

Illustration 2

g01324126

(A) Location of warning label
(1) 402D-05
(2) 403D-07

(3) 403D-11
(4) 403D-15 and 403D-15T
(5) 404D-15

(6) 404D-22, 404D-22T and 404D-22TA

For options regarding the removal, installation, and replacement, consult your Perkins dealer or your Perkins distributor. Refer to the Disassembly and Assembly Manual, "Turbocharger - Remove and Turbocharger - Install" for further information.

Inspecting

NOTICE

The compressor housing for the turbocharger must not be removed from the turbocharger for cleaning.

The actuator linkage is connected to the compressor housing. If the actuator linkage is moved or disturbed the engine may not comply with emissions legislation.

1. Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe to the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
2. Check for the presence of oil. If oil is leaking from the back side of the compressor wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the intake air (clogged air filters), which causes the turbocharger to slobber.

3. Inspect the bore of the housing of the turbine outlet for corrosion.
4. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing.

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Walk-Around Inspection

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the correct place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of the water pump and the installation of water pump and/or seal, refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" for more information or consult your Perkins dealer or your Perkins distributor.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the rocker cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps and/or tie-wraps.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks or other damage.

Product Information Section

Model Views

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Model View Illustrations

The following model views show typical features of the 400 series engines. Due to individual applications, your engine may appear different from the illustrations.

Note: Individual components are detailed on the 404D-22T turbocharged engine only.

