SERVICE MANUAL

COMPACT EXCAVATOR
15C-1, 16C-1, 18Z-1, 19C-1, 19C-1 PC

EN - 9813/7900 - ISSUE 2 - 05/2018

This manual contains original instructions, verified by the manufacturer (or their authorized representative).

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Foreword

The Operator's Manual

⚠

You and others can be killed or seriously injured if you operate or maintain the machine without first studying the Operator's Manual. You must understand and follow the instructions in the Operator's Manual. If you do not understand anything, ask your employer or JCB dealer to explain it.

Do not operate the machine without an Operator's Manual, or if there is anything on the machine you do not understand.

Treat the Operator's Manual as part of the machine. Keep it clean and in good condition. Replace the Operator's Manual immediately if it is lost, damaged or becomes unreadable.

Contents

00 - General

Introduction

The relationship between the rotation of the camshaft and the rotation of the crankshaft is of critical importance.

Since the valves control the flow of the air/fuel mixture intake and exhaust gases, they must be opened and closed at the appropriate time during the stroke of the piston.

For this reason, the camshaft is connected to the crankshaft through a gear mechanism.

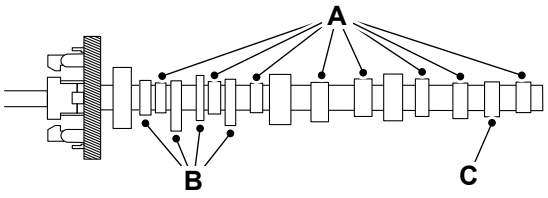
When the engine runs the crankshaft drives the camshaft through the gears. The camshaft opens and closes the inlet and exhaust valves through the push rods in time with the four stroke cycle.

Technical Data

Table 48.

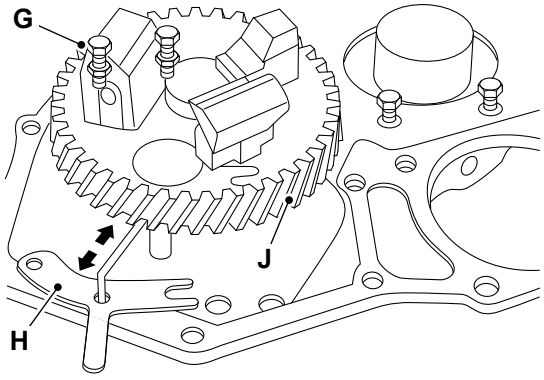
Description	Data	
	Standard	Service limit
Height of the camshaft lobe for the inlet and exhaust valves	34.453 –34.507 mm	33.7 mm
Height of the camshaft lobe for the fuel injection pump	41.94 –42.06 mm	41.8 mm
Height of the camshaft lobe for the fuel priming pump	31.9 –32 mm	30 mm

Figure 153.



A Camshaft lobe for the inlet and exhaust valves
B Camshaft lobe for the fuel injection pump
C Camshaft lobe for the fuel priming pump

Figure 154.

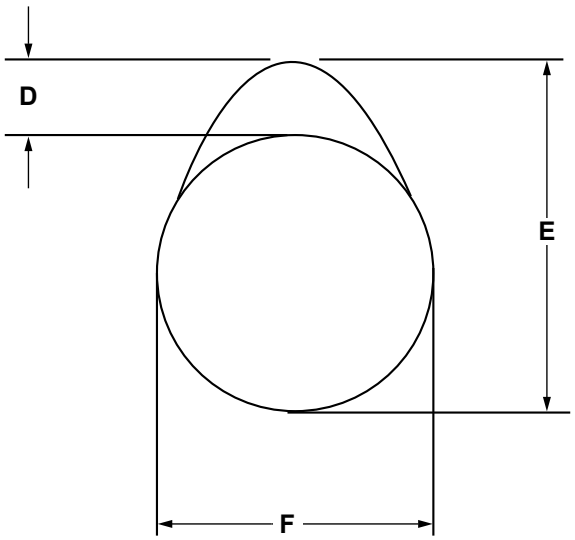


G Setscrew
H Retainer plate
J Camshaft gear

To determine the lobe lift use the following procedure:

1. Measure the height of the camshaft lobe.
2. Measure the base circle.

Figure 155.



D Actual camshaft lobe lift
E Height of the camshaft lobe
F Base circle

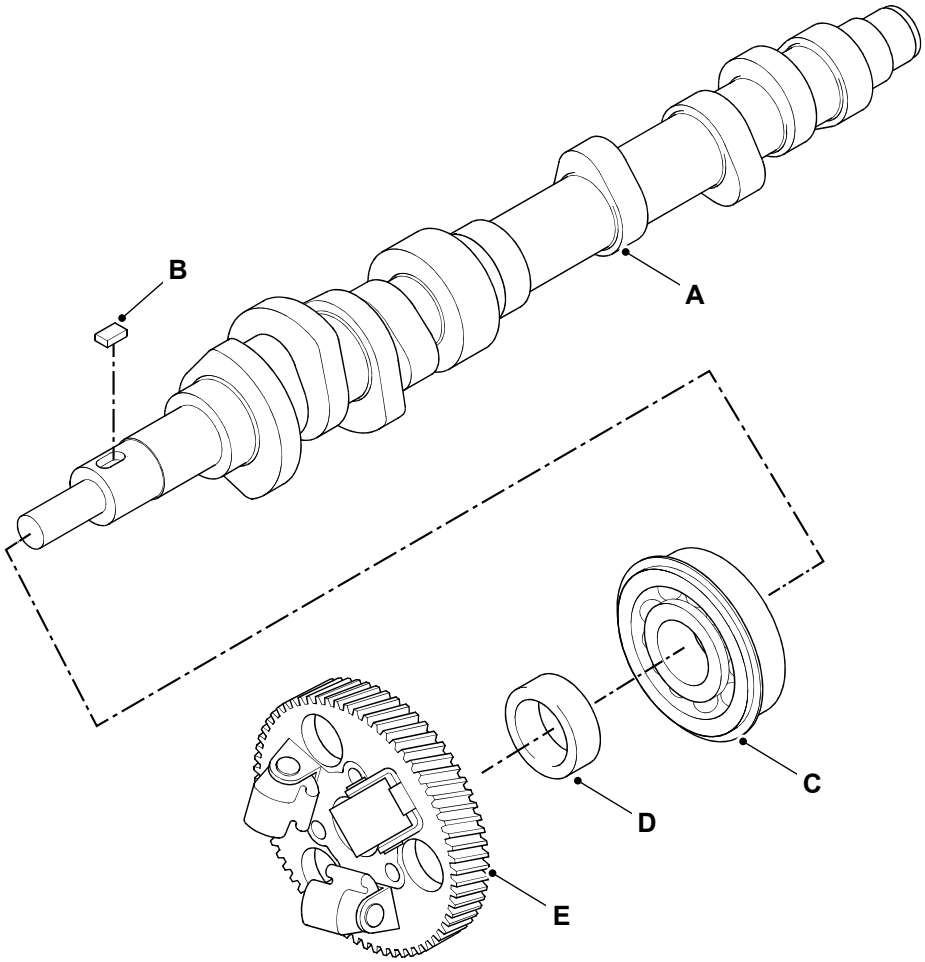
3. Subtract the base circle diameter (1) from the height of the camshaft lobe (2). The difference is the actual camshaft lobe lift.

