SERVICE MANUAL

SKIDSTEER LOADER

135, 155, 175, 190, 205

EN - 9813/6750 - ISSUE 1 - 04/2016

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

Foreword

The Operator's Manual

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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

This section contains information about the complete engine assembly. For specific engine technical information refer to the technical data section.

Make sure that the correct engine service tools, consumables and torque figures are used when you perform service procedures.

Replacement of oil seals, gaskets, etc., and any component that show signs of wear or damage, is expected as a matter of course.

It is expected that components will be cleaned and lubricated where required, and that any opened hose or pipe connections will be blanked to prevent excessive loss of hydraulic fluid, engine oil and ingress of dirt.

Basic Description

The Perkins 400 series engines are indirect injection engines. The engines are controlled with a mechanically actuated fuel injection pump. The engine cylinders are arranged in-line. The cylinder head assembly has one inlet valve and one exhaust valve for each cylinder. Each cylinder valve has a single valve spring.

The crankshaft for the four cylinder engine has five main bearing journals. End play is controlled by the thrust washers that are located on the rear main bearing.

The timing gears are stamped with timing marks in order to ensure the correct assembly of the gears. When the No. 1 piston is at top center compression stroke, the teeth that are stamped on the crankshaft gear and the camshaft gear will be in alignment with the idler gear.

The crankshaft gear turns the idler gear which then turns the camshaft gear and the gear for the engine oil pump.

The fuel injection pump is mounted in the crankcase. The fuel injection pump is operated by lobes on the camshaft. The fuel transfer pump is located on the right hand side of the crankcase. The fuel transfer pump is also operated by lobes on the camshaft.

The fuel injection pump conforms to requirements for emissions. If any adjustments to the fuel injection pump timing and high idle are required you must refer to a Perkins distributor or a Perkins dealer. Some fuel injection pumps have mechanical governors that control the engine rpm. Some fuel injection pumps have a governor that is electrically controlled.

A gerotor oil pump is located in the centre of the idler gear. The engine oil pump sends lubricating oil to the main oil gallery through a pressure relief valve and an engine oil filter. The rocker arms receive pressurized oil through an externally located oil line that runs from the main oil gallery to the cylinder head.

Coolant from the bottom of the radiator passes through the belt driven centrifugal cooling pump. The coolant is cooled by the radiator and the temperature is regulated by a water temperature regulator.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to correct operation and maintenance recommendations. Engine performance and efficiency also depend on the use of recommended fuels, lubrication oils, and coolants. Refer to the Maintenance Schedules (PIL 78-24).

Health and Safety

Hot Components

Touching hot surfaces can burn skin. The engine and machine components will be hot after the unit has been running. Allow the engine and components to cool before servicing the unit.

Turning the Engine

Do not try to turn the engine by pulling the fan or fan belt. This could cause injury or premature component failure.

Notice: *The engine and other components could be damaged by high pressure washing systems. Special precautions must be taken if the machine is to be washed using a high pressure system.Make sure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system. Do not aim the water jet directly at bearings, oil seals or the engine air induction system.*

WARNING! *To bleed the injectors you must turn the engine. When the engine is turning, there are parts rotating in the engine compartment.Before starting this job make sure that you have no loose clothing (cuffs, ties etc) which could get caught in rotating parts.When the engine is turning, keep clear of rotating parts.*

Notice: *Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.*

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

WARNING! *The engine has exposed rotating parts. Switch off the engine before working in the engine compartment. Do not use the machine with the engine cover open.*

WARNING! *Hot oil and engine components can burn you. Make sure the engine is cool before doing this job.Used engine crankcase lubricants contain harmful contaminants. In laboratory tests it was shown that used engine oils can cause skin cancer.*

Notice: *A drive belt that is loose can cause damage to itself and/or other engine parts.*

WARNING! *Do not open the high pressure fuel system with the engine running. Engine operation causes high fuel pressure. High pressure fuel spray can cause serious injury or death.*

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.

Technical Data

Table 18.

