
Perkins Peregrine

Models WG and WJ

USER'S HANDBOOK

Six cylinder turbocharged diesel engines for automotive applications

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This publication is divided into six chapters:

- 1 General information**
- 2 Engine views**
- 3 Operation instructions**
- 4 Preventive maintenance**
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1

General information

Introduction

The Peregrine is a new family of engines for automotive applications from Perkins Engines Limited, a world leader in the design and manufacture of high performance diesel engines.

Perkins approved assembly and quality standards, together with the latest technology, have been applied to the manufacture of your engine to give you reliable and economic power.

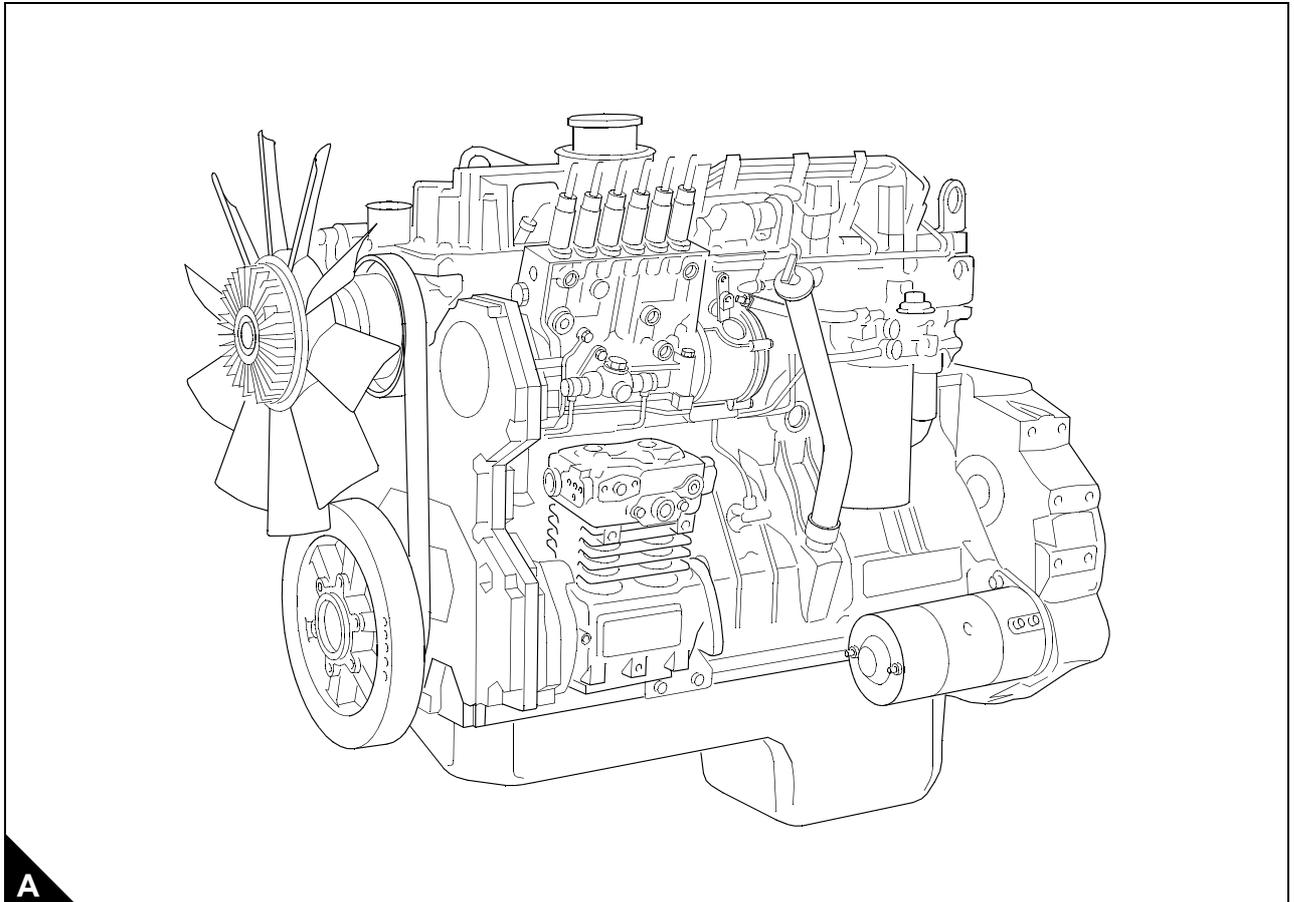
To ensure that you use the relevant information for your specific engine type, refer to "Engine identification" on page 9.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: Is used where the information is important, but there is not a danger.



Safety precautions

These safety precautions are important.

You must refer also to the local regulations in the country of use. Some items only apply to specific applications.

Only use these engines in the type of application for which they have been designed.

- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put fuel in the tank while the engine runs (unless it is absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme caution must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or auxiliary equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation.

Warning! *Some moving parts cannot be seen clearly while the engine runs.*

- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not use salt water or any other coolant which can cause corrosion in the closed coolant circuit.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operator's position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets.
- Discard used lubricating oil in a safe place to prevent contamination.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes.
- Always use a safety cage to protect the operator when a component is to be pressure tested in a bath of water. Fit safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.

Continued

- Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately.
- Turbochargers operate at high speed and at high temperatures. Keep fingers, tools and other objects away from the inlet and outlet ports of the turbocharger and avoid contact with hot surfaces.
- Fit only genuine Perkins parts.

How to care for your engine

This handbook has been written to assist you to maintain and operate your engine correctly.

To obtain the best performance and the longest life from your engine, you must ensure that the maintenance operations are done at the intervals indicated in Chapter 4, Preventive maintenance. If the engine works in a very dusty environment or other adverse conditions, certain maintenance intervals will have to be reduced. Renew the filter canisters and lubricating oil regularly in order to ensure that the inside of your engine remains clean.

Ensure that all adjustments and repairs are done by personnel who have had the correct training. Perkins can provide training at the Perkins Customer Training Department, Peterborough.

The terms "left side" and "right side" apply when the engine is seen from the flywheel end.

Warning! Read the "Safety precautions" on page 2 and remember them. They are given for your protection and must be applied at all times.

Engine preservation

Introduction

The recommendations indicated below are designed to prevent damage to the engine when it is withdrawn from service for a prolonged period. Use these procedures after the engine is withdrawn from service. The instructions for the use of POWERPART products are given on the outside of each container.

Procedure

- 1 Completely clean the outside of the engine.
- 2 When a preservative fuel is to be used, drain the fuel system and fill it with the preservative fuel. POWERPART Lay-Up 1 can be added to the normal fuel to change it to a preservative fuel. If preservative fuel is not used, the system can be completely filled with normal fuel but the fuel must be drained and discarded at the end of the storage period together with the fuel filter canister.
- 3 Operate the engine until it is warm. Then correct leakages of fuel, lubricating oil or air. Stop the engine and drain the lubricating oil from the sump.
- 4 Renew the canister of the lubricating oil filter.
- 5 Fill the sump to the full mark with new and clean lubricating oil and add POWERPART Lay-up 2 to the oil to protect the engine against corrosion. If POWERPART Lay-Up 2 is not available, use a correct preservative fluid instead of the lubricating oil. If a preservative fluid is used, this must be drained and the lubricating oil sump must be filled to the correct level with normal lubricating oil at the end of the storage period.
- 6 Drain the coolant system, see "How to drain the cooling system" on page 21. In order to protect the cooling system against corrosion, fill it with an approved antifreeze mixture because this gives protection against corrosion, see "Coolant specification" on page 35.

Caution: *If protection against frost is not necessary and a corrosion inhibitor is to be used, it is recommended that you consult the Technical Service Department, Perkins Sales and Service Limited, Peterborough.*

- 7 Operate the engine for a short period in order to circulate the lubricating oil and the coolant in the engine.
- 8 Clean the engine breather pipe and seal the end of the pipe.
- 9 Remove the atomisers and spray POWERPART Lay-Up 2 for one to two seconds into each cylinder bore with the piston at bottom dead centre. Slowly turn the crankshaft one revolution and then fit the atomisers, complete with new seat washers.
- 10 Disconnect the air inlet pipe at the rocker cover. Release the cap screws and remove the rocker cover. Spray POWERPART Lay-Up 2 around the rocker shaft assembly and into the induction ports in the cylinder head, as indicated on the container label. Fit the rocker cover and connect the air inlet pipe.

Remove the air filter. Then, if necessary, remove the pipe(s) installed between the air filter and the turbocharger. Seal the air inlet to the turbocharger with waterproof tape.

Continued

- 11 Remove the exhaust pipe. Spray POWERPART Lay-Up 2 into the turbocharger. It is recommended that the spray time for the turbocharger is 50% longer than the spray time for the manifold, which is indicated on the container label. Seal the turbocharger with waterproof tape.
- 12 Disconnect the battery. Then put the battery into safe storage in a fully charged condition. Before the battery is put into storage, protect its terminals against corrosion. POWERPART Lay-Up 3 can be used on the terminals.
- 13 Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.
- 14 Remove the drive belts and put them into storage.
- 15 In order to prevent corrosion, spray the engine with POWERPART Lay-Up 3. Do not spray the area inside the alternator cooling fan.