Table 49. Torque Values

Item	Description	Nm
G	Setscrew	11

Component Identification

Figure 156.



A Camshaft
B Woodruff key
C Bearing
D Spacer
E Gear

Operation

As the crankshaft rotates the camshaft also rotates, driven by a gear on the crankshaft. The inlet and exhaust valves are opened by lobes on the camshaft in time with the cycle.

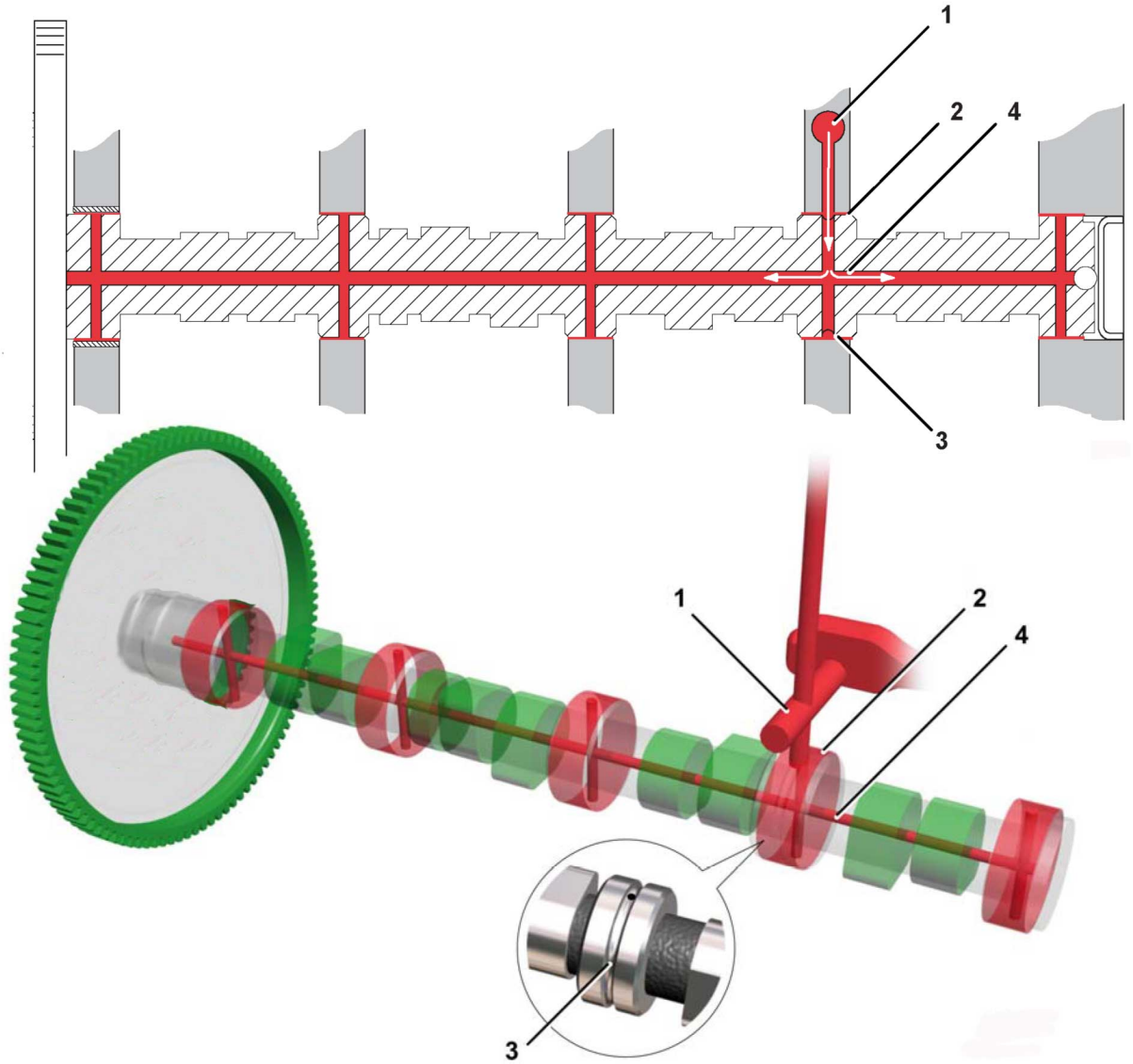
The diagrams show the position of the camshaft at each part of the four stroke cycle, refer to Engine-General, Operation. Refer to: PIL 15-00-00.

It can be seen that for a complete cycle the camshaft revolves once. Since the crankshaft revolves twice during the cycle it follows that the camshaft is driven at half crankshaft (engine) speed.

Lubrication

Oil is fed from the main gallery via a drilling to the camshaft bearing. A groove around the diameter of the bearing and connecting the cross drilling ensures that oil is always fed to the centre drilling. Oil is then transferred to the remaining camshaft bearings by further cross drillings in the shaft. The cam lobes and tappets are 'splash' lubricated.

Figure 157.



1 Main gallery
2 Camshaft bearing
3 Groove
4 Centre drilling

Check (Condition)

1. Inspect the camshaft gear teeth for signs of damage or excessive wear.
2. Inspect the cam lobes, the camshaft journals, and the cam bearing surfaces inside the crankcase for signs of excessive wear, or scoring. Make sure that the dimensions are within the service limits.
3. Inspect the bearing surfaces of the tappets for signs of excessive wear or damage. Check that the dimensions are within service limits.
4. Inspect the tappet bores inside the crankcase for signs of excessive wear or damage. Check that the dimensions are within service limits.
5. If any of the camshaft journals or lobes are worn or damaged then the relative oil feed galleries in the crankcase and camshaft may be blocked. Make sure all oil ways are clear and free from debris.

