Perkins

2000 SERIES

6 cylinder diesel engines for trucks

# USER'S HANDBOOK

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Perkins Engines (Shrewsbury) Limited
Shrewsbury, Shropshire, SY1 4DP, England.

# Contents

# General information 1

# General Information

## Introduction

The new range of Industrial engines are the latest development from Perkins Engines (Shrewsbury) Limited, a world leader in the design and manufacture of high performance diesel engines.

More than fifty years of diesel production experience, together with the use of the latest technology, have been used in the manufacture of your engine to give you reliable and economic power.

To ensure that you use the correct information for your specific engine type, refer to 'Engine identification' on page 1.05.

## 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 shown in 'Preventive maintenance'. If the engine operates in very dusty or other adverse conditions, certain maintenance intervals will have to be reduced. Change the filter elements and lubricating oil regularly in order to ensure that the inside of your engine is kept clean.

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 obtain parts and service from your Perkins distributor. If you do not know the address of your nearest distributor, enquire at one of the Perkins companies given on page 1.06.

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

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

## Safety precautions

These safety precautions are important.

You must refer to the local regulations in the country of operation.

- Do not use these engines in marine applications.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away any 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).
- Never clean, add lubricating oil to, or adjust the engine while it runs (unless you have had the correct training, when extreme caution must be used to prevent injury).
- Do not make any adjustments that you do not understand.
- Ensure that the engine is not in a position to cause a concentration of toxic emissions.
- Other people must be kept at a safe distance while the engine, equipment or vehicle is operated.
- Do not permit loose clothing or long hair near parts which move.
- Keep away from parts which move during engine operation.
  **Attention:** The fan cannot be seen clearly while the engine runs.
- Do not operate the engine if one or more of the safety guards have been removed.
- Do not remove the radiator cap 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 cooling system.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) as 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 you make a repair 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.
- Diesel fuel can damage the skin of some people. Protect your hands with gloves or a special skin protection solution.
- If your skin comes into contact with high-pressure fuel obtain medical assistance immediately.
- 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.
- 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 and instructions for its use.

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

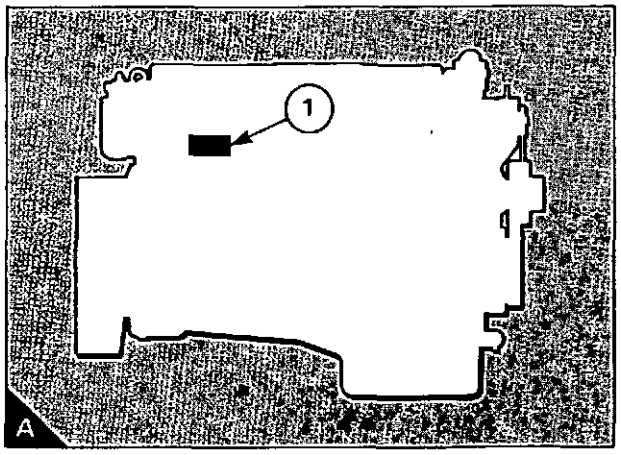
*The Series 2000 engine is a six cylinder in line unit* available in either turbocharged or turbocharged/ charge cooled form. It is supplied in various power ratings between 165 kW (221 bhp) and 368 kW (494 bhp) gross.

The engine number is stamped on the data plate which is fastened to the right hand side of the crankcase (A1).

A typical engine number is 8D26113U 74656P which comprises the following codes:

| | | |
|---|---|---|
| 8D | = | Engine family |
| 26113 | = | Engine number |
| U | = | Country of origin |
| 74656 | = | Build line number |
| N | = | Year of manufacture |

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



## Perkins companies

**Australia**
Perkins Engines Australia Pty. Limited,
Suite 2,
364 Main Street,
Mornington 3931, Australia
Telephone: 059 751877 Telex: AA30816

**France**
Moteurs Perkins S.A.
9 - 11 Avenue Michelet,
93407 Saint Ouen, Cedex, France
Telephone: (1) 42-23-20-00
Telex: 642924F
Cablegrams: 'Perkoil' Paris

**Germany**
Perkins Motoren G.m.b.H.
8752 Kleinostheim, Postfach 1180,
West Germany
Telephone: 06027 5010 Telex: 04188869

**Italy**
Motori Perkins S.p.A.
Via Gorizia, PO Box 12,
22070 Portichetto/Luisago (Como), Italy
Telephone: (031) 927364 Telex: 380658 Perkit I
Cables: 'Perkoil' Portichetto

**Japan**
Perkins Engines K.K.
6th Floor, Reinanzaka Building, 14 - 2 Akasake,
Minato-Ku, Tokyo 107, Japan
Telephone: 03 586 7377
Telex: Perkoil J2424823
Cablegrams: 'Perkoil' Tokyo
Fax: 03 582 1596

**Singapore**
Perkins Engines Asia Pacific,
130 Hillview Avenue,
Singapore 2366
Telephone: 7605722
Telex: RS37729
Fax: 7602025

**United Kingdom**
Perkins Engines Limited,
Frank Perkins Way, Eastfield,
Peterborough, PE1 5NA, England
Telephone: (0733) 67474 Telex: 32501
Cables: 'Perkoil' Peterborough

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

**U.S.A.**
Perkins Engines Inc.
PO Box 697,
32500 Van Born Road, Wayne,
Michigan 48184, U.S.A.
Telephone: 313595 9600
Telex: 234002 Perken Wane
Cables: Perken Wane

Perkins Engines Latin America Inc.
PO Box 697,
32500 Van Born Road, Wayne,
Michigan 48184, U.S.A.
Telephone: 313 595 9600
Telex: 234002 Perken Wane
Cables: Perken Wane

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

# Engine views 2

# Engine Views

## Introduction

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

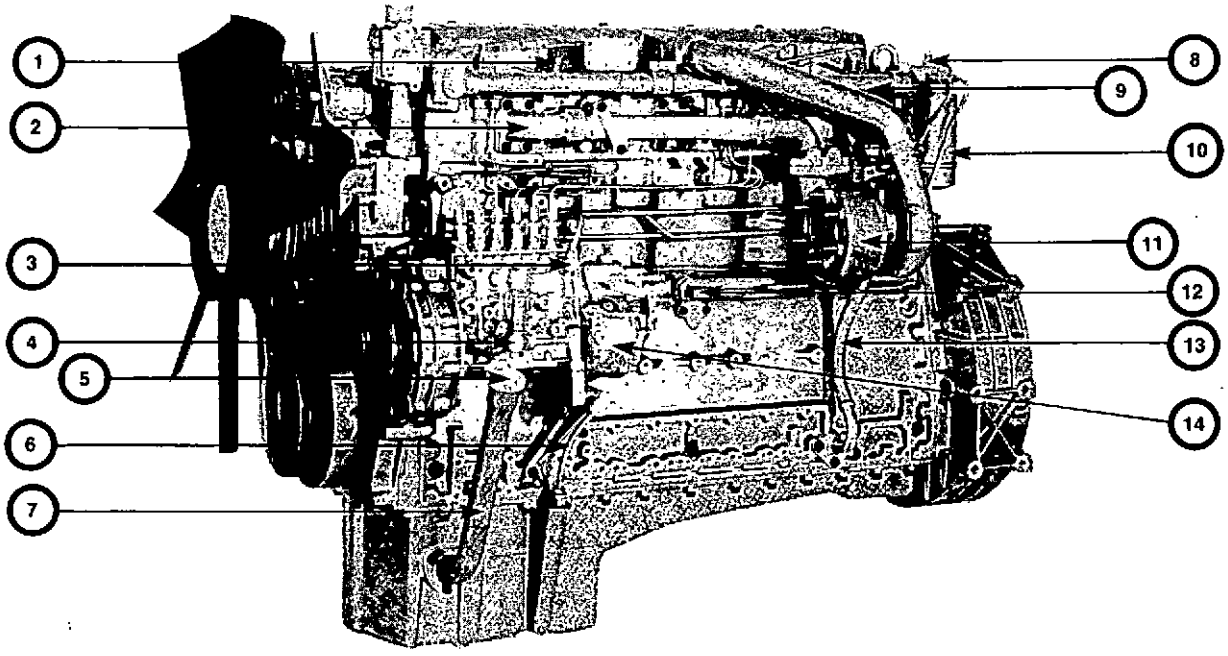
## Location of engine parts

### Front and left hand side view of engine

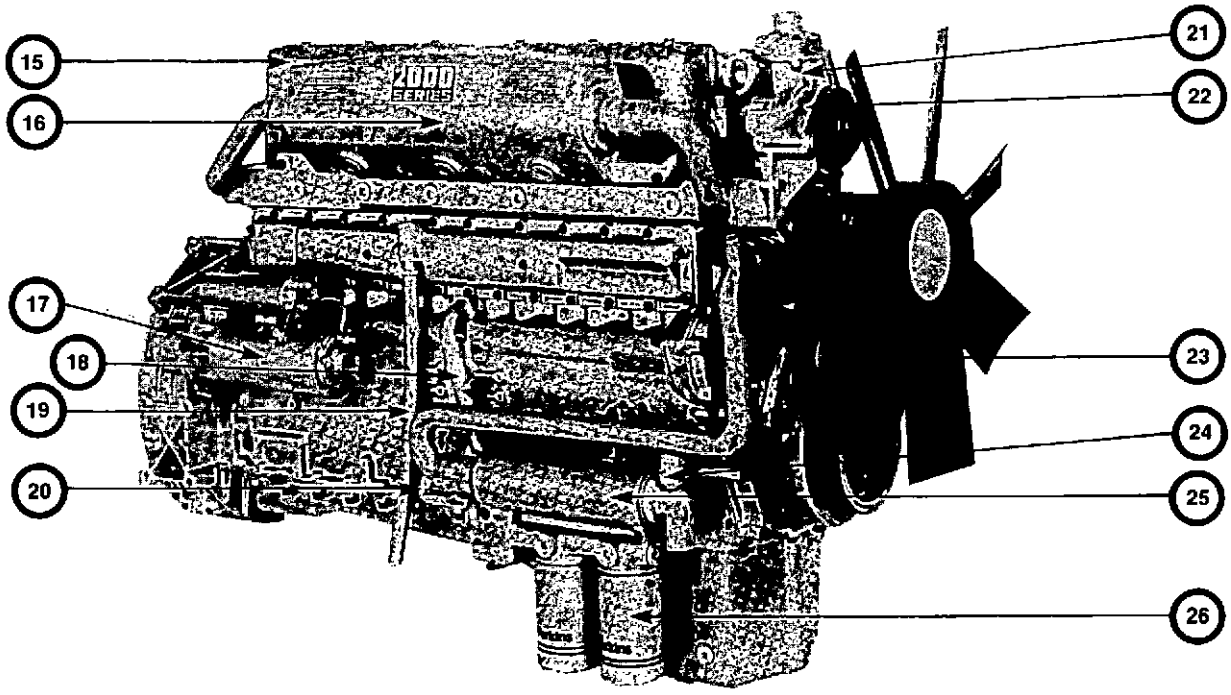
1 Fuel injector
2 Exhaust manifold
3 Fuel relief valve
4 Fuel feed pump
5 Oil filler cap
6 Dipstick and tube
7 Oil filler tube
8 Spill return connection
9 Coolant rail
10 Fuel filter canister
11 Turbocharger
12 Turbocharger oil feed pipe
13 Turbocharger oil drain pipe
14 Governor

### Front and right hand side view of engine

15 Rocker cover
16 Charge cooler/inlet manifold
17 Starter motor
18 Lubricating oil feed to main gallery
19 Breather pipe
20 Coolant drain plug
21 Thermostat
22 Alternator
23 Belt tensioner
24 Coolant by-pass
25 Oil cooler
26 Oil filter canister (2)




**Front and left side view**




**Front and right side view**

# Operating instructions 3

## Routine procedure with a new or overhauled engine

Note that every new or reconditioned engine supplied by Perkins Engines (Shrewsbury) Limited is run in before leaving the factory.

1 Check that all wrappings and sealing blanks have been removed.

2 Refit any components removed for storage or transportation.

3 Ensure that all coolant and lubricating oil drain plugs are securely fitted.

4 Dependent on installation, connect remote control linkages, pressure gauge pipework, air intake duct and electrical wiring.

5 Connect fuel supply and exhaust pipework.

6 Fill the fuel supply tank(s) with the correct grade of fuel (see page 5.03).

7 Fill the cooling system with the approved coolant mixture (see page 5.03).

8 Fill the sump to the UPPER mark on the dipstick with the correct grade of lubricating oil (see page 5.03).

9 Prime the fuel injection pump and governor (described on this page).

10 Prime the turbocharger (described on this page).

11 Bleed the fuel system of air as described on page 4.07.

12 Lubricate all control linkages and check for freedom of movement.

13 With the stop control in the STOP position, motor the engine on the starter until oil pressure is registered on the gauge.

## Routine starting

### Daily checks before initial start

1 Check that the level of coolant is about 3 inches below the filler neck, or as otherwise specified in the Vehicle Manual. Top up, if necessary, with the correct coolant mixture. Investigate any marked loss of coolant.

2 Check oil level in engine sump. With the engine stopped the oil should be at the UPPER mark on the dipstick. If necessary, replenish with oil of the same grade and specification as that already in the system. Do NOT overfill.

3 Check fuel level in tank. Turn on fuel cock, if fitted.

### Normal start

Perform daily servicing checks then proceed as follows:

Turn the fuel cock on.

Move the stop control to the RUN position.

Move the speed control lever to the maximum speed position.

Press the starter button and release when engine fires.

Release the speed control lever to IDLING.

### Starting a new, overhauled or layed-up engine

If an engine has been stored or layed-up for a period exceeding one month the fuel injection pump, governor and turbocharger must be primed with clean engine oil of the same grade and specification as that already in the system.

To prime the fuel injection pump and governor, unscrew the plug on the right-hand side of the injection pump and fill with engine oil up to the level of the plug. Refit the plug and tighten securely.

### Starting procedure

Perform daily servicing checks, then proceed as follows:

Prime the fuel injection pump, governor and turbocharger bearings.

Turn the fuel cock on.

Secure the stop control in the STOP position.

Do NOT move the speed control lever.

Press the starter button for 10 seconds and wait for 10 seconds, then press for 20 seconds and wait for 20 seconds.

With stop control in RUN position, proceed as for normal start.

## Starting in low temperatures

In addition to the employment of cold starting aids, as described below, efficient starting in low temperatures will depend on the use of a correct lubricating oil of suitable viscosity in conjunction with an adequate starter battery.

An engine started from cold in a temperature of 10°C (50°F) will accelerate instantly to maximum speed. At −30°C (−22°F) it may take up to 20 minutes for engine speed to increase from 'self-sustaining' (450 rev/min) to maximum.

