Introduction

About this Manual

Using the Service Manual

This publication is designed for the benefit of JCB Distributor Service Engineers who are receiving, or have received, training by JCB Technical Training Department.

These personnel should have a sound knowledge of workshop practice, safety procedures, and general techniques associated with the maintenance and repair of engines.

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. Finally, please remember above all else **SAFETY MUST COME FIRST**!

The manufacturer's policy is one of continuous improvement. The right to change the specification of the engine without notice is reserved. No responsibility will be accepted for discrepancies which may occur between the specifications of the engine and the descriptions contained in this publication.

Section Numbering

The manual is compiled in sections, the first three are numbered and contain information as follows:

1 **General Information** includes torque settings and service tools.

2 **Care & Safety** includes warnings and cautions pertinent to aspects of workshop procedures etc.

3 **Routine Maintenance**includes service schedules and recommended lubricants.

The remaining sections deal with Descriptions, Fault Finding, Dismantling, Overhaul etc. of specific components, for example:

4 **Systems Descriptions**

5 **Fault Finding** ...etc.

Left Side, Right Side

References to the 'left' side and the 'right' side of the engine are when viewed from the flywheel end of the engine, as shown at **1A**.

Fig 1.

Units of Measurement

In this manual, the S.I. system of units is used. For example, liquid capacities are given in litres. The imperial units follow in parenthesis () e.g. 28 litres (6 UK gal).

