

5. Install Tooling (B) to the cylinder block. Refer to Illustration 175.
6. Install Tooling (C) to the cylinder block.
7. Align a new gasket (6) with Tooling (B) and Tooling (C). Install the gasket to the cylinder block.

**Note:** Ensure that Tabs (X) on the gasket are engaged in Holes (Y) in the cylinder block.

8. Install the front housing over Tooling (B) and over Tooling (C) onto the cylinder block.

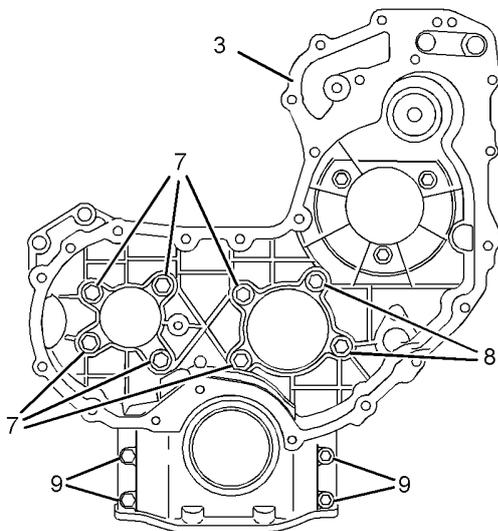


Illustration 177 g01269948

- (7) M8 by 20 mm
- (8) M8 by 35 mm
- (9) M8 by 25 mm

9. Install bolts (9) to front housing (3) finger tight.
10. Remove Tooling (B).
11. Loosely install bolt (7) and bolt (8). Refer to Illustration 177 for the correct position of the bolts.
12. Align the bottom face of front housing (3) to the lower machined face of the cylinder block. Use Tooling (D) and a feeler gauge in order to check the alignment between the front housing and the cylinder block. Refer to Illustration 176. Refer to Specifications, "Front Housing and Covers" for further information.

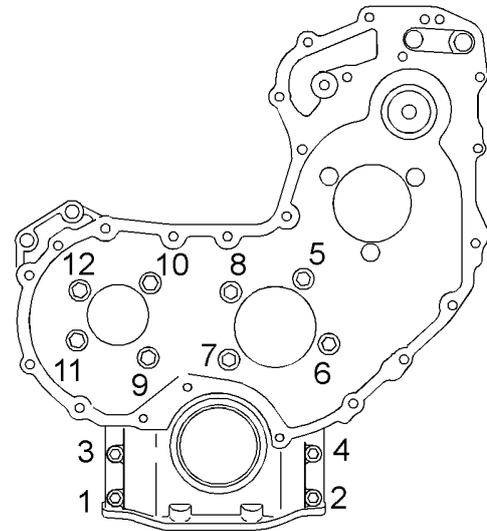


Illustration 178 g01269949

Tightening sequence for the front housing

13. Tighten bolts (7), (8) and (9) to a torque of 28 N·m (20 lb ft). Tighten the bolts in the sequence that is shown in Illustration 178.

**Note:** Ensure that the housing and the cylinder block are correctly aligned.

14. Remove Tooling (C) from the cylinder block.
15. If necessary, install a new crankshaft front seal. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Remove and Install".

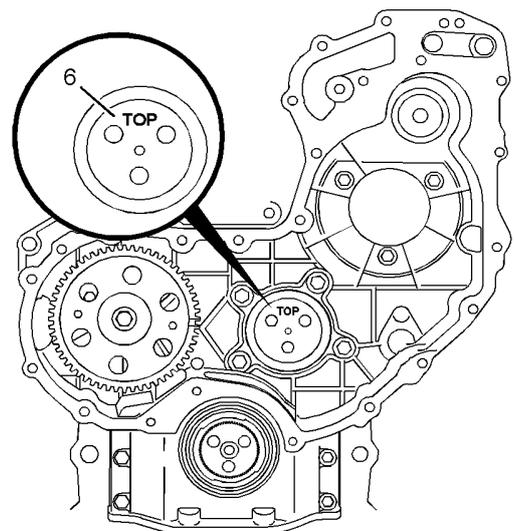


Illustration 179 g01475068

Typical example

i02933583

16. If the engine is equipped with a heavy duty idle gear. Install plate (6). Refer to Disassembly and Assembly, "Idler Gear - Install" for the correct procedure.

