RENR8913
September 2006

Specifications

1104D Industrial Engine

NH (Engine)
NJ (Engine)

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.

⚠ WARNING

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.

Perkins 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 Perkins 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. Perkins dealers or Perkins distributors have the most current information available.

⚠ WARNING

When replacement parts are required for this product Perkins recommends using Perkins replacement parts.

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

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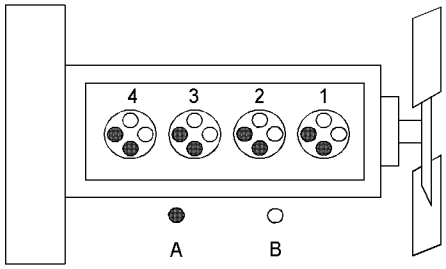
Engine Design



g01187485

Illustration 1

Cylinder and valve location

(A) Exhaust valve
(B) Inlet valve

Bore ..... 105 mm (4.133 inch)

Stroke ..... 127 mm (5.000 inch)

Displacement ..... 4.4 L (269 in^3)

Cylinder arrangement ..... In-line

Type of combustion ..... Direct injection

Compression ratio

Turbocharged engines and turbocharged aftercooled engines 16.2:1

Number of cylinders 4

Valves per cylinder 4

Valve lash

Inlet valve ..... 0.35 mm (0.0138 inch)
Exhaust valve ..... 0.35 mm (0.0138 inch)

Firing order 1, 3, 4, 2

When the crankshaft is viewed from the front of the engine, the crankshaft rotates in the following direction: ..... Clockwise

When the camshaft is viewed from the front of the engine, the camshaft rotates in the following direction: ..... Clockwise

The front 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.

i02519279

Fuel Injection Lines

WARNING

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

Refer to Operation and Maintenance Manual, “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

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

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

Manifold to Injector

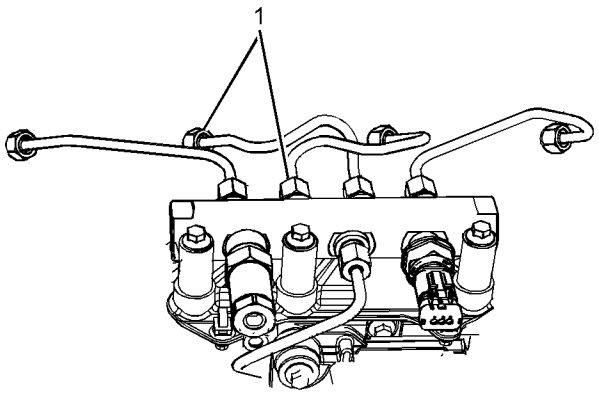


Illustration 2 g01260742
Typical example

(1) Tighten the union nuts for the high pressure fuel lines (1) to the following torque. ..... 30 N·m (22 lb ft)

Pump to Manifold

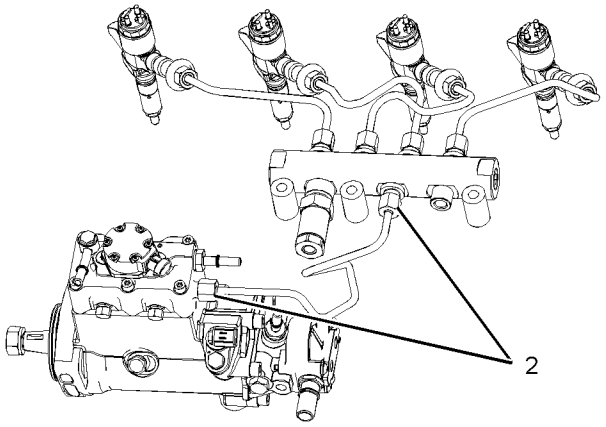


Illustration 3 g01260743
Typical example

(1) Tighten the union nuts for the high pressure fuel line (2) to the following torque. .. 30 N·m (22 lb ft)

i02519422

Fuel Injection Pump

Note: Before the pump is removed from the engine the fuel injection pump shaft must be locked. Position the engine to TC compression stroke of number one cylinder before tightening the locking screw. The locking screw will prevent the shaft from rotating. If the fuel injection pump was removed prior to correctly timing the engine and locking the shaft, the fuel injection pump will need to be timed by trained personnel. In order to time the fuel injection pump, refer to Disassembly and Assembly, “Fuel Injection Pump - Install”.

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

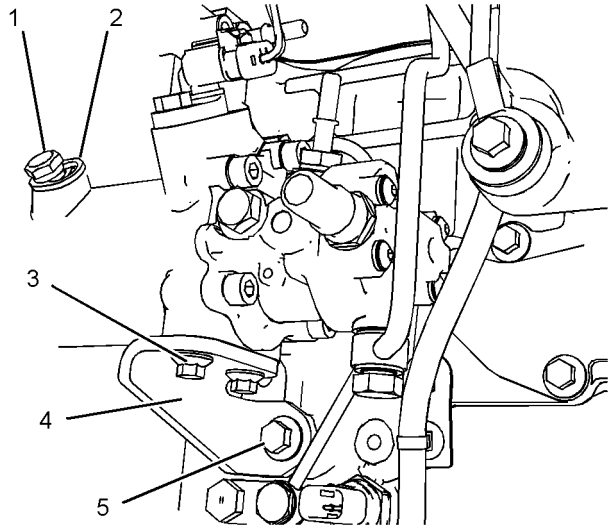


Illustration 4 g01260784
Typical example

(1) Locking screw

(2) Washer

(3) Setscrews

(4) Support bracket

(5) Setscrew

Locking the shaft

Loosen locking screw (1) and move the washer (2) to the locked position. Tighten the locking screw to the following torque. .... 9 N·m (79 lb in)

Unlocking the shaft

Loosen locking screw (1) and move the washer (2) to the unlocked position. Tighten the locking screw to the following torque. ..... 9 N·m (79 lb in)

(3) Tighten the mounting setscrews to the following torque. ..... 22 N·m (16 lb ft)

(5) Tighten the mounting setscrew to the following torque. ..... 44 N·m (32 lb ft)

Note: The support bracket must be installed after the coolant pump is installed. In order to stop the distortion of the timing case, finger tighten the setscrew (5) and then tighten the setscrews (3).

Tighten the bolts that hold the fuel pump to the front housing to the following torque. ..... 25 N·m (18 lb ft)

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Fuel Injectors

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

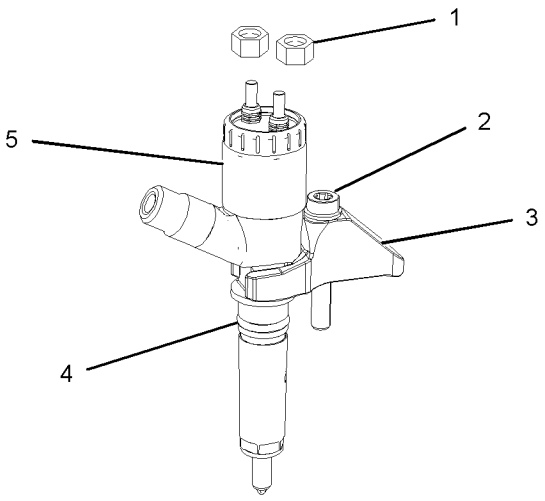

Illustration 5 g01179017

(1) Tighten the nuts to the following torque 2.4 N·m (21 lb in).

(2) Tighten the bolt in the clamp for the fuel injection nozzle to the following torque. .. 27 N·m (19 lb ft)

(3) Clamp

(4) O ring seal

(5) Trim code

Note: Refer to the Troubleshooting, "Injector Trim File" for more information.

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Fuel Transfer Pump

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

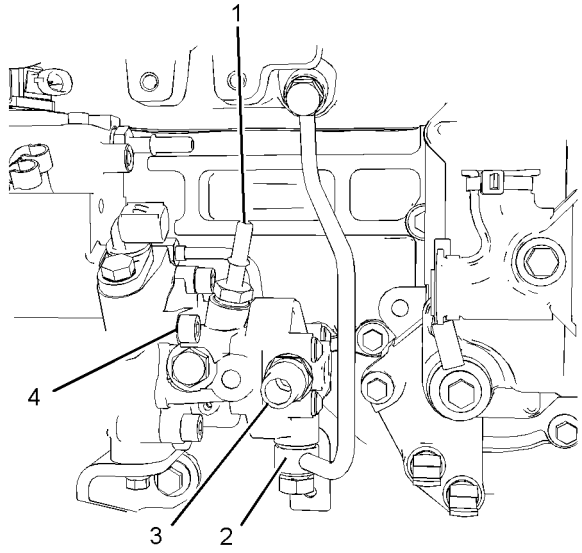


Illustration 6 g01260765

(1) Fuel outlet
(2) Fuel return from cylinder head
(3) Fuel supply
(4) Retaining setscrew

(4) Retaining setscrew ..... 30 N·m (22 lb ft)

The outlet pressure for the fuel ..... 400 to 500 kPa (58.0160 to 72.5200 psi)

i02519336

Fuel Filter Base

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

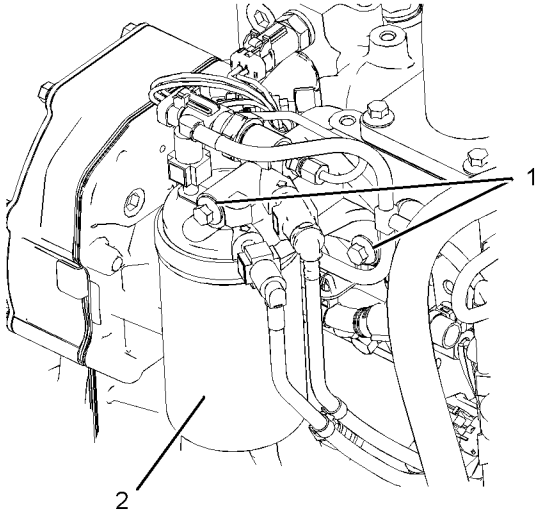


Illustration 7 g01260768
Typical example

(1) Retaining setscrews ..... 44 N·m (32 lb ft)

(2) The canister for the fuel filter

i02519432

Fuel Priming Pump

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

Hand Fuel Priming Pump

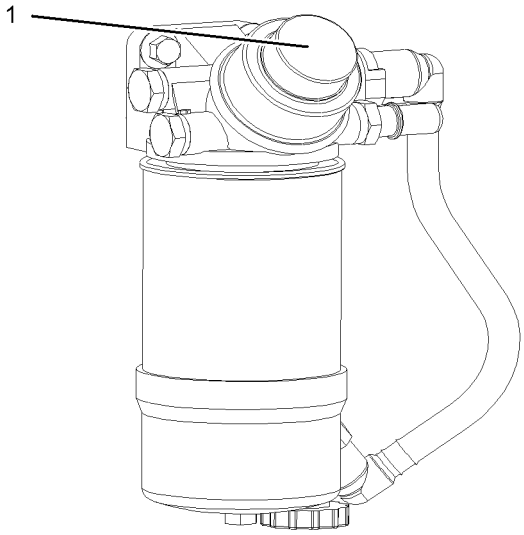


Illustration 8 g01265616
Typical example

(1) The plunger that is hand operated.

Electric fuel Priming Pump

The electric fuel priming pump operates on 12 volts or 24 volts.

i02392326

Lifter Group

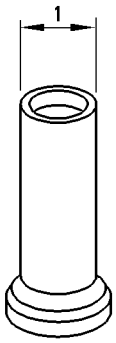


Illustration 9 g00629433

(1) Diameter of the lifter body .. 18.987 to 19.012 mm (0.7475 to 0.7485 inch)

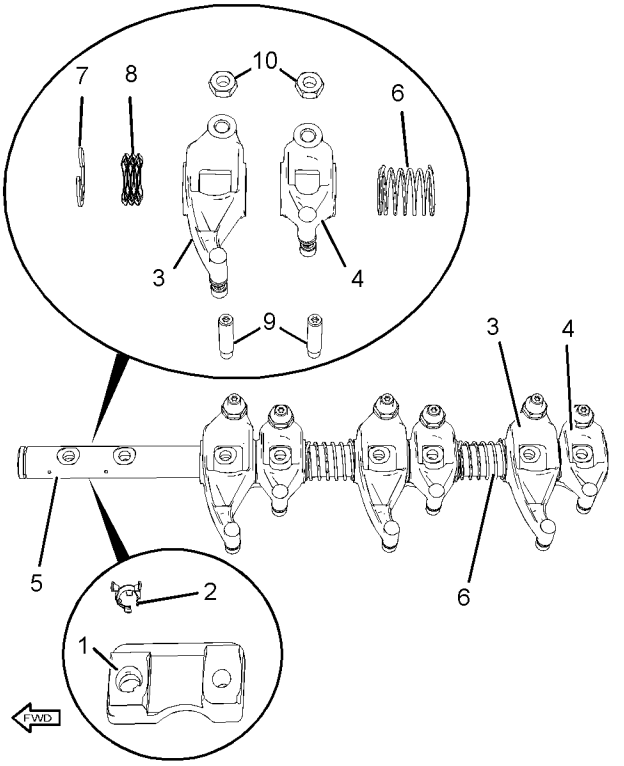
Bore diameter in the cylinder block ..... 19.05 to 19.082 mm (0.7500 to 0.7513 inch)

Clearance

Clearance of the lifter ..... 0.038 to 0.095 mm (0.0015 to 0.0037 inch)

i02504776

Rocker Shaft



g01253910

Illustration 10

Typical example

(1) Pedestal

(2) Locator

(3) Inlet rocker arm

Diameter of the rocker arm bore .... 25.031 to 25.051 mm (0.9855 to 0.9863 inch)

(4) Exhaust rocker arm

Diameter of the rocker arm bore ..... 25.031 to 25.051 mm (0.9855 to 0.9863 inch)