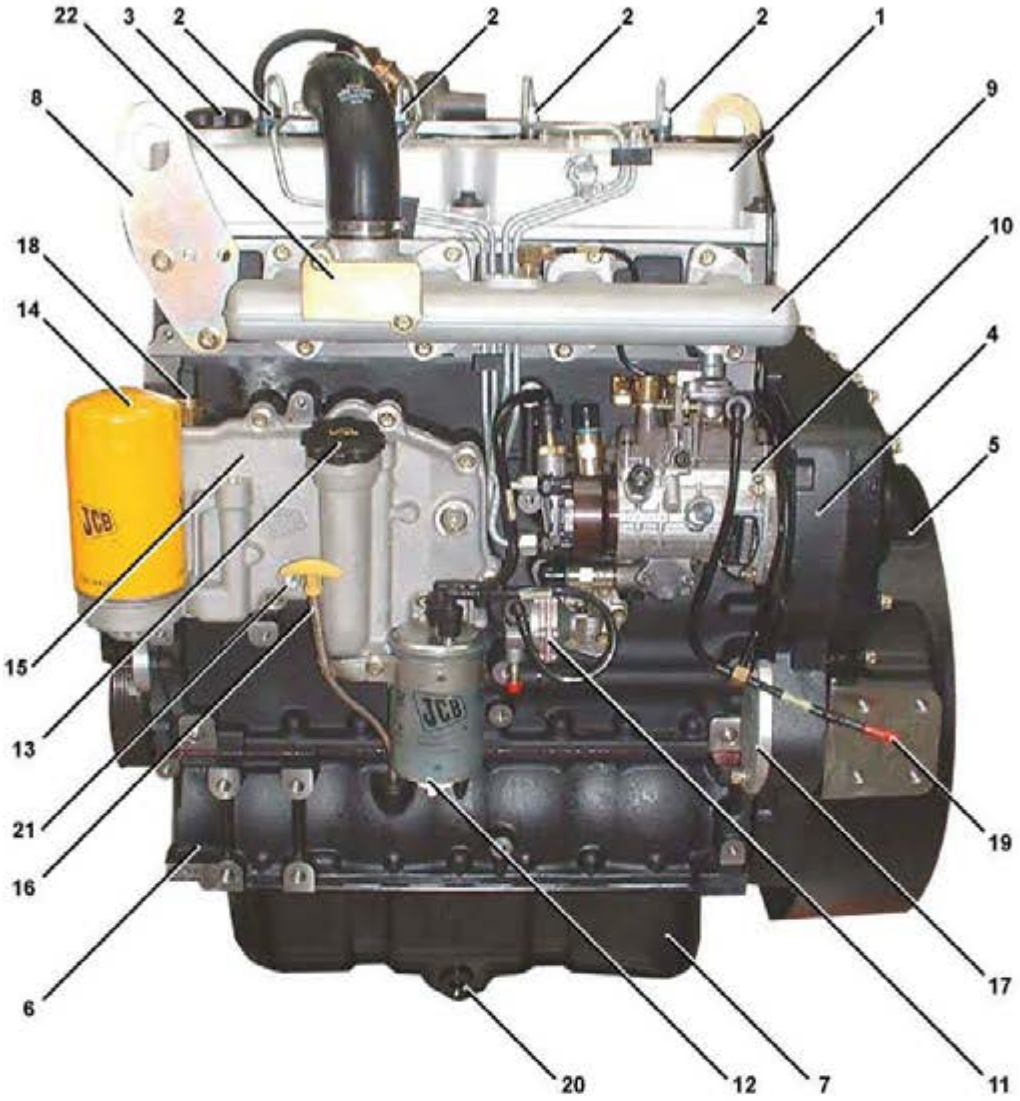


Fig 5. SB Type engine shown

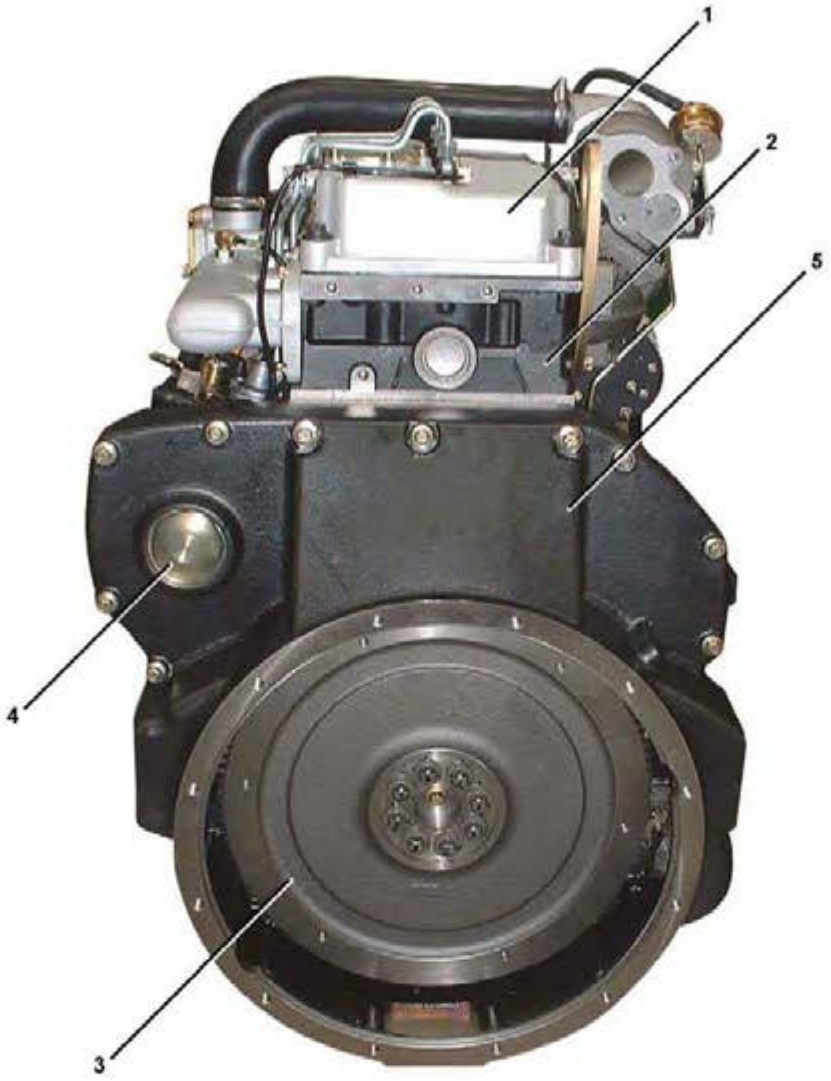


Fig 8. SB Type engine shown

Table 4. Engine - As viewed on the flywheel (rear) end

⇨ *Fig 8. (1-11)*

1	Rocker cover	4	Fuel injection pump drive gear cover
2	Cylinder head	5	Flywheel housing
3	Flywheel		

Inlet and Exhaust Valve Data

Max lift inlet	
- SA, SB, SC	9.37 mm @ 101° atdc
- SD, SF	9.64 mm @ 101° atdc
Max lift exhaust	
- SA	9.42 mm @ 110° btdc
- SB, SC	9.42 mm @ 115° btdc
- SD, SF	9.84 mm @ 115° btdc
Inlet opens (top of ramp)	
- SA, SB, SC	10° btdc
- SD, SF	6° btdc
Inlet closes	
- SA, SB, SC	32° abdc
- SD, SF	28° abdc
Exhaust opens	
- SA	50° bbdc
- SB, SC	60° bbdc
- SD, SF	41° bbdc
Exhaust closes	
- SA, SB, SC	10° atdc
- SD, SF	9° atdc
Valve stem diameter	
- SA, SB, SC	Inlet: 6.935 +/-0.0075 mm (0.273 +/-0.0003 in)
	Exhaust: 6.975 +/-0.0075 mm (0.275 +/-0.0003 in)
- SD, SF	Inlet: 6.928 to 6.943 mm (0.2727 to 0.2733 in)
	Exhaust: 6.918 to 6.933 mm (0.2724 to 0.2729 in)
Valve spring free length	40.18 mm (1.581 in)
Valve guide bore diameter	
- min	6.958 mm (0.2739 in)
- max	6.968 mm (0.2743 in)
Valve face angle	
- inlet	60.5 °
- exhaust	45.17 °
Valve length	131.9 to 132.4 mm (5.193 to 5.213 in)
Valve sealing	stem seal with sealing washer
Valve head depth (below cylinder head surface)	
- inlet	0.89 to 1.39 mm (0.035 to 0.055 in)

Lubricants and Capacities

Engine Lubricating Oil

New engines DO NOT require a running-in period. The engine/machine should be used in a normal work cycle immediately, glazing of the piston cylinder bores, resulting in excessive oil consumption, could occur if the engine is gently run-in. Under no circumstances should the engine be allowed to idle for extended periods; (e.g. warming up without load).

