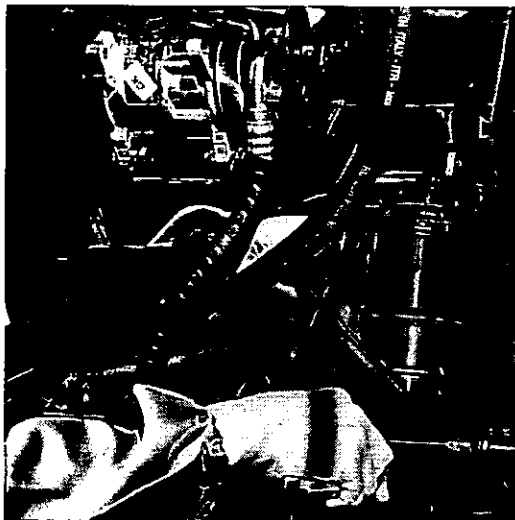
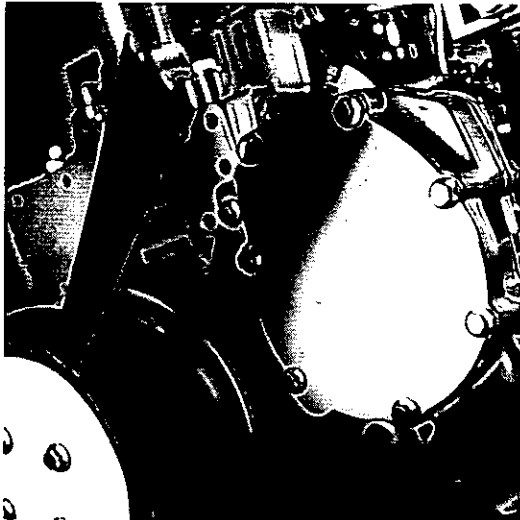




User Handbook

4.108



TPD1218

USERS HANDBOOK

4.108 Diesel Engine

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March 1989

Perkins Engines Ltd.,

Peterborough, England.

*This publication is written in
Perkins Approved Clear English*

PACE

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General information

Introduction

This handbook has been written to give you assistance in the correct maintenance and operation of your engine.

To get the best performance and longest life from your engine, you must have the maintenance operations done at the periods shown in 'Preventive maintenance'. If the engine operates in very dusty or other adverse conditions, some maintenance periods will have to be reduced. Keep your engine clean inside by regular filter element and lubricating oil changes.

Ensure that all adjustments and repairs are done by personnel who have had the correct training. Perkins Distributors have these personnel available. You can also get parts and other service from your Perkins Distributor. If you do not know the location of your nearest distributor, check with one of the Perkins companies given on page 8.

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

Read and remember the 'Safety precautions'. These are given for your protection and must be used at all times.

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. **Attention:** Some moving parts can not 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.

CARECARD

The Perkins **CARECARD** system is only applicable where the Perkins distributor is responsible for the engine service.

When you receive your new equipment, give all the relevant details to your Perkins distributor who will provide a **CARECARD** (see fig. 1) and instructions for its use.


	CARECARD
ENGINE NO.	
ISSUED TO	
SIGNED	
ISSUED BY	
EXPIRES	

Fig. 1 CARECARD

Each time you need service or information, give the **CARECARD** to your distributor. This will enable the distributor to provide the correct service and ensure that genuine Perkins parts are used. The distributor will also ensure that you obtain the best performance from your Perkins engine at all times.

Engine identification

The engine number is stamped on the flange to which the fuel injection pump is installed (see 1, fig. 2). A typical engine number is ED20138U500123J.

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

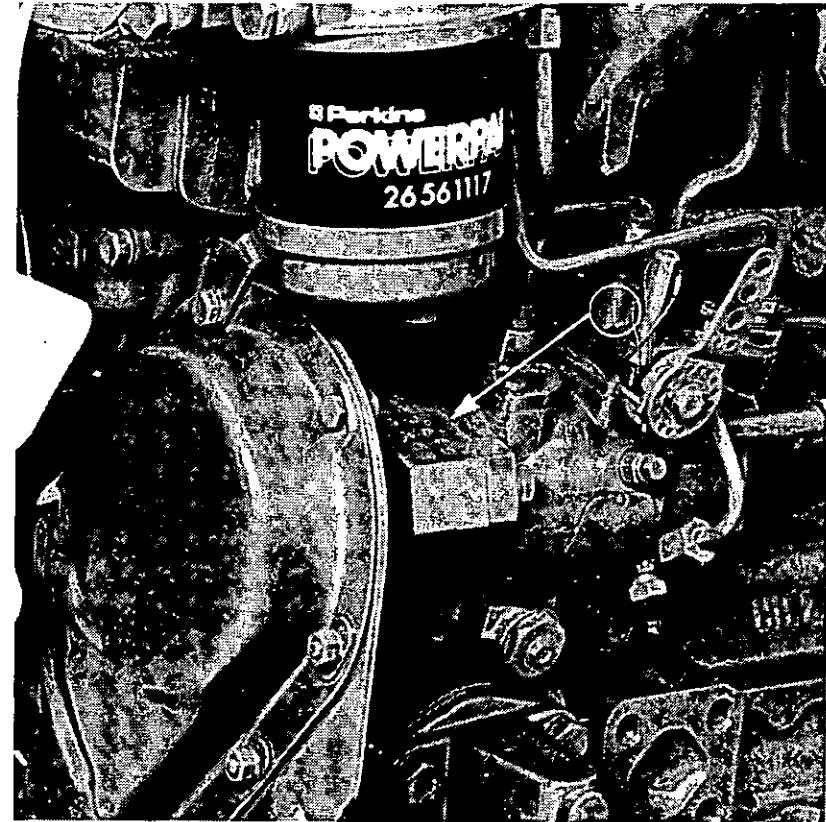


Fig. 2 Engine number position

Perkins companies

Australia

Perkins Engines Australia Pty. Ltd.,
Suite 2, 364 Main Street,
Mornington 3931, Victoria, Australia.
Telephone: 597 51877
Telex: Perkoil AA 30816
Fax: 597 58793

France

Moteurs Perkins S.A.,
9-11 Ave. Michelet,
93583 Saint Ouen, Cedex, France.
Telephone: (1) 40-10-42-00
Telex: 642924F
Fax: (1) 40-10-42-45

Germany

Perkins Motoren G.m.b.H.,
8752 Kleinostheim, Postfach 1180,
West Germany.
Telephone: Kleinostheim 6027 5010
Telex: 4188869A PER D
Fax: 6027 501124

Italy

Motori Perkins S.p.A.,
Via Socrate 8,
22070 Casnate con Bernate (Como), Italy.
Telephone: 031 452332
Telex: 380658 Perkit I
Fax: 031 452335

Japan

Massey Ferguson Perkins Engines K.K.,
Reinanzaka Building, 6th Floor,
14-2 Akasaka, 1-chome, Minato-ku,
Tokyo 107, Japan.
Telephone: (03) 586 7377
Telex: Perkoil J2424823
Cable: Perkoil
Fax: (03) 582-1596

Singapore

Perkins Engines Asia Pacific,
4 Kian Teck Drive,
Singapore 2262.
Telephone: 2656333/2653223
Telex: Perkoil RS37729
Fax: 2641188

United Kingdom

Perkins Engines Limited,
Eastfield, Peterborough, PE1 5NA, England.
Telephone: (0733) 67474
Telex: 32501 Perken G
Fax: (0733) 582240

Perkins Engines (Shrewsbury) Limited,
Sentinel Works,
Shrewsbury, SY1 4DP, England.
Telephone: (0743) 52262
Telex: 35171/2 PESL G
Fax: (0743) 69911

United States of America

Perkins Engines Inc.,
1700 Bellemeade Court,
Lawrenceville,
Georgia 30245, U.S.A.
Telephone: 404 822 3000
Telex: 544141 Perken Law
Fax: 404 822 3006

Perkins Engines Latin America Inc.,
Suite 620,
999 Ponce de Leon Boulevard,
Coral Gables,
Florida 33134, U.S.A.
Telephone: 305 442 7413
Telex: 32501 Perken G
Fax: 305 442 7419

In addition to the above, there are Perkins Distributors in most countries. Perkins Engines Ltd., Peterborough or one of the above companies can give details.

Engine views

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

- 1 Lubricating oil filler cap
- 2 Exhaust manifold
- 3 Fuel oil filter
- 4 Fuel injection pump
- 5 Lubricating oil filter
- 6 Sump drain plug
- 7 Crankshaft pulley
- 8 Drive belt
- 9 Fan
- 10 Water pump
- 11 Alternator pulley
- 12 Thermostat housing

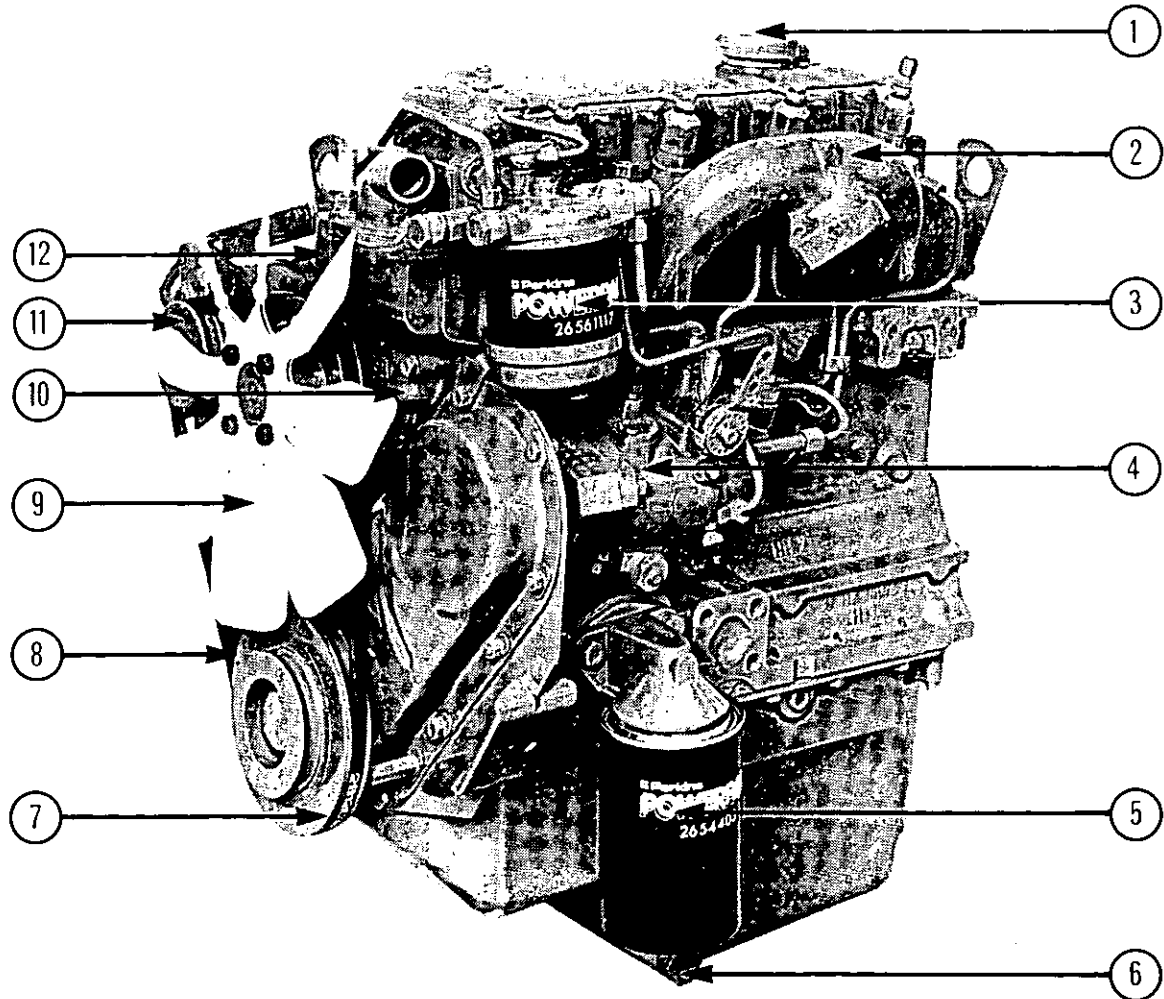


Fig. 3 Front/left side of 4.108 engine

-
- 13 Front lift bracket
 - 14 Induction manifold
 - 15 Alternator
 - 16 Lubricating oil dipstick
 - 17 Breather pipe
 - 18 Lubricating oil sump
 - 19 Cylinder block drain plug
 - 20 Fuel lift pump
 - 21 Thermostart
 - 22 Rear lift bracket
 - 23 Rocker cover
 - 24 Atomiser