Clearance

Maximum clearance of both the rocker arm bores ..... 0.089 mm (0.0035 inch)

The service limit for both rocker arm bores ..... 0.17 mm (0.0067 inch)

(5) Rocker shaft

Diameter of the rocker shaft ..... 24.962 to 24.987 mm (0.9828 to 0.9837 inch)

(6) Spring

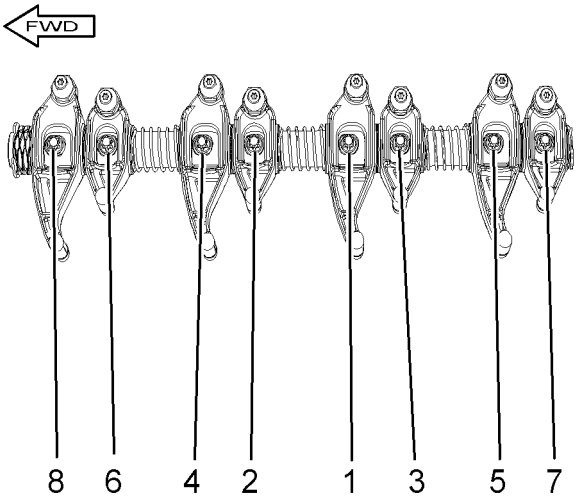
(7) Snap ring

(8) Spring

(9) Adjuster

(10) Locknut

Torque for the locknut ..... 27 N·m (20 lb ft)



g01254105

Illustration 11

Tightening sequence

Tighten the fasteners in the sequence that is in illustration 11. Tighten the fasteners to the following torque. ..... 35 N·m (25 lb ft)

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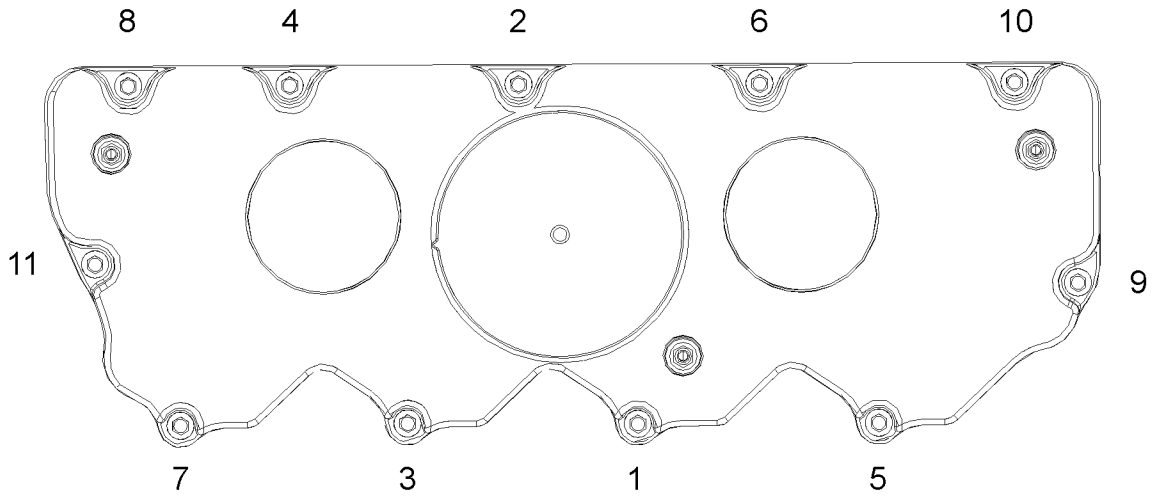
Valve Mechanism Cover



g01252367

Illustration 12

Typical example

Tighten the bolts for the valve mechanism cover in the sequence that is shown in illustration 12 to the following torque. ..... 6 N·m (53 lb in)

i02503124

Cylinder Head Valves

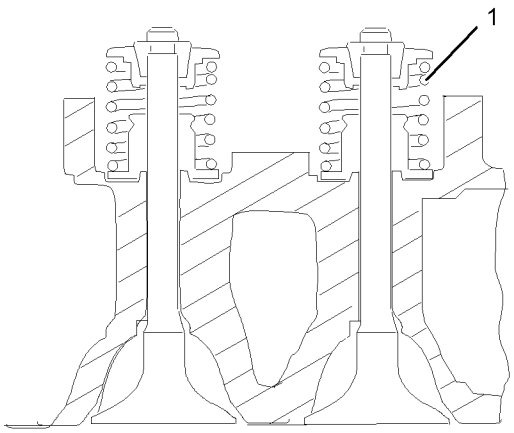


Illustration 13 g01164859

Typical example

The valve spring (1) may be used on the inlet valve or the exhaust valve. When the valve springs are replaced the valve springs must be replaced in pairs.

Table 1

The load for the valve spring	The length of the valve spring
161.5 to 178.5 N (36.3 to 40.1 lb)	31.5 mm (1.2402 inch)
337.9 ± 373.5 N (76 ± 84 lb)	21.5 mm (0.8465 inch)

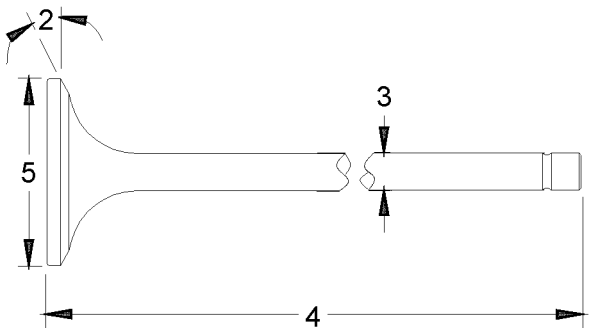


Illustration 14 g01193821

(2) Valve face angle

Inlet ..... 30 degrees
Exhaust ..... 45 degrees

(3) Valve stem diameter

Inlet .. 5.942 to 5.957 mm (0.2339 to 0.2345 inch)
Exhaust ..... 5.927 to 5.942 mm (0.2333 to 0.2339 inch)

Clearance

Maximum clearance of the inlet valve stem ..... 0.05 mm (0.0020 inch)
The service limit for the inlet valve stem ..... 0.08 mm (0.0031 inch)

Clearance

Maximum clearance of the exhaust valve stem ..... 0.065 mm (0.0026 inch)
The service limit for the inlet valve stem ..... 0.09 mm (0.0035 inch)

(4) Length of valve

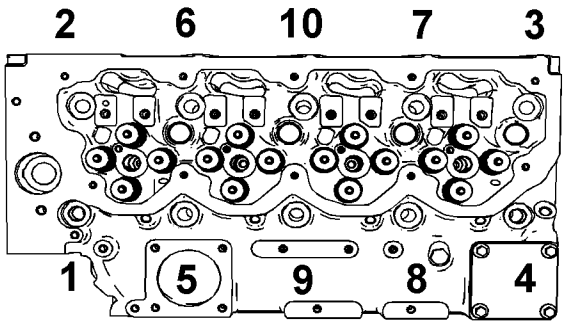
Inlet valve ..... 107.925 to 108.375 mm (4.2490 to 4.2667 inch)
Exhaust valve ..... 107.703 to 108.153 mm (4.2403 to 4.2580 inch)

(5) Valve head

Diameter of inlet valve head ..... 35 mm (1.3780 inch)
Diameter of exhaust valve head ..... 33 mm (1.2992 inch)

i02505671

Cylinder Head



g01250785

Illustration 15

Typical example

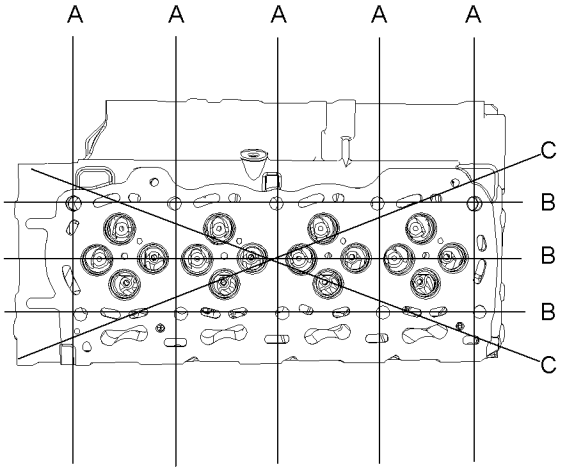
Lubricate the threads and the underside of the head bolts with clean engine oil.

Tighten the bolts in the sequence that is shown in illustration 15 to the following torque. ..... 50 N·m (37 lb ft)

Tighten the bolts again to the following torque. ..... 100 N·m (74 lb ft)

Tighten the head bolts to the additional amount. ..... 225 degrees

Minimum thickness of cylinder head ..... 100.95 mm (3.9744 inch)



g01254471

Illustration 16

Typical example

Note: The maximum distortion of the bottom face of the cylinder head is given in table 2.

Table 2

Dimension	Maximum Permissible Distortion
Width (A)	0.03 mm (0.0018 inch)
Length (B)	0.05 mm (0.0019 inch)
Diagonal Line (C)	0.05 mm (0.0019 inch)

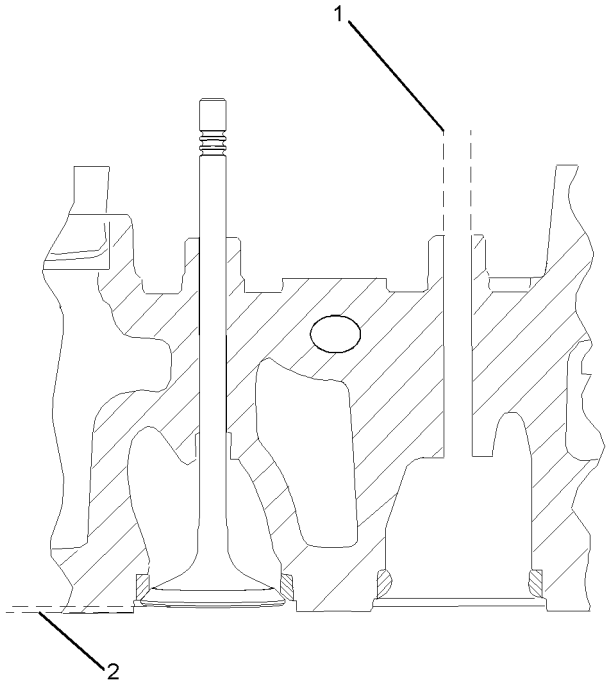


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Illustration 17

Typical example

(1) Valve guide bores

Inlet and exhaust ..... 5.979 to 5.992 mm (0.2354 to 0.2359 inch)

(2) Valve depths

Inlet .. 0.905 to 1.163 mm (0.0356 to 0.0458 inch)

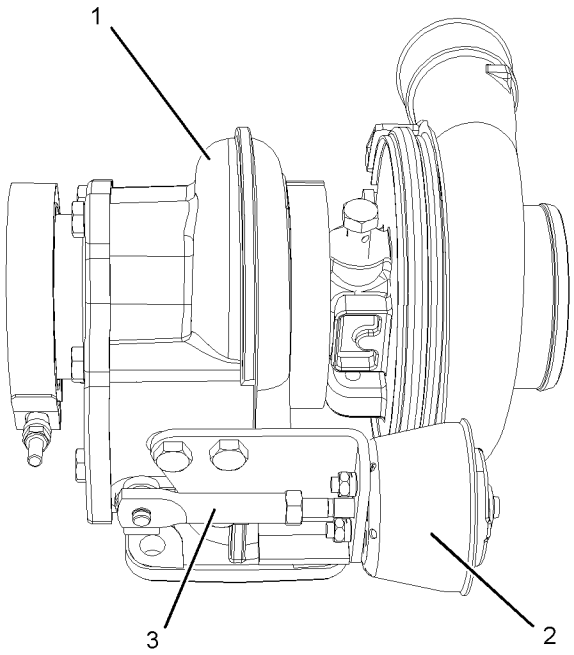
The service limit for the depth of the inlet valve ..... 1.41 mm (0.0555 inch)

Exhaust ..... 0.876 to 1.131 mm (0.0345 to 0.0445 inch)

The service limit for the exhaust valve depth ..... 1.38 mm (0.0543 inch)

i02527109

Turbocharger



g01265255

Illustration 18

Typical example

(1) Turbocharger

(2) Actuator

(3) Actuator rod

The maximum test pressure for the wastegate ..... 112 kPa (16.2445 psi)

The movement for the rod actuator ..... 1 mm (0.0394 inch)

Table 3

The part number for the turbocharger	The pressure for the wastegate
2674A804	112 kPa (16.2445 psi)
2674A805	112 kPa (16.2445 psi)
2674A806	112 kPa (16.2445 psi)
2674A607	112 kPa (16.2445 psi)
2674A608	112 kPa (16.2445 psi)
2674A609	100 kPa (14.5040 psi)
2674A611	100 kPa (14.5040 psi)
2674A612	100 kPa (14.5040 psi)

i02504751

Exhaust Manifold

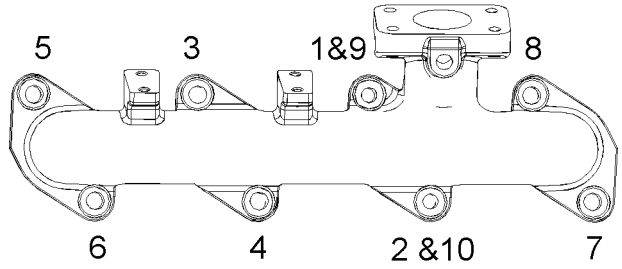


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Illustration 19

Typical example

Tighten the exhaust manifold bolts in the sequence that is shown in illustration 19 to the following torque. ..... 40 N·m (30 lb ft)

i02526614

Camshaft

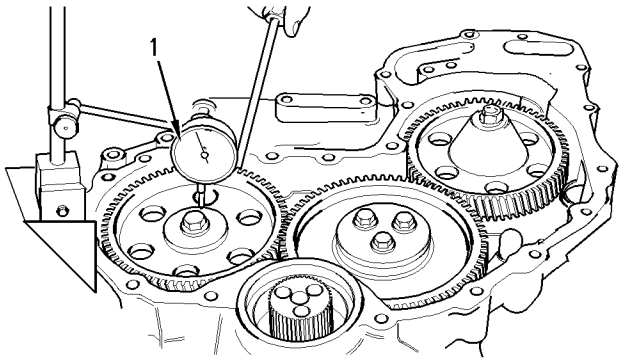

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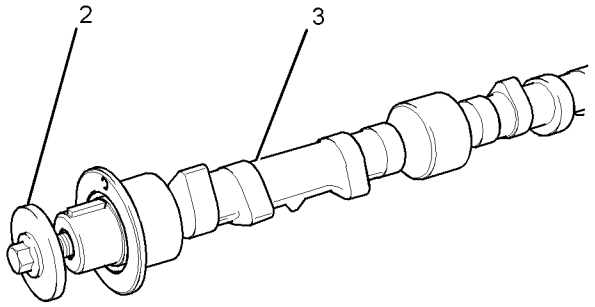
Illustration 20

Checking the end play of the camshaft

(1) End play of a camshaft ..... 0.126 to 0.558 mm (0.0050 to 0.0220 inch)

Maximum permissible end play of a worn camshaft ..... 0.62 mm (0.0244 inch)



g01195129

Illustration 21

Typical example

(2) Bolt

Tighten the bolt to the following torque. ... 95 N·m (70 lb ft)

(3) The diameters of the camshaft journals are given in the following tables.