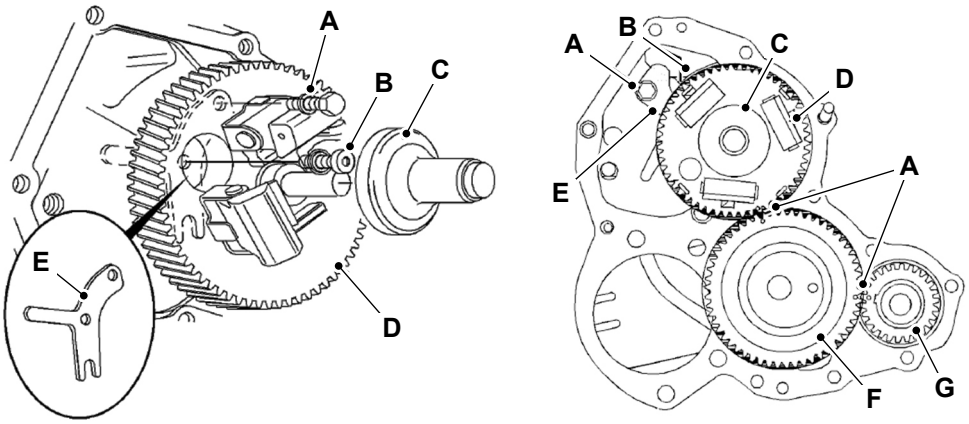
   Refer to: PIL 15-03-00.

Remove and Install

Remove

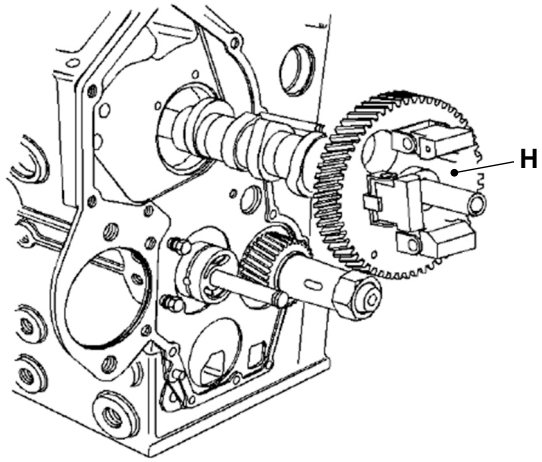
1. Remove the valve tappet.
   Refer to: PIL 15-42-21.
2. Remove the timing gear front case.
   Refer to: PIL 15-51-21.
3. If installed, remove the mechanical fuel transfer pump.
   Refer to: PIL 18-21-00.
4. Remove the slider from the camshaft gear.
5. Rotate the camshaft gear to align the access hole in the camshaft gear with the fastener.
6. Remove the bolt 1 and then bolt 2.
7. Remove the camshaft retainer.
8. Rotate the crankshaft until the timing marks are aligned on the following gears:
   8.1. Crankshaft gear
   8.2. Camshaft gear
   8.3. Idler gear
9. Carefully remove the camshaft assembly from the crankcase.
10. Make sure that the lobes of the camshaft and the camshaft bearings are not damaged.

Figure 158.



A Bolt 1
B Bolt 2
C Slider
D Camshaft gear
E Camshaft retainer
F Idler gear
G Crankshaft gear

Figure 159.



H Camshaft assembly

Install

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Before installation, lubricate the bearings of the camshaft with clean engine oil.
3. Tighten the bolts to the correct torque value.

Table 50. Torque Values

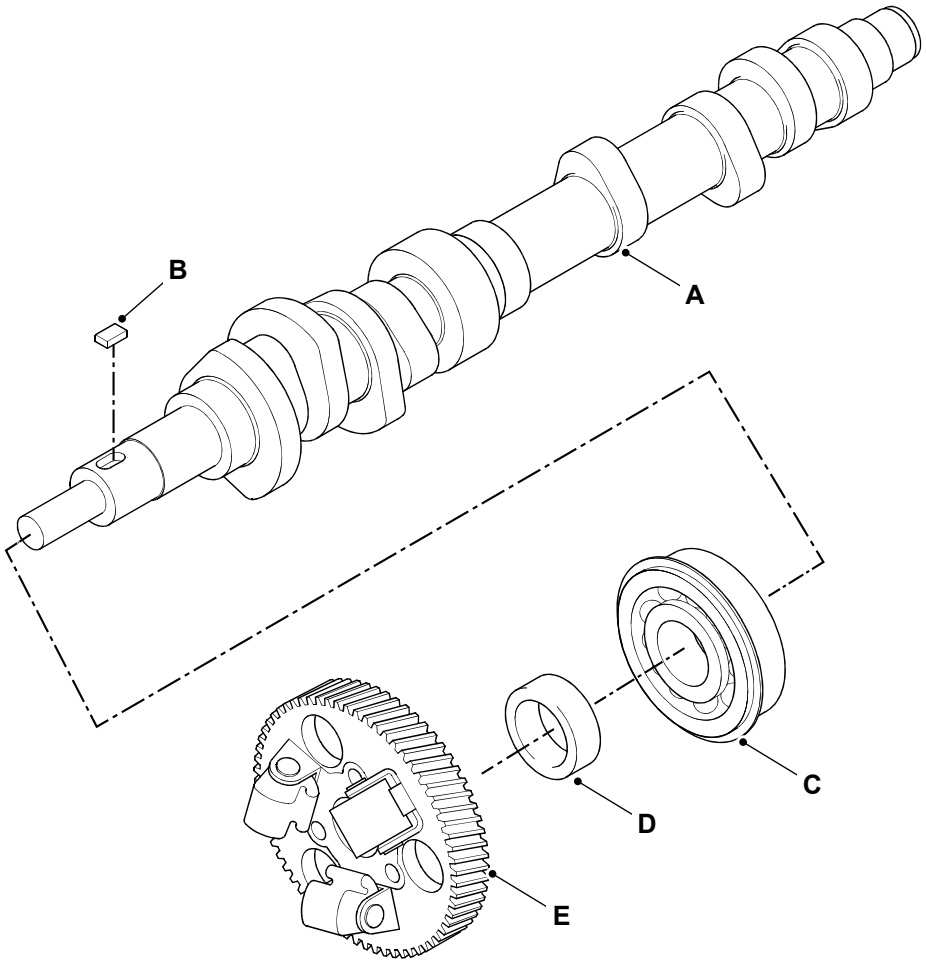
Item	Description	Nm
A	Bolt 1	10
B	Bolt 2	10

Disassemble and Assemble

Disassemble

1. Remove the camshaft assembly.
   Refer to: PIL 15-15-00.
2. Remove the gear with a combination puller.
3. Keep the gear in the correct position on a suitable support to prevent damage to the governor flyweights.
4. Remove the spacer and the woodruff key from the camshaft.
5. Remove the bearing from the camshaft with the combination puller.
6. Make a note of the orientation of the bearing to help installation.

