

# Disassembly and Assembly

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## **400C Industrial Engine**

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HB (Engine)  
HD (Engine)  
HH (Engine)  
HL (Engine)  
HM (Engine)  
HN (Engine)  
HP (Engine)  
HR (Engine)

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# Disassembly and Assembly Section

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## Fuel Priming Pump - Remove

### 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.

Dispose of all fluids according to local regulations and mandates.

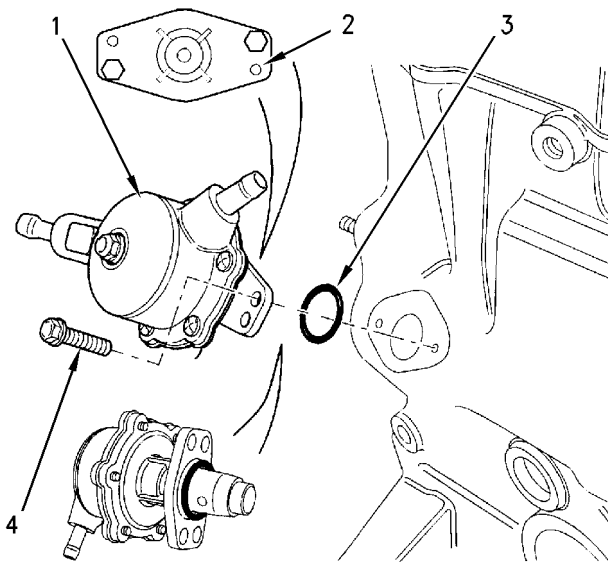


Illustration 1

g00824616

Typical example

1. Loosen the hose clamps and remove the two fuel lines from the fuel priming pump (1). Note the positions of the fuel inlet and the fuel outlet for installation.

2. Install suitable plugs into the fuel lines in order to prevent contamination.
3. Remove the two setscrews (4) that fasten the fuel priming pump (1) to the cylinder block.

**Note:** The fuel priming pump can be oriented in two positions. Before removing the fuel priming pump (1) from the cylinder block, note the orientation of the flange (2) of the fuel priming pump (1) for assembly.

4. Remove the fuel priming pump (1) and the O-ring (3). Discard the O-ring.

**Note:** In order to remove the fuel priming pump from the engine, it may be necessary to rotate the crankshaft until the operating plunger of the fuel priming pump is not under pressure.

i02186279

## Fuel Priming Pump - Install

### Installation Procedure

**NOTICE**

Keep all parts clean from contaminants.

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Dispose of all fluids according to local regulations and mandates.

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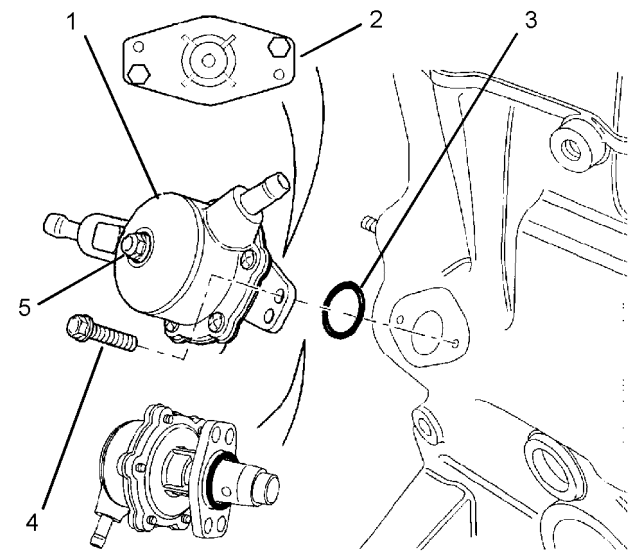


Illustration 2

g01129954

Typical example

1. Clean the mating surfaces of the fuel priming pump on the cylinder block and clean the flange (2) of the fuel priming pump.

**Note:** Ensure that the camshaft lobe for the fuel priming pump is at minimum lobe lift before the fuel priming pump is installed. The fuel priming pump can be oriented in two positions. Ensure that the fuel priming pump is oriented in the correct position.

2. Install a new O-ring (3) to the fuel priming pump(1).
3. Lubricate the operating plunger of the fuel priming pump (1) with clean engine oil.
4. Install the fuel priming pump (1) to the engine. Ensure that the operating plunger is positioned correctly on the camshaft lobe.
5. Install the two setscrews (4) that fasten the fuel priming pump (1) to the cylinder block. Tighten the setscrews to a torque of 6 N·m (4.5 lb ft).
6. Loosely install the hose clamps to the fuel lines. Connect the appropriate fuel lines to the fuel inlet and the fuel outlet of the fuel priming pump (1). Tighten the hose clamps.

**Note:** The fuel inlet for the fuel priming can be rotated 360 degrees by loosening setscrew (5). The fuel inlet is adjustable in 15 degree increments. If adjustment is made to the position of the fuel inlet, tighten setscrew (5) to a torque of 2.5 N·m (22 lb in).

7. Prime the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime" for additional information.

## Fuel Filter Base - Remove

### Removal Procedure

#### NOTICE

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#### NOTICE

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Dispose of all fluids according to local regulations and mandates.