A minimum API CF4 grade oil must be used. Superior grade oils may be more appropriate for heavy duty applications (such as sustained high loads and operation at elevated temperatures).

The choice of lubricant viscosity should be made based on the lowest ambient temperature at which the machine will be started and the maximum ambient temperature at which it will operate.

The following table provides guidance as to the temperature range that can be accommodated by standard oil viscosities and can be used to select an appropriate grade. ⇨ *Table 54. (1-57)*.

Table 54.

Oil Viscosity	Minimum Temperature °C (°F)	Maximum Temperature °C (°F)
SAE 0W30	- 40 (-40)	+ 30 (86)
SAE 0W20	- 40 (-40)	+ 10 (50)
SAE 5W20	- 30 (-22)	+ 10 (50)
SAE 5W40	- 30 (-22)	+ 40 (104)
SAE 10W30	- 20 (-4)	+ 40 (104)
SAE 15W40	- 15 (-5)	+ 50 (122)

Recommended Oils

Table 55.

Engine Oil	Specification
JCB High Performance(1)	ACEA E2:B2:A2, API CF4/SG(1)
JCB Extreme Performance	ACEA E5/B3/A3, API CH-4/SJ

(1) Not suitable for generator set applications.

Engine Oil Capacity

Choose the grade of oil to suit the temperature range as detailed. ⇨ *Table 54. (1-57)*. The engine oil capacity, including filter and clean sump is 12 litres MIN and 15 litres MAX mark on the dipstick.

Table 56.

Item	Capacity litres (UK Gal)	
	Minimum	Maximum
Engine	12 (2.6)	15 (3.3)

