



Specifications

C27 and C32 Generator Set Engines

DWB1-Up (Generator Set)
SXC1-Up (Generator Set)
MED1-Up (Power Module)
WDR1-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 "NOTICE" labels on the product and in this publication.

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

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



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

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

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Specifications Section

i02810716

Engine Design

SMCS Code: 1201

S/N: DWB1-Up

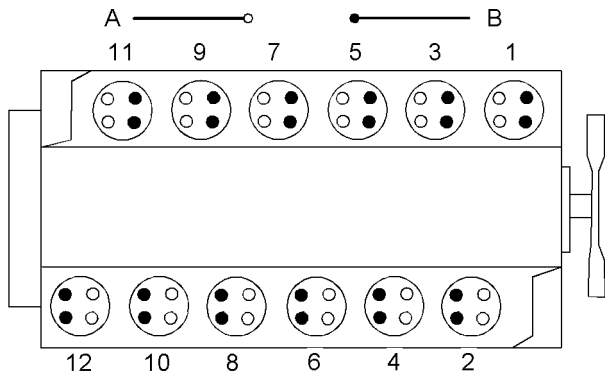


Illustration 1

g01113721

(A) Inlet valves
(B) Exhaust valves

- Bore 137.2 mm (5.40 inch)
- Stroke 152.4 mm (6.00 inch)
- Displacement 27 L (1648 cu in)
- Compression ratio 15:1
- Cylinder arrangement 65 degrees V 12
- Valves per cylinder 4
- Type of combustion Direct injection
- Valve lash with engine stopped (cold)
 - Inlet 0.38 ± 0.08 mm (0.015 ± 0.003 inch)
 - Exhaust 0.76 ± 0.08 mm (0.030 ± 0.003 inch)

Note: The front of the engine is opposite of the flywheel end of the engine. The left side and the right side of the engine are viewed from the flywheel end of the engine. The No. 1 cylinder is the front cylinder on the left side. The No. 2 cylinder is the front cylinder on the right side.

The crankshaft rotation is viewed from the flywheel end of the engine.

Crankshaft rotation Counterclockwise

Note: Number one cylinder is the front cylinder on the left side of the cylinder block. Number two cylinder is the front cylinder on the right side of the cylinder block.

Firing order 1, 10, 9, 6, 5, 12, 11, 4, 3, 8, 7, 2

i02810723

Engine Design

SMCS Code: 1201

S/N: SXC1-Up

S/N: MED1-Up

S/N: WDR1-Up

C32

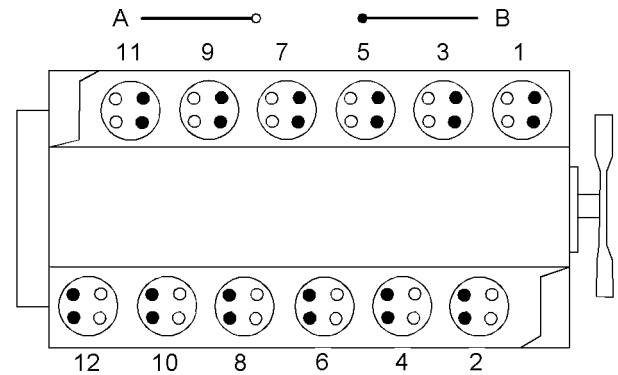


Illustration 2

g01113721

(A) Inlet valves
(B) Exhaust valves

- Bore 145 mm (5.7 inch)
- Stroke 165 mm (6.5 inch)
- Displacement 32 L (1953 cu in)
- Compression ratio 15:1
- Cylinder arrangement 65 degree V 12
- Valves per cylinder 4
- Type of combustion Direct injection
- Valve lash measurement
 - Inlet 0.38 ± 0.08 mm (0.015 ± 0.003 inch)
 - Exhaust 0.76 ± 0.08 mm (0.030 ± 0.003 inch)
- Crankshaft rotation direction (view from the flywheel end) Counterclockwise

Note: The front of the engine is opposite of the flywheel end of the engine. The left side of the engine and the right side of the engine is viewed from the flywheel end of the engine.

Note: Number one cylinder is the front cylinder on the left side of the cylinder block. Number two cylinder is the front cylinder on the right side of the cylinder block.

Firing order (injection sequence) 1, 10, 9, 6, 5, 12, 11, 4, 3, 8, 7, 2

Run the pump at 840 rpm with the inlet open to the atmosphere for 10 seconds. Block the inlet. The pump must maintain vacuum of 45 kPa (6.5 psi) minimum in 30 seconds.

Run the pump at 120 rpm with a blocked inlet that is full of fuel for 30 seconds. The pump inlet must have a suction lift of 60.9 kPa (18 In Hg) minimum.

When the pump is viewed from the drive gear end or the drive shaft, the rotation of the pump is counterclockwise.

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i02786381

Fuel Transfer Pump

SMCS Code: 1256

Part No.: 286-2531

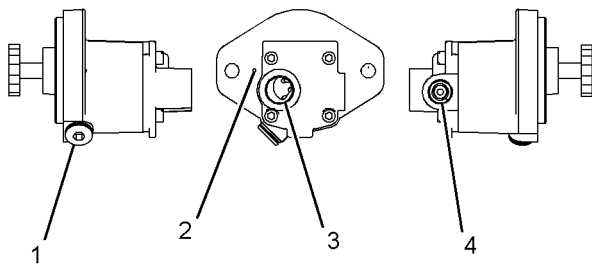


Illustration 3

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- (1) Pressure regulating valve
- (2) Weep hole
- (3) Inlet port
- (4) Outlet port

Note: Maximum inlet pressure to the pump shall not exceed 69 kPa (10 psi).

When the fuel transfer pump is using diesel fuel, the fuel transfer pump has the following specifications:

Run the pump at 2940 rpm. The full bypass pressure should be the following value. 716 to 786 kPa (104 to 114 psi)

Run the pump at 840 rpm. The flow at 550 kPa (80 psi) must be 6.0 L/min (1.6 US gpm).

Run the pump at 2940 rpm. The flow at 650 kPa (94 psi) must be 9.0 L/min (2.38 US gpm).

Run the pump at 120 rpm with the inlet open to the atmosphere for 10 seconds. Block the inlet. The pump must maintain vacuum of 30 kPa (4.5 psi) minimum in 30 seconds.

Fuel Filter Base

SMCS Code: 1261; 1262

Part No.: 237-9311

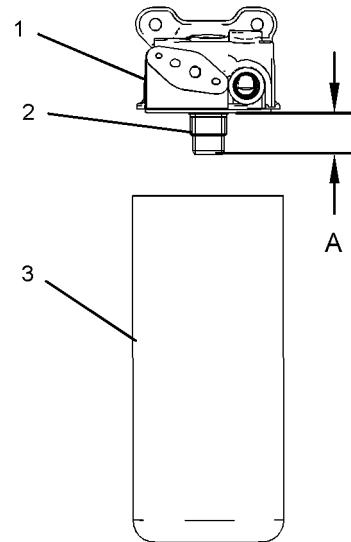


Illustration 4

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- (1) Base
- (3) Fuel filter

(2) Torque for the stud 70 ± 15 N·m (50 ± 11 lb ft)

(A) Apply 154-9731 Thread Lock Compound on the tapered end of the stud to the following distance. 39.5 ± 0.5 mm (1.56 ± 0.02 inch)

i02792816

Electronic Unit Injector Mechanism

SMCS Code: 1290

Part No.: 235-1401, 235-1402
S/N: DWB1-Up

Part No.: 235-1402, 253-8352, 261-0048
S/N: SXC1-Up

Part No.: 261-0048
S/N: MED1-Up

Part No.: 235-1401, 261-0048
S/N: WDR1-Up

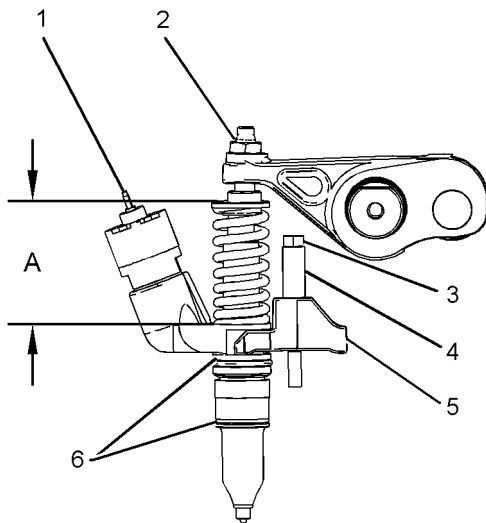


Illustration 5

g01395719

(4) Spacer

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

Note: Before installation of the unit injector, lubricate the top two O-ring seals (6) with a 50/50 mixture of clean engine oil and 8T-2998 Lubricant.

(1) Torque for cap nut .. 2.50 ± 0.25 N·m (22 ± 2 lb in)

(2) Torque for nut 100 ± 10 N·m (75 ± 7 lb ft)

(A) Adjust the unit injector height from the timing seat to the following distance. 78.0 ± 0.2 mm (3.07 ± 0.01 inch)

Use the following procedure to tighten the bolt (3) for clamp (5):

1. Tighten the bolt for the clamp to 55 ± 10 N·m (41 ± 7 lb ft).
2. Loosen the bolt for the clamp until the bolt is finger tight.
3. Tighten the bolt for the clamp again to 55 ± 10 N·m (41 ± 7 lb ft).

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Electronic Unit Injector Rocker Arm

SMCS Code: 1123

Part No.: 243-2468, 280-8043, 301-5349

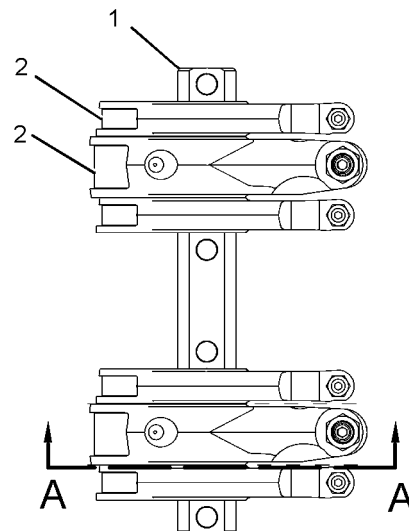


Illustration 6

g01395736

Typical example

- (1) Shaft assembly
- (2) Rocker arm

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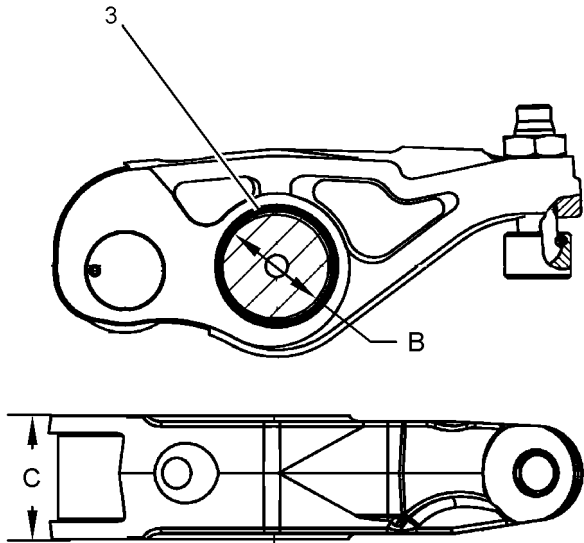


Illustration 7 g01401981

View A-A
Typical example
(3) Bearing joint

(B) Bore

New parts 40.065 ± 0.015 mm
(1.5774 ± 0.0006 inch)
Maximum dimension for worn parts .. 40.193 mm
(1.5824 inch)

(C) Bearing for the rocker arm and the pin must not extend beyond either face of the rocker arm.

Valve Mechanism

SMCS Code: 1102

Part No.: 260-9631

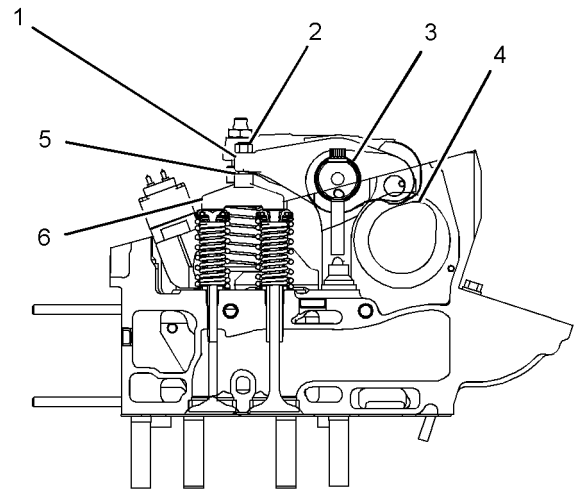


Illustration 8 g01246863

- (1) Rocker arm
 - (4) Camshaft
 - (6) Valve bridge
- (2) Torque for the adjustment screw locknut 30 ± 7 N·m (22 ± 5 lb ft)
- (3) Rocker shaft assembly
- Diameter of a new rocker arm shaft 40.000 ± 0.010 mm (1.5748 ± 0.0004 inch)
 - Bore in a new bearing for rocker arm shaft 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch)
 - Maximum dimension for the bore in a worn bearing for rocker arm shaft 40.193 mm (1.5824 inch)

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

- (5) Location for checking the 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)

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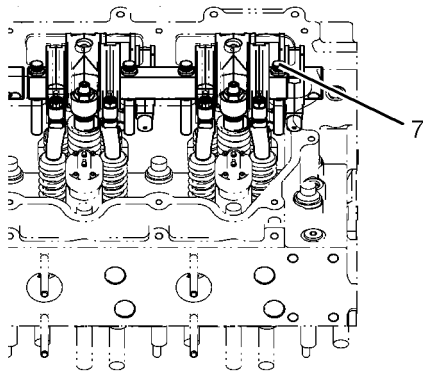


Illustration 9

g01404154

Left side of engine

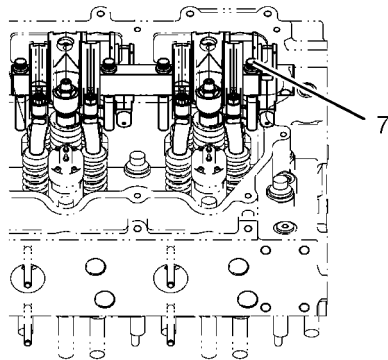


Illustration 10

g01404155

Right side of engine

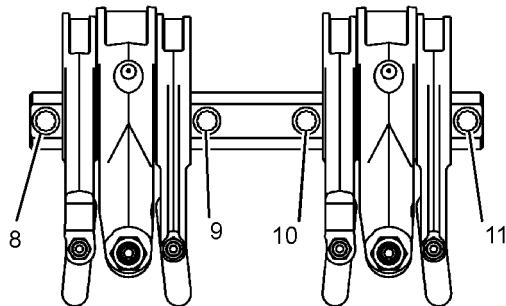


Illustration 11

g01400354

Tightening sequence

Note: Tighten the bolts for the rocker arm group in the sequence 9, 10, 8, 11, 9, 10. Refer to Illustration 11.

