UENR0616
March 2012

Specifications

1106A-70TA and 1106C-70TA Industrial Engines

PR (Engine)
PT (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

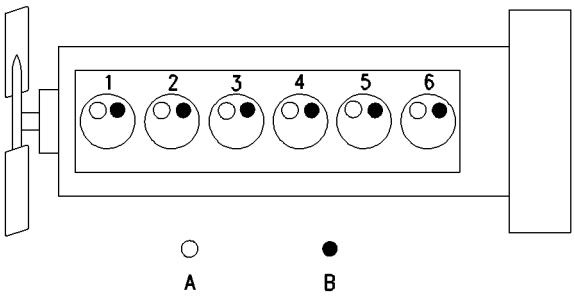

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Illustration 1

Cylinder and valve location

(A) Inlet valve
(B) Exhaust valve

Bore ..... 105 mm (4.13385 inch)

Stroke ..... 135 mm (5.31495 inch)

Displacement ..... 7.01 L (427.78 cubic inch)

Cylinder arrangement ..... In-line

Type of combustion ..... Direct injection

Compression ratio for 1106A-70TA engine 16:1

Compression ratio for 1106C-70TA engine 18.5:1

Number of cylinders 6

Valves per cylinder 2

Valve lash

Inlet valve ..... 0.35 mm (0.014 inch)
Exhaust valve ..... 0.45 mm (0.018 inch)

Firing order 1, 5, 3, 6, 2, 4

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 of the engine. The left side of the engine and the right side of the engine are determined from the flywheel end. No. 1 cylinder is the front cylinder of the engine.

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Fuel Injection Lines

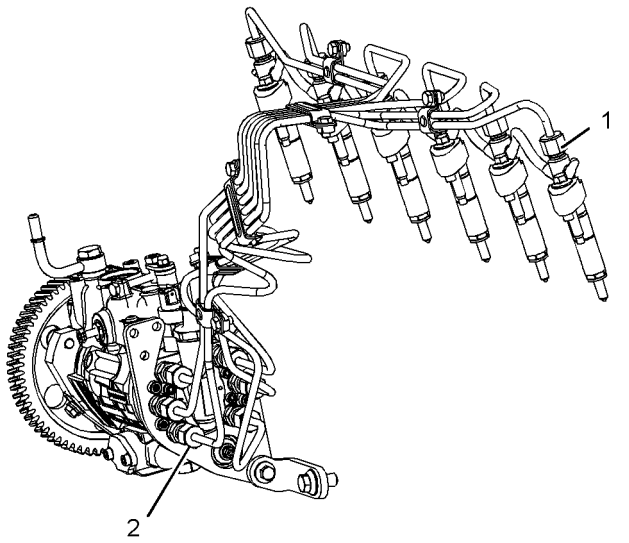

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Illustration 2

Typical example

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

(2) Tighten the union nuts for the fuel injection pump to the following torque. ..... 30 N·m (22 lb ft)

i02709983

Fuel Injection Pump

Note: Before the fuel injection 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.

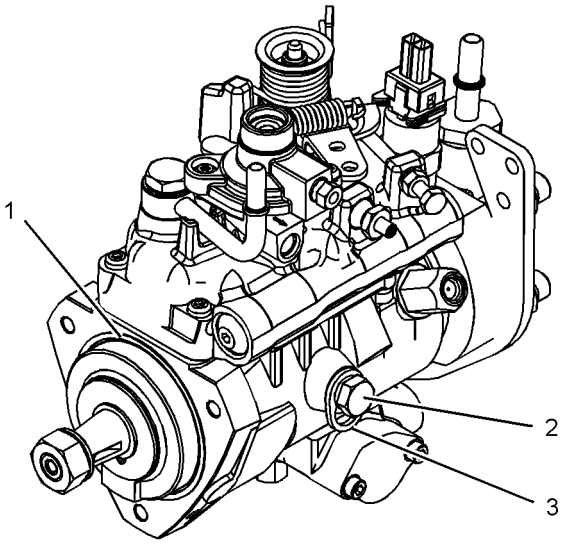

Illustration 3 g01352237

Typical example

Note: The solenoid on the fuel injection pump is a serviceable item. The fuel injection pump is a nonserviceable item.

(1) O-ring

(2) Locking screw

(3) Washer

Locking the shaft

Loosen locking screw (2) and move the washer (3) to the locked position. Tighten the bolt to the following torque. ..... 17 N·m (12 lb ft)

Unlocking the shaft

Loosen locking screw (2) and install the washer (3) to the unlocked position. Tighten the bolt to the following torque. ..... 12 N·m (9 lb ft)

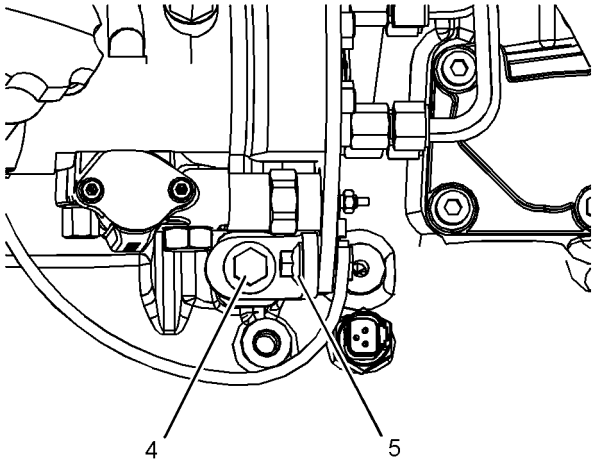

Illustration 4 g01352239

Typical example of a support bracket

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

(5) Tighten the mounting bolt and the nut to the following torque. ..... 22 N·m (16 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 bolt (4) and then tighten the nut and bolt (5). Tighten the bolt (4).

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

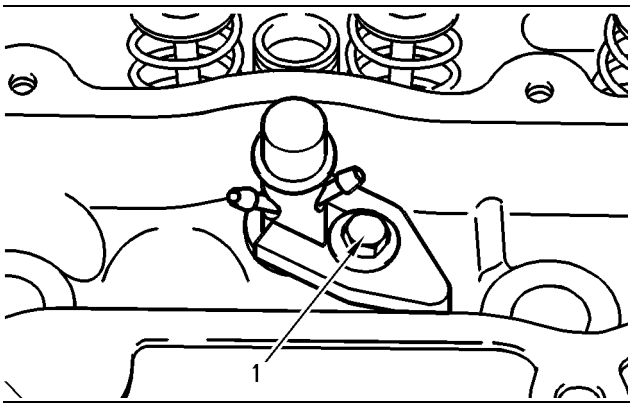

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Illustration 5

Typical example

(1) Tighten the bolt in the clamp for the fuel injector to the following torque. ..... 35 N·m (26 lb ft)

Leakage in 10 seconds ..... 0 drops

Service setting for the injection pressure for the fuel injectors ..... 29 + 0.5 MPa (4206 + 73 psi)

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Fuel Transfer Pump

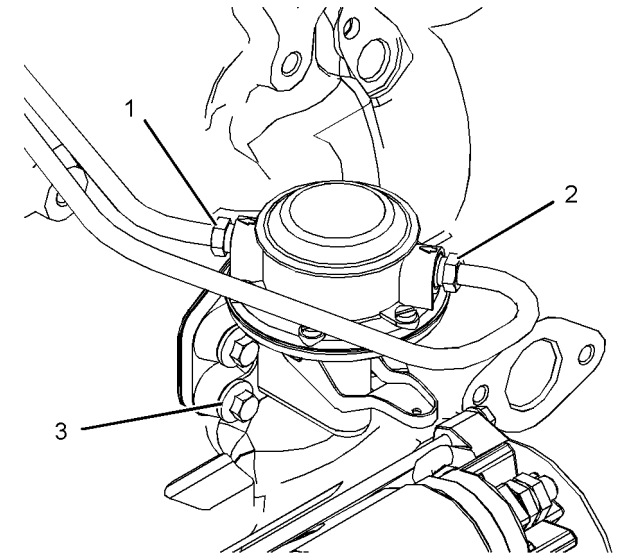

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Illustration 6

Typical example

(1), (2) Tighten the union nuts to the following torque. ..... 30 N·m (22 lb ft)

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

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Fuel Filter Base (Primary 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.

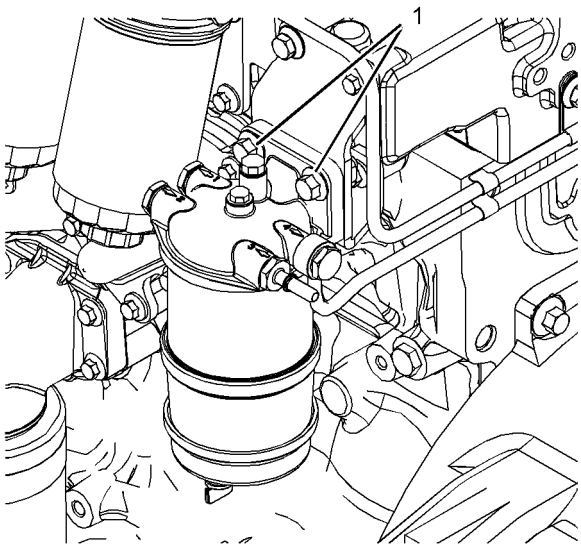

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Illustration 7

Typical example

(1) Tighten the setscrews to the following torque. ..... 44 N·m (32 lb ft)

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Fuel Filter Base (Secondary 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.