892/01155 - FIP Gear Removal Tool

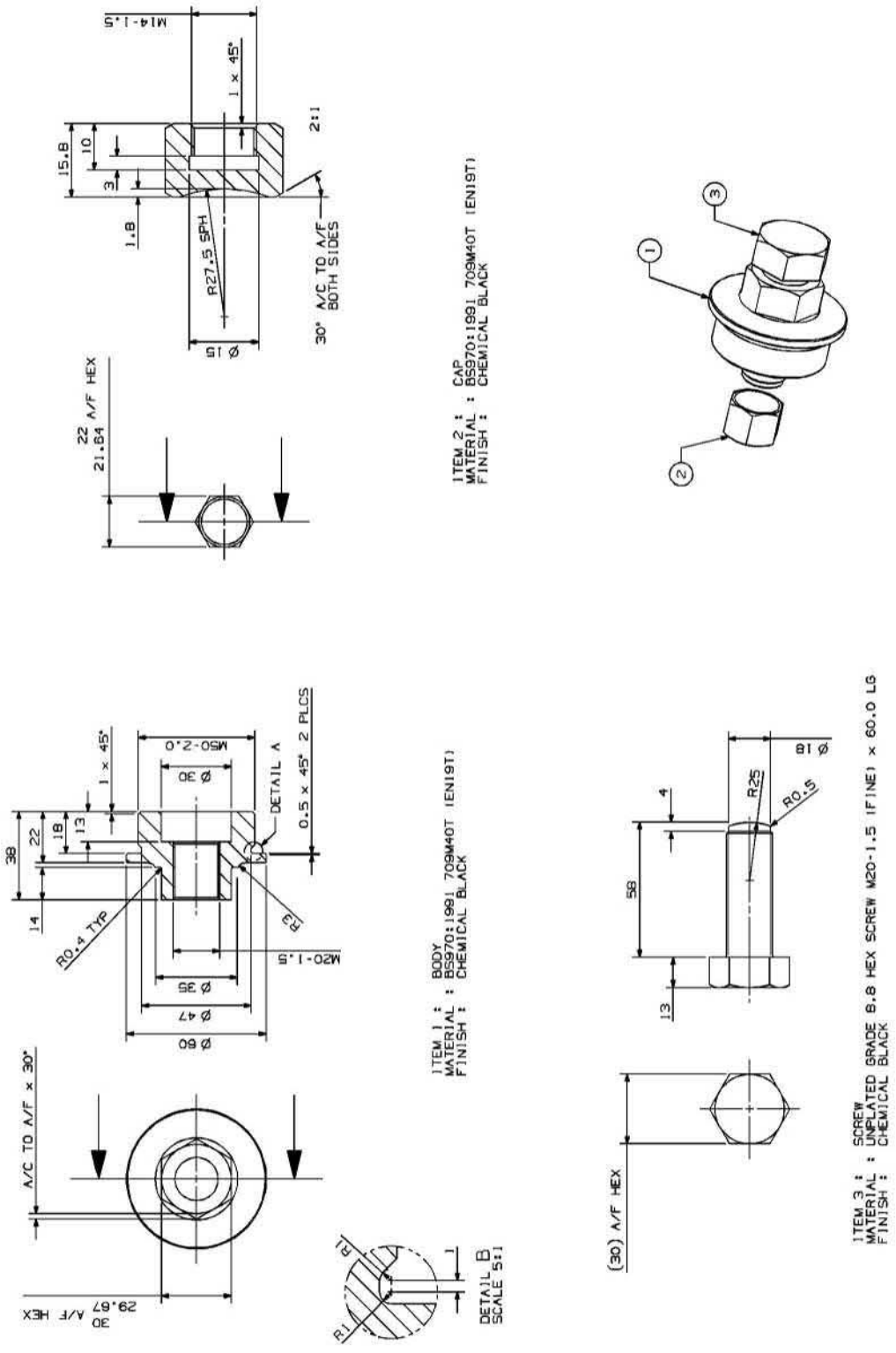


Fig 91.

Cleaning the Engine

Do not attempt to clean any part of the engine while it is running. Stop the engine and allow it to cool for at least one hour. Disconnect the machine battery.

Use an approved water soluble degreaser to soften any oil deposits. Wash with clean water and allow the engine to dry.

High Pressure Cleaning

⚠ CAUTION

The engine or certain components could be damaged by high pressure washing systems; special precautions must be taken if the engine is to be washed using a high pressure system.

Ensure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system.

ENG-3-3

Special precautions must be taken if the engine is to be washed using a high pressure cleaning system as follows:

1 Do not aim the jet wash directly at the fuel injector seals (shown at **A**).

2 Do not wash any part of the:

- fuel injection pump
- cold start device
- electrical shut off solenoid (ESOS)
- electrical connections

3 Care should be taken, when an engine is cleaned with a high pressure cleaning system.

4 Ensure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system.

The engine or certain components could be damaged by pressure washing systems.

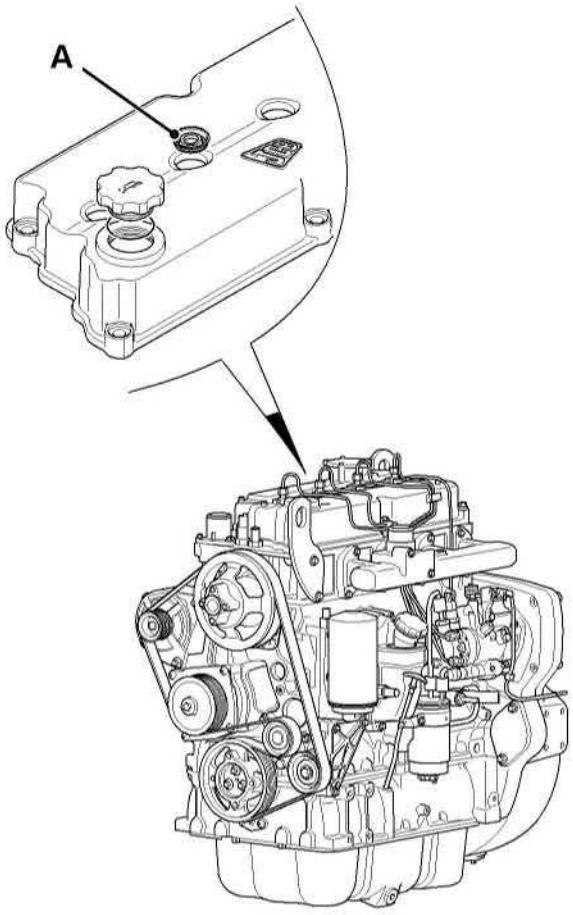


Fig 1.