## Excess fuel device

An automatic excess fuel device fitted only to variable speed engines operates when the speed control lever is moved to the maximum speed position.

All generator set engines will be fitted with manual excess levers.

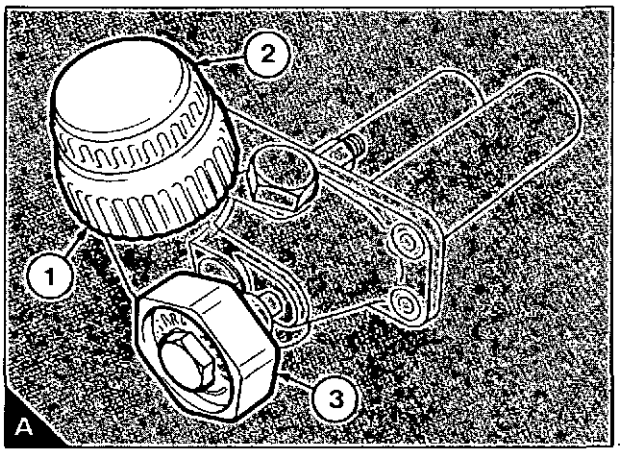
## 'Start Pilot' Systems

**1 ER System.** Remove the capsule chamber cap (A1) and pull the piercer (A2) fully out. Insert a fluid capsule into the chamber, refit the cap and push the piercer fully in. Pause to allow the capsule to empty and repeat with up to three further capsules, dependent on the severity of cold. Then operate the pump (A3) for three double strokes whilst operating the starter switch to turn the engine.

**Viso-F System.** Use the canister to fill the reservoir to the MAX mark. Then operate the pump for three double strokes.

**2** Open the speed control lever and operate the starter switch, continuing to pump steadily. Do not exceed 20 seconds continuous cranking, and pause between each attempt.

**3** When the engine fires and runs, release the starter and continue pumping steadily until the engine accelerates. Then return the speed control lever to IDLING.



## 'Fleetguard' System

The system consists of an expendable screw-on canister containing 710cm³ of ether under pressure which is supplied to the engine by a remotely-operated control valve. Each operation of the valve injects 6cm³ of atomised ether into the inlet manifold.

Open the speed control lever and operate the starter. With the engine turning, pull the system control knob for two seconds; on releasing it, ether will be discharged into the inlet manifold for three seconds.

Dependent on the severity of cold, repeat the ether priming until the engine fires and runs; then release the starter and continue to prime until the engine accelerates. Return the speed control lever to IDLING.

Do not exceed 20 seconds continuous cranking, and pause for 20 seconds, without priming, between each attempt.

## Running the engine

The following precautions will help to ensure a long and trouble-free life for the engine:

1 Do not subject the engine to high speeds and loads until working temperature is reached.

2 Avoid long periods of idling or 'OFF LOAD' running.

3 Do not allow engine speed to exceed the rated maximum. Over-speeding will shorten engine life and can result in component failure.

4 Fill the fuel tank at the end of each day to prevent condensation and to permit any sediment to settle.

## Stopping the engine

Allow the engine to run "off load" for three (3) minutes to allow the turbocharger to reduce speed and temperature.

Switch off engine protection devices if applicable.

Move the stop control to the STOP position and release when the engine stops turning.

# Preventive maintenance 4

# Preventive maintenance

## Preventative maintenance periods

These preventative maintenance periods are general in application. Check the periods given by the manufacturer of the equipment in which the engine is installed.

The servicing intervals may be reduced at the discretion of operators to suit local conditions but must NOT be extended without the written consent of Perkins Engines (Shrewsbury) Limited as required by the Perkins Guarantee.

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

*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 recommended intervals as stated below.

**A** - Every 10 hours or daily
**B** - At pre-delivery inspection
**C** - Every 400 hours
**D** - Every 2000 hours
**E** - Every 10000 hours

## ENGINE IN INTERMITTENT USE

For engines in this category (e.g. those powering emergency generating sets) which are in use for an aggregate of less than 500 hours in twelve months, the Servicing Schedule should be supplemented by the following calendar-based Schedule to avoid deterioration due to prolonged intervals between servicing

### Weekly

Check lubricating oil level, and replenish as necessary to upper mark on dipstick. Check coolant level, and replenish as necessary to 25mm (1 inch) from upper face of top tank.

### Monthly

Check pH value and, where applicable, specific gravity of coolant. If engine has not been run during the month, prime the turbocharger bearings with 0.2 litre (⅓ pint) of engine oil at filler point on bearing housing.

### 6-monthly

Change engine lubricating oil, and renew oil filter elements.

### 12-monthly

Remove fuel injectors, inspect for corrosion, and check on test rig. Service or renew as necessary, refit and vent high-pressure fuel system. Drain and flush coolant system. Refill with appropriate coolant.

## Schedules

| A | B | C | D | E | Operation |
|---|---|---|---|---|---|
| ● | | | | | Check the lubricating oil level in the sump |
| ● | | | | | Check the coolant level |
| | | ● | | | Renew the lubricating oil |
| | ● | ● | | | Check the drive belts |
| | | ● | | | Renew the lubricating oil filter canisters |
| | | ● | | | Renew the fuel filter canister |
| | | | ● | | Ensure that the fuel injectors are checked (2) |
| | | | ● | | Ensure that the tappet clearances are checked and adjusted, if it is necessary (2) |
| | | | | ● | Ensure that the alternator, turbocharger, starter motor etc, are checked (2) |
| | | | ● | | Drain, flush, and refill cooling system with the approved coolant mixture |
| | | | | ● | Engine overhaul - intermediate 8000 to 10000 hours<br>major 16000 to 20000 hours |
| ● | ● | ●<br>● | ●<br>● | ●<br>● | Clean the air cleaner or empty the dust bowl of the air filter<br>- dusty conditions<br>- normal power house conditions |
| ● | ● | ● | ● | ● | Check the lubricating oil pressure at the gauge (1) |
| | | ● | ● | ● | Clean or renew the air filter element |

(1) If one is fitted

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

## Oil filter canister renewal

Twin expendable oil filter canisters are fitted to the filter header bracket which is an integral part of the heat exchanger casing, mounted to the front right-hand side of the engine.

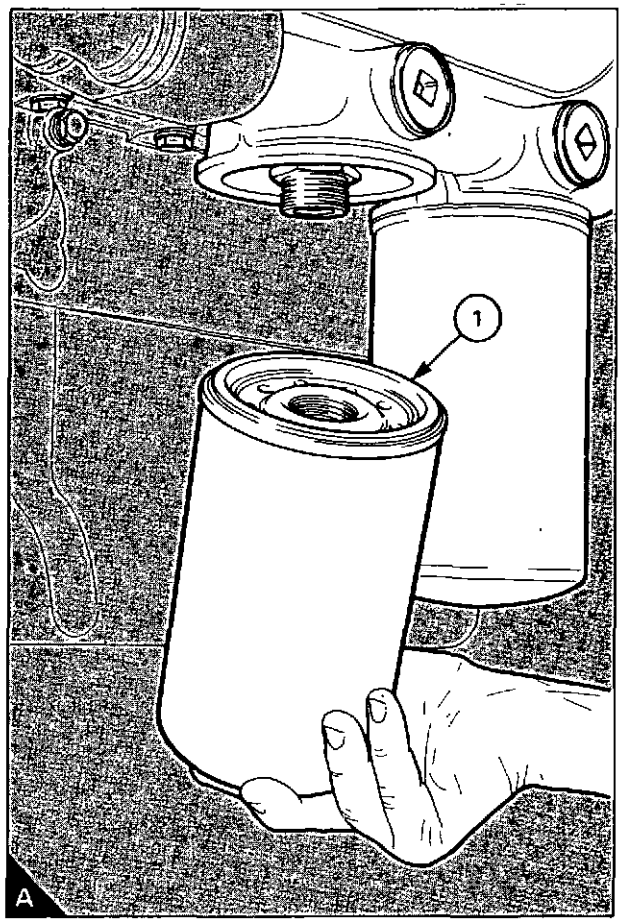
1 Place a tray under the filters and unscrew each canister in turn using strap wrench GA 5074.

2 Check that the seal rings are correctly fitted (A1) on the new canisters and clean the filter header bracket contact faces.

3 Fill two new canisters with a clean approved grade of lubricating oil and apply a light smear to the seal ring.

4 Screw each canister into position until the sealing rings contact the face of the header and then a further ¾ of a turn by hand. Do NOT overtighten.

A non-adjustable valve fitted in the base of each canister allows unfiltered oil to circulate through the engine if a canister becomes choked and the pressure drop across it exceeds 1.05 kgf/cm² (15 lbf/sq inch).



## Engine lubricating oil change

Ensure the engine is on level ground.

**1** Whilst the engine is warm remove the drain plug (A1) and drain into a suitable container.

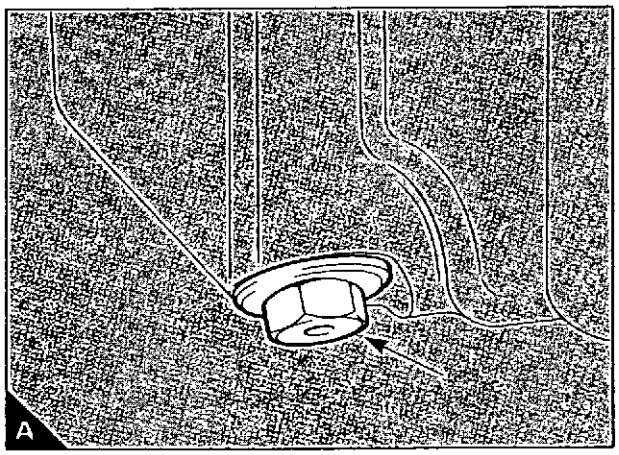
**2** Refit drain plug with new washer and tighten to a torque loading of 115 Nm (85 lbf ft). Wire lock the plug.

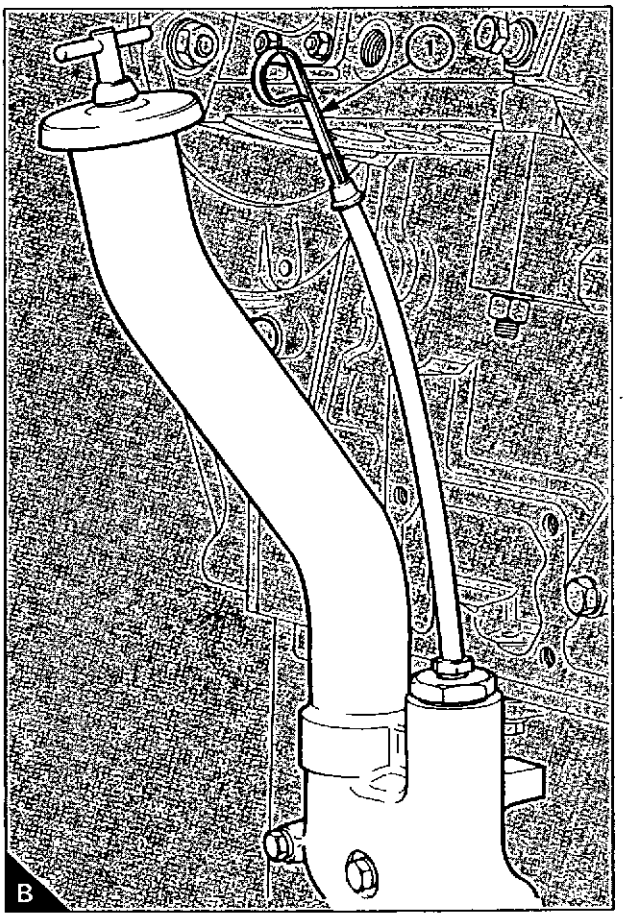
**3** Renew both oil filter canisters.

**4** Clean the area surrounding the oil filler cap before removing the cap.

**5** Use a clean container and funnel and fill the engine to the upper mark on the dipstick (B1) with a recommended grade of oil. Do NOT overfill.

**6** Check level after initial run and replenish as necessary. Check for oil leaks.



## Checking valve tappet clearances

Check and adjust tappets in the following sequence whilst the injectors are removed for servicing.

| Valves rocking on cylinder No. | Check tappets on cylinder No. |
|---|---|
| 6 | 1 |
| 3 | 4 |
| 5 | 2 |
| 1 | 6 |
| 4 | 3 |
| 2 | 5 |

Valves rocking means 'inlet valve just opening' and 'exhaust valve just closing'.

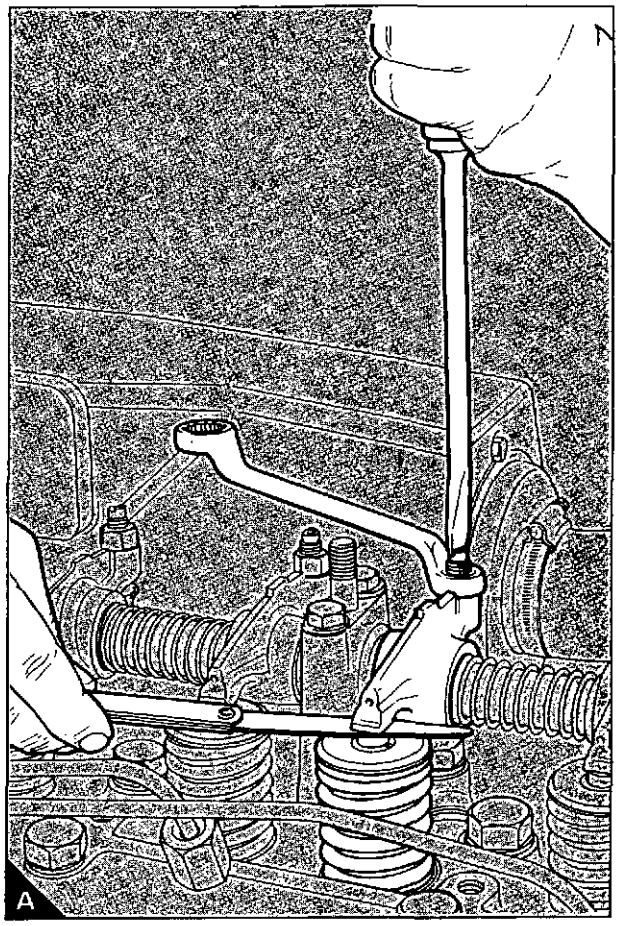
**1** Remove the engine rocker covers.

**2** Turn the engine in the normal direction of rotation until the valves on No. 6 cylinder are 'rocking'. Check and adjust the tappet clearances on No. 1 cylinder to the correct clearances.