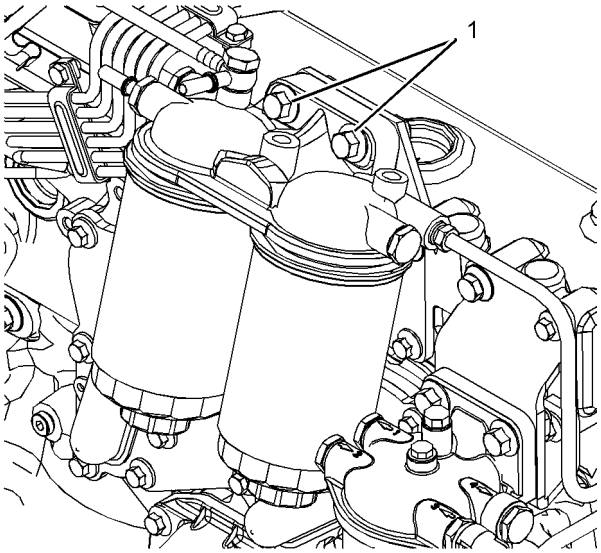

Illustration 8 g02267613
Typical example

(1) Tighten the setscrews to the following torque. ..... 44 N·m (32 lb ft)

i02676273

Lifter Group

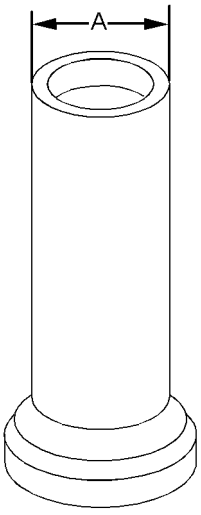

Illustration 9 g01344742

(A) 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)

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Rocker Shaft

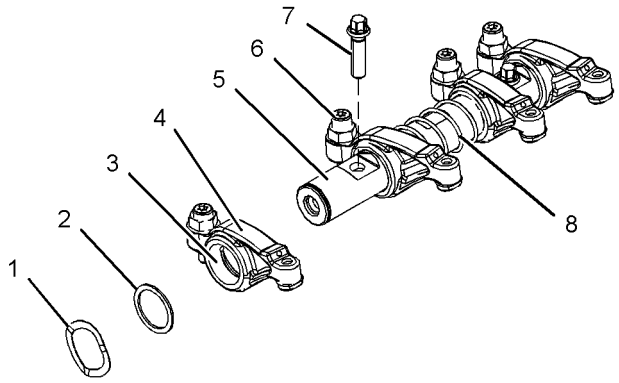

Illustration 10 g02266473
Typical example

(1) Washer

(2) Circlip

(3) Rocker arm bore

Diameter of the rocker arm bore for the bushing ..... 25.01 to 25.05 mm (0.9847 to 0.9862 inch)

Rocker arm bushing

Clearance between the rocker arm bushing and the rocker shaft ..... 0.03 to 0.09 mm (0.0010 to 0.0035 inch)
Maximum permissible clearance between the rocker arm bushing and the rocker shaft ..... 0.17 mm (0.007 inch)

(4) Rocker arm

(5) Rocker shaft

Diameter of the rocker shaft .. 24.96 to 24.99 mm (0.9827 to 0.9839 inch)

(5) In order to install the rocker shaft assembly, ensure that the machined square is to the top of the rocker shaft.

(6) Locknut

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

(7) Tighten the bolts to the following torque. .. 35 N·m (26 lb ft)

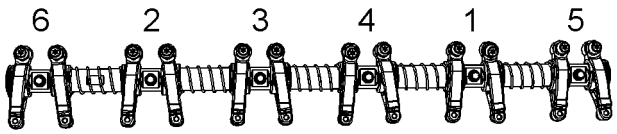

Illustration 11 g02266475

Typical example

Note: The shaft has a seat that has been cut into the top of the shaft for the bolt head.

Note: Refer to illustration 11, in order to tighten the bolts in the correct sequence.

(8) Spring

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Valve Mechanism Cover

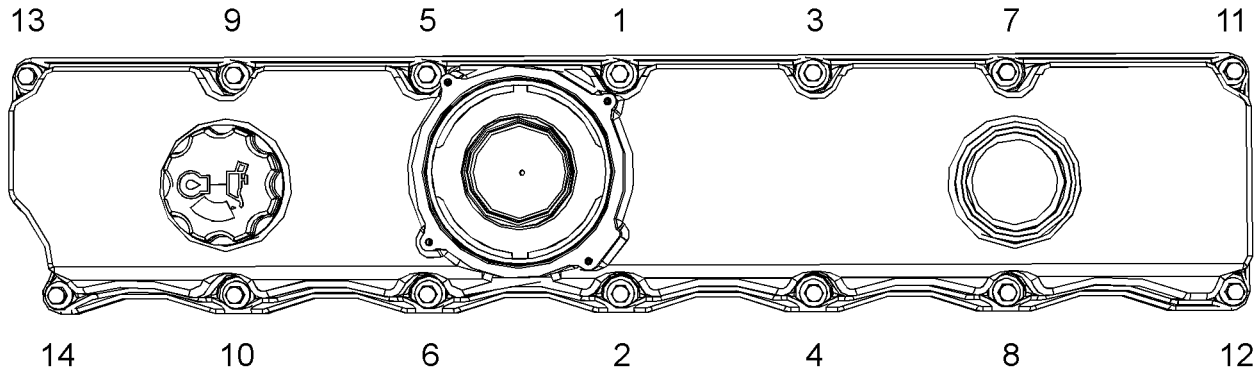

Illustration 12 g02356799

Typical example

Tighten the bolts for the valve mechanism cover in the sequence that is shown in illustration 12 to the following torque. ..... 22 N·m (16 lb ft)

i04048909

Cylinder Head Valves

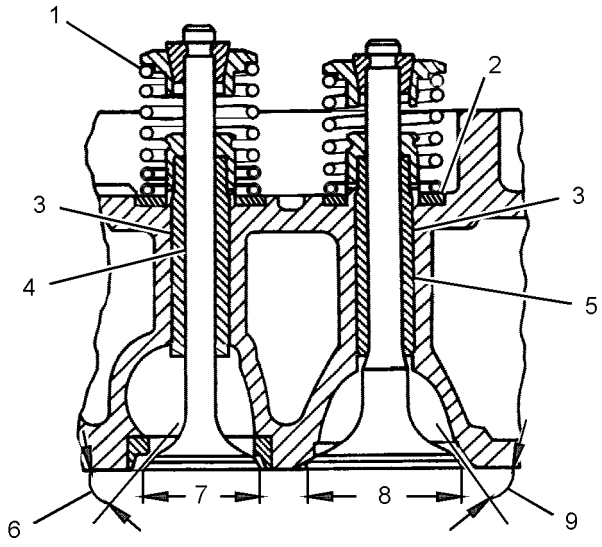

Illustration 13 g01277243

Typical example

(1) Valve spring

Length of the inlet valve spring under test force ..... 41.75 mm (1.6437 inch)

Test force of the inlet valve spring ..... 326.4 N (73.4 lb)

Length of the exhaust valve spring under test force ..... 41.5 mm (1.6339 inch)

Test force of the exhaust valve spring .... 332.5 N (74.7 lb)

(2) Valve spring recess

(3) Valve guides

Inside diameter of valve guide ..... 9.000 to 9.022 mm (0.3543 to 0.3552 inch)

Outside diameter of the exhaust valve guide ..... 13.034 to 13.047 mm (0.5131 to 0.5137 inch)

Outside diameter of the inlet valve guide ..... 13.034 to 13.047 mm (0.5131 to 0.5137 inch)

Interference fit of valve guide in cylinder head ..... 0.007 to 0.047 mm (0.0003 to 0.0019 inch)

Length of valve guide ..... 47.25 to 47.75 mm (1.86023 to 1.87992 inch)

Note: When new valve guides are installed, new valves and new valve seat inserts must be installed. The valve guides and the valve seat inserts are supplied as partially finished parts. The unfinished valve guides and unfinished valve seat inserts are installed in the cylinder head. Then, the guides and inserts are cut and reamed in one operation with special tooling. This procedure ensures the concentricity of the valve seat to the valve guide in order to create a seal that is tight. Refer to Disassembly and Assembly for removal and installation procedures.

(4) Exhaust valve

Diameter of the exhaust valve stem ..... 8.938 to 8.960 mm (0.3519 to 0.3528 inch)

Clearance of valve in valve guide .. 0.040 to 0.084 mm (0.00157 to 0.00331 inch)

Overall length of the exhaust valve ..... 128.92 to 129.37 mm (5.075 to 5.093 inch)

(5) Inlet valve

Diameter of the inlet valve stem ..... 8.957 to 8.971 mm (0.35264 to 0.35319 inch)

Clearance of valve in valve guide ..... 0.029 to 0.065 mm (0.00114 to 0.00256 inch)

Overall length of the inlet valve ..... 128.92 to 129.37 mm (5.075 to 5.093 inch)

(6) Exhaust valve face angle from the vertical axis

Valve face angle ..... 30 degrees
Valve seat angle ..... 30 degrees

(7) Diameter of the exhaust valve head ..... 41.51 to 41.75 mm (1.634 to 1.643 inch)

(8) Diameter of the head of the inlet valve ... 46.20 to 46.46 mm (1.819 to 1.829 inch)

(9) Angle of the inlet valve face from the vertical axis

Valve face angle ..... 30 degrees
Valve seat angle ..... 30 degrees

The valve lash is the following value when the engine is cold:

Inlet valves ..... 0.35 mm (0.014 inch)
Exhaust valves ..... 0.45 mm (0.018 inch)

i04051329

Cylinder Head

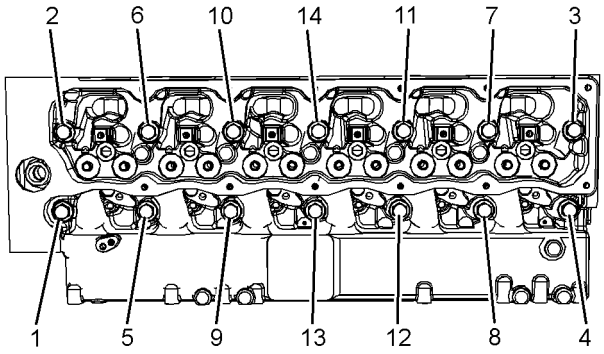

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Illustration 14

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 14 to the following torque. ..... 50 N·m (37 lb ft)
Tighten the bolts again to the following torque. ..... 160 N·m (118 lb ft)
Tighten the head bolts to the additional amount. ..... 130 degrees

Minimum thickness of cylinder head ..... 118 mm (4.64566 inch)

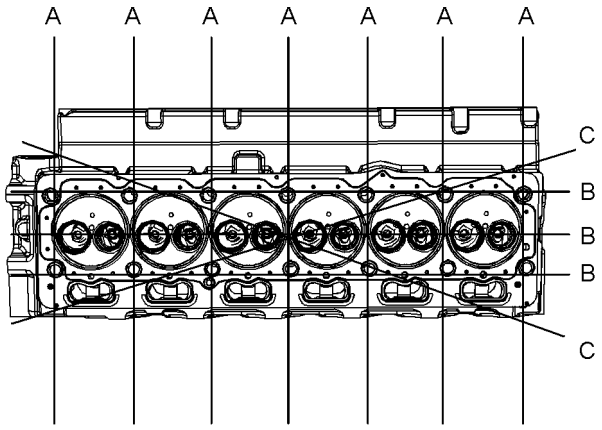

Illustration 15 g02260053
Typical example

Note: The maximum distortion of the cylinder head is given in table 1.

