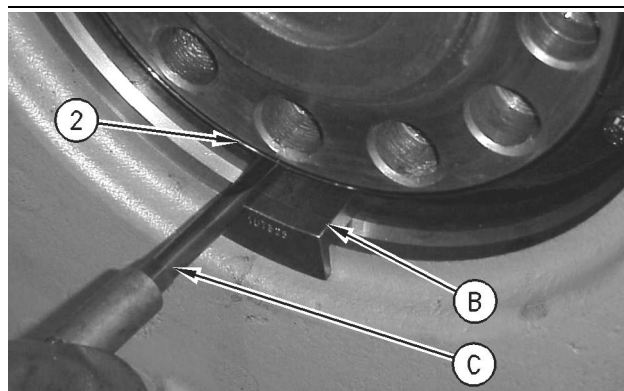


Illustration 601

g00659181

2. Insert Tooling (B) between the front housing and wear sleeve (2).

NOTICE

The use of excessive force on the sleeve distorter can cause the distorter adapter to crack the housing. To help avoid damage to the engine, do not use excessive force to remove the wear sleeve.

3. Insert Tooling (C) between Tooling (B) and wear sleeve (2). Carefully turn Tooling (C) until the edge of the tool creates a crease in wear sleeve (2).

Repeat this procedure several times around wear sleeve (2) until wear sleeve (2) can be removed by hand.

i02415670

Crankshaft Front Seal and Wear Sleeve - Install

SMCS Code: 1160-012; 7558-012

Installation Procedure

Table 67

Required Tools			
Tool	Part Number	Part Description	Qty
D	6V - 4003	Seal Locator As	1
	2N - 5006	Bolt	2
E	8T - 3099	Seal Installer	1
F	9S - 8858	Nut	1
G	169 - 5464	Quick Cure Primer	1
H	4C - 9507	Retaining Compound	1
J	1P - 0808	Multipurpose Grease	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Every time that the crankshaft seal is removed from the wear sleeve, a new wear sleeve and crankshaft seal must be installed.

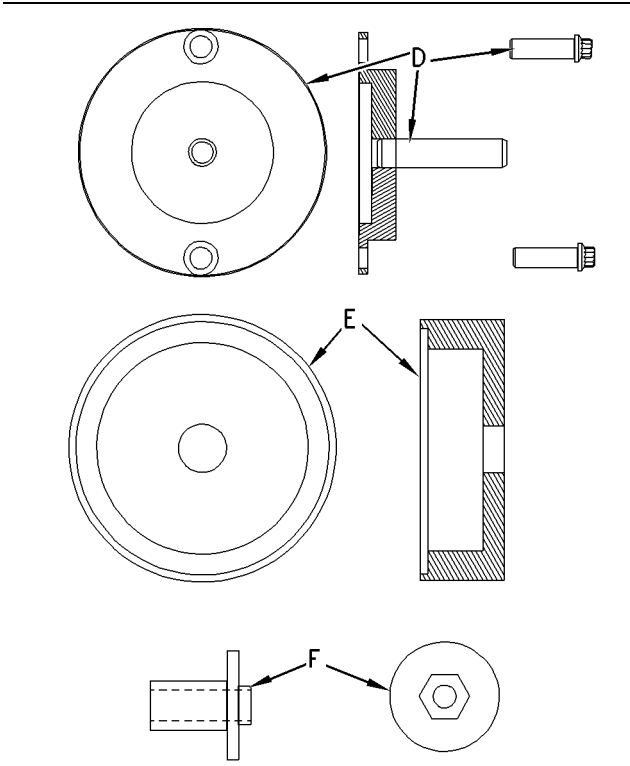


Illustration 602

g01005029

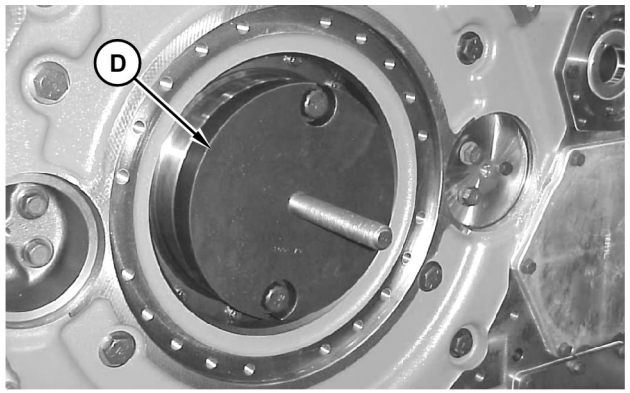


Illustration 603

g01207497

1. Attach Tooling (D) to the crankshaft.
2. Clean the outer diameter of the crankshaft and the inner diameter of the new wear sleeve with Tooling (G).
3. Apply Tooling (H) to the outer diameter of the crankshaft and the inner diameter of the new wear sleeve.

NOTICE

If the crankshaft seal and the wear sleeve come apart during installation, the crankshaft seal and the wear sleeve must be replaced.

Note: The front crankshaft seal and the wear sleeve cannot be interchanged with the rear crankshaft seal and the wear sleeve.

NOTICE

Do not place engine oil on the crankshaft seal for installation. Lubrication of the crankshaft seal can give a false indication of leakage at a later time.

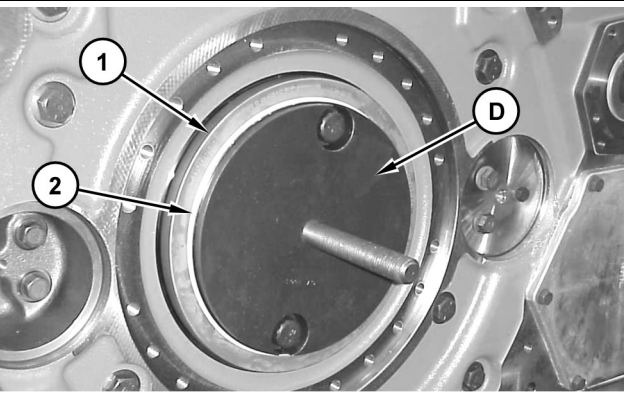


Illustration 604

g01207499

4. Place front seal (1) and wear sleeve (2) onto Tooling (D).

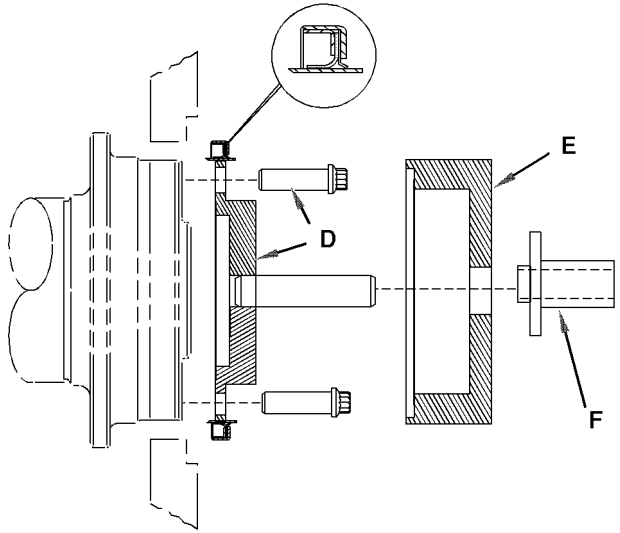


Illustration 605

g01051474

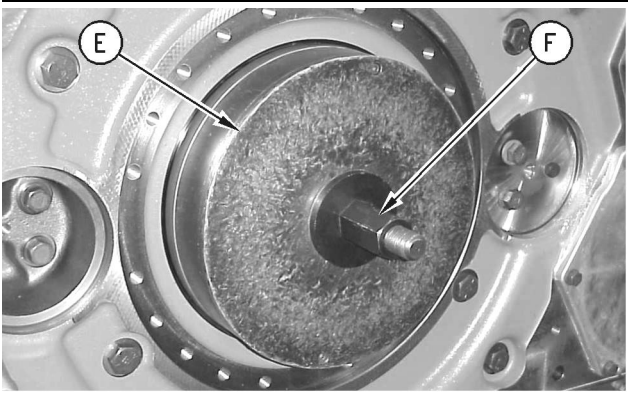


Illustration 606

g01005047

5. Place Tooling (E) onto Tooling (D). Apply Tooling (J) onto the face of the washer on Tooling (F). Install Tooling (F) onto Tooling (E). Tighten the nut until Tooling (E) contacts Tooling (D).
6. Remove the tooling from the crankshaft.

End By:

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

i02415754

Flywheel - Remove and Install

SMCS Code: 1156-010

Removal Procedure

Table 68

Required Tools			
Tool	Part Number	Part Description	Qty
A	138 - 7573	Link Bracket	2
B	-	Guide Bolts 1 - 14 NF by 8 inch	2
C	2D - 1201	Eyebolts	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove the magnetic pickups.

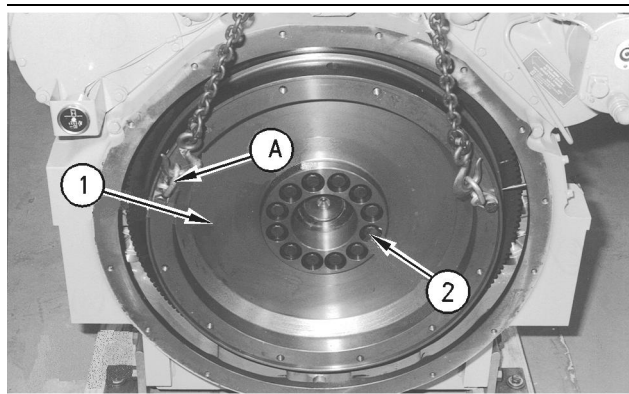


Illustration 607

g00911678

2. Install Tooling (A) on flywheel (1) and attach a suitable lifting device. The weight of flywheel (1) is approximately 167 kg (370 lb).
3. Remove two bolts (2) on each side of the crankshaft.
4. Install Tooling (B).
5. Remove remaining bolts (2).
6. Remove flywheel (1).

Use the following procedure if flywheel (1) is not easily separated from the crankshaft:

- a. Install Tooling (C) in each side of flywheel (1).
- b. Use a prybar to remove flywheel (1) from the crankshaft.

Installation Procedure

Table 69

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	2
B	-	Guide Bolts 1 - 14 NF by 8 inch	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the condition of the flywheel ring gear. Use the following procedure in order to replace the ring gear, if necessary.
 - a. Remove the damaged ring gear from the flywheel.

- b. Raise the temperature of the new ring gear.
- c. Install the gear on the flywheel. Ensure that the chamfer of the gear teeth will be toward the pinion of the starting motor.

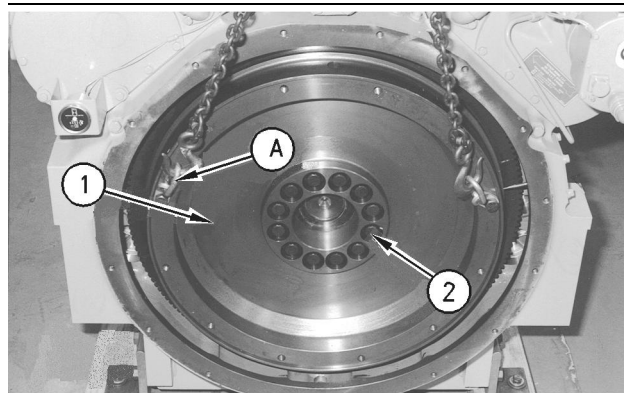


Illustration 608

g00911678

2. Install Tooling (B) in the end of the crankshaft.
 3. Install Tooling (A) onto flywheel (1) and attach a suitable lifting device. The weight of flywheel (1) is approximately 167 kg (370 lb).
- Note:** Ensure that the mark on flywheel (1) is aligned with the mark on the crankshaft.
4. Lift flywheel (1) into position onto Tooling (B).
 5. Apply clean engine oil to bolts (2) and install bolts (2).
 6. Remove Tooling (A) and Tooling (B). Install remaining two bolts (2). Tighten bolts (2) to the correct torque.

Note: Refer to Specifications, "Flywheel" for the correct torque.

7. Install the magnetic pickups.

i02724254

Crankshaft Rear Seal and Wear Sleeve - Remove

SMCS Code: 1161-011; 7558-011

Removal Procedure

Table 70

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-7600	Slide Hammer Puller	1
B	6V-3143	Distorter Adapter	1
C	5P-7409	Sleeve Distorter	1

Start By:

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

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Every time that the crankshaft seal is removed from the wear sleeve, a new wear sleeve and crankshaft seal must be installed.

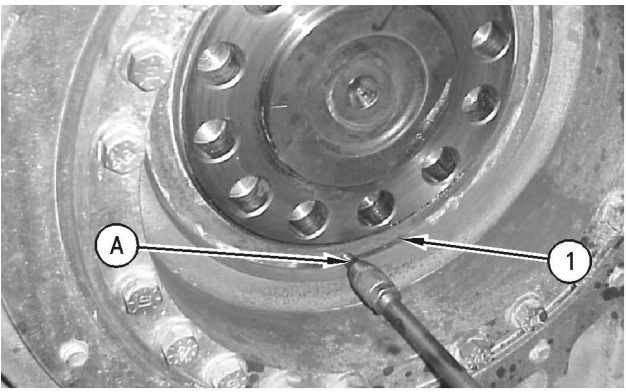


Illustration 609

g00659239

1. Drill three evenly spaced holes in crankshaft rear seal (1). Use Tooling (A) in order to remove crankshaft rear seal (1).

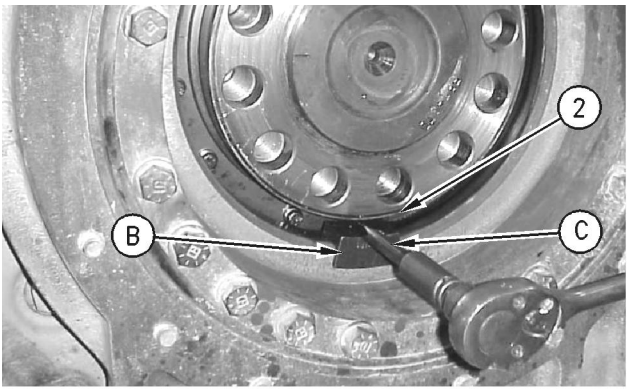


Illustration 610

g00659240

2. Insert Tooling (B) between the rear housing and wear sleeve (2).

NOTICE

The use of excessive force on the sleeve distorter can cause the distorter adapter to crack the housing. To help avoid damage to the engine, do not use excessive force to remove the wear sleeve.

3. Insert Tooling (C) between Tooling (B) and wear sleeve (2). Carefully turn Tooling (C) until the edge of the tool causes a crease in wear sleeve (2).

Repeat this procedure several times around wear sleeve (2) until wear sleeve (2) can be removed by hand.

i02415901

Crankshaft Rear Seal and Wear Sleeve - Install

SMCS Code: 1161-012; 7558-012

Installation Procedure

Table 71

Required Tools			
Tool	Part Number	Part Description	Qty
D	6V-4003	Seal Locator As	1
	2N-5006	Bolt	2
E	8T-3099	Seal Installer	1
F	9S-8858	Nut	1
G	169-5464	Quick Cure Primer	1
H	4C-9507	Retaining Compound	1
J	1P-0808	Multipurpose Grease	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Every time that the crankshaft seal is removed from the wear sleeve, a new wear sleeve and crankshaft seal must be installed.

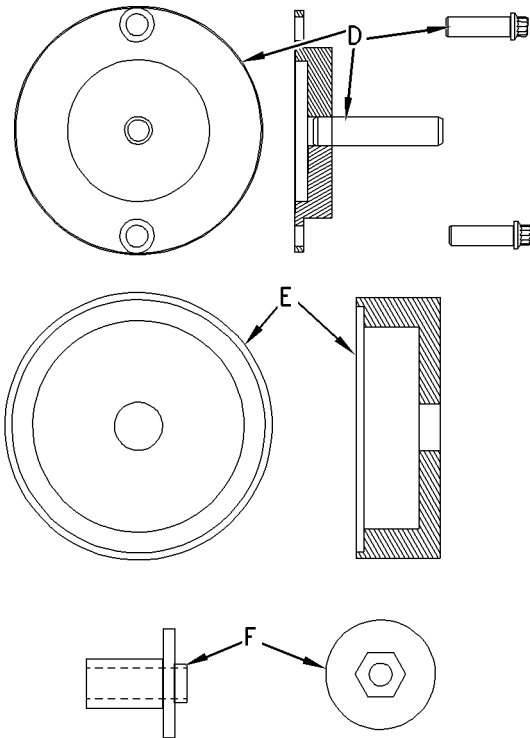


Illustration 611

g01005029

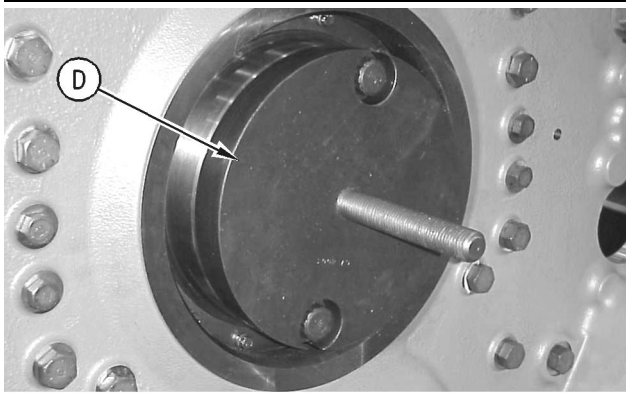


Illustration 612

g01005030

1. Attach Tooling (D) to the crankshaft.
2. Clean the outer diameter of the crankshaft and the inner diameter of the new wear sleeve with Tooling (G).

3. Apply Tooling (H) to the outer diameter of the crankshaft and the inner diameter of the new wear sleeve.

NOTICE

If the crankshaft seal and the wear sleeve come apart during installation, the crankshaft seal and the wear sleeve must be replaced.

Note: The rear crankshaft seal and the wear sleeve cannot be interchanged with the front crankshaft seal and the wear sleeve.

NOTICE

Do not place engine oil on the crankshaft seal for installation. Lubrication of the crankshaft seal can give a false indication of leakage at a later time.

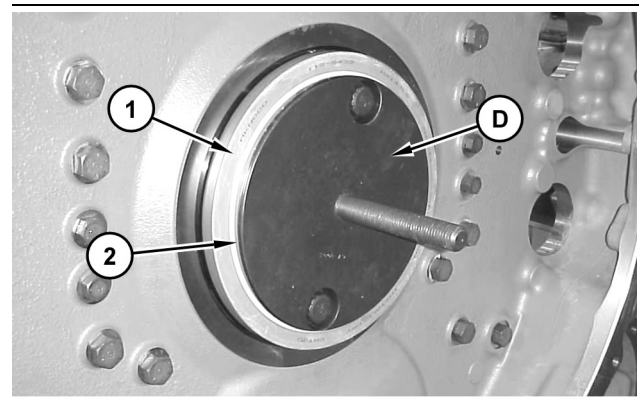


Illustration 613

g01207617

4. Place rear seal (1) and the wear sleeve (2) onto Tooling (D).

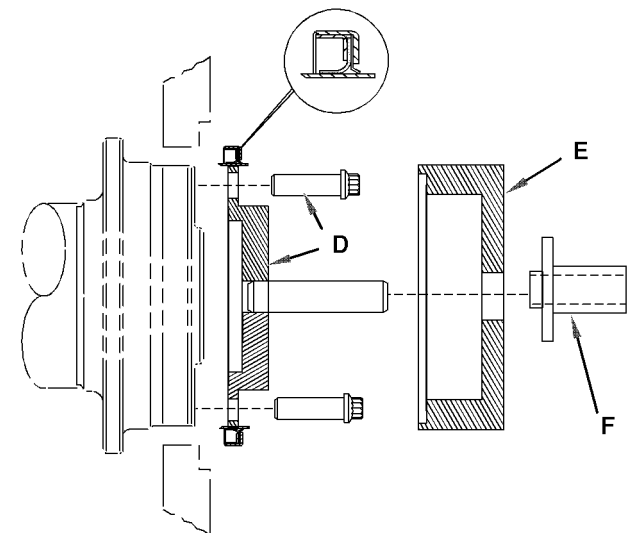


Illustration 614

g01051474

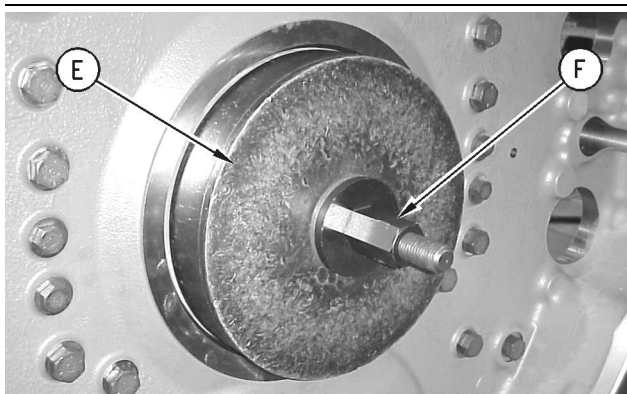


Illustration 615

g01005035

5. Place Tooling (E) onto Tooling (D). Apply Tooling (J) onto the face of the washer on Tooling (F). Install Tooling (F) onto Tooling (E). Tighten the nut until Tooling (E) contacts Tooling (D).

6. Remove the tooling from the crankshaft.

End By:

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

i02517352

Flywheel Housing - Remove

SMCS Code: 1157-011

Removal Procedure

Table 72

Required Tools			
Tool	Part Number	Part Description	Qty
A	8B-7548	Push-Puller Tool Group	1
	8B-7559	Adapter	2
	8H-0684	Ratchet Wrench	1
	8B-7561	Step Plate	3
B	138-7573	Link Bracket	2
C	169-5464	Quick Cure Primer	-

Start By:

- a. Remove the starting motors. Refer to Disassembly and Assembly, "Air Starting Motor - Remove" or Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

- b. If the exhaust elbow is attached to the flywheel housing, remove the exhaust elbow and remove the bracket for the exhaust elbow. Refer to Disassembly and Assembly, "Exhaust Elbow - Remove and Install".

- 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.

1. Use the timing pins in order to properly time the engine. Refer to Testing and Adjusting, "Camshaft Timing". Refer to Testing and Adjusting, "Finding the Top Center Position for the No. 1 Piston".
2. Remove the crankshaft rear seal and the wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Rear Seal and Wear Sleeve - Remove".
3. Remove the camshaft covers and gaskets.
4. Remove the bolts and plates from the camshafts.

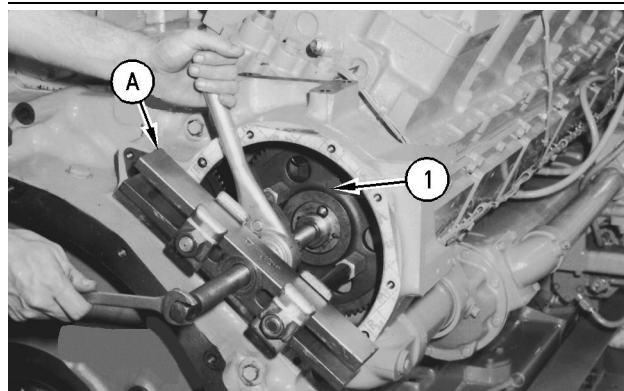


Illustration 616

g00912881

5. Use Tooling (A) in order to remove camshaft drive gears (1).

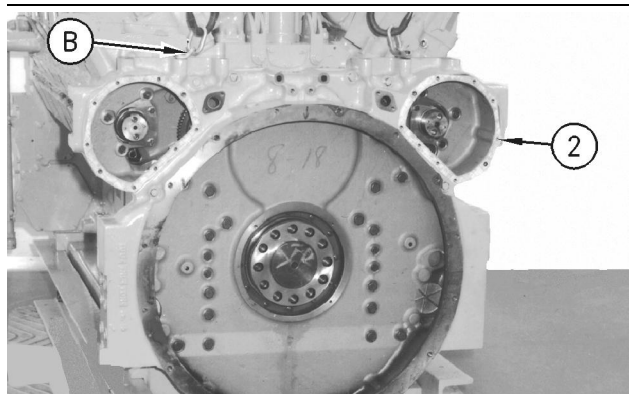


Illustration 617

g00912883

6. Install Tooling (B) into flywheel housing (2). Attach a suitable lifting device to Tooling (B). The weight of flywheel housing (2) is approximately 251 kg (553 lb).
7. Remove the bolts and remove flywheel housing (2) and the gasket.
8. After removing flywheel housing (2), clean the mating surface of the cylinder block and the mating surface of the flywheel housing with Tooling (C). If necessary, use a gasket scraper and a solvent in order to remove any residual gasket material. Both mating surfaces must be clean, dry, and free of any oil before installation.

i02517419

Flywheel Housing - Install

SMCS Code: 1157-012

Installation Procedure

Table 73

Required Tools			
Tool	Part Number	Part Description	Qty
B	138-7573	Link Bracket	2
D	-	Guide Bolts 5/8 - 11 NC by 8 inch	2
E	185-3984 ⁽¹⁾ or 4C-5300	Gasket Sealant	-

⁽¹⁾ EAME

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Refer to Engine News, 27 March 2006, "Sealing and Installing the Flywheel Housing" for more information.

1. Ensure that the mating surface of the flywheel housing and the engine block are clean. Both mating surfaces must be clean, dry, and free of any oil before Tooling (E) is applied.

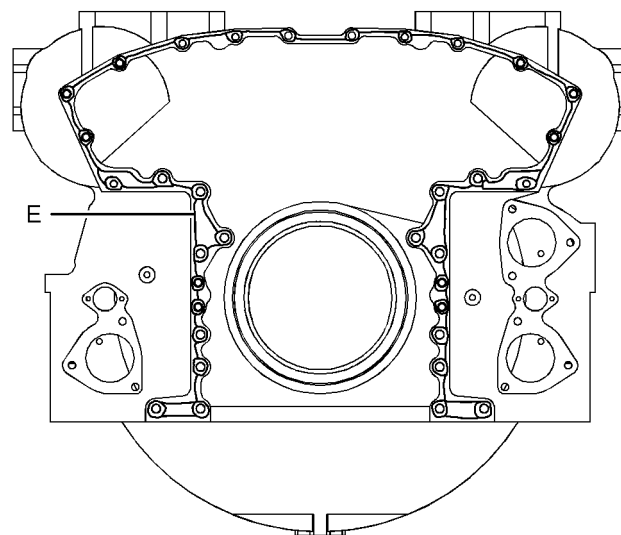


Illustration 618

g01259519

2. Apply a 6.0 mm (0.25 inch) bead of Tooling (E) to the mating surface of the flywheel housing. Refer to Illustration 618.
3. Install Tooling (D) into the cylinder block.