Figure 160.



A Camshaft
B Woodruff key
C Bearing
D Spacer
E Gear

Assemble

1. Make sure that all of the components of the camshaft assembly are clean and free from damage.
2. Lubricate the nose of the camshaft with clean engine oil.
3. Install the bearing to the camshaft with a suitable press.
   - 3.1. Make sure that you install the bearing in the correct orientation.
   - 3.2. Make sure that you press the camshaft bearing squarely onto the camshaft or damage to the bearing may occur.
   - 3.3. Do not press on the outer race of the bearing.
4. Install the spacer and the woodruff key to the camshaft.
5. Align the gear with the woodruff key.
6. Install the gear to the nose of the camshaft with a suitable press.
7. Install the camshaft assembly.

   Refer to: PIL 15-15-00.

Adjust

⚠ **CAUTION** Make sure the engine cannot be started. Disconnect the battery before doing this job, otherwise you could be injured.

1. Make the machine safe.

   Refer to: PIL 01-03.

2. Make sure that the engine is safe to work on. If the engine has been running, let it cool before you start the service work.

3. Open the engine cover.

   Refer to: PIL 06-06-06.

4. Press the drive belt at the centre between the crankshaft pulley and the alternator pulley with a force of 5 kgf.

5. Make sure that the drive belt deflects to specified distance.

   Distance: 7 mm

6. To adjust the drive belt tension, do as follows:

   6.1. Loosen the alternator mounting bolts.

   6.2. Loosen the tension adjustment bolt and move the alternator.

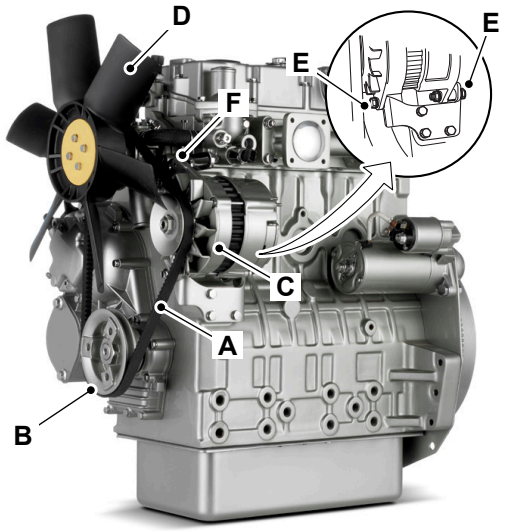
7. Make sure of the following:

   7.1. Excessive fan belt slack may result in damage to the engine timing cover.

   7.2. Any leverage required to position the alternator must be applied at the drive end only. If necessary, use only a wooden lever.

8. Tighten the bolts in the sequence given below:

Figure 162.



A Drive belt
B Crankshaft pulley
C Alternator
D Fan
E Alternator mounting bolt
F Tension adjustment bolt

   8.1. Tension adjustment bolt.

   8.2. Rear alternator mounting bolt.

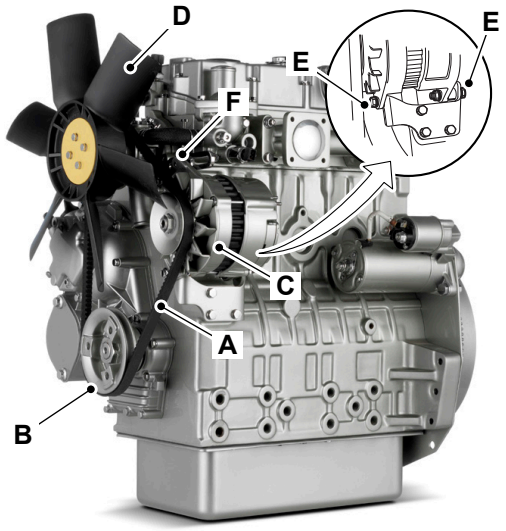
   8.3. Front alternator mounting bolt.

Remove and Install

Remove

1. Make the machine safe.
   Refer to: PIL 01-03-27.
2. Get access to the drive belt.
3. Disconnect the battery.
   Refer to: PIL 33-03-00.
4. Loosen the alternator mounting bolts and the tension adjustment bolt.
5. If necessary, remove the fan.
6. Remove the drive belt.

Figure 163.



A Drive belt
B Crankshaft pulley
C Alternator
D Fan
E Alternator mounting bolt
F Tension adjustment bolt

Install

1. Installation is the opposite of the removal procedure. Additionally do the following steps.
2. Make sure of the following:
   2.1. 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.
3. When new belts are installed, check the belt tension again after 20 hours of engine operation.
4. Tighten the bolts in the sequence given below:
   4.1. Tension adjustment bolt
   4.2. Rear alternator mounting bolt
   4.3. Front alternator mounting bolt

Health and Safety

Oil

Oil is toxic. If you swallow any oil, do not induce vomiting, seek medical advice. Used engine oil contains harmful contaminants which can cause skin cancer. Do not handle used engine oil more than necessary. Always use barrier cream or wear gloves to prevent skin contact. Wash skin contaminated with oil thoroughly in warm soapy water. Do not use petrol, diesel fuel or paraffin to clean your skin.

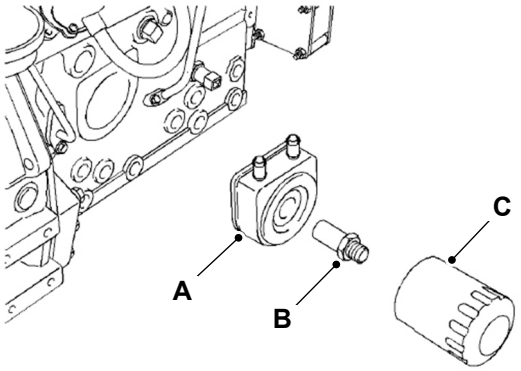
CAUTION! *It is illegal to pollute drains, sewers or the ground. Clean up all spilt fluids and/or lubricants. Used fluids and/or lubricants, filters and contaminated materials must be disposed of in accordance with local regulations. Use authorised waste disposal sites.*

CAUTION! *Oil will gush from the hole when the drain plug is removed. Keep to one side when you remove the plug.*

CAUTION! *The oil filter canister will contain some oil which could spill out when you remove the canister.*

Component Identification

Figure 164.



A Oil cooler
B Adaptor
C Oil filter

Check (Level)

⚠ **Notice:** Do not exceed the maximum level of engine oil in the sump. If the maximum is exceeded, the excess must be drained to the correct level. An excess of engine oil could cause the engine speed to increase rapidly without control.