Caution: *After a period in storage, but before the engine is started, operate the starter motor with the engine stop control in the "stop" position until oil pressure is indicated. Oil pressure can be indicated either by a gauge or when a low pressure warning light is extinguished. If a solenoid stop control is used on the fuel injection pump, it must be disconnected for this operation.*

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins are not responsible for damage which may occur when an engine is in storage after a period in service.

Parts and service

If problems occur with your engine or with the components fitted onto it, your Perkins distributor can make the necessary repairs and will ensure that only the correct parts are fitted and that the work is done correctly.

Certain components can be supplied by your Perkins distributor through the Perkins POWER COMPONENTS system. These will enable you to reduce the cost of certain repairs.

POWERPART recommended consumable products

Perkins have made available the products recommended below in order to assist in the correct operation, service and maintenance of your engine and your machine. The instructions for the use of each product are given on the outside of each container. These products are available from your Perkins distributor.

POWERPART Antifreeze

Protects the cooling system against frost and corrosion. Part number 1 litre 21825166 or 5 litres 21825167.

POWERPART Atomiser thread sealant

To seal the threads of the atomiser into the cylinder head. Currently Hylomar Advance Formulation.

POWERPART Chisel

Allows easy removal of old gaskets and joints. Currently Loctite chisel. Part number 21825163.

POWERPART Compound

To seal the outer diameter of seals. Currently Loctite Forma Gasket No 2. Part number 1861147.

POWERPART Easy Flush

Cleans the cooling system. Part number 2182501.

POWERPART Gasket eliminator

Improves flange sealing when a gasket is not used. It provides a seal with temperature resistance that is flexible in positions where vibration and pressure occur. Currently Loctite 515. Part number 21826040.

POWERPART Jointing compound

Universal jointing compound which seals joints. Currently Hylomar. Part number 1861155 or 1861117.

POWERPART Lay-Up 1

A diesel fuel additive for protection against corrosion. Part number 1772204.

POWERPART Lay-Up 2

Protects the inside of the engine and of other closed systems. Part number 1762811.

POWERPART Lay-Up 3

Protects outside metal parts. Part number 1734115.

POWERPART Liquid gasket

To seal flat faces of components where no joint is used. Especially suitable for aluminium components. Currently Loctite 518. Part number 21820518.

POWERPART Nutlock

To retain and seal threaded fasteners and cup plugs where easy removal is necessary. Currently Loctite 242e. Part number 21820242

POWERPART Platelock

Medium strength anaerobic threadlock for tight fitted metal surfaces. Suitable for metal plated surfaces and stainless steel. Currently Loctite 243. Part number 21826039.

Continued

POWERPART Repel

Dries damp equipment and gives protection against corrosion. Passes through dirt and corrosion to lubricate and to assist removal of components. Currently Loctite repel. Part number 21825164.

POWERPART Retainer (high strength)

To retain components which have an interference fit. Currently Loctite 638. Part number 21820638.

POWERPART Retainer (oil tolerant)

To retain components which have a transition fit. Currently Loctite 603. Part number 21820603.

POWERPART Silicone adhesive

An RTV silicone adhesive for application where low pressure tests occur before the adhesive sets. Used for sealing flange where oil resistance is needed and movement of the joint occurs. Currently Loctite 5900. Part number 21826038.

POWERPART Silicone rubber sealant

Silicone rubber sealant which prevents leakage through gaps. Currently Hylosil. Part number 1861108.

POWERPART Studlock

To permanently retain large fasteners and studs. Currently Loctite 270. Part number 21820270.

POWERPART Threadlock

To retain small fasteners where easy removal is necessary. Currently Loctite 222e. Part number 21820222.

POWERPART Threadlock (heavy duty)

To provide a heavy duty seal to components that have a light interference fit. Currently Loctite 262. Part number 21820262.

POWERPART Threadlock (hydraulic/pneumatic)

To retain and seal pipe connections with fine threads. Especially suitable for hydraulic and pneumatic systems. Currently Loctite 542. Part number 21820542.

POWERPART Threadlock (pipe)

To retain and seal pipe connections with coarse threads. Pressure systems can be used immediately. Currently Loctite 575. Part number 21820575.

Service literature

Workshop manuals, installation drawings and other service publications are available. For further information contact Technical Service, Perkins Group of Companies Limited, Peterborough.

Training

Local training for the correct operation, service and overhaul of engines is available at certain Perkins distributors. If special training is necessary, contact the Perkins Customer Training Department, Peterborough.

Engine identification

The Peregrine family consists of a range of six cylinder in-line engines which are turbocharged and intercooled.

In this handbook, the different engine types are indicated by their code letters, which are the first two letters of the engine number as indicated below:

Code letters	Capacity		Aspiration system
	Litre	in ³	
WG	7,6	466	Turbocharged / intercooled
WJ	8,6	531	Turbocharged / intercooled

The engine number is stamped on the left side of the cylinder block, (A1). An example of an engine number is WJ1296N123456.

The components of the engine number are as follows:

WJ1296N123456

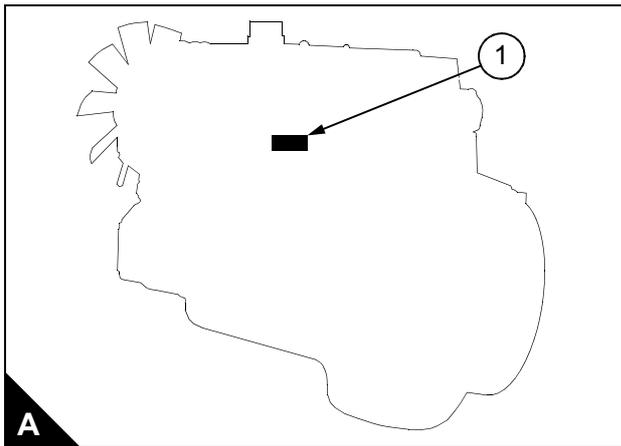
WJ = Type code letters

1296 = Build list number

N = Built in the USA

123456 = Engine serial number

If you need parts, service or information for your engine, you must give the complete engine number to your Perkins distributor.



Engine data

Number of cylinders	6
Cylinder arrangement	In line
Cycle	Four stroke
Induction system	Turbocharged/intercooled
Combustion system	Direct injection
Nominal bore:	
W	109,2 mm (4.301 in)
WJ	116,6 mm (4.590 in)
Stroke:	
WG and WJ	135,9 mm (5.350 in)
Compression ratio	16.5:1
Cubic capacity:	
WG	7,64 litres (466.4 in ³)
WJ	8,71 litres (531.0 in ³)
Firing order	1, 5, 3, 6, 2, 4
Valve tip clearances (cold):	
- Inlet	0,64 mm (0.025 in)
- Exhaust	0,64 mm (0.025 in)
Lubricating oil pressure	345 kN/m ² (50 lbf/in ²) 3,5 kgf/cm ²
(maximum engine speed and normal engine temperature)	
Capacity of a typical lubricating oil sump ⁽¹⁾ :	
- Without filter canister	20,8 litres (36.6 UK pints) 22 US quarts
- With filter canister	26,4 litres (46.5 UK pints) 28 US quarts
Typical coolant capacity (engine only)	12,8 litres (22.5 UK pints) 13,5 US quarts
Direction of rotation	Clockwise from the front

(1) The capacity of the sump may vary according to the application. Fill to the "Full" mark on the dipstick. Do not exceed the "Full" mark.