(7) Torque for bolts 109 ± 15 N·m (80 ± 11 lb ft)

Valve Mechanism

SMCS Code: 1102

Part No.: 223-6398

S/N: DWB1-Up

Part No.: 223-6398

S/N: SXC1-Up

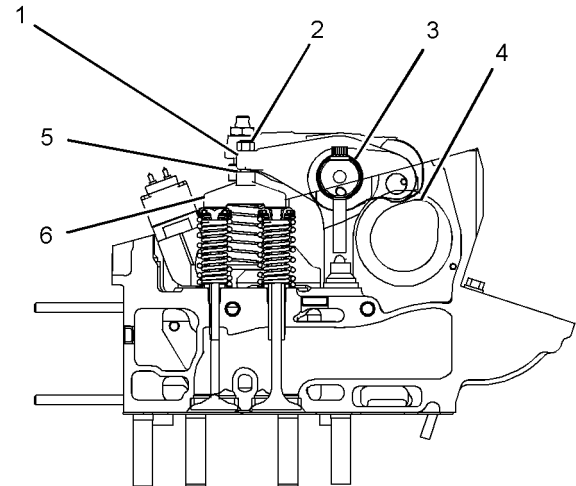


Illustration 12

g01246863

(1) Rocker arm
(4) Camshaft
(6) Valve bridge

(2) Torque for the adjustment screw locknut 30 ± 7 N·m (22 ± 5 lb ft)

(3) Rocker shaft assembly

Diameter of a new rocker arm shaft 40.000 ± 0.010 mm (1.5748 ± 0.0004 inch)
Bore in a new bearing for rocker arm shaft 40.065 ± 0.015 mm (1.5774 ± 0.0006 inch)
Maximum dimension for the bore in a worn bearing for rocker arm shaft 40.193 mm (1.5824 inch)

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

(5) Location for checking the 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)

i02794979

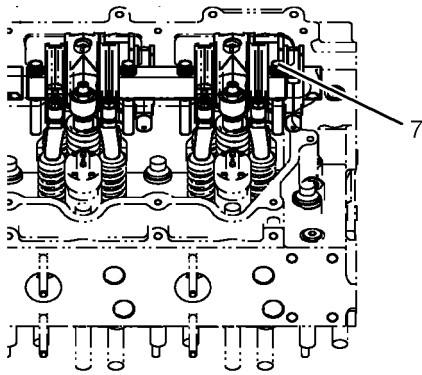


Illustration 13 g01400357
Left side of engine

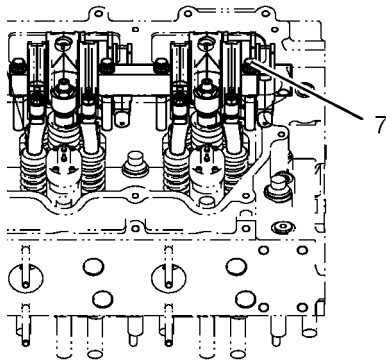


Illustration 14 g01400358
Right side of engine

(7) Torque for bolts 109 ± 15 N·m (80 ± 11 lb ft)

Cylinder Head Valves

SMCS Code: 1105

Part No.: 223-6431, 284-8892

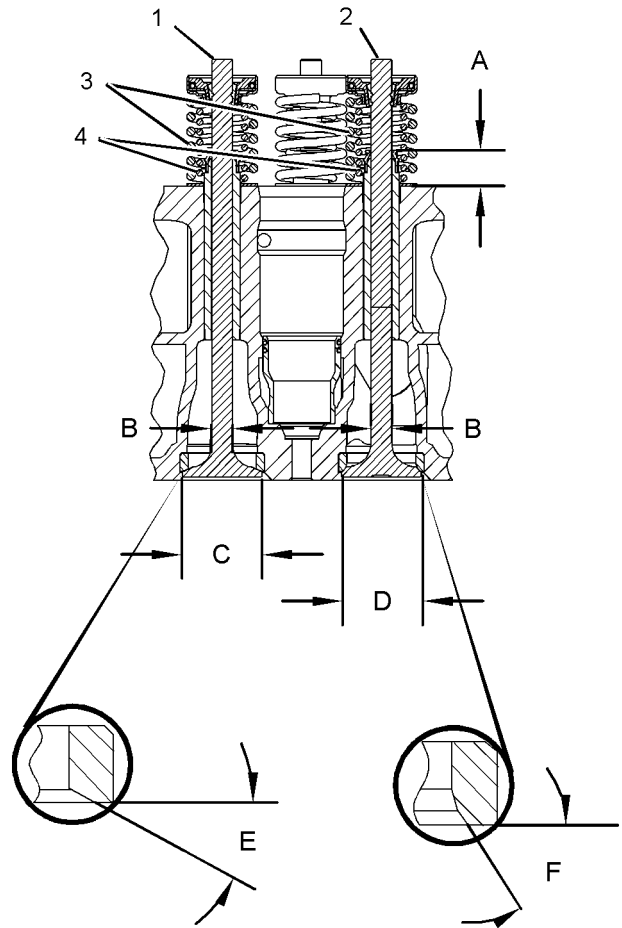


Illustration 15 g01395835

Note: Apply 8T-2998 Lubricant to the inner diameter of the valve guides immediately prior to the installation of inlet valve (1) and exhaust valve (2) into the cylinder head.

(3) 211-3123 Spring

Length under test force ... 67.12 mm (2.643 inch)
 Test force 320 ± 25 N (71.9 ± 5.6 lb)
 Approximate free length after test 76.70 mm
 (3.020 inch)
 Outside diameter 36.3 mm (1.43 inch)

(4) 211-3122 Spring

Length under test force ... 60.14 mm (2.368 inch)
 Test force 150 ± 12 N (33.7 ± 2.7 lb)
 Approximate free length after test 71.70 mm
 (2.823 inch)
 Outside diameter 25.17 mm (0.991 inch)

- (A) Height to the step that is in the valve guide 35.0 ± 0.5 mm (1.38 ± 0.02 inch)
- (B) New valve stem diameter 9.441 ± 0.010 mm (0.3717 ± 0.0004 inch)
- (C) Diameter of inlet valve 47.00 ± 0.13 mm (1.850 ± 0.005 inch)
- (D) Diameter of exhaust valve 41.81 ± 0.13 mm (1.646 ± 0.005 inch)
- (E) Face angle for inlet valve seat insert 30.25 ± 0.25 degrees
- (F) Face angle for exhaust valve seat insert 45.25 ± 0.25 degrees

Bore in cylinder head for valve seat insert (exhaust valve) 42.774 ± 0.025 mm (1.6840 ± 0.0010 inch)

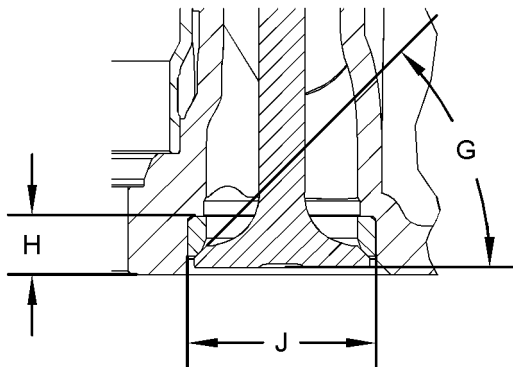


Illustration 16

g01397152

- (G) Angle of valve face
 - Angle of the face of the inlet valve 29.25 ± 0.25 degrees
 - Angle of the face of the exhaust valve 44.25 ± 0.25 degrees
- (H) Depth of the bore in the cylinder head for the valve seat insert
 - Inlet 14.00 ± 0.05 mm (0.551 ± 0.002 inch)
 - Exhaust ... 13.90 ± 0.05 mm (0.547 ± 0.002 inch)

Note: Shrink the valve seat inserts by reducing the temperature. Shrinking the valve seat inserts allows placement into the counterbore.

- (J) Valve seat insert
 - Diameter of valve seat insert (inlet valve) 48.025 ± 0.013 mm (1.8907 ± 0.0005 inch)
 - Bore in cylinder head for valve seat insert (inlet valve) 47.950 ± 0.025 mm (1.8878 ± 0.0010 inch)
 - Diameter of valve seat insert (exhaust valve) 42.840 ± 0.013 mm (1.6866 ± 0.0005 inch)

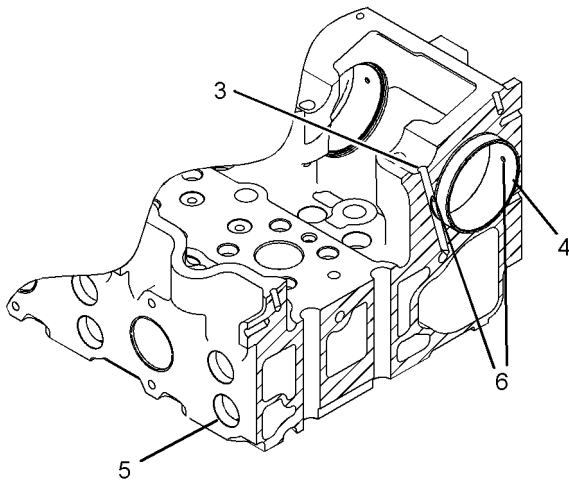


Illustration 18 g01353135

- (3) Oil gallery
- (4) Camshaft bearing
- (5) Typical location for cup plug
- (6) Oil holes

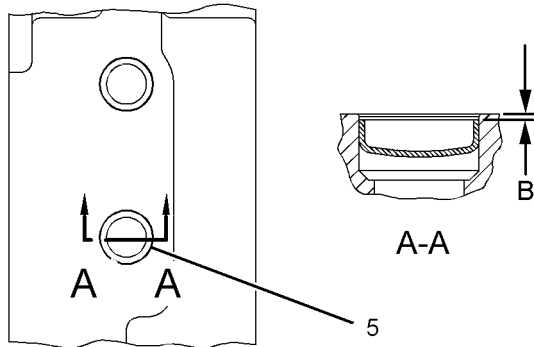


Illustration 19 g01353136

Cylinder head face

Note: Lubricate the bores for the cup plugs with 6V - 6640 Sealant prior to installing the cup plugs.

(B) The cup plugs are measured from the face of the cylinder head to the top edge of the plug. Depth of installation 1.25 ± 0.25 mm
(0.049 ± 0.010 inch)

NOTICE

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

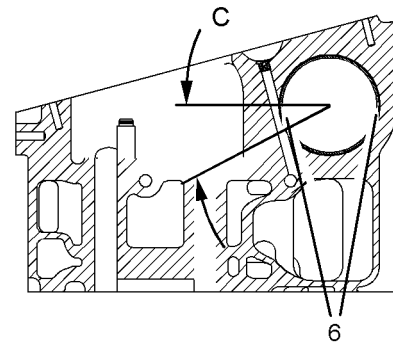


Illustration 20

g01353140

Orientation of bearing joint

(C) 20 ± 3 degrees below horizontal

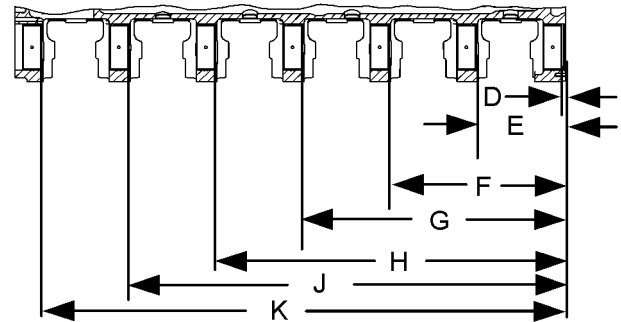


Illustration 21

g01353461

The depth of installation of the camshaft bearings is very important. Install bearings (4) to the following depths:

Installation depth for camshaft bearings (4)

- D 8.0 ± 0.5 mm (0.32 ± 0.02 inch)
- E 227.5 ± 0.5 mm (8.96 ± 0.02 inch)
- F 411.7 ± 0.5 mm (16.21 ± 0.02 inch)
- G 595.8 ± 0.5 mm (23.46 ± 0.02 inch)
- H 780.0 ± 0.5 mm (30.71 ± 0.02 inch)
- J 964.1 ± 0.5 mm (37.96 ± 0.02 inch)
- K 1140.3 ± 0.5 mm (44.89 ± 0.02 inch)

i02383782

i02797500

Turbocharger

SMCS Code: 1052

Part No.: 261-0501, 267-4742, 294-3666
S/N: DWB1-Up

Part No.: 246-4411, 261-0501, 297-1024
S/N: SXC1-Up

Part No.: 261-0501, 297-1024
S/N: MED1-Up

Part No.: 261-0501, 267-4742, 297-1024
S/N: WDR1-Up

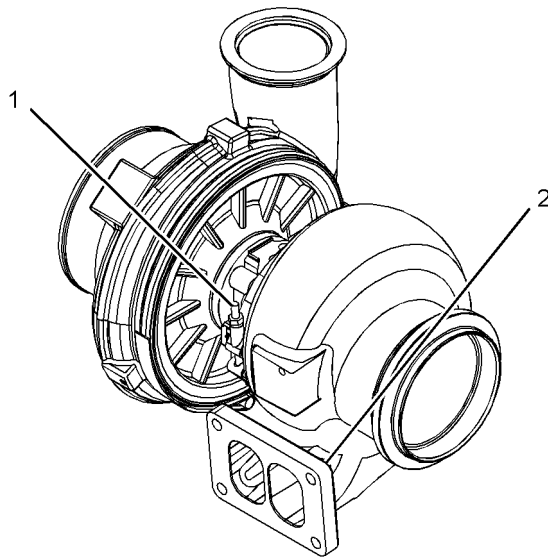


Illustration 22

g01189130

(1) V-band clamps

Tighten the V-band clamps to the following torque. $14 \pm 1 \text{ N}\cdot\text{m}$ ($10 \pm 1 \text{ lb ft}$)
Gently hit around the V-band clamps with a soft hammer. Again tighten the V-band clamps to the following torque value. ... $14 \pm 1 \text{ N}\cdot\text{m}$ ($10 \pm 1 \text{ lb ft}$)

(2) Nuts for mounting the turbocharger

Apply 5P-3931 Anti-Seize Compound on the washer face and the threads of the mounting studs for the turbocharger before assembly. Tighten the nuts that hold the turbocharger to the exhaust manifold to the following torque. $55 \pm 9 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$)

Exhaust Manifold

SMCS Code: 1059

Part No.: 261-0500
S/N: DWB1-Up

Part No.: 252-0768, 261-0500
S/N: SXC1-Up

Part No.: 261-0500
S/N: MED1-Up

Part No.: 261-0500
S/N: WDR1-Up

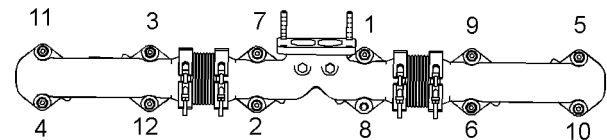


Illustration 23

g01189643

Note: Use a centering tool in at least one oversize hole per manifold section in order to align the manifolds. Do not remove the centering tool until the locknuts are required to be tightened in the numerical sequence that is shown in Illustration 23.

Use the following procedure to tighten the locknuts:

Note: Apply 4C-5599 Anti-Seize Compound to the threads of the locknuts before assembly.

1. In the numerical sequence that is shown in Illustration 23, tighten the locknut (1) through locknut (12) to $20 \pm 3 \text{ N}\cdot\text{m}$ ($15 \pm 2 \text{ lb ft}$).
2. In the numerical sequence that is shown in Illustration 23, tighten the locknut (1) through locknut (12) again to $38 \pm 5 \text{ N}\cdot\text{m}$ ($28 \pm 4 \text{ lb ft}$).

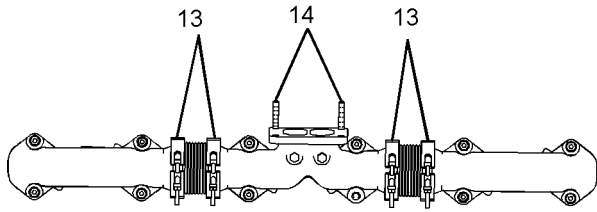


Illustration 24

g01397693

(13) Torque for the clamps 8.5 ± 1.0 N·m
(75 ± 9 lb in)

Note: Apply 4C-5599 Anti-Seize Compound to the threads of the taperlock studs before assembly.