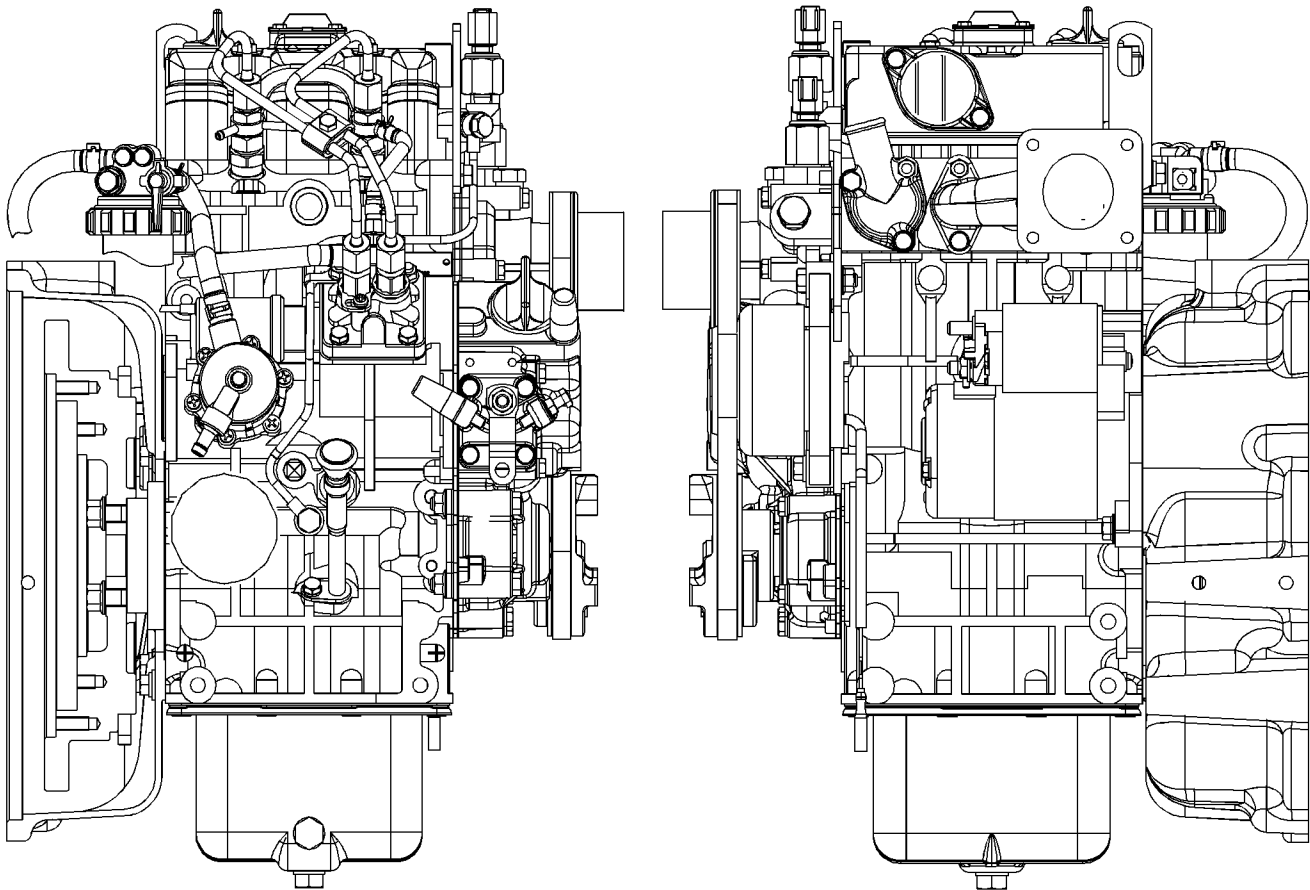


Illustration 9
Typical view of the 402D-05 engine

g01299985

- Renew the canister(s) of the lubricating oil filter.
- Fill the oil pan to the Full Mark on the engine oil level gauge with new, clean lubricating oil. Add 1762811 POWERPART Lay-Up 2 to the oil in order to protect the engine against corrosion. If 1762811 POWERPART Lay-Up 2 is not available, use a preservative of the correct specification instead of the lubricating oil. If a preservative is used, this must be drained completely at the end of the storage period and the oil pan must be refilled to the correct level with normal lubricating oil.

Cooling System

To help prevent excessive engine wear, use the following guidelines:

NOTICE

Do not drain the coolant while the engine is still hot and the system is under pressure because dangerous hot coolant can be discharged.

If freezing temperatures are expected, check the cooling system for adequate protection against freezing. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" (Maintenance Section).

NOTICE

To prevent frost damage, ensure that all the coolant is removed from the engine. This is important if the system is drained after it has been flushed with water, or if an antifreeze solution too weak to protect the system from frost has been used.

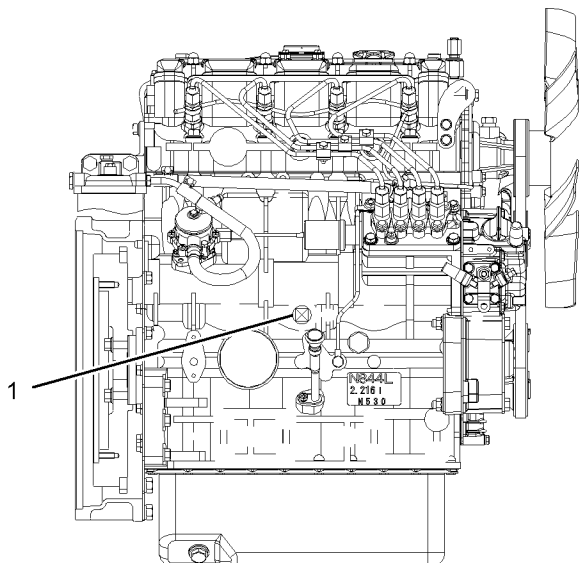


Illustration 25
Typical example

g01298045

1. Ensure that the vehicle is on level ground.
 2. Remove the filler cap of the cooling system.
 3. Remove the drain plug (1) from the side of the cylinder block in order to drain the engine. Ensure that the drain hole is not restricted.
 4. Open the tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a tap or a drain plug, disconnect the hose at the bottom of the radiator.
 5. Flush the cooling system with clean water.
 6. Fit the drain plugs and the filler cap. Close the tap or connect the radiator hose.
 7. Fill the cooling system with an approved antifreeze mixture because this gives protection against corrosion.
- Note:** Certain corrosion inhibitors could cause damage to some engine components. Contact the Service Department of Perkins for advice.
8. Operate the engine for a short period in order to circulate the lubricating oil and the coolant in the engine.
 9. Disconnect the battery. Put the battery into safe storage in a fully charged condition. Before the battery is put into storage, protect the terminals against corrosion. 1734115 POWERPART Lay-Up 3 can be used on the terminals.
 10. Clean the crankcase breather if one is installed. Seal the end of the pipe.
 11. Remove the fuel injectors and spray 1762811 POWERPART Lay-Up 2 for one or two seconds into each cylinder bore with the piston at BDC.
 12. Slowly rotate the crankshaft for one complete revolution and then replace the fuel injectors.

Induction System

- Remove the air filter assembly. If necessary, remove the pipes that are installed between the air filter assembly and the turbocharger. Spray 1762811 POWERPART Lay-Up 2 into the turbocharger. The duration of the spray is printed on the container. Seal the turbocharger with waterproof tape.

2. Move the alternator in order to increase or decrease the belt tension.
3. Tighten adjusting bolt (1). Tighten mounting bolts (2). Refer to the Specifications Manual for the correct torque settings.

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Alternator and Fan Belts - Replace

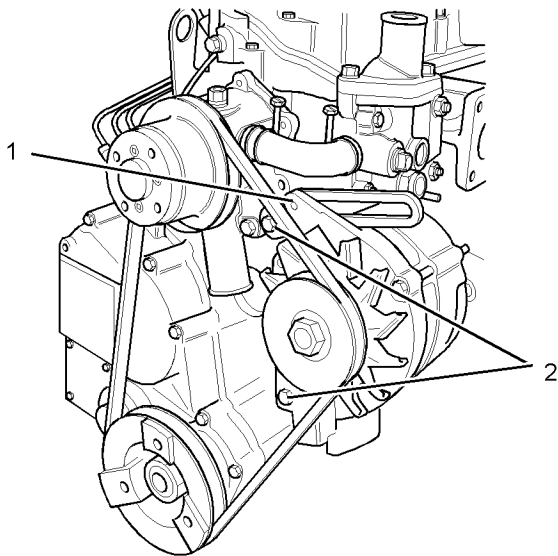


Illustration 31

g01091158

Typical example

- (1) Adjusting bolt
- (2) Mounting bolts

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

Note: When new belts are installed, check the belt tension again after 20 hours of engine operation.