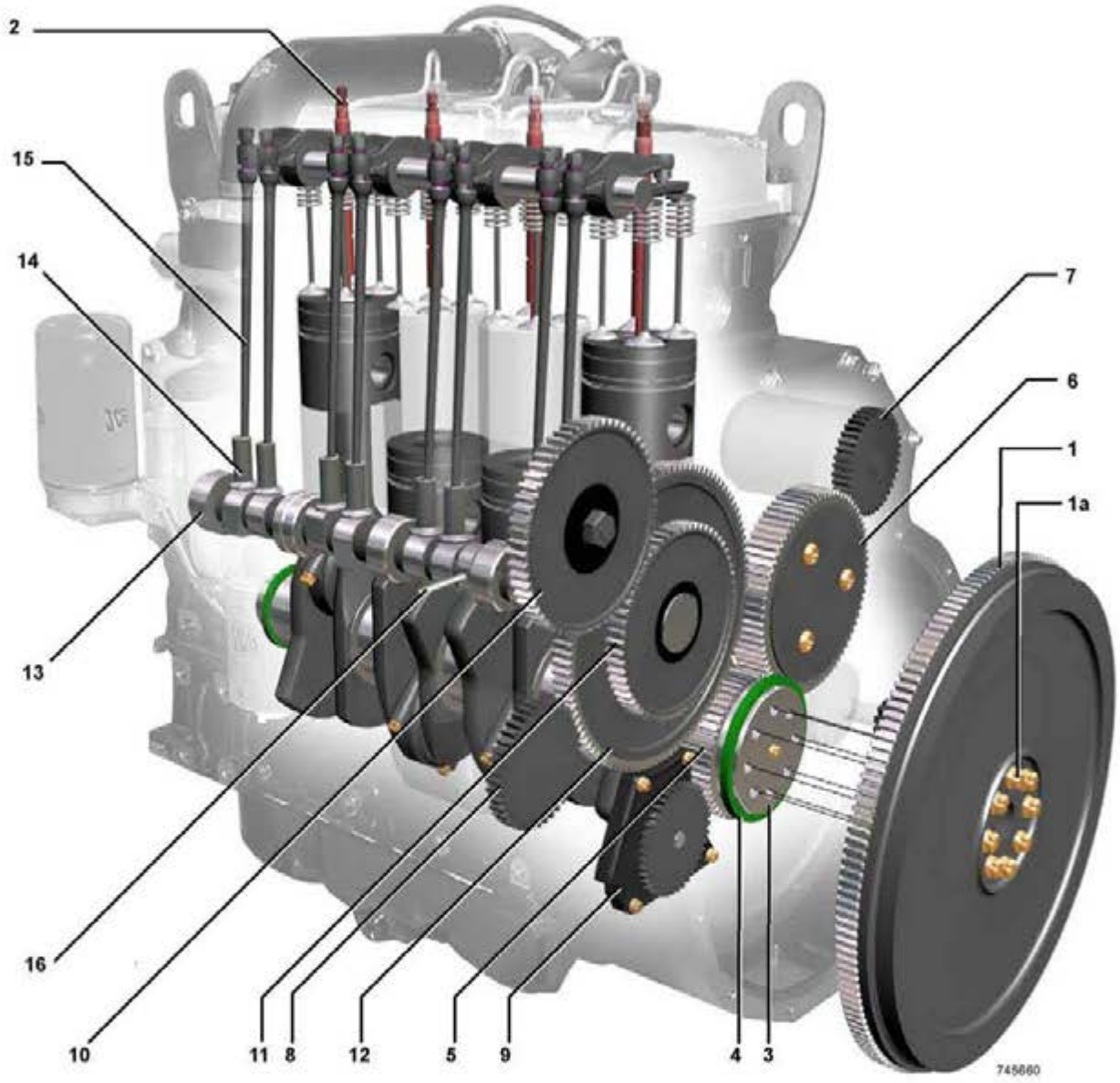


Fig 6. Engine - As viewed on the rear left side

⇨ *Table 6. (📄 4-10)*

Oil Cooler and Filter

⇨ *Fig 20. (🗋 4-32)*

The oil cooler and filter are incorporated in a housing **20-1** bolted to the side of the cylinder block. The housing allows transfer of lubricating oil from the cylinder block to the oil cooler **20-5** and filter head **20-3**. Coolant also transfers to the housing and passes over the oil cooler matrix **20-5** causing heat to exchange from the oil to the coolant.

Cooled and filtered oil then passes back into the main oil gallery in the block via port **20-10**.

An engine oil filler point is also included via cap **20-2** and port **20-11** which aligns with a port in the block.

Oil Cooler Matrix

Although the cooler matrix **20 -5** is a separate component, it is a non serviceable part and must not be removed from the housing. The housing/cooler assembly is leak tested during manufacture to minimise the risk of cross contamination of coolant and lubricating oil.

Oil Filter

The oil filter **20-13** is a 'spin on' type which screws on and off the filter head **20-3**.

Engine running - shown at **20-A**. The oil pump delivers oil at pressure to the filter via port **20 -9**. The lip seal **20-15** is forced off its seat and oil flows through a large area paper element **20-14**. Filtered oil enters the inner part of the filter and forces down the valve plate **20-16** against spring **20-17**. Oil then leaves the filter and filter head via port **20-10**.

Engine stopped - shown at **20-B**. With the engine stopped oil pressure in the galleries and filter decays. As it does so, valve plate **20-16** is pushed on its seat under the action of spring **20-17**, preventing oil draining down from the engine galleries. Lip seal **20-15** also falls on its seat and oil is prevented from draining from the filter assembly. These features help protect the engine from oil starvation on start up.

Table 16. Key

⇨ *Fig 20. (🗋 4-32)*	
1	Oil cooler and filter housing
2	Oil filler cap
3	Oil filter head
4	Oil filter drain down plug
5	Oil cooler matrix
6	Sealing gasket - housing to cylinder block
7	Coolant gallery
8	Oil gallery - from pump to cooler
9	Oil gallery - from cooler to filter head
10	Oil gallery - from filter head to main oil gallery
11	Oil fill port
12	Oil pressure switch
13	Oil filter
14	Filter element
15	Lip seal
16	Valve plate
17	Spring

