

Product: ENGINE - MACHINE
Model: C4.4 ENGINE - MACHINE 444
Configuration: C4.4 Industrial Engine 44400001-UP

Disassembly and Assembly C4.4 Industrial Engine

Media Number -KENR6216-02

Publication Date -01/06/2009

Date Updated -02/05/2017

i02930003

Fuel Injection Lines - Install

SMCS - 1252-012

Installation Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
B	276-1216	Injector Pipe Nut Tool	1

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to Systems Operation, Testing and Adjusting Manual, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Note: The following procedure should be adopted in order to install the fuel injection lines when the electronic unit injectors or the fuel manifold have not been removed. If the electronic unit injectors or the fuel manifold have been removed, refer to Disassembly and Assembly, "Electronic

Unit Injector - Install" and Disassembly and Assembly, "Fuel Manifold (Rail) - Remove and Install" for more information.

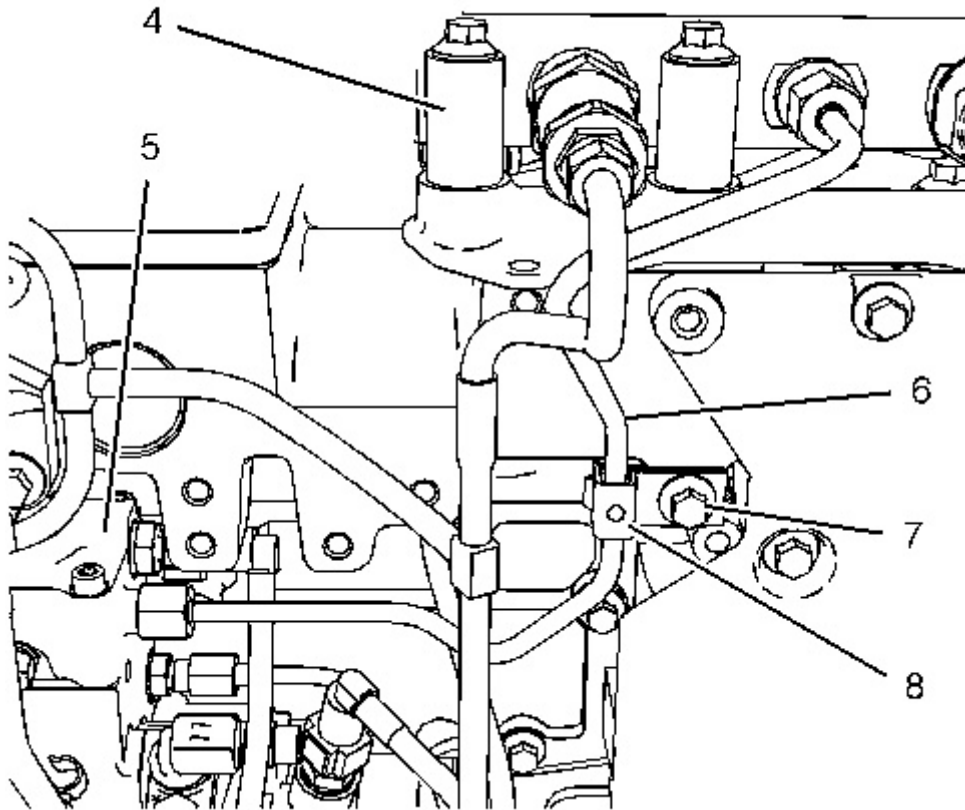


Illustration 1
Typical example

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1. Remove the caps from the port in fuel injection pump (5) and from the appropriate port in fuel manifold (4). Remove the caps from the new fuel injection line (6).
2. Loosely connect the nuts at both ends of fuel injection line (6), to fuel manifold (4) and to fuel injection pump (5). Ensure that the ends of the fuel injection line are correctly seated in the fuel injection pump and in the fuel manifold.
3. Use Tooling (B) to tighten the nuts on fuel injection line (6) to a torque of 30 N·m (22 lb ft).
4. Install bolt (7) to clip (8). Tighten bolt (7) to a torque of 22 N·m (16 lb ft).

Ensure that fuel injection line does not contact any other engine component.

5. Install the electronic control module. Refer to Disassembly and Assembly, "Electronic Control Module - Remove and Install".
6. If necessary, install the crankcase breather. Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".

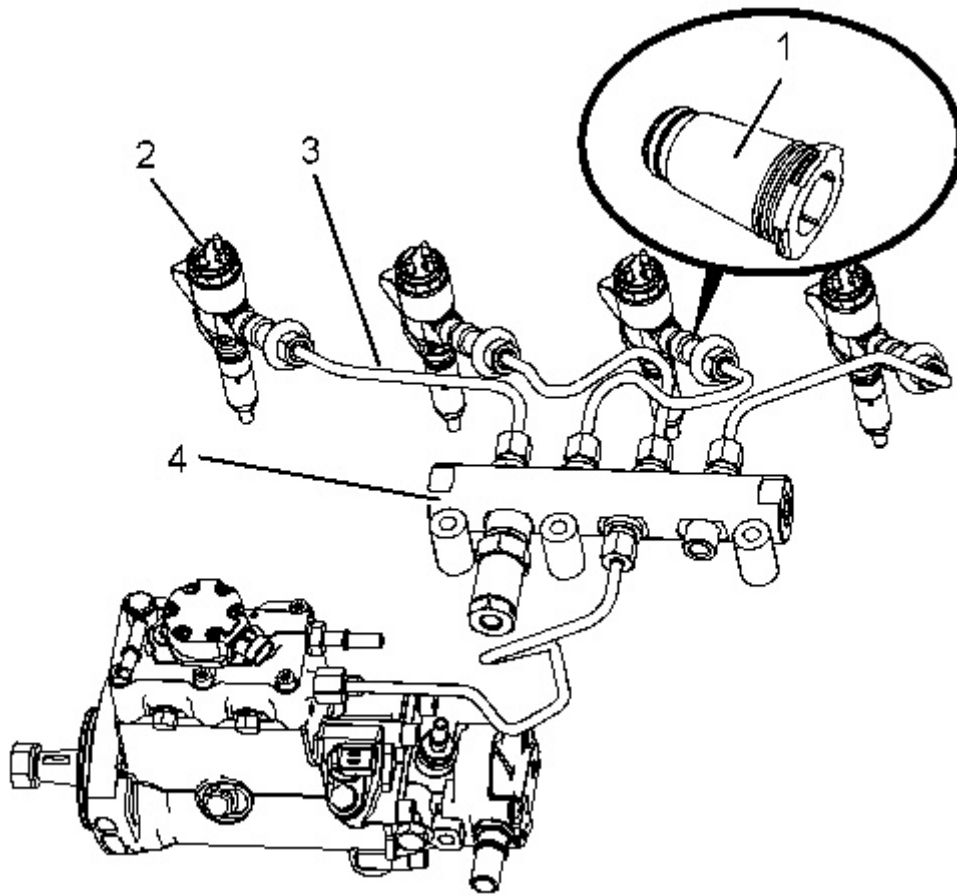


Illustration 2
Typical example

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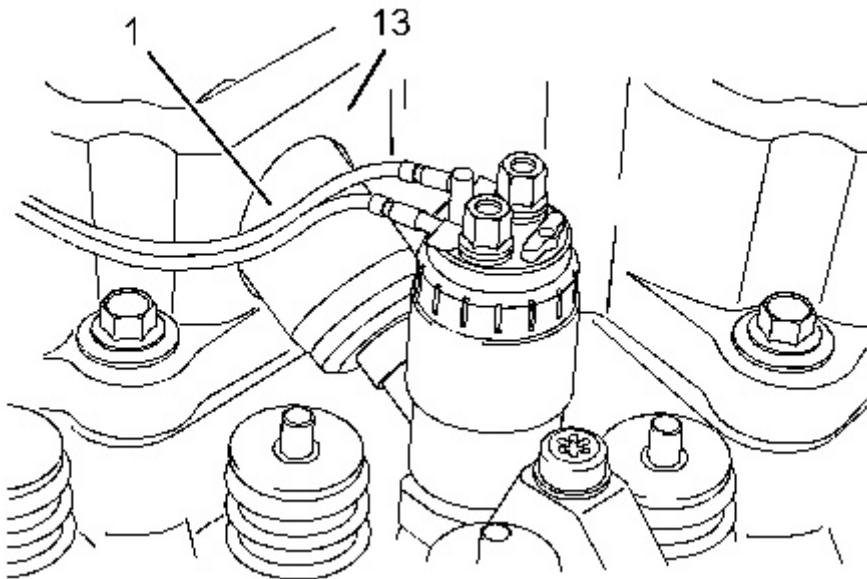


Illustration 3
Typical example
The valve mechanism cover is not shown for clarity.