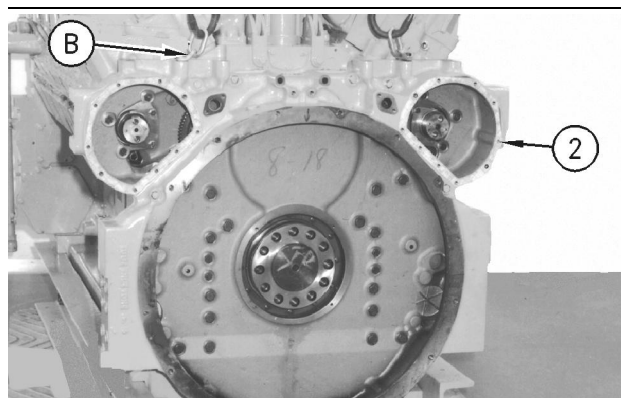


Illustration 619

g00912883

4. Install Tooling (B) onto flywheel housing (2). Attach a suitable lifting device to Tooling (B). The weight of flywheel housing (2) is approximately 251 kg (553 lb).
5. Lift flywheel housing (2) into position onto Tooling (D).

Note: For the correct positions of the bolts, see Illustration 620 or Illustration 621.

6. Install the bolts and the hard washers that secure flywheel housing (2) to the cylinder block. Remove Tooling (D) and install the remaining bolts and the remaining hard washers.

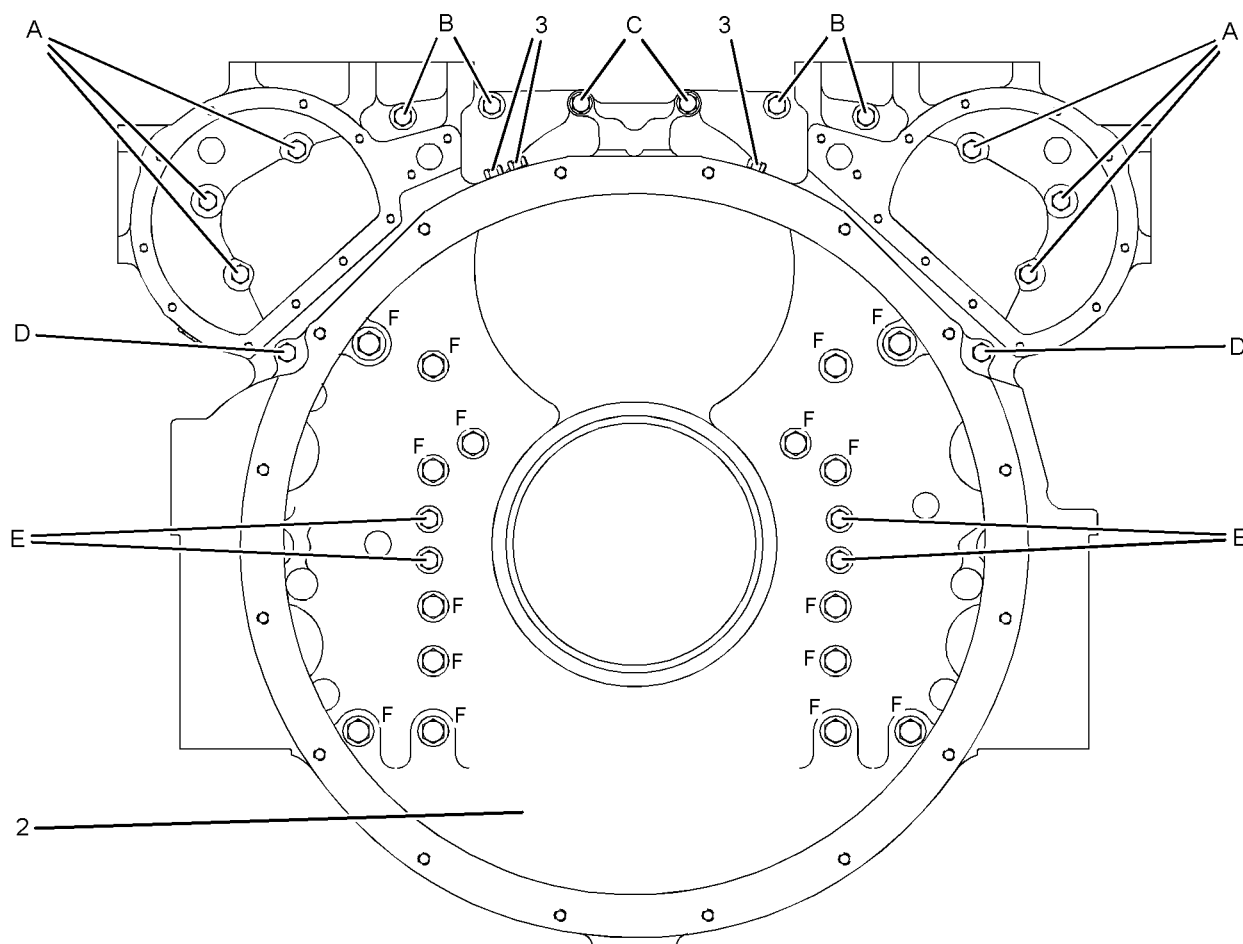


Illustration 620

g01259521

(A) 1/2 - NC
(B) 1/2 - NC

(C) 1/2 - NC
(D) 1/2 - NC

(E) 1/2 - NC
(F) 5/8 - NC

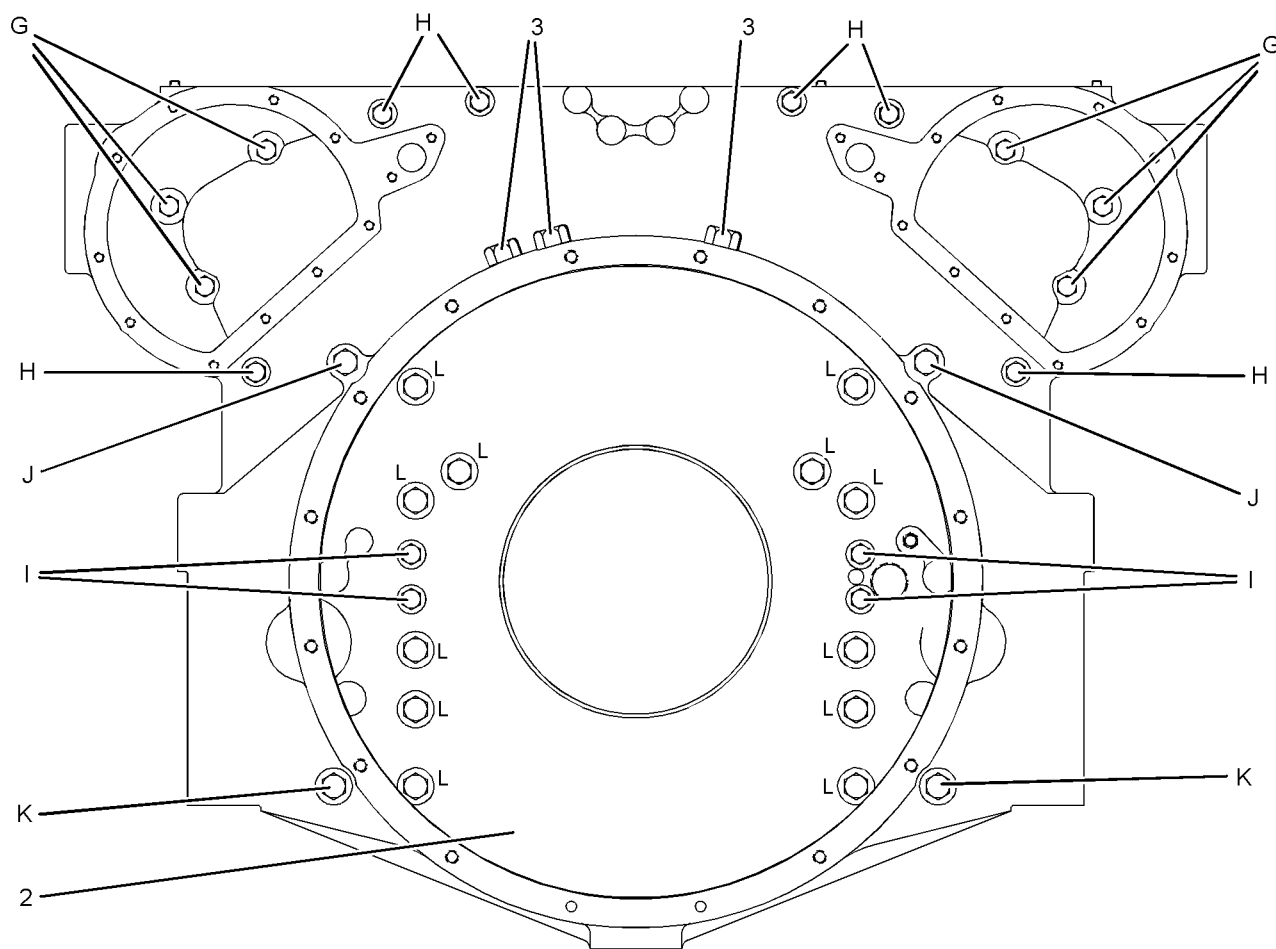


Illustration 621

g01259551

(G) 1/2 - NC
(H) 1/2 - NC

(I) 1/2 - NC
(J) 5/8 - NC

(K) 5/8 - NC
(L) 5/8 - NC

7. Tighten the bolts in flywheel housing (2) evenly. Tighten the 1/2 - NC bolts to a torque of 135 ± 20 N·m (100 ± 15 lb ft). Tighten the 5/8 - NC bolts to a torque of 270 ± 40 N·m (200 ± 30 lb ft). The torque for plugs (3) is 70 ± 15 N·m (50 ± 11 lb ft).

8. Install the crankshaft rear seal and the wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Rear Seal and Wear Sleeve - Install".

9. Place the camshaft timing pins in position and place the timing bolt in the flywheel with the No. 1 piston at the top center position on the compression stroke.

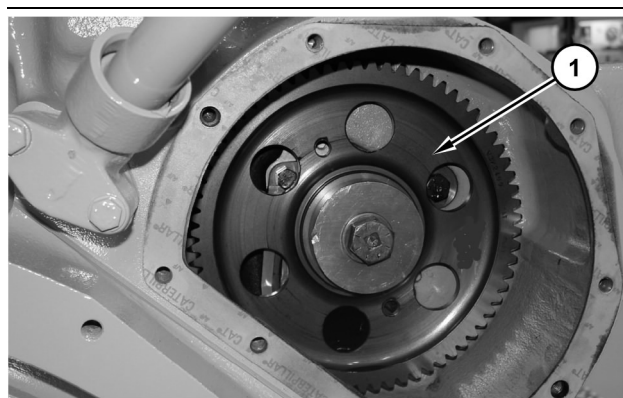


Illustration 622

g01226902

10. Use the following procedure in order to install camshaft drive gears (1).

- a. Clean the taper of the camshaft and clean the tapered bore of the camshaft gear with a lint free cloth that is saturated with a solvent in order to remove any excess oil. Clean the parts again with a lint free alcohol wipe in order to remove any residue. If the alcohol wipe is dirty after cleaning the parts, clean the parts again with a lint free alcohol wipe until no residue is left on the alcohol wipe.

Note: It is critical that the taper of the camshaft and the tapered bore of the camshaft gear are clean, dry, and free of residue before assembly.

- b. Ensure that the camshaft timing pins and the timing pin for the flywheel are installed.
- c. Place camshaft drive gears (1) in position. Remove the backlash by rotating the gears in the opposite direction of engine rotation.

Note: For "Standard Rotation" engines, turn the camshaft drive gears CLOCKWISE. For "Reverse Rotation" engines, turn the camshaft drive gears COUNTERCLOCKWISE.

- d. Install the bolt and the plate for the camshafts.
- e. Install the bolt and the timing ring for the camshafts. Ensure that the hole in the timing ring is properly seated on the locating pin.
- f. Tighten the bolts to a torque of 360 N·m (265 lb ft).
- g. Place a Mark on the bolts.
- h. Place a driver against the retaining plate of the camshaft gear. Strike the driver solidly with a hammer 3 to 4 times.
- i. Tighten the bolts again to a torque of 360 N·m (265 lb ft).
- j. Repeat Steps 10.h and 10.i until the Mark has turned at least 90 degrees.

11. Remove the timing pins from the camshafts and the flywheel.

12. Install the gaskets and camshaft covers.

End By:

- a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Install".
- b. If the exhaust elbow was removed, install the exhaust elbow. Refer to Disassembly and Assembly, "Exhaust Elbow - Remove and Install".

- c. Install the starting motors. Refer to Disassembly and Assembly, "Air Starting Motor - Install" or Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

i02087183

Engine Oil Sequence Valves - Remove and Install

SMCS Code: 1332-010

Removal Procedure

Start By:

- a. Remove the front drive housing. Refer to Disassembly and Assembly, "Front Drive Housing - Remove and Install".
- b. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

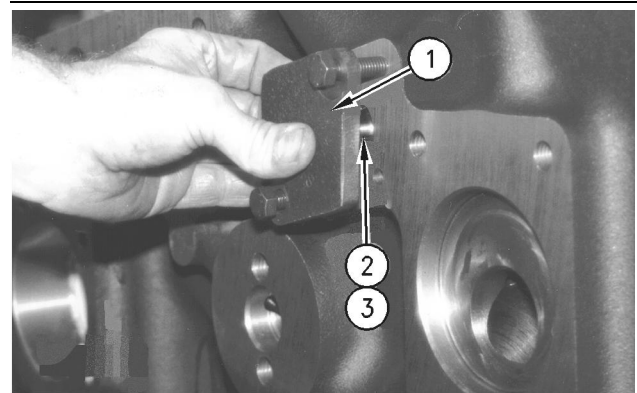


Illustration 623

g00912963

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.

1. Remove cover (1) from the front of the cylinder block.
2. Remove plunger assembly (2) and spring (3) from the front of the cylinder block.

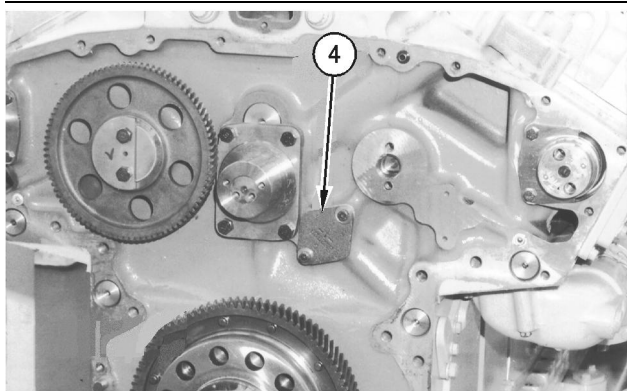


Illustration 624

g00912966

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 the idler gear and the shaft. Remove cover (4) on the rear of the cylinder block.

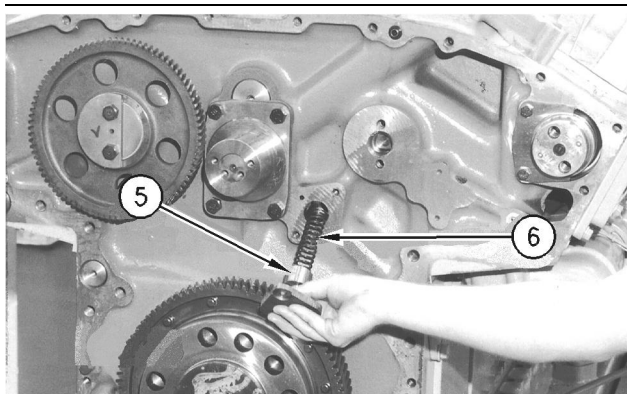


Illustration 625

g00912969

4. Remove plunger assembly (5) and spring (6) from the rear of the cylinder block.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

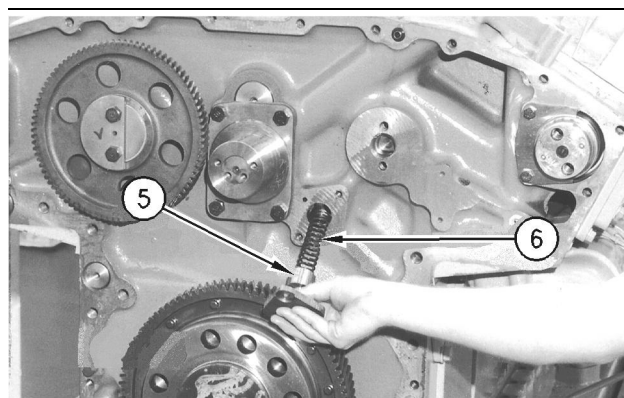


Illustration 626

g00912969

1. Place clean engine oil on spring (6) and plunger assembly (5).
2. Install spring (6) and plunger assembly (5).

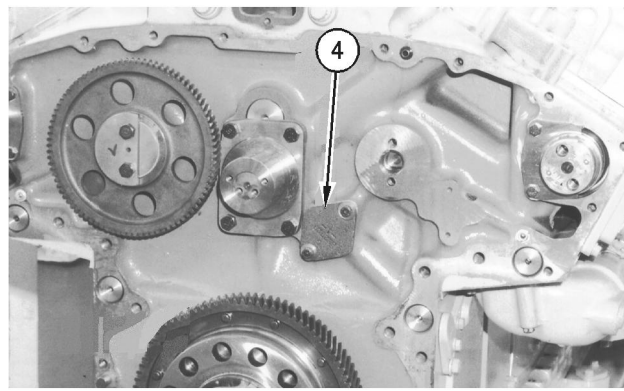


Illustration 627

g00912966

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. Install cover (4) on the rear of the cylinder block. Install the idler gear and the shaft.

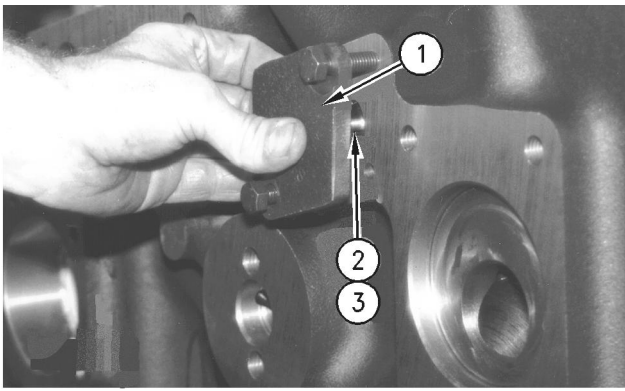


Illustration 628

g00912963

⚠ 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.

4. Place clean engine oil on spring (3) and plunger assembly (2).
5. Install spring (3) and plunger assembly (2) on the front of the cylinder block.
6. Install cover (1) on the front of the cylinder block.

End By:

- a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Install".
- b. Install the front drive housing. Refer to Disassembly and Assembly, "Front Drive Housing - Remove and Install".

i02062075

Gear Group (Rear) - Remove

SMCS Code: 1206-011; 1212-011

Removal Procedure

Table 74

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Group	1

Start By:

- a. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - 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: The following Step is for a 3508 Engine.

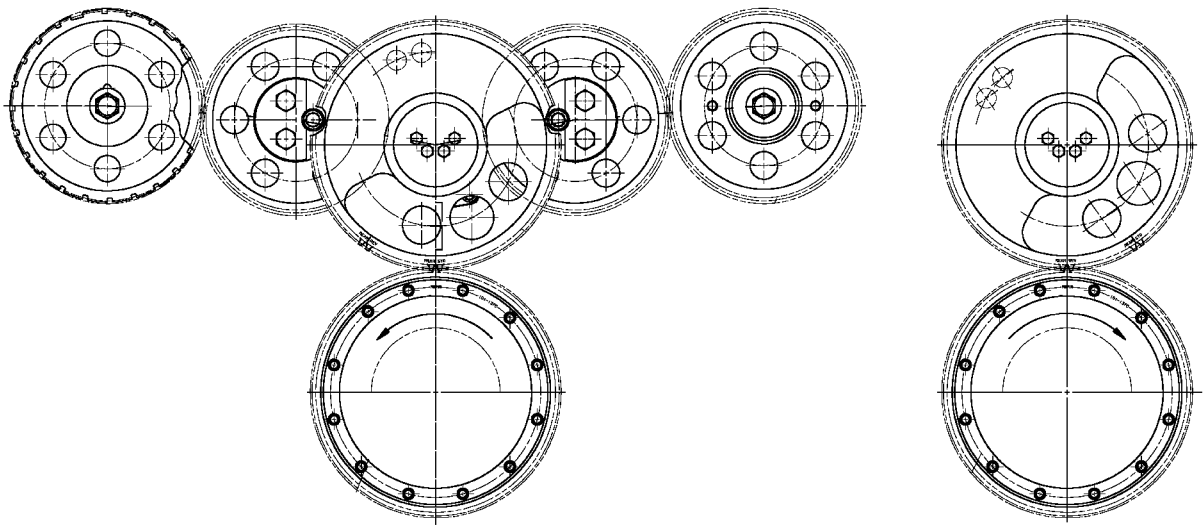


Illustration 629

g01056631

1. The engine must be put in time before the flywheel housing is removed. This is done in order to make sure that the rear gear group is in alignment with the rotation of the engine, as shown.

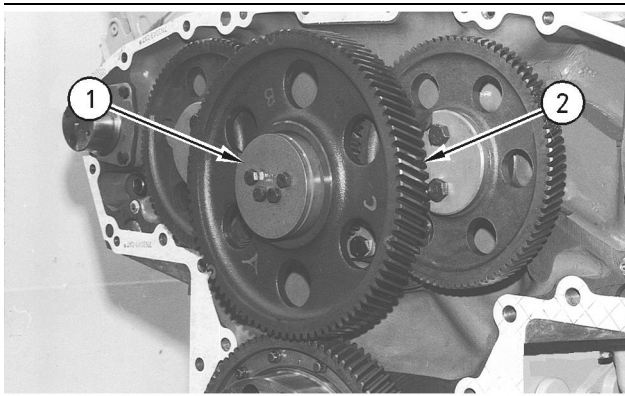


Illustration 630

g00913045

2. Remove plate (1) and gear (2).

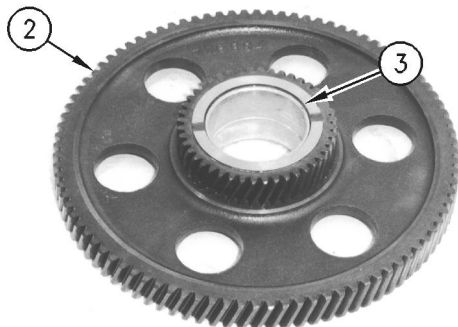


Illustration 631

g00913049

3. Use Tooling (A) and a suitable press to remove bearing (3) from gear (2).

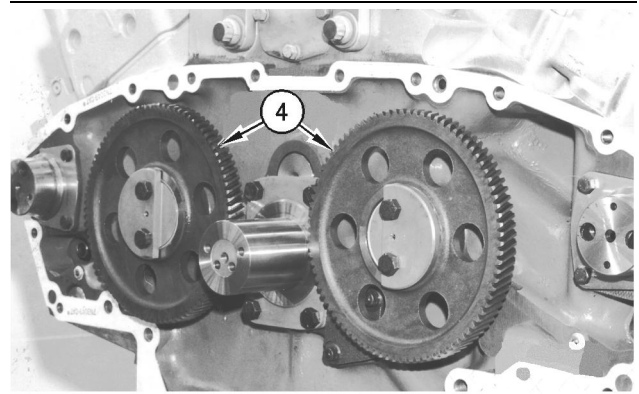


Illustration 632

g00913054

4. Remove the bolts, the washers, and camshaft idler gears (4).

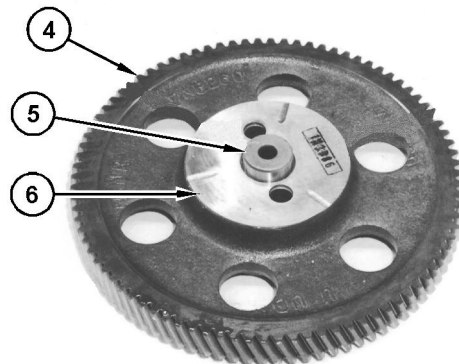


Illustration 633

g01051669

5. Remove washers (6) and shafts (5) from camshaft idler gears (4).

6. Use Tooling (A) and a suitable press to remove bearings from camshaft idler gears (4).

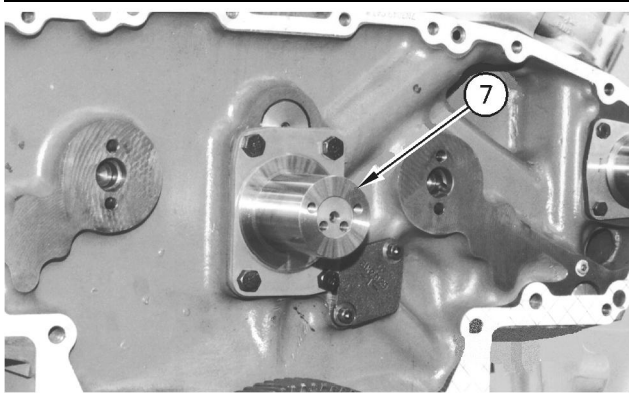


Illustration 634

g00913136

7. Remove the bolts from shaft (7) and remove shaft (7).

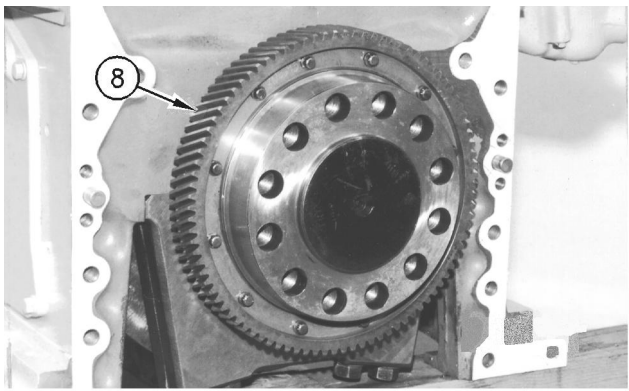


Illustration 635

g00913137

8. Remove the bolts and crankshaft gear (8) from the end of the crankshaft.

Gear Group (Rear) - Install

SMCS Code: 1206-012; 1212-012

Installation Procedure

Table 75

Required Tools			
Tool	Part Number	Part Description	Qty
A	1P-0520	Driver Gp	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

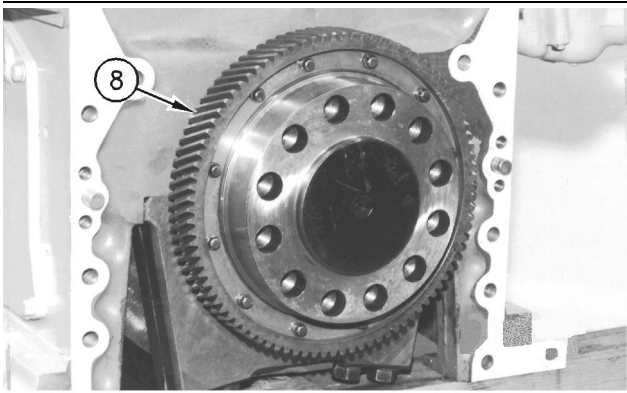


Illustration 636

g00913137

1. Install crankshaft gear (8) and the bolts.

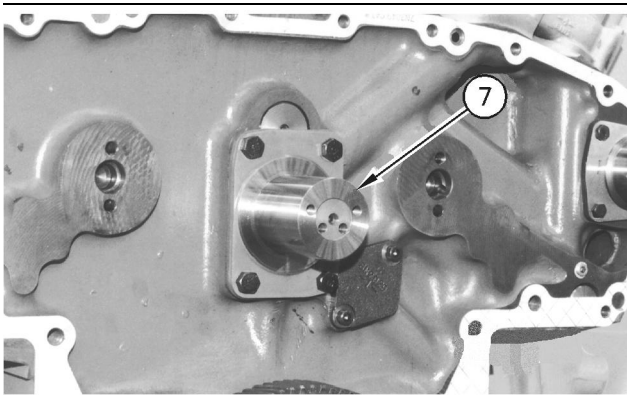


Illustration 637

g00913136

2. Install shaft (7) and the bolts. The torque for the bolts is 140 ± 10 N·m (105 ± 5 lb ft).

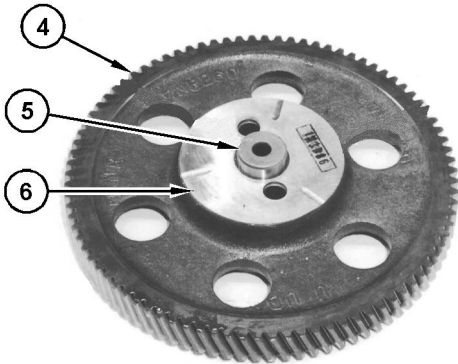


Illustration 638

g01051669

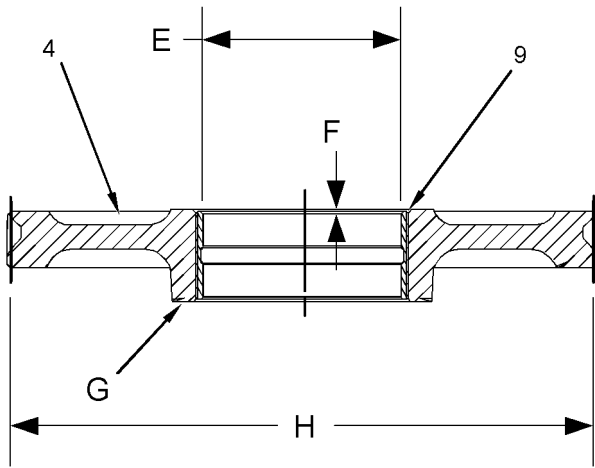


Illustration 639

g01068502

(4) Camshaft Idler Gear. (9) Bearing. (E) 75.060 ± 0.010 mm (2.9551 ± 0.0004 inch). (F) 1.00 ± 0.25 mm (0.040 ± 0.010 inch).