(14) Torque for the taperlock studs 35 ± 5 N·m
(26 ± 4 lb ft)

i02815205

Camshaft

SMCS Code: 1210

Part No.: 246-4410, 260-9307

S/N: DWB1-Up

Part No.: 246-4410, 260-9307

S/N: SXC1-Up

Part No.: 260-9307

S/N: WDR1-Up

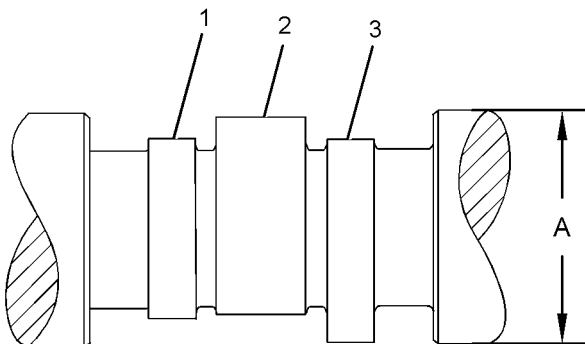


Illustration 25

g01398108

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

Note: The end of the camshaft that is marked "F" must be placed at the front of the engine. Lubricate the camshaft bearings, the journals, and the lobes with a 50/50 mixture of 8T-2998 Lubricant and clean engine oil.

(A) Diameter of camshaft journal .. 84.85 ± 0.02 mm
(3.341 ± 0.001 inch)

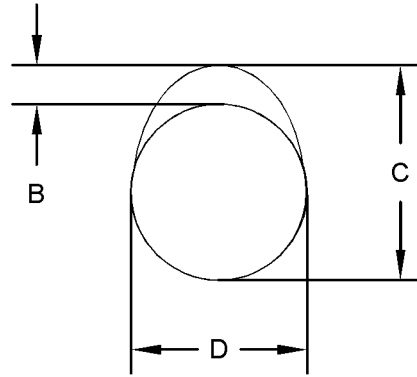


Illustration 26

g01398109

Use the following procedure to find the actual lobe lift:

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

(B) Specified camshaft lobe lift

Exhaust lobe 8.51520 mm (0.335243 inch)

Injector lobe (right bank) 10.33685 mm
(0.406961 inch)

Injector lobe (left bank) 10.34660 mm
(0.407345 inch)

Inlet lobe 9.61850 mm (0.378680 inch)

The maximum permissible difference between the actual lobe lift in Step 3 and the specified camshaft lobe lift is 0.13 mm (0.005 inch).

i02798297

Camshaft

SMCS Code: 1210

Part No.: 246-4409, 260-9308
S/N: SXC1-Up

Part No.: 260-9308
S/N: MED1-Up

Part No.: 260-9308
S/N: WDR1-Up

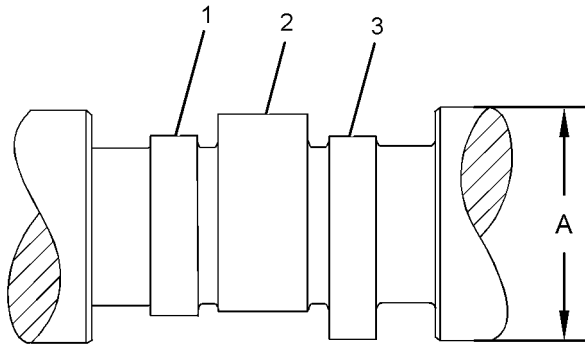


Illustration 27

g01398084

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

Note: The end of the camshaft that is marked “F” must be placed at the front of the engine. Lubricate the camshaft bearings, the journals, and the lobes with a 50/50 mixture of 8T-2998 Lubricant and clean engine oil.

(A) Diameter of camshaft journal .. 84.85 ± 0.02 mm
(3.341 ± 0.001 inch)

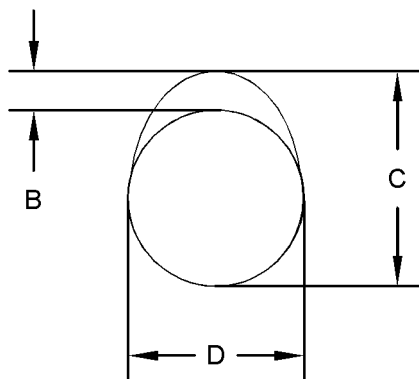


Illustration 28

g01398078

Use the following procedure to find the actual lobe lift:

1. Measure the camshaft lobe height (C).
2. Measure the base circle (D).

3. Subtract the base circle measurement in Step 2 from the camshaft lobe height in Step 1. The difference is the actual lobe lift.

(B) Specified camshaft lobe lift

Exhaust lobe	8.51520 mm (0.335243 inch)
Injector lobe (right bank)	10.33667 mm (0.406954 inch)
Injector lobe (left bank)	10.33718 mm (0.406974 inch)
Inlet lobe	9.61850 mm (0.378680 inch)

The maximum permissible difference between the actual lobe lift in Step 3 and the specified camshaft lobe lift is 0.13 mm (0.005 inch).

i02385184

Engine Oil Lines

SMCS Code: 1307

Part No.: 122-1790, 188-4641
S/N: DWB1-Up

Part No.: 122-1790, 188-4641
S/N: SXC1-Up

Part No.: 122-1790
S/N: MED1-Up

Part No.: 122-1790, 188-4641
S/N: WDR1-Up

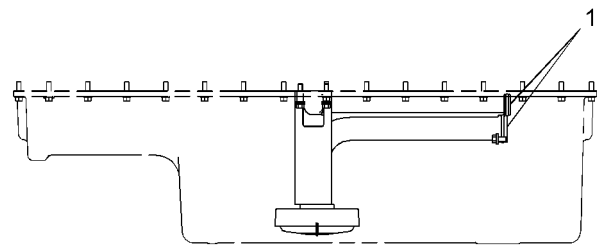


Illustration 29

g01189707

- (1) Lubricate the bores and the O-Ring seals lightly with engine oil.

i02798318

Engine Oil Filter Base

SMCS Code: 1306

Part No.: 264 - 1492

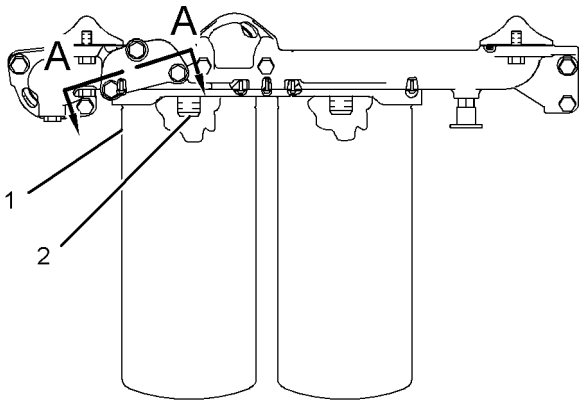


Illustration 30

g01188271

1. Apply clean engine oil to the filter gasket.
2. Put the engine oil filter assembly (1) in position.
3. Turn the engine oil filter assembly (1) by hand until the filter gasket makes contact with the oil filter base.
4. Additionally tighten the engine oil filter assembly by 3/4 of a turn.

Note: Apply 154 - 9731 Thread Lock Compound on the last 7.6 mm (0.30 inch) of the threads of hollow stud from taperlock end.

(2) Torque for the hollow stud 81 ± 14 N·m
(60 ± 10 lb ft)

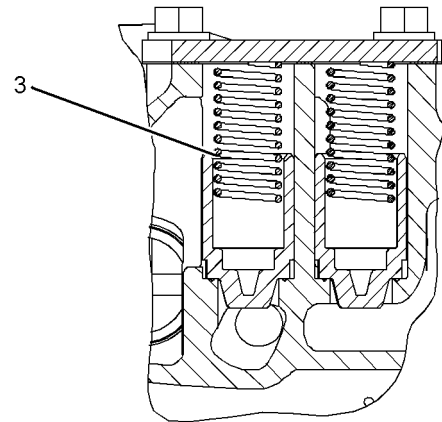


Illustration 31

g01402272

Section A-A

(3) 4N-8150 Spring

Length under test force ... 55.24 mm (2.175 inch)
 Test force 75.619 ± 5.800 N (17.0 ± 1.3 lb)
 Free length after test .. 93.726 mm (3.6900 inch)
 Outside diameter 20.6 mm (0.81 inch)

The nominal opening pressure of the oil filter bypass valve 247 kPa (36 psi)

i02415677

Engine Oil Pump

SMCS Code: 1304

Part No.: 116 - 1980

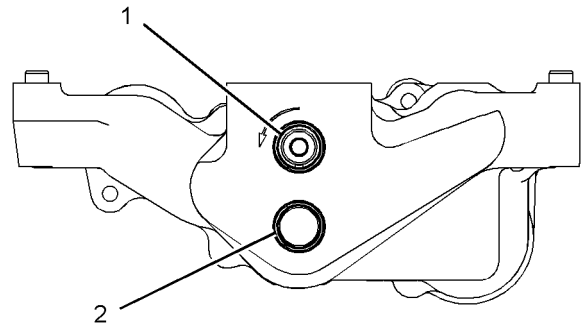


Illustration 32

g01207493

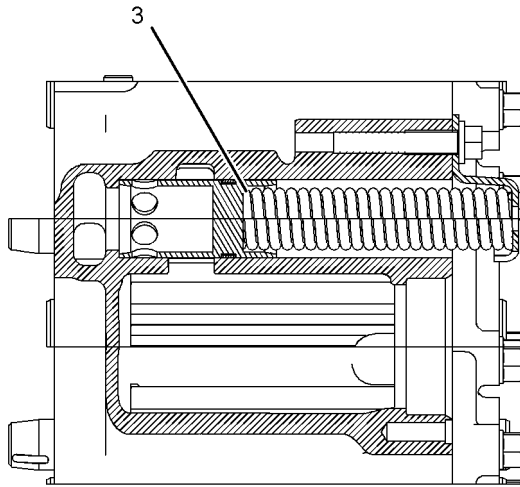


Illustration 33

g01207495

- (1) Diameter of new drive shaft .. 22.217 ± 0.005 mm
(0.8747 \pm 0.0002 inch)
- (2) Diameter of new idler shaft .. 22.217 ± 0.005 mm
(0.8747 \pm 0.0002 inch)
- (3) 2S-2760 Spring
- Length under test force .. 117.14 mm (4.612 inch)
 Test force 499 \pm 24 N (110 \pm 5 lb)
 Free length after test 152.91 mm (6.020 inch)
 Outside diameter 27.00 mm (1.063 inch)

Note: The 2S-2760 Spring is for the relief of oil pressure.

i02811401

Water Lines

SMCS Code: 1380

Part No.: 255-5536

S/N: DWB1-Up

Part No.: 235-2013, 255-5536

S/N: SXC1-Up

Part No.: 255-5536

S/N: MED1-Up

Part No.: 255-5536

S/N: WDR1-Up

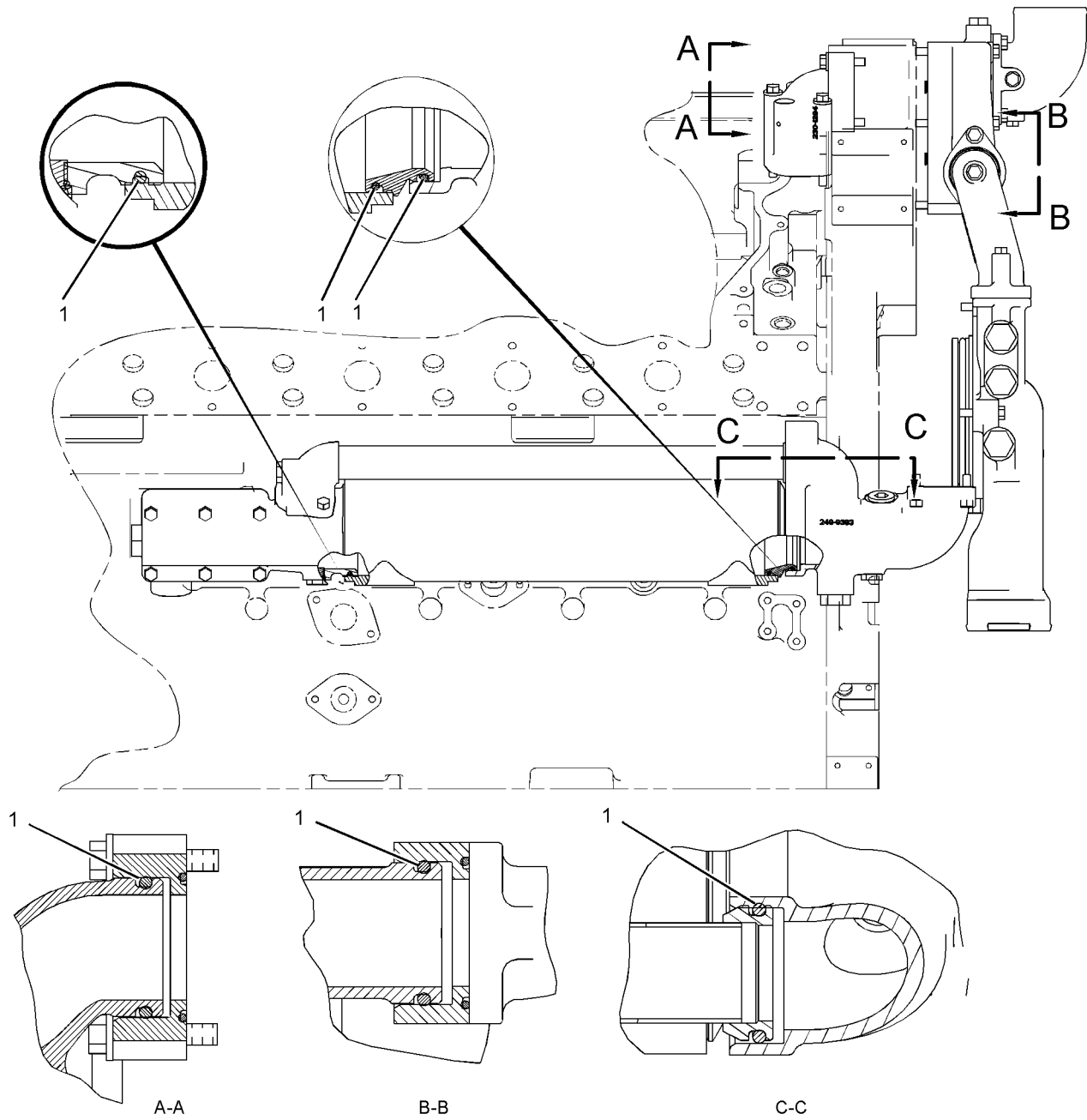


Illustration 34
Right side view of engine

g01402275

- (1) Apply a light coat of glycerin to the O-ring seals and the bores for the O-ring seals.

i02799191

Water Temperature Regulator

SMCS Code: 1355

Part No.: 248-5513

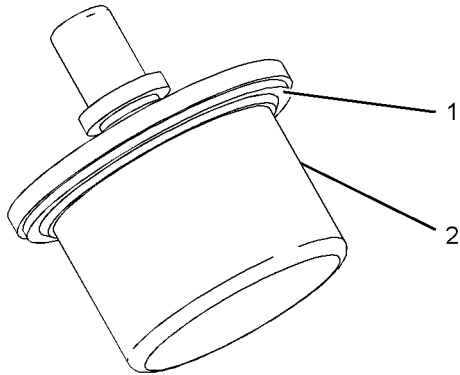


Illustration 35

g01056598

Typical example

(1) Seal

(2) Water temperature regulator

- Opening temperature 81 to 84 °C
(178 to 183 °F)
- Fully open temperature 92 °C (198 °F)
- Minimum stroke at fully open
temperature 10.4 mm (0.41 inch)

i02798334

Water Pump

SMCS Code: 1361

Part No.: 230-4172

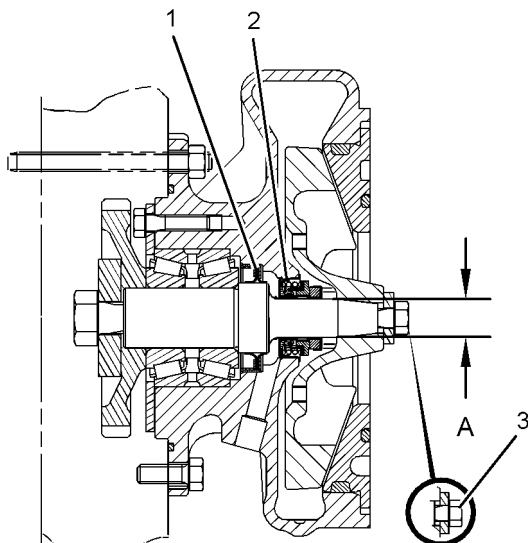


Illustration 36

g01398145

Note: Do not install the lip type seal (1) by hand. Use the installation tool and a press to install the lip type seal. Make sure that the primary lip is toward the water pump drive gear. Press the lip type seal until the lip type seal is flush into the counterbore.