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7. Install a new seal (1) to electronic unit injector (2) and to valve mechanism cover base (13).

Note: Ensure that the flange on the seal is flush with the valve mechanism cover base.

8. Remove the caps from the new fuel injection line (3).

Note: Ensure that a dust seal is installed to the fuel injection line. Install the fuel injection line for number one cylinder first. Install the fuel injection lines in numerical order.

9. Remove the caps from electronic unit injector (2) and from the appropriate port in fuel manifold (4).
10. Loosely connect the nuts at both ends of fuel injection line (3), to electronic unit injector (2) and to the appropriate port in fuel manifold (4). Ensure that the ends of the fuel injection line are correctly seated in the electronic unit injector and in the fuel manifold.
11. Use Tooling (B) to tighten the nuts on fuel injection line (3) to a torque of 30 N·m (22 lb ft). Ensure that the dust seal is seated correctly against seal (1).

12. Follow Step 7 through Step 11 in order to install the remaining fuel injection lines.

Note: Ensure that fuel injection lines do not contact any other engine component.

13. Turn the fuel supply to the ON position.
 14. Turn the battery disconnect switch to the ON position.
 15. Remove the air from the fuel system. Refer to Operations and Maintenance Manual, "Fuel System - Prime".
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Date Updated -02/05/2017

i03458221

Fuel Injection Pump - Remove

SMCS - 1251-011

Removal Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A ⁽¹⁾	9U-6198	Crankshaft Turning Tool	1
A ⁽²⁾	9U-7336	Housing	1
	5P-7305	Engine Turning Tool	1
B	230-6284	Timing Pin (Camshaft)	1
C	230-6283	Timing Pin (Crankshaft)	1
D	278-4138	Cap Kit	1

⁽¹⁾ Install Tooling to the front pulley.

⁽²⁾ Install Tooling into the aperture for the electric starting motor.

Start By:

- a. Remove the electronic control module. Refer to Disassembly and Assembly, "Electronic Control Module - Remove and Install".
- b. Remove the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".

Note: Either Tooling (A) can be used. Use the Tooling that is most suitable.

 **WARNING**

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to Systems Operation, Testing and Adjusting Manual, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

NOTICE

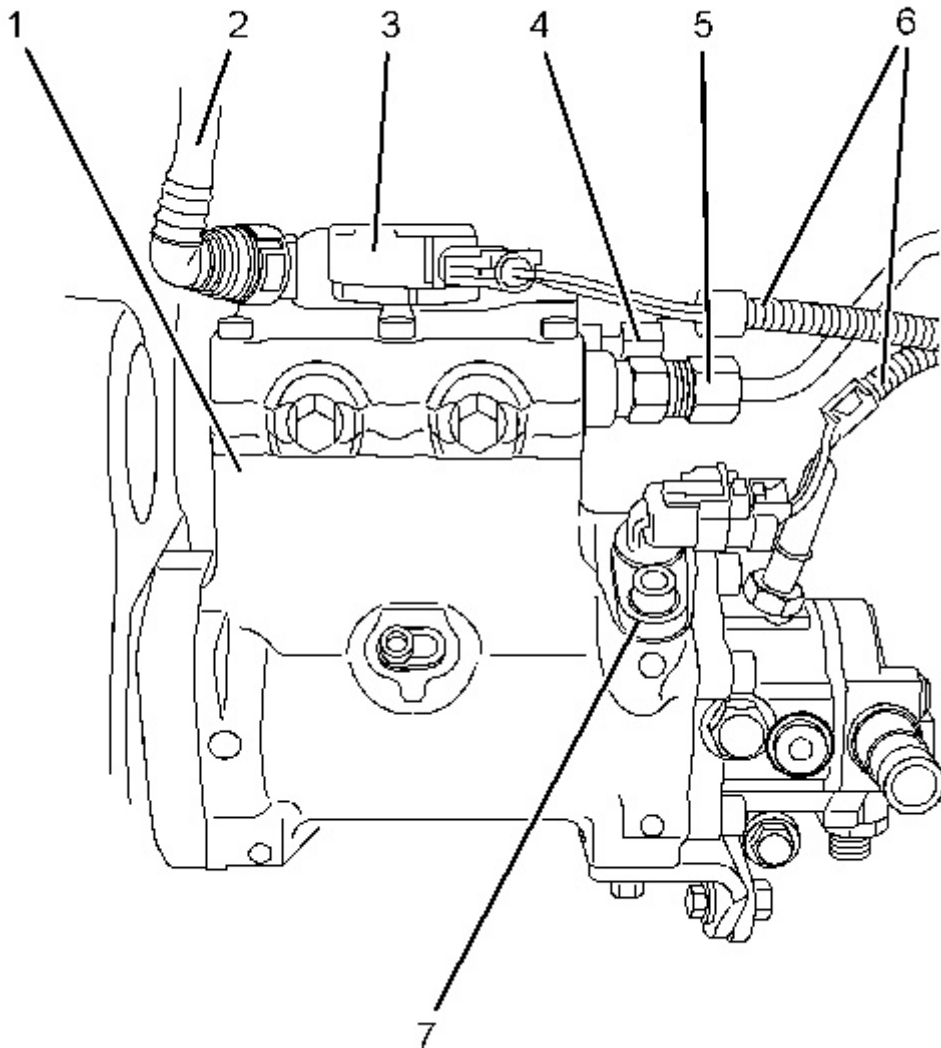
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on wires and on all tube assemblies for installation purposes. Plug all hose assemblies and tube assemblies. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

1. Turn the fuel supply to the OFF position.
2. Turn the battery disconnect switch to the OFF position.
3. If necessary, remove the fuel filter base. Refer to Disassembly and Assembly, "Fuel Filter Base - Remove and Install".

