SERVICE MANUAL

ENGINE

JCB T2/3 Mech Engine 4 Cyl

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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. Renewal of oil seals, gaskets, etc., and any component showing obvious signs of wear or damage is expected as a matter of course. It is expected that components will be cleaned and lubricated where appropriate, 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 JCB DieselMax engine is a 4 cylinder diesel engine in which the fuel is ignited by compression ignition (C.I.). The engine operates on a four stroke cycle.

The engine is started by an electric starter motor. The starter motor turns the engine via a pinion and teeth on the engine flywheel, refer to (PIL 15-75).

When the engine runs the crankshaft drives the camshaft via gears. The camshaft opens and closes the inlet and exhaust valves and via push rods in time with the four stroke cycle. The engine has 16 valves, 2 inlet and 2 exhaust valves for each cylinder.

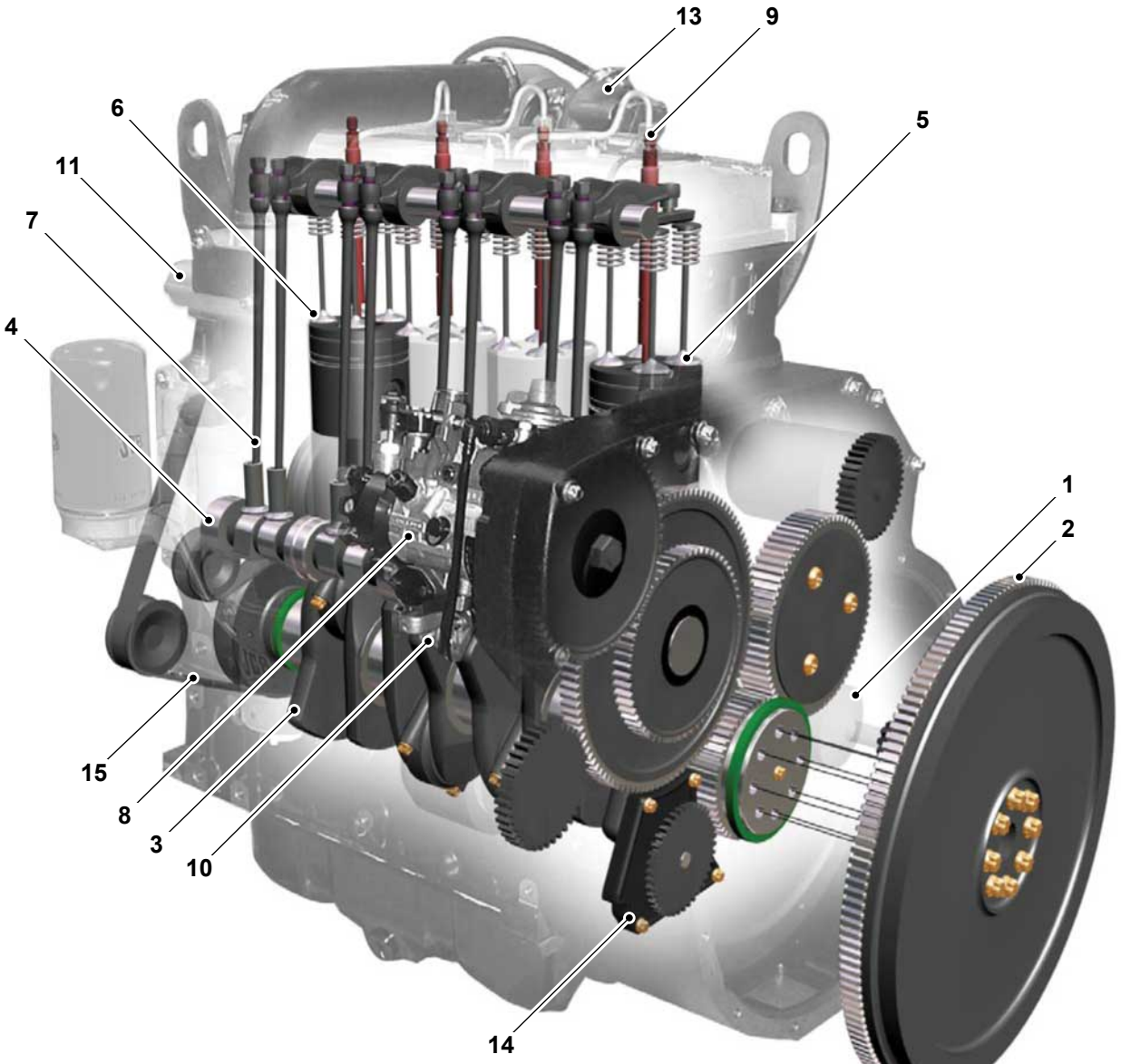
The crankshaft also drives a mechanical fuel injection pump via gears. The pump injects fuel via injectors, or atomisers into each cylinder in time with the four stroke cycle.