3. Use Tooling (A) and a suitable press to install the bearings in camshaft idler gears (4). Install bearing (9) into gear (4) to Depth (F), as shown.
 4. Machine the inside diameter of bearing (9) to Dimension (E), as shown.
- Note:** The surface finish of Bore (E) must be 0.8 micrometers. Pitch Diameter (H) must be concentric with a total indicator reading of 0.12 mm (0.005 inch). Surface (G) of gear (4) must be square with Bore (E) within 0.05 mm (0.002 inch).
5. Place clean engine oil on the bearings and install shafts (5) with washers (6) on camshaft idler gears (4).

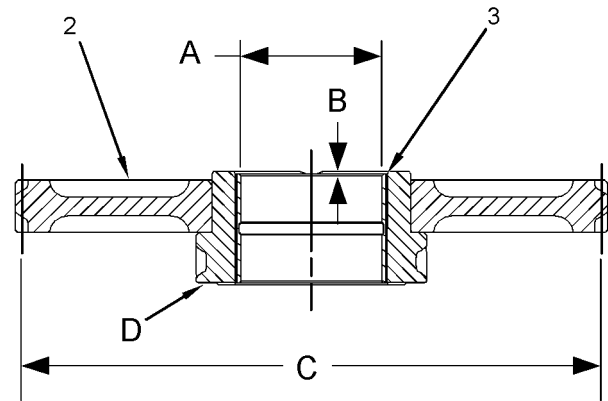


Illustration 641

g01068516

(2) Cluster Idler Gear. (3) Bearing. (A) 75.060 ± 0.010 mm (2.9551 ± 0.0004 inch). (B) 1.5 ± 0.5 mm (0.06 ± 0.02 inch).

7. Use Tooling (A) and a suitable press to install bearing (3) in gear (2). Install bearing (2) to Depth (B), as shown.
 8. Machine the inside diameter of the bearing to Dimension (A), as shown.
- Note:** The surface finish of Bore (A) must be 0.8 micrometers. Pitch Diameter (C) must be concentric with a total indicator reading of 0.15 mm (0.006 inch). Surface (D) of gear (2) must be square with Bore (A) within 0.05 mm (0.002 inch).

Note: The following Step is for a 3508 Engine.

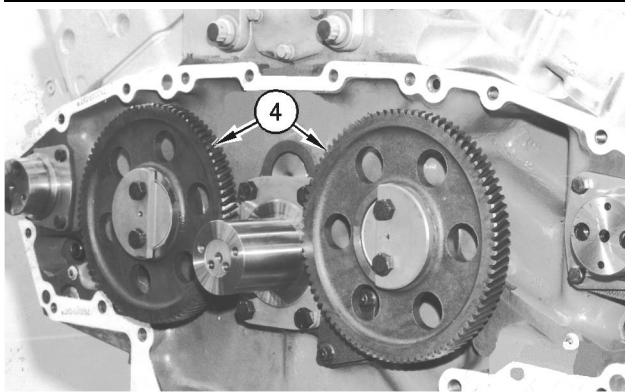


Illustration 640

g00913054

6. Install camshaft idler gears (4) and the bolts.

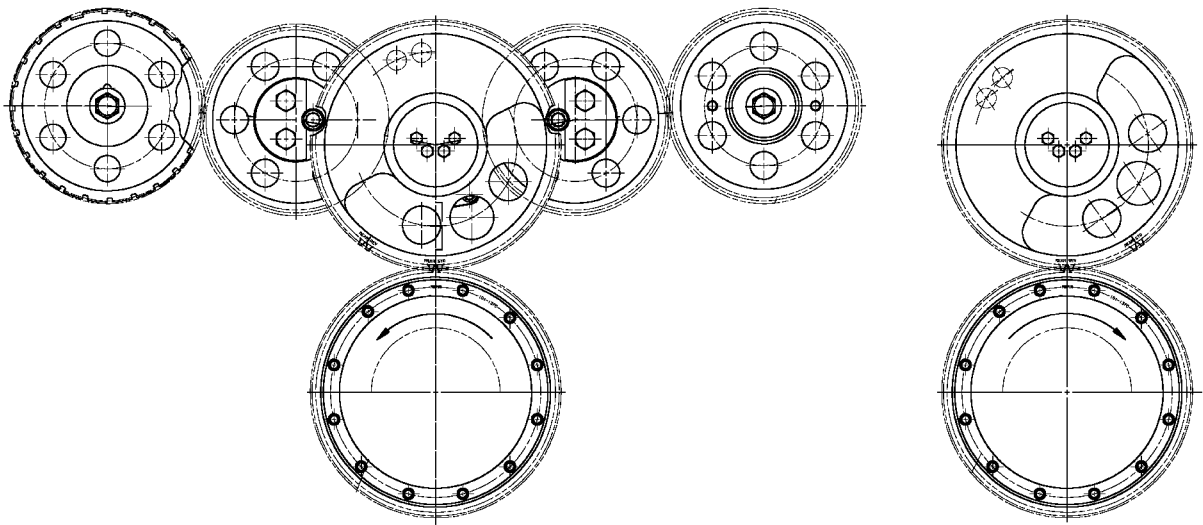


Illustration 642

g01056631

Note: When you install the rear cluster gear assembly to the crank gear, there are no timing marks on the G3512 and the G3516 engines. On the G3508 engines, the rear cluster gears have timing marks that must be aligned with the marks that are on the cluster gears.

i02087195

9. Put clean engine oil on the bearing and install the gear assembly on the shaft. Make sure that the marks on the gear assembly and the crankshaft are in alignment with the rotation of the engine, as shown.

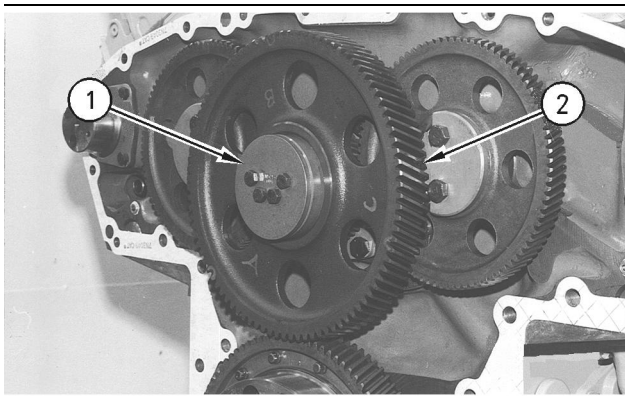


Illustration 643

g00913045

10. Place clean engine oil on gear (2) and install gear (2) on the engine.

11. Install plate (1) and the bolts.

End By:

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

Piston Cooling Jets - Remove and Install

SMCS Code: 1331

Removal Procedure

Start By:

- a. Remove the engine oil pump, if necessary. 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.

1. Remove the cylinder block cover from the side of the engine.

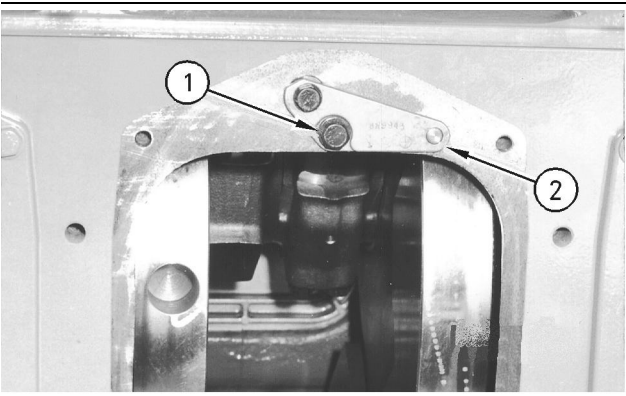


Illustration 644 g00913178

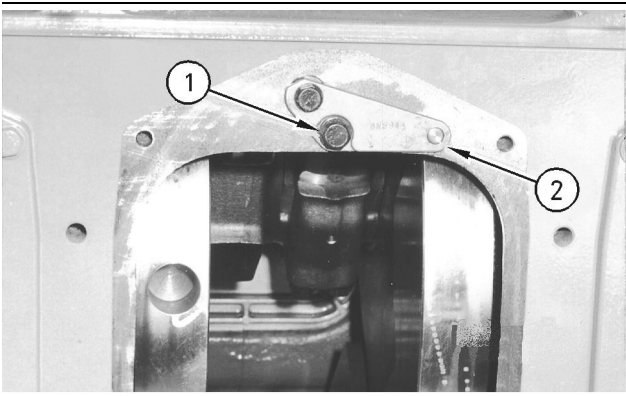


Illustration 647 g00913178

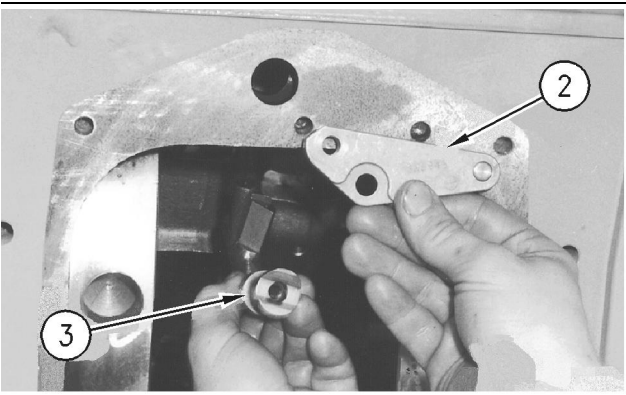


Illustration 645 g00913185

2. Remove bolts (1) and retainer (2).
3. Remove piston cooling jet (3) from the inside of the engine.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.
Contaminants may cause rapid wear and shortened component life.

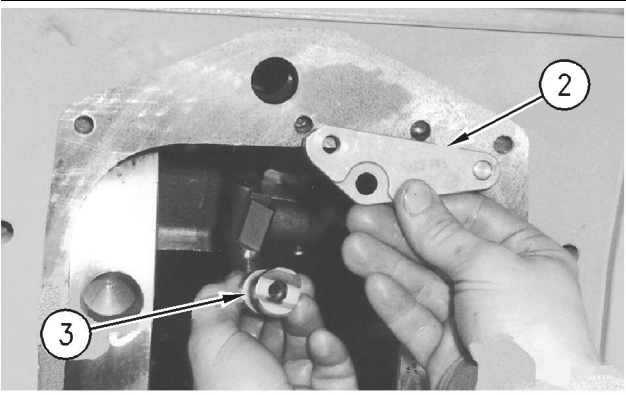


Illustration 646 g00913185

1. Position piston cooling jet (3) in the engine block. Ensure that the oil holes in the end of the jet are facing toward the piston.
2. Install retainer (2) and bolts (1).
3. Install the cylinder block cover on the side of the engine.

End By:

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

i02717761

Bearing Clearance - Check

SMCS Code: 1203-535; 1219-535

Measurement Procedure

Table 76

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

Note: Plastic gauge may not be necessary when the engine is in the chassis.

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 648.

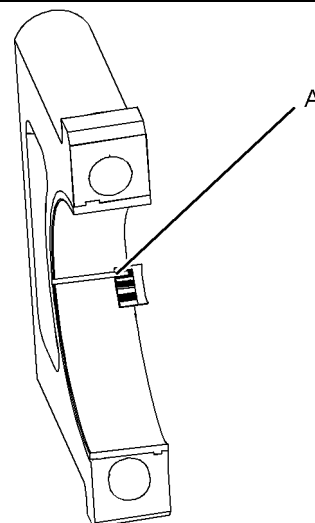


Illustration 648

g01152855

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.

i02140851

Connecting Rod Bearings - Remove and Install

SMCS Code: 1219-010

Removal Procedure

Table 77

Required Tools			
Tool	Part Number	Part Description	Qty
A	5R-7425	Barring Gp ⁽¹⁾	1

⁽¹⁾ The 9S-9082 Engine Turning Tool is alternate tooling.

Start By:

- a. Remove the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

- 1. Use Tooling (A) to turn the flywheel in order to access the connecting rod cap that will be removed.

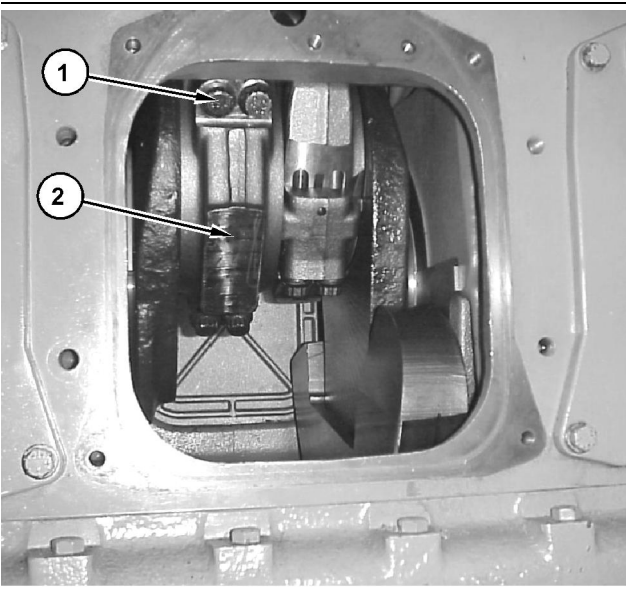


Illustration 649

g01064418

Note: Inspect the connecting rod and connecting rod cap for the proper identification mark. The connecting rod and the connecting rod cap should have an etched number on the side. The number should match the cylinder number. Mark the connecting rod and the connecting rod cap, if necessary.

- 2. Remove bolts (1) and connecting rod cap (2) from the crankshaft.
- 3. Push the connecting rod away from the crankshaft and remove the upper half of the connecting rod bearing.

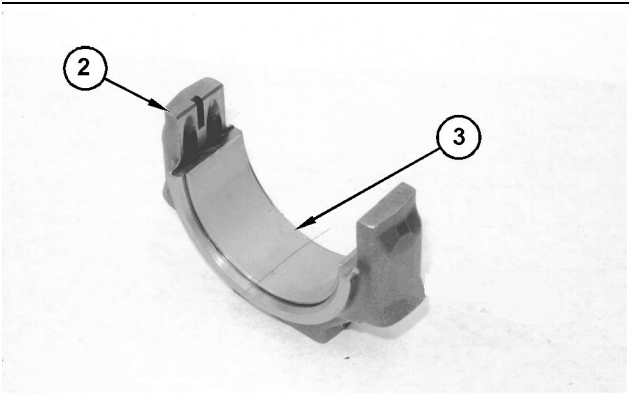


Illustration 650

g01064420

- 4. Remove lower half (3) of the connecting rod bearing from connecting rod cap (2).

Installation Procedure

Table 78

Required Tools			
Tool	Part Number	Part Description	Qty
B	6V - 4876	Lubricant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

- 1. Check the clearance of the bearings. Refer to Disassembly and Assembly, "Bearing Clearance - Check" for the correct procedure.
- 2. Place clean engine oil on the connecting rod bearings.

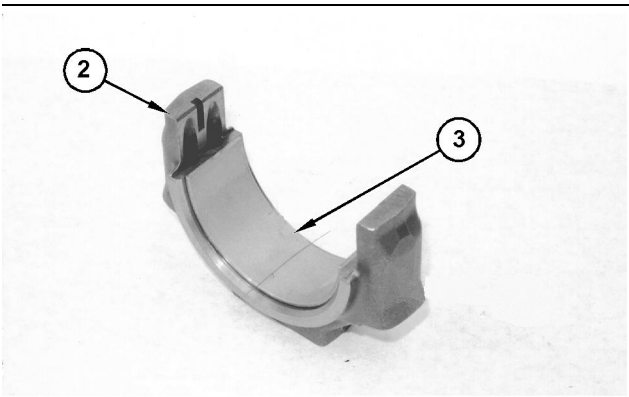


Illustration 651

g01064420

3. Install lower half (3) of the connecting rod bearing in connecting rod cap (2). Ensure that the tab on the back of the bearing is in the bearing tab groove on the connecting rod cap.
4. Install the upper half of the connecting rod bearing in the connecting rod. Ensure that the tab on the back of the bearing is in the bearing tab groove on the connecting rod.
5. Position the connecting rod on the crankshaft.

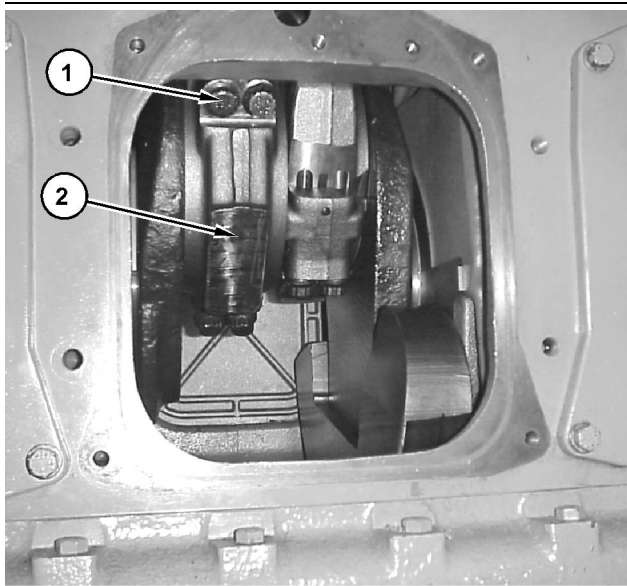


Illustration 652

g01064418

6. Position connecting rod cap (2) onto the connecting rod. Ensure that the number on the side of connecting rod cap (2) corresponds to the number that is on the connecting rod.
7. Apply Tooling (B) to bolts (1) and install bolts (1).

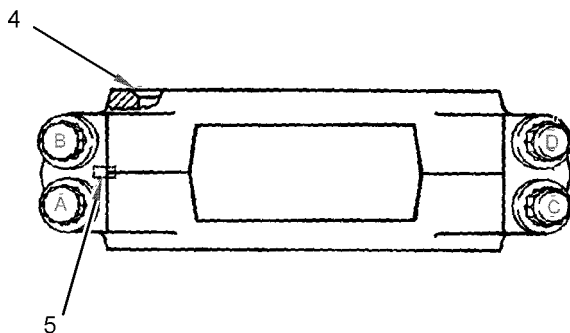


Illustration 653

g01064455

- (4) Side of the connecting rod with the chamfer
(5) Location pin

- a. Tighten Bolts (A) and (B) to 90 ± 5 N·m (65 ± 4 lb ft).
 - b. Tighten Bolts (C) and (D) to 90 ± 5 N·m (65 ± 4 lb ft).
 - c. Tighten Bolts (C) and (D) again to 90 ± 5 N·m (65 ± 4 lb ft).
 - d. Tighten all of the bolts for an additional 90 ± 5 degrees ($1/4$ turn).
8. Check the side clearance that is between two of the connecting rods that are on the same journal. The clearance must be 0.85 ± 0.332 mm (0.034 ± 0.0130 inch).

End By:

- a. Install the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

i02040853

Crankshaft Main Bearings - Remove

SMCS Code: 1203-011

Removal Procedure

Table 79

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1
B	9U-5023	Main Bearing Wrench	1
C	2P-5517	Main Bearing Tool	1
D	230-5843 ⁽¹⁾ or 236-6688 ⁽²⁾	Main Bearing Cap Tool	2

⁽¹⁾ Use with 19.0 mm (3/4 inch) main bearing cap bolts.

⁽²⁾ Use with 22.2 mm (7/8 inch) main bearing cap bolts.

Start By:

- a. Remove the 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.

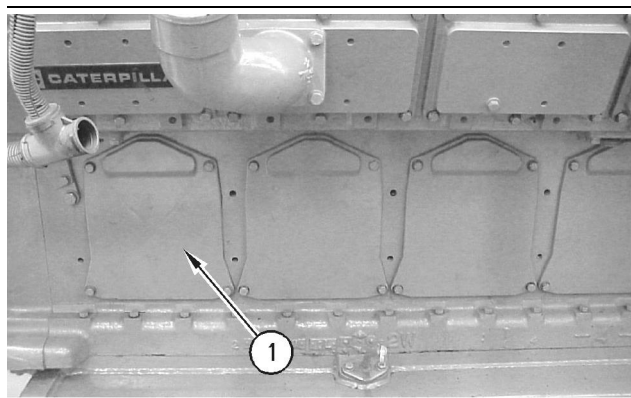


Illustration 654

g00930577

1. Remove covers (1) from the side of the engine.
2. Use Tooling (A) in order to rotate the crankshaft. Rotate the crankshaft in order to position the counterweight on the top.

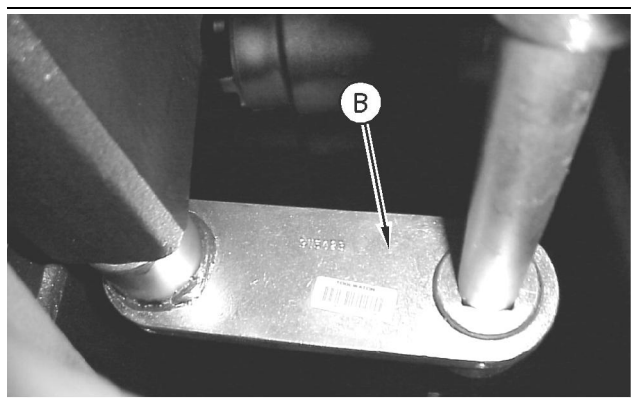


Illustration 655

g00930580

3. Use Tooling (B) and loosen the bolts for the main bearing cap.

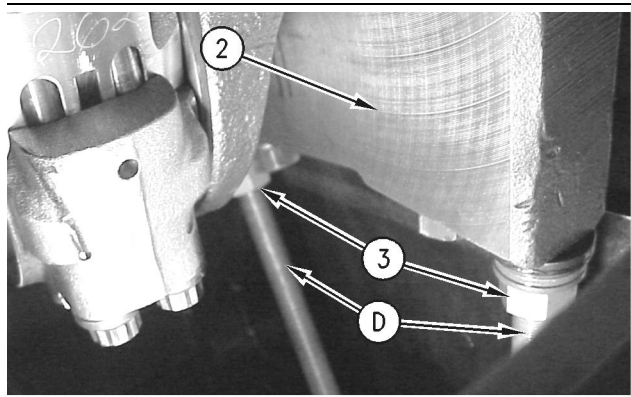


Illustration 656

g00930589

4. Remove the two outer bolts for main bearing cap (2) and install Tooling (D). Install Tooling (D) until Tooling (D) bottoms out in the block. Adjust nuts (3) on Tooling (D) until nuts (3) make contact with main bearing cap (2). Remove the two inner bolts for main bearing cap (2).

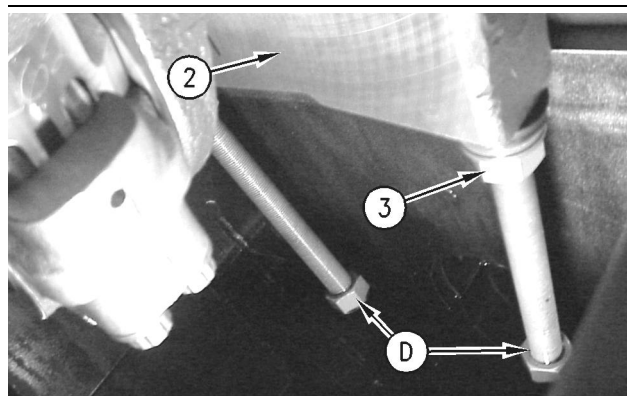


Illustration 657

g00930593

5. Loosen nuts (3) evenly in order to lower main bearing cap (2). Lower main bearing cap (2) to the end of the bolt on Tooling (D) in order to gain access to the main bearings.