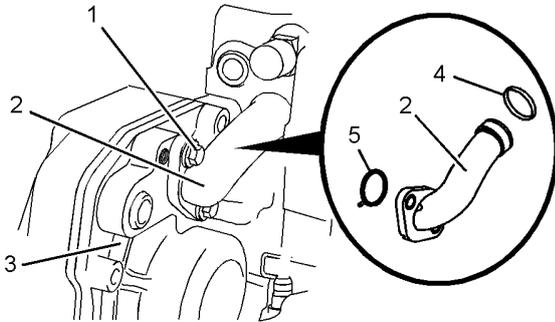


Illustration 180

g01475066

Typical example

17. Install new O-ring seal (4) and O-ring seal (5) to bypass tube (2). Use Tooling (E) in order to lubricate O-ring seal (5). Install bypass tube (2) to front housing (3). Install bolts (1). Tighten the bolts to a torque of 22 N·m (16 lb ft).

**Note:** Ensure that any brackets that are secured by the bolts are installed in the correct location.

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

#### End By:

- a. Install the fuel injection pump. Refer to Disassembly and Assembly, "Fuel Injection Pump - Install".
- b. Install the timing gears. Refer to Disassembly and Assembly, "Gear Group (Front) - Remove and Install".
- c. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
- d. Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
- e. Install the alternator. Refer to Disassembly and Assembly, "Alternator - Install".
- f. Install the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

## Accessory Drive - 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.

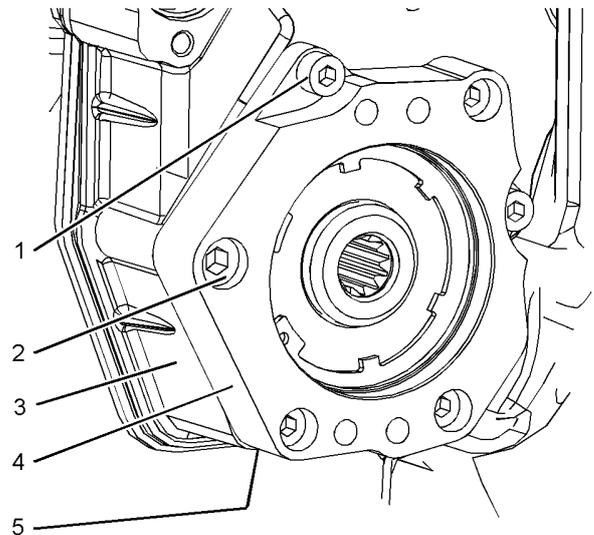


Illustration 181

g01441026

Typical example

1. Remove allen head screw (1) from accessory drive housing (4). Remove allen head screws (2) from accessory drive housing (4).
2. Remove accessory drive housing (4) from front housing (3).
3. Remove O-ring seal (5) (not shown) from accessory drive housing (4).

i02933581

## Accessory Drive - Disassemble

### Disassembly Procedure

Table 46

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Bearing Puller	1
	-	Puller	1
	-	Crossblock	1
	-	Puller Leg	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.

Dispose of all fluids according to local regulations and mandates.

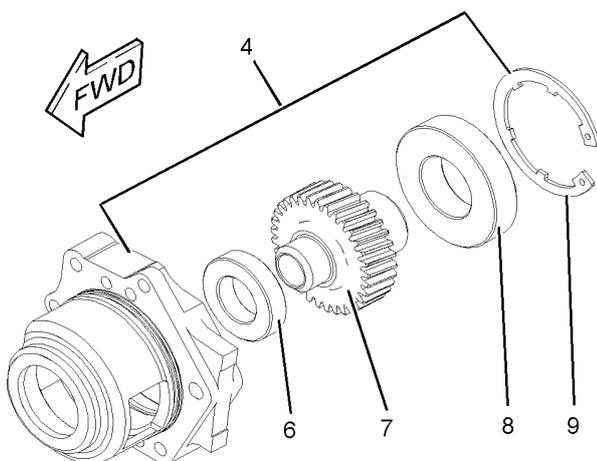


Illustration 182

g01440573

Typical example

1. Remove circlip (9) from accessory drive housing (4).

2. Place accessory drive housing (4) onto a suitable support. Press the assembly of gear (7), bearing (6) and bearing (8) out of accessory drive housing (4).

3. Use a Tooling (A) in order to remove bearing (6) and bearing (8) from gear (7).

i02933580

## Accessory Drive - Assemble

### Assembly Procedure

Table 47

Required Tools			
Tool	Part Number	Part Description	Qty
B	21820603	POWERPART Retainer	1

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

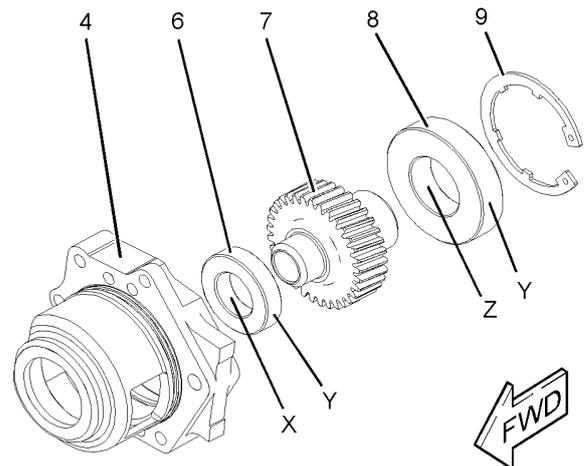


Illustration 183

g01440577

Typical example

1. Inspect the condition of the teeth and the splines of gear (7) for wear or damage. Inspect bearing (6) and bearing (8). Inspect circlip (9), and front housing (4) for wear or damage. Replace any components that are worn or damaged.