Refer to the Disassembly and Assembly Manual for the installation procedure and the removal procedure for the belt.

i02322315

Battery - Replace

WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Switch the engine to the OFF position. Remove all electrical loads.
2. Turn off any battery chargers. Disconnect any battery chargers.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the NEGATIVE “-” terminal on the starting motor. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the POSITIVE “+” terminal on the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Dispose of used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before the cables are connected, ensure that the engine start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.

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Installation Procedure

Table 4

Required Tools			
Tool	Part Number	Part Description	Qty
A	21825739	Valve Spring Compressor	1
B ⁽¹⁾	-	Adapter	1
B ⁽²⁾	27610235	Adapter	1
B ⁽³⁾	21825934	Adapter	1

(1) 402D-05 and 403D-07 engines

(2) 403D-11 and 404D-15 engines

(3) 403D-15, 403D-15T, 404D-22, 404D-22T and 404D-22TA engines

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Do not turn the crankshaft while the valve springs are removed.

NOTICE

Plug the apertures for the push rods in the cylinder head in order to prevent the entry of loose parts into the engine.

NOTICE

Install suitable plugs to the inlet ports of the cylinder head in order to prevent the entry of loose parts into the engine.

1. Inspect the valve springs for the correct length. Refer to Specifications, "Cylinder Head Valves".

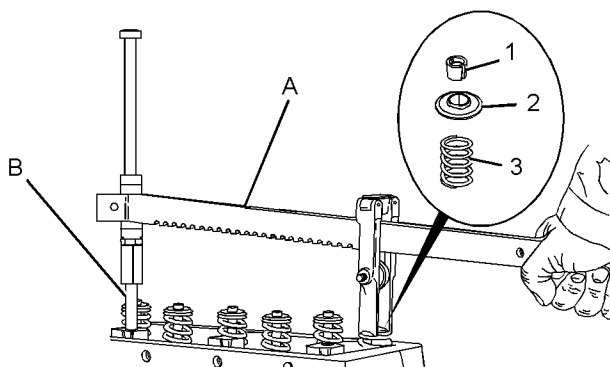


Illustration 28

g01304583

Typical example

2. Install valve spring (3) onto the cylinder head. Position valve spring retainer (2) onto valve spring (3).

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

3. Install Tooling (A) and (B) in the appropriate position on the cylinder head in order to compress the valve spring.

4. Apply sufficient pressure to Tooling (A) in order to install valve keepers (1).

Note: Do not compress the spring so that valve spring retainer (2) touches the valve stem seal.

Install the valve spring keepers.

5. Carefully release the pressure on Tooling (A).

Note: Ensure that the valve keepers are correctly seated.

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

6. Remove Tooling (A). Ensure that all of the valves are secured in place by a valve spring and valve keepers. Rotate the crankshaft through about 45 degrees in order to clear the piston from the valve. Lightly strike the top of the valve with a soft hammer in order to ensure that the valve keepers are properly installed.

End By:

- a. Install the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

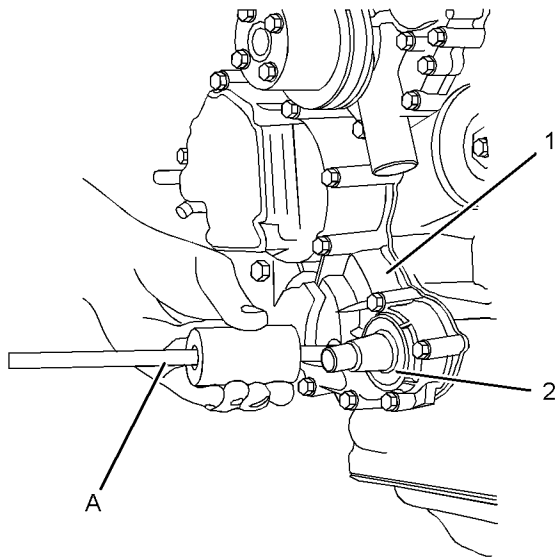


Illustration 84

g01310976

Typical example

1. Use a 4 mm (0.158 inch) drill in order to make three holes in crankshaft front seal (2).

NOTICE

Ensure that the main lip is used in order to remove the crankshaft front seal. Do not damage the edge of the housing for the crankshaft front seal.

Note: Do not damage the crankshaft during the removal process of the crankshaft front seal.