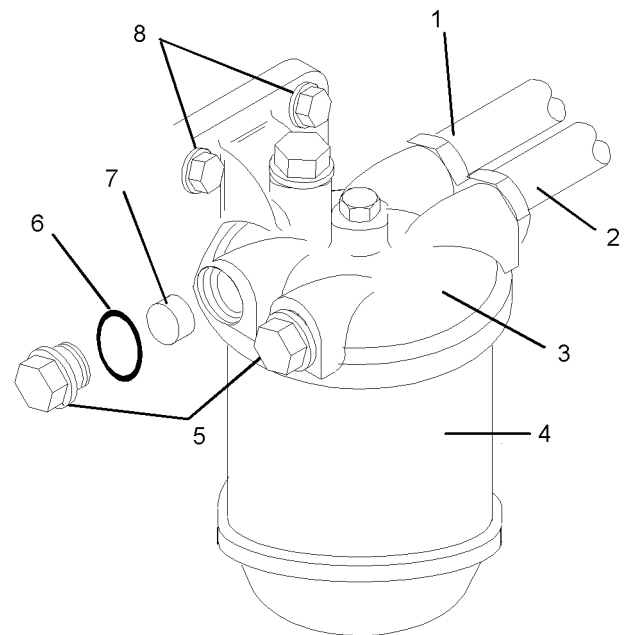


Illustration 3

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Typical example

1. Disconnect the fuel lines (1) and (2). Inspect the condition of the rubber olives (not shown) that seal the fuel lines. If the olives are damaged or worn, use new parts for replacement.

**Note:** Put identification marks on all the fuel lines for installation purposes. Plug all the fuel lines and all the ports in the fuel filter base. This helps prevent fluid loss, and this helps to keep contaminants from entering the system.

2. Remove the fuel filter element (4). Refer to Operations and Maintenance Manual, "Fuel System Filter - Replace".
3. If necessary, remove the plugs (5), the washers (6) and the inner seals (7).
4. Remove the setscrews (8) and the nuts (not shown).
5. Remove the fuel filter base (3) from the engine.

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## Fuel Filter Base - Install

### Installation Procedure

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

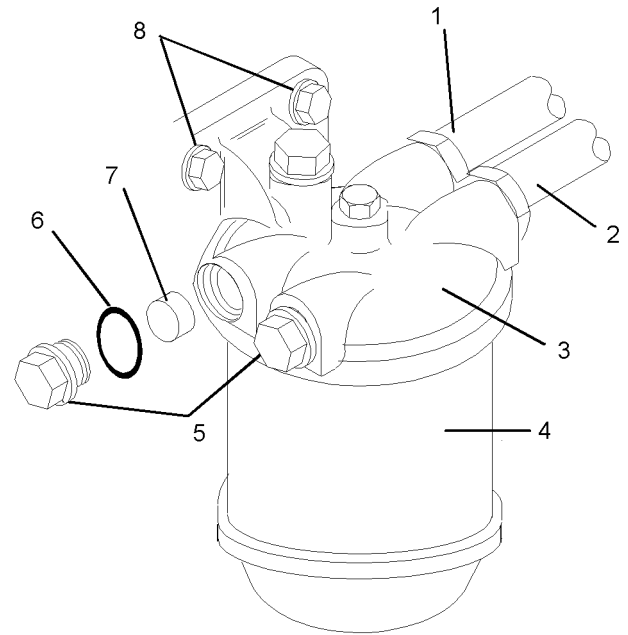


Illustration 4

g01118406

Typical example

1. Align the fuel filter base (3) with the mounting bracket. Install the bolts (8) and nuts (not shown). Tighten the nuts to a torque of 22 N·m (16.2 lb ft).
- Note:** Some fuel filters are installed by the OEM and torques for the mounting fasteners may vary. Check with the OEM Installation Manual for the correct torque setting.
2. If necessary, install the fuel filter element (4) to the fuel filter base (3). Refer to Operations and Maintenance Manual, "Fuel System Filter - Replace".
3. If necessary, install new olives onto the fuel lines. Connect the fuel lines (1) and (2) to the fuel filter base (3). Tighten the nuts on the fuel lines (1) and (2) to a torque of 9 N·m (6.6 lb ft).
4. If necessary, install new inner seals (7) to the fuel filter base (3).

Install new washers (6) onto the plugs (5) and install the plugs (5) to the fuel filter base (3). Tighten the plugs (5) to a torque of 22.5 N·m (16.6 lb ft).

**End By:**

- a. Remove the air from the fuel system. Refer to Operations and Maintenance Manual, "Fuel System - Prime".

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## Fuel Injection Lines - Remove and Install

### Removal Procedure

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#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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#### 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.

Dispose of all fluids according to local regulations and mandates.

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#### NOTICE

Do not let the tops of fuel injectors turn when the fuel line nuts are loosened or tightened.

The nozzles will be damaged if the top of the injector turns in the body.

The engine will be damaged if a defective fuel injector is used because the shape of fuel (spray pattern) that comes out of the nozzle will not be correct.

**Note:** The removal procedure is similar for the two cylinder, the three cylinder and the four cylinder engines. The illustrations show the 404C-22 and 404C-22T engines.