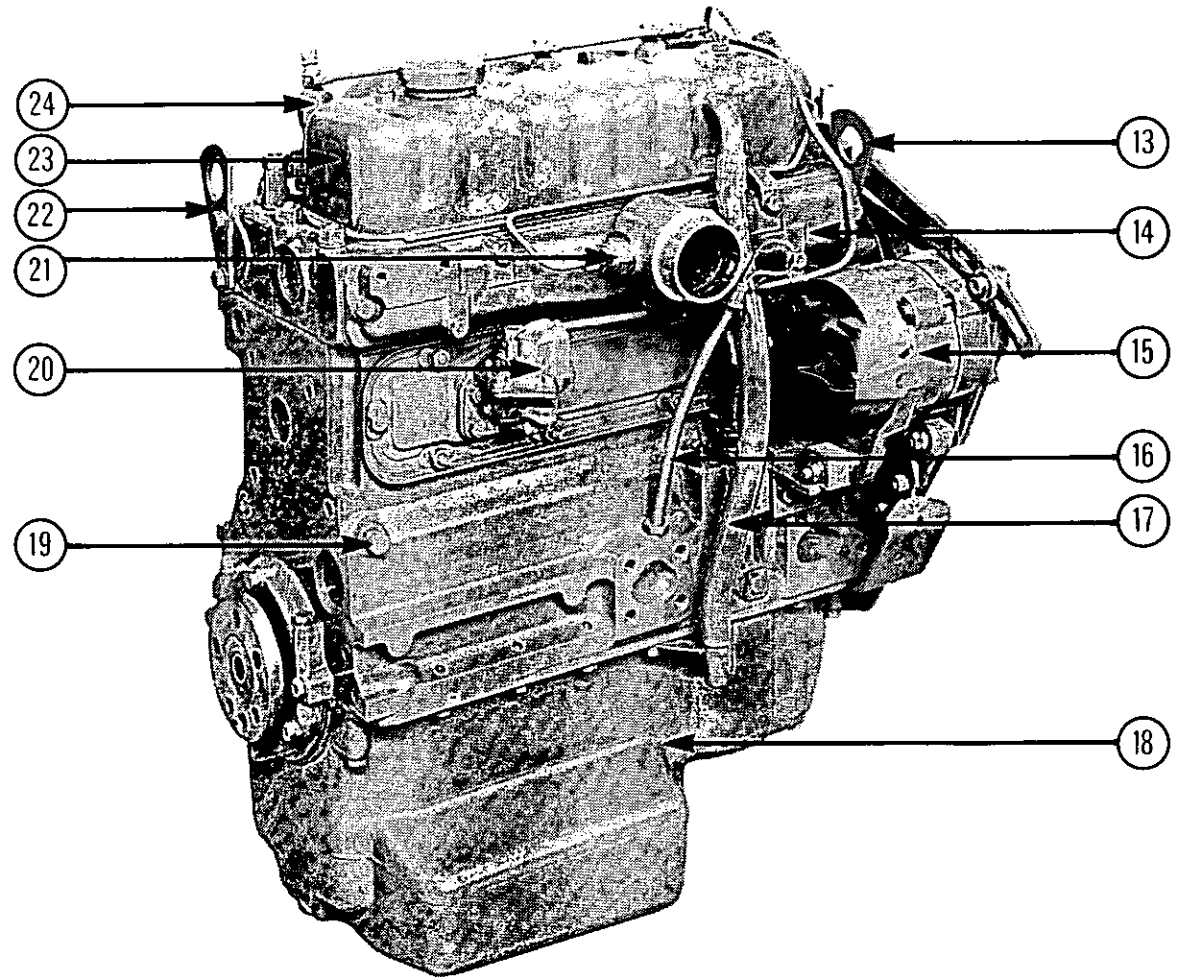


Fig. 4 Rear/right side of 4.108 engine

Engine data

Number of cylinders	Four
Cylinder arrangement	In line
Cycle	Four stroke
Induction system	Naturally aspirated
Combustion system	Indirect injection
Nominal bore	79,4 mm (3.125 in)
Stroke	88,9 mm (3.50 in)
Compression ratio	22:1
Cubic capacity	1,76 litre (107.4 in ³)
Firing order	1, 3, 4, 2
Valve tip clearance	
Inlet (cold)	0,30 mm (0.012 in)
Exhaust (cold)	0,30 mm (0.012 in)
Lubricating oil pressure	207 kN/m ² (30 lbf/in ²) 2,10 kgf/cm ² minimum at maximum engine speed and normal engine temperature.
Direction of rotation	Clockwise from the front.

Instructions for operation

To start the engine

There are several factors which affect engine start, for example:

- The power of the batteries.
- Performance of the starter motor.
- Viscosity of the lubricating oil.
- Installation of a cold start system.

Diesel engines need a cold starting aid when they are to operate in very cold conditions. Your machine will normally be fitted with the correct equipment for your area of operation.

Different systems of cold starting aids can be fitted to Perkins diesel engines and they are:

Thermostart: An electrically operated device which heats the induction air. This device burns a controlled amount of fuel.

Start Pilot: A hand pump discharges the cold start fluid into the induction manifold through an atomiser. The cold start fluid is held in a separate reservoir.

KBi: The cold start fluid is held in an aerosol container. It is released by a push button operated solenoid and sprayed into the induction manifold by a nozzle.

Glow plug: An electrically operated device fitted to the cylinder head (mechanically governed engine only) which when activated supplies a high temperature inside the pre-combustion chamber of each cylinder.

Engine start procedure without cold starting aids

1 Ensure that the stop control (where fitted) is in the 'run' position.

2 Adjust the engine speed control to the maximum speed position.

3 Turn the start key to the 'S' or 'HS' position (see fig. 5), to engage the starter motor.

4 As soon as the engine starts, release the start key to the 'R' position.

5 Adjust the engine speed control.

6 If the engine does not start in 15 seconds, release the start key to the 'R' position. Do not engage the starter motor again until 10 to 15 seconds have passed.

Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.

Engine start procedure with Thermostart

1 Ensure that the stop control (where fitted) is in the 'run' position.

2 Turn the start key to the 'H' position (see fig. 5) and hold it there for 20 seconds.

3 Adjust the engine speed control to the maximum speed position.

4 Turn the start key to the 'HS' position to engage the starter motor. As the engine starts, release the start key to the 'R' position and adjust the engine speed control to give a smooth idle speed.

5 If the engine does not start in 15 seconds, return the start key to the 'H' position for 10 seconds and then engage the starter motor again.

Engine start procedure with Start Pilot

The Start Pilot hand pump must not be used until the starter motor is engaged.

Experience will show how much fluid is needed for each engine start.

1 Where necessary, charge the reservoir with fluid. Raise the cover of the reservoir and press the can, head down, on to the filler plug and hold squarely until fluid fills the bowl up to the maximum mark.

2 Ensure that the stop control (where fitted) is in the 'run' position.

3 Adjust the engine speed control to the maximum speed position.

4 Turn the key to the 'HS' position (see fig. 5) to engage the starter motor for a maximum of 30 seconds and operate the Start Pilot pump during this period. As the engine starts release the start key to the 'R' position and adjust the engine speed control to give a smooth idle speed.

5 If the engine does not start during the first 30 seconds, disengage the starter motor for another 30 seconds and then engage the starter motor again and operate the Start Pilot hand pump.

 **Start Pilot equipment must not be used with heat type cold starting aids such as Thermostart.**

The air filter at the outer end of the pump must be inspected from time to time and 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 in the induction manifold can be removed and washed in kerosene, when necessary.

Engine start procedure with KBI

1 Where necessary, renew the screw type canister. A safety valve is integral with the container.

2 Ensure that the stop control (where fitted) is in the 'run' position.

3 Adjust the engine speed control to the maximum speed position.

4 Engage the starter motor.

5 As the engine turns, press the KBI 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 and after 5 seconds press the KBI button again for 2 seconds.

In some conditions, it is necessary to give another application of KBI fluid after the engine has started to ensure that the engine continues to run.



KBI equipment must not be used with heat type cold starting aids such as Thermostart.

O Off
R Run
H Heat
HS Heat and start

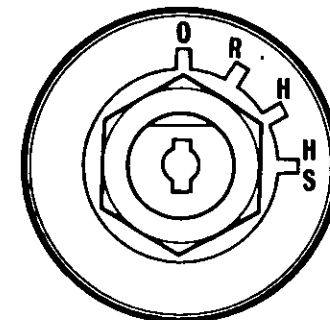


Fig. 5 Heat/start switch

Engine start procedure with glow plugs

- 1 Ensure that the stop control (where fitted) is in the 'run' position.
- 2 Turn the start key to the 'H' position (see fig. 5) and hold it there for 20 to 30 seconds.
- 3 Adjust the speed control to the maximum speed position.
- 4 Turn the start key to the 'HS' position to engage the starter motor. As the engine starts, release the start key to the 'R' position and adjust the engine speed control to give a smooth idle speed.
- 5 If the engine does not start in 15 seconds, return the start key to the 'H' position for 10 to 15 seconds and then engage the starter motor again.

To stop the engine

Either turn the engine start key to the 'O' position (fig. 5) or operate the separate stop control. Where a separate stop control is used, ensure that the control is returned to the 'run' position, after the engine has stopped and the engine start key is turned to the 'O' position.

Engine speed adjustment

The idle or maximum speed settings must not be changed by the engine operator as this can damage the engine or transmission. If the seals on the fuel injection pump are broken during the warranty period by a person who is not approved by Perkins Engines Ltd., it can have an effect on the warranty.

Running-in procedure

A gradual 'running-in' of a new or Power Exchange engine is not necessary. Extended light load operation during the early life of the engine is not recommended.