4. If necessary, remove the fuel priming pump. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".
 5. If necessary, remove the crankcase breather. Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".
 6. Use Tooling (A) in order to rotate the crankshaft so that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Centre Position for No.1 Piston".
 7. Use Tooling (B) in order to lock the camshaft in the correct position. Use Tooling (C) in order to lock the crankshaft in the correct position. Refer to Disassembly and Assembly, "Gear Group (Front) - Remove and Install" for the correct procedure.
 8. Remove the backlash from the fuel pump gear. Lock the fuel injection pump in the correct position and remove the fuel pump gear. Refer to Disassembly and Assembly, "Fuel Pump Gear - Remove" for the correct procedure.
-



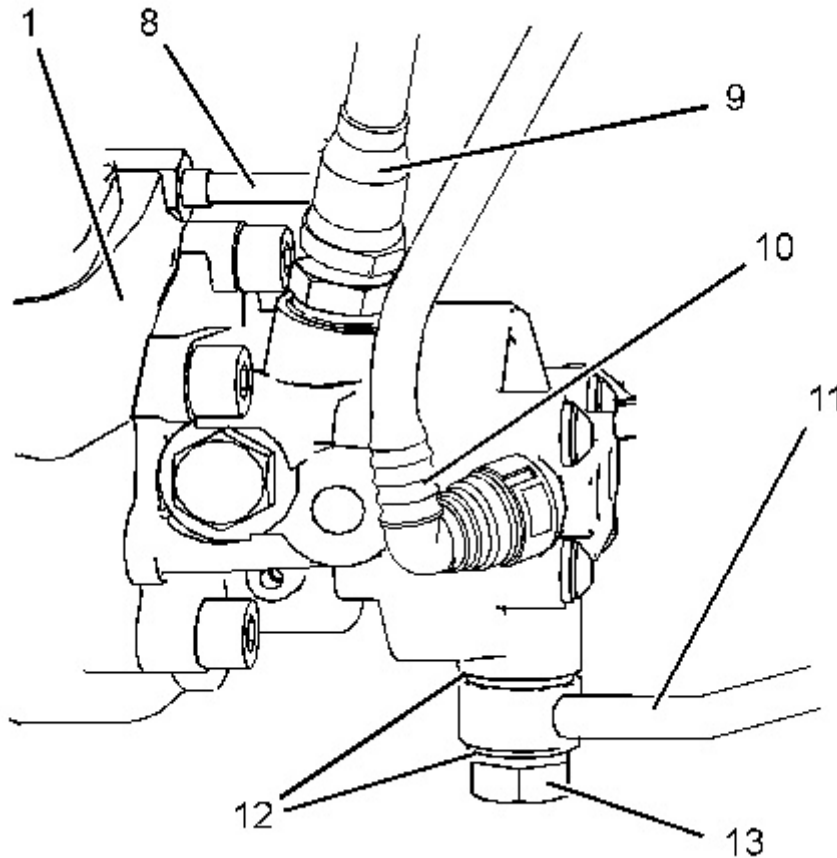


Illustration 2

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Typical example

9. Disconnect plastic tube assembly (2) from fuel injection pump (1).
10. Disconnect harness assembly (6) from solenoid (3). Slide the locking tab into the unlocked position and disconnect harness assembly (6) from position sensor (7).

Note: The harness assembly should be positioned in order to avoid an obstruction to the fuel injection pump.

11. Disconnect plastic tube assembly (10) from fuel injection pump (1).
12. Disconnect plastic tube assembly (9) from fuel injection pump (1).
13. Disconnect plastic tube assembly (4) from fuel injection pump (1).
14. Remove banjo bolt (13) and remove sealing washers (12).
15. Plug or cap all open ports and tube assemblies immediately with new plugs or caps.

Note: Ensure that quick fit connections are clean before the tube assemblies are plugged.

16. Remove fuel injection line (5). Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove". Use Tooling (D) in order to plug the open ports in the fuel injection pump and in the fuel manifold. Discard the fuel injection line.
 17. Remove tube assembly (8) for the engine oil supply to the fuel injection pump. Remove the banjo bolt and the sealing washers from the tube assembly.
-

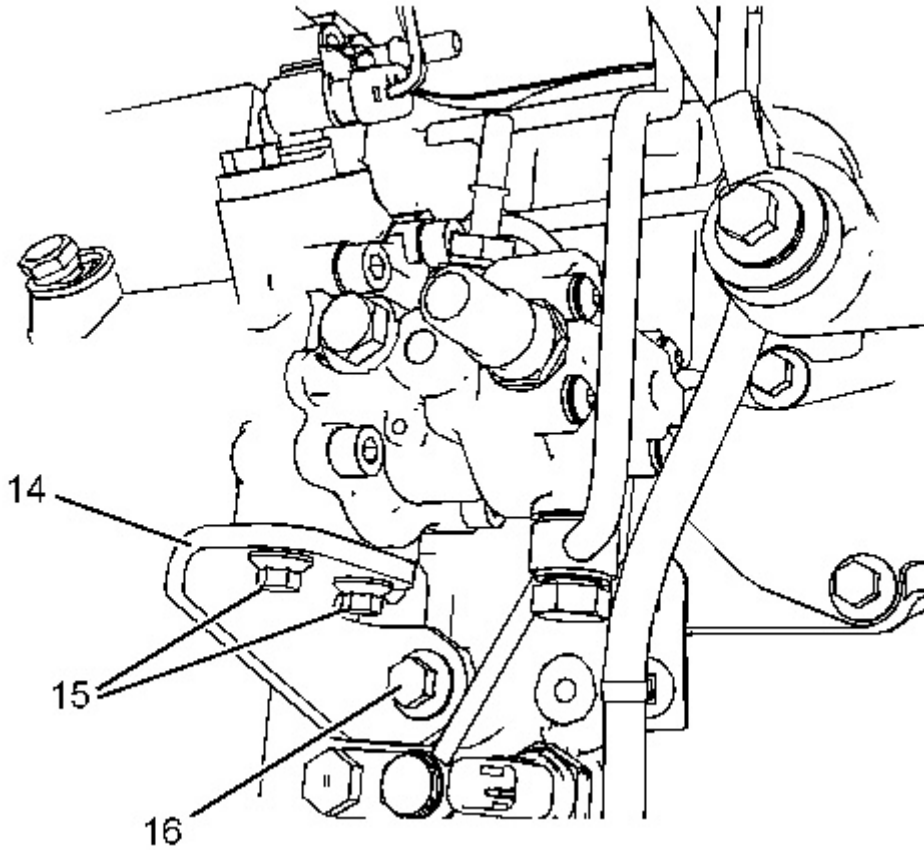


Illustration 3
Typical example

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18. Remove bolts (15) and remove bolt (16). Remove support bracket (14).
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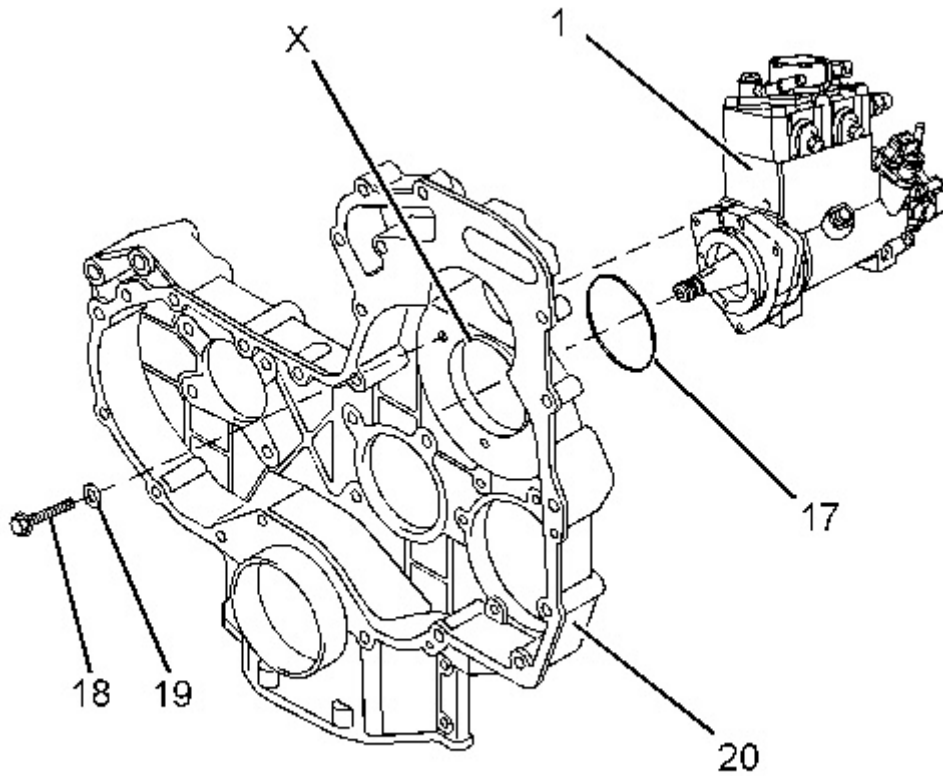


Illustration 4
Typical example

g01801934

19. Remove bolts (18) and remove sealing washers (19).

Note: The fuel injection pump should be supported by hand as the bolts are removed.