Note: Use the installation tool to install the seal group (2). Press the seal group onto the shaft until the stationary cup of the seal group is fully seated in the pump housing.

(3) Torque for the bolt 39 ± 3 N·m (29 ± 2 lb ft)

(A) Diameter of the water pump
shaft 19.100 ± 0.010 mm
(0.7520 ± 0.0004 inch)

Maximum air leakage per minute with an air pressure test of 140 kPa (20 psi)

Water side 10 cc (0.6 cu in)
Side with oil 24 cc (1.5 cu in)

i02798357

Cylinder Block

SMCS Code: 1201

Part No.: 237-0842
S/N: DWB1-Up

Part No.: 246-2894, 253-9882
S/N: SXC1-Up

Part No.: 253-9882
S/N: MED1-Up

Part No.: 237-0842, 253-9882
S/N: WDR1-Up

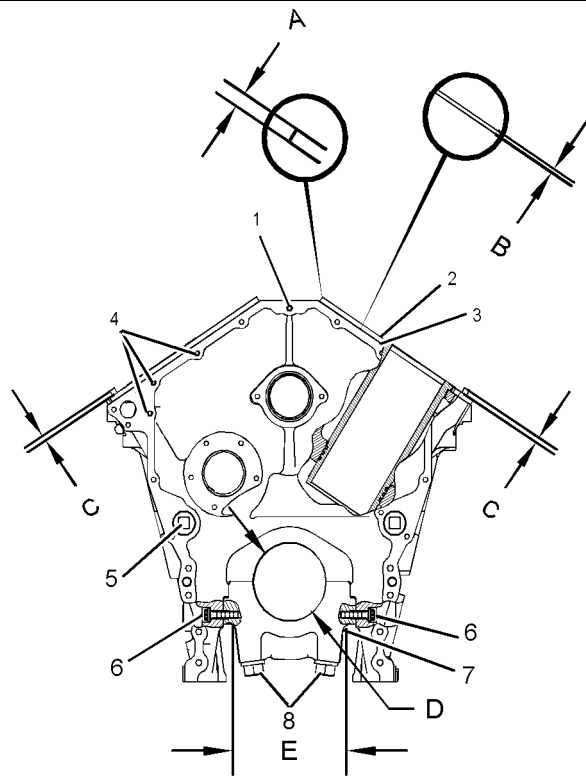


Illustration 37
Front of the engine

Note: Apply 6V-6640 Sealant to the pipe threads of stud (1). Tighten the stud with the coated pipe threads into the cylinder block.

(4) Torque for three taperlock studs 35 ± 5 N·m
(26 ± 4 lb ft)

Note: The top face of the cylinder block, both sides of plate gasket (3) and bottom surface of spacer plate (2) must be free of fuel, oil, water, gasket adhesives, assembly compounds and any other contaminants during assembly.

(A) Thickness of the spacer plates 8.585 ± 0.025 mm
(0.3380 ± 0.0010 inch)

(B) Thickness of plate gasket that is between cylinder block and spacer plate 0.208 ± 0.025 mm
(0.0082 ± 0.0010 inch)

(C) Extension of the dowels on the left bank and right bank from the cylinder block 18.5 ± 0.5 mm
(0.73 ± 0.02 inch)

Note: Apply 5P-3413 Pipe Sealant on the threads of the taperlock plugs (5) before assembly.

(5) Torque for the four taperlock plugs .. 80 ± 15 N·m
(60 ± 11 lb ft)

(D) Bore in cylinder block for main bearing 129.891 ± 0.013 mm
(5.1138 ± 0.0005 inch)

(E) Dimensions for main bearing cap
The width of the slot for the main bearing caps 236.00 ± 0.05 mm (9.291 ± 0.002 inch)
Width of main bearing cap .. 235.500 ± 0.025 mm
(9.2716 ± 0.0010 inch)

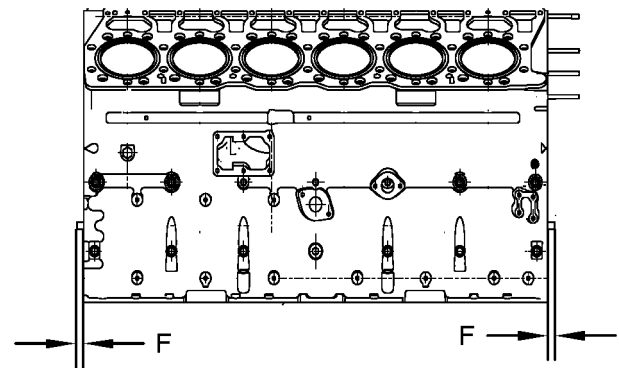


Illustration 38
Right side of the engine

(F) Extension of dowels from the rear face of the cylinder block and from the front face of the cylinder block .. 19.0 ± 0.5 mm (0.75 ± 0.02 inch)

Note: The main bearing caps (7) must be installed with the identifying marks toward the front of the engine. The number of the main bearing cap (7) must also match the cast number on the left side of each main bearing saddle.

Use the following procedure to install the main bearing caps:

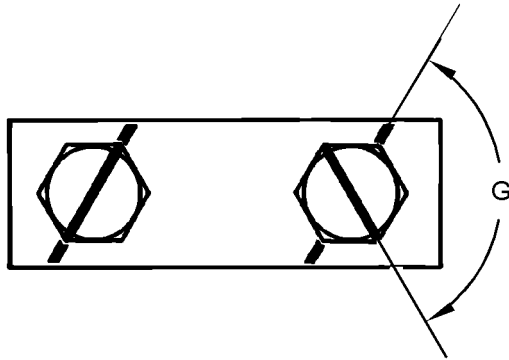


Illustration 39

g01398970

Marks for tightening main bearings

1. Apply clean engine oil on the threads of the main bearing cap bolts (8). Loosely install the main bearing cap bolts (8).
2. Apply clean engine oil on the threads of the side bolts (6) and the washers. Loosely install the side bolts and the washers.
3. Tighten the main bearing cap bolts (8) first on the main bearing tab side of the main bearing cap (7) to 258 ± 14 N·m (190 ± 10 lb ft).
4. Tighten the main bearing cap bolts (8) that are opposite the main bearing tab side of the main bearing cap (7) to 258 ± 14 N·m (190 ± 10 lb ft).
5. Put a mark on each main bearing cap bolt (8) and each main bearing cap (7). See Illustration 39.
6. Tighten the main bearing cap bolts (8) that are placed opposite the main bearing tab side of the main bearing cap (7) from the mark by angle (G) of 120 ± 5 degrees.
7. Tighten the main bearing cap bolts (8) that are placed on the main bearing tab side of the main bearing cap (7) from the mark by angle (G) of 120 ± 5 degrees.
8. Tighten the side bolts (6) that are opposite the main bearing tab side of the main bearing cap (7) to 80 ± 10 N·m (60 ± 7 lb ft).
9. Tighten the side bolts (6) that are placed on the main bearing tab side of the main bearing cap (7) to 80 ± 10 N·m (60 ± 7 lb ft).

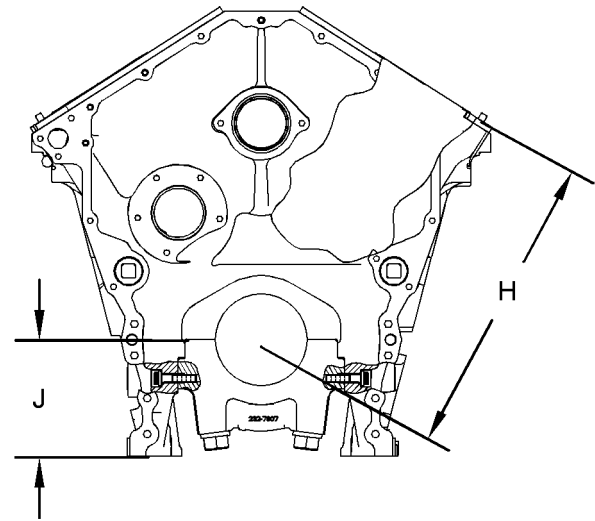


Illustration 40

g01398978

- (H) The distance from the centerline of the crankshaft bearing bore to the top of the cylinder block ... 419.10 ± 0.15 mm (16.500 ± 0.006 inch)
- (J) The distance from the centerline of the crankshaft bearing bore to the bottom of the cylinder block 165.10 ± 0.10 mm (6.500 ± 0.004 inch)

i02811418

Cylinder Liner

SMCS Code: 1216

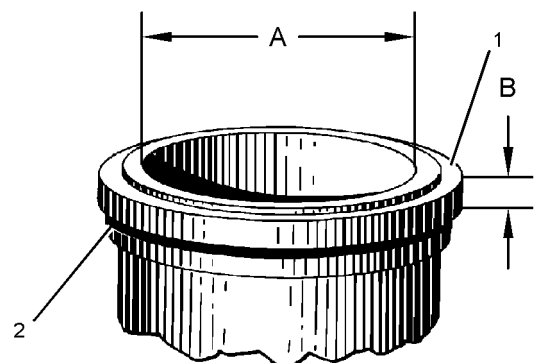
Part No.: 197-9322
S/N: DWB1-UpPart No.: 197-9322
S/N: SXC1-UpPart No.: 197-9322
S/N: WDR1-Up

Illustration 41

g01402328

(A) Bore in new cylinder liner .. 137.185 ± 0.025 mm
(5.4010 \pm 0.0010 inch)

(B) Dimensions for flange (1)

Thickness of flange on cylinder
liner 8.89 ± 0.02 mm (0.350 ± 0.001 inch)
Minimum thickness 8.870 mm (0.3492 inch)

Use the following procedure to install the cylinder liner:

1. Apply liquid soap on the cylinder block liner bore surfaces and the rubber seals that are on the lower end of the cylinder liner.
2. Dip the filler band (2) completely in clean engine oil.
3. Immediately install the filler band in the groove that is under the flange.
4. Install the cylinder liner into the cylinder block before the expansion of the filler band.

Note: Refer to Reuse And Salvage Guidelines, SEBF8049, "Visual Inspection of the Piston" for more information. Also, refer to Guideline For Reusable Parts and Salvage Operations, SEBF8068, "Cylinder Liners" for more information.

i02801040

Cylinder Liner

SMCS Code: 1216

Part No.: 215-2985, 253-8766
S/N: SXC1-Up

Part No.: 253-8766
S/N: MED1-Up

Part No.: 253-8766
S/N: WDR1-Up

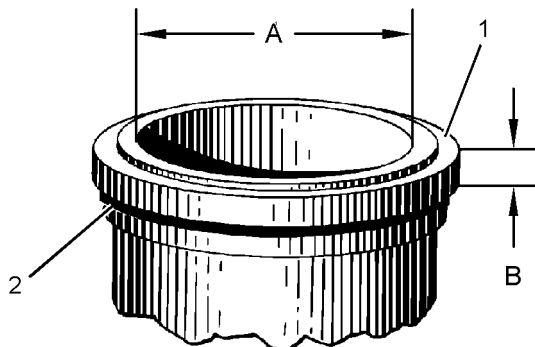


Illustration 42

g01399536

(A) Bore in new cylinder liner .. 145.000 ± 0.025 mm
(5.7086 \pm 0.0010 inch)

(B) Dimensions for flange (1)

Thickness of flange on cylinder
liner 8.89 ± 0.02 mm (0.350 ± 0.001 inch)
Minimum thickness 8.870 mm (0.3492 inch)

Use the following procedure to install the cylinder liner:

1. Apply liquid soap on the cylinder block liner bore surfaces and the rubber seals that are on the lower end of the cylinder liner.
2. Dip the filler band (2) completely in clean engine oil.
3. Immediately install the filler band in the groove that is under the flange.
4. Install the cylinder liner into the cylinder block before the expansion of the filler band.

Note: Refer to Reuse And Salvage Guidelines, SEBF8049, "Visual Inspection of the Piston" for more information. Also, refer to Guideline For Reusable Parts And Salvage Operations, SEBF8068, "Cylinder Liners" for more information.

i02801044

Crankshaft

SMCS Code: 1202

Part No.: 225-6052
S/N: DWB1-Up

Part No.: 224-3250, 225-6052
S/N: SXC1-Up

Part No.: 224-3250
S/N: MED1-Up

Part No.: 224-3250, 225-6052
S/N: WDR1-Up

Note: To measure a crankshaft that may be bent, a procedure must be followed. Refer to the Guideline For Reusable Parts And Salvage Operations, SEBF8054, "Procedure to Measure and Straighten Bent Crankshafts" for the correct procedure.

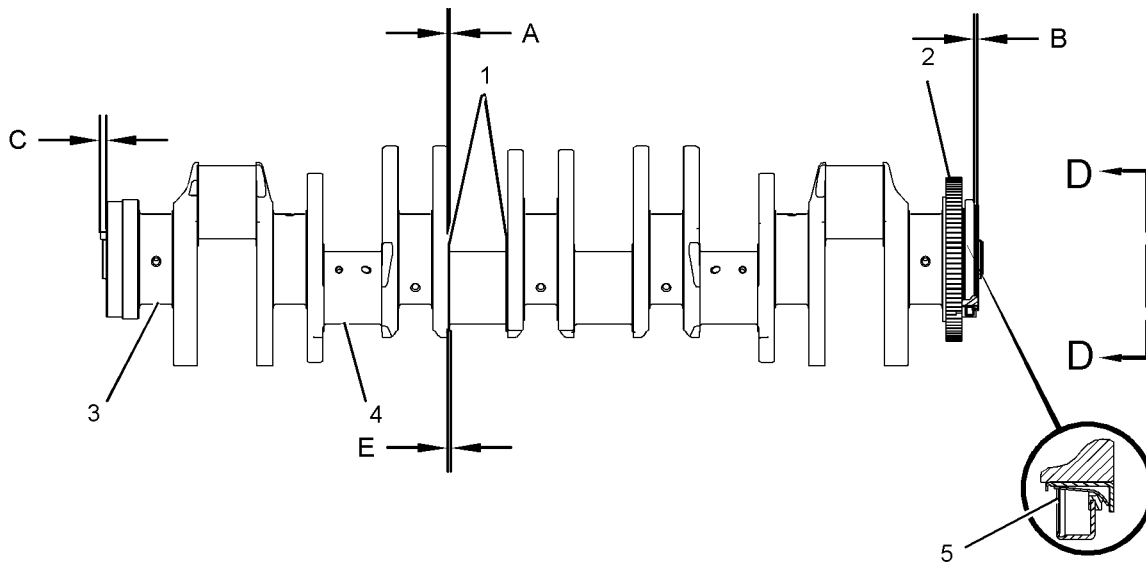


Illustration 43

g01399550

Typical example

(3) Main journal

(4) Rod journal

Note: Thrust plates (1) are used on the center main bearing only.

(A) Thickness of new thrust plate 5.74 ± 0.04 mm
(0.226 ± 0.002 inch)

Note: Check assembled installation depth with the crankshaft in any axial position.

(B) Assembled installation depth ... 4.68 to 5.28 mm
(0.184 ± 0.208 inch)

(C) Maximum extension of dowel from the crankshaft face 8.4 mm (0.33 inch)

(E) End play

New crankshaft 0.10 to 0.60 mm
(0.004 to 0.024 inch)

Maximum end play with used bearings .. 0.89 mm
(0.035 inch)

(2) The crankshaft gear must be installed on the crankshaft with the timing mark "V" on the outside of the crankshaft.

(3), (4) Refer to the Specifications, "Connecting Rod and Main Bearing Journals" for more information.

Note: The seal and the sleeve should not be used if the seal and the sleeve have been separated.

