

JCB Dieselmex Mechanical Engine

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Publication No.
9806/3000-05



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Component Labels

In addition to the engine labels, some of the machine engine components will also have a label attached, or a part number etched into the casting, these include:

- the starter motor
- the alternator
- the fuel injection pump
- engine bedplate
- engine block
- cylinder head
- turbo charger

In some instances, it may be necessary to quote the information on these labels, for instance if there is a parts query, or a warranty claim. Make a note of these numbers.

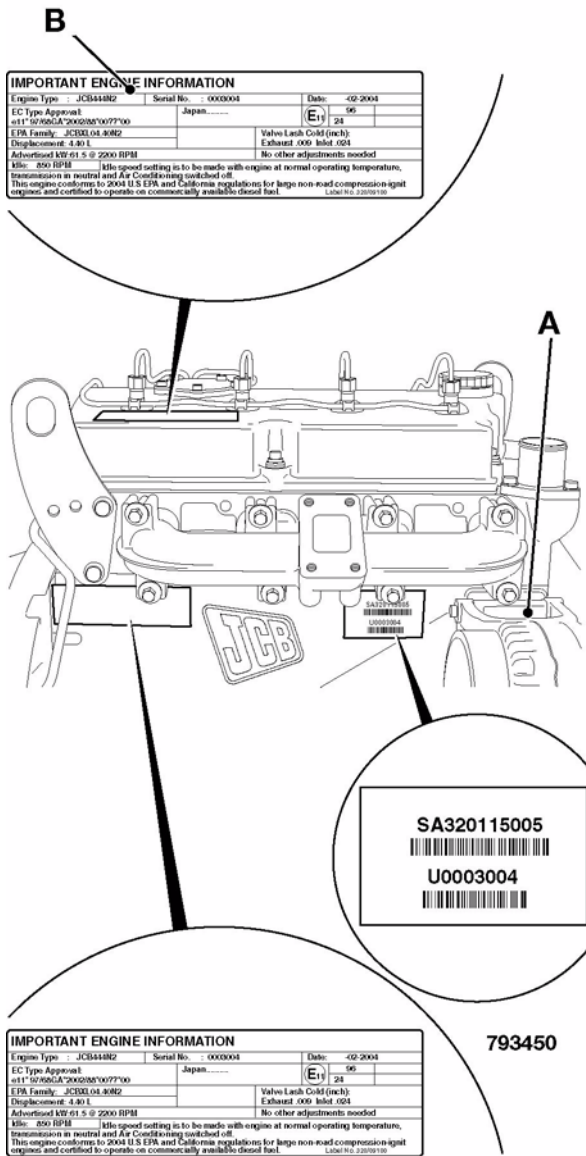


Fig 2.

The last three parts of the engine identification number are stamped on the cylinder block at position **2A** as follows:

U 00001 04

Cylinder Head Data

Cylinder head distortion (maximum permissible)	
- end to end	0.05 mm (0.002 in)
- side to side	0.03 mm (0.0012 in)
Valve recess depth	
- Inlet	0.85 mm (0.033 in)
- Exhaust	0.85 mm (0.033 in)
Valve seat angle	
- inlet	120 ° (inclusive)
- exhaust	90 ° (inclusive)
Cylinder head bolts torque ⁽¹⁾	
- first stage	40 Nm (30 lbf ft)
- second stage	75 Nm (56 lbf ft)
- third stage	repeat 75 Nm
- fourth stage	torque angle + 90 °
- final stage	torque angle + 180°
Surface finish for cylinder head joint	Rz < 15um; Rmax < 20um
Permissible wave profile	wt < 10um 2.5 distance

(1) *Torque information MUST be used in conjunction with recommended procedures contained in this manual. Failure to use the appropriate and correct removal, replacement, dismantle and assembly procedures may result in an engine failure in service. Refer also to the procedures for the correct bolt tightening sequence.*

Usage and Effects of Fuels

Note: The information that follows does not indicate types of fuel that are acceptable or unacceptable. ⇒ [Acceptable and Unacceptable Fuels \(□ 1-22\)](#).

1 Low Sulphur Diesel

In its basic form because of the process of reducing sulphur by removal of sulphur containing compounds (which contribute to mechanical lubrication) an increase in the wear rate of the fuel injection equipment could occur. In view of this, the major fuel producers add suitable lubricity improvers to enable the FIE to run satisfactorily, with no acceleration in wear rate. They must ensure that the lubricity improvers do not themselves create residual deposits that could block the fuel system e.g. filter, injectors etc.

In addition to the lubrication effect there can also be a further reduction in the aromatic content of the fuel which can lead to shrinking/cracking of traditionally nitrile rubber seals throughout the fuel injection equipment that has previously been exposed to higher sulphur level fuels. The major fuel producers tend to maintain the total aromatic content to an acceptable level (15% by volume).

2 Ultra Low Sulphur Diesel

Also known as 'city diesel'. Available throughout the UK and some parts of Europe since March 1999. This fuel has a maximum sulphur content of 0.005% by weight and a further reduction in the natural lubricity and aromatic content than experienced with low sulphur diesel. Major oil producers will add lubrication improvers and also maintain the total aromatic content to an acceptable level.

3 Unmodified Vegetable Oils

Burned in diesel engines neat or used as an extender to mineral derived fuel. When these are subjected to heat in the fuel injection system they form sticky deposits that can be found inside the fuel pump and a hard lacquer in the injectors where exposure to even higher temperatures takes place.

4 Chemically Modified Vegetable Oils (FAME/VOME)

These fuels have been derived from a wide range of vegetable oils and animal fats, resulting in better

stability, viscosity and cetane number than those produced from unmodified vegetable oils, but it is recognised that there are potential problems associated with the finished fuel characteristics. These oils are less stable than mineral oil derived fuels when stored and they will readily degrade producing fatty acids, methanol and water, none of which are desirable in the FIE. These effects are known to be accelerated when the fuel is stored in the presence of air and water together.

An extract 'common statement' from the FIE manufactures specifies that "The fuel injection equipment manufacturers can accept no liability whatsoever for failure attributable to operating their products with fuels for which the products were not designed, and no warranties or representations are made as to the possible effects of running these products with such fuels".

The three most common Fame types are RME - Rapeseed methyl ester (preferred crop in Europe), SME - Soyabean methyl ester (preferred crop in USA). Less common FAME's can be derived from animal fats (e.g. modified beef extracts) and reclaimed cooking oils.

5 B20 Biodiesel

Biodiesel refers to pure fuel before it is blended with diesel fuel ⇒ [Chemically Modified Vegetable Oils \(FAME/VOME\) \(□ 1-25\)](#). When biodiesel is blended with diesel fuel it is referred to as B5, B20 etc, where the number indicates the percentage of biodiesel in the fuel, for example B5 contains 5% biodiesel.

Biodiesel has different characteristics than mineral based fuels in that it is able to mix with water and therefore will have a high water retention capacity - this could lead to seals swelling, fuel system corrosion and seal damage.

Biodiesels will 'cloud' at higher temperatures than mineral based fuels. To explain Cloud Point - the lowest temperature at which fluid can flow and performs its functions is referred to as Pour Point. Just prior to reaching its Pour Point the diesel fluid becomes 'cloudy' due to crystallization of waxy constituents - this is know as Cloud Point. Using diesel at temperature below its cloud point can result



Section 1 - General Information Torque Settings

Zinc Plated Fasteners and Dacromet Fasteners

Table 10. Torque Settings - Rivet Nut Bolts/Screws

Bolt Size		Nm	kgf m	lbf ft
ISO Metric Thread	mm			
M3	3	1.2	0.1	0.9
M4	4	3.0	0.3	2.0
M5	5	6.0	0.6	4.5
M6	6	10.0	1.0	7.5
M8	8	24.0	2.5	18.0
M10	10	48.0	4.9	35.5
M12	12	82.0	8.4	60.5

Table 11. Torque Settings - Internal Hexagon Headed Cap Screws (Zinc)

Bolt Size	Nm	kgf m	lbf ft
ISO Metric Thread			
M3	2.0	0.2	1.5
M4	6.0	0.6	4.5
M5	11.0	1.1	8.0
M6	19.0	1.9	14.0
M8	46.0	4.7	34.0
M10	91.0	9.3	67.0
M12	159.0	16.2	117.0
M16	395.0	40.0	292.0
M18	550.0	56.0	406.0
M20	770.0	79.0	568.0
M24	1332.0	136.0	983.0

Table 22. Oil Pump Bolts

Item	Nm	lbf ft	Angle
Oil pump bolts	22-26	16-19	-

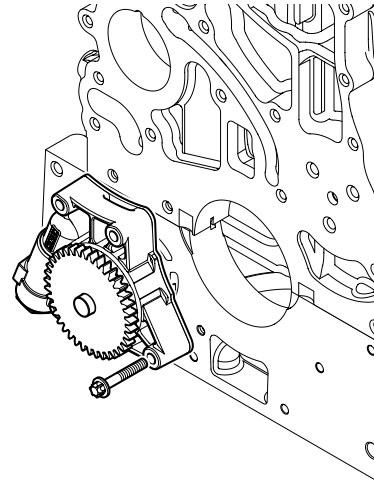


Fig 16.

Table 23. Idler Blanking Plug

Item	Nm	lbf ft	Angle
Idler blanking plug	17-19	13-14	-

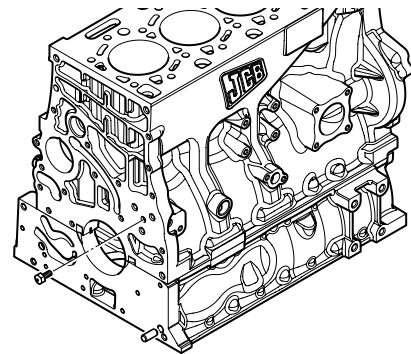
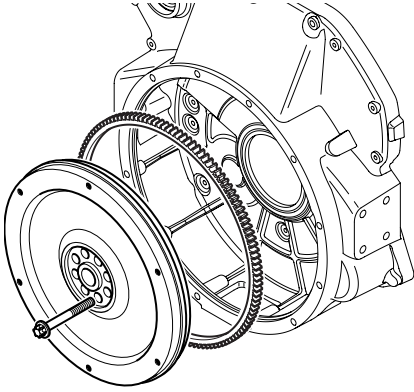


Fig 17.

Table 49. Flywheel to Crankshaft Hub Bolts

Item	Nm	lbf ft	Angle
Flywheel to crankshaft hub retaining bolts ⁽¹⁾			
- first stage torque	40	30	-
- second stage torque	120	89	-
- final stage angle torque	-	-	+ 120°

Note⁽¹⁾: Torque information MUST be used in conjunction with recommended procedures contained in this manual.



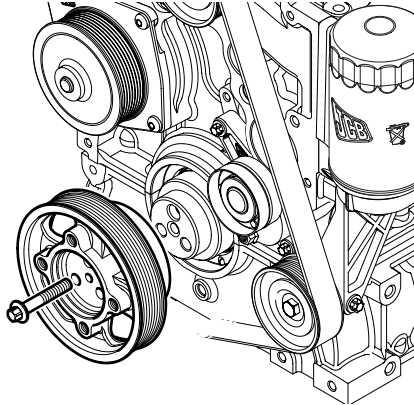
The diagram shows a flywheel being attached to a crankshaft hub. A bolt is shown passing through the center of the flywheel into the hub. The flywheel has a gear-like outer edge.

Fig 43.