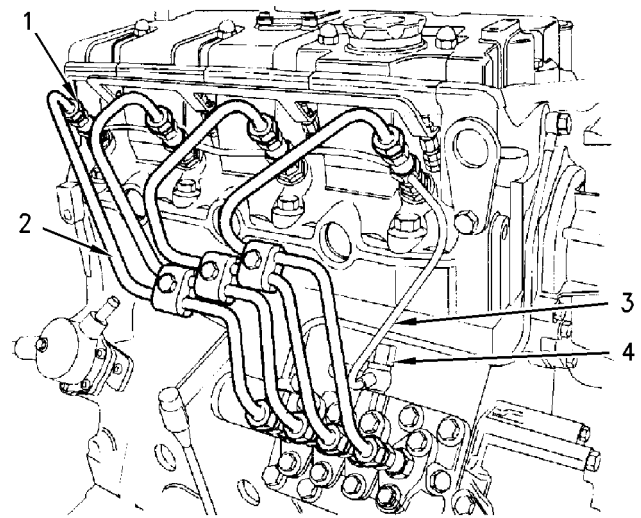


Illustration 5  
404C-22 and 404C-22T engines

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1. Disconnect the union nuts (1) for the fuel injection lines (2) from the fuel injectors.
  2. Disconnect the union nuts (1) for the fuel injection lines (2) from the fuel injection pump.
  3. Remove the fuel injection lines (2) from the engine as a unit.
- Note:** Place identification marks on all tube assemblies for installation. Plug all tube assemblies in order to prevent contamination.
4. Install suitable plastic plugs to the outlet connections of the fuel injection pump.
  5. The 403C-15, 403C-17, 404C-22 and 404C-22T engines have a rigid fuel return line.

For engines with a rigid fuel return line, remove the banjo bolt (4) from the fuel return line (3). Remove the washers (8) from the fuel return line (3). Discard the washers.

The 402C-05, 403C-07, 403C-11 and 404C-15 engines have a flexible fuel return hose.

For engines with a flexible fuel return hose, disconnect the union nut from the banjo piece.

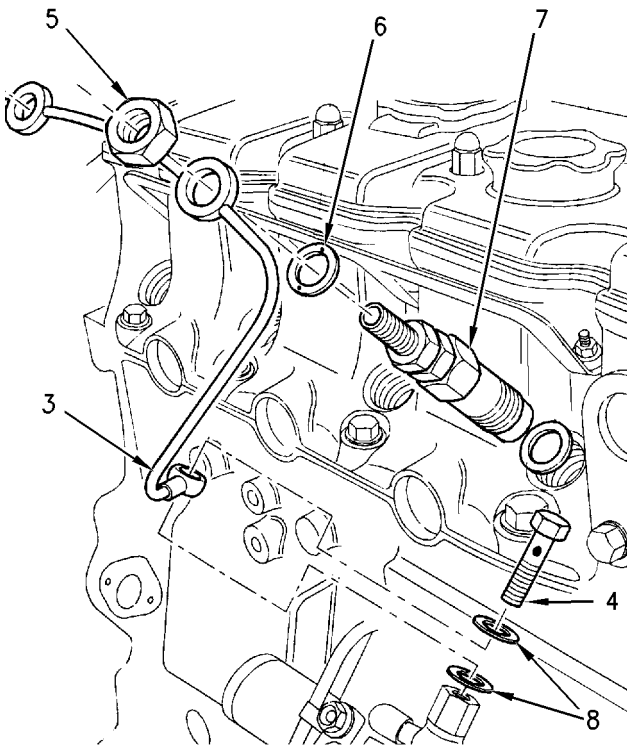


Illustration 6  
404C-22 and 404C-22T engines  
g00824793

6. Remove the nut (5) from the fuel injectors (7).
7. Remove the fuel return line (3) from the engine and remove washers (6) from the fuel injectors (7). Discard the washers.
8. Install suitable plastic plugs to the fuel injectors.

## Installation Procedure

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

### NOTICE

Do not let the tops of fuel injectors turn when the fuel line nuts are loosened or tightened.

The nozzles will be damaged if the top of the injector turns in the body.

The engine will be damaged if a defective fuel injector is used because the shape of fuel (spray pattern) that comes out of the nozzle will not be correct.

**Note:** The installation procedure is similar for the two cylinder, the three cylinder and the four cylinder engines. The illustrations show the 404C-22 and 404C-22T engines.

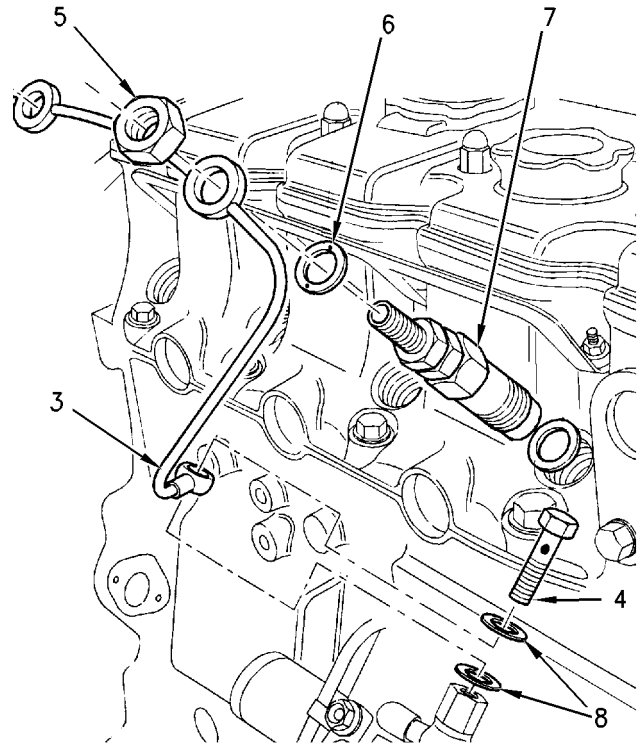


Illustration 7  
404C-22 and 404C-22T engines  
g00824793

1. Remove the plastic plugs from the fuel injectors (7). Install new washers (6) to the fuel injectors (7) and install the fuel return line (3) to the fuel injectors.