(5) The front crankshaft seal is installed on the front of the crankshaft. The seal driver can not contact the seal inside a 177.80 ± 0.25 mm (7.000 ± 0.010 inch) diameter.

Note: The seal and the sleeve can not be used if the seal and the sleeve have been separated.

Note: The sleeve must be flush with the front face of the crankshaft within 0.13 mm (0.005 inch).

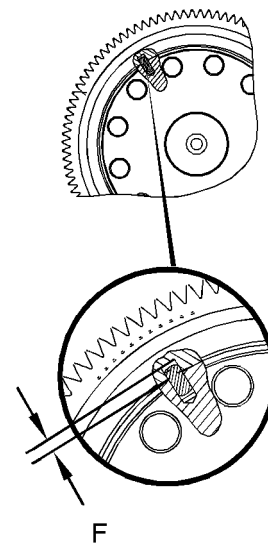


Illustration 44

g01399556

View D-D

(F) Extension of the dowel from the surface of the crankshaft 4.1 ± 0.5 mm (0.16 ± 0.02 inch)

i02664969

i02801053

Vibration Damper and Pulley

SMCS Code: 1205

Part No.: 256-6003

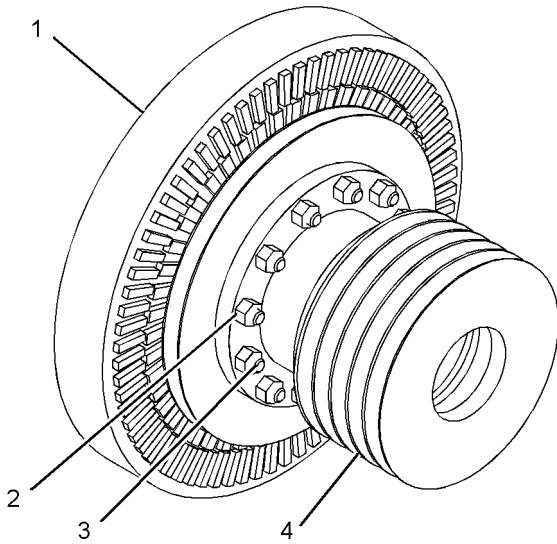


Illustration 45

g01188235

(1) Damper
(4) Pulley

(2) Torque for 12 full nuts 135 ± 20 N·m
(100 ± 15 lb ft)

(3) Torque for 12 taperlock studs 65 ± 10 N·m
(48 ± 7 lb ft)

Vibration Damper and Pulley

SMCS Code: 1205

Part No.: 267-2104
S/N: DWB1-Up

Part No.: 267-2104
S/N: SXC1-Up

Part No.: 267-2104
S/N: WDR1-Up

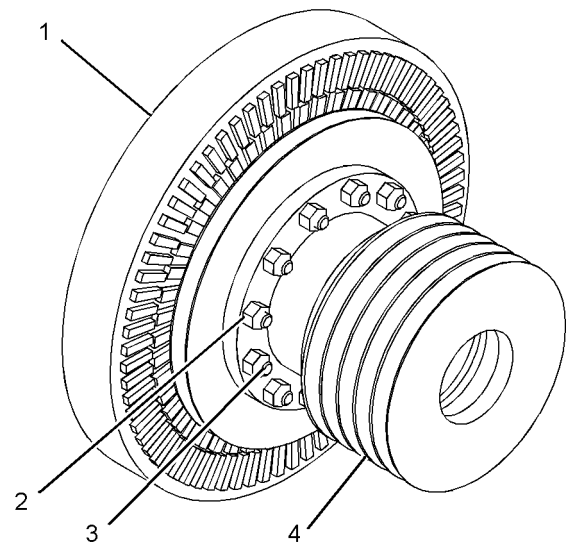


Illustration 46

g01188235

(1) Damper
(4) Pulley

(2) Torque for 12 full nuts 120 ± 20 N·m
(90 ± 15 lb ft)

(3) Torque for 12 taperlock studs 65 ± 10 N·m
(48 ± 7 lb ft)

i02664967

Vibration Damper and Pulley

SMCS Code: 1205

Part No.: 301 - 6972
S/N: SXC1-Up

Part No.: 301 - 6972
S/N: MED1-Up

Part No.: 301 - 6972
S/N: WDR1-Up

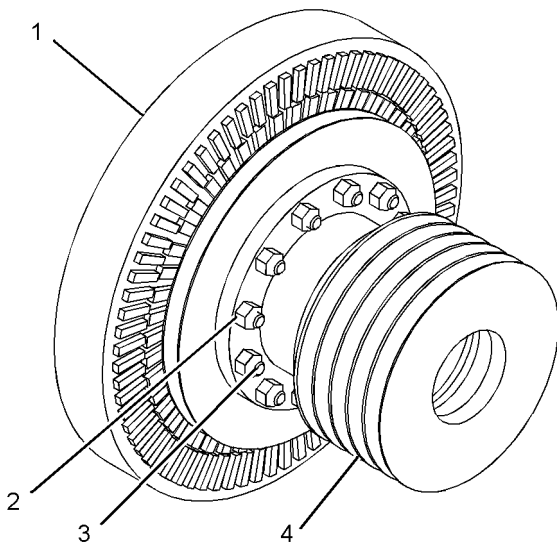


Illustration 47

g01188235

- (1) Damper
- (4) Pulley

(2) Torque for 12 full nuts 150 ± 20 N·m
(110 ± 15 lb ft)

(3) Torque for 12 taperlock studs 65 ± 10 N·m
(48 ± 7 lb ft)

i02739840

Connecting Rod and Main Bearing Journals

SMCS Code: 1230

Part No.: 232 - 3232

Refer to the Guideline for Reusable Parts for more information.

Connecting Rod Bearing Journals

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Connecting Rod	
Original Size	97.028 ± 0.020 mm (3.8200 ± 0.0008 inch)

Clearance between new bearing and new journal ... 0.070 to 0.178 mm (0.0028 to 0.0070 inch)

Main Bearing Journals

Table 2

Diameter of Crankshaft Journal (Bearing Surface) for Main Bearings	
Original Size	120.650 ± 0.020 mm (4.7500 ± 0.0008 inch)
Undersize Journal 0.63 mm (0.025 inch)	120.015 ± 0.020 mm (4.7250 ± 0.0008 inch)
Undersize Journal 1.27 mm (0.050 inch)	119.380 ± 0.020 mm (4.7000 ± 0.0008 inch)

Main bearing cap with two bolts

Clearance between new bearing and new journal 0.076 to 0.186 mm
(0.0030 to 0.0073 inch)

Main bearing cap with four bolts

Clearance between new bearing and new journal 0.071 to 0.178 mm
(0.0028 to 0.0070 inch)

i02801090

Connecting Rod

SMCS Code: 1218

Part No.: 232-3232
S/N: DWB1-Up

Part No.: 215-1955, 232-3232
S/N: SXC1-Up

Part No.: 215-1955, 232-3232
S/N: MED1-Up

Part No.: 215-1955, 232-3232
S/N: WDR1-Up

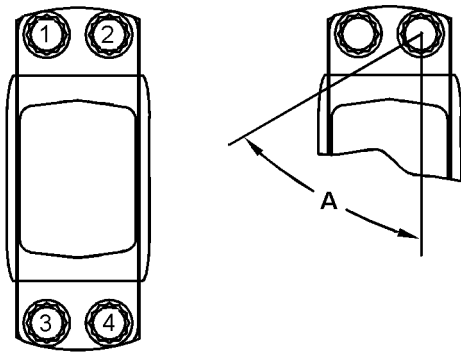


Illustration 48

g01318414

Tightening sequence, and index mark for torque-turn process
(1),(2),(3),(4) Bolts for rod cap

Note: The connecting rods should be installed in the engine so that the part number of the forging for the rod assembly is facing the connecting rod that is on the same crankshaft pin. The opposite side of the connecting rods will face the thrust surface of the crankshaft journal.

Use the following procedure for tightening the bolts for the rod cap:

1. Prior to assembly, lubricate the threads of the bolts and the seating face of the bolt heads with clean engine oil.
2. Finger tighten all of the bolts.
3. Tighten bolts (1) and (3) to 70 ± 4 N·m (50 ± 3 lb ft).
4. Tighten bolts (2) and (4) to 70 ± 4 N·m (50 ± 3 lb ft).

Note: Use a paint stick to place an index mark on each of the bolts. Use the index mark as a reference in order to torque the bolts for an additional angle.

5. Tighten bolts (2) and (4) by an additional angle (A) of 60 ± 5 degrees.

6. Tighten bolts (1) and (3) again to 70 ± 4 N·m (50 ± 3 lb ft).

7. Tighten bolts (1) and (3) by an additional angle (A) of 60 ± 5 degrees.

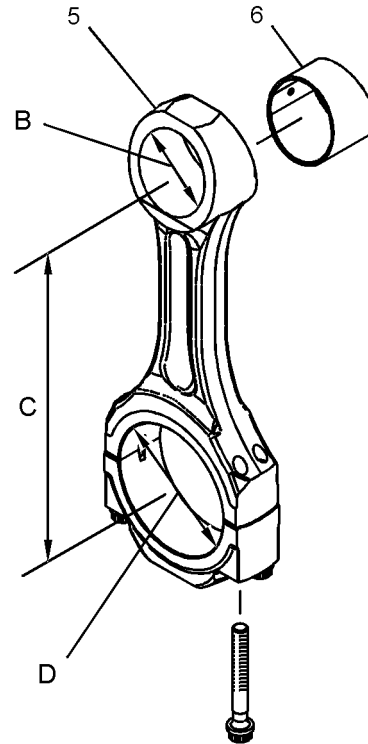


Illustration 49

g01399607

(6) Bearing for piston pin

(5) Connecting rod

- (B) Inside diameter of connecting rod of bearing for the piston pin 64.592 ± 0.013 mm
(2.5430 ± 0.0005 inch)
- (C) Distance between the center of the bore for the bearing for piston pin and the center of the bore for the crankshaft journal 274.91 mm
(10.823 inch)
- (D) Inside diameter of connecting rod for the crankshaft journal after the bearing for connecting rod has been installed and the bolts have been torqued. 103.500 ± 0.013 mm
(4.0748 ± 0.0005 inch)

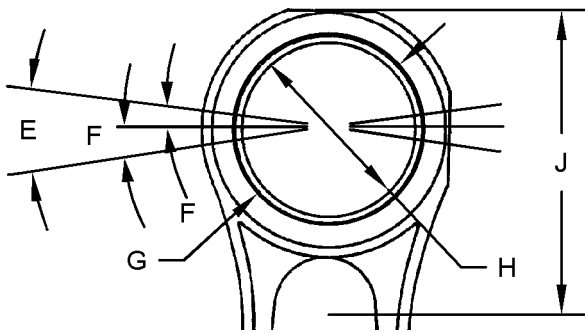


Illustration 50

g01399634

Note: The bearing joint must be located within area (E) along the horizontal centerline of the piston pin bore.

(F) Maximum angle from the horizontal centerline ± 5 degrees

Note: The bore of bearing for piston pin must be machined after installation into the connecting rod.

(G) Outside diameter of bearing for piston pin before installation into the connecting rod .. 64.717 ± 0.013 mm (2.5479 ± 0.0005 inch)

(H) Dimensions for piston pin

Bore diameter of bearing for the piston pin after machining 60.035 ± 0.008 mm (2.3636 ± 0.0003 inch)

Diameter of piston pin 59.975 ± 0.005 mm (2.3612 ± 0.0002 inch)

Note: Apply heat to the connecting rod prior to installation of bearing for piston pin. **Do not use a torch to heat the connecting rod.**

(J) Maximum length for heating the connecting rod during the installation of bearing for piston pin 95 mm (3.7 inch)

Temperature for heating for connecting rod 175 to 260 °C (347 to 500 °F)

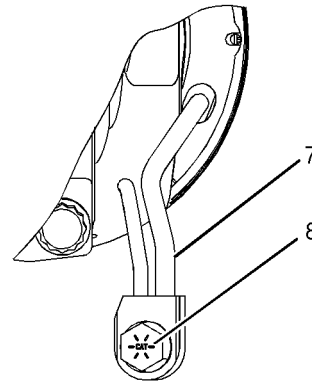


Illustration 51

g01401199

(7) Oil jet tube assembly

(8) Torque for the special bolt of oil jet tube assembly 25 ± 6 N·m (18 ± 4 lb ft)

i02417361

Piston and Rings

SMCS Code: 1214; 1215

Part No.: 239-6114

S/N: DWB1-Up

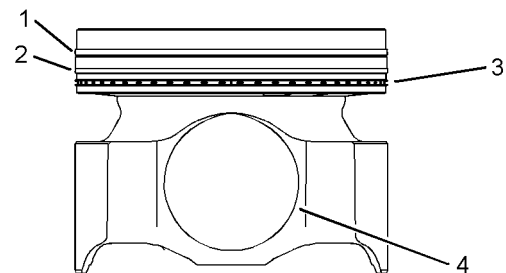


Illustration 52

g01091802

Note: Refer to Guideline for Reusable Parts for information on the pistons, the piston pins, and the retaining rings.

The 1U-6431 Piston Ring Groove Gauge Gp is used for measuring the ring grooves in keystone style pistons. Refer to the Special Instruction that is supplied with the Piston Ring Groove Gauge.

The 5P-3519 Piston Ring Groove Gauge Gp is available for checking the ring grooves with straight sides. Refer to the Guideline for Reusable Parts for instructions on the Piston Ring Groove Gauge.

Top Piston Ring

(1) Top piston ring

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

There is a clearance between the ends of the piston ring. When the piston ring is installed in a cylinder liner with a bore of 137.16 mm (5.400 inch), the clearance is the following value. 0.40 ± 0.10 mm (0.02 ± 0.004 inch)

There is an increase in the clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore. Increase 0.08 mm (0.003 inch)

Intermediate Piston Ring

(2) Intermediate piston ring

Install the piston ring with "UP-2" mark toward the top of the piston.

There is a clearance between the ends of the piston ring. When the piston ring is installed in a cylinder liner with a bore of 137.16 mm (5.400 inch), the clearance is the following value. 0.77 ± 0.125 mm (0.0303 ± 0.0049 inch)

There is an increase in the clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore. Increase 0.08 mm (0.003 inch)

Oil Control Ring

(3) Oil Control Ring

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

Width of groove in new piston for oil control ring 3.02 ± 0.01 mm (0.119 ± 0.001 inch)

Thickness of new oil control ring 2.98 ± 0.01 mm (0.117 ± 0.001 inch)

There is a clearance between the ends of the piston ring. When the piston ring is installed in a cylinder liner with a bore of 137.16 mm (5.400 inch), the clearance is the following value. 0.55 ± 0.15 mm (0.028 ± 0.006 inch)

There is an increase in the clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore. Increase 0.08 mm (0.003 inch)

Piston Pin Bore

(4) Piston pin bore

Diameter of the bore in the bearing that is installed into the piston skirt for the piston pin 59.40 ± 0.04 mm (2.339 ± 0.002 inch)

Diameter of the new piston pin .. 59.975 ± 0.005 mm (2.3612 ± 0.0002 inch)

i02417176

Piston and Rings

SMCS Code: 1214; 1215

Part No.: 213-4835
S/N: SXC1-Up

Part No.: 213-4835
S/N: MED1-Up

Part No.: 213-4835
S/N: WDR1-Up

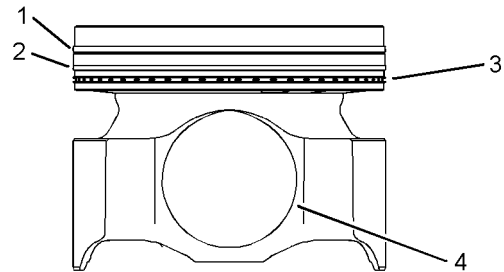


Illustration 53

g01091802

Note: Refer to Guideline for Reusable Parts for information on the pistons, the piston pins, and the retaining rings.