**3** Continue to rotate the engine and adjust the remaining tappets in the sequence given above.

**4** Refit rocker covers.

Tappet clearances:
Exhaust - 0.508 mm (0.020 inches)
Inlet - 0.254 mm (0.010 inches)



## How to eliminate air from the fuel system

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

Air can enter the system if:

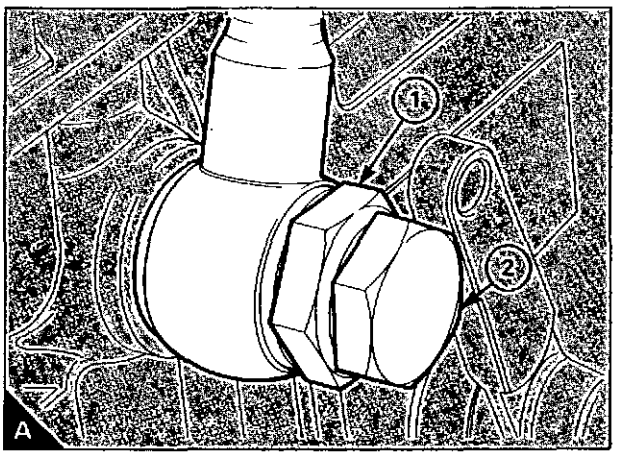
- The fuel tank is drained during normal operation.
- The low pressure fuel pipes are disconnected.
- A part of the fuel system leaks during engine operation.
- The fuel filter canister has been removed.

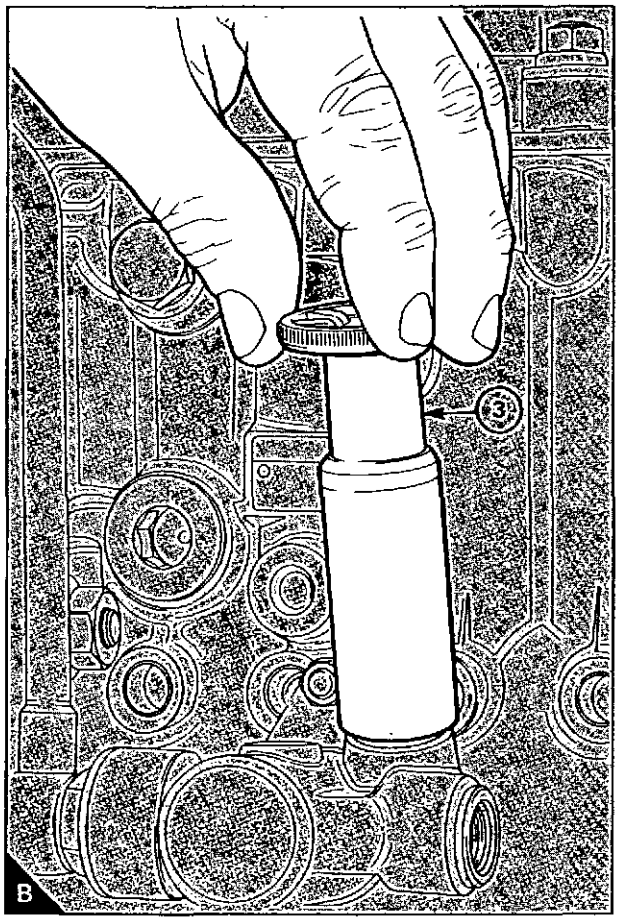
In order to remove air from the fuel system, proceed as follows:

**1** Using a 19M spanner, slacken the banjo bolt (A1) which secures the fuel spill pipe to the pump housing approximately ½ to 1 complete turn. Do NOT unscrew the bolt (A2) retaining the relief valve spring and plunger in position.

**2** Operate the hand priming pump (B3) until 'bubble-free' fuel flows from the slackened banjo bolt.

**3** Whilst continuing to operate the priming pump, retighten the banjo bolt.



## How to renew the fuel filter element

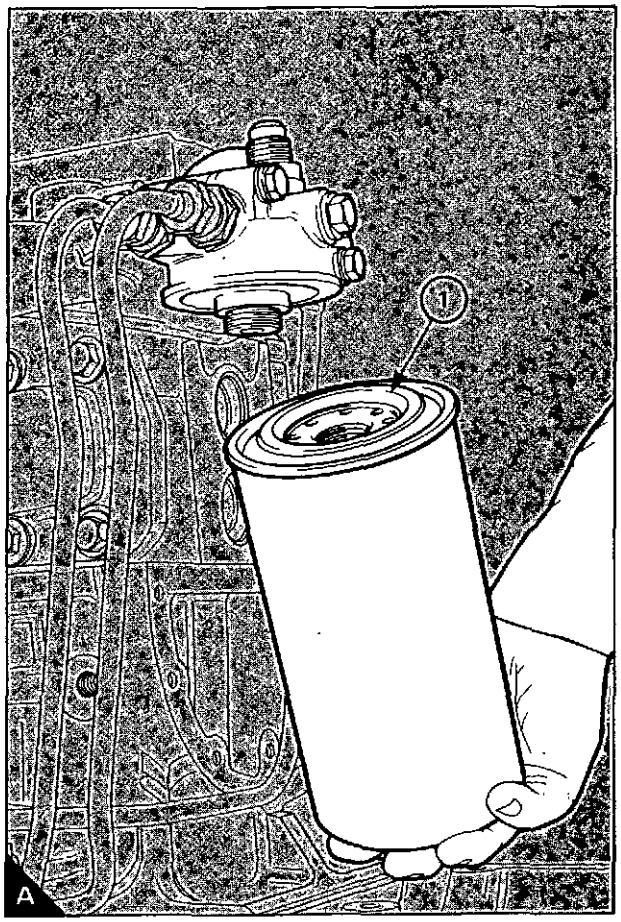
The fuel filter is mounted at the rear of the engine, and is a single canister unit.

1 Clean the outer area of the filter and unscrew the single canister, if necessary using GA 5074 *strap wrench. Discard the canister.*

2 Check that the seal ring is correctly fitted (A) on the new canister and clean the contact face of the header bracket.

3 Lightly smear the face of the seal ring with fuel oil and screw on the canister until the joint faces are just in contact.

4 Tighten further by hand for a maximum ¾ turn. Do NOT overtighten.



## How to check the drive belts

Check all drive belts for wear or damage. Renew belts in sets if wear or damage is obvious. Do NOT fit an individual belt unless it is standard fitting.

It is recommended that a bolt tensioner gauge, fitted at the centre of the longest free length (A1) is used to check the belt tension.

The correct belt deflection at this point should be 12mm (½ inch) under the following pressures:

## Fan belts

254mm (10 inch) pulley centres:
6.3 to 7.25 kgf (14 to 16 lbf)
321mm (12.625 inch) pulley centres:
5 to 6 kgf (11 to 13 lbf)

## Alternator belts

All engines:
6.5 to 7.5 kgf (14.5 to 16.5 lbf)

## Belt adjustment

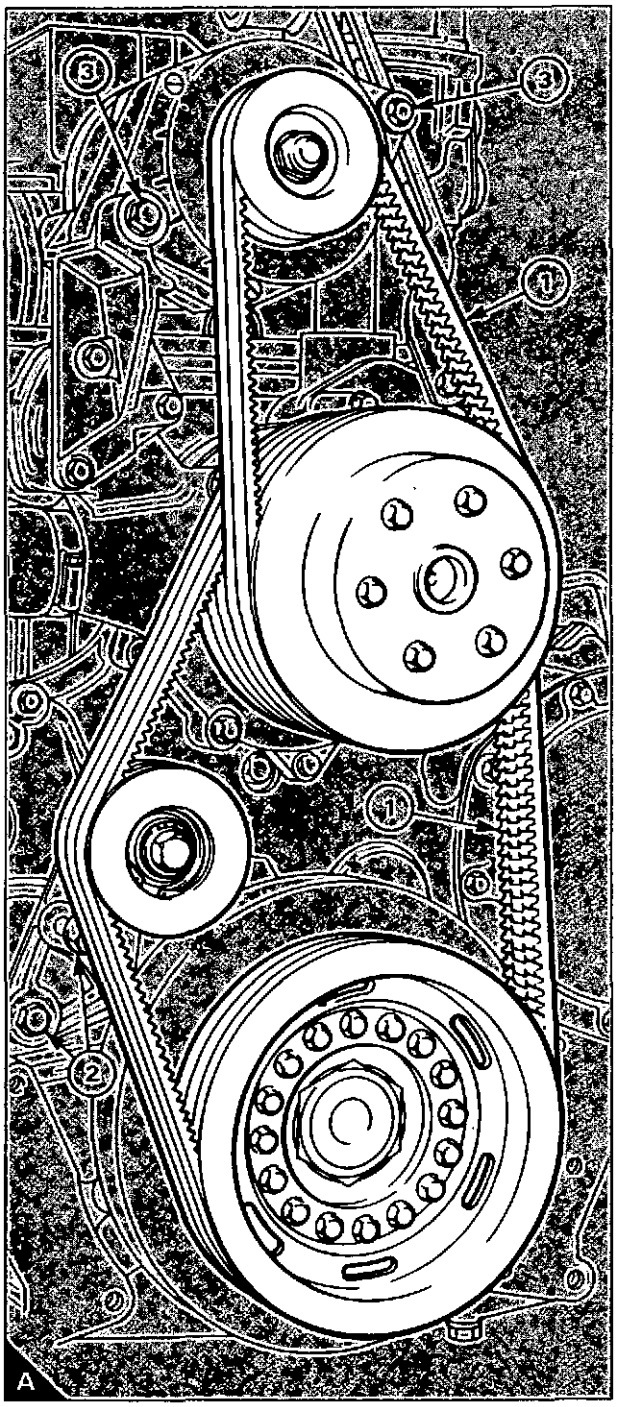
**(a) Coolant pump drive belts**

Slacken the belt tensioner securing and clamping bolts (A2); slide the tensioner until the correct belt tension is obtained and tighten the two bolts.

**(b) Alternator belts**

Slacken the fixing and adjusting bolts (A3) and position the alternator to obtain the correct belt tension. Tighten the two bolts.

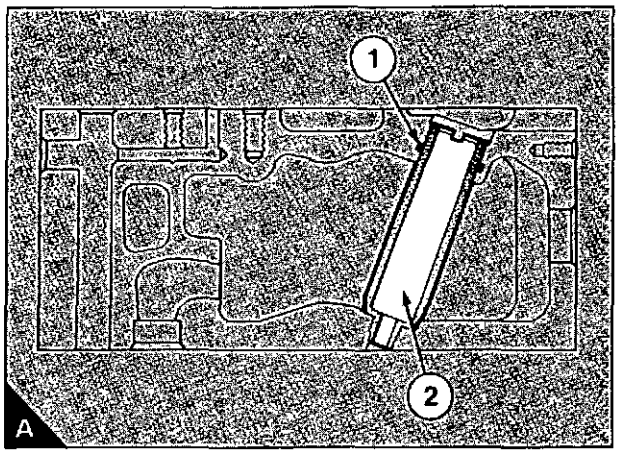
Re-check the belts to ensure the tension is still correct. Maximum life and efficiency of the belts will only be obtained if they are maintained at the correct tension.



## Injector sleeves

Steel sleeves are fitted through the coolant galleries of each cylinder head and screwed into the bottom deck; the thread being sealed with Hylomar Universal sealing compound. The top of the sleeve is sealed by an 'O' ring (A1) fitted to a groove in the cylinder head.

Torque tighten sleeve to 27 Nm (20 lbf ft).




## Cleaning (servicing) injector sleeves

Before fitting injectors the sleeve seating faces should be cleaned by adopting the following procedure.

Apply grease to the reamer and seating face cleaning tool; insert the tool into the injector sleeve (A2) and clean carbon deposits from the seating face. DO NOT REMOVE ANY METAL FROM THE SEATING FACE.

The gas seal between the injector nozzle and seating face is formed by a copper washer which must be changed at the recommended injector servicing period. If on removal of an injector, the copper sealing washer remains in the sleeve it can be removed with the cleaning tool.

The application of grease to the cleaning tool will retain any carbon particles.

To prevent dirt ingress between the injector and sleeve, a rubber seal is fitted over the injector body just below the retaining clamp. When the injector is fitted, this seal is then enclosed in a counterbore in the cylinder head immediately above the injector sleeve. An aluminium distance piece is then fitted over the seal and when tightened, the injector clamp compresses the seal into the counterbore.

This seal should be replaced at the recommended injector servicing period.

Apply a light smear of copper grease to the outside of the fuel injector barrel prior to fitting, taking particular care to prevent the injector nozzle becoming contaminated.

## Service Tools

| | | |
|---|---|---|
| Removal wrench | - | GA 5164 |
| Cleaning kit | - | GA 5165 |

## Fuel injector fault

A faulty injector will be shown by an engine misfire. In order to ascertain which injector is faulty, run the engine at a fast idle speed and slacken each high pressure pipe union in turn, at the injector end of pipe. Slackening the pipe to the faulty injector will have little or no effect on the engine speed.

## Injector removal

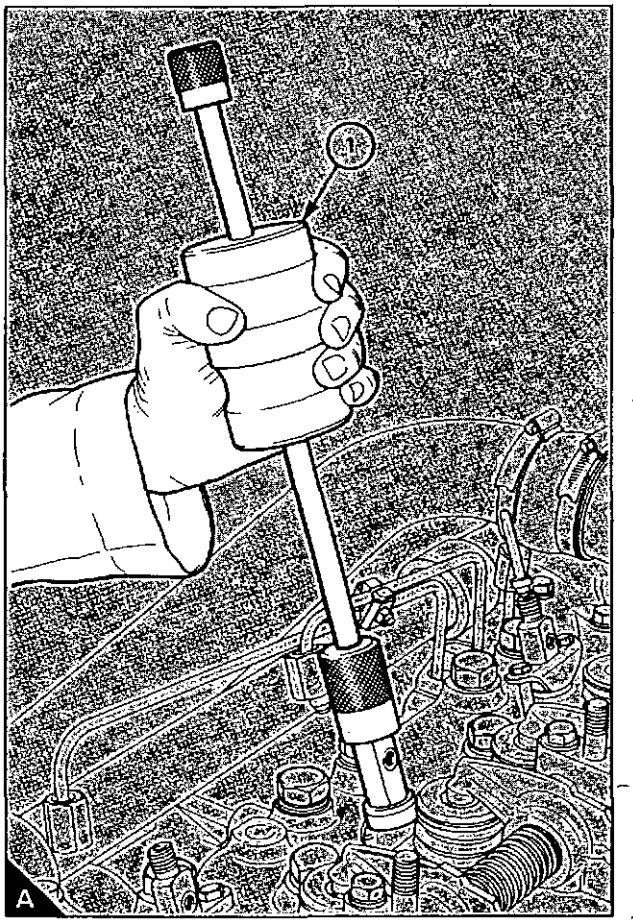
**1** Clean the area immediately surrounding the injector.