Air is drawn into the engine, via the inlet manifold and exhaust gases exit via the exhaust manifold. The engine uses an exhaust driven turbocharger which pressurises the air at the inlet manifold, refer to (PIL 18-36).

A mechanical lubrication oil pump is driven by the crankshaft via gears. The pump pressurises and circulates oil for engine lubrication and cooling purposes.

A drive belt driven by the crankshaft, drives a coolant circulation pump, alternator, radiator cooling fan and other ancillaries such as an air conditioning compressor.

Figure 3.



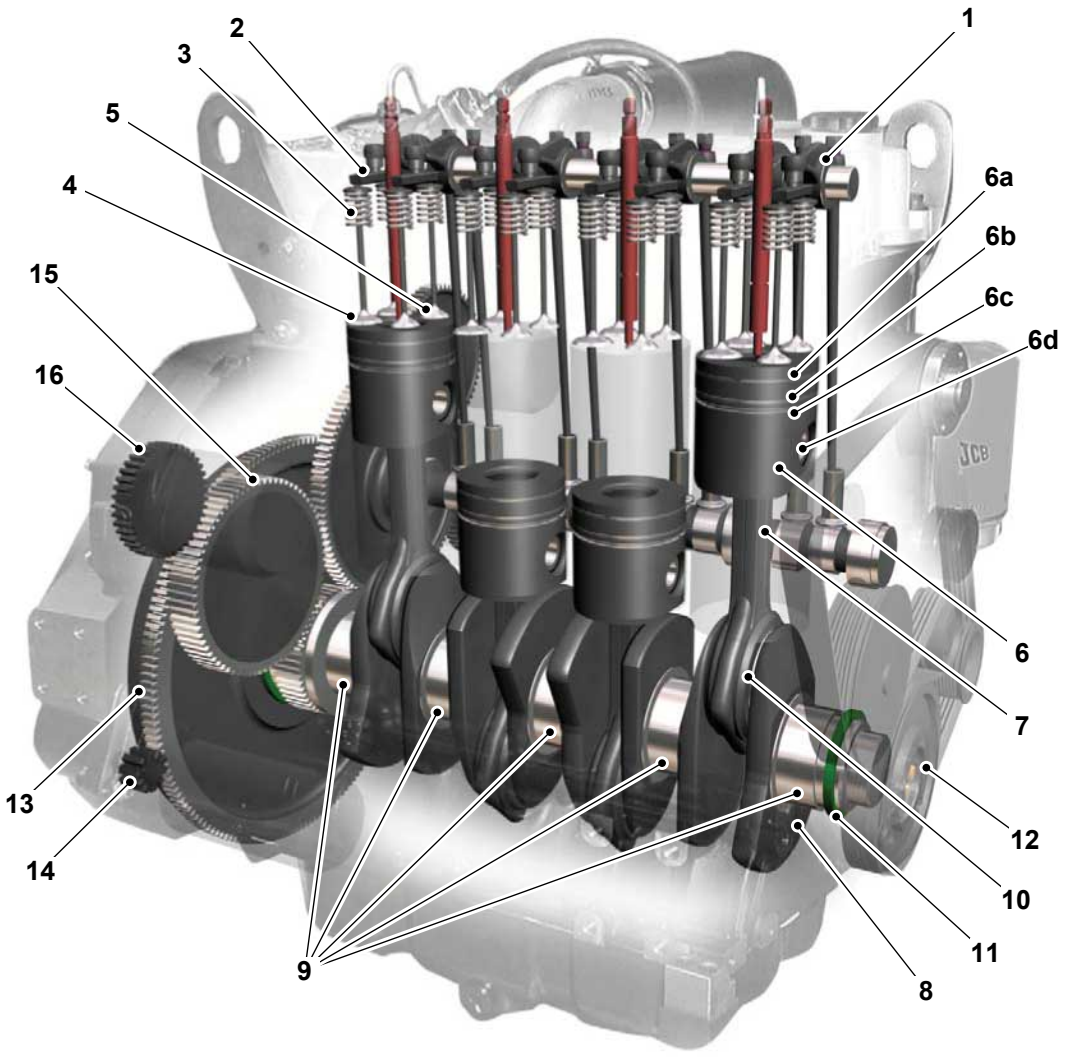
1 Starter motor
2 Flywheel
3 Crankshaft
4 Camshaft
5 Inlet valves (x8)
6 Exhaust valves (x8)
7 Push rods (x8)
8 Fuel injection pump
9 Fuel injectors (x4)
10 Fuel lift pump
11 Inlet manifold
13 Turbocharger
14 Lubrication oil pump
15 Front end drive belt

Internal

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

As viewed on the right hand side. Refer to Figure 4.