The 1U-6431 Piston Ring Groove Gauge Gp is used for measuring the ring grooves in keystone style pistons. Refer to the Special Instruction that is supplied with the Piston Ring Groove Gauge.

The 5P-3519 Piston Ring Groove Gauge Gp is available for checking the ring grooves with straight sides. Refer to the Guideline for Reusable Parts for instructions on the Piston Ring Groove Gauge.

Top Piston Ring

(1) Top piston ring

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

There is a clearance between the ends of the piston ring. When the piston ring is installed in a cylinder liner with a bore of 144.975 mm (5.708 inch), the clearance is the following value. 0.40 ± 0.10 mm (0.02 ± 0.004 inch)

There is an increase in the clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore. Increase 0.08 mm (0.003 inch)

Intermediate Piston Ring

(2) Intermediate piston ring

Install the piston ring with "UP-2" mark toward the top of the piston.

There is a clearance between the ends of the piston ring. When the piston ring is installed in a cylinder liner with a bore of 144.975 mm (5.708 inch), the clearance is the following value. .. 0.600 ± 0.125 mm (0.0236 ± 0.0049 inch)

There is an increase in the clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore. Increase 0.08 mm (0.003 inch)

Oil Control Ring

(3) Oil Control Ring

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

Width of groove in new piston for oil control ring 3.02 ± 0.01 mm (0.119 ± 0.001 inch)

Thickness of new oil control ring 2.98 ± 0.01 mm (0.117 ± 0.001 inch)

There is a clearance between the ends of the piston ring. When the piston ring is installed in a cylinder liner with a bore of 144.975 mm (5.708 inch), the clearance is the following value. 0.55 ± 0.15 mm (0.028 ± 0.006 inch)

There is an increase in the clearance between the ends of the piston rings for each 0.030 mm (0.0012 inch) increase in the cylinder liner bore. Increase 0.08 mm (0.003 inch)

Piston Pin Bore

(4) Piston pin bore

Diameter of the bore in the bearing that is installed into the piston skirt for the piston pin 59.40 ± 0.04 mm (2.339 ± 0.002 inch)

Diameter of the new piston pin .. 59.975 ± 0.005 mm (2.3612 ± 0.0002 inch)

i02801103

Housing (Front)

SMCS Code: 1151

Part No.: 238-9862

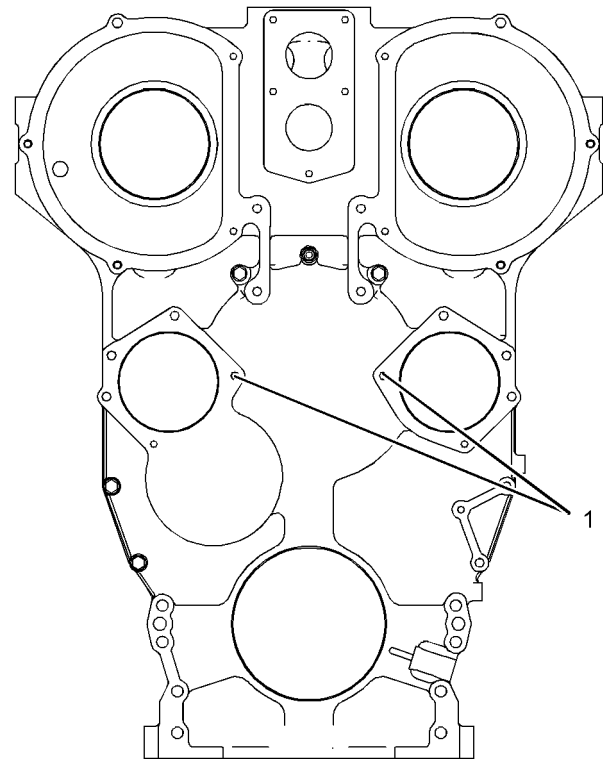


Illustration 54

g01399842

(1) Studs are supplied with a previously applied thread lock compound. Install the shortest threaded end of stud into the front housing assembly.

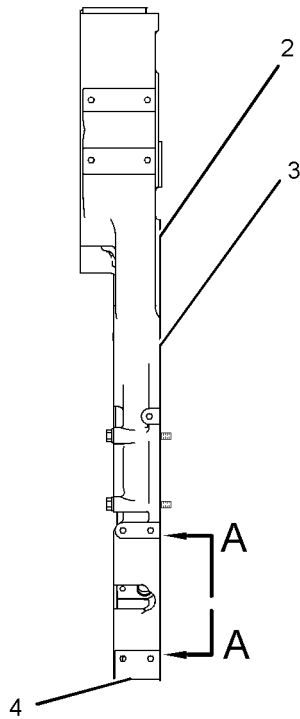


Illustration 55

g01399843

Note: The rear face of the front housing assembly (3) and the front face of the cylinder block must be free of oil, fuel, water, dirt and any other contaminants during assembly. The gasket for the front housing assembly must also be free of contaminants during assembly.

Note: The gasket (2) for the front housing assembly must be trimmed after assembly with the face (4) so that the gasket is flush.

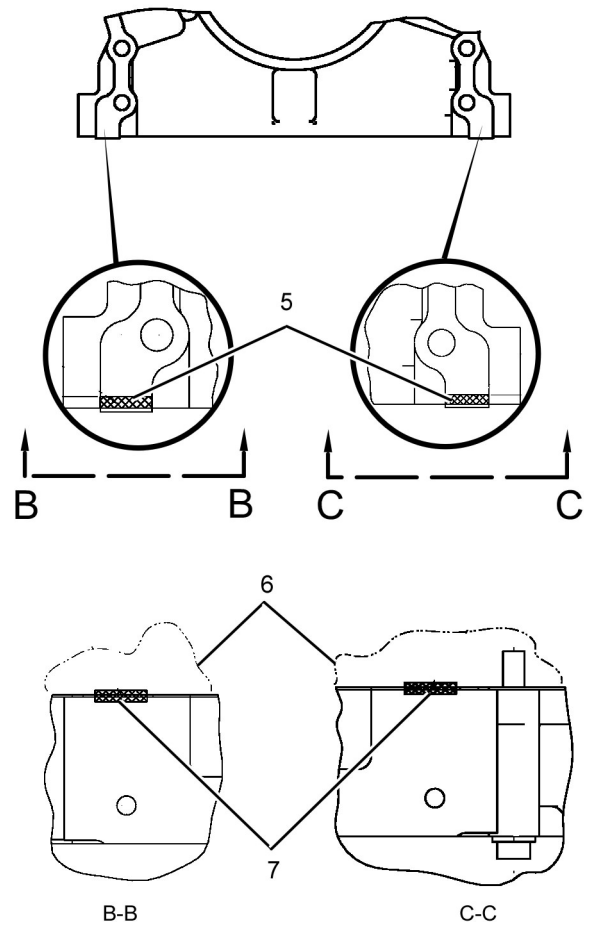


Illustration 56

g01399846

View A-A

(6) Cylinder block

- (5) Apply a continuous bead of 4C-9612 Silicone Sealant immediately prior to assembling the front housing assembly. After assembly of the front housing assembly, remove excess sealant from the flange with a straight edge.
- (7) Apply 4C-9612 Silicone Sealant to the T-shaped joints immediately prior to the installation of the gasket for the pan. The application of the sealant should cover the entire width of the T-shaped joints, as shown.

i02801118

Housing (Rear)

SMCS Code: 1157

Part No.: 233 - 2462

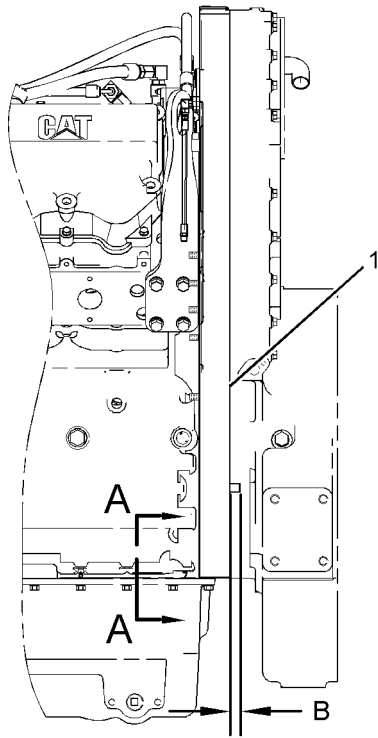


Illustration 57 g01399863
Left side view of engine

Note: The rear face of the cylinder block and the front face of the rear housing (1) must be free of oil, fuel, water, dirt, assembly compounds and any other contaminants during assembly. The gasket for the rear housing must also be free of contaminants during assembly.

(B) Dowel extension from the rear housing at two places 19.0 ± 0.5 mm (0.75 ± 0.02 inch)

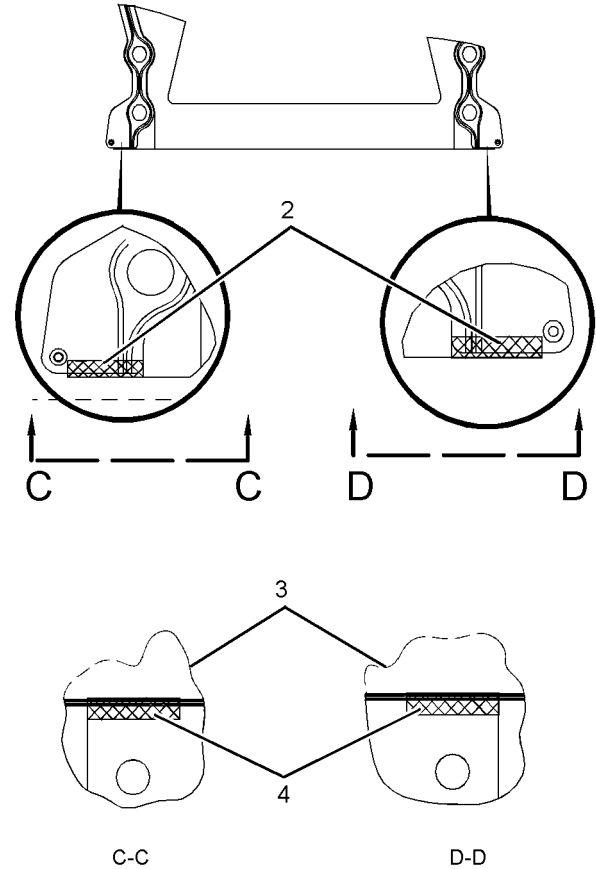


Illustration 58 g01399864
View A-A

(3) Cylinder block

- (2) Apply a continuous bead of 230 - 6262 Sealant immediately prior to assembling the rear housing. After assembly of the rear housing, remove any excess sealant from the flange with a straight edge.
- (4) Apply 230 - 6262 Sealant to the T-shaped joints immediately prior to the installation of the gasket for the pan. The application of the sealant should cover the entire width of the T-shaped joints, as shown.

i02801133

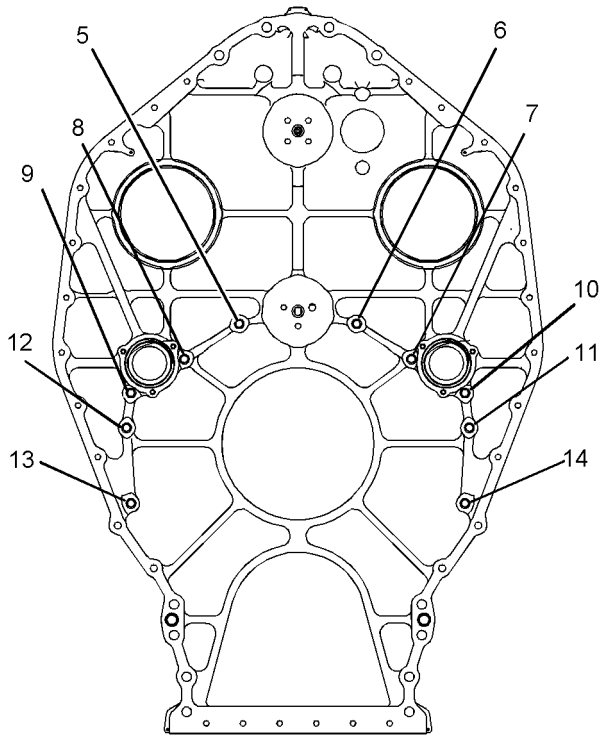


Illustration 59 g01399869

Rear view

Use the following procedure to tighten the bolts for the rear housing:

1. Start with bolt (5) and continue to tighten all of the remaining bolts in the numerical sequence that is shown to a torque of 55 ± 10 N·m (41 ± 7 lb ft).

- Bolt (5) and bolt (6) are 3/8-16 X 1 3/4 inches.
- Bolts (7) through bolts (14) are 3/8-16 X 2 1/4 inches.

Gear Group (Front)

SMCS Code: 1206

Part No.: 235-0993

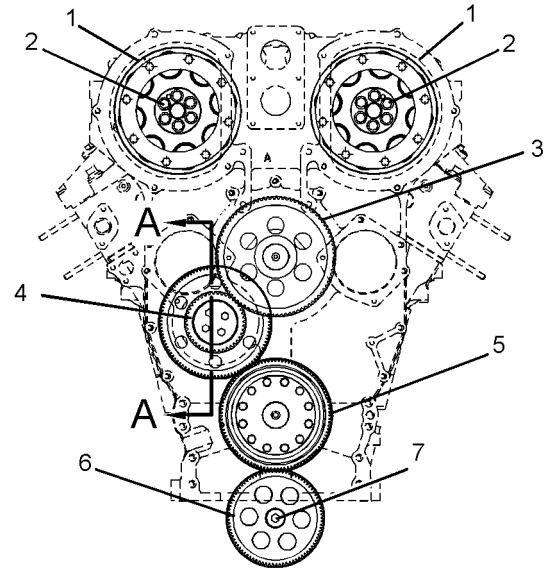


Illustration 60 g01399881

- (1) Damper group
- (3) Gear assembly
- (5) Crankshaft gear
- (6) Gear

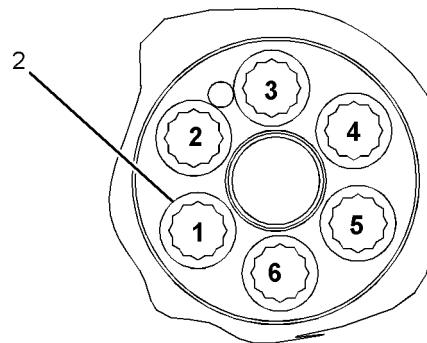


Illustration 61 g01399901

Tightening sequence

Note: Tighten the bolts for the camshaft gear in the sequence 1, 4, 2, 5, 3, 6, 1, 4. Refer to Illustration 61.

- (2) Torque for the 12 bolts of the camshaft gear 240 ± 40 N·m (175 ± 30 lb ft)
- (4) Lubricate the shaft, the bearing bore, and the thrust faces of the idler gear assembly with clean engine oil.

(7) Torque for the bolt $55 \pm 10 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$)

i02801439

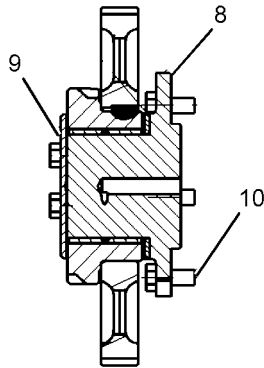


Illustration 62
Section A-A

g01399922

(8) Lubricate the drive idler shaft with clean engine oil.

Note: Install the thrust plate with the oil groove side toward the idler gear assembly.

(9) Lubricate the thrust faces of the thrust plate with clean engine oil.