2

Engine views

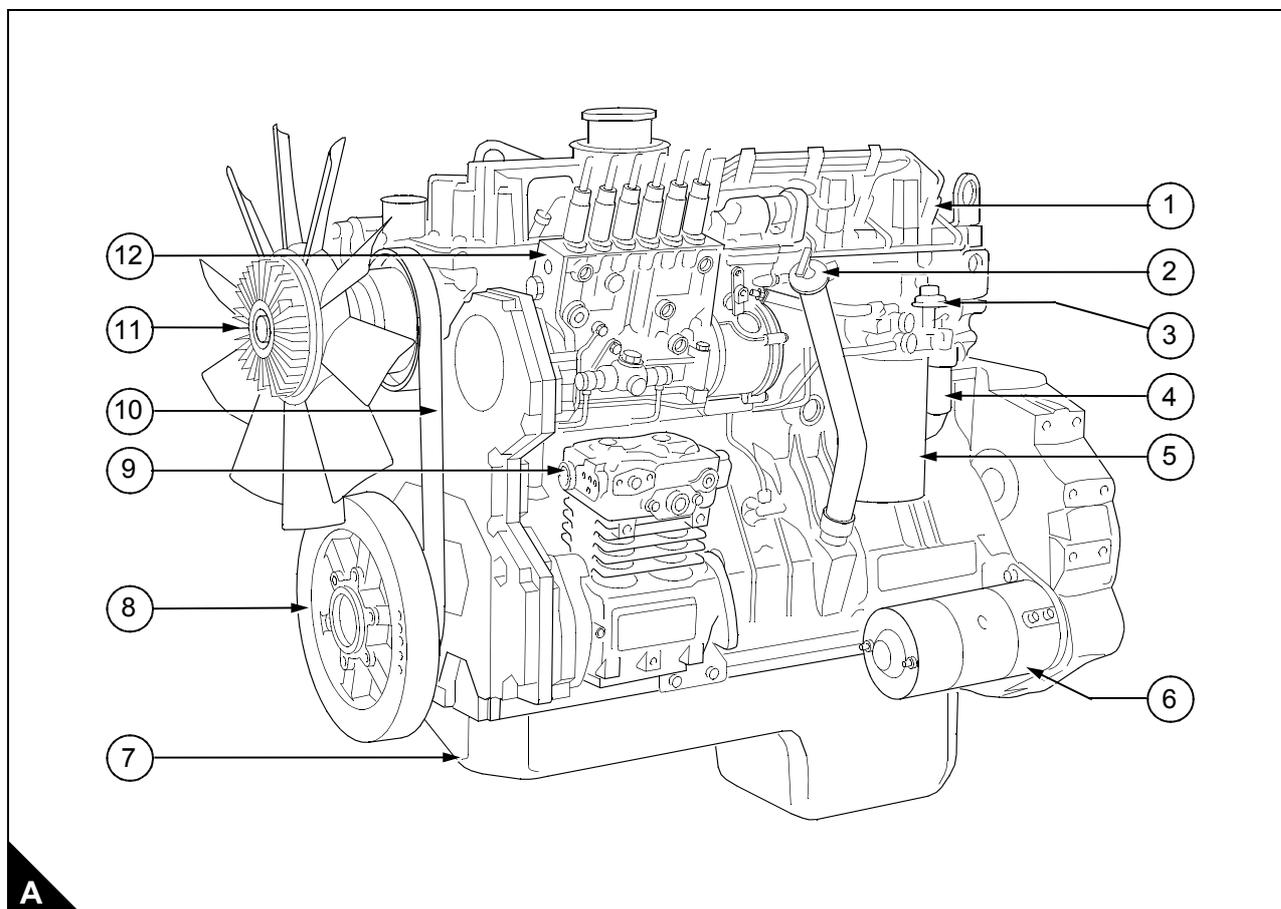
Introduction

Perkins engines are built for specific applications and the views which follow do not necessarily match your engine specification.

Location of engine parts

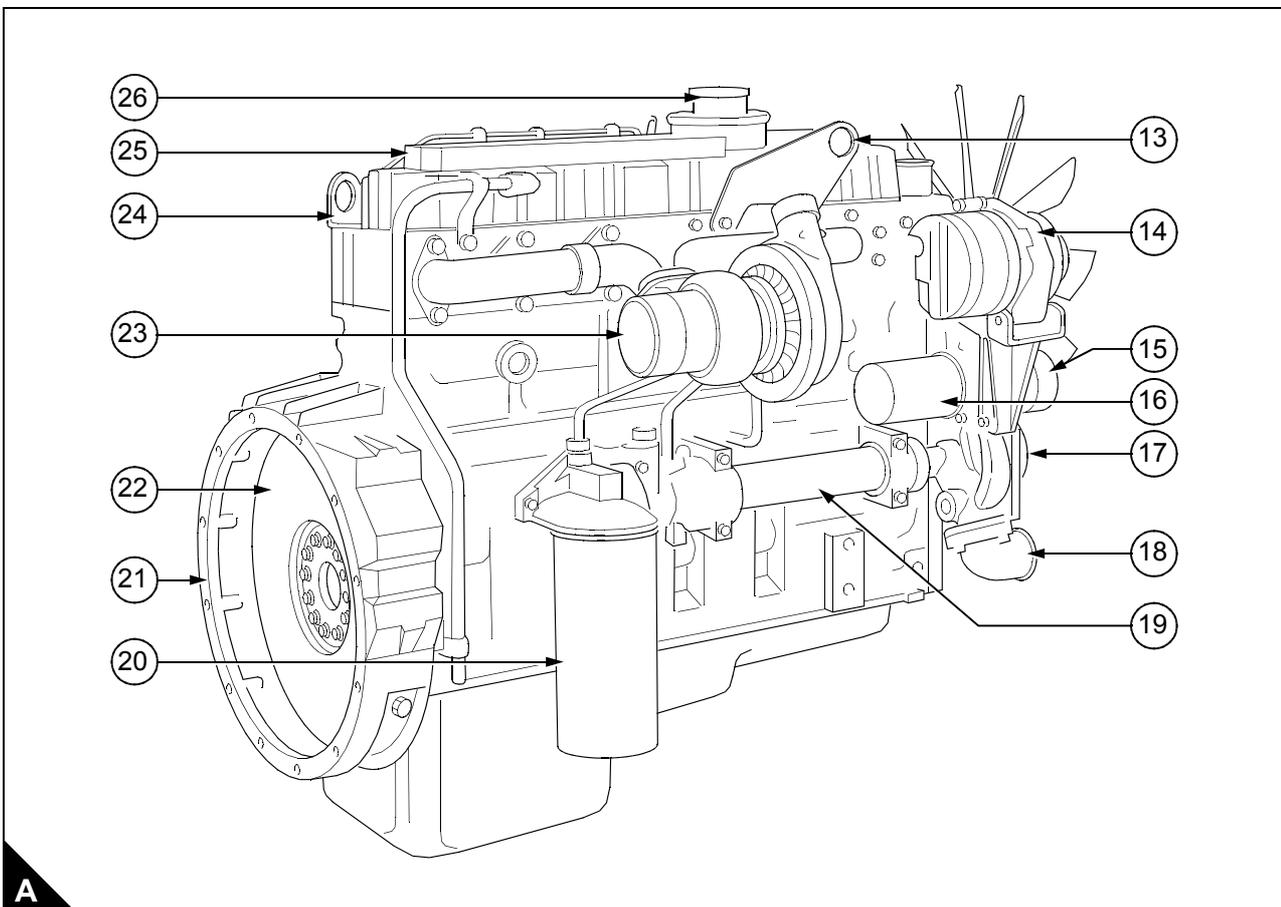
Front and left side view

- | | |
|---------------------------------------|---------------------------------------|
| 1 Atomiser | 7 Sump for the engine lubricating oil |
| 2 Lubricating oil filler and dipstick | 8 Crankshaft damper |
| 3 Fuel priming pump | 9 Compressor |
| 4 Fuel strainer | 10 Drive belt |
| 5 Canister for the fuel filter | 11 Fan |
| 6 Starter motor | 12 Fuel injection pump |



Rear and right side view

- | | |
|--|--|
| 13 Front lift bracket | 20 Canister for the lubricating oil filter |
| 14 Alternator | 21 Flywheel housing |
| 15 Tensioner for the drive belt | 22 Flywheel |
| 16 Canister for the coolant filter / inhibitor | 23 Turbocharger |
| 17 Coolant pump | 24 Rear lift bracket |
| 18 Coolant inlet connection | 25 Rocker cover and induction manifold |
| 19 Lubricating oil cooler | 26 Air inlet connection |



3

Operation instructions

How to start the engine

Several factors affect engine start, for example:

- The power of the batteries
- The performance of the starter motor
- The viscosity of the lubricating oil
- The installation of a cold start system

The engine will start with the fuel injection pump in excess fuel at temperatures as low as -20 °C (-4 °F). In conditions where the temperature is lower than this, an ether start system may be necessary.

Before the engine is started the operator should understand fully the reason for the controls and their use.

Before the engine is started:

- Check that there is sufficient coolant and, if necessary, add the correct coolant. See Chapter 4, Preventive maintenance.
- Check that there is sufficient lubricating oil in the sump and, if necessary, add lubricating oil. See Chapter 4, Preventive maintenance. Ensure that the lubricating oil is of the correct grade for the ambient conditions.
- Fill the fuel tank with fuel of the correct specification.
- Check the air filter and its connections.
- Ensure that all of the electrical connections are tight.

Notes:

- See Chapter 5, Engine fluids for the correct engine fluids.
- The procedures to start the engine may vary according to the application. If possible, consult the User's Handbook for the application.

Caution: *If the engine has not run for several weeks, see **Caution** on page 5.*

How to start a warm engine

Ambient temperature more than 15°C (60°F)

- 1 Apply the hand brake. Ensure that the transmission is in the out-of-drive position. Ensure that the engine speed control is in the minimum speed position.
- 2 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 3 Turn the start key to the "ON" position.
- 4 Continue to turn the start key to engage the starter motor. If the application has a start button, press and hold the button.
- 5 Release the start key (or the button) as soon as the engine starts. The start key will return to the "ON" position.