Table 4

Camshaft Journals	Standard Diameter
1	50.711 to 50.737 mm (1.9965 to 1.9975 inch)
2	50.457 to 50.483 mm (1.9865 to 1.9875 inch)
3	49.949 to 49.975 mm (1.9665 to 1.9675 inch)

Maximum wear on the camshaft journals ... 0.05 mm (0.0021 inch)

Check the camshaft lobes for visible damage. If a new camshaft is installed you must install new lifters.

i02505262

Camshaft Bearings

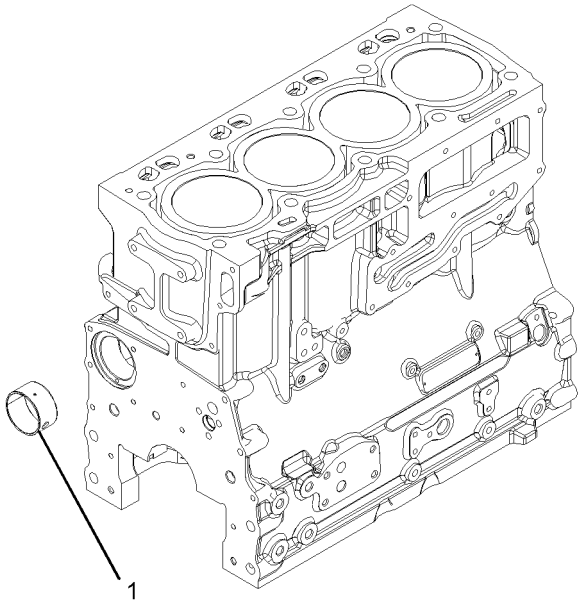


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Illustration 22

Typical example

(1) The diameter of the installed camshaft bearing ..... 50.787 to 50.848 mm (1.9995 to 2.0019 inch)

i02505073

Engine Oil Filter Base

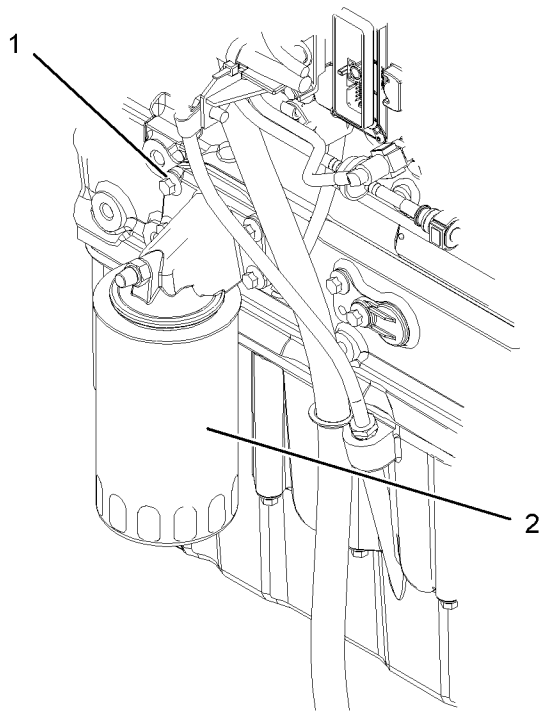


Illustration 23 g01254114

Typical example

(1) Setscrew

Tighten the setscrews to the following torque. ..... 22 N·m (16 ft)

(2) Engine oil filter

Tighten the engine oil filter to the following torque. ..... 12 N·m (8 lb ft)

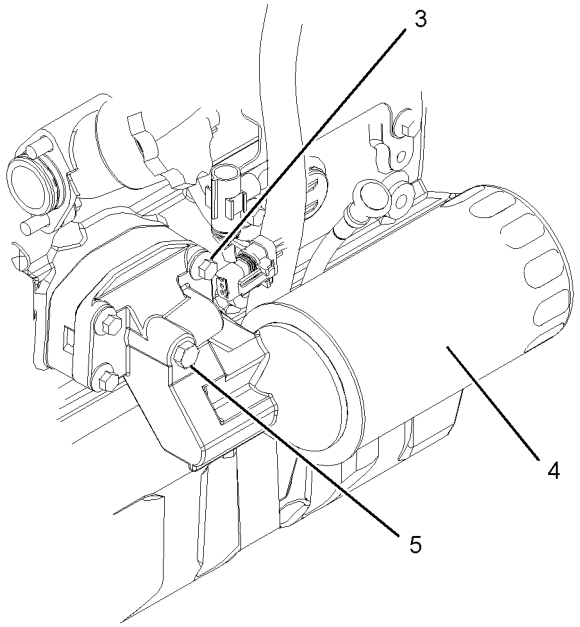


Illustration 24 g01254115

Typical example

(3) Setscrew

Tighten the setscrews to the following torque. ..... 22 N·m (16 ft)

(4) Engine oil filter

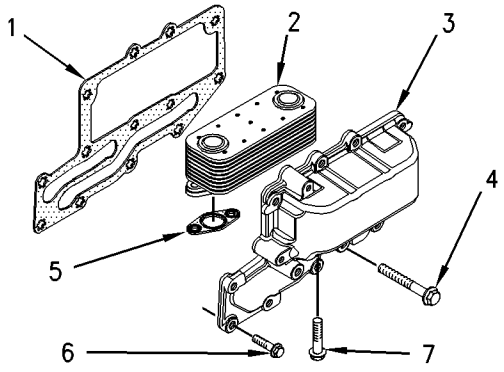
Tighten the engine oil filter to the following torque. ..... 12 N·m (8 lb ft)

(5) Plug

Tighten the plug to the following torque. .. 12 N·m (8 lb ft)

i02505212

Engine Oil Cooler

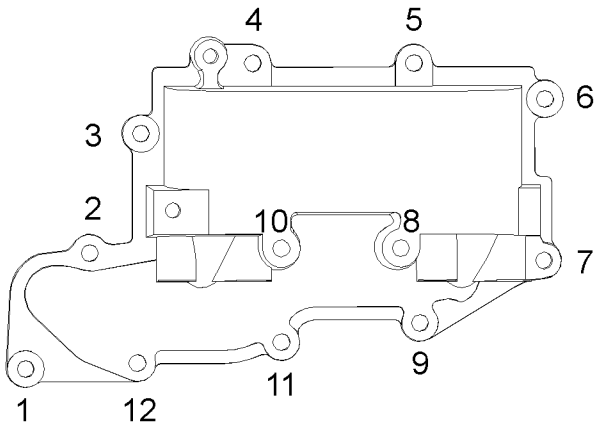


g00952614

Illustration 25

Typical example

(1) Joint
(2) Oil cooler
(3) Housing
(4) Setscrew
(5) Seal
(6) Setscrew
(7) Setscrew



g01254185

Illustration 26

Setscrews

Tighten the setscrews (7) to the following torque. ..... 22 N·m (16 lb ft)

Setscrews

Tighten the setscrews (4) and (6) in the sequence that is in illustration 26 to the following torque. ..... 22 N·m (16 lb ft)

i02505677

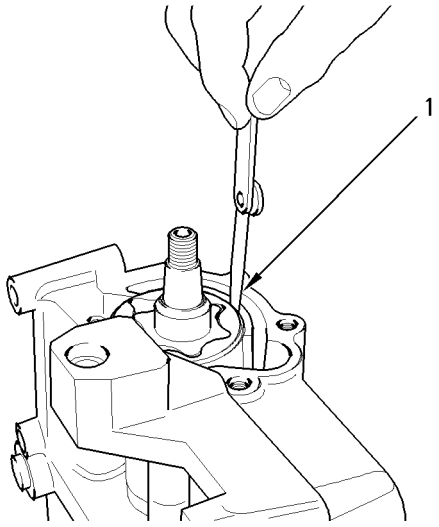
Engine Oil Pump

Engines with Balancer Group

Type ..... Gear-driven differential rotor

Number of lobes

Inner rotor 6
Outer rotor 7



g00989248

Illustration 27

The oil pump for the balancer

(1) Clearance of the outer rotor to the body .. 0.130 to 0.24 mm (0.0050 to 0.0094 inch)

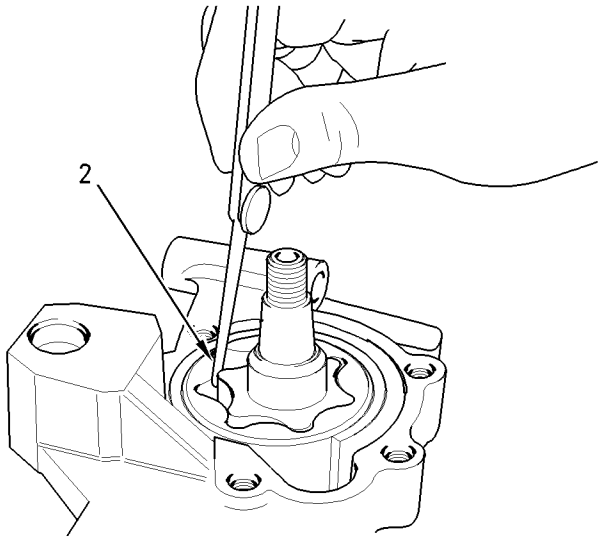


Illustration 28 g00989236

Inner rotor

(2) Clearance of inner rotor to outer rotor ..... 0.050 to 0.200 mm (0.0020 to 0.0079 inch)

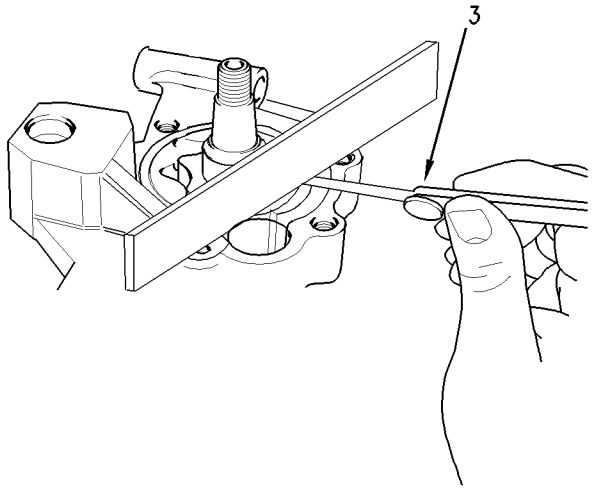


Illustration 29 g00989217

The end play for the rotor

(3) End play of rotor assembly

Inner rotor ..... 0.04 to 0.11 mm (0.0016 to 0.0043 inch)
Outer rotor ..... 0.04 to 0.00 mm (0.0016 to 0.0043 inch)

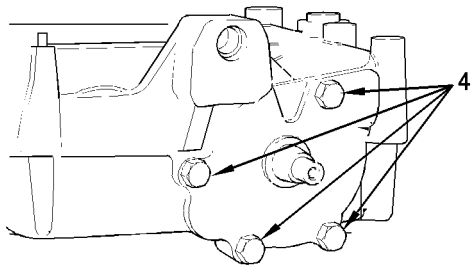


Illustration 30 g00938724

The end cover

(4) Torque for cover bolts for oil pump ..... 26 N·m (19 lb ft)

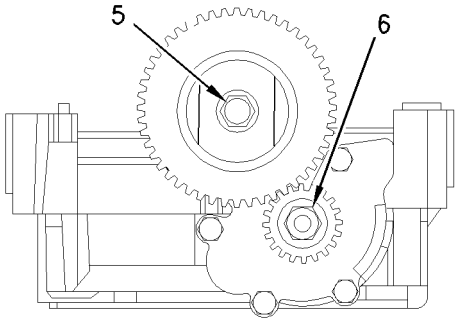


Illustration 31 g00989519

Idler gear and pump gear

Note: Replace the idler gear bolt (5) and the nut for the oil pump gear (6).

(5) Tighten the idler gear bolt to the following torque. ..... 26 N·m (19 lb ft)

Note: Set the engine to the TC position. Refer to Systems Operation, Testing and Adjusting Manual, “Finding Top Center Position for No. 1 Piston”. Install the balancer. Refer to Disassembly and Assembly, “Balancer - Install”. Install the gear for the oil pump and tighten the nut (6).