Full load can be applied to a new or Power Exchange engine as soon as the engine is put into service and the coolant temperature is at a minimum of 60°C (140°F).

Do not run the engine at high no load speeds.

Do not apply an overload to the engine.

Altitude

If this naturally aspirated engine is to operate at an altitude higher than 600m (2,000ft), the fuel delivery can be changed to reduce smoke and fuel consumption. Perkins Engines Ltd., can give the percentage of fuel reduction needed if details of engine application and ambient conditions are given. Any change to the fuel injection pump settings must be made by a Perkins distributor or an approved fuel pump distributor.

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	2.5/4.5 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. Fuel with a low cetane number can cause cold start problems and effect combustion.

Viscosity is the resistance to flow and, if this is outside the limits, engine performance can be effected.

Density: Lower density will reduce engine power, higher density will increase engine power and exhaust smoke.

Sulphur: High sulphur content (not normally found in Europe, North America or Australasia) can cause engine wear. Where only high sulphur fuels are available, it will be necessary to use a highly alkaline lubricating oil in the engine or to reduce the lubricating oil change interval.

Distillation: This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light weight hydrocarbons can effect 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 effect engine performance. It is recommended that you consult the Perkins Technical Service Department at Peterborough, especially if JP4 fuel is to be used. Aviation fuels are more flammable than diesel fuel and need careful storage and management.

If you need advice on any adjustment to the engine 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 Technical Service Department at one of the addresses on page 8.

Lubricating oil specification

Lubricating oils must be equal to the specification API SE CC (MIL-L-46152) CCMC D1 or API SE CD (MIL-L-2104C) CCMC D2. Lubricating oils for engines installed in heavy duty earthmoving equipment must be equal to the specification API SE CD (MIL-L-2104C).

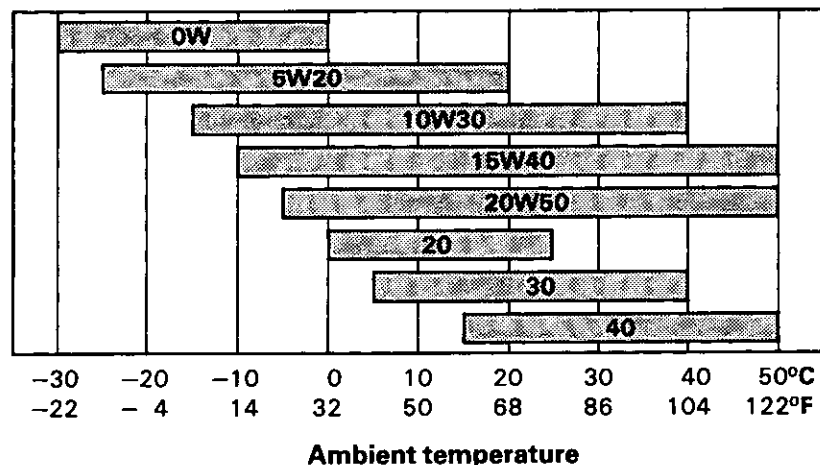
Note: Users are advised not to use a lubricating oil equal

to specification API SE CD (MIL-L-2104C) CCMC D2 (other than those installed in heavy duty earthmoving equipment) for the first 800/1600km (500/1,000 miles), 25/50 hours of operation.

The type of lubricating oil used may be affected by the quality of the fuel oil which is used. For further details see 'Fuel specification' on page 15.

Always ensure that the correct viscosity grade of lubricating oil is used for the temperature range in which the engine will operate as shown in the chart below.

Recommended SAE viscosity grades



Coolant specifications

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 can not be held responsible for frost or corrosion damage.

- 1 If it is possible, use clean soft water.
- 2 If an antifreeze mixture, other than Perkins POWER-PART, 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: 1985: 'Specification for corrosion inhibiting, engine coolant concentrate (antifreeze)'.

United States of America: ASTM D3306-74: 'Ethylene Glycol Base Engine Coolant'.

Australia: AS 2108-1977: 'Antifreeze Compounds and Corrosion Inhibitors for Engine Cooling Systems'.

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 antifreeze must consist of equal quantities of antifreeze and water. Concentrations of more than 50% of antifreeze must not be used because these can effect 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 the necessary protection against corrosion and also raises the boiling point of the coolant.

If an antifreeze is not used, a correct mixture of corrosion inhibitor must be added to the water.

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

Attention: Certain corrosion inhibitor mixtures contain soluble oil which can have an adverse effect on certain types of water hose.

To drain the cooling system

- 1** Ensure that the vehicle or machine is on level ground.
- 2** Remove the radiator filler cap.
- 3** Remove the drain plug from either side of the cylinder block (see 1, fig. 6) drain the engine. Ensure that the drain hole does not have any restriction.

4 Open the tap or remove the drain plug at the bottom of the radiator to drain the radiator. If a tap or plug is not fitted to the radiator, disconnect the bottom radiator hose.

Where fitted, the lubricating oil cooler (if water cooled) must be drained.

5 Where necessary, flush the system with clean water.

6 Fit the drain plugs and radiator cap. Where necessary, close the radiator tap or connect the radiator hose.

7 Put 250ml (½ pint) of antifreeze, without water, into the oil cooler (if fitted) for protection against frost if water drains down when the machine is moved.

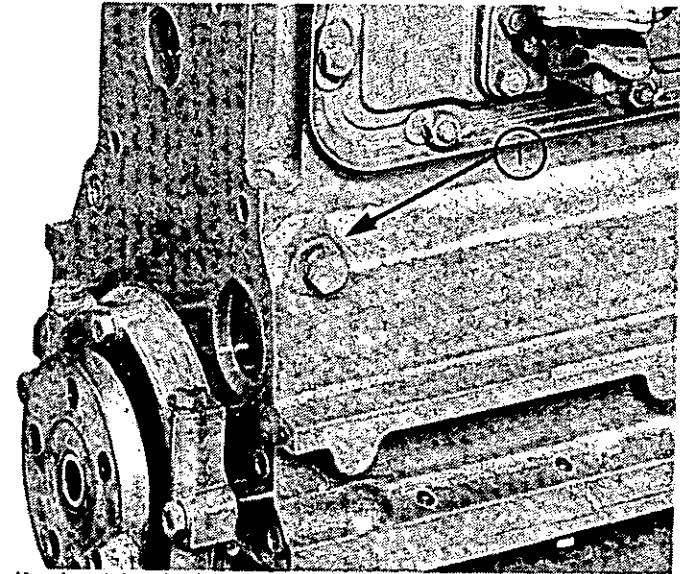


Fig. 6 Cylinder block drain plug

Preventive maintenance

These preventive maintenance periods are general in application unless specifically detailed. Check the periods given by the manufacturer of the equipment in which the engine is installed and, where necessary, use the shorter periods. These periods and procedures must also be adapted to ensure correct operation for any local vehicle or machine regulations.

Note: On stop/start short distance operation the hours run are more important than the distance.

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

These maintenance periods are only for engines that are operated with fuel and lubricating oil 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.

Daily or every 8 hours

Check amount of coolant.

Check amount of lubricating oil in the sump.

Check lubricating oil pressure (where a gauge is installed).

In extreme dust conditions, clean the wet type air cleaner or empty the dust bowl of the air filter.

Every 6000 km (4,000 miles), 150 hours or 3 months

Renew the lubricating oil.

Renew the lubricating oil filter canister.

Clean the wet type air cleaner, or empty the dust bowl of the air filter.

Check the drive belt for condition and tension (this must be checked monthly on engines rated above 3000rev/min).

Check for water in the fuel pre-filter (where fitted) and drain as necessary.

Clean the compressor air filter (if fitted).

Refrigeration unit engines have a larger capacity sump and a larger lubricating oil filter canister and the lubricating oil filter change can be extended to 1000 hours.

Every 18000 km (12,000 miles), 450 hours or 12 months

Clean or renew the air filter element.

Renew fuel filter element (agricultural and industrial applications).

Every 36000 km (24,000 miles) or 900 hours

Renew the fuel filter element (vehicle applications).

Every 108000 km (72,000 miles) or 2,700 hours

Have the accessory equipment (starter motor, alternator, exhaust, etc.) checked.

Check and, if necessary, adjust the valve tip clearances.

Have the atomisers checked.

Post delivery service

The service procedures given below must be applied at the first 800/1600km (500/1,000 miles), 25/50 hours of operation.

- 1 Run the engine until it is warm. Stop the engine and drain the lubricating oil from the sump.
- 2 Check the tension of the cylinder head nuts (see page 20).
- 3 Renew the canister of the lubricating oil filter (see page 22). Fill the sump to the 'full' mark on the dipstick with clean new lubricating oil to an approved grade.
- 4 Adjust the valve tip clearances (see page 24).
- 5 Check that the induction and exhaust manifold nuts are tight.
- 6 Check the tension of the alternator/water pump drive belt (see page 23).
- 7 Check that all fasteners are tight.
- 8 Run the engine and check for fuel, coolant and lubricating oil leakage.
- 9 If necessary, get a person who has had the correct training to adjust the idle speed.

Instructions for maintenance

To check the cylinder head nut tension

1 Run the engine until the coolant outlet temperature is higher than 77°C (170°F).

2 Stop the engine and remove the cylinder head cover.

3 Check the tension of the cylinder head nuts in the correct sequence (see fig. 7). The correct torque tension is 81 Nm (60lbfft) 8,3kgfm.

If a nut turns when checked, tighten it to the correct tension.

If a nut does not turn when checked, loosen it by 30° to 60° and then tighten to the correct torque tension.

After all the nuts have been tightened, check the first 10 positions again to ensure that they are still to the correct tension. During this last check, do not loosen the nuts.

4 Check the valve tip clearances (see page 24) and adjust as necessary.

5 Install the cylinder head cover.

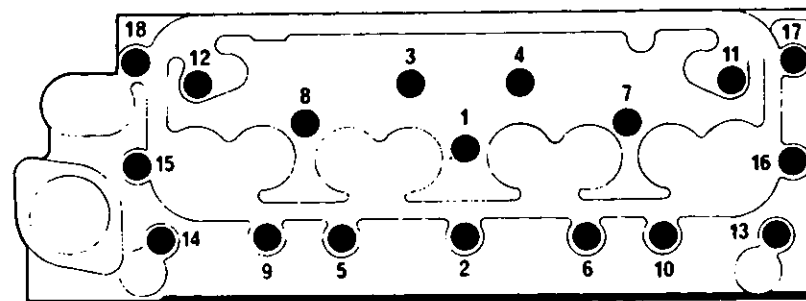


Fig. 7 Sequence to tighten cylinder head nuts

Air filter

Environment conditions have an important effect on the frequency at which the dry type air filter will need service.

Some air filters have a separate dust bowl that has to be cleaned at intervals. The amount of dust in the bowl will show if it has been removed at the correct time for the conditions of operation. Do not let the bowl get full of dust as this will reduce the life of the filter element. Some air filters have automatic dust valves through which dust is discharged from the filter. The rubber dust valve must be kept clean and checked to ensure that the sides of the valves close together, but will come apart freely.

Where a restriction indicator is installed, it will give a positive indication that the air filter element needs service. This will prevent the early removal of the filter element which causes extra cost or late element removal which can cause loss of engine power.