Table 1

Dimension	Maximum Permissible Distortion
Width (A)	0.03 mm (0.0012 inch)
Length (B)	0.05 mm (0.0020 inch)
Diagonal Line (C)	0.05 mm (0.020 inch)

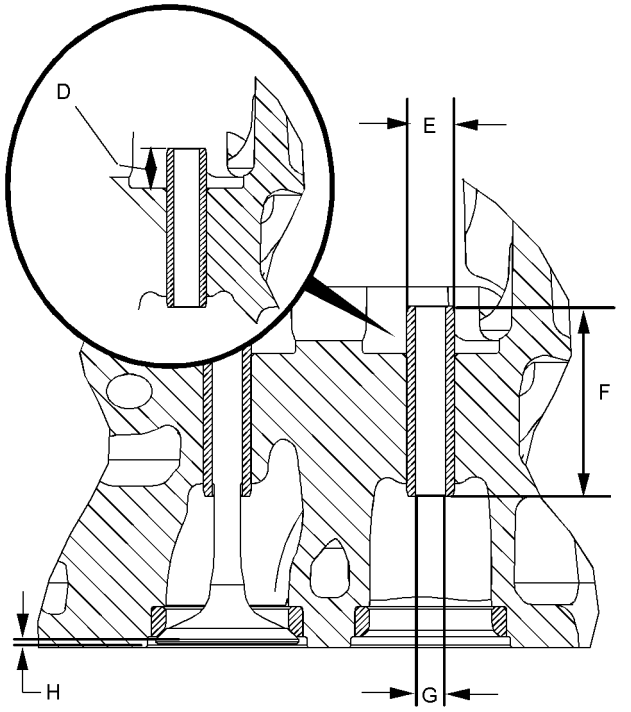

Illustration 16 g02328933
Typical example

(D) Valve guide height from the top of the valve guide to the valve spring seat ..... 12.35 to 12.65 mm (0.48622 to 0.49803 inch)

(E) Outside diameter of the valve guides ..... 13.034 to 13.047 mm (0.51315 to 0.51366 inch)

(F) Length of the valve guides ... 47.25 to 47.75 mm (1.86023 to 1.87992 inch)

(G) Internal diameter of the valve guides ..... 9.000 to 9.022 mm (0.35433 to 0.35520 inch)

(H) Valve depths

Inlet ..... 0.995 to 1.495 mm (0.03917 to 0.05886 inch)
The service limit for the depth of the inlet valve ..... 1.09 mm (0.04291 inch)
Exhaust ..... 0.65 to 1.007 mm (0.02559 to 0.03965 inch)
The service limit for the exhaust valve depth ..... 2.06 mm (0.08110 inch)

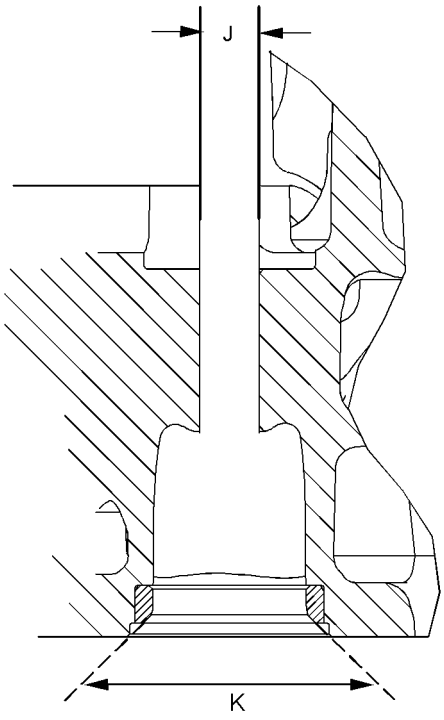

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Illustration 17

Typical example

(J) Diameter of the parent bore in the cylinder head ..... 13.000 to 13.027 mm (0.51181 to 0.51287 inch)

(K) Seat angle

Inlet ..... 120 degrees
Exhaust ..... 120 degrees

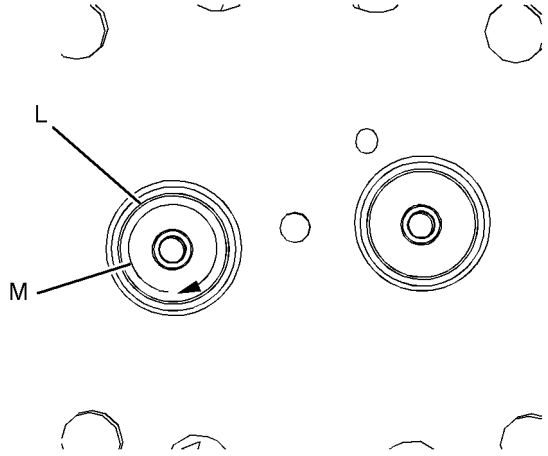

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Illustration 18

Typical example

(L) Seat surface finish ..... Ra 0.8 microns

(M) Concentricity of valve seat to valve guide parent bore Maximum Total Indicated Reading (TIR) ..... 0.05 mm (0.00197 inch)

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Turbocharger

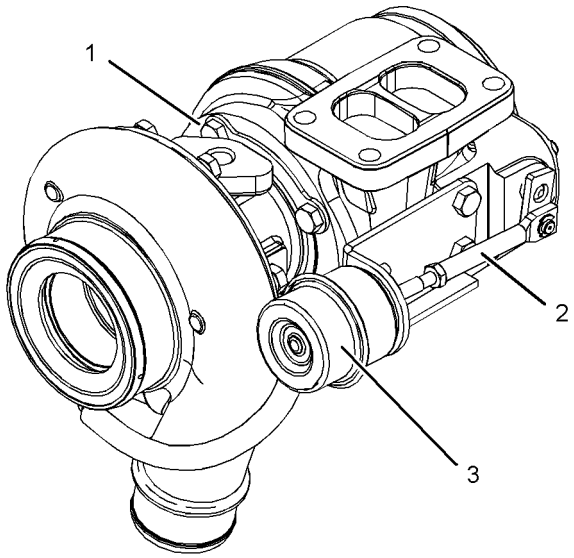

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Illustration 19

Typical example

(1) Turbocharger
(2) Actuator rod (if equipped)
(3) Actuator (if equipped)

The maximum test pressure for the wastegate (if equipped) ..... 125 kPa (18 psi)

The movement for the rod actuator (if equipped) ..... 3 mm (0.118 inch)

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Exhaust Manifold

Exhaust manifold for Top Mounted Turbocharger

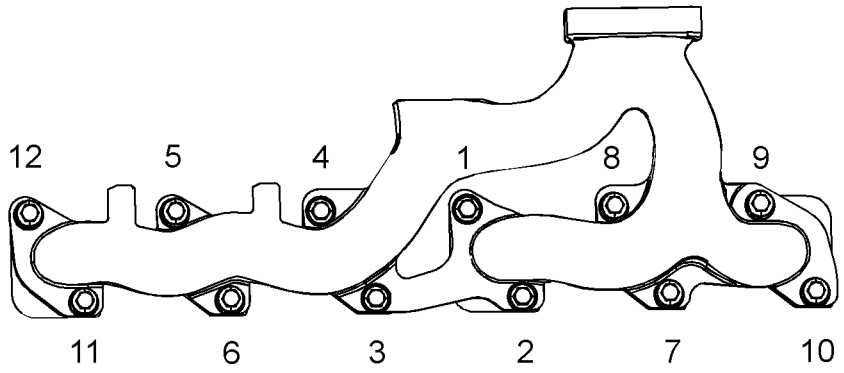

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Illustration 20

Typical example

Tighten the exhaust manifold bolts in the sequence that is shown in illustration 20 to the following torque. ..... 44 N·m (32 lb ft)

Exhaust manifold for Side Mounted Turbocharger

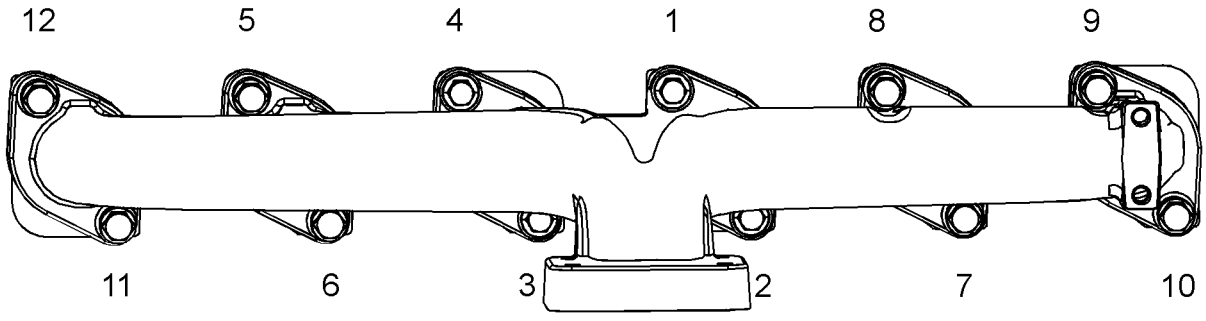

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Illustration 21

Typical example

Tighten the exhaust manifold bolts in the sequence that is shown in illustration 21 to the following torque. ..... 44 N·m (32 lb ft)

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Camshaft

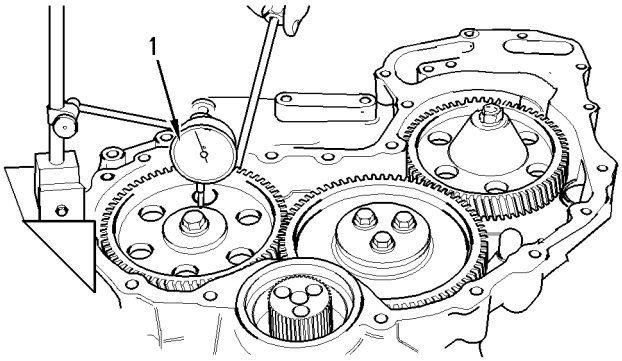

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Illustration 22

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)

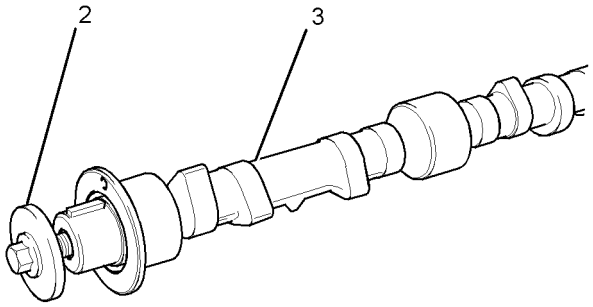

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Illustration 23

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 2

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	50.203 to 50.229 mm (1.9765 to 1.9775 inch)
4	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.