Table 50. Front Pulley to Crankshaft Bolts

Item	Nm	lbf ft	Angle
Front pulley to crankshaft retaining bolts ⁽¹⁾			
- first stage torque	30	22	-
- second stage torque	75	56	-
- final stage angle torque	-	-	+ 180°

Note⁽¹⁾: Torque information MUST be used in conjunction with recommended procedures contained in this manual.

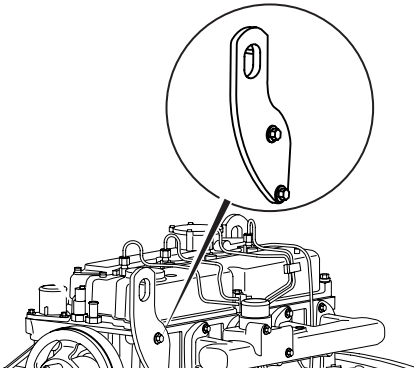


The diagram shows a front pulley being attached to a crankshaft. A bolt is shown passing through the center of the pulley into the crankshaft. The pulley has a V-shaped groove on its outer edge.

Fig 44.

Table 51. Lifting Bracket Bolts

Item	Nm	lbf ft	Angle
Lifting bracket retaining bolts	43-51	32-38	-



The diagram shows a lifting bracket being attached to an engine component. A bolt is shown passing through the bracket into the engine. A circular inset provides a magnified view of the bolt head and the bracket's surface.

Fig 45.

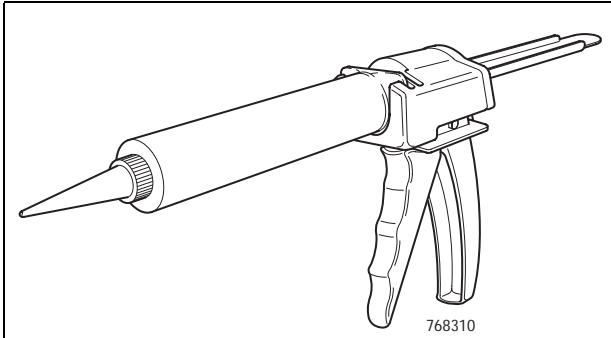


Fig 72. 892/01173 Sealant Applicator

Use to apply the anaerobic and silicone sealant evenly and correctly.

Note: For reference use the following sealant bead sizes: 1.5 mm bead for anaerobic sealant, 4.0 mm bead for silicone sealant .

Use to access the inner mounting nut of the fuel injection pump.

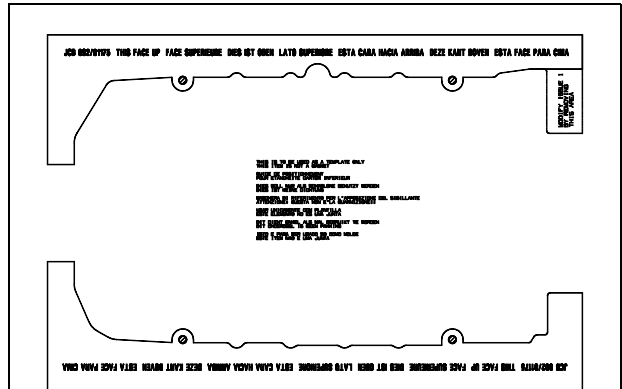


Fig 75. 892/01175 Template For Application Of Bedplate To Engine Block Anaerobic Sealant

Use to ensure correct sealant application.

Note: Correct positioning of the sealant is critical to ensure joint integrity.

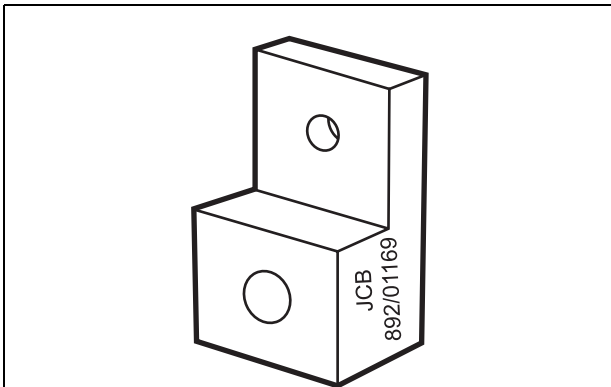


Fig 73. 892/01169 Top Dead Centre (TDC) Setting Tool

Use to correctly set the No. 1 piston to TDC (firing) when removing and replacing the fuel injection pump.

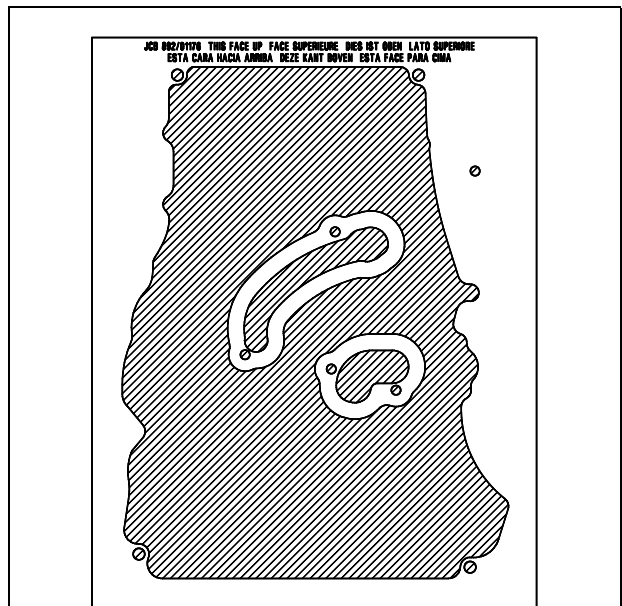


Fig 76. 892/01176 Template For Application Of Gear Case To Engine Block Anaerobic Sealant

Use to ensure correct sealant application.

Note: Correct positioning of the sealant is critical to ensure joint integrity.

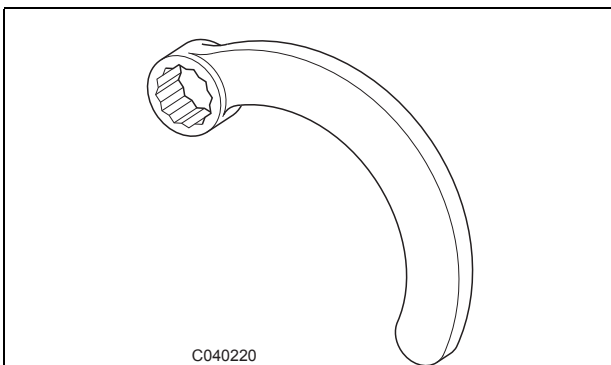
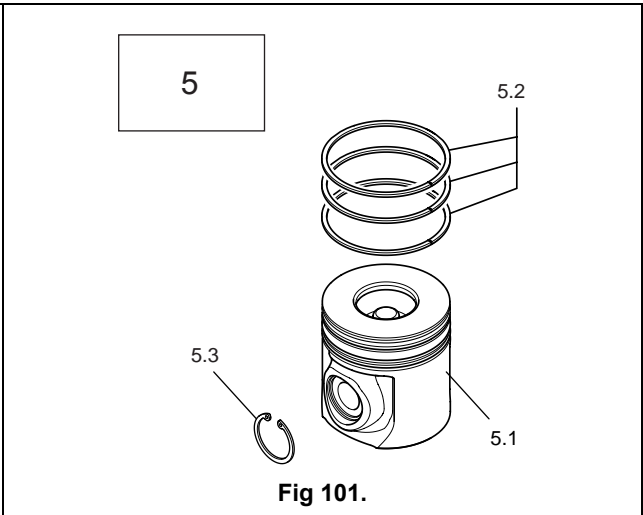


Fig 74. 892/01179 'C' Shaped Ring Spanner

Item	Description	Qty
5	Piston kit TCA	1
5.1	Piston assy TCA (NSP)	1
5.2	Piston ring kit std	1
5.3	Retainer - piston pin	1



Item	Description	Qty
19	Engine overhaul kit TCA std	1
17.1	Bolt - M8 x 57 Con. Rod	8
5	Piston kit TCA	4
6	Top gasket kit	1
8	Bottom gasket kit	1

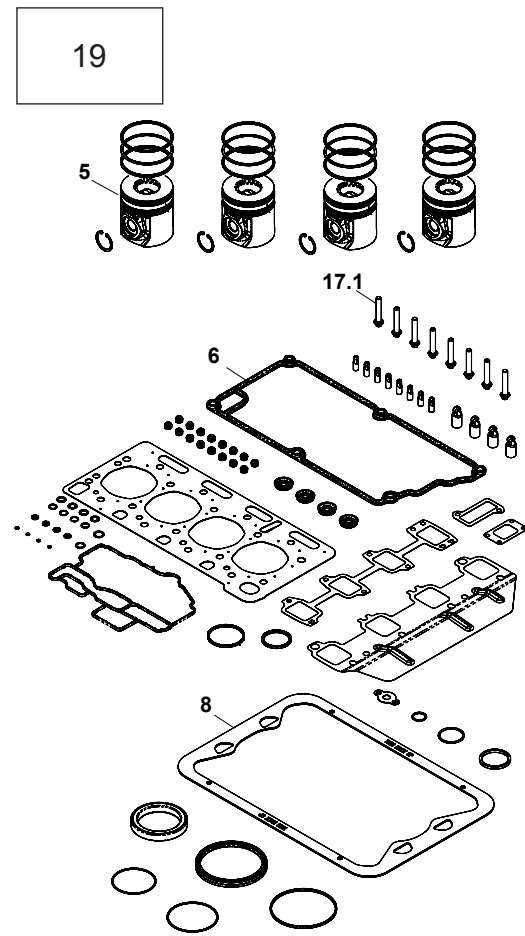


Fig 115.

Care and Safety

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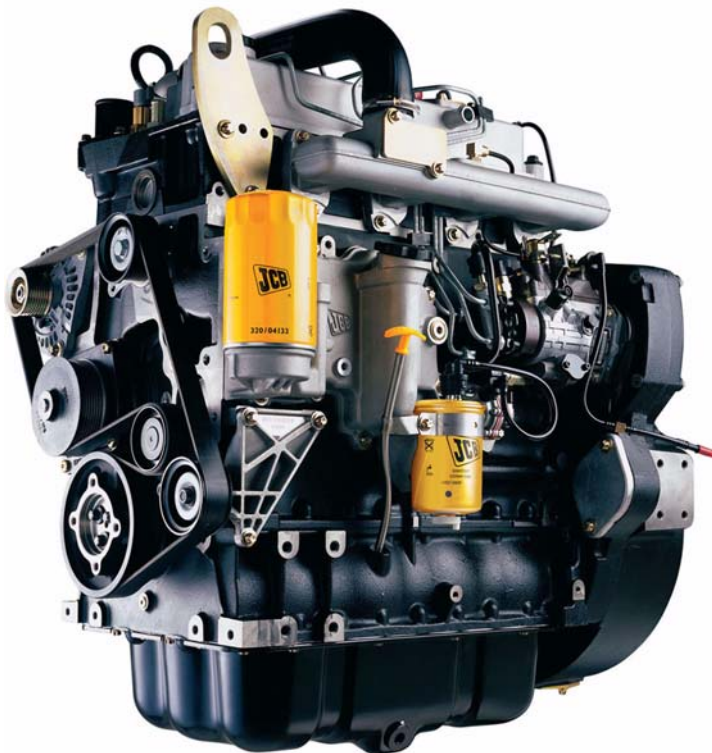
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Publication No.
9806/3000-02



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WARNING

Certain seals and gaskets (e.g. crankshaft oil seal) on JCB machines contain fluoroelastomeric materials such as Viton, Fluorel and Technoflon. Fluoroelastomeric materials subjected to high temperatures can produce highly corrosive hydrofluoric acid. **THIS ACID CAN SEVERELY BURN.**

New fluoroelastomeric components at ambient temperature require no special safety precautions.