**2** Remove the fuel leak-off pipe from the injector.

**3** Remove the high pressure pipe from the injector, if necessary releasing the pipe clamp. Do NOT bend the pipe.

**4** Remove the injector retaining bolts and clamp and withdraw the injector. Extract the bottom washer and temporarily seal the top of the injector sleeve to prevent the ingress of foreign particles.

**5** Tight injectors may be removed using GA 5100 slide hammer (A1) with adaptor GA 5100/12.



A

## Injector replacement

1 Ensure the injector sleeve is clean and free of carbon deposits.

2 Fit new seal rings (A1) on the injector and copper washer (A2).

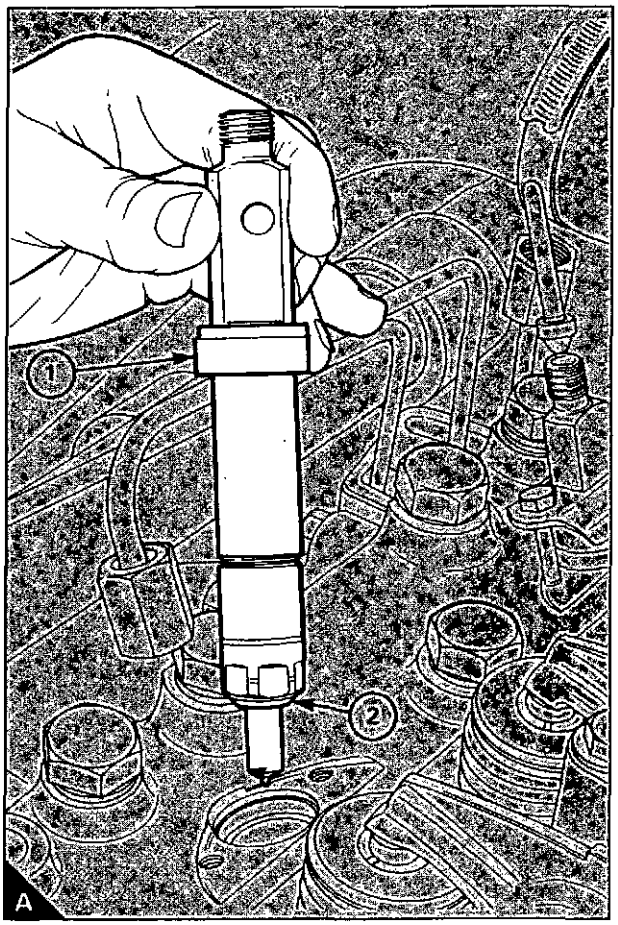
3 Slide the injector into position and secure with bolts and clamp. Tighten bolts evenly to 11 Nm (8 lbf ft).

4 Fit the high pressure pipe, ensuring the pipe is correctly positioned and does not twist when tightening the nuts.

5 Fit and tighten any clamp plate which may have been disturbed.

6 Fit the leak-off pipe with new washers.

7 Run the engine and check for leaks.



## Draining the cooling system

It is recommended the system is drained as soon as possible after the engine is stopped and before any deposits in the coolant have settled.

**1** Ensure the engine is on level ground.

**2** Remove the radiator filler cap carefully, especially when the engine is hot.

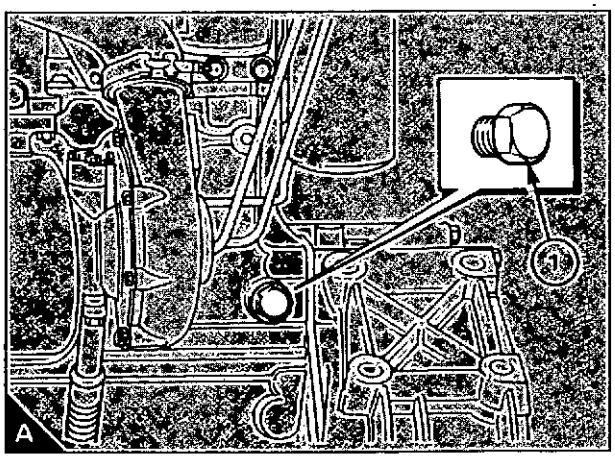
**3** Remove the coolant drain plug, (A1), from the rear of the left-hand side of the engine. Ensure the drain hole is not restricted.

**4** To drain the radiator refer to the vehicle Manufacturers Instruction Manual.

**5** Flush the system with clean water.

**6** Replace the engine drain plug and any items removed in accordance with the Instruction Manual as in item 4.

**7** Affix a 'coolant drained' label in a prominent position if the engine is not to be refilled immediately.



# Engine fluids 5

# Engine fluids

## Fuel, lubrication and cooling systems

Fuel injection is provided by a Bosch in-line fuel pump mounted on the wheel case backplate and gear-driven directly from the engine gear-train. An all-speed or constant speed mechanical governor and boost control is fitted on the rear of the fuel pump which also incorporates a feed pump with a hand priming device.

To improve governing to BS5514 : Part 4 1979 and ISO 3046/1V : 1979 class 1A or for variable droop specification electric governing may be offered.

A gear-driven oil pump lifts lubricating oil from the sump and circulates it through the heat exchanger and filters to provide lubrication of bearings. The oil galleries through which the oil passes are drilled within the engine crankcase.

The Perkins approved coolant is a mixture of inhibited ethylene glycol or inhibited propylene glycol and clean fresh water, circulated through the engine by a belt driven pump. A triple-element wax-capsule thermostat with radiator by-pass ensures rapid warming up and an oil-to-coolant heat exchanger maintains the lubricating oil at a constant temperature.

Publication TSD 3187 gives further details of the fuel, coolant and lubricating oil recommendations and copies are obtainable from Perkins Engines (Shrewsbury) Limited or their Distributors.

The following abbreviated list of oils are amongst those which comply with the Perkins recommendations. The onus is on the Operator to ensure that the oil used does meet the previous requirements.

## Recommended engine oils

| Manufacturer | Preferred Multi-grade oils | Acceptable Multi-grade oils |
|---|---|---|
| Agip | Agip Sigma Turbo 15/40 | Super Diesel Multi-grade 15W/40 |
| BP | Vanellus C3 Extra 15W/40<br>Vanellus FE 15W/30 | Vanellus C3 multi-grade 15W/40 |
| Burmah Castrol | Deusol Turbomax 15W/40 | Deusol RX Super 15W/40 |
| Caltex | RPM Delo 450 15W/40 | PRM Delo 400 15W/40 |
| Daltons | Silkolene Turbolene 15W/40 | Silkolene Ashford 15W/40 |
| Elf | Multi-performance 4D 15W/40 | Multi-performance 3C 15W/40 |
| Esso | Diesel Motor Oil 500 15W/40 | Essolube XD3 15W/40 |
| Mobil | Delvac 1400 Super 15W/40 | Delvac Super 15W/40 |
| Morris's | Golden Film Ring - Free XHD 15W/40 | Golden Film Ring - Free XS 15W/40 |
| Petrofina | Fina Kappa LDO 15W/40 | Dilano HPD 15W/40 |
| Shell | Myrina 20W/40 | Rimula X 15W/40 |

For information regarding engines operating in ambient temperatures below −15 deg. C, please contact the PE (S) L Service Department.

**Guarantee**

It is explicit in the PE (S) L Guarantee that an engine must be operated with approved fuel, lubricant and coolant, and maintained in accordance with the engine Servicing Schedule.

## Diesel fuel

A distillate fuel with at least 85% recovery by 350° C. (IP 123) having a maximum sulphur content of 0.5% with a Cetane Number not less than 45.

The following specifications meet these requirements:

British Standards Institution B.S. 2869 : 1983 Class A2 - (0.5% Sulphur - 45 minimum Cetane).

ASTM Diesel Fuel Classification: D975 No. 2-D.

The use of fuels not meeting the above requirements may result in damage and/or reduced engine life and may affect the Warranty. If in doubt please consult Perkins Engines (Shrewsbury) Limited.

## Coolant

**1** The coolant approved for use in all diesel engines manufactured by PE(S)L is a mixture of 50% inhibited ethylene glycol or 50% inhibited propylene glycol and 50% clean fresh 'soft' water.

Mixtures containing methanol are NOT approved.

Anti-freeze mixtures supplied by most major Chemical and Oil companies are suitable, but the Operator is responsible for obtaining the Manufacturer's assurance that the ethylene glycol or propylene glycol products they supply have an inhibitor performance level suitable for a multi-metal cooling system.

**2** If anti-freeze is not available, and there is no likelihood of ambient temperatures below 10° C, then clean fresh 'soft' water may be used, treated with 1% by volume of PE(S)L inhibitor, in the cooling system. This proportion is the equivalent of 0.5 litre of inhibitor to 50 litres or 11 Imperial gallons of water. The inhibitor is available in bottles under PE(S)L Part Nos. OE45141 (0.5 litre) and OE45142 (1.0 litre).

**The use of any other product may cause serious problems in the cooling system, and the use of insufficiently inhibited coolant mixtures may lead to erosion and/or corrosion of aluminium or cast iron components in the system.**

**3** If the acceptability of the available water supply is in doubt, refer to the appropriate Service instruction, ESI 70, obtainable free of charge from PE(S)L Dealers and Distributors.

## Lubricating oil

PE(S)L recommend the use of a multi-grade oil, with a viscosity rating of SAE 15W/40, for all engines operating at ambient temperatures above −15° C (5° F). The oil selected must adequately meet the requirements for high quality monograde oils, as described in specification: MIL-L-2104C/2104D: API-CD/SF.

# Fault diagnosis 6

## Fault diagnosis

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

## Code list of possible causes

1 Battery capacity low.
2 Bad electrical connections.
3 Fault in the starter motor.
4 Wrong grade of lubricating oil.
5 The starter motor turns the engine too slowly.
6 Fuel tank empty.
7 Fault in the stop control.
8 Restriction in a fuel pipe.
9 Fault in the fuel lift pump.
10 Dirty fuel filter element.
11 Restriction in the air filter or the induction system.
12 Air in the fuel system.
13 Fault in the injectors or injectors of the wrong type.
14 Cold start system not used correctly.
15 Fault in cold start system.
16 Restriction in the fuel tank vent.
17 Wrong type or grade of fuel used.
18 Restricted movement of the engine speed control.
19 Restriction in the exhaust pipe.
20 The engine temperature is too high.
21 The engine temperature is too low.
22 Wrong tappet clearances.
23 Wet type air cleaner is too full or wrong type of oil is used.
24 Not enough lubricating oil in the sump.
25 Fault in gauge.
26 Dirty lubricating oil filter element.
27 Fan damage.
28 Fault in engine mounting or flywheel housing.
29 Too much lubricating oil in the sump.
30 Restriction in air or water passages of radiator.
31 Restriction in breather pipe.
32 Not enough coolant in system.
33 Fault in exhauster or vacuum pipe leakage.
34 Fault in fuel injection pump.
35 Broken drive on the fuel injection pump.
36 Wrong timing of the fuel injection pump.
37 Wrong valve timing.
38 Bad compression.
39 Leakage past the cylinder head gasket.
40 Valves are not free.
41 Wrong high pressure pipes.
42 Worn cylinder bores.
43 Leakage past the valves and seats.
44 Piston rings are not free or are worn or broken.
45 Valve stems and/or guides are worn.
46 Crankshaft bearings are worn or damaged.
47 Lubricating oil pump is worn.
48 Relief valve is not free to close.
49 Relief valve is not free to open.
50 Relief valve spring is broken.
51 Fault in suction pipe of lubricating oil pump.
52 Piston damage.
53 Wrong piston height.
54 Flywheel housing or flywheel is not aligned correctly.
55 Fault in thermostat or thermostat is of wrong type.
56 Restriction in coolant passages.
57 Fault in water pump.
58 Damage to valve stem oil seals (where they are fitted).
59 Restriction in sump strainer.
60 Valve spring is broken.
61 Turbocharger impeller damage, or dirty impeller.
62 Leakage past the lubricating oil seal of the turbocharger.
63 Leakage in the induction system (turbocharged engines).

# Engine preservation 7

# Engine preservation

## Running-in after repair

Every new or reconditioned engine supplied by Perkins is run-in before leaving the Factory and requires no special treatment when put into service.

When a 'Short Engine' has been installed, or when a partial overhaul has involved replacement of cylinder liners and piston rings, the Operator is advised to carry out the following simple running-in sequence before subjecting the engine to full load:

1 Run the engine 'OFF LOAD' until working temperature is reached.

2 Increase the engine load gradually until 'FULL LOAD' conditions are achieved over a period of three to four hours.

## Storage

When the engine is out of use, whether temporarily or for a longer period, it must be protected against corrosion. The extent of the anti-corrosive treatment will depend on the anticipated duration of the storage period and the condition under which the engine will be kept. Where necessary, precautions against frost damage must also be taken.

All new or reconditioned engines leaving the Factory have been treated with anti-corrosion inhibitors to Perkins standards. Each engine may be stored under cover, in dry conditions, for a period of up to 12 months from the date of despatch from the Factory, without the need for further inhibition.

Should the storage period exceed 12 months, the engine must be thoroughly examined and re-inhibited.

After the initial run of any engine the original inhibition will be lost and the following storage recommendations must be adhered to. Failure to observe these instructions could affect the Perkins Engines Guarantee.

## Recommendations

Short term storage:

| | |
|---|---|
| Up to seven days: | No action is necessary. |
| Up to three months: | Each week, run the engine until normal operating temperature is reached. If the engine cannot be run, turn the crankshaft by hand a minimum of three revolutions. |

## Long-term storage:

If it is necessary to store an engine for a period of between three months and twelve months, the following inhibiting procedures must be followed:

**1** Remove and clean the thermostat. Apply a silicon grease, such as MS4, to the thermostat spindles, operating the valves manually to work the grease between the spindles and the glands. Reassemble the thermostat in its housing.

**2** Run the engine until normal working temperature is reached, shut the engine down and immediately drain the lubricating oil from the sump and oil filter canisters.

**3** Fill the oil bowls with PX4 inhibitor and refit the bowls to the header bracket.

**4** Fill the sump to the normal oil level with PX4 inhibitor and once again run the engine until normal working temperature is reached.

**5** Stop the engine, disconnect the fuel supply and reconnect to a supply of PX4 inhibitor. Restart the engine, whilst still hot, and run it off load for ten minutes.

**6** Stop the engine, disconnect the supply of PX4 inhibitor and blank off the end of the fuel feed pipe. Attach a label in a prominent position to indicate that the fuel supply has been disconnected. Drain the fuel filter canisters. See 'Note' following.

**7** Remove the fuel injectors and immerse them in a container of PX4 inhibitor.

**8** Set the fuel control to the 'NO FUEL' position, remove the rocker covers and disconnect the air cleaner(s).

**9** Motor the engine on the starter and, simultaneously, spray PX4 inhibitor into the manifolds until vapour emerges from each fuel injector orifice.

