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# **Perkins 6.3544 Series**

Models TU, TW and TX

## **USER'S HANDBOOK**

**6 cylinder diesel engines for vehicle, industrial and agricultural use**

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**This publication is divided into six chapters:**

- 1 General information**
- 2 Engine views**
- 3 Operation instructions**
- 4 Preventive maintenance**
- 5 Engine fluids**
- 6 Fault diagnosis**

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# 1

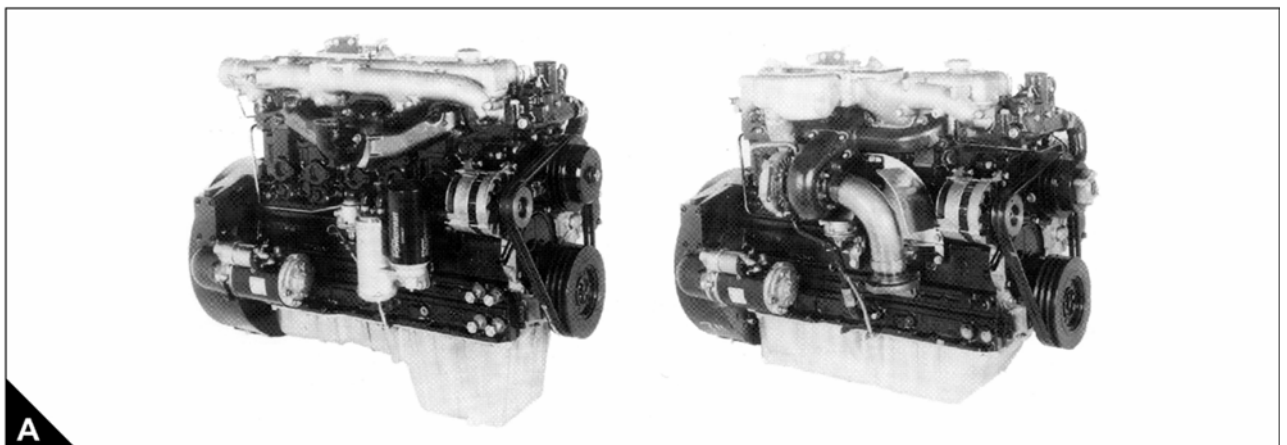
## General information

### Introduction

The 6.3544 Series of engines are designed for use in vehicle, industrial and agricultural applications.

More than fifty years of diesel production experience, 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 8.



## 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 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.
- Do not move mobile equipment if the brakes are not in good condition.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- Use extreme care if emergency repairs must be made at sea or in adverse conditions.
- 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.
- Fit only genuine Perkins parts.



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## 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 elements 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 distributors have this type of personnel available. You can also obtain parts and service from your Perkins distributor.

The left and right sides of the engine are as seen from the rear.

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 kept full with normal fuel but the fuel must be drained and discarded at the end of the storage period together with the fuel filter element(s).
- 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 canisters) of the lubricating oil filter.
- 5 Fill the sump to the full mark on the dipstick 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 cooling system, see "How to drain the cooling system" on page 27. In order to protect the cooling system against corrosion, it is better to fill it with a coolant that has a corrosion inhibitor, see "Coolant specification" on page 45.  
**Caution:** *If protection against frost is not necessary and a corrosion inhibitor is to be used, it is recommended that you consult the Service Department, Perkins Power 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 (if one is fitted) 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 BDC.
- 10 Slowly turn the crankshaft one revolution and then fit the atomisers with new seat washers and new dust seals.
- 11 Remove the air filter/cleaner. Then, if necessary, remove the pipes) installed between the air filter/cleaner and induction manifold or turbocharger. Spray POWERPART Lay-Up 2 into the induction manifold or 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 manifold or the turbocharger with waterproof tape.
- 12 Remove the exhaust pipe. Spray POWERPART Lay-Up 2 into the exhaust manifold or 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 manifold or the turbocharger with waterproof tape.
- 13 If the lubricating oil filler is fitted onto the rocker cover, remove the filler cap. If the lubricating oil filler is not fitted onto the rocker cover, remove the rocker cover. Spay POWERPART Lay-Up 2 around the rocker shaft assembly. Fit the filler cap or rocker cover.
- 14 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.

*Continued*

**15** Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.

**16** Remove the drive belts and put them into storage.

**17** 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.

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## Parts and service

### Introduction

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 EXCHANGE system. These will enable you to reduce the cost of certain repairs.

### Service literature

Workshop manuals and other service publications are available from your Perkins distributor at a nominal cost.

### Training

Local training for the correct operation, service and overhaul of engines is available at certain Perkins distributors. If special training is necessary, your Perkins distributor can advise you how to obtain it at the Perkins Product Education Department, Peterborough, or other main centres.

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**POWERPART consumable products**

Perkins have made available the products indicated 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. See "Coolant specification" on page 45.

**POWERPART Easy Flush**

Cleans the cooling system

**POWERPART Hylomar**

Universal jointing compound which seals joints.

**POWERPART Hylosil**

Silicone rubber sealant which prevents leakage through gaps.

**POWERPART Lay-Up 1**

A diesel fuel additive for protection against corrosion. See "Engine preservation" on page 4.

**POWERPART Lay-Up 2**

Protects the inside of the engine and of other closed systems. See "Engine preservation" on page 4.

**POWERPART Lay-Up 3**

Protects outside metal parts. See "Engine preservation" on page 4.

**LOCTITE Chisel**

Allows easy and rapid removal of old gaskets and joints.

**LOCTITE Repel**

Dries damp equipment and gives protection against corrosion. Passes through dirt and corrosion to lubricate and to assist removal of components.

**LOCTITE 222e**

To retain small fasteners where easy removal is necessary.

**LOCTITE 242e**

To retain and seal threaded fasteners and cup plugs where easy removal is necessary.

**LOCTITE 270**

To permanently retain large fasteners and studs.

**LOCTITE 518**

To seal flat faces of components where no joint is used. Especially suitable for aluminium components.

**LOCTITE 542**

To retain and seal pipe connections with fine threads. Especially suitable for hydraulic and pneumatic systems.

**LOCTITE 575**

To retain and seal pipe connections with coarse threads. Pressure systems can be used immediately.

**LOCTITE 603**

To retain components which have a transition fit.

**LOCTITE 638**

To retain components which have an interference fit.

## Engine identification

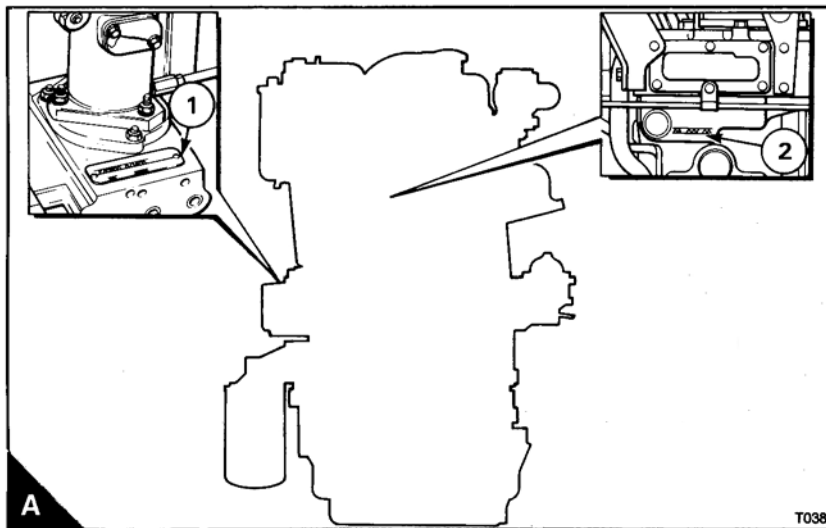
The 6.3544 Series consists of a range of six cylinder engines. The range has four basic engine types, naturally aspirated, compensated, turbocharged and turbocharged/intercooled.

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	Engine type letters
TW	Naturally aspirated
TU	Turbocharged and turbocharged/ intercooled
TX	Compensated

The engine number is stamped on a label which is fastened to the auxiliary drive housing (A1). Some engines also have the number stamped on the rear face of the cylinder block (A2). An example of an engine number is **TU30122\*U814627T\***.

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



**Engine data**

<b>Number of cylinders</b>	6
<b>Cylinder arrangement</b>	In line
<b>Cycle</b>	Four stroke
<b>Induction system</b>	
Engine type TW	Naturally aspirated
Engine type TU	Turbocharged and Turbocharged/air charge cooled
Engine type TX	Altitude compensated
<b>Combustion system</b>	Direct injection
<b>Nominal bore</b>	98,43 mm (3.875 in)
<b>Stroke</b>	127,0 mm (5.00 in)
<b>Compression ratio</b>	
Engine types TW, TX	16.0:1
Engine type TU	15.5:1
<b>Cubic capacity</b>	5,80 litres (354 in <sup>3</sup> )
<b>Firing order</b>	1, 5, 3, 6, 2, 4
<b>Valve tip clearances (cold)</b>	
Inlet	0,20 mm (0.008 in)
Exhaust	0,45 mm (0.018 in)
<b>Turbocharger boost pressure (measured at the induction manifold) <sup>(1)</sup></b>	
Engine type TU	76/93 kN/m <sup>2</sup> (11.0/13.5 lbf/in <sup>2</sup> ) 0,80/0,95 kgf/cm <sup>2</sup>
<b>Lubricating oil pressure (minimum at maximum engine speed and normal engine temperature)</b>	207kN/m <sup>2</sup> (30 lbf/in <sup>2</sup> ) 2,1kgf/cm <sup>2</sup>
<b>Direction of rotation</b>	Clockwise from the front

(1) This will vary according to the application, the load and the speed.