Used fluoroelastomeric components whose temperatures have not exceeded 300°C (572°F) require no special safety precautions. If evidence of decomposition (e.g. charring) is found, refer to the next paragraph for safety instructions **DO NOT TOUCH COMPONENT OR SURROUNDING AREA.**

Used fluoroelastomeric components subjected to temperatures greater than 300°C (572°F) (e.g. engine fire) must be treated using the following safety procedure. Make sure that heavy duty gloves and special safety glasses are worn:

- 1 Thoroughly wash contaminated area with 10% calcium hydroxide or other suitable alkali solution, if necessary use wire wool to remove burnt remains.
- 2 Thoroughly wash contaminated area with detergent and water.
- 3 Contain all removed material, gloves etc. used in this operation in sealed plastic bags and dispose of in accordance with Local Authority Regulations.

DO NOT BURN FLUOROELASTOMERIC MATERIALS.

INT-3-3-5_3

CAUTION

Damaged or spent batteries and any residue from fires or spillage should be put in a closed acid proof receptacle and must be disposed of in accordance with local environmental waste regulations.

INT-3-1-12

CAUTION

Do not disconnect the battery while the engine is running, otherwise the electrical circuits may be damaged.

INT-3-1-14

DANGER

Electrolyte

Battery electrolyte is toxic and corrosive. Do not breathe the gases given off by the battery. Keep the electrolyte away from your clothes, skin, mouth and eyes. Wear safety glasses.

INT-3-2-1_3

WARNING

Compressed air is dangerous. Wear suitable eye protection and gloves. Never point a compressed air jet at yourself or others.

0147_1

WARNING

Machinery utilizing the engine must be correctly parked and prepared, for example safety strut fitted, prior to completing maintenance tasks on the engine.

Maintenance must be completed by suitably qualified personnel.

You or others could be killed or seriously injured if the machine is not correctly prepared and maintained.

ENG-1-5

CAUTION

Do not allow dirt to enter the fuel system. Before disconnecting any part of the fuel system, thoroughly clean around the connection. When a component has been disconnected, for example a fuel pipe, always fit protective caps and plugs to prevent dirt ingress.

Failure to follow these instruction will lead to dirt entering the fuel system. Dirt in the fuel system will seriously damage the fuel injection equipment and could be expensive to repair.

ENG-1-7

Service Schedules

A badly maintained engine is a danger to the operator and the people working around him. Make sure that the regular maintenance and lubrication jobs listed in the service schedules are done to keep the engine in a safe and efficient working condition.

WARNING

Machinery utilizing the engine must be correctly parked and prepared, for example safety strut fitted, prior to completing maintenance tasks on the engine.

Maintenance must be completed by suitably qualified personnel.

You or others could be killed or seriously injured if the machine is not correctly prepared and maintained.

ENG-1-5

Apart from the daily jobs, the schedules are based on machine running hours. Keep a regular check on the hourmeter readings to correctly gauge service intervals. Do not use a machine which is due for a service. Make sure any defects found during the regular maintenance checks are rectified immediately.

How to Use the Service Schedules

T3-012_3

In the example shown, **A** shows all service requirements to be carried out every 10 hours and **B** shows the requirements to be carried out every 500 hours.

Important: Services should be carried out at either the hourly interval or calendar interval, whichever occurs first. Refer to **Calendar Equivalents**.

Operation	Pre-start Cold Checks, Service Points and Fluid Levels							
	10	50	100 ⁽¹⁾	500	1000	2000	8000	
ENGINE								
Coolant Quality and Level - Check	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Cooling System - Drain and Refill						<input type="checkbox"/>	<input type="checkbox"/>	
Oil level - Check	<input type="checkbox"/>	<input type="checkbox"/>						
Oil and Filter ⁽²⁾⁽³⁾⁽⁴⁾ - Change				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Air Cleaner Dust Valve ⁽⁵⁾ - Change				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Air Cleaner Outer Element ⁽⁶⁾ - Change					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Air Cleaner Inner Element - Change					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Pre-Cleaner (if fitted) - Check			<input type="checkbox"/>					
Water Separator - Check for contamination and Drain		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Engine Fuel Filter - Change					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Front End Accessory Drive (FEAD) Belt Condition - Check				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Front End Accessory Drive (FEAD) Belt - Change							<input type="checkbox"/>	
Engine Mounting Bolts for Tightness - Check			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
All Hoses - Condition - Check		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Radiator ⁽⁷⁾ - Clean			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Crankcase Ventilation Filter - Change					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

795390-1

Calendar Equivalents

T3-088

- Every 10 Hours = Daily
- Every 50 Hours = Weekly
- Every 500 Hours = Six Months
- Every 1000 Hours = Yearly
- Every 2000 Hours = 2 Years
- Every 5000 Hours = 5 Years

Service Schedule Applications

Service schedules differ depending on engine application. Make sure you refer to the correct schedule as follows:

⇒ [Table 1. All Applications Except Generator Set Applications \(□ 3-6\)](#)

⇒ [Table 2. Generator Set Applications Only \(□ 3-7\)](#)

Changing the Water Separator Pre- Filter

Note: Refer to the machine handbook for information relating to the location of the pre-filter and water separator.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.

CAUTION

Do not allow dirt to enter the fuel system. Before disconnecting any part of the fuel system, thoroughly clean around the connection. When a component has been disconnected, for example a fuel pipe, always fit protective caps and plugs to prevent dirt ingress.

Failure to follow these instructions will lead to dirt entering the fuel system. Dirt in the fuel system will seriously damage the fuel injection equipment and could be expensive to repair.

ENG-1-7

- 2 Drain and remove the water separator bowl **9C**.
[⇒ Draining the Water Separator and Fuel Filter \(3-13\)](#).
- 3 To remove the filter element **9A**, release locking ring **9B** and discard element.
- 4 Fit new element and secure in position with locking ring **9B**.
- 5 Refit water separator bowl **9C**.
- 6 Make sure that the water in fuel electrical connector **9D** is correctly fitted.

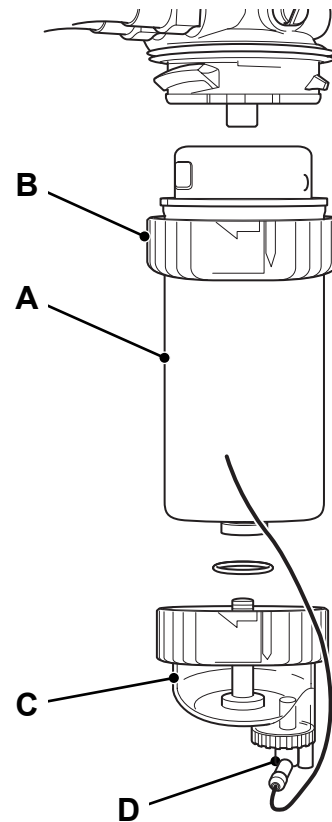


Fig 9.

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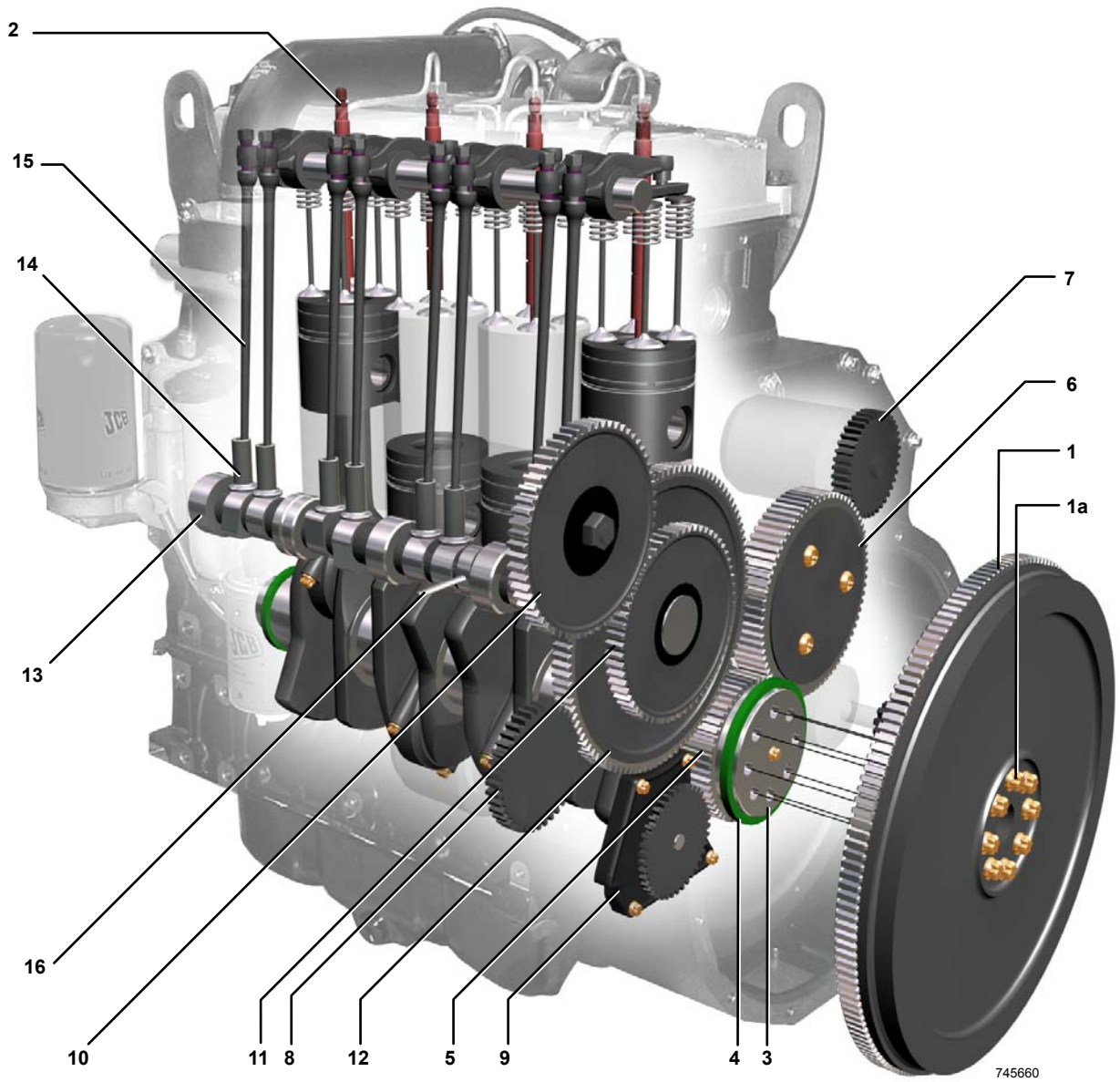


Fig 6. Engine - As viewed on the rear left side

⇒ [Table 6. \(□ 4-10\)](#)

Timing Gears

The timing gears are located inside a casing at the flywheel end of the engine.

⇒ [Fig 11. \(□ 4-20\)](#)

All the gears are driven via the crankshaft gear **11-A** as follows:

- 1 **Camshaft gear 11-B.** The camshaft is driven at half crankshaft speed.
- 2 **Fuel injection pump gear 11-C.** The fuel injection pump is driven via compound gear **11-D** fitted to the camshaft. The pump rotates at half crankshaft speed
- 3 **Oil pump gear 11-E.** The lubrication oil pump is driven directly by the crankshaft gear.
- 4 **Heavy Duty PTO Gear 11-F** (if fitted). The PTO is driven by the crankshaft gear via idler gear **11-G**.