Figure 4.



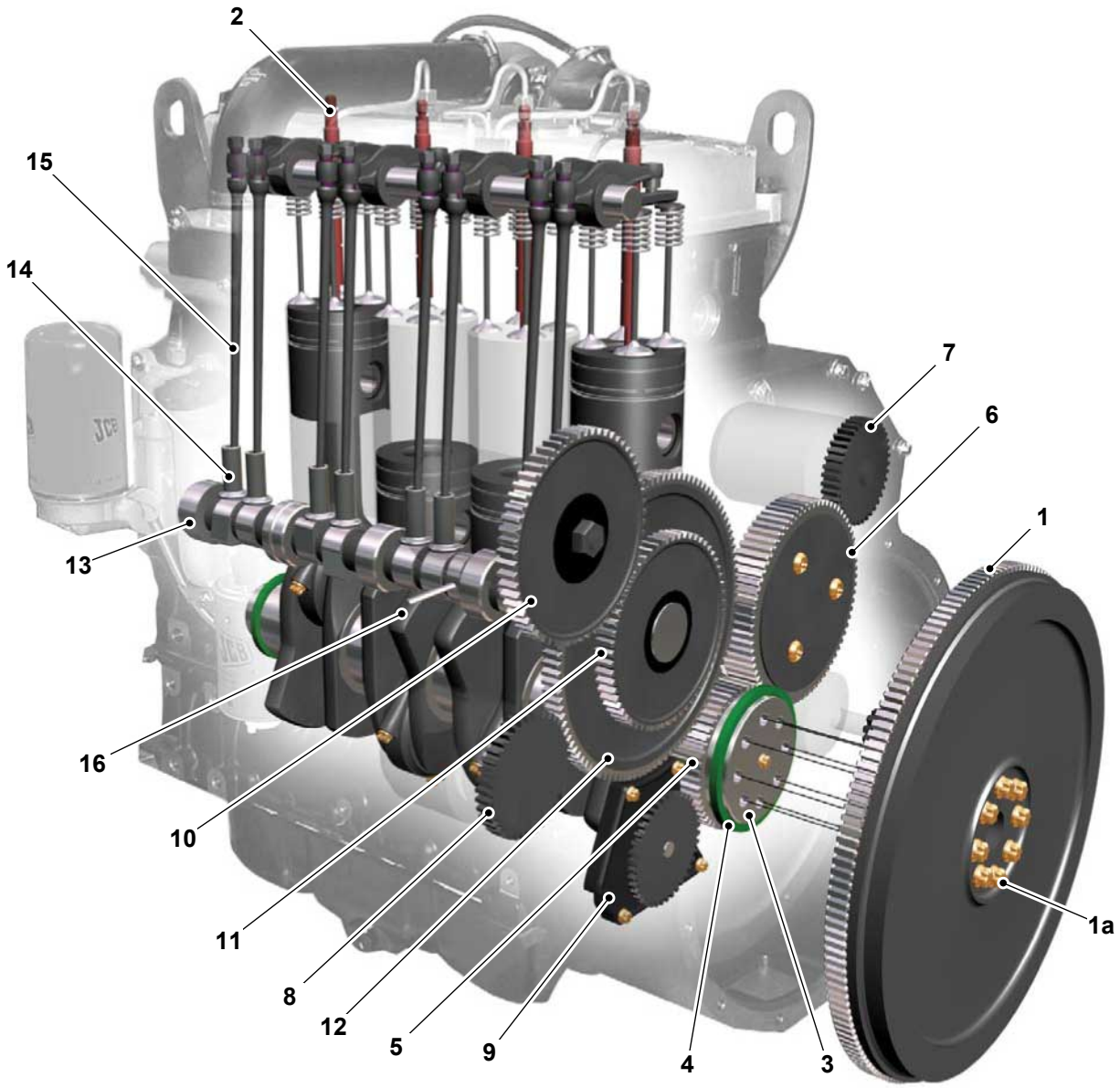
1 Rocker assembly
2 Valve bridge piece (x8)
3 Valve spring (x8)
4 Inlet valve (x8)
5 Exhaust valve (x8)
6 Piston assembly (x4)
6a Piston ring - top compression (x4)
6b Piston ring - 2nd compression (x4)
6c Piston ring - oil control (x4)
6d Gudgeon pin (x4)
7 Connecting rod assembly (x4)
8 Crankshaft
9 Main bearing - crankshaft (x5)
10 Big end bearing - crankshaft/connecting rod (x4)
11 Front crankshaft oil seal
12 Front end drive belt pulley
13 Flywheel
14 Starter motor pinion