1. Make the machine safe.
   Refer to: PIL 01-03-27.
2. Make sure that the engine is safe to work on. If the engine has been running, let it cool before you start the service work.
3. Wait for the oil to drain back into the engine sump before you take a reading. If not, a false low reading may be recorded which can cause the engine to be overfilled.
4. Open the engine compartment cover.
   Refer to: PIL 06-06-06.
5. Remove and clean the dipstick.
6. Replace the dipstick.
7. Remove the dipstick.
8. Check the oil level. The oil should be between the two marks on the dipstick.
9. If necessary, add more oil.
   Refer to: PIL 15-00-00.
10. Close the engine compartment cover.
    Refer to: PIL 06-06-06.

Remove and Install

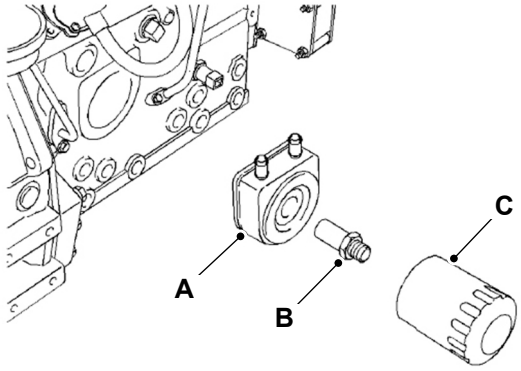
Important: Use of an oil filter not recommended by JCB could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Use only JCB recommended oil filters.

Remove

1. Drain the engine oil.
   Refer to: PIL 15-00-00.
2. Remove the oil filter with a suitable tool.
3. Use a suitable container to recover any residual oil.
4. Inspect the oil filter as follows. The steps 4.1 to 4.5 can be carried out as a preventive maintenance.
   4.1. Cut the oil filter open with a suitable tool.
   4.2. Break apart the pleats and check the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.
   4.3. Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element.
   4.4. The ferrous metals indicate wear on the steel and cast iron parts of the engine.
   4.5. Non-ferrous metals indicate wear on the aluminum parts, brass parts or bronze parts of the engine. These affected parts include the following items:

- Main bearings
- Connecting Rod bearings
- Turbocharger bearings
- Cylinder heads

Figure 165.



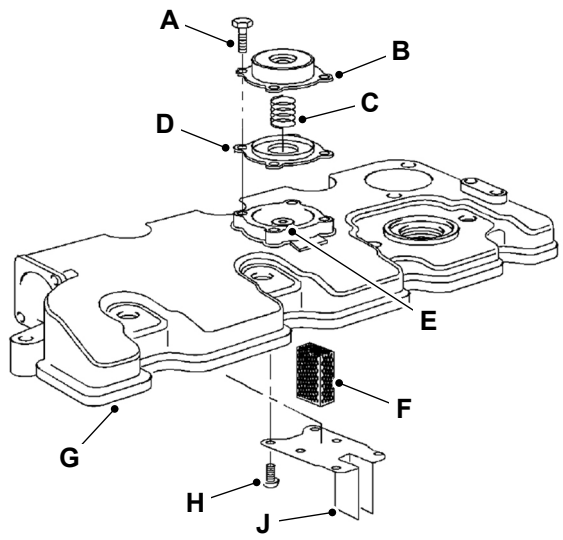
A Oil cooler
B Adaptor
C Oil filter

Install

1. Clean the sealing surface of the oil cooler.
2. Apply clean engine oil to the new oil filter seal.
3. Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.
4. Install the oil filter. Tighten the oil filter by hand. Do not overtighten the oil filter.

Component Identification

Figure 168.



A Bolt
B Cover
C Spring
D Diaphragm
E Vent hole
F Gauze
G Rocker cover
H Screws
J Plate

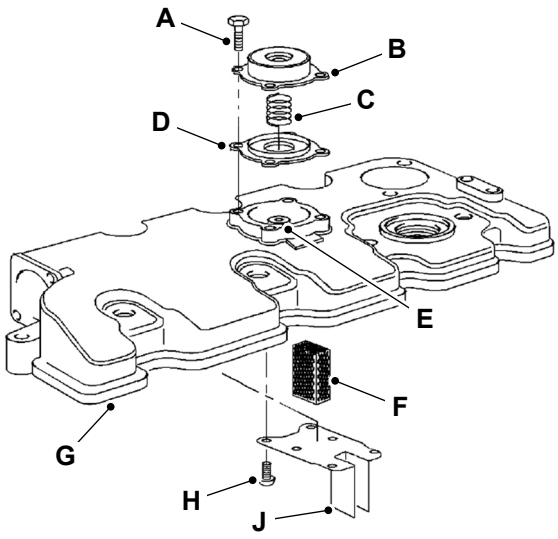
Remove and Install

⚠ **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 tools to release the spring force.

Remove

1. Remove the bolts.
2. Carefully remove the cover assembly, spring and the diaphragm.
3. Make a note of the orientation of the cover to help installation.
4. Remove the spring and the diaphragm from the cover.
5. If necessary, remove the breather gauze as follows:
   - 5.1. Remove the rocker cover.
     Refer to: PIL 15-42-06.
   - 5.2. Remove the screws and the plate.
   - 5.3. Remove the gauze from the rocker cover.

Figure 169.



A Bolt
B Cover
C Spring
D Diaphragm
E Vent hole
F Gauze
G Rocker cover
H Screws
J Plate

Install

1. Inspect all the components.
   1.1. Clean all the parts.
   1.2. Replace the worn or damaged parts.
   1.3. Make sure that the cavity for the breather in the rocker cover is clean.
   1.4. Make sure that the vent holes are free from restriction.
2. If removed, install the gauze for the breather as follows:
   2.1. Install the gauze to the rocker cover.
   2.2. Position the plate on the rocker cover and install the screws.
   2.3. Tighten the screws to the correct torque value.
   2.4. Install the rocker cover.
   Refer to: PIL 15-42-06.
3. Install the diaphragm and the spring to the cover.
4. Position the cover assembly, spring and the diaphragm on the rocker cover.
5. Make sure that you install the cover in the correct orientation.
6. Install the bolts.
7. Tighten the bolts to the correct torque value.