**10** Using a suitable self-metering spray gun, spray 40 ccs. of PX4 inhibitor into each cylinder through the fuel injector orifice, then refit the injectors.

**Note:** The engine must NOT be rotated after this operation and should carry a prominent notice to this effect.

**11** Spray the valve gear with PX4 inhibitor, then refit the rocker covers.

**12** Drain the PX4 inhibitor from the engine sump and oil filter canisters. Attach a 'NO OIL' notice to the oil filler cap(s).

**13** Drain the cooling system and refill with a fresh coolant mixture of inhibited ethylene glycol or inhibited propylene glycol and clean water.

**Note:** The mixture must NOT contain less than 50% inhibited ethylene glycol or inhibited propylene glycol and may contain up to 90% by volume.

Allow the system to settle for 15 minutes, then completely drain the coolant mixture. Attach a 'NO COOLANT' notice to the coolant filler cap.

**14** Disconnect the exhaust system at the turbocharger diffuser outlet or, on normally aspirated engines, at the junction of the manifolds. Inject two grammes of VPI 260 powder and fit a blanking plate. Do NOT reconnect the exhaust pipe.

**15** Inject two grammes of VPI 260 powder into the turbocharger, if fitted.

**16** Inject two grammes of VPI 260 powder into the air cleaning ducting. Air cleaners should be sprayed internally with PX4 inhibitor or VPI 260 powder.

**17** Brush coat or spray all unpainted areas of the engine and auxiliary equipment with Crodafluid PM47, paying special attention to the fluid control linkage.

**Caution:** Do NOT spray PM47 into the vent apertures of the alternator.

**18** Wrap the alternator, starter motor and tachometer generator in mouldable wax wrapping and seal with adhesive tape.

**19** Seal the air cleaner inlet, crankcase breather and any other openings with mouldable wax wrapping and adhesive tape or plastic caps as appropriate.

**20** Remove all driving belts, dust them liberally with french chalk and place them in a sealed polythene bag attached to the engine.

21 Finally, affix a label in a prominent position on the engine, stating:
(a) That the exhaust system has been blanked off.

(b) The dates on which the engine was inhibited and will require re-inhibiting.

If the engine is to remain in storage for more than one year, the above procedure must be carried out at the end of each twelve month period.

## Removal from storage

Refer to 'OPERATING' for details of the preparation of an engine after storage, which applies equally with a newly-installed unit.

## Approved inhibiting products

| Component | Product | Manufacturer |
|---|---|---|
| Thermostat | MS4 silicone grease | Ambersil Limited<br>Whitney Road<br>Basingstoke<br>Hants |
| Lubrication system | PX4 inhibitor | Croda Chemicals Limited<br>Churchill Road<br>Doncaster<br>Yorks |
| Fuel system | PX4 inhibitor | Croda Chemicals Limited |
| Valve gear | PX4 inhibitor | Croda Chemicals Limited |
| Cooling system | Inhibited ethylene glycol or inhibited propylene glycol | Various |
| Induction/exhaust systems | PX4 inhibitor<br>VPI 260 powder | Croda Chemicals Limited<br>Shell Chemicals Limited<br>Stanlow Terminal<br>Ellesmere Port<br>Wirral<br>Cheshire |
| Engine and auxiliaries - exterior | 'Crodafluid' PM47<br>Mouldable wax wrapping | Croda Chemicals Limited<br>Carrs Paper Limited<br>Shirley<br>Solihull<br>West Midlands |

**Note:** Spin-on type oil and fuel filter canisters are designed so that when mounted above the header bracket, the lubricating oil or fuel does not drain back into the sump or supply tank from their respective canisters, when the engine is stopped.

To drain a filter canister for inhibition purposes, hold the canister inverted over a suitable container and using a small blunt instrument inserted into one of the fluid inlet openings, gently press open the rubber non-return seal.

During this operation, care must be taken not to damage the rubber seal or the internal element of the filter.

# Parts and service 8

# Parts and service

## Introduction

If problems occur with your engine or with 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.

## Service literature

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

## Training

A five day course on servicing and overhaul of the range of engines is available at the Factory. For details, apply to: The Superintendent, Customer Training Centre, Perkins Engines (Shrewsbury) Limited, Shrewsbury, Shropshire.

## Service Instructions and Bulletins

Service techniques and engine design are under constant review at Perkins, so that from time to time it becomes necessary to revise manuals and associated publications to include the results of this development work. Between revisions, all concerned are provided with full details of changes as they occur, the information being produced in leaflet form and sent in bulk to Dealers and Distributors for onward transmission as necessary.

**1** Changes in Service techniques are issued as Service Instructions for inclusion in Service Manuals by Dealers, Distributors and Operators.

**2** Engine design changes are issued as Modifications in Service Bulletins for the information of Dealers and Distributors.

# Engine data 9

# Engine data

| | |
|---|---|
| **Type** | |
| 165 kW (221 bhp) to 257 kW (345 bhp) gross | Liquid cooled, four stroke turbocharged six cylinder in-line diesel engine |
| 229 kW to (307 bhp) to 368 kW (494 bhp) gross | Liquid cooled, four stroke turbocharged/charge cooled six cylinder in-line diesel engine |
| **Bore** | 130.17 mm (5.125) |
| **Stroke** | 152.4 mm (6.00 inch) |
| **Capacity** | 12.17 litres (742.64 $in^3$) |
| **Compression ratio** | 15.9 : 1 |
| **Rotation** | Anti-clockwise, viewed on flywheel |
| **Cylinder firing order** | 1, 4, 2, 6, 3, 5 |
| **Cylinder numbering** | From front (fan end) to rear (flywheel end) |
| **Valve tappet clearance** | Inlet - 0.25 mm (0.010 in) cold<br>Exhaust - 0.50 mm (0.020 in) cold |
| **Injection timing** | As stamped on engine data plate |
| **Coolant capacity** | 20.4 litres (4.5 Imp. gallons), engine only |
| **System pressure** | Maximum 70 kN/sq m (10 lbf/sq in) to suit installation |
| **Operating temperature** | (At sea level) |
| Normal Running | 78 to 95 deg. C (172 to 203 deg. F) |
| **Thermostat** | Triple-element wax capsule type with radiator by-pass |
| **Heat exchanger** (Oil-to-coolant) | Single unit, baffled and finned tube pack, with part coolant by-pass |
| **Fuel system** | Pressurised supply with return to tank |
| **Primary filter** | Harwood water separator |
| **Feed pump** | Bosch - single acting |
| **Fuel feed pressure** | 103 to 207 kN/sq m (15 to 30 lbf/sq in) |
| **Main fuel filter** | Single, engine mounted, spin-on type expendable canister |
| **Fuel injection pump** | Bosch S3000 with 12 mm lower-helix elements (snubber |
| 165 kW (221 bhp) to | valves fitted to variable speed engines over 300 bhp only). |
| 257 kW (345 bhp) gross | Boost control device fitted to 300 bhp engines only. Automatic selection of excess fuel and retarded timing for starting. Retard −6° engine. |
| 229 kW (307 bhp) to 368 kW (494 bhp) gross | Bosch S7100 with 12 mm lower-helix elements and snubber valves. Boost control device fitted. Automatic selection of excess fuel and retarded timing for starting. Retard −6° engine. |
| **Governor** | Bosch RQV or Bosch RQ or Electric. (Depending on requirements). |
| **Fuel injectors** | Bosch or CAV low spring type opening pressure 240 atmospheres |

| | |
|---|---|
| **Lubrication system** | Wet sump type |
| **Oil capacity** | 25 litres (5.5 Imp. gallons) to maximum mark on dipstick |
| **Oil pressure** | 350 to 480 kN/sq m (50 to 70 lbf/sq in) normal running. Minimum permissible 207 kN/sq m (30 lbf/sq in) |
| **Pressure relief valve** | Spring and plunger type housed in oil pump body |
| **Oil filters** | Two spin-on expendable canisters with integral by-pass valves |
| **Turbocharger** | Holset - H2C or H2D |
| **Air compressor (if fitted)** | WABCO single cylinder, flange mounted |
| **Alternator** | BUTEC - belt driven |
| **Starter motor** | Butec LMS1A (24V) |
| **Cold start aids** | Optional - Start Pilot or Fleetguard |

# Preliminary service information 10

# Preliminary service information

## Caution:

*Some joints and gaskets contain asbestos which is bonded as compressed fibre and encapsulated in rubber.*

The asbestos is Chrysotile or 'white' asbestos which is generally considered to be safer than the 'blue' or 'brown' asbestos varieties known as crocidolite or amosite. The risk of asbestos from joints occurs at their edges or if the joint is split on disassembly of components or if the joint is subjected to abrasion.

Regular factory monitoring has shown the level of asbestos on assembly to be very small and far below the accepted level. If the joint is split there is slightly more risk but certain precautions can keep this risk to a minimum.

It is recommended that when stripping or rebuilding engines using any asbestos joints:

**1** Undertake the work in a well ventilated area.

**2** Do not smoke.

**3** To remove joints use only a hand scraping method rather than a rotary wire brush.

**4** Wet the joint being removed with oil or water to minimise the risk of being exposed to any loose particles.

The chances of being exposed to dangerous levels on engine assembly or strip are very small and consequently the risk of damage to health from asbestos on Perkins engines must be regarded as extremely low, provided the above actions are implemented.

**Note:**
*This is for technical information only and cannot be used as a basis for a warranty claim.*

## Torque loadings

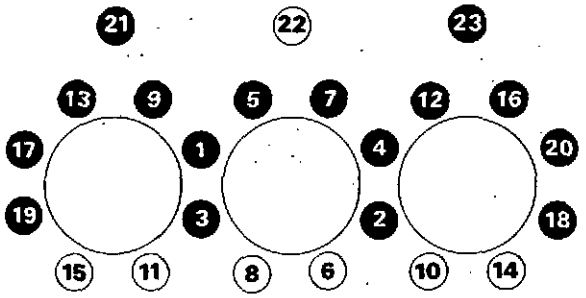
These torque loadings apply to oil-wetted threads on all engines unless otherwise indicated, subject to the following conditions:

1 It must NOT be assumed that application of the specified torque is, in itself, sufficient to ensure that the components concerned are adequately secured together. The recommended method of assembling and, where applicable, tightening sequence must also be observed. This information is given in the relevant Technical Publications.

2 Where the bolt or nut is locked by a tabwasher, lockplate or splitpin the specified torque may be exceeded, if necessary, by the MINIMUM amount required to reach a locking position.

| | Nm | Torque (lbf ft) | kgf m |
|---|---|---|---|
| **Air compressor (if fitted)** | | | |
| Crankshaft drivegear nut | 176 | (130) | 18.0 |
| Cylinder head bolts | 25 to 30 | (18 to 22) | 2.5 to 3.0 |
| **Alternator pulley nut** | | | |
| C.A.V. 7" | 88 | (65) | 8.9 |
| C.A.V. 5" alternator | 54 | (40) | 5.5 |
| Butec alternator (Full nut-Nyloc) | 95 | (70) | 9.6 |
| **Camshaft** | | | |
| Drivegear setbolts | 61 | (45) | 6.2 |
| Thrustplate setbolts | 54 | (40) | 5.5 |
| **Coolant pump** | | | |
| Pulley securing setscrews (low mounted pump) | 24 | (18) | 2.5 |
| **Connecting rods** | | | |
| Big end setbolts and nuts | 217 | (160) | 22.1 |
| **Crankshaft-hub retaining nut** | 949 | (700) | 96.7 |
| **Crankshaft damper retaining setbolts** | 41 | (30) | 4.1 |

| | Nm | Torque (lbf ft) | kgf m |
|---|---|---|---|
| **Cylinder heads** | | | |
| Initial tightening of all setscrews and nuts | 204 | (150) | 20.7 |
| Further tightening of 1 to 23 (black circles) below | 237 | (175) | 24.2 |
| Setscrews - exhaust manifold | 45 | (33) | 24.2 |




| | | | |
|---|---|---|---|
| Injector sleeves | 27 | (20) | 2.8 |
| Rocker pedestal setbolts | 41 | (30) | 4.1 |
| Tappet screw locknuts | 41 | (30) | 4.1 |
| Injector clamping bolts | 10.8 | (8.0) | 1.1 |
| Rocker cover - securing nuts | 11 | (8.0) | 1.1 |
| Injector high pressure pipe | 45 | (33) | 24.2 |
| **Flywheel retaining setbolts** | 122 | (90) | 12.4 |
| **Flywheel friction face bolts** | | | |
| 5/16 - inch UNC | 24 | (18) | 2.5 |
| 3/8 - inch UNF | 45 | (33) | 4.5 |
| **Flywheel housing, bolts to crankcase** | 61 | (45) | 6.2 |
| ***Injection pump*** | | | |
| Pump hub nut | 163 | (120) | 16.5 |
| Pump mounting nuts | 47 | (35) | 4.8 |
| Gear to hub setscrews | 45 | (33) | 4.5 |
| **Injector nozzle capnut** | 41 | (30) | 4.1 |
| **Lubricating oil filters** | | | |
| Centre bolts, retaining bowls to header | 27 | (20) | 2.7 |
| Adaptor insert | 61 | (45) | 6.2 |
| **Crankcase** | | | |
| Front, centre and rear bearing cap bolts | 217 | (160) | 22.1 |
| Intermediate bearing cap bolts | 272 | (200) | 27.6 |
| Lateral setbolts | 95 | (70) | 9.6 |
| **Perception head locknuts (tachogenerator)** | 2 | (1.6) | 0.2 |
| **Sump** | | | |
| Insert for drain plug | 325 | (240) | 33.2 |
| Drain plug in insert | 115 | (85) | 11.7 |
| **Turbocharger 'V' band nut** | 14 | (10) | 1.4 |

## Fits and clearances (Production)

The dimensions listed here are as used during production of the engine in the factory and are given as a guide to persons working on engine overhauls.

| | mm's | inches |
|---|---|---|
| **Crankshaft** | | |
| Bearing clearance (main bearings) | 0.088 to 0.0139 | 0.0035 to 0.0055 |
| Pinion bore | 0.013 to 0.038 | 0.0005 to 0.0015 |
| End float | 0.127 to 0.33 | 0.005 to 0.013 |
| **Camshaft** | | |
| Bearing clearance | 0.127 to 0.177 | 0.005 to 0.007 |
| End float | 0.152 to 0.40 | 0.006 to 0.016 |
| Gear train backlash | 0.051 to 0.152 | 0.002 to 0.006 |
| **Pistons** | | |
| Squish clearance | 0.30 to 0.38 | 0.012 to 0.015 |
| **Connecting rods** | | |
| Big end running clearance | 0.063 to 0.10 | 0.0025 to 0.004 |
| Side clearance | 0.076 to 0.20 | 0.003 to 0.008 |
| **Valve tappet clearance** | | |
| Inlet (cold) | 0.254 | 0.010 |
| Exhaust (cold) | 0.508 | 0.020 |
| **Oil pump (drive gear)** | | |
| Backlash | 0.102 to 0.254 | 0.004 to 0.010 |
| End float | 0.127 to 0.165 | 0.005 to 0.006 |
| **Main idler gear** | | |
| End float | 0.051 to 0.20 | 0.002 to 0.008 |
| **Damper hub** | | |
| Backlash on splines | 0.0127 to 0.076 | 0.0005 to 0.003 |
| **Flywheel housing** (cast iron to SAE 0.5 only) | | |
| Concentricity to crankshaft | 0.254 maximum (Total indicator reading) | 0.010 |

## Air cleaners

The air cleaner is a Donaldson - 14 inch dry type unit fitted with a ServiSignal mini-restriction indicator and rain hood.