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Camshaft Bearings

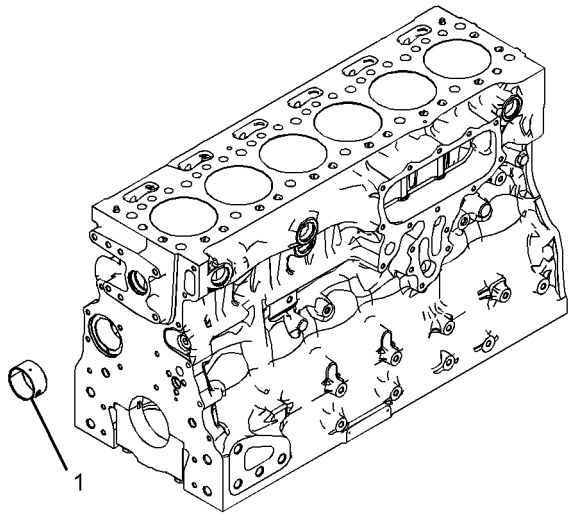

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Illustration 24

Typical example

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

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Engine Oil Filter Base

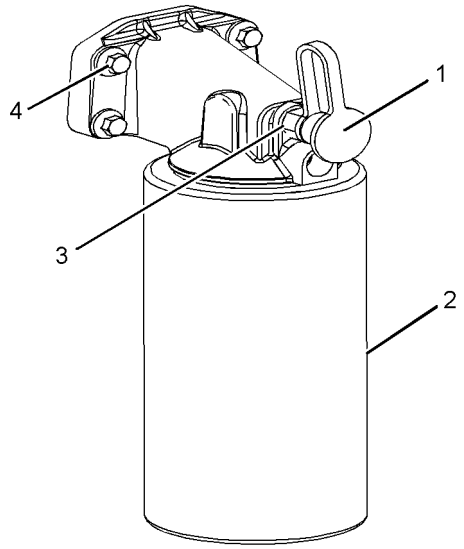

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Illustration 25

Typical example

(1) Dust cap

(2) Engine oil filter

Torque for the engine oil filter .. 12 N·m (106 lb in)

(3) Engine oil sampling valve

Torque for the engine oil sampling valve (if equipped) ..... 12 N·m (106 lb in)

Torque for the plug (if equipped) ... 12 N·m (106 lb in)

(4) Setscrew

Torque for the setscrews that retain the oil filter base ..... 22 N·m (16 lb ft)

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Engine Oil Cooler

Engine Oil Cooler with a Low Mounted Filter Base

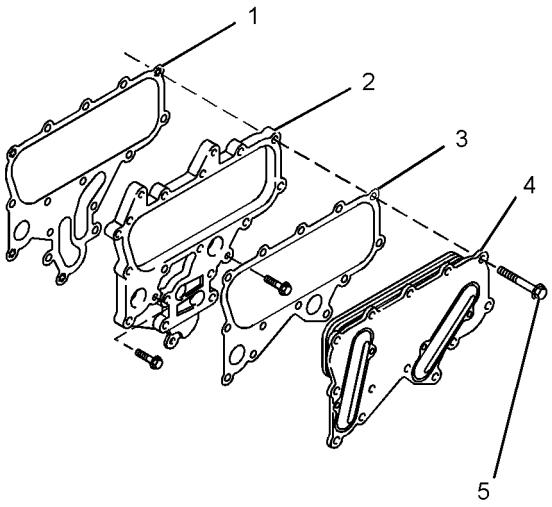

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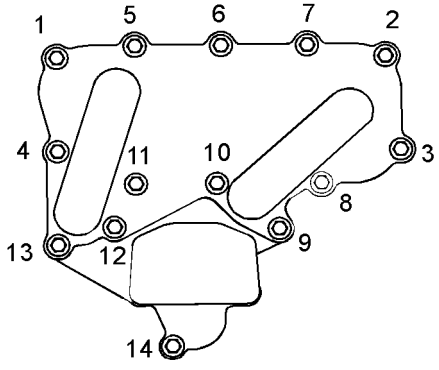
Illustration 26

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



g01332172

Illustration 27

Setscrews

Tighten the setscrews (5) in the sequence that is in illustration 27 to the following torque. .. 22 N·m (16 lb ft)

Engine Oil Cooler with a High Mounted Filter Base

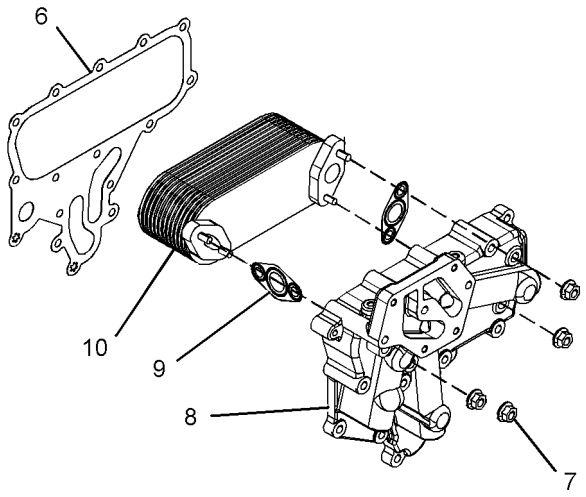


Illustration 28 g01322246

(6) Joint
(7) Nuts
(8) Housing
(9) Joint
(10) Oil cooler

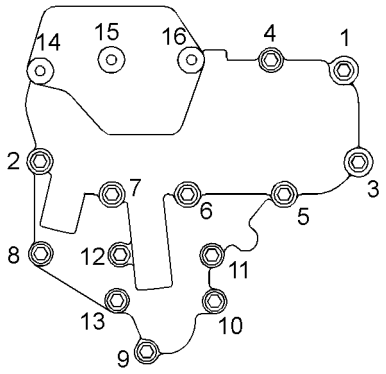


Illustration 29 g01332195

Setscrews

Tighten the setscrews in the sequence that is in illustration 29 to the following torque. ..... 22 N·m (16 lb ft)

i02369776

Engine Oil Pump

Type ..... Gear-driven differential rotor

Number of lobes

Inner rotor 4
Outer rotor 5

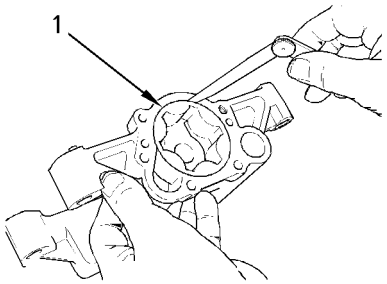


Illustration 30 g00938064

(1) Clearance of the outer rotor to the body ..... 0.050 to 0.330 mm (0.0020 to 0.0130 inch)

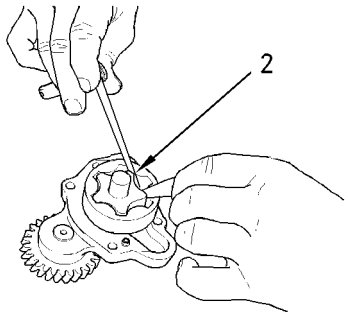


Illustration 31 g00938061

Checking the clearance

(2) Service limit of inner rotor to outer rotor ..... 0.080 to 0.250 mm (0.0031 to 0.0098 inch)

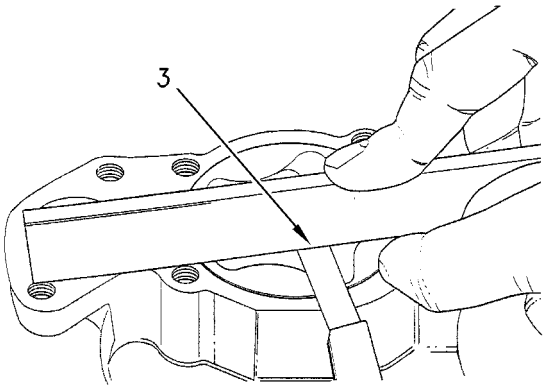


Illustration 32 g00938799

Checking the end play

(3) End play of rotor assembly

Inner rotor ..... 0.050 to 0.180 mm
(0.0020 to 0.0071 inch)
Outer rotor ..... 0.050 to 0.180 mm
(0.0020 to 0.0071 inch)

Tighten the bolts that hold the front cover of the oil pump assembly to the following torque. ..... 22 N·m
(16 lb ft)

i02379117

Engine Oil Pressure

The minimum oil pressure at the maximum engine speed and at normal operating temperature is the following value. ..... 315 kPa (45 psi)

i04048914

Engine Oil Pan

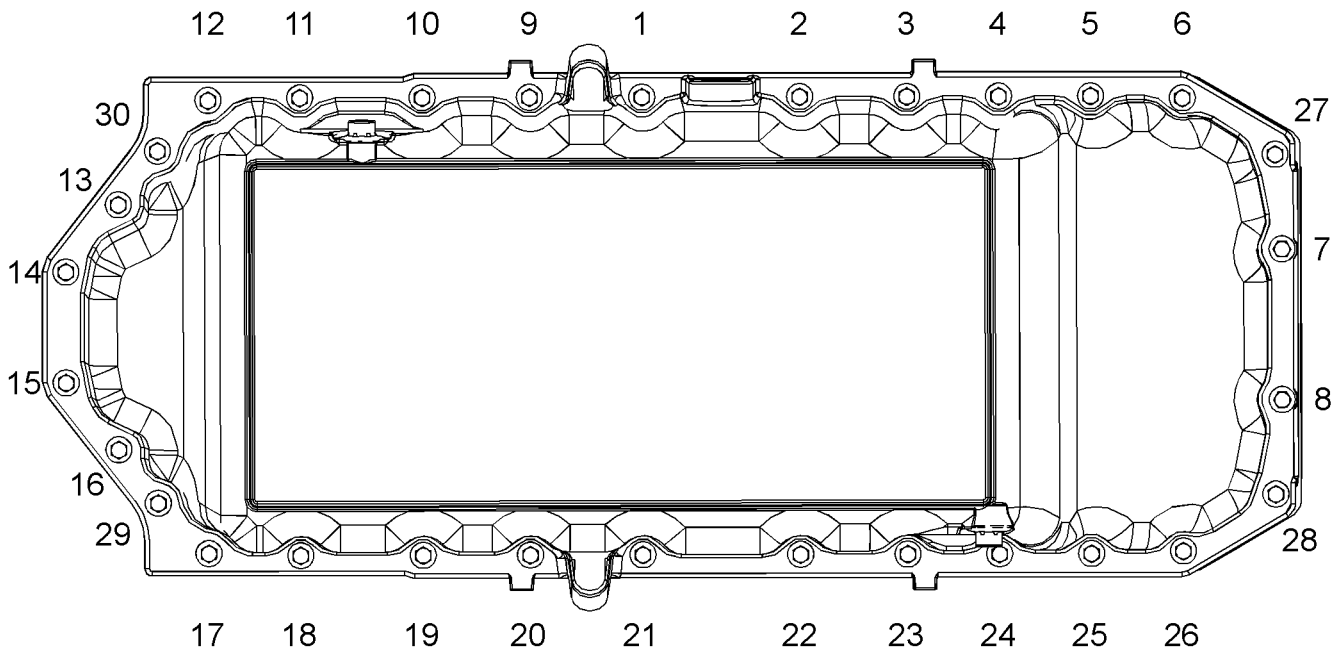


Illustration 33
Typical example

g02263834

Tighten the fasteners in the sequence that is shown in illustration 33 to the following torque. ..... 22 N·m
(16 lb ft)

Refer to Disassembly and Assembly for the correct procedure to install the engine oil pan.