Table 52. Torque Values

Item	Description	Nm
A	Bolt	3

Technical Data

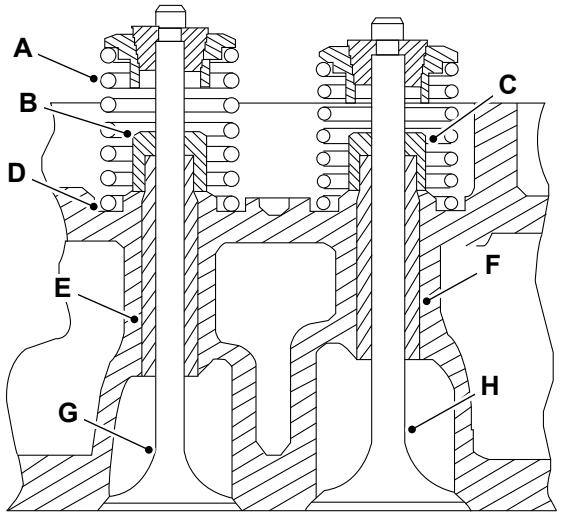
Table 53.

Description	Data	
	Inlet valve	Exhaust valve
Number of valves per cylinder	1	1
Valve lash	0.2 mm	0.2 mm
Valve guide seal	Black garter spring with a label "EX"	Silver garter spring
Valve seat angle Refer to Figure 174.	45 °	45 °

Table 54.

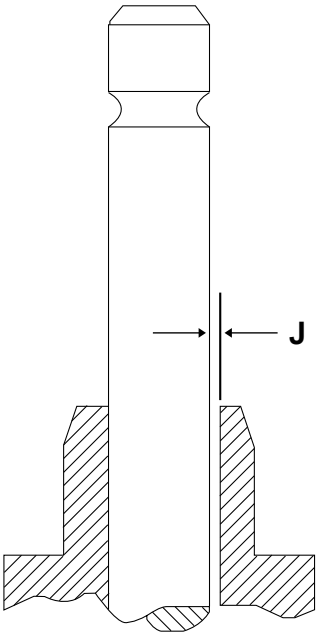
Description	Data	
	Standard	Service limit
Valve spring free length	35 mm	33.5 mm
Valve spring test force	79 N	68.6 N
Valve spring length under test force	30.4 mm	-
Clearance between the exhaust valve and the valve guide Refer to Figure 171.	0.05 –0.075 mm	0.25 mm
Clearance between the inlet valve and the valve guide Refer to Figure 171.	0.03 –0.06 mm	0.2 mm
Diameter of the exhaust valve stem	6.94 –6.955 mm	6.84 mm
Diameter of the inlet valve stem	6.955 –6.97 mm	6.89 mm
Thickness of the valve head Refer to Figure 172.	0.925 –1.075 mm	0.5 mm
Valve depth below the cylinder head face Refer to Figure 173.	0.65 –0.95 mm	1.8 mm
Contact face exhaust valve Refer to Figure 174.	1.94 –2.16 mm	2.5 mm
Contact face inlet valve Refer to Figure 174.	1.5 –2 mm	2.5 mm

Figure 170.



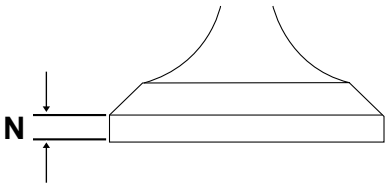
A Valve spring
B Exhaust valve guide seal
C Inlet valve guide seal
D Valve spring recesses
E Exhaust valve guide
F Inlet valve guide
G Exhaust valve stem
H Inlet valve stem

Figure 171.



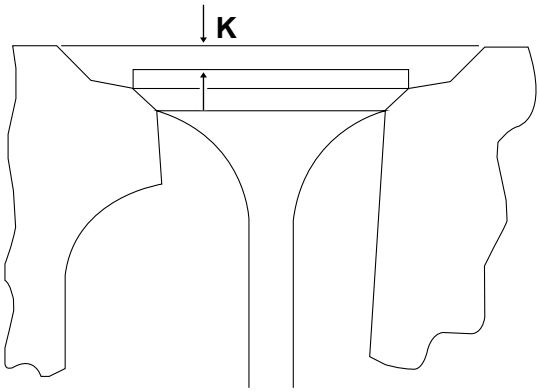
J Valve - valve guide clearance

Figure 172.



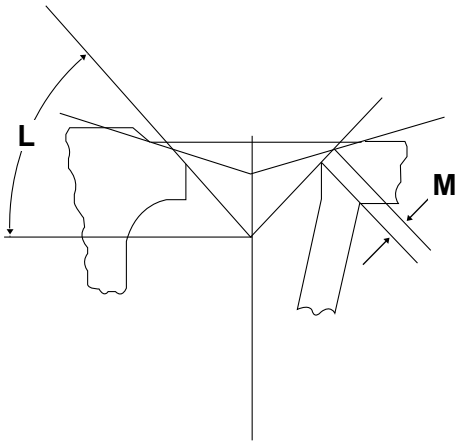
N Valve head thickness

Figure 173.



K Valve depth

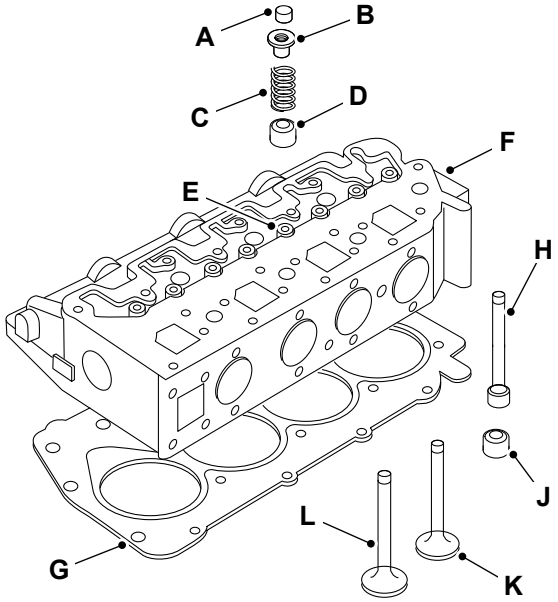
Figure 174.



L Valve seat angle
M Contact face

Component Identification

Figure 175.



A Collets
B Valve spring retainer
C Valve spring
D Valve seal
E Valve guide
F Cylinder head
G Cylinder head gasket
H Push-rod
J Tappet
K Exhaust valve
L Inlet valve

Operation

The inlet valve and the exhaust valve are opened and closed by the rotation and movement of the following components:

- Crankshaft
- Idler gear
- Camshaft
- Valve tappets
- Push-rods
- Rocker arms
- Valve springs

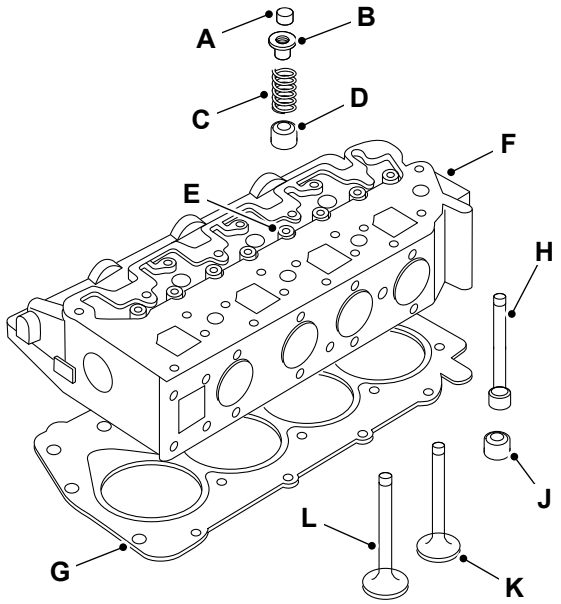
The camshaft drive gear is driven by the idler gear at half the speed of the crankshaft. The camshaft gear, the idler gear and the crankshaft gear are timed together. The camshaft lobes, two for each cylinder, (operating exhaust and inlet valves) actuate the valve tappets.