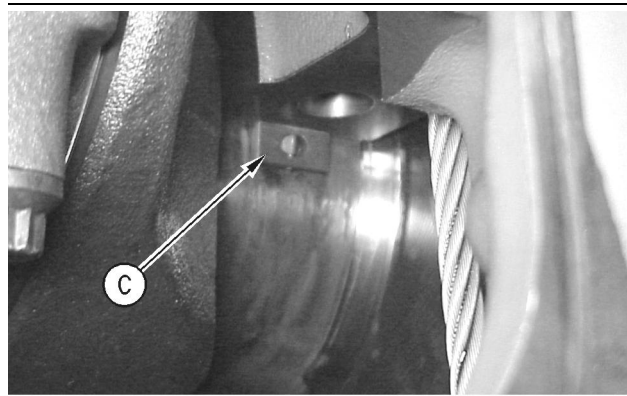


Illustration 658

g00930603

6. Use Tooling (A) and rotate the crankshaft until the oil hole of the crankshaft journal is just below the side of the main bearing without the tab. Install Tooling (C) and remove the upper bearing.

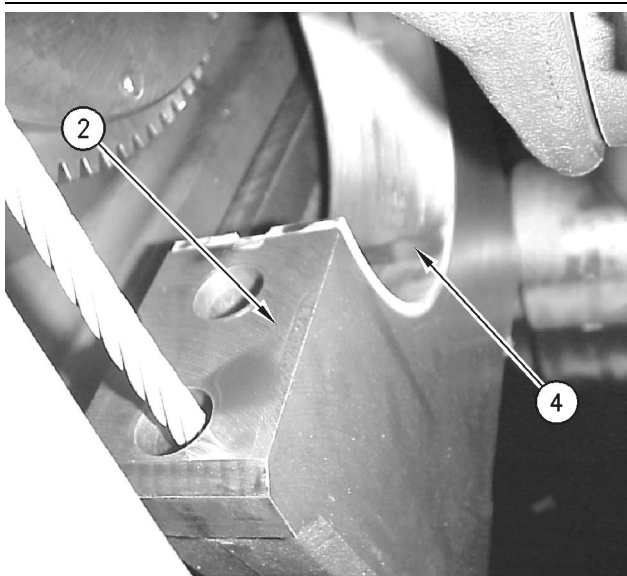


Illustration 659

g00930606

7. Remove lower main bearing (4) from main bearing cap (2).

i01987340

Crankshaft Main Bearings - Install

SMCS Code: 1203-012

Installation Procedure

Table 80

Required Tools			
Tool	Part Number	Part Description	Qty
A	9S-9082	Engine Turning Tool	1
B	9U-5023	Main Bearing Wrench	1
C	2P-5517	Main Bearing Tool	1
D	230-5843 ⁽¹⁾ or 236-6688 ⁽²⁾	Main Bearing Cap Tool	2
E	9S-7351	Torque Wrench	1
F	6V-4876	Lubricant	1

⁽¹⁾ Use with 19.0 mm (3/4 inch) main bearing cap bolts.

⁽²⁾ Use with 22.2 mm (7/8 inch) main bearing cap bolts.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Measure the clearances of the main bearings. Refer to Disassembly and Assembly, "Bearing Clearance - Check".

NOTICE

Ensure that the upper halves and the lower halves of the main bearings are installed with the tabs fitting into the notch in the cylinder block and the notch in the main bearing cap.

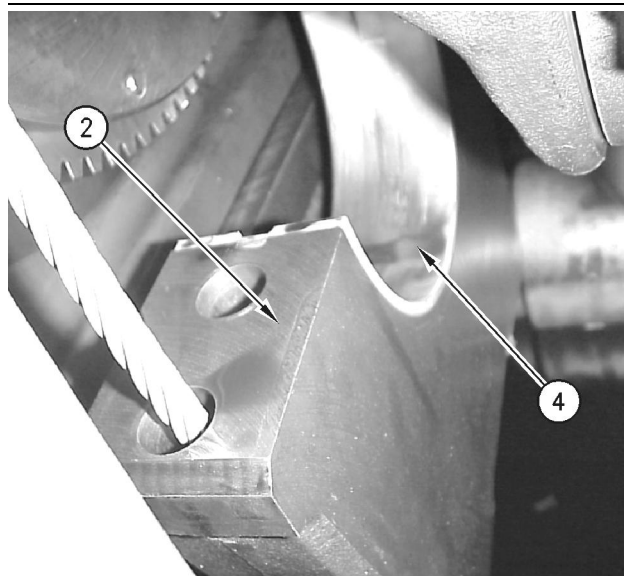


Illustration 660

g00930606

2. Coat the main bearings with clean engine oil. Install new lower main bearing (4) into main bearing cap (2).
3. Install the new upper main bearing with the side without the tab into the side of the block with the tab. Use your hand and roll the upper main bearing into position. Use Tooling (A) and rotate the crankshaft. Rotate the crankshaft until the oil hole is positioned in front of the side of the upper main bearing with the tab.
4. Install Tooling (C) and finish rolling the upper main bearing into position. Make sure that Tooling (C) does not slide under the upper main bearing.
5. Remove Tooling (C).

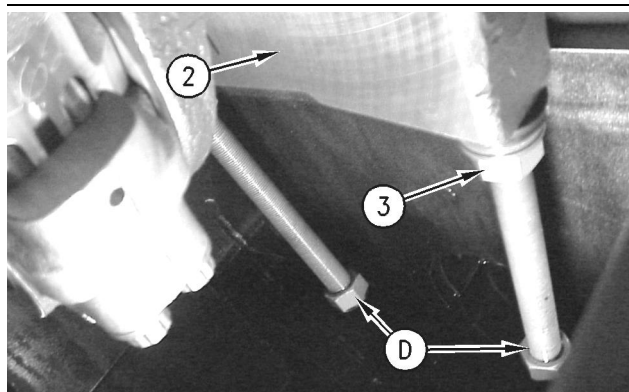


Illustration 661

g00930593

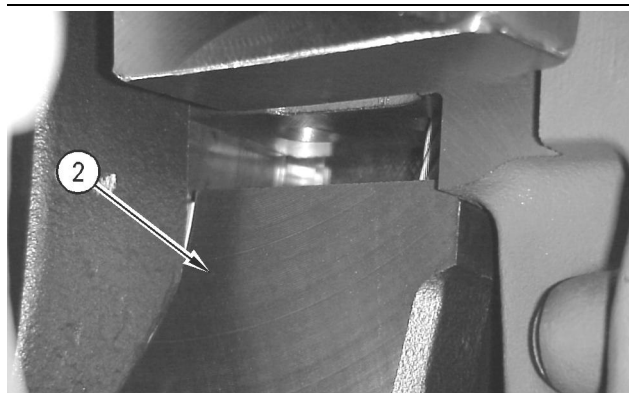


Illustration 662

g00930745

6. Tighten nuts (3) on Tooling (D) in order to raise main bearing cap (2) to the block. Nuts (3) must be tightened evenly in order for main bearing cap (2) to fit into the block.
7. Coat the threads of the bolts for the main bearing caps and coat the underside of the bolt heads with clean engine oil. Install the two inner bolts for the main bearing cap. Remove Tooling (D) and install the two outer bolts for the main bearing cap.

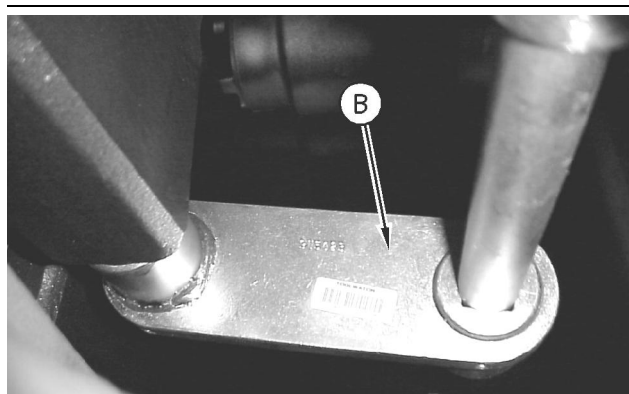


Illustration 663

g00930580

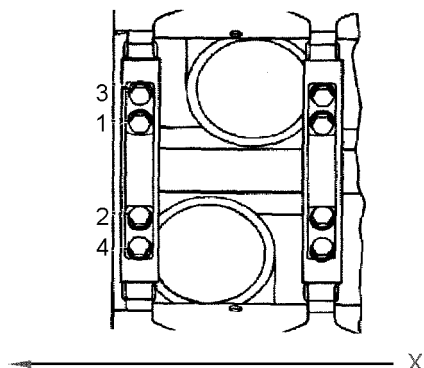


Illustration 664

g01049012

8. Use Tooling (E) and Tooling (B) and tighten the bolts according to the sequence that is shown in Illustration 664. Arrow (X) points to the front of the engine. Tighten the bolts to a torque of $190 \pm 14 \text{ N}\cdot\text{m}$ ($140 \pm 10 \text{ lb ft}$).
9. Tighten the bolts for an additional 180 ± 5 degrees ($1/2$ turn).

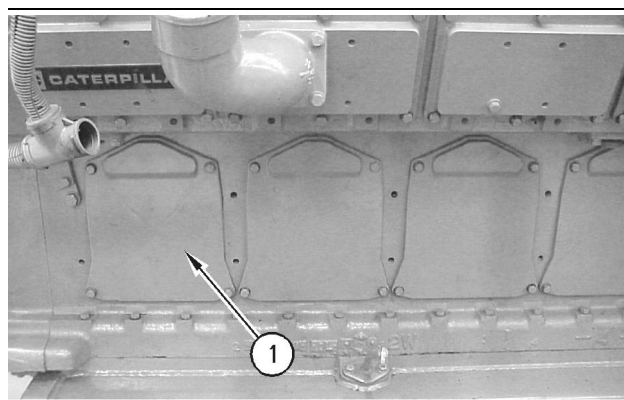


Illustration 665

g00930577

10. Install covers (1) onto the side of the engine.

Note: For more information on the crankshaft, refer to Specifications.

End By:

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

i02418035

Pistons and Connecting Rods - Remove

SMCS Code: 1225-011

Removal Procedure

Table 81

Required Tools			
Tool	Part Number	Part Description	Qty
A	5R-7425	Barring Gp ⁽¹⁾	1
B	1P-1861	Retaining Ring Pliers	1
C	6V-4020	Piston Ring Expander	1
D	5P-8639	Hydraulic Press	1
	8F-0024	Hose Assembly	1
	1P-2375	Quick Connect Coupler	1
	1P-2376	Quick Connect Coupler	1
	1U-5230	Hand Hydraulic Pump	1
E	5P-8649	Adapter	1
F	6V-3043	Spacer	1
G	6V-3042	Adapter	1

(1) The 9S-9082 Engine Turning Tool is alternative tooling.

Start By:

- Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".
- Remove the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The front end of the engine is the end that is opposite of the flywheel. The number one cylinder is the right front cylinder and the number two cylinder is the front left cylinder.

- Remove the cover from the front right side of the flywheel housing. Use Tooling (A) to rotate the flywheel until all four bolts in the connecting rod cap can be removed.

- Mark the cylinder number on each connecting rod and on the corresponding connecting rod cap.

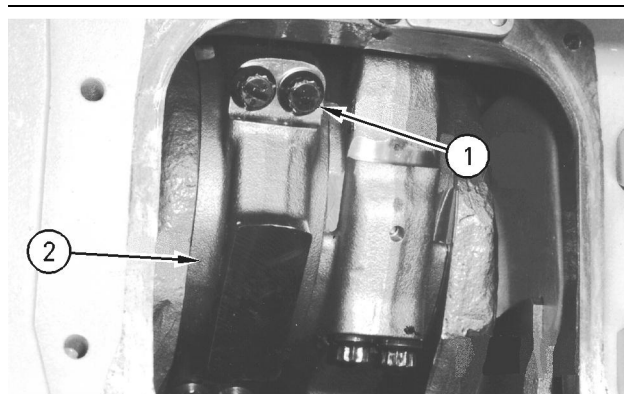


Illustration 666

g00913801

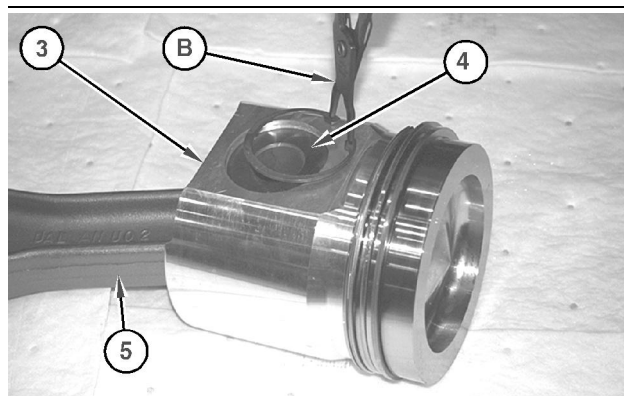


Illustration 667

g01051820

- Remove bolts (1) and connecting rod cap (2) from connecting rod (5).
- Remove the piston and connecting rod assembly.
- Use Tooling (B) to remove the retaining rings that hold piston pin (4). Remove piston pin (4). Remove piston (3) from connecting rod (5).
- Remove the bearings from connecting rod (5) and from connecting rod cap (2).

Note: To help in the removal of the piston rings, separate the piston skirt from the piston crown.

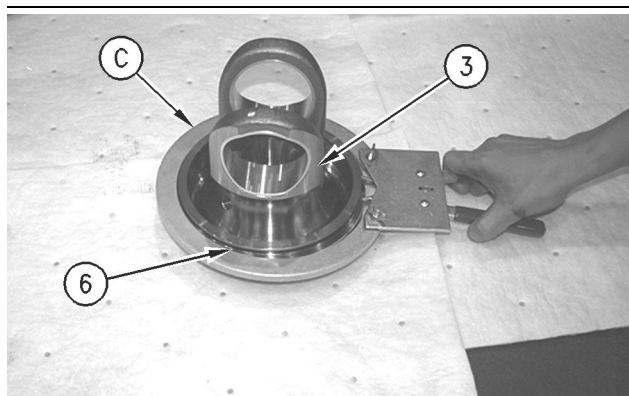


Illustration 668

g00913818

7. Use Tooling (C) to remove piston rings (6) from piston (3).
8. Clean the piston ring grooves with an acceptable ring groove tool. Refer to Guideline For Reusable Parts, SEBF8059, "Procedure To Clean And Inspect 3500 Series Engine Pistons" for the correct procedure for cleaning the pistons.

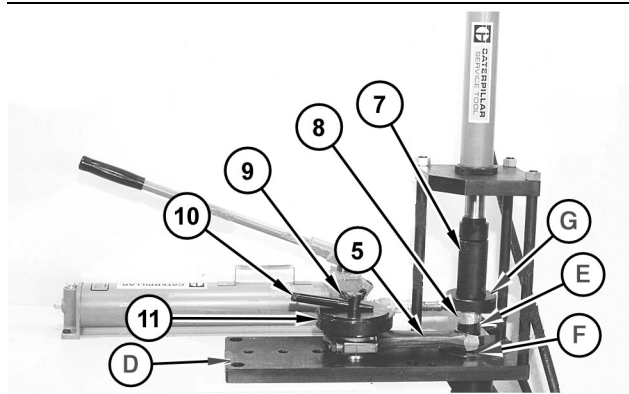


Illustration 669

g01208346

9. Raise the temperature of connecting rod (5). Place Tooling (F) in the base plate of Tooling (D). Place connecting rod (5) on the base plate.

Note: Do not use a direct flame in order to heat connecting rod (5).

10. Place the piston pin bearing in the center of the port assembly on Tooling (D). Install pin (9) in the center of the bore for the piston pin.
11. Install Tooling (E). Align the hole in Tooling (E) with the hole that is in the base plate of Tooling (D).
12. Install bar clamp (11) and clamp pin (10).

Note: The old bearing is pushed out while the new bearing is installed.

13. Position Tooling (G) with the tapered side facing downward. The piston pin bearing joint must be aligned with the hole in Tooling (E) and the hole in the base plate of Tooling (D).

14. Place pusher (7) on Tooling (G).

15. Use Tooling (D) to push new piston pin bearing (8) into connecting rod (5) until Tooling (G) makes contact with connecting rod (5).

16. Remove connecting rod (5) and the old piston pin bearing from Tooling (D).

17. After the piston pin bearing is installed, measure the diameter of the bearing bore. The correct diameter is 70 ± 0.01 mm (2.8 ± 0.000 inch).

i02418583

Pistons and Connecting Rods - Install

SMCS Code: 1225-012

Installation Procedure

Table 82

Required Tools			
Tool	Part Number	Part Description	Qty
A	5R - 7425	Barring Gp ⁽¹⁾	1
B	1P - 1861	Retaining Ring Pliers	1
C	6V - 4020	Piston Ring Expander Gp	1
H	1U - 7616	Piston Ring Compressor Gp	1
J	6V - 4876	Lubricant	1

⁽¹⁾ The 9S - 9082 Engine Turning Tool is alternative tooling.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

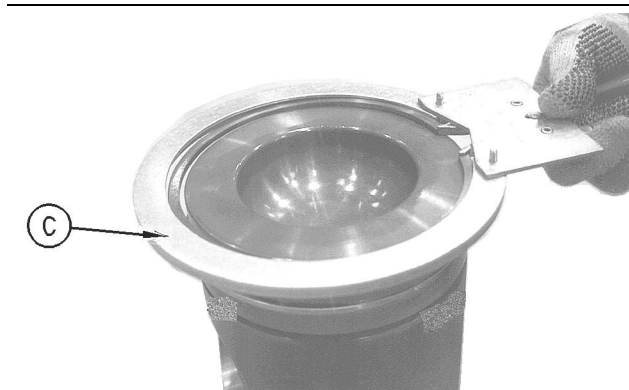


Illustration 670

g01004841

1. Use Tooling (C) to install the piston rings onto the piston.
 - a. For the oil control ring, ensure that the ends of the spring are 180 degrees from the ring gap. The white portion of the spring must be visible at the ring gap.
 - b. Install the intermediate ring with the side marked "UP-2" toward the top of the piston.
 - c. Install the top ring with the side marked "UP-1" toward the top of the piston.
 - d. After the rings are installed, rotate the rings so that the gaps are spread apart by 120 degrees. Orient the oil control ring gap toward the bore for the piston pin.

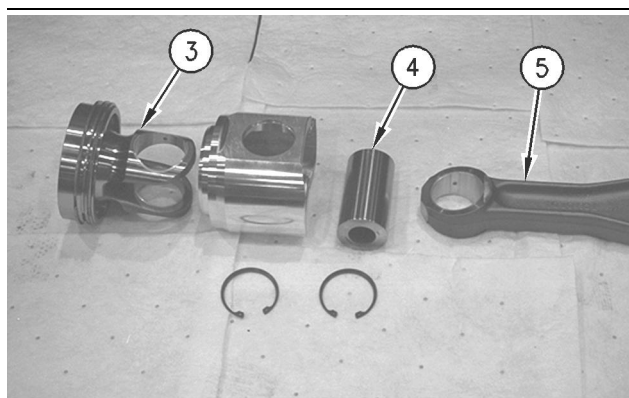


Illustration 671

g01006026

2. Place the piston crown into the piston skirt. Use clean engine oil to coat the bore of piston (3), piston pin (4), and the piston pin bearing in connecting rod (5). Position connecting rod (5) inside piston (3). Insert piston pin (4) through piston (3) and the bearing.

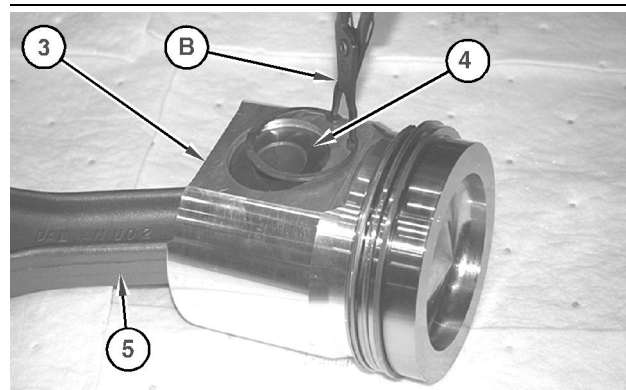


Illustration 672

g01051820

3. Use Tooling (B) to install the retaining rings. Orient the retaining ring gaps toward the top of piston (3).
4. Install the upper half of the connecting rod bearing in connecting rod (5). Ensure that the tab on the back of the bearing is in the bearing tab groove in connecting rod (5).
5. Coat the piston rings, the cylinder liner, and the upper half of the connecting rod bearing with clean engine oil.

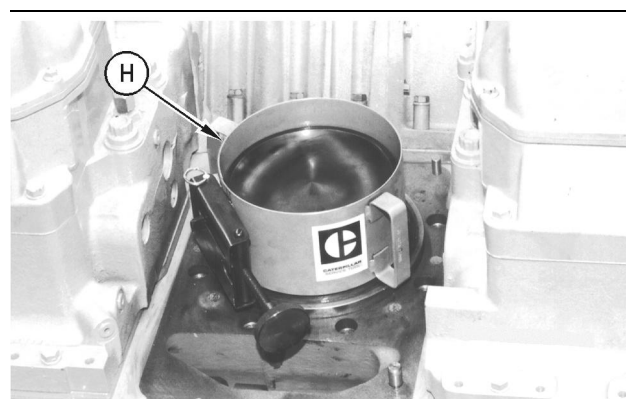


Illustration 673

g01004842

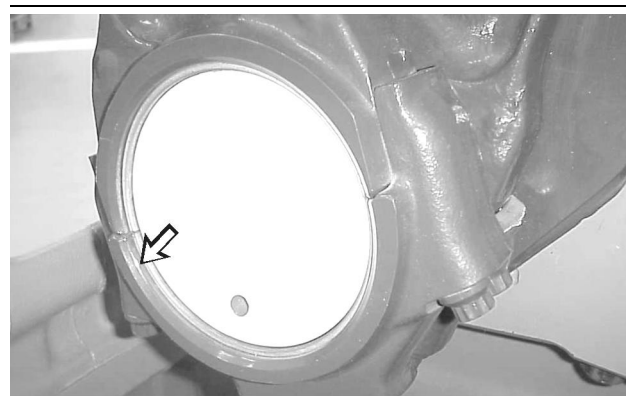


Illustration 674

g00613051

Chamfer on one side of the connecting rod bore

6. Use Tooling (H) to compress the piston rings.

NOTICE

Improper installation of the piston and connecting rod assembly will result in severe damage to the engine.

Make sure that the side of the connecting rod bore with the chamfer is oriented next to the surface of the crankshaft thrust plate. The square side of the connecting rod bore must be next to the other connecting rod that is on the same crankshaft journal.

7. Install the piston and connecting rod assembly into the cylinder liner. Ensure that the side of the connecting rod bore with the chamfer is oriented next to the surface of the crankshaft thrust plate. The square side of the connecting rod bore must be next to the other connecting rod that is on the same crankshaft journal.

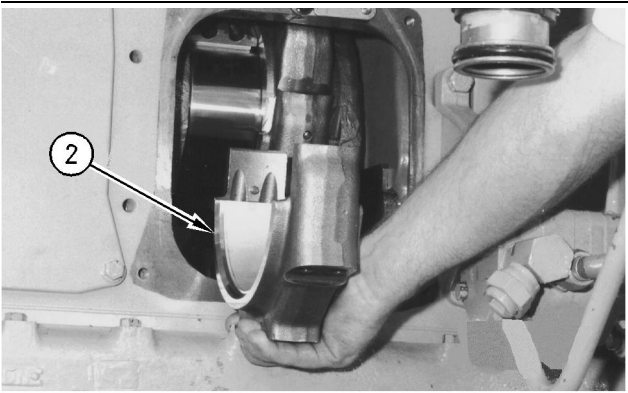


Illustration 675

g01006030

8. Install the lower half of the connecting rod bearing in connecting rod cap (2). Ensure that the tab on the back of the bearing is in the bearing tab groove on the connecting rod cap (2). Coat the bearing with clean engine oil.
9. Apply Tooling (J) to the bolt threads and to all of the surfaces of the bolts that contact connecting rod cap (2).
10. Position connecting rod cap (2) on the connecting rod and install the bolts.

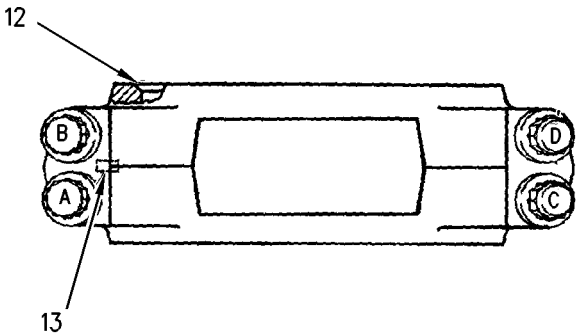


Illustration 676

g01006031

- (12) Side of the connecting rod with the chamfer
(13) Location pin

- a. Tighten Bolts (A) and (B) to 90 ± 5 N·m (65 ± 4 lb ft).
 - b. Tighten Bolts (C) and (D) to 90 ± 5 N·m (65 ± 4 lb ft).
 - c. Tighten Bolts (A) and (B) again to 90 ± 5 N·m (65 ± 4 lb ft).
 - d. Tighten Bolts (C) and (D) again to 90 ± 5 N·m (65 ± 4 lb ft).
 - e. Tighten all of the bolts for an additional 90 ± 5 degrees (1/4 turn).
11. Check the side clearance that is between two of the connecting rods that are on the same journal. The clearance must be 0.85 ± 0.332 mm (0.034 ± 0.0130 inch).

End By:

- a. Install the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".
- b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

i02141166

Cylinder Liner - Remove

SMCS Code: 1216-011

Removal Procedure

Table 83

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

Start By:

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

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

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system and the engine block into a suitable container for storage or for disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".
2. Place covers over the crankshaft journals in order to shield the journals from dirt and coolant.
3. Use Tooling (A) in order to remove the cylinder liner.