(6) Tighten the nut to the following torque. .... 95 N·m (70 lb ft)

Tighten the bolts that hold the balancer to the cylinder block to the following torque. ..... 54 N·m (40 lb ft)

Engines without Balancer Group

Type ..... Gear-driven differential rotor

Number of lobes

Inner rotor 5
Outer rotor 6

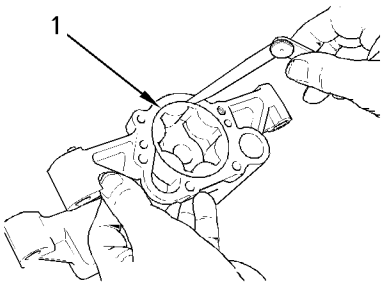


Illustration 32 g00938064
The oil pump

(1) Clearance of the outer rotor to the body ..... 0.152 to 0.330 mm (0.0059 to 0.0129 inch)

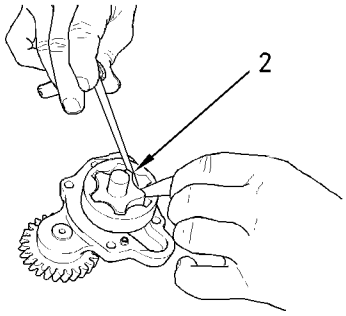


Illustration 33 g00938061
Checking the clearance

(2) Clearance of inner rotor to outer rotor ..... 0.040 to 0.127 mm (0.0015 to 0.0050 inch)

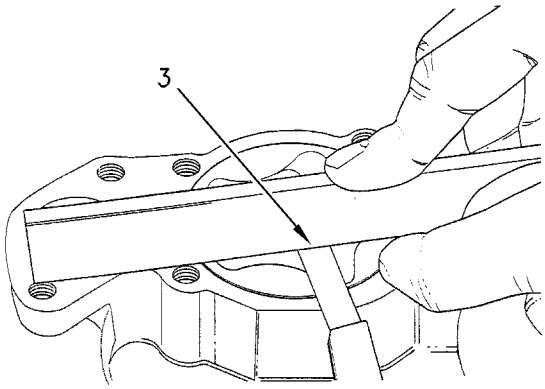


Illustration 34 g00938799
Checking the end play

(3) End play of rotor assembly

Inner rotor ..... 0.038 to 0.089 mm (0.0014 to 0.0035 inch)
Outer rotor ..... 0.025 to 0.076 mm (0.0010 to 0.0029 inch)

Tighten the bolts that hold the front cover of the oil pump assembly to the following torque. ..... 26 N·m (19 lb ft)

i01958104

Engine Oil Pressure

The minimum oil pressure at the maximum engine speed and at normal operating temperature is the following value. ..... 300 kPa (43 psi)

i02506230

Engine Oil Pan

Table 5

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	21826038	POWERPART Retainer	1

Front sealant

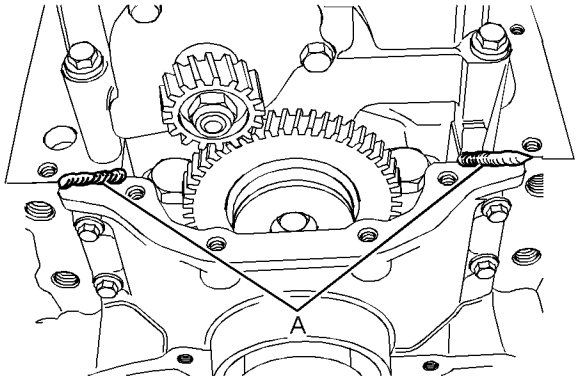


Illustration 35 g01254690

Applying sealant

Apply Tooling (A) to the cylinder block and to the timing case.

Note: Apply a sealant bead of 3.5 mm (0.1378 inch) that is shown in illustration 35.

Rear sealant

Note: Install the rear oil seal before sealant is applied to the bridge.

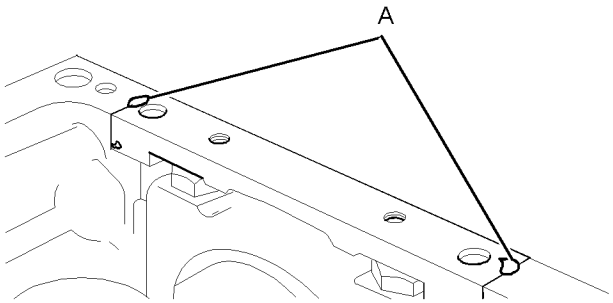


Illustration 36 g01254887

Applying sealant

ApplyTooling (A) to the bridge. The sealant must not protrude more than 5 mm (0.1969 inch) above the bridge.

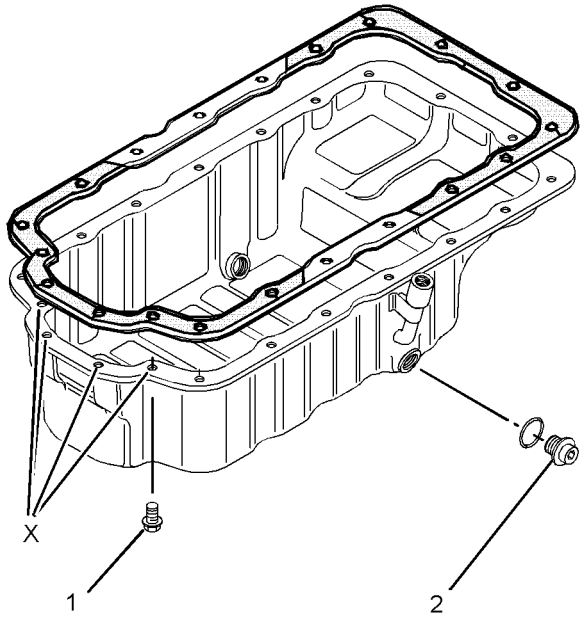


Illustration 37 g01255016

Typical example

(1) Tighten the four front bolts in position (X) to the following torque. ..... 22 N·m (16 lb ft)

Tighten the remaining bolts to the following torque. ..... 22 N·m (16 lb ft)

(2) Drain plug

Tighten the drain plug for the engine oil pan to the following torque. ..... 34 N·m (25 lb ft)

i02505676

Engine Oil Bypass Valve

Installed in the Oil Pump

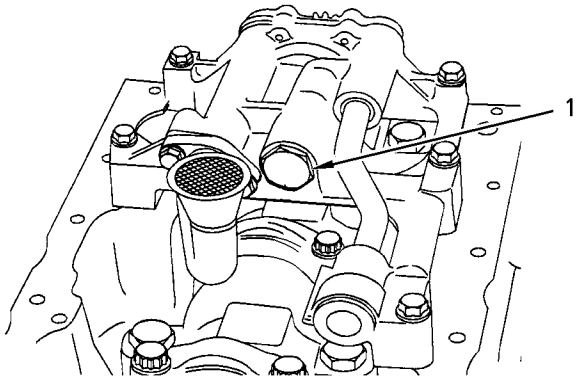


Illustration 38 g00919893
Typical engine oil pump

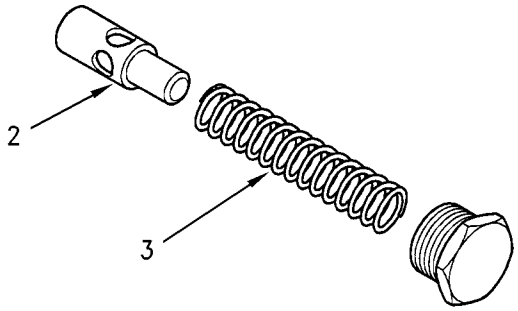


Illustration 39 g00921377
Relief valve and spring

(1) Tighten the plug for the relief valve to the following torque. ..... 35 N·m (26 lb ft)

(2) Plunger

Diameter of the plunger ..... 19.186 to 19.211 mm (0.7554 to 0.7563 inch)

Clearance of plunger in bore .. 0.039 to 0.114 mm (0.0015 to 0.0045 inch)

(3) Spring

Length of the spring ..... 80.94 mm (3.1866 inch)

Installed in the Balancer

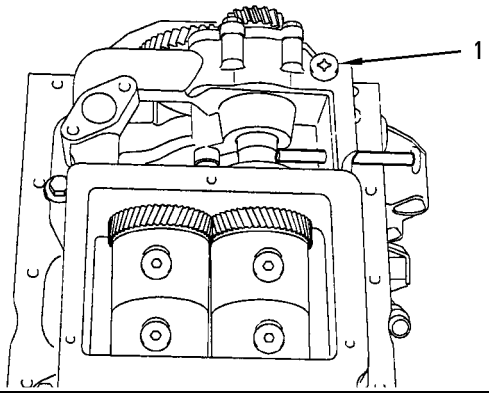


Illustration 40 g00919890
Plug

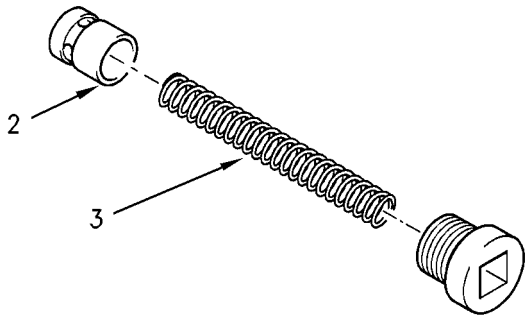


Illustration 41 g00921379
The relief valve for the balancer

(1) Tighten the plug for the relief valve to the following torque. ..... 35 N·m (26 lb ft)

(2) Plunger

Diameter of the plunger ..... 14.46 to 14.48 mm (0.5692 to 0.5700 inch)

Clearance of the plunger in the bore .... 0.04 to 0.08 mm (0.0015 to 0.0031 inch)

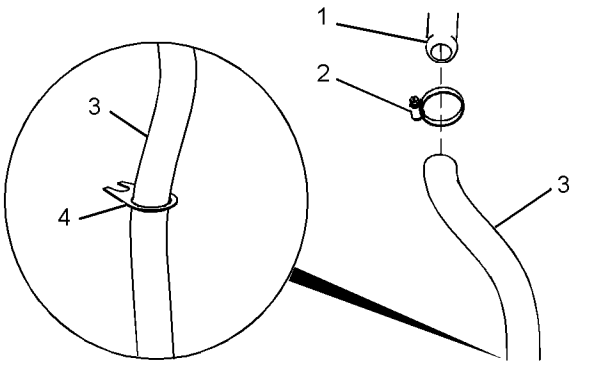
(3) Spring

Length of the spring ..... 67 mm (2.6378 inch)

i02527053

Crankcase Breather

Open crankcase breather



g01277901

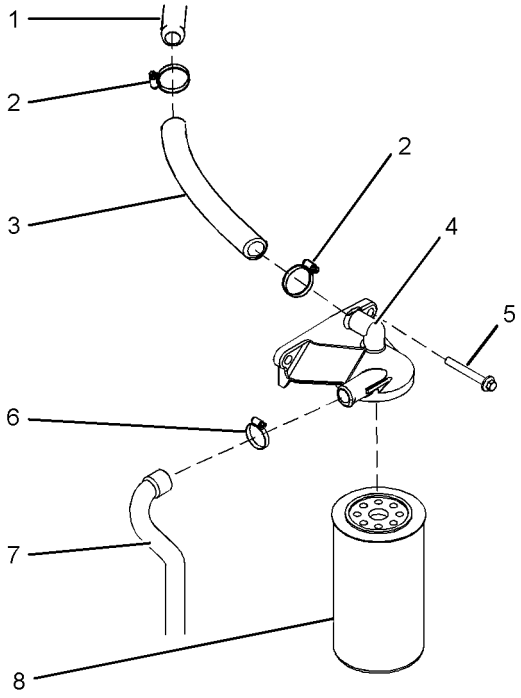
Illustration 42

Typical example

(1) Connection
(2) Clamp
(3) Hose
(4) Clip

(2) Tighten the clamp to the following torque. .. 5 N·m (44 lb in)

Breather Canister



g01277902

Illustration 43

Typical example

(1) Connection
(2) Clamp
(3) Hose
(4) Filter base
(5) Bolts
(6) Clamp
(7) Hose
(8) Canister

(5) Tighten the bolts to the following torque. .. 22 N·m (16 lb ft)

(2) Tighten the clamps to the following torque. ..... 3 N·m (26 lb in)

(6) Tighten the clamp to the following torque. .. 3 N·m (26 lb in)

(8) Tighten the canister to the following torque. ..... 12 N·m (106 lb in)

i02504533

Water Temperature Regulator and Housing

Table 6

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	21820221	POWERPART Red Rubber Grease	1

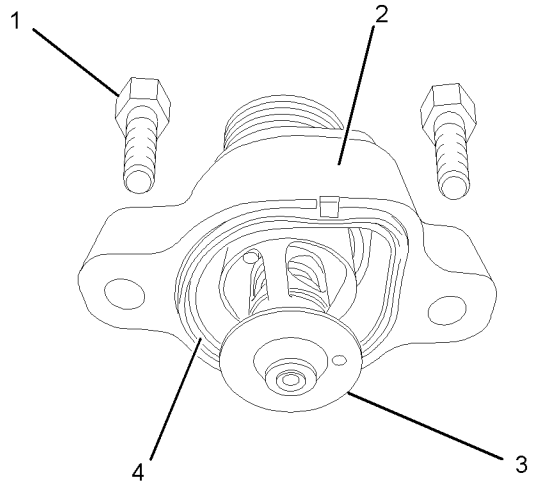


Illustration 44 g01253716

Typical example

Note: Apply Tooling (A) to the O-ring (4) in order to install the water temperature regulator housing (2).