15 High duty PTO (Power Take-Off) idler gear (if fitted)

16 High duty PTO device drive gear (if fitted)

As viewed on the rear left side. Refer to Figure 5.

Figure 5.



1 Flywheel
1a Flywheel - crankshaft fixing bolts (x8)
2 Fuel injector (atomiser) (x4)
3 Flywheel hub
4 Rear crankshaft oil seal
5 Crankshaft drive gear
6 High duty PTO idler gear (if fitted)
7 High duty PTO device drive gear (if fitted)
8 Low duty PTO device (if fitted)
9 Lubrication oil pump
10 Fuel injection pump drive gear
11 Camshaft compound gear
12 Camshaft drive gear
13 Camshaft
14 Tappet (x8)
15 Push rod (x8)
16 Fuel lift pump actuator pin

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 5. Basic Engine Data - 444 Engine

Engine variants (Tier 2/stage 2)	
- SA	Naturally aspirated
- SB	Turbocharged
- SC	Turbocharged with inter-cooler
Engine variants (tier 3):	
- SG	Naturally aspirated
- SD	Turbocharged
- SF	Turbocharged with inter-cooler
Rated speed	
Vehicle applications	2200 RPM (Revolutions Per Minute)
Generator set application - 50 Hz	1500 RPM
Generator set application - 60 Hz	1800 RPM
Weight (dry):	
- SA, SG	472kg
- SB, SC, SD, SF	477kg
Number of cylinders	4
Nominal bore size	103mm
Stroke	132mm
Cylinder arrangement	In line
Combustion cycle	4-stroke
Firing order	1-3-4-2
Displacement	4.399L
Compression ratio	
- SA	18.6 : 1
- SB	18.3 : 1
- SC	17.5 : 1
- SD	17.2 : 1
- SF	17.2 : 1
Engine compression	see Note(1)
Direction of rotation (viewed from front {crankshaft pulley} end)	Clockwise
Valves	4 per cylinder
Valve clearances measured at the valve end of the rocker (measured cold):	
- Inlet	0.19–0.27mm
- Exhaust	0.56–0.64mm
Lubricating oil pressure(2)	>4.6bar (66.7psi)
Combustion system	Direct injection
Fuel injection pump	Rotary mechanical

(1) Compression variance between each cylinder should be no greater than 3.5bar (50.7psi).
(2) Engine at normal operating temperature and maximum revs.

Table 6. Basic Engine Data - 448 Engine

Engine variants (tier 2/stage 2)	
- DA	Naturally aspirated
- DB	Turbocharged
- DC	Turbocharged with inter-cooler
Engine variants (tier 3):	
- DG	Naturally aspirated
- DD	Turbocharged
- DF	Turbocharged with inter-cooler
Rated speed	
Vehicle applications	2200 RPM
Generator set application - 50 Hz	1500 RPM
Generator set application - 60 Hz	1800 RPM
Weight (dry):	
- DA, DG	472kg
- DB, DC, DD, DF	477kg
Number of cylinders	4
Nominal bore size	106mm
Stroke	135mm
Cylinder arrangement	In line
Combustion cycle	4-stroke
Firing order	1-3-4-2
Displacement	4.765L
Compression ratio	
- DA	18.6 : 1
- DC	18.1 : 1
Engine compression	see Note(1)
Direction of rotation (viewed from front {crankshaft pulley} end)	Clockwise
Valves	4 per cylinder
Valve clearances measured at the valve end of the rocker (measured cold):	
- Inlet	0.19–0.27mm
- Exhaust	0.56–0.64mm
Lubricating oil pressure(2)	>4.6bar (66.7psi)
Combustion system	Direct injection
Fuel injection pump	Rotary mechanical

(1) Compression variance between each cylinder should be no greater than 3.5bar (50.7psi).
(2) Engine at normal operating temperature and maximum revs.