A	Oil filter state - engine running
B	Oil filter state - engine stopped

Table 11. Engine - RPM Surges

Cause	Remedy
Fuel level low.	Check/fill fuel tank.
If the condition occurs at idle, the idle speed set too low for accessories.	Check the engine idle rpm setting is as specified in the machine's service manual.
Throttle adjsutment incorrectly set or binding.	Check the engine maximum rpm setting is as specified in the machine's service manual. Check the throttle linkage and cable for binding etc.
Fuel injection lines leaking.	Inspect and correct as required leaks in the high pressure lines, fittings injector sealing washers, or delivery valves.
	WARNING: Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of pressurised fluid and wear protective glasses. If fluid penetrates your skin, get medical help immediately.
Fuel tank cap vent/breather blocked.	Inspect and rectify as required - replace cap if necessary.
Fuel is aerated.	Check the fuel system for loose connections and possible air ingress points. Rectify and bleed the fuel system. Refer to ***Engine Fuel System, Section 3***.
One or more engine injector worn or malfunctioning.	Check and externally clean the injector. If the problem still persists, the injector must be checked by a local FIE specialist, or they can be replaced with new.
Worn or malfunctioning fuel injection pump (injection pump not delivering fuel).	Check for operation of the fuel injection pump, refer to ***Test Procedures, Section 6.*** The fuel injection pump must be take to a local FIE specialist to have the fuel delivery timing checked. Ensure that all obvious causes have been eliminated before removing the injection pump. Refer to ***Fuel Injection Pump, Section 7*** for removal and replacement procedures.

Introduction

Test Procedures Introduction

When completing any tests on equipment, the appropriate safety precautions must be adhered to.

Refer to ***Care & Safety, Section 2***, for a reminder of safe practices and potential hazards.

Use appropriate testing equipment. Always use genuine parts and equipment.

A list of the recommended service tools is given in Section 1, use the tools when specified. For instance, there is a crankshaft turning tool specifically designed to enable the engineer to turn the engine by hand (say to set top dead centre (TDC)).

Safety must always come first, if you are unsure about any of the procedures, ask someone who knows.

If the engine must be running during the test, make sure there is adequate ventilation. If the machine is inside, then exhaust extraction equipment should be used.

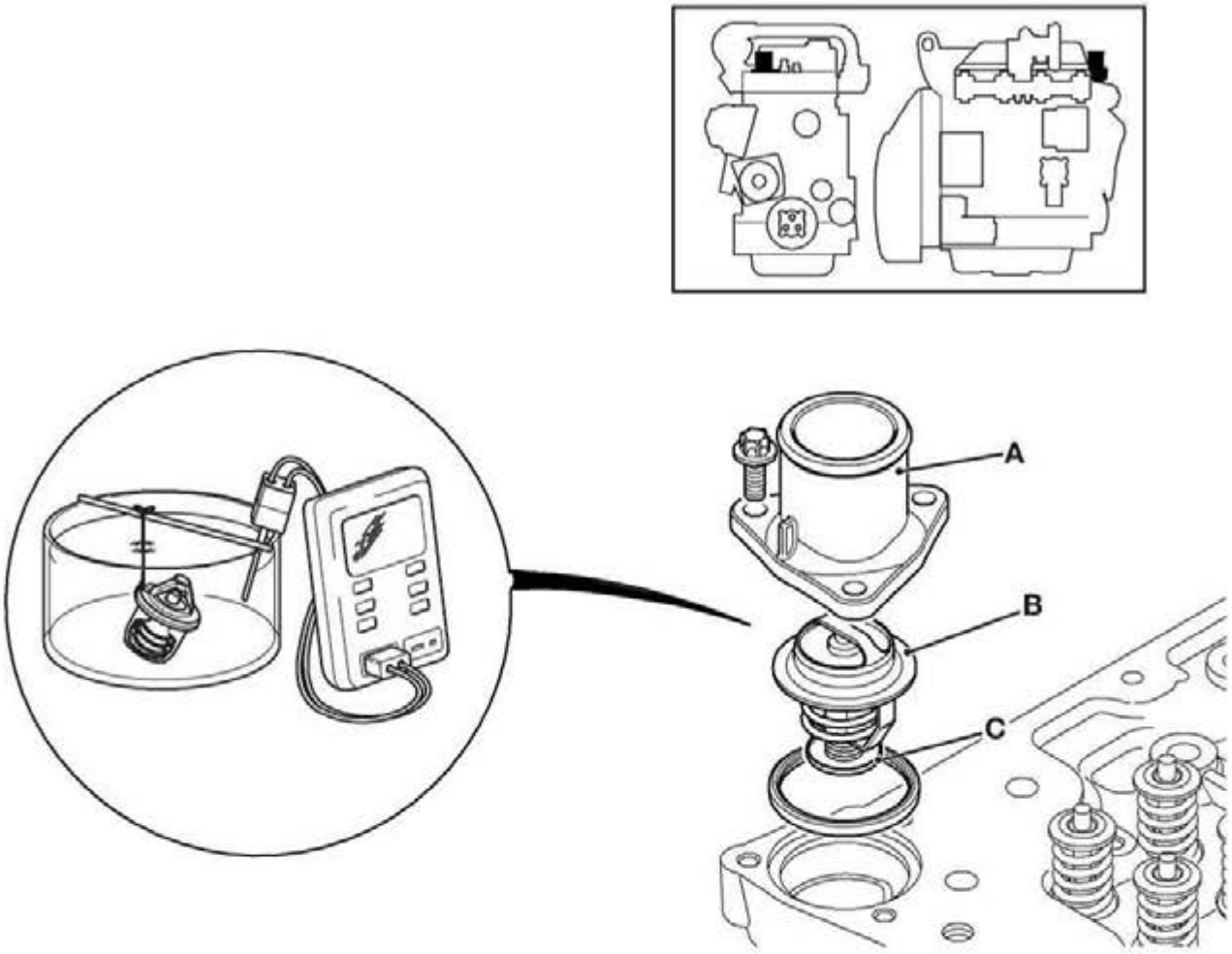


Fig 5.

