

# SERVICE MANUAL

LOADALL (ROUGH TERRAIN  
VARIABLE REACH TRUCK)

**533-105, 535-v125, 540-140,  
540-170, 540-200, 540-v140,  
540-v180, 550-140, 550-170**

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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.

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**Introduction**

The valve train system opens and closes the valves with correct timing in relation to the piston movements.

Each push rod has one end in a valve tappet and the other end under a rocker arm, or as applicable. The adjusting screw has a ball shaped end that locates in the push rod. The adjusting screw is used for setting the valve clearance.

The valves extend through the cylinder head. There are no sleeves or valve guides in the cylinder head. The valves are made from a special metal to provide a long service life. Damaged or worn valves cannot be lapped or reground and must be replaced with new ones. Each valve stem has an oil seal.

The Valve seat inserts are pressed into the cylinder head. The seat inserts are also made from a special metal to provide for a long service life. Damaged or worn seat inserts can be removed and replaced with new ones.

## Technical Data

**Table 113. Inlet and Exhaust Valve Data**

|                                                |                               |
|------------------------------------------------|-------------------------------|
| Max lift Inlet                                 | 9.64 mm @ 101 ° AT-DC         |
| Max lift Exhaust                               | 9.84 mm @ 115 ° BTDC          |
| Inlet opens (top of ramp)                      | 6 ° BTDC                      |
| Inlet closes                                   | 28 ° ATDC                     |
| Exhaust opens                                  | 41 ° BTDC                     |
| Exhaust closes                                 | 6 ° ATDC                      |
| Valve stem diameter                            |                               |
| - Inlet                                        | 6.928 –6.943 mm               |
| - Exhaust                                      | 6.918 –6.933 mm               |
| Valve spring free length                       | 51.1 mm                       |
| Valve guide bore diameter                      |                               |
| - min                                          | 6.958 mm                      |
| - max                                          | 6.973 mm                      |
| Valve face angle                               |                               |
| - Inlet                                        | 60.5 °                        |
| - Exhaust                                      | 45.17 °                       |
| Valve length                                   | 131.9 –132.4 mm               |
| Valve sealing                                  | Stem seal with sealing washer |
| Valve head depth (below cylinder head surface) |                               |
| - Inlet                                        | 0.89 –1.39 mm                 |
| - Exhaust                                      | 0.95 –1.45 mm                 |
| Valve rim thickness                            | 2.98 –3.38 mm                 |
| Valve Clearances (engine cold)                 |                               |
| - Inlet                                        | 0.15 –0.21 mm <sup>(1)</sup>  |
| - Exhaust                                      | 0.43 –0.49 mm <sup>(1)</sup>  |

(1) The values refer to the tappet adjuster end of the valve rockers.

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Hello dear friend!

Thank you very much for reading.

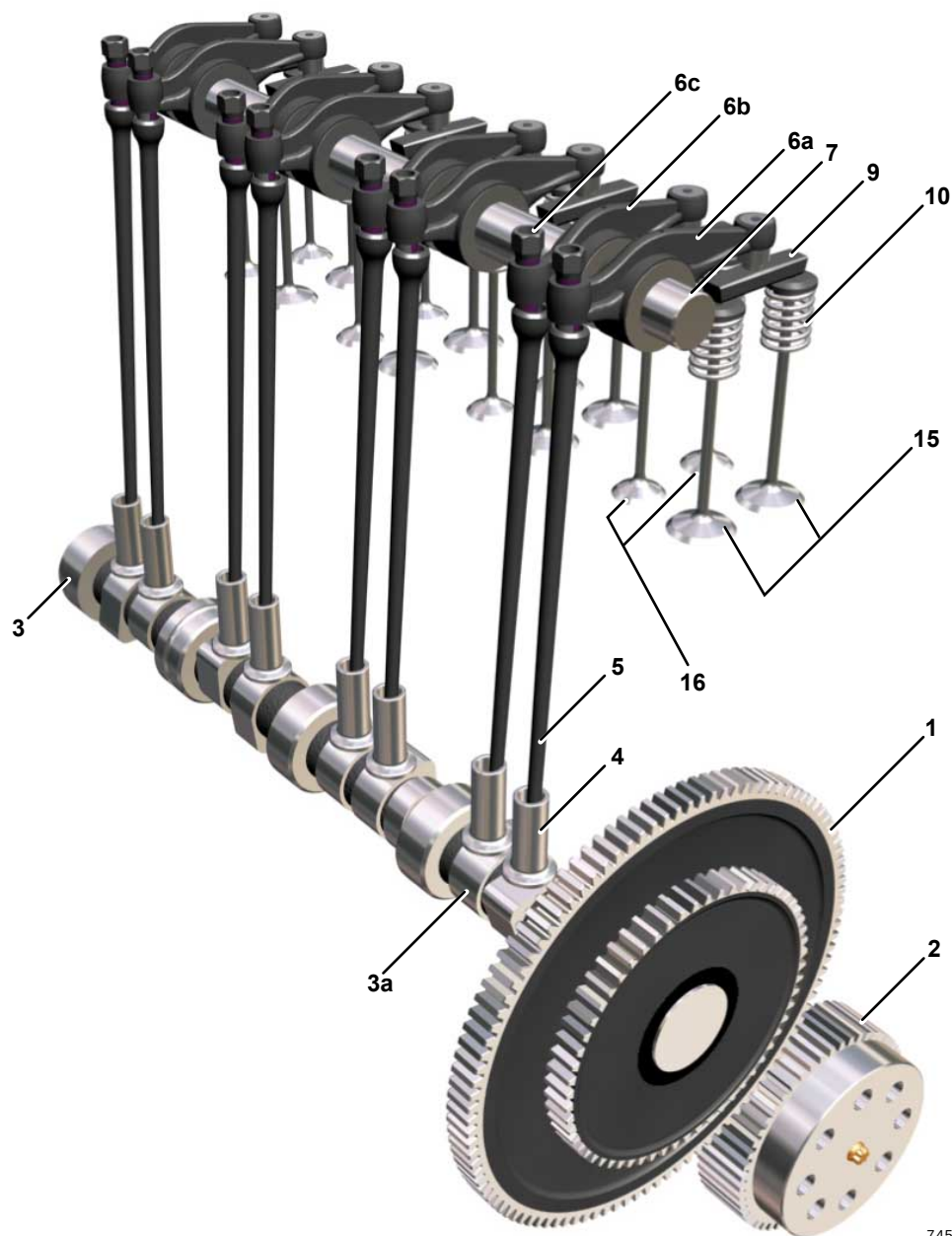
Enter the link into your browser.

The full manual is available for immediate download.

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## Component Identification

Figure 380.