**Note:** The washers (6) have two small holes.

2. Install the nuts (5) to the fuel injectors (7).
3. The 403C-15, 403C-17, 404C-22 and 404C-22T engines have a rigid fuel return line.

For engines with a rigid fuel return line, install new washers (8) to the fuel return line (3) and install the banjo bolt (4) to the fuel injection pump. Tighten the banjo bolt (4) to a torque of 7 N·m (5.2 lb ft).

The 402C-05, 403C-07, 403C-11 and 404C-15 engines have a flexible fuel return hose.

For engines with a flexible fuel return hose, connect the fuel return hose to the banjo piece and tighten the union nut.

4. Tighten the nuts (5) to a torque of 27 N·m (20 lb ft).

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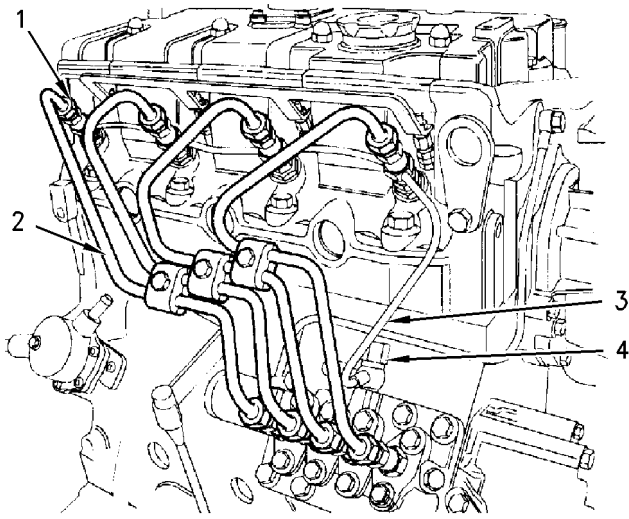


Illustration 8  
404C-22 and 404C-22T engines  
g00818680

5. Remove the plastic plugs from the fuel injection lines (2) and remove the plastic plugs from the outlet connections of the fuel injection pump. Install the fuel injection lines to the engine as a unit.
6. Connect the fuel injection lines (2) to the fuel injection pump.
7. Connect the fuel injection lines (2) to the fuel injectors (7).
8. For the 402C-05 and 403C-07 engines, tighten the union nuts (1) to a torque of 20 N·m (15 lb ft).  
  
For the 403C-11, 403C-15, 403C-17, 404C-15, 404C-22 and 404C-22T engines, tighten the union nuts (1) to a torque of 23 N·m (17 lb ft).
9. Prime the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime" for more information.

**Note:** If new fuel injection lines have been installed, do not make any adjustments to the engine controls. Check the maximum engine speed at no load. Refer to Testing and Adjusting, "Engine Speed - Check" for more information.

## Fuel Shutoff Solenoid - Remove and Install

### 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.

Dispose of all fluids according to local regulations and mandates.

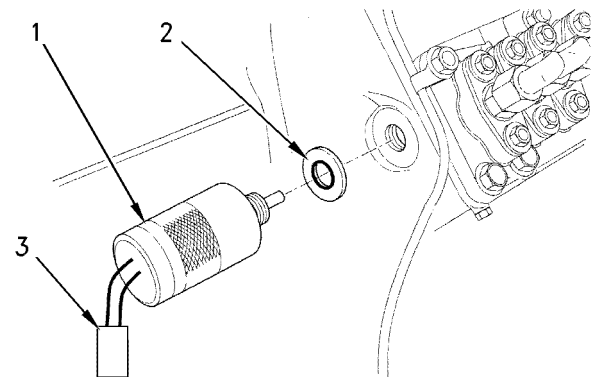


Illustration 9  
g00824952

1. Disconnect electrical connections (3) to the fuel shutoff solenoid (1). Mark all connections for later installation.
2. Remove fuel shutoff solenoid (1) from the fuel injection pump housing by rotating the fuel shutoff solenoid in a counterclockwise direction.
3. Remove the O-ring (2) from fuel shutoff solenoid (1).