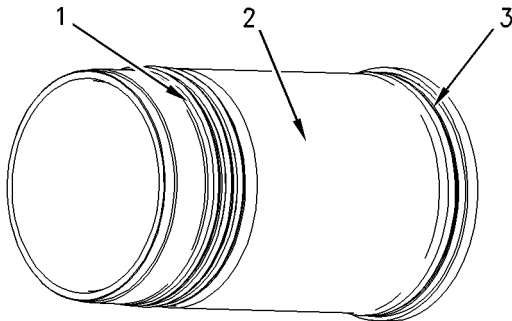


Illustration 677

g01004731

4. Remove O-ring seals (1) and filler band (3) from cylinder liner (2).

Cylinder Liner - Install

SMCS Code: 1216-012

Installation Procedure

Table 84

Required Tools			
Tool	Part Number	Part Description	Qty
B	1U-9895	Crossblock	1
	3H-0465	Push-Puller Plate	2
	8F-6123	Bolt	2
	0S-1575	Bolt	4
	3B-1925	Washer	4
C	8T-0455	Liner Projection Tool Group	1
D	2P-8260	Cylinder Liner Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Cylinder Liner Projection

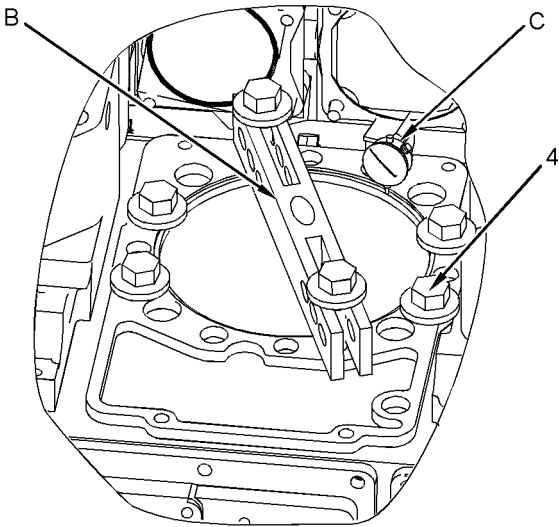


Illustration 678

g01208517

1. Install a new gasket for the spacer plate and install the spacer plate.

2. Do not install the O-ring seals or the filler band on the cylinder liner. Position the cylinder liner in the cylinder bore.

3. Secure the spacer plate and the cylinder liner in position according to the following procedure:

- Install bolts (4) and the washers around the cylinder liner.
- Tighten bolts (4) evenly to a torque of 95 N·m (70 lb ft).
- Install Tooling (B). Ensure that Tooling (B) is in position at the center of the cylinder liner. Ensure that the surface of the cylinder liner is clean. Tighten the bolts on Tooling (B) evenly to a torque of 70 N·m (50 lb ft).

4. Use Tooling (C) to measure the liner projection.

5. Place the gauge body on the spacer plate near the liner flange. Gauge should read zero. Position the gauge body so that the point is on the outer ring of the liner flange. The gauge will read the liner projection. Measure four equally distant points around the liner flange.

Note: If the measurements around the liner are different, rotate the liner to a different position within the bore. If the liner projection is not within specifications, move the liner to a different bore. Inspect the top face of the cylinder block. Measure the cylinder block bore for the liner. If the bore is too shallow, the bore may require rework.

6. The liner projection must be 0.06 to 0.20 mm (0.000 to 0.008 inch).

The maximum acceptable difference between the high measurements and the low measurements is 0.05 mm (0.002 inch).

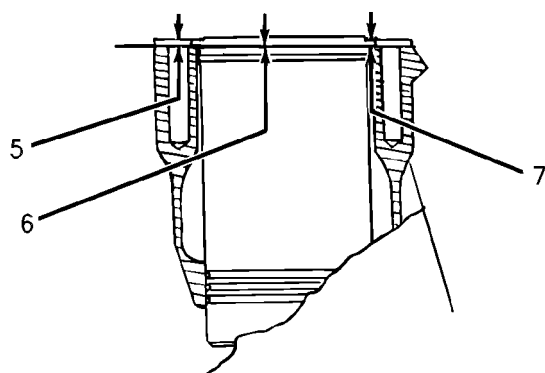


Illustration 679

g00578874

7. If the liner projection is not 0.06 to 0.20 mm (0.000 to 0.008 inch), measure the thickness of the following items:

(5) Spacer plate 12.31 ± 0.025 mm
(0.490 ± 0.0010 inch)

(6) Spacer plate gasket 0.21 ± 0.025 mm
(0.010 ± 0.0010 inch)

(7) Cylinder liner flange 12.65 ± 0.020 mm
(0.500 ± 0.0010 inch)

8. When the liner projection is correct, make alignment marks on the liner and the cylinder block.

9. Remove Tooling (B) and Tooling (C). Remove the liner, the spacer plate, and the gasket for the spacer plate.

Install the Cylinder Liner

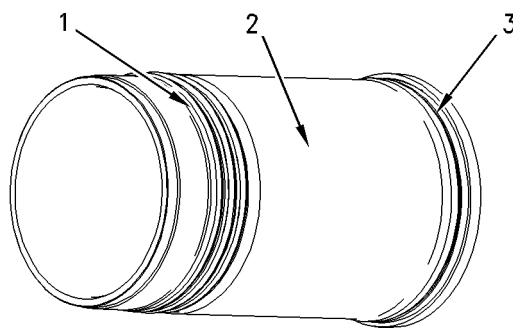


Illustration 680

g01004731

1. Apply liquid soap on the grooves for O-ring seals (1) and on O-ring seals (1). Install O-ring seals (1) on cylinder liner (2). Also, coat the cylinder block bore for cylinder liner (2) with liquid soap.

2. Dip filler band (3) in clean engine oil. Immediately install filler band (3) onto cylinder liner (2).

3. Immediately install cylinder liner (2) before filler band (3) can expand. Ensure that the marks that are on cylinder liner (2) and the cylinder block are aligned.

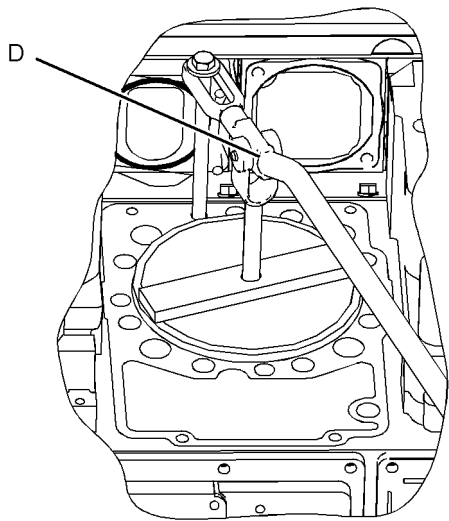


Illustration 681

g01256602

4. Use Tooling (D) to press the cylinder liner into the cylinder block.

End By:

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

i02465569

Camshaft - Remove

SMCS Code: 1210-011

Removal Procedure

Table 85

Required Tools			
Tool	Part Number	Part Description	Qty
A	238-9586	Camshaft Drive Group	1
B	1P-0820	Hydraulic Puller	1
	8B-7548	Push-Puller Tool Group	1
	8B-7559	Adapter	2
	5H-1504	Hard Washer	3
	9U-6600	Hand Hydraulic Pump	1
C	125-0200	Camshaft Pilot As	2
D	125-0201	Camshaft Guide As	1
E	8T-3169	Crank Assembly	1

Start By:

- a. Remove the valve cover base. Refer to Disassembly and Assembly, "Valve Cover Base - Remove and Install".
- b. Remove the speed/timing sensor. Refer to the Service Manual, "Electronic Troubleshooting" module.
- c. Remove the electronic control module. Refer to Disassembly and Assembly, "Electronic Control Module (ECM) and Personality Module (PM) - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

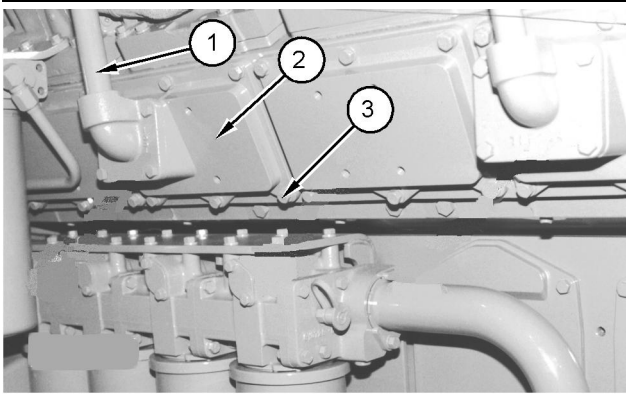


Illustration 682

g01007161

- 1. Remove tube assemblies (1).
- 2. Remove bolts (3) and covers (2) from both sides of the engine.

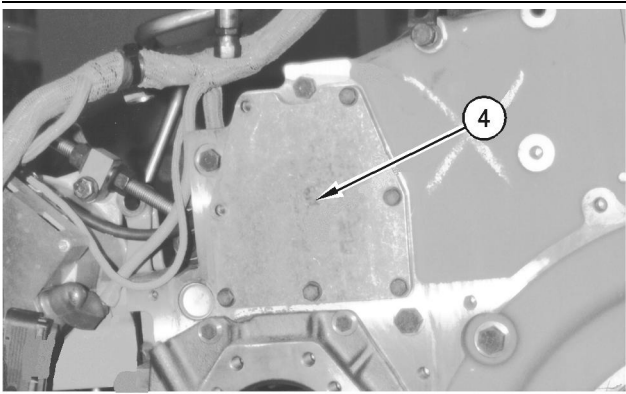


Illustration 683

g00914348

- 3. Remove covers (4) from both sides of the front housing.

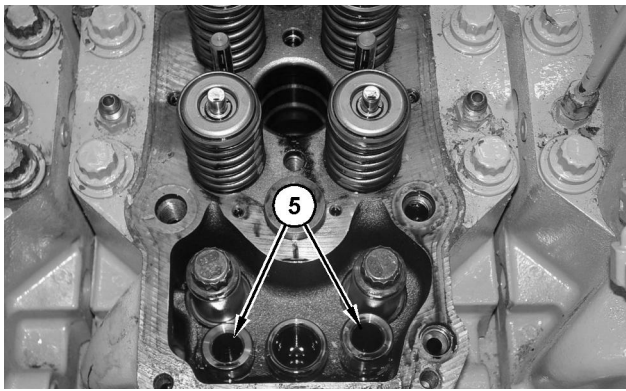


Illustration 684

g01053356

4. Pull valve lifters (5) away from the camshaft. Hold valve lifters (5) in position with O-ring seals.

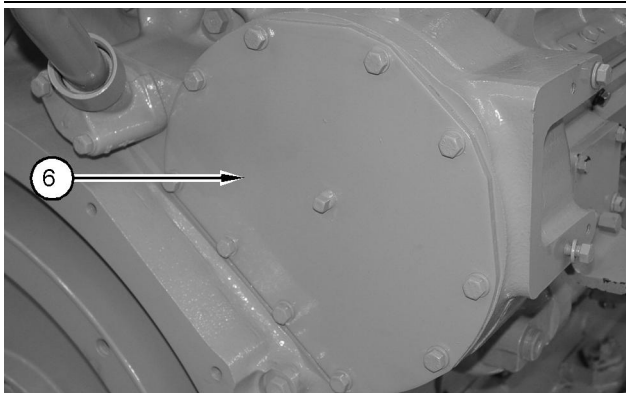


Illustration 685

g01053366

5. Remove covers (6) for the camshaft drive gears from the flywheel housing.

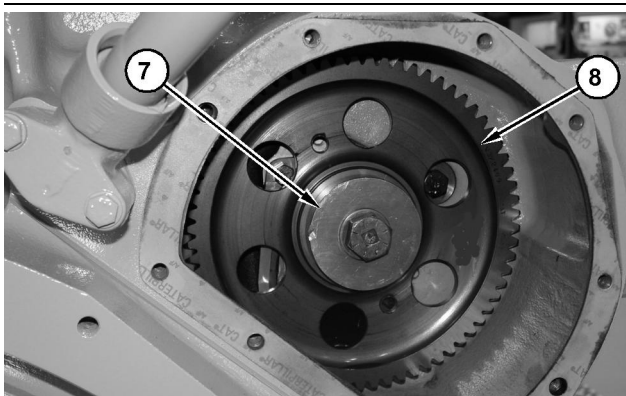


Illustration 686

g01053357

6. Remove the bolt and plate (7) that fastens camshaft drive gear (8) to the camshaft.

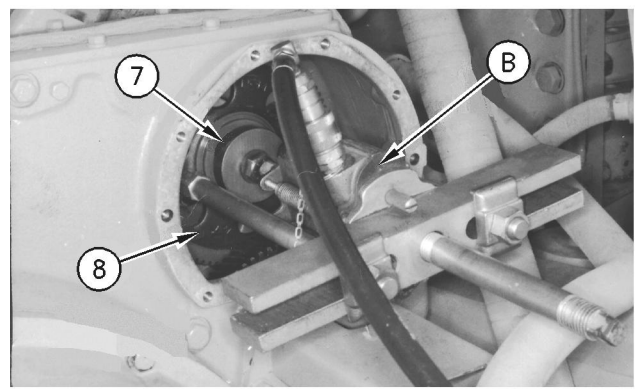


Illustration 687

g00914453

7. Place the three washers from Tooling (B) behind plate (7) and install the bolt.

NOTICE

Do not apply more than 51675 kPa (7500 psi) pressure to the hydraulic puller. The adapters are rated at 6 1/2 tons each and the hydraulic puller is rated at 17 tons at 68900 kPa (10000 psi). If too much pressure is applied, the gear may be damaged.

8. Install Tooling (B) on camshaft drive gear (8). Apply 51675 kPa (7500 psi) to Tooling (B). Strike the screw on Tooling (B) with a hammer until camshaft drive gear (8) is free from the camshaft. Remove Tooling (B) and camshaft drive gear (8).

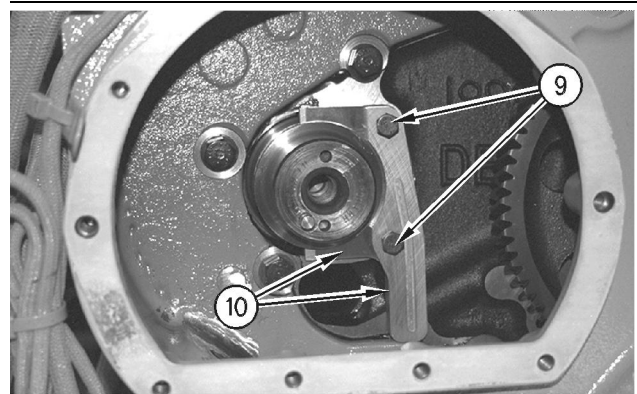


Illustration 688

g00613686

9. Remove bolts (9) and thrust washers (10) that fasten the camshaft to the engine block.
10. Perform Steps 5 through 9 for the camshaft on the other side of the engine.

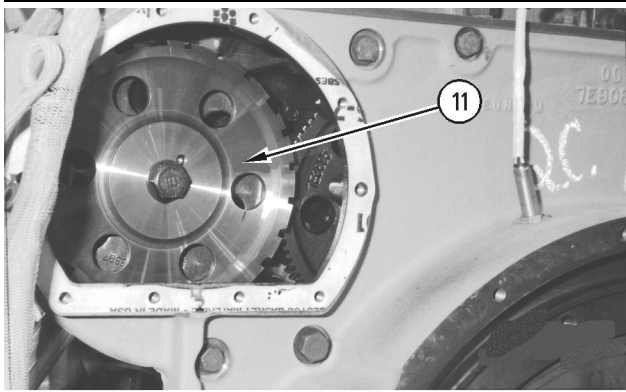


Illustration 689 g00914454

11. Remove timing ring (11) from the camshaft.

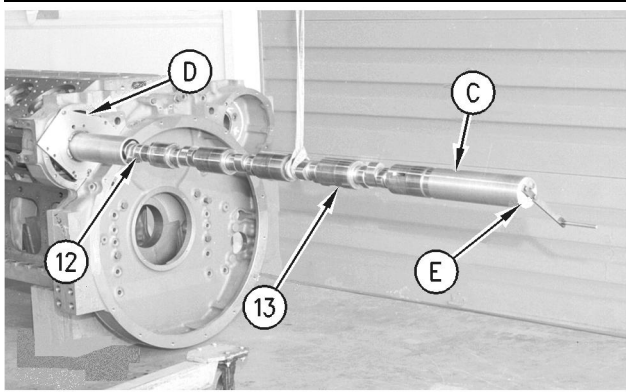


Illustration 690 g00914462

12. Install Tooling (C) on each end of the camshaft.

Note: Tooling (D) can be installed on the flywheel housing in order to remove the camshaft from the rear. Tooling (D) can also be installed on the front housing in order to remove the camshaft from the front of the engine.

13. Install Tooling (D) on the flywheel housing.

14. Install Tooling (E) on the end of Tooling (C).

Note: The following Step is for 3508B Engines.

Note: The weight of the camshaft for 3508 Engines is approximately 46 kg (101 lb). The camshaft is one piece.

15. Rotate the camshaft with Tooling (E). Pull the camshaft out of the engine until a suitable lifting device can be attached. Remove the camshaft from the engine.

Note: The following Steps are for 3512B and 3516B Engines.

Note: The weight of the camshaft for 3512B Engines is approximately 72 kg (158 lb). The weight of the camshaft for 3516B Engines is approximately 82 kg (181 lb).

16. Rotate the camshaft with Tooling (E). Pull the camshaft out of the engine until a suitable lifting device can be attached. Remove front camshaft (12) and rear camshaft (13) as a unit.

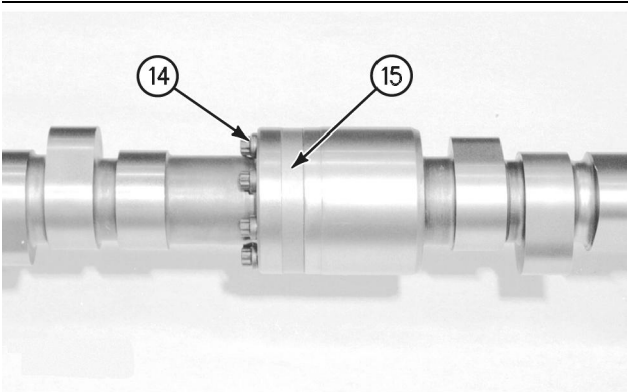


Illustration 691 g00579149

17. Remove bolts (14). Separate the camshafts and remove spacer (15).

18. Remove the dowel from the front of the camshaft, if necessary.

19. Repeat Steps 11 through 18 for the other camshaft.

i02419334

Camshaft Bearings - Remove

SMCS Code: 1211-011

Removal Procedure

Table 86

Required Tools			
Tool	Part Number	Part Description	Qty
A	6V-4077	Camshaft Bearing Tool	1
B	8S-2241	Camshaft Bearing Tool Group	1
C	5P-5247	Hydraulic Puller	1
D	8H-0684	Ratchet Wrench	1

Start By:

- a. Remove the camshafts. Refer to Disassembly and Assembly, “Camshaft - Remove”.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

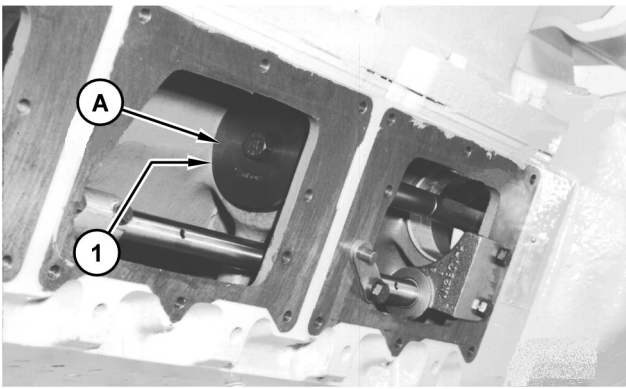


Illustration 692 g01208871

1. Use the following steps to install Tooling (A).
 - a. Install the pilot group in camshaft bearing (1) (not shown).
 - b. Place the backup plate in position and ensure that camshaft bearing (1) (not shown) is between the two parts.
 - c. Install the bolt that holds Tooling (A) together.
 - d. Use the extensions to obtain the correct length for Tooling (A).
 - e. Install the puller plate on the bolt and the flywheel housing or the front housing.

Note: Tooling (B) can be used to remove the camshaft bearings when the flywheel housing and the front housing have been removed.

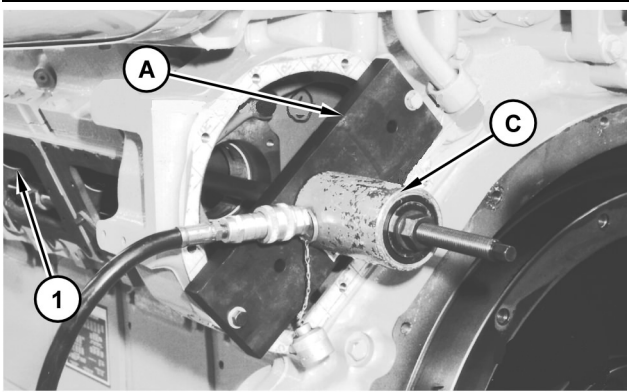


Illustration 693 g01208875

2. Install Tooling (C) on Tooling (A). Pull camshaft bearing (1) from the cylinder block.
- Note:** Tooling (D) can be used in place of Tooling (C), if necessary.

i02062129

Camshaft Bearings - Install

SMCS Code: 1211-012

Installation Procedure

Table 87

Required Tools			
Tool	Part Number	Part Description	Qty
A	6V - 4077	Camshaft Bearing Tool	1
B	8S - 2241	Camshaft Bearing Tool Group	1
C	5P - 5247	Hydraulic Puller	1
D	8H - 0684	Ratchet Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

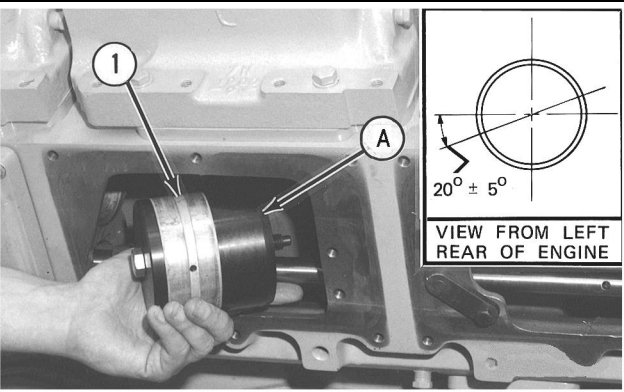


Illustration 694

g00578338

1. Install camshaft bearing (1) on Tooling (A).

Note: Tooling (B) can be used to install the camshaft bearings when the flywheel housing and the front housing have been removed.

2. Position camshaft bearing (1) and Tooling (A) in the bore.

Note: The camshaft bearing joint must be on the horizontal centerline of the bore. The upper oil hole must be 20 ± 5 degrees above the horizontal centerline of the bore. The lower oil hole of the camshaft bearing should be 20 ± 5 degrees below the horizontal centerline of the bore. The camshaft bearing joints on the right side of the engine must face the inside of the cylinder block. The camshaft bearing joints on the left side of the engine must face the outside of the cylinder block.

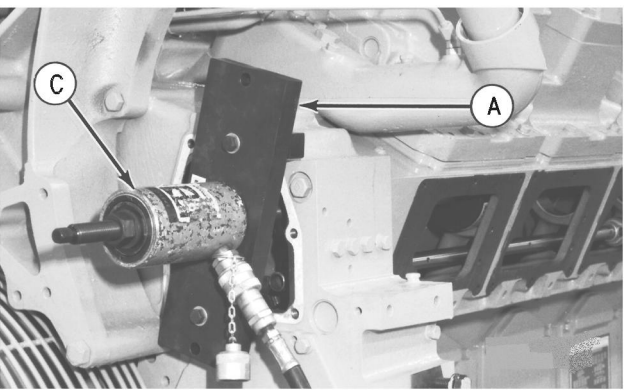


Illustration 695

g00578349

3. Install Tooling (C) on Tooling (A) and pull the camshaft bearing into the bore.

Note: Tooling (D) can be used in place of Tooling (C).

4. After the camshaft bearing is installed, measure the bore. The bore must be 92.00 ± 0.06 mm (3.620 ± 0.002 inch).

End By:

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

i02458929

Camshaft - Install

SMCS Code: 1210-012

Installation Procedure

Table 88

Required Tools			
Tool	Part Number	Part Description	Qty
A	238-9586	Camshaft Drive Group	1
C	125-0200	Camshaft Pilot As	2
D	125-0201	Camshaft Guide As	1
E	8T-3169	Crank As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. The following steps are for the installation of a camshaft in the 3512B Engines and 3516B Engines. The camshaft is in two pieces.

Note: Ensure that the camshafts are assembled and installed according to the marks on the ends of the camshafts.

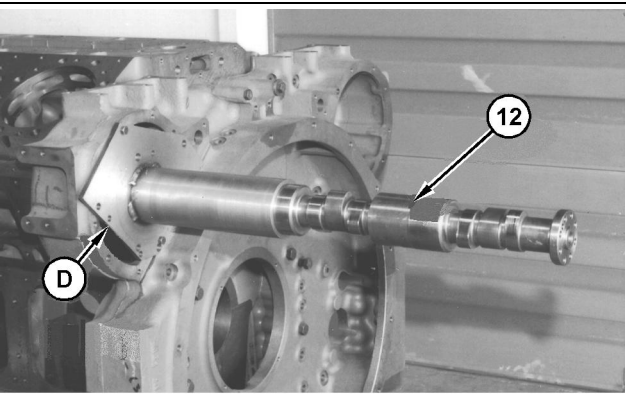


Illustration 696

g01053512

- a. Install Tooling (D) on the flywheel housing. Do not tighten the bolts on Tooling (D).

- b. Install Tooling (C) on the end of the front half of the camshaft.
- c. Ensure that the camshaft and the camshaft bearings are clean. Place clean engine oil on the lobes and the journals of the camshaft. Also place clean engine oil on the camshaft bearings.
- d. Attach a suitable lifting device to the camshaft. The weight of one-half of the camshaft for 3512B Engines is approximately 36 kg (80 lb). The weight of one-half of the camshaft for 3516B Engines is approximately 41 kg (90 lb).
- e. Position the front half of camshaft (12) in the engine until Tooling (C) is in the first camshaft bearing.
- f. Rotate camshaft (12) and tighten the bolts for Tooling (D).
- g. Rotate camshaft (12) and insert the camshaft until the camshaft is slightly protruding from Tooling (D).