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

Air cleaner

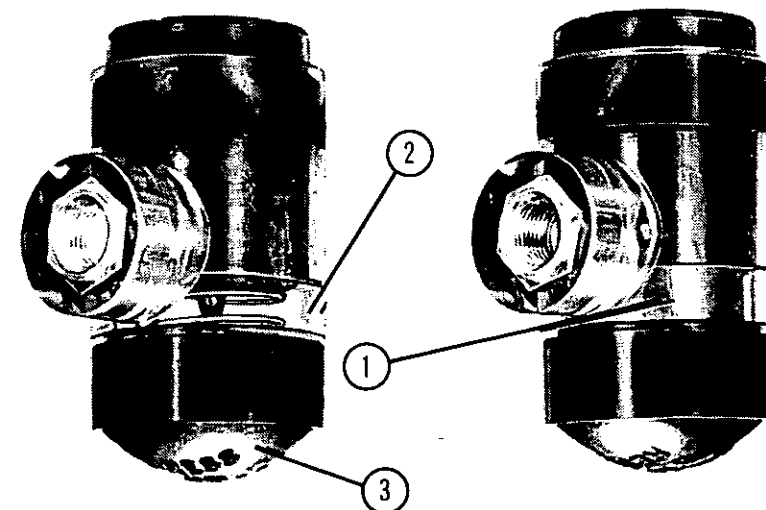
The wet type air cleaner must be drained at a suitable interval and the container and element cleaned with kerosene or other suitable fluid. Do not use gasoline. Fill with clean engine lubricating oil to the indicated level.

Restriction indicator

The restriction indicator for these engines must be the type that operates at a pressure difference of 457mm (18in) of water gauge. It is installed on the air filter outlet or between the air filter and the induction manifold.

When the red warning indicator (1, fig. 8) is seen through the clear panel (2) 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 (3) of the restriction indicator to reset the red warning indicator.



1 Red panel 2 Clear panel 3 Rubber bottom

Fig. 8 Restriction indicator

To renew the lubricating oil filter canister

- 1 Put a tray under the filter to hold any lubricating oil drops.
- 2 Remove the filter canister (see fig. 9) with a strap wrench or similar tool and discard the canister.
- 3 Clean the filter head.
- 4 Add clean engine lubricating oil to the new canister. Give the oil time to fill the canister through the filter element.
- 5 Lubricate the top of the canister seal with clean engine lubricating oil.
- 6 Install the new canister and tighten it by hand only. Do not use a strap wrench.
- 7 After lubricating oil has been added to the sump, run the engine and check for leakage from the filter.

Note: The canister has a valve inside to ensure that lubricating oil does not drain from the filter and a special tube is fitted, so ensure that the correct Perkins POWER-PART canister is used.



Fig. 9 To renew lubricating oil filter canister

To check the drive belt

Renew the belt if it is worn or damage has occurred.

With thumb pressure, press the fan belt down at the centre of the longest free length and check the movement (see fig. 10). The belt movement must be 10 mm ($\frac{3}{8}$ in).

To adjust the belt tension:

- 1 Loosen the alternator mounting and adjustment link fasteners.
- 2 Change the alternator position to give the correct tension and tighten the alternator and adjustment link fasteners.
- 3 Check the belt tension again to ensure that it is still correct.

If a new belt is fitted, the belt tension must be checked again after the first 800km (500 miles) or 25 hours of operation.

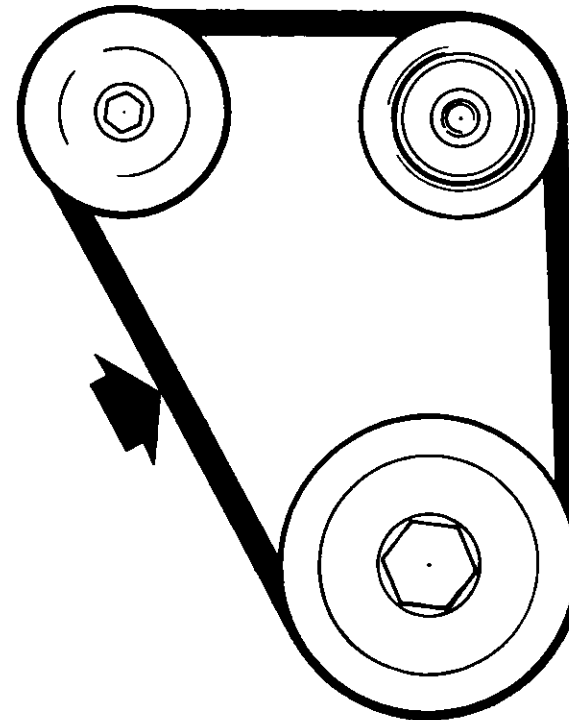


Fig. 10 To check drive belt tension

To check the valve tip clearances

These are checked between the top of the valve stem and the rocker lever (see fig. 11). The correct clearance for the inlet and exhaust valves is 0,30 mm (0.012 in).

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 4 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of number 1 cylinder valves and adjust if necessary.

2 With number 2 cylinder valves set as given above for number 4 cylinder, check/adjust clearances of number 3 cylinder valves.

3 With number 1 cylinder valves set, check/adjust clearances of number 4 cylinder valves.

4 With number 3 cylinder valves set, check/adjust clearances of number 2 cylinder valves.

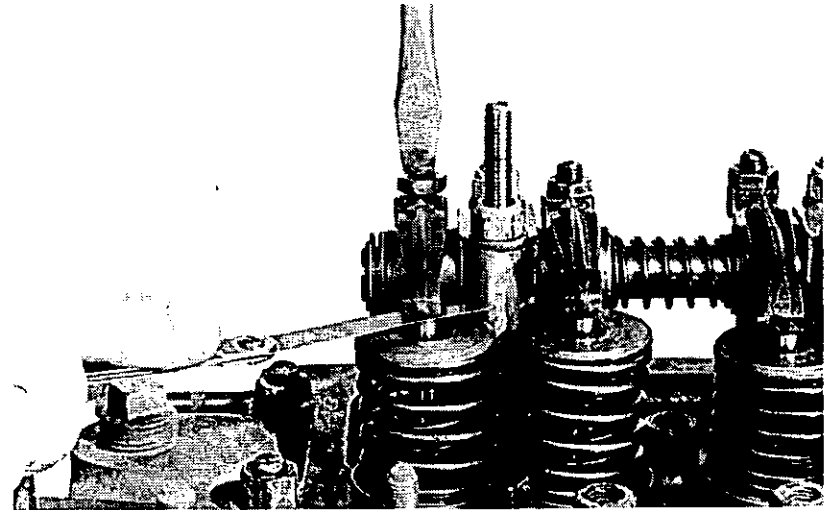


Fig. 11 To check valve tip clearances

To renew a fuel filter element

- 1 Clean the outside of the fuel filter element.
- 2 Release the setscrew in the centre of the cover of (each) filter (see fig. 12).
- 3 Lower the filter bottom cover (see fig. 13).
- 4 Remove the element and discard.
- 5 Before you put the new element in position, clean the top and bottom filter covers.
- 6 If the joints are not in good condition, renew them.
- 7 Put the bottom cover on the bottom of the new element and assemble it squarely to the filter head so that the element fits in the centre against the joint in the filter head.
- 8 Hold in this position and fit the setscrew in the centre of the filter head.
- 9 Remove air from the fuel system (see page 26).



Fig. 12 To loosen fuel filter setscrew



Fig. 13 To lower fuel filter bottom cover

To eliminate air from the fuel system

If air gets into 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.
- Any part of the low pressure fuel system leaks during engine operation.

Eliminate air from the fuel system as follows:

- 1 Loosen the banjo connection bolt which is fitted on the top of the filter (see fig. 14).
- 2 Operate the priming lever on the fuel lift pump (see fig. 15) until fuel, free of air, comes from the filter vent point. Tighten the banjo connection bolt. If the drive cam for the fuel lift pump is at the point of maximum lift, it will not be possible to operate the priming lever. If this occurs, the crankshaft must be turned through one revolution.

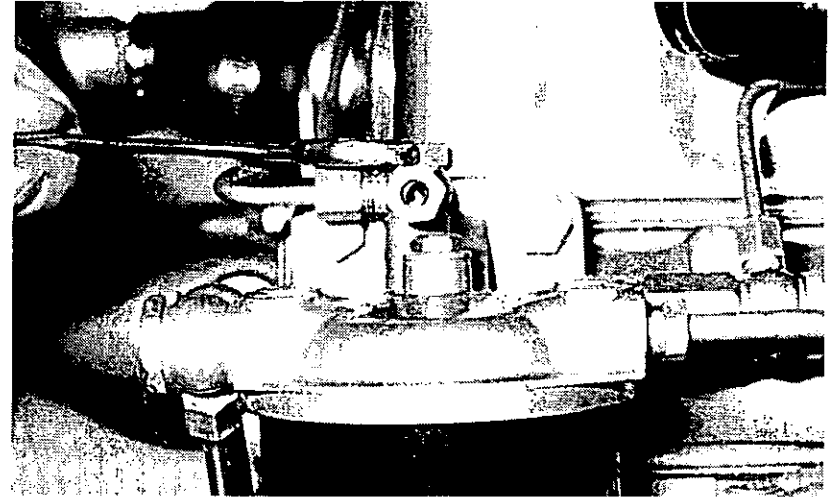


Fig. 14 Vent screw on fuel filter

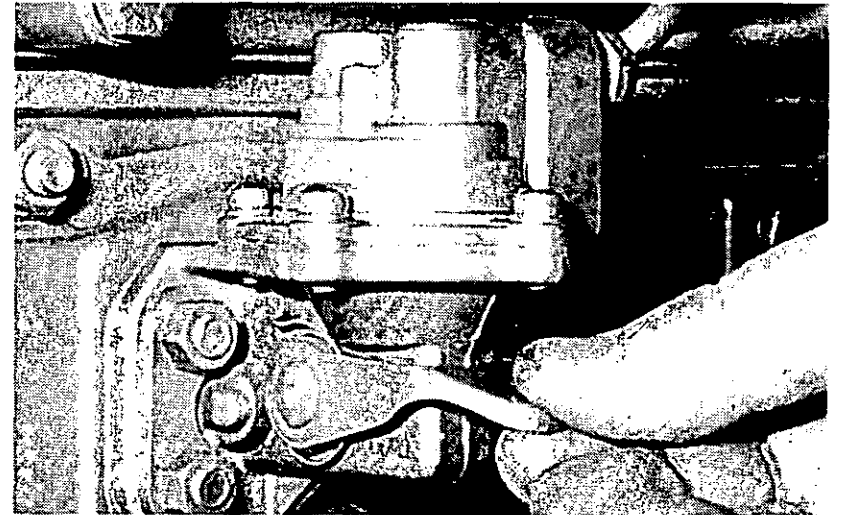


Fig. 15 Priming lever on fuel lift pump

3 Ensure that the stop control is in the run position. If an electrical stop control is used, turn the key of the start switch to the 'R' position.

4 Loosen the vent plug in the lock screw for the hydraulic head of the fuel injection pump (see fig. 16).

5 Operate the priming lever of the fuel lift pump until fuel, free of air, comes from the vent plug. Tighten the vent plug.

6 For mechanically governed pumps (see fig. 17). Loosen the vent plug on the governor housing of the fuel injection pump.