2. Use Tooling (A) to carefully remove crankshaft front seal (2). Alternate the position of Tooling (A) from one hole to another hole. This will allow you to evenly remove the crankshaft front seal from front housing (1).

Alternative Removal Procedure

Start By:

- a. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
- b. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: This is an alternative procedure to remove the crankshaft front oil seal. This procedure may be used if the front housing has been removed from the engine.

1. Use a suitable mandrel and a press in order to remove the oil seal from the front cover. Ensure that the front cover is supported in order to prevent damage to the cover while the oil seal is being removed.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

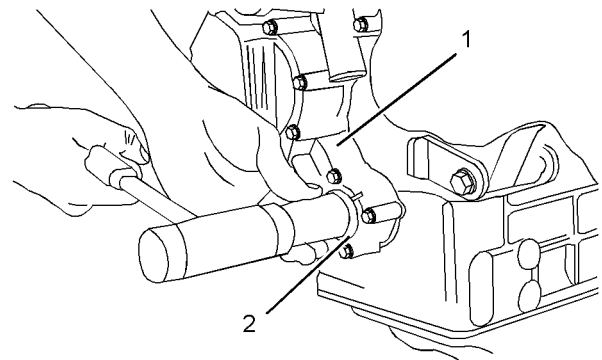


Illustration 85

g01311777

Typical example

1. Ensure that the bore in front housing (1) and the nose of the crankshaft are clean and free from damage.
2. Lubricate the lip of a new crankshaft front seal (2) with clean engine oil.
3. Position crankshaft front seal (2) in the bore of front housing (1).

NOTICE

Ensure that the lip of the crankshaft front seal that is spring loaded is facing toward the inside of the front housing and that it is square with the bore of the housing for the crankshaft front seal.

4. Use a suitable tool to install crankshaft front seal (2) to front housing (1).

6. Remove joint (7) from the base of rocker shaft assembly (3).

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Rocker Shaft - Disassemble (403D-15, 403D-15T, 404D-22, 404D-22T and 404D-22TA Engines)

Disassembly Procedure

Start By:

- a. Remove the rocker shaft and the pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Make a temporary identification mark on each rocker arm assembly in order to show the location.

Note: Used components must be reinstalled in the original location. Do not interchange components.

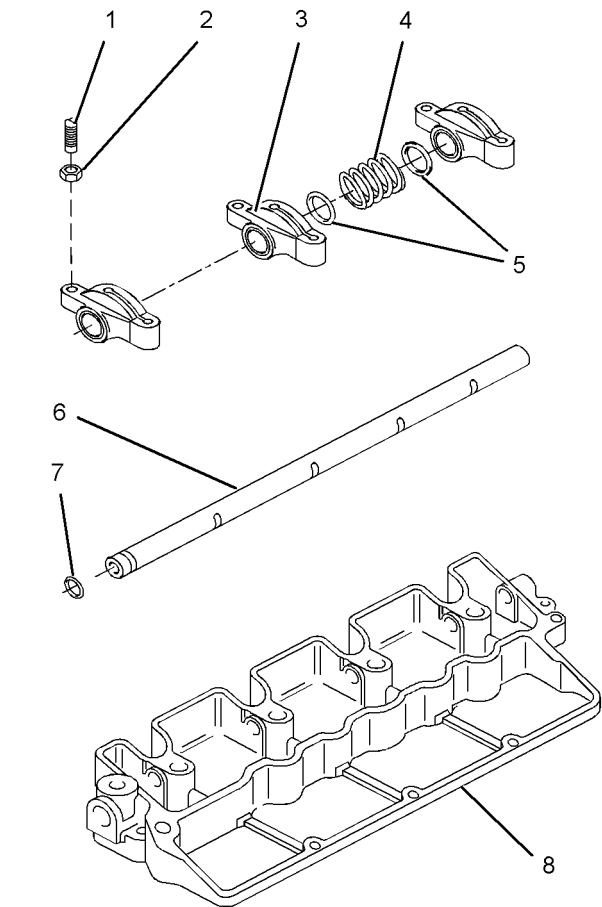


Illustration 114

g01317304

Typical example

2. In order to remove rocker shaft (6), install a suitable bolt into the end of the rocker shaft. Use the bolt to pull the rocker shaft from base (8).

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

3. Remove rocker arms (3), washers (5), and springs (4).
4. Remove O-ring seal (7) from rocker shaft (6).
5. Remove adjustment screws (1) and nuts (2) from rocker arms (3).