### Installation Procedure

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



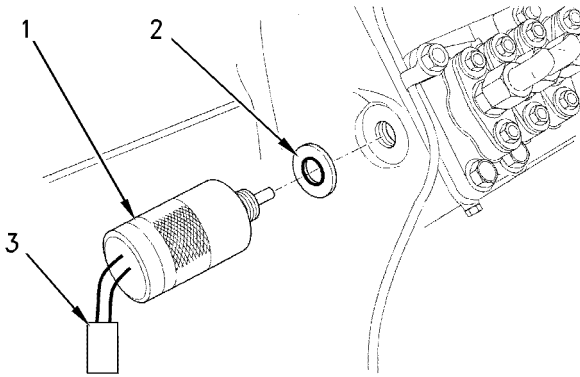


Illustration 10

g00824952

1. Check the condition of O-ring (2). If the O-ring is worn or damaged use a new part for replacement.
2. Install fuel shutoff solenoid (1) into the fuel injection pump housing by rotating the fuel shutoff solenoid in a clockwise direction. Tighten the fuel shutoff solenoid to a torque of 17.5 N·m (12.9 lb ft).
3. Reconnect electrical connection (3) to fuel shutoff solenoid (1) before you operate the engine.

i02797470

## Fuel Injection Pump - Remove

### Removal Procedure

#### Start By:

- a. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".
- b. Remove the fuel shutoff solenoid. Refer to Disassembly and Assembly, "Fuel Shutoff Solenoid - 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.

Dispose of all fluids according to local regulations and mandates.

**Note:** The removal procedure is similar for the two cylinder, the three cylinder and the four cylinder engines. The illustrations show the four cylinder engine.

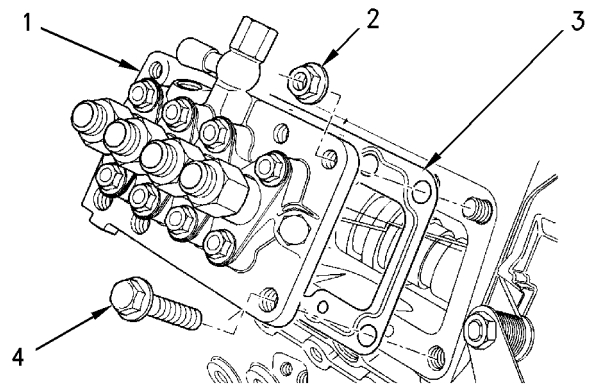


Illustration 11

g00825132

Typical example

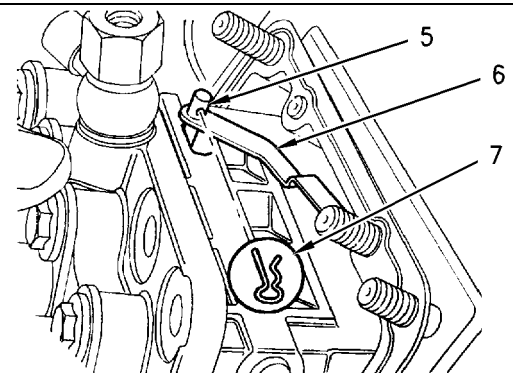


Illustration 12

g00825137

Typical example

1. Remove the setscrews (4) and the nuts (2) that fasten the fuel injection pump to the cylinder block.

**Note:** If the fuel rack control (5) has not been moved away from the recess of the stop solenoid, damage may occur.

2. Carefully raise the fuel injection pump (1) from the cylinder block and remove the clip (7) that connects the link (6) to the fuel rack control (5).
3. Remove the fuel injection pump (1) from the cylinder block.
4. Remove the shims (3) from the mounting face of the cylinder block.

**Note:** Record the thickness of each shim and the number of shims for reassembly. The fuel injection timing is determined by the thickness of the shim pack that is between the fuel injection pump and the mounting face on the cylinder block. For more information on the fuel injection pump, refer to Specifications, "Fuel Injection Pump".

i02801637

## Fuel Injection Pump - Install

### Installation Procedure

**NOTICE**

Keep all parts clean from contaminants.

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**NOTICE**

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Dispose of all fluids according to local regulations and mandates.

**Note:** The installation procedure is similar for the two cylinder, the three cylinder and the four cylinder engines. The illustrations show the four cylinder engine.

1. Clean the mounting face of the fuel injection pump on the cylinder block. Clean the mating surface of the fuel injection pump.

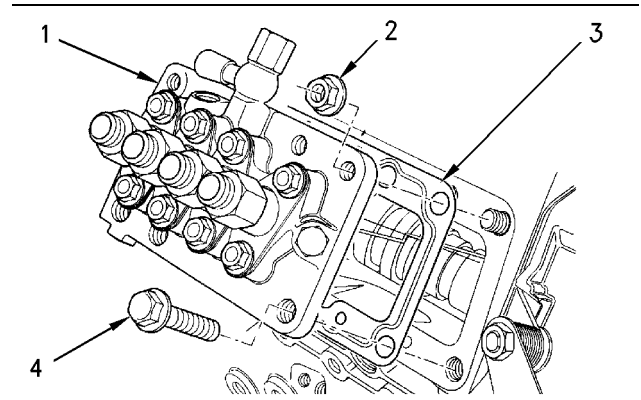


Illustration 13  
Typical example

g00825132

2. Install the correct thickness and the correct number of shims (3) on the mounting face of the cylinder block. Refer to Specifications, "Fuel Injection Pump".