7 Operate the priming lever of the fuel lift pump until fuel, free of air, comes from the vent plug. Tighten the vent plug on the governor housing.

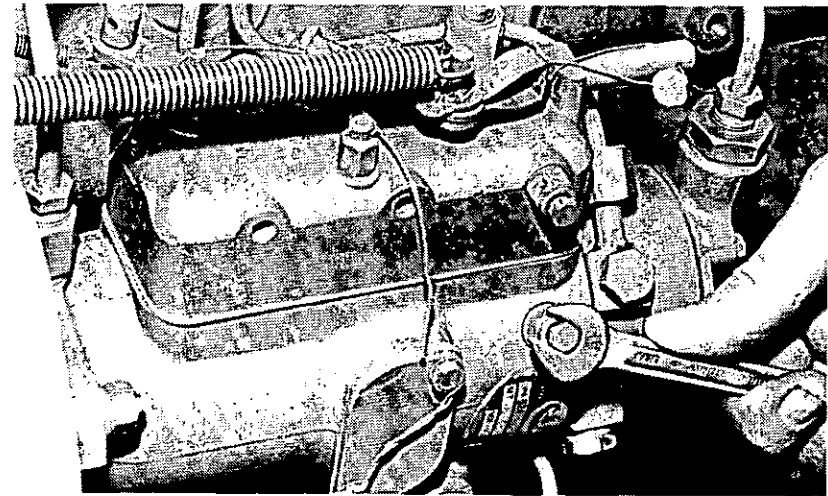


Fig. 16 Vent plug on hydraulic head

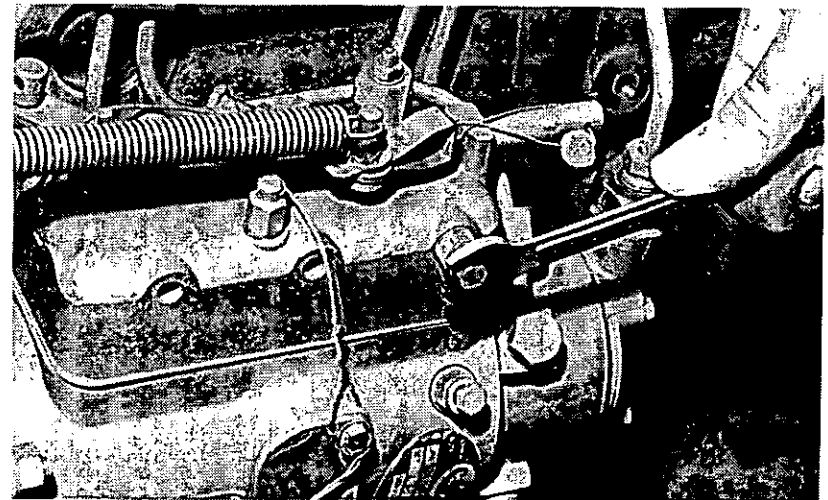


Fig. 17 Vent plug on mechanical governor

8 For hydraulically governed pumps (see fig. 18). Loosen the vent plug (1) on the governor housing of the fuel injection pump. During this operation ensure that the anti-stall device (2) does not move.

9 Operate the priming lever of the fuel lift pump until fuel, free of air, comes from the vent plug. Tighten the vent plug on the governor housing.

10 If the fuel pipe to the Thermostart cold starting aid has been drained, loosen the union nut (1) at the Thermostart (see fig. 19).

11 Operate the priming lever of the fuel lift pump until fuel, free of air, comes from the union nut at the Thermostart. Tighten the union nut.

12 Loosen the high pressure pipe connections at two of the atomisers. Operate the starter motor until fuel, free of air, comes from the pipe connections. Tighten the high pressure pipe connections.

13 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.

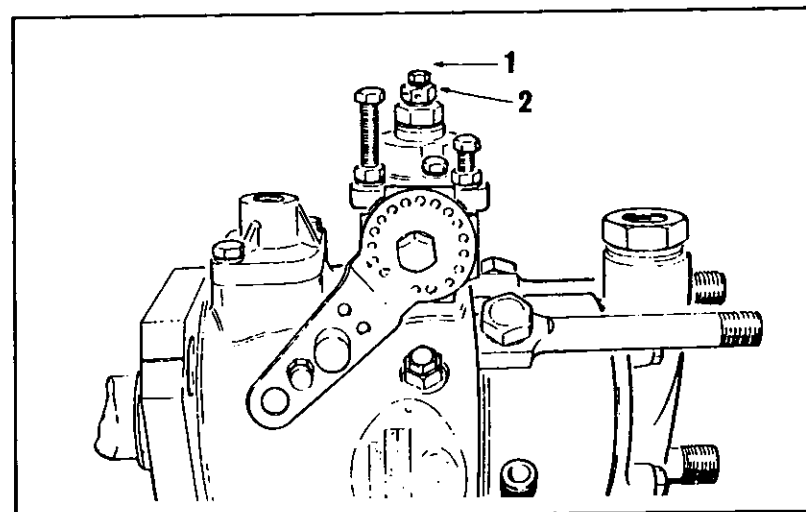


Fig. 18 Vent plug on hydraulic governor

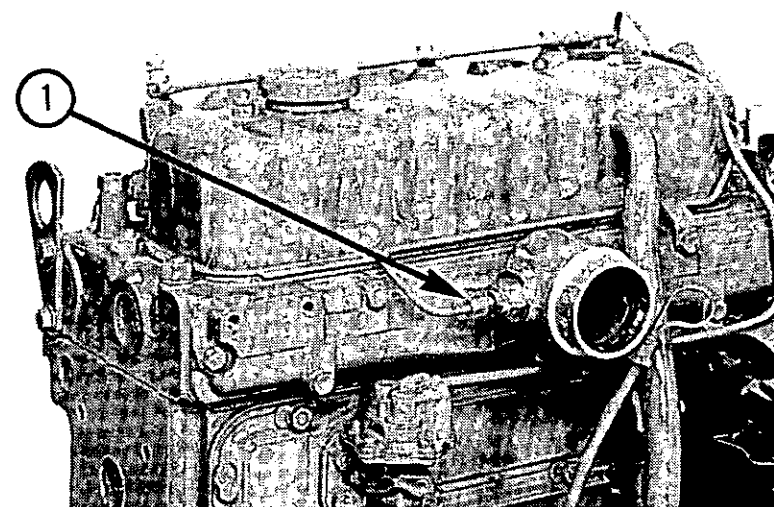


Fig. 19 Union nut at Thermostart connection

Atomiser fault

An atomiser fault can be shown by an engine misfire.

To find which atomiser is at fault, run the engine at a fast idle speed and loosen and tighten the high pressure fuel pipe union at each atomiser. When the union nut of the atomiser at fault is loosened, it will have little or no effect on the engine speed.



Do not let the fuel spray on to your skin.

To renew an atomiser

- 1 Remove the fuel leak off pipe.
- 2 Remove the high pressure pipe union nuts from the atomiser and fuel injection pump and release the pipe. Do not bend the pipe. Where necessary, release the pipe clamp(s).
- 3 Remove the atomiser flange nuts and remove the atomiser and seat washer. Remove the dust seal and, if suitable for use, fit it to the new atomiser.
- 4 Put the new atomiser in position complete with a dust seal and a new seat washer. Ensure the atomiser is not tilted and tighten the flange nuts evenly by small amounts to 16Nm (12lbfft) 1,7kgfm.

5 Fit the high pressure fuel pipe and tighten the nut to 20Nm (15lbfft) 2,1kgfm. Where necessary, tighten the pipe clamp(s).

6 Fit the leak off pipe.

7 Run the engine and check for fuel and air leakage.

Protection of an engine not in service

The recommendations given below are to ensure that damage is prevented when an engine is removed from service for an extended period. Use these procedures immediately the engine is removed from service. The instructions for the use of POWERPART products are given on the outside of each container.

1 Thoroughly clean the outside of the engine.

2 Where a preservative fuel is to be used, drain the fuel system and fill 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 charged with normal fuel but this will have to be drained and discarded at the end of the storage period together with the fuel filter.

3 Run the engine until it is warm. Correct any fuel, lubricating oil or air leakage. Stop the engine and drain the lubricating oil sump.

4 Renew the lubricating oil filter canister.

5 Fill the sump to the full mark on the dipstick with clean new lubricating oil or with a correct preservative fluid. POWERPART Lay-Up 2 can be added to the lubricating oil to give protection against corrosion during the period in storage. If a preservative fluid is used, this must be drained and normal lubricating oil used when the engine is returned to service.

6 Drain the cooling system, see page 17. To give protection against corrosion, it is better to fill the cooling system with a coolant that has a corrosion inhibitor, see 'Engine coolant' on page 16. If frost protection is needed, use an antifreeze mixture. If no frost protection is needed, use water with an approved corrosion inhibitor mixture.

7 Run the engine for a short period to send the lubricating oil and coolant around the engine.

8 Clean out the engine breather pipe and seal the end of the pipe.

9 Remove the atomisers and spray POWERPART Lay-Up 2 into each cylinder bore. If this is not available, clean engine lubricating oil will give a degree of protection. Spray into the cylinder bores 70 ml (1/8 pint) of lubricating oil divided evenly between the four cylinders.

10 Slowly turn the crankshaft one revolution and then install the atomisers complete with new seat washers and suitable dust seal.

11 Remove the air filter/cleaner and any pipe installed between it and the induction manifold. Spray POWERPART Lay-Up 2 into the induction manifold. Seal the manifold with waterproof tape.

12 Remove the exhaust pipe. Spray POWER Lay-Up 2 into the exhaust manifold. Seal the manifold with water-proof tape.

13 Remove the lubricating oil filler cap. Spray POWER-PART Lay-Up 2 around the rocker shaft assembly. Fit the filler cap.

14 Disconnect the battery and put it into safe storage in a fully charged condition. Before the battery is put into storage, give the battery terminals a protection against corrosion. POWERPART Lay-Up 3 can be used on the terminals.

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

16 Remove the drive belt and put it into storage.

17 To prevent corrosion, spray the engine with POWER-PART Lay-Up 3. Do not spray inside the alternator cooling fan area.

Note: Before the engine is started after a period in storage, operate the starter motor with the engine stop control in the 'off' position until oil pressure shows on the oil pressure gauge or the oil warning light goes out. If a solenoid stop control is used, this will have to be disconnected for this operation.

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins Engines Ltd. are not responsible for any damage that occurs in relation to a service storage period.