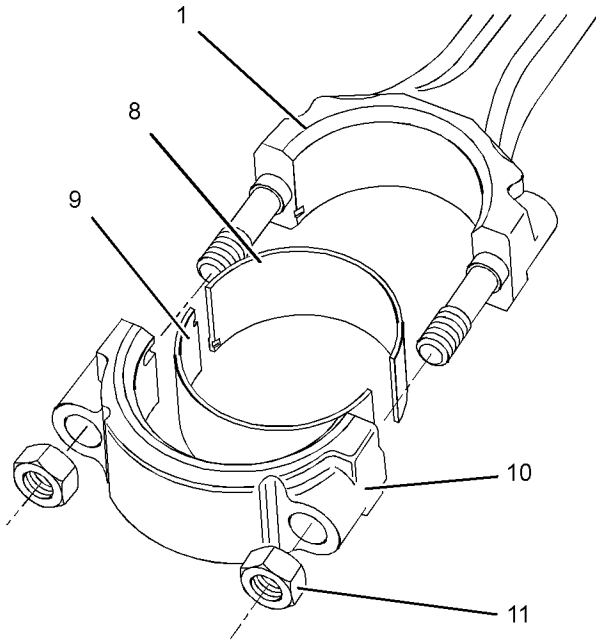


Illustration 152 g01311837
Typical example

6. Install the upper half of connecting rod bearing (8) to connecting rod (1).
7. Install the lower half of connecting rod bearing (9) to connecting rod cap (10).

End By:

- a. Install the pistons and the connecting rods. Refer to Disassembly and Assembly, "Piston and Connecting Rods - Install".

Pistons and Connecting Rods - Install

Installation Procedure

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
A	21825491	Piston Ring Compressor	1

i02645746

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. If the connecting rod caps were temporarily installed, remove the connecting rod caps. If necessary, thoroughly clean all of the components.
2. Apply clean engine oil to the cylinder bore, to the piston rings, to the outer surface of the piston and to the connecting rod bearings.

Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil to the connecting rod bearings during final assembly.

3. Rotate the crankshaft until the crankshaft pin is at the bottom center position. Lubricate the crankshaft pin with clean engine oil.

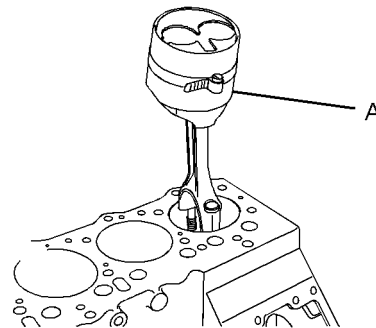


Illustration 153 g01311916
Typical example

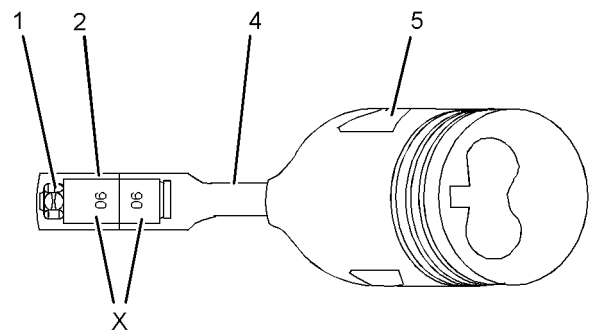


Illustration 154 g01311924
Typical example

404D-22 Engine

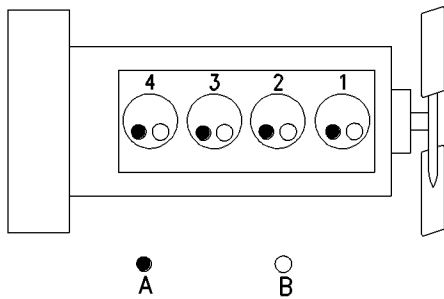


Illustration 7 g00296424

Cylinder and valve location

- (A) Exhaust valve
- (B) Inlet valve

Bore 84 mm (3.31 inch)

Stroke 100 mm (3.94 inch)

Displacement 2.216 L (135.2 in³)

Cylinder arrangement In-line

Type of combustion Indirect injection

Compression ratio 23.3:1

Number of cylinders 4

Valves per cylinder 2

Valve lash

Inlet valve 0.2 mm (0.0078 inch)

Exhaust valve 0.2 mm (0.0078 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 of the engine. The left side and the right side of the engine are determined from the flywheel end. Number 1 cylinder is the front cylinder of the engine.

404D-22T Engine

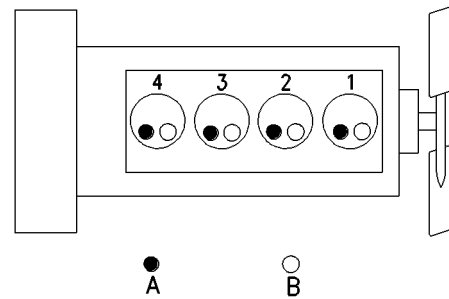


Illustration 8 g00296424

Cylinder and valve location

- (A) Exhaust valve
- (B) Inlet valve

Bore 84 mm (3.31 inch)

Stroke 100 mm (3.94 inch)

Displacement 2.216 L (135.2 in³)

Cylinder arrangement In-line

Type of combustion Indirect injection

Compression ratio for Turbocharged engines
..... 23.5:1

Number of cylinders 4

Valves per cylinder 2

Valve lash

Inlet valve 0.2 mm (0.0078 inch)

Exhaust valve 0.2 mm (0.0078 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 of the engine. The left side and the right side of the engine are determined from the flywheel end. Number 1 cylinder is the front cylinder of the engine.