When the camshaft rotates the cam lobes act on the tappets. The push rods act on the rockers which pivot on the camshaft.

Each valve has a compression spring. The function of the spring is to close the valve and at the same time return the rocker arm and push rod to ensure that the tappets follow the camshaft lobes. The spring is located on the valve stem by a retainer and collets.

The illustration shows a four cylinder engine - but the operation is the same for the three cylinder version.

Figure 176.



A Collets
B Valve spring retainer
C Valve spring
D Valve seal
E Valve guide

F Cylinder head
G Cylinder head gasket
H Push-rod
J Tappet
K Exhaust valve
L Inlet valve

Check (Condition)

Valve Lash Setting

The valve lash setting given below is applicable only when the engine is cold.

Table 55.

Inlet valve	0.2 ± 0.05 mm
Exhaust valve	0.2 ± 0.05 mm

Valve Lash Inspection

If the valve lash requires adjustment several times in a short period of time, excessive wear exists in a different part of the engine. You must repair the problem to prevent further damage to the engine.

Not enough valve lash can cause rapid wear of the camshaft and the valve tappets. Not enough valve lash can indicate that the valve seats are worn. The valves become worn due to the following causes:

- Incorrect operation of the fuel injectors.
- Excessive dirt and oil are present in the inlet air filter.
- Incorrect fuel settings on the fuel injection pump.
- The load capacity of the engine is frequently exceeded.

The excessive valve lash can cause broken valve stems, springs and the spring retainers. This excessive valve lash can be an indication of the following problems:

- Worn camshaft and valve tappets.
- Worn rocker arms.
- Bent push-rods.
- Broken socket on the upper end of a push-rod.
- Loose the adjustment screw for the valve lash.

1. If the camshaft and valve tappets show rapid wear, look for fuel in the lubrication oil or dirty lubrication oil as a possible cause.
2. The valve lash is measured between the top of the valve stem and the rocker arm lever.
3. Remove the rocker cover and perform the adjustment procedure to adjust the valve lash.

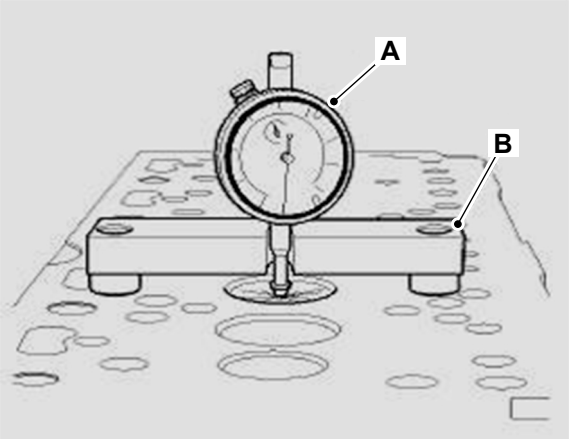
   Refer to: PIL 15-30-00.
4. Inspect the valves for the cracks and other damage.
5. Check the valve stems for wear.
6. Check that the valve springs are the correct length under the test force.

Refer to: PIL 15-30-00.

Valve Depth Check

1. Use the DTI (Dial Test Indicator) with the DTI holder to check the depths of the inlet valves and the exhaust valves below the face of the cylinder head.
2. Use the cylinder head face to zero the DTI.
3. Position the DTI holder and the DTI and measure the valve depth.

Figure 177.



A DTI
B DTI holder

4. Measure the depth of the inlet valve and the exhaust valve before the valve springs are removed.
5. Make sure that the valve depth is within the specified limits.

   Refer to: PIL 15-30-00.

   5.1. If the valve depth below the cylinder head face exceeds the service limit, replace the valve and check the valve depth.

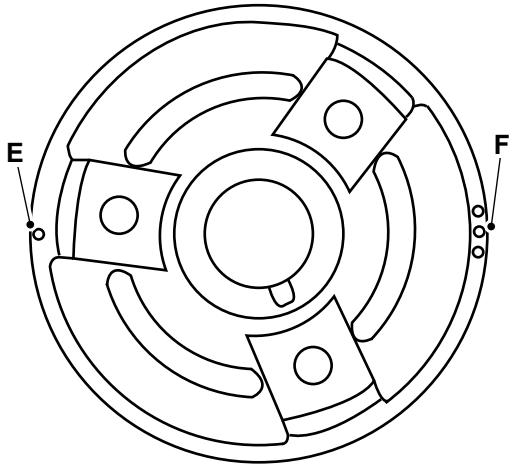
   5.2. If the valve depth still exceeds the service limit, renew the cylinder head or if installed, renew the valve seat inserts.

Adjust

Valve Lash Adjustment

1. Make the machine safe.
   Refer to: PIL 01-03-27.
2. Remove the timing gear front case.
   Refer to: PIL 15-51-21.
3. Rotate the crankshaft in a clockwise direction (viewed from the front of the engine).
4. When the inlet valve of the No. 4 cylinder has started to open and the exhaust valve of the No. 4 cylinder has not completely closed, make sure that the "Top" mark on the timing case aligns with the "Single dot" on the crankshaft pulley.