(1) Tighten the bolts that fasten the housing to the following torque. ..... 44 N·m (32 lb ft)

(2) Water temperature regulator housing

(3) Water temperature regulator

Opening temperature ..... 82° to 87°C (179.6000° to 156.6000°F)
Full opening temperature .... 95 °C (203.0000 °F)
Minimum stroke at full temperature ..... 9 mm (0.3543 inch)

i02363605

Water Pump

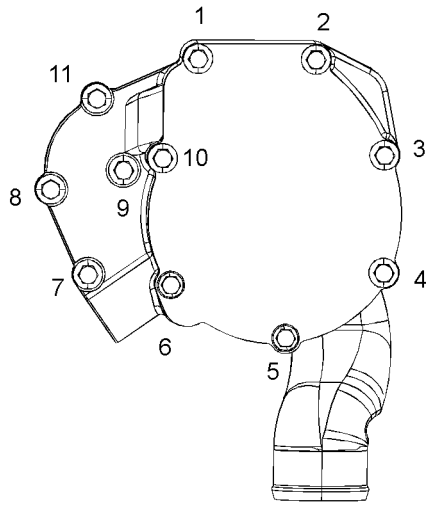


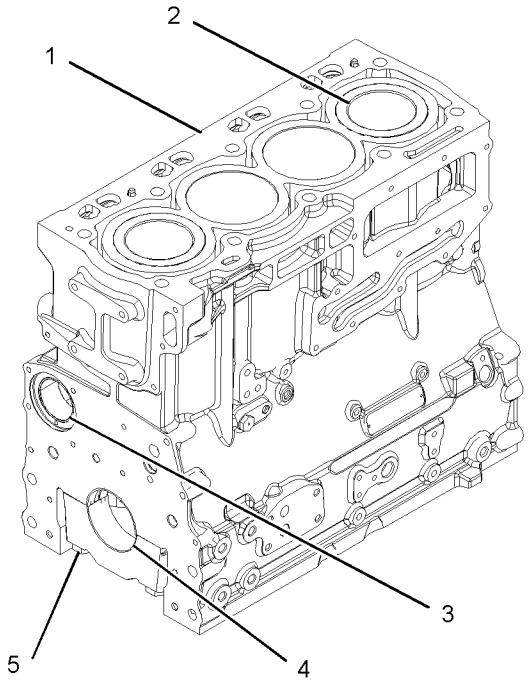
Illustration 45 g01183807

Tightening sequence

Tighten the setscrews in the numerical sequence that is shown in illustration 45 to the following torque. ..... 22 N·m (16 lb ft)

i02505673

Cylinder Block



g01254475

Illustration 46
Cylinder block

(1) Cylinder block

(2) Cylinder bore ..... 105.000 to 105.025 mm (4.1338 to 4.1348 inch)

The first oversize bore diameter ..... 105.5 to 105.525 mm (4.1535 to 4.1545 inch)

The second oversize bore diameter ..... 106.000 to 106.025 mm (4.1732 to 4.1742 inch)

The maximum permissible wear for the cylinder bore ..... 0.15 mm (0.0059 inch)

(3) Camshaft bearings

Diameter of the bushing in the cylinder block for the number 1 camshaft bearing ..... 55.563 to 55.593 mm (2.1875 to 2.1887 inch)

Diameter of the bore in the cylinder block for the number 2 camshaft journal ..... 50.546 to 50.597 mm (1.9900 to 1.9920 inch)

Diameter of the bore in the cylinder block for the number 3 camshaft journal ..... 50.038 to 50.089 mm (1.9700 to 1.9720 inch)

(4) Main bearings

Bore in the cylinder block for the main bearings ..... 88.246 to 88.272 mm (3.4742 to 3.4753 inch)

Install the main bearing cap bolts (5). Refer to Disassembly and Assembly, “Crankshaft Main Bearings - Remove and Install” or Disassembly and Assembly, “Crankshaft - Install” for the correct procedure.

(5) Main bearing cap bolts

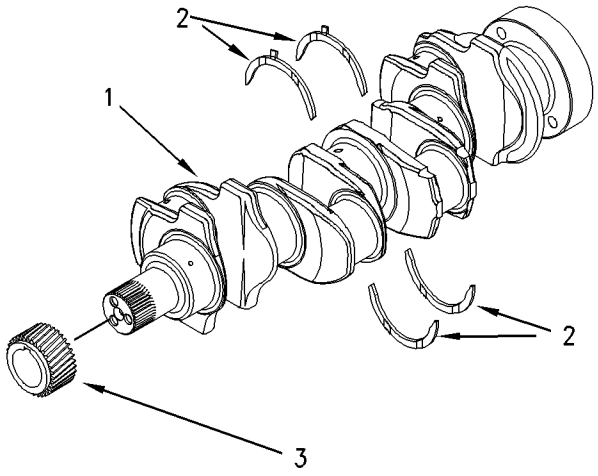
Evenly tighten the main bearing cap bolts. Torque for the main bearing cap bolts. .. 80 N·m (59 lb ft)

Note: Tighten the bolts for the main bearing cap for an additional 90 degrees.

Note: Ensure that the crankshaft can rotate freely.

i02506995

Crankshaft



g01255050

Illustration 47

Typical example

(1) Crankshaft gear
(2) Crankshaft
(3) Crankshaft thrust washers

Maximum permissible temperature of the gear for installation on the crankshaft ..... 180 °C (356 °F)

The end play of a new crankshaft ... 0.16 to 0.38 mm (0.0063 to 0.0150 inch)

Standard thickness of thrust washer ..... 2.26 to 2.31 mm (0.0890 to 0.0909 inch)

Oversize thickness of thrust washer ..... 2.45 to 2.50 mm (0.0965 to 0.0984 inch)

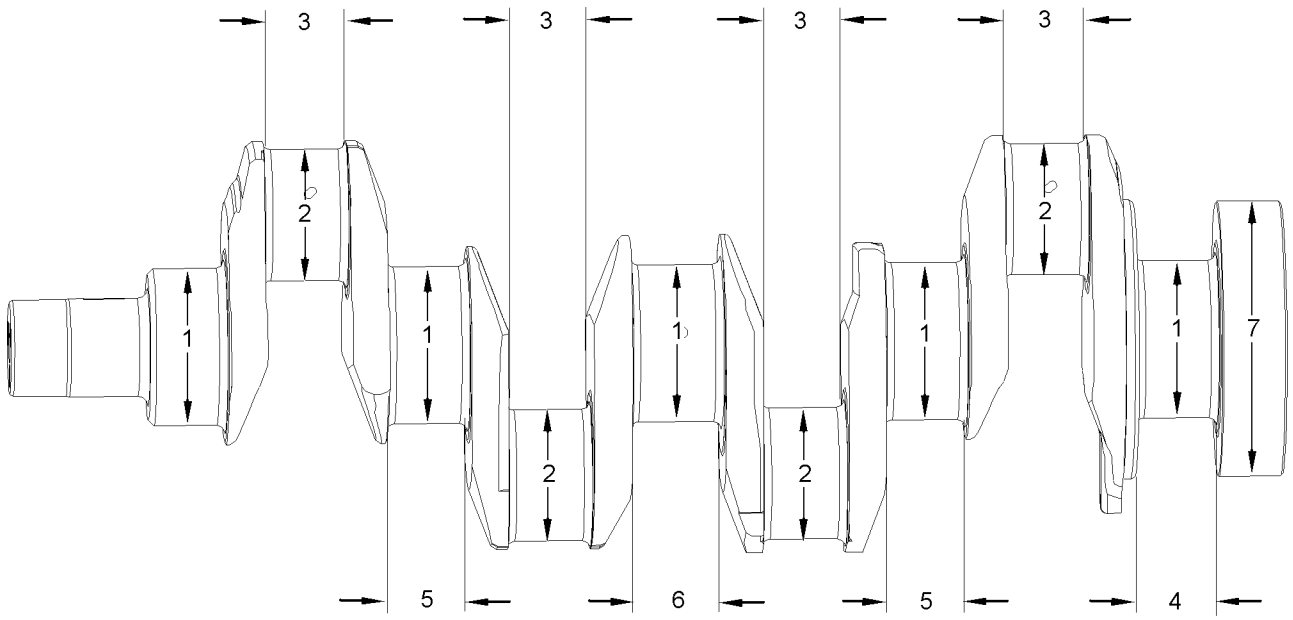


Illustration 48
g01261588
Typical example

Table 7

The Undersize Diameter of the Crankshaft Journals			
NUMBER	**0.25 mm (0.010 inch)**	**0.51 mm (0.020 inch)**	**0.76 mm (0.030 inch)**
1	75.926 to 75.905 mm (2.9892 to 2.9884 inch)	75.672 to 75.651 mm (2.9792 to 2.9784 inch)	75.418 to 75.397 mm (2.9692 to 2.9684 inch)
2	63.236 to 63.216 mm (2.4896 to 2.4888 inch)	62.982 to 62.962 mm (2.4796 to 2.4788 inch)	62.728 to 62.708 mm (2.4696 to 2.4688 inch)
3	40.551 mm (1.5965 inch) maximum	N/A	N/A
4	39.47 mm (1.5539 inch) maximum	N/A	N/A
5	39.47 mm (1.5539 inch) maximum	N/A	N/A
6	44.68 mm (1.7591 inch) maximum	N/A	N/A
7	Do not machine this diameter.	Do not machine this diameter.	Do not machine this diameter.

Item (6) in table 7 can be repaired with a crankshaft wear sleeve. Refer to Disassembly and Assembly, “Crankshaft Wear Sleeve (Rear) - Remove and Install” for more information.

Table 8

Minimum Width of machined Area of Crankshaft Web			
Web	1, 2, 3, 6 and 7	4 and 5	8
	18.31 mm (0.7209 inch)	19.11 mm (0.7524 inch)	26.61 mm (1.0476 inch)

If necessary, machine the thrust face in order to remove damage. Refer to table 8 for information.

Refer to table 9 for the run out of the crankshaft journals.

Table 9

Journal	Run out of the Journals
(1)	Mounting
(2)	0.08 mm (0.0031 inch)
(3)	0.15 mm (0.0059 inch)
(4)	0.08 mm (0.0031 inch)
(5)	Mounting

The radii of all the crankshaft journals must be machined. This machining must return the crankshaft to the original standard. The radii must give a smooth transition from the journal to the side machined face.

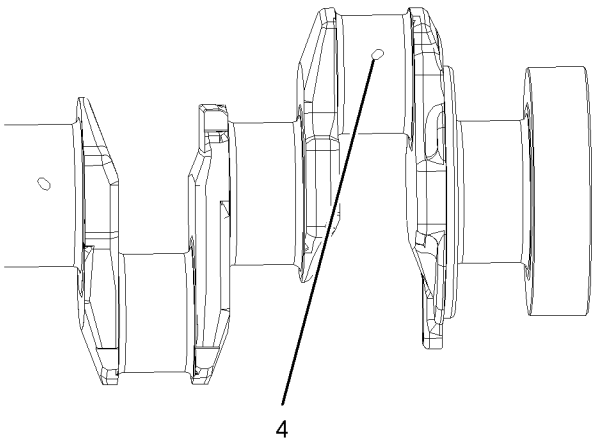


Illustration 49 g01261590
Typical example

The edge of the oil holes (4) must be machined to the original standard after machining of the crankshaft.

Oil hole

The maximum radius of the edge of the oil hole ..... 0.5 mm (0.0197 inch)

Surface finish of all journals ..... Ra 0.2 microns

Surface finish of all radii ..... Ra 0.4 microns

Inspect the crankshaft for structural cracking after machining.

Refer to Specifications, “Connecting Rod Bearing Journal” for more information on the connecting rod bearing journals and connecting rod bearings.

Refer to Specifications, “Main Bearing Journal” for information on the main bearing journals and for information on the main bearings.

i02504536

Crankshaft Seals

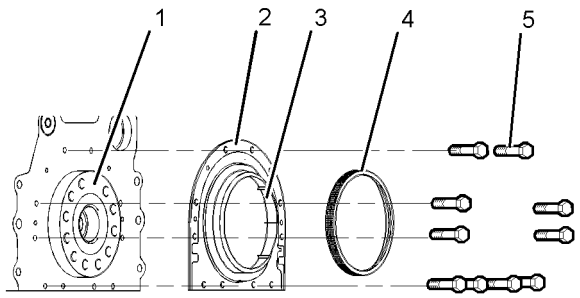


Illustration 50 g01253721
Typical example

(1) Crankshaft

(2) Crankshaft seal

(3) Plastic sleeve

(4) Alignment tool

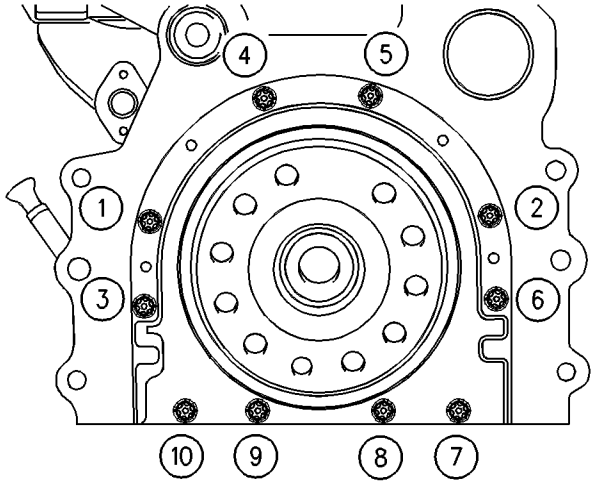


Illustration 51 g00915076

(5) Tighten bolts 1, 2, 3, 4, 5, 6, 7, and 10 in the sequence that is shown in Illustration 51 to the following torque. ..... 22 N·m (16 lb ft)

Remove the alignment tool.