20. Carefully remove fuel injection pump (1) from front housing (20). Ensure that Bore (X) in the front housing is not damaged as the fuel injection pump is removed.

21. Remove O-ring seal (17) from fuel injection pump (1).

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Publication Date -01/06/2009

Date Updated -02/05/2017

i03502184

Fuel Injection Pump - Install

SMCS - 1251-012

Installation Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A ⁽¹⁾	9U-6198	Crankshaft Turning Tool	1
A ⁽²⁾	9U-7336	Housing	1
	5P-7305	Engine Turning Tool	1
B	230-6284	Timing Pin (Camshaft)	1
C	230-6283	Timing Pin (Crankshaft)	1
E	338-1054	Timing Tool (Fuel Injection Pump)	1
F	1U-6396	O-ring Assembly Compound	1

⁽¹⁾ The Crankshaft Turning Tool is used on the front pulley.

⁽²⁾ This Tool is used in the aperture for the electric starting motor.

Note: Either Tooling (A) can be used. Use the Tooling that is most suitable.

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to Systems Operation, Testing and Adjusting Manual, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

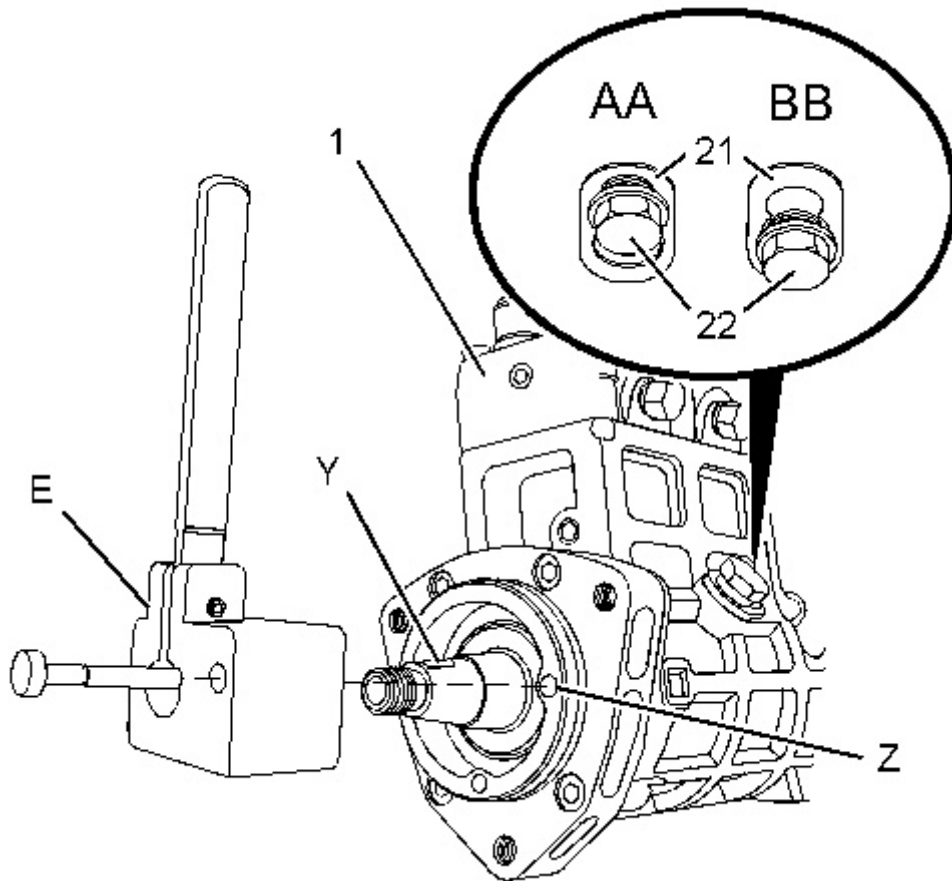


Illustration 1
Typical example

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Note: A new fuel injection pump is supplied, locked in the correct position. Do not unlock the fuel injection pump before installation.

1. If the fuel injection pump timing has been lost, it is possible to reset the fuel injection pump timing. Follow Step 1.a through Step 1.e in order to reset the fuel injection pump timing.
 - a. Loosen locking screw (22) and slide spacer (21) to Position (AA). Tighten locking screw (22) to a torque of 9 N·m (80 lb in). This will prevent the locking screw from tightening against the shaft of the fuel injection pump.

The fuel injection pump is now unlocked.

- b. Position Tooling (E) onto the shaft of fuel injection pump (1). Align the lever of Tooling (E) with Keyway (Y) and engage the lever into the keyway.

Note: The lever of Tooling (E) should be a close fit in the keyway. If the lever is a loose fit in the keyway, it is not possible to reset the fuel injection pump timing.

- c. Rotate the shaft of the fuel injection pump and engage the pin of Tooling (E) into Hole (Z).

The fuel injection pump timing is now set in the correct position.

- d. Loosen locking screw (22) and slide spacer (21) to Position (BB). Tighten locking screw (22) to a torque of 9 N·m (80 lb in). The locking screw is now tightened against the shaft of the fuel injection pump.

The fuel injection pump is now locked.

- e. Remove Tooling (E).

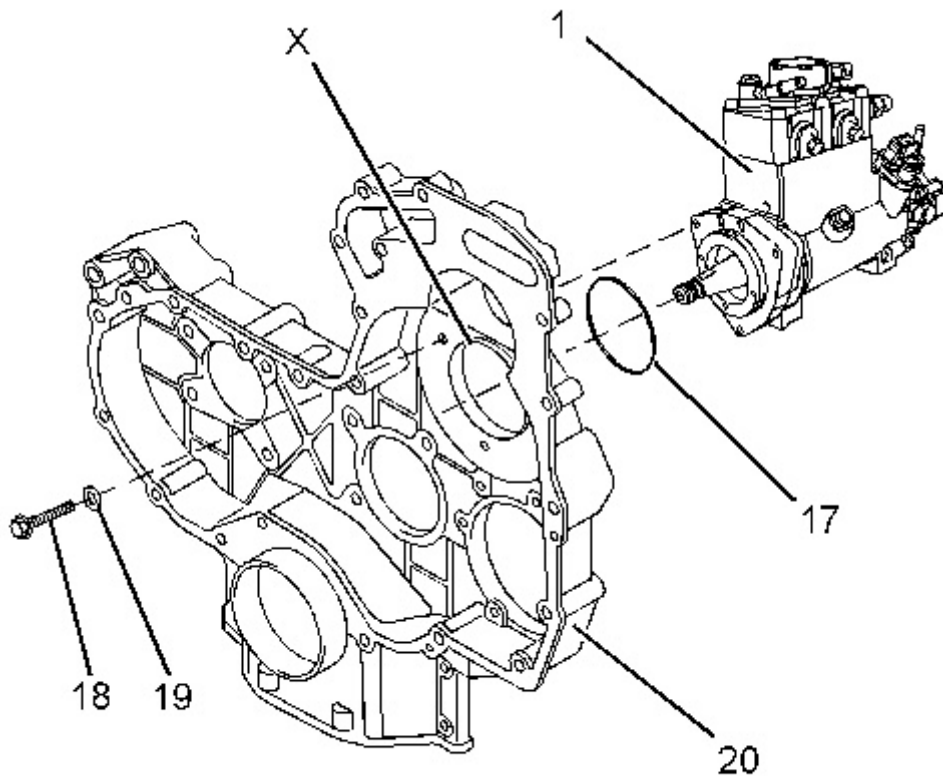


Illustration 2

g01801934

Typical example

2. Inspect Bore (X) in front housing (20) for damage. If the bore is damaged, replace the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove" and Disassembly and Assembly, "Housing (Front) - Install".