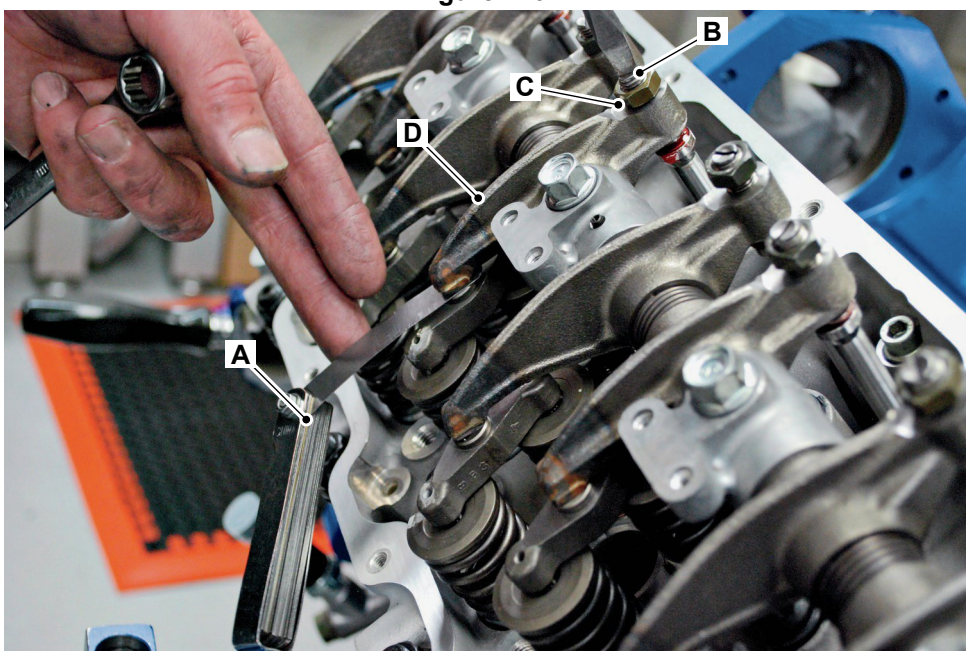
Figure 178.



E Single dot on crankshaft pulley
F Middle dot on crankshaft pulley

   4.1. The "Single dot" on the crankshaft pulley is the reference point for the TDC (Top Dead Centre) position of No. 1 and No. 4 cylinders.
   4.2. The "Middle dot" on the crankshaft pulley is the TDC reference point for No. 2 and No. 3 cylinders.
5. Check the valve lash of the inlet valve and the exhaust valve of the No. 1 cylinder.
6. If necessary, make an adjustment as follows:
   6.1. Loosen the locknut from the adjustment screw.
   6.2. Place the appropriate feeler gauge between the rocker arm and the valve.

Figure 179.



A Feeler gauge
B Adjusting screw
C Locknut
D Rocker arm

6.3. Hold the locknut and turn the adjustment screw.

6.4. Adjust the valve lash until the correct specification is achieved.

6.5. After each adjustment, hold the adjusting screw and tighten the locknut.

7. Rotate the crankshaft in a clockwise direction to the specified angle.

   Angle: 180 °

8. When the inlet valve of the No. 2 cylinder has started to open and the exhaust valve of the No. 2 cylinder has not completely closed, make sure that the "Top" mark on the timing case aligns with "Middle dot" on the crankshaft pulley.

9. Check the valve lash of the inlet valve and the exhaust valve of the No. 3 cylinder. If necessary, do the step 6

10. Rotate the crankshaft in a clockwise direction to the specified angle.

    Angle: 180 °

11. When the inlet valve of the No. 1 cylinder has started to open and the exhaust valve of the No. 1 cylinder has not completely closed, make sure that the "Top" mark on the timing case aligns with "Single dot" on the crankshaft pulley.

12. Check the valve lash of the inlet valve and the exhaust valve of the No. 4 cylinder. If necessary, do the step 6

13. Rotate the crankshaft in a clockwise direction to the specified angle.

    Angle: 180 °

14. When the inlet valve of the No. 3 cylinder has started to open and the exhaust valve of the No. 3 cylinder has not completely closed, make sure that the "Top" mark on the timing case aligns with "Middle dot" on the crankshaft pulley.

15. Check the valve lash of the inlet valve and the exhaust valve of the No. 2 cylinder. If necessary, do the step 6.

16. Install the timing gear front case.

    Refer to: PIL 15-51-21.

Suggest:

If the above button click is invalid.

Please download this document

first, and then click the above link

to download the complete manual.

Thank you so much for reading

Remove and Install

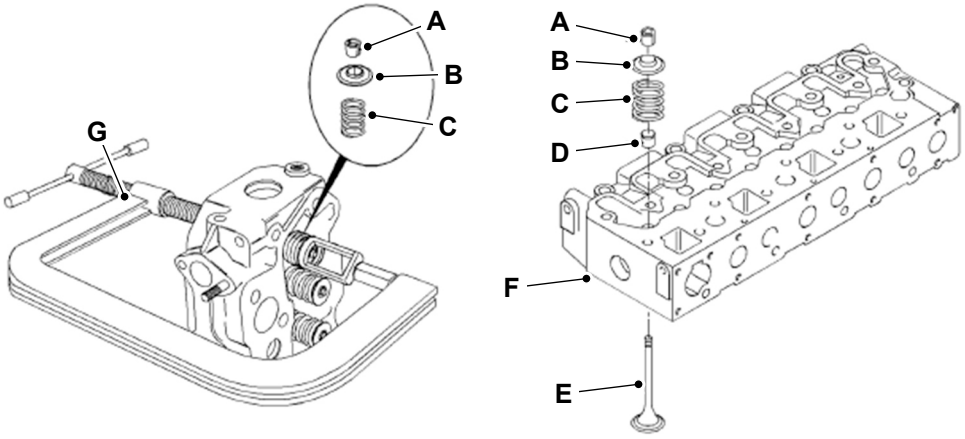
⚠ **WARNING** Personal injury can result from being struck by parts propelled by a released spring force. Make sure to wear all necessary protective equipment. Follow the recommended procedure and use all recommended tools to release the spring force.

WARNING The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Make sure 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.

Remove

1. Make the machine safe.
   Refer to: PIL 01-03-27.
2. Make sure that the engine is safe to work on. If the engine has been running, let it cool before you start the service work.
3. Remove the cylinder head.
   Refer to: PIL 15-06-00.
4. Clean the bottom face of the cylinder head.
5. Check the depth of the valves below the face of the cylinder head before you remove the valve springs.
6. Mark the heads of the valves to help installation. Do not stamp the heads of the valves, this can cause the valves to fracture.
7. Compress the valve spring with the valve spring compressor tool.
8. Make sure that you compress the valve spring squarely or damage to the valve stem may occur.
9. Remove the valve keepers.
10. Do not compress the valve spring so that the valve spring retainer touches the valve stem seal.
11. Remove the valve spring compressor tool.
12. Remove the valve spring retainer.
13. Remove the valve spring.
14. Remove the valve.
15. Remove the valve stem seal.
16. Do the step 7 to step 15 for the remaining valves.

Figure 180.



A Valve keeper
B Spring retainer
C Valve spring
D Valve stem seal
E Valve
F Cylinder head
G Valve spring compressor tool