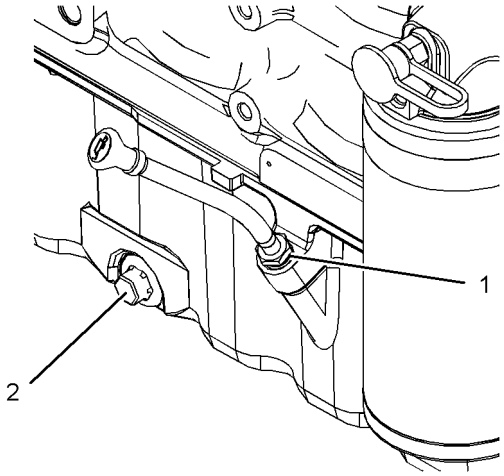


Illustration 34 g02263836
Typical example

(1) Tighten the nut to the following torque. .... 18 N·m (13 lb ft)

(2) Tighten the plug to the following torque. .. 34 N·m (25 lb ft)

i04048911

Crankcase Breather

Unfiltered Breather

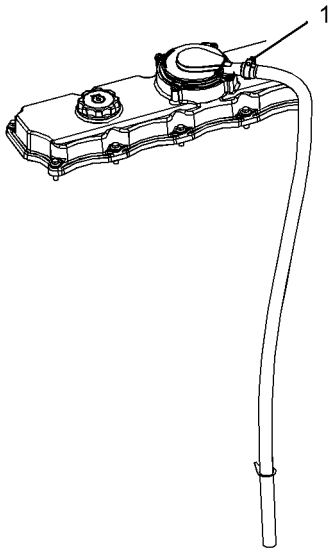


Illustration 35 g02716418
Typical example

Align the outlet of the breather to the flexible pipe.

(1) Clamp

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

Filtered Breather

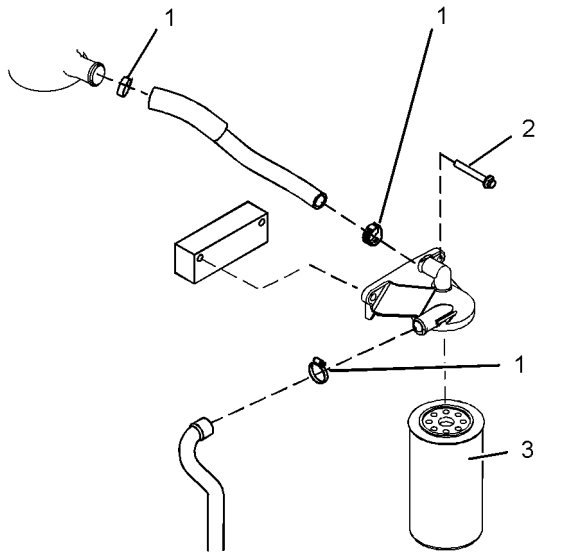


Illustration 36 g02716419
Typical example

(1) Clamps

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

(2) Setscrews

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

(3) Canister

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

i02953189

Water Temperature Regulator and Housing

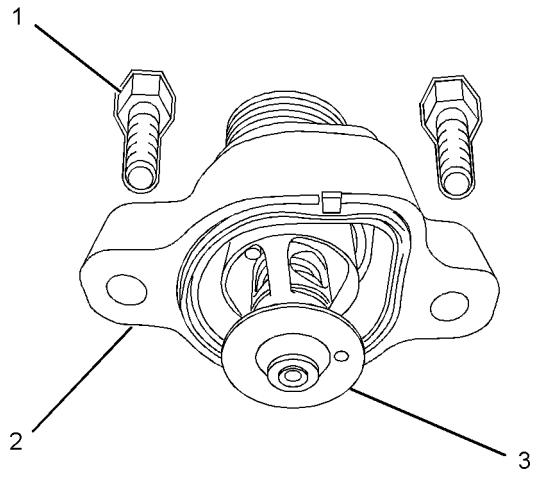


Illustration 37 g01332230
Typical example

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

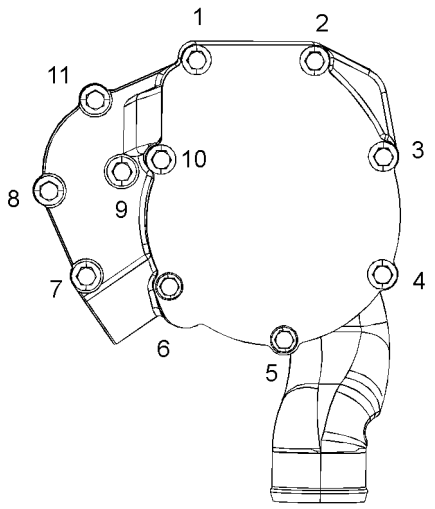
(2) Water temperature regulator housing

(3) Water temperature regulator

Opening temperature ..... 82° to 87°C (180° to 189°F)
Full opening temperature ..... 95 °C (203 °F)
Minimum stroke at full temperature ..... 9 mm (0.3543 inch)

i02363605

Water Pump



g01183807

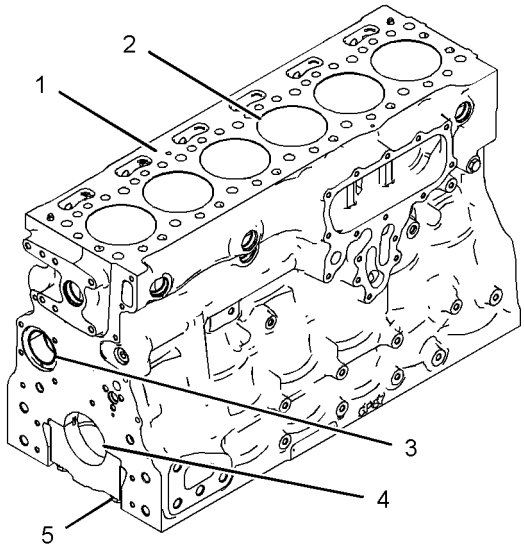
Illustration 38

Tightening sequence

Tighten the setscrews in the numerical sequence that is shown in illustration 38 to the following torque. ..... 22 N·m (16 lb ft)

i04047872

Cylinder Block



g02262274

Illustration 39

Typical example

(1) Cylinder block

(2) Cylinder bore ..... 105.000 to 105.025 mm (4.1338 to 4.1348 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 ..... 50.292 to 50.343 mm (1.9800 to 1.9820 inch)

Diameter of the bore in the cylinder block for the number 4 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)

(5) Main bearing cap bolts

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

1. Apply clean engine oil to the threads of the main bearing cap bolts.
2. Put the main bearing caps in the correct position that is indicated by a number on the top of the main bearing cap. Install the main bearing caps with the locating tabs in correct alignment with the recess in the cylinder block.
3. Evenly tighten the main bearing cap bolts.

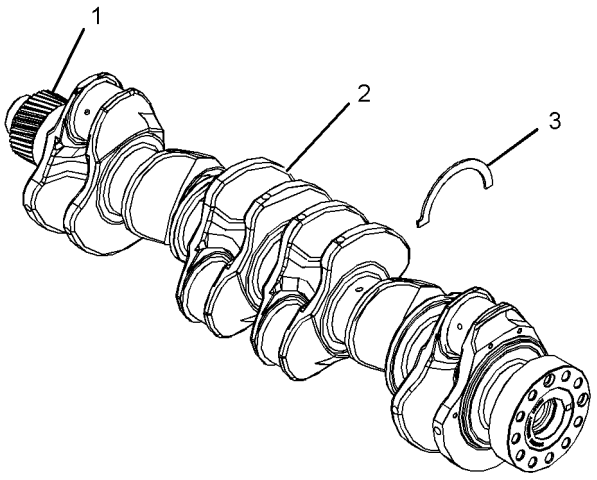
   Torque for the main bearing cap bolts. ..... 80 N·m (59 lb ft)

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

Note: Ensure that the crankshaft can rotate freely.

i04476871

Crankshaft



g02260273

Illustration 40

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 ..... 0.1 to 0.41 mm (0.00394 to 0.01614 inch)

Standard thickness of thrust washer ..... 2.69 to 2.75 mm (0.1059 to 0.1083 inch)

Oversize thickness of thrust washer ..... 2.89 to 2.95 mm (0.1138 to 0.1161 inch)

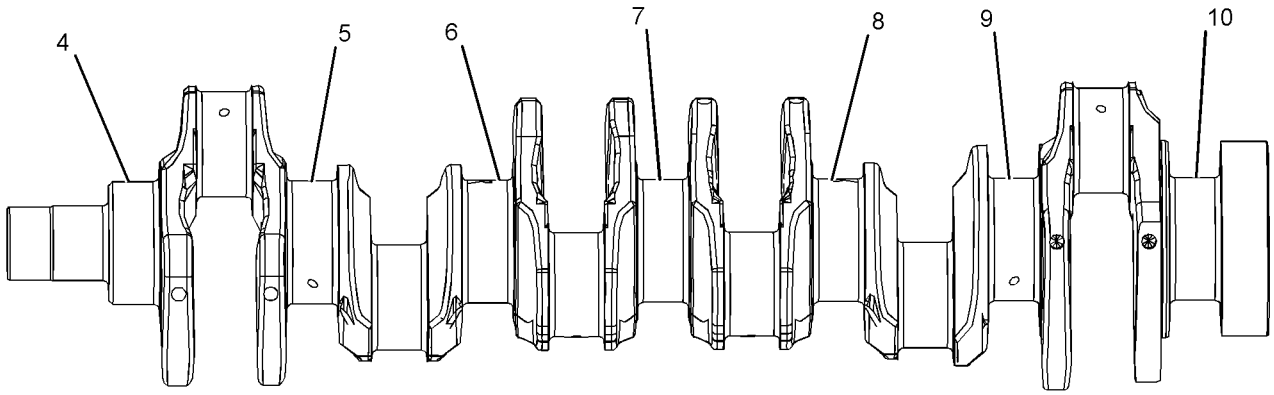


Illustration 41 g01869273

(4) Journal #1
(5) Journal #2
(6) Journal #3
(7) Journal #4
(8) Journal #5
(9) Journal #6
(10) Journal # 7

Refer to table 3 for the run out of the crankshaft journals.