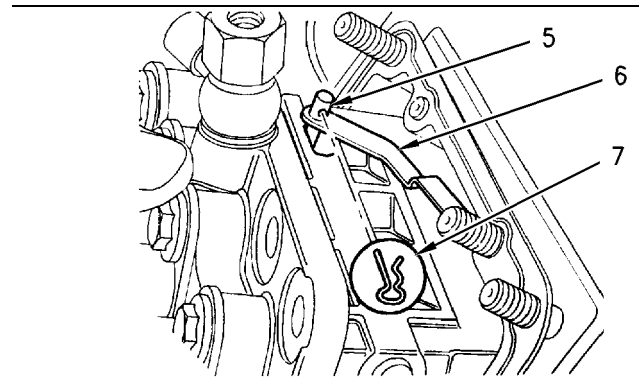


Illustration 14  
Typical example

g00825137

3. Position the fuel injection pump (1) close to the mounting face of the cylinder block, and connect the link (6) and the fuel rack control (5) with the clip (7).
4. Put the fuel injection pump (1) in position on the mounting face of the cylinder block.
5. Install the setscrews (4) and the nuts (2) that fasten the fuel injection pump to the cylinder block.

For 402C-05, 403C-07, 403C-11 and 404C-15 engines, tighten the setscrews (4) and the nuts (2) to a torque of 6 N·m (53 lb in).

For 403C-15, 403C-17, 404C-22 engines and 404C-22T engines, tighten the setscrews (4) and the nuts (2) to a torque of 15 N·m (11 lb ft).

**End By:**

- a. Install the fuel shutoff solenoid. Refer to Disassembly and Assembly, "Fuel Shutoff Solenoid - Remove and Install".
- b. Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

i02801638

## Fuel Injector - Remove

### Removal Procedure

**Start By:**

- a. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

---

**NOTICE**

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**NOTICE**

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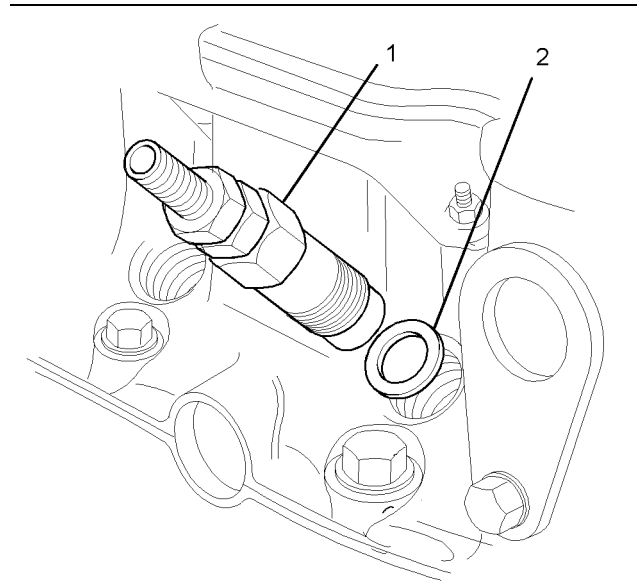


Illustration 15  
Typical example

g01124706

1. Use a deep socket to remove the fuel injector (1) from the cylinder head.
2. Remove the seat washers (2) from the cylinder head. Discard the old seat washers.

**Note:** 402C-05 and 403C-07 engines have two seat washers. The seat washers are different diameters. 403C-11, 403C-15, 403C-17, 404C-15, 404C-22 and 404C-22T engines have one seat washer.

3. Cap all openings or plug all openings immediately after disassembly.

i02801639

## Fuel Injector - Install

### Installation Procedure

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**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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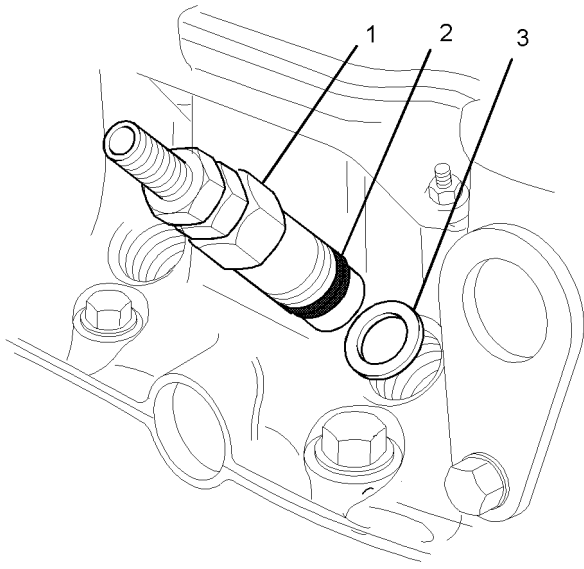


Illustration 16  
Typical example g01113718

1. Clean the injector bore in the cylinder head. Ensure that no debris enters the cylinder head. Clean the threads on the body of the injector.
2. Install new seat washers (3) into the injector bore in the cylinder head.

**Note:** 402C-05 and 403C-07 engines have two seat washers. The seat washers are different diameters. 403C-11, 403C-15, 403C-17, 404C-15, 404C-22 and 404C-22T engines have one seat washer.

3. Apply a bead of 1861117 POWERPART Universal Jointing Compound (2) to the first two threads of the injector that engage into the cylinder head. The bead of Universal Jointing Compound should have a diameter of 2 mm (0.08 inch) and a length of 6 mm (0.25 inch).

**Note:** Ensure that the universal jointing compound does not cover the surface of the fuel injector body below the threads.