- 5 **Low Duty PTO Gear 11-H** (if fitted). The PTO is driven by the camshaft gear **11-B**.

Timing

The engine must be 'timed' so that the camshaft operates the valves and the fuel injection pump injects the fuel at the correct times relative to the crankshaft position.

Valve timing is achieved by ensuring that the camshaft drive gear **B** is meshed to the crankshaft gear **A** at their correct angular positions, ⇒ [The Four Stroke Cycle \(□ 4-14\)](#) for more information about valve timing.

Timing of the fuel injection pump is not dependent on drive gear meshing. The pump drive shaft is supplied locked at the correct angular position relative to crankshaft/camshaft position. With the crank and camshaft positioned correctly (using temporary locking pins), the pump is fitted to drive gear **11-C** and its drive shaft unlocked.

Table 9. Key

⇒ [Fig 11. \(□ 4-20\)](#)

A	Crankshaft gear	E	Oil pump gear
B	Camshaft gear	F	Heavy duty PTO device gear (if fitted)
C	Fuel injection pump gear	G	Heavy duty PTO idler gear (if fitted)
D	Compound camshaft gear	H	Low duty PTO device gear (if fitted)

Oil Pump

⇒ [Fig 19. \(□ 4-30\)](#)

The oil pump **19-1** is a rotor type located inside the timing gear case. The pump is driven by gears via the crankshaft.

The pump consists of two rotors, one running inside the other. The outer rotor **19-2** has one more lobe than the inner rotor **19-3** and turns on a different axis.

When rotated the gap between the inner and outer rotor lobes increases, drawing oil in through the inlet port **19-4**. After a half rotation the gap reaches a maximum, the inlet port is closed and the outlet port **19-5** opened.

Further rotation causes the gap between the lobes to diminish, forcing the oil out through the outlet port.

A pressure relief valve assembly **19-6** is integral with the pump body. As oil pressure increases it acts on a spool **19-8** to overcome the pressure of spring **19-7**. As the spool moves it uncovers a port allowing pressurised oil directly back to the inlet port **19-4**. In practice the spool is continually opening and closing to maintain the correct oil pressure value. The valve is not adjustable.

Table 15. Key

⇒ [Fig 19. \(□ 4-30\)](#)

- 1 Oil pump
- 2 Outer rotor
- 3 Inner rotor
- 4 Inlet port
- 5 Outlet port
- 6 Relief valve assembly
- 7 Relief valve spring
- 7a Relief valve port - return to inlet port **4**
- 8 Relief valve spool
- 8a Relief valve pressure port - connected to port **5**
- 9 Oil pump connecting ports - engine bed plate

Pre-Filter/Water Separator, Lift Pump and Fuel Filter

⇒ Fig 26. (□ 4-40)

Pre Filter/Water Separator

The pre-filter/water separator **26-1** is designed to separate water and dirt from the fuel using a special chemically treated paper filter element. A bowl **26-1a** fitted to the bottom of the trap collects the water removed from the fuel. The bowl is fitted with an electric probe **26-1c** which senses when the water is above a preset level. The probe enables a suitable alarm/indicator device. Water can be drained off by means of a drain screw **26-1b** fitted in the base of the bowl.

It is essential that the water trap is drained regularly. Water must be drained immediately if the probe signals an alarm.

Lift Pump

The lift pump **26-2** is a diaphragm type driven from the engine camshaft. The pump draws fuel from the tank, through the water trap, pumping it through the filter and into the fuel injection pump.

The pump incorporates a manually operated priming lever **26-2a** to aid fuel priming after maintenance.

State A - Pumping

When the camshaft rotates the lobe **26-2a** pushes on the actuator pin **26-2b**. The pin operates the pump lever **26-2c** pushing the diaphragm **26-2d** and compressing spring **26-**

2e. As the diaphragm moves, fuel in the pump chamber pressurises, forcing ball **26-2f** from its seat and compressing spring **26-2g**. Fuel flows from the pump chamber via outlet port **26-2h**. At the same time fuel pressure and spring **26-2j** force ball **26-2k** against its seat, preventing fuel flowing back through the inlet port **26-2m**.

State B - Lifting

When the camshaft rotates further the lobe **26-2a** moves away from actuator pin **26-2b**. Spring **26-2e** pushes on the diaphragm **26-2d** causing a pressure drop in the pump chamber. This draws ball **26-2k** of its seat compressing spring **26-2j** and fuel is drawn into the pump chamber through inlet port **26-2m**. At the same time ball **26-2f** is drawn onto its seat, assisted by spring **26-2g** preventing fuel flowing back through the outlet port **26-2h**.

Fuel Filter

The fuel filter **26-3** consists of a paper element **26-3a** folded in such a way as to give a very large surface area. Fuel is pumped into the filter and passes through the paper element where any dirt particles or water droplets are retained. An integral sediment bowl **26-3b** at the bottom of the filter enables water to be drained off by means of screw **26-3c**.

It is most important that the fuel filter is changed regularly in accordance with the machine service schedule. Use only genuine JCB replacement filters.

Table 19. Key

⇒ Fig 26. (□ 4-40)			
1	Pre-filter/water separator	2f	Ball - outlet non return valve
1a	Bowl	2g	Spring - outlet non return valve
1b	Drain screw	2h	Outlet port
1c	Water level probe	2j	Spring - inlet non return valve
2	Lift pump	2k	Ball - inlet non return valve
2a	Cam lobe - fuel lift pump	2m	Inlet port
2b	Actuator pin	3	Fuel filter
2c	Pump lever	3a	Element
2d	Diaphragm	3b	Sediment bowl
2e	Spring	3c	Drain screw

Injectors and Combustion

Injectors

When fuel is injected it is sent through high pressure pipes to the multi-point injector **34-1** (atomiser).

Injector needle **34-2** is held on its seat by spring **34-3**. When the injection pressure generated by the injection pump is high enough, needle **34-2** is forced off its seat compressing spring **34-3**. Fuel is then injected under high pressure into the cylinder. The high pressure is necessary to ensure the fuel atomises thoroughly.

When the fuel pressure from the injection pump begins to fall spring **34-3** snaps needle **34-2** back onto its seat. This ensures that only fuel at the highest pressure is injected into the cylinder producing maximum atomisation. Fuel trapped in the injector body is allowed to bleed back to the fuel tank via bleed-off port **34-4**. The fuel at the bleed off port is at low pressure.

The high pressure fuel injector pipes **34-5** consist of thick walled, seamless steel tubing. The ends of the tubes are formed with conical nipples for sealing in the sealing cones on the injection pump and on the nozzle holder body **6**. It is essential that the pipes are maintained and fitted correctly for safe and effective engine operation.

Table 24. Key

⇒ Fig 34. (□ 4-49)	
1	Multi-point injector
2	Needle
3	Spring
4	Bleed-off port
5	High pressure injector pipe
6	Nozzle holder
7	Pressure channel
8	Injection nozzle
9	Pressure adjusting shims
10	Pressure spindle
11	Locating pins
12	Intermediate disc
13	Nozzle retaining nut
14	Filter
15	Union nut - injector pipe

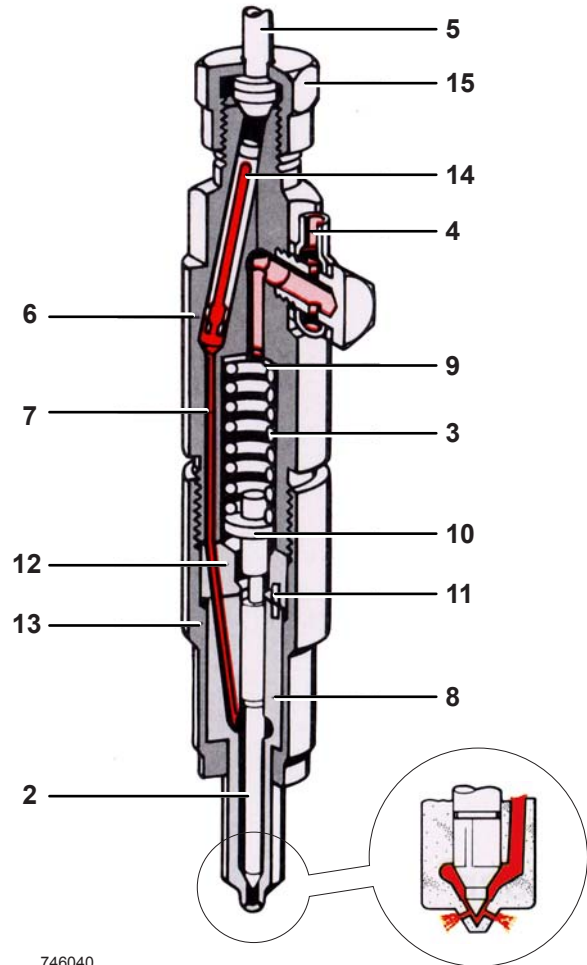


Fig 34.

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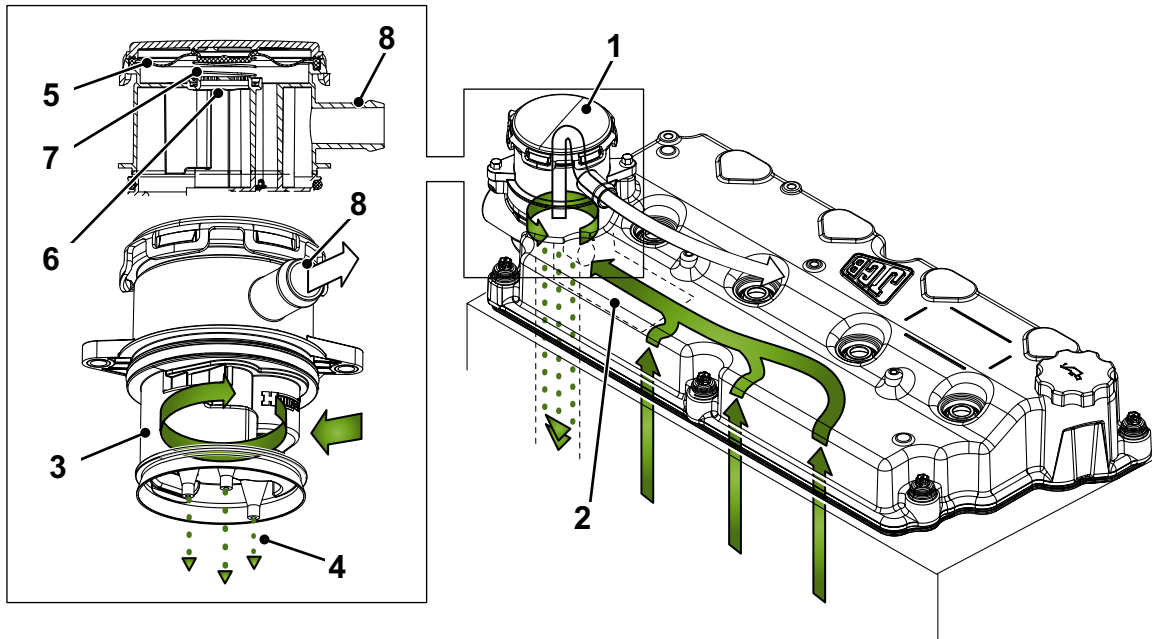


Fig 43.

The engine is fitted with an 'open' crankcase ventilation (CCV) system.

The engine breather assembly **43-1** is mounted on the rocker cover. The breather prevents the build up of pressure in the crankcase, caused by the reciprocating motion of the pistons, and hot gases that may 'blow by' the pistons during the combustion process. The breather also separates the oil trapped in the vapour from the crankcase.