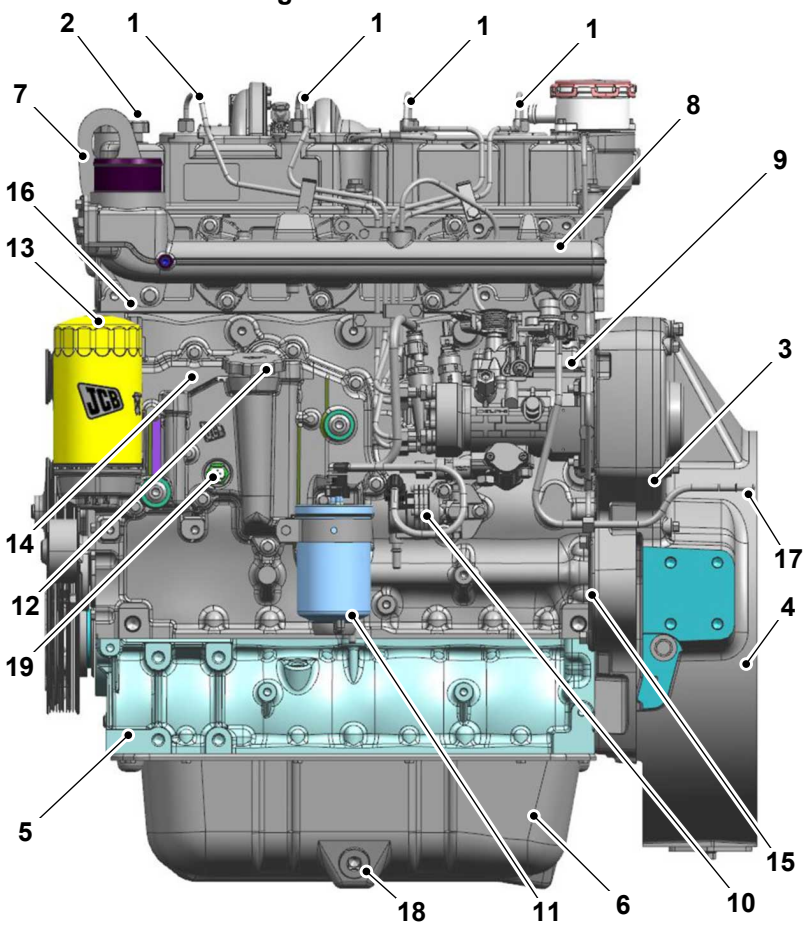
Component Identification

External

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

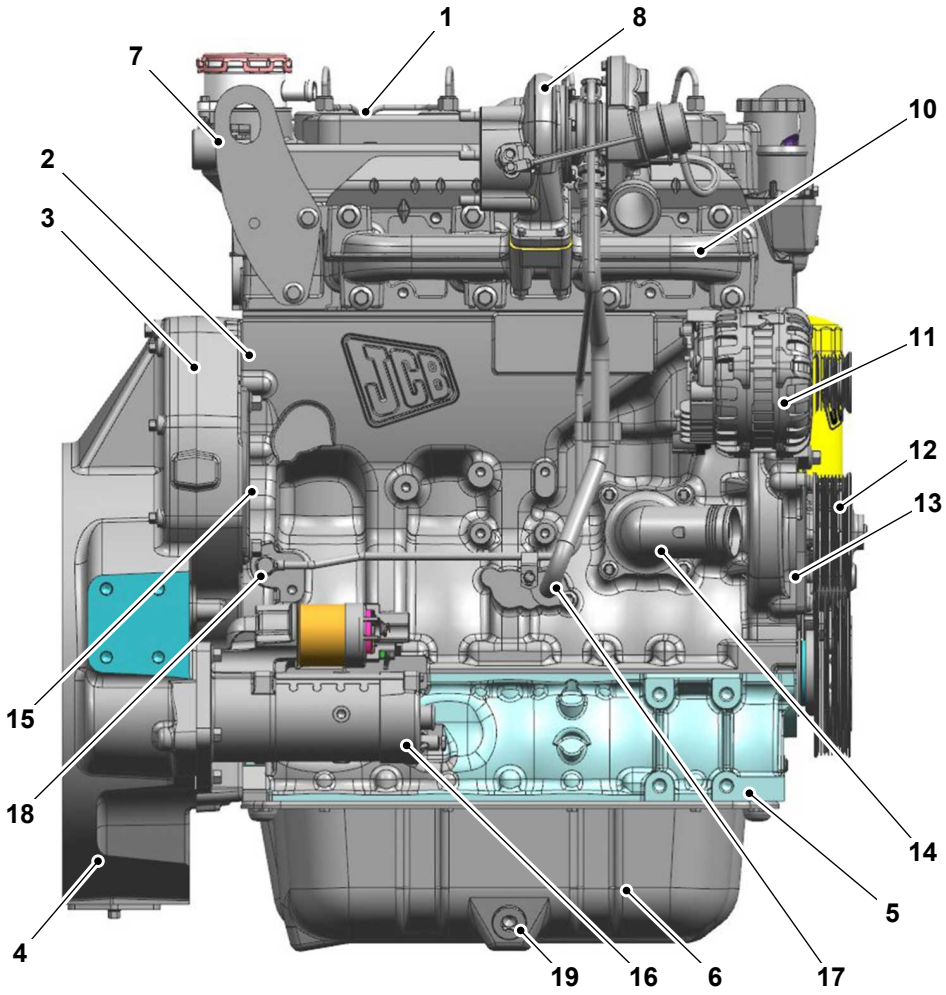
Remember that the left and right sides are determined when viewing the flywheel (rear) end of the engine.