Caution: *Caution: If the engine does not start within 30 seconds, release the start key and wait two to three minutes to allow the starter motor to cool. If after three tries the engine does not start, turn the key to the "OFF" position and locate and correct the problem. Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.*

- 6 When the engine starts check that the lubricating oil pressure exceeds 69 kPa (10 lbs/in²) 0,70 kgf/cm² within the first 10 seconds (see "Engine data" on page 10 for the correct lubricating oil pressure). If a gauge is not fitted, check that the warning light for low oil pressure is extinguished. If this does not occur, stop the engine and find and correct the fault. Allow the engine to warm at approximately 1000 rev/min for three to five minutes before load is applied.

How to start a cold engine

Ambient temperatures from +15°C (+60°F) to -20°C (-4°F)

1 Apply the hand brake. Ensure that the transmission is in the out-of-drive position.

2 Ensure that the engine speed control is in the minimum speed position.

Engines equipped with a manual stop control: Ensure that the manual stop control is in the "run" position. Then adjust the engine speed control to the maximum speed position.

3 Turn the start key to the "ON" position.

4 Continue to turn the start key to engage the starter motor. If the application has a start button, press and hold the button. If the engine is equipped with an electrical stop control, move the engine speed control to the maximum speed position after the starter motor is engaged.

5 Release the start key (or the button) as soon as the engine starts. The start key will return to the "ON" position. Then release the engine speed control.

6 When the engine starts check that the lubricating oil pressure exceeds 69 kPa (10 lbs/in²) 0,70 kgf/cm² within the first 10 seconds (see "Engine data" on page 10 for the correct lubricating oil pressure). If a gauge is not fitted, check that the warning light for low oil pressure is extinguished. If this does not occur, stop the engine and find and correct the fault. Allow the engine to warm at approximately 1000 rev/min for three to five minutes before load is applied.

Caution: *If the engine does not start within 30 seconds, release the start key and wait two to three minutes to allow the starter motor to cool. If after three tries the engine does not start, turn the key to the "OFF" position and locate and correct the problem. Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.*

How to start an engine with an ether start system

Ambient temperature below -20°C (-4°F)

Warning! Ether is very flammable and is toxic. Apply the safety precautions on the container for the use and storage of ether and for the disposal of empty containers.

- 1 Apply the hand brake. Ensure that the transmission is in the out-of-drive position. Ensure that the engine speed control is in the minimum speed position. Check the ether container to ensure that a supply of ether is available under pressure.
- 2 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 3 Ensure that the engine speed control is still in the idle position.
- 4 Turn the start key to the "ON" position.
- 5 Continue to turn the start key (or press the start button, if one is fitted) to engage the starter motor and at the same time press the ether injection button. Allow one to two seconds for the ether injection system to fill then release the injection button to release a measured amount of ether into the engine. While the engine is still at cranking speed move the engine speed control to the maximum speed position.

Caution: Release of ether into the cylinders before the starter motor is engaged may cause damage to the pistons and piston rings.

- 6 Release the start key (or the start button, if one is fitted) as soon as the engine starts. The start key will return to the "ON" position. Then release the engine speed control.

Caution: If the engine does not start within 30 seconds, release the start key and wait two to three minutes to allow the starter motor to cool. If after three tries the engine does not start, turn the key to the "OFF" position and locate and correct the problem. Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.

Note: In extremely cold conditions, it is permissible to inject further ether into the engine if the engine runs roughly after the initial start.

Caution: Do not inject ether into a warm engine.

- 7 When the engine starts check that the lubricating oil pressure exceeds 69 kPa (10 lbs/in²) 0,70 kgf/cm² within the first 25 seconds (see "Engine data" on page 10 for the correct lubricating oil pressure). If a gauge is not fitted, check that the warning light for low oil pressure is extinguished. If this does not occur, stop the engine and find and correct the fault. Allow the engine to warm at approximately 1000 rev/min for three to five minutes before load is applied.

How to stop the engine

According to the equipment fitted, either turn the engine start key to the "OFF" position or operate the manual stop control. If a manual stop control is used, ensure that the control returns to the "run" position after the engine has stopped. Also ensure that the engine start key is turned to the "OFF" position. It is recommended that the engine is operated at idle speed for three to five minutes before the engine is stopped. This will allow the lubricating oil and the coolant to carry the heat away from large ferrous components.

Caution: *It is recommended that a turbocharged engine is run at approximately 1000 rev/min at a reduced load for 2-3 minutes before it is shut down. This will allow the turbocharger to cool.*

Adjustment of engine speed range

The idle or maximum speed settings must not be changed by the engine operator because this can damage the engine or the transmission. The warranty of the engine can be affected if the seals on the fuel injection pump are broken during the warranty period by a person who is not approved by Perkins.

Engine operation at idle speed

Do not operate the engine for long periods at idle speed as this could have an adverse affect on the engine performance or damage the engine.

Running-in

A gradual running-in of a new engine is not necessary. Maximum load can be applied to a new engine as soon as the engine is put into service.

- The engine will benefit if the load is applied as soon as possible after the engine is put into service.
- Before maximum load is applied to the engine, ensure that the coolant is at normal working temperature.
- Prolonged operation at light loads during the early life of the engine can cause lubricating oil to enter the exhaust system.

Cautions:

- *Do not operate the engine at high speeds without a load.*
- *Do not overload the engine.*

Altitude

The engine will run correctly up to an altitude of 3000 m (10,000 ft). If the engine is to run at an altitude above 3000 m (10,000 ft), changes must be made to the settings of the fuel injection pump. These changes must be made by an approved distributor for the fuel injection pump.

4

Preventive maintenance

Preventive maintenance periods

These preventive maintenance periods apply to average conditions of operation. Check the periods given by the manufacturer of the equipment in which the engine is installed. Use the periods which are shortest. When the operation of the engine must conform to the local regulations these periods and procedures may need to be adapted to ensure correct operation of the engine.

It is good preventive maintenance to check for leakage and loose fasteners at each service.

These maintenance periods apply only to engines that are operated with fuel and lubricating oil which conform to the specifications given in this handbook.

Schedules

The schedules which follow must be applied at the interval (miles or months) which occur first.

- | | | | |
|----------|--|----------|--|
| A | Every day or every 8 hours | E | Every 193 100 km (120 000 miles) |
| B | Every 19 300 km (12 000 miles) or 6 months | F | Every 290 000 to 322 000 km (180 000 to 200 000 miles) |
| C | Every 38 600 km (24 000 miles) or 12 months | G | Annually |
| D | Every 154 400 km (96 000 miles) or 24 months | | |

A	B	C	D	E	F	G	Operation
●							Check the amount of coolant
●							Check the intercooler and the coolant radiator for debris
		●					Renew the canister of the coolant filter ⁽³⁾
			●				Renew the coolant ⁽⁴⁾
	●						Check the condition of the drive belt
●							Drain water from the fuel pre-filter ⁽¹⁾
		●					Renew the canister of the fuel filter and renew the fuel strainer
					●		Ensure that the atomisers are checked ⁽²⁾
	●						Ensure that the idle speed is checked and adjusted, if it is necessary ⁽²⁾
●							Check the amount of lubricating oil in the sump
●							Check the lubricating oil pressure at the gauge ⁽¹⁾
		●					Renew the engine lubricating oil ⁽⁵⁾
		●					Renew the canister of the lubricating oil filter
		●					Clean or renew the air filter element (or earlier if in extremely dusty conditions)
				●			Ensure that the valve tip clearances of the engine are checked and, if necessary, adjusted ⁽²⁾
					●		Ensure that the turbocharger impeller and the turbocharger compressor casing are cleaned ⁽²⁾
					●		Ensure that the alternator, the starter motor, and the turbocharger, etc. are checked ⁽²⁾
					●		Inspect the thermostat ⁽²⁾
					●		Inspect the electrical system ⁽²⁾

(1) If one is fitted.

(2) By a person who has had the correct training.

(3) Also if the coolant system has been drained.

(4) The system should be flushed and a new filter canister fitted.

(5) The oil change interval will change with the sulphur content of the fuel (see the table below and "Fuel specification" on page 33).
The interval to change the canister of the lubricating oil filter is not affected.