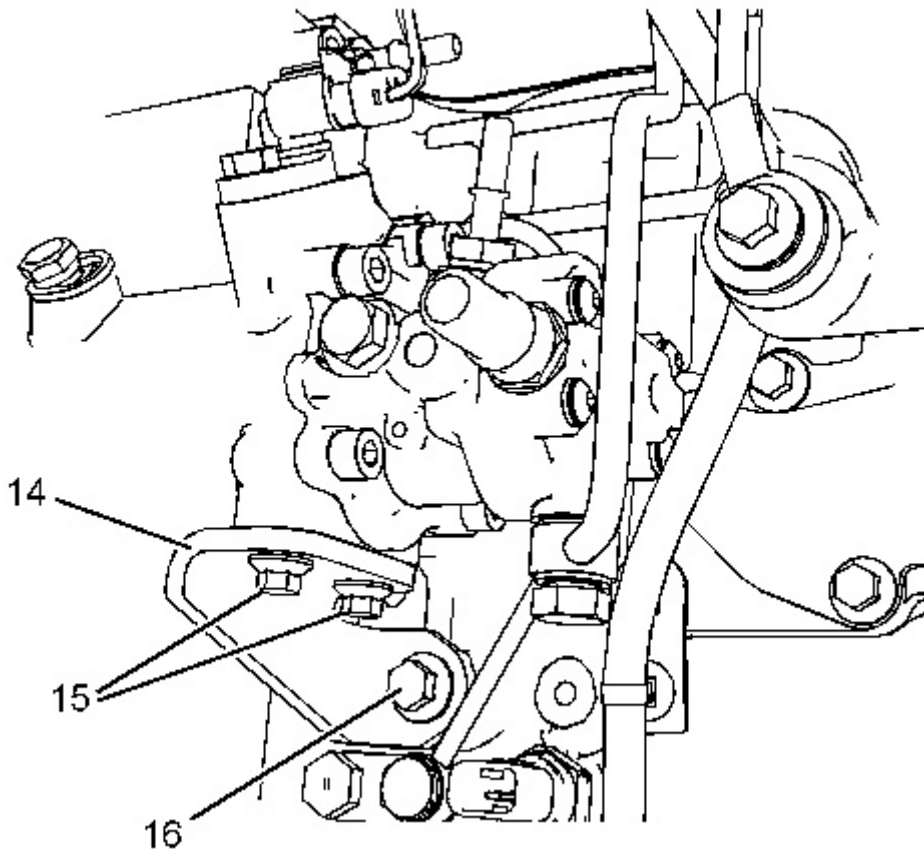
3. Use Tooling (F) to lubricate a new O-ring seal (17). Install the O-ring seal onto fuel injection pump (1).
4. Align fuel injection pump (1) with front housing (20). Carefully install the fuel injection pump to the front housing.

Note: The fuel injection pump should be supported by hand until the bolts are installed.

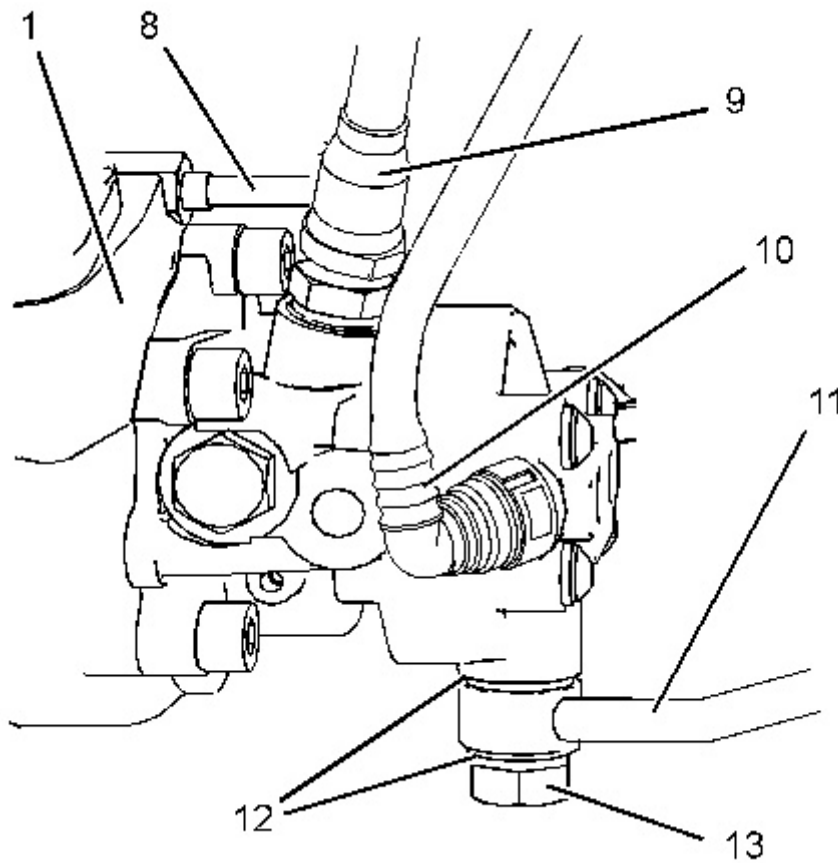
5. Install bolts (18) and new sealing washers (19). Tighten the bolts to a torque of 25 N·m (18 lb ft).
6. If necessary, use Tooling (A) in order to rotate the crankshaft so that number one piston is at top dead center on the compression stroke. Refer to System Operation, Testing and Adjusting, "Finding Top Centre Position for No.1 Piston".
7. Use Tooling (B) in order to lock the camshaft in the correct position. Use Tooling (C) in order to lock the crankshaft in the correct position. Refer to Disassembly and Assembly, "Gear Group (Front) - Remove and Install" for the correct procedure.
8. Install the fuel injection pump gear to the fuel injection pump. Refer to Disassembly and Assembly, "Fuel Injection Pump Gear - Install" and refer to Disassembly and Assembly, "Gear Group (Front) - Install".

Note: Ensure that the fuel injection pump is unlocked after the installation of fuel injection pump gear is completed.

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



10. Position support bracket (14) and install bolts (15) finger tight. Install bolt (16) finger tight.
11. Tighten bolt (16) to a torque of 44 N·m (32.5 lb ft). Tighten bolts (15) to a torque of 22 N·m (16 lb ft).