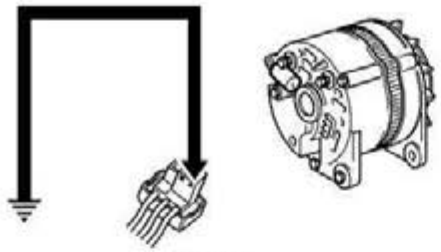


Fig 13.

Check 2

Note: *The following checks should be made using an analogue (moving pointer) type meter.*

1 Stop the engine and turn the starter switch to OFF.

2 Withdraw the alternator plug and connect the test meter between the large terminals and 'earth'. With the meter set to measure 12V DC, the meter should show battery voltage. If the reading is zero, check the cables for continuity, particularly at the starter terminals.

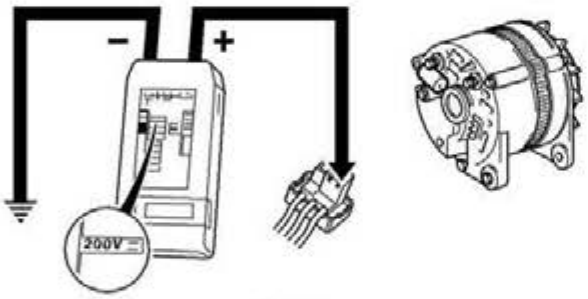


Fig 14.

If the voltage is correct, check the alternator. ⇨ *Alternator Charging Test (🗋 6-24)*.

Alternator Charging Test

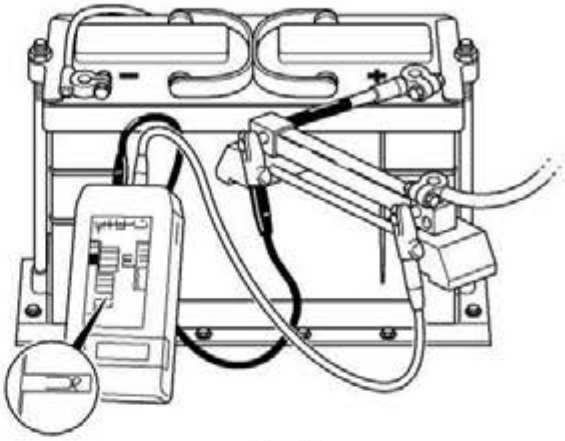


Fig 15.

1 Ensure that all battery and alternator connections are in place, secure and making good metal - to - metal contact, especially the 'earth' connections to chassis and engine.

2 Make sure that the alternator drive belt tension is correctly adjusted.

3 If the battery is in a fully charged condition, switch on the working lights for 3 minutes before commencing the test. Alternatively, operate the starter for a few moments with the engine shut off solenoid (ESOS) fuse removed (See ***Fuse Identification***).

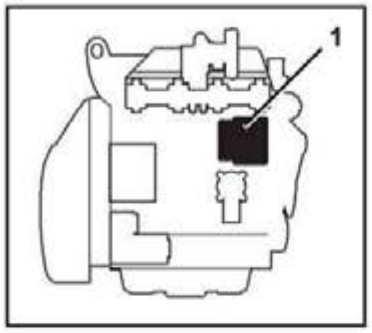
4 Install a 100 amp open - type shunt between the battery positive lead and the battery positive terminal.

5 Connect a multimeter positive lead to machine side of the shunt and negative lead to battery side of the shunt.

6 Connect the leads to the meter and set the meter to the relevant range as follows.

Alternator

Removal and Replacement



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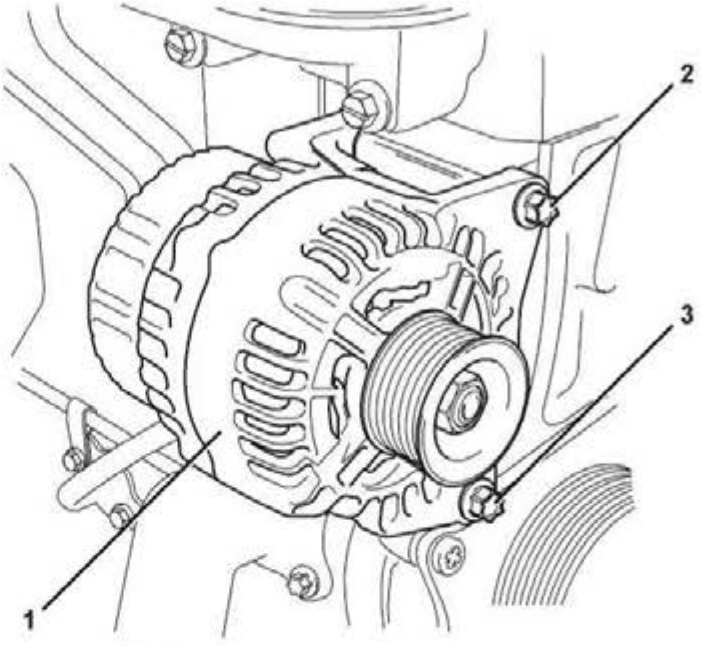

Fig 3.