Table 3

Journal	Run Out of the Journals
(1)	Mounting
(2)	0.05 mm (0.0020 inch)
(3)	0.1 mm (0.0039 inch)
(4)	0.15 mm (0.0059 inch)
(5)	0.1 mm (0.0039 inch)
(6)	0.05 mm (0.0020 inch)
(7)	Mounting

Inspect the crankshaft for wear or for damage. For more information regarding the servicing of the crankshaft, contact the Global Technical Support Center.

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.

i02934550

Crankshaft Seals

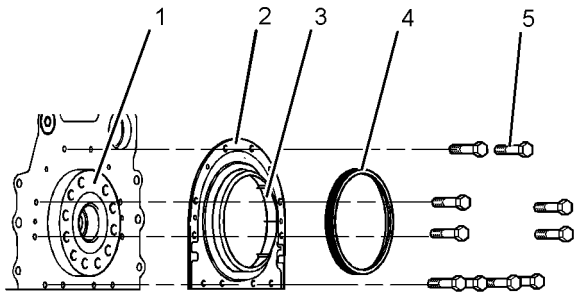


Illustration 42 g01455434

Typical example

(1) Crankshaft

(2) Crankshaft seal

(3) Plastic sleeve

(4) Alignment tool

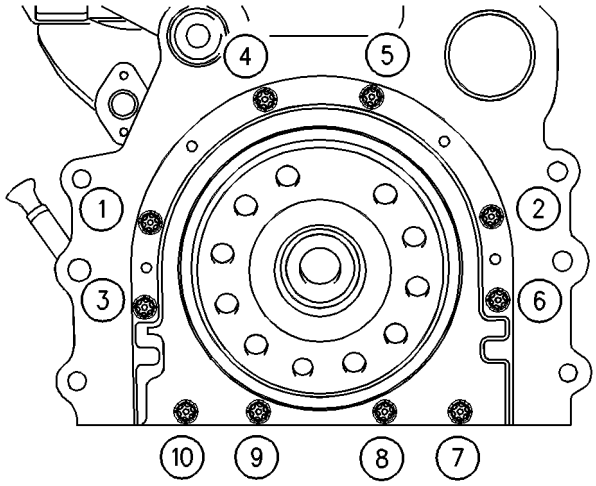


Illustration 43 g00915076

(5) Tighten bolts 1, 2, 3, 4, 5, 6, 7, and 10 in the sequence that is shown in Illustration 43 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 43 to the following torque. ..... 22 N·m (16 lb ft)

i04051330

Vibration Damper and Pulley

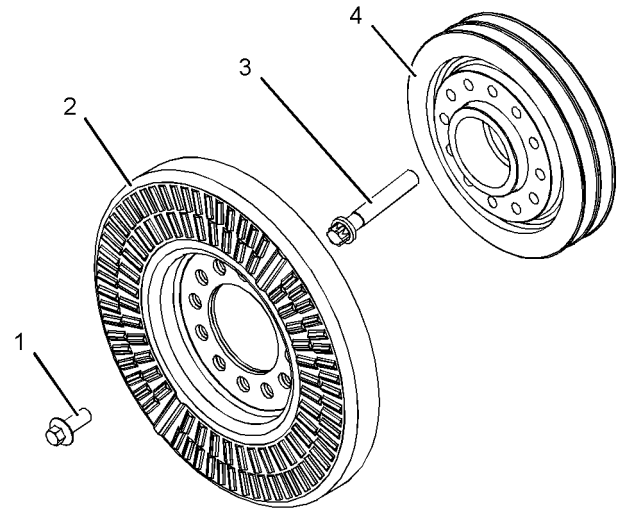


Illustration 44 g02260014
Typical example

(1) Tighten the damper setscrews to the following torque. ..... 115 N·m (84 lb ft)

(2) Vibration damper

(3) Tighten the setscrews for the adapter to the following torque. ..... 40 N·m (30 lb ft)

(4) Crankshaft adapter and pulley

i04047908

Connecting Rod Bearing Journal

The original size of the connecting rod bearing journal on the crankshaft ..... 71.970 to 71.990 mm (2.83346 to 2.83425 inch)

Maximum permissible wear of a bearing journal on the crankshaft when a new connecting rod is installed ..... 0.04 mm (0.0016 inch)

Width of the connecting rod bearing journals on the crankshaft ..... 37.962 to 38.038 mm (1.4946 to 1.4976 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 0.2 microns

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

i04047857

Main Bearing Journal

The original size of the main bearing journal ..... 83.99 to 84.01 mm (3.307 to 3.308 inch)

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

Surface finish of bearing journals and crank pins ..... 0.2 microns

Width of new main bearing journal ..... 35.235 to 35.165 mm (1.3872 to 1.3844 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 (0.030 inch)

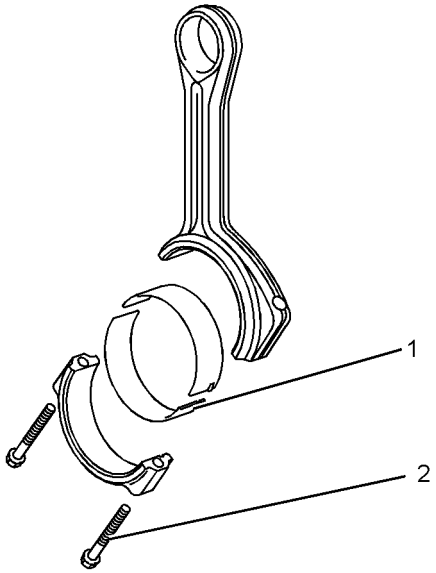
Thickness at center of the shells .. 2.083 to 2.089 mm (0.0820 to 0.0823 inch)

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 ..... 0.026 to 0.084 mm (0.0010 to 0.0033 inch)

i04048757

Connecting Rod



g01333876

Illustration 45
Typical example

(1) The bearing shell for the connecting rod

Table 4

Thickness of Connecting Rod Bearing at the Center	1.994 to 2 mm (0.0785 to 0.0787 inch)
Thickness of Connecting Rod Bearing for the Cap at the Center	1.994 to 2 mm (0.0785 to 0.0787 inch)
Bearing Clearance	0.025 to 0.070 mm (0.0010 to 0.0028 inch)

Table 5

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.

Tighten the setscrews for the connecting rod again to the following torque. ..... 40 N·m (30 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).

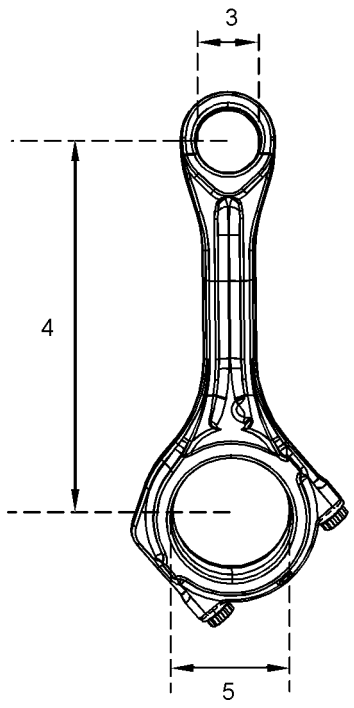


Illustration 46 g01333883

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 ..... 72.025 to 72.05 mm (2.8356 to 2.8366 inch)

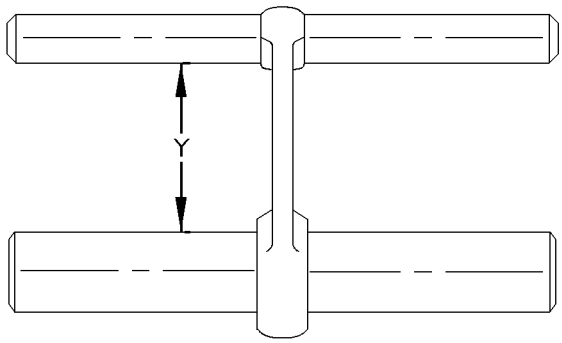


Illustration 47 g00915056

Connecting rods are color coded. The color code is a reference for the length (Y) of the connecting rod. Refer to table 6 for the different lengths of connecting rods.

Table 6

Length Grades for Connecting Rods		
Grade Letter	**Color Code**	**Length (Y)**
R	Red	161.259 to 161.292 mm (6.3488 to 6.3501 inch)
G	Green	161.183 to 161.216 mm (6.3458 to 6.3471 inch)
B	Blue	161.107 to 161.140 mm (6.3428 to 6.3441 inch)

i04047904

Piston and Rings

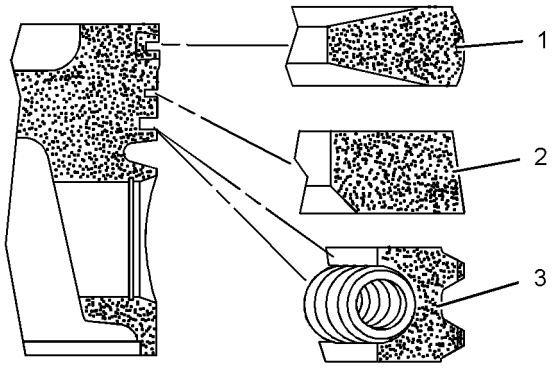


Illustration 48 g01363510

Typical example

(1) Top compression ring

The shape of the top compression ring ..... Keystone with a barrel face

Width 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 for turbocharged engines 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 chamfer in the bottom edge with a tapered face

Width of intermediate compression ring .. 2.470 to 2.495 mm (0.0972 to 0.0982 inch)

Clearance between the intermediate compression ring and the piston groove ..... 0.065 to 0.110 mm (0.0026 to 0.0043 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 for turbocharged engines 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) Oil control ring

Shape of oil control ring ..... a two-piece coil that is spring loaded

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

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

Note: 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 .. 0.41 to 0.55 mm (0.01614 to 0.02165 inch)

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

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

Width of third groove in 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)

Diameter of the bore for the piston pin ..... 39.703 to 39.709 mm (1.5631 to 1.5633 inch)

i03520280

Piston Cooling Jet

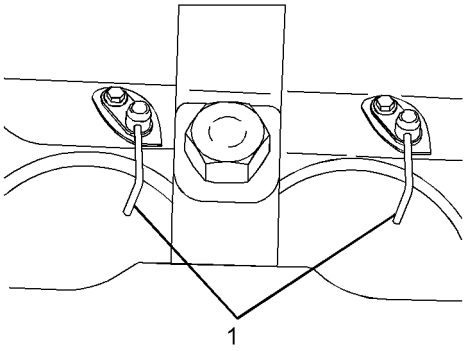


Illustration 49 g01352576

(1) Installed piston cooling jets

The valve must move freely. Torque for the bolt ..... 9 N·m (7 lb ft)