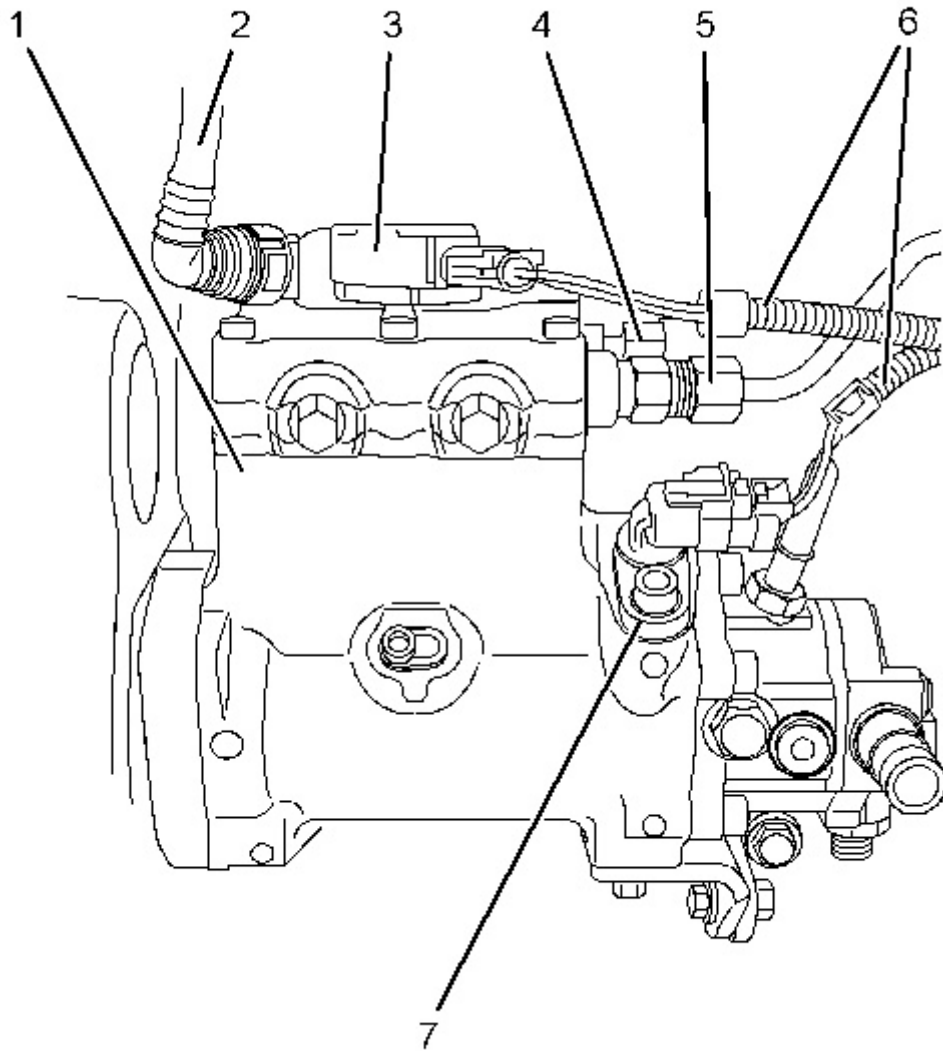


Illustration 5

g01563275

Typical example

12. Install the banjo bolt and new sealing washers to tube assembly (8). Install tube assembly (8) for the oil feed to the fuel injection pump. Tighten the banjo bolt and the nut to a torque of 15 N·m (11 lb ft).
13. Install a new fuel injection line (5). Refer to Disassembly and Assembly, "Fuel Injection Lines - Install".
14. Install new sealing washers (12) and banjo bolt (13) to tube assembly (11). Tighten the banjo bolt to a torque of 21 N·m (15 lb ft).
15. Connect plastic tube assembly (4) to fuel injection pump (1).
16. Connect plastic tube assembly (9) to fuel injection pump (1).
17. Connect plastic tube assembly (10) to fuel injection pump (1).

18. Connect harness assembly (6) to solenoid (3). Connect harness assembly (6) to position sensor (7). Slide the locking tab into the locked position.
 19. Connect plastic tube assembly (2) to fuel injection pump (1).
 20. If necessary, install the crankcase breather. Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".
 21. If necessary, install the fuel priming pump. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".
 22. If necessary, install the fuel filter base. Refer to Disassembly and Assembly, "Fuel Filter Base - Remove and Install".
 23. Turn the battery disconnect switch to the ON position.
 24. Turn the fuel supply to the ON position.
 25. Remove the air from the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime" for more information.
-

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Media Number -KENR6216-02

Publication Date -01/06/2009

Date Updated -02/05/2017

i02930008

Fuel Injection Pump Gear - Remove

SMCS - 1251-011

Removal Procedure

Table 1

Required Tools			
Tool	Part Number	Part Descriptions	Qty
A ⁽¹⁾	9U-6198	Crankshaft Turning Tool	1
A ⁽²⁾	9U-7336	Housing	1
	5P-7305	Engine Turning Tool	1
B	230-6284	Timing Pin (Camshaft)	1
C	230-6283	Timing Pin (Crankshaft)	1
D	1P-2320	Combination Puller	1

⁽¹⁾ The Crankshaft Turning Tool is used on the front pulley.

⁽²⁾ This Tool is used in the aperture for the electric starting motor.

Start By:

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

Note: Either Tooling (A) can be used. Use the Tooling that is most suitable.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

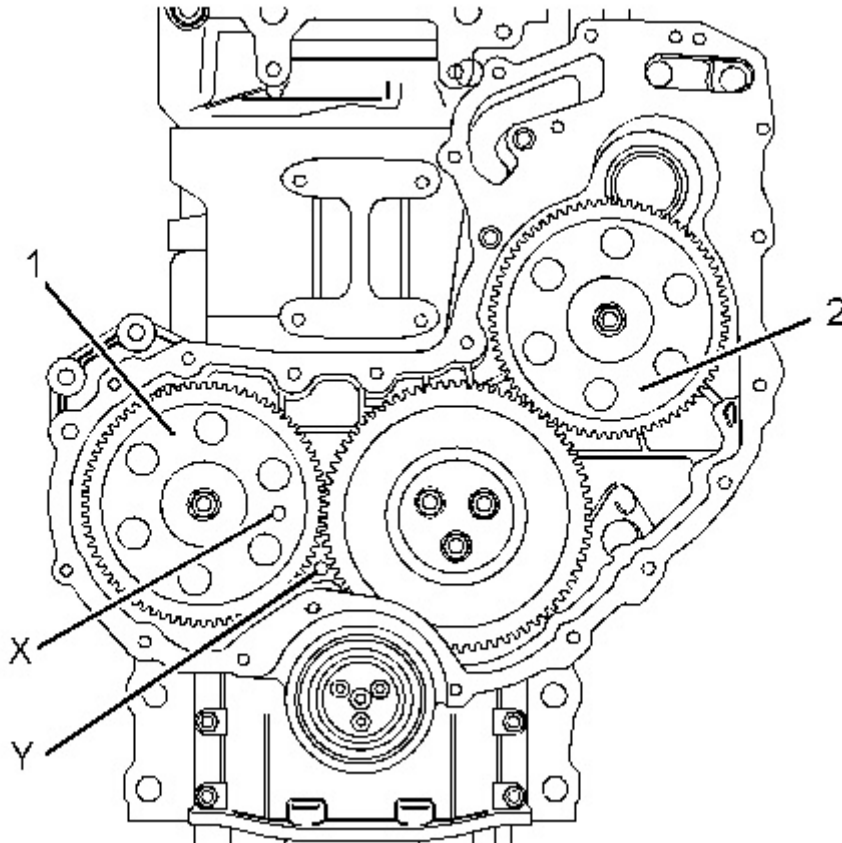
NOTICE

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: Care must be taken in order to ensure that the fuel injection pump timing is not lost during the removal of the fuel pump gear. Carefully follow the procedure in order to remove the fuel pump gear.