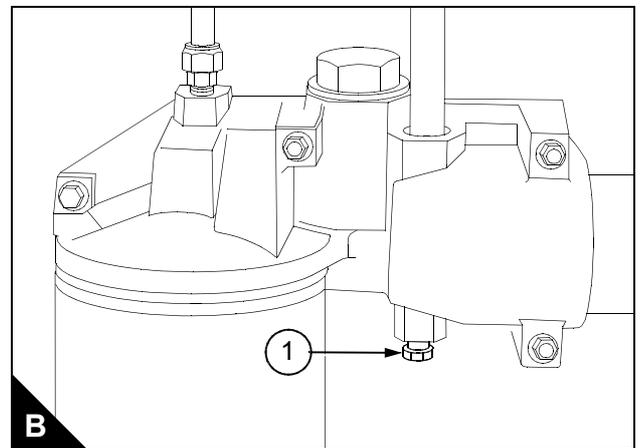
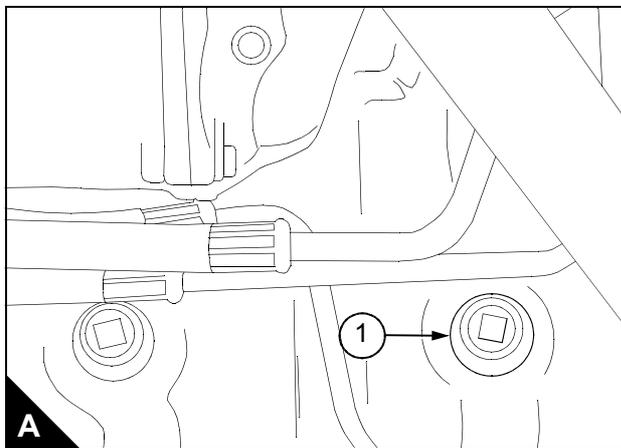
Percentage of sulphur in the fuel (%)	Oil change interval
<0,5	Normal
0,5 to 1,0	0,75 of normal
>1,0	0,50 of normal

How to drain the cooling system

Warning! Do not drain the coolant while the engine is still hot and the system is under pressure because dangerous hot coolant can be discharged.

- 1 Ensure that the machine is on level ground.
- 2 Remove the filler cap of the cooling system.
- 3 Remove the drain plug (A1) from the side of the cylinder block (below the rear of the fuel injection pump) and the drain plug (B1) from the lubricating oil cooler in order to drain the engine. Ensure that the drain holes are not restricted.
- 4 Open the tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a tap or drain plug, disconnect the hose at the bottom of the radiator.
- 5 Flush the system with POWERPART Easy Flush.
- 6 Fit the drain plugs and the filler cap. Close the radiator tap or connect the radiator hose.
- 7 Renew the canister of the coolant filter, see "How to renew the canister of the coolant filter / inhibitor" on page 23.

Caution: The canister contains a corrosion inhibitor which is circulated around the cooling system as the coolant passes through the canister. It is important that only the genuine correct Perkins canister is used.



How to fill the cooling system

Caution: See "Coolant specification" on page 35 for details of the correct coolant to be used in the cooling system. If coolant is added to the system during service, it must consist of the same original mixture as used to fill the system. The engine must be allowed to cool before coolant is added.

If coolant has to be added to the cooling system, mix 227 ml (8 ounces) of Perkins inhibitor to 4,54 litres (1 gallon) 1.2 US gallons of coolant.

The inhibitor is prepared especially for these engines and is available from your Perkins Distributor.

Part numbers for the inhibitor are shown in the table below:

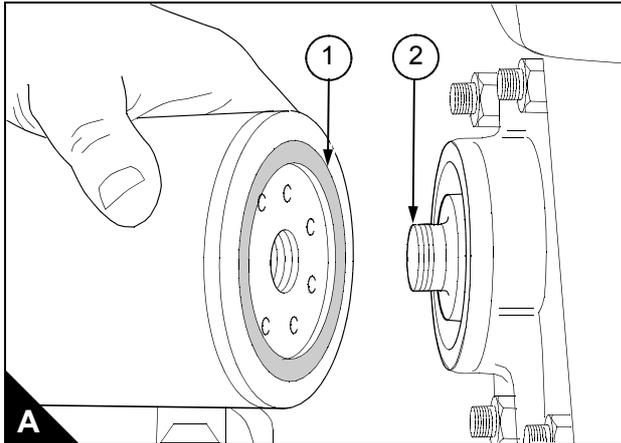
Quantity (litres)	Part number
0,6	815 586 C1
1,0	815 587 C1
208,0	815 583 C1

- 1 Remove the filler cap of the cooling system.
- 2 The cooling system must be filled very slowly in order to eliminate air. Fill the cooling system until coolant reaches the bottom of the filler tube. Fit the filler cap.
- 3 Start the engine. Allow the engine to operate at a fast idle until the engine reaches its normal temperature of operation. Stop the engine and allow it to cool.
- 4 Remove carefully the filler cap and add coolant until the level of the coolant reaches the filler tube. Fit the filler cap.

How to renew the canister of the coolant filter / inhibitor

Caution: The canister contains a corrosion inhibitor which is circulated around the cooling system as the coolant passes through the canister. It is important that only the genuine correct Perkins canister is used.

- 1 Thoroughly clean the outside surfaces of the coolant filter assembly.
- 2 Use a strap wrench or similar tool to loosen the filter canister and remove the canister (A). Valves in the filter head will prevent the loss of coolant when the canister is removed.
- 3 Ensure that the threaded adaptor (A2) is secure in the filter head and that the inside of the head is clean.
- 4 Lubricate lightly the seal (A1) on top of the new canister with clean engine coolant. Fit the new canister to the filter head and tighten, by hand only. Do not overtighten the canister.



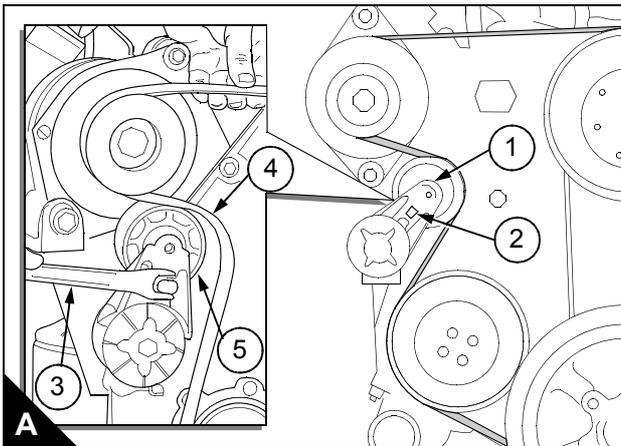
How to check the drive belt

There is no need to check the tension of the belt as the tension is set automatically. The condition of the belt should be checked. The belt should be renewed if there are cracks in the belt or if the belt is contaminated by oil or grease.

How to renew the drive belt

1 Fit a square headed lever (A3) into the 12,7 mm (0.5 in) hole (A2) in the tensioner assembly (A1). Operate the lever to release the tension from the belt (A4) and remove the belt. The tensioner will return to its original position by spring pressure. Remove the lever.

2 With the lever in the tensioner, pull the tensioner outwards. Put the new belt in position around all of the pulleys. Ensure that the tensioner pulley (A5) is on the outside of the belt. Allow the tensioner to return and tension the belt. Remove the lever.



Fuel pre-filter

This will normally be fitted between the fuel tank and the engine. Check the filter bowl for water at regular intervals and drain as necessary.

How to renew the fuel strainer and the canister of the fuel filter

The fuel filter assembly has a fuel strainer to remove larger particles from the fuel and a filter canister to remove the smaller particles. The fuel strainer and the filter canister should be renewed at the same time.

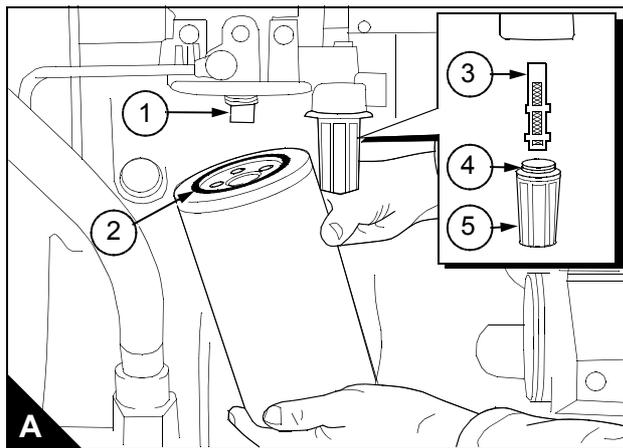
- 1 Thoroughly clean the outside surfaces of the fuel filter assembly.
- 2 Use a strap wrench or similar tool to loosen the filter canister, and remove the canister.
- 3 Use a 29 mm (1 $\frac{1}{8}$ in) socket spanner to remove the plastic cover (A5) from the fuel strainer. Remove the strainer (A3) and the 'O' ring (A4) from the cover.
- 4 Fit a new strainer and a new 'O' ring to the cover and fit the cover to the filter head.

Caution: Ensure that the open end of the new strainer is toward the filter head.

- 5 Ensure that the threaded adaptor (A1) is secure in the filter head and that the inside of the head is clean. Lubricate lightly the seal (A2) of the new canister with clean diesel fuel. Fit the new canister to the filter head and tighten the canister by hand until the seal contacts the filter head. Tighten the canister a further $\frac{1}{2}$ turn by hand only. Do not use a strap wrench.

- 6 Eliminate the air from the fuel filter, "How to eliminate air from the fuel system" on page 28.

Caution: It is important that only the genuine Perkins parts are used. The use of wrong parts could damage the fuel injection pump.



Atomiser fault

An atomiser fault can cause an engine misfire.

In order to find which atomiser is defective, operate the engine at a fast idle speed. Loosen and tighten the union nut of the high-pressure fuel pipe at each atomiser. When the union nut of the defective atomiser is loosened, it has little or no effect on the engine speed.