Fault diagnosis

Problem	Possible causes
Starter motor turns engine too slowly	1, 2, 3, 4
Will not start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33
Difficult to start	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33
Not enough power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33
Misfire	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32
High fuel consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33
Black exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33
Blue/white exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56
Low lubricating oil pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58
Engine knocks	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59
Runs erratically	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49
High lubricating oil pressure	4, 38, 41
Engine temperature too high	11, 13, 14, 16, 18, 19, 24, 25, 45, 47, 50, 51, 52, 53, 54, 57
Crankcase pressure	25, 31, 33, 34, 45, 55, 60
Bad compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59
Starts and stops	10, 11, 12

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 Low engine speed from starter motor.
- 6 Fuel tank empty.
- 7 Stop control fault.
- 8 Restriction in fuel pipe.
- 9 Fault in fuel lift pump.
- 10 Dirty fuel filter element.
- 11 Restriction in air filter or induction system.
- 12 Air in fuel system.
- 13 Fault in fuel injection pump.
- 14 Fault in atomisers or not correct type.
- 15 Cold start equipment not used correctly.
- 16 Fault in cold start equipment.
- 17 Broken fuel injection pump drive.
- 18 Fuel injection pump timing not correct.
- 19 Valve timing not correct.
- 20 Bad compression.
- 21 Restriction in fuel tank vent.
- 22 Type or grade of fuel not correct.
- 23 Restriction of engine speed control movement.
- 24 Restriction in exhaust pipe.
- 25 Cylinder head gasket leaks.
- 26 Engine temperature too high.
- 27 Engine temperature too low.
- 28 Valve tip clearances not correct.
- 29 Valves not free.
- 30 Wrong high pressure pipes.
- 31 Worn cylinder bores.
- 32 Valves and seats do not seal correctly.
- 33 Piston rings not free or are worn or broken.
- 34 Valve stems and/or guides worn.
- 35 Wet type air cleaner too full or wrong type of oil used.
- 36 Crankshaft bearing wear or damage.
- 37 Not enough lubricating oil in the sump.
- 38 Gauge not correct.
- 39 Lubricating oil pump worn.
- 40 Relief valve not free to close.
- 41 Relief valve not free to open.
- 42 Relief valve spring broken.
- 43 Fault in suction pipe of lubricating oil pump.
- 44 Dirty lubricating oil filter element.
- 45 Piston damage.
- 46 Piston height not correct.
- 47 Fan damage.
- 48 Fault in engine mounting (housing).
- 49 Flywheel housing or flywheel not aligned correctly.
- 50 Fault in thermostat or wrong type.
- 51 Restriction in coolant passages.
- 52 Water pump drive belt loose.
- 53 Restriction in radiator.
- 54 Fault in water pump.
- 55 Restriction in breather pipe.
- 56 Damage to valve stem oil seals (where used).
- 57 Not enough coolant in system.
- 58 Restriction in sump strainer.
- 59 Valve spring broken.
- 60 Fault in exhauster or vacuum pipe leakage.

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 page 16.

POWERPART De-Icer

Removes frost.

POWERPART Easy Flush

Cleans the cooling system.

POWERPART Easy Seal

Stops leakages from the cooling system.

POWERPART Foam Action Gasket Remover

Allows easy and rapid removal of old gaskets and joints.

POWERPART Hylomar

Universal jointing compound which seals joints.

POWERPART Hylosil

Silicone rubber sealant which prevents leakage through gaps.

POWERPART Inhibitor

Protects cooling system against corrosion when anti-freeze is not used.

POWERPART Lay-Up 1

A diesel fuel additive for protection against corrosion. See page 30.

POWERPART Lay-Up 2

Protects the inside of the engine and of other closed systems. See page 30.

POWERPART Lay-Up 3

Protects outside metal parts. See page 31.

POWERPART Moisture Dispersant and Rust Penetrant

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

POWERPART Retaining Compound

Retains components which have a transition fit or an interference fit, for example, pulleys, bushes etc.

POWERPART Studlock

Secures threaded fasteners. Recommended for fasteners which, normally, are not removed.

POWERPART Threadseal

Seals threads and pipe connections. Low pressure systems can be used immediately.

Examples of service assistance

Service

If any problems occur with your engine or the components fitted to 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 some repairs.

Extended warranty

The engine warranty period can be extended to two years. For details get in contact with your nearest Perkins distributor.

Service literature

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

Training

Local training on correct engine operation, overhaul and service is available at some Perkins distributors. If special training is needed, your Perkins distributor can give details of how to get this at the Product Education Department, Peterborough, or other main centres.

Parts illustrations

The illustrations which follow are a guide for your assistance in the purchase of Perkins service parts. A list of the reference numbers and part descriptions is given on pages 47 and 48.

There can be differences in the shape of similar components in different engine applications.

Many years of experience and development have ensured that Perkins parts are of the highest quality and standard. Use correct Perkins parts which are available from all Perkins distributors.

To ensure you get the correct parts when you order, give the complete engine number, the machine or vehicle description, name and serial number.

Note: Perkins Engines Ltd. can not supply an operator direct. To purchase the correct Perkins parts, give an order to your Perkins distributor.