# 2

## Engine views

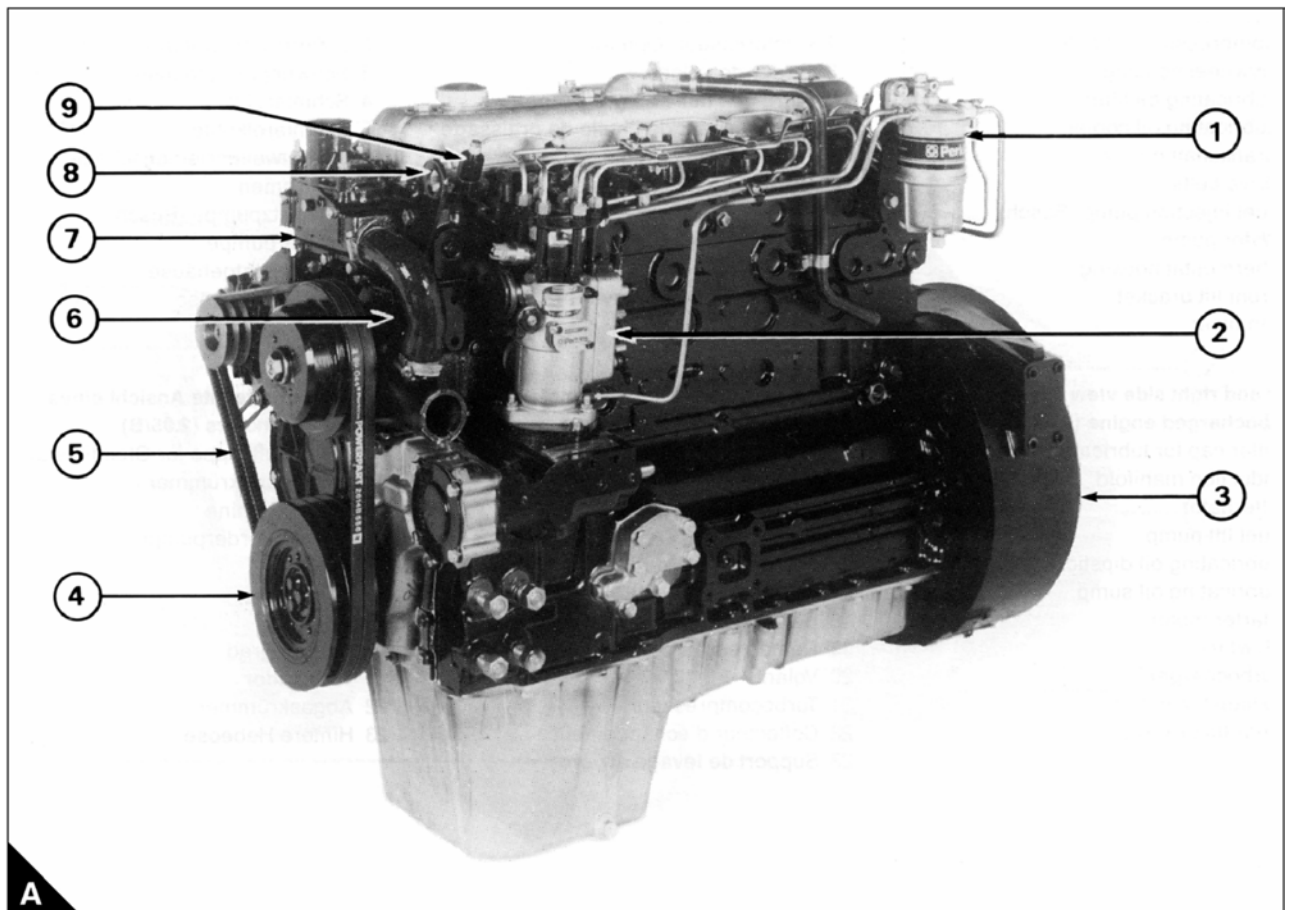
### Introduction

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

### Location of engine parts (naturally aspirated engines)

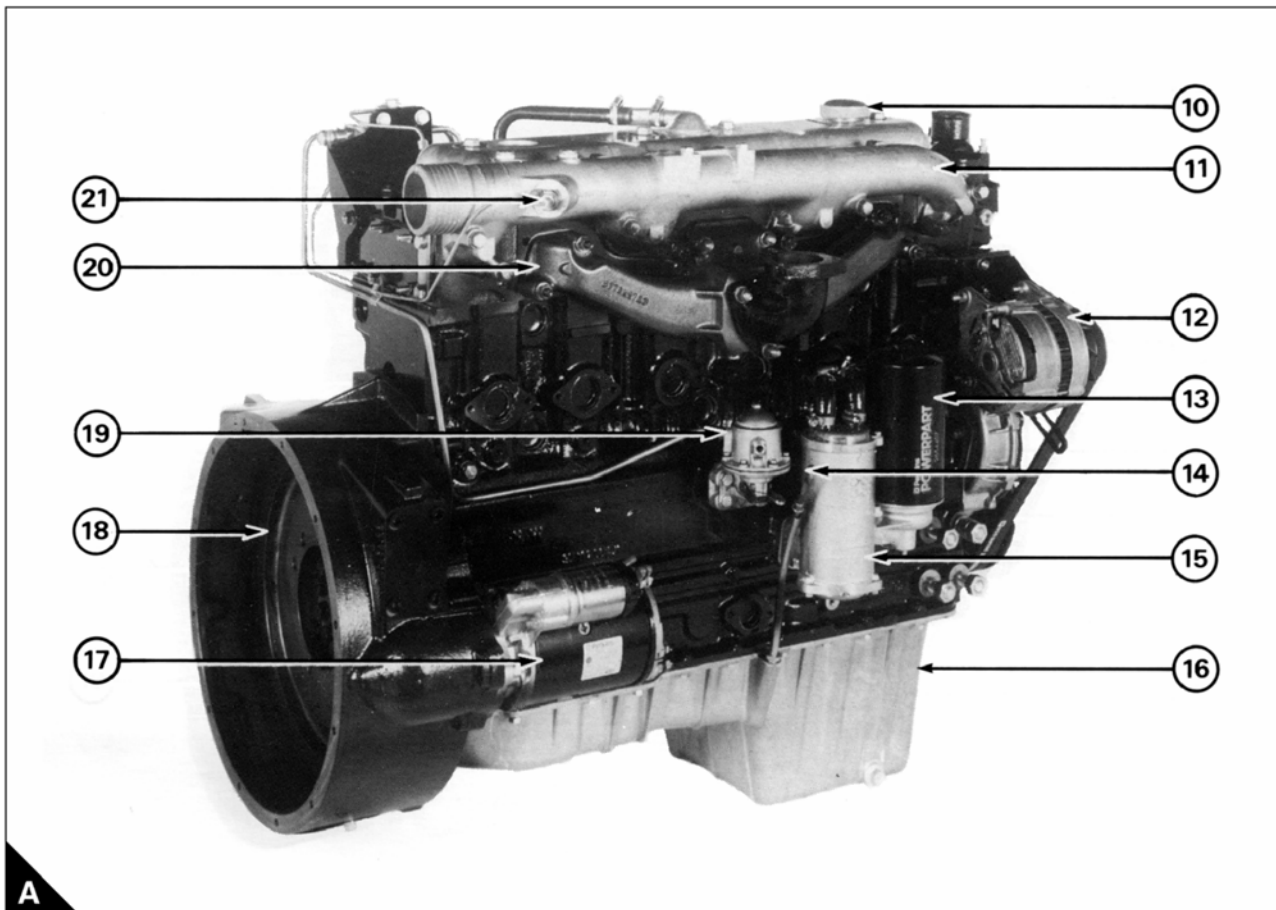
#### Front and left side view of a naturally aspirated engine

- |                             |                      |
|-----------------------------|----------------------|
| 1 Fuel filter               | 6 Water pump         |
| 2 Fuel injection pump (CAV) | 7 Thermostat housing |
| 3 Flywheel housing          | 8 Front lift bracket |
| 4 Crankshaft pulley         | 9 Atomiser           |
| 5 Drive belts               |                      |



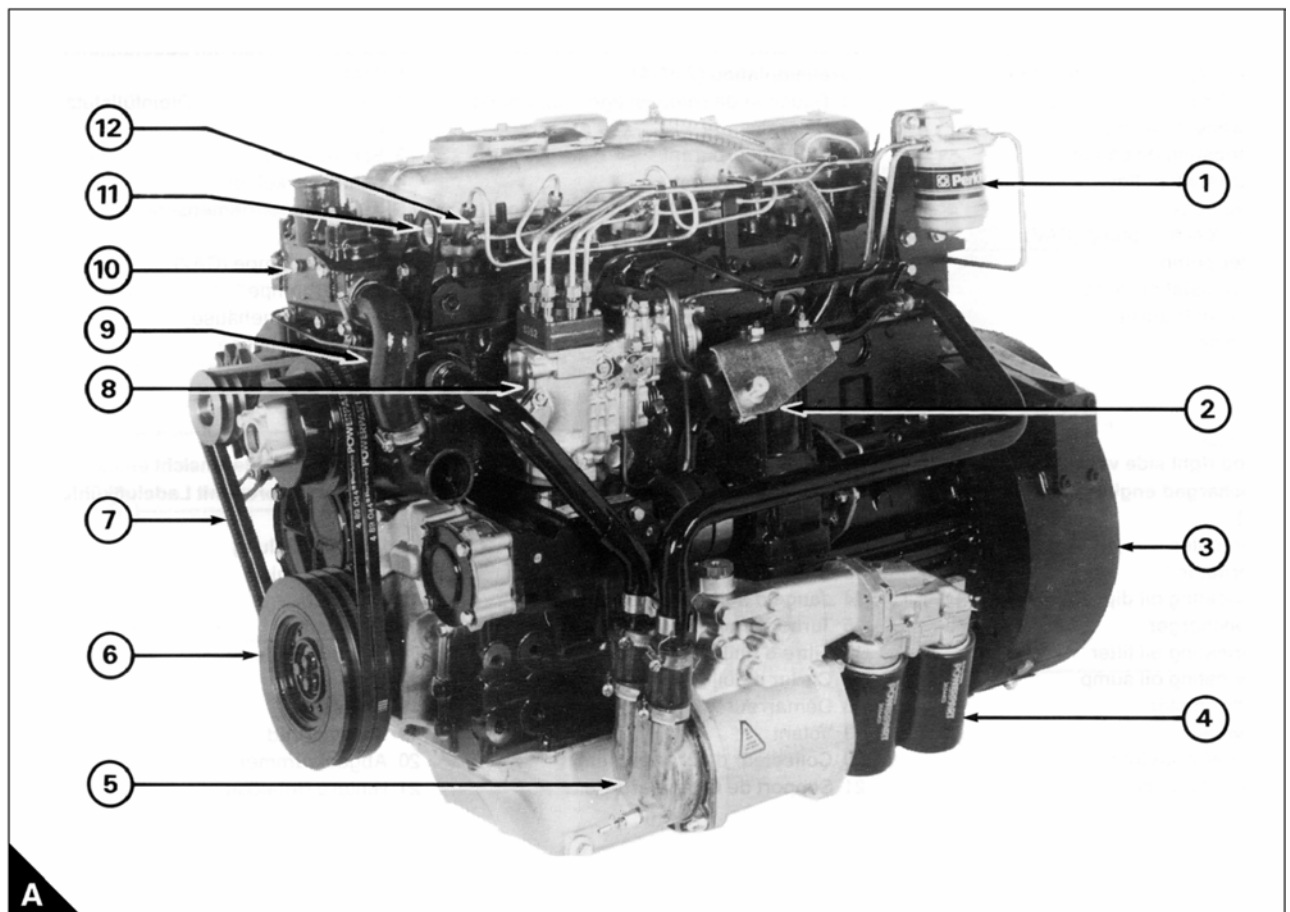
**Rear and right side view of a naturally aspirated engine**

- |                                   |                         |
|-----------------------------------|-------------------------|
| 10 Filler cap for lubricating oil | 16 Lubricating oil sump |
| 11 Induction manifold             | 17 Starter motor        |
| 12 Alternator                     | 18 Flywheel             |
| 13 Lubricating oil filter         | 19 Fuel lift pump       |
| 14 Lubricating oil dipstick       | 20 Exhaust manifold     |
| 15 Lubricating oil cooler         | 21 Fuelled starting aid |