### Servicing

To obtain the best performance from the air cleaner, servicing should only be carried out when indicated, as determined by the restriction indicator. Over servicing does not take full advantage of the features of the air cleaner and may cause damage.

To service the air cleaner:

1 Slacken the clamp ring and remove the dust bowl and baffle assembly.

2 Unscrew the wing nut and separate the bowl and baffle.

3 Empty the bowl, clean both components and reassemble.

4 Unscrew the element securing wing nut and carefully withdraw the element.

5 Direct a jet of compressed air, maximum pressure of 700 kN/m² (100 lbf/sq in), up and down the inside of the element pleats. Do NOT hold the jet nozzle close to the element.

6 Inspect the element for damage by placing a lighted bulb inside. Thin areas or perforations indicate that the element must be renewed immediately.

7 Clean the air cleaner body, refit the element and dust bowl assembly and tighten the clamp ring.

8 Reset the restriction indicator.

**Note:** An alternative method of cleaning the element is to soak it in a solution of D1400 detergent, following the instructions on the packet. This detergent is obtainable from Donaldson Filter Components Limited, or their agents.

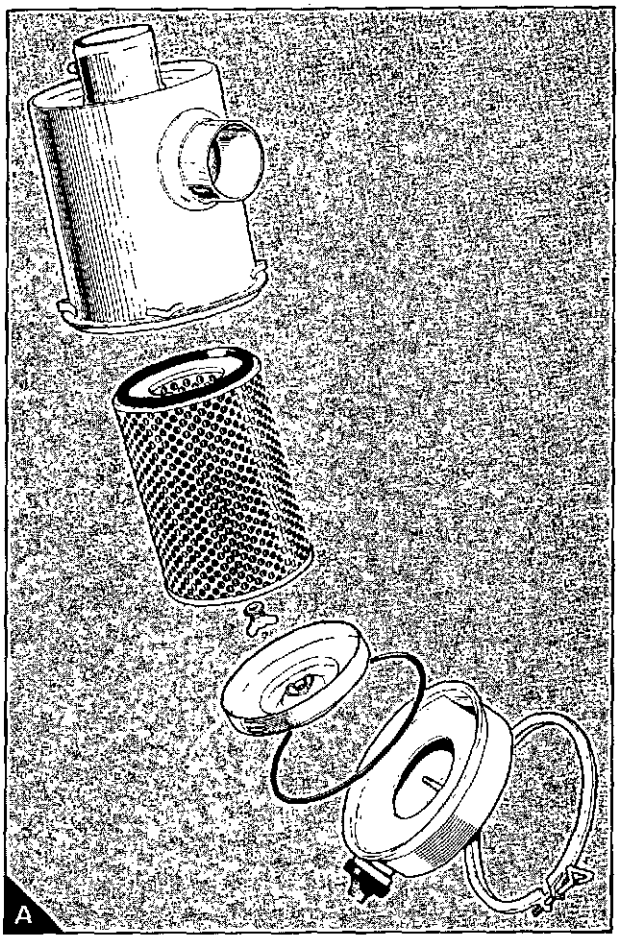
### Restriction indicator

An indicator is fitted to the air cleaner to give visual warning of the fouling of the element.

As fouling increases, a red sleeve gradually moves into view in the indicator sight glass. At the limit of fouling the sleeve will reach the service level and remain there when the engine is shutdown. This indicates that the air cleaner must be serviced immediately.

If during engine operation the sleeve shows partial restriction there is no immediate necessity to service the air cleaner. It is however advisable to service the air cleaner at normal shutdown.

Press the button (B1) in the end of the indicator to reset.


A

B

## Alternator

### Description

The belt driven alternator fitted on the Series 2000 engine is a Butec-type A3024 with an integral regulator.

### Operation

The three phase alternator is of the rotating field/ stationary stator type. The twelve pole rotor is dynamically balanced to ensure safe operation at high speed.

An integral regulator is mounted on the slip ring end housing and controls the output. Rectification of the output is by silicon diodes contained in two heat sinks in the slip ring end housing.

A centrifugal fan draws cooling air through the alternator and over the heat sink fins.

### Servicing

Regularly clean the exterior of the alternator and ensure that the ventilation apertures are clear. Fouling in the area of the diodes can cause flashover and should be removed by spraying with an approved cleaning fluid such as Electronic Cleaning Fluid, Grade 8-23, available from Applied Chemicals Limited, Uxbridge, Middlesex.

Proceed with the following checks at the intervals specified on page 4.03.

**1** Check the condition and tension of the drive belt. Adjust or renew as necessary.

**2** Disconnect the two regulator leads from the brush box terminals, noting the positions for reassembling. remove the two securing screws and lift off the regulator.

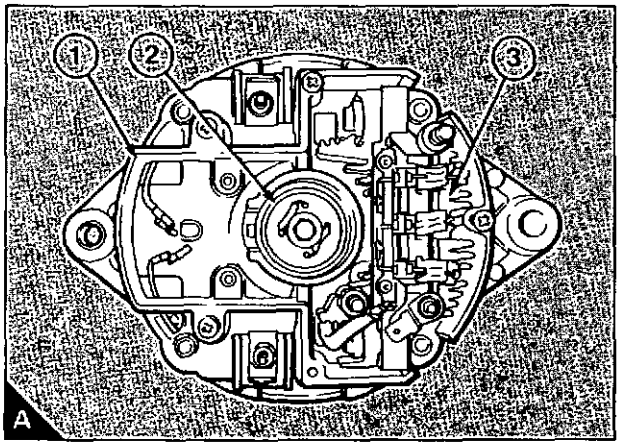
**3** Remove the brush box retaining screws, disconnect the leads and lift out the box assembly.

**4** Check the brushes and ensure the brush protrudes at least 10mm (0.394 in) from the brush box. If brush protrusion is below 10mm new brushes must be fitted.

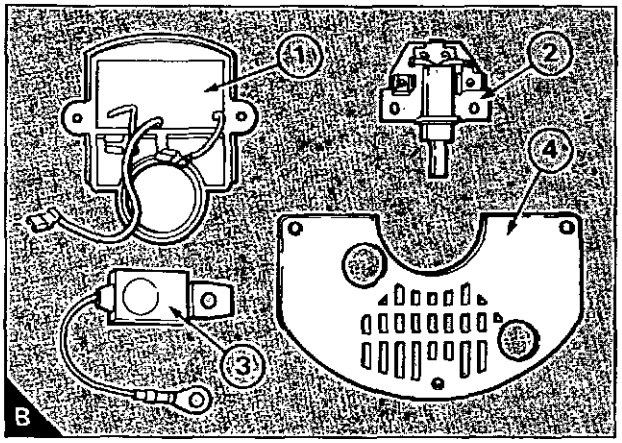
**5** Remove the four securing screws, withdraw the brush gear housing and inspect the slip ring assembly.

**6** Clean off any dirt from the components using a soft cloth moistened with petrol or white spirit. Worn or scored slip rings must be renewed.

**7** When fitting new components it is advisable to refer to the Manufacturers Instruction Manual.




A 1 Brush gear housing
2 Slip ring assembly
3 Rectifier assembly




B 1 Regulator
2 Brush box assembly
3 Capacitor
4 Plastic cover

## Teddington Control Switches

### Servicing

No servicing is necessary on the switches. It is, however, recommended that they are checked for operating efficiency at regular intervals, as engine operating conditions permit. The checks should be carried out at a maximum period of six months.

The switches are factory set at a predetermined setting and no attempt must be made to alter the settings.

### *Testing*

1 Oil pressure switch (A).

(a) Screw the oil pressure switch into a suitable pressure fitting and apply pressure in excess of 207 kN/m$^2$ (30 lbf/sq in).

(b) Connect a battery and appropriate light bulb across the switch terminals, and gradually reduce the system pressure. Note the pressure at which the light is extinguished; this pressure should be between 138 and 165 kN/m$^2$ (20 and 24 lbf/sq in).

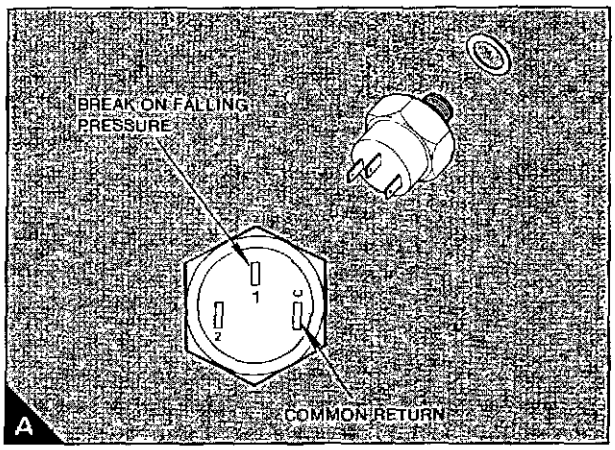
2 *Coolant temperature switch* (B).

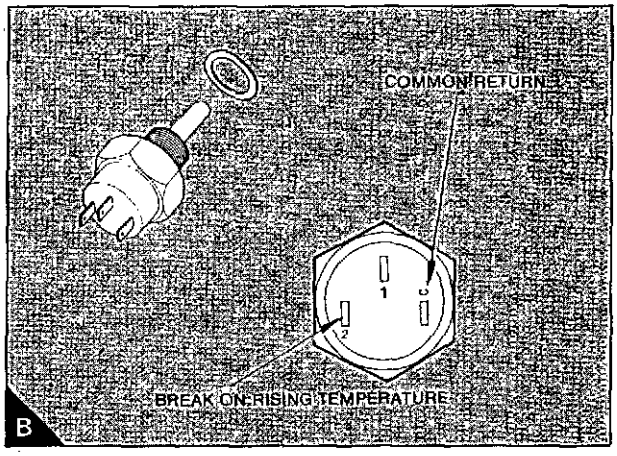
(a) Connect a battery and appropriate light bulb across the switch terminals, and immerse the switch sensor in a suitable container of oil; place an accurate thermometer close to the sensor.

(b) Heat the oil to 100°C and maintain this temperature for 15 minutes.

(c) Gradually increase the temperature and note the thermometer reading at which the light is extinguished; this should not be above 110°C.

If the pressure or temperature readings extend beyond the above limits, a replacement switch must be fitted where appropriate.



## Cylinder heads

### Cylinder head gasket fitting:

Ensure the crankcase top face is clean and dry. Fit the four dowels which locate the cylinder head gaskets in position on the face of the crankcase. Spray both sides of the cylinder head gaskets with a coating of Hylomar before fitting. Fit the large coolant bobbins in position with new seal rings and locate the gaskets in position on the dowels.

### Cylinder head fitting:

**1** All setbolts are fitted with a hardened plain washer under the bolt heads and should be clean, straight and free from obvious damage.

**2** Check with a straight edge held along the threads that there is no reduction in diameter to any part of the thread. Damaged setbolts must be discarded.

**3** Screw in a guide bar opposite each oilway stud. Clean the faces of the cylinder heads and lower into position.

**4** Lightly oil wet the washers and setbolt threads. Avoid excess.

**5** Place the setbolts in position, thus avoiding damage to the threads which may occur if the bolts are dropped.

**6** Screw in each setbolt by hand to ensure correct location.

**7** Tighten in the following sequence to the recommended torque, in the numerical order shown on 'A'.

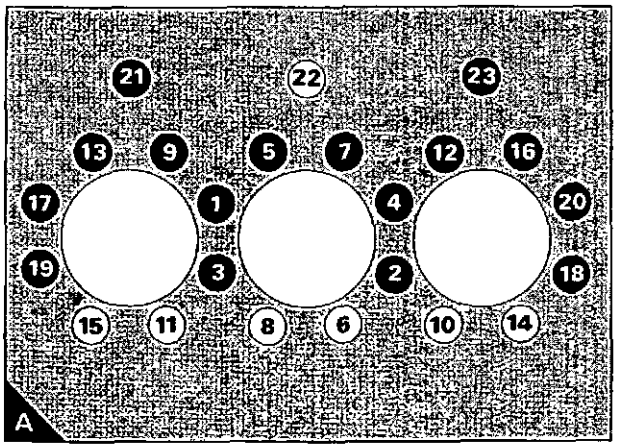
a) Tighten all setbolts and nut in the sequence 1 to 23 to 68 Nm (50 lbf ft).

b) Repeat (a) to a torque loading of 136 Nm (100 lbf ft).

c) Repeat (a) to a torque loading of 204 Nm (150 lb ft).

d) Tighten the setbolts in black circles on diagram (A) in sequence to a torque loading of 237 Nm (175 lbf ft).

Retorquing of the cylinder head after the engine has been in service will NOT be necessary.

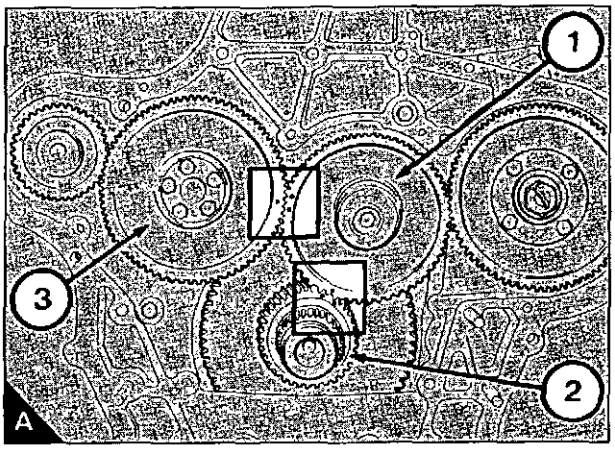


## Engine gear train

The idler (A1), camshaft (A3) and crankshaft gears (A2) are each machined with timing marks to ensure the correct relationship between gears on assembly.

These marks are as illustrated on (A) and must be assembled in the given positions with the number 1 *piston at TDC on compression stroke.*

After the engine has run or been turned from the original setting the marked teeth will not necessarily be in mesh with number 1 piston at TDC on compression stroke.