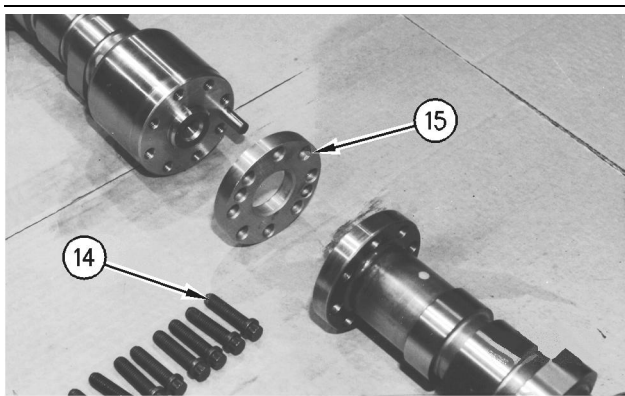


Illustration 697

g00914670

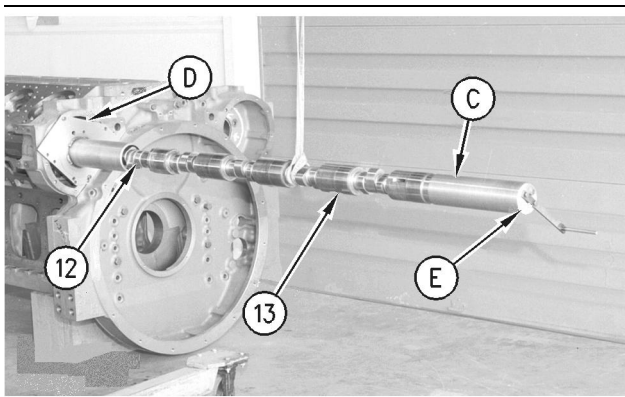


Illustration 698

g00914462

- h. If the dowel was removed from the front half of camshaft (12), install the dowel. Install the dowel to 22 ± 0.5 mm (0.9 ± 0.02 inch) from the surface of the camshaft.

- i. Attach a suitable lifting device to rear half of camshaft (13). The weight of one-half of the camshaft for 3512B Engines is approximately 36 kg (80 lb). The weight of one-half of the camshaft for 3516B Engines is approximately 41 kg (90 lb). Install spacer (15) and the rear half of camshaft (13) onto the front half of camshaft (12). Install bolts (14) and tighten to a torque of 55 ± 7 N·m (41 ± 5 lb ft).
- j. Install Tooling (C) and Tooling (E) on the rear half of camshaft (13).
- k. Rotate the rear half of camshaft (13) and insert the camshaft into the engine.
- l. Remove all Tooling. Repeat Steps 1.a through 1.k for the camshaft on the opposite side of the engine. Go to Step 3.

2. The following steps are for the installation of the camshaft in 3508B Engines. The camshaft is one piece.

- a. Install Tooling (D) on the flywheel housing. Do not tighten the bolts on Tooling (D).
- b. Install Tooling (C) on the end of the camshaft.
- c. Ensure that the camshaft and the camshaft bearings are clean. Place clean engine oil on the lobes and the journals of the camshaft. Also place clean engine oil on the camshaft bearings.

Note: Ensure that the camshafts are installed according to the marks on the ends of the camshafts.

- d. Attach a suitable lifting device to the camshaft. The weight of the camshaft is approximately 46 kg (101 lb). Insert the camshaft in the engine until Tooling (C) is in the first camshaft bearing.
- e. Install Tooling (E). Rotate the camshaft and tighten the bolts on Tooling (D).
- f. Rotate the camshaft and insert the camshaft into the engine.
- g. Repeat Steps 2.a through 2.f for the camshaft on the opposite side of the engine. Go to Step 3.

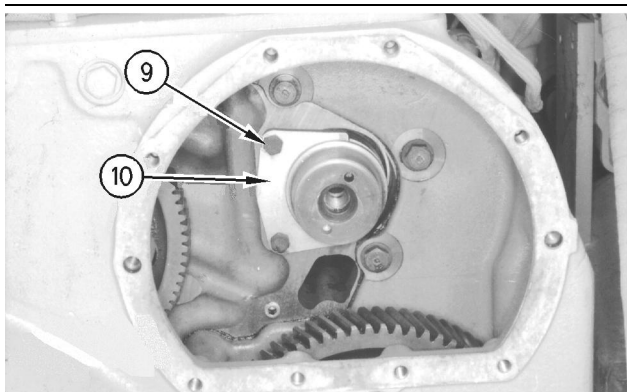


Illustration 699

g00914691

3. Install thrust washers (10) and bolts (9) that fasten the camshaft to the engine.

NOTICE

If the camshaft is out of time more than 18 degrees (approximately 1/2 of the timing pin is out of the groove), the valves can make contact with the pistons. This will cause damage to the engine. Refer to Testing and Adjusting, "Camshaft Timing" for more information.

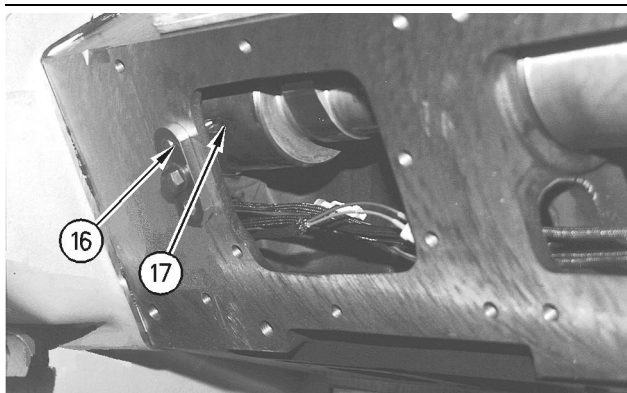


Illustration 700

g00914693

4. Remove timing pin (16) from the storage position on the side of the engine.
5. Turn the camshaft until timing pin (16) can be installed through the cylinder block and into groove (17) that is in the camshaft.
6. Repeat Steps 4 and 5 for the camshaft on the opposite side of the engine.

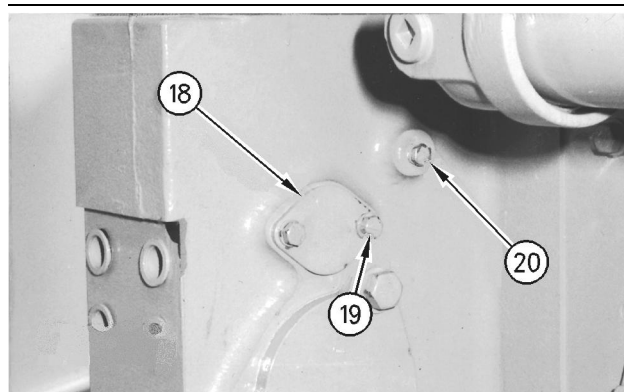


Illustration 701

g00914707

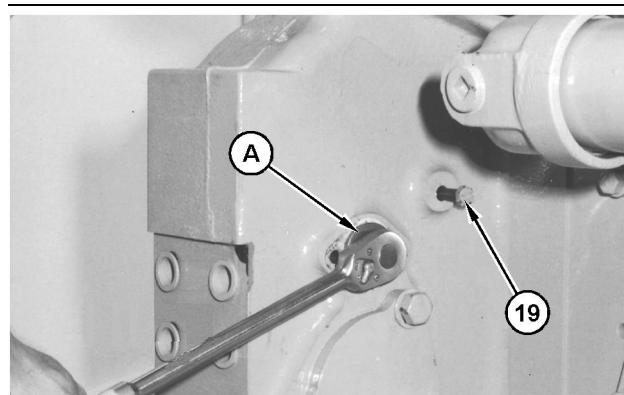


Illustration 702

g01053668

7. Remove bolts (19), cover (18), and plug (20).
8. Install one bolt (19) into the flywheel housing through the hole for plug (20). Use Tooling (A) and a ratchet to turn the flywheel until bolt (19) can be installed through the hole and into the flywheel. This will position the No. 1 cylinder at the top center. Refer to Testing and Adjusting, "Finding the Top Center Position for the No. 1 Piston" for more information.

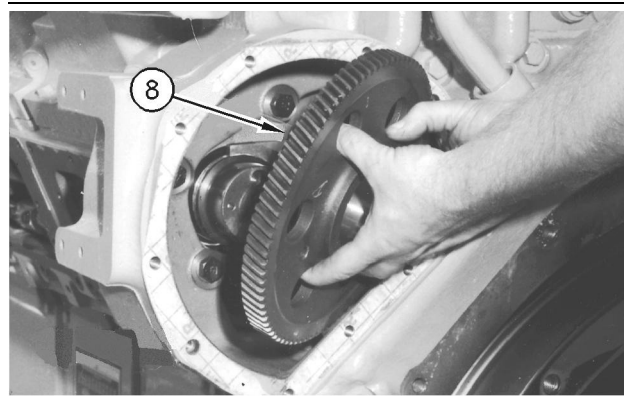


Illustration 703

g00914726

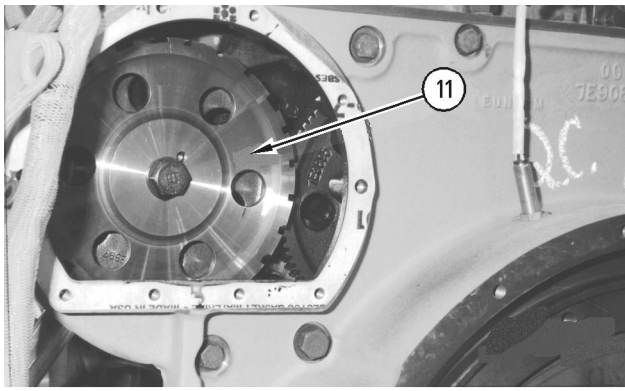


Illustration 704

g00914728

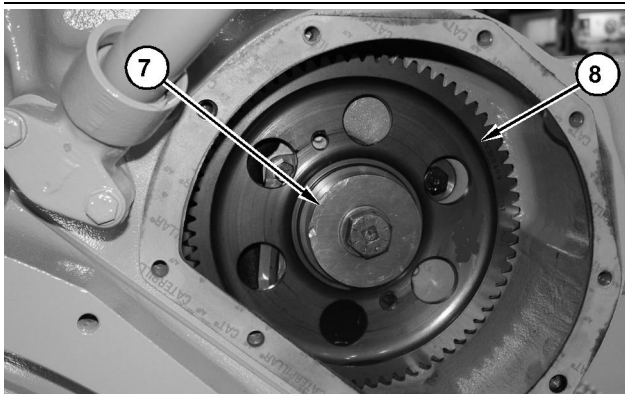


Illustration 705

g01053357

9. Use the following procedure in order to install camshaft drive gears (8).

- a. Clean the taper of the camshaft and clean the tapered bore of the camshaft gear with a lint free cloth that is saturated with a solvent in order to remove any excess oil. Clean the parts again with a lint free alcohol wipe in order to remove any residue. If the alcohol wipe is dirty after cleaning the parts, clean the parts again with a lint free alcohol wipe until no residue is left on the alcohol wipe.

Note: It is critical that the taper of the camshaft and the tapered bore of the camshaft gear are clean, dry, and free of residue before assembly.

- b. Ensure that the camshaft timing pins and the timing pin for the flywheel are installed.
- c. Place camshaft drive gears (8) in position. Remove the backlash by rotating the gears in the opposite direction of engine rotation.

Note: For "Standard Rotation" engines, turn the camshaft drive gears CLOCKWISE. For "Reverse Rotation" engines, turn the camshaft drive gears COUNTERCLOCKWISE.

- d. Install the bolt and plate (7).

- e. Install the bolt and timing ring (11). Ensure that the hole in the timing ring is properly seated on the locating pin.
- f. Tighten the bolt to a torque of 360 N·m (265 lb ft).
- g. Place a Mark on the bolt.
- h. Place a driver against the retaining plate of the camshaft gear. Strike the driver solidly with a hammer 3 to 4 times.
- i. Tighten the bolt again to a torque of 360 N·m (265 lb ft).
- j. Repeat Steps 9.h and 9.i until the Mark has turned at least 90 degrees.

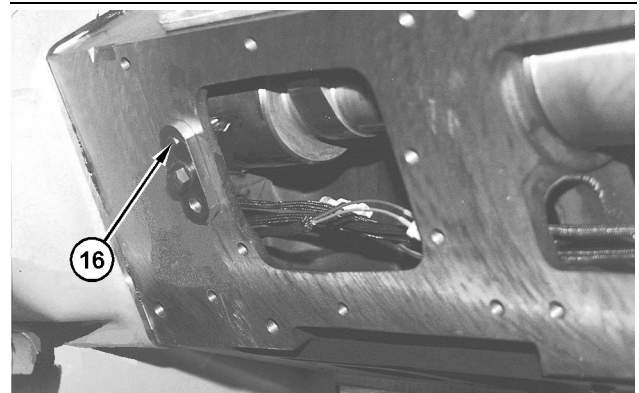


Illustration 706

g01053666

10. Remove the timing pins from the camshafts. Install timing pins (16) in the original locations.

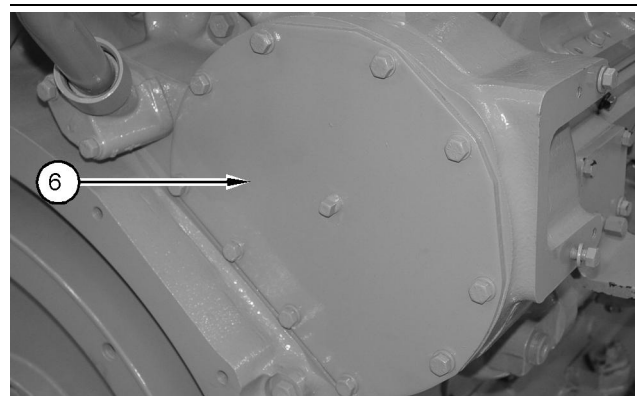


Illustration 707

g01053366

11. Install the gaskets and covers (6) over the camshaft drive gears on both sides of the engine.

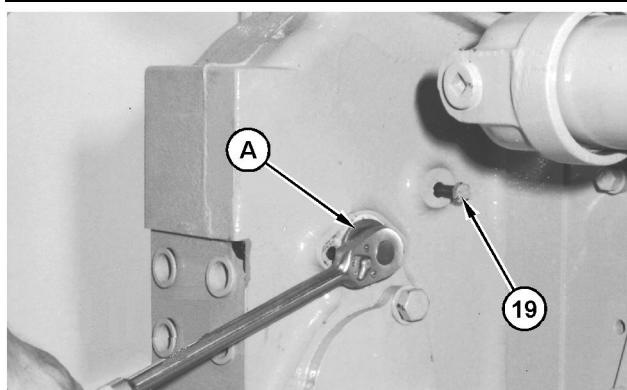


Illustration 708

g01053668

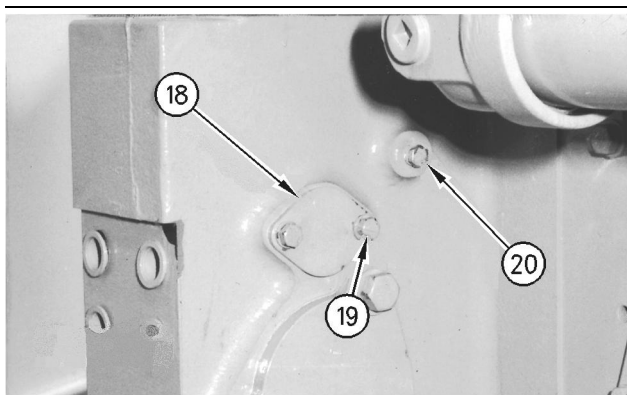


Illustration 709

g00914707

- 12.** Remove bolt (19) from the flywheel. Install plug (20) in the timing hole. Remove Tooling (A) and install cover (18) with bolts (19) on the flywheel housing.

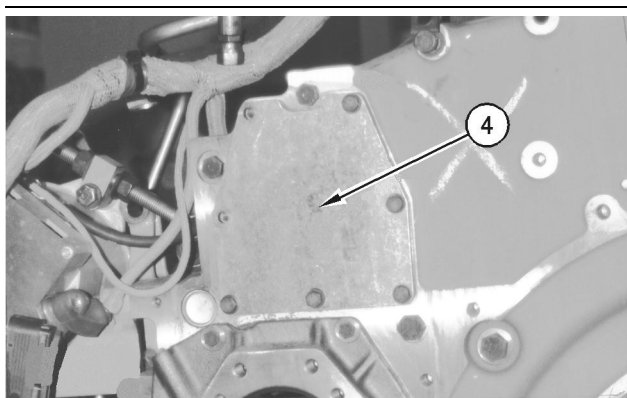


Illustration 710

g00914348

- 13.** Install covers (4) on the front housing.

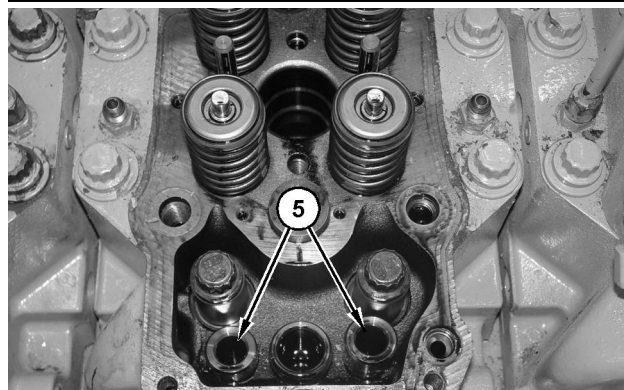


Illustration 711

g01053356

- 14.** Remove the O-ring seals from valve lifters (5). Push the valve lifters (5) against the camshaft.

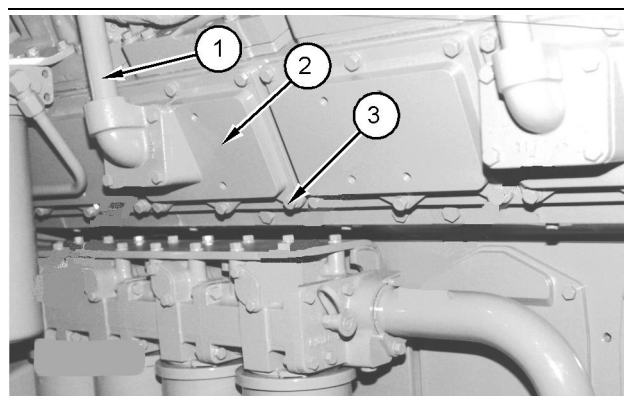


Illustration 712

g01007161

- 15.** Position covers (2) and install bolts (3) on both sides of the engine.

- 16.** Install tube assemblies (1).

End By:

- a. Install the electronic control module. Refer to Disassembly and Assembly, "Electronic Control Module (ECM) and Personality Module (PM) - Remove and Install".
- b. Install the speed/timing sensor. Refer to the Service Manual, "Electronic Troubleshooting" module.
- c. Install the valve cover base. Refer to Disassembly and Assembly, "Valve Cover Base - Remove and Install".

i02421036

Crankshaft - Remove

SMCS Code: 1202-011

Removal Procedure

Table 89

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-9832	Engine Rollover Stand	1
B	138-7576	Link Bracket	2

Start By:

- a. Remove the rocker shaft assemblies and the pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Remove".
- b. Remove the front housing. Refer to Disassembly and Assembly, "Front Drive Housing - Remove and Install".
- c. Remove the balancer gear from the rear gear group. Refer to Disassembly and Assembly, "Gear Group (Rear) - Remove".
- d. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove".
- e. Remove the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".

NOTICE

Failure to remove the rocker shaft assemblies and push rods can result in damaged valves when the pistons and connecting rods are pushed away from the crankshaft.

To help avoid damage to the valves, remove the rocker shaft assemblies and push rods before you remove the crankshaft.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

- 1. Use Tooling (A) to turn the engine to a horizontal position. The engine can be supported with Tooling (A) or with blocks. The engines have the following weights:

- 3508B Engines weigh approximately 4445 kg (9800 lb).
- 3512B Engines weigh approximately 5902 kg (13,000 lb).
- 3516B Engines weigh approximately 7718 kg (17,000 lb).

Note: It is not necessary to remove the counterweights from the crankshaft, if the piston and connecting rod assemblies have been removed from the engine.

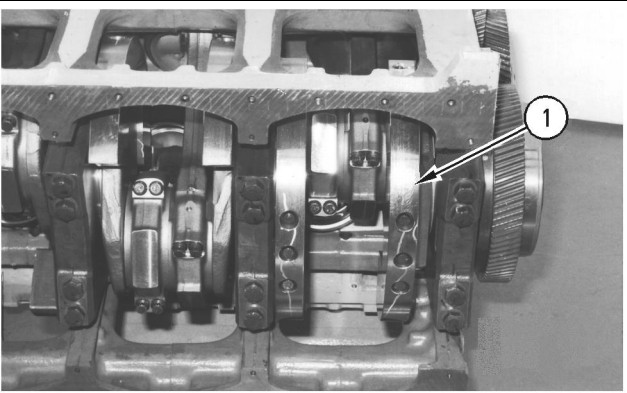


Illustration 713

g00914774

- 2. Place identification marks on counterweights (1). Remove counterweights (1) from the crankshaft.

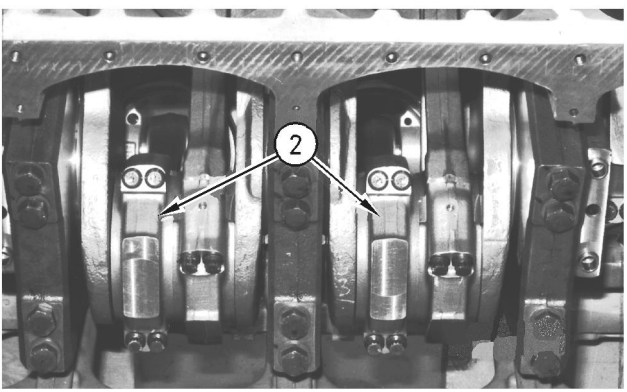


Illustration 714

g00914776

Note: Ensure that the journals of the crankshaft are not scratched by the connecting rods.

- 3. Remove connecting rod caps (2) and push the connecting rods away from the crankshaft.

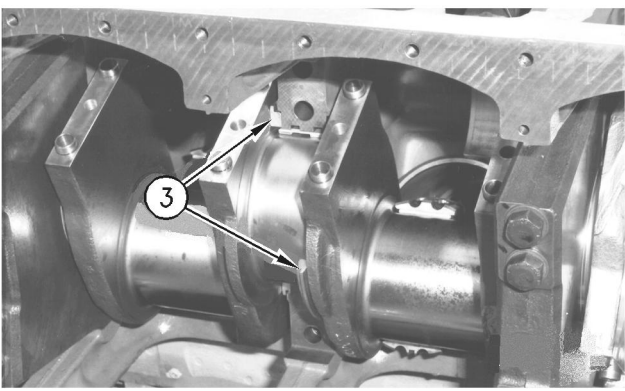


Illustration 715

g00914800

4. Remove the center main bearing cap and thrust plates (3) from each side of the center main bearing.

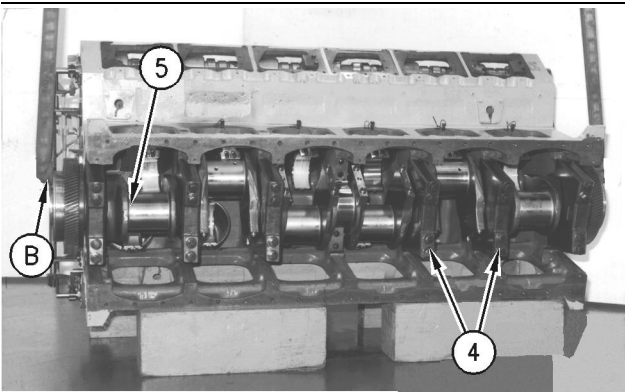


Illustration 716

g00930694

5. Attach Tooling (B) to each end of the crankshaft.
6. Attach a suitable lifting device to Tooling (B) (Illustration 716). For 3508B Engines, the crankshaft weighs approximately 398 kg (877 lb). For 3512B Engines, the crankshaft weighs approximately 590 kg (1300 lb). For 3516B Engines, the crankshaft weighs approximately 800 kg (1764 lb). Remove remaining main bearing caps (4). Remove crankshaft (5) from the engine.
7. Remove the upper halves of the main bearings.
8. Remove the upper halves of the connecting rod bearings.

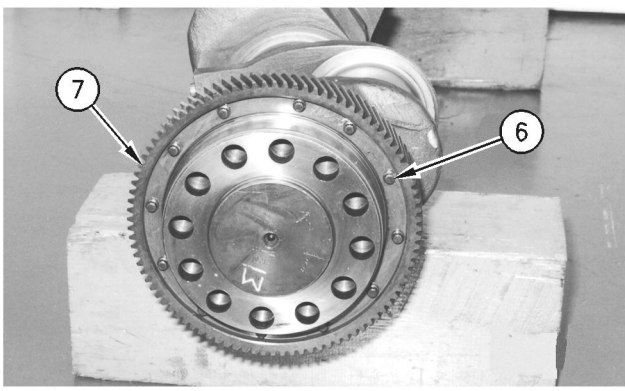


Illustration 717

g00914805

9. If necessary, remove bolts (6) and crankshaft gear (7) from each end of the crankshaft.

i02421041

Crankshaft - Install

SMCS Code: 1202-012

Installation Procedure

Table 90

Required Tools			
Tool	Part Number	Part Description	Qty
A	4C-9832	Engine Rollover Stand	1
B	138-7576	Link Bracket	2
C	6V-4876	Lubricant	1
D	8T-5096	Dial Indicator Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

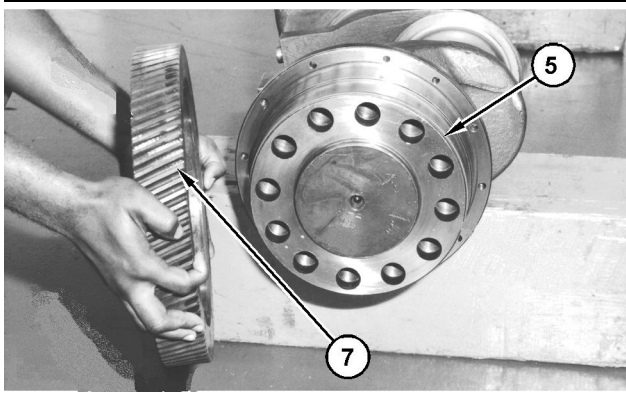


Illustration 718

g01049072

1. If crankshaft gear (7) was removed, install the gear on crankshaft (5).
2. Check the clearance of the main bearings. Refer to Disassembly and Assembly, "Bearing Clearance - Check".

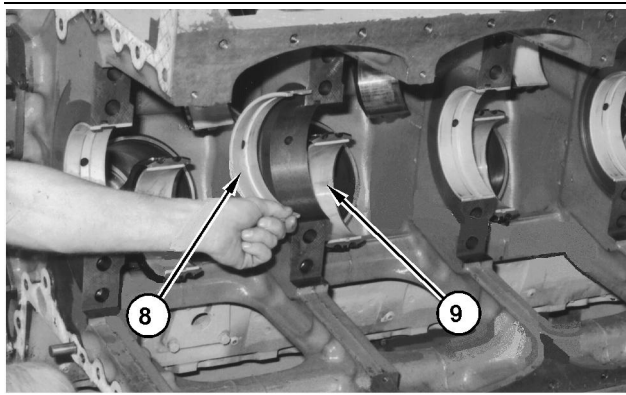


Illustration 719

g01049073

Note: The upper halves of the main bearings have an oil hole in the center.