2. Apply a small continuous bead of Tooling (B) to inner Surface (X) of bearing (6). Place the gear shaft on a suitable support. Press on the inner race of bearing (6) until bearing (6) is against the shoulder of gear (7). Remove any excess sealant.
3. Apply a small continuous bead of Tooling (B) to inner Surface (Z) of bearing (8). Place the inner race of bearing (8) onto a suitable support. Press the shaft of gear (7) onto bearing (8) until the shoulder of the gear is against the bearing. Remove any excess sealant.
4. Apply a small continuous bead of Tooling (B) to outer Surface (Y) of bearing (6) and bearing (8). Place accessory drive housing (4) on a suitable support. Press the assembly of the gear into the accessory drive housing. Ensure that bearing (6) is against the front face of the recess in accessory drive housing (4). Remove any excess sealant.
5. Install circlip (9) into the groove in accessory drive housing (4). Ensure that circlip (9) is correctly positioned in the groove.

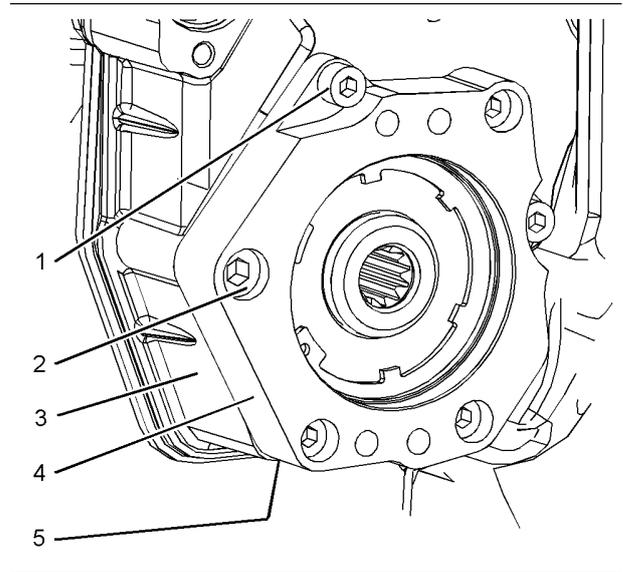


Illustration 184

g01441026

Typical example

i02933582

## Accessory Drive - Install

### Installation Procedure

Table 48

Required Tools			
Tool	Part Number	Part Description	Qty
C	21820221	POWERPART Rubber Lubricant	1
D	21820117	POWERPART Threadlock and Nutlock	1

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

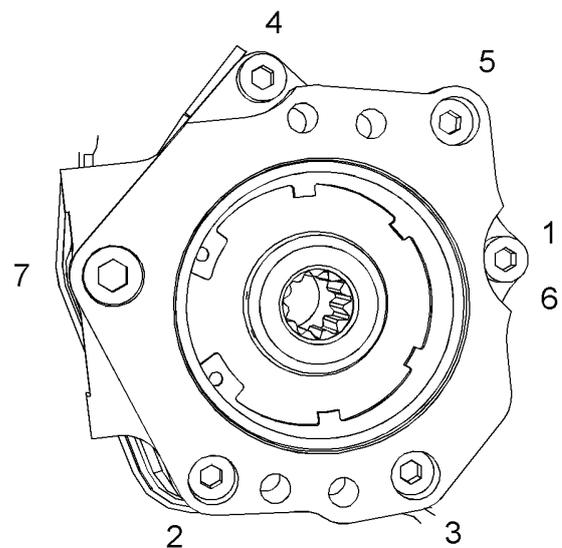


Illustration 185

g01444555

Sequence for tightening accessory drive

1. Inspect the bore in front housing (3) for damage. If necessary, replace the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove" and Disassembly and Assembly, "Housing (Front) - Install".
2. Lightly lubricate a new O-ring seal (5) (not shown) with Tooling (C). Install the O-ring seal (not shown) into the groove in accessory drive housing (4).
3. Lightly lubricate all bearings, and all gears with clean engine lubricating oil. Install the assembly of the accessory drive to the front housing. Ensure that the flange on the accessory drive housing is flush with the front housing.