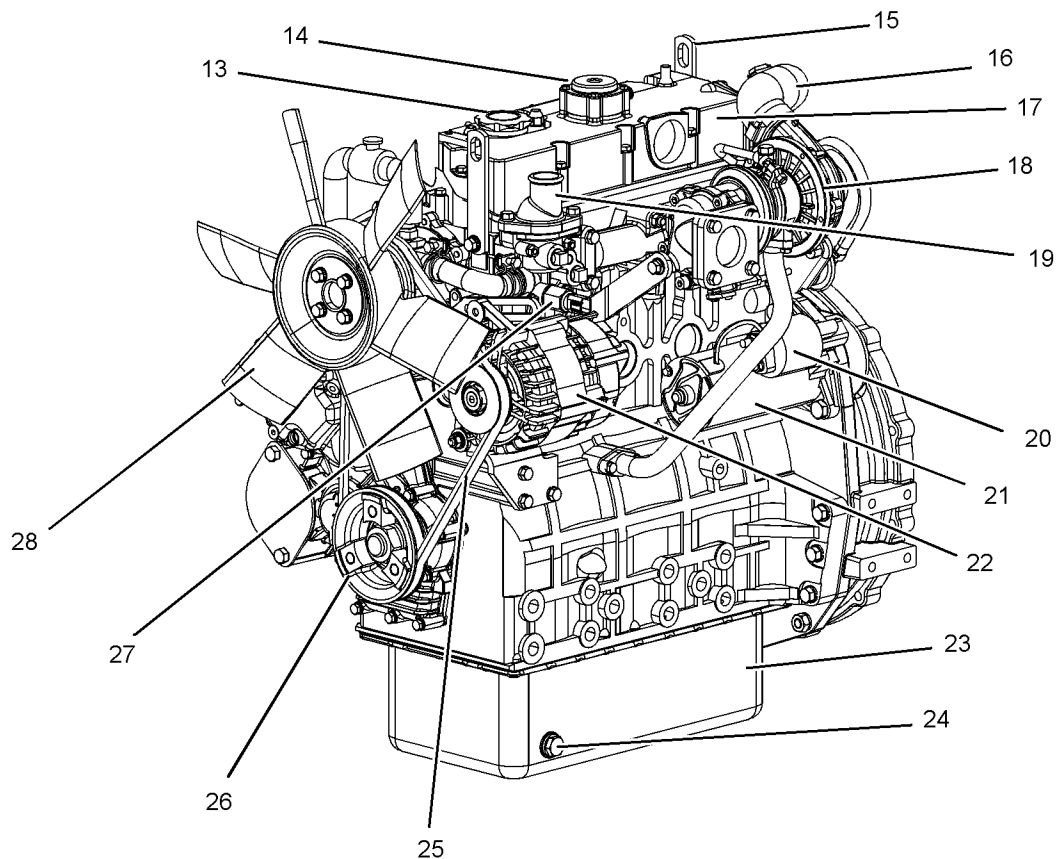


Illustration 13

g01334477

Right side view of the 404D-22T Turbocharged engine

- | | | |
|--------------------------------|--|---------------------------------|
| (13) Top engine oil filler cap | (19) Water temperature regulator housing | (25) Fan drive belt |
| (14) Crankcase breather | (20) Starting motor solenoid | (26) Crankshaft pulley |
| (15) Rear lifting eye | (21) Electric starting motor | (27) Coolant temperature switch |
| (16) Air inlet elbow | (22) Alternator | (28) Cooling fan |
| (17) Valve mechanism cover | (23) Engine oil pan | |
| (18) Turbocharger | (24) Engine oil drain plug | |

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Fuel System

General Operation of the Fuel System

Refer to Systems Operation, "General Information" for locations of the components for the fuel system.

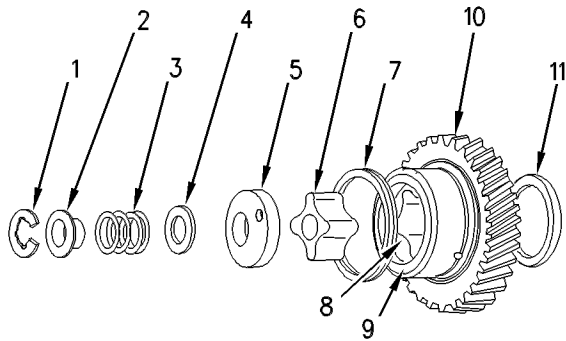


Illustration 25

g00458938

Idler gear and components of the oil pump

- (1) Snap ring
- (2) Collar
- (3) Spring
- (4) Shim
- (5) Oil pump cover
- (6) Inner rotor
- (7) Spring
- (8) Outer rotor
- (9) Bush
- (10) Idler gear
- (11) Thrust washer

Pressure for the lubrication system is supplied by an engine oil pump which uses rotors. The oil pump is part of the idler gear (10). The idler gear is driven by the crankshaft gear.