3. Install the upper halves of main bearings (8) in the cylinder block. Coat the bearings with clean engine oil.
4. Install the upper halves of connecting rod bearings (9) in the connecting rod assemblies. Coat the bearings with clean engine oil.

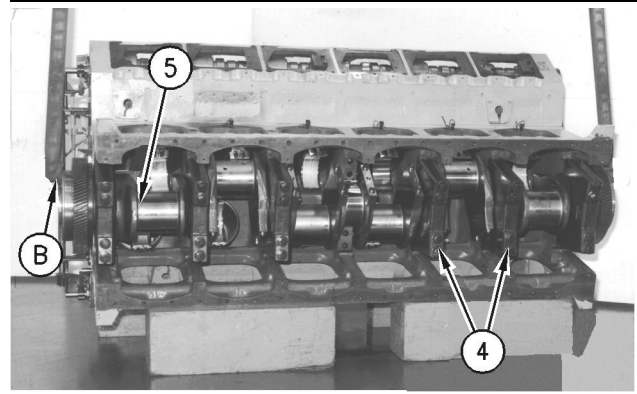


Illustration 720

g00930694

Note: Ensure that the word "FRONT" that is on the end of the crankshaft is toward the front of the engine.

5. Attach Tooling (B) and a suitable lifting device to crankshaft (5). For 3508B Engines, the crankshaft weighs approximately 398 kg (877 lb). For 3512B Engines, the crankshaft weighs approximately 590 kg (1300 lb). For 3516B Engines, the crankshaft weighs approximately 800 kg (1764 lb). Position the crankshaft in the cylinder block.

6. Ensure that the lower halves of the main bearings are in position in the main bearing caps. Coat the bearings with clean engine oil.

Note: Main bearing caps (4) must be installed with the word "FRONT" and the part number toward the front of the engine. Each main bearing cap has a number on the bottom surface and each main bearing must be installed in the corresponding position in the cylinder block.

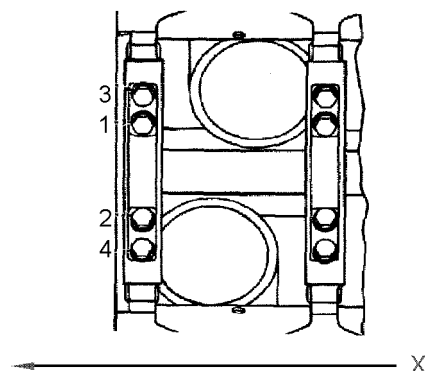


Illustration 721

g01049012

7. Coat the threads of the bolts for the main bearing caps with clean SAE 30 engine oil. Except for the center main bearing cap, place the main bearing caps into position. Install the bolts and washers.

Tighten the bolts according to the sequence that is shown in Illustration 721. Arrow (X) points to the front of the engine. Tighten the bolts to a torque of 190 ± 14 N·m (140 ± 10 lb ft). Then tighten the bolts for an additional 180 ± 5 degrees ($1/2$ turn).

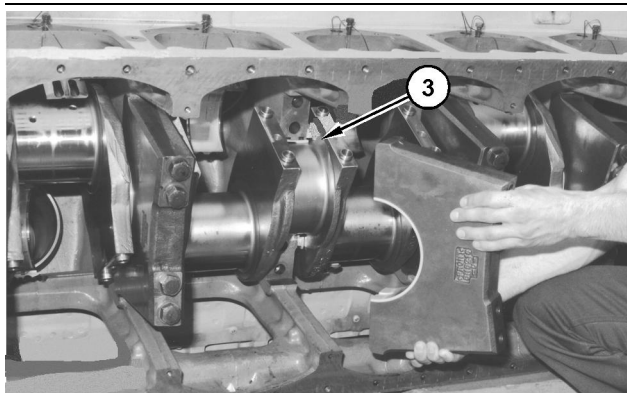


Illustration 722

g01049103

8. Place clean engine oil on thrust plates (3). Install thrust plates (3).
9. Install the center main bearing. Use the tightening procedure that is in Step 7.
10. Use Tooling (D) to measure the end play of the crankshaft. The end play must not exceed 0.17 to 0.63 mm (0.007 to 0.025 inch).
11. Make sure that the upper halves of the bearings are in position on the connecting rods. Make sure that the lower halves of the bearings are in position on the connecting rod caps.
12. Check the clearance of the connecting rod bearings. Refer to Disassembly and Assembly, "Bearing Clearance - Check".
13. Position one connecting rod onto a journal of the crankshaft.

Note: The number that is on the side of the connecting rod caps must be installed next to the corresponding number that is on the side of the connecting rod.

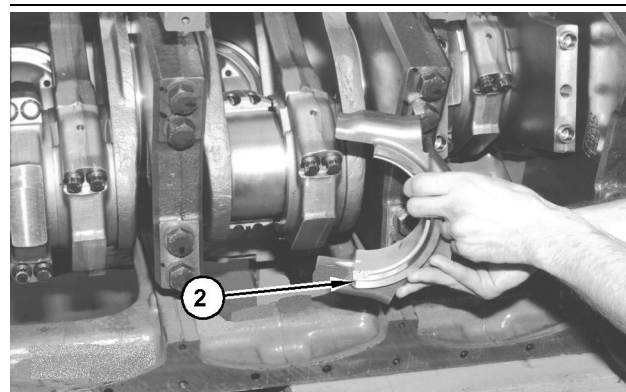


Illustration 723

g01049104

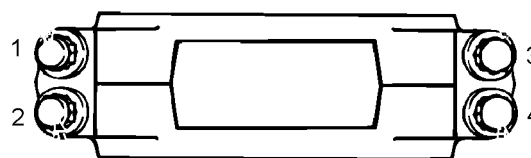


Illustration 724

g01049105

14. Place Tooling (C) on the bolt threads, shanks, and seats.
15. Place connecting rod cap (2) into position. Install the bolts. Use the following procedure to tighten the bolts:
 - a. Tighten Bolts (1) and (2) to a torque of 90 ± 5 N·m (65 ± 4 lb ft).
 - b. Tighten Bolts (3) and (4) to a torque of 90 ± 5 N·m (65 ± 4 lb ft).
 - c. Tighten Bolts (3) and (4) again to a torque of 90 ± 5 N·m (65 ± 4 lb ft).
 - d. Tighten each bolt for an additional 90 ± 5 degrees ($1/4$ turn). An impact wrench may be used.
16. After measuring the clearance of the connecting rod bearing, coat the bearings with clean engine oil. Use the same procedure to install the remaining connecting rod caps.

NOTICE

Each counterweight is numbered and must be installed in the same position as the corresponding number on the crankshaft mounting pad in order to prevent damage to the crankshaft.

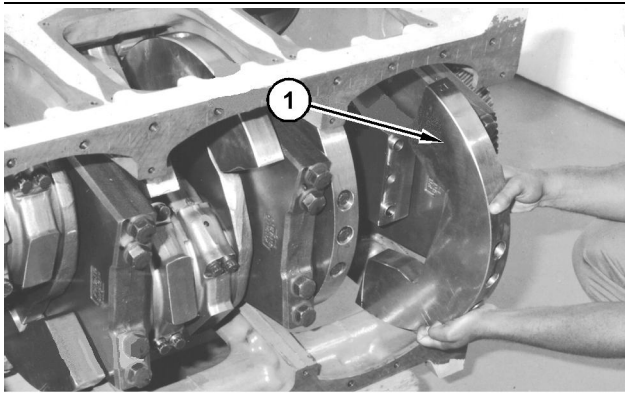


Illustration 725

g01049106

17. If the counterweights have been removed, install counterweights (1). Use the correct tightening procedure for the specific engine model:

18. The following procedure is for the installation of the counterweights in 3508B Engines.

Note: Do not reuse counterweight bolts.

- a. Ensure that the dowels are in the correct position and install the counterweights on the crankshaft.
- b. Apply Tooling (C) to the bolt threads, shanks, and seats.
- c. Tighten the bolts evenly to a torque of $200 \pm 5 \text{ N}\cdot\text{m}$ ($150 \pm 4 \text{ lb ft}$).
- d. Loosen the bolts.
- e. Tighten the bolts evenly to a torque of $70 \pm 5 \text{ N}\cdot\text{m}$ ($50 \pm 4 \text{ lb ft}$).
- f. Tighten the bolts for an additional 120 ± 5 degrees ($1/3$ turn).

19. The following procedure is for the installation of the counterweights in 3512B and 3516B Engines.

Note: Do not reuse counterweight bolts.

- a. Ensure that the dowels are in the correct position and install the counterweights on the crankshaft.
- b. Apply Tooling (C) to the bolt threads, shanks, and seats.

c. Tighten the bolts evenly to a torque of $70 \pm 5 \text{ N}\cdot\text{m}$ ($50 \pm 4 \text{ lb ft}$).

d. Tighten the bolts for an additional 120 ± 5 degrees ($1/3$ turn).

20. Use Tooling (A) in order to turn the engine to a vertical position.

Note: For more information on the crankshaft, refer to Specifications.

End By:

- a. Install the piston cooling jets. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".
- b. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Install".
- c. Install the balancer gear on the rear gear group. Refer to Disassembly and Assembly, "Gear Group (Rear) - Install".
- d. Install the front housing. Refer to Disassembly and Assembly, "Front Drive Housing - Remove and Install".
- e. Install the rocker shaft assemblies and the pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rods - Install".

i02838650

Radiator Group - Remove

SMCS Code: 1353-011

Removal Procedure

Table 91

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2

Start By:

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

Note: The cooling system components and weights may vary depending on your arrangement.

Note: Put identification on all lines, hoses, wires, and tubes for installation purposes. Use caps and plugs on all lines, hoses, and tubes in order to prevent fluid loss or contamination of the systems.

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 Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

1. 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".

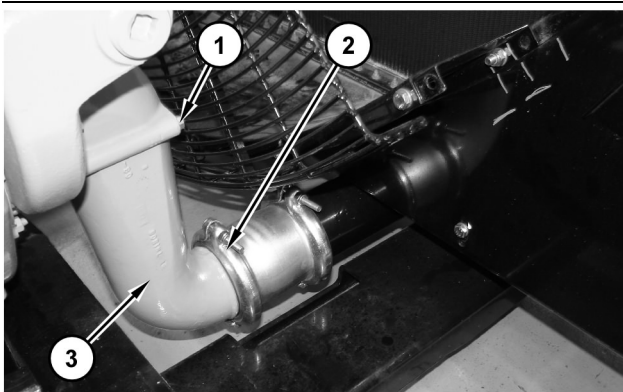


Illustration 726

g01415775

2. Remove bolts (1) and clamps (2) in order to remove elbow (3).



Illustration 727

g01415777

3. Disconnect hose assemblies (4).



Illustration 728

g01415779

4. Disconnect tube assembly (5).

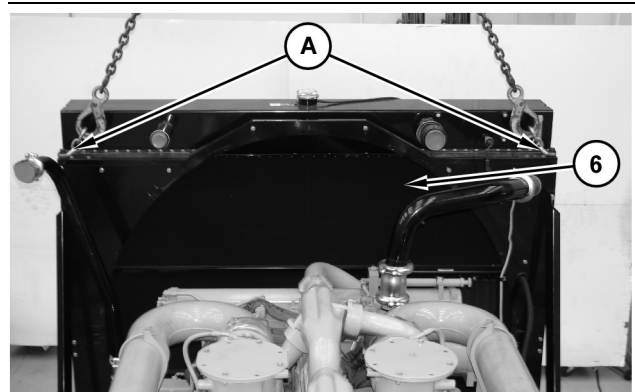


Illustration 729

g01415820

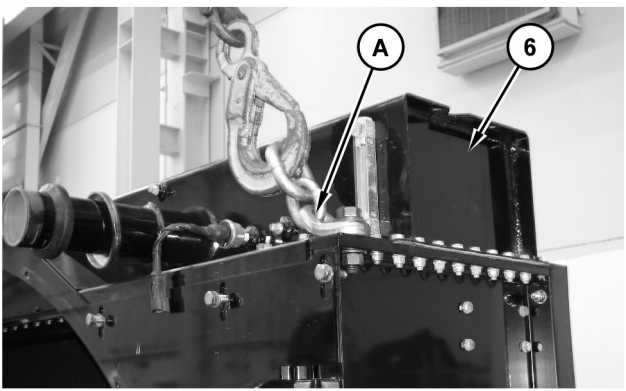


Illustration 730 g01415821

5. Attach Tooling (A) and a suitable lifting device to radiator group (6). The weight of radiator group (6) is approximately 862 kg (1900 lb).

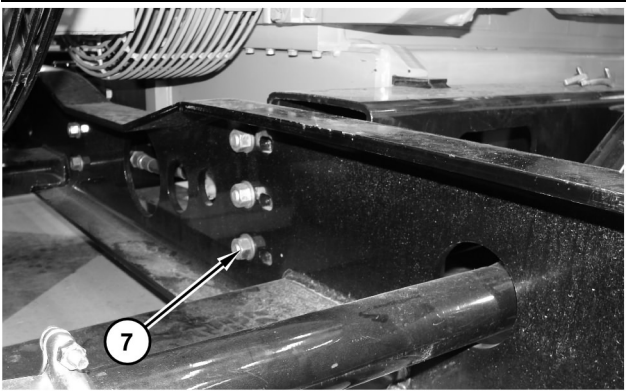


Illustration 731 g01415834

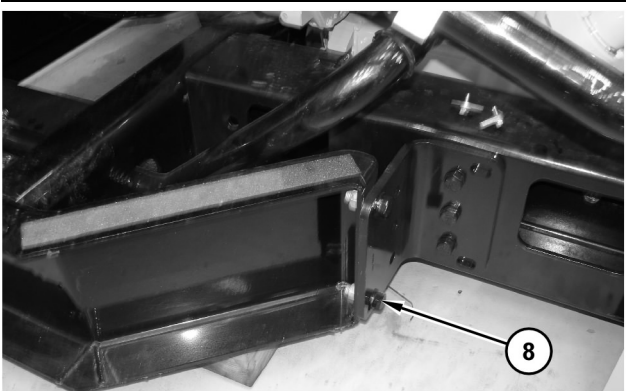


Illustration 732 g01415835

6. Remove bolts (7) and (8).

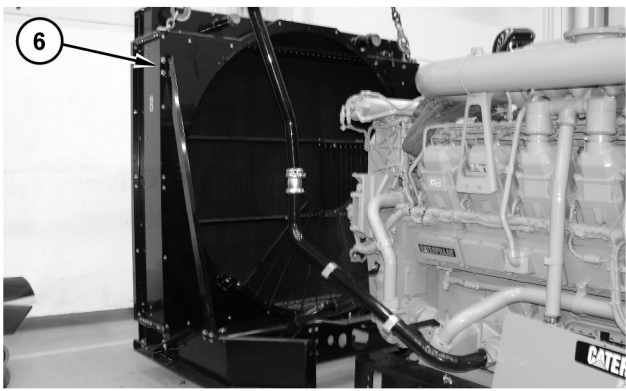


Illustration 733 g01415836

7. Remove radiator group (6).

i02839203

Radiator Group - Install

SMCS Code: 1353-012

Installation Procedure

Table 92

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2

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 Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: The cooling system components and weights may vary depending on your arrangement.

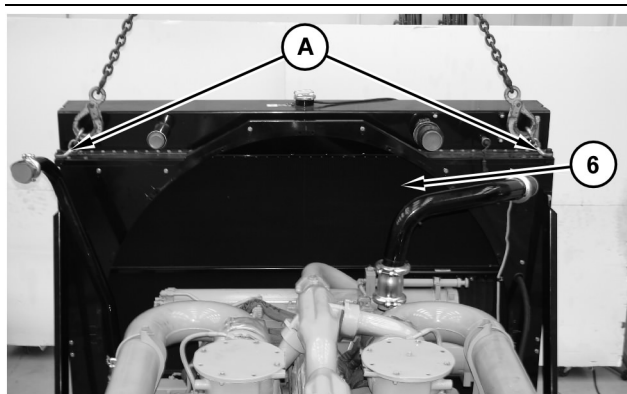


Illustration 734

g01415820

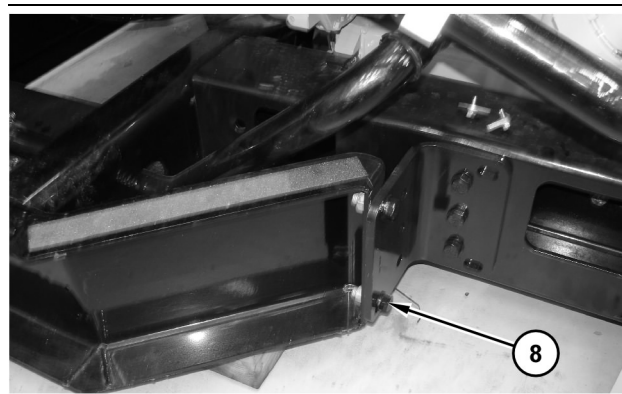


Illustration 737

g01415835

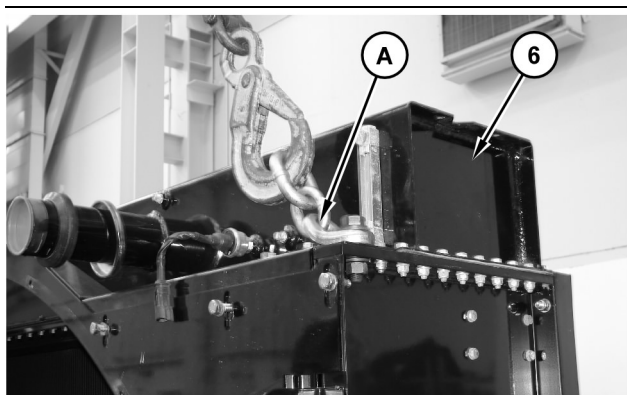


Illustration 735

g01415821

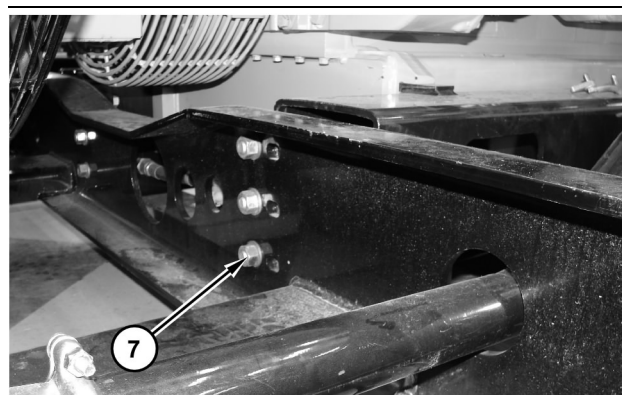


Illustration 738

g01415834

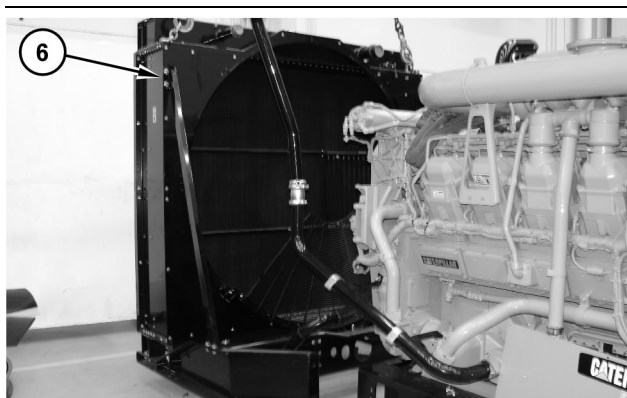


Illustration 736

g01415836

1. Attach Tooling (A) and a suitable lifting device to radiator group (6). The weight of radiator group (6) is approximately 862 kg (1900 lb). Place radiator group (6) in position.

Note: Do not tighten bolts (8) and (7) until the fan is centered in the radiator.

2. Install bolts (8) and (7).



Illustration 739

g01415779

3. Connect tube assembly (5).



Illustration 740 g01415777

4. Connect hose assemblies (4).

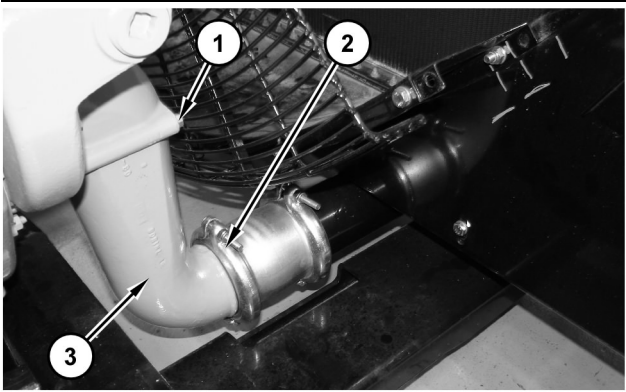


Illustration 741 g01415775

5. Install elbow (3), clamps (2), and bolts (1).

6. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

End By:

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

Start By:

- a. Remove the radiator group. Refer to Disassembly and Assembly, "Radiator Group - Remove".
- b. Remove the fuel cooler. Refer to Disassembly and Assembly, "Fuel Cooler - Remove and Install".

Note: The cooling system components and weights may vary depending on your arrangement.

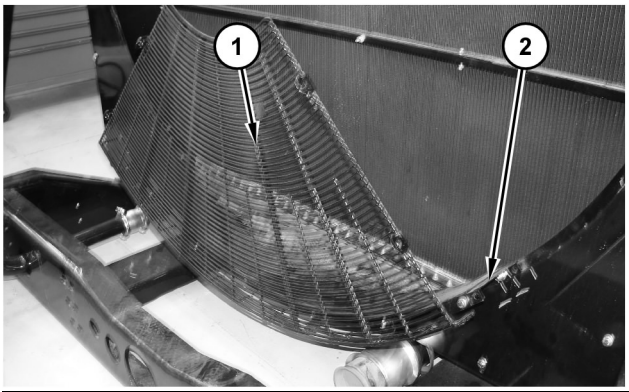


Illustration 742 g01416296

1. Remove fan guard assembly (1) and shroud assembly (2).

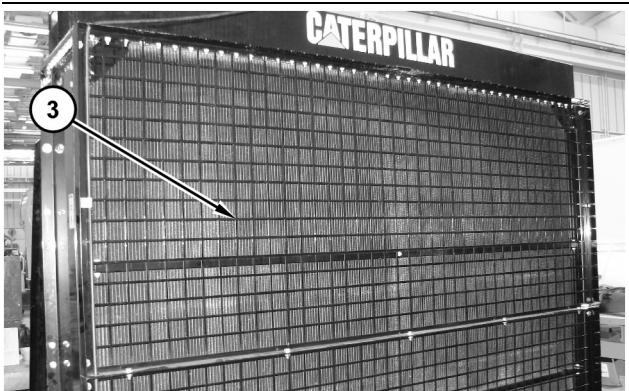


Illustration 743 g01416300

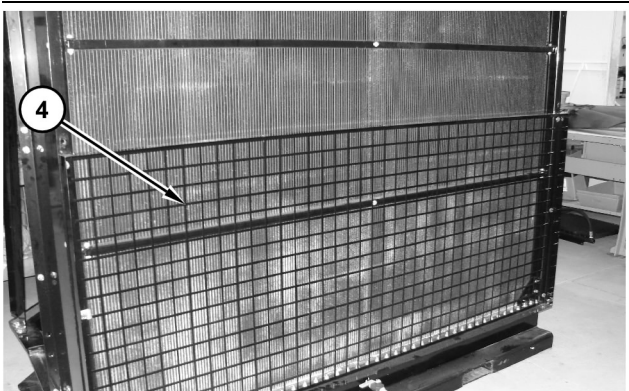


Illustration 744 g01416301

2. Remove guards (3) and (4) for the radiator core.

i02839439

Radiator Core - Remove

SMCS Code: 1353-011

Removal Procedure

Table 93

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	4

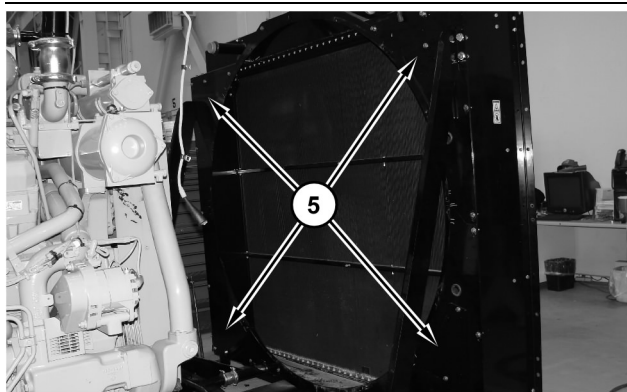


Illustration 745

g01416351

3. Remove shrouds (5).

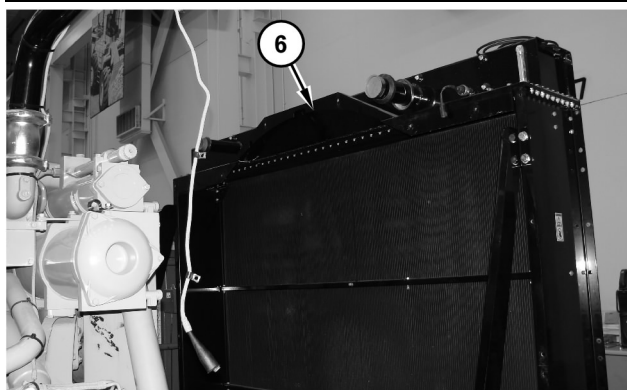


Illustration 746

g01416352

4. Remove radiator support (6).

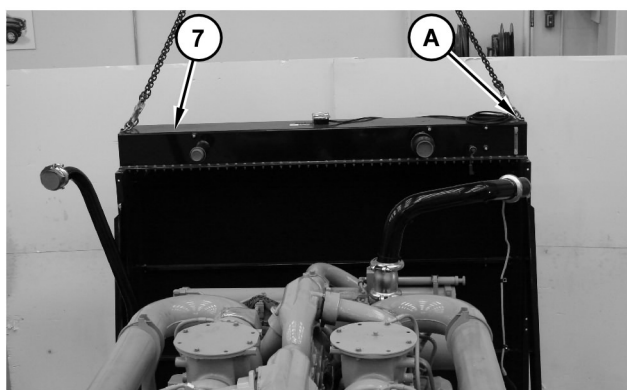


Illustration 747

g01416353

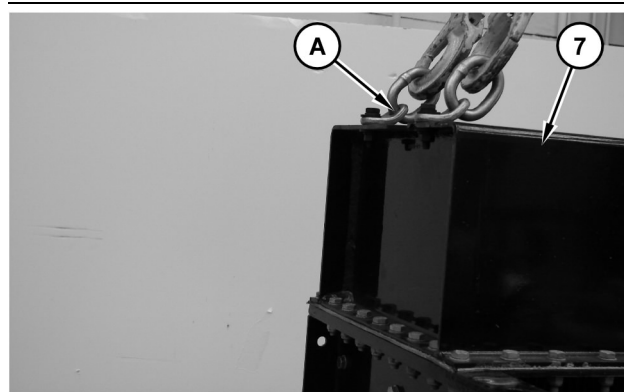


Illustration 748

g01416354

5. Attach Tooling (A) and a suitable lifting device to top tank assembly (7).

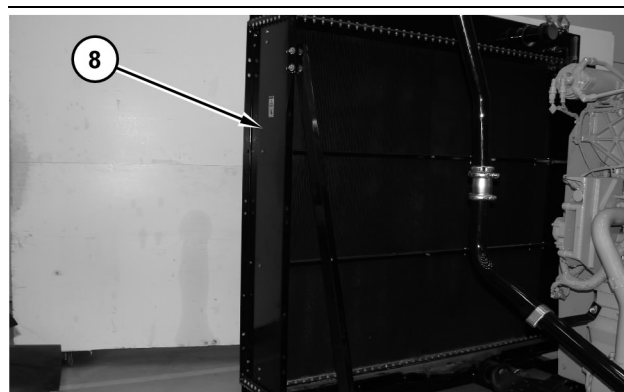


Illustration 749

g01416355

6. Use two people in order to remove side panel assembly (8). The weight of side panel assembly (8) is approximately 36 kg (80 lb). Repeat for the other side.