Figure 6. Left hand Side



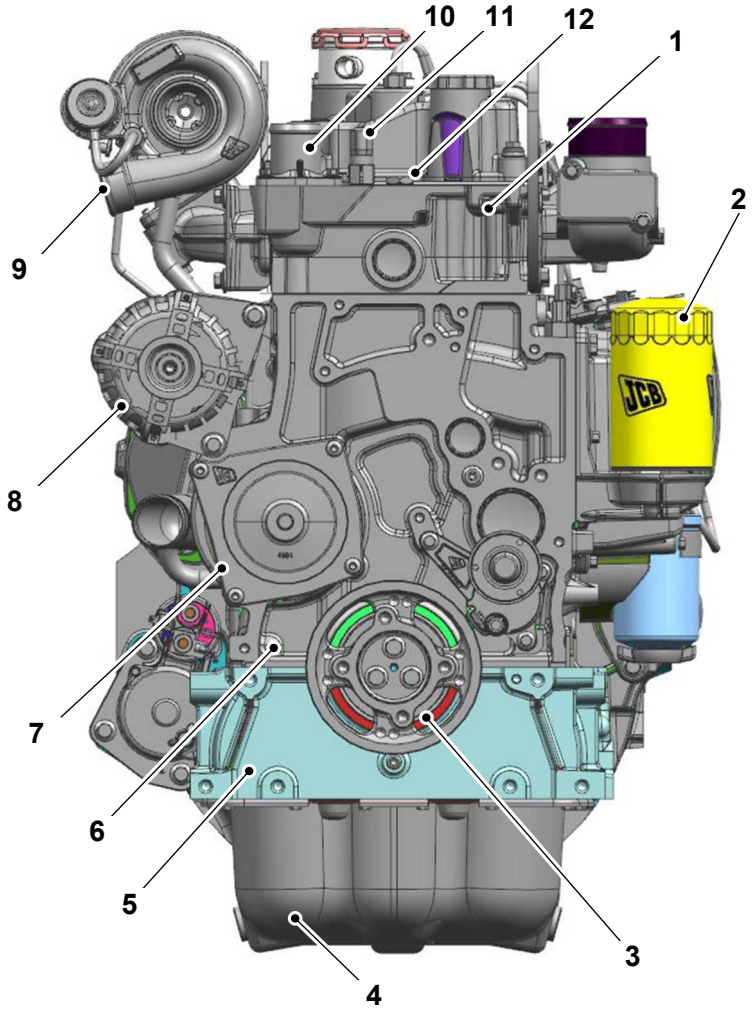
1 Fuel injectors and high pressure fuel pipes
2 Lubrication oil filler cap
3 Timing gear case
4 Flywheel housing
5 Bed plate
6 Lubrication oil sump
7 Engine lifting eye
8 Air inlet manifold
9 Fuel injection pump
10 Fuel lift pump
11 Fuel filter
12 Lubrication oil filler cap
13 Lubrication oil filter
14 Lubrication oil cooler housing
15 Low duty PTO (Power Take-Off) (blanking cover if no device is installed)
16 Water temperature sender (cold start)
17 Low pressure fuel line (to tank)
18 Oil drain plug (sump)
19 Oil pressure switch