1. Use Tooling (A) in order to rotate the crankshaft so that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Centre Position for No.1 Piston".
-



Typical example

2. Install Tooling (B) through Hole (X) in camshaft gear (1) into the front housing. Use Tooling (B) in order to lock the camshaft in the correct position.
3. Install Tooling (C) into Hole (Y) in the front housing. Use Tooling (C) in order to lock the crankshaft in the correct position.

Note: Do not use excessive force to install Tooling (C). Do not use Tooling (C) to hold the crankshaft during repairs.

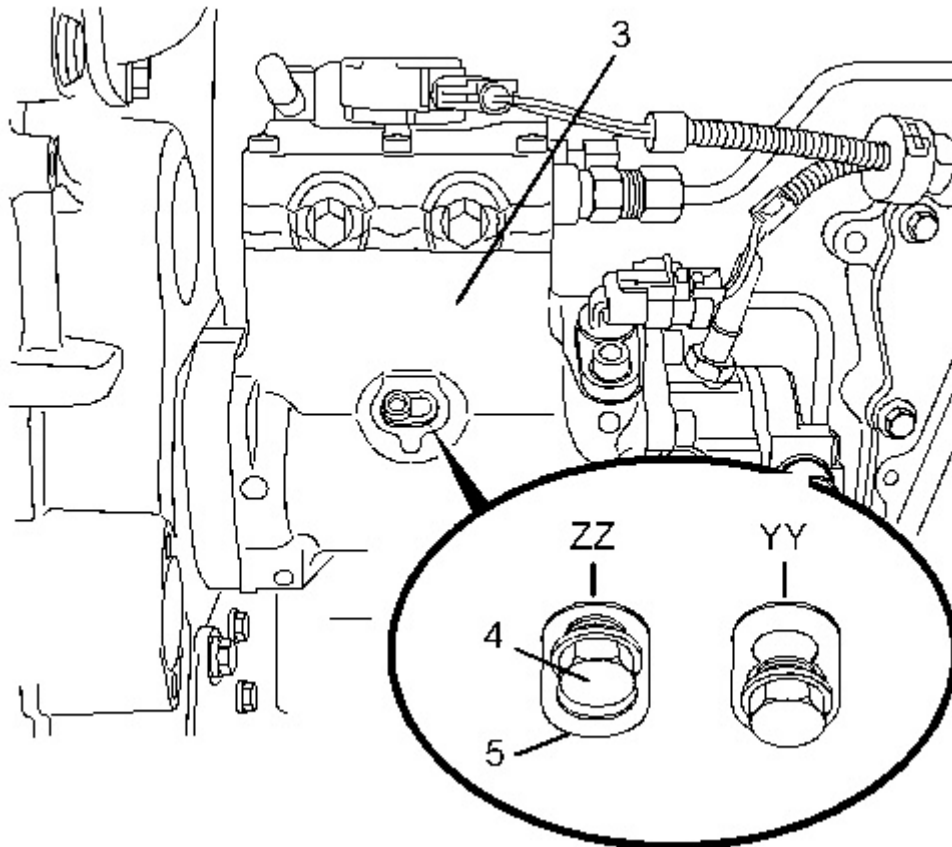


Illustration 2

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Typical example

4. Apply sufficient pressure to fuel injection pump gear (2) in a counterclockwise direction in order to remove the backlash. Lock fuel injection pump (3) in this position.

In order to lock fuel injection pump (3), loosen locking screw (4) in the fuel injection pump. Slide spacer (5) into Position (YY). Tighten locking screw (4) against the shaft of the fuel injection pump to a torque of 9 N·m (80 lb in).

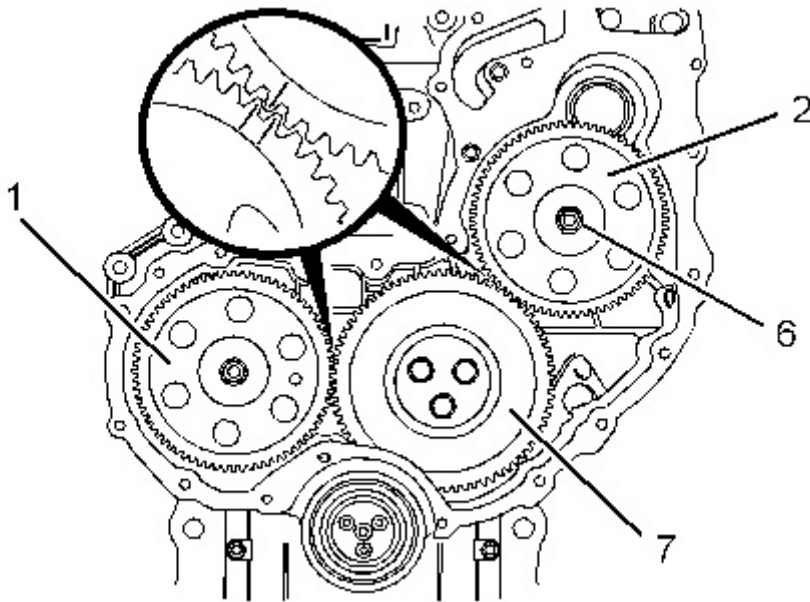


Illustration 3

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Alignment of timing marks

5. Mark gear (1), gear (2) and gear (7) in order to show alignment. Refer to Illustration 3.

Note: Identification will ensure that the gears can be installed in the original alignment.

6. Loosen nut (6) on fuel pump gear (2).

7. Install Tooling (D) through three holes in fuel pump gear (2). Tighten Tooling (D) until the fuel pump gear is released.

8. Remove Tooling (D) from fuel pump gear (2).

9. Remove nut (6) and the washer from fuel pump gear (2). Remove the fuel pump gear.

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i02930007

Fuel Injection Pump Gear - Install

SMCS - 1251-012

Installation Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
B	230-6284	Timing Pin (Camshaft)	1
C	230-6283	Timing Pin (Crankshaft)	1
E	9U-7324	Indicator Bracket	1
	7H-1942	Dial Indicator	1
	3S-3268	Indicator Contact Point	1
	7H-1940	Universal Attachment	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The fuel injection pump must remain locked until the procedure instructs you to unlock the fuel injection pump.

1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".
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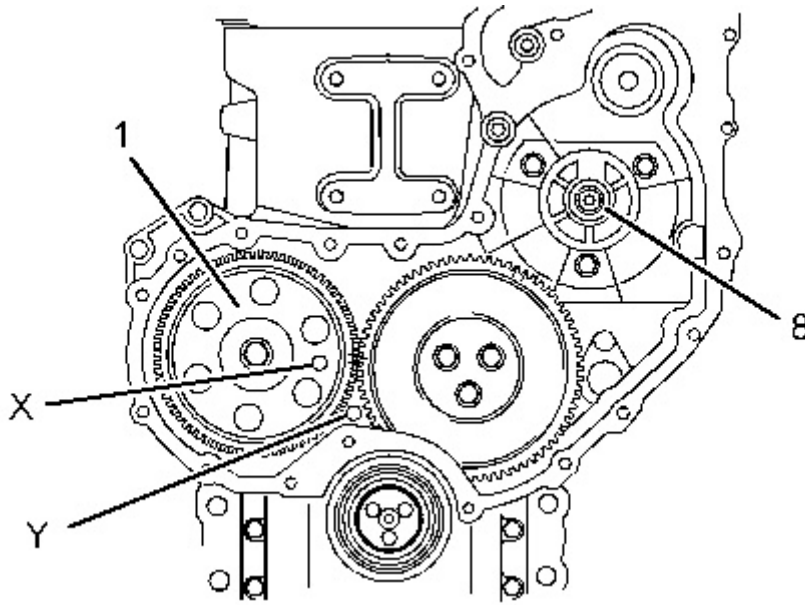