Piston Cooling Jet Alignment

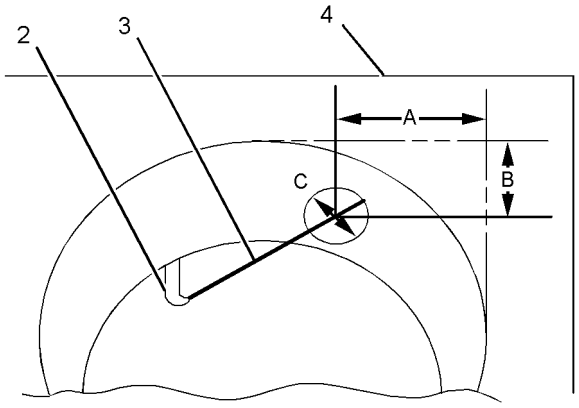


Illustration 50 g01352578

(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 58.5 mm (2.30315 inch) and dimension (B) is 13.5 mm (0.53150 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 10 mm (0.39370 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.

i03907004

Accessory Drive

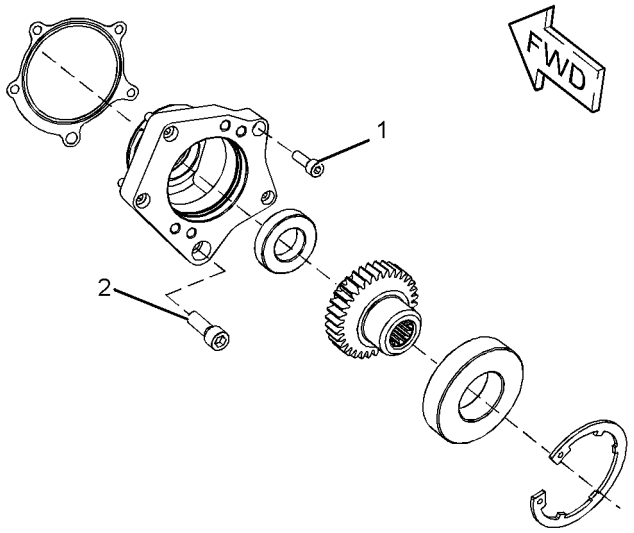


Illustration 51 g02148372

Typical example

(1) Tighten the allen head screws to the following torque. ..... 22 N·m (16 lb ft)

(2) Tighten the allen head screws to the following torque. ..... 78 N·m (58 lb ft)

i02935111

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)

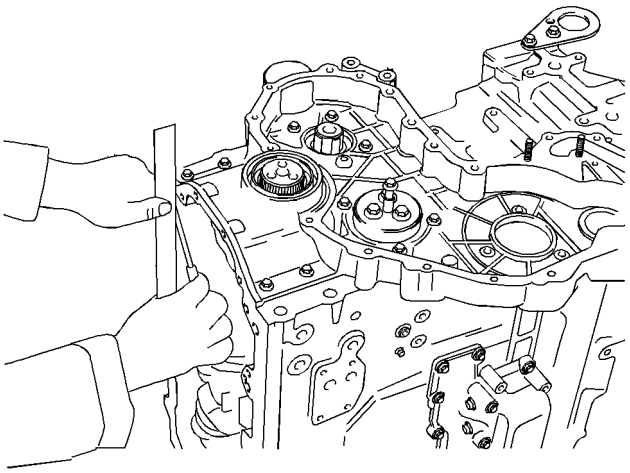


Illustration 52 g01332260
Alignment

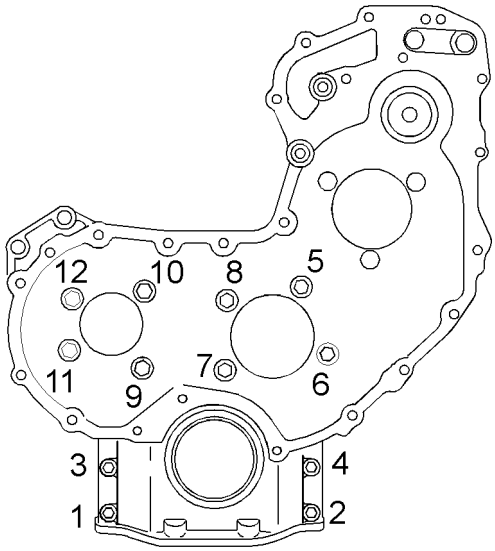


Illustration 53 g01332261
Typical example

Tighten the setscrew to the sequence that is shown in illustration 53 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)

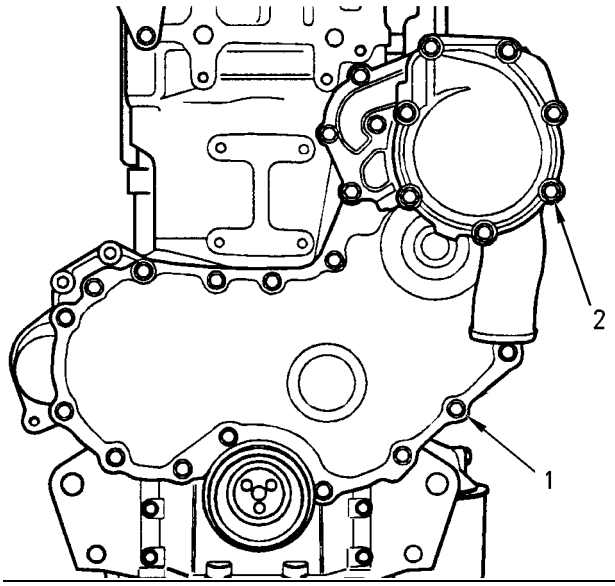


Illustration 54 g00918672
Typical example

(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.

i02796838

Gear Group (Front)

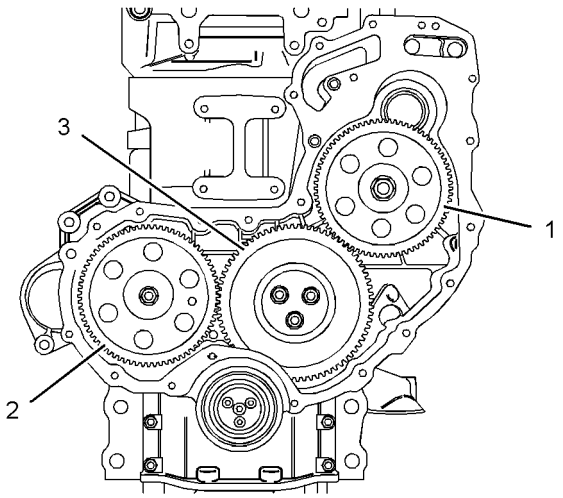


Illustration 55 g01332521
Gear train

(1) Fuel injection pump drive gear

Tighten the nut to the following torque. ... 24 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 the Specifications Module, “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 ..... 30.164 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 ..... 0.10 to 0.205 mm (0.0039 to 0.0081 inch)

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

Idler gear end play with roller bearings ..... 0.10 to 0.75 mm (0.0039 to 0.0295 inch)

Number of teeth 73

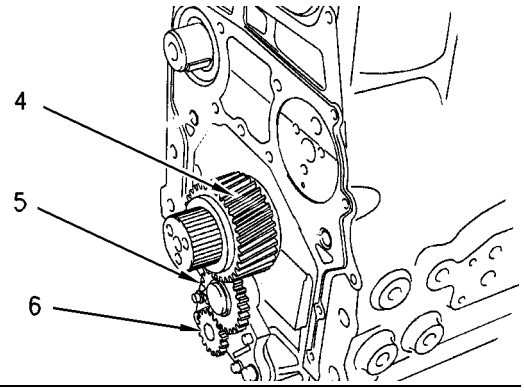


Illustration 56 g00996214
The gear train for the oil pump

(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 ..... −0.020 to +0.020 mm (−0.0008 to +0.0008 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 0.15 mm (0.0020 to 0.0059 inch)

Backlash between the oil pump idler gear (5) and the crankshaft gear (4) ..... 0.08 to 0.23 mm (0.0031 to 0.0091 inch)

Backlash between the idler gear (3) and the crankshaft gear (4) ..... 0.05 to 0.15 mm (0.0020 to 0.0059 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)

i04047745

Flywheel

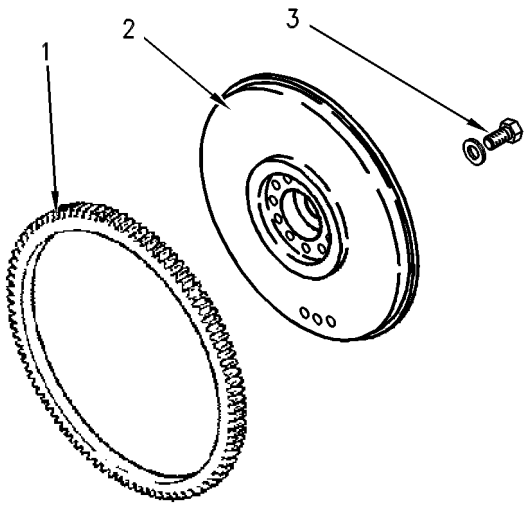


Illustration 57 g00584712
Typical example

(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 12 flywheel bolts to the following torque. ..... 140 N·m (103 lb ft)

i04478670

Flywheel Housing

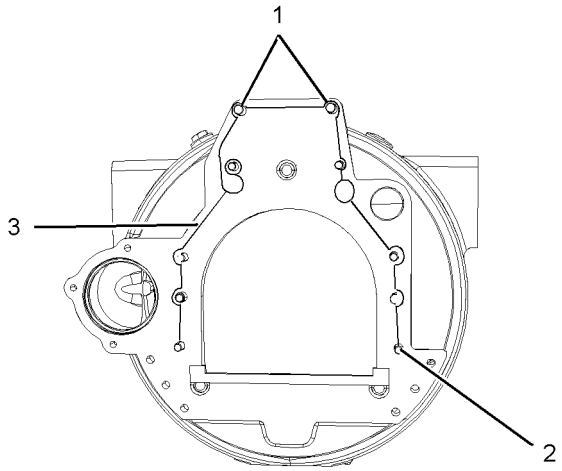


Illustration 58 g01185448
Typical example

Note: Tighten the setscrew (2) before you tighten setscrews (1).