74570C

- 1 Camshaft drive gear
- 3 Camshaft
- 4 Tappets (x8)
- 6a Rockers - inlet (x4)
- 6c Adjusting screws (x8)
- 7 Rocker shaft
- 9 Bridge pieces (x8)
- 11 Retainer (x16)
- 13 Oil seal - valve stems (x16)

- 2 Crankshaft gear
- 3a Lobes
- 5 Push rods (x8)
- 6b Rockers - exhaust (x4)
- 6d Swivel tip - rockers
- 8 Wave washers (x8)
- 10 Valve springs (x16)
- 12 Collets (x32)
- 14 Valve seat inserts (x16)

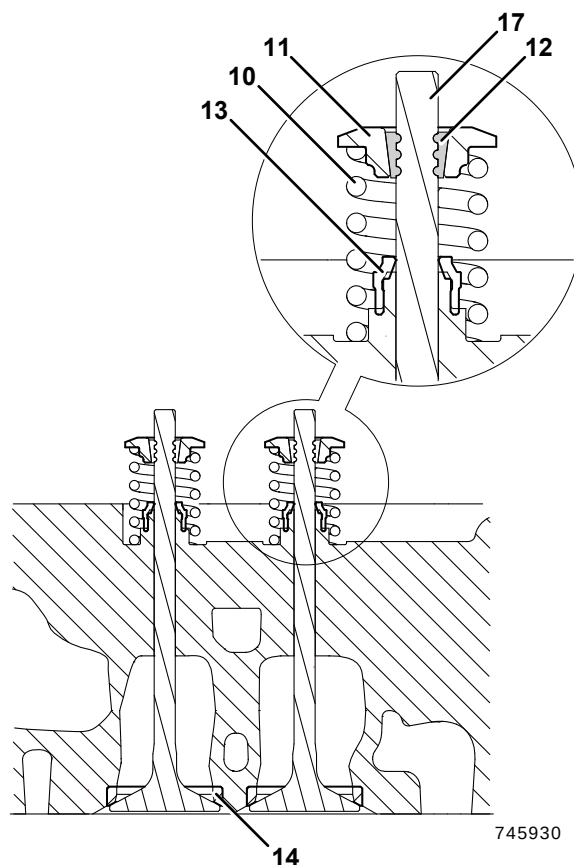
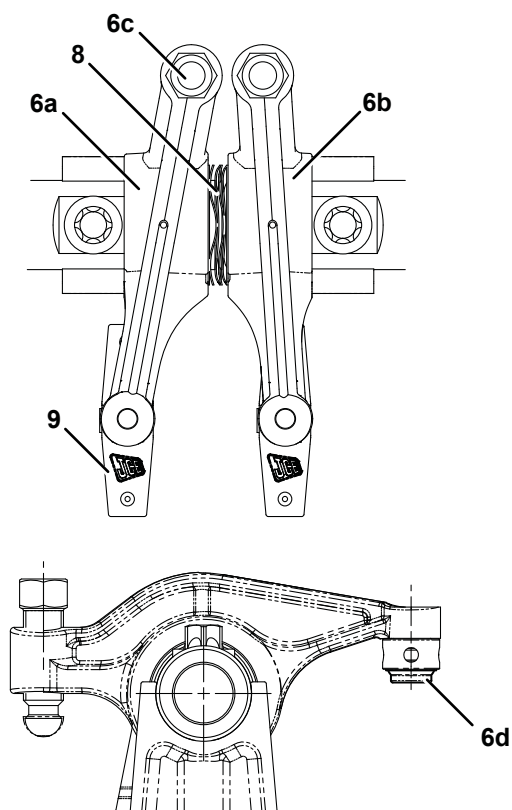
**15** Inlet valves (x8)

**17** Valve stem

**16** Exhaust valves (x8)

## Cross Sectional View

**Figure 381.**



745930

**6a** Rockers - inlet (x4)

**6c** Adjusting screws (x8)

**8** Wave washers (x8)

**10** Valve springs (x16)

**12** Collets (x32)

**14** Valve seat inserts (x16)

**6b** Rockers - exhaust (x4)

**6d** Swivel tip - rockers

**9** Bridge pieces (x8)

**11** Retainer (x16)

**13** Oil seal - valve stems (x16)

**17** Valve stem

## Operation

The camshaft drive gear is driven by the crankshaft gear at half the speed of the crankshaft. 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, depressing two valves at the same time via the bridge piece.

The screw is self locking in the rocker by means of a tapered thread. Wave washers act like springs to keep the rockers in their correct positions along the camshaft and prevent them contacting one another. The rockers incorporate a swivel tip to ensure alignment with the bridge piece. This prevents excessive wear.

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 split collets.

## Adjust

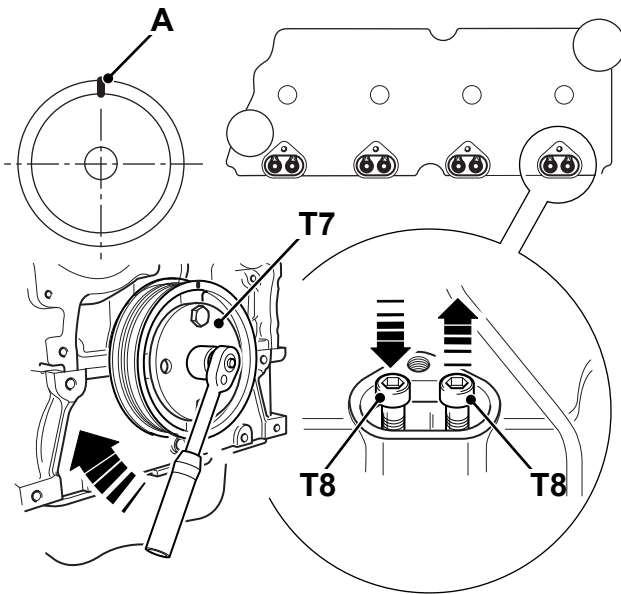
### Special Tools

| Description                                                                | Part No.  | Qty. |
|----------------------------------------------------------------------------|-----------|------|
| Crankshaft Turning Tool (95.25mm PCD)- JCB 4 Cylinder Ecomax and Dieselmex | 892/01147 | 1    |
| Valve Clearance Service Kit                                                | 892/01380 | 1    |

### Engine Position

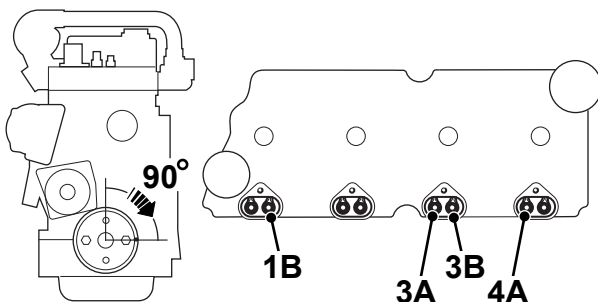
The engine needs to be set to two different positions to measure and adjust all of the valves. The graphics show which valves are applicable at which engine position.

1. 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.
2. Get access to the engine.
3. Remove the tappet covers. Refer to (PIL 15-42).
4. Put the indicator pins into the holes inside the tappet adjusters for cylinder number 4. Make sure that the pins do not fall into the engine.
5. Use the crankshaft turning tool to turn the engine crankshaft clockwise. Stop turning the crankshaft when one indicator pin starts to move up after the other pin has moved down. This is the position where the exhaust valve is almost closed and the inlet valve is just starting to open.  
Special Tool: Crankshaft Turning Tool (95.25mm PCD)- JCB 4 Cylinder Ecomax and Dieselmex (Qty.: 1)  
Special Tool: Valve Clearance Service Kit (Qty.: 1)
6. Put a mark on the crankshaft pulley at the 12 o'clock position.