4. Install the fuel injector (1) into the cylinder head. Use a deep socket to tighten the fuel injector to a torque of 64 N·m (47 lb ft).

**Note:** If a new fuel injector has been installed, do not make any adjustments to the engine controls. Refer to Testing and Adjusting, "Engine Speed - Check" for more information.

**End By:**

- a. Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

## Turbocharger - Remove and Install

### Removal procedure

**NOTICE**

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**NOTICE**

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Dispose of all fluids according to local regulations and mandates.

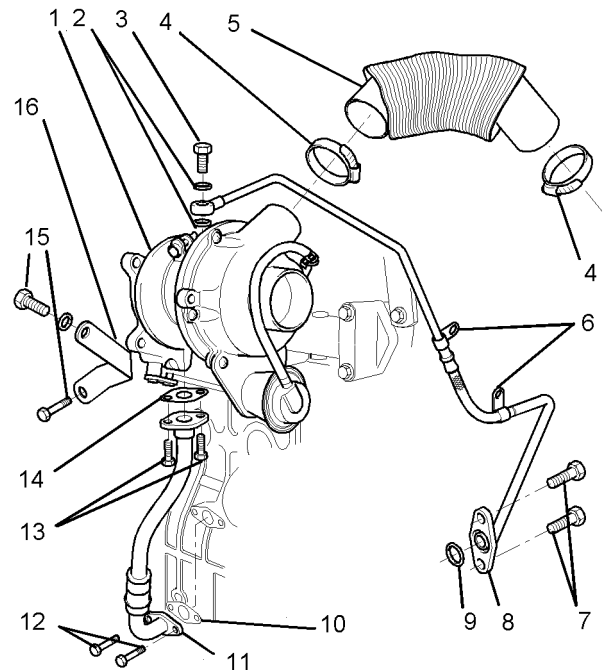


Illustration 17 g01114005

1. Clean the outer surfaces of the turbocharger (1).
2. Loosen the hose clamps (4). Remove the air inlet hose (5).

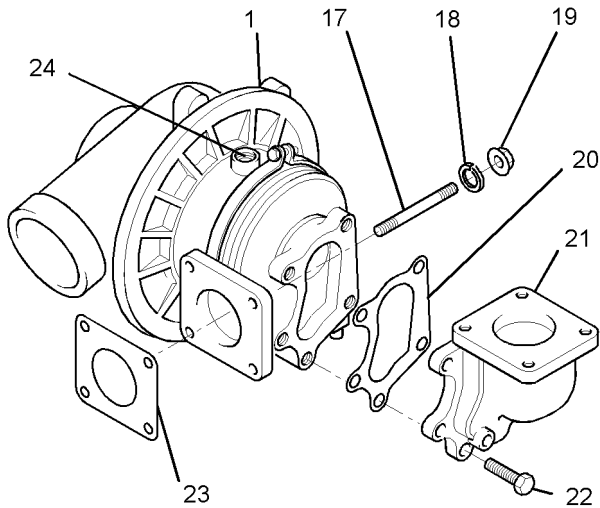


Illustration 18

g01114003

3. Remove the exhaust pipe (not shown) from the exhaust elbow (21). Refer to the OEM provided information for the correct procedure in order to remove the exhaust pipe.
4. Remove the setscrews (15) and remove the support bracket for the turbocharger (16). Note the position of the support bracket for installation.
5. Remove the setscrews (22). Remove the exhaust elbow (21) from the turbocharger (1). Remove the gasket for the exhaust elbow (20) from the turbocharger. Discard the gasket.
6. Place a suitable container below the turbocharger (1) in order to collect any spillage of oil.
7. Remove the banjo bolt (3). Remove the oil supply tube assembly (8). Remove the washers (2) from the turbocharger. Discard the washers. If necessary, remove the setscrews (not shown) for the tube clips (6). Remove the setscrews (7). Remove the oil supply tube assembly (8) from the cylinder block. Remove the O-ring (9). Discard the O-ring.
8. Remove the setscrews (13). Remove the oil drain tube assembly (11) from the turbocharger. Remove the joint (14) and discard the joint. If necessary, remove the setscrews (12) and remove the oil drain tube assembly (11) from the cylinder block. Remove the joint (10). Discard the joint.

9. Remove the nuts (19) and the washers (18). Remove the turbocharger (1) from the exhaust manifold. Remove the turbocharger gasket (23) from the exhaust manifold. Discard the gasket. If necessary, remove the studs (17) from the exhaust manifold.

**Note:** Do not use the actuator rod of the wastegate to lift the turbocharger.

10. Inspect the turbocharger for damage. If the turbocharger is damaged use a new part for replacement. Refer to Testing and Adjusting, "Wastegate - Test".
11. Install suitable plastic plugs into the oil supply and into the oil drain ports of the turbocharger (1). Install suitable plastic covers to the inlet and to the outlet of the turbocharger. Install suitable plastic plugs to the oil supply tube assembly (8) and to the oil drain tube assembly (11).

## Installation procedure

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove all of the plastic plugs from all of the ports of the turbocharger (1). Clean the mating surfaces of the exhaust manifold and the turbocharger.