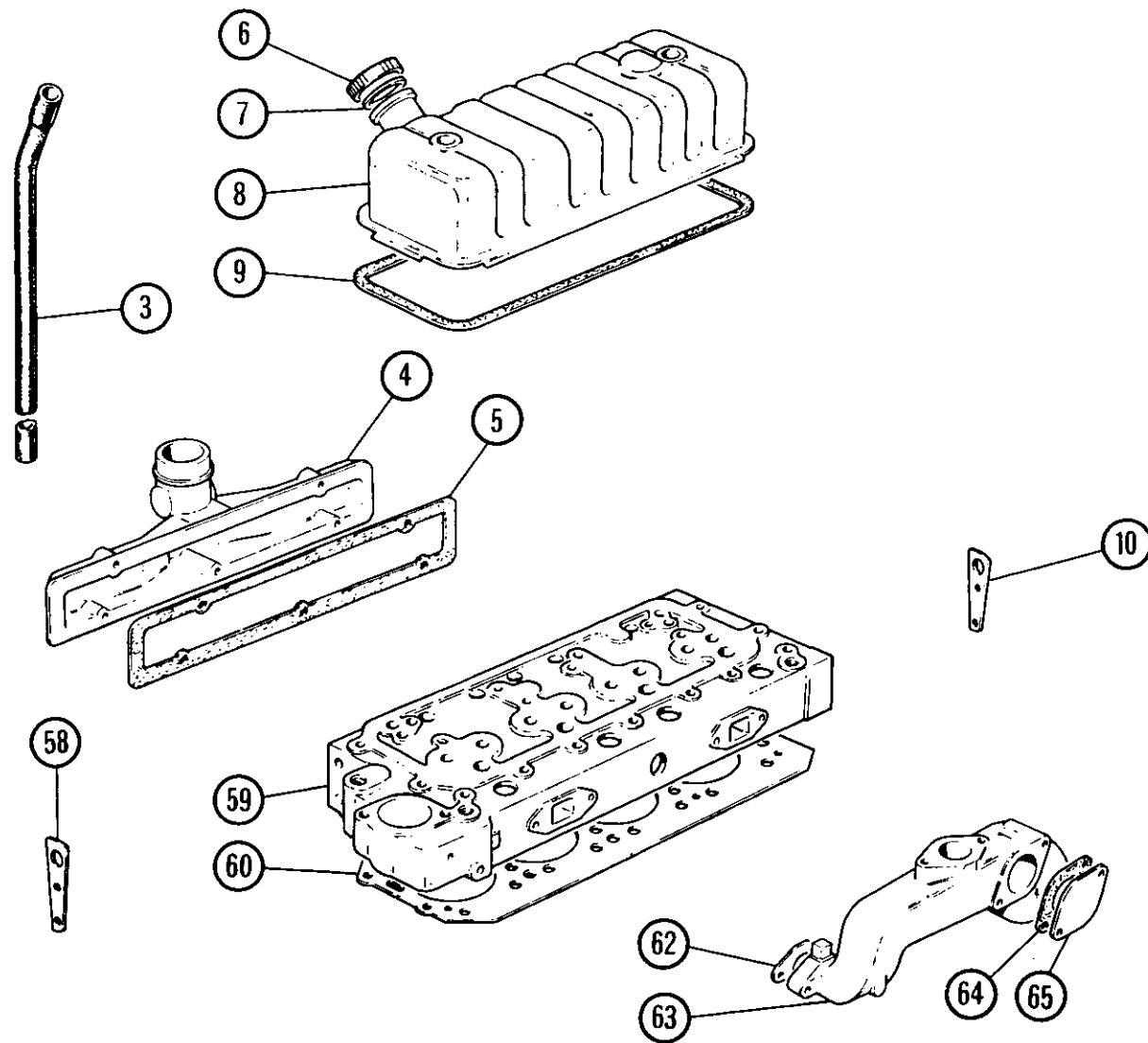


Fig. 20 Cylinder head arrangement

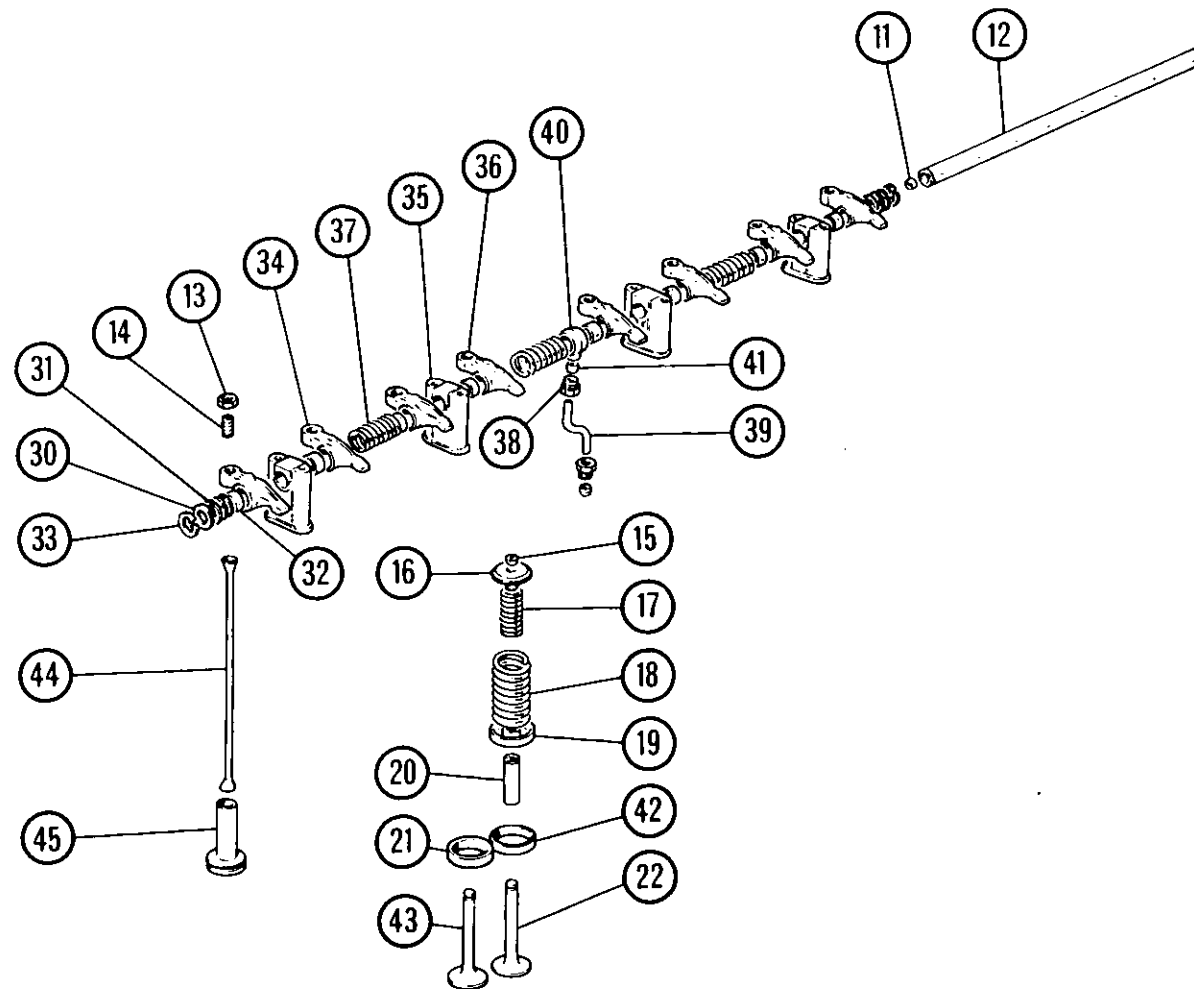


Fig. 21 Valves and rocker assembly

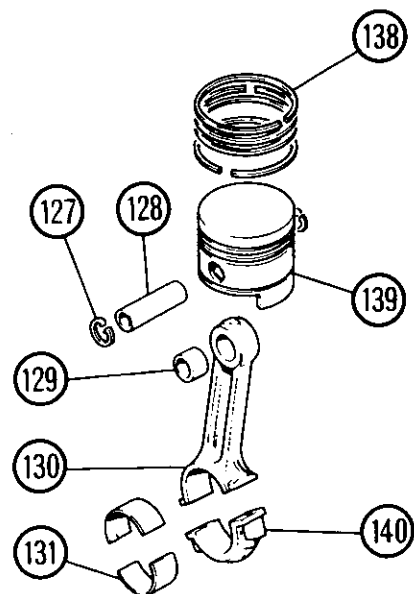


Fig. 22 Piston and connecting rod

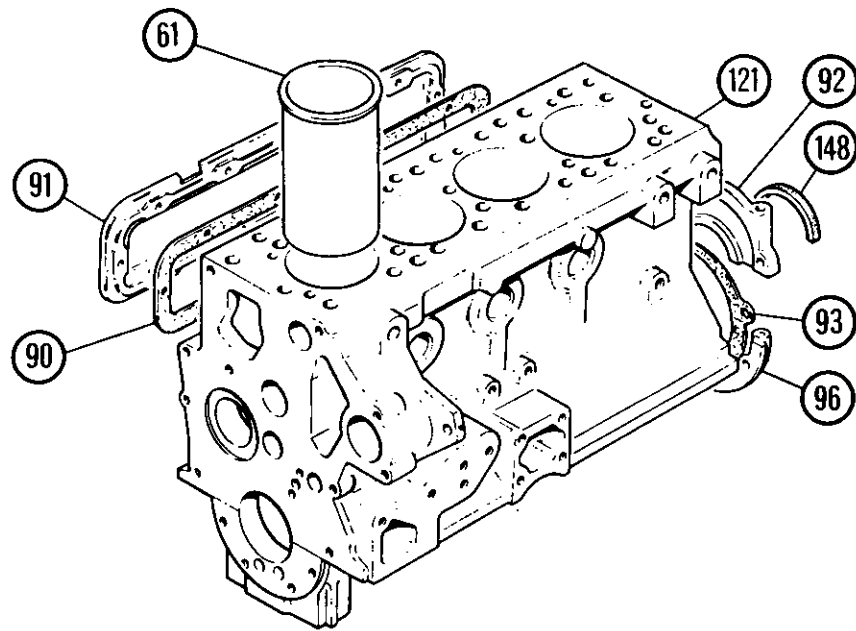


Fig. 23 Cylinder block assembly

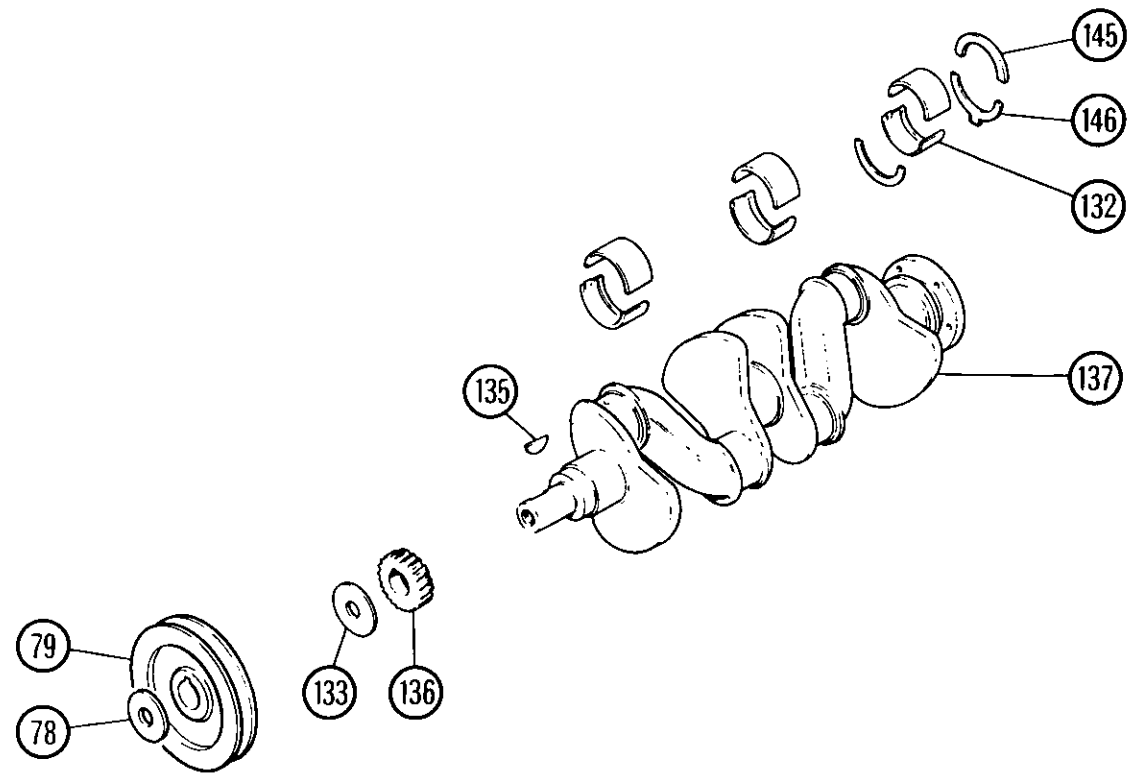


Fig. 24 Crankshaft assembly and pulley

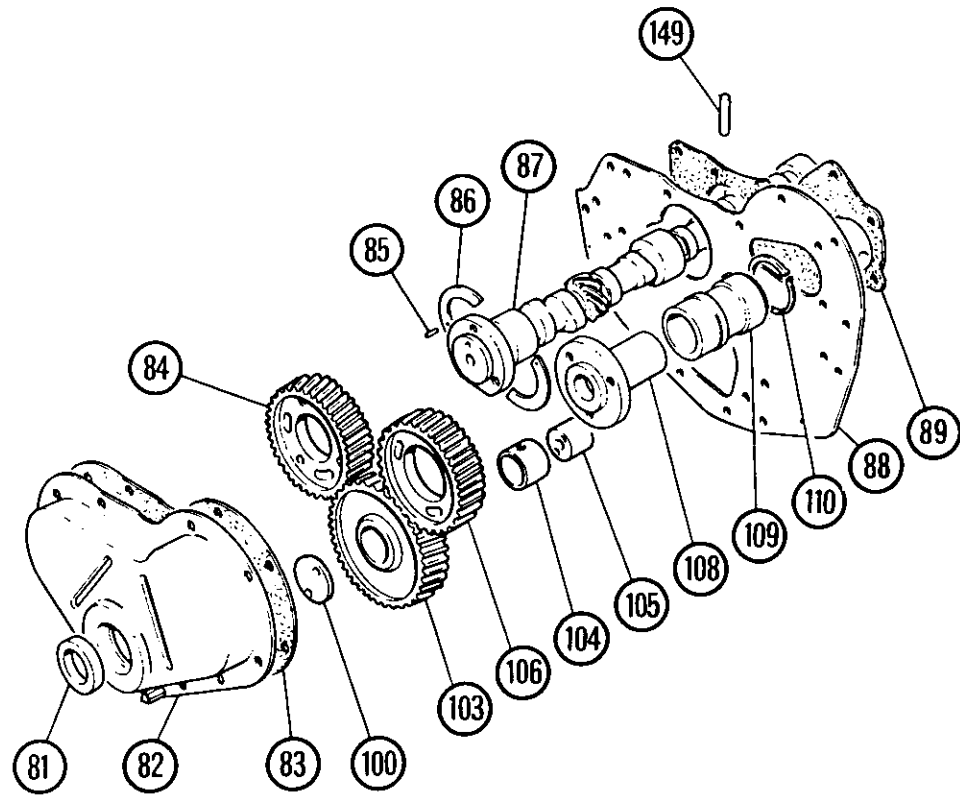


Fig. 25 Timing case and drive arrangement

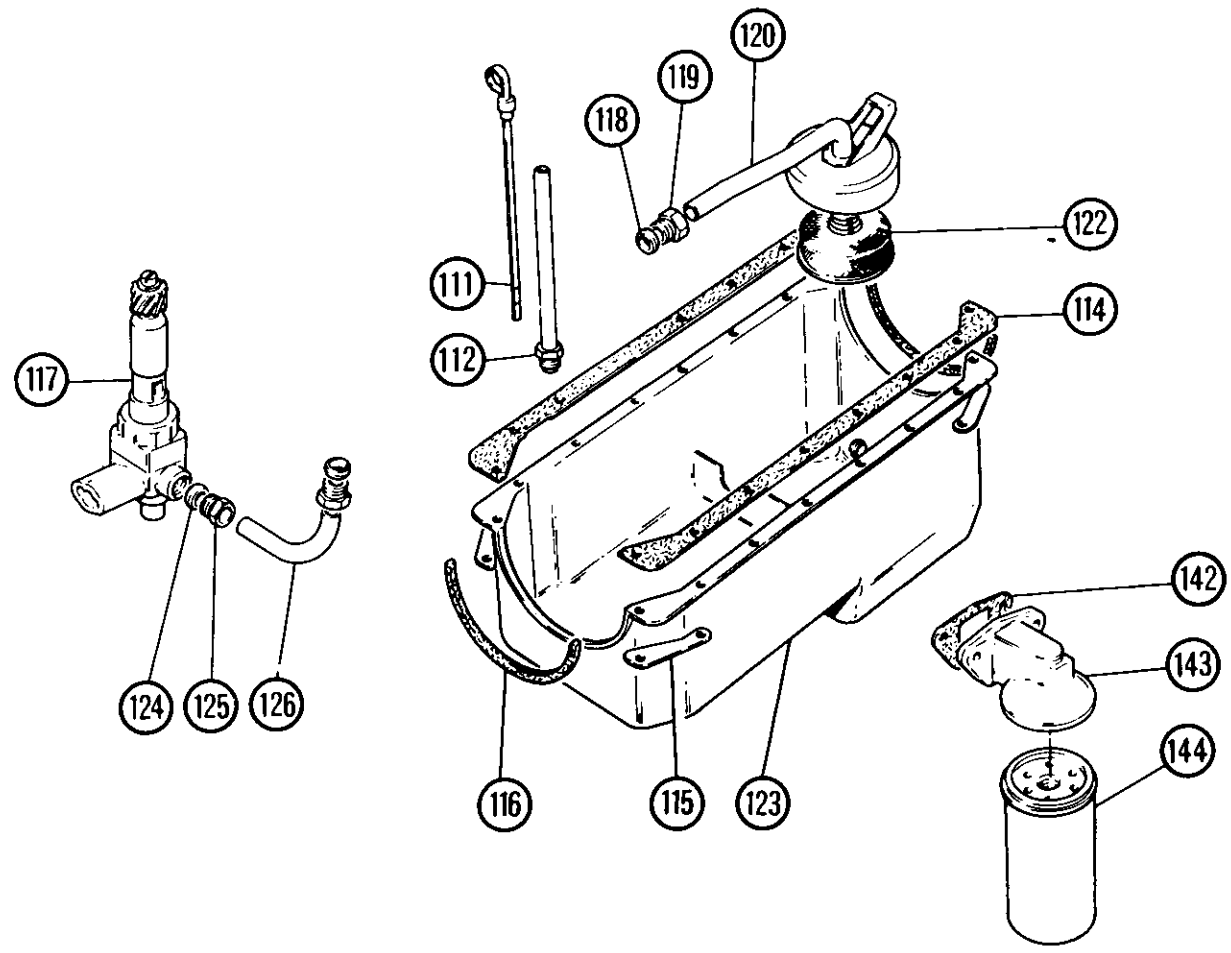


Fig. 26 Lubrication system components

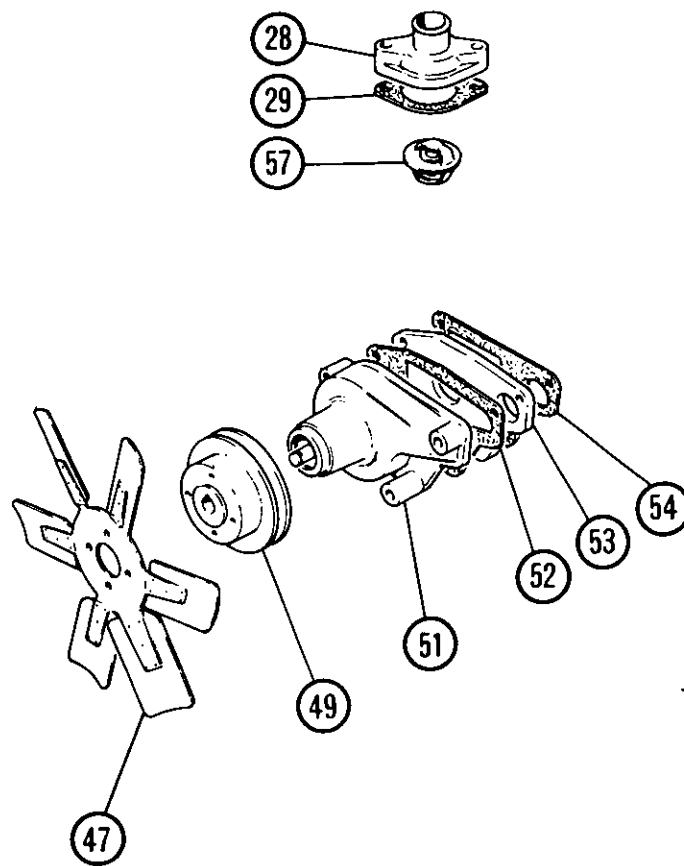


Fig. 27 Cooling system components

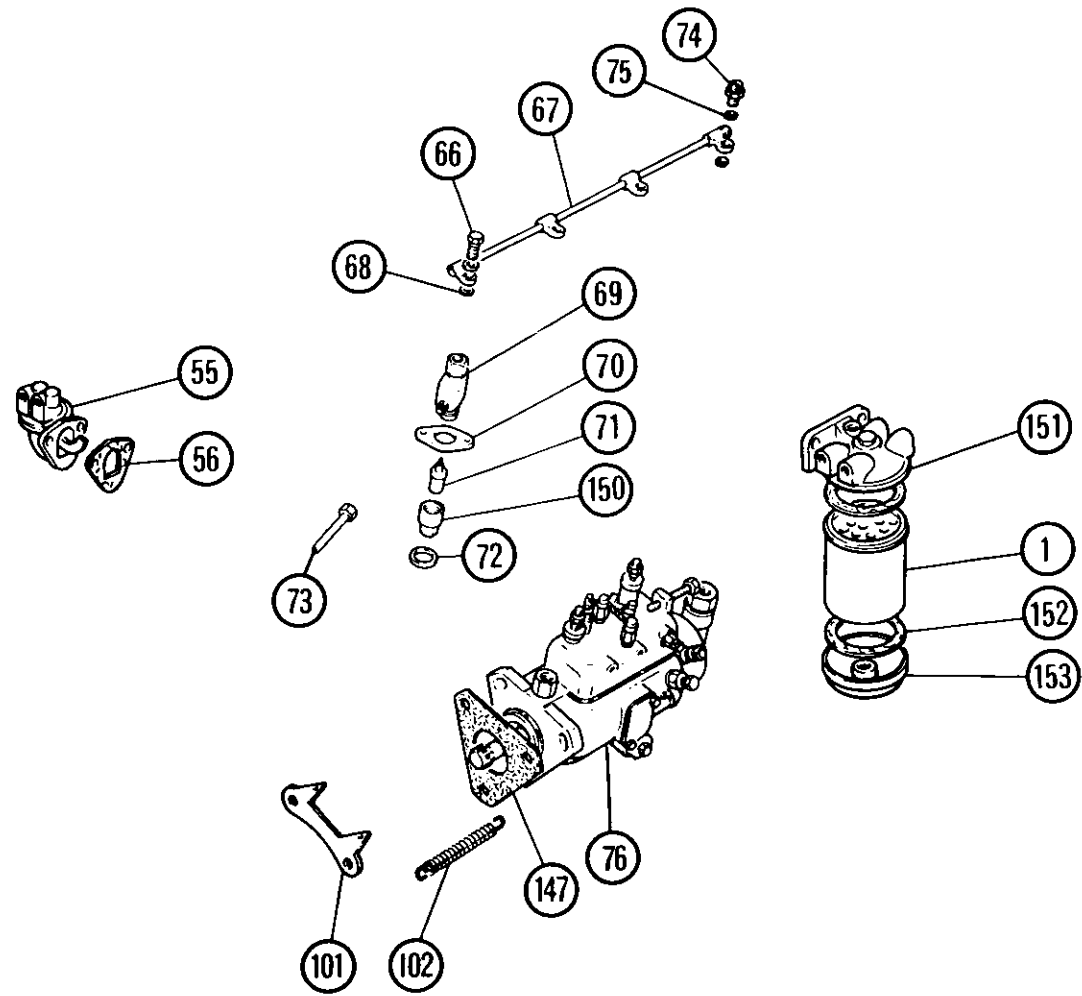


Fig. 28 Fuel system components

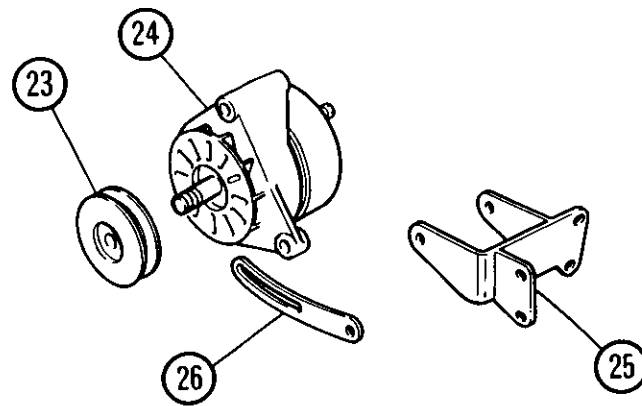


Fig. 29 Alternator and bracket

Part descriptions

To be used with the illustrations given on pages 37 to 46.

1 Fuel oil filter	31 Spring washer	62 Joint	101 Spring anchor bracket
3 Breather pipe	32 Bush	63 Exhaust manifold	102 Spring
4 Induction manifold	33 Circlip	64 Joint	103 Idler gear
5 Joint	34 Rocker lever	65 Blanking plate	104 Bush
6 Filler cap	35 Bracket	66 Banjo correction	105 Hub
7 Joint	36 Rocker lever	67 Leak off pipe	106 Fuel pump gear
8 Rocker cover	37 Spring	68 Washer	108 Hub
9 Joint	38 Union	69 Atomiser body	109 Bush
10 Engine lifting bracket	39 Lubricating oil feed pipe	70 Atomiser securing flange	110 Circlip
11 Plug	40 Banjo connection	71 Nozzle assembly	111 Dipstick
12 Rocker shaft	41 Olive	72 Sealing washer	112 Dipstick tube
13 Lock nut	42 Valve seat insert	73 Fuel injection pipe	114 Sump side joint
14 Adjusting screw	43 Inlet valve	74 Union	115 Sump stiffener plate