Tighten bolts 8 and 9 in the sequence that is shown in Illustration 51 to the following torque. ..... 22 N·m (16 lb ft)

i02506934

Crankshaft Pulley

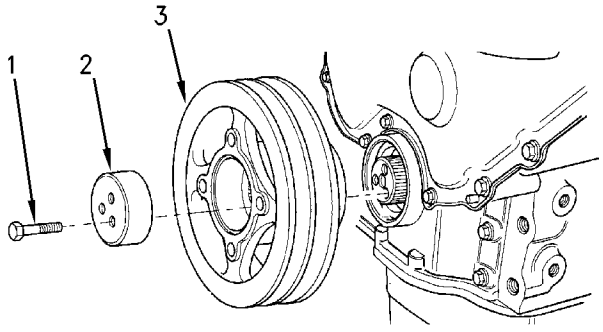


Illustration 52 g00915497

A standard pulley

Note: Lubricate the threads of the bolts with clean engine oil before installation.

(1) Tighten the three bolts for the crankshaft pulley to the following torque. ..... 115 N·m (85 lb ft)

Note: Recheck the torque of the bolts (1) once.

(2) Thrust block

(3) Crankshaft pulley

Crankshaft Pulley for the Poly V-Belt

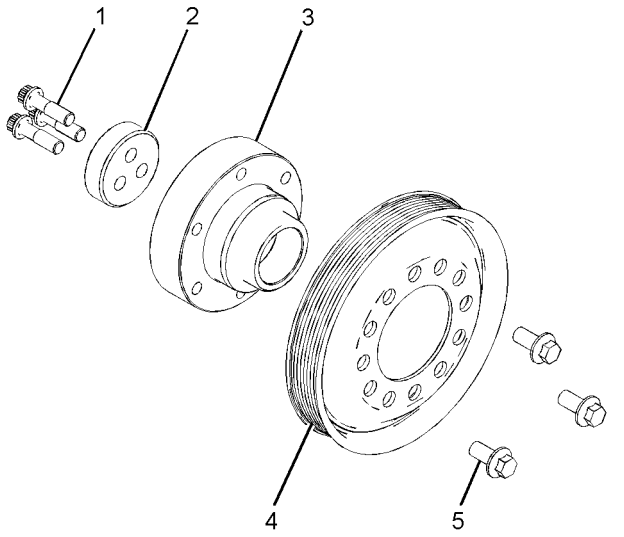


Illustration 53 g01254970

Typical example

(1) Bolt
(2) Thrust block
(3) Crankshaft adapter
(4) Crankshaft pulley
(5) Bolt

(1) Tighten the three bolts for the thrust block to the following torque. ..... 115 N·m (85 lb ft)

Note: Recheck the torque of the bolts (1) once.

(5) Tighten the three bolts for the crankshaft pulley to the following torque. ..... 78 N·m (58 lb ft)

i02504771

Connecting Rod Bearing Journal

Refer to Specifications, “Crankshaft” for information on the undersize crankshaft journals.

The original size of the connecting rod bearing journal ... 63.47 to 63.49 mm (2.4988 to 2.4996 inch)

Maximum permissible wear of a bearing journal on a new connecting rod ..... 0.04 mm (0.0016 inch)

Width of the connecting rod bearing journals ..... 40.348 to 40.424 mm (1.5885 to 1.5915 inch)

Radius of the fillet of the connecting rod bearing journals ..... 3.68 to 3.96 mm (0.145 to 0.156 inch)

Surface finish of connecting rod bearing journals ..... Ra 0.4 microns

Surface finish of radii ..... Ra 1.3 microns

i02506007

Main Bearing Journal

Refer to Specifications, “Crankshaft” for information on the undersize main bearing journals, and information on the width of main bearing journals.

The original size of the main bearing journal ..... 76.180 to 76.159 mm (2.9992 to 2.9984 inch)

Maximum permissible wear of the main bearing journals ..... 0.040 mm (0.0016 inch)

Radius of the fillet of the main bearing journals ..... 3.68 to 3.69 mm (0.1448 to 0.1452 inch)

Surface finish of bearing journals and crank pins ..... 0.4 microns

Surface finish of radii ..... 1.3 microns

Width of new main bearing journal ... 39.34 to 39.24 mm (1.5488 to 1.5449 inch)

Width of new center main bearing journal ... 44.22 to 44.15 mm (1.7409 to 1.7382 inch)

The shell for the main bearings

The shells for the main bearings are available for remachined journals which have the following undersize dimensions.

Undersize bearing shell .... 0.25 mm (0.010 inch)
Undersize bearing shell .... 0.51 mm (0.020 inch)
Undersize bearing shell .. 0.76 mm (0.0299 inch)

Thickness at center of the shells .. 2.083 to 2.089 mm (0.0820 to 0.0823 inch)

Width of the main bearing shells .. 31.62 to 31.88 mm (1.244 to 1.255 inch)

Clearance between the bearing shell and the main bearing journals ..... 0.117 to 0.058 mm (0.0046 to 0.0023 inch)

i02505708

Connecting Rod

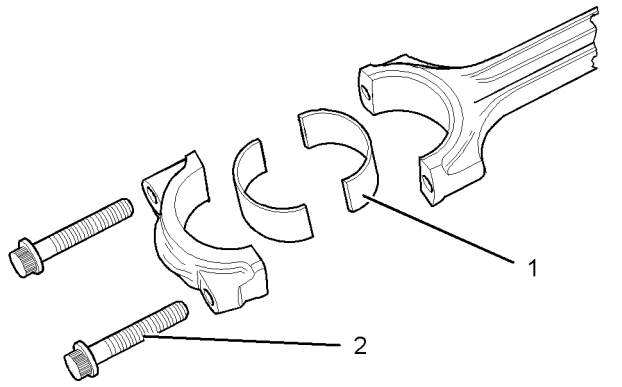


Illustration 54 g01254512
Typical example

(1) The bearing shell for the connecting rod

Table 10

Thickness of Connecting Rod Bearing at the Center	1.8352 to 1.8415 mm (0.0723 to 0.0725 inch)
Thickness of Connecting Rod Bearing for the Cap at the Center	1.8352 to 1.8415 mm (0.0723 to 0.0725 inch)
Bearing Clearance	0.034 ± 0.081 mm (0.0013 ± 0.0032 inch)

Table 11

Undersized Connecting Rod Bearing
0.25 mm (0.010 inch)
0.51 mm (0.020 inch)
0.76 mm (0.030 inch)

The mating surfaces of the connecting rod are produced by hydraulically fracturing the forged connecting rod.

(2) Tighten the setscrews for the connecting rod to the following torque. ..... 18 N·m (13 lb ft)

Tighten the setscrews for the connecting rod again to the following torque. ..... 70 N·m (52 lb ft)

Tighten the setscrews for the connecting rod for an additional 120 degrees. The setscrews for the connecting rod (2) must be replaced after this procedure.

Note: Always tighten the connecting rod cap to the connecting rod, when the assembly is out of the engine. Tighten the assembly to the following torque 20 N·m (14 lb ft).

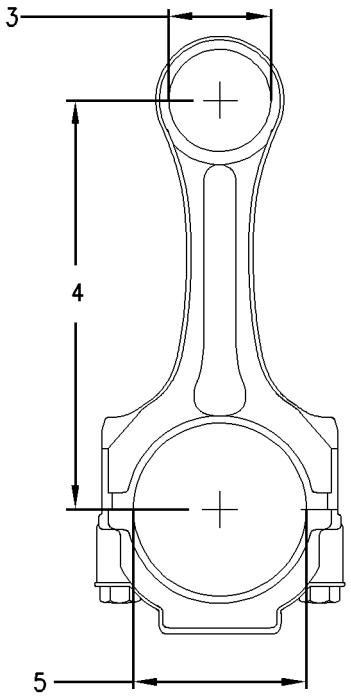


Illustration 55 g01254518

Typical example

(3) Diameter of the finished bore for the piston pin ..... 39.738 to 39.723 mm (1.5645 to 1.5639 inch)

(4) Distance between the parent bores ..... 219.05 to 219.1 mm (8.6240 to 8.6260 inch)

(5) Diameter for the finished bore for the connecting rod bearing ..... 67.208 to 67.221 mm (2.6460 to 2.6465 inch)

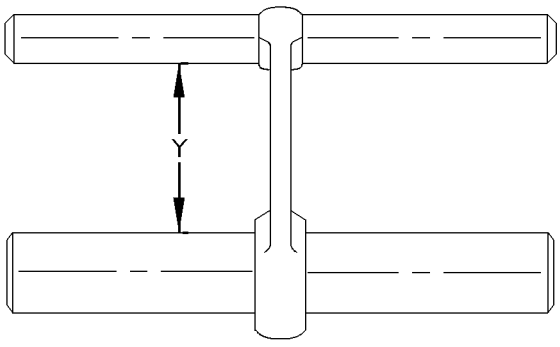


Illustration 56 g00915056

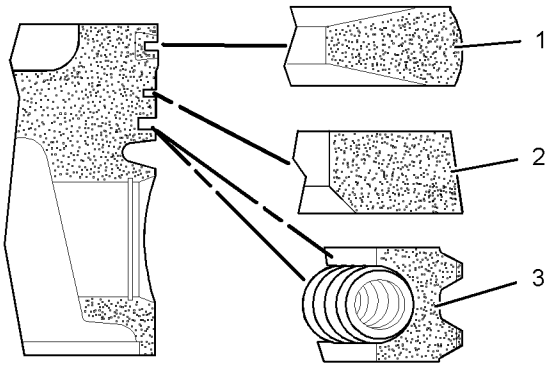
Connecting rods are color coded. The color code is a reference for the length (Y) of the connecting rod. Refer to table 12 for the different lengths of connecting rods.

Table 12

Length Grades for Connecting Rods		
Grade Letter	**Color Code**	**Length (Y)**
F	Red	165.761 to 165.728 mm (6.5260 to 6.5247 inch)
G	Orange	165.715 to 165.682 mm (6.5242 to 6.5229 inch)
H	White	165.670 to 165.637 mm (6.5224 to 6.5211 inch)
J	Green	165.624 to 165.591 mm (6.5206 to 6.5193 inch)
K	Purple	165.578 to 165.545 mm (6.5188 to 6.5175 inch)
L	Blue	165.532 to 165.499 mm (6.5170 to 6.5157 inch)

i02363087

Piston and Rings



g01155119

Illustration 57

Typical example

(1) Top compression ring

The shape of the top compression ring .. tapered

Ring gap ..... 0.30 to 0.45 mm (0.0118 to 0.0177 inch)

Note: When you install a new top compression ring, make sure that the word “TOP” is facing the top of the piston. New top piston rings have a yellow identification mark which must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(2) Intermediate compression ring

The shape of the intermediate compression ring ..... Internal bevel in the bottom edge with a tapered face

Width of intermediate compression ring .... 2.47 to 2.495 mm (0.0972 to 0.0982 inch)

The clearance between a new intermediate compression ring and the piston groove in a new piston ..... 0.065 to 0.011 mm (0.0026 to 0.0004 inch)

Ring gap ..... 0.65 to 0.85 mm (0.0256 to 0.0335 inch)

Note: When you install a new intermediate compression ring, make sure that the word “TOP” is facing the top of the piston. New intermediate rings have a blue identification mark which must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(3) The oil control ring

Width of oil control ring ..... 2.97 to 2.99 mm (0.1169 to 0.1177 inch)

The clearance between a new oil control ring and the groove in a new piston ..... 0.03 to 0.07 mm (0.0011 to 0.0027 inch)

Ring gap ..... 0.30 to 0.55 mm (0.0118 to 0.0216 inch)

Note: The oil control ring is a two-piece ring that is spring loaded. A pin is used in order to hold both ends of the spring of the oil control ring in position. The ends of the spring of the oil control ring must be installed opposite the end gap of the oil control ring.

Note: Ensure that the ring end gaps of the piston rings are spaced 120 degrees from each other.

Piston

Note: An arrow which is marked on the piston crown must be toward the front of the engine.

Piston height above cylinder block .. 0.21 to 0.35 mm (0.008 to 0.014 inch)

Width of top groove in the piston ..... Tapered

Width of second groove in new piston ..... 2.56 to 2.58 mm (0.1008 to 0.1016 inch)

Width of third groove in new piston .. 3.02 to 3.04 mm (0.1189 to 0.1197 inch)

Piston pin

Diameter of a new piston pin ..... 39.694 to 39.700 mm (1.5628 to 1.5630 inch)

Oversize Piston

Table 13

Standard piston	
1 Oversize	+0.5 mm (0.0197 inch) piston
2 Oversize	+1.0 mm (0.0394 inch) piston

i02367100

Piston Cooling Jet

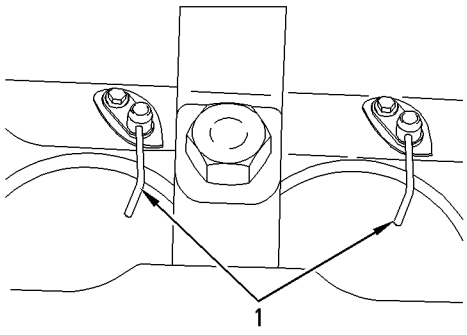


Illustration 58 g00942652

(1) Installed piston cooling jets

The valve must move freely. Tighten the bolt to the following torque. ..... 9 N·m (7 lb ft)

Piston Cooling Jet Alignment

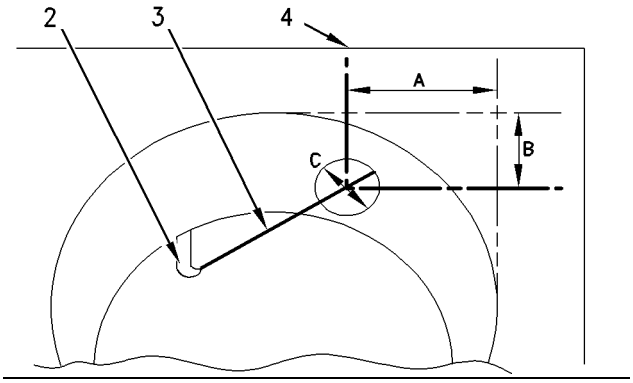


Illustration 59 g01006929

(2) Piston cooling jet
(3) Rod
(4) Cylinder block

Use the following procedure in order to check the alignment of the piston cooling jet.