4. Apply Tooling (D) to allen head screws (1) and allen head screw (2).
5. Install allen head screws (1) and allen head screw (2) to accessory drive housing (4).
6. Tighten allen head screws (1) to a torque of 22 N·m (16 lb ft).

Tighten allen head screw (2) to a torque of 44 N·m (32 lb ft). Tighten allen head screws (1) and (2) in the sequence that is shown in Illustration 185.

7. Ensure that there is tactile backlash between the idler gear and the accessory drive gear.

i02933599

## Crankcase Breather - Remove and Install (Filtered Breather)

### Removal Procedure

#### 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.

#### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

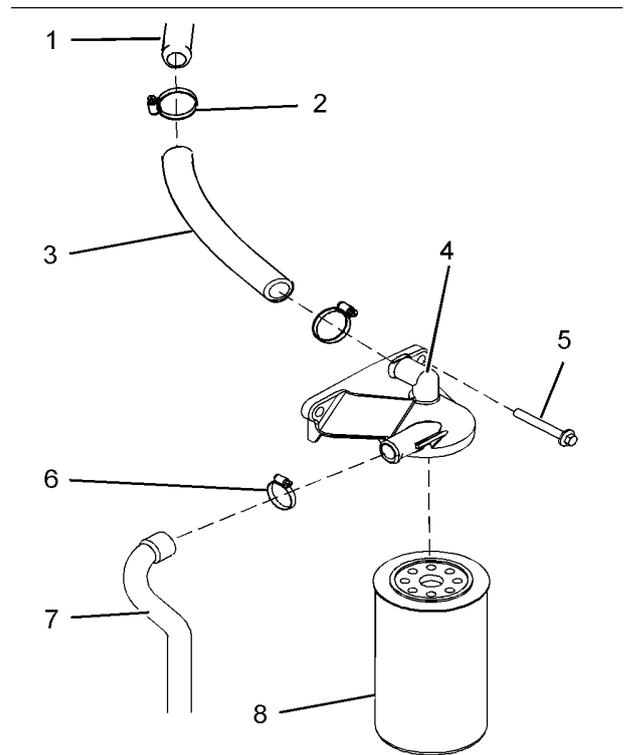


Illustration 186

g01475258

Typical example

1. Remove canister (8). Refer to Operation and Maintenance Manual, "Crankcase Breather (Canister) - Replace".
2. Loosen clamp (6) and remove hose (7).
3. Release spring clamps (2) in order to remove hose (3). Remove the hose from connection (1) on the valve mechanism cover and from filter base (4).
4. Remove bolts (5) and remove filter base (4).

**Note:** If a spacer is installed between the filter base and the engine, remove the spacer.

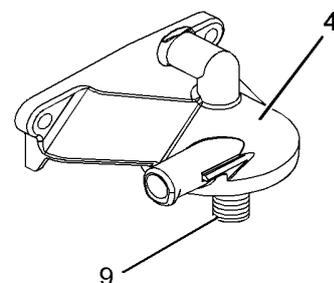


Illustration 187

g01903114

5. If necessary, use a suitable tool in order to remove connection (9) from filter base (4).

## Installation Procedure

Table 49

Required Tools			
Tool	Part Number	Part Description	Qty
A	21820118	Thread Lock Compound	1

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all components of the crankcase breather are clean and free from damage. Replace any components that are damaged.

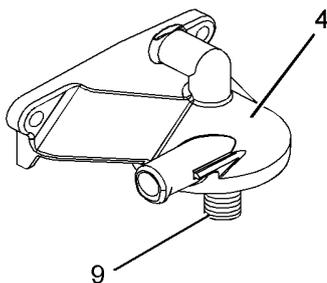


Illustration 188

g01903114

2. If necessary, install connection (9) to filter base (4). Follow Step 2.a through Step 2.c in order to install connection (9) to filter base (4).
- Apply a bead of Tooling (A) to the threads of connection (9).
  - Install connection (9) to filter base (4).
  - Tighten connection (9) to a torque of 50 N·m (37 lb ft).