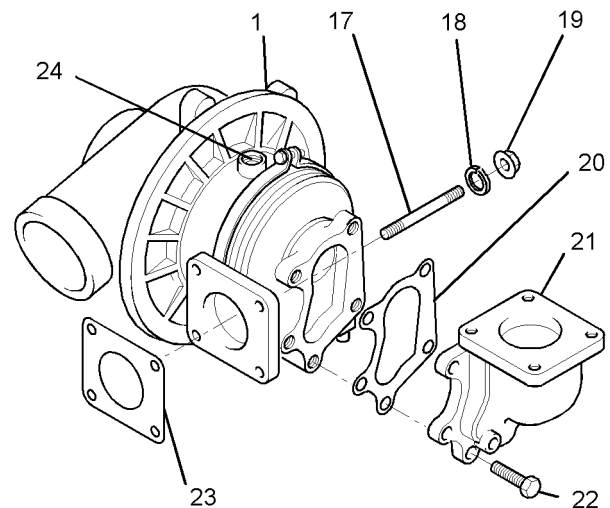


Illustration 19

g01114003

2. Ensure that all of the turbocharger inlet and outlet ports are clean and free from restrictions. The turbocharger shaft must rotate freely.

- If the studs (17) were previously removed, install the studs into the exhaust manifold. Install a new gasket (23) over the studs (17).

**Note:** Do not use any sealant on the gasket (23).

**Note:** Do not use the actuator rod of the wastegate to lift the turbocharger (1).

- Position the turbocharger (1) onto the exhaust manifold.
- Install the washers (18) and install the nuts (19). Tighten the nuts to a torque of 25 N·m (18 lb ft).
- Lubricate the bearing housing of the turbocharger (1) with clean engine oil. Apply the lubricant through the oil supply port (24).

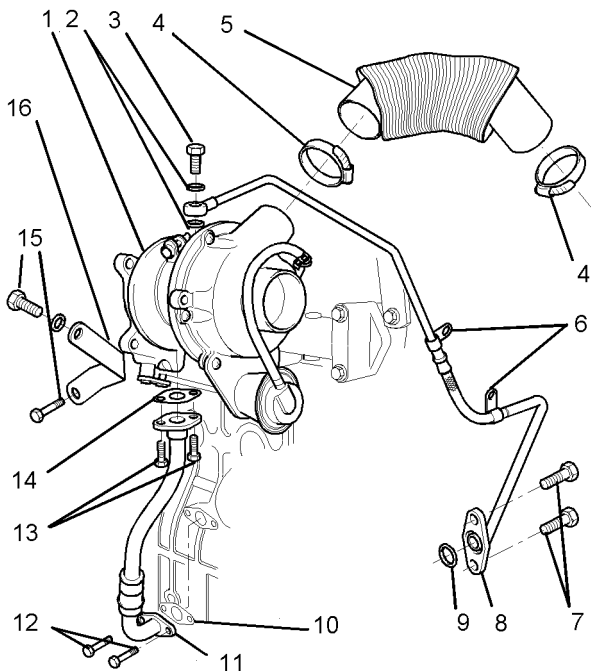


Illustration 20

g01114005

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- Clean the oil supply tube assembly (8) and the oil drain tube assembly (11). Inspect the oil supply tube assembly and the oil drain tube assembly. If necessary, replace the tube assemblies.
- Position a new joint (14) and the oil drain tube assembly (11) onto the bottom of the turbocharger. Install the setscrews (13). Tighten the setscrews to a torque of 10 N·m (7 lb ft).
- If necessary, position a new joint (10) and the oil drain tube assembly (11) onto the cylinder block. Install the setscrews (12). Tighten the setscrews to a torque of 10 N·m (7 lb ft).

- Position the new washers (2) and the oil supply tube assembly (8) onto the turbocharger (1). Install the banjo bolt (3). Tighten the banjo bolt to a torque of 18 N·m (13 lb ft).

- If necessary, install a new O-ring (9) and the oil supply tube assembly (8) to the cylinder block. Install the setscrews (7). Tighten the setscrews to a torque of 10 N·m (7 lb ft).

- If necessary, install the spacer (not shown) and install the setscrews (not shown) to the tube clips (6). Torque the setscrews to 10 N·m (7 lb ft).

**Note:** Ensure that the oil supply tube assembly (8) does not come into contact with any other component when the assembly is installed onto the engine.

- Clean the mating surfaces of the exhaust elbow (21). Position a new gasket (20) and the exhaust elbow (21) on the turbocharger (1). Install the setscrews (22). Tighten the setscrews to a torque of 32 N·m (24 lb ft).

- Install the set screws (15) and install the support bracket for the turbocharger (16). Tighten the setscrews to a torque of 25 N·m (18 lb ft).

- Ensure that the inlet hose (5) is clean and free from defects or restrictions. Loosely install the hose clamps (4) to the air inlet hose (5). Install the air inlet hose to the connection of the inlet manifold and to the inlet of the turbocharger. Tighten the hose clamps.

**Note:** Do not use oil or grease in order to install the air inlet hose. In order to install a new air inlet hose, lubricate the connection of the inlet manifold and lubricate the inlet of the turbocharger with a solution of water and 5% soap.

- Position the exhaust pipe onto the exhaust elbow (21). Refer to the OEM information for the correct procedure in order to install the exhaust pipe.

## Exhaust Manifold - Remove and Install

### Removal Procedure

#### NOTICE

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