Figure 7. Right Hand Side



1 Breather chamber inspection cover
2 Crankcase
3 Timing gear case
4 Flywheel housing
5 Bedplate
6 Lubrication oil sump
7 Lifting eye
8 Turbocharger (turbocharged engine only)
9 Turbocharger wastegate actuator assembly
10 Exhaust manifold
11 Alternator and drive pulley assembly (belt not installed)
12 Coolant pump drive pulley (belt not installed)
13 Coolant pump housing (crankcase)
14 Coolant inlet/radiator hose connector
15 Heavy duty PTO (blanking cover if no device is installed)
16 Starter motor
17 Turbocharger oil drain line (turbocharged engine only)
18 Turbocharger oil feed line (turbocharged engine only)
19 Oil drain plug (sump)

Figure 8. Front End



1 Cylinder head
2 Lubrication oil filter
3 Crankshaft pulley
4 Lubrication oil sump
5 Bedplate
6 Crankcase
7 Coolant pump and drive pulley assembly
8 Alternator and drive pulley assembly
9 Turbocharger (turbocharged engine only)
10 Coolant thermostat housing/radiator hose connector
11 Coolant temperature sender
12 Cab heater water hose connector

Operation

The Four Stroke Cycle

This section describes the cycle sequence, for the 6 cylinders of the diesel engine.

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

Table 7. The Four Stroke Cycle

Stage 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.

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.

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 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.

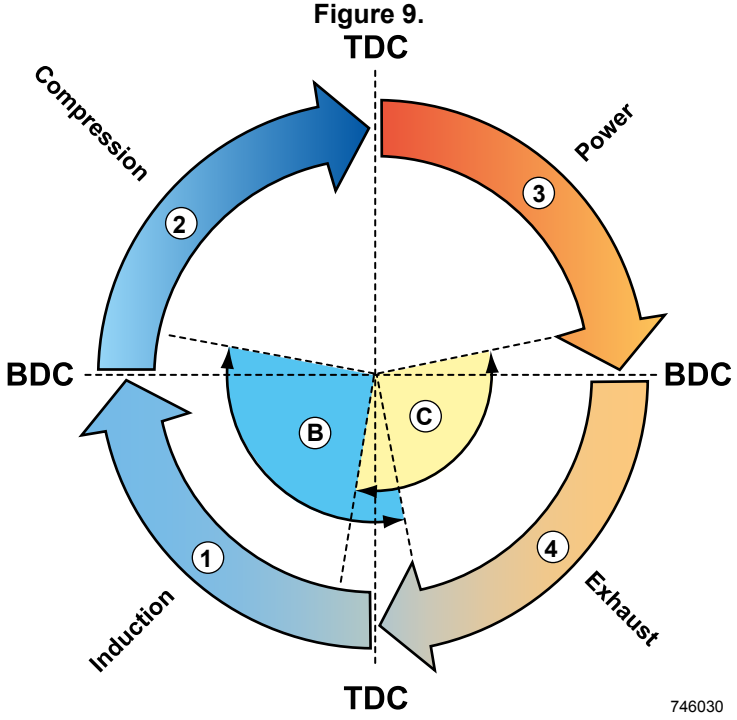
This combustion causes a very rapid rise in both temperature and pressure. The high pressure generated propels the piston downward turning the crankshaft and producing energy.

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.