1. Insert rod (3) into the end of the piston cooling jet (2). Rod (3) has a diameter of 1.70 mm (0.067 inch). Rod (3) must protrude out of the top of the cylinder block.

2. Dimension (A) is 50.75 mm (1.9980 inch) and dimension (B) is 9.35 mm (0.3681 inch). Dimension (A) and dimension (B) are tangential to the cylinder bore (4).

3. The position of the rod (3) must be within dimension (C). Dimension (C) is 14 mm (0.5512 inch).

Note: Ensure that the rod (3) can not damage the piston cooling jet when the alignment is checked. The piston cooling jets can not be adjusted. If a piston cooling jet is not in alignment the piston cooling jet must be replaced.

i02369751

Front Housing and Covers

The front housing must be aligned to the cylinder block face. ..... + 0.05 to minus 0.05 mm (+ 0.0020 to minus 0.0020 inch)

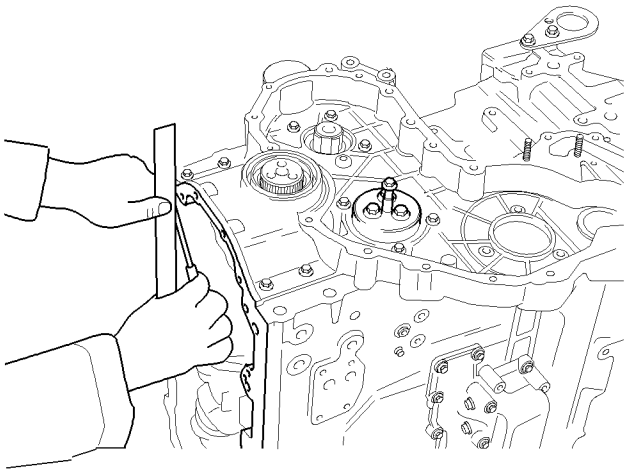


Illustration 60 g00995663
Alignment

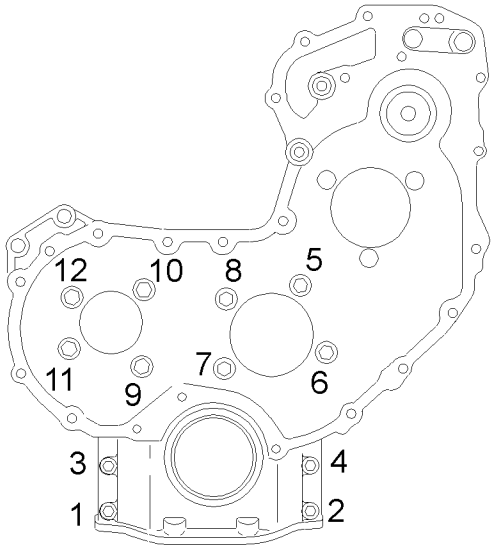


Illustration 61 g01203927
Typical example

Tighten the setscrew to the sequence that is shown in illustration 61 to the following torque. ..... 28 N·m (20 lb ft)

(1) Tighten the bolts that fasten the front cover to the front housing to the following torque. ..... 22 N·m (16 lb ft)

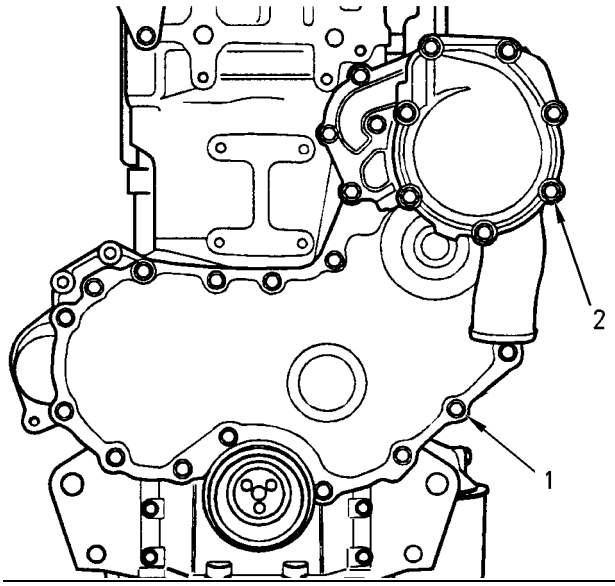


Illustration 62 g00918672
Typical example

(2) Tighten the bolts that fasten the water pump to the front housing to the following torque. ..... 22 N·m (16 lb ft)

Note: Refer to Specifications, “Water Pump” for the correct bolt tightening sequence for the water pump.

i02504717

Gear Group (Front)

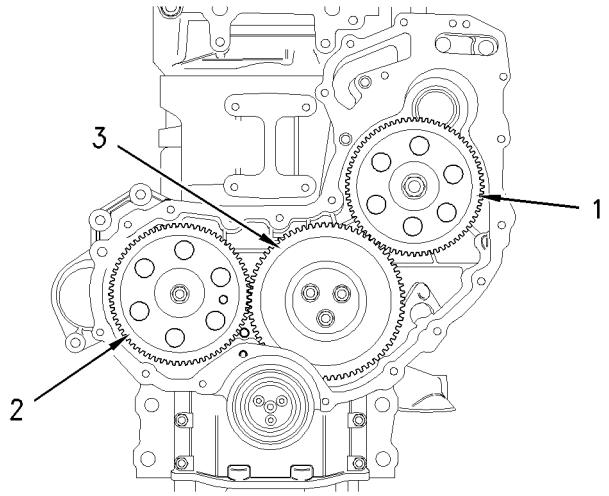


Illustration 63 g00995886
Gear train

(1) Fuel injection pump drive gear

Tighten the nut to the following torque. ... 25 N·m (18 lb ft)
Release the lock on the fuel injection pump shaft. Torque the nut to the following torque. .... 90 N·m (66 lb ft)

Number of teeth 68

Note: Refer to Specifications, “Fuel Injection Pump” for the locking torque for the fuel injection pump shaft.

(2) Camshaft gear

Tighten the bolt for the camshaft gear to the following torque. ..... 95 N·m (70 lb ft)

Number of teeth 68

(3) Idler gear and hub

Tighten the bolts for the idler gear to the following torque. ..... 44 N·m (33 lb ft)

Width of idler gear and split bearing assembly ..... 30.165 to 30.135 mm (1.1876 to 1.1864 inch)

Inside diameter of idler gear bearings with flanges ..... 50.797 to 50.818 mm (1.9999 to 2.0007 inch)

Outside diameter of idler gear hub ..... 50.716 to 50.737 mm (1.9967 to 1.9975 inch)

Clearance of idler gear bearing on hub .... 0.06 to 0.102 mm (0.0024 to 0.0040 inch)

Idler gear end play ..... 0.13 to 0.205 mm (0.0051 to 0.0081 inch)

Maximum permissible end play ..... 0.38 mm (0.015 inch)

Idler gear end play with roller bearings ..... 0.24 to 0.954 mm (0.0094 to 0.0376 inch)

Number of teeth 73

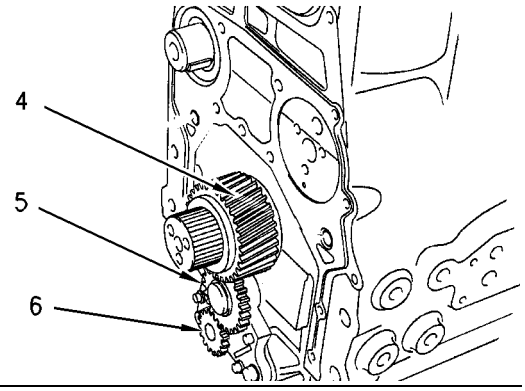


Illustration 64 g00996214

The gear train for the oil pump

(4) Crankshaft gear

Bore diameter of crankshaft gear ..... 51.00 to 51.03 mm (2.0079 to 2.0091 inch)

Outside diameter of crankshaft hub ..... 51.021 to 51.002 mm (2.0087 to 2.0079 inch)

Clearance of gear on crankshaft ..... −0.021 to +0.028 mm (−0.0008 to 0.0011 inch)

Number of teeth 34

(5) Oil pump idler gear

Inside diameter of oil pump idler gear bearing ..... 16.012 to 16.038 mm (0.6304 to 0.6314 inch)

Outside diameter of oil pump idler gear shaft ..... 15.966 to 15.984 mm (0.6286 to 0.6293 inch)

Clearance of oil pump idler gear bearing on shaft ..... 0.028 to 0.072 mm (0.0011 to 0.0028 inch)

End play of the oil pump idler gear ..... 0.050 to 0.275 mm (0.0019 to 0.0108 inch)

(6) Oil pump gear

The number of teeth on the oil pump gear 17

Backlash values

Backlash between the idler gear (5) and the oil pump drive gear (6) ..... 0.05 to 0.14 mm (0.0020 to 0.0055 inch)

Backlash between the oil pump idler gear (5) and the crankshaft gear (4) ..... 0.8 to 0.23 mm (0.0315 to 0.0091 inch)

Backlash between the idler gear (3) and the crankshaft gear (4) ..... 0.05 to 0.015 mm (0.0020 to 0.0006 inch)

Backlash between the camshaft gear (2) and the idler gear (3) ..... 0.05 to 0.15 mm (0.0020 to 0.0059 inch)

Backlash between the fuel injection pump gear (1) and the idler gear (3) ..... 0.05 to 0.15 mm (0.0020 to 0.0059 inch)

Backlash between the water pump gear (not shown) and the fuel injection pump gear (1) ..... 0.05 to 0.15 mm (0.0020 to 0.0059 inch)
Backlash between the power take-off drive (if equipped) and the idler gear (3) ..... 0.05 to 0.250 mm (0.0020 to 0.0098 inch)

i02503254

Flywheel

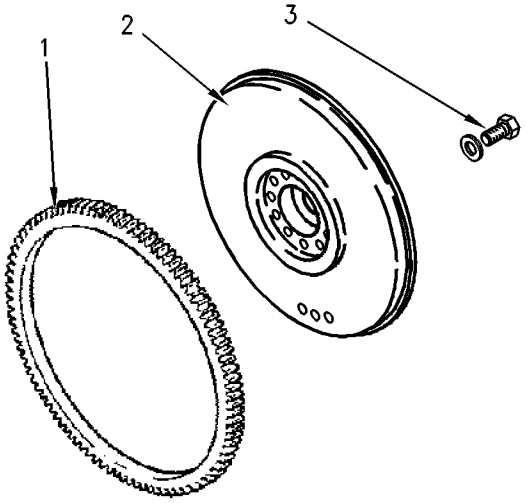


Illustration 65 g00584712
Typical example

(1) Flywheel ring gear

Heat the flywheel ring gear to the following temperature. ..... 250 °C (480 °F)

Note: Do not use an oxyacetylene torch to heat the flywheel ring gear.

(2) Flywheel

(3) Bolt

Tighten the flywheel bolts to the following torque. ..... 115 N·m (85 lb ft)

i02505674

Flywheel Housing

Table 14

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	21820117	POWERPART Threadlock and Nutlock	1

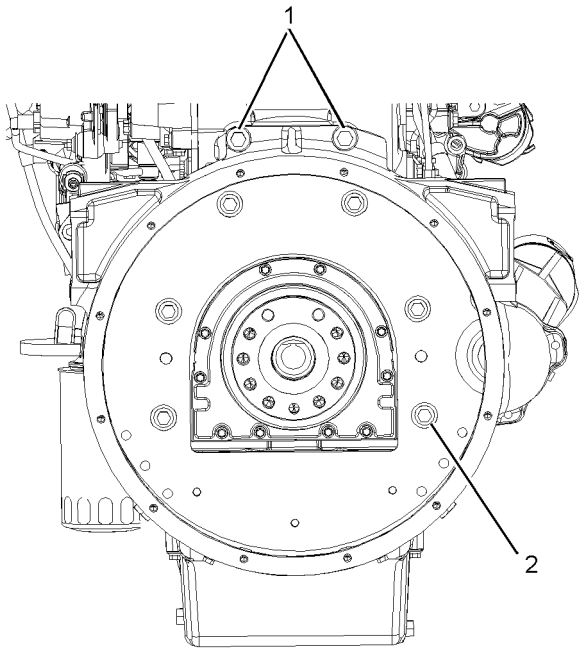


Illustration 66 g01254486
Typical example

Setscrew

(1) Tighten the setscrew to the following torque. ..... 75 N·m (55 lb ft)

Setscrew

(2) Tighten the setscrew to the following torque. ..... 63 N·m (46 lb ft)

Note: If 12.9 setscrews are installed, apply Tooling (A) to the setscrews. Tighten the 12.9 setscrews to a torque of 70 N·m (52 lb ft).

i02519438

Belt Tension Chart

Table 15

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Belt Tension Gauge	1

Table 16

Belt Tension Chart			
Size of Belt	**Width of Belt**	**Gauge Reading**	
		Initial Belt Tension(1)	**Used Belt Tension**(2)
1/2	13.89 mm (0.547 Inch)	535 N (120 lb)	355 N (80 lb)
Measure the tension of the belt that is farthest from the engine.			