A series of ports in the cylinder block and cylinder head allow hot vapour to vent from the crankcase and pass into the rocker cover. The vapour flows through a ventilation chamber **43-2** inside the rocker cover to the oil separator **43-3**.

Galleries inside the separator create a 'cyclone' effect, this effect separates out the oil droplets suspended in the vapour. The trapped oil droplets **43-4** drain from the bottom of the separator back into the engine sump. The oil drains via a port in the cylinder head and block.

A possible cause of negative crankcase pressure is a blocked air filter. This can result in oil being sucked from the sump into the cylinders. The engine can 'run - away' by burning its own oil.

Diaphragm **43-5** acts as a non-return valve. When there is positive pressure in the crankcase, the filtered vapour opens the breather port **43-6** assisted by the force of the spring **43-7** allowing the crankcase gas to vent to atmosphere via port **43-8**. Should a negative pressure develop however, the diaphragm will move against the force of the spring and close off the breather port to prevent unfiltered air being drawn into the engine.



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Table 7. Engine - Noise Excessive

Cause	Remedy
Drive belt squeal, insufficient tension or abnormally high loading.	Check the tensioner and inspect the drive belt for loading, deterioration, Make sure water pump, tensioner pulley, fan alternator turn freely. Check for paint/oil or other material on pulleys. Check the tension of accessory drive belts.
Cold start advance not operating correctly.	Check for correct operation of the cold start advance. Refer to Test Procedures, Section 6 . If engine will not reach operating temperature, ⇒ Table 24. Coolant - Under Temperature (□ 5-27) .
Intake air or exhaust leaks.	⇒ Table 13. Engine - Exhaust Smoke Excessive (Black Smoke) (□ 5-16) and ⇒ Table 14. Engine - Exhaust Smoke Excessive (White/Blue Smoke) (□ 5-17) .
Fuel is contaminated or incorrect grade diesel fuel used.	Refer to Fuel Systems Data, Section 1 for recommended diesel fuels. If the fuel is suspect, verify by operating the engine with recommended clean fuel from a temporary tank.
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances. Refer to Valve Clearances, Section 12 . Make sure the push rods are not bent or the rocker levers are not severely worn.
Turbocharger noise.	Check turbocharger impeller and turbine wheel for housing contact.
Inlet and exhaust valve springs broken.	Check and fit new valve springs, Refer to Valves, Valve and Springs and Stem Seals, Section 12 .
Worn crank/connecting rod bearings (knocking under load).	Check/replace rod and main bearings. Refer to Crankshaft, Section 12 .
Excessive camshaft bearing wear.	Check bearings (engine overhaul required), refer to Section 12 .
Worn or damaged pistons and/or piston rings.	Check piston assemblies (engine overhaul required), refer to Section 12 .
One or more engine injectors 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.
Gear train noise.	Visually inspect and measure gear backlash. Replace gears as required.

B Charts - Fuel

Table 16. Fuel - Consumption Excessive

Cause	Remedy
Additonal load on engine.	Check/repair accessories and vehicle components. Refer to the equipment manufacturer's procedures.
Operator technique.	Review operation for correct gear shifts, deceleration and idling.
Fuel leaks.	<p>Check for external leaks and engine lubricating oil dilution. For fuel dilution, check for internal leaks at the fuel transfer pump and injection pump.</p> <p>Inspect and correct as required leaks in the high pressure lines, fittings injector sealing washers, or delivery valves.</p> <p>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.</p>
Fuel is contaminated or incorrect grade diesel fuel used.	Refer to Fuel Systems Data, Section 1 for recommended diesel fuels. If the fuel is suspect, verify by operating the engine with recommended clean fuel from a temporary tank.
Intake air or exhaust leaks.	⇒ Table 13. Engine - Exhaust Smoke Excessive (Black Smoke) (□ 5-16) and ⇒ Table 14. Engine - Exhaust Smoke Excessive (White/Blue Smoke) (□ 5-17) .
Engine compression low in one or more cylinders.	Check the engine compression. Refer to Engine Compression Check, Section 6 .
Injection pump timing incorrect.	<p>If the pump has recently been removed and replaced, the timing could be incorrect if the correct removal procedures were not followed.</p> <p>The timing can only be checked by a local FIE specialist using the appropriate equipment. Refer to Fuel Injection Pump, Section 7 for removal and replacement procedures.</p>
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.
Inlet and exhaust valve clearances set incorrectly.	Set the valve clearances to the recommended clearances. Refer to Valve Clearances, Section 12 .

Test Procedures

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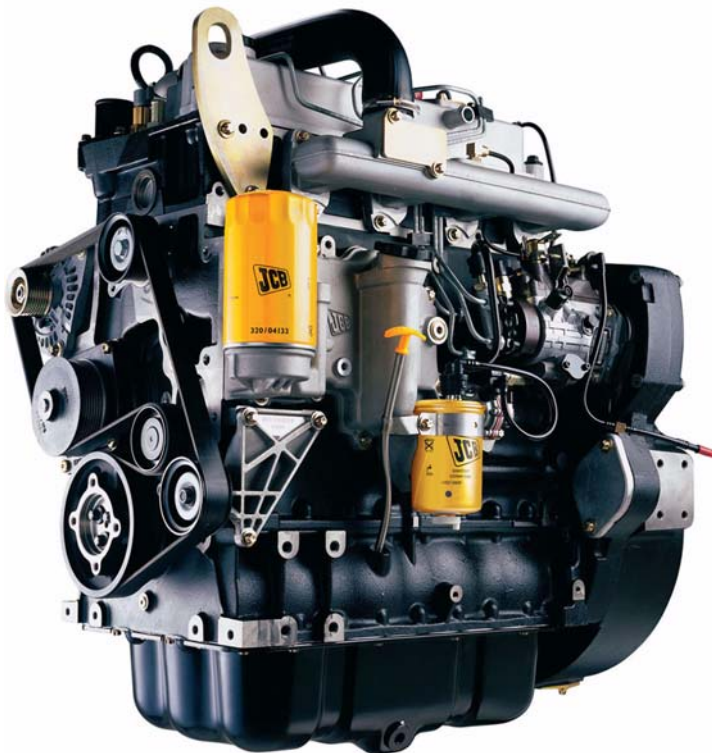
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Publication No.
9806/3000-02



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Engine Oil Pressure

Use the following procedures to measure the oil pressure. Refer to **Section 4, System Descriptions** for a full explanation of the lubricating oil circuit.

Several factors can influence the engine oil pressure, the following conditions are assumed:

- The correct engine oil has been used, refer to **Section 1, Lubricants and Capacities**.
- The engine oil level is correct, refer to **Section 3, Checking the Oil Level**.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Disconnect the electrical connector to oil pressure switch **4-A**, and remove the switch from the cooler housing.
- 3 Fit a suitable test gauge into the vacant pressure switch port (M10x1.5 thread). Make sure the gauge has a sealing washer as shown at **4-B**.
- 4 Start the engine, increase the engine revs to the rated speed. Record the pressure gauge reading - refer to **Section 1, Technical Data**, for the recommended circuit pressure.
- 5 Remove the pressure gauge and refit the pressure switch.

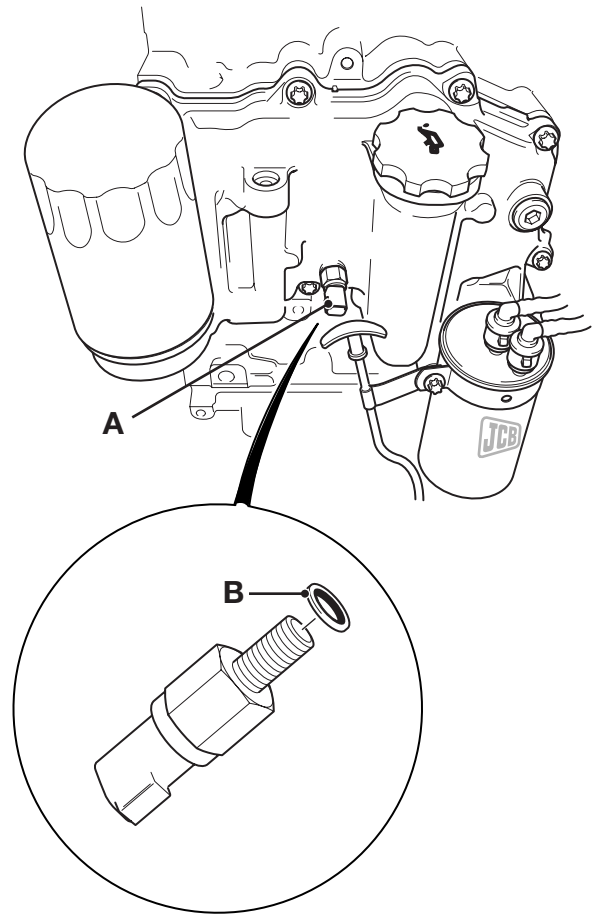


Fig 4.

plugged into the black socket (sometimes, this socket is also marked by a "-", or "E" or marked as "COMMON" or "COM"). The red test lead should be plugged into the red socket marked with "+", "V" or "Ω".

- 2 When making measurements ensure that the test probes have a good clean contact with bare metal, free from grease, dirt, and corrosion as these can cause a false reading.
- 3 When measuring voltage: Make sure that the correct range is selected, that is set the selector to a value equal to or greater than that you are about to measure. e.g. If asked to measure 12 Volts, set the selector to the 12V range. If there is no 12V range, set the selector to the next range higher, 20V for instance. If the meter is set to a range that is too low, it may be damaged. e.g. setting to the 2V range to measure 12V.

Measuring DC Voltage

- 1 Select the correct range on the multimeter.
 - a On the FLUKE 85.
Turn the switch to position **9-B**.
 - b On the AV0 2003.
Move the right slider switch to position **10-A**, and the left hand slider switch to the appropriate range.
 - c On an analogue meter.
Turn the dial to the appropriate DC Volts range.
- 2 Connect the black probe to the nearest available suitable earth point, usually this will be the starter motor earth, the battery negative, or the chassis. Connect the red probe to the wire or contact from which you are measuring the voltage.

Measuring Resistance

- 1 Make sure there is no power to the part of the circuit you are about to measure.
- 2 Connect one probe at one end of the component or wire to be checked and the other probe at the other end. It does not matter which way round the two probes are placed.
- 3 Select the correct range on the multimeter.
 - a On the FLUKE 85.
 - i Turn the switch to position **9-C** and check that the W sign at the right hand side of the display window is on. If the F sign is on instead, press the blue button **9-G** to change the reading to Ω. Touch the meter lead probes together and press the **REL**³ key on the meter to eliminate the lead resistance from the meter reading.
 - b On the AV0 2003.
 - i Move the right hand slider switch to position **10-B**, and the left hand slider switch to the appropriate Ohms (Ω) range.
 - c On an analogue meter.
 - i Move the dial to the appropriate Ohms (Ω) range.

- b If the reading between terminal **19-D** and earth is below 8.0V, connect the voltmeter between terminal **19-E** and earth. An increase in the reading to 8.0V indicates either a faulty start relay or a fault in the feed from the transmission selector switch to the relay solenoid. Check also the solenoid earth connection.

If the reading between **19-E** and earth is less than 8.0V, the fault must be in either the starter switch or in the wiring between the solenoid, starter switch, and the start relay.