## Fuel injection pump timing

### Checking and adjusting

1 The injection timing position is stamped on the engine data plate.

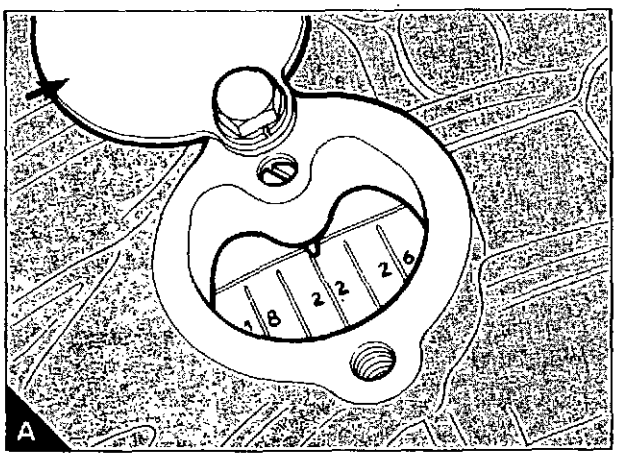
2 Secure the stop lever in the NO FUEL position and remove the front rocker cover.

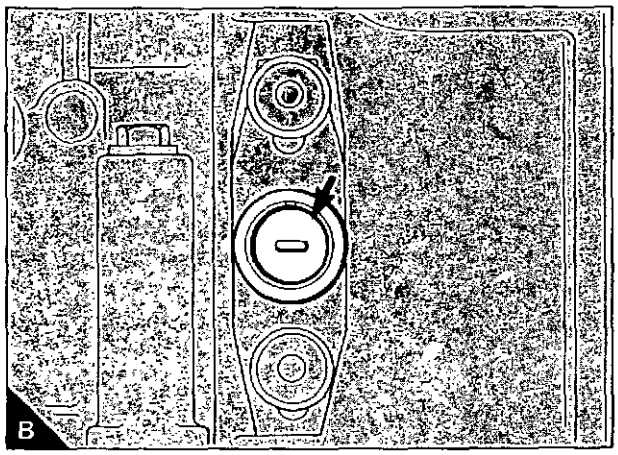
3 Turn the engine in the direction of rotation (anti-clockwise viewed on flywheel) until No. 1 inlet valve closes and remove the timing pointer cover (A) from the lower left-hand side of the flywheel housing.

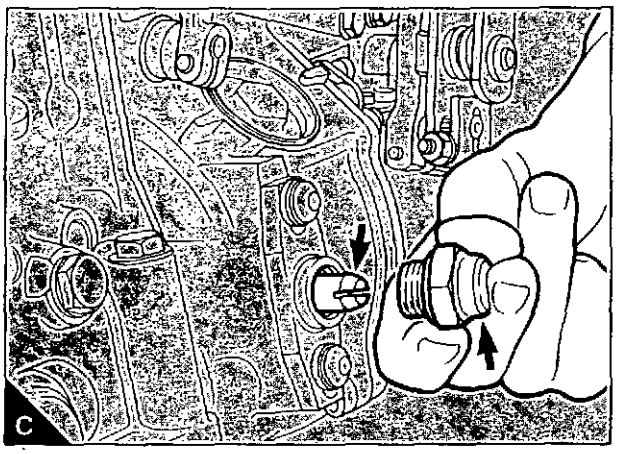
4 Continue turning the engine until the figure on the flywheel, corresponding to that stamped on the engine data plate, aligns with the timing pointer in the flywheel housing aperture.

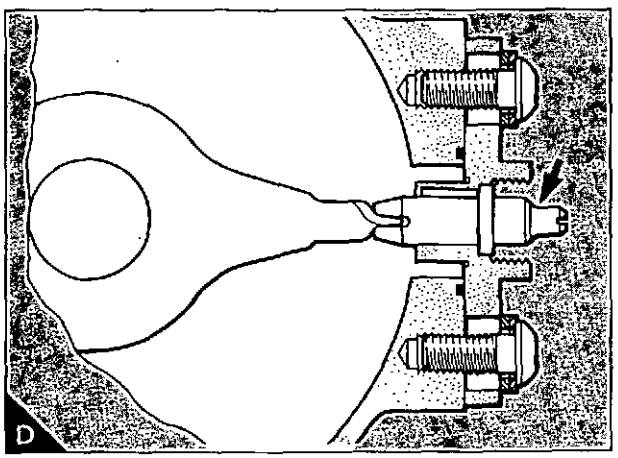
5 Remove the capnut (C) from the injection pump and withdraw the timing location device. Ensure the timing pointer (B) is now visible through the aperture.

6 Invert the timing location device and replace it in its original position with the location slot in a horizontal position. If the timing is correct the location device (D) will enter fully.



7 If the location device does not enter fully the timing is incorrect and the access cover (E) must be removed from the front of the engine.

8 Slacken the 4 gear securing bolts (F) and turn the pump camshaft with a 30 mm spanner until the location device enters fully under slight pressure.

9 Tighten the 4 gear securing bolts to a torque loading of 45 Nm (33 lbf ft) and withdraw the pointer location device.

10 Turn the engine backwards a minimum of 60 deg and proceed with a repeat of 4, 5 and 6 as previous.

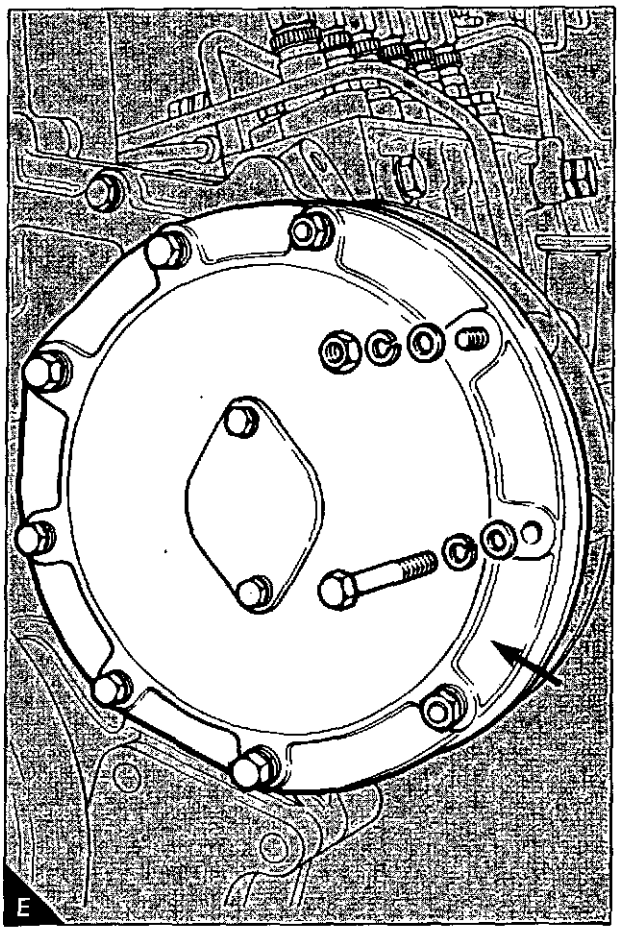
11 If timing still incorrect repeat 4 to 9 inclusive as previous.

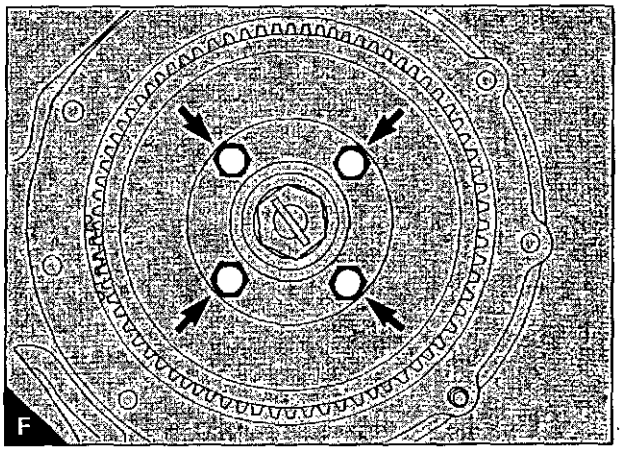
12 Proceed as follows when the timing is correct.

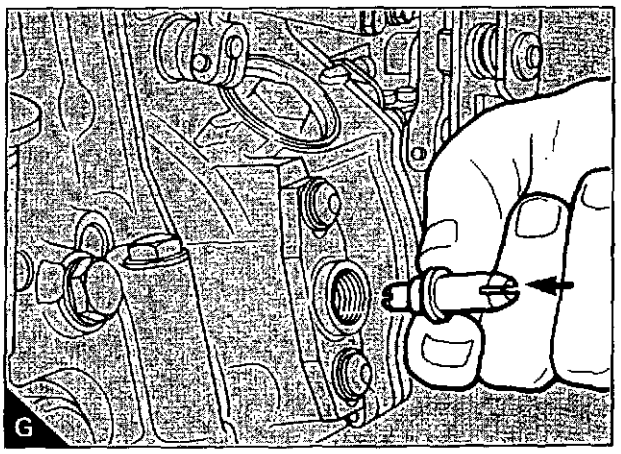
13 Refit the front access cover plate removed in 7.

14 Withdraw, invert and refit the timing pointer device (G). The pointer location slot MUST face outwards. Refit the capnut.

15 Refit the rocker cover, release the engine stop lever and refit the timing pointer cover plate to the flywheel housing.



## Fuel injection pump replacement

### Pump removal

1 Remove all the relevant pipework and linkage. Do NOT bend the pipes.

2 Remove the front rocker cover and turn the engine in the direction of rotation until No. 1 inlet valve closes.

3 Remove the pump access cover (A) from the front of the engine.

4 Unscrew and remove the four bolts 'B' retaining the pump drive gear together with the clamping plate; withdraw the drive gear.

5 Remove the four pump securing nuts and washers from the pump flange (C) and the two rear securing nuts, bolts and washers.

6 Carefully ease the pump towards the rear of the engine to remove.

7 Remove the pump hub for fitment to the replacement pump.

### Pump replacement

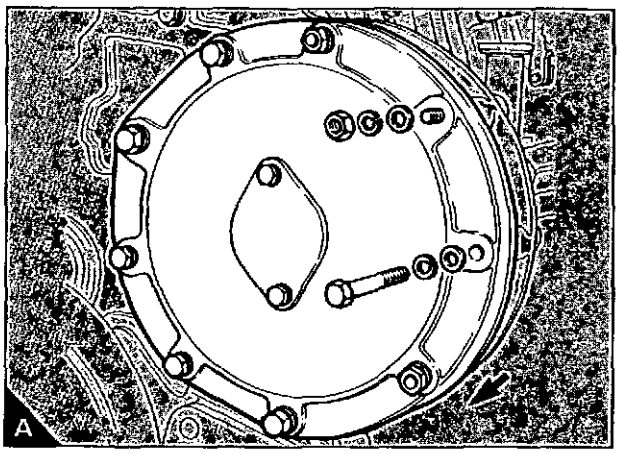
1 The injection timing position is stamped on the data plate affixed to the right hand side of the engine.

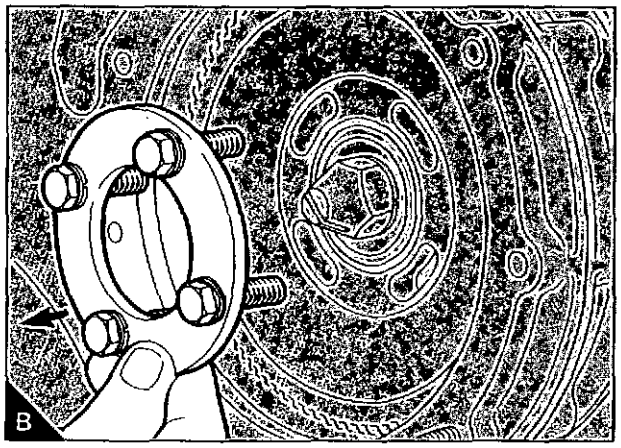
2 Turn the engine in the direction of rotation until the No. 1 inlet valve closes.

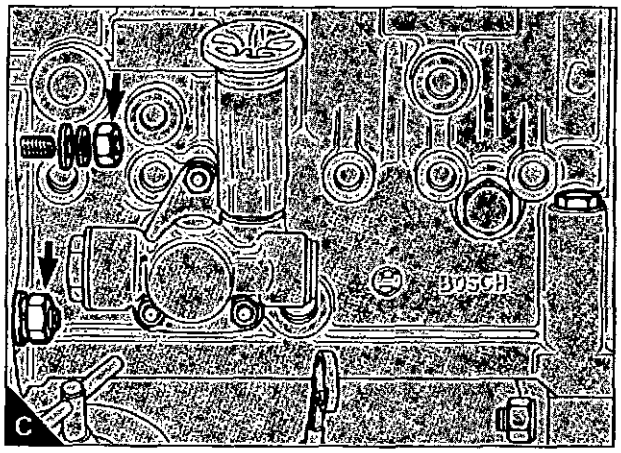
3 Remove the timing pointer cover plate from the lower right hand side of the flywheel housing (D).

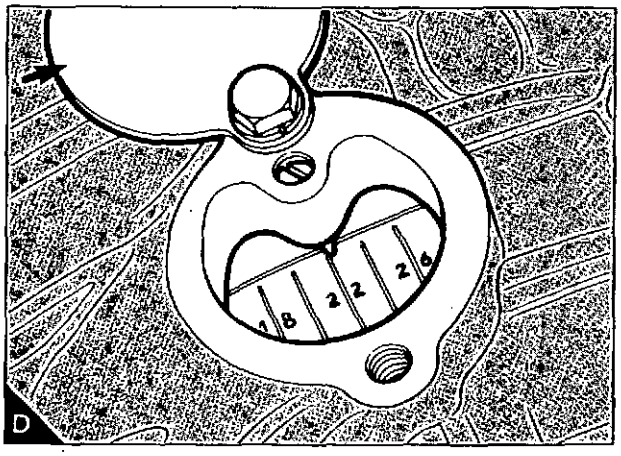
4 Continue turning the engine until the timing figure on the flywheel (corresponding to the injection timing on the data plate) aligns with the pointer in the flywheel housing aperture.

5 Fit the drive hub to the replacement pump and tighten the nut to a torque loading of 163 Nm (120 lbf ft).



**6** Fit the new 'O' rings; apply a light smear of linalube to the larger ring (E).

**7** Fit the fuel pump on the four studs in the rear of the wheelcase adaptor with the washers and nuts. Tighten to finger tight pressure only at this stage.