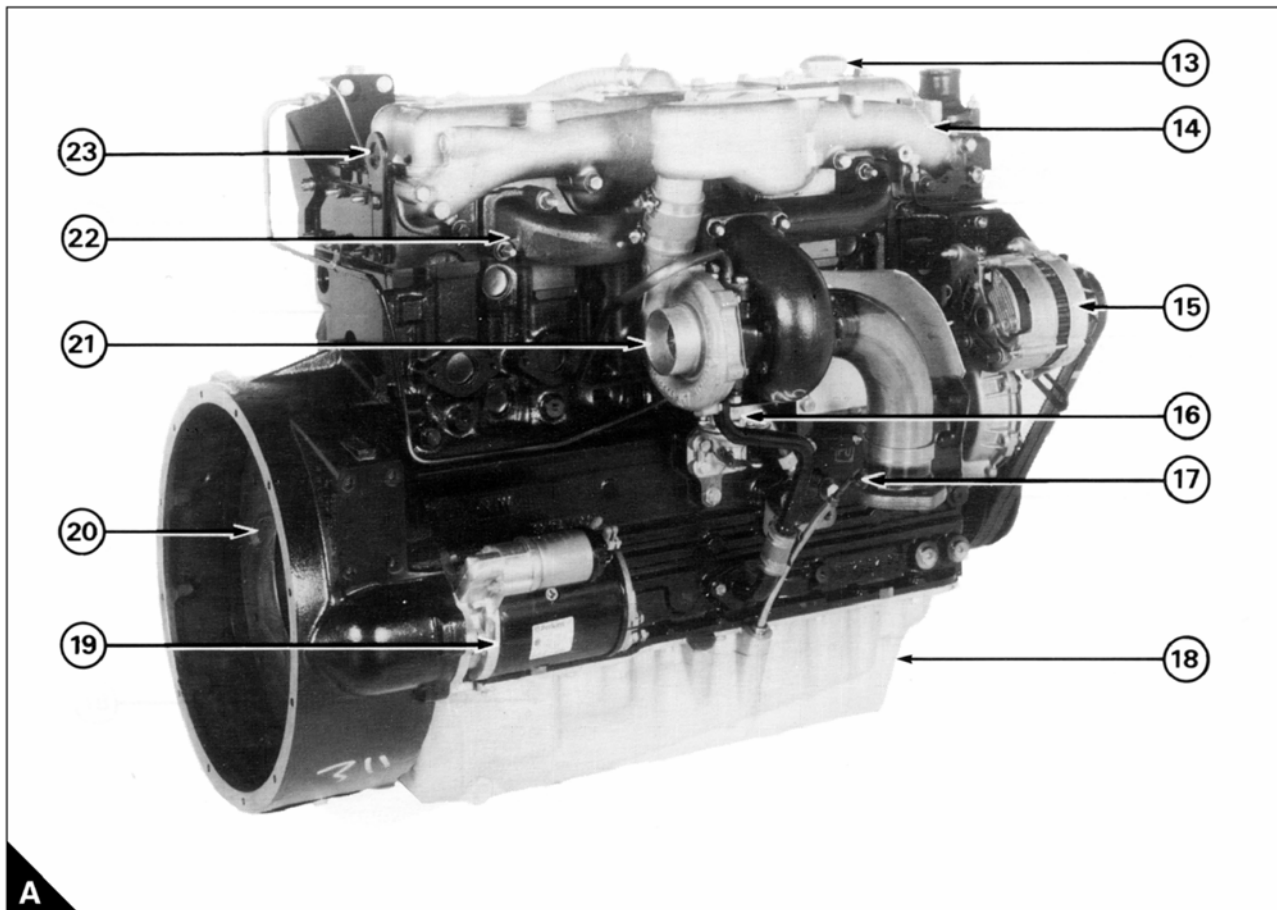
**Location of engine parts (turbocharged engines)****Front and left side view of a turbocharged engine**

- |                          |                               |
|--------------------------|-------------------------------|
| 1 Fuel filter            | 7 Drive belts                 |
| 2 Compressor (Option)    | 8 Fuel injection pump (Bosch) |
| 3 Flywheel housing       | 9 Water pump                  |
| 4 Lubricating oil filter | 10 Thermostat housing         |
| 5 Lubricating oil cooler | 11 Front lift bracket         |
| 6 Crankshaft pulley      | 12 Atomiser                   |



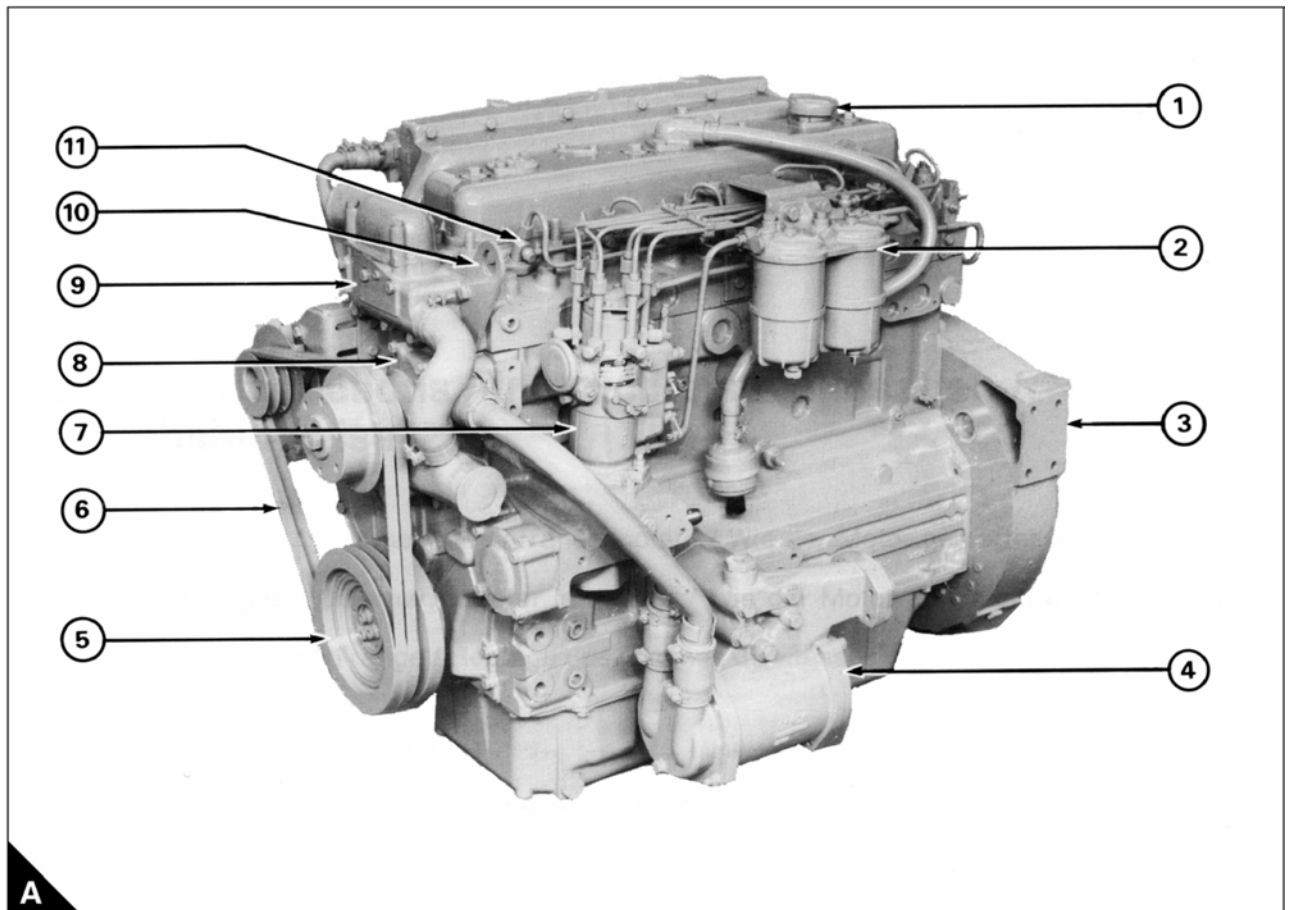
**Rear and right side view of a turbocharged engine**

- |                                   |                      |
|-----------------------------------|----------------------|
| 13 Filler cap for lubricating oil | 19 Starter motor     |
| 14 Induction manifold             | 20 Flywheel          |
| 15 Alternator                     | 21 Turbocharger      |
| 16 Fuel lift pump                 | 22 Exhaust manifold  |
| 17 Lubricating oil dipstick       | 23 Rear lift bracket |
| 18 Lubricating oil sump           |                      |



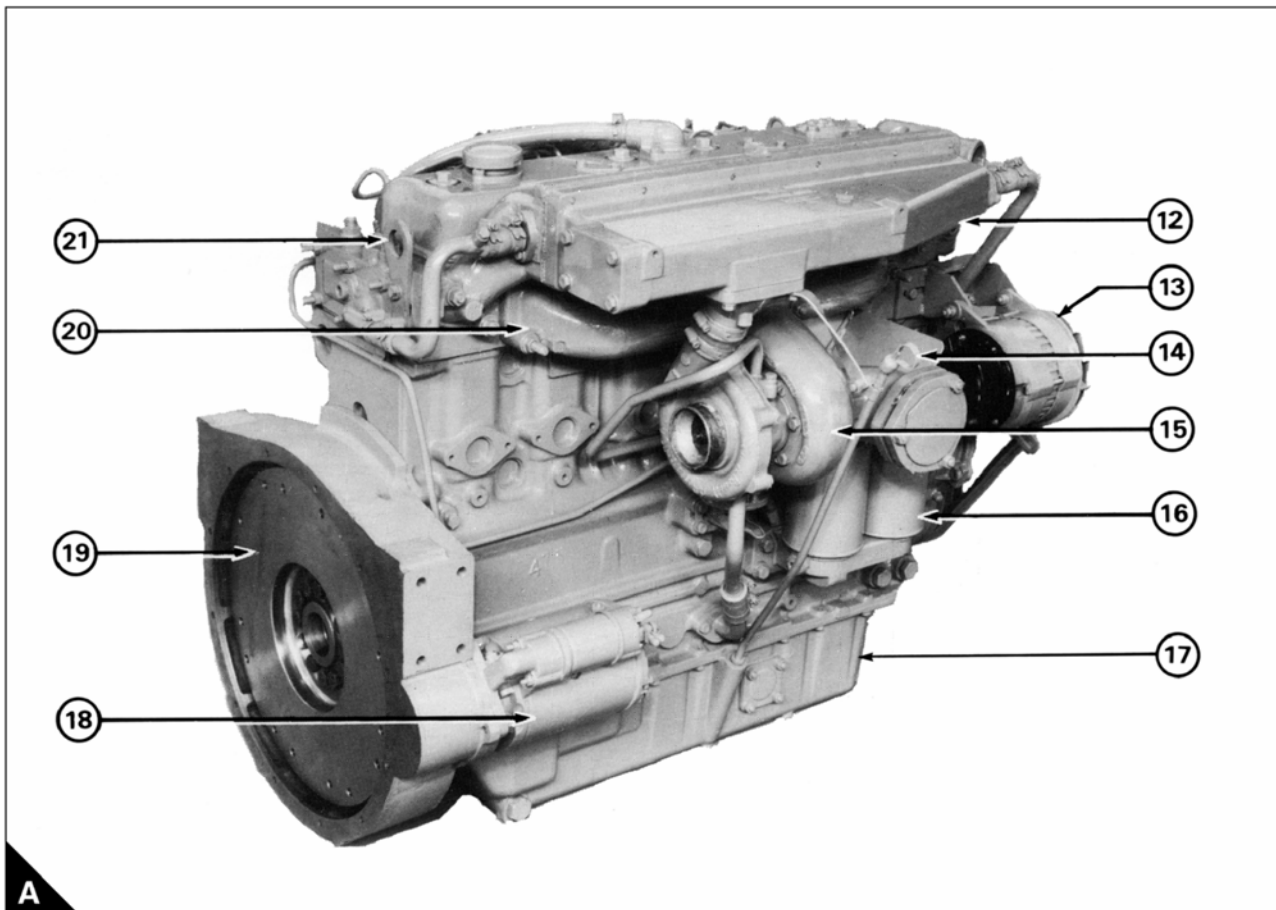
**Location of engine parts (turbocharged engines with intercooler)****Front and left side view of a turbocharged engine with intercooler**

- |                                  |                             |
|----------------------------------|-----------------------------|
| 1 Filler cap for lubricating oil | 7 Fuel injection pump (CAV) |
| 2 Fuel filter                    | 8 Water pump                |
| 3 Flywheel housing               | 9 Thermostat housing        |
| 4 Lubricating oil cooler         | 10 Front lift bracket       |
| 5 Crankshaft pulley              | 11 Atomiser                 |
| 6 Drive belts                    |                             |



**Rear and right side view of a turbocharged engine with intercooler**

- |                             |                         |
|-----------------------------|-------------------------|
| 12 Intercooler              | 17 Lubricating oil sump |
| 13 Alternator               | 18 Starter motor        |
| 14 Lubricating oil dipstick | 19 Flywheel             |
| 15 Turbocharger             | 20 Exhaust manifold     |
| 16 Lubricating oil filter   | 21 Rear lift bracket    |



A

# 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.

Diesel engines need a cold starting aid if they are to start in very cold conditions. Normally, your vehicle will be fitted with the correct equipment for your region of operation.