Illustration 1
Typical example

g01765193

2. Ensure that Tooling (C) is installed in Hole (Y) in the front housing. Use Tooling (C) in order to lock the crankshaft in the correct position.
 3. Ensure that Tooling (B) is installed into Hole (X) in camshaft gear (1).
 4. Ensure that shaft (8) on the fuel injection pump is clean, dry and free from damage.
 5. Ensure that the fuel injection pump is locked in the correct position. Refer to Disassembly and Assembly, "Fuel Injection Pump - Install".
 6. Ensure that the fuel pump gear is clean, dry and free from wear or damage. If necessary, replace the fuel pump gear.
-

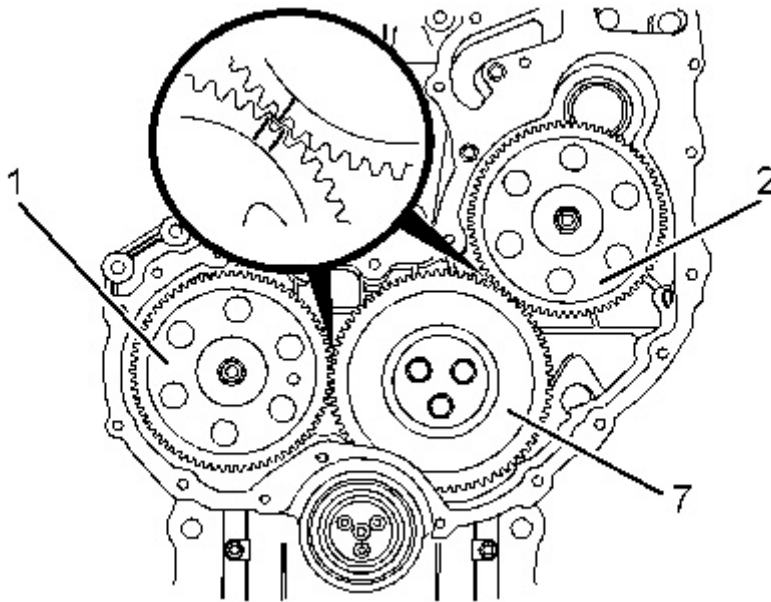


Illustration 2

g01769115

Alignment of timing marks

7. Install fuel pump gear (2) to shaft (8) of the fuel injection pump. Ensure that the timing marks on gear (2) and gear (7) are in alignment and that the mesh of the gears is correct.

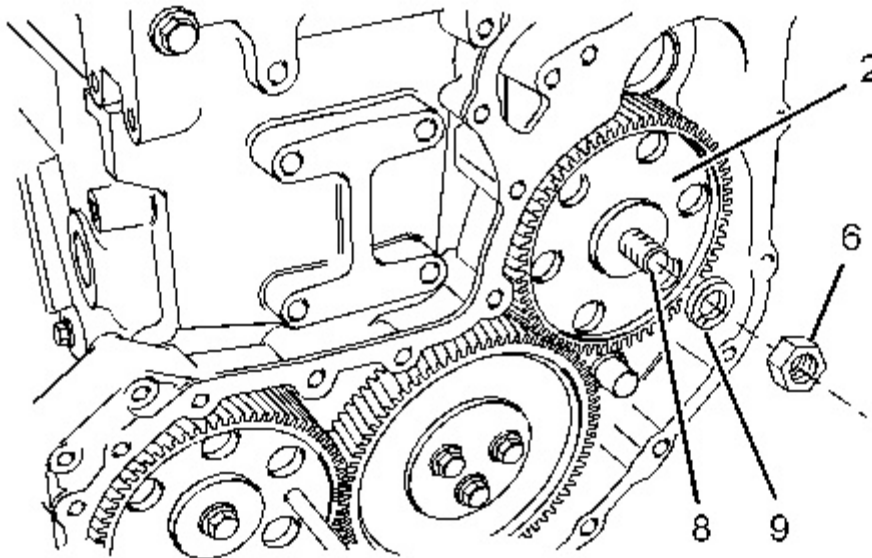


Illustration 3

g01769133

Typical example

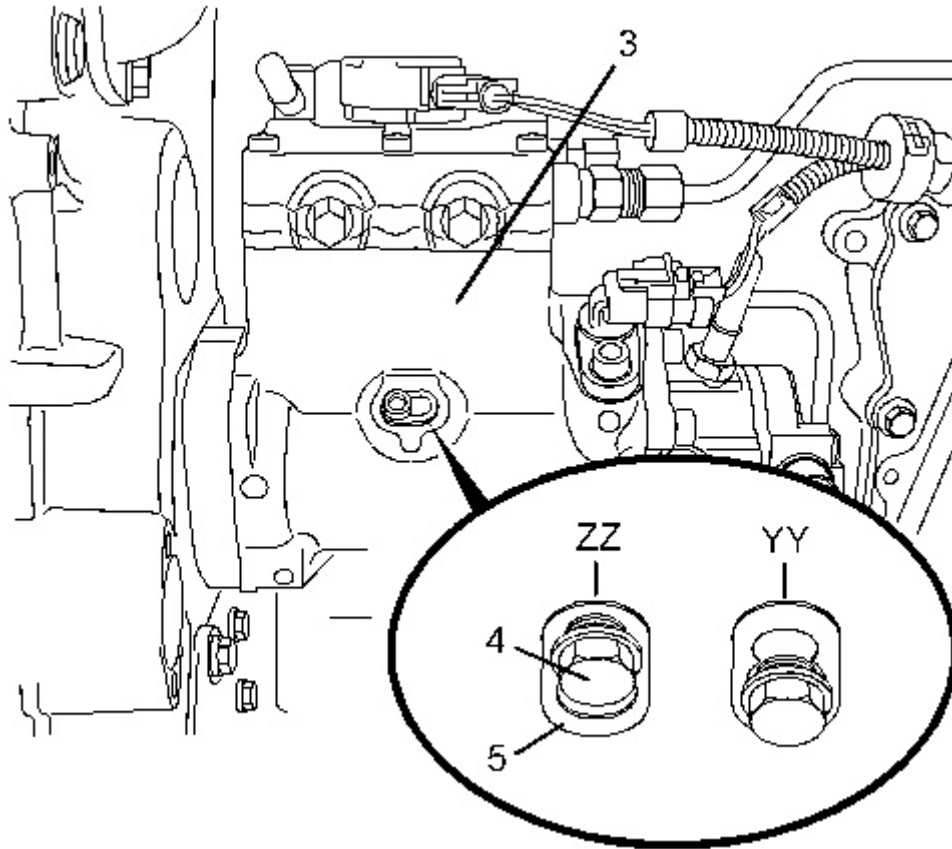


Illustration 4

g01459724

Typical example

8. Install a new spring washer (9) and install nut (6) to shaft (8) of the fuel injection pump. Apply sufficient pressure to fuel injection pump gear (2) in a counterclockwise direction in order to remove the backlash. Tighten nut (6) to a torque of 25 N·m (18 lb ft). Unlock fuel injection pump (3).

In order to unlock the fuel injection pump, loosen locking screw (4) on the fuel injection pump. Slide spacer (5) into position (ZZ). Tighten the locking screw against the spacer to a torque of 9 N·m (80 lb in). This will prevent the locking screw from tightening against the shaft of the fuel injection pump.

9. Remove Tooling (B) and Tooling (C).
10. Tighten nut (6) to a torque of 90 N·m (66 lb ft).
11. Use Tooling (E) to measure the backlash of gears (2) and (7). Ensure that the backlash for the gears is within specified values. Refer to Specifications, "Gear Group (Front)" for further information.
12. Lubricate the teeth of the gears with clean engine oil.

End By:

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

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