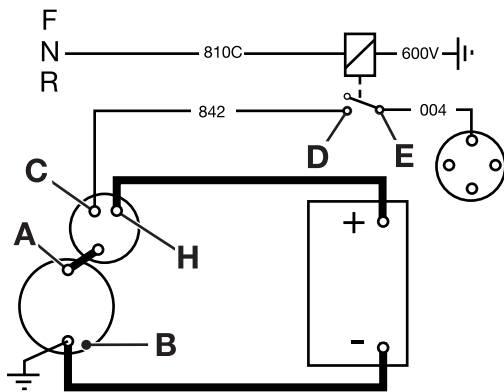


Fig 19.

- 4 Connect the voltmeter between battery negative and starter earth connection **20-B**. The reading in the 'start' position should be practically zero, maximum permissible reading 0.25V.

If the reading is above 0.25V, a high resistance in the earth lead or connections is indicated.

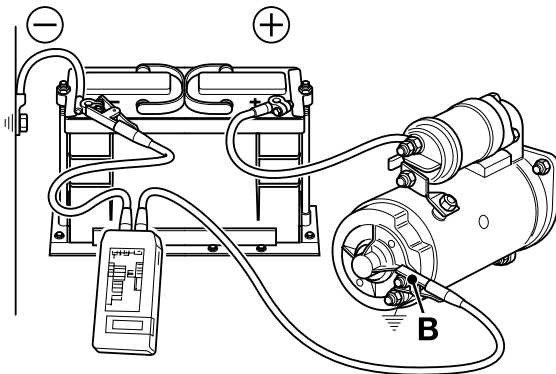


Fig 20.

- 5 Connect the voltmeter between battery positive and the starter main terminal **21-A**. With the starter switch 'off', the voltmeter should indicate battery voltage, but it should fall to practically zero when the switch is turned to the 'on' position, maximum permissible reading 0.25V.

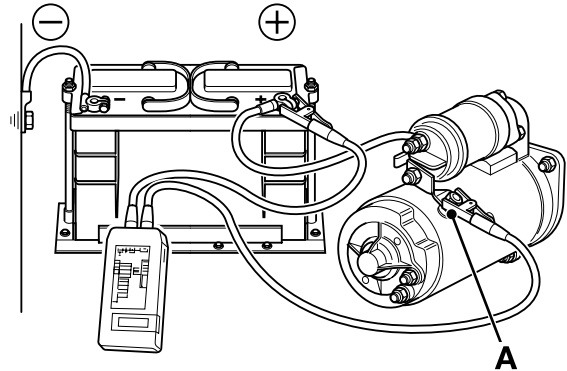


Fig 21.

If the reading is above 0.25V, a high resistance is present in the insulated lead or in the solenoid. Connect the voltmeter between the battery positive and solenoid connection **22-H**. If the voltmeter now reads zero with the switch closed, the fault is in the solenoid.

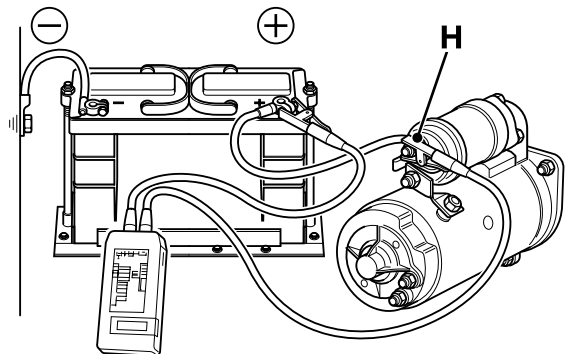


Fig 22.

- 6 Finally refit the engine stop fuse.

Low Pressure Fuel Lines

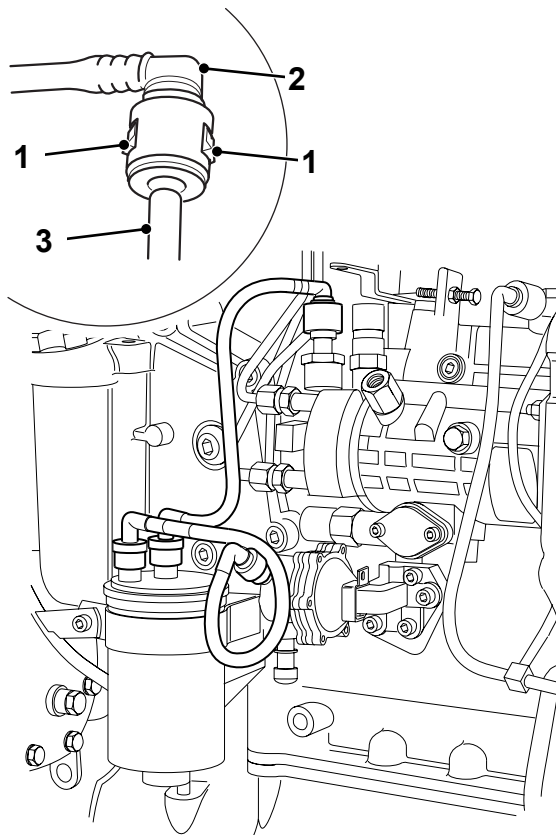


Fig 4.

Before disconnecting or removing fuel lines:

- 1 Ensure that the engine cannot be started.
- 2 Clean off all dirt and debris from around the fuel line connectors.

DO NOT attempt to repair fuel lines or connectors. If a fuel line or connector is damaged the fuel line assembly must be renewed.

Removal

The low pressure fuel lines have a nylon fitting attached to the pipe that replaces the nut and olive. The fittings are part of the pipe and not a separate item. A damaged fitting

will result in the pipe having to be replaced as a completed assembly.

- 1 To release the fuel line, first press and hold buttons 1 (1 each side of the coupler). Push the coupler 2 towards the connector spigot 3 then withdraw.
- 2 Cap all open ports to prevent ingress of dirt and debris.

Replacement

- 1 To refit the fuel line, press and hold buttons 1. Push the coupler 2 over the connector spigot 3 and release the button 1. The connector will be heard to click when it is fully home and locked in place.
- 2 To check that the connection has been fully remade, attempt to pull the connector from the connector spigot without releasing the lock mechanism. (A gentle pull is all that is required, if the connection is not good the connector will release very easily.)

After replacing fuel lines:

- 1 Ensure that all lines are correctly fitted and located in retaining clips as applicable. If retaining clips are missing or damaged they must be replaced or renewed.

WARNING

Fluid Under Pressure

Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of fluid under pressure and wear protective glasses. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of fluid. If fluid penetrates your skin, get medical help immediately.

INT-3-1-10_2

WARNING

Fuel

Fuel is flammable; keep naked flames away from the fuel system. Stop the engine immediately if a fuel leak is suspected. Do not smoke while refuelling or working on the fuel system. Do not refuel with the engine running. Completely wipe off any spilt fuel which could cause a fire. There could be a fire and injury if you do not follow these precautions.

INT-3-2-2_3

Important: DO NOT loosen the fuel injection pump lock bolt 12-4.

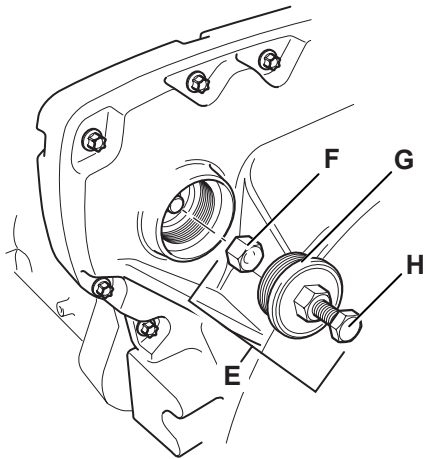
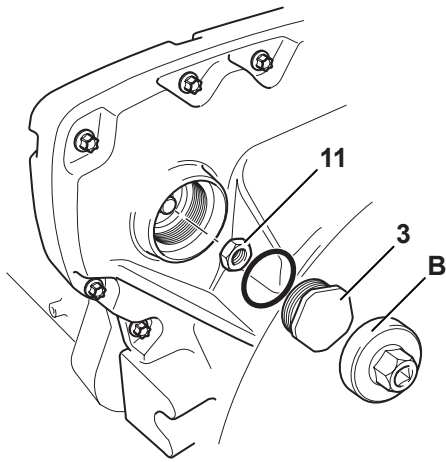


Fig 13.



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Lubrication System

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9806/3000-02



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Before Removing

Note: The illustrations show the engine inverted. If the oil pump is being removed prior to crankshaft or camshaft removal the engine must be inverted. If the oil pump only is being removed (for inspection or renewal) then the engine need not be inverted.

- 1 This procedure requires service parts. Make sure you have obtained the correct service parts before you start, see **Service Parts**.
- 2 Drain the oil from the engine, see **Section 3 Routine Maintenance**.
- 3 Remove the starter motor, see **Section 10 Electrical System - Starter Motor**.
- 4 Remove the flywheel, see **Flywheel - Removal and Replacement**.
- 5 Remove the flywheel housing, see **Flywheel Housing - Removal and Replacement**.

Removal

- 1 Undo bolt **6-4** and remove the flywheel hub **6-3**. DO NOT remove the crankshaft gear **6-X**.
- 2 Undo bolts **6-2** and lift the oil pump **6-1** away from the timing case.

Note that the oil pump is a non serviceable item. If the oil pump is damaged or worn it must be renewed as a complete assembly.

Inspection

- 1 Check the oil pump internal parts for signs of damage and excessive wear.
- 2 Using feeler gauges, measure the inner and outer rotor clearance, and the rotor end float to confirm they are within service limits, see **Section 1 Technical Data**.

Replacement

Replacement is the reverse of removal but note the following:

- 1 Ensure that all items are clean and free from damage and corrosion.
- 2 Lubricate the pump rotor with clean engine oil.
- 3 Make sure the dowel **6-Y** locates into the hole in the timing case.
- 4 Fit the flywheel hub **6-3** to the crankshaft gear **6-X**, locating on the dowel. Torque tighten the bolts **6-2** and **6-4**, see [⇒ Table 7. Torque Settings \(□ 9-7\)](#).