Perkins engines can be equipped with various cold starting systems. For the 6.3544 Series engines these systems are:

**Fuelled starting aid:** An electrically operated device which ignites a specific amount of diesel fuel in the induction manifold in order to heat the induction air.

**Port heaters:** These electrical devices are fitted in the induction manifold and heat the induction air. They are operated automatically when the starter motor is engaged. When these devices are fitted, the start procedure for a cold engine is the same as that given for a cold engine without starting aids.

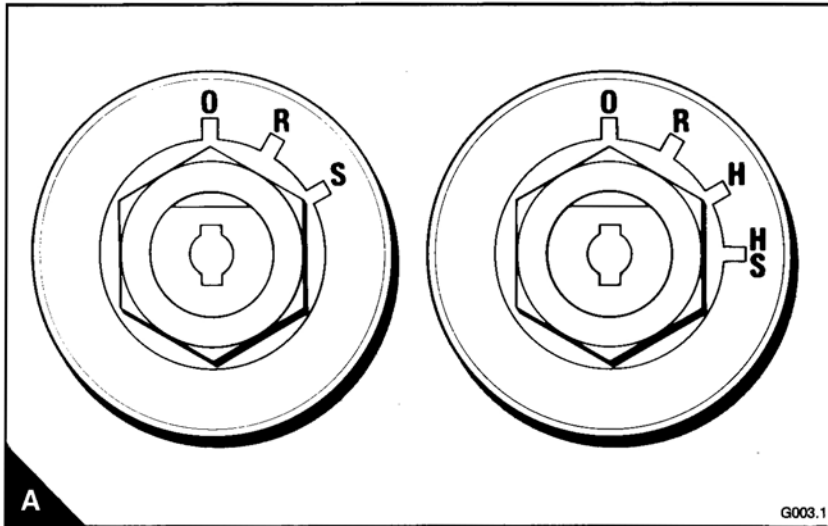
**Start Pilot:** A hand pump is used to inject a cold start fluid into the induction manifold through an atomiser. The cold start fluid ignites at a lower temperature than diesel fuel. The cold start fluid is contained in a separate reservoir. Certain models use a push button to actuate a solenoid which releases the cold start fluid from an aerosol container.

**KBi:** This system uses an aerosol container filled with a cold start fluid. The fluid is released by a solenoid, which is operated by a push button. The cold start fluid is sprayed into the induction manifold through a nozzle. The cold start fluid ignites at a lower temperature than diesel fuel.

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

### How to start a warm engine

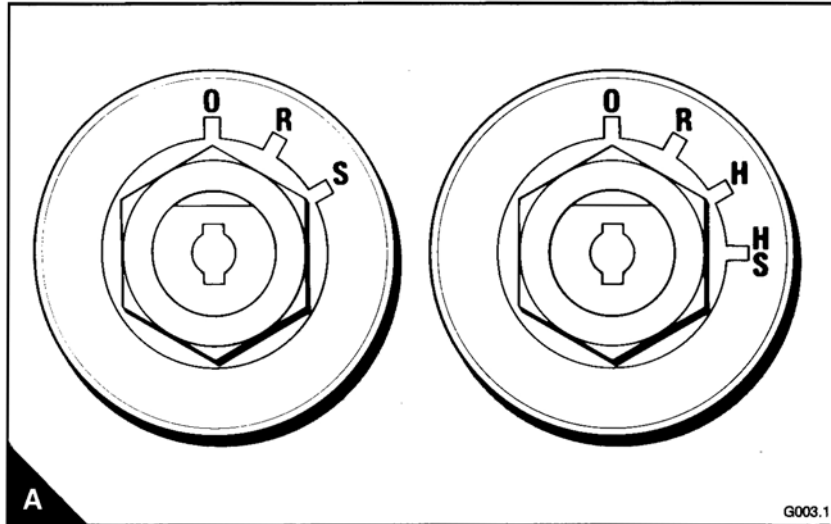
- 1 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 2 Adjust the engine speed control to the quarter open position.
- 3 Turn the start key to the "HS" or "S" position (A) to engage the starter motor.
- 4 Allow the start key to return to the "R" position, as soon as the engine starts.
- 5 Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.





**How to start a cold engine without starting aids**

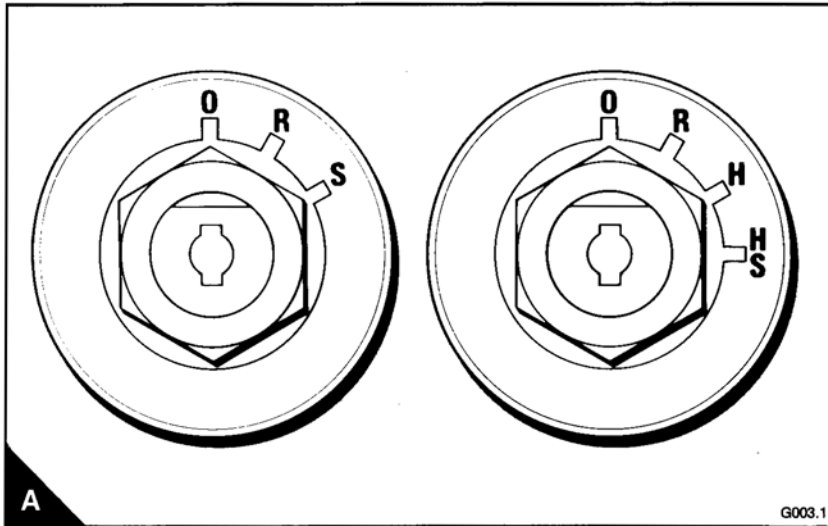
- 1 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 2 Adjust the engine speed control to the maximum speed position.
- 3 Turn the start key to the "S" position (A) to engage the starter motor. Allow the key to return to the "R" position, when the engine starts. Then adjust the engine speed control to get an even idle speed.
- 4 If the engine does not start in 30 seconds, release the start key to the "R" position for another 30 seconds. Then engage the starter motor again for a maximum period of 30 seconds.



### How to start a cold engine with the fuelled starting aid

- 1 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 2 Turn the start key to the "H" position (A) and keep it there for 15 seconds.
- 3 Adjust the engine speed control to the maximum speed position.
- 4 Turn the start key to the "HS" position in order to engage the starter motor. Allow the start key to return to the "R" position, when the engine starts. Then adjust the engine speed control to give an even idle speed.
- 5 If the engine does not start in 15 seconds, turn the start key to the "H" position and hold it there for 10 seconds. Then engage the starter motor again.

**Warning!** Ether type fuels must not be used at the same time as a fuelled starting aid.



## How to start a cold engine with manually operated Start Pilot

**Warning!** Do not use the hand pump until the starter motor is engaged.

The amount of fluid which is necessary for an engine start will be found by experience.

- 1 If necessary, fill the reservoir with fluid. Lift the cover of the reservoir and press the can, head down, onto the filler plug. Hold it squarely until the fluid fills the bowl to the maximum mark.
- 2 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 3 Adjust the engine speed control to the maximum speed position.
- 4 Turn the start key to the "S" position (A) in order to engage the starter motor. Hold the start key in this position for a maximum of 30 seconds and operate the hand pump during this period. When the engine starts, release the start key to the "R" position and adjust the engine speed control to get an even idle speed.
- 5 If the engine does not start in 30 seconds, allow the start key to return to the "R" position for another 30 seconds. Then engage the starter motor and operate the hand pump again.

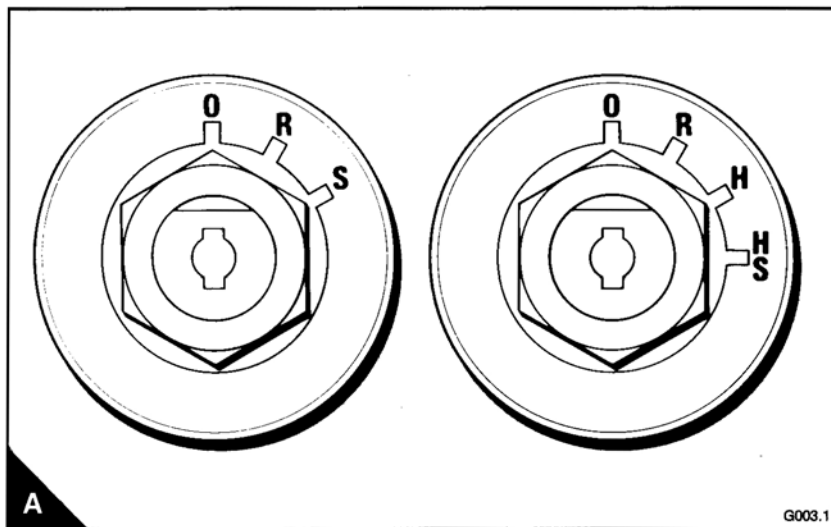
In certain conditions, it is necessary to inject a little more fluid after the engine has started in order to ensure that the engine continues to run.

The air filter at the outer end of the pump must be inspected from time to time. If necessary, it must be washed in kerosene.

The inside surface of the cylinder can be lightly lubricated with a thin lubricating oil.

The nozzle can be removed from the induction manifold and washed in kerosene, if necessary. Use the direction mark on the nozzle body to ensure that the nozzle is fitted in its original position.

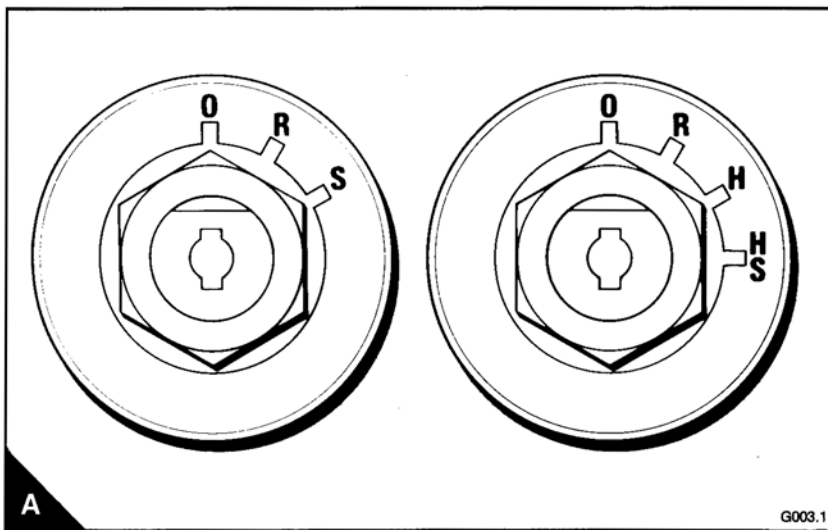
**Warning!** Start Pilot equipment must not be used with heater type starting aids such as the fuelled starting aid.