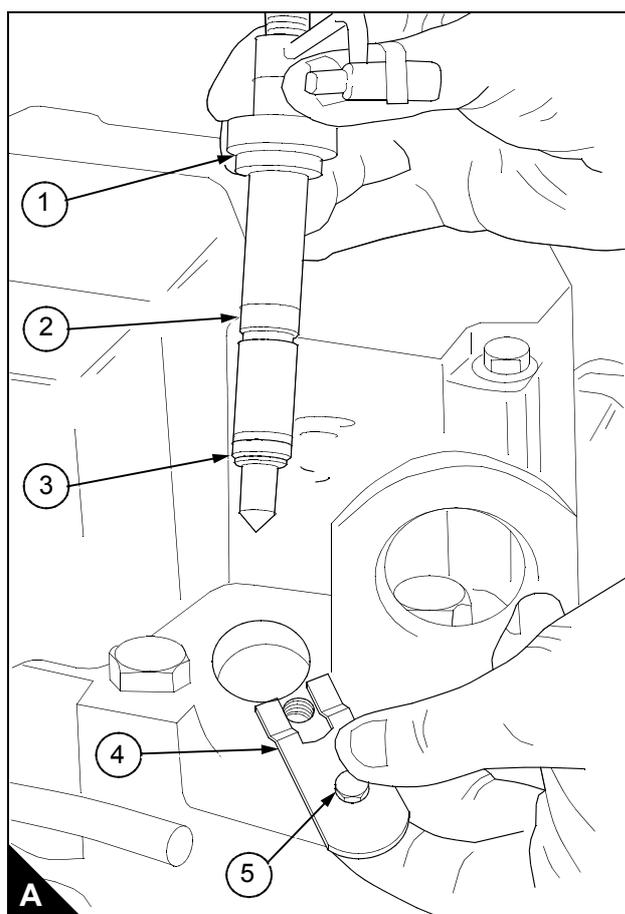
Warning! *Ensure that the fuel does not spray onto your skin.*

How to renew an atomiser

- 1 Clean thoroughly the area around the atomiser to be removed.
 - 2 Release the spring clips and remove the fuel leak-off pipe.
 - 3 Remove the union nuts of the high-pressure pipe from the atomiser and from the fuel injection pump. Do not bend the pipe. If necessary, remove the pipe clamps.
 - 4 Remove the setscrew (A5) of the atomiser clamp and remove the clamp (A4), the atomiser (A2) and its seat washer (A3). Remove the dust seal (A1) and fit a new dust seal onto the new atomiser.
- Caution:** Do not turn the atomiser from side to side during the removal of the atomiser as this action could loosen the atomiser sleeve in the cylinder head.
- 5 Put the new atomiser in position with its new dust seal and a new seat washer. Ensure that the fuel leak-off connection is not toward the engine. Fit the clamp and engage the clamp setscrew. Ensure that the atomiser is not tilted and tighten the setscrew to 25 Nm (19 lbf ft) 2,5 kgf m.
 - 6 Fit the high-pressure fuel pipe and tighten the union nuts to 40 Nm (30 lbf ft) 4,0 kgf m. If necessary, fit the pipe clamps.

Cautions:

- Do not tighten the union nuts of the high-pressure pipes more than the recommended torque tension.
 - If there is a leakage from the union nut, ensure that the pipe is correctly aligned with the atomiser inlet.
 - Do not tighten the atomiser union nut more, as this can cause a restriction at the end of the pipe. This can affect the fuel delivery.
- 7 Push the leak off pipe onto the leak off connection and fit the spring clips.
 - 8 Operate the engine and check for leakage of fuel and air.



How to eliminate air from the fuel system

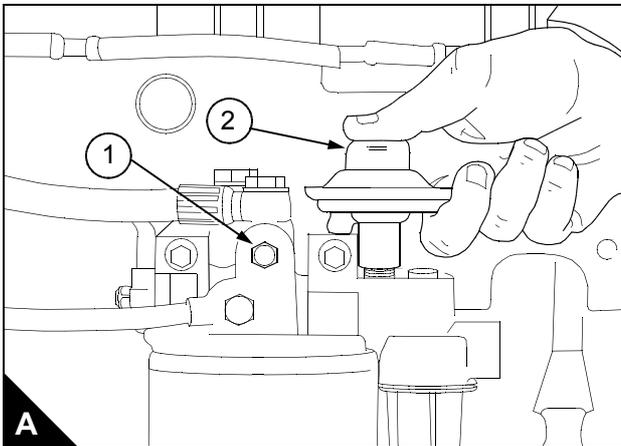
If air enters the fuel system, it must be eliminated before the engine can be started.

Air can enter the system if:

- The fuel tank is drained during normal operation.
- The low-pressure fuel pipes are disconnected.
- A part of the low-pressure fuel system leaks during engine operation.

In order to eliminate air from the fuel system, proceed as follows:

- 1 Loosen the vent plug on the top of the fuel filter head (A1).
- 2 Operate the plunger of the fuel priming pump (A2) until fuel, free from air, comes from the filter vent point. Tighten the vent plug.
- 3 Ensure that the manual stop control is in the "run" position. If an electrical stop control is used, turn the start key to the "ON" position.
- 4 Operate the starter motor for intervals of 15 seconds until the engine starts. If the engine runs correctly for a short time and then stops or runs roughly, check for air in the fuel system. If there is air in the fuel system, there is probably a leakage in the low pressure system. Stop the engine and turn the start key to the "OFF" position.



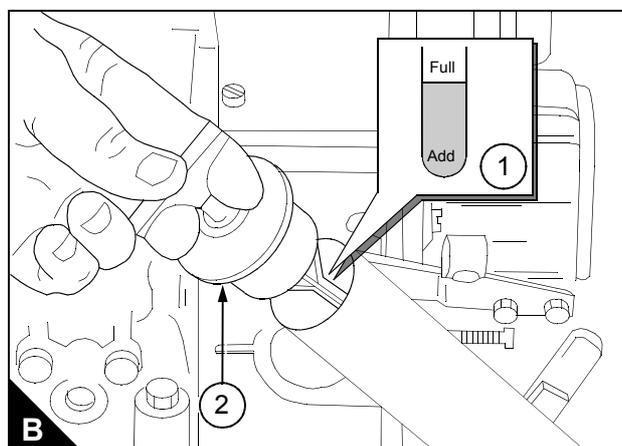
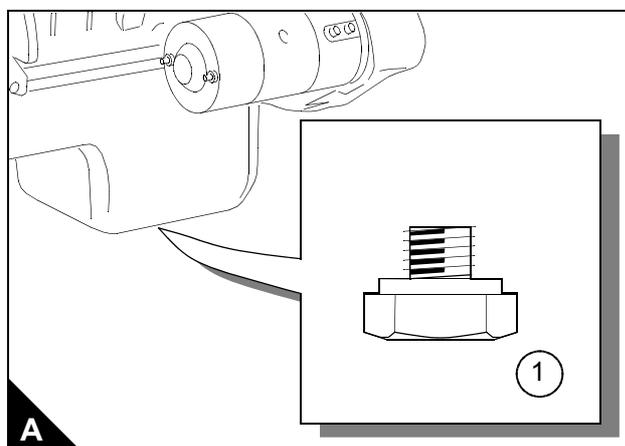
How to renew the lubricating oil

- 1 Operate the engine until it is warm.
- 2 Stop the engine.
- 3 Put a container with a capacity of approximately 30 litres (6.5 gallons) 32 US quarts beneath the sump. Remove the sump drain plug (A1) and its washer and drain the lubricating oil from the sump. Ensure that the washer is not damaged. Fit the drain plug and its washer and tighten the plug to 68 Nm (50 lbf ft) 6,9 kgf m.
- 4 Turn the handle on top of the filler cap (B2) counter-clockwise to release the filler cap and dipstick assembly from the filler tube.
- 5 Fill the sump to the "FULL" mark on the dipstick (B1) with new and clean lubricating oil of an approved grade, see "Lubricating oil specification" on page 34.
- 6 Fit the dipstick and filler cap assembly and turn the handle on the cap clockwise to tighten the filler cap in the filler tube.
- 7 Remove the container of used lubricating oil from beneath the engine.

Warning! Discard the used lubricating oil in a safe place and in accordance with local regulations.

- 8 Start the engine and check for lubricating oil leakage. Stop the engine. After 15 minutes check the oil level on the dipstick and, if necessary, put more lubricating oil into the sump.

Caution: Do not fill the sump past the "FULL" mark on the dipstick



How to renew the canister of the lubricating oil filter

- 1 Put a tray under the filter to retain spilt lubricating oil. Clean thoroughly the outside surfaces of the filter assembly.
- 2 Use a strap wrench or similar tool to loosen the filter canister. Remove and discard the canister. Ensure that the adaptor (A1) is secure in the filter head.