15 Cotters	44 Push rod	75 Sealing washer	116 Joint
16 Valve cap	45 Tappet	76 Fuel injection pump	117 Lubricating oil pump
17 Inner valve spring	47 Fan	78 Washer	118 Olive
18 Outer valve spring	49 Water pump pulley	79 Pulley	119 Union
19 Valve spring seat	51 Water pump	81 Seal	120 Suction pipe assembly
20 Valve guide	52 Joint	82 Timing case	121 Cylinder block
21 Valve seat insert	53 Plate	83 Joint	122 Lubricating oil strainer
22 Exhaust valve	54 Joint	84 Camshaft gear	123 Lubricating oil sump
23 Alternator pulley	55 Fuel lift pump	85 Dowel	124 Olive
24 Alternator	56 Joint	86 Thrust plate	125 Union
25 Bracket	57 Thermostat	87 Camshaft	126 Lubricating oil feed pipe
26 Adjustment link	58 Engine lifting bracket	88 Timing case back plate	127 Circlip
28 Thermostat housing	59 Cylinder head	89 Joint	128 Gudgeon pin
29 Joint	60 Gasket	90 Joint	129 Bush
30 Washer	61 Cylinder liner	91 Cover	130 Connecting rod
		92 Rear oil seal upper half	131 Big end bearing
		93 Joint	132 Main bearing
		96 Rear oil seal lower half	133 Washer
		100 Plate	135 Key

136 Crankshaft gear
137 Crankshaft
138 Piston rings
139 Piston
140 Connecting rod cap

142 Joint
143 Lubricating oil filter head
144 Lubricating oil filter
canister
145 Thrust washer

146 Thrust washer
147 Joint
148 Seal
149 Fuel lift pump push rod

150 Nozzle cap nut
151 Fuel filter head
152 Joint
153 Bowl

Latest information

Introduction

The purpose of this page is to enable important information to be added to this handbook after publication.

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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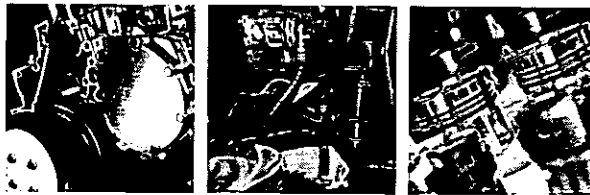
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