### How to start a cold engine with KBi or electrically operated Start Pilot

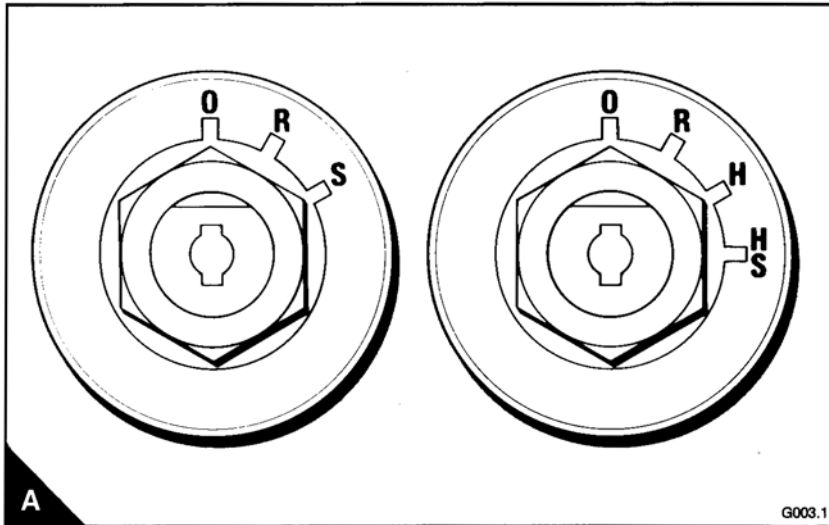
- 1 If necessary, renew the screw type canister. Ensure that the sealing washer remains in position when the new canister is fitted. Each container has a safety valve.
- 2 If the engine is equipped with a manual stop control, ensure that it is in the "run" position.
- 3 Adjust the engine speed control to the maximum speed position.
- 4 Turn the start key to the "S" position (A) in order to engage the starter motor.
- 5 When the engine turns, press the starting aid button for a maximum period of 2 seconds. If the engine does not start after the first 2 second application, keep the starter motor engaged. After 5 seconds, press the button again for 2 seconds.
- 6 Allow the start switch to return to the "R" position, when the engine starts. Then adjust the engine speed control to get an even idle speed. In certain conditions it is necessary to inject a little more fluid after the engine has started, in order to ensure that the engine continues to run.

**Warning!** KBi equipment must not be used with heater type cold starting aids such as the fuelled starting aid.



## How to stop the engine

According to the equipment fitted, either turn the engine start key to the "O" position (A) 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 "O" position.



## 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 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.

## Running-in

A gradual running-in of a new engine or POWER EXCHANGE engine is not necessary. Prolonged operation at light loads during the early life of the engine is not recommended.

Maximum load can be applied to a new engine as soon as the engine is put into service and the coolant temperature has reached a minimum of 60 °C (140 °F).

### **Cautions:**

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

---

## Turbocharged engines

Because of the power characteristics of the turbocharged engine it is necessary to maintain a high engine speed when you climb a gradient. To ensure that the engine is not overloaded at low engine speeds engage a lower gear.

## Altitude

If the naturally aspirated engine is to run at an altitude above 600 m (2,000 ft), the fuel delivery can be changed to reduce fuel consumption and smoke. Perkins can give the percentage of fuel reduction necessary if details of engine application and ambient conditions are given. Information for turbocharged engines can be obtained from Perkins. Changes to the settings of the fuel injection pump must be made by a Perkins distributor or 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. If necessary, use the shorter periods. 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.

**Caution:** *For short distance operation with frequent stops, the hours of operation are more important than the distance.*

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 (kilometres, miles, hours or months) which occurs first.

- A First service at 800/1600 km (500/1000 miles), 25/50 hours
- B Every day or every 8 hours
- C Every 7500 km (5000 miles), 250 hours or 4 months
- D Every 15000 km (10000 miles), 500 hours or 12 months
- E Every 30000 km (20000 miles), 1000 hours
- F Every 90000 km (60000 miles), 2500 hours

A	B	C	D	E	F	Operation
●	●					Check the amount of coolant
●		●				Check the drive belt(s)
			●			Clean the sediment chamber and the strainer of the fuel lift pump
●	●					Check for water in the fuel pre-filter <sup>(1)</sup>
			●			Renew the fuel filter element (fuel filter with single element)
				●		Renew the fuel filter elements (fuel filter with twin element)
					●	Ensure that the atomisers are checked <sup>(2)</sup>
●						Ensure that the idle speed is checked and adjusted, if it is necessary <sup>(2)</sup>
	●					Check the amount of lubricating oil in the sump
●	●					Check the lubricating oil pressure at the gauge <sup>(1)</sup>
●		●				Renew the lubricating oil <sup>(3)</sup>
●		●				Renew the canisters) of the lubricating oil filter
					●	Clean the vent valve of the engine breather system <sup>(1)</sup>
						Clean the air cleaner or empty the dust bowl of the air filter
●	●					-extremely dusty conditions
		●				-normal conditions
			●			Clean or renew the air filter element, if this has not been indicated earlier
				●		Ensure that the turbocharger impeller, the turbocharger compressor casing and the turbocharger drain pipe for the lubricating oil are cleaned <sup>(2)</sup>
		●				Clean the compressor air filter <sup>(1)</sup>
					●	Ensure that the exhaustor or compressor <sup>(1)</sup> is checked <sup>(2)</sup>
●						Ensure that the valve tip clearances are checked and adjusted, if it is necessary <sup>(2)</sup>
						Ensure that the alternator, starter motor etc. are checked <sup>(2)</sup>

(1) If there is one fitted.

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

(3) The oil change interval will change with the sulphur content of the fuel (see the table below and "Fuel specification" on page 43).  
The interval to change the canister of the lubricating oil filter is not affected.

Sulphur content of fuel %	Oil change interval		
	Hours	Months	Miles
< 0.5	250	4	5000
0.5-1.0	190	3	3750
> 1.0	120	2	2500

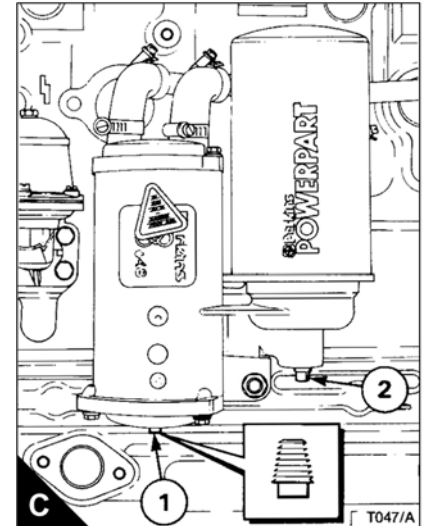
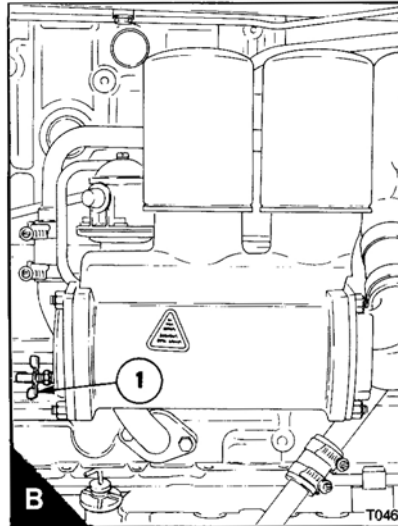
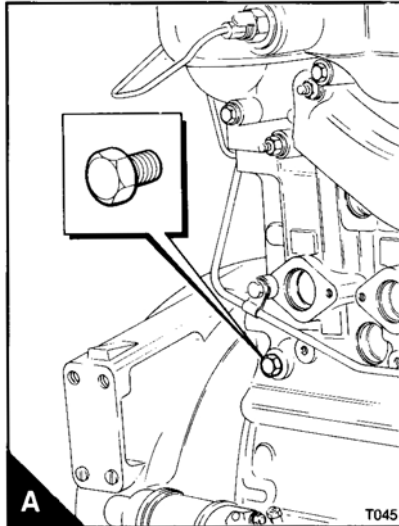


## How to drain the cooling system

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

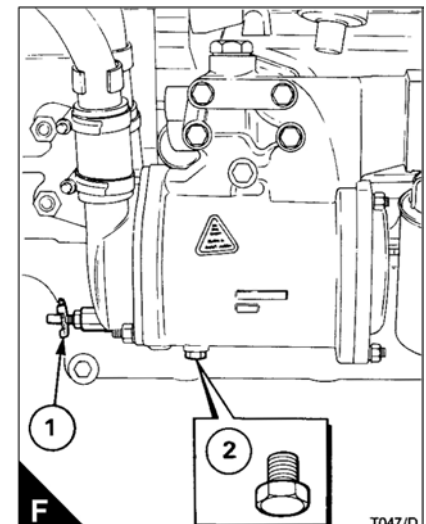
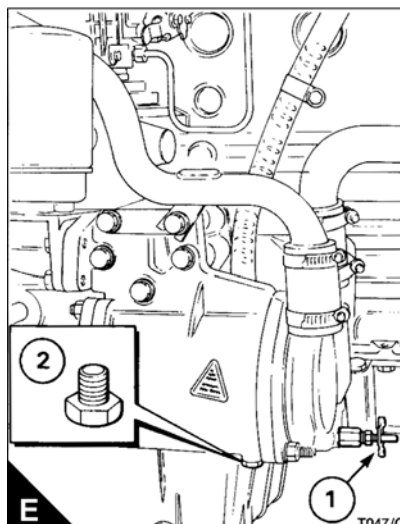
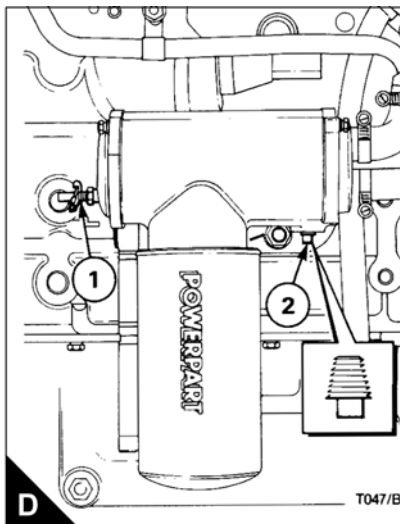
- 1 Ensure that the machine is on level ground.
- 2 Remove the filler cap of the cooling system.
- 3 Remove the drain plug from either side of the cylinder block (A) in order to drain the engine.

**Note:** Ensure that the drain hole is not restricted.



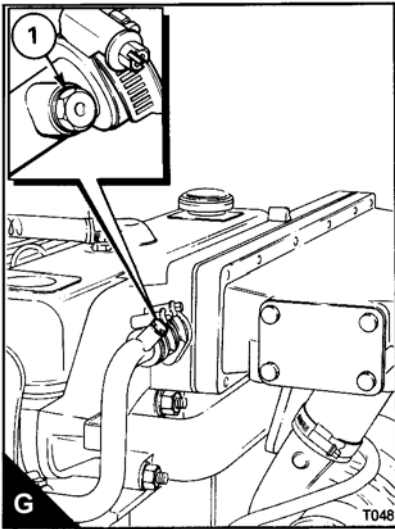
4 Open the tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a tap or drain plug, disconnect the hose at the bottom of the radiator.