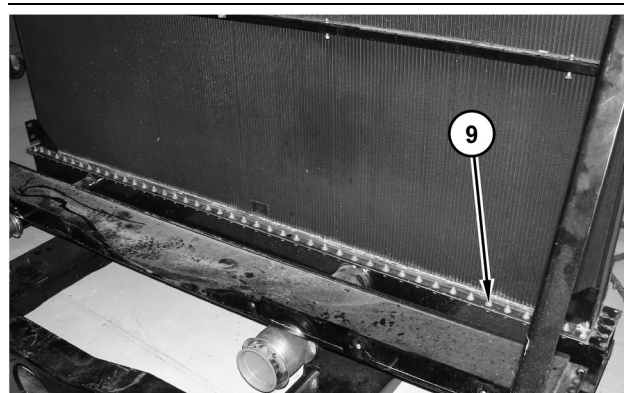


Illustration 750

g01416357

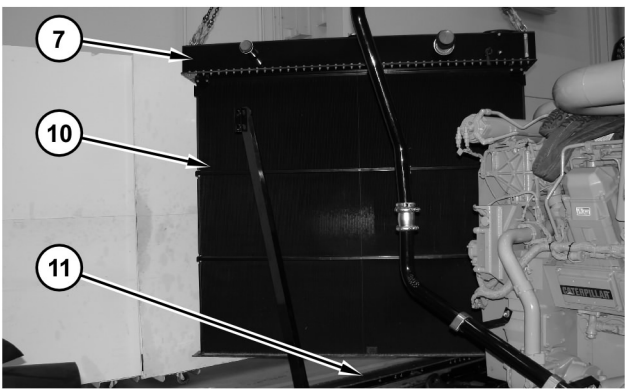


Illustration 751 g01416358

7. Remove bolts (9). Remove top tank assembly (7) and radiator core (10) together. The weight of top tank assembly (7) and radiator core (10) is approximately 318 kg (700 lb). Remove gasket (11).

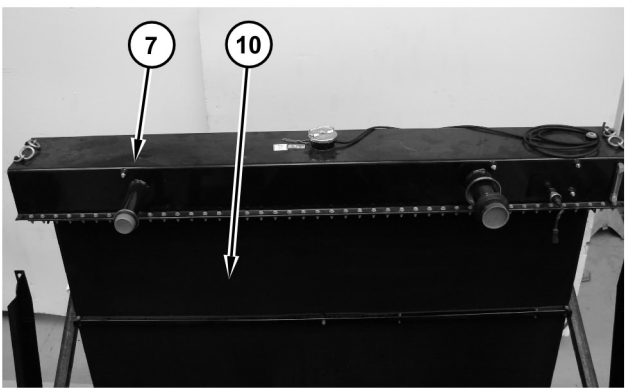


Illustration 752 g01416362

8. Secure top tank assembly (7) and radiator core (10) in a vertical position.



Illustration 753 g01416363

9. Remove bolts (12). Use two people in order to remove support assembly for header (13). The weight of support assembly for header (13) is approximately 36 kg (80 lb).



Illustration 754 g01416365

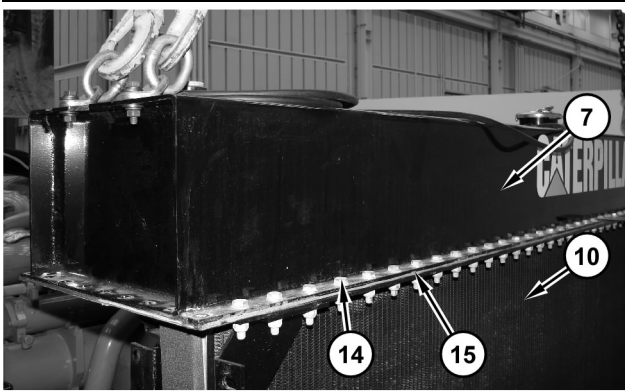


Illustration 755 g01416366

10. Attach Tooling (A) and a suitable lifting device to top tank assembly (7). The weight of top tank assembly (7) is approximately 125 kg (275 lb). Remove bolts (14) in order to remove top tank assembly (7) from radiator core (10). The weight of radiator core (10) is approximately 192 kg (425 lb). Remove gasket (15).

i02840331

Radiator Core - Install

SMCS Code: 1353-012

Installation Procedure

Table 94

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7573	Link Bracket	4

Note: The cooling system components and weights may vary depending on your arrangement.



Illustration 756

g01416365

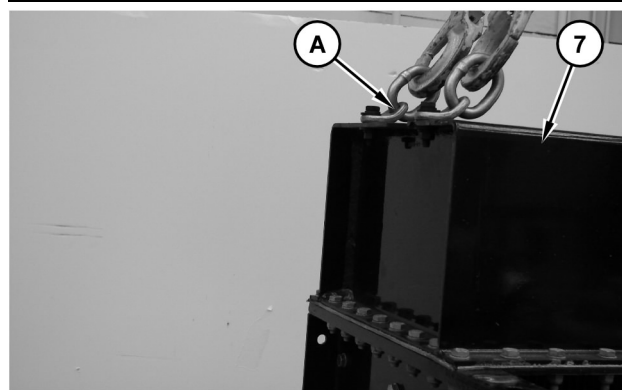


Illustration 759

g01416354

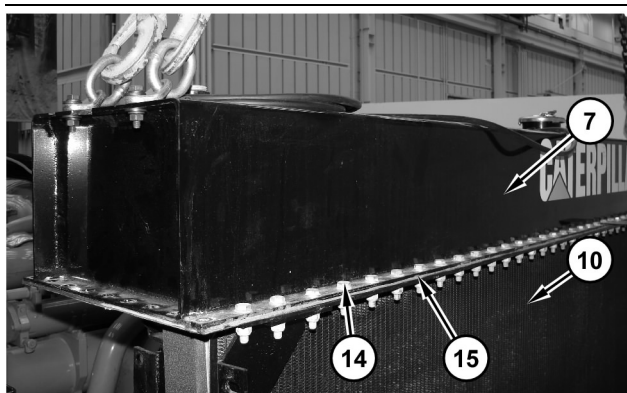


Illustration 757

g01416366

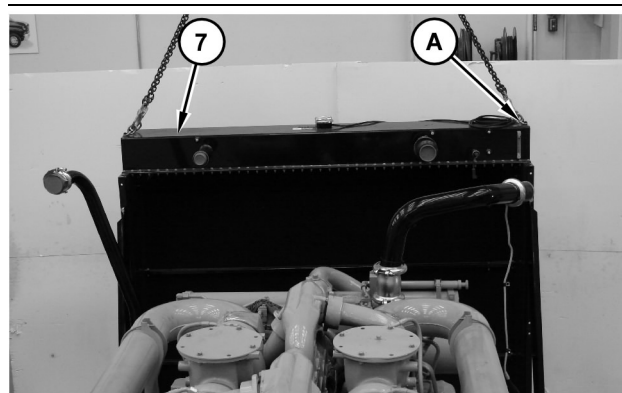


Illustration 760

g01416353

1. Attach Tooling (A) and a suitable lifting device to top tank assembly (7). The weight of top tank assembly (7) is approximately 125 kg (275 lb). Install gasket (15). Install top tank assembly (7) on radiator core (10). The weight of radiator core (10) is approximately 192 kg (425 lb). Install bolts (14).

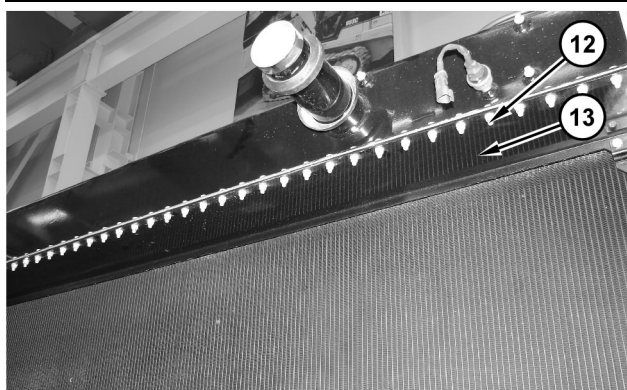


Illustration 758

g01416363

2. Use two people in order to install support assembly for header (13). The weight of support assembly for header (13) is approximately 36 kg (80 lb). Install bolts (12).

3. Attach Tooling (A) and a suitable lifting device to top tank assembly (7).



Illustration 761

g01416358

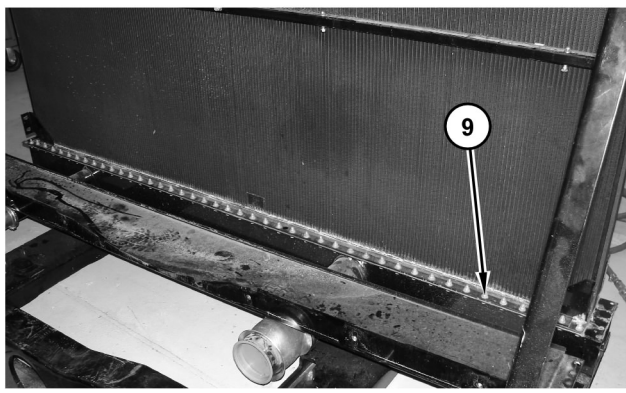


Illustration 762

g01416357

4. Install gasket (11). Install top tank assembly (7) and radiator core (10) together. The weight of top tank assembly (7) and radiator core (10) is approximately 318 kg (700 lb). Install bolts (9).

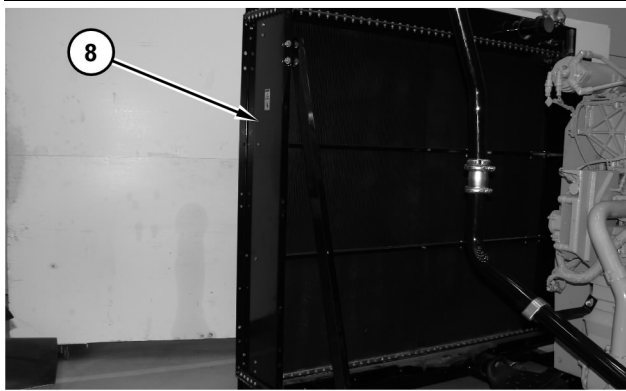


Illustration 763

g01416355

5. Use two people in order to install side panel assembly (8). The weight of side panel assembly (8) is approximately 36 kg (80 lb). Repeat for the other side.

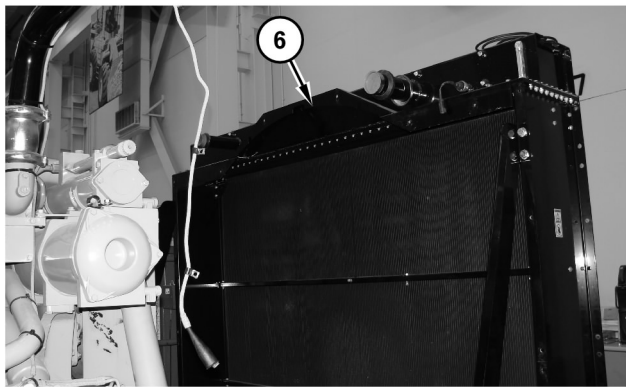


Illustration 764

g01416352

6. Install radiator support (6).

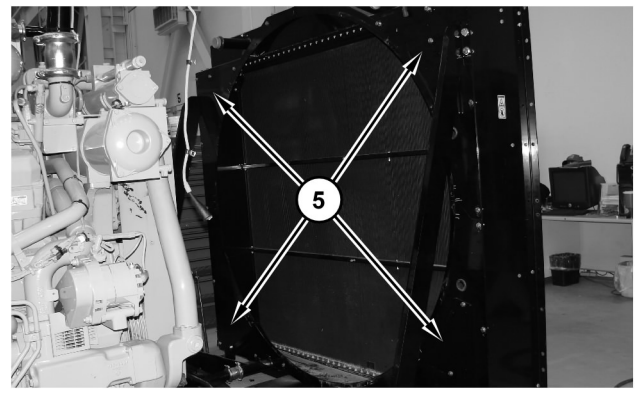


Illustration 765

g01416351

7. Install shrouds (5).

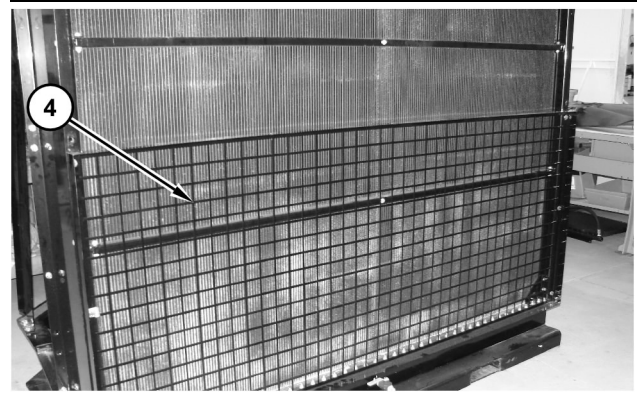


Illustration 766

g01416301

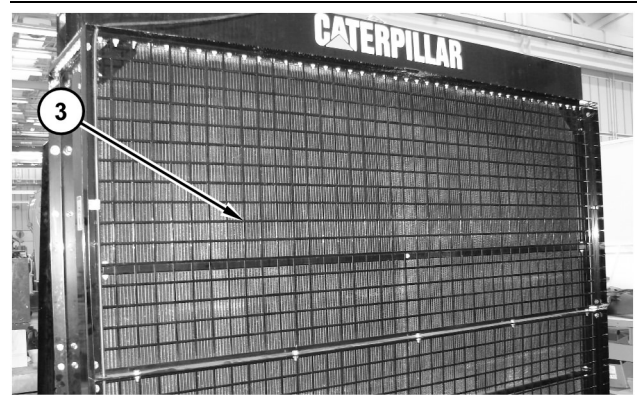


Illustration 767

g01416300

8. Install guards (4) and (3) for the radiator core.

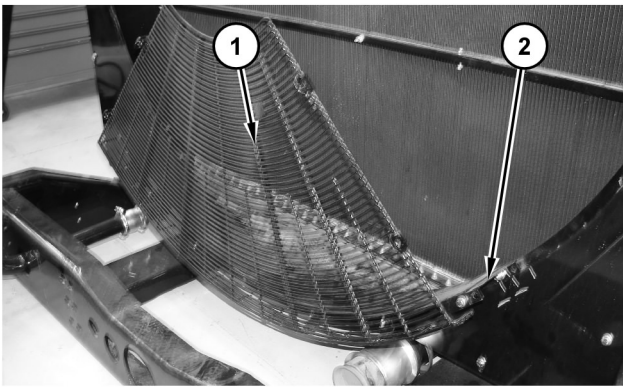


Illustration 768

g01416296

9. Install shroud assembly (2) and fan guard assembly (1).

End By:

- a. Install the fuel cooler. Refer to Disassembly and Assembly, "Fuel Cooler - Remove and Install".
- b. Install the radiator group. Refer to Disassembly and Assembly, "Radiator Group - Install".

i02838408

Fan - Remove and Install

SMCS Code: 1356-010

Removal Procedure

Table 95

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-9200	Lever Puller Hoist	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 Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: The cooling system components and weights may vary depending on your arrangement.

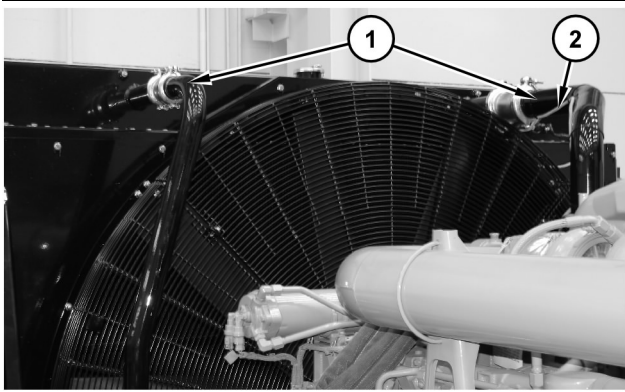


Illustration 769

g01415411

- 1. 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".
- 2. Disconnect tube assemblies (1) and disconnect harness assembly (2).

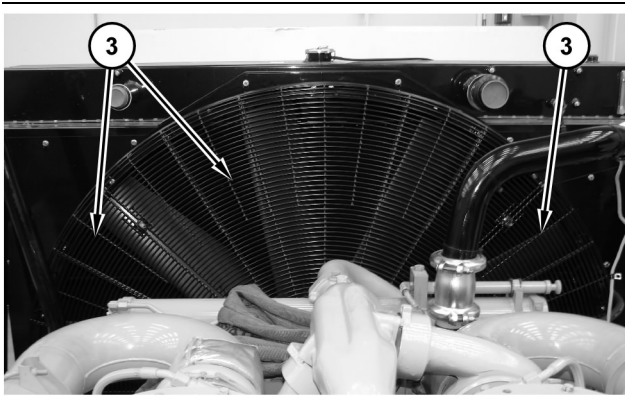


Illustration 770

g01415414

3. Remove fan guard assemblies (3).

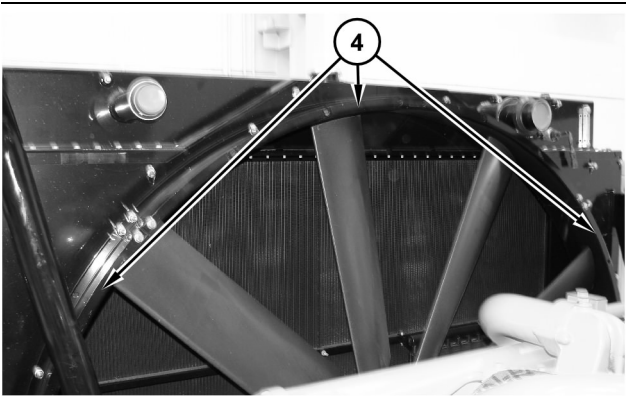


Illustration 771

g01415415

4. Remove shroud assemblies (4).

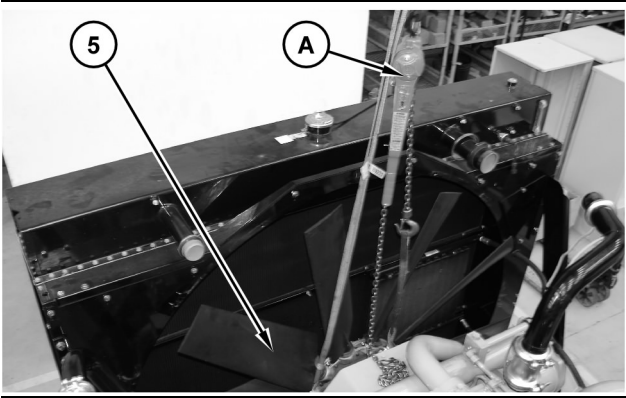


Illustration 772

g01415422

5. Attach Tooling (A) and a suitable lifting device to fan assembly (5). The weight of fan assembly (5) is approximately 45 kg (100 lb).

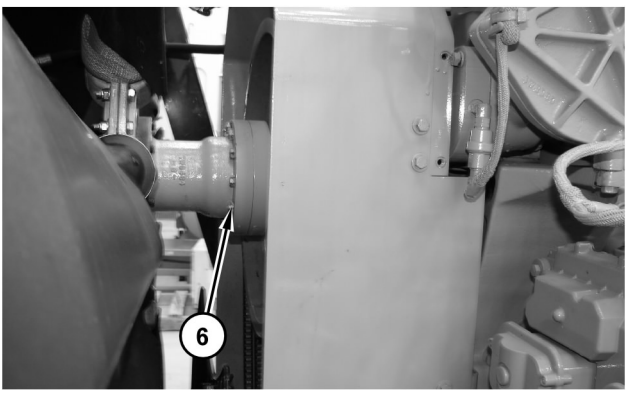


Illustration 773

g01415426

6. Remove bolts (6).



Illustration 774

g01415432

7. Remove fan assembly (5).

Installation Procedure

Table 96

Required Tools			
Tool	Part Number	Part Description	Qty
A	1U-9200	Lever Puller Hoist	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

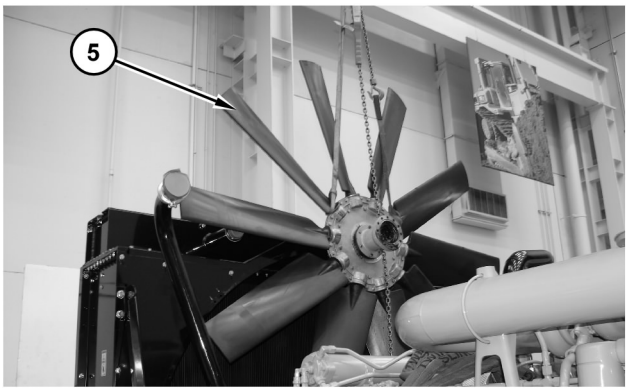


Illustration 775

g01415432

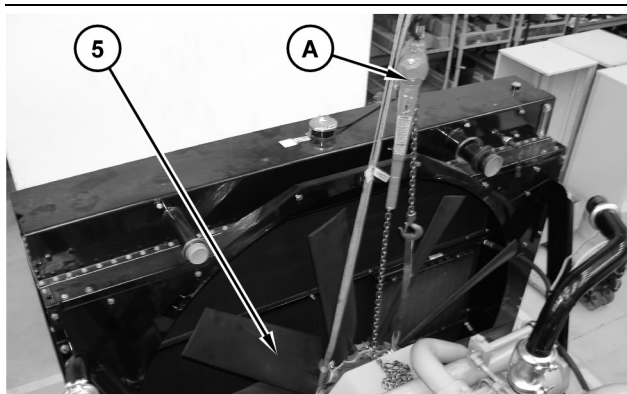


Illustration 776

g01415422

1. Attach Tooling (A) and a suitable lifting device to fan assembly (5). The weight of fan assembly (5) is approximately 45 kg (100 lb). Place fan assembly (5) in position.

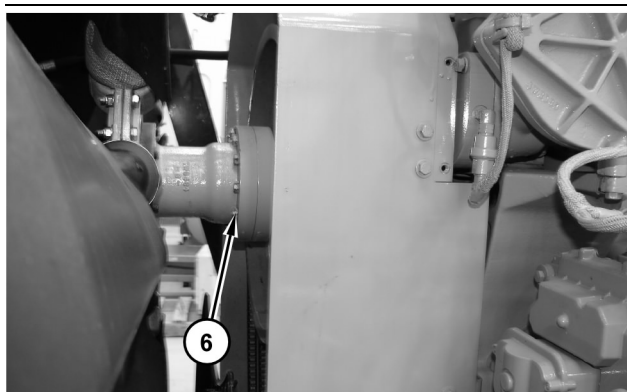


Illustration 777

g01415426

2. Install bolts (6).

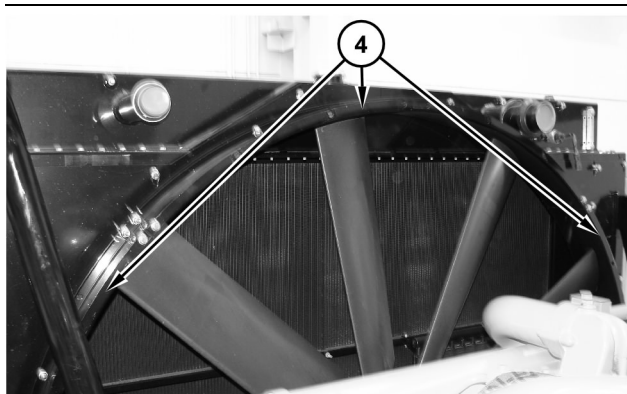


Illustration 778

g01415415

3. Install shroud assemblies (4).

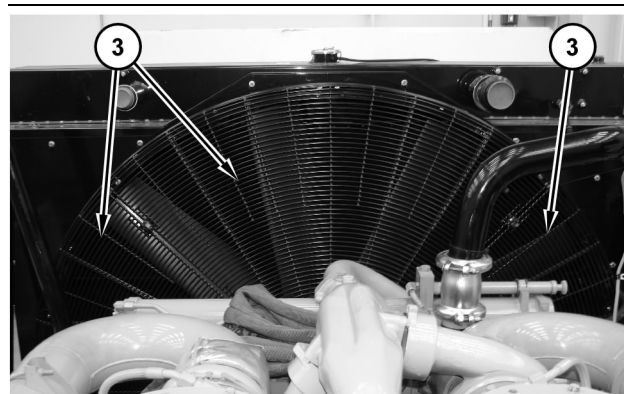


Illustration 779

g01415414

4. Install fan guard assemblies (3).

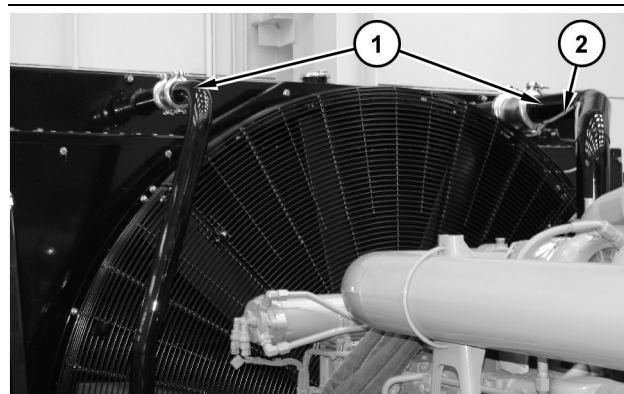


Illustration 780

g01415411

5. Connect harness assembly (2) and tube assemblies (1).
6. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

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