The oil pump has an inner rotor (6) and an outer rotor (8). The axes of rotation of the rotors are off-center relative to each other. There is a pin that is inserted through a hole in the oil pump cover (5) into the outer rotor. The pin functions as a key in order to keep the outer rotor in a fixed position with the idler gear.

The outer rotor is pressed into the bush (9). The bush is pressed into the idler gear (10).

The inner rotor has four lobes which mesh with the five lobes of the outer rotor. When the outer lobe rotates, the distance increases between the lobes of the outer rotor and the lobes of the inner rotor in order to create suction. Then, the space between the lobes is filled with oil. When the distance decreases between the lobes, pressure is created. This pressure forces the oil into the chamber for the engine oil relief valve.

Lubricating oil from the oil pan flows through a strainer and a line to the suction side of the engine oil pump. The suction side is in the timing gear case. The lubricating oil flows from the outlet side of the pump to a relief valve. The relief valve is installed on the right side of the cylinder block. The lubricating oil, which flows around the relief valve, flows to the oil filter.

When the engine rpm increases, the flow rate of the oil pump increases. The increase in the flow rate from the oil pump causes the pressure to increase. The relief valve opens if the oil pressure is too high. When the oil pressure on the plunger of the relief valve is greater than the force of the spring in the relief valve, the relief valve opens. The lubricating oil which flows through the relief valve is returned to the oil pan.

The oil filter is installed on the right side of the cylinder block. Turbocharged engines have an engine oil cooler that is installed between the oil filter and the cylinder block. The oil flows through the oil filter into the main oil gallery. The main oil gallery is drilled through the total length of the right side of the cylinder block.

Oil flows from the main oil gallery through an externally mounted oil supply line to the cylinder head. An oil pressure switch measures the oil pressure at this location. This oil lubricates the rocker arm assembly. The oil passes through the rocker shaft to the bore of each rocker arm lever. Then, the oil flows from the rocker arm levers through holes that are located in the top of the rocker arm levers. The valve stems, the valve springs, and the tappets are lubricated by the splash and the mist of the oil.

The lubricating oil flows through drilled holes in the main oil gallery to passages in the main journals of the crankshaft. Then, the oil flows to the main bearings of the crankshaft. Also, the oil flows through passages in the crankshaft to the large end bearings of the connecting rods. The piston bearings, the pistons, and the cylinder bores are lubricated by the splash and the mist of the oil.

A hole is located in the bore of each main bearing. This hole allows oil to flow through passages that lubricate the journals of the camshaft for the valves. The bearing for the front journal receives oil from the front main journal of the crankshaft. The camshaft is lubricated by the splash of the oil.

The timing gears are lubricated by the splash of the oil. Lubricating oil from the timing case returns to the oil pan.

i02747028

Cooling System

The coolant system contains the following components:

- Radiator
- Pressure cap for the radiator
- Fan for the radiator

Note: If the thickness of the shim is 0.5 mm (0.0197 inch) or the thickness of the shim is below 0.5 mm (0.0197 inch), install beaded shims. If the shim thickness is above 0.5 mm (0.0197 inch), install the non-beaded shim. Then install the beaded shim. Ensure that the beading on the beaded shim faces upward, toward the bottom of the fuel injection pump.

On 404D-22, 404D-22T and 404D-22TA engines, select the correct combination of shims from table 1.

Table 1

Shim Thickness (mm)	Part Number	Beaded
0.2	131437490	Yes
0.3	131437500	Yes
0.4	131437510	Yes
0.5	131437520	Yes
0.5	131437530	No

On 403D-15 and 403D-15T engines, select the correct combination of shims from table 2.

Table 2

Shim Thickness (mm)	Part Number	Beaded
0.2	131437541	Yes
0.3	131437551	Yes
0.4	131437561	Yes
0.5	131437571	Yes
0.5	131437580	No

On 403D-07 and 403D-11 engines, select the correct combination of shims from table 3.

Table 3

Shim Thickness (mm)	Part Number	Beaded
0.2	131437590	Yes
0.3	131437600	Yes
0.4	131437610	Yes
0.5	131437620	Yes
0.5	131437630	No

On 402D-05 engines, select the correct combination of shims from table 4.

Table 4

Shim Thickness (mm)	Part Number	Beaded
0.2	131437381	Yes
0.3	131437391	Yes
0.4	131437401	Yes
0.5	131437411	Yes
0.5	131437470	No

On 404D-15 engines, select the correct combination of shims from table 5.

Table 5

Shim Thickness (mm)	Part Number	Beaded
0.2	131437670	Yes
0.3	131437680	Yes
0.4	131437690	Yes
0.5	1314374700	Yes
0.5	131437710	No

If the original shim thickness can not be determined, contact the Dealer Solution Network. The user must provide the full engine number of the product that is serviced.