5 If a lubricating oil cooler is fitted, open the drain tap or remove the drain plug (B1 or C1/D1/E1/F1) in order to drain the coolant from the oil cooler.



*Continued*

- 6 If a water to air charge cooler is fitted, the vent plug (G1) must be removed when the cooling system is drained or filled.
- 7 If necessary, flush the system with clean water.
- 8 Fit the drain plugs in the cylinder block. Fit the filler cap. Close the radiator tap or connect the radiator hose. Close the drain tap or fit the drain plug of the oil cooler. If a water to air charge cooler is fitted, fit the vent plug.
- 9 If frost may occur while the engine is drained, disconnect a pipe connection at the oil cooler and put 250 ml ( $\frac{1}{2}$  pint) of POWERPART antifreeze into the oil cooler. Connect the coolant pipe.



## How to check the drive belt(s)

Renew a belt if it is worn or damaged. If twin belts are fitted, they must be renewed together.

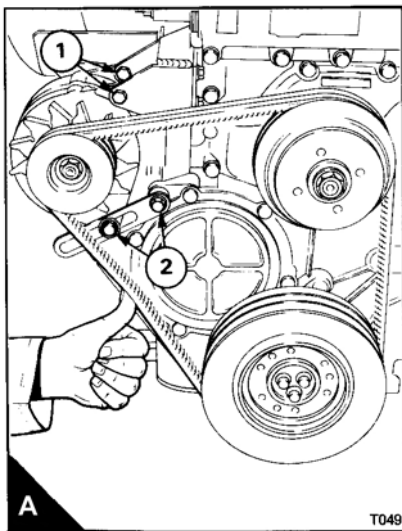
To check the belt tension, press down the belt with the thumb at the centre of the longest free length and check the deflection (A). With moderate thumb pressure - 45N (10 lbf) 4,5 kgf - the correct deflection of the belt is 10 mm ( $\frac{3}{8}$  in).

If twin belts are fitted, check/adjust the tension on the tighter belt.

## How to adjust the belt tension

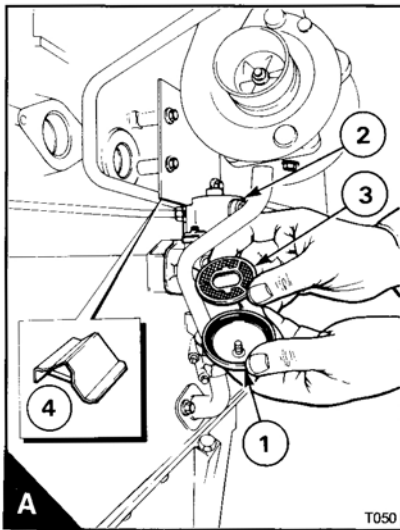
- 1 Loosen the pivot fasteners (A1) of the alternator and the adjustment link fasteners (A2).
- 2 Change the position of the alternator to give the correct tension. Tighten the pivot fasteners of the alternator and the adjustment link fasteners. Where there are two pivot fasteners, tighten the front fastener and then the rear fastener.
- 3 Check the belt tension again to ensure that it is still correct.

**Note:** If a new belt is fitted, the belt tension must be checked again after the first 25 hours of operation.



## How to clean the gauze strainer of the fuel lift pump

- 1 Remove the cover and joint (A1) from the top of the fuel lift pump (A2) and remove the gauze strainer (A3). On engine types TU and TX, it will be necessary to remove the small heat shield (A4) which is fitted above the pump.
- 2 Carefully wash all the sediment from the lift pump body.
- 3 Clean the gauze strainer, joint and cover.
- 4 Assemble the lift pump. Use a good joint and ensure that the lift pump body and the cover are fitted together correctly because leakage at this point will let air into the fuel system. On engine types TU and TX, fit the heat shield.
- 5 Eliminate the air from the fuel system through the filter vent point, see "How to eliminate air from the fuel system" on page 33.



## Fuel pre-filter

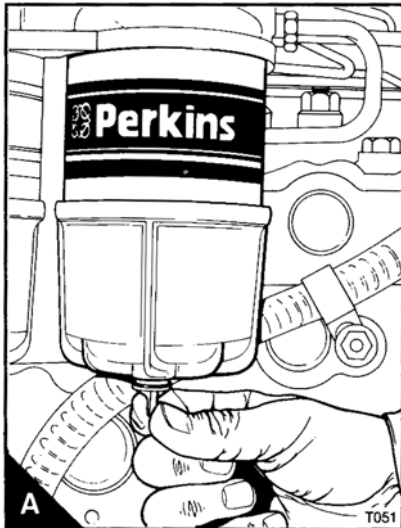
This will normally be fitted between the fuel tank and the engine. Check the filter bowl for water at regular intervals and drain as necessary, see "How to drain the cooling system" on page 27.

## How to renew the filter element(s) of the fuel filter

**Caution:** It is important that only the genuine Perkins fuel filter element is used. The use of a wrong element can damage the fuel injection pump.

The filter can have one or two elements. When twin elements are fitted, both of the elements must be renewed at the same time.

- 1 Clean the outside surfaces of the fuel filter assembly. If a drain tap is fitted to the filter bowl, drain the fuel from the filter (A).
- 2 Hold the bottom cover of the filter element and release the setscrew which is fitted through the filter head above the centre of each element.
- 3 Lower the bottom cover of the filter (B).
- 4 Remove the element and discard it.
- 5 Clean the inside surfaces of the filter head and of the cover.
- 6 Renew the seals and lightly lubricate them with clean fuel.
- 7 Put the bottom cover under the new element and hold it squarely to the filter head. Ensure that the element is fitted in the centre against the joint in the filter head. With the assembly in this position, engage and tighten the setscrew.
- 8 Eliminate the air from the fuel filter, see "How to eliminate air from the fuel system" on page 33.



## Atomiser fault

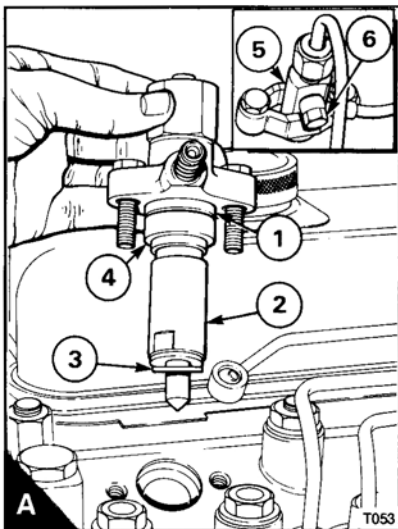
An atomiser fault can cause an engine misfire.

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 Remove the fuel leak-off pipe.
- 2 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.
- 3 Remove the atomiser setscrews and remove the clamp (A5) if fitted, the atomiser (A2) and its seat washer (A3). Remove the dust seal (A4) and the spacer (A1) and fit the spacer and a new dust seal onto the new atomiser.
- 4 Put the new atomiser in position with its spacer, new dust seal and a new seat washer. The seat washers for engine types TW and TX are 2,03 mm (0.080 in) thick and for engine type TU they are 0,71 mm (0.028 in) thick. Where the atomiser has the high-pressure connection on the top, ensure that the fuel leak-off connection (A6) is not toward the engine. Position the clamp (if fitted) and engage the atomiser setscrews. Ensure that the atomiser is not tilted and tighten the flange setscrews evenly and gradually to 18 Nm (14 lbf ft) 1,8 kgf m.
- 5 Fit the high-pressure fuel pipe and tighten the union nuts to 22 Nm (16 lbf ft) 2,2 kgf m. If necessary, fit the pipe clamps.
- 6 Renew the aluminium washers and fit the leak-off pipe.
- 7 Operate the engine and check for leakage of fuel and air.



## How to eliminate air from the fuel system

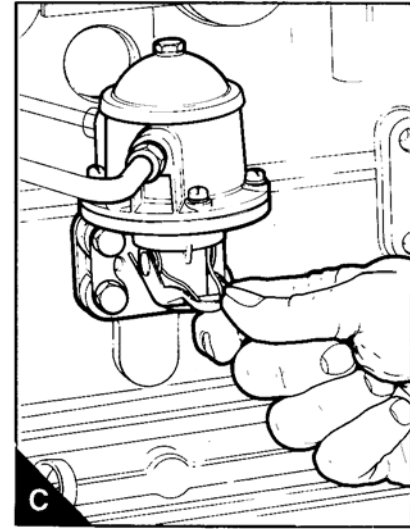
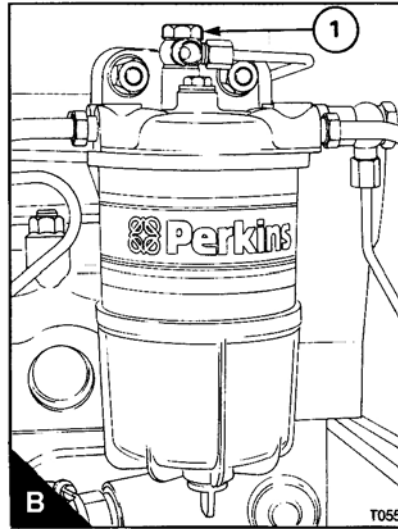
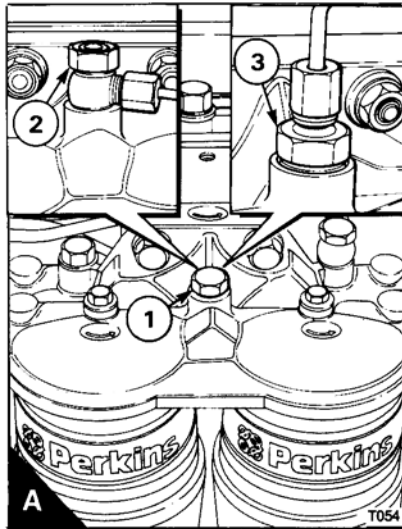
If air enters the system, it must be eliminated before the engine can be started.

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.

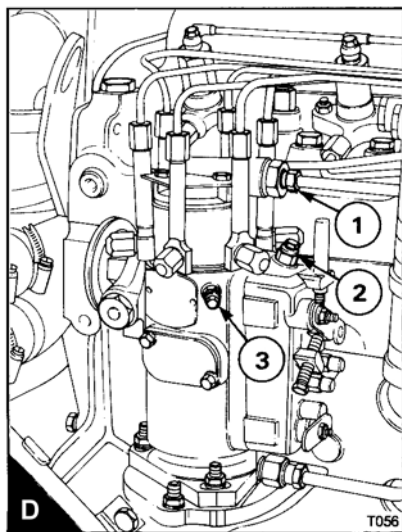
In order to eliminate air from the fuel system, proceed as follows:

**1** For fuel filters with twin elements loosen the vent plug (A1), the banjo connection bolt (A2) or the straight connection (A3). For fuel filters with a single element loosen the banjo connection bolt (B1).



**2** Operate the priming lever on the fuel lift pump (C) until fuel, free from air, comes from the filter vent point. Tighten the vent plug, banjo connection bolt or the straight connection. If the drive cam of the fuel lift pump is at the point of maximum cam lift, it will not be possible to operate the priming lever. In this situation, the crankshaft must be turned one revolution.