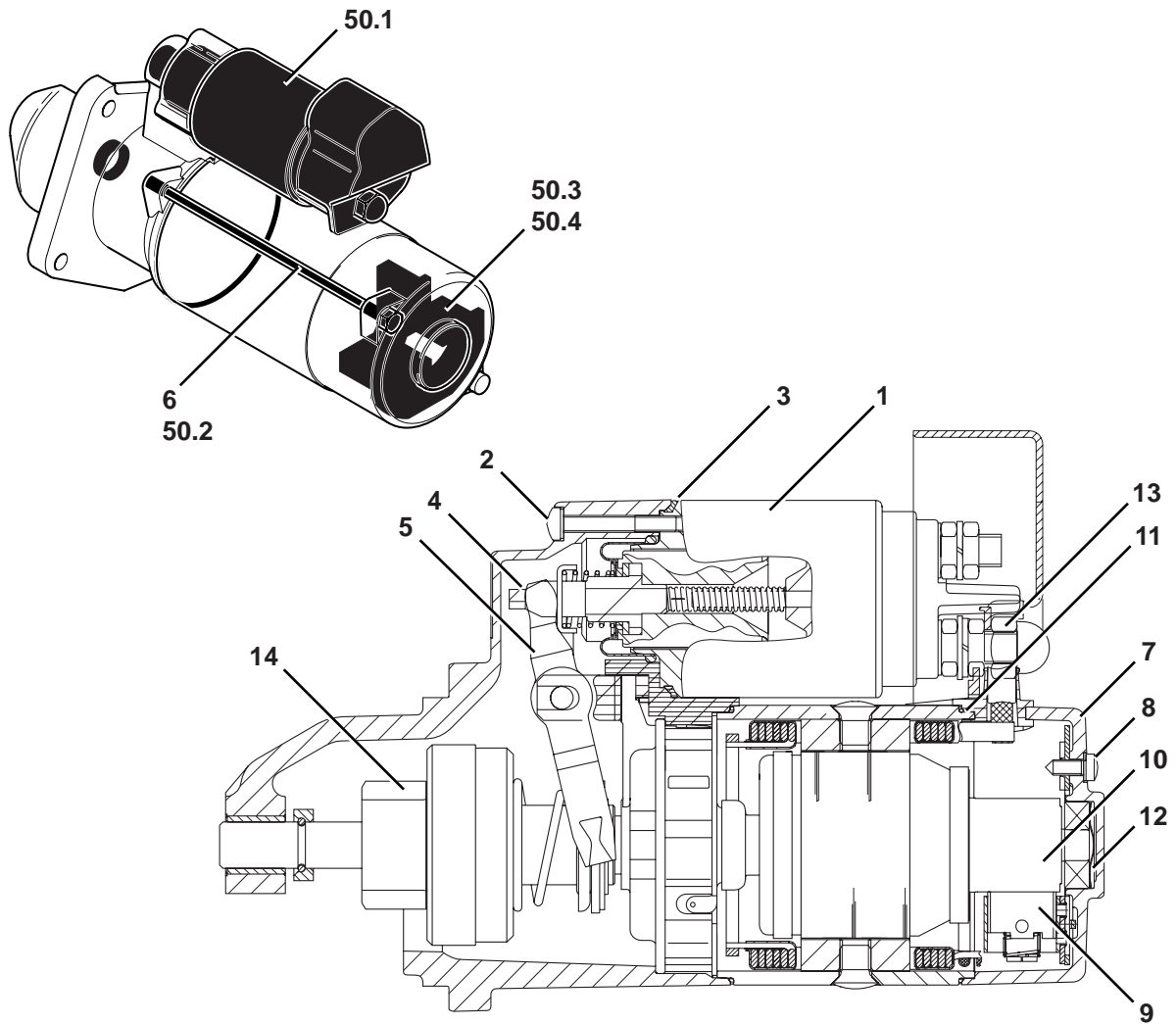
Table 7. Torque Settings

Item	Nm	lbf ft
2	24	17.7
4	47	34.7

After Replacing

- 1 Refit the flywheel housing, see **Flywheel Housing - Removal and Replacement**.
- 2 Refit the flywheel to the crankshaft hub, see **Flywheel - Removal and Replacement**.
- 3 Refit the starter motor, see **Section 10 Electrical System - Starter Motor**.

Dismantling and Assembly

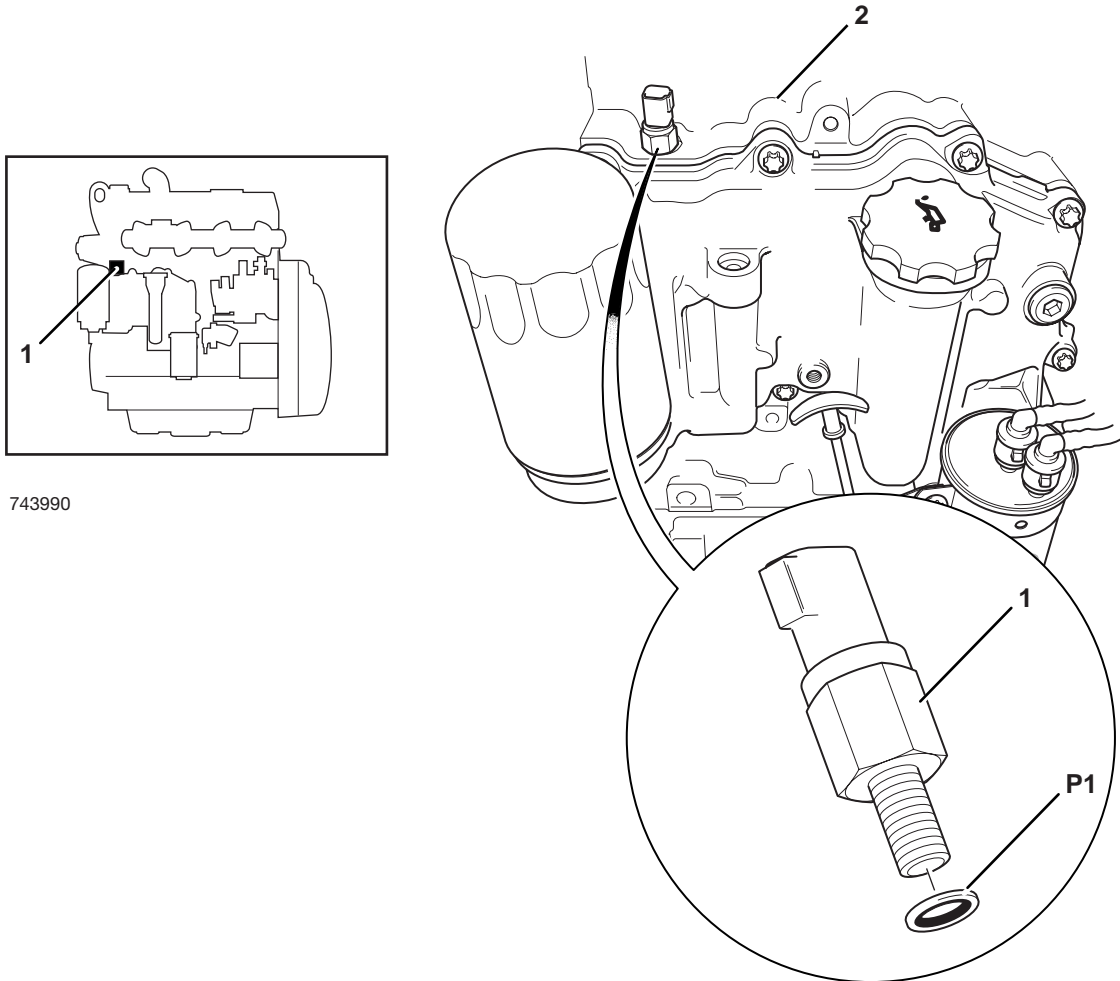


743740

Fig 2.

Engine Cold Start Switch

Removal and Replacement



743990

Fig 7.

Table 21. Component Identification

1	Engine cold start switch
2	Cylinder block

Table 22. Service Parts

P1	Sealing washer - switch
----	-------------------------

Table 23. Service Tools

Item	Part Number	Description
T1	General	Ring spanner

Before Removing

- 1 Ensure that the engine is safe to work on. If the engine has been running, make sure the engine has cooled sufficiently before you start.

Turbocharger

Removal and Replacement

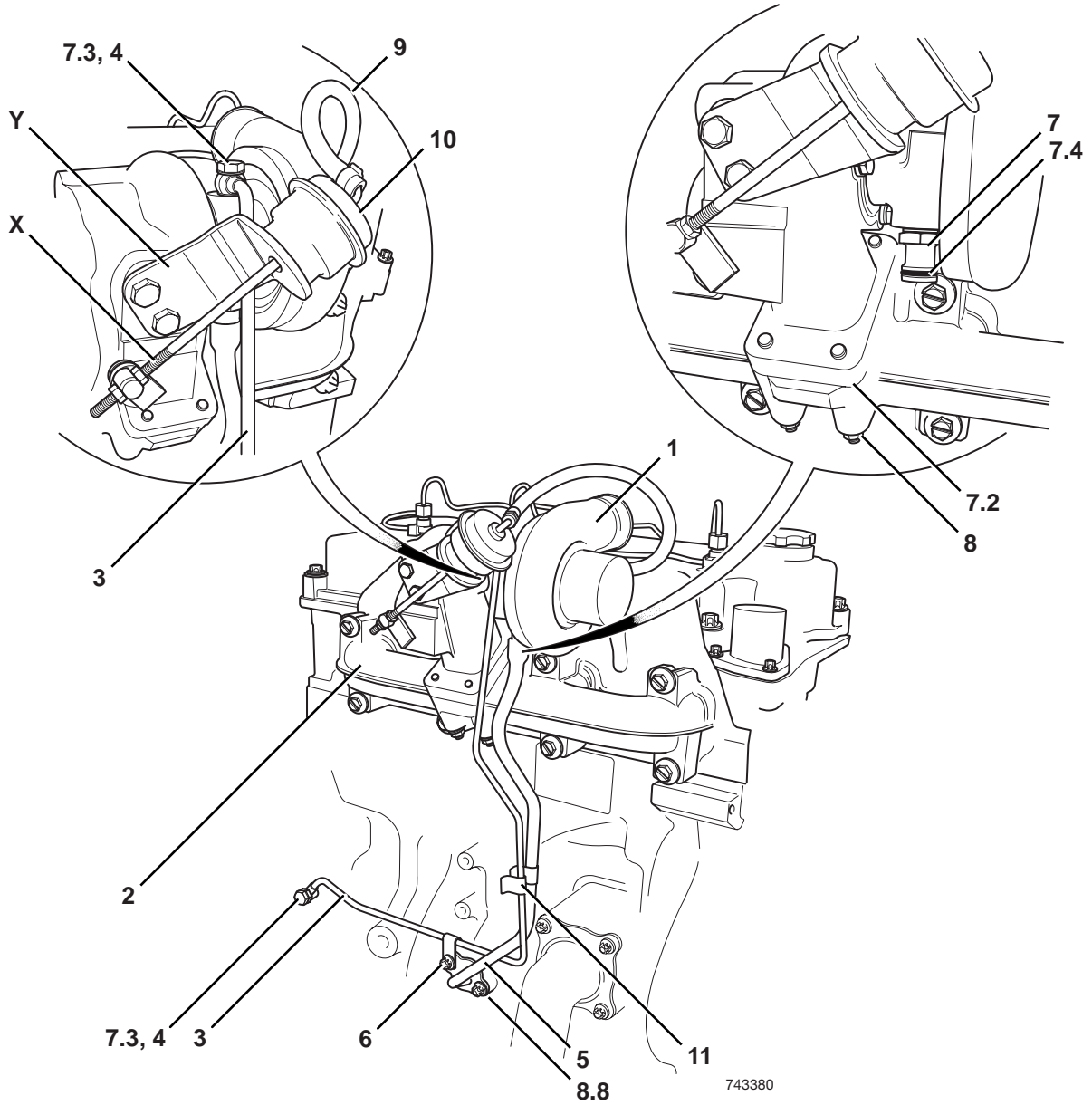


Fig 1.

Base Engine

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Publication No.
9806/3000-05



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Before Dismantling

- 1 Remove the rocker cover, see **Rocker Cover - Removal and Replacement**.
- 2 Remove the rocker assembly, see **Rocker Assembly - Removal and Replacement**.

- 2 Measure and adjust the valve clearances, see **Valve Clearances - Adjustment**.

Dismantling

- 1 Lift out the rocker shaft fixing bolts **2** and **3**, then remove the pedestals **4** and **5**, rockers **6** and **7**, and wave washers **8** from the rocker shaft **1** as shown. Label the pedestals and rockers to ensure they are refitted in the correct positions on assembly.

Inspection

- 1 Check the rocker shaft and rocker bushings for signs of damage and excessive wear. Measure the rocker shaft diameter and rocker bearing bushes to confirm they are within service limits, see **Section 1 Technical Data**.

Note: *The rocker bearing bushes are not renewable. If a rocker bearing bush is damaged or worn the rocker must be renewed as a complete assembly.*

- 2 Make sure that all oil ways and cross drillings in the rocker shaft and pedestals are clear and free from debris. Use an air line to blow through cross drillings.