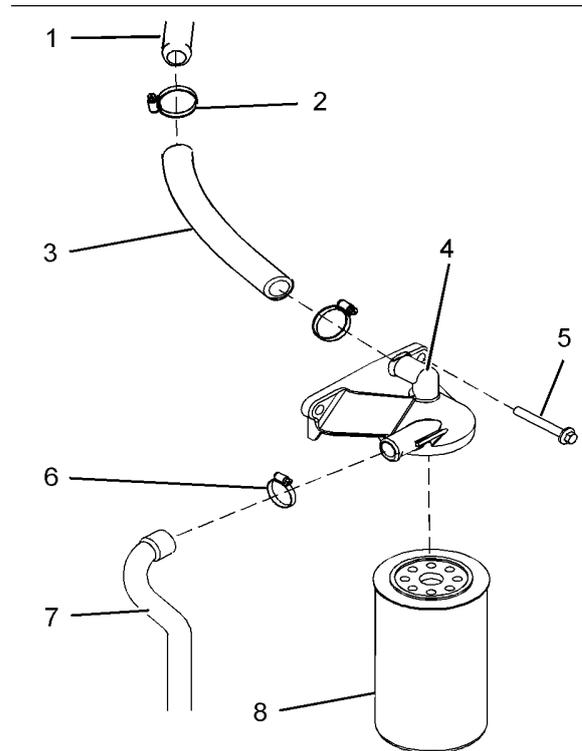


Illustration 189

g01475258

Typical example

3. Install bolts (5) to filter base (4).

**Note:** If spacers are installed, position the spacers over the bolts.

4. Install the assembly of the filter base to the engine.

5. Tighten bolts (5) to a torque of 22 N·m (16 lb ft).

6. Install spring clamps (2) to hose (3). Install hose (3) to connection (1) on the valve mechanism cover and to filter base (4).

**Note:** Ensure that the spring clamps are correctly positioned in order to secure the hose.

7. Install clamp (6) to hose (7). Install hose (7) to filter base (4). Tighten the clamp securely.

8. Install a new canister (8) to filter base (4). Refer to Operation and Maintenance Manual, "Crankcase Breather (Canister) - Replace".

i02933600

## Crankcase Breather - Remove and Install (Unfiltered Breather)

### Removal Procedure

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

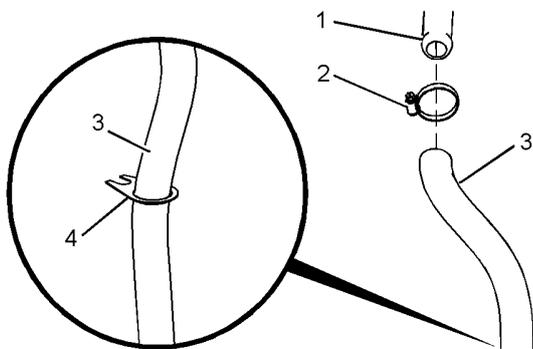


Illustration 190

g01475234

Typical example

1. Loosen clamp (2) and remove hose (3) from connection (1) on the valve mechanism cover. Withdraw hose (3) from clip (4) and remove the hose.

### Installation Procedure

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all components of the crankcase breather are clean and free from damage. Replace any components that are damaged.

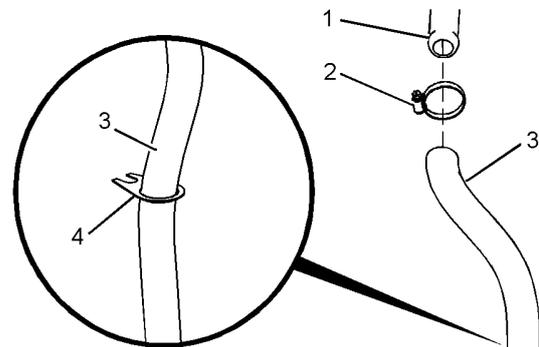


Illustration 191

g01475234

Typical example

2. Connect hose (3) to connection (1) on the valve mechanism cover. Tighten clamp (2). Install hose (3) into clip (4).

i02933677

## Valve Mechanism Cover - Remove and Install

### Removal Procedure

**Start By:**

- a. Disconnect the crankcase breather or remove the crankcase breather. Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

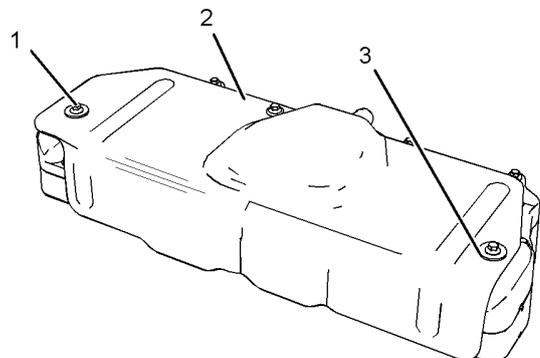


Illustration 192

g01788614

1. If the valve mechanism cover is equipped with a heat shield, remove bolts (1) and washers (3) from heat shield (2).

**Note:** The washers are two different sizes. Note the position of the washers for installation purposes.

2. Remove heat shield (2).

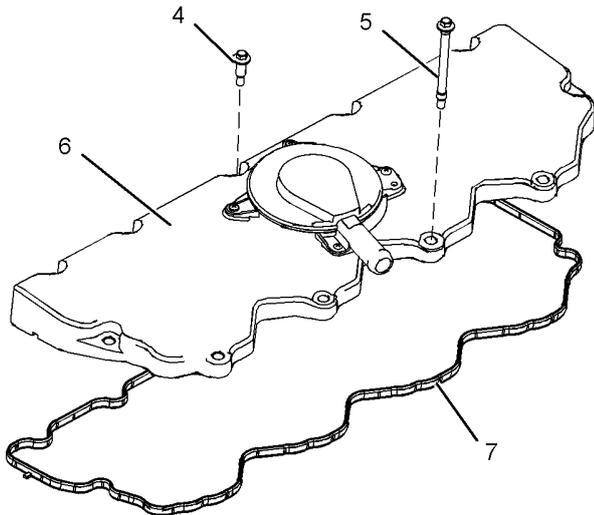


Illustration 193

g01788720

Typical example

3. Remove bolts (4) and bolts (5) from valve mechanism cover (6).
4. Remove valve mechanism cover (6) from the valve mechanism cover base.
5. Remove gasket (7) from valve mechanism cover (6).

## Installation Procedure

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the valve mechanism cover. Clean the faces of the valve mechanism cover base.

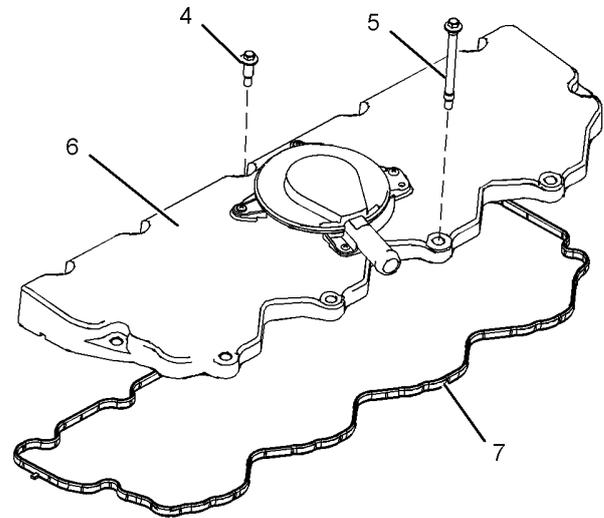


Illustration 194

g01788720

Typical example

2. Install a new gasket (7) to valve mechanism cover (6).

**Note:** Ensure that the gasket is fully seated into the groove of the valve mechanism cover.

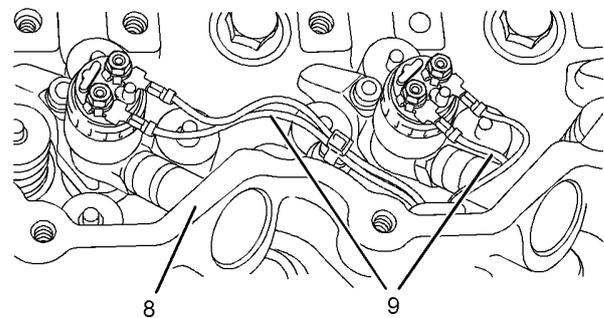


Illustration 195

g01788815

Typical example

3. Ensure that harness assemblies (9) are not in contact with the rocker arms or in contact with the valve mechanism cover base. Position valve mechanism cover (6) onto valve mechanism cover base (8). Ensure that harness assemblies (9) are not trapped during the assembly procedure. Install bolts (4) and bolts (5).

i02933678

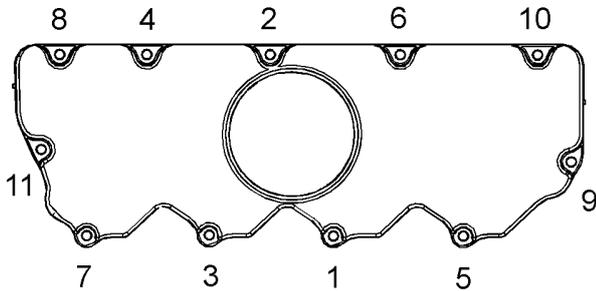


Illustration 196  
Tightening sequence for the valve mechanism cover

4. Tighten bolts (4) and bolts (5) in the numerical sequence that is shown in Illustration 196. Tighten the bolts to a torque of 6 N·m (53 lb in).

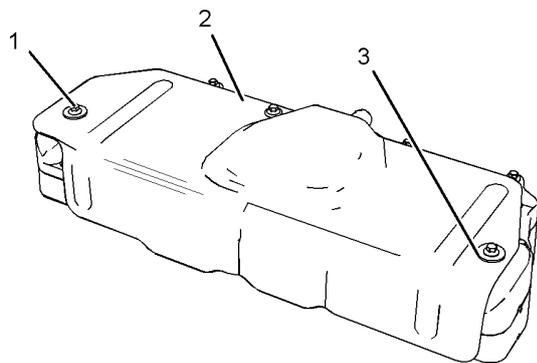


Illustration 197

5. If necessary, position heat shield (2) onto the valve mechanism cover.
6. Install bolts (1) and washers (3). Tighten the bolts to a torque of 9 N·m (80 lb in).

**End By:**

- a. Connect the crankcase breather or install the crankcase breather. Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".

## Valve Mechanism Cover Base - Remove and Install

### Removal Procedure

Table 50

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Circlip Pliers	1

**Start By:**

- a. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".
- b. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove".

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

**NOTICE**

Use a deep socket in order to remove the electrical connections from the electronic unit injectors. Use of incorrect tooling will result in damage to the electronic unit injectors.

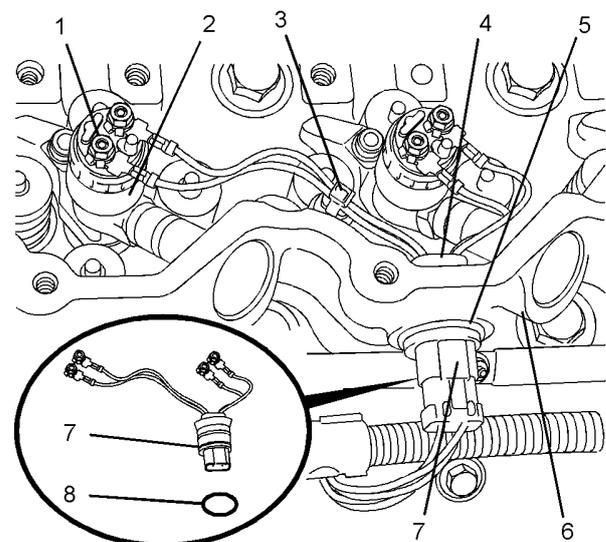


Illustration 198  
Typical example

g01476212

1. Make a temporary identification mark on connections (1).
2. Use a deep socket to remove connections (1) from electronic unit injectors (2).
3. Disconnect plugs (7) from harness assemblies (4).
4. If necessary, follow Step 4.a through Step 4.e in order to remove harness assemblies (4) from valve mechanism cover base (6).
  - a. Cut cable strap (3).
  - b. Use Tooling (A) to remove circlip (5).
  - c. From the outside of valve mechanism cover base (6), push harness assembly (4) inward. Withdraw the harness assembly from valve mechanism cover base (6).
  - d. Remove O-ring seal (8) from harness assembly (4).
  - e. Repeat Step 4.a through Step 4.d in order to remove the remaining harness assembly.

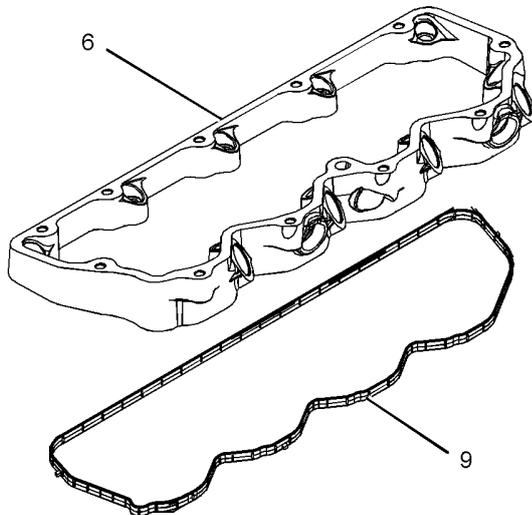


Illustration 199  
Typical example

g01245186

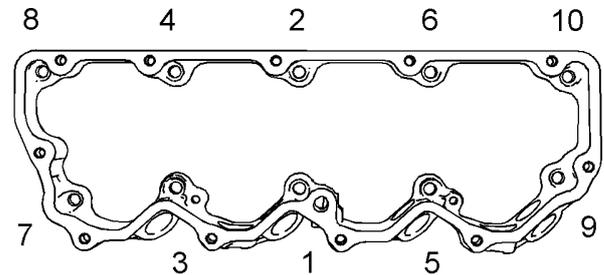


Illustration 200

g01245190

Sequence for loosening captive bolts in valve mechanism

5. Progressively loosen the captive bolts that secure the valve mechanism cover base in reverse numerical order. Refer to Illustration 200. This will help prevent distortion of the valve mechanism cover base.

**Note:** The captive bolts cannot be removed from the valve mechanism cover base.

6. Remove the valve mechanism cover base from the cylinder head.
7. Remove gasket (9) from the valve mechanism cover base .

## Installation Procedure

Table 51

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Circlip Pliers	1
B	21820221	POWERPART Rubber Grease	1
C	27610296	Torque wrench	1
D	27610349	Alignment Pins	2

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

### NOTICE

Use a deep socket in order to remove the electrical connections from the electronic unit injectors. Use of incorrect tooling will result in damage to the electronic unit injectors.

1. Clean the valve mechanism cover base. Ensure that the gasket surfaces are free from damage.

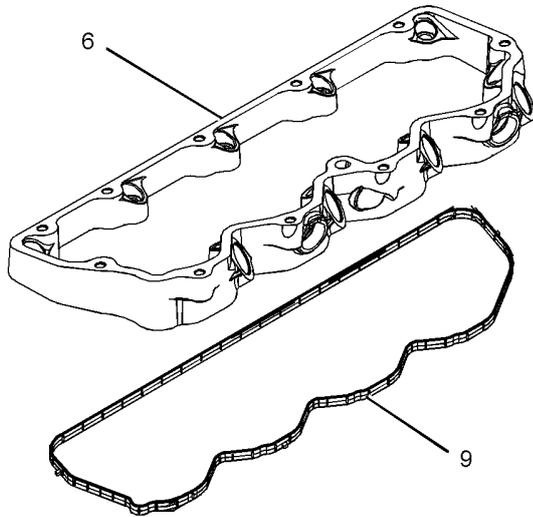


Illustration 201  
Typical example

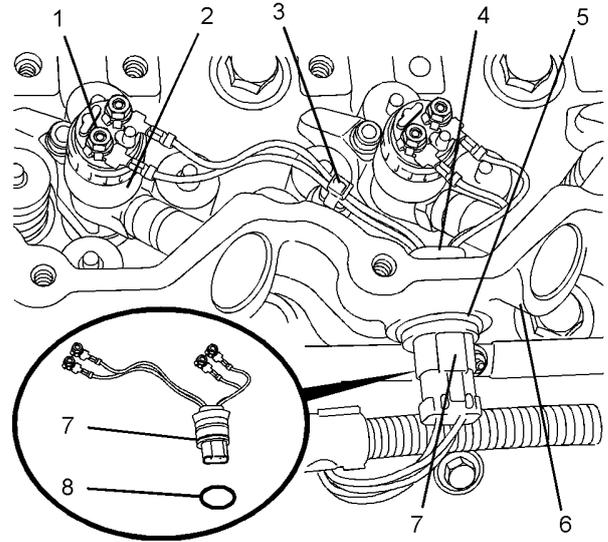


Illustration 203  
Typical example

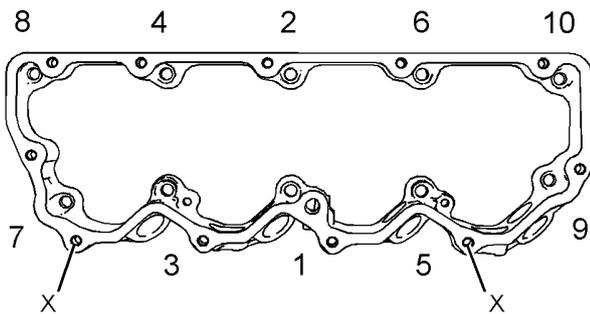


Illustration 202  
Tightening sequence for the valve mechanism cover base

2. Install gasket (9) to valve mechanism cover base (6). Ensure that the gasket is seated correctly in the groove in the valve mechanism cover base.
3. Position valve mechanism cover base (6) on the cylinder head.
4. Install Tooling (D) into the valve mechanism cover base in Positions (X).
5. Progressively tighten the captive bolts that secure the valve mechanism cover base. Tighten the captive bolts to a torque of 9 N·m (79 lb in) in the sequence that is shown in Illustration 202.
6. Remove Tooling (D).

7. If necessary, install the harness assemblies for the electronic unit injectors. Follow Step 7.a through Step 7.e in order to install the harness assemblies to the electronic unit injectors.

- a. Ensure that harness assembly (4) and the bore in valve mechanism cover base (6) are clean and free from damage. Replace any damaged components.
- b. Use Tooling (B) to lubricate a new O-ring seal (8). Install O-ring seal (8) onto harness assembly (4).
- c. From the inside of valve mechanism cover base (6), push harness assembly (4) into the valve mechanism cover base.
- d. Use Tooling (A) to install circlip (5).
- e. Repeat Step 7.a through Step 7.e for the remaining harness assembly.

8. Use a deep socket to connect harness (4) to electronic unit injectors (2). Use Tooling (C) to tighten connectors (1) to a torque of 2.4 N·m (21 lb in).
9. If necessary, install new cable strap (3) to harness assemblies (4).

**Note:** Ensure that the cable straps conform to the Perkins specification.

10. Connect plugs (7) to harness assemblies (4).