**8** Slacken the pump support bracket securing bolts (F). Do NOT disturb the bolts into the crankcase.

**9** Tighten the four flange securing nuts to a torque loading of 47 Nm (35 lbf ft).

**10** Refit and tighten the pump rear mounting bolts to a torque loading of 40 Nm (30 lb ft).

**11** Tighten the pump support bracket securing bolts.

**12** Remove the capnut and withdraw the timing pointer location device (G).

**13** Turn the pump camshaft using a 30 mm spanner until the timing pointer is visible in the centre of the aperture.

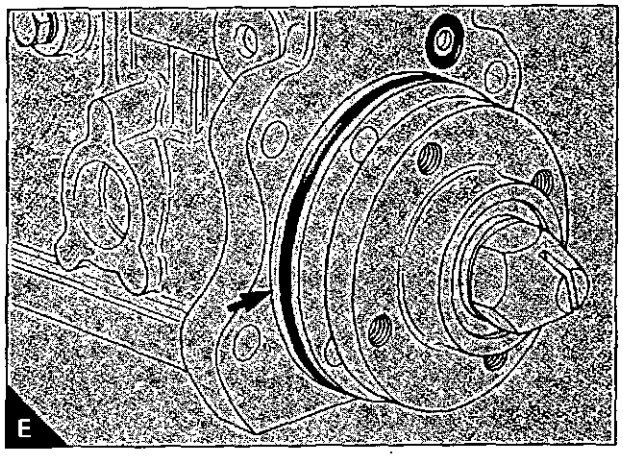
**14** Fit the pump drive gear with the hub bolt holes centrally positioned in the slotted holes in the gear.

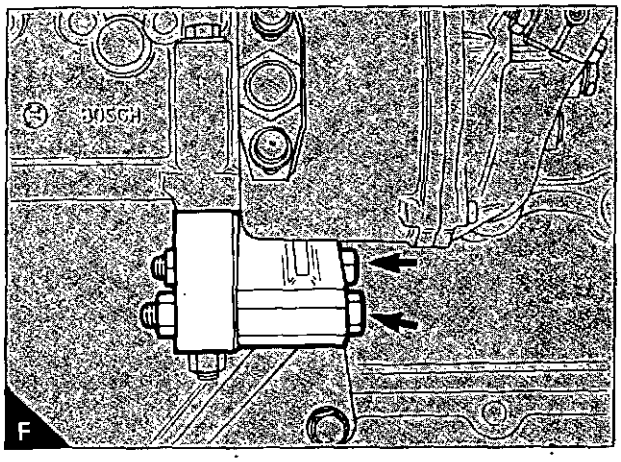
**16** Fasten the stop lever in the NO FUEL POSITION.

**17** Ensure the timing pointer location device is still positioned in the centre of the aperture.

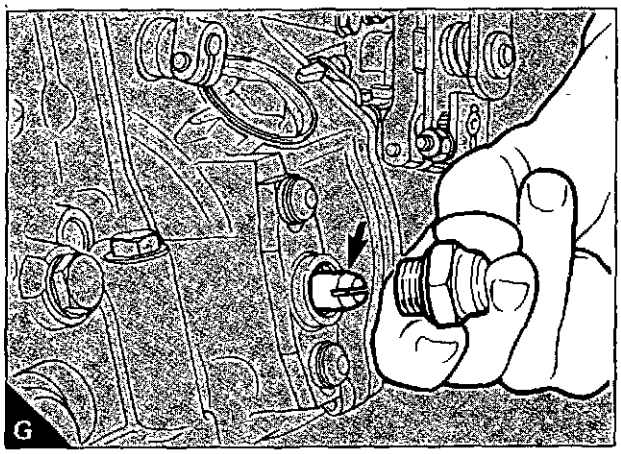
**18** Insert the timing pointer location device with the slotted end entered in a horizontal position.

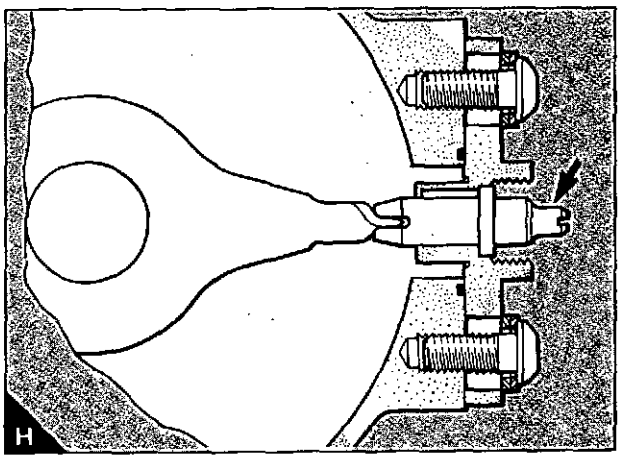
**19** If necessary turn the pump camshaft using a 30 mm spanner until the pointer location device enters fully (H).


E



F


G


H

**20** Tighten the pump drive gear securing bolts to a torque loading of 45 Nm (33 lbf ft).

**21** Withdraw the timing pointer device.

**22** Turn the engine backwards at least 60 degrees and repeat the timing check. Proceed when the timing is correct.

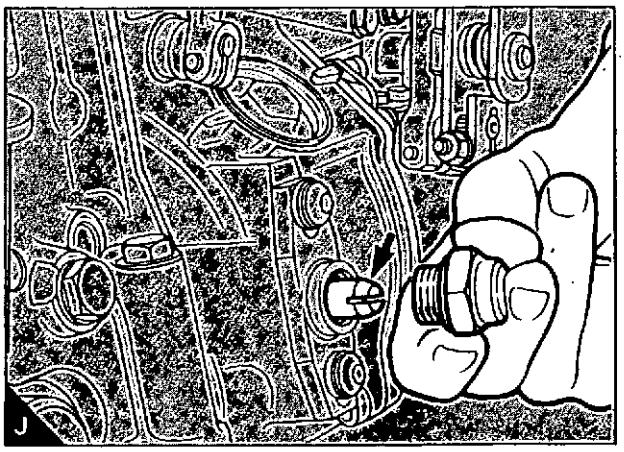
**23** Refit the front access cover plate.

**24** Insert the timing pointer location device with the location slot outwards and refit the capnut (J).

**25** Refit the front rocker cover.

**26** Refit the timing pointer cover plate to the flywheel housing.

**27** Release the stop lever to the RUN position.



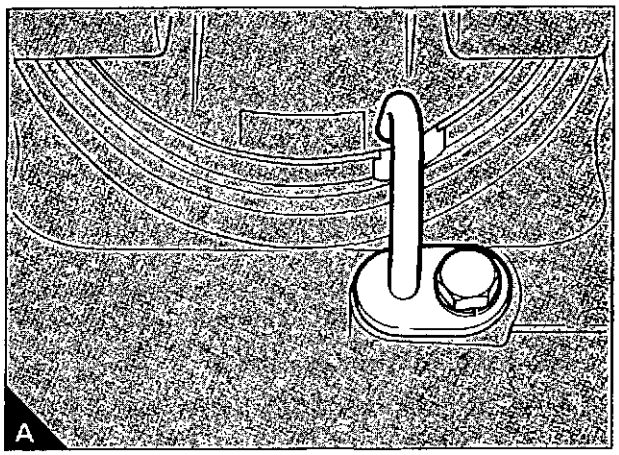
## Piston cooling

### Cooling jets

The jets are fitted to the crankcase at the bottom of each cylinder bore with a passageway into the main oil gallery. Engine lubricating oil is directed under pressure through the jet to the underside of piston for cooling purposes.

### Jet position

Each jet is secured in position by a setscrew and spring washer with an 'O' ring seal fitted on the underside. If a jet has been removed it must be refitted with the pipe centrally positioned in the slot in the piston skirt. Always blow through the jet with compressed air to ensure a clear passage before fitting.



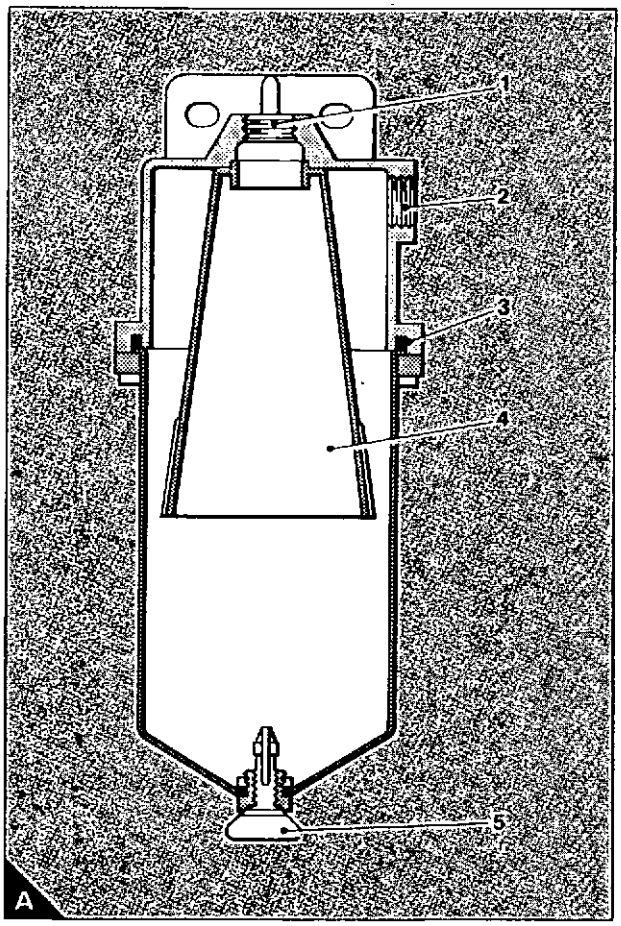
## Primary fuel filter

### Harwood separator/filter

The Harwood separator/filter (A) is mounted between the fuel supply tank and the feed pump and works on the centrifugal principle. Fuel is lifted from the supply tank by the feed pump and enters the filter through (A2). The fuel then swirls around the cone (A4) in the centre of the bowl, causing any sediment or water to be forced outwards and sink to the bottom of the bowl, before passing through (A1) to the fuel pump. A drain cock (A5) fitted in the base of the filter bowl should be removed at regular intervals to drain off any sediment or water which has accumulated. Always ensure the drain cock is firmly secured.

During engine overhaul, unscrew the three clamping ring setbolts and remove the filter bowl. Clean all the components with paraffin and blow dry using a compressed air jet.

Using a new sealing ring (A3), refit the bowl to the filter header, align the clamping ring and evenly tighten the three setbolts.



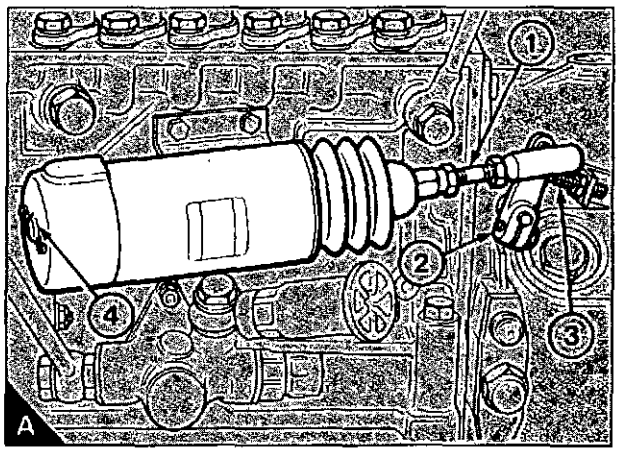
## Solenoid stop control

### Description

A Synchro-Start type solenoid switch is mounted to the side of the fuel injection pump. The solenoid is used in the energised-to-run mode and is connected, via a linkage, to the governor stop control lever.

On energising, the dual circuits in the solenoid actuate a plunger which, in turn, moves the stop control lever to the RUN position.

A pull-in coil draws in the plunger until the internal switch contacts are open. This breaks the circuit in the pull-in coil and leaves a low-consumption hold-in coil energised to maintain the stop lever in the RUN position. On de-energisation, a coil spring returns the plunger to its rest position and the stop control lever to STOP. This occurs when the STOP button is pressed, when an engine protection device breaks the circuit or, as the result of an electrical failure.




### Adjustments

Accurate setting of the linkage between the solenoid and stop control lever is essential to prevent possible burn-out of pull-in windings.

Adjust the linkage (A1) from the solenoid with the stop lever (A2) in the NO run position.

The linkage must be adjusted to give full travel of the fuel pump rack and rest firmly against the 'stop' (A3) in the NO run position. With the linkage correctly adjusted the button (A4) in the end of the solenoid should protrude 0.4mm (0.016 in) in the full run position.

## Starter Motor

### Description

The Butec LMS1 starter motor is an electrically operated 24 volt unit incorporating an externally-mounted solenoid switch. The drive gear engages with a starter ring which is an integral part of the flywheel assembly.

### Servicing

Periodically inspect the starter cables for damage, and ensure that the terminals and the starter securing bolts are tight.

Every 5000 hours running, or more frequently if found necessary, remove the leads from the battery.

Remove the starter motor and service as follows:

**1** Clean the exterior of the starter and remove the commutator cover. Use a jet of dry compressed air to blow away dust particles from the brush gear.

**2** Inspect the commutator for wear and damage; an even burnished dark copper colour indicates a satisfactory condition. Signs of wear or damage indicate that a new or reconditioned commutator is required.

**3** Ensure the brushes slide freely in their holders and check that their spring loading is 1.42 to 1.68 kgf (50 to 59 ozf). A significantly lower figure indicates worn bushes; minimum acceptable length 15.9mm (0.625 in).

**4** If new bushes are required they must be bedded to the commutator and the brush leads kept clear of other parts.

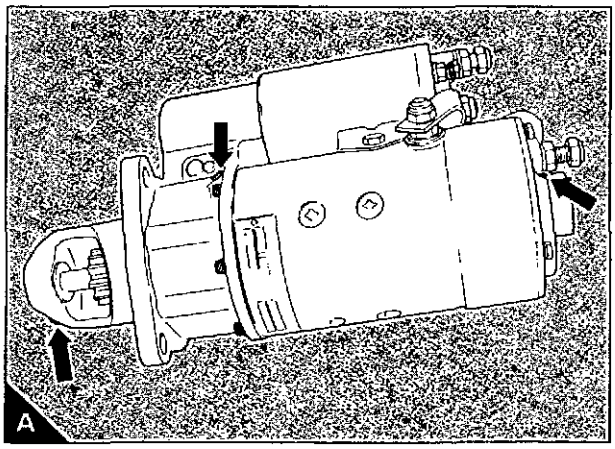
**5** Apply glycerine to the cover band gasket, and refit the band so that the joint is over the rib of the starter casing.

**6** Remove the screws from the three points arrowed on (A) and apply three or four drops of SAE 5W/20 engine oil to the lubricator wicks. Replace the screws.

**Note:** A replacement starter should also be lubricated in this manner before fitting.

**7** Clean the splines of the starter drive and lubricate with a thin film of graphite grease. Check that the pinion moves freely.

**8** Refit the starter to the engine, ensuring it is correctly located and the terminals are clean and firmly secured. Refit the battery leads.



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