(1) Tighten the setscrew to the following torque. ..... 78 N·m (57 lb ft)

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

Flywheel Housing and Oil Seal

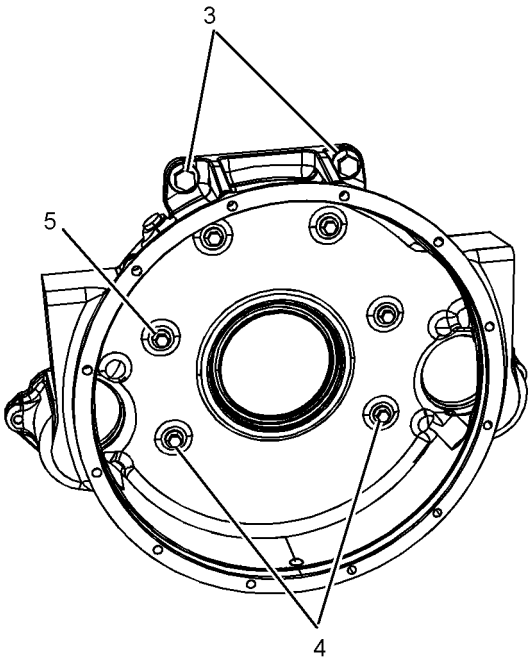


Illustration 59 g02341377

Typical example

Note: Tighten the setscrew (4) before you tighten setscrews (3).

(3) Tighten the top setscrew to the following torque. ..... 190 N·m (140 lb ft)

(4) Tighten the bottom setscrew to the following torque. ..... 115 N·m (84 lb ft)

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

i04048917

Fan Drive

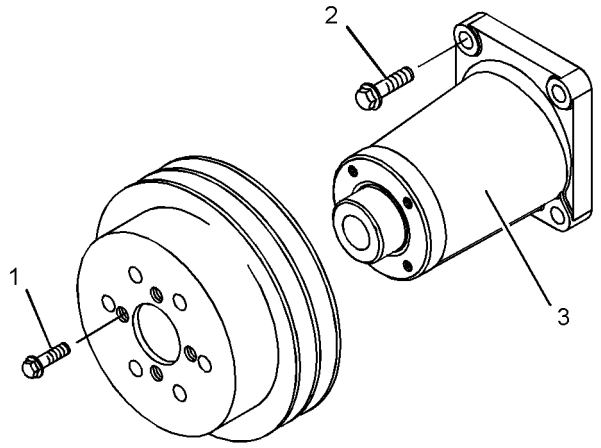


Illustration 60 g01338248

Typical example

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

Fan drive housing

Tighten the bolts (2) that secure the fan drive housing (3) to the cylinder head to the following torque. ..... 44 N·m (32 lb ft)

Maximum permissible end play of the shaft .. 0.20 mm (0.0079 inch)

i02562748

Engine Lifting Bracket

All engines are equipped with two engine lifting brackets. Some lifting brackets require two bolts and some lifting brackets may require four bolts.

Tighten the bolts on each engine lifting bracket to the following torque. .... 44 ± 11 N·m (32 ± 8 lb ft)

i02656398

Alternator

The 12 Volt and 24 Volt Denso Alternators

Three types of alternator are available.

Output

Two 12 volt alternators are available. ..... 100 Amp and 120 Amp
One 24 volt alternator ..... 80 Amp

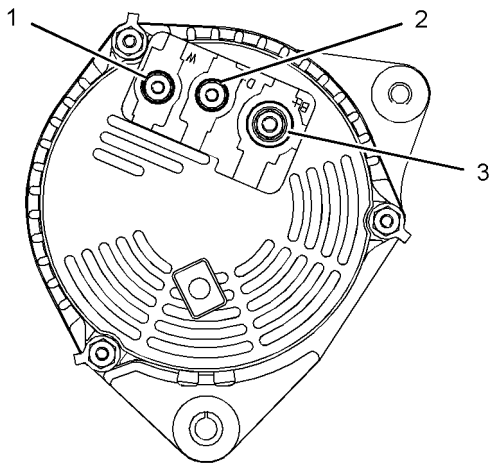


Illustration 61 g01332517
Typical example

(1) Terminal “W”

Tighten the terminal nut to the following torque. ..... 3.7 N·m (33 lb in)

(2) Terminal “D+”

Tighten the terminal nut to the following torque. ..... 3.7 N·m (33 lb in)

(3) Terminal “B+”

Tighten the terminal nut to the following torque. ..... 7 N·m (62 lb in)

The 12 Volt and 24 Volt Iskra Alternator

12 volt output

Two alternators are available. ..... 150 Amp and 175 Amp

24 volt output

The 24 volt alternator ..... 100 Amp

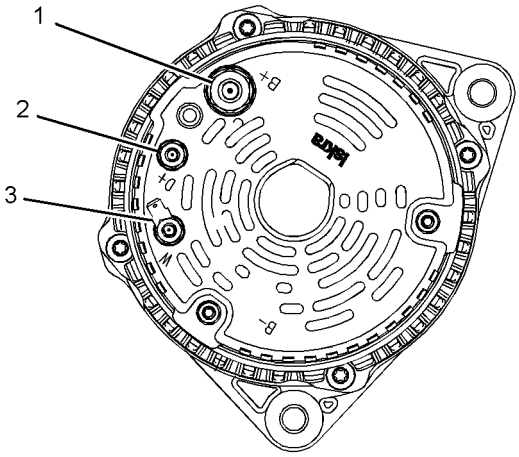


Illustration 62 g01332519
Typical example

(1) Terminal “B+”

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

(2) Terminal “D+”

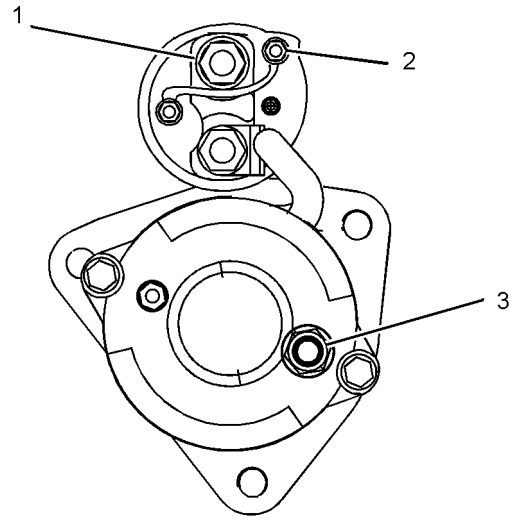
Tighten the terminal nut to the following torque. ..... 3 N·m (26 lb in)

(3) The terminal “W” is spade-type.

i04476873

Starter Motor

24 V Starting Motor 8 kW



g01332526

Illustration 63

Typical example

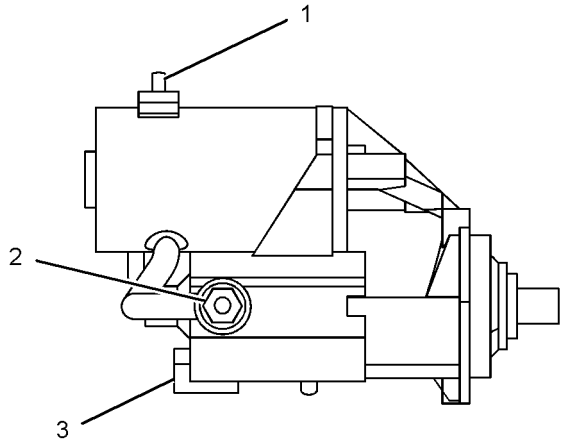
(1) Tighten the positive terminal nut to the following torque. ..... 25 N·m (18 lb ft)

(2) Tighten the nut for the solenoid terminal to the following torque. ..... 2.5 N·m (22 lb in)

(3) Tighten the nut on the negative terminal to the following torque. ..... 25 N·m (18 lb ft)

Rated voltage ..... 24 V

24 V Starting Motor 4.5 kW



g01332527

Illustration 64

Typical example

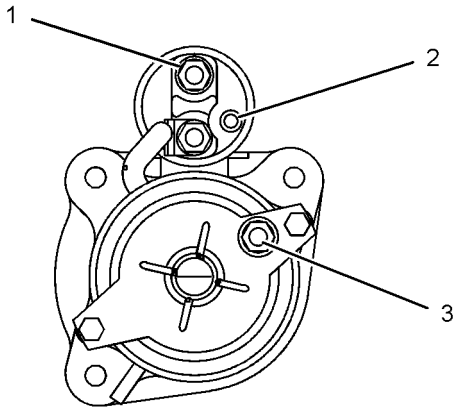
(1) Tighten the negative terminal nut to the following torque. ..... 15 N·m (11 lb ft)

(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 V

12 V Starting Motor 3 kW



g01332528

Illustration 65

Typical example

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

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

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

Rated voltage ..... 12 V

12 V Starting Motor 5 kW

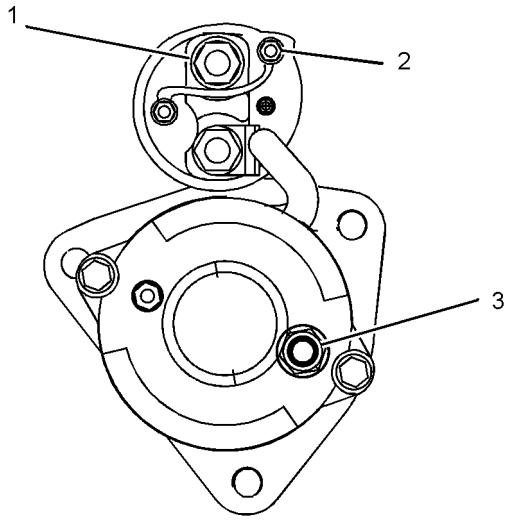


Illustration 66 g01332529
Typical example

(1) Tighten the positive terminal nut to the following torque. ..... 25 N·m (18 lb ft)

(2) Tighten the nut for the solenoid terminal to the following torque. ..... 2.5 N·m (22 lb in)

(3) Tighten the nut on the negative terminal to the following torque. ..... 25 N·m (18 lb ft)

Rated voltage ..... 12 V

i02652625

Glow Plugs

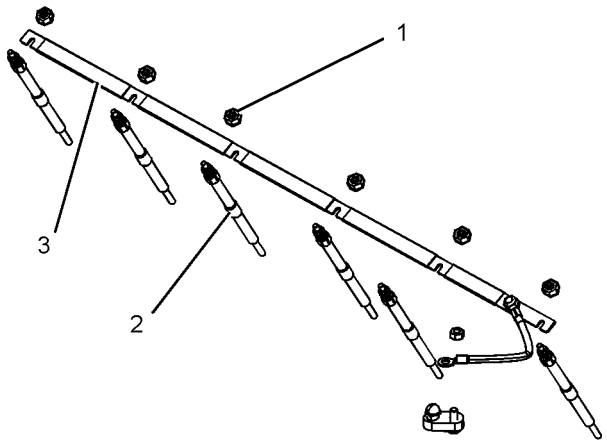


Illustration 67 g01332542
Typical example

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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