**Figure 382.**


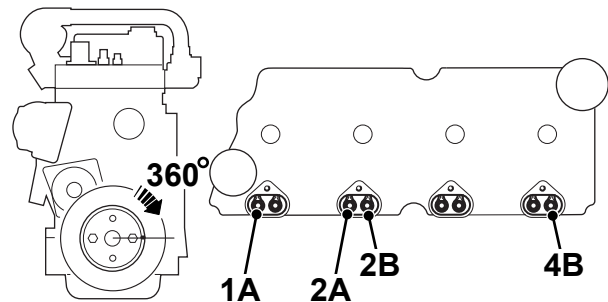
- A** 12 o'clock position  
**T7** Crankshaft turning tool  
**T8** Indicator pins (obtain locally)

7. Turn the engine crankshaft 90 degrees clockwise.
8. Measure and, if necessary, adjust the clearances for the correct valves.

**Figure 383. 90 Degree Position**


- 1B** Inlet valve-Cylinder 1  
**3A** Exhaust valve-Cylinder 3  
**3B** Inlet valve-Cylinder 3  
**4A** Exhaust valve-Cylinder 4

9. Remove the valve clearance service tools. Turn the engine crankshaft 360 degrees clockwise. Use the mark on the crankshaft pulley as a reference.
10. Measure and, if necessary, adjust the clearances for the correct valves.

**Figure 384. 360 Degree Position**


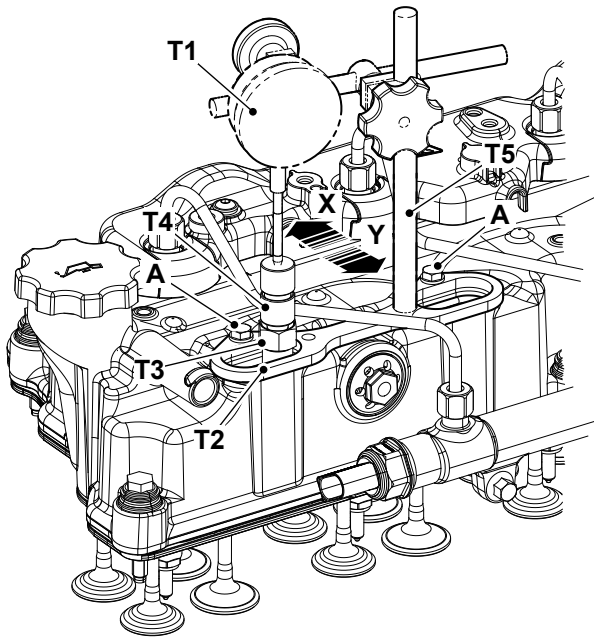
- 1A** Exhaust valve-Cylinder 1  
**2A** Exhaust valve-Cylinder 2  
**2B** Inlet valve-Cylinder 2  
**4B** Inlet valve-Cylinder 4

## Valve Clearances

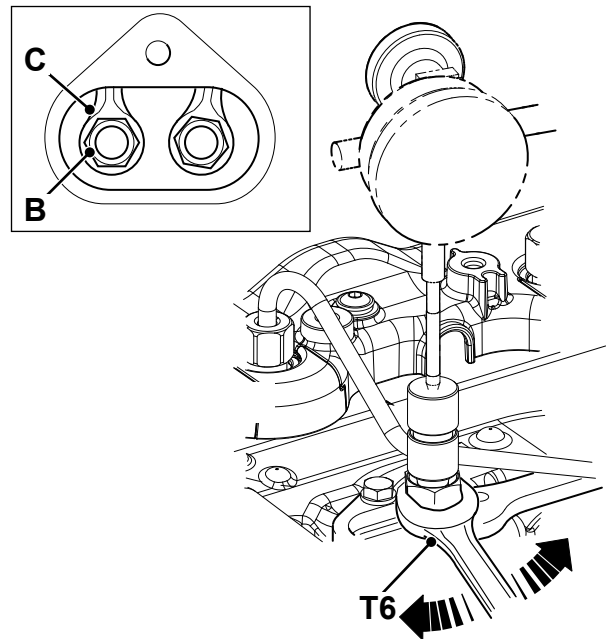
The procedure describes how to measure and, if necessary, adjust one valve clearance. The procedure for all the valves is the same. Do the procedure for the correct valves at each of the two engine positions. Remember you must remove the valve clearance service tools before you turn the engine crankshaft.

**Important:** The engine must be cold before you measure or adjust the valve clearances.

1. Install the adaptor plate in the correct position on the rocker cover using the screws A.
2. Make sure that the crankshaft is in the correct position.
3. Put the adaptor sleeve on the correct valve tappet adjuster screw.
4. Push the lock bar into the correct valve tappet adjuster screw.
5. Tighten the lock bar by turning it with your hand.
6. Assemble the DTI support and DTI.
7. Push and then pull the lock bar in the direction of the arrows X and Y. Do this until you are sure that the lock bar is correctly installed and oil is moved away from the cam follower and push rod.
8. **Important:** Apply a side force on the lock bar at the same time as pushing and pulling. This prevents the rocker moving along the rocker shaft and giving a false reading on the DTI. Apply a force to the left on the exhaust valve tappets and to the right on the inlet valve tappets.

**Figure 385.**


- A** Screws
- T1** Dial Test Indicator (DTI)(obtain locally)
- T2** Adaptor plate (part of valve clearance service kit)
- T3** Adaptor sleeve (part of valve clearance service kit)
- T4** Lock bar (part of valve clearance service kit)
- T5** DTI Support (obtain locally)

**Figure 386.**


- B** Tappet adjusters
- C** Rockers
- T6** Spanner open ended (obtain locally)

9. Pull the lock bar in the direction of arrow Y and turn the DTI to zero.
10. Push the lock bar in the direction of arrow X and record the DTI indication.
11. Compare the valve clearance measurement with the correct clearances. If an adjustment is necessary:
  - 11.1. Turn the tappet adjuster using an open ended spanner on the adaptor sleeve. Turn the sleeve clockwise to reduce the clearance and counterclockwise to increase the clearance.
  - 11.2. Important: The tappet adjusters are set in position by thread friction with the rockers. Make sure that the torque to turn the tappet adjusters is more than the minimum necessary. If any of the adjusters show a lower torque value then the adjuster and its related rocker must be replaced.

## Remove and Install

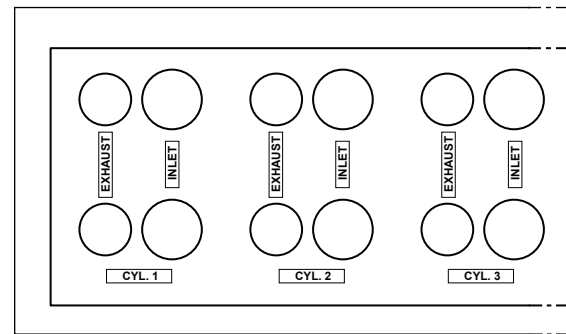
### Special Tools

| Description                                                  | Part No.  | Qty. |
|--------------------------------------------------------------|-----------|------|
| Valve Stem Seal<br>Installation Tool<br>(444/448/672 Engine) | 892/01152 | 1    |

### Before Removal

1. This procedure requires service parts. Make sure you have obtained the correct service parts before you start, refer to Parts Catalogue.
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. Get access to the engine.
4. Remove the thermostat, refer to (PIL 21-12).
5. Remove all of the fuel injector pipes, refer to (PIL 18-96).
6. Remove the rocker cover, refer to (PIL 15-42).
7. Remove the fuel injectors, refer to (PIL 18-18).
8. Remove the rocker assembly, refer to (PIL 15-42).
9. Remove the exhaust manifold, refer to (PIL 18-24).
10. Remove the inlet manifold, refer to (PIL 18-24).
11. Remove the cylinder head assembly from the cylinder block, refer to (PIL 15-06).
12. Measure the valve recession with a suitable DTI (Dial Test Indicator). Clean the carbon deposits from a small area of the valve heads for location of the DTI probe. If the valve recession is outside the serviceable limits, it is advisable to obtain a new or reconditioned cylinder head assembly, refer to Technical Data (PIL 15-06).
13. To aid removal and replacement, use a wooden valve stand to retain the valves after removal. Add labels to make sure that the valves are correctly replaced.

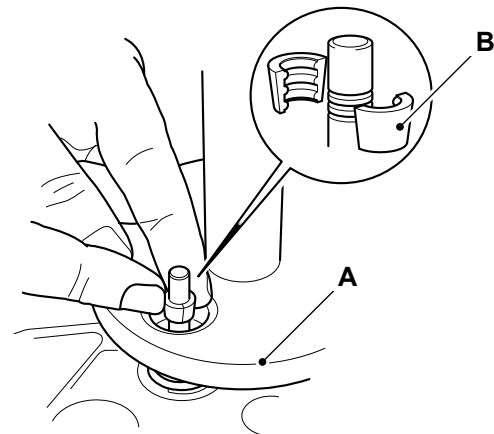
**Figure 387. Valve Stand**



### Remove

1. Use a spring compressor tool to compress each valve spring and remove the collets. Make sure that the springs are compressed squarely.

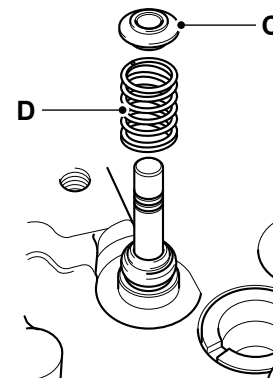
**Figure 388.**



- A** Spring compressor tool  
**B** Collets

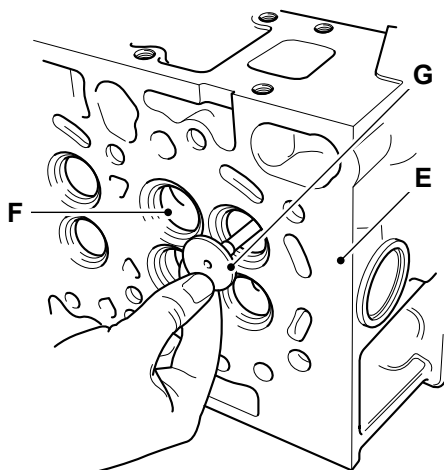
2. Remove the spring compressor tool and lift off the retainer and valve spring.

**Figure 389.**



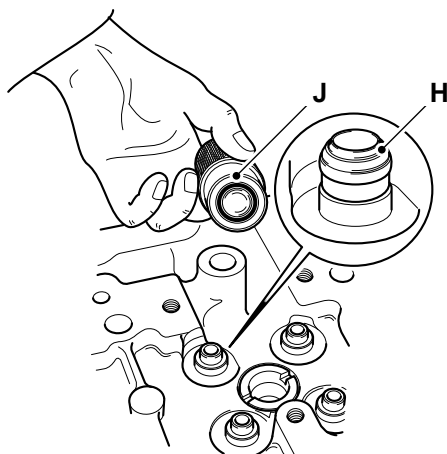
- C** Retainer  
**D** Valve spring

3. Turn the cylinder head on its side and withdraw the inlet valves and exhaust valves as shown.

**Figure 390.**


**E** Cylinder head  
**F** Inlet valves  
**G** Exhaust valves

4. When removing, note the respective position of each valve. Use a suitable valve stand to keep the valves together and identify them with their respective cylinder. Note: The exhaust valves have smaller diameter heads.
5. Remove the valve stem seals. Discard the seals.

**Figure 391.**


**H** Valve stem seals  
**J** Punch tool

## Inspection

1. Carefully clean the carbon deposits from the valves, take care not to damage the valve seats.
2. Check that the valves and valve seats are not cracked, burnt or damaged.
3. Check the valve stems and valve guides for wear, refer to Technical Data (PIL 15-30).

If there is evidence of wear or damage to the valves, guides or seats, it is advisable to obtain a new or reconditioned cylinder head assembly.

## Before Installation

1. Position the cylinder head upside down in a suitable jig or fixture.
2. Make sure that all items are clean and free from damage and corrosion.
3. Install the injectors into the cylinder head to do a trial check of the nozzle protrusion. Note the relative positions for the injectors, and then remove the injectors for installation at a later stage.

## Installation

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Install the new valve stem seals as shown. Use the installation tool to avoid damaging the seals. Pre-assemble the seal into the tool. Locate the tool over the valve guide and gently press the seal into place. Lubricate the seal with P80 fluid.  
[Special Tool: Valve Stem Seal Installation Tool \(444/448/672 Engine\) \(Qty.: 1\)](#)
3. With the cylinder head on its side, insert the inlet valves and exhaust valves as shown. Make sure that the valves are installed in the correct positions. Lubricate the valve stems with clean engine oil before assembly. Carefully push the end of the valve stem through the stem seals.

4. Install the valve springs on to the valve stems, together with a retainer. Use the spring compressor tool to compress each valve spring and insert the collets. Make sure that the collets are correctly seated in the valve stem grooves, before you remove the spring compressor tool.

## After Installation

1. Tap the valve stems in turn using a rubber mallet top fully seat the valves.

## Check (Condition)

1. Check the bearing shell surfaces for signs of damage and excessive wear.  
[Refer to: PIL 15-33-00.](#)
2. Measure the crank pin diameters to confirm they are within service limits.  
[Refer to: PIL 15-12-00.](#)
3. Renew any parts that are worn or not within the specified tolerances.

## Remove and Install

### Special Tools

| Description                 | Part No.  | Qty. |
|-----------------------------|-----------|------|
| Torque Wrench<br>(10-100Nm) | 993/70111 | 1    |

### Before Removal

This procedure requires service parts. Make sure you have obtained the correct service parts before you start. Refer to Parts Catalogue.

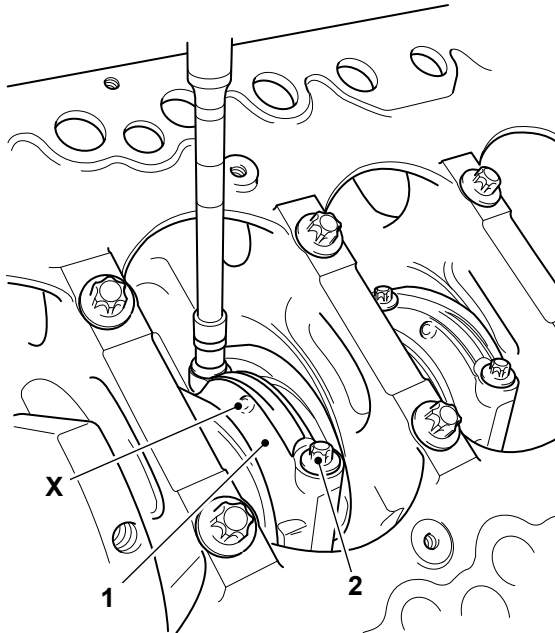
1. Make the machine safe.  
[Refer to: PIL 01-03.](#)
2. Make sure that the engine is safe to work on. If the engine has been running, let it cool before you start the service work.
3. Remove the engine from the machine.  
[Refer to: PIL 15-00-00.](#)
4. Disconnect and remove the fuel pipes from the injectors.  
[Refer to: PIL 18-96-00.](#)
5. Remove the rocker cover.  
[Refer to: PIL 15-42-06.](#)
6. Remove the fuel injectors.  
[Refer to: PIL 18-18-03.](#)
7. Drain the oil from the engine.  
[Refer to: PIL 15-21-00.](#)
8. Remove the oil sump.  
[Refer to: PIL 15-45-00.](#)
9. Position the engine upside down in a suitable jig or fixture, supported at the front of the crankcase.

The connecting rod and the big-end bearing cap have been fracture split and must be kept together as a set. Care must be taken to avoid contamination and or damage to the fracture split surfaces.

### Remove

1. It is recommended that the big-end bearing caps are removed in pairs, cylinders 1 and 4 and cylinders 2 and 3. Rotate the crankshaft so that the big-end bearing caps on cylinders 2 and 3 are positioned as shown.
2. Remove the bolts and lift off the big-end bearing caps from the connecting rods. The bolts must not be re-used, discard the bolts.

**Figure 392.**

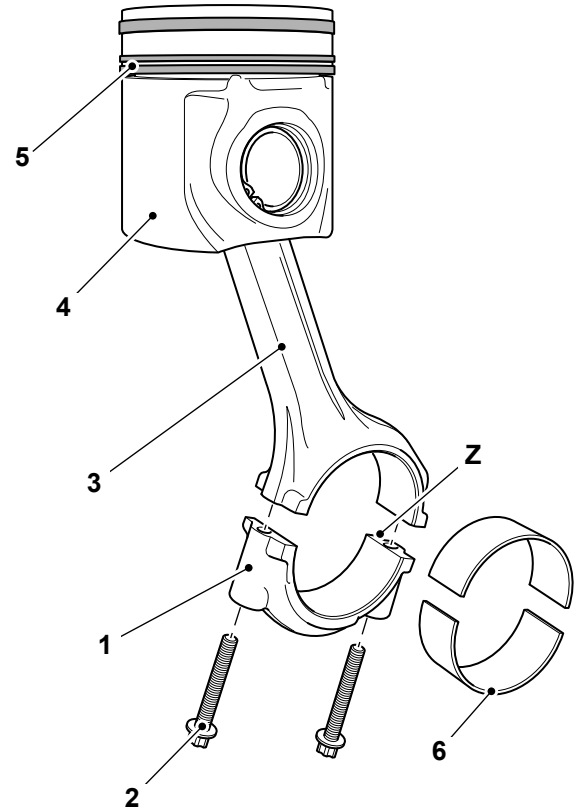


- 1 Big-end bearing caps
- 2 Big-end bearing cap bolts
- X Cast notch

2.1. Make sure that the tool is kept in line with the bolt to avoid damaging the screw thread.

3. Lift out the bearing shells from the bearing caps. Carefully rotate the crank to disengage from the connecting rods and get access to the upper bearing shells. Lift out the upper bearing shells. It is recommended that the bearing shells are renewed. If they are to be reused, label the bearing shells to make sure that they are installed in their original positions on assembly.

**Figure 393.**



- 1 Big-end bearing cap
- 2 Bolts
- 3 Connecting rod
- 4 Piston
- 5 Piston rings
- 6 Big end bearing shells
- Z Fracture split surfaces

4. Carefully rotate the crankshaft to position the big-end bearing caps of cylinders 1 and 4. Make sure that the crank does not foul the connecting rods of cylinders 2 and 3. Remove the bearing caps and bearing shells as described in previous steps.
5. Inspect the big-end bearings for signs of damage and excessive wear.

### Install

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Make sure that all items are clean and free from damage and corrosion.
3. Install the upper bearing shell to the connecting rod. Lubricate the bearing shell with clean engine oil.
4. Install the lower bearing shell to the big-end bearing cap. Lubricate the bearing shell with

clean engine oil. Install the big-end bearing cap to the connecting rod. Make sure that the cast notch on the bearing cap faces to the front of the engine. Use compressed air to clean the fracture surfaces before assembly.

5. Install new big end bearing cap bolts. Tighten the new bolts in three stages to the correct torque value.

**Special Tool: Torque Wrench (10-100Nm) (Qty.: 1)**

- 5.1. Make sure that the tool is kept in inline with the bolt to avoid damaging the screw thread.

- 5.2. The bolts are tightened using a torque and angle method.

**Refer to: PIL 72-00-00.**

**Figure 394.**

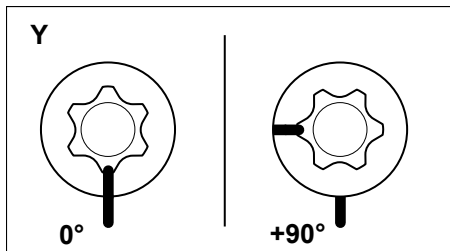
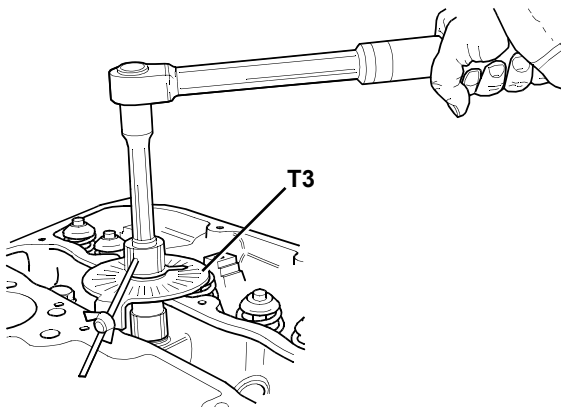


**Figure 395.**



**T3** Angle gauge (obtain locally)

## After Installation

1. The after installation procedure is the opposite of the before removal procedure.

**Table 115. Torque Table**

| Item            | Torque Value (Nm) | Angle (degrees) |
|-----------------|-------------------|-----------------|
| 2 (1st Stage)   | 35                |                 |
| 2 (2nd Stage)   | 65                |                 |
| 2 (Final Stage) |                   | 90              |

## 00 - General

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## Introduction

The piston is acted upon by the pressure of the expanding combustion gases in the combustion chamber space at the top of the cylinder. This force then acts downwards through the connecting rod and on to the crankshaft.

The pistons are cast from aluminium alloys for increased strength and improved fatigue life.

The connecting rod is attached to the piston by a swivelling piston pin. This pin is mounted within the piston, The pin itself is of hardened steel and is fixed in the piston, but free to move in the connecting rod. The pins are prevented from moving sideways and the ends of the pin digging into the cylinder wall by circlips.

## Technical Data

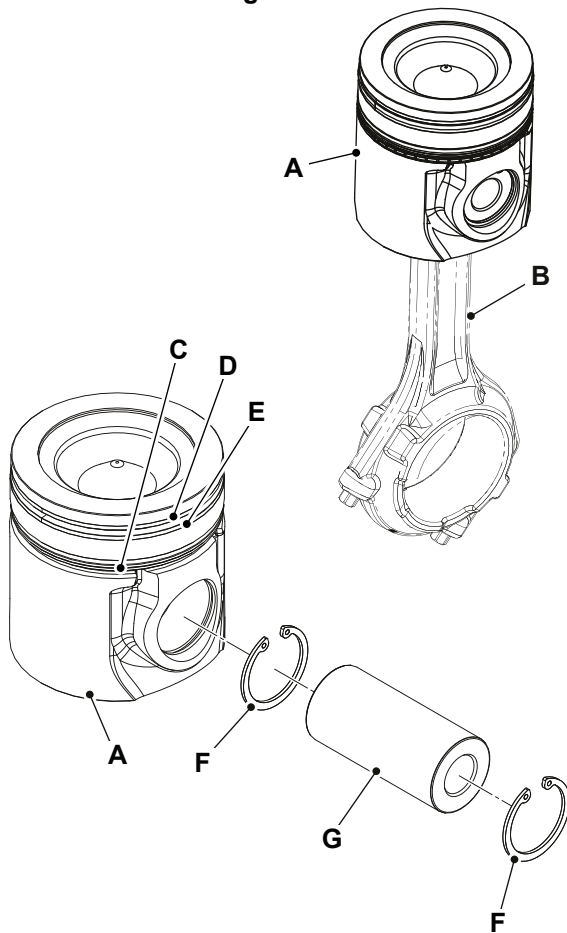
**Table 116.**

| Engine                               | 444                                | 448                                |
|--------------------------------------|------------------------------------|------------------------------------|
| Gudgeon pin bore diameter            |                                    |                                    |
| - min.                               | 40.01 mm                           | 42.008 mm                          |
| - max.                               | 40.015 mm                          | 42.013 mm                          |
| Piston ring clearance                |                                    |                                    |
| - Top ring                           | Full keystone ring                 | Full keystone ring                 |
| - Middle ring                        | 0.125 –0.08 mm                     | 0.125 –0.08 mm                     |
| - Bottom (oil) ring                  | 0.09 –0.05 mm                      | 0.09 –0.05 mm                      |
| Piston ring gap                      |                                    |                                    |
| - Top ring                           | 0.3 –0.4 mm                        | 0.3 –0.4 mm                        |
| - Middle ring                        | 0.55 –0.8 mm                       | 0.55 –0.8 mm                       |
| - Bottom (oil) ring                  | 0.25 –0.5 mm                       | 0.25 –0.5 mm                       |
| Piston height above crankcase (cold) | 0.00025 –0.36825 mm <sup>(1)</sup> | 0.00025 –0.36825 mm <sup>(1)</sup> |
| Piston groove width                  |                                    |                                    |
| - Top ring                           | 3.114 –3.134 mm                    | 3.114 –3.134 mm                    |
| - Middle ring                        | 2.575 –2.595 mm                    | 2.575 –2.595 mm                    |
| - Bottom (oil) ring                  | 4.04 –4.06 mm                      | 4.04 –4.06 mm                      |
| Piston skirt                         | 102.853 –102.871 mm                | 105.851 –105.869 mm                |
| Piston pin                           | 39.994 –40 mm                      | 41.994 –42 mm                      |

(1) Nominal measurement is 0.03325 mm

## Component Identification

Figure 396.



- A** Piston
- B** Connecting rod
- C** Oil control ring
- D** Piston ring - compression No.1
- E** Piston ring - compression No.2
- F** Retaining circlips
- G** Piston pin

The jets spray oil directly to the under side of the pistons effectively transferring heat away from the

**Note:** On turbocharged engines additional J-jets are installed. Oilways connect the J-shaped jets fixed to the crankcase at the underside of each cylinder bore.

1 Crankshaft  
2 Oil jet  
4 Bearing bushes  
6 J shaped jets

## Check (Condition)

1. Check the piston for signs of damage and excessive wear. Measure the piston skirt diameter, piston pin bore and the clearance in the piston ring grooves to confirm they are within service limits.

[Refer to: PIL 15-36-00.](#)

2. Check the piston pin for signs of damage and excessive wear. Measure the pin diameter to confirm it is within service limits. Refer to Piston.

[Refer to: PIL 15-36-00.](#)

The connecting rod small end bearing bush is not renewable. If the small end bearing bush is damaged or worn the connecting rod must be renewed as a complete assembly.

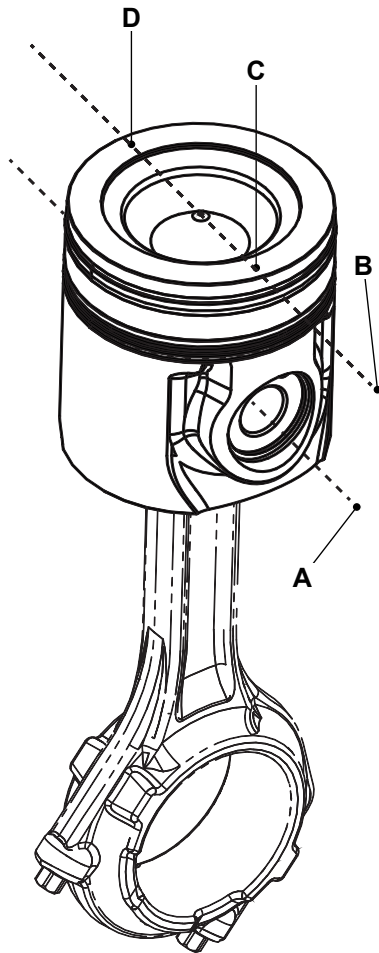
## Calibrate

### Piston Height Measurement Above Cylinder Block- DTI Method

In the event of sufficient liquid entering the engine, a hydraulic lock can occur. This may result in bending of one or more of the connecting rods. Bending of the connecting rod(s) can occur even when the engine is cranked by the starter motor.

Bending of the connecting rod may be very slight and can be checked by carrying out this procedure prior to a full strip down:

1. With the cylinder head removed, make sure the surface of the engine block and piston are clean.
2. Zero a DTI (Dial Test Indicator) on the top face of the cylinder block adjacent to the area on the piston to be measured. The aim of the procedure is to use the DTI to take a measurement across 2 locations on the piston that are on the axis of the gudgeon pin. This will be towards the front and rear of the engine.
3. Rotate the engine and bring the piston up until it is 3mm below the engine block face. Carefully reposition the zeroed DTI above the area of the piston to be measured.
4. Rotate the engine to bring the piston up to exactly TDC (Top Dead Centre) and record the measurement at position 1.
5. Repeat steps 2 to 4 for position 2.
6. Calculate the average of the 2 readings to give a figure of the piston height above the cylinder block.
7. Compare the reading obtained to the technical data.  
[Refer to: PIL 15-36-00.](#)
  - 7.1. If the reading obtained is lower than zero, the connecting rod may be bent.
  - 7.2. If the reading obtained is equal to the range stated in technical data, the connecting rod is not bent.
8. Repeat steps 2 to 7 to check all connecting rods/pistons.
9. If any connecting rods are bent, strip the engine and check for further damage.
10. If the engine is serviceable, any connecting rod that is bent must be replaced.

**Figure 398. DTI Measurement**


- A** Gudgeon pin axis
- B** Line of measurement above gudgeon pin axis
- C** Piston measurement point 1
- D** Piston measurement point 2

### Piston Height Measurement Above Cylinder Block- Straight Edge Method

If a DTI is not available, a calibrated straight edge may be used to take a measurement. The measurement will be less accurate.

1. With the cylinder head removed, make sure the surface of the engine block and piston are clean.
2. Rotate the engine until the piston to be measured is at TDC.
3. Position the straight edge on top of the piston along the axis of the gudgeon pin.
4. Use feeler gauges to measure the gap between the cylinder block face and underside of the straight edge on both sides, position 1 and position 2.

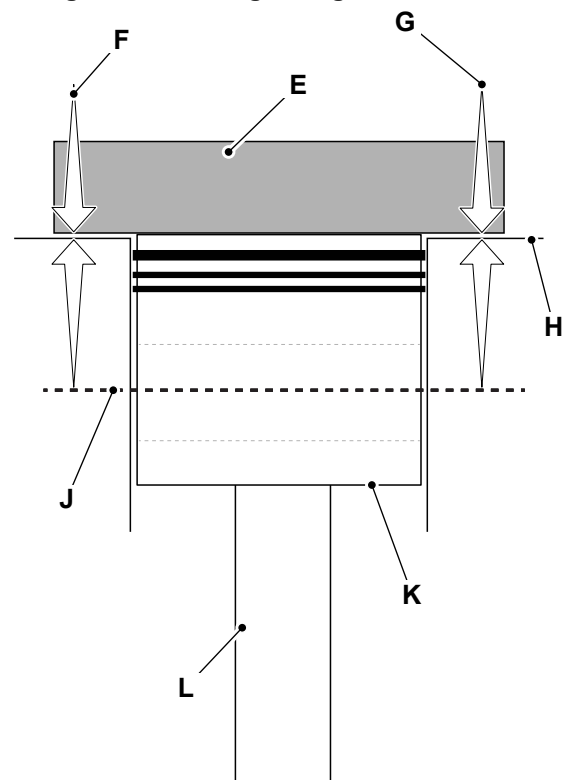
5. Calculate the average of the 2 readings to give a figure of the piston height above the cylinder block.

5.1. If the reading obtained is lower than zero, the connecting rod may be bent.

5.2. If the reading obtained is equal to the range stated in technical data, the connecting rod is not bent.

[Refer to: PIL 15-36-00.](#)

6. Repeat steps 1 to 5.2 to check all connecting rods/pistons.

**Figure 399. Straight Edge Measurement**


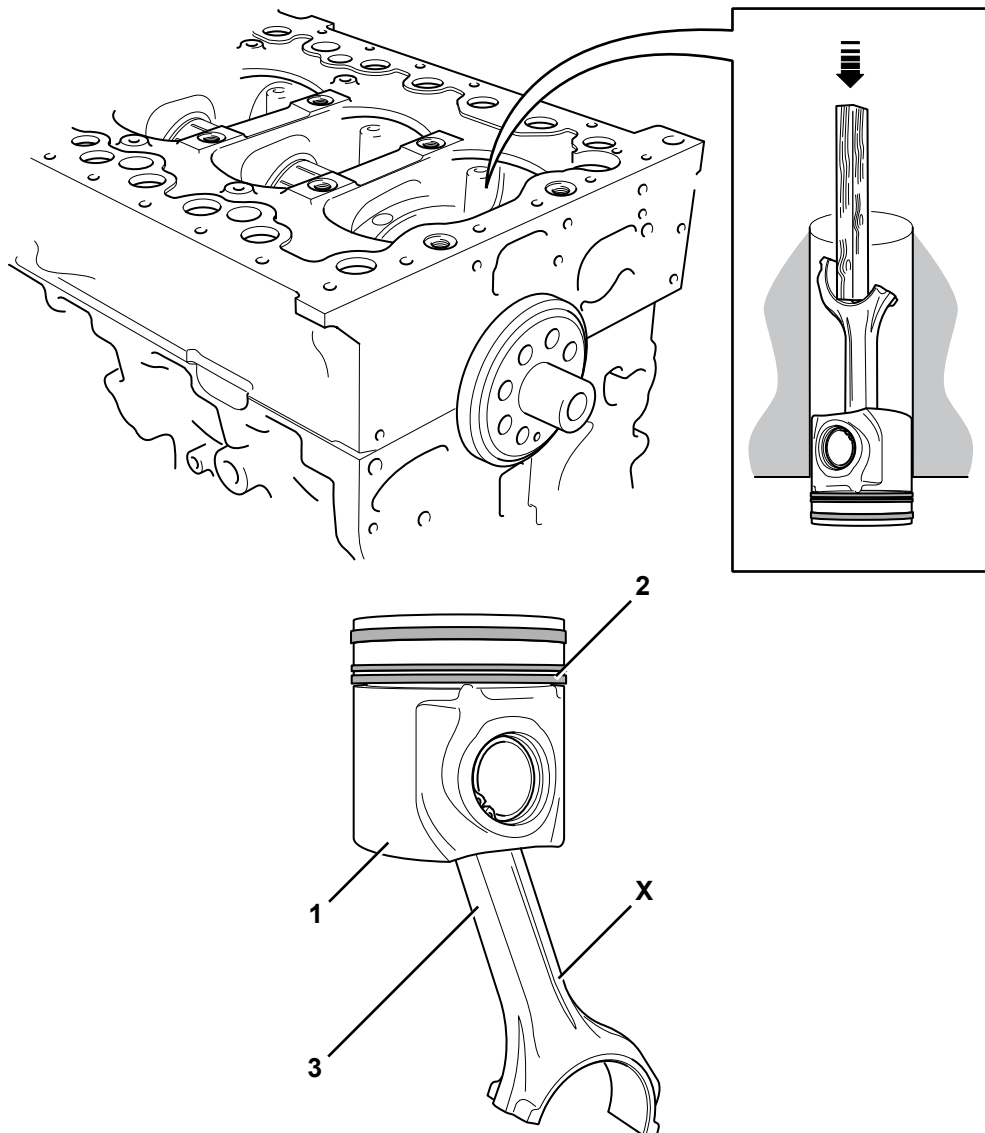
- E** Straight edge
- F** Measurement position 1
- G** Measurement position 2
- H** Cylinder block- top face
- J** Gudgeon pin axis
- K** Piston
- L** Connecting rod

## Remove and Install

### Before Removal

The following procedure is for one piston and connecting rod assembly. Note that each assembly must be replaced in the same cylinder bore. Label each piston and connecting rod assembly to make sure it is installed in the correct position on assembly.

1. This procedure requires service parts. Make sure that you have obtained the correct service parts before you start. Refer to Parts Catalogue.
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. Get access to the engine.
4. Disconnect and remove the fuel pipes from the injectors. Refer to (PIL 18-96).
5. Remove the rocker cover. Refer to (PIL 15-42).
6. Remove the fuel injectors. Refer to (PIL 18-18).
7. Remove the cylinder head assembly. Refer to (PIL 15-06).
8. Remove the oil sump. Refer to (PIL 15-45).
9. Remove the big end bearing caps. Refer to (PIL 15-33-06).

**Figure 400.**


- 1 Piston
- 3 Connecting rod

- 2 Piston ring
- X Longest side of connecting rod

## **Remove**

The piston and connecting rod assemblies are removed through the top of the crankcase.

1. Use a suitable scraper and wire wool to clean off the carbon deposits from around the top of the cylinder bore. Take care not to scratch or damage the cylinder bore.
2. Use a hammer and a short length of wood to tap the piston from the connecting rod side. Take care not to scratch or damage the cylinder bore or the connecting rod bearing surface.

## **Install**

1. The installation procedure is the opposite of the removal procedure. Additionally do the following steps.
2. Make sure that all items are clean and free from damage and corrosion.
3. If the upper big end bearing shell has been removed replace it. Refer to (PIL 15-33-06).
4. Lubricate the cylinder bore with clean engine oil.
5. Use a suitable compressor tool to compress the piston rings.
6. Insert the piston and connecting rod assembly into the cylinder bore, make sure that the longest side of the connecting rod is on the exhaust side of the crankcase. Take care not to damage the cooling jets when you guide the connecting rod down the cylinder bore and over the crank pin diameter.

## **After Installation**

1. Install the big end bearing caps. Refer to (PIL 15-33-06).
2. Carry out the procedures listed under Before removal in reverse order.

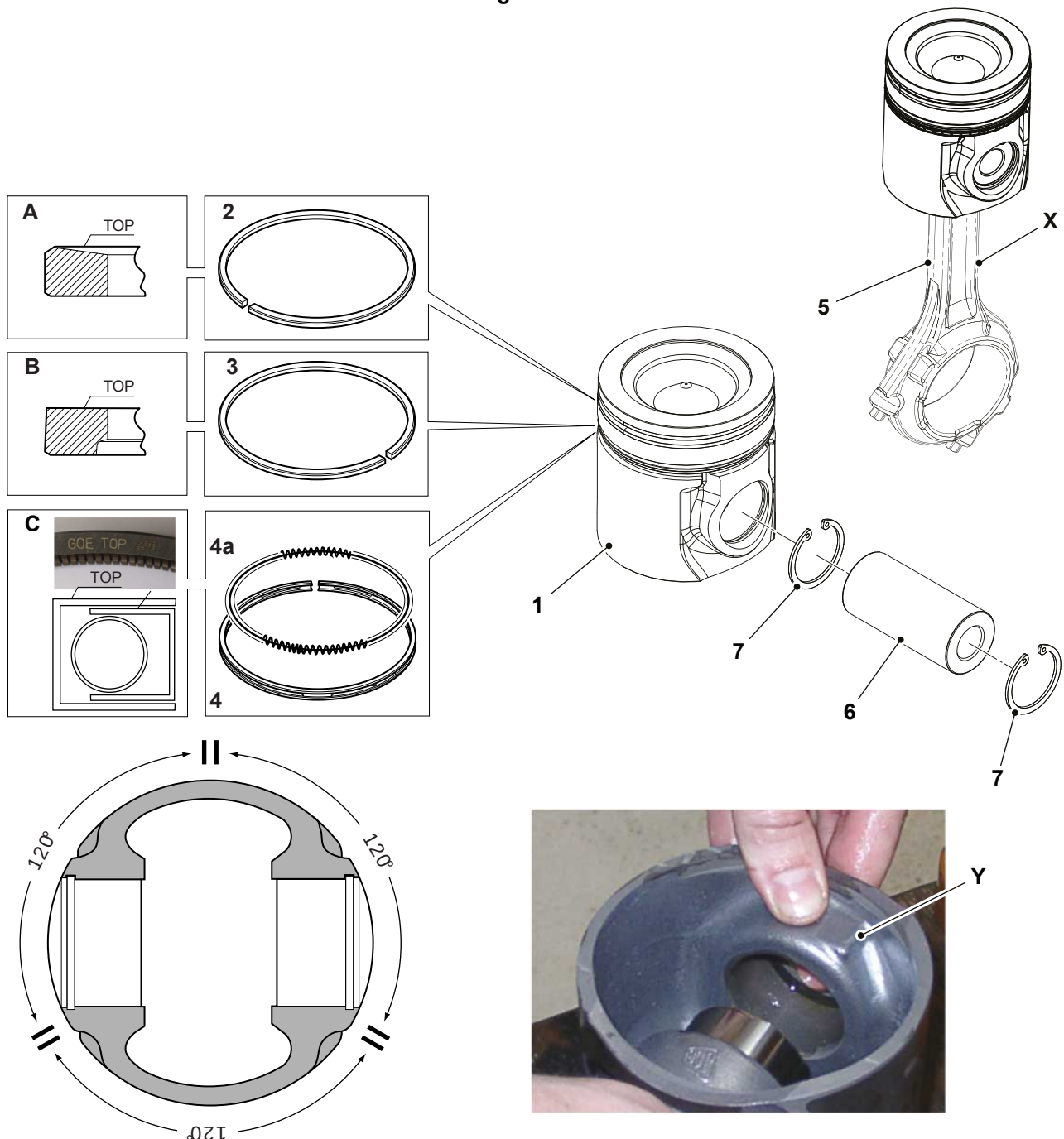
## Disassemble and Assemble

### Dismantle

1. Clamp the connecting rod in a vice. Take care not to damage the connecting rod.
2. It is recommended that the piston rings are renewed. If they are to be reused, label the rings to ensure they are installed in the correct positions and the correct way up on assembly.

Carefully remove the piston rings from the piston. To avoid damage or distortion to the rings, use a suitable piston ring expander tool. Note that the oil control ring is installed with a spiral wire. Pull the wire apart and remove it.

3. Remove the circlips and push out the piston pin.
4. Use a suitable cleaning agent, clean the carbon deposits from the piston.

**Figure 401.**


- 1 Piston
- 3 Piston ring - compression No.2
- 4a Spiral wire - oil control ring
- 6 Piston pin
- X Connecting rod - longest side

- 2 Piston ring - compression No.1
- 4 Piston ring - oil control ring
- 5 Connecting rod
- 7 Retaining circlip (x2)
- Y Cast boss - piston

### Inspect

1. Inspect the pistons for signs of wear or damage.  
Refer to Check (Condition) (PIL 15-36-00).



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## Assemble

1. The assembly procedure is the opposite of the disassemble procedure. Additionally do the following steps.
2. Make sure that all items are clean and free from damage and corrosion.
3. Lubricate the piston pin with clean engine oil. Assemble the connecting rod to the piston and insert the piston pin. Make sure that the long side of the connecting rod is on the same side as the internal cast boss in the piston.
4. Install new circlips. Make sure that they are installed correctly in the groove in the piston.
5. Lubricate the piston with clean engine oil. Install the piston rings to the piston in sequence as follows:
  - 5.1. Install the spiral wire for the oil control ring in the bottom groove and locate the locking wire inside both ends of the spiral as shown. Using a piston ring expander tool to install the oil control ring in the bottom groove and locate the locking wire inside both ends of the spiral as shown. Ensure that the ring gap is positioned 180° to the locking wire. Note: The correct ring orientation can also be determined from the profile shape of the ring as shown at C.
  - 5.2. Install the No.2 compression ring into the middle groove. Note that new rings have a reference number etched on one face. Make sure that this face is installed uppermost in the piston groove. Note: The correct ring orientation can also be determined from the profile shape of the ring as shown at B.
  - 5.3. Install the No.1 compression ring into the top groove. Note that new rings have a reference number etched on one face. Make sure that this face is installed uppermost in the piston groove. Note: The correct ring orientation can also be determined from the profile shape of the ring as shown at A.
6. Rotate the piston rings so that the ring gaps are 120° apart as shown.

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