Table 7. Component Identification

1	Alternator
2	Fixing bolt (long)
3	Fixing bolt (short)

Weight - 7.3 Kg (16.1 lb)

Table 8. Service Tools

Item	Part Number	Description
T1	General	Star drive socket

Cylinder Head

Rocker Cover

Removal and Replacement

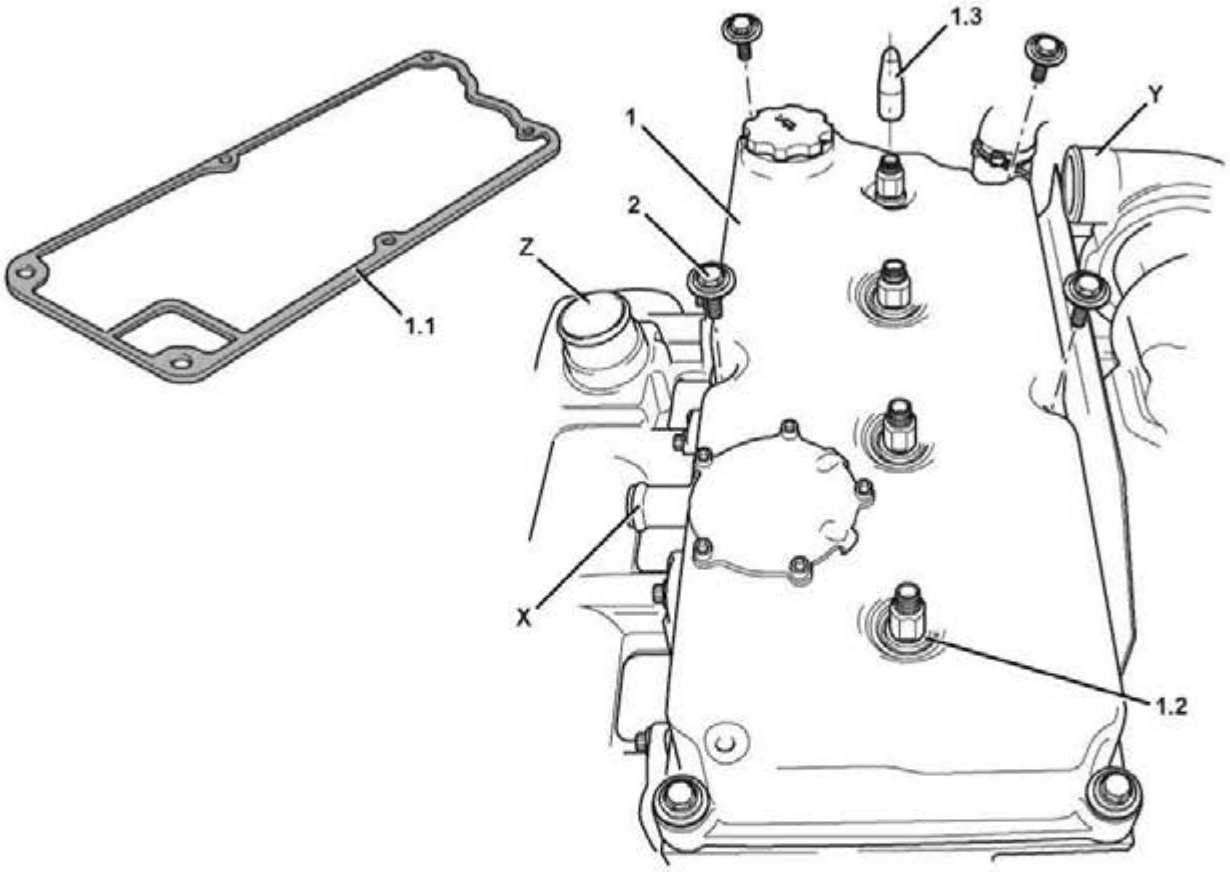

Fig 1.

Table 1. Service Parts

1	Rocker cover gasket kit
	Includes:
1.1	Rocker cover gasket
1.2	Rocker cover injector seals
1.3	Injector sleeves/covers
1.4	Injector pipe caps

Table 2. Component Identification

1	Rocker cover
2	Retaining bolts (6 off)
X	Pipe stub (Breather hose)
Y	Turbocharger outlet (Turbocharged engines only)
Z	Inlet manifold