(1) Initial Belt Tension refers to a new belt.
(2) Used Belt Tension refers to a belt that has been in operation for 30 minutes or more at the rated speed.

Install Tooling (A) at the center of the longest free length of belt and check the tension on both belts. Check and adjust the tension on the tightest belt. To adjust the belt tension, refer to Disassembly and Assembly, “Alternator - Install”.

Note: A poly v-belt has an automatic belt tensioner. No manual adjustment of the poly v-belt is required.

To replace the poly v-belt, refer to Disassembly and Assembly, “Alternator Belt - Remove and Install”.

i01721280

Engine Lifting Bracket

All engines are equipped with two engine lifting brackets.

Tighten the two bolts on each engine lifting bracket to the following torque. .. 44 N·m (32 lb ft)

i02504537

Alternator

The 12 Volt Denso Alternator

Six types of alternator are available.

Output

Four 12 volt alternators are available. ... 75 Amp, 85 Amp, 100 Amp and 120 Amp
Two 24 volt alternators are available. ..... 55 Amp and 75 Amp

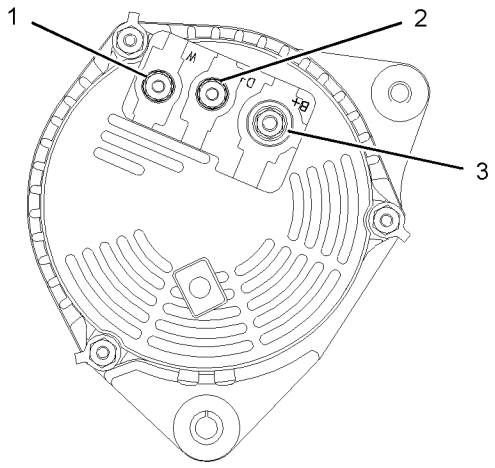


Illustration 67 g01194950
Typical example

(1) Terminal “W”

Tighten the terminal nut to the following torque. ..... 1.5 N·m (13 lb in)

(2) Terminal “D+”

Tighten the terminal nut to the following torque. ..... 1.5 N·m (13 lb in)

(3) Terminal “B+”

Tighten the terminal nut to the following torque. ..... 3.3 N·m (29 lb in)

The 24 Volt Iskra Alternator

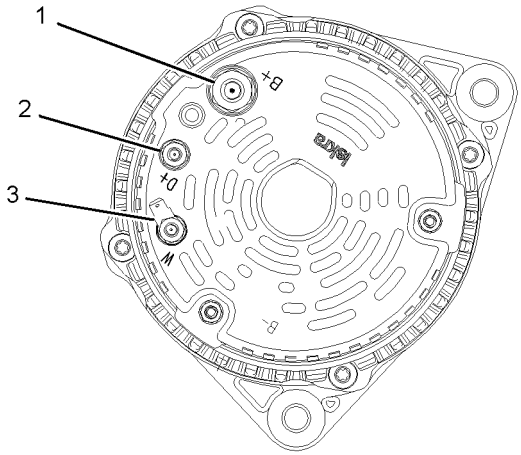


Illustration 68 g01194953
Typical example

(1) Terminal “B+”

Tighten the terminal nut to the following torque. ..... 11 N·m (97 lb in)

(2) Terminal “D+”

Tighten the terminal nut to the following torque. ..... 3 N·m (26 lb in)

(3) The terminal “W” is spade-type.

24 volt output

The 24 volt alternator ..... 100 Amp

i02504538

Starter Motor

24 Volt Starting Motor 4.5 Kw

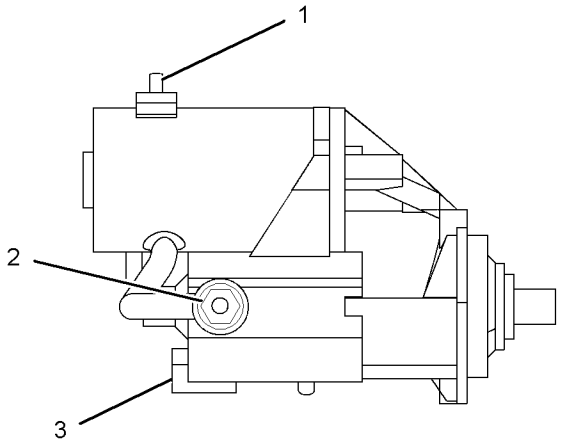


Illustration 69 g01200801

Typical example

(1) Tighten the negative terminal nut to the following torque. ..... 15 N·m (11 lb ft)

(2) Tighten the positive terminal nut to the following torque. ..... 21 N·m (15 lb ft)

(3) Tighten the solenoid terminal to the following torque. ..... 3.5 N·m (31 lb in)

Rated voltage ..... 24 volts

12 Volt Starting Motor 3 Kw

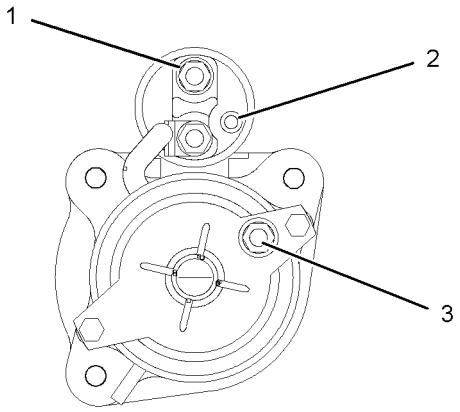


Illustration 70 g01200844

Typical example

(1) Tighten the nut for the positive terminal (terminal 30) to the following torque. ..... 6 N·m (53 lb in)

(2) Tighten the solenoid terminal (terminal 50) to the following torque. ..... 8 N·m (70 lb in)

(3) Tighten the nut for the terminal for the earth to the following torque. ..... 8 N·m (70 lb in)

Rated voltage ..... 12 volts

Pull in voltage ..... 8 volts

i02371978

Coolant Temperature Sensor

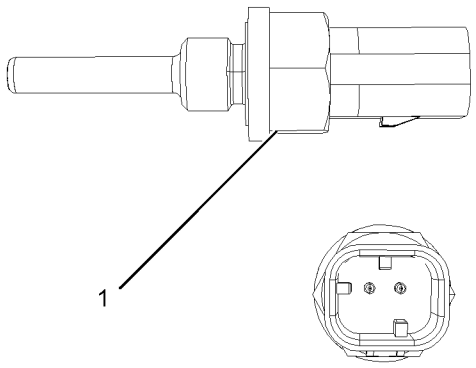


Illustration 71 g01183334

Typical example

(1) Sensor

Tighten the sensor to the following torque. ..... 15 N·m (11 lb ft)

i02388157

Fuel Pressure Sensor

⚠ WARNING

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

Refer to the Operation and Maintenance manual, “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

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

Ensure that all adjustments and repairs are performed by personnel that have had the correct training.

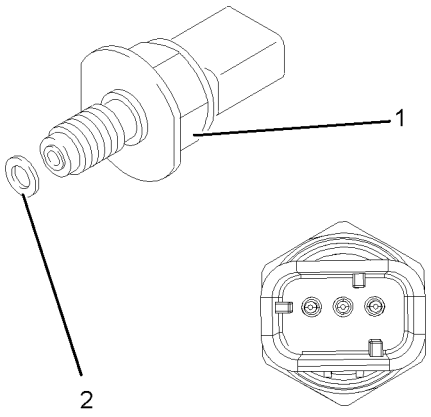


Illustration 72 g01192226

(1) Fuel pressure sensor
(2) Washer

Fuel pressure sensor

Tighten the fuel pressure sensor to the following torque. ..... 34 N·m (25 lb ft)

i02371981

Engine Oil Pressure Sensor

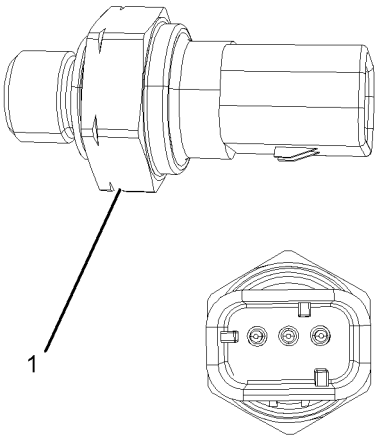


Illustration 73 g01183333

Typical example

(1) Sensor

Tighten the sensor to the following torque. ..... 10 N·m (7 lb ft)

i02371977

Boost Pressure Sensor

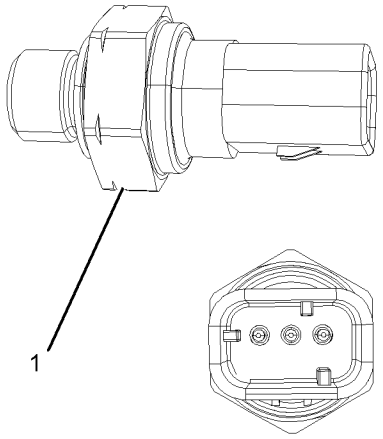


Illustration 74 g01183333

Typical example

(1) Sensor

Tighten the sensor to the following torque. ..... 10 N·m (7 lb ft)

i02493822

Inlet Manifold Temperature Sensor

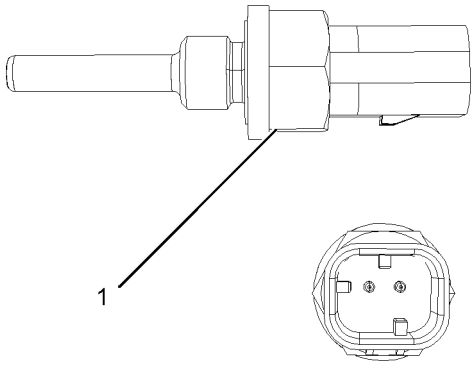


Illustration 75 g01183334

Typical example

(1) Sensor

Tighten the sensor to the following torque. ..... 20 N·m (15 lb ft)

i02404840

Crankshaft Position Sensor

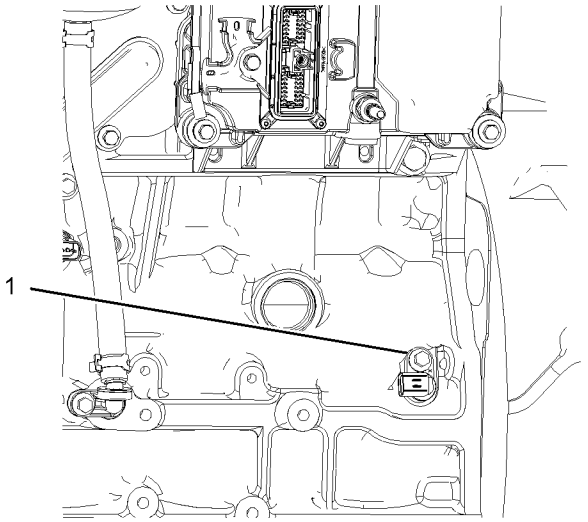


Illustration 76 g01201229

Typical example

(1) Tighten the bolt for the sensor to the following torque. ..... 22 N·m (16 lb ft)

i02506817

Electronic Control Module

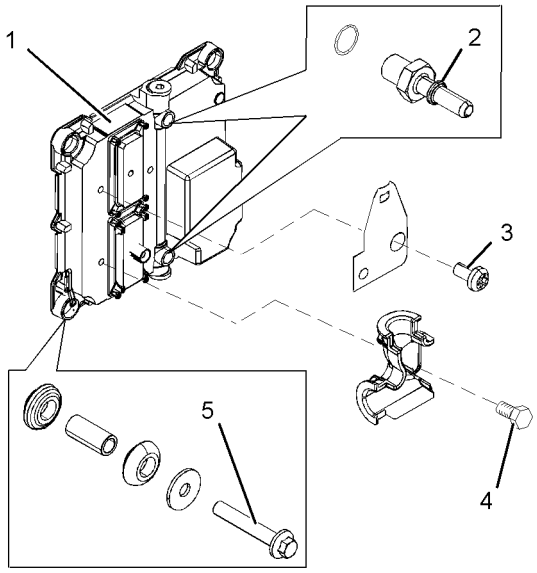


Illustration 77 g01254910

(1) Electronic control module (ECM)
(2) Connectors
(3) Setscrew
(4) Setscrew

(2) Connectors

Tighten the connectors to the following torque. ..... 18.5 N·m (14 lb ft)

(3) Setscrew

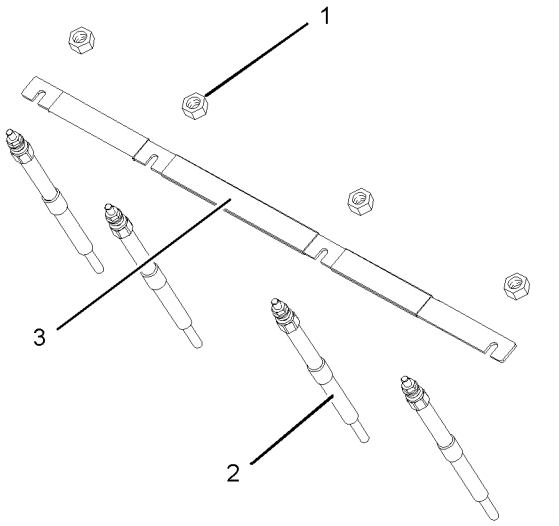
Tighten the setscrew to the following torque. ..... 5 N·m (44 lb in)

(4) Setscrew

Tighten the setscrew to the following torque. ..... 22 N·m (16 lb ft)

i02505941

Glow Plugs



g01254601

Illustration 78

Typical example

Tighten the glow plugs (2) in the cylinder head to the following torque. ..... 15 N·m (11 lb ft)

Tighten the nuts (1) for the bus bar (3) that is installed on top of the glow plugs to the following torque. ..... 2 N·m (18 lb in)

Voltage ..... 12 or 24 volts

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V

W

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