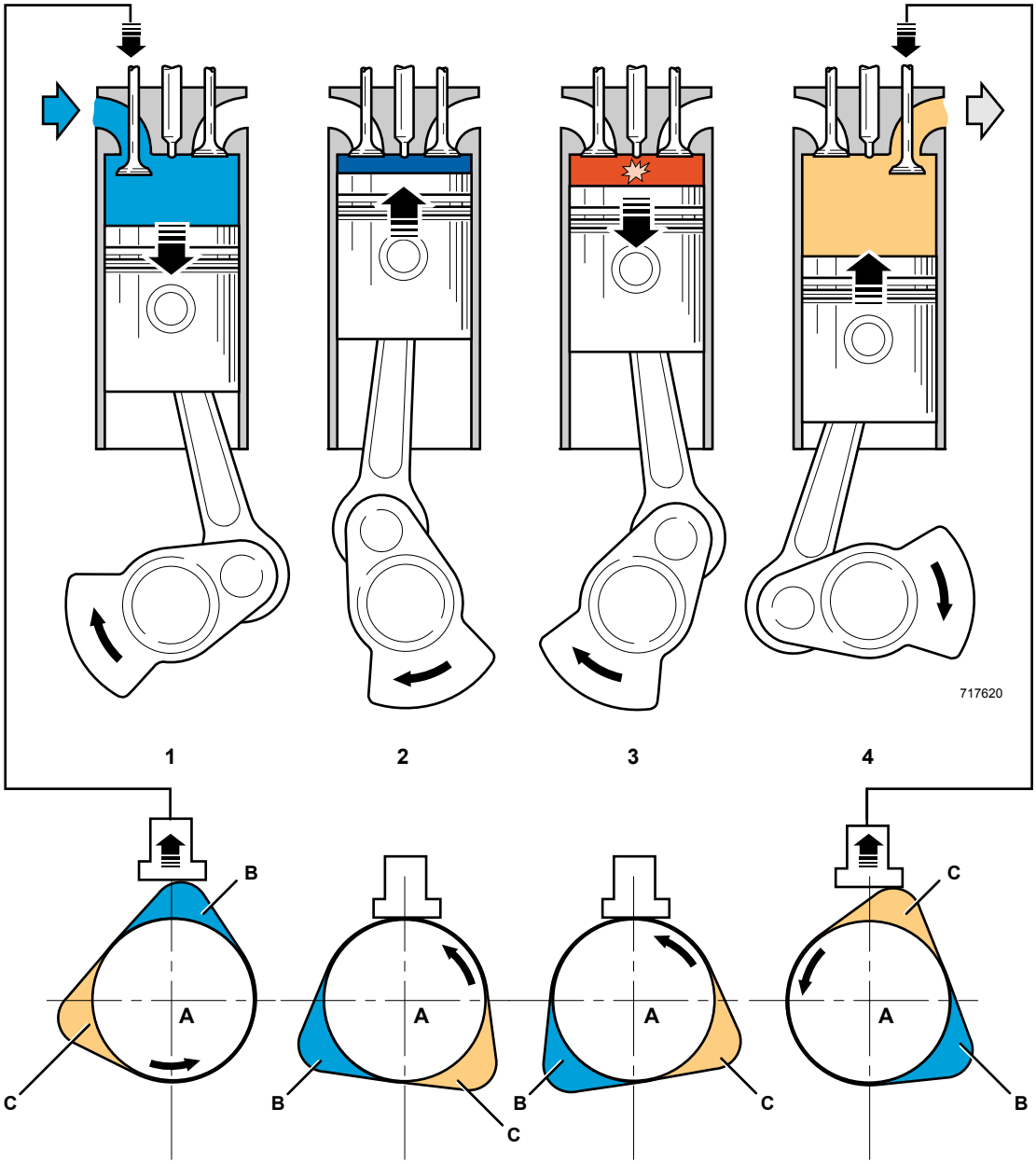
In a running engine these four phases are continuously repeated. Each stroke is half a revolution of the crankshaft, thus, in one cycle of a four stroke engine, the crankshaft revolves twice.

Figure 9.



1 Induction
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 (Top Dead Centre)

Figure 10.



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

Drain and Fill

Refer to Engine, Oil Filter, (PIL 15-21-00).

Clean

⚠ **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: 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.

Before carrying out any service procedures that require components to be removed, the engine must be properly cleaned.

Cleaning must be carried out either in the area of components to be removed or, in the case of major work, or work on the fuel system, the whole engine and surrounding machine must be cleaned.

Stop the engine and allow it to cool for at least one hour. DO NOT attempt to clean any part of the engine while it is running.

1. Make sure that the electrical system is isolated.
2. Make sure that all electrical connectors are correctly coupled. If connectors are open fit the correct caps or seal with water proof tape.
3. Cover the alternator with a plastic bag to prevent water ingress.
4. Seal the engine air intake, exhaust and breather system.
5. Make sure that the oil filler caps and dipstick are correctly installed.
6. Use a low pressure water jet and soft bristle brush to soak off caked mud or dirt.
7. Apply an approved cleaning and degreasing agent with a brush. Obey the manufacturers instructions.
8. Use a pressure washer to remove the soft dirt and oil. Important: DO NOT aim the water jet directly at oil seals or electrical and alternator. DO NOT place the jet nozzle closer than 600mm (24 in) to any part of the engine.
9. When the pressure washing is complete move the machine away from the wash area, or alternatively, clean away the material washed from the machine.

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