(10) Torque for the five locking bolts $55 \pm 10 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$)

Gear Group (Rear)

SMCS Code: 1204; 1206

Part No.: 224 - 1213

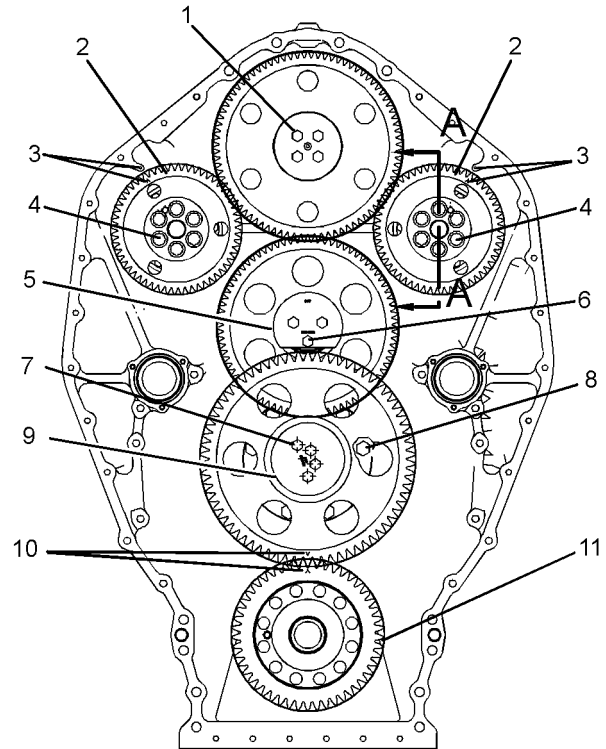


Illustration 63

g01400122

Note: Lubricate the shaft, the bearing bore, and the thrust faces of the idler gear assembly with clean engine oil.

(1) Torque for the bolts of the idler gear assembly $55 \pm 10 \text{ N}\cdot\text{m}$ ($41 \pm 7 \text{ lb ft}$)

(2) Lubricate the shaft, the bearing bore, and the thrust faces of the camshaft gear assembly with clean engine oil.

(3) With the number one piston in the top dead center position, align the timing marks. The mark on the camshaft gear must be in alignment with the mark in the rear housing.

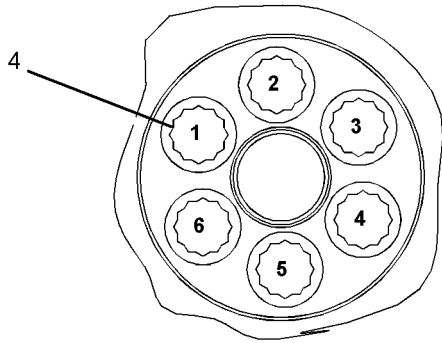


Illustration 64 g01400123
Tightening sequence

Note: Tighten the bolts for the camshaft gear in the sequence 1, 4, 2, 5, 3, 6, 1, 4. Refer to Illustration 64.

- (4) Torque for the 12 bolts of the camshaft gear assembly 240 ± 40 N·m (175 ± 30 lb ft)
- (5) Install the plate with the side marked “OUT” away from the gear face.

Note: Lubricate the shaft, the bearing bore, and the thrust faces of the idler gear assembly with clean engine oil.

- (6) Torque for the bolts of the idler gear assembly 55 ± 10 N·m (41 ± 7 lb ft)

Note: Lubricate the shaft, the bearing bore, and the thrust faces of the idler gear assembly with clean engine oil.

- (7) Torque for the locking bolt of idler gear assembly 55 ± 10 N·m (41 ± 7 lb ft)
- (8) Torque for the bolts for the stub shaft of idler gear assembly 135 ± 20 N·m (100 ± 15 lb ft)
- (9) Install the thrust plate with the side marked “OUT” away from the gear face.
- (10) With the number one piston in the top dead center position, align the timing marks. The mark on the idler gear must be in alignment with the mark on the crankshaft gear.
- (11) Lubricate the shaft, the bearing bore, and the thrust faces of the crankshaft gear assembly with clean engine oil.

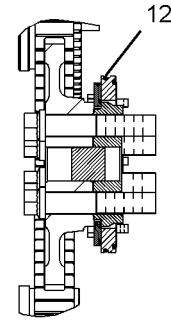


Illustration 65 g01400787
Section A-A

(12) Lubricate the O-ring seals lightly with clean engine oil.

i02801643

Flywheel

SMCS Code: 1156

Part No.: 258-4884

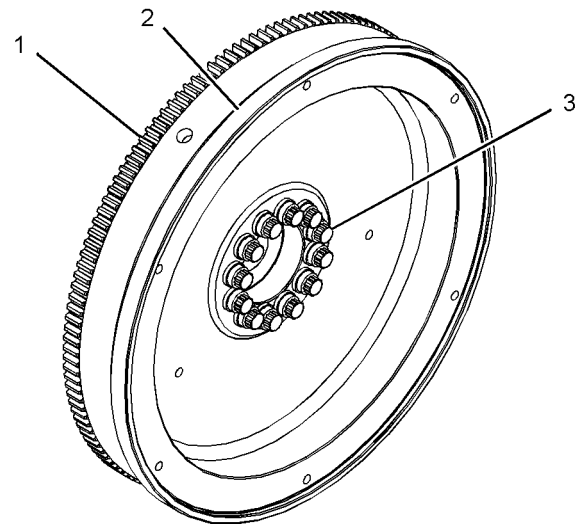


Illustration 66 g01188636
(1) Flywheel gear
(2) Flywheel

Note: Refer to Systems Operation/Testing and Adjusting for the correct method for flywheel runout and flywheel inspection.

Note: Replace the twelve bolts (3) at service.

- 1. Apply 6V-4876 Lubricant to the threads of the bolts (3) before assembly.

Note: Tighten the twelve bolts in a circular pattern. The circular pattern can be in a clockwise direction or in a counterclockwise direction.

2. Torque each bolt to 100 ± 5 N·m (75 ± 4 lb ft).

Note: Tighten the twelve bolts again with the circular pattern that was used in Step 2.

3. Turn each bolt by an additional 180 ± 5 degrees.

i02801652

Flywheel Housing

SMCS Code: 1157

Part No.: 272-0246

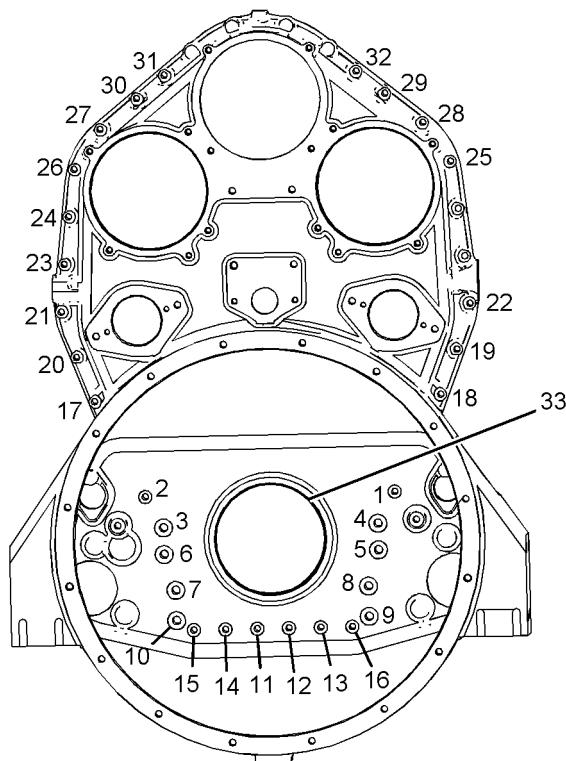


Illustration 67

g01400125

Rear view

Note: The front face of the flywheel housing and the rear face of the housing for the rear gear group must be free of oil, fuel, water, assembly components and any other contaminants during assembly. The gasket for the flywheel housing must be free of contaminants during assembly.

Note: The seal and the sleeve must not be used if the seal and the sleeve have been separated.

1. In the numerical sequence that is shown in Illustration 67, torque bolt (1) and bolt (2) to 55 ± 10 N·m (41 ± 7 lb ft). Bolts (1) and (2) are 3/8-16 X 4 3/4 inches.

2. In the numerical sequence that is shown in Illustration 67, torque bolt (3) through bolt (10) to 135 ± 20 N·m (100 ± 15 lb ft). Bolts (3) through bolts (10) are 1/2-13 X 5 inches.

3. In the numerical sequence that is shown in Illustration 67, torque bolt (11) through bolt (32) to 47 ± 9 N·m (35 ± 7 lb ft). Bolts (11) through bolts (32) are 3/8-16 X 2 1/2 inches.

(33) The seal driver must not contact the seal within the following diameter. 177.80 ± 0.25 mm (7.000 ± 0.010 inch)

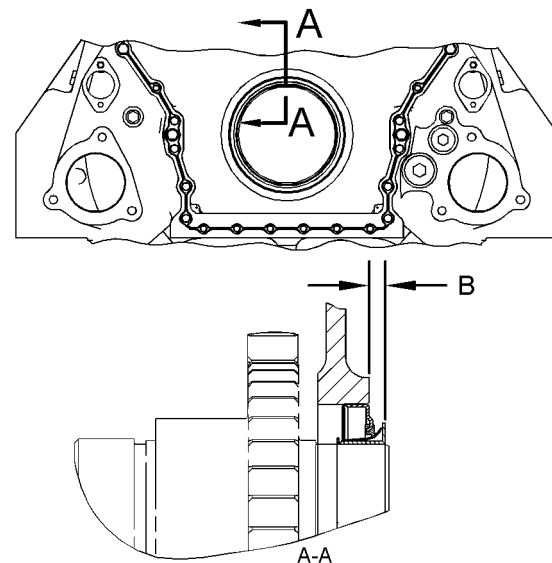


Illustration 68

g01404146

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft in any axial position.

(B) Assembled installation depth 5.8 to 6.4 mm (0.23 to 0.25 inch)

i02801662

Flywheel Housing

SMCS Code: 1157

Part No.: 239-3646
S/N: DWB1-Up

Part No.: 239-3646
S/N: SXC1-Up

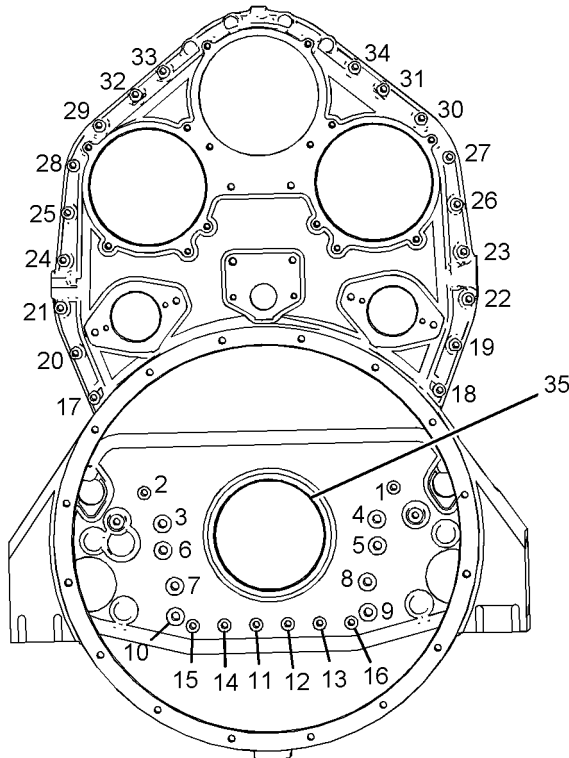


Illustration 69
Rear view

g01400129

Note: The front face of the flywheel housing and the rear face of the housing for the rear gear group must be free of oil, fuel, water, assembly components and any other contaminants during assembly. The gasket for the flywheel housing must be free of contaminants during assembly.

1. In the numerical sequence that is shown in Illustration 69, torque bolt (1) and bolt (2) to 55 ± 10 N·m (41 ± 7 lb ft). Bolts (1) and (2) are 3/8-16 X 4 3/4 inches.
2. In the numerical sequence that is shown in Illustration 69, torque bolt (3) through bolt (10) to 135 ± 20 N·m (100 ± 15 lb ft). Bolts (3) through bolts (10) are 1/2-13 X 5 inches.

3. In the numerical sequence that is shown in Illustration 69, torque bolt (11) through bolt (34) to 47 ± 9 N·m (35 ± 7 lb ft). Bolts (11) through bolts (34) are 3/8-16 X 2 1/2 inches.

- (35) The seal driver must not contact the seal within the following diameter. 177.80 ± 0.25 mm (7.000 ± 0.010 inch)

Note: The seal and the sleeve must not be used if the seal and the sleeve have been separated.

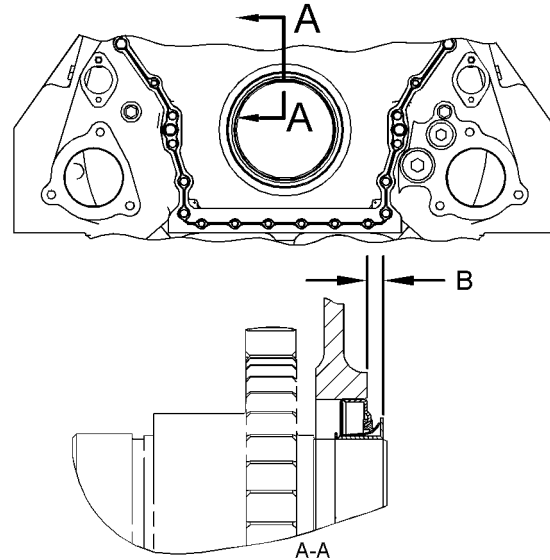


Illustration 70

g01404114

Note: Check assembled installation depth of the crankshaft seal group with the crankshaft in any axial position.

- (B) Assembled installation depth 5.8 to 6.4 mm (0.23 to 0.25 inch)

i02801674

Engine Support (Rear)

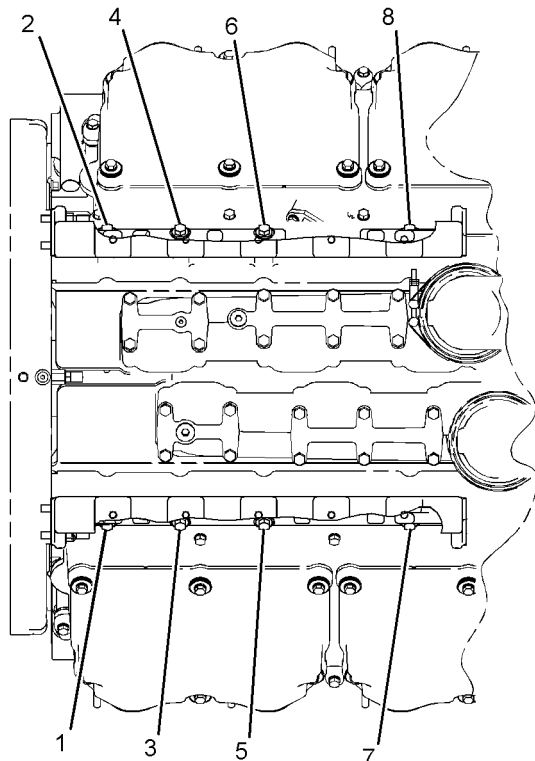
SMCS Code: 1154**Part No.:** 234-5913**S/N:** DWB1-Up**Part No.:** 234-5913**S/N:** SXC1-Up**Part No.:** 234-5913**S/N:** WDR1-Up

Illustration 71

g01302593

Top view

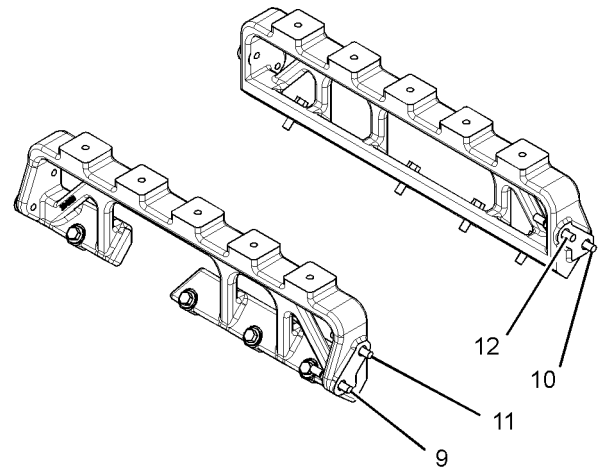


Illustration 72

g01302592

Rear view

Use the following procedure to tighten the studs and bolts:

1. Tighten stud (9) through stud (12) in the numerical sequence that is shown in Illustration 72 to 5 ± 5 N·m (45 ± 45 lb in).
2. Tighten bolt (1) through bolt (8) in the numerical sequence that is shown in Illustration 71 to 47 ± 9 N·m (35 ± 7 lb ft).
3. Again, tighten stud (9) through stud (12) in the numerical sequence that is shown in Illustration 72 to 47 ± 9 N·m (35 ± 7 lb ft).

i02385671

i02806500

Engine Support (Rear)

SMCS Code: 1154

Part No.: 236-8766
S/N: DWB1-Up

Part No.: 236-8766
S/N: SXC1-Up

Part No.: 236-8766
S/N: MED1-Up

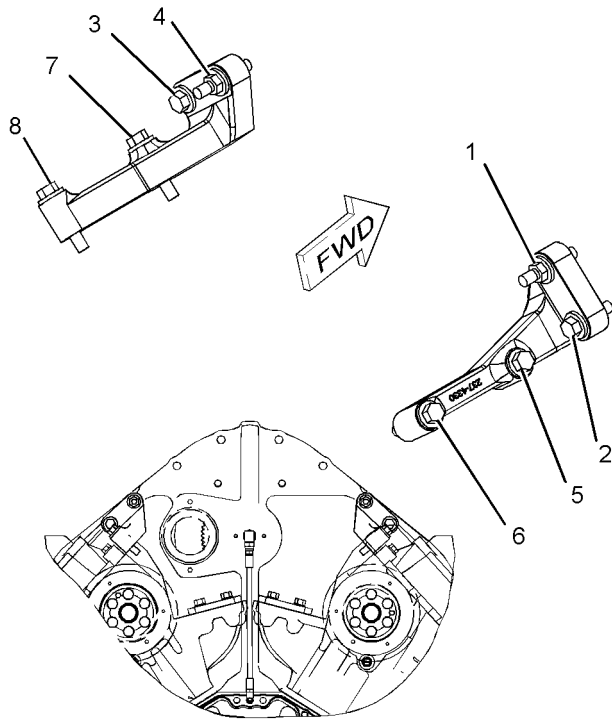


Illustration 73
Rear view

g01190146

1. Tighten bolt 1 through bolt 4 in a numerical sequence.

Tighten the bolts to the following torque. 5 ± 3 N·m (45 ± 25 lb in)
2. Tighten bolt 5 through bolt 8 in a numerical sequence.

Tighten the bolts to the following torque. 47 ± 9 N·m (35 ± 7 lb ft)
3. Again, tighten bolt 1 through bolt 4 in a numerical sequence.

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

Alternator and Regulator

SMCS Code: 1405; 1410

Part No.: 5N-5692
S/N: DWB1-Up

Part No.: 5N-5692
S/N: SXC1-Up

Part No.: 5N-5692
S/N: WDR1-Up

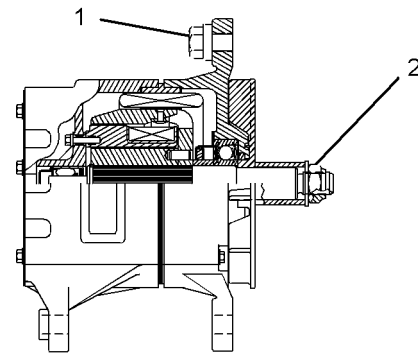


Illustration 74

g01364499

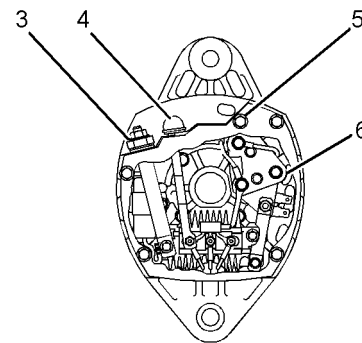


Illustration 75

g01400391

- 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
- Minimum full load current at 5000 rpm 42.3 Amp
- Minimum full load current at 2000 rpm 15.8 Amp

Output voltage 28 ± 1 V

i02806498

Note: Tighten the bolt (1) before tightening the mounting bolt.

- (1) Torque for the bolt 88.4 ± 6.8 N·m (65 ± 5 lb ft)
- (2) Final installation torque for the flange nut 102 ± 7 N·m (75 ± 5 lb ft)
- (3) (B+) terminal. Final installation torque for the nut 6.2 ± 0.6 N·m (55 ± 5 lb in)

Note: Use a 7/16 ring terminal for (B+) terminal.

- (4) The peak voltage for (R) terminal must not be less than the output voltage for (B+) terminal.
- (5) (B-) terminal. Final installation torque for the screw 2.25 ± 0.25 N·m (20 ± 2 lb in)
- (6) Voltage regulator assembly

Voltage setting No adjustment
Permissible voltage range 27 to 29 V

i02703924

Coolant Temperature Sensor

SMCS Code: 1906
Part No.: 264-4297

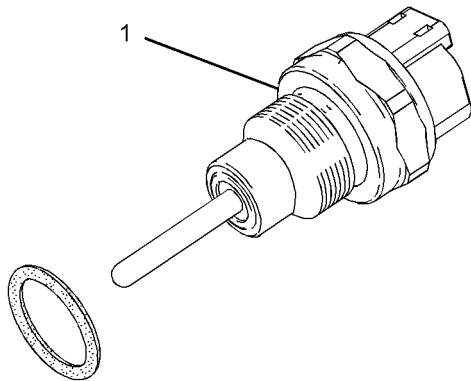


Illustration 76 g01089060

- (1) Final installation torque for temperature sensor 20 ± 3 N·m (15 ± 2 lb ft)

Output type Passive

Fuel Temperature Sensor

SMCS Code: 1922
Part No.: 264-4297

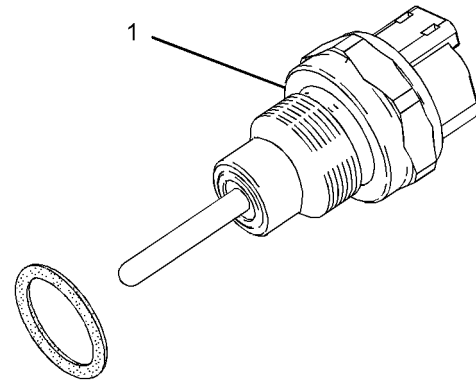


Illustration 77 g01089060

- (1) Final installation torque for temperature sensor group 20 ± 3 N·m (15 ± 2 lb ft)

Output type Passive

i02665531

Fuel Pressure Sensor

SMCS Code: 1718
Part No.: 194-6725

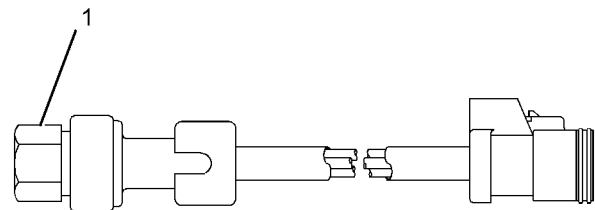


Illustration 78 g01190345

- (1) Final installation torque for the pressure sensor group 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.00 ± 0.25 VDC

Operating temperature -40 to 125 °C
(-40 to 257 °F)

Maximum operating pressure (absolute pressure) 1135 kPa (165 psi)

i02665532

Engine Oil Pressure Sensor

SMCS Code: 1924

Part No.: 274-6719

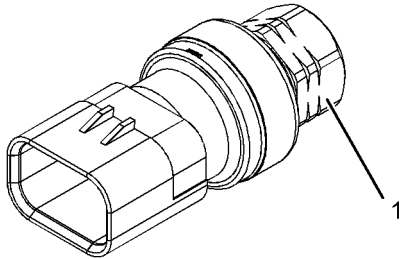


Illustration 79

g01155331

Note: Prior to installing the pressure sensor group onto the engine, apply 5P-3413 Pipe Sealant to the first three threads of the pressure sensor group.

(1) Final installation torque for the pressure sensor group 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.0 ± 0.5 VDC

Operating temperature -40 to 125 °C
(-40 to 257 °F)

Maximum operating pressure (absolute pressure) 1135 kPa (165 psi)

i02606267

Engine Oil Pressure Sensor

SMCS Code: 1924

Part No.: 194-6725

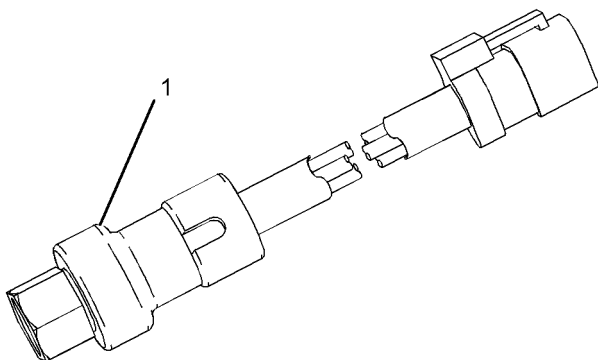


Illustration 80

g01068621

(1) Sensor assembly

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

Operating temperature -40 to 125 °C
(-40 to 257 °F)

Maximum input pressure (absolute pressure) 1135 kPa (165 psi)

Input supply voltage 5 ± 0.25 VDC

i02806477

Engine Oil Temperature Sensor

SMCS Code: 1929

Part No.: 197-8392, 264-4297

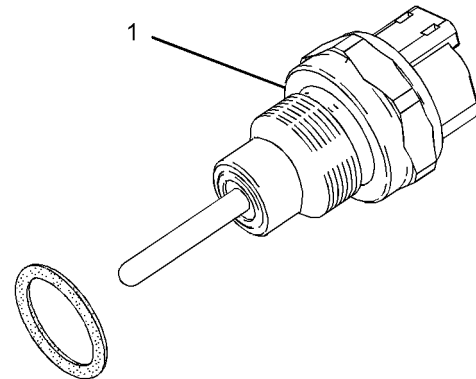


Illustration 81

g01089060

(1) Final installation torque for the temperature sensor group 20 ± 3 N·m (15 ± 2 lb ft)

Output type Passive

i0266631

Atmospheric Pressure Sensor

SMCS Code: 1923

Part No.: 194-6724

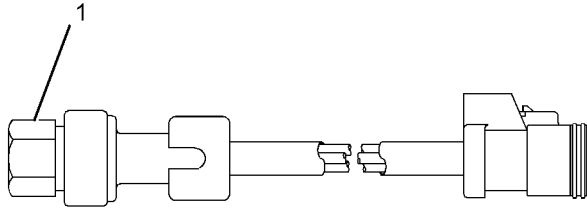


Illustration 82

g01190345

(1) Final installation torque for the pressure sensor group 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.00 ± 0.25 VDC

Operating temperature -40 to 125 °C
(-40 to 257 °F)

Maximum operating pressure (absolute pressure) 472 kPa (68 psi)

i02806451

Atmospheric Pressure Sensor

SMCS Code: 1923

Part No.: 274-6717

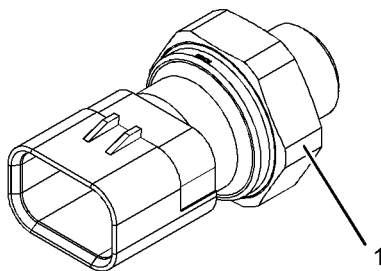


Illustration 83

g01154731

(1) Final installation torque for the pressure sensor group 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.0 ± 0.5 VDC

Operating temperature -40 to 125 °C
(-40 to 257 °F)

Maximum operating pressure (absolute pressure) 116 kPa (17 psi)

i02786528

Atmospheric Pressure Sensor

SMCS Code: 1923

Part No.: 194-6722

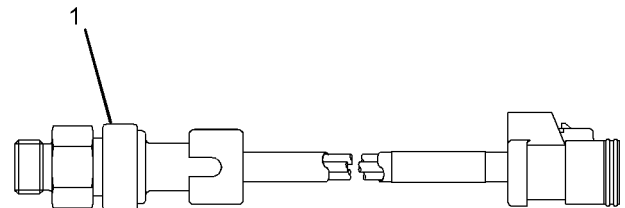


Illustration 84

g01392045

(1) Final installation torque for the pressure sensor group 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.00 ± 0.25 VDC

i02806452

Atmospheric Pressure Sensor

SMCS Code: 1923

Part No.: 276-6793

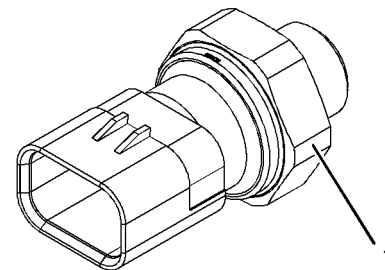


Illustration 85

g01154731

(1) Final installation torque for pressure sensor group 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.0 ± 0.5 VDC

Operating temperature -40 to 125 °C
(-40 to 257 °F)

Maximum operating pressure (absolute pressure) 472 kPa (68 psi)

i02806458

Inlet Air Temperature Sensor

SMCS Code: 1921

Part No.: 264-4297

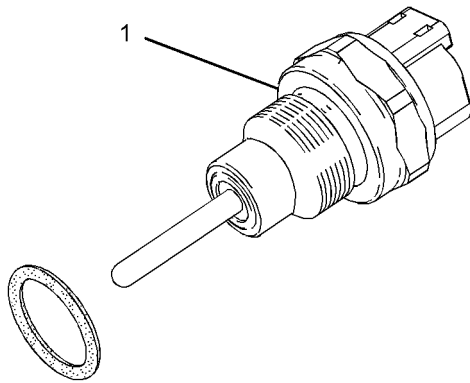


Illustration 86

g01089060

(1) Final installation torque for temperature sensor group 20 ± 3 N·m (15 ± 2 lb ft)

Output type Passive

i02789606

Inlet Manifold Air Pressure Sensor

SMCS Code: 1058; 1923

Part No.: 194-6724

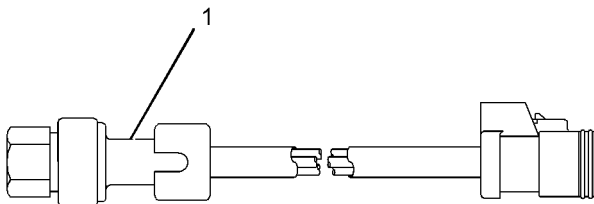


Illustration 87

g01046622

(1) Tighten the sensor to the following torque. 10 ± 2 N·m (90 ± 18 lb in)

Operating voltage 5.00 ± 0.25V

Output type Voltage

i02811430

Speed/Timing Sensor

SMCS Code: 1907; 1912

Part No.: 239-2397

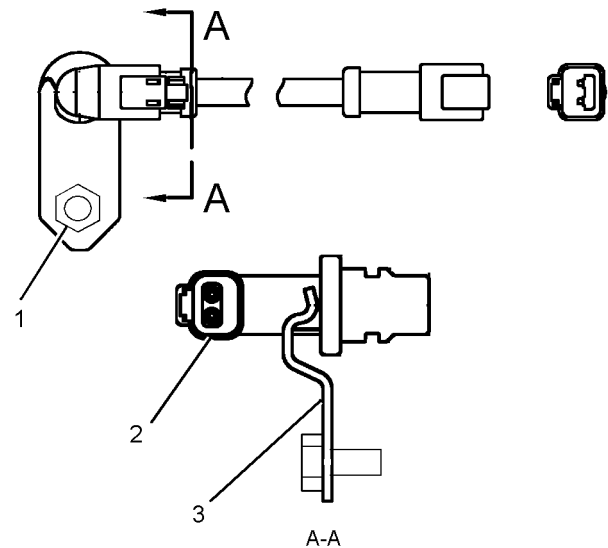


Illustration 88

g01400335

- (1) Bolt
- (2) Speed sensor

(3) Ensure that the bracket is installed in the orientation that is shown.

Note: Ensure that the speed sensor is seated before bolt (1) is tightened.

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