**3** *CAV fuel injection pumps*: Loosen the union nut (D1). Operate the priming lever of the fuel lift pump until air free fuel comes from the union nut. Tighten the union nut.



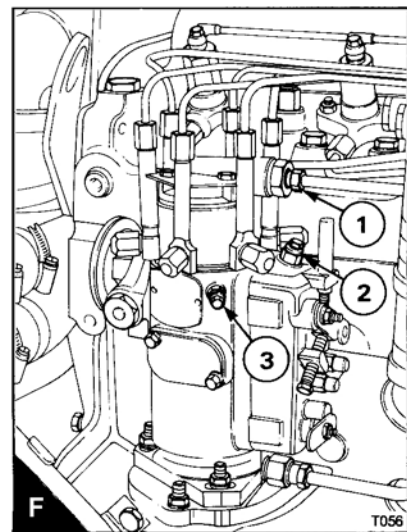
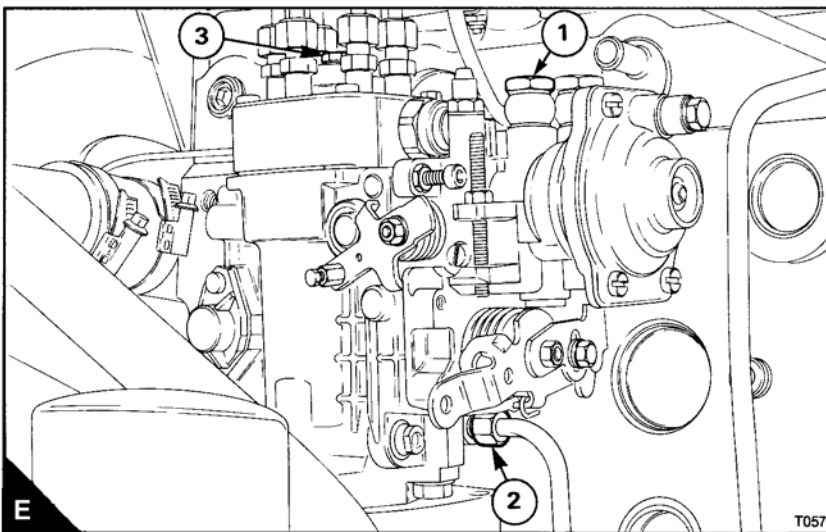
*Continued*

**Bosch fuel injection pumps:** Loosen the banjo connection bolt (E1) and union nut (E2). Operate the lever of the fuel lift pump until air free fuel comes from the banjo connection. Tighten the banjo connection bolt. Continue to operate the lever of the fuel lift pump until air free fuel comes from the union nut. Tighten the union nut.

**4** Ensure that the manual stop control is in the "run" position. If an electrical stop control is used, turn the start key to the "R" position.

**5 CAV fuel injection pumps:** Loosen the vent screw in the lock screw of the hydraulic head (F3) and the vent screw on the governor cover of the fuel injection pump (F2). Operate the priming lever of the fuel lift pump until air free fuel comes from the vent screw in the lock screw of the hydraulic head. Tighten the vent screw. Continue to operate the priming lever of the fuel lift pump until air free fuel comes from the vent screw on the governor cover. Tighten the vent screw.

**Bosch fuel injection pumps:** Clean the top of the fuel pump. Loosen the vent screw (E3) a maximum of half a turn. Operate the lever of the fuel lift pump until air free fuel comes from the vent screw. Tighten the vent screw.

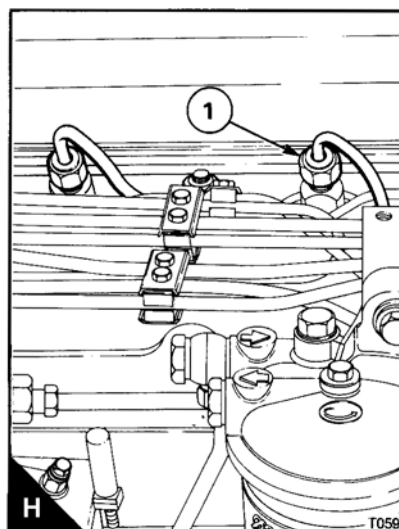
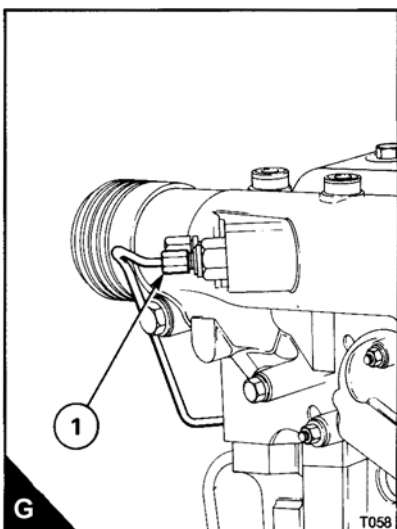


**6** Loosen the union nut(s) (G1) at the fuelled starting aids) (if fitted) and operate the lift pump until air free fuel comes from the connection(s). Tighten the union nuts) at the starting aid(s).

**7** Loosen the union nuts of the high-pressure pipes (H1) at two of the atomisers. Operate the starter motor until air free fuel comes from the pipe connections. Tighten the high-pressure pipe connections.

**8** The engine is now ready to start.

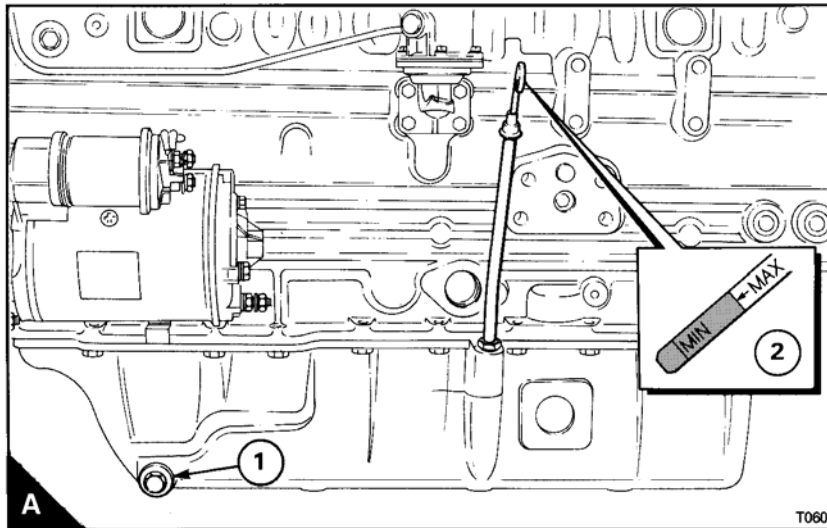
If the engine runs correctly for a short time and then stops or runs roughly, check for air in the fuel system. If there is air in the fuel system, there is probably a leakage in the low pressure system.





## How to renew the lubricating oil

- 1 Operate the engine until it is warm.
- 2 Stop the engine, remove the sump drain plug (A1) and its "O" ring and drain the lubricating oil from the sump. Ensure that the "O" ring is not damaged. Fit the drain plug and its "O" ring and tighten the plug to 34 Nm (25 lbf ft) 3,5 kgf m.
- 3 If a lubricating oil cooler is fitted, remove the oil drain plug (if one is fitted), refer to "How to drain the cooling system" on page 27, and drain the lubricating oil from the oil cooler. Fit the drain plug.
- 4 Fill the sump to the "MAX" mark on the dipstick (A2) with new and clean lubricating oil of an approved grade, see "Lubricating oil specification" on page 44.



## How to renew the canister of the lubricating oil filter

The filter can have one or two canisters. When two canisters are fitted, both must be renewed at the same time.

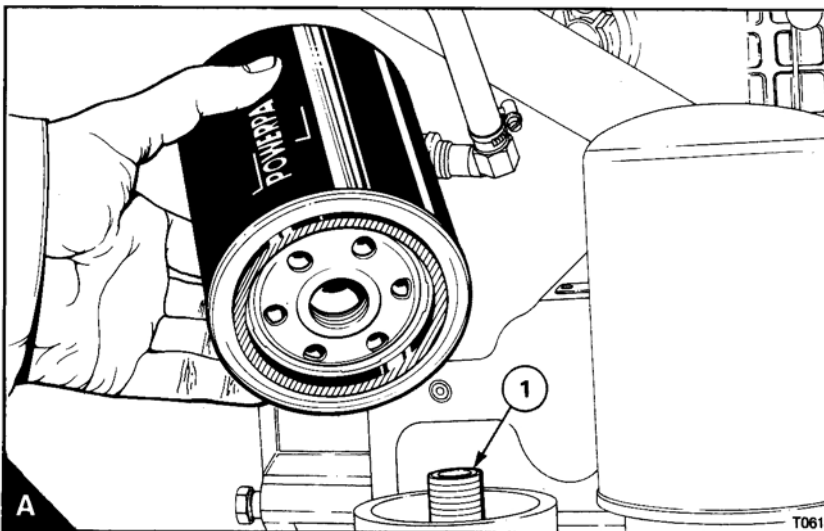
- 1 Put a tray under the filter to retain spilt lubricating oil.
- 2 Remove the filter canister with a strap wrench or similar tool. Ensure that the adaptor (A1) is secure in the filter head. Then discard the canister.
- 3 Clean the filter head.
- 4 Add clean engine lubricating oil to the new canister. Allow the oil enough time to pass through the filter element.
- 5 Lubricate the top of the canister seal with clean engine lubricating oil.
- 6 Fit the new canister and tighten it by hand only.

**Caution:** Do not use a strap wrench.

7 Ensure that there is lubricating oil in the sump. On turbocharged engines, 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.

8 Operate the engine and check for leakage from the filter. When the engine has cooled, check the oil level on the dipstick and put more oil into the sump, if necessary.

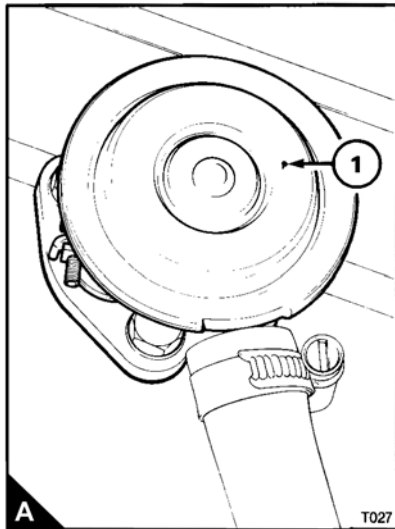
**Caution:** The canister contains a valve and special tube to ensure that lubricating oil does not drain from the filter. Therefore, ensure that the correct Perkins POWERPART canister is used.



## How to clean the engine breather valve

**Note:** A breather valve is fitted only to certain engine types TW and TX.

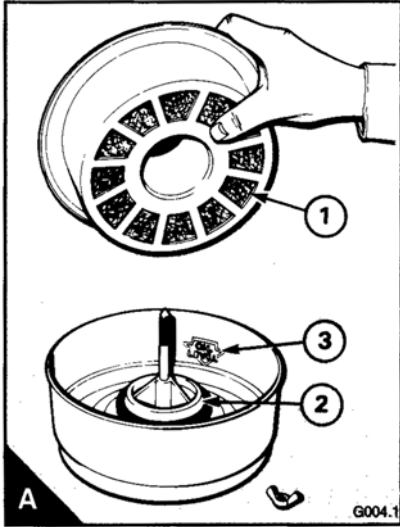
- 1 Disconnect the hose clips and remove the pipe between the induction manifold and the breather valve (A).
- 2 Release the clamp screw and remove the breather valve from the rocker cover.
- 3 Seal the small hole (A1) in the top cover of the breather valve with a water proof tape.
- 4 Wash the breather valve in kerosene and dry it with low pressure air. Remove the seal from the top of the breather valve.
- 5 Ensure that the pipe fitted between the breather valve and the induction manifold is clean.
- 6 Fit the breather valve to the rocker cover. Fit the pipe between the induction manifold and the breather valve. Tighten the clamp screw of the breather valve and then the hose clips.