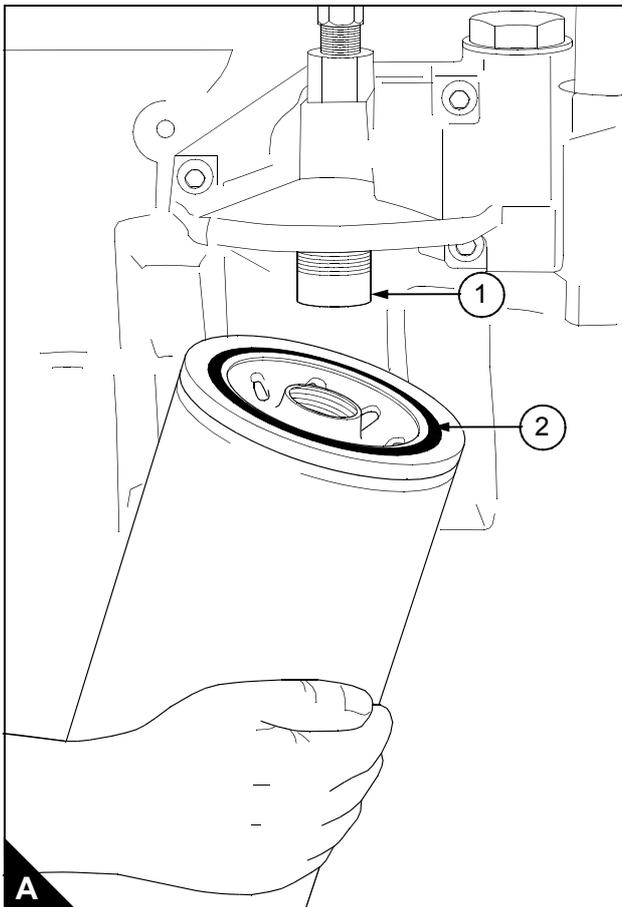
Warning! Discard the used canister and lubricating oil in a safe place and in accordance with local regulations.

- 3 Clean inside the filter head
- 4 Lubricate the seal (A2) on top of the canister with clean engine lubricating oil.
- 5 Fit the new canister and tighten by hand until the seal contacts the filter head. Tighten the canister a further $\frac{1}{2}$ to $\frac{3}{4}$ of a turn by hand only. Do not use a strap wrench.
- 6 Ensure that there is lubricating oil in the sump.

Ensure that the engine will not start and operate the starter motor until oil pressure is obtained. To ensure that the engine will not start, either put the manual stop control in the "stop" position or disconnect the electrical stop control of the fuel injection pump. Oil pressure is indicated when the warning light is extinguished or by a reading on the gauge.

- 7 Start the engine and check for leakage from the filter. Stop the engine. After 15 minutes check the oil level on the dipstick and, if necessary, put more lubricating oil into the sump.

Caution: Do not fill the sump past the "FULL" mark on the dipstick.



Air filter

Environmental conditions have an important effect on the frequency at which the air filter needs service.

The filter element must be cleaned or renewed according to the manufacturer's recommendations.

Restriction indicator

The restriction indicator for these engines must work at a pressure difference of 635 mm (25 in) of water gauge. It is fitted on the air filter outlet or between the air filter and the induction manifold.

The restriction indicator should be tested according to the manufacturer's recommendations.

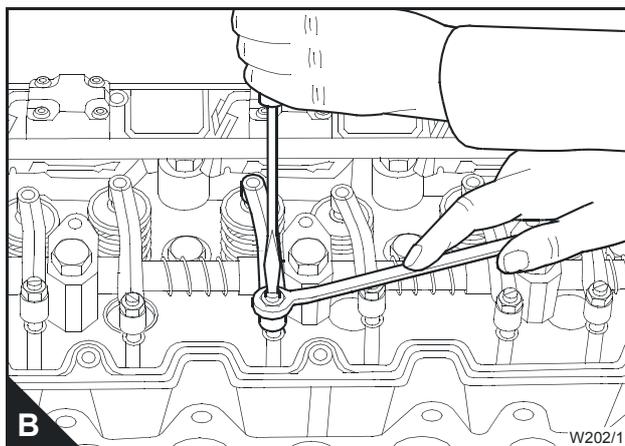
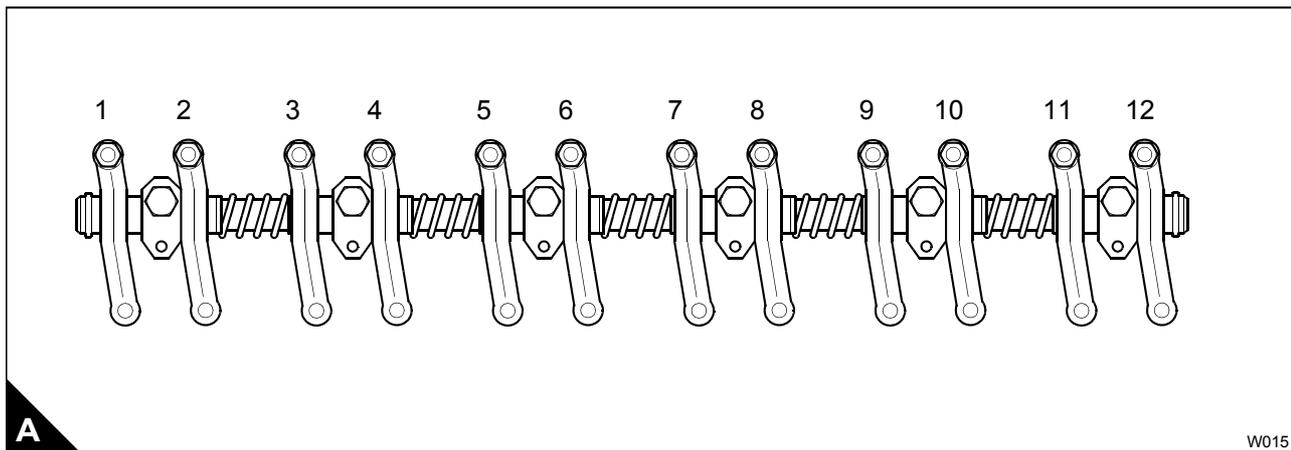
How to set the valve tip clearances

The valve tip clearance is checked with feeler gauges between the top of the valve stem and the rocker lever (B), with the engine cold. The correct clearance for the inlet valves and the exhaust valves is 0,64 mm (0.025 in). The valve positions are shown at (A).

The arrangement of the valves for each cylinder in sequence is inlet valve then exhaust valve.

Note: Number 1 cylinder is at the front of the engine.

- 1 Disconnect the air inlet pipe at the rocker cover/induction manifold.
- 2 Release the 13 cap screws which retain the rocker cover and remove the cover.
- 3 Turn the crankshaft in the normal direction of rotation until valve 11 (A) has just opened and valve 12 has not closed fully. Check/adjust the clearances of valves 1 and 2.
- 4 Set valves 3 and 4 as indicated above then check/adjust the clearances of valves 9 and 10.
- 5 Set valves 7 and 8 then check/adjust the clearances of valves 5 and 6.
- 6 Set valves 1 and 2 then check/adjust the clearances of valves 11 and 12.
- 7 Set valves 9 and 10 then check/adjust the clearances of valves 3 and 4.
- 8 Set valves 5 and 6 then check/adjust the clearances of valves 7 and 8.
- 9 If necessary, put a new rocker cover/induction manifold gasket in position on the cylinder head. Align carefully the cover and the gasket. Fit the cap screws which retain the rocker cover and tighten them to 17 Nm (13 lbf ft) 1,7 kgf m.
- 10 Connect the air inlet pipe to the rocker cover.



5

Engine fluids

Fuel specification

To get the correct power and performance from your engine, use good quality fuel. The recommended fuel specification for Perkins engines is indicated below:

Cetane number	50 minimum
Viscosity	2.0/4.5 centistokes at 40 °C
Density	0,835/0,855 kg/litre
Sulphur	0.2% of mass, maximum
Distillation	85% at 350 °C

Cetane number indicates ignition performance. A fuel with a low cetane number can cause cold start problems and affect combustion.

Viscosity is the resistance to flow and engine performance can be affected if it is outside the limits.

Density: A lower density reduces engine power, a higher density increases engine power and exhaust smoke.

Sulphur: A high sulphur content (not normally found in Europe, North America or Australasia) can cause engine wear. Where only high sulphur fuels are available, it is necessary to use a highly alkaline lubricating oil in the engine or to renew the lubricating oil more frequently, see "Lubricating oil specification" on page 34.

Distillation: This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light-weight hydrocarbons can affect the combustion characteristics.

Low temperature fuels

Special winter fuels may be available for engine operation at temperatures below 0 °C. These fuels have a lower viscosity and also limit the wax formation in the fuel at low temperatures. If wax formation occurs, this could stop the fuel flow through the filter.

If you need advice on adjustments to an engine setting or to the lubricating oil change periods which may be necessary because of the standard of the available fuel, consult the Technical Service Department of Perkins International Limited at Peterborough or your nearest Perkins Distributor.