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Fuel Injector - Test

Perform the following procedures in order to determine if a fuel injector does not work correctly.

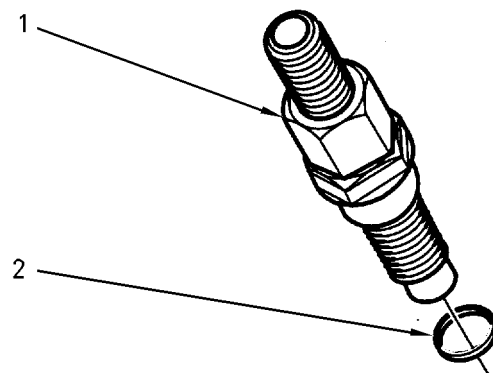


Illustration 38

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- (1) Fuel injector
- (2) Sealing washer

1. Run the engine at low idle.

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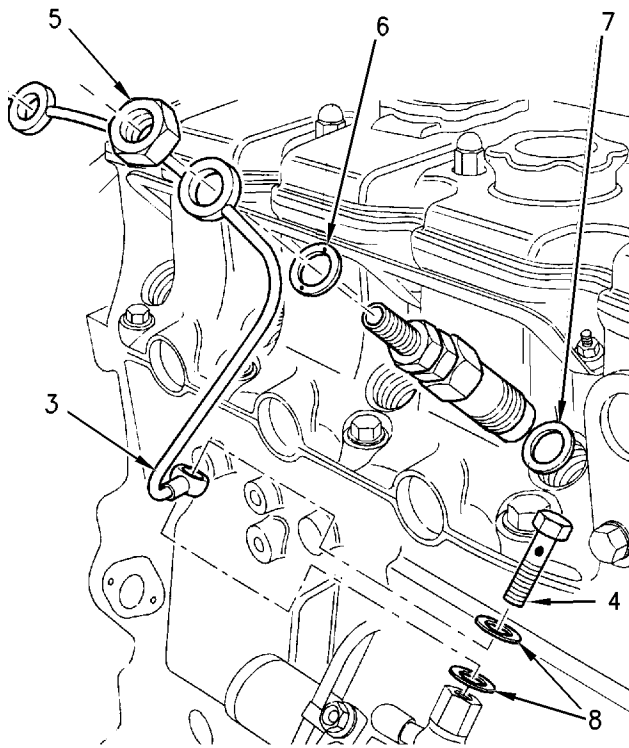


Illustration 11

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- (5) Tighten the nut to the following torque. 27 N·m (20 lb ft)
- (6) Washers for the fuel return line
- (7) Washer for the fuel injector
- (8) Washers for the banjo bolt

Note: All washers must be replaced when the fuel lines are removed.

Fuel Injection Pump

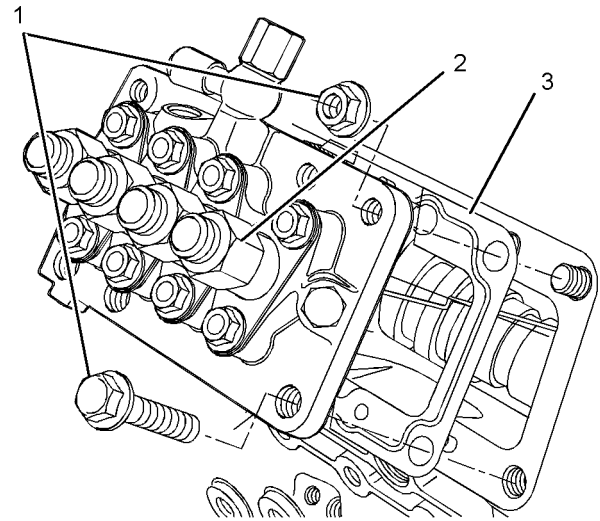


Illustration 12

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Typical example

Type of fuel injection pump In-line cassette

Direction of rotation of the camshaft for the fuel injection pump Clockwise from the drive end

- (1) Tighten the mounting nuts and setscrews to the following torque.
 - 402D-05, 403D-07, 403D-11 and 404D-15 10 N·m (89 lb in)
 - 403D-15, 403D-15T, 404D-22, 404D-22T and 404D-22TA 15 N·m (11 lb ft)
- (2) Tighten the delivery valve holders to the following torque. 42 N·m (31 lb ft)
- (3) Shim

The shim adjusts the timing of the fuel injection pump. A thicker shim retards the timing. A thinner shim advances the timing. The timing changes one degree for each 0.10 mm (0.004 inch) difference in the thickness of the shim. More than one shim can be used. If the fuel injection pump is reinstalled, new shims, which have the same thickness as the original shims, must be installed.

If any of the following new components are installed, new shims which have the same thickness as the original shims must be used.

- Camshaft