## Air cleaner

A typical wet type air cleaner is shown in (A).

The wet type air cleaner must be drained at a suitable interval. The container and element (A1) must be cleaned with kerosene or with another suitable fluid. Do not use gasoline. Check that the seal (A2) is not damaged and renew it, if necessary. Fill to the indicated level (A3) with clean engine lubricating oil.



## Air filter

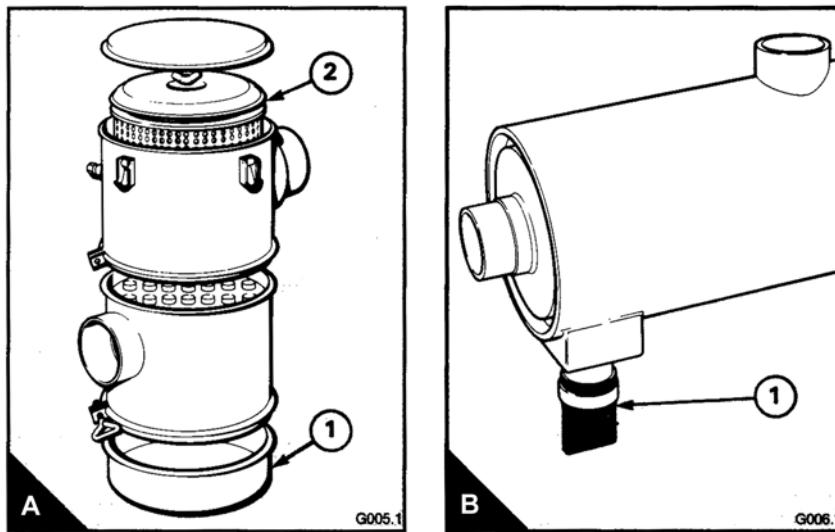
Environmental conditions have an important effect on the frequency at which the air filter needs service.

Certain air filters have a separate dust bowl (A1) which must be cleaned at intervals. The amount of dust in the bowl shows if it has been removed at the correct time for the conditions of operation. Do not let dust completely fill the bowl, because this will reduce the life of the filter element (A2).

Certain air filters have automatic dust valves (B1) through which dust is expelled from the filter. The rubber dust valve must be kept clean. Ensure that the sides of the valves close completely together and that they can separate freely.

If a restriction indicator is fitted, see "Restriction indicator" on page 40, it will indicate precisely when the air filter element needs service. This prevents the premature removal of the filter element which causes extra cost or late removal of the element which can cause loss of engine power.

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

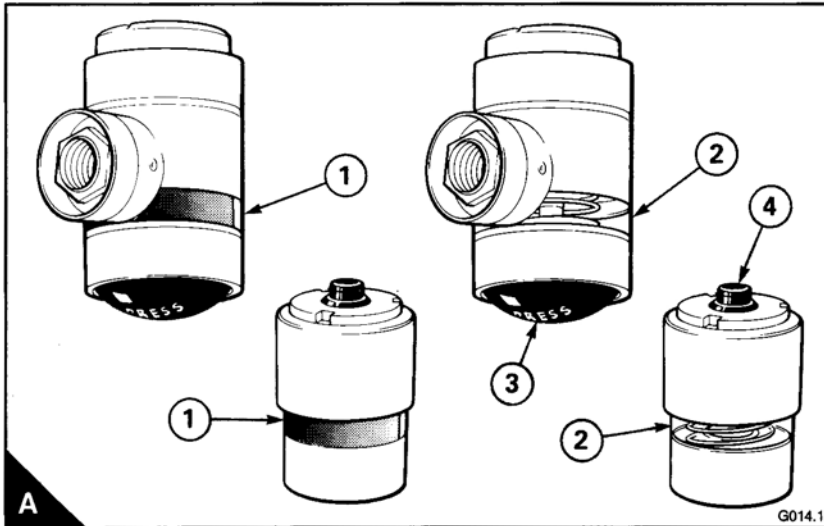


## Restriction indicator

The restriction indicator for these engines must work at a pressure difference of 508/558 mm (20/22 in) of water gauge. It is fitted on the air filter outlet or between the air filter and the induction manifold.

When the red warning indicator (A1) is seen through the clear panel (A2) after the engine has stopped, the air filter element must be removed for service.

After a clean element has been fitted, press the rubber bottom (A3) or the button (A4) of the restriction indicator to reset the red warning indicator.

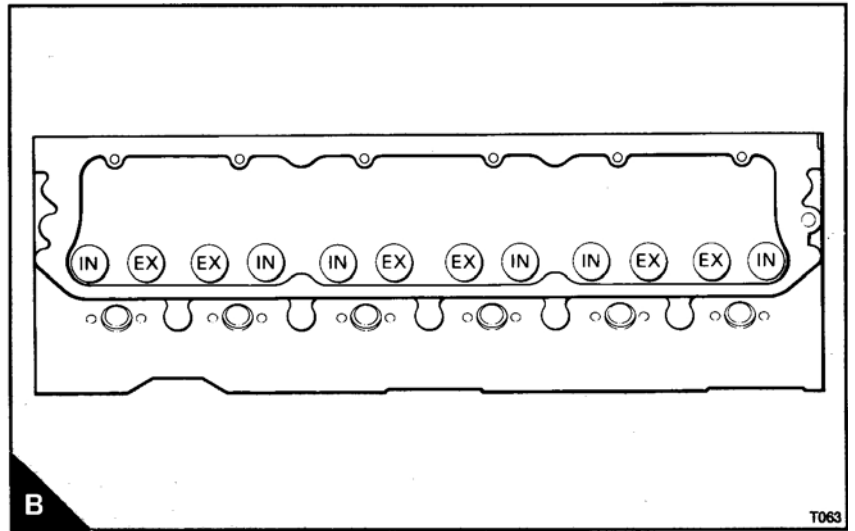
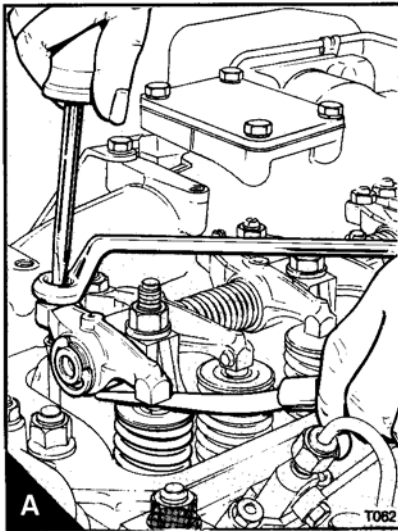


## How to check the valve tip clearances

These are checked between the top of the valve stem and the rocker lever (A), with the engine cold. The correct clearances are 0,20 mm (0.008 in) for inlet valves and 0,45 mm (0.018 in) for exhaust valves. The valve positions are shown at (B).

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

- 1 Turn the crankshaft in the normal direction of rotation until the inlet valve of number 6 cylinder has just opened and the exhaust valve of the same cylinder has not closed completely. Check the clearances of the valves of number 1 cylinder and adjust them, if necessary.
- 2 Set the valves of number 2 cylinder as indicated above for number 6 cylinder. Then check/adjust the clearances of the valves of number 5 cylinder.
- 3 Set the valves of number 4 cylinder. Then check/adjust the clearances of the valves of number 3 cylinder.
- 4 Set the valves of number 1 cylinder. Then check/adjust the clearances of the valves of number 6 cylinder.
- 5 Set the valves of number 5 cylinder. Then check/adjust the clearances of the valves of number 2 cylinder.
- 6 Set the valves of number 3 cylinder. Then check/adjust the clearances of the valves of number 4 cylinder.



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# 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	45 minimum (Industrial and agricultural use)
	50 minimum (Vehicle use)
Viscosity	2.5/4.5 centistokes at 40 °C
Density	0,835/0,855 kg/litre
Sulphur	0.5 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. Refer to the maintenance "Schedules" on page 26.

**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.

#### Aviation kerosene fuels

These fuels can be used but they can affect engine performance. It is recommended that you consult the Perkins Technical Service Department at Peterborough, especially if JP4 fuel is to be used. These fuels are more flammable than diesel fuel and need careful storage and careful management.

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 available fuel, consult your nearest Perkins distributor or the Perkins Technical Service Department.

**Lubricating oil specification**

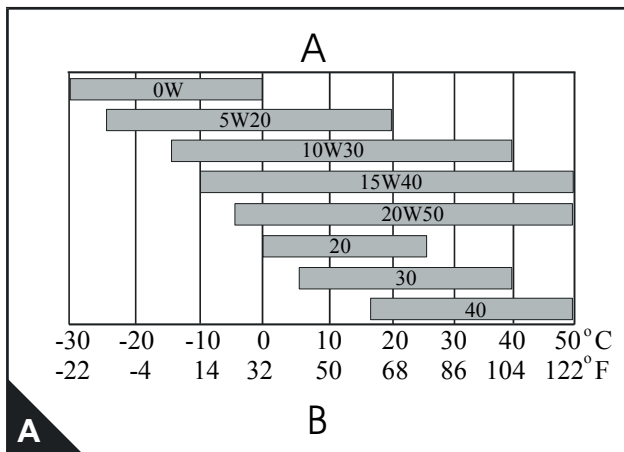
Use only a good quality lubricating oil to the relevant specification as shown in the table below.

**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 43.

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 below.

Engine type	Specifications	
	API CC/SE	API CD/SE CCMC D4 <sup>(1)</sup>
Naturally aspirated	●	●
Naturally aspirated engines in heavy duty earth moving equipment		●
Turbocharged		●

(1) Not recommended during the first 20/40 hours of operation, nor for light load applications, with naturally aspirated engines.



**Viscosity chart**

A = Recommended viscosity

B = Ambient temperature

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## 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 or 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 the standards below:

**United Kingdom:** BS.6580:MOD AL39: "Specification for corrosion inhibiting, engine coolant concentrate (antifreeze)".

Perkins POWERPART antifreeze exceeds the requirements of the above standards.

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 antifreeze is not used, add a correct mixture of corrosion inhibitor to the water.

Renew the mixture of water and corrosion inhibitor every six months or check it according to the inhibitor manufacturer's recommendations.

**Caution:** *Certain corrosion inhibitor mixtures could cause damage to some engine components. It is recommended that you consult the Service Department, Perkins Power Sales and Service Limited, Peterborough if a corrosion inhibitor is to be used.*

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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, 18, 19, 20, 21	34, 36, 37, 38, 39, 42, 43, 44, 61, 63, 65
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 system 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	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 system is too high	4, 25	49
The engine oil temperature is too high	11, 13, 15, 19, 27, 29, 30, 32, 64	34, 36, 37, 39, 52, 55, 56, 57
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	

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**Code 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 filter/cleaner or 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 a wrong specification is used in wet type air cleaner.
- 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.

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- 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 (if there is one fitted).
  - 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 (turbocharged engines).
  - 64 Drive belt of water pump loose or broken.
  - 65 Leak from pipe for boost pressure control.

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