

This handbook has been written and produced by the Service Publications Department of Perkins Engines Ltd., of Peterborough, England.

Every endeavour has been made to ensure that the information contained in this book is correct at the date of publication, but due to continuous developments, Perkins Engines Ltd., reserve the right to alter the contents without notice.

handbook for 4.212 4.236 4.248 diesel engines

Publication No. 201 SER 1075

Published by:—

Perkins Engines Ltd., Peterborough

Telephone Peterborough 67474

Telex 32132

Cables 'Perkoil' Peterborough

Date June 1972

PERKINS PARTS **for** **PERKINS PRODUCTS**

To ensure you obtain the best results from your engine and to safeguard your guarantee, fit only genuine Perkins Parts. These are readily obtainable throughout the world.

index

Air	32
Air Cleaner	20
Air Restriction Indicator	20
Altitude	8
Anti-Freeze	39
Approved Fuel Oil Specifications	10
Approved Lubricating Oils	38
Atomiser Faulty	34
Atomiser Replacement	35
Cold Weather Starting Aids	16
Data	11
De-aerating (bleeding) the Fuel System	12
Dynamo Rear Bush	25
Engine Identification	9
Engine Number	9
Engine Views	7
Fan Belt	24
Fault Finding	36
Fuel Filter Element Change	26
Fuel Oil and Storage	29
Hints	35
Introduction	5
Leaks	33
Lubricating Oils	32
Oil Filter Element Change	27
Overseas Companies	4
Parts Illustrations	51
Post Delivery Checkover	18
Precautions against Frost	39
Preparing the Engine for Return to Service	48
Preventive Maintenance	19
Running Adjustment	18
Running-in	18
Starting	15
Starting Difficulty	34
Stopping	15
Valve Tip Clearance	28
Withdrawing an Engine from Service	41

OVERSEAS COMPANIES

AUSTRALIA

Perkins Engines Australia Pty