Aviation kerosene fuels

Caution: Do not use aviation kerosene fuel JP4.

JP5 and JP8 can be used, but they can affect engine performance and wear in the fuel injection pump could increase. It is recommended that you consult the Technical Service Department of Perkins International Limited at Peterborough if aviation kerosene fuel is to be used.

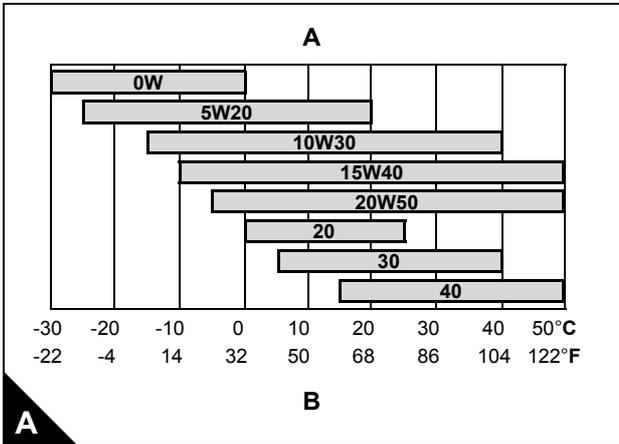
Caution: Aviation kerosene fuels are more flammable than diesel fuel and need careful storage and careful management.

Lubricating oil specification

Use only a good quality lubricating oil which is not less than the specification API CF-4 or CCMC D5.

Caution: *The type of lubricating oil to be used may be affected by the quality of the fuel which is available. For further details see "Fuel specification" on page 33.*

Always ensure that the correct viscosity grade of lubricating oil is used for the ambient temperature range in which the engine will run as shown in the chart (A).



Viscosity chart

A = Recommended viscosity grades

B = Ambient temperature

Coolant specification

The quality of the coolant which is used can have a great effect on the efficiency and life of the cooling system. The recommendations indicated below can help to maintain a good cooling system and to protect it against frost and/or corrosion.

If the correct procedures are not used, Perkins cannot be held responsible for frost or corrosion damage.

- 1 If it is possible, use clean soft water in the coolant.
- 2 If an antifreeze mixture, other than Perkins POWERPART, is used to prevent frost damage, it must have an ethanediol base (ethylene glycol) with a corrosion inhibitor. It is recommended that the corrosion inhibitor is of the sodium nitrite/sodium benzoate type. The antifreeze mixture must be an efficient coolant at all ambient temperatures and it must provide protection against corrosion. It must also have a specification at least as good as the requirements of either BS6580 or MOD AL39. Perkins POWERPART antifreeze exceeds the requirements of the above standard.

The quality of the antifreeze coolant must be checked at least once a year, for example, at the beginning of the cold period. The coolant must be renewed every two years.

The antifreeze mixture must consist of equal quantities of antifreeze and water. Concentrations of more than 50% of antifreeze must not be used because these can affect adversely the performance of the coolant.

- 3 When frost protection is not necessary, it is still an advantage to use an approved antifreeze mixture because this gives a protection against corrosion and also raises the boiling point of the coolant. If an approved antifreeze mixture is not available, add a correct mixture of corrosion inhibitor to the water.

Caution: *Certain corrosion inhibitor mixtures could cause damage to some engine components. It is recommended that the corrosion inhibitor available from Perkins distributors is used. The part numbers for this corrosion inhibitor are: 1 815 586 C1 (0,6 litre); 1 815 587 C1 (1,0 litre); 1 815 583 C1 (208 litre). If there is doubt about the corrosion inhibitor to be used, contact the Service Department, Perkins International Limited, Peterborough.*

Renew the coolant and coolant filter in accordance with the maintenance "Schedules" on page 20.

Caution: *Certain corrosion inhibitor mixtures could cause damage to some engine components. It is recommended that the corrosion inhibitor available from Perkins distributors is used. The part numbers for this corrosion inhibitor are: 1 815 586 C1 (0,6 litre); 1 815 587 C1 (1,0 litre); 1 815 583 C1 (208 litre). If there is doubt about the corrosion inhibitor to be used, contact the Service Department, Perkins International Limited, Peterborough.*

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6

Fault diagnosis

Problems and possible causes

Problem	Possible causes	
	Checks by the user	Checks by the workshop personnel
The starter motor turns the engine too slowly	1, 2, 3, 4	
The engine does not start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 17	34, 35, 36, 37, 38, 42, 43, 44
The engine is difficult to start	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19	34, 36, 37, 38, 40, 42, 43, 44
Not enough power	8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21	34, 36, 37, 38, 39, 42, 43, 44, 61, 63, 64
Misfire	8, 9, 10, 12, 13, 15, 20, 22	34, 36, 37, 38, 39, 40, 41, 43
High fuel consumption	11, 13, 15, 17, 18, 19, 21, 22	34, 36, 37, 38, 39, 40, 42, 43, 44, 63
Black exhaust smoke	11, 13, 15, 17, 19, 21, 22	34, 36, 37, 38, 39, 40, 42, 43, 44, 61, 63
Blue or white exhaust smoke	4, 15, 21, 23	36, 37, 38, 39, 42, 44, 45, 52, 58, 62
The pressure of the lubricating oil is too low	4, 24, 25, 26	46, 47, 48, 50, 51, 59
The engine knocks	9, 13, 15, 17, 20, 22, 23	36, 37, 40, 42, 44, 46, 52, 53, 60
The engine runs erratically	7, 8, 9, 10, 11, 12, 13, 15, 16, 18, 20, 22, 23	34, 38, 40, 41, 44, 52, 60
Vibration	13, 18, 20, 27, 28	34, 38, 39, 40, 41, 44, 52, 54
The pressure of the lubricating oil is too high	4, 25	49
The engine temperature is too high	11, 13, 15, 19, 27, 29, 30, 32, 65	34, 36, 37, 39, 52, 55, 56, 57, 64
Crankcase pressure	31, 33	39, 42, 44, 45, 52
Bad compression	11, 22	37, 39, 40, 42, 43, 44, 45, 53, 60
The engine starts and stops	10, 11, 12	

List of possible causes

- 1 Battery capacity low.
- 2 Bad electrical connections.
- 3 Fault in starter motor.
- 4 Wrong grade of lubricating oil.
- 5 Starter motor turns engine too slowly.
- 6 Fuel tank empty.
- 7 Fault in stop control.
- 8 Restriction in a fuel pipe.
- 9 Fault in fuel lift pump.
- 10 Dirty fuel filter element.
- 11 Restriction in air induction system.
- 12 Air in fuel system.
- 13 Fault in atomisers or atomisers of an incorrect type.
- 14 Cold start system used incorrectly.
- 15 Fault in cold start system.
- 16 Restriction in fuel tank vent.
- 17 Wrong type or grade of fuel used.
- 18 Restricted movement of engine speed control.
- 19 Restriction in exhaust pipe.
- 20 Engine temperature is too high.
- 21 Engine temperature is too low.
- 22 Incorrect valve tip clearances.
- 23 Too much oil or oil of the wrong type is used in wet type air cleaner, if one is fitted.
- 24 Not enough lubricating oil in sump.
- 25 Defective gauge.
- 26 Dirty lubricating oil filter element.
- 27 Fan damaged.
- 28 Fault in engine mounting or flywheel housing.
- 29 Too much lubricating oil in sump.
- 30 Restriction in air or water passages of radiator.
- 31 Restriction in breather pipe.
- 32 Insufficient coolant in system.
- 33 Vacuum pipe leaks or fault in exhauster.
- 34 Fault in fuel injection pump.
- 35 Broken drive on fuel injection pump.
- 36 Timing of fuel injection pump is incorrect.
- 37 Valve timing is incorrect.
- 38 Bad compression.
- 39 Cylinder head gasket leaks.
- 40 Valves are not free.
- 41 Wrong high-pressure pipes.
- 42 Worn cylinder bores.
- 43 Leakage between valves and seats.
- 44 Piston rings are not free or they are worn or broken.
- 45 Valve stems and/or guides are worn.
- 46 Crankshaft bearings are worn or damaged.

-
- 47 Lubricating oil pump is worn.
 - 48 Relief valve does not close.
 - 49 Relief valve does not open.
 - 50 Relief valve spring is broken.
 - 51 Fault in suction pipe of lubricating oil pump.
 - 52 Piston is damaged.
 - 53 Piston height is incorrect.
 - 54 Flywheel housing or flywheel is not aligned correctly.
 - 55 Fault in thermostat or thermostat is of an incorrect type.
 - 56 Restriction in coolant passages.
 - 57 Fault in water pump.
 - 58 Valve stem seal is damaged.
 - 59 Restriction in sump strainer.
 - 60 Valve spring is broken.
 - 61 Turbocharger impeller is damaged or dirty.
 - 62 Lubricating oil seal of turbocharger leaks.
 - 63 Induction system leaks.
 - 64 Turbocharger waste-gate does not work correctly, if one is fitted.
 - 65 Drive belt for water pump is loose.

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