Assembly

Assembly is the reverse of dismantling but note the following:

- 1 Lubricate the rocker shaft and rocker bearing bushes with clean engine oil.
- 2 Make sure that the rockers and pedestals are refitted in their original positions along the rocker shaft. Note the position of the oil feed pedestal **5**.
- 3 Insert the rocker shaft fixing bolts to hold the rockers and pedestals loosely in position before fitting the assembly into the cylinder head. Note the position of the longer bolt **3**.

After Assembly

- 1 Refit the rocker assembly, see **Rocker Assembly - Removal and Replacement**.

Front End Accessory Drive Belt System (FEAD)

Tensioner

Removal and Replacement

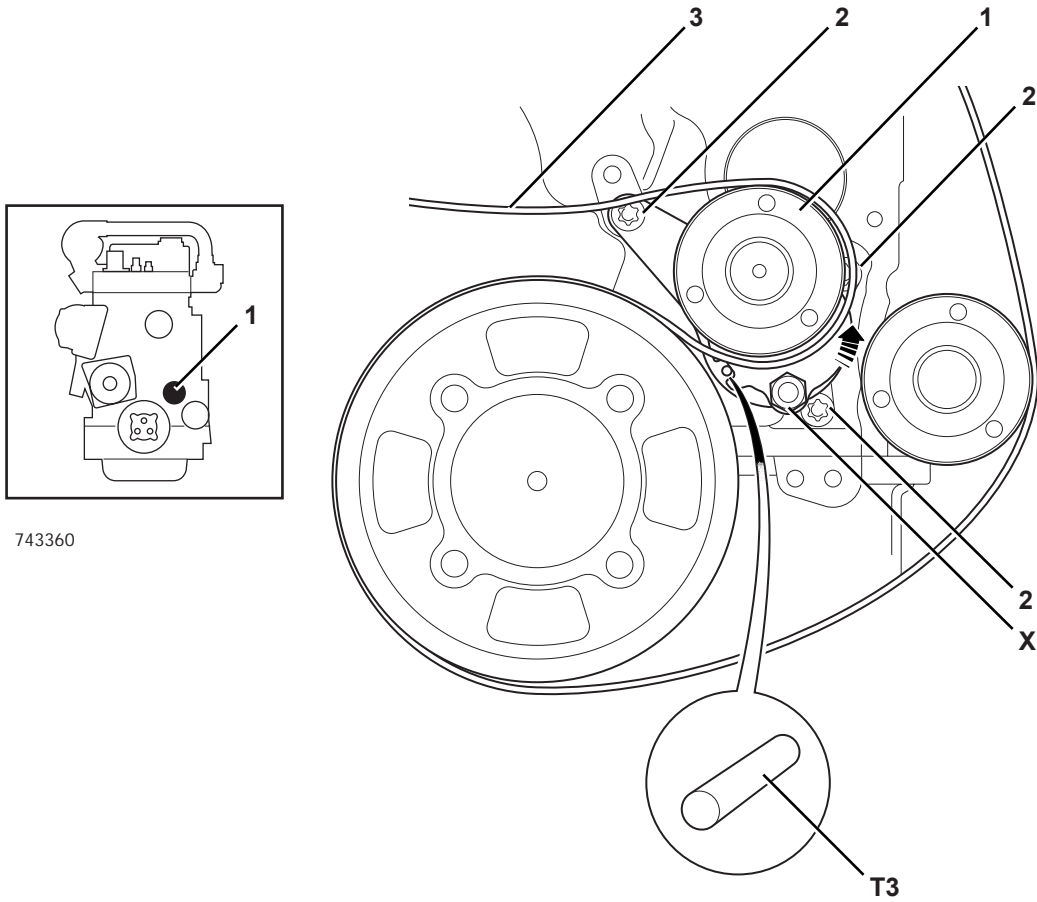


Fig 9.

Before Removing

Note: The illustrations show the engine inverted. If the drive gear components are being removed prior to crankshaft or camshaft removal the engine must be inverted. If the gear components only are being removed (for inspection/renewal) then the engine need not be inverted.

- 1 Remove the fuel injection pump, see **Section 7 Fuel System - Fuel Injection Pump**.
- 2 After releasing the drive gear from the injection pump drive shaft, loosely refit the fixing nut **2**, retaining the gear **1**. DO NOT lock the gear **1** to the taper on the injection pump drive shaft.
- 3 Remove the starter motor, see **Section 10 Electrical System - Starter Motor**.
- 4 Remove the flywheel, see **Flywheel - Removal and Replacement**.
- 5 Remove the flywheel housing, see **Flywheel Housing - Removal and Replacement**.

Removal

- 1 Undo the the fixing nut **2** and lift out the gear **1**.
- 2 If the the rear timing case is to be removed, remove the fuel injection pump.

Replacement

- 1 Loosely fit the fuel injection pump and the drive gear **1** using fixing nut **2**. DO NOT lock the gear **1** to the taper on the injection pump drive shaft.
- 2 Carry out the procedures listed under Before removing in reverse order. Note that gear fixing nut **2** is torque tightened as part of the fuel injection pump replacing procedure.

Table 43. Component Identification

⇒ Fig 18. (□ 12-36)

1	Timing case - rear
2	Timing case fixing bolts (19 off)
3	Cylinder block/bed plate assembly
4	Dowel
5	Dowel - with flats

Table 44. Service Parts

P1	Anaerobic sealant
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Table 45. Service Tools

Item	Part Number	Description
T1	General	Alignment pins (Locally manufacture)
T2	892/01176	Sealant template
	Comprising:	
	A	Main template
	B	Long gallery template
	C	Short gallery template

Before Removing

- 1 Drain the oil from the engine, see **Section 3 Routine Maintenance**.
- 2 Disconnect and remove the fuel lines from the injectors, see **Section 7 Fuel System - Fuel Lines**.
- 3 Remove the fuel injection pump, see **Section 7 Fuel System - Fuel Injection Pump**.
- 4 Remove the fuel lift pump, see **Section 7 Fuel System - Fuel Lift Pump**.
- 5 Remove the starter motor, see **Section 10 Electrical System - Starter Motor**.
- 6 Remove the high duty PTO device (if fitted).
- 7 Remove the low duty PTO device (if fitted).
- 8 Remove the flywheel, see **Flywheel - Removal and Replacement**.
- 9 Remove the flywheel housing, see **Flywheel Housing - Removal and Replacement**.

- 10 Remove the fuel injection pump drive gear, see **Drive Gear - Fuel Injection Pump - Removal and Replacement**.
- 11 Remove the oil pump, see **Section 9 Lubrication System - Oil Pump**.
- 12 Remove the high duty PTO idler drive gear (if fitted), see **Drive Gear - High Duty P.T.O. Idler - Removal and Replacement**.
- 13 Remove the crankshaft drive gear, see **Drive Gear - Crankshaft - Removal and Replacement**.
- 14 Remove the camshaft, see **Camshaft and Tappets - Removal and Replacement**.

Removal

- 1 Undo bolts **2** and then separate the timing case **1** from the cylinder block/bed plate assembly **3**. DO NOT use a lever to separate the timing case from the cylinder block/bed plate assembly.

Replacement

Important: Anaerobic sealant will not start to cure whilst it is open to the atmosphere, however when air is excluded (for instance when the two parts are put together) it will immediately start to harden. Make sure that all the necessary tools, bolts etc are readily available prior to assembling the components. The parts must be fitted and torque tightened within 5 minutes (with a maximum permissible time of 15 minutes.).

- 1 Carefully remove all traces of the old sealing compound from the timing case **1** and cylinder block/bed plate assembly **3** mating faces. Make sure that the mating faces are clean and free from damage. Clean the inside of the case **1** using a suitable degreaser.
- 2 Fit two alignment pins **T1** to the cylinder head/bed plate assembly **3**.
- 3 Make sure that dowels **4** and **5** are correctly located in the cylinder block.

Note: Dowel **5** has flats which must be positioned relative to dowel **4**, as shown **W**. This ensures correct alignment of the timing cover **1**.

Crankshaft Assembly

Crankshaft Pulley

Removal and Replacement

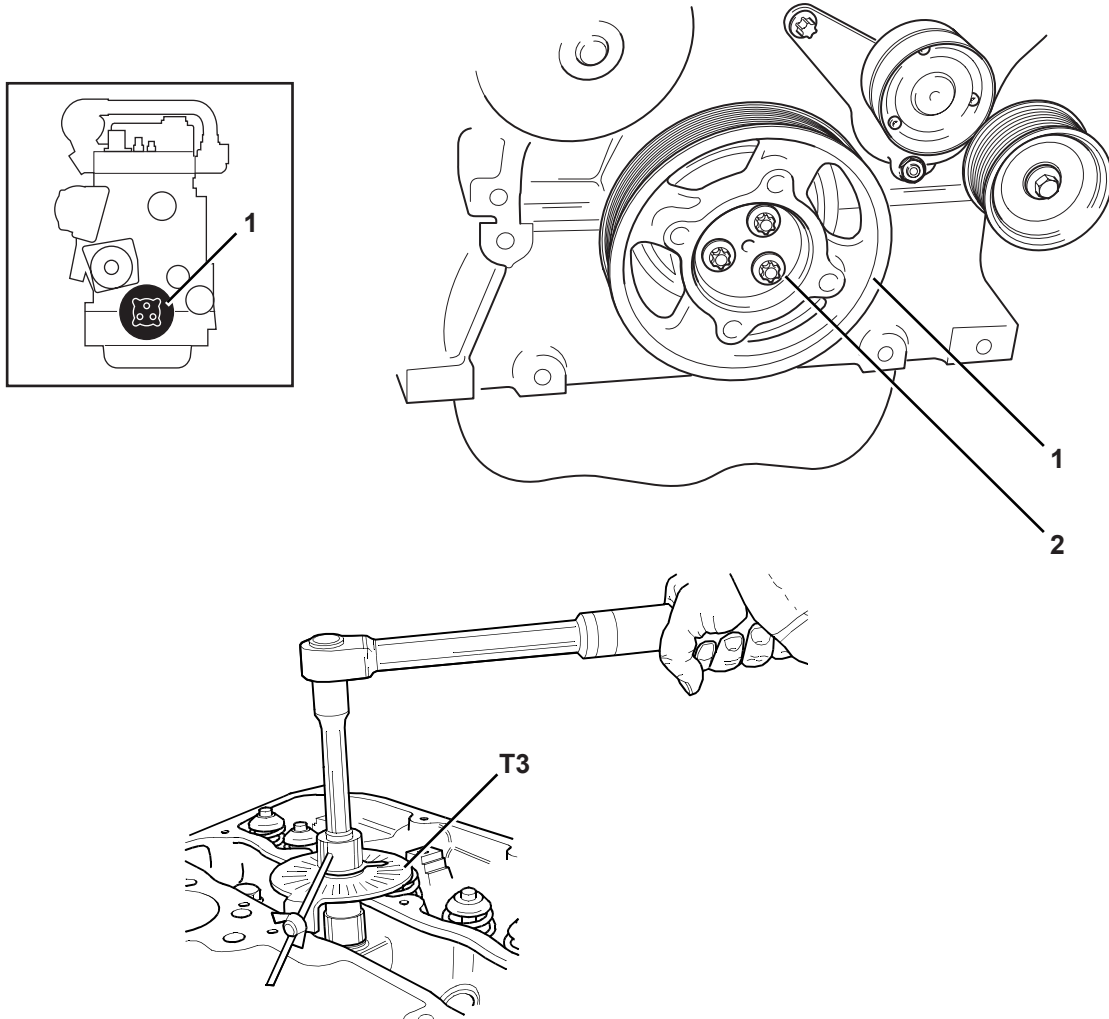


Fig 24.

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