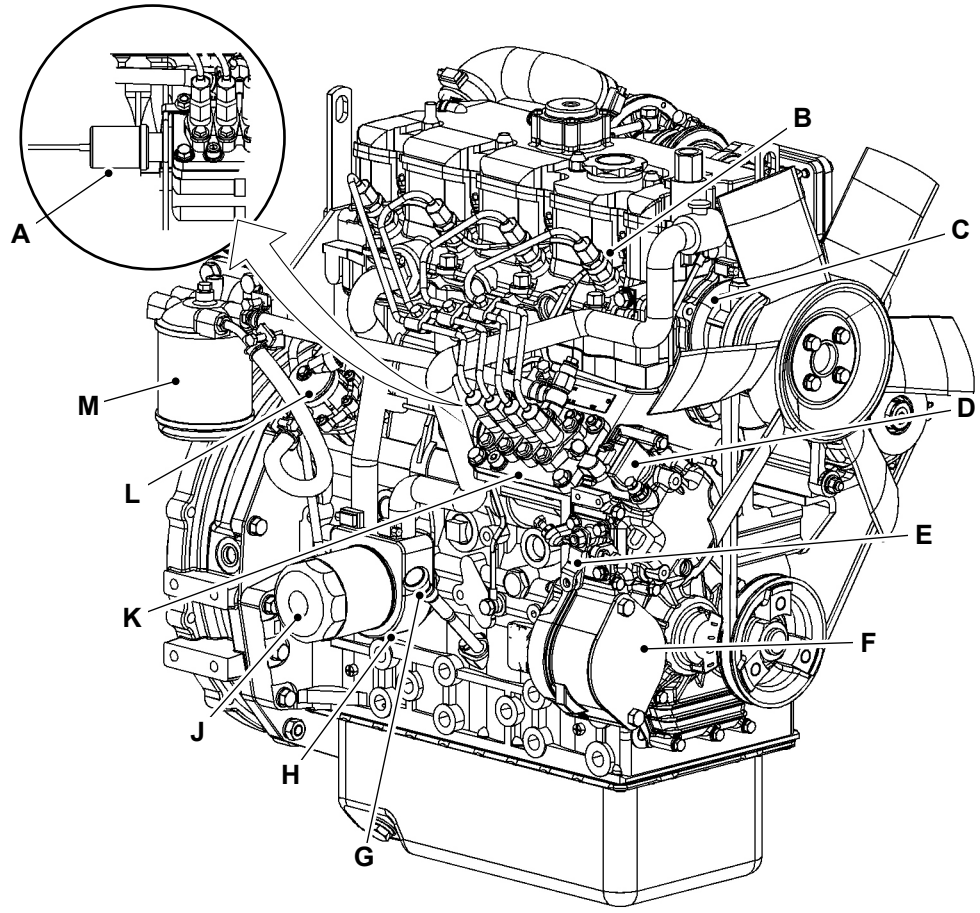
Description	Data
Engine type	GN 404D-22
Emission compliance	Tier 3
Number of cylinders	4
Nominal bore size	88mm
Stroke	102mm
Cylinder arrangement	Vertical In-line
Combustion Cycle	4-stroke
Firing order	1-3-4-2
Compression ratio	23.3:1
Swept volume	2.216L
Valve clearance (cold)	0.2mm
Idling speed	1400 RPM (Revolutions Per Minute)
Maximum no-load speed	2800 RPM
Power output	34kW at 2600 RPM

Component Identification

External

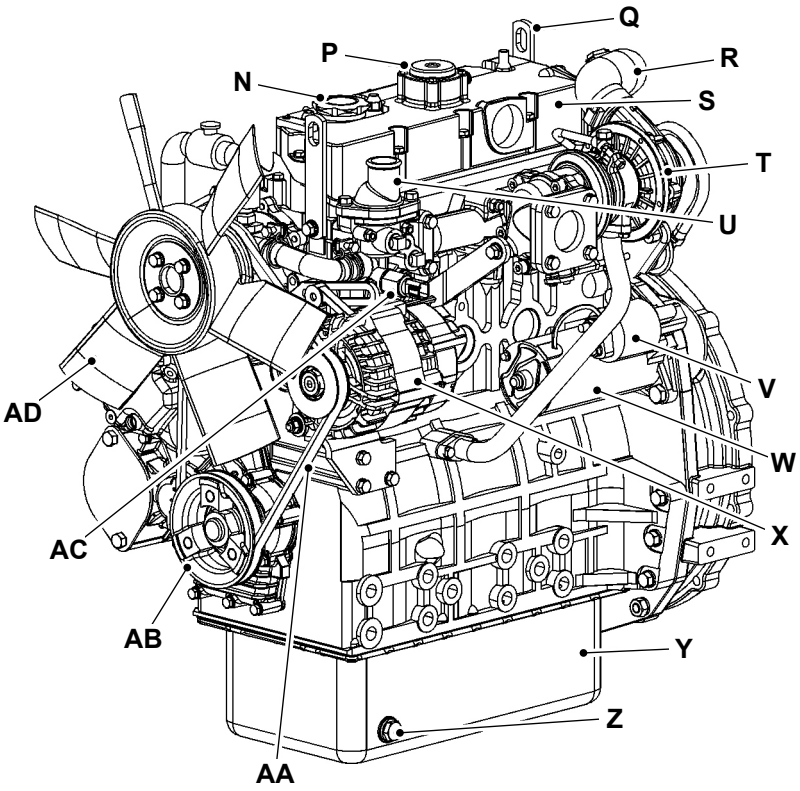
The following identifies the main components of a typical engine assembly visible from the exterior. Some variants may differ in detail.

Figure 90. Front and right side view



A Fuel shutoff solenoid
B Number one fuel injector
C Water pump
D Lower engine oil filler cap
E Throttle lever
F Cover plate for the accessory drive
G Engine oil level gauge
H Engine oil cooler
J Engine oil filter
K Fuel injection pump
L Transfer pump
M Fuel filter

Figure 91. Front and left side view



N Top engine oil filler cap
Q Rear Lifting eye
S Valve mechanism cover
U Water temperature regulator housing
W Electric starting motor
Y Engine oil pan
AA Fan drive belt
AC Coolant temperature switch
P Crankcase breather
R Air inlet elbow
T Turbocharger
V Starting motor solenoid
X Alternator
Z Engine oil drain plug
AB Crankshaft pulley
AD Cooling fan

Operation

The Four Cylinder Cycle

This section describes the cycle sequence for the 4 cylinder engine.

With the crankshaft positioned as shown, the pistons in numbers 1 and 4 cylinders are at top dead centre and pistons in numbers 2 and 3 cylinders are at bottom dead centre.

It is important to note that number 1 cylinder is firing and about to start its Power stroke. Rotating the crankshaft a further full rotation would position the pistons as described but the engine would be at a different stage in its four stroke cycle, with number 1 cylinder about to start its Induction stroke.

Firing Order

A cylinder is said to be firing, when the fuel/air mixture ignites and the piston is about to start its power stroke.

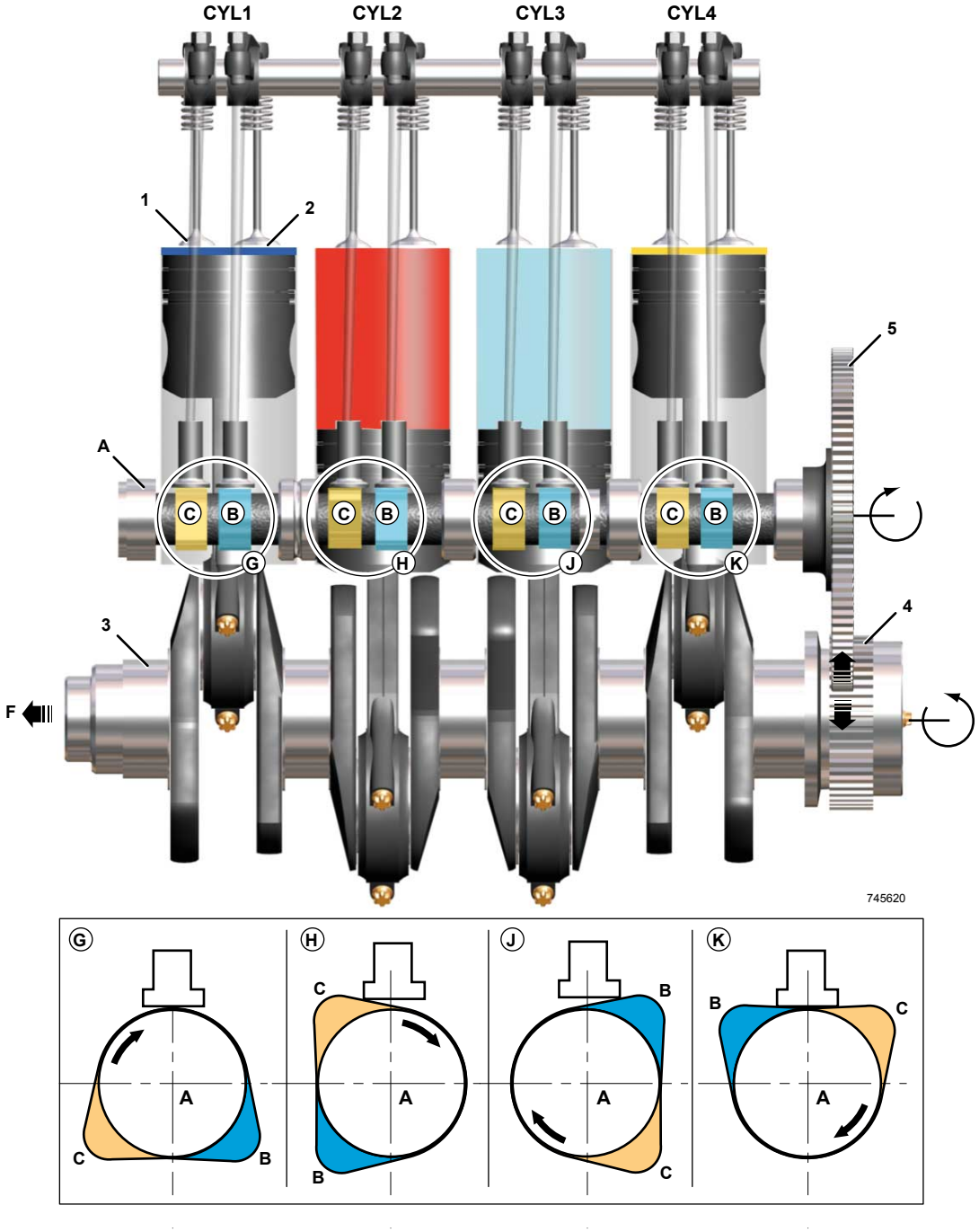
From the stages described, it can be seen that number 1 cylinder will be next to fire. Number 3 cylinder is starting its compression stroke and is next in the cycle, followed by cylinders 4 and 2. The firing order is therefore; 1, 3, 4, 2.

The stages in the four stroke cycle for each cylinder are as follows:

Table 19. The Four Stroke Cycle

Cylinder number	Piston operation	Valve operation
1	The piston is at the top of its Compression stroke and is about to start its Power stroke.	Inlet and exhaust valves closed
2	The piston is at the bottom of its Power stroke and is about to start its Exhaust stroke.	Inlet valves closed, exhaust valves about to open
3	The piston is at the bottom of its Induction stroke and is about to start its Compression stroke.	Exhaust valves closed, inlet valves about to close.
4	The piston is at the top of its Exhaust stroke and is about to start its Induction stroke.	Valve Operation Exhaust valves about to close, inlet valves about to open

Figure 92. Typical Four Cylinder Engine



CYL1	Cylinder number 1	**CYL2**	Cylinder number 2
CYL3	Cylinder number 3	**CYL4**	Cylinder number 4
A	Camshaft	**B**	Camshaft lobe - Inlet valve operation
C	Camshaft lobe - Exhaust valve operation	**F**	Front of engine
1	Exhaust valves	**2**	Inlet valves
3	Crankshaft	**4**	Crankshaft gear
5	Camshaft drive gear		

Four Stroke Cycle

Induction

As the piston travels down the cylinder, it draws filtered air at atmospheric pressure and ambient temperature through an air filter and inlet valves into the cylinder.

Compression

When the piston reaches the bottom of its stroke, the inlet valves close. The piston then starts to rise up the cylinder compressing the air trapped in the cylinder. This causes the temperature and pressure of the air to rise. Fuel is injected into the cylinder when the piston is near to TDC (Top Dead Centre).

Power

The piston continues to rise after the start of fuel injection, causing a further increase in pressure and temperature.

The temperature rises to a point at which the fuel/air mixture ignites. A cylinder is said to be firing when the fuel/air mixture ignites.

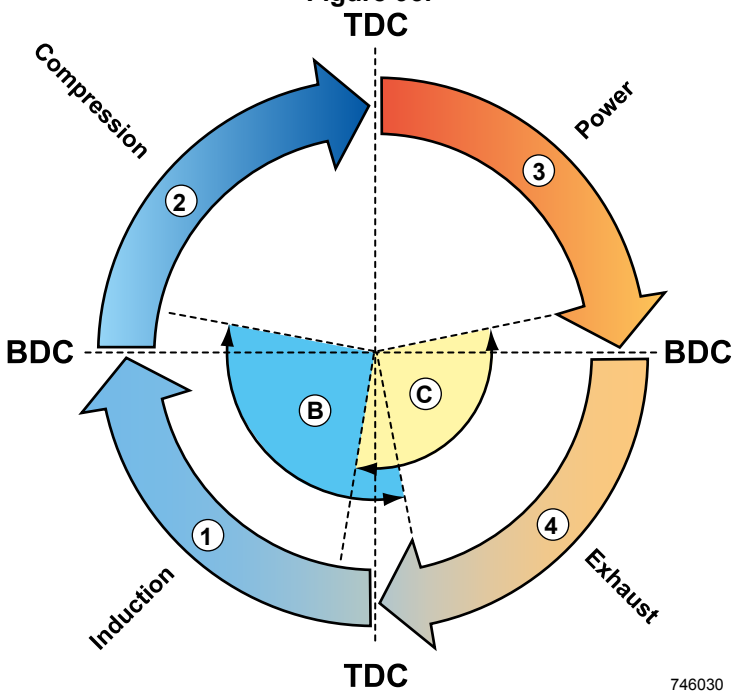
This combustion causes a very rapid rise in both temperature and pressure. The high pressure generated propels the piston downwards turning the crankshaft and producing energy.

Exhaust

Once the piston has reached the bottom of its travel, the exhaust valves open and momentum stored in the flywheel forces the piston up the cylinder expelling the exhaust gases.

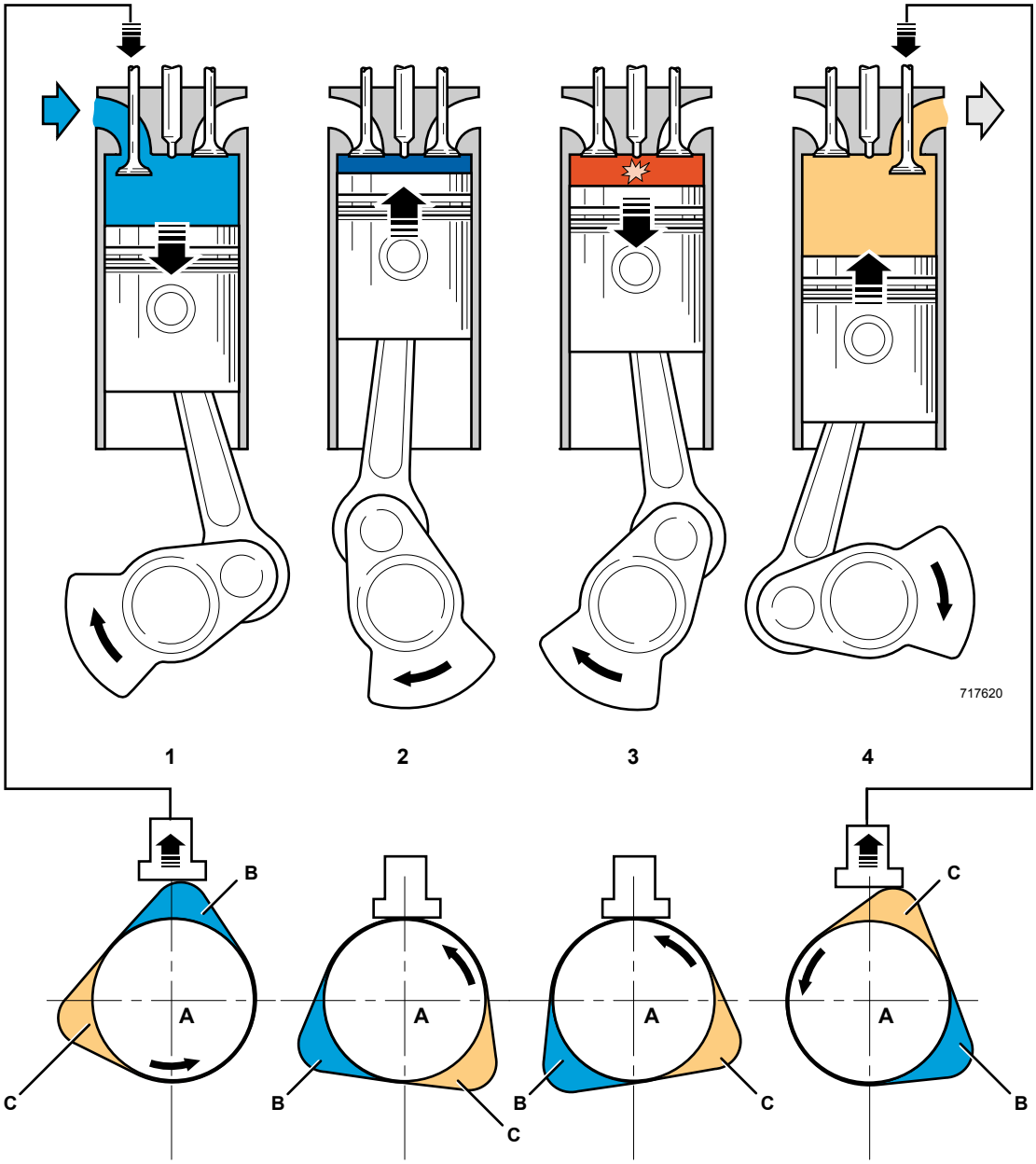
In a running engine, these four phases are continuously repeated. Each stroke is half a revolution of the crankshaft, thus, in one cycle of a four stroke engine, the crankshaft revolves twice.

Figure 93.



1 Induction stroke
2 Compression stroke
3 Power stroke
4 Exhaust stroke
A Camshaft
B Camshaft lobe - Inlet valve operation
C Camshaft lobe - Exhaust valve operation
BDC Bottom dead centre
TDC TDC

Figure 94.



1 Induction stroke
2 Compression stroke
3 Power stroke
4 Exhaust stroke
A Camshaft
B Camshaft lobe - Inlet valve operation
C Camshaft lobe - Exhaust valve operation

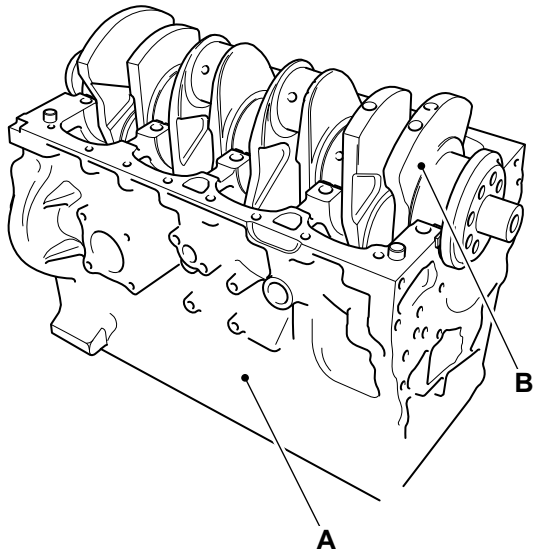
00 - General

Introduction

The crankcase is the housing for the crankshaft. The enclosure forms the largest cavity in the engine and is located below the cylinders. It is integral with the cylinder bank and forms an engine block. It has an opening in the bottom to which an oil sump is attached with a gasket and bolted joint.

The crankcase protects the crankshaft and connecting rods from foreign objects it also keeps the engine oil contained and allows the oil to be pressurised and also provide the rigid structure with which to join the engine to the transmission.

Figure 97.



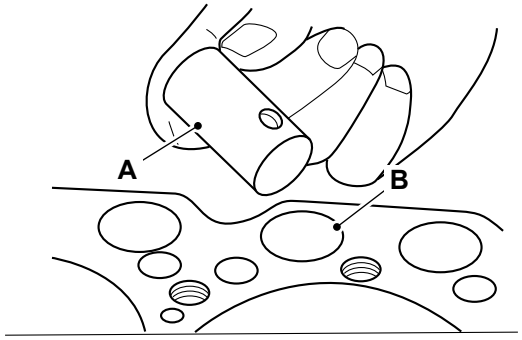
A Crankcase
B Crankshaft

Technical Data

Table 42. Cylinder bore data

Description	Data
Diameter of bore	84–84.019mm
Bore service limit	84.2mm
Flatness of the top of the cylinder	Less than 0.05mm
Service limit for the flatness	0.12mm
Clearance between the tappet and the tappet bore (Maximum)	0.058mm
Clearance between the tappet and the tappet bore (Service limit)	0.08mm

Figure 98.

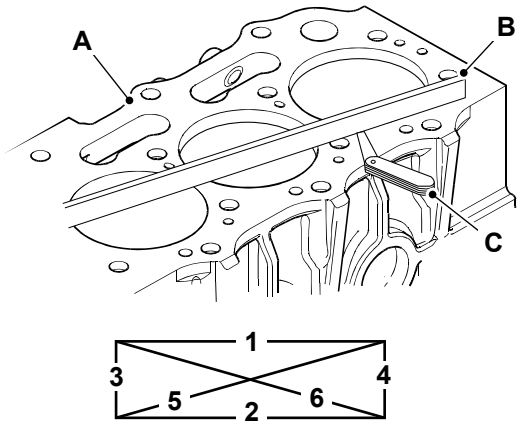


A Tappet
B Tappet bore

Check (Condition)

1. Check the six positions for flatness with a straight edge and the feeler gauge. Refer to Figure 99.

Figure 99.



A Crankcase
B Straight edge
C Feeler gauge

2. Inspect the top of the crankcase for cracks, damage and warping.
3. Inspect each cylinder bore.
   - 3.1. Make sure that there are no signs of scoring or corrosion.
   - 3.2. Measure each cylinder bore with a suitable gauge.
   - 3.3. Measure the area of each cylinder bore that is in contact with the top, middle and bottom piston rings.
   - 3.4. Make sure that you measure each cylinder bore at right angles to the crankshaft.
   - 3.5. Do NOT use the flex-hone process on this engine.
4. Make sure that the cylinder bore dimensions do not exceed the specified service limits. Refer to Technical data (PIL 15-03).
5. If the service limit for the crankcase is exceeded, you must replace the crankcase.

Technical Data

Table 43. Cylinder head gasket

Piston height below top face of crankcase	Gasket Thickness
+0.35mm to +0.5mm	1.2mm
+0.5mm to +0.6mm	1.3mm

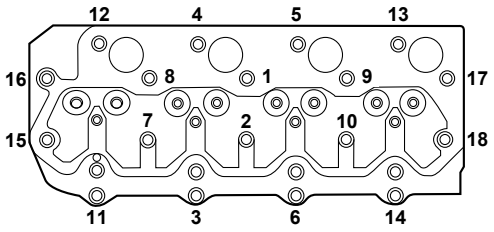
Table 44. Distortion of the cylinder head

Description	Data
Distortion of the cylinder head	0–0.05mm
Maximum service limit	0.12mm
Maximum limit for re-grinding the cylinder head	0.15mm

Check (Condition)

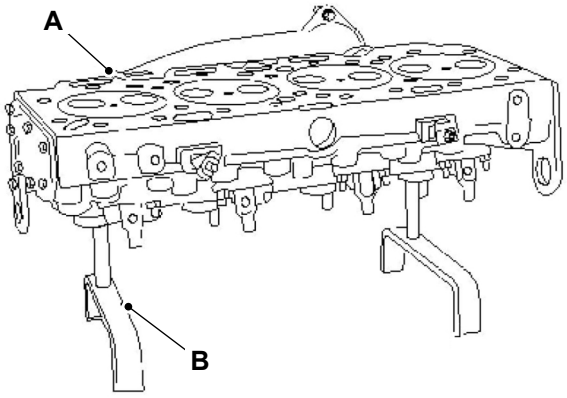
1. Make the machine safe. Refer to (PIL 01-03).
2. Get access to the engine. Refer to (PIL 06-06).
3. Remove the cylinder head bolts in the reverse numerical order. This will prevent distortion of the cylinder head. Refer to Figure 100.

Figure 100.



4. Remove the cylinder head from the engine.
5. Clean the cylinder head thoroughly.
6. Make sure that the contact surface of the cylinder head and the contact surface of the crankcase are clean, smooth and flat.
7. Inspect the bottom surface of the cylinder head for pitting, corrosion and cracks.
8. Inspect the area around the valve seats and the holes for the fuel injectors.
9. Put the cylinder head on a suitable support.

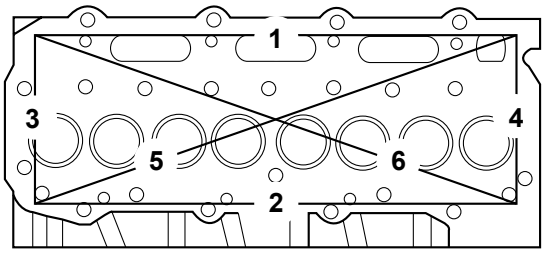
Figure 101.



A Cylinder head
B Support

10. Use a straight edge and a feeler gauge to check the six positions for distortion. Refer to Figure 102.

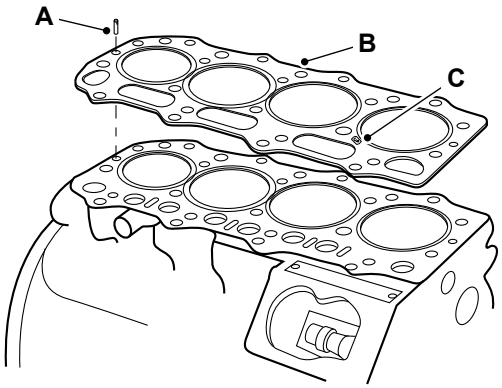
Figure 102.



Calibrate

- The dowel pins in the crankcase hold the cylinder head gasket in the correct position when the cylinder head is installed. Refer to Figure 103.
- The stamped marking on the cylinder head gasket must face upward. This makes sure that the cylinder head gasket is installed correctly. Refer to Figure 103.

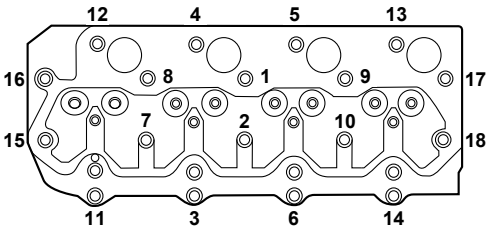
Figure 103.



A Dowel pins
B Gasket
C Stamped marking

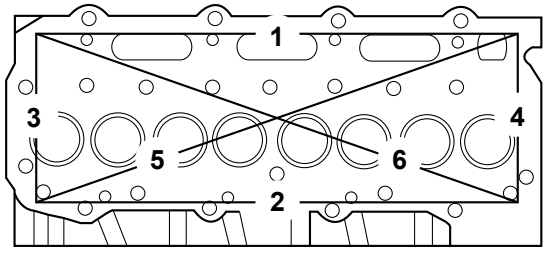
- Before you tighten the bolts, apply clean engine oil on the threads of the bolts. The bolts must be tightened to the torque of 101N·m in the specified numerical sequence only. Refer to Figure 104.

Figure 104.



- Use a straight edge and a feeler gauge to check the six positions for distortion. Refer to Figure 105.

Figure 105.



Our support email:

ebooklibonline@outlook.com