



# Specifications

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## **3406E and 3456 Generator Set Engines**

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BGA1-Up (Generator Set)  
CCB1-Up (Generator Set)  
EPE1-Up (Engine)  
C1G1-Up (Generator Set)  
C3G1-Up (Generator Set)  
C4G1-Up (Generator Set)  
CAH1-Up (Generator Set)  
GHJ1-Up (Generator Set)  
9NN1-Up (Engine)  
CBX1-Up (Generator Set)  
8AZ1-Up (Generator Set)

## 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 "NOTIÇE" 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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# Specifications Section

## Engine Design

SMCS Code: 1201

### 3406E

i02155355

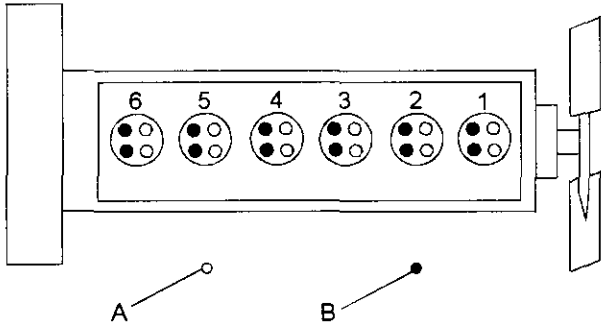


Illustration 1  
Cylinder and valve location  
(A) Inlet. (B) Exhaust.

g01094029

- Bore ..... 137.2 mm (5.40 inch)
- Stroke ..... 165.1 mm (6.50 inch)
- Displacement ..... 14.6 L (890 cu in)
- Cylinder Arrangement ..... In-Line
- Valves per Cylinder ..... 4
- The Adjustment For The Inlet Valve Lash is the Following Value. .... 0.38 mm (0.015 inch)
- The Adjustment For The Exhaust Valve Lash is the Following Value. .... 0.76 mm (0.030 inch)
- Firing Order (Injection Sequence) ..... 1, 5, 3, 6, 2, 4
- Crankshaft rotation ..... counterclockwise

**Note:** The front end of the engine is opposite the flywheel end. The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

### 3456

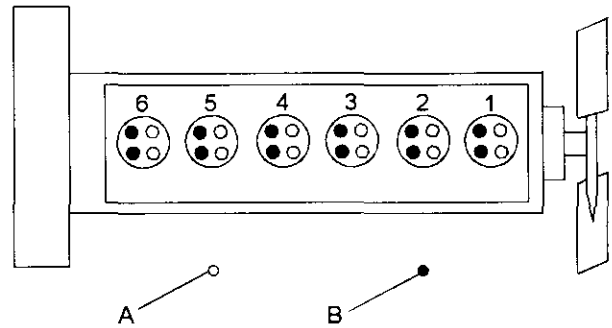


Illustration 2  
Cylinder and valve location  
(A) Inlet. (B) Exhaust.

g01094029

- Bore ..... 140.0 mm (5.51 inch)
- Stroke ..... 171.0 mm (6.73 inch)
- Displacement ..... 15.8 L (964 cu in)
- Cylinder Arrangement ..... In-Line
- Valves per Cylinder ..... 4
- The Adjustment For The Inlet Valve Lash is the Following Value. .... 0.38 mm (0.015 inch)
- The Adjustment For The Exhaust Valve Lash is the Following Value. .... 0.76 mm (0.030 inch)
- Firing Order (Injection Sequence) ..... 1, 5, 3, 6, 2, 4
- Crankshaft rotation ..... counterclockwise

**Note:** The front end of the engine is opposite the flywheel end. The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

i01544942

# Fuel Transfer Pump

SMCS Code: 1256

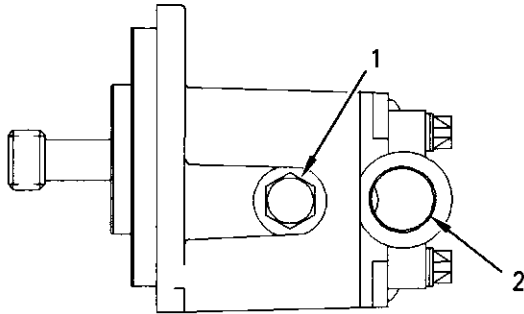


Illustration 3

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- (1) Pressure regulating valve
- (2) Inlet port

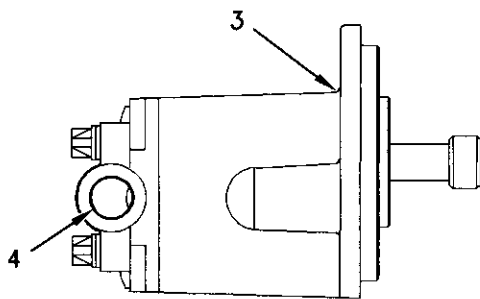


Illustration 4

g00759647

- (3) Weep hole
- (4) Outlet port

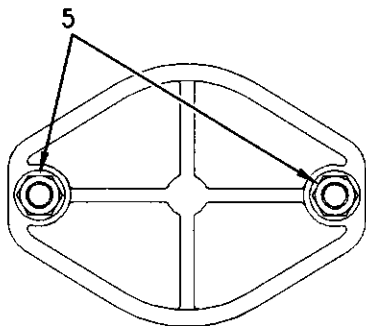


Illustration 5

g00533385

Typical cover opposite the fuel transfer pump

## (5) Nuts

Tighten the nuts to the following torque. ....  $30 \pm 5 \text{ N}\cdot\text{m}$  ( $22 \pm 4 \text{ lb ft}$ )

i01980916

# Fuel Filter Base

SMCS Code: 1261; 1262

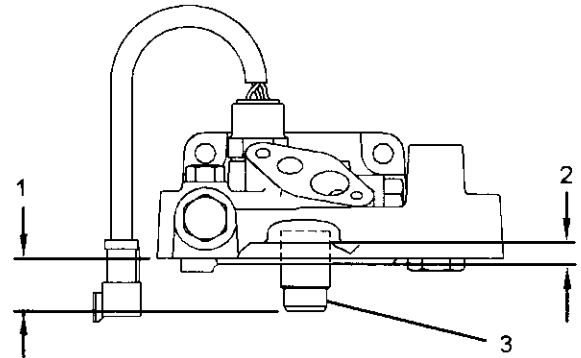


Illustration 6

g01026708

- (1) The sealing surface of the base to the end of the stud is the following dimension. ....  $24.6 \pm 1.3 \text{ mm}$  ( $0.97 \pm 0.05 \text{ inch}$ )
- (2) Apply 155-0695 Thread Lock Compound on the tapered end of the stud to the following dimension. ....  $7.7 \text{ mm}$  ( $0.30 \text{ inch}$ )
- (3) Stud  
Tighten the stud to the following torque. ....  $70 \pm 15 \text{ N}\cdot\text{m}$  ( $50 \pm 11 \text{ lb ft}$ )

i02162348

## Electronic Unit Injector Mechanism

SMCS Code: 1290

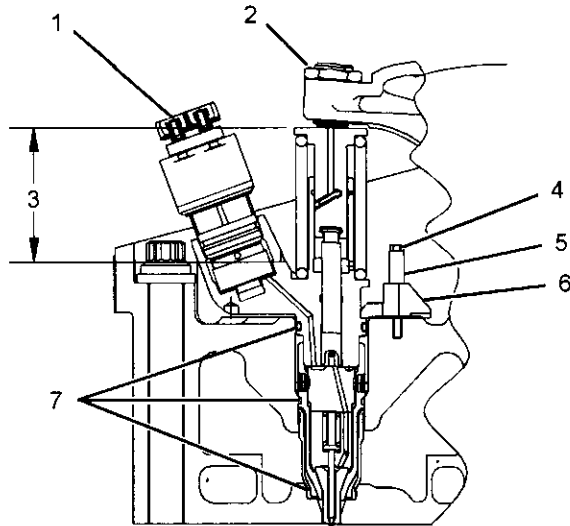


Illustration 7

g01096477

(1) Cap nut

Tighten the cap nuts to the following torque. ....  $2.5 \pm 0.25$  N·m ( $22 \pm 2$  lb in)

(2) Adjusting screw locknut

Tighten the adjusting screw locknut to the following torque. ....  $100 \pm 10$  N·m ( $74 \pm 7$  lb ft)

(3) Unit injector height

Adjust the unit injector height to the following dimension. ....  $78.0 \pm 0.2$  mm ( $3.07 \pm 0.01$  inch)

(4) Unit injector clamp retaining bolt

1. Tighten the unit injector clamp retaining bolt to  $55 \pm 10$  N·m ( $41 \pm 7$  lb ft).

2. Loosen the retaining bolt until the bolt is finger tight.

3. Tighten the retaining bolt again to  $55 \pm 10$  N·m ( $41 \pm 7$  lb ft).

(5) Spacer

(6) Unit injector clamp

(7) O-ring seals

Before installation of the unit injector, lubricate the top two O-ring seals with a 50/50 mixture of clean engine oil and 8T - 2998 Lubricant.

**Note:** Refer to Testing and Adjusting, "Electronic Unit Injector - Adjust" for the correct procedure for setting the lash on the electronic unit injector.

i01157325

## Valve Mechanism

SMCS Code: 1102

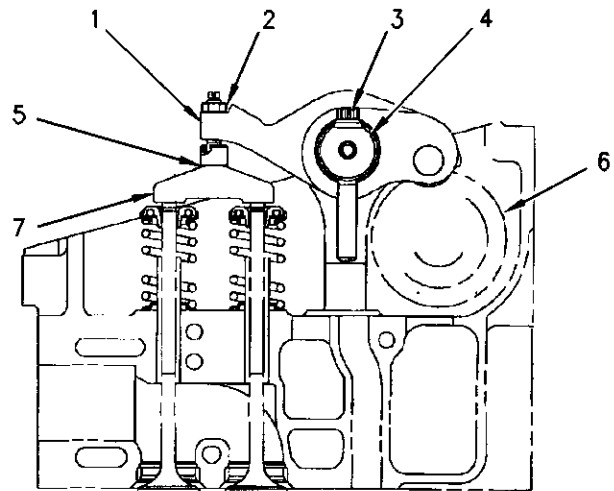


Illustration 8

g00579258

Typical example

(1) Valve rocker arm assembly

(2) Adjusting screw locknut

Tighten the adjusting screw locknut to the following torque. ....  $30 \pm 7$  N·m ( $22 \pm 5$  lb ft)

**Note:** If the engine is equipped with a compression brake, the mounting bolts for the compression brake replace bolts (3). Refer to Specifications, "Compression Brake".

(3) Bolt

Tighten the bolts to the following torque. ....  $109 \pm 15$  N·m ( $80 \pm 11$  lb ft)

(4) Rocker arm shaft

Diameter of a new rocker arm shaft .....  $40.000 \pm 0.010$  mm ( $1.5748 \pm 0.0004$  inch)

Bore in a new rocker arm bearing for the rocker arm shaft ..... 40.065 ± 0.015 mm  
(1.5774 ± 0.0006 inch)  
Maximum dimension for the bore in a worn rocker arm bearing for the rocker arm shaft .. 40.193 mm  
(1.5824 inch)

(5) Valve lash

Inlet valves ..... 0.38 ± 0.08 mm  
(0.015 ± 0.003 inch)  
Exhaust valves ..... 0.76 ± 0.08 mm  
(0.030 ± 0.003 inch)

**Note:** Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust" for the correct procedure on setting the engine valve lash.

(6) Camshaft

(7) Valve bridge assembly

i01218127

## Valve Mechanism Cover

SMCS Code: 1107

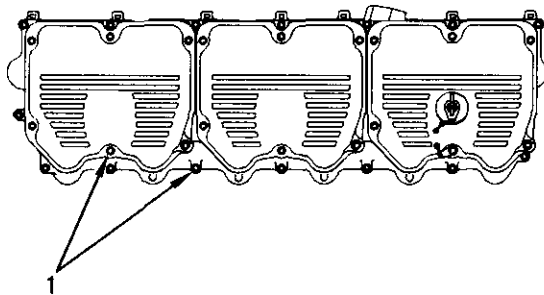


Illustration 9  
Typical Example

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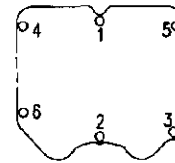


Illustration 10

g00285630

### Tightening Sequence For Valve Cover And Base

**Note:** Apply 4C-4030 Thread Lock Compound to the bolts that fasten the wiring for the electronic unit injectors to the valve cover base.

(1) Torque for bolts ..... 18 ± 3 N·m (13 ± 2 lb ft)

**Note:** The valve cover seal and the cover base seal are cut to size at assembly. Coat seal joints with 3S-6252 Sealant.

i02155532

## Cylinder Head Valves

SMCS Code: 1105

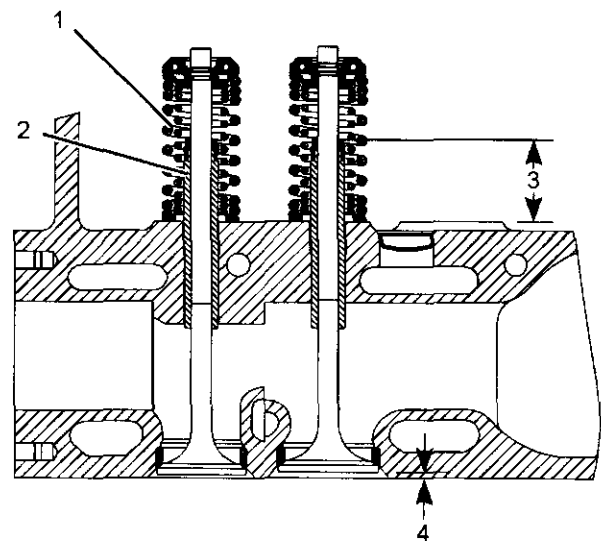


Illustration 11

g01094016

**Note:** Apply 8T - 2998 Lubricant to the valve stems prior to installation in the cylinder head.

(1) Valve springs

**211-3122 Spring (Inner)**

Assembled length .....	60.14 mm (2.368 inch)
Load at assembled length .....	150 ± 12 N (34 ± 3 lb)
Operating length (minimum) .....	44.02 mm (1.733 inch)
Load at minimum operating length ....	400 ± 18 N (90 ± 4 lb)
Free length after test .....	71.70 mm (2.823 inch)
Outside diameter .....	25.17 mm (0.991 inch)

**211-3123 Spring (Outer)**

Assembled length .....	67.12 mm (2.643 inch)
Load at assembled length .....	320 ± 25 N (72 ± 6 lb)
Operating length (minimum) .....	51.00 mm (2.008 inch)
Load at minimum operating length ....	900 ± 45 N (202 ± 10 lb)
Free length after test .....	76.70 mm (3.020 inch)
Outside diameter .....	36.30 mm (1.429 inch)

(2) Valve guide

Bore of installed valve guide (new parts) .....	9.487 ± 0.025 mm (0.3735 ± 0.0010 inch)
-------------------------------------------------	--------------------------------------------

Maximum recommended diameter of the valve guide bore ..... 9.538 mm (0.3755 inch)

**Note:** Do not use a combination of a valve and a valve guide that has a difference of 0.13 mm (0.005 inch) or more.

(3) Height to top of valve guide .....	35.00 ± 0.50 mm (1.378 ± 0.020 inch)
----------------------------------------	-----------------------------------------

(4) Valve recess

Inlet (new parts) .....	2.20 to 2.80 mm (0.087 to 0.110 inch)
Exhaust (new parts) .....	1.20 to 1.80 mm (0.047 to 0.071 inch)
Inlet (reconditioned parts) .....	2.20 to 3.29 mm (0.087 to 0.129 inch)
Exhaust (reconditioned parts) ...	1.20 to 2.29 mm (0.0472 to 0.090 inch)

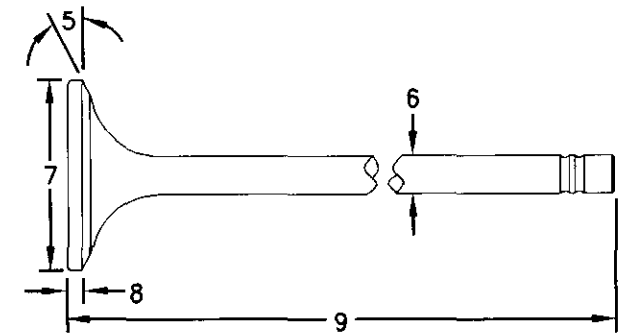


Illustration 12  
153-7023 Inlet Valve and 153-7024 Exhaust Valve

(5) Valve face angle

Inlet .....	29 1/4 ± 1/4 degrees
Exhaust .....	44 1/4 ± 1/4 degrees

(6) Valve stem diameter

New valve stem diameter ..... 9.441 ± 0.010 mm  
(0.3717 ± 0.0004 inch)

Minimum recommended valve stem diameter ..... 9.408 mm (0.3704 inch)

(7) Diameter of valve head

Inlet .....	47.00 ± 0.13 mm (1.850 ± 0.005 inch)
Exhaust ...	41.81 ± 0.13 mm (1.646 ± 0.005 inch)

(8) Minimum recommended valve lip thickness

Inlet .....	2.75 mm (0.108 inch)
Exhaust .....	2.05 mm (0.081 inch)

(9) Overall length of valve

Inlet .....	202.00 ± 0.45 mm (7.953 ± 0.018 inch)
Exhaust ..	202.06 ± 0.45 mm (7.955 ± 0.018 inch)

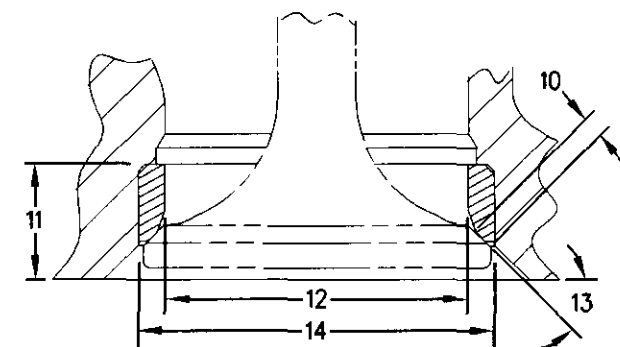


Illustration 13  
175-3617 Valve Seat Insert (Inlet) and 152-7582 Valve Seat Insert (Exhaust)

## (10) Minimum recommended width of the valve seat

Inlet ..... 2.00 mm (0.079 inch)  
Exhaust ..... 1.25 mm (0.049 inch)

## (11) Depth of bore in the cylinder head for the valve seat insert

Inlet ..... 14.00 ± 0.10 mm (0.551 ± 0.004 inch)  
Exhaust ... 13.90 ± 0.10 mm (0.547 ± 0.004 inch)

## (12) Inside diameter of valve seat insert

Inlet ..... 41.00 ± 0.50 mm (1.614 ± 0.020 inch)  
Exhaust ... 36.50 ± 0.50 mm (1.437 ± 0.020 inch)

## (13) Angle of valve seat face

Inlet ..... 30 1/4 ± 1/2 degrees  
Exhaust ..... 45 1/4 ± 1/2 degrees

## (14) Outside diameter of valve seat insert

Inlet .. 48.025 ± 0.013 mm (1.8907 ± 0.0005 inch)  
Exhaust ..... 42.840 ± 0.013 mm  
(1.6866 ± 0.0005 inch)

Diameter of the bore in the cylinder head for the valve seat insert

Inlet .. 47.950 ± 0.025 mm (1.8878 ± 0.0010 inch)  
Exhaust ..... 42.774 ± 0.025 mm  
(1.6840 ± 0.0010 inch)

i02093735

## Cylinder Head

**SMCS Code:** 1100

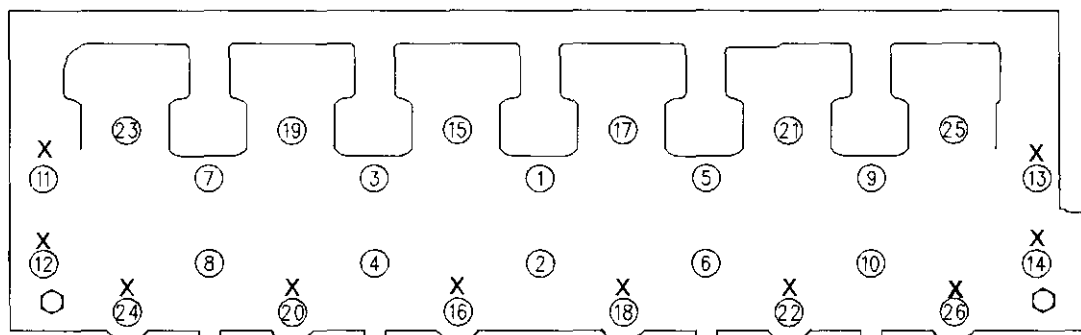


Illustration 14

g01025099

The bolts that are marked "X" are 216 mm (8.5 inch) long. The remainder of the bolts are 194 mm (7.6 inch) long.

Apply 6V-4876 Lubricant to the bolt threads and both sides of the washers. Tighten the bolts in the following step sequence:

1. In a numerical sequence, tighten bolts 1 through 26.

Torque for bolts ..... 270 ± 15 N·m (200 ± 11 lb ft)

2. In a numerical sequence, tighten bolts 1 through 26.

Torque for bolts ..... 450 ± 15 N·m (330 ± 11 lb ft)

3. In a numerical sequence, again tighten bolts 1 through 26.

Torque for bolts ..... 450 ± 15 N·m (330 ± 11 lb ft)

**Note:** The flatness of the cylinder head should be within a total of 0.13 mm (.005 inch). Also, the flatness of the cylinder head should be within a maximum of 0.05 mm (.002 inch) for any 150 mm (5.9 inch) span.

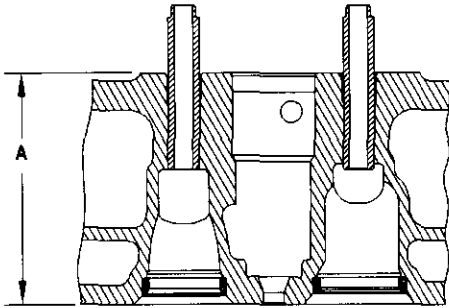


Illustration 15

g00643834

(A) Cylinder Head Thickness

Thickness of a new cylinder head ..... 120.00 ± 0.15 mm (4.724 ± 0.006 inch)  
 Minimum thickness of a used cylinder head ..... 119.50 mm (4.705 inch)

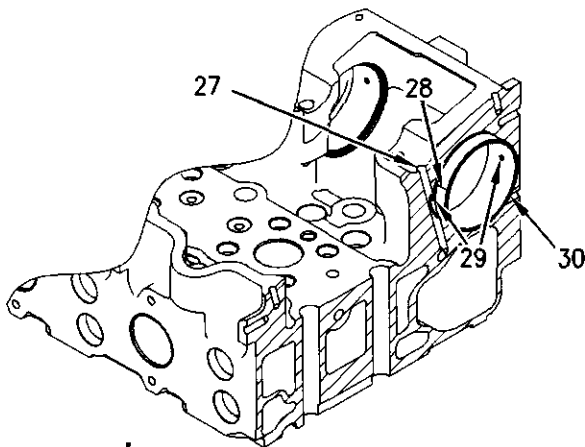


Illustration 16

g01007827

- (27) Oil gallery
- (28) Bearing joint
- (29) Oil holes

(30) Camshaft bearing

**NOTICE**

Camshaft bearings must be installed into their correct position. Failure to do so will result in engine damage.

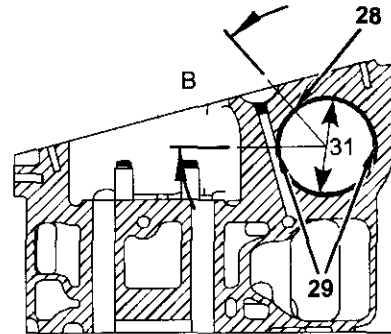


Illustration 17

g01067535

- (B) Orientation of bearing joint
- (28) Bearing joint
- (31) Diameter of Camshaft Bore

(31) Diameter of camshaft bore .. 90.985 ± 0.020 mm (3.582 ± 0.001 inch)

Orientation of bearing joint (B) ..... 20° ± 5° above horizontal

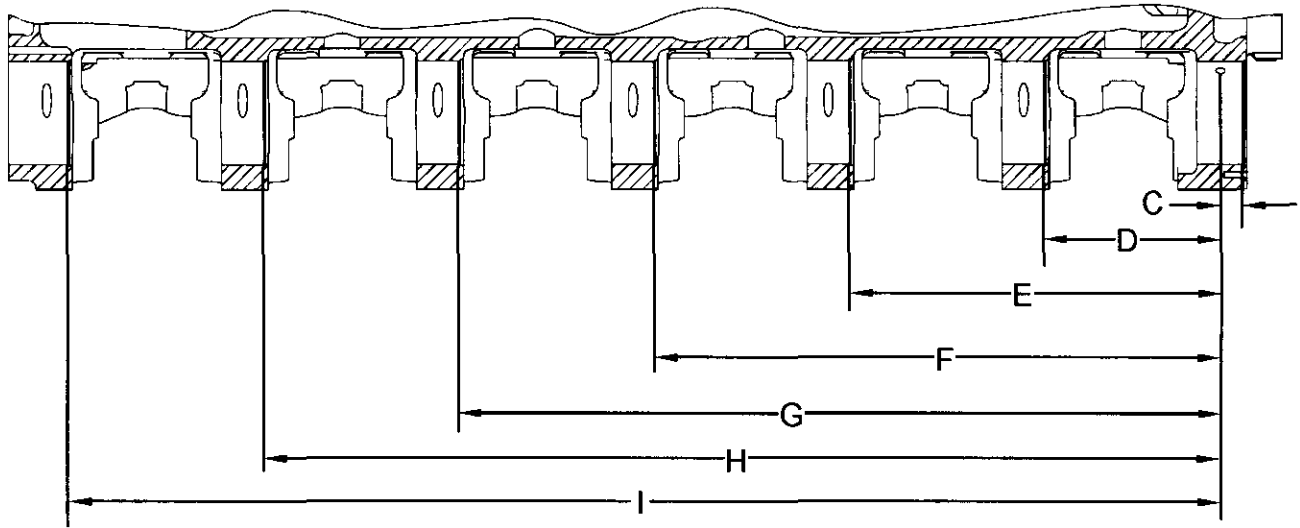


Illustration 18

g01060954

The depth of installation of the camshaft bearings is very important. Install bearings (30) to the following depths:

Installation depth for camshaft bearings (30)

C .....	19.12 ± 0.50 mm (0.75 ± 0.02 inch)
D .....	154.7 ± 0.5 mm (6.09 ± 0.02 inch)
E .....	326.2 ± 0.5 mm (12.84 ± 0.02 inch)
F .....	497.6 ± 0.5 mm (19.59 ± 0.02 inch)
G .....	669.1 ± 0.5 mm (26.34 ± 0.02 inch)
H .....	840.5 ± 0.5 mm (33.09 ± 0.02 inch)
I .....	1012.0 ± 0.5 mm (39.84 ± 0.02 inch)

Lightly hit the clamps with a soft faced hammer. Again tighten the clamp bolts to the following torque. .... 14 ± 1 N·m (10 ± 1 lb ft)

Tighten the mounting bolts for the turbocharger to the following torque. .... 55 ± 9 N·m (41 ± 7 lb ft)

i01117248

## Exhaust Manifold

SMCS Code: 1059

i01683515

## Turbocharger

SMCS Code: 1052

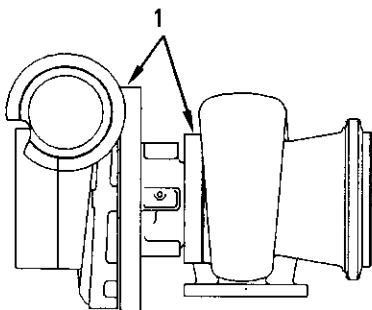


Illustration 19

g00466856

(1) Tighten the clamp bolts to the following torque. .... 14 ± 1 N·m (10 ± 1 lb ft)

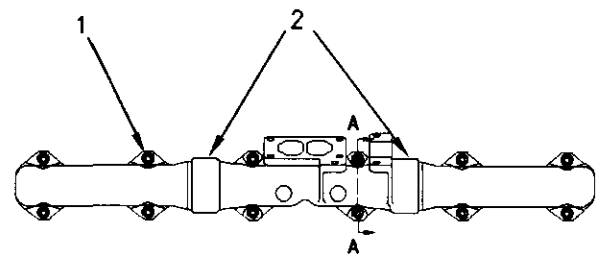


Illustration 20

g00590579

Typical example

i01728529

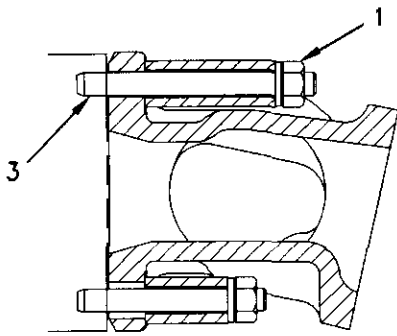


Illustration 21  
Typical example

g00566220

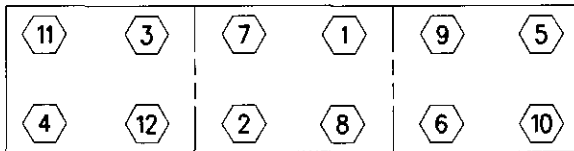


Illustration 22  
Tightening sequence

g00566145

(1) Locknut

Tighten the locknuts in the numerical sequence that is shown in Illustration 22 to the following torque. ....  $38 \pm 5 \text{ N}\cdot\text{m}$  ( $28 \pm 4 \text{ lb ft}$ )

(2) Manifold ends

Apply engine oil to the female ends of the manifolds before assembly. Apply 2P - 2333 High Temperature Sealer to the male ends of the manifolds before assembly. Remove excess sealer from the assembled joint.

(3) Stud

Apply 5P - 3931 Anti-Seize Compound to the threads of the studs that engage the locknuts. Tighten the studs in the cylinder head to the following torque. ....  $35 \pm 5 \text{ N}\cdot\text{m}$  ( $26 \pm 4 \text{ lb ft}$ )

## Camshaft

SMCS Code: 1210

### Type 1

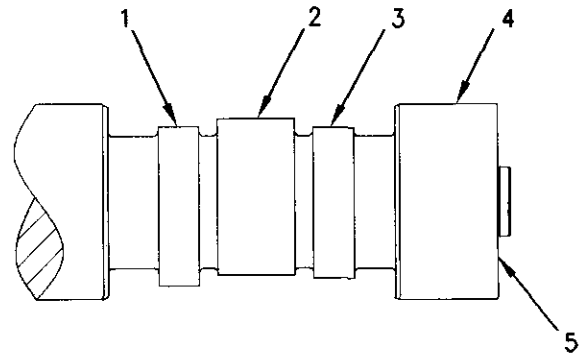


Illustration 23  
185 - 9699 Camshaft Group

g00562795

- (1) Exhaust lobe
- (2) Injector lobe
- (3) Inlet lobe

**Note:** Lubricate the camshaft lobes with a 50/50 mixture of 8T - 2998 Lubricant and clean engine oil.

(4) Bearing journal

Diameter of the bearing journals ...  $84.85 \pm 0.02 \text{ mm}$  ( $3.341 \pm 0.001 \text{ inch}$ )

**Note:** Lubricate the camshaft bearings with clean engine oil prior to installing the camshaft.

(5) Front of camshaft

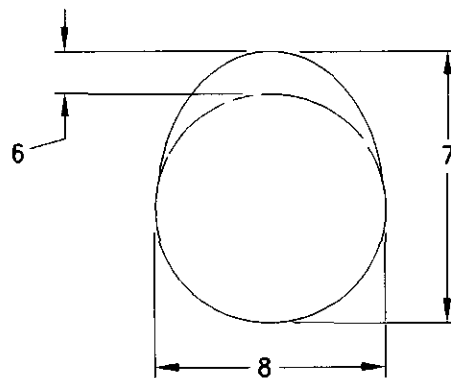


Illustration 24

g00466866

(6) Camshaft lobe lift

Specified camshaft lobe lift

Exhaust lobe .....	8.515 mm (0.3352 inch)
Inlet lobe .....	9.431 mm (0.3713 inch)
Injector lobe .....	10.451 mm (0.4115 inch)

- (7) Camshaft lobe height
- (8) Base circle

To find the lobe lift, use the procedure that follows:

1. Measure camshaft lobe height (7).
2. Measure base circle (8).
3. Subtract the base circle measurement (Step 2) from the camshaft lobe height (Step 1). The difference is the actual lobe lift.

Maximum permissible difference between the actual lobe lift (Step 3) and the specified lobe lift of a new camshaft ..... 0.13 mm (0.005 inch)

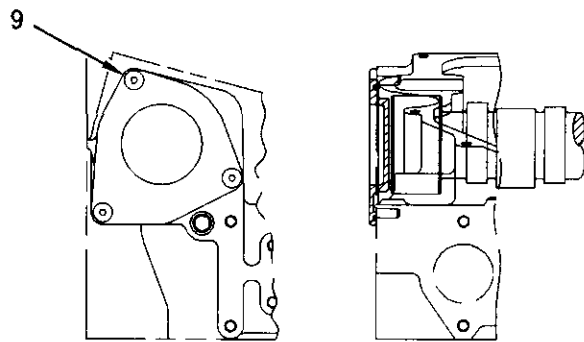


Illustration 25

g00544839

- (9) Bolt

Tighten the bolts that fasten the cover to the cylinder head to the following torque. ..  $13 \pm 3 \text{ N}\cdot\text{m}$   
( $10 \pm 2 \text{ lb}\cdot\text{ft}$ )

Type 2

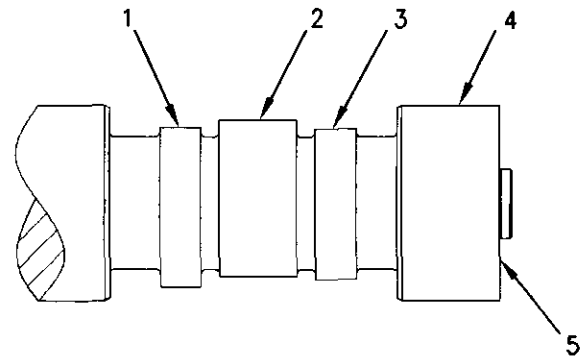


Illustration 26

g00562795

6I-1543 and 130-9710 Camshaft Group

- (1) Exhaust lobe
- (2) Injector lobe
- (3) Inlet lobe

**Note:** Lubricate the camshaft lobes with a 50/50 mixture of 8T-2998 Lubricant and clean engine oil.

- (4) Bearing journal

Diameter of the bearing journals ...  $84.85 \pm 0.02 \text{ mm}$  ( $3.341 \pm 0.001 \text{ inch}$ )

**Note:** Lubricate the camshaft bearings with clean engine oil prior to installing the camshaft.

- (5) Front of camshaft

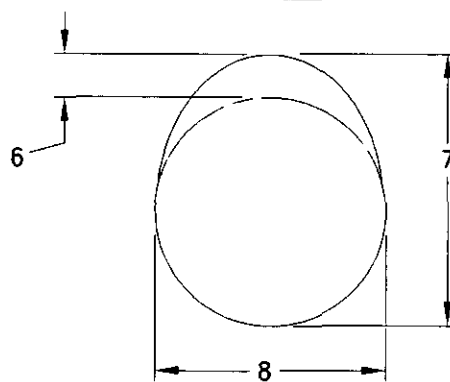


Illustration 27

g00466866

- (6) Camshaft lobe lift

Specified camshaft lobe lift

Exhaust lobe .....	8.515 mm (0.3352 inch)
Inlet lobe .....	9.702 mm (0.3820 inch)
Injector lobe .....	10.451 mm (0.4115 inch)

- (7) Camshaft lobe height

(8) Base circle

To find the lobe lift, use the procedure that follows:

1. Measure camshaft lobe height (7).
2. Measure base circle (8).
3. Subtract the base circle measurement (Step 2) from the camshaft lobe height (Step 1). The difference is the actual lobe lift.

Maximum permissible difference between the actual lobe lift (Step 3) and the specified lobe lift of a new camshaft ..... 0.13 mm (0.005 inch)

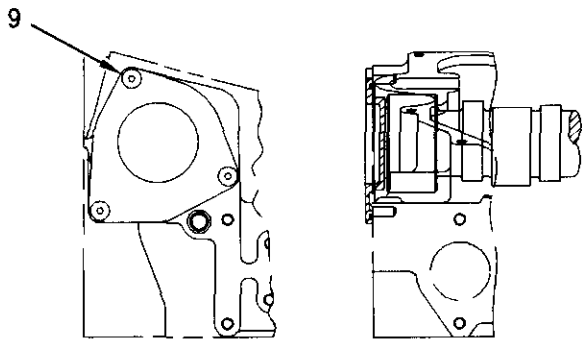


Illustration 28

g00544839

(9) Bolt

Tighten the bolts that fasten the cover to the cylinder head to the following torque. ..  $13 \pm 3$  N·m  
( $10 \pm 2$  lb ft)

## Engine Oil Filter Base

SMCS Code: 1306

101114678

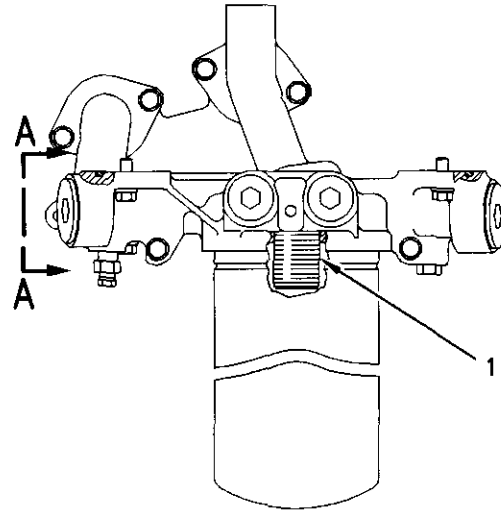


Illustration 29

g00286386

- (1) Apply 9S-3263 Thread Lock Compound on the tapered end of the stud to the following dimension. .... 10.5 mm (0.41 inch)

Tighten the stud to the following torque. ..  $68 \pm 7$  N·m  
( $50 \pm 5$  lb ft)

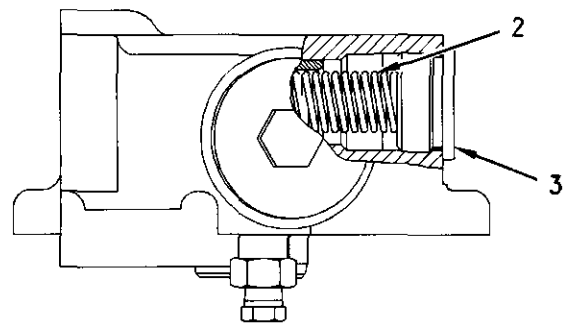


Illustration 30

g00589708

View A-A

- (2) 4N-8150 Spring

Length under test force ... 55.25 mm (2.175 inch)  
 Test force .....  $76 \pm 5$  N ( $17.0 \pm 1.13$  lb)  
 Free length after test ..... 93.7 mm (3.69 inch)  
 Outside diameter ..... 20.6 mm (0.81 inch)  
 The filter and the cooler bypass valves will open with the following pressure difference. ....  $255 \pm 20$  kPa ( $37 \pm 3$  psi)

(3) Plug

Tighten the plug (3) to the following torque. .... 100 ± 15 N·m (74 ± 11 lb ft)

i01080836

## Engine Oil Pump

SMCS Code: 1304

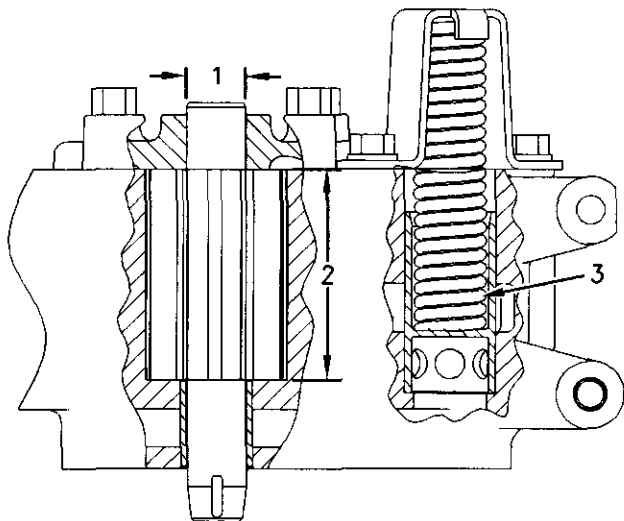


Illustration 31

g00566332

### NOTICE

Before operation, the pump must be lubricated with clean engine oil and the pump must turn freely by hand or damage to parts can be the result.

(1) Diameter of shafts ..... 22.217 ± 0.005 mm  
(0.8747 ± 0.0002 inch)

Diameter of bores in cover for shafts .... 22.258 ± 0.008 mm (0.8763 ± 0.0003 inch)

(2) Length of gears ..... 79.375 ± 0.025 mm  
(3.1250 ± 0.0010 inch)

Depth of bores for gears ..... 79.502 ± 0.020 mm  
(3.1300 ± 0.0008 inch)

(3) 2S-2760 Spring

Length under test force ..... 117.9 mm (4.64 inch)  
Test force ..... 150 ± 8 N·m (110 ± 6 lb ft)  
Free length after test ..... 152.9 mm (6.02 inch)  
Outside diameter ..... 27 mm (1.063 inch)

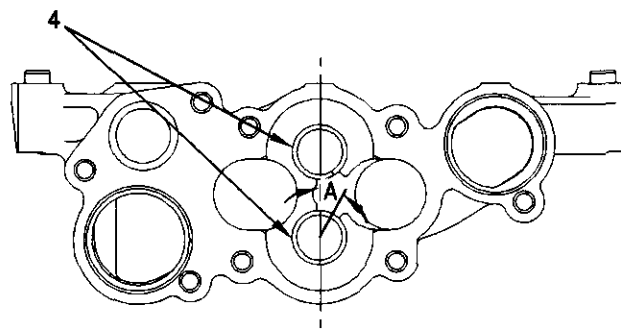


Illustration 32

g00566395

Pump body

(4) Bearings

Install the bearings so the bearings are even with the outside of the pump body.

(A) Position of bearing joint from the centerline through bearing bores ..... 30 ± 15 degrees

i02156150

## Engine Oil Pan

SMCS Code: 1302

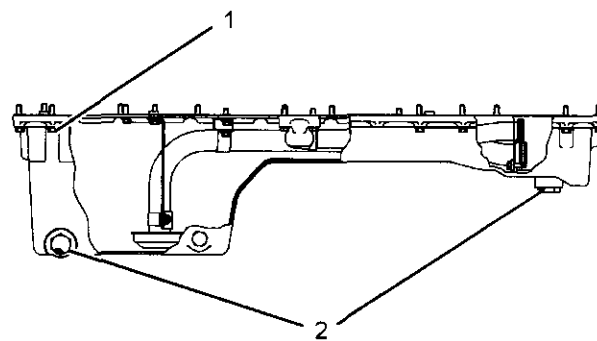


Illustration 33

g01094010

(1) Bolt

Tighten the bolts to the following torque. .... 47 ± 9 N·m (35 ± 7 lb ft)

(2) Drain plug

Tighten the drain plugs to the following torque. .... 70 ± 15 N·m (52 ± 11 lb ft)

i01429378

i02012215

## Water Temperature Regulator

SMCS Code: 1355

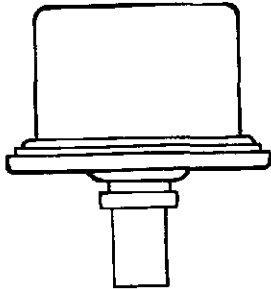


Illustration 34  
Typical example

g00285471

Completely open temperature ..... 98 °C (208 °F)  
Minimum opening distance at 98 °C  
(208 °F) ..... 10.4 mm (0.41 inch)

## Water Pump

SMCS Code: 1361

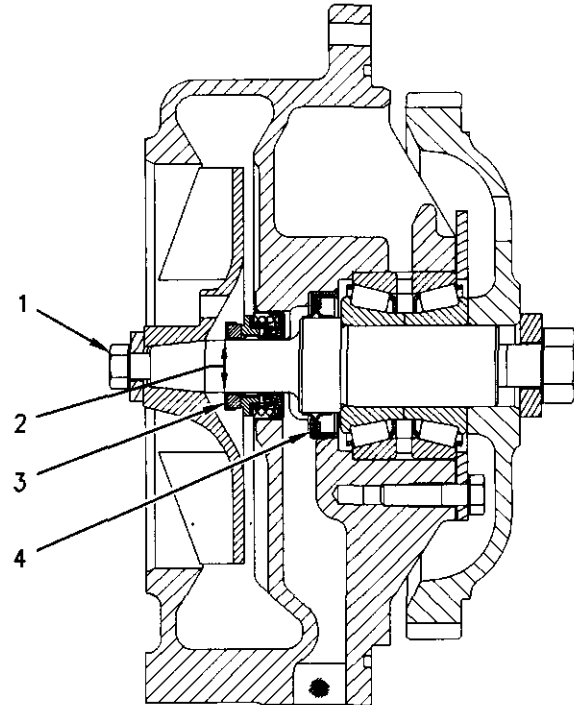


Illustration 35  
Typical example

g00568324

### (1) Bolt

Tighten the bolt that holds the impeller to the following torque. .... 39 ± 3 N·m (29 ± 2 lb ft)

(2) The shaft diameter at the carbon seal assembly seat area is the following dimension. .... 19.10 ± 0.01 mm (0.7520 ± 0.0004 inch)

### (3) Coolant seal

Press the seal assembly onto the water pump shaft until the stationary cup is fully seated in the pump housing.

### (4) Oil seal

Install the oil seal with the primary lip toward the water pump drive gear. Press the oil seal into the counterbore with a press.

i02163757

# Cylinder Block

SMCS Code: 1201

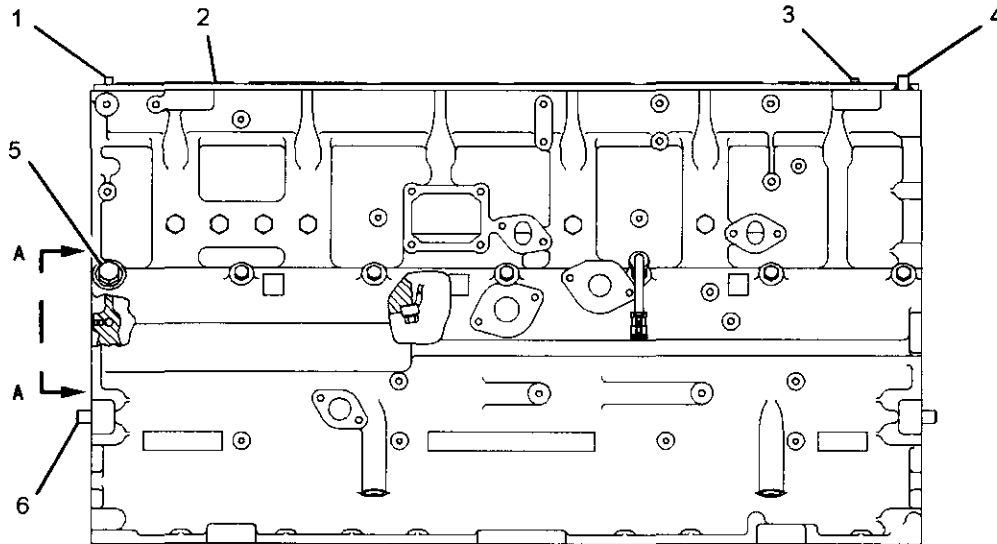


Illustration 36  
Right side view

g01097311

**(1) Dowel**

Apply 7M-7456 Bearing Mount Compound to the dowel before installation.

The dowel extends above the top surface of the cylinder block by the following distance. ....  $18.5 \pm 0.5$  mm  
( $0.73 \pm 0.02$  inch)

**(2) Spacer plate**

Thickness of the spacer plate ..  $8.585 \pm 0.025$  mm  
( $0.3380 \pm 0.0010$  inch)

Thickness of the gasket that is placed between the spacer plate and the cylinder block .....  $0.20 \pm 0.02$  mm  
( $0.008 \pm 0.001$  inch)

Cylinder liner projection above the spacer plate .....  $0.025$  to  $0.152$  mm  
( $0.0010$  to  $0.0060$  inch)

**(3) Dowel**

The dowel extends above the top surface of the cylinder block by the following distance. ....  $16.0 \pm 0.5$  mm  
( $0.63 \pm 0.02$  inch)

**(4) Dowel**

Apply 7M-7456 Bearing Mount Compound to the dowel before installation.

The dowel extends above the top surface of the cylinder block by the following distance. ....  $20.0 \pm 0.5$  mm  
( $0.79 \pm 0.02$  inch)

**(5) Plug**

Tighten the plug to the following torque. ....  $70 \pm 10$  N·m  
( $52 \pm 7$  lb ft)

**(6) Dowel**

The dowels extend past the end of the cylinder block by the following distance. ...  $19.1 \pm 0.5$  mm  
( $0.75 \pm 0.02$  inch)

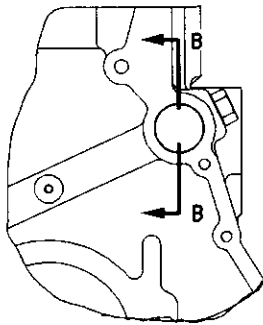


Illustration 37  
View A-A

g00284986

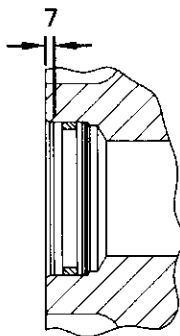


Illustration 38  
View B-B

g00562849

(7) Installation depth of the plug .....  $2.0 \pm 2.0$  mm  
( $0.08 \pm 0.08$  inch)

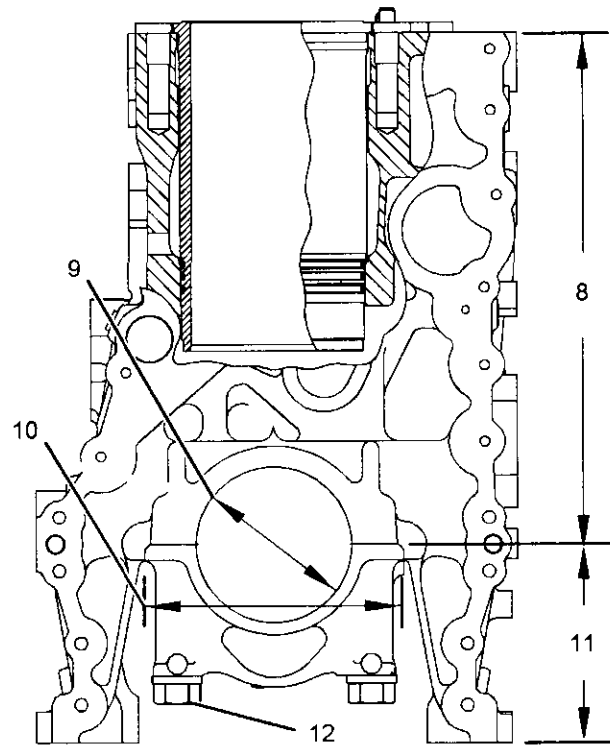


Illustration 39  
Front view

g01096193

(8) Dimension from the centerline of the crankshaft bearing bore to the top of the cylinder block

New .....	$425.45 \pm 0.15$ mm
	( $16.750 \pm 0.006$ inch)
Minimum .....	$425.02$ mm
	( $16.733$ inch)

**Note:** The total flatness of the top contact surface of the cylinder block must be within 0.10 mm (0.004 inch). The flatness must also be within 0.05 mm (0.002 inch) for any 177.5 mm (6.99 inch) section of the surface.

(9) Bore in the cylinder block for the main bearings

(10) Main bearing cap

Main bearing cap width .....	$215.900 \pm 0.025$ mm
	( $8.5000 \pm 0.0010$ inch)
Width of the cylinder block for the main bearing cap .....	$215.900 \pm 0.013$ mm
	( $8.5000 \pm 0.0005$ inch)

(11) New dimension from the centerline of the crankshaft bearing bore to the bottom of the cylinder block pan rails .....

	$165.10 \pm 0.10$ mm
	( $6.500 \pm 0.004$ inch)

(12) Main bearing cap bolts

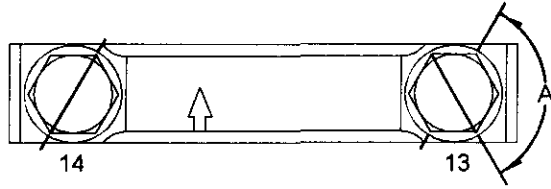


Illustration 40 g01062353  
Torque-turn tightening method for main bearing cap bolts

Use the following procedure in order to tighten the main bearing cap bolts:

1. Apply clean engine oil to the threads of the bolts.
2. Tighten the bolts first on the bearing tab side (13) of the cap.  
  
Torque for bolts .....  $260 \pm 14 \text{ N}\cdot\text{m}$   
( $190 \pm 10 \text{ lb ft}$ )
3. Tighten the bolts on the opposite end (14) of the cap.  
  
Torque for bolts .....  $260 \pm 14 \text{ N}\cdot\text{m}$   
( $190 \pm 10 \text{ lb ft}$ )
4. Put a mark on each bolt and each cap.
5. Tighten the bolts on the opposite end of the bearing tab (14) from the mark to angle (A).  
  
Angle (A) .....  $120 \pm 5 \text{ degrees (2 flats)}$
6. Tighten the bolts on the bearing tab side (13) of the cap from the mark to the following value.  
  
Angle (A) .....  $120 \pm 5 \text{ degrees (2 flats)}$

- (15) Straight thread O-ring plug
- (16) Piston cooling jet

To prevent damage to the piston cooling jets during service, the piston cooling jets must be removed.

Minimum permissible clearance between the piston, the piston cooling jet, and the crankshaft .....  $0.63 \text{ mm}$   
( $0.025 \text{ inch}$ )

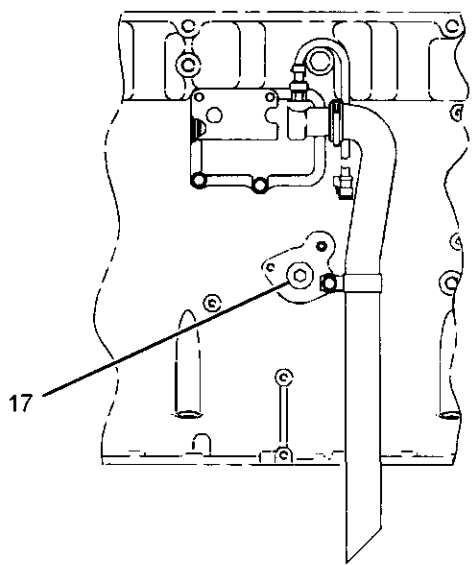


Illustration 42 g01097309  
Left side view

- (17) Plug  
Tighten the plug to the following torque. ....  $35 \pm 7 \text{ N}\cdot\text{m}$  ( $25 \pm 5 \text{ lb ft}$ )

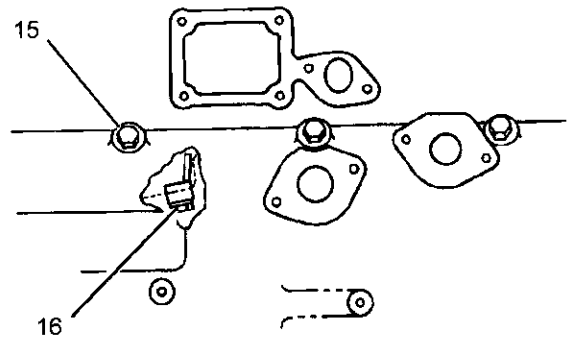


Illustration 41 g01096201  
Right side view

i01467444

## Cylinder Liner

SMCS Code: 1216

### 3406E

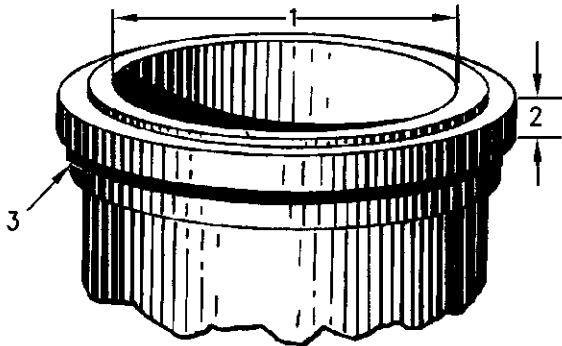


Illustration 43

g00288159

The following steps are for installing the cylinder liner into the cylinder block.

1. Apply 5P-3975 Rubber Lubricant on the surfaces of the cylinder liner bore. Apply 5P-3975 Rubber Lubricant on the rubber seals on the lower part of the cylinder liner.
2. Put the filler band completely in clean engine oil for a moment.
3. Install filler band (3) in the groove under the liner flange without delay.
4. Install the liner in the bore immediately, before the filler band expands.

(1) Bore in new liner .....  $137.185 \pm 0.025$  mm  
( $5.4010 \pm 0.0010$  inch)

(2) Thickness of flange on liner ...  $8.890 \pm 0.020$  mm  
( $0.3500 \pm 0.0008$  inch)

The minimum thickness of the part that can be used again is the following value. ....  $8.870$  mm  
( $0.3492$  inch)

(3) Filler band

**Note:** Refer to Guideline For Reusable Parts, SEBF8068, "Cylinder Liners" for more information. Also, refer to Testing and Adjusting, "Cylinder Liner - Projection" for the procedure for inspecting the projection of the cylinder liners.

### 3456

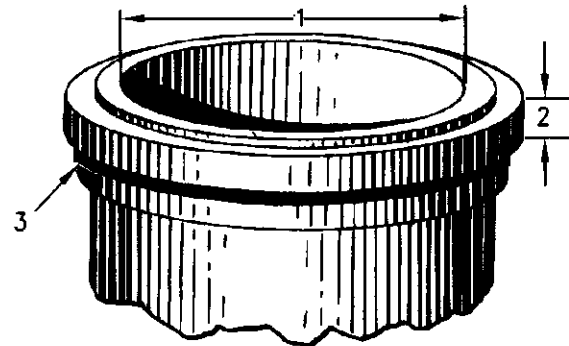


Illustration 44

g00288159

The following steps are for installing the cylinder liner into the cylinder block. Refer to Special Instruction, REHS0272 for more information.

1. Apply 5P-3975 Rubber Lubricant on the cylinder block liner bore surfaces and on the rubber seals on the lower part of the cylinder liner.
2. Put the filler band completely in clean engine oil for a moment.
3. Install filler band (3) in the groove under the liner flange without delay.
4. Install the liner in the bore immediately, before the filler band expands.

(1) New cylinder liner bore .....  $139.685 \pm 0.025$  mm  
( $5.4994 \pm 0.0010$  inch)

(2) Thickness of cylinder liner  
flange .....  $8.890 \pm 0.020$  mm  
( $0.3500 \pm 0.0008$  inch)

Minimum recommended thickness of the cylinder  
liner flange .....  $8.870$  mm ( $0.3492$  inch)

(3) Filler band

**Note:** Refer to Guideline for Reusable Parts, SEBF8068.

i02003609

# Crankshaft

SMCS Code: 1202

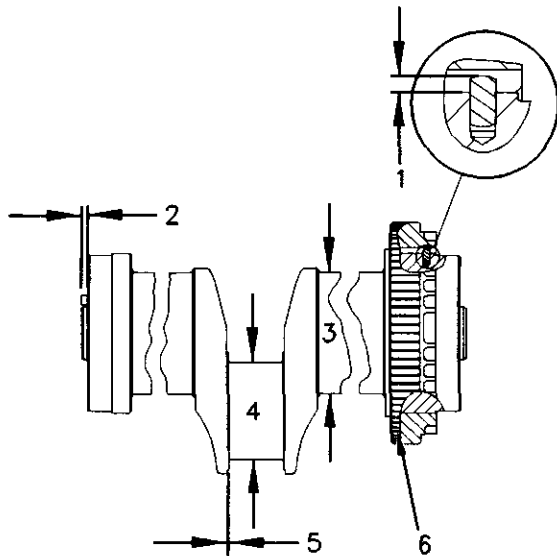


Illustration 45

g00955608

**Note:** For the correct procedure on measuring for a bent crankshaft, refer to the Guideline for Reusable Parts, SEBF8054, "Procedure to Measure and Straighten Crankshafts".

- (1) The length of the dowel from the surface of the crankshaft .....  $4.1 \pm 0.5$  mm ( $0.16 \pm 0.02$  inch)
- (2) The length of the dowel from the surface of the crankshaft ..... 6.4 mm (0.25 inch)
- (3) Main bearing journal
- (4) Connecting rod bearing journal

Refer to Specifications, "Connecting Rod Bearing Journal" and Specifications, "Main Bearing Journal" for more information about the crankshaft journals.

- (5) Crankshaft end play
  - The end play for the crankshaft (new) ..... 0.15 to 0.55 mm (0.007 to 0.022 inch)
  - The maximum permissible end play with used bearings ..... 0.89 mm (0.035 inch)

- (6) Timing gear

**Note:** The timing mark "V" must be oriented to the front of the crankshaft when the gear is installed.

# Crankshaft Seals

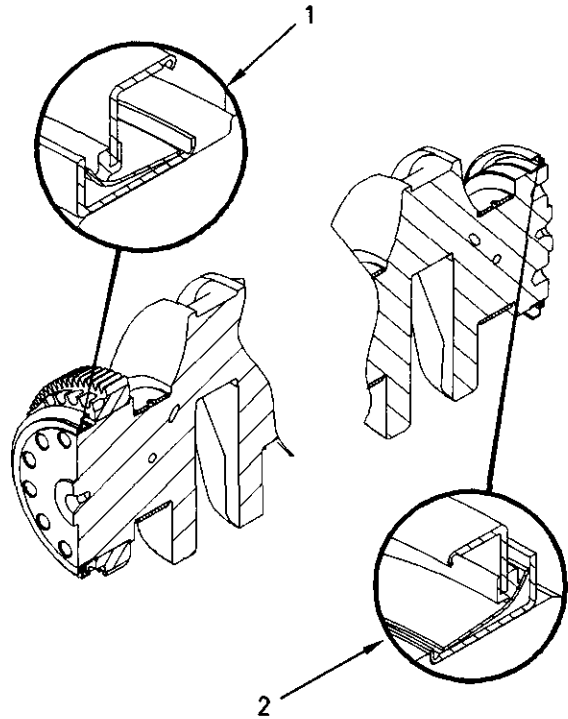


Illustration 46

g00960341

**Note:** Refer to Special Instruction, SMHS8508, "Special Handling Information and Installation Instructions for Crankshaft Seal Groups That Have Hydrodynamic Grooves In the Sealing Lip" for the correct procedure on the installation of the front and the rear seals..

**Note:** Do not separate the seal from the sleeve. If the seal is separated from the sleeve, the seal must be replaced.

- (1) Front crankshaft seal

During installation, the seal driver should not contact the seal within the following diameter. ....  $177.80 \pm 0.25$  mm ( $7.000 \pm 0.010$  inch)

After installation, the face of the seal's wear sleeve should be flush with the front face of the crankshaft with the following tolerance. ....  $-0.13$  to  $0.13$  mm ( $-0.005$  to  $0.005$  inch)

After installation, the front face of the seal's casing should be within the following dimension from the front face of the crankshaft. ....  $5.28 + 0.00 - 0.60$  mm ( $0.208 + 0.000 - 0.024$  inch)

After installation, the face of the seal's casing must be parallel with the front face of the crankshaft within the following tolerance. ....  $\pm 0.13$  mm ( $\pm 0.005$  inch)

(2) Rear crankshaft seal

i01157258

During installation, the seal driver should not contact the seal within the following diameter. .... 177.80 ± 0.25 mm  
(7.000 ± 0.010 inch)

After installation, the face of the seal's wear sleeve should be within the following dimension from the rear face of the crankshaft. .... 1.5 ± 0.5 mm  
(0.06 ± 0.02 inch)

After installation, the face of the seal's casing should be within the following dimension from the rear face of the crankshaft. .... 6.4 + 0.0 - 0.6 mm  
(0.25 + 0.00 - 0.03 inch)

After installation, the face of the seal's casing must be parallel with the rear face of the crankshaft within the following tolerance. .... ± 0.13 mm  
(± 0.005 inch)

i01086162

**Vibration Damper**

**SMCS Code:** 1205

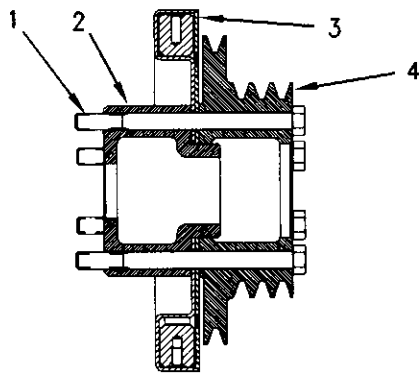


Illustration 47  
Typical example

g00379837

**NOTICE**

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

(1) Bolt

Apply 4C-5593 Anti-Seize Compound to the bolts.

(2) Adapter

(3) Damper assembly

(4) Pulley

**Connecting Rod Bearing Journal**

**SMCS Code:** 1202; 1219; 1225

Refer to Guideline For Reusable Parts, SEBF8009, "Main and Connecting Rod Bearings" and Guideline For Reusable Parts, SEBF8041, "Crankshaft Measurements".

Table 1

Connecting Rod Bearing Journal	
Original Size Journal	90.000 ± 0.020 mm (3.5433 ± 0.0008 inch)
Undersize Journal 0.63 mm (0.025 inch)	89.370 ± 0.020 mm (3.5185 ± 0.0008 inch)
Undersize Journal 1.27 mm (0.050 inch)	88.730 ± 0.020 mm (3.4933 ± 0.0008 inch)

Clearance between the new bearing and the journal ..... 0.062 mm to 0.160 mm  
(0.0024 inch to 0.0063 inch)

Maximum permissible clearance between the bearing and the journal ..... 0.20 mm (0.008 inch)

i01338954

**Main Bearing Journal**

**SMCS Code:** 1202; 1203

Table 2

Diameter of Crankshaft Journal (Bearing Surface) for Main Bearings	
Original Size	120.650 ± 0.020 mm (4.7500 ± .0008 inch)
Undersize Journal 0.63 mm (.025 inch)	120.015 ± 0.020 mm (4.7250 ± .0008 inch)
Undersize Journal 1.27 mm (.050 inch)	119.380 ± 0.020 mm (4.7000 ± .0008 inch)

Clearance between new bearing and new journal ..... 0.091 ± 0.186 mm (.0036 ± .0073 inch)

Maximum permissible clearance between bearing and journal ..... 0.25 mm (.010 inch)

i01157275

# Connecting Rod

**SMCS Code:** 1218

Refer to Special Instruction, SMHS7366, "Using the 5P-2050 Connecting Rod Checking Fixture" for information on checking and on reconditioning connecting rods. Also refer to Guideline For Reusable Parts, SEBF8064, "Salvage Of Non-Serrated Connecting Rods".

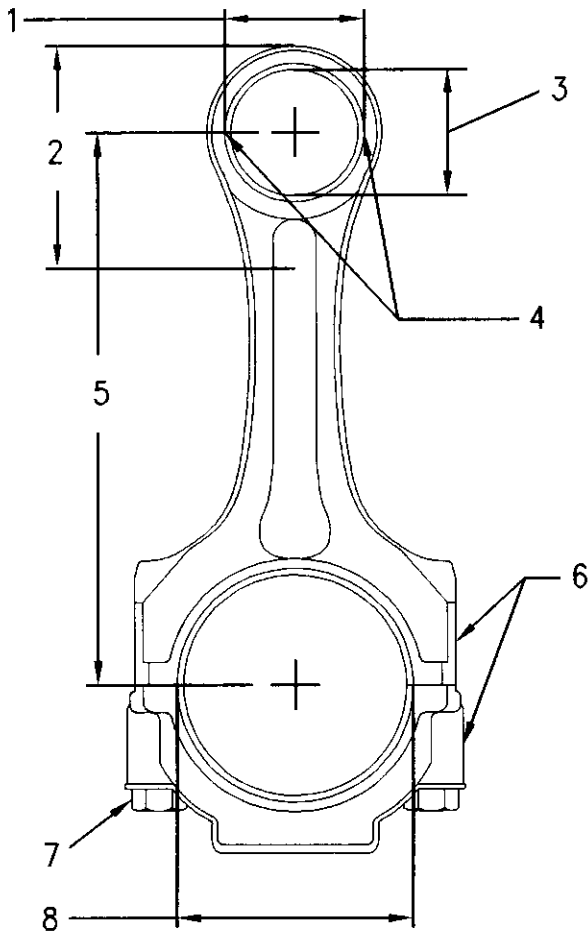


Illustration 48

g00490254

- (1) Bore in connecting rod for the piston pin bearing .....  $59.640 \pm 0.013$  mm ( $2.3480 \pm 0.0005$  inch)

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

- (2) The connecting rod must be heated from 175 to 260 °C (347 to 468 °F) for the installation of the piston pin bearing. Maximum distance for heating the connecting rod .. 85.0 mm (3.35 inch)

- (3) Piston pin bearing bore diameter .....  $55.035 \pm 0.008$  mm ( $2.1667 \pm 0.0003$  inch)

Thoroughly lubricate the piston pin with clean engine oil prior to assembly of the piston and the connecting rod.

- (4) The bearing joint must be within  $\pm 5$  degrees at either location.
- (5) Distance between the centers of bearings .....  $261.62 \pm 0.05$  mm ( $10.300 \pm 0.002$  inch)

- (6) Etch the cylinder number on the connecting rod and the cap in this location. Mark the connecting rod and the cap with a number 1 through 6. Mark the numbers on the same side of the connecting rod as the bearing tab slots.

### (7) Connecting rod bolts

Use the following procedure in order to tighten the connecting rod bolts.

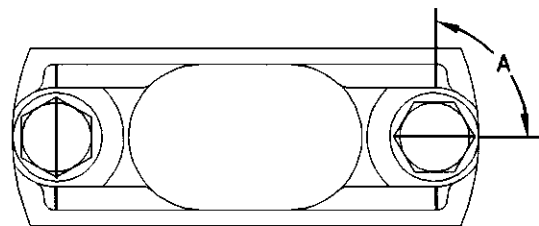


Illustration 49

g00577290

Torque-turn tightening method for connecting rod cap bolts

1. Lubricate the bolt threads and the seating faces of the caps with 4C-5593 Anti-Seize Compound.
2. Tighten the connecting rod bolts.  
Torque for bolts .....  $90 \pm 8$  N·m ( $65 \pm 6$  lb ft)
3. Put a mark on each bolt and each cap.
4. Tighten each bolt from the mark to angle (A).  
Angle (A) .....  $90 \pm 5$  degrees (1/4 turn)
- (8) Bore in the connecting rod for the bearing for the crankshaft connecting rod journal .....  $96.200 \pm 0.013$  mm ( $3.7874 \pm 0.0005$  inch)

i02015217

# Piston and Rings

**SMCS Code:** 1214; 1215

**S/N:** 9NN1-Up

**S/N:** 8AZ1-Up

Refer to Guideline for Reusable Parts, SEBF8049, "Pistons" and Guideline for Reusable Parts, SEBF8051, "Piston Pins and Retaining Rings".

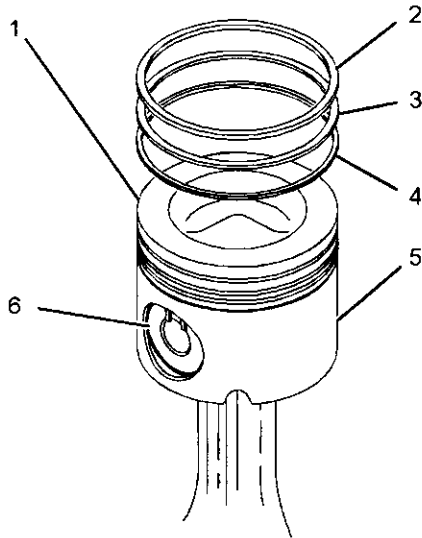


Illustration 50

g01041839

Thoroughly lubricate the outer surface of the piston and the piston rings with clean engine oil before installation in the cylinder block.

(1) Piston crown assembly

(2) Top piston ring

Install the top ring with the side marked "UP-1" toward the top of the piston.

When the piston ring is installed in a cylinder liner that has a bore size of 137.16 mm (5.400 inch), the clearance between the ends of the piston ring is the following value. .... 0.55 ± 0.15 mm (0.023 ± 0.006 inch)

(3) Intermediate ring

Install the intermediate ring with the side marked "UP-2" toward the top of the piston.

When the piston ring is installed in a cylinder liner that has a bore size of 137.16 mm (5.400 inch), the clearance between the ends of the piston ring is the following value. .... 0.83 ± 0.15 mm (0.033 ± 0.006 inch)

(4) Oil control ring

The spring ends of the oil control ring should be assembled 180° from the ring end gap.

Width of the groove in a new piston for the oil control ring ..... 4.03 ± 0.01 mm (0.159 ± 0.001 inch)

Thickness of the new oil control ring ..... 3.98 ± 0.01 mm (0.1567 ± 0.0004 inch)

Clearance between the groove and the new oil control ring ..... 0.05 ± 0.02 mm (0.002 ± 0.001 inch)

Maximum permissible clearance between the groove and the oil control ring after use ..... 0.15 mm (0.006 inch)

When the oil control ring is installed in a cylinder liner that has a bore size of 137.16 mm (5.400 inch), the clearance between the ends of the piston ring is the following value. .... 0.55 ± 0.15 mm (0.022 ± 0.006 inch)

For each 0.03 mm (0.001 inch) increase in the cylinder liner bore size, the clearance between the ends of the piston ring increases by 0.08 mm (0.003 inch).

**Note:** The rings should be positioned with the gaps of the rings approximately 120° from each other.

(5) Piston skirt

(6) Piston pin

Diameter of the new piston pin ... 55.000 ± 0.005 mm (2.1654 ± 0.0002 inch)  
Length of the piston pin ..... 113.20 ± 0.15 mm (4.457 ± 0.006 inch)

Thoroughly lubricate the piston pin with clean engine oil prior to assembly.

Bore in the piston crown bearing for the piston pin ... 55.047 ± 0.008 mm (2.1672 ± 0.0003 inch)  
Bore in the piston skirt for the piston pin ... 55.013 ± 0.004 mm (2.1659 ± 0.0002 inch)

i01042072

## Piston and Rings

**SMCS Code:** 1214; 1215

**S/N:** BGA1-Up

**S/N:** CCB1-Up

**S/N:** EPE1-Up

**S/N:** C1G1-Up

**S/N:** C3G1-Up

**S/N:** C4G1-Up

**S/N:** CAH1-Up

**S/N:** GHJ1-Up

**S/N:** CBX1-Up

Refer to Guideline for Reusable Parts, SEBF8049, "Pistons" and Guideline for Reusable Parts, SEBF8051, "Piston Pins and Retaining Rings".

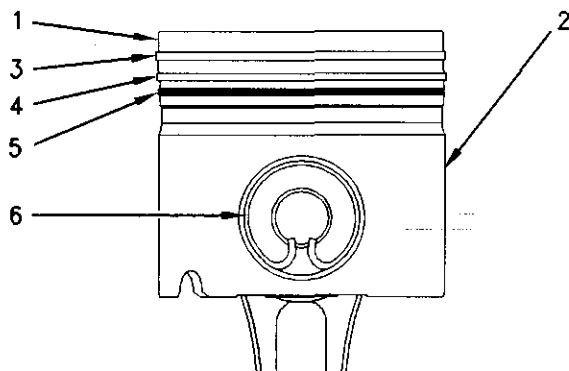


Illustration 51

g00514913

Thoroughly lubricate the outer surface of the piston and the piston rings with clean engine oil before installation in the cylinder block.

(1) Piston crown assembly

(2) Piston skirt

(3) Top piston ring

Install the top ring with the side marked "UP-1" toward the top of the piston.

When the piston ring is installed in a cylinder liner that has a bore size of 139.66 mm (5.498 inch), the clearance between the ends of the piston ring is the following value. .... 0.50 ± 0.10 mm  
(0.020 ± 0.004 inch)

(4) Intermediate ring

Install the intermediate ring with the side marked "UP-2" toward the top of the piston.

When the piston ring is installed in a cylinder liner that has a bore size of 139.66 mm (5.498 inch), the clearance between the ends of the piston ring is the following value. .... 0.83 ± 0.15 mm  
(0.033 ± 0.006 inch)

(5) Oil control ring

The spring ends of the oil control ring should be assembled 180 degrees from the ring end gap.

Width of the groove in a new piston for the oil control ring ..... 4.033 ± 0.013 mm  
(0.1588 ± 0.0005 inch)

Thickness of the new oil control ring .... 3.980 ± 0.010 mm (0.1567 ± 0.0004 inch)

Clearance between the groove and the new oil control ring ..... 0.053 ± 0.023 mm  
(0.0021 ± 0.0009 inch)

Maximum permissible clearance between the groove and the oil control ring after use ..... 0.15 mm (0.006 inch)

When the oil control ring is installed in a cylinder liner that has a bore size of 139.66 mm (5.498 inch), the clearance between the ends of the piston ring is the following value. .... 0.450 ± 0.150 mm  
(0.0177 ± 0.0059 inch)

For each 0.03 mm (0.001 inch) increase in the cylinder liner bore size, the clearance between the ends of the piston ring increases by 0.08 mm (0.003 inch).

**Note:** The rings should be positioned with the gaps of the rings approximately 120 degrees from each other.

(6) Piston pin bore

Thoroughly lubricate the piston pin with clean engine oil prior to assembly.

Bore in the piston crown bearing for the piston pin ..... 55.0355 ± 0.0055 mm  
(2.1667 ± 0.0002 inch)

Bore in the piston skirt for the piston pin ... 55.020 ± 0.005 mm (2.1661 ± 0.0002 inch)

Diameter of the new piston pin ... 55.000 ± 0.005 mm (2.1654 ± 0.0002 inch)

Length of the piston pin ..... 113.20 ± 0.15 mm  
(4.457 ± 0.006 inch)

i01560865

## Housing (Front)

SMCS Code: 1151

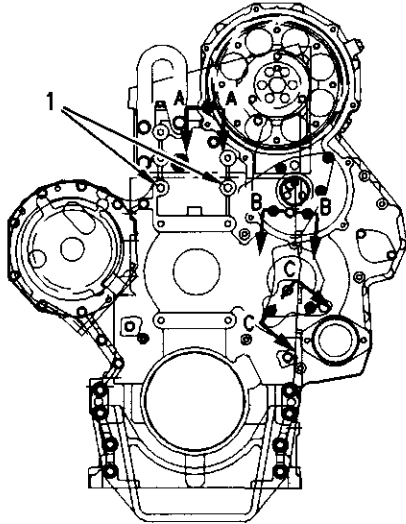


Illustration 52  
Typical Example  
g00547095

### (1) Studs

Tighten the studs that are in the block to the following torque. ....  $102 \pm 10 \text{ N}\cdot\text{m}$  ( $75 \pm 7 \text{ lb ft}$ )

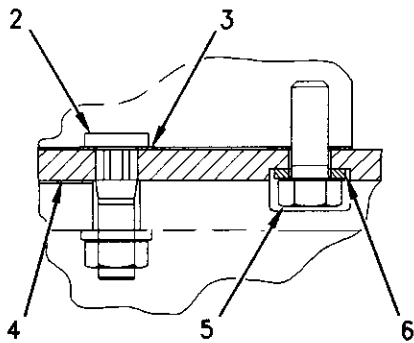


Illustration 53  
Typical example of View A-A, View B-B, and View C-C  
g00550498

### (2) Brake stud

Apply 155-0695 Thread Lock Compound to the serrations of brake stud (2) prior to installation.

### (3) Sealing washer

### (4) Plate

### (5) Bolt

Use the following procedure in order to tighten the bolts that fasten the plate to the cylinder block.

### 1. Use hand tools to tighten the bolts.

Tighten the bolts to the following torque. ....  $55 \pm 5 \text{ N}\cdot\text{m}$  ( $40 \pm 4 \text{ lb ft}$ )

### 2. Use hand tools to tighten the bolts again.

Tighten the bolts to the following torque. ....  $55 \pm 5 \text{ N}\cdot\text{m}$  ( $40 \pm 4 \text{ lb ft}$ )

### (6) Belleville washer

**Note:** Apply 8T-9022 Silicone Gasket in order to fill the space at the connecting joint of the front plate, oil pan gasket, and cylinder block.

i02145609

## Gear Group (Front)

SMCS Code: 1206

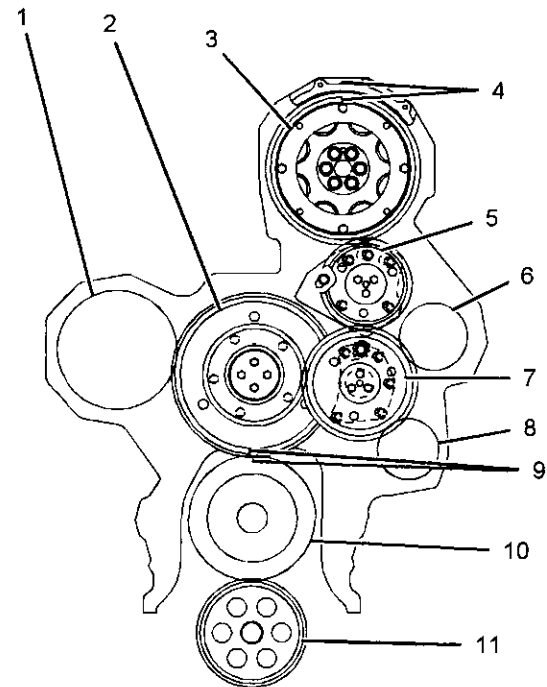


Illustration 54  
g01090281

### (1) Water pump drive gear

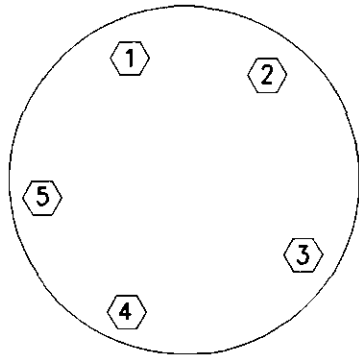


Illustration 55  
Stub shaft for cluster gear g00537659

(2) Cluster gear

Apply 9S-3263 Thread Lock Compound to the five bolts for the stub shaft.

Tighten the five bolts for the stub shaft in the following sequence. See Illustration 55 for the numbering of the bolts. .... 1, 3, 4, 5, 2, 1, 2, 3, 4, 5, 1

Apply 9S-3263 Thread Lock Compound to the four bolts that fasten the cluster gear to the stub shaft.

Tighten the four bolts that fasten the cluster gear to the stub shaft to the following torque. ....  $30 \pm 7 \text{ N}\cdot\text{m}$  ( $22 \pm 5 \text{ lb}\cdot\text{ft}$ )

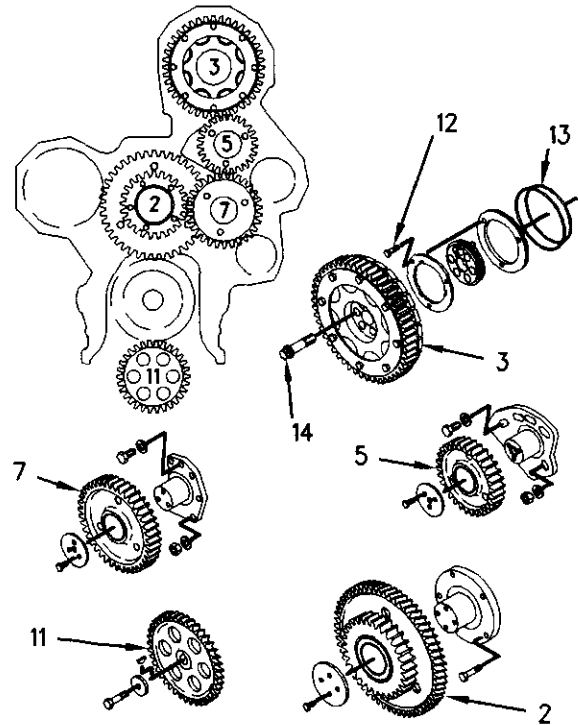


Illustration 56 g00818810  
(3) Camshaft gear  
(12) Camshaft retainer bolts  
(13) Seals  
(14) Camshaft gear bolts

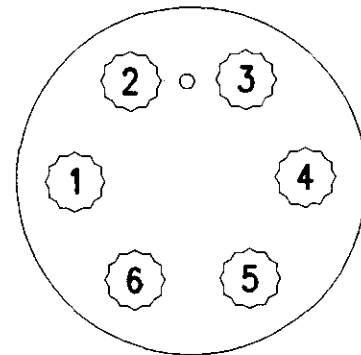


Illustration 57 g00593987  
Torque sequence for the camshaft gear

(4) Align the timing mark on the camshaft gear with the timing mark on the front housing when the No. 1 piston is at top center.

(3) Camshaft gear

Lightly lubricate the O-ring seal on the outside of the camshaft sealing plate with a 50/50 mixture of 8T-2998 Lubricant and clean engine oil. Apply 9S-3263 Thread Lock Compound to the three bolts for the camshaft sealing plate.

Tighten the three camshaft sealing plate bolts to the following torque. See Illustration 56. ....  $12 \pm 3 \text{ N}\cdot\text{m}$  ( $9 \pm 2 \text{ lb ft}$ )  
Tighten the camshaft bolts in the following sequence. See Illustration 57 for the numbering of the bolts. .... 1, 4, 2, 5, 3, 6, 1, 4  
Tighten the six camshaft gear bolts to the following torque. ....  $240 \pm 40 \text{ N}\cdot\text{m}$  ( $177 \pm 30 \text{ lb ft}$ )

(5) Adjustable idler gear

Install the plate with the oil groove toward the gear face. Apply 9S-3263 Thread Lock Compound to the three bolts that fasten the adjustable idler gear to the stub shaft.

Tighten the three bolts for the adjustable idler gear to the stub shaft to the following torque. ....  $30 \pm 7 \text{ N}\cdot\text{m}$  ( $22 \pm 5 \text{ lb ft}$ )

Refer to Testing and Adjusting, "Gear Group (Front) - Time" for the backlash adjustment procedure.

Backlash between the camshaft gear and the adjustable idler gear .....  $0.216 \pm 0.114 \text{ mm}$   
( $0.0085 \pm 0.0045 \text{ inch}$ )

Apply 9S-3263 Thread Lock Compound to the one bolt and five studs for the stub shaft.

Tighten the one bolt and five nuts for the stub shaft to the following torque. ....  $55 \pm 10 \text{ N}\cdot\text{m}$   
( $41 \pm 7 \text{ lb ft}$ )

(6) Air compressor gear (if equipped)

(7) Idler gear

Apply 9S-3263 Thread Lock Compound to the one bolt and five studs for the stub shaft.

Tighten the one bolt and five nuts for the stub shaft to the following torque. ....  $55 \pm 10 \text{ N}\cdot\text{m}$   
( $41 \pm 7 \text{ lb ft}$ )

Apply 9S-3263 Thread Lock Compound to the three bolts that fasten the idler gear to the stub shaft.

Tighten the three bolts that fasten the idler gear to the stub shaft to the following torque. ....  $30 \pm 7 \text{ N}\cdot\text{m}$  ( $22 \pm 5 \text{ lb ft}$ )

(8) Gear for the fuel transfer pump drive

(9) Align the timing mark on the crankshaft gear with the timing mark on the cluster gear.

(10) Crankshaft gear

(11) Oil pump drive gear

i02044332

## Flywheel

SMCS Code: 1156

S/N: 9NN1-Up

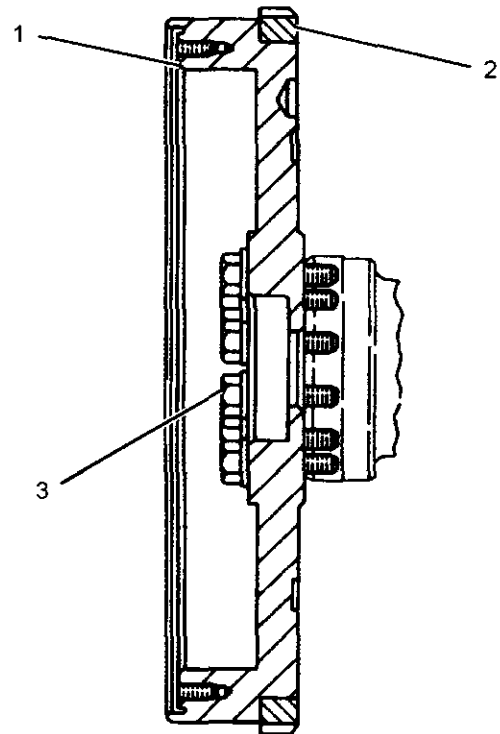


Illustration 58

g01090276

(1) Flywheel

(2) Flywheel ring gear

**Note:** Do not heat the ring gear with a torch.

(3) Bolt

Apply engine oil to the threads of the bolts.

Tighten the bolts to the following torque. ....  $360 \pm 25 \text{ N}\cdot\text{m}$  ( $265 \pm 20 \text{ lb ft}$ )

i02171970

i02164321

# Flywheel

SMCS Code: 1156

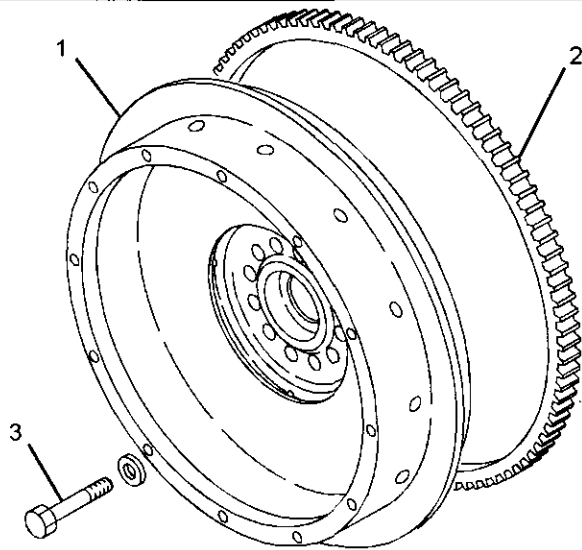


Illustration 59

g01100782

- (1) Flywheel
- (2) Flywheel ring gear

**Note:** Do not heat the ring gear with a torch.

- (3) Bolt

Apply engine oil to the threads of the bolts.  
Tighten the bolts to the following torque. .... 270 ± 40 N·m (200 ± 30 lb ft)

# Flywheel Housing

SMCS Code: 1157

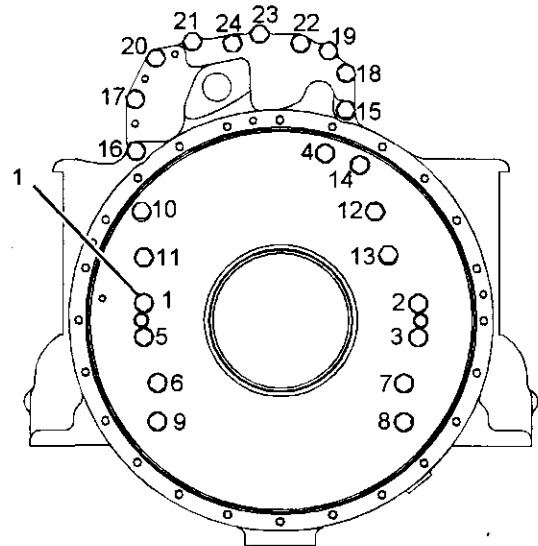


Illustration 60

g01097720

Typical example

**Note:** During assembly, inspect the following components for any foreign materials: the front face of the flywheel housing, the two sides of the flywheel housing gasket, and the rear face of the cylinder block. These components must be free of the following substances: oil, fuel, water, gasket adhesive, assembly compounds, and any other foreign material. Apply a small amount of 8T-9022 Silicone Gasket in order to fill the space between the cylinder block, the flywheel housing, and the oil pan before installing the oil pan gasket and the oil pan.

- (1) To tighten the flywheel housing bolts, use the procedure that follows:
  1. In a numerical sequence, tighten bolt 1 through bolt 9.  
  
Torque for bolts ..... 100 ± 20 N·m (74 ± 15 lb ft)
  2. In a numerical sequence, tighten bolt 10 through bolt 24.  
  
Torque for bolts ..... 40 ± 10 N·m (30 ± 7 lb ft)
  3. In a numerical sequence, again tighten bolt 1 through bolt 9.  
  
Torque for bolts ..... 135 ± 20 N·m (100 ± 15 lb ft)
  4. In a numerical sequence, again tighten bolt 10 through bolt 24.  
  
Torque for bolts ..... 55 ± 10 N·m (41 ± 7 lb ft)

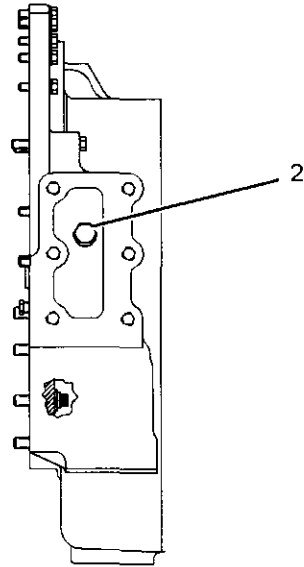


Illustration 61  
Typical example

g01097730

(2) Plug

Tighten the plugs to the following torque. .... 55 ± 14 N·m (41 ± 10 lb ft)

i02103416

## Flywheel Housing

SMCS Code: 1157

S/N: 9NN1-Up

**Note:** During assembly, inspect the following components for any foreign materials: the front face of the flywheel housing, the two sides of the flywheel housing gasket and the rear face of the cylinder block. These components must be free of the following substances: oil, fuel, water, gasket adhesive, assembly compounds, and any other foreign material. Apply a small amount of 8T-9022 Silicone Gasket in order to fill the space between the cylinder block, the flywheel housing, and the oil pan before installing the oil pan gasket and the oil pan. The components must be assembled within twenty minutes of applying the sealant.

Use the following procedure to tighten the flywheel housing bolts.

1. Tighten the bolt (1) through bolt (9) in the proper numerical sequence to 100 ± 20 N·m (74 ± 15 lb ft).
2. Tighten bolt (10) through bolt (22) in the proper numerical sequence to 40 ± 10 N·m (30 ± 7 lb ft).
3. Tighten bolt (1) through bolt (9) again in the proper numerical sequence to 135 ± 20 N·m (100 ± 15 lb ft).
4. Tighten bolt (10) through bolt (22) again in the proper numerical sequence to 55 ± 10 N·m (41 ± 7 lb ft).

i01617888

## Belt Tension Chart

SMCS Code: 1357

**Note:** Do not use the belt tension charts for belts with tensioners that are spring loaded.

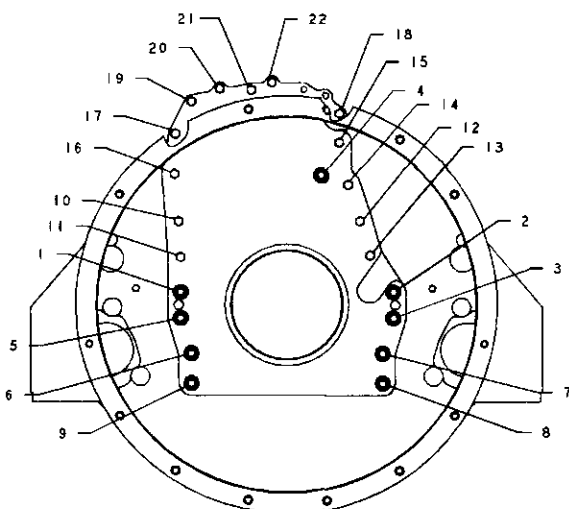


Illustration 62

g01071470

Numerical torque sequence for the 130-4680 Flywheel Housing Gp bolts

Table 3

Belt Tension Chart					
Size of Belt	Width of Belt	Gauge Reading		Kent-Moore Gauge Numbers	
		Belt Tension "Initial" <sup>(1)</sup>	Belt Tension "Used" <sup>(2)(3)</sup>	Number of the Old Gauge	Number of the New Gauge
3/8	10.72 mm (0.422 inch)	534 ± 111 N (120 ± 25 lb)	400 ± 22 N (90 ± 5 lb)	BT-33-97	BT 3397
1/2	13.89 mm (0.547 Inch)	578 ± 111 N (130 ± 25 lb)	445 ± 44 N (100 ± 10 lb)	BT-33-97	BT 3397
5V	15.88 mm (0.626 Inch)	712 ± 111 N (160 ± 25 lb)	445 ± 44 N (100 ± 10 lb)	BT-33-72C	BT 3372C
11/16	17.48 mm (0.688 Inch)	712 ± 111 N (160 ± 25 lb)	445 ± 44 N (100 ± 10 lb)	BT-33-72C	BT 3372C
3/4	19.05 mm (0.750 Inch)	712 ± 111 N (160 ± 25 lb)	445 ± 44 N (100 ± 10 lb)	BT-33-72C	BT 3372C
15/16	23.83 mm (0.938 Inch)	712 ± 111 N (160 ± 25 lb)	445 ± 44 N (100 ± 10 lb)	BT-33-77	BT 3372C
8PK	27.82 mm (1.095 inch)	1068 ± 111 N (240 ± 25 lb)	890 ± 44 N (200 ± 10 lb)	BT-33-109	BT 33109
6PK	20.94 mm (0.824 Inch)	801 ± 111 N (180 ± 25 lb)	667 ± 44 N (150 ± 10 lb)	BT-33-109	BT 33109

**Measure the tension of the belt that is farthest from the engine.**

(1) Belt tension "Initial" is for a new belt.

(2) Belt tension "Used" is for a belt that has operated for 30 minutes or more of operation at the rated speed.

(3) If a belt falls below the "Used" belt tension, the belt should be tightened again to the high side of the "Used" belt tension.

Table 4

For DAYCO Supplied Belts Only		
Size of Belt	Belt Tension "Initial" <sup>(1)</sup>	Belt Tension "Used" <sup>(2)(4)</sup>
.380 (V-Belt)	623 ± 22 N (140 ± 5 lb)	245 - 534 N (100 ± 5 lb)
.440 (V-Belt)	667 ± 22 N (150 ± 5 lb)	245 - 534 N (100 ± 5 lb)
.500 (V-Belt)	712 ± 22 N (160 ± 5 lb)	245 - 534 N (100 ± 5 lb)
.600 (V-Belt)	779 ± 22 N (175 ± 5 lb)	245 - 534 N (100 ± 5 lb)
.660 (V-Belt)	890 ± 22 N (200 ± 5 lb)	245 - 534 N (100 ± 5 lb)
.790 (V-Belt)	890 ± 22 N (200 ± 5 lb)	245 - 534 N (100 ± 5 lb)
4 - RIB PVK	623 ± 22 N (140 ± 5 lb)	267 - 445 N (90 ± 5 lb)
5 - RIB PVK	779 ± 22 N (175 ± 5 lb)	334 - 556 N (100 ± 5 lb)
6 - RIB PVK	934 ± 22 N (210 ± 5 lb)	400 - 667 N (130 ± 5 lb)
8 - RIB PVK	1157 ± 22 N (260 ± 5 lb)	534 - 890 N (180 ± 5 lb)
10 - RIB PVK	1557 ± 22 N (350 ± 5 lb)	667 - 1112 N (230 ± 5 lb)
12 - RIB PVK	1869 ± 22 N (420 ± 5 lb)	800 - 1335 N (270 ± 5 lb)
15 - RIB PVK	2336 ± 22 N (525 ± 5 lb)	1000 - 1669 N (350 ± 5 lb)

(1) Belt tension "Initial" is for a new belt.

(2) Belt tension "Used" is for a belt that has operated for 30 minutes or more of operation at the rated speed.

(4) If a belt falls below the "Used" belt tension, the belt should be tightened again to the "Initial" belt tension.

i01780306

## Alternator and Regulator

SMCS Code: 1405; 1410

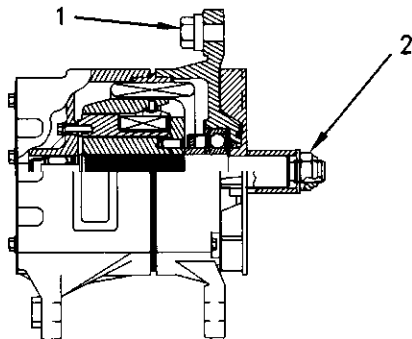


Illustration 63

g00705976

(2) Shaft nut

Tighten the shaft nut to the following torque. ....  $105 \pm 4 \text{ N}\cdot\text{m}$  ( $77 \pm 3 \text{ lb ft}$ )

(3) Terminal nut

Tighten the positive terminal nut to the following torque. ....  $6.2 \pm 0.6 \text{ N}\cdot\text{m}$  ( $54.87 \pm 5.31 \text{ lb in}$ )

(4) Terminal nut

Tighten the ground terminal nut to the following torque. ....  $2.25 \pm 0.25 \text{ N}\cdot\text{m}$  ( $19.914 \pm 2.213 \text{ lb in}$ )

(5) Regulator

Voltage setting ..... No adjustment  
Permissible voltage range ..... 27 to 29 V

i00821305

## Alternator Mounting

SMCS Code: 1405

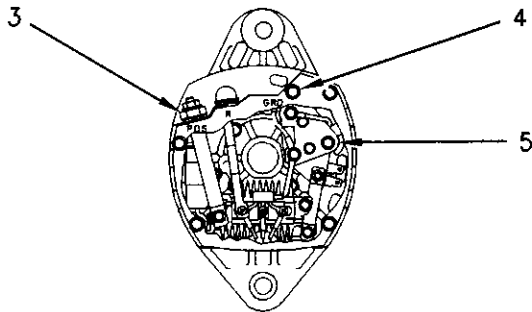


Illustration 64

g00706000

Voltage ..... 24 V

Amperage ..... 45 Amp

**Note:** Load the battery with a carbon pile 4C-4911 Battery Load Tester in order to get the maximum alternator output.

Polarity ..... Negative ground

Rotation ..... Either direction

The minimum full load current at 5000 rpm is the following value. .... 42.3 Amp

The minimum full load current at 2000 rpm is the following value. .... 15.8 Amp

Output voltage .....  $28 \pm 1 \text{ V}$

(1) Bolt

Tighten the bolt to the following torque. ....  $88 \pm 7 \text{ N}\cdot\text{m}$  ( $65 \pm 5 \text{ lb ft}$ )

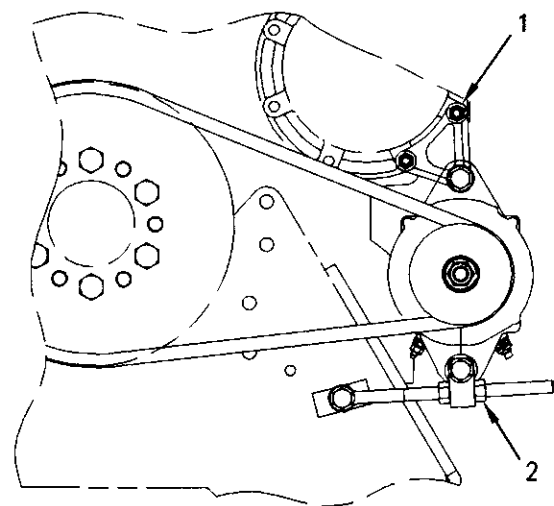


Illustration 65

g00393648

Typical example

(1) Apply 9S-3263 Thread Lock Compound to the studs. Tighten the nuts to the following torque. ....  $70 \pm 5 \text{ N}\cdot\text{m}$  ( $52 \pm 4 \text{ lb ft}$ )

(2) Tighten the nuts to the following torque. ....  $30 \pm 15 \text{ N}\cdot\text{m}$  ( $22 \pm 11 \text{ lb ft}$ )

i02178048

# Electric Starting Motor

SMCS Code: 1453

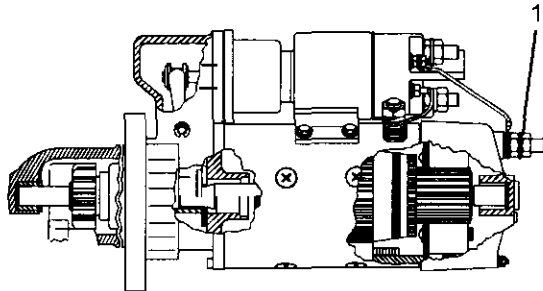


Illustration 66

g01102573

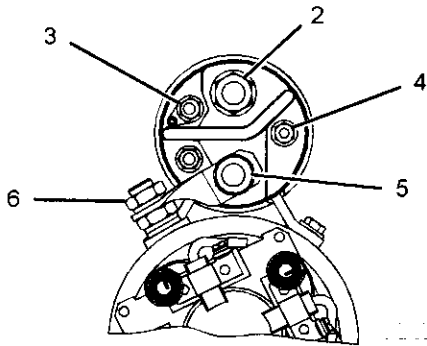


Illustration 67

g01102578

When the electric starting motor is viewed from the pinion end, the motor rotates in the following direction. .... Clockwise

No load conditions at 25 °C (77 °F)

Speed ..... 5500 rpm minimum  
Current draw ..... 140 Amp maximum  
Voltage ..... 24 V

- (1) Tighten the nut on the ground terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (2) Tighten the nut on the battery terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (3) Tighten the nut on the ground terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (4) Tighten the nut on the switch terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (5) Tighten the nut on the motor terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)

- (6) Tighten the nut on the motor frame terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)

## 9X-0332 Solenoid Kit

Current consumption at 25 °C (77 °F)

Pull in windings at 24V ..... 51 Amp  
Hold in windings at 24V ..... 7 Amp

i02178072

# Electric Starting Motor

SMCS Code: 1453

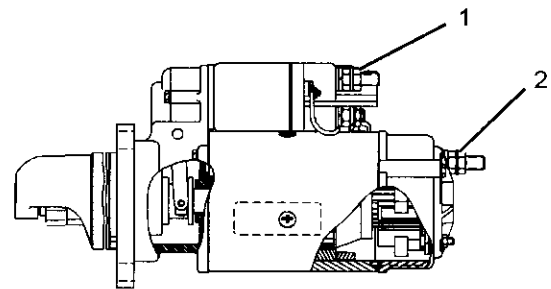


Illustration 68

g01102594

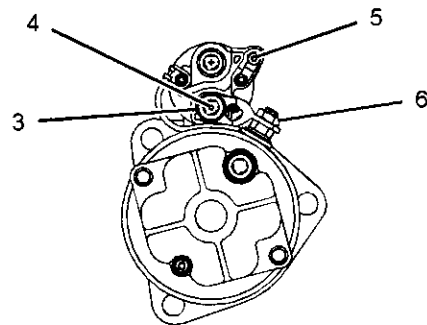


Illustration 69

g01102596

When the electric starting motor is viewed from the pinion end, the motor rotates in the following direction. .... Clockwise

No load conditions at 25 °C (77 °F)

Speed ..... 3300 rpm minimum  
Current draw ..... 80 Amp maximum  
Voltage ..... 23.5 V

- (1) Tighten the nut on the battery terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (2) Tighten the nut on the ground terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)

i02108570

- (3) Tighten the nut on the motor terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (4) Tighten to the following torque. .... 1.5 ± 0.5 N·m (13 ± 4 lb in)
- (5) Tighten the nut on the switch terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (6) Tighten the nut on the motor frame terminal to the following torque. .... 17.5 ± 2.5 N·m (13 ± 2 lb ft)

**3E-0135 Solenoid**

Current consumption at 25 °C (77 °F)

Pull in windings at 24V ..... 103 Amp  
Hold in windings at 24V ..... 19 Amp

## Electric Starting Motor

**SMCS Code:** 1453

**Part No.:** 207 - 1564  
**S/N:** BGA1-Up

**Part No.:** 207 - 1564  
**S/N:** CCB1-Up

**Part No.:** 207 - 1564  
**S/N:** EPE1-Up

**S/N:** C1G1-Up

**Part No.:** 207 - 1564  
**S/N:** C3G1-Up

**S/N:** C4G1-Up

**Part No.:** 207 - 1564  
**S/N:** CAH1-Up

**Part No.:** 207 - 1564  
**S/N:** GHJ1-Up

**Part No.:** 207 - 1564  
**S/N:** 9NN1-Up

**Part No.:** 207 - 1564  
**S/N:** CBX1-Up

**Part No.:** 207 - 1564  
**S/N:** 8AZ1-Up

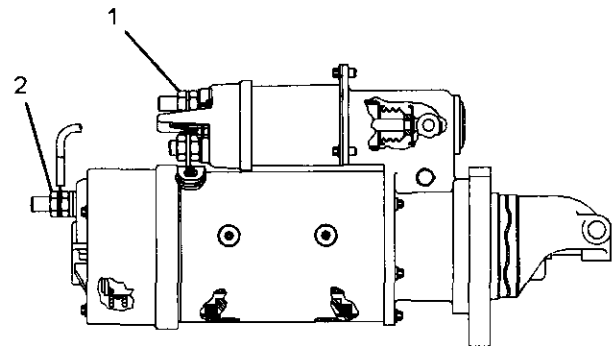


Illustration 70

g01102584

i02178061

## Electric Starting Motor

SMCS Code: 1453

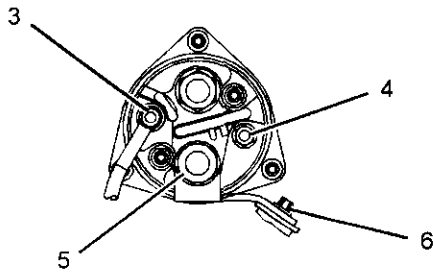


Illustration 71

g01102587

When the electric starting motor is viewed from the drive end, the motor rotates in the following direction. .... Clockwise

No load conditions at 25 °C (77 °F)

Speed ..... 7643 ± 1683 rpm  
Current draw ..... 76.5 ± 14.5 amp  
Voltage ..... 23 V

- (1) Tighten the nut on the battery terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (2) Tighten the nut on the ground terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (3) Tighten the nut on the ground terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (4) Tighten the nut on the switch terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (5) Tighten the nut on the motor terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (6) Tighten the nut on the motor frame terminal to the following torque. .... 8 ± 3 N·m (71 ± 27 lb in)

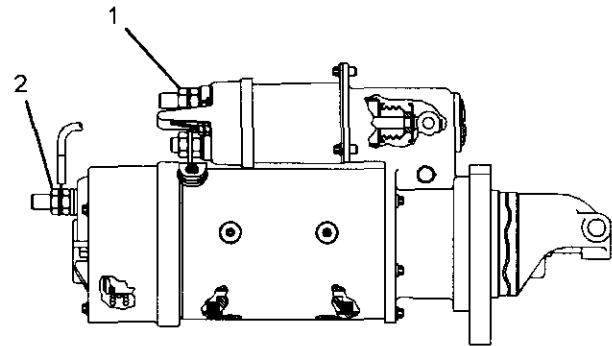


Illustration 72

g01102584

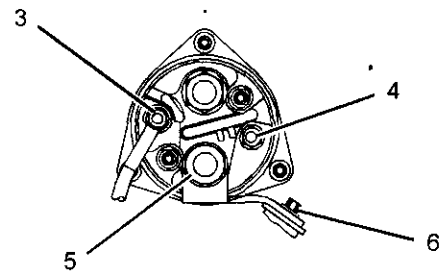


Illustration 73

g01102587

When the electric starting motor is viewed from the pinion end, the motor rotates in the following direction. .... Clockwise

No load conditions at 25 °C (77 °F)

Speed ..... 7643 ± 1683 rpm  
Current draw ..... 67.5 ± 7.5 amp  
Voltage ..... 23 V

- (1) Tighten the nut on the battery terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (2) Tighten the nut on the ground terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)
- (3) Tighten the nut on the ground terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (4) Tighten the nut on the switch terminal to the following torque. ... 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (5) Tighten the nut on the motor terminal to the following torque. .... 30.5 ± 3.5 N·m (22 ± 3 lb ft)

- (6) Tighten the nut on the motor frame terminal to the following torque. ....  $8 \pm 3$  N·m ( $71 \pm 27$  lb in)

i01117693

**9X-9511 Solenoid Assembly**

Current consumption at 25 °C (77 °F)

Pull in windings at 20V .....  $56.5 \pm 4.5$  Amp  
Hold in windings at 20V ..... 14.6 Amp

i01115751

**Electrical Ground Stud**

**SMCS Code:** 1408

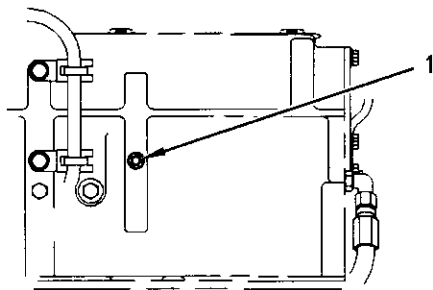


Illustration 74  
Typical example

g00590230

- (1) Nut

Tighten the outer nut on the ground stud to the following torque. ....  $10 \pm 3$  N·m ( $89 \pm 27$  lb in)

**Magnetic Pickup**

**SMCS Code:** 1905; 1907

**S/N:** BGA1-Up

**S/N:** CCB1-Up

**S/N:** EPE1-Up

**S/N:** C1G1-Up

**S/N:** C3G1-Up

**S/N:** C4G1-Up

**S/N:** CAH1-Up

**S/N:** GHJ1-Up

**S/N:** CBX1-Up

**S/N:** 8AZ1-Up

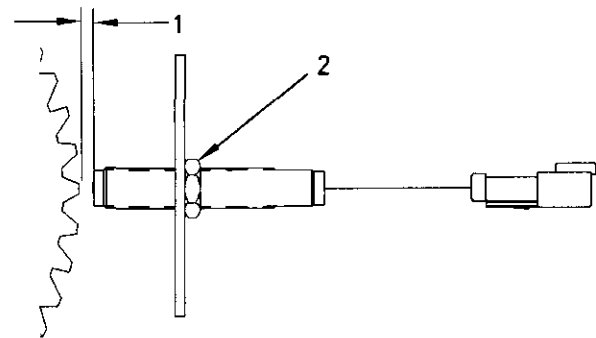


Illustration 75

g00345302

Typical schematic of magnetic pickup

While the engine is stopped, install the magnetic pickup. Once the magnetic pickup is in contact with the flywheel ring gear, turn the magnetic pickup counterclockwise to the following distance. ....  $180 \pm 15$  degrees

- (1) Clearance between magnetic pickup and flywheel ring gear ...  $0.70 \pm 0.14$  mm ( $0.028 \pm 0.006$  inch)
- (2) Install the locknut and tighten the locknut to the following torque. ....  $25 \pm 5$  N·m ( $18 \pm 4$  lb ft)

i01061244

i01999536

## Coolant Temperature Sensor

**SMCS Code:** 1906

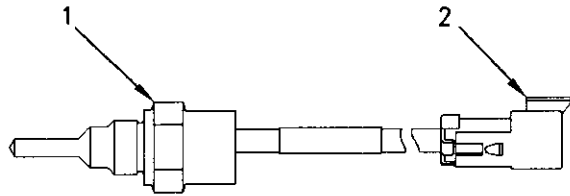


Illustration 76

g00551502

(1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $20 \pm 3 \text{ N}\cdot\text{m}$  ( $15 \pm 2 \text{ lb ft}$ )

(2) Receptacle

## Coolant Level Sensor

**SMCS Code:** 7470-NS

**S/N:** BGA1-Up

**S/N:** CCB1-Up

**S/N:** C1G1-Up

**S/N:** C3G1-Up

**S/N:** C4G1-Up

**S/N:** CAH1-Up

**S/N:** GHJ1-Up

**S/N:** 9NN1-Up

**S/N:** CBX1-Up

**S/N:** 8AZ1-Up

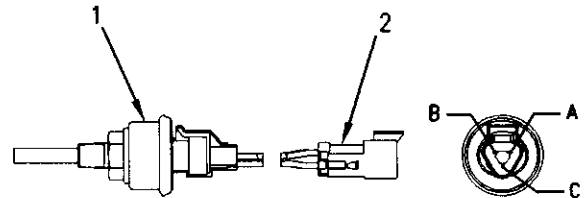


Illustration 77

g00509267

(1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $22 \pm 3 \text{ N}\cdot\text{m}$  ( $16 \pm 2 \text{ lb ft}$ )

(2) Plug with socket A, socket B, and socket C

i00996813

i02164354

### Coolant Level Sensor

SMCS Code: 7470-NS

S/N: BGA1-Up

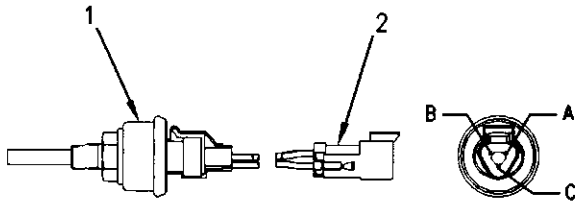


Illustration 78

g00509267

- (1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $30 \pm 5 \text{ N}\cdot\text{m}$  ( $22 \pm 4 \text{ lb ft}$ )

- (2) Plug with socket A, socket B, and socket C

i01061247

### Fuel Temperature Sensor

SMCS Code: 1922

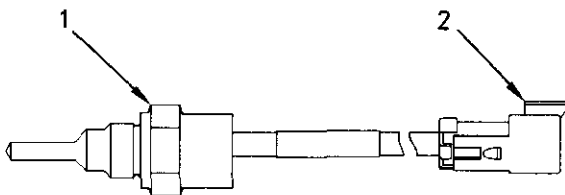


Illustration 79

g00551502

- (1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $20 \pm 3 \text{ N}\cdot\text{m}$  ( $15 \pm 2 \text{ lb ft}$ )

- (2) Receptacle

### Fuel Pressure Sensor

SMCS Code: 1718

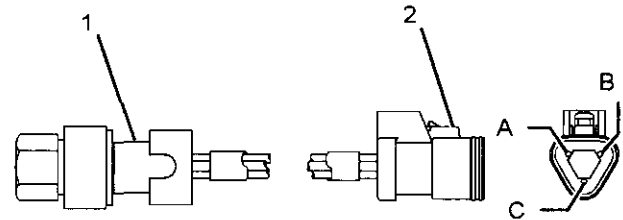


Illustration 80

g01096518

- (1) Sensor Assembly

Tighten the sensor assembly to the following torque. ....  $10 \pm 2 \text{ N}\cdot\text{m}$  ( $90 \pm 18 \text{ lb in}$ )

- (2) Plug with socket A, socket B, and socket C

i02162406

### Engine Oil Pressure Sensor

SMCS Code: 1924

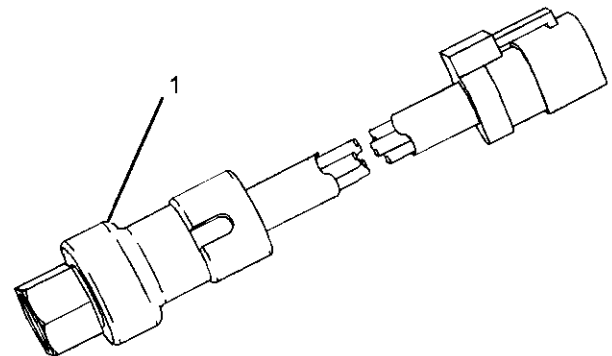


Illustration 81

g01068621

- (1) Sensor assembly

Tighten sensor assembly to the following torque. ....  $10 \pm 2 \text{ N}\cdot\text{m}$  ( $90 \pm 18 \text{ lb in}$ )

i02079756

i02162416

## Atmospheric Pressure Sensor

SMCS Code: 1923

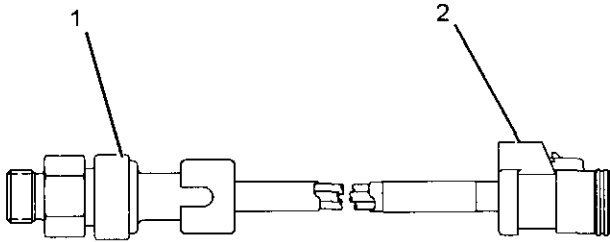


Illustration 82

g01100304

- (1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $10 \pm 2$  N·m ( $90 \pm 18$  lb in)

- (2) Plug

i01182162

## Inlet Air Temperature Sensor

SMCS Code: 1921

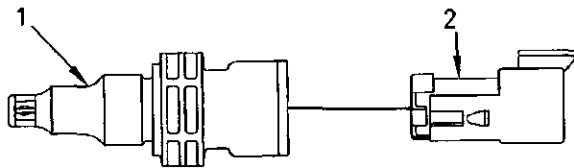


Illustration 83

g00285681

Typical example

- (1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $15 \pm 3$  N·m ( $11 \pm 2$  lb ft)

- (2) Receptacle

## Turbocharger Outlet Pressure Sensor

SMCS Code: 1917

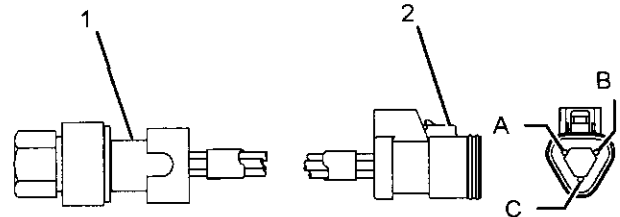


Illustration 84

g01096518

- (1) Sensor assembly

Tighten the sensor assembly to the following torque. ....  $10 \pm 2$  N·m ( $90 \pm 18$  lb in)

- (2) Plug with socket A, socket B, and socket C

i01878872

## Speed/Timing Sensor

SMCS Code: 1907; 1912

There are two sensors for timing the engine. There is a speed sensor on the crankshaft in order to determine the position of the crankshaft. This sensor is used during normal engine operation. Another speed sensor is located on the camshaft for starting the engine.

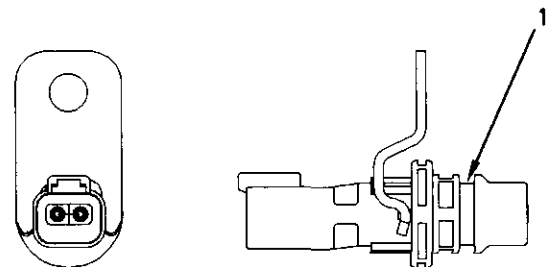


Illustration 85

g00956194

Speed sensor for the crankshaft

Lubricate seal (1) with engine oil before installation.

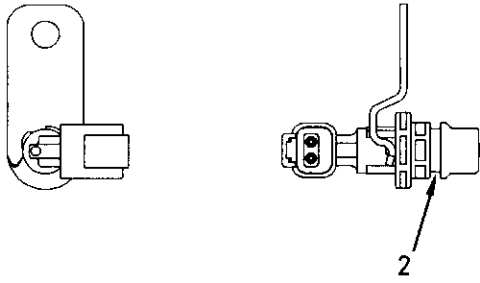


Illustration 86

g00956196

Speed sensor for the camshaft

Lubricate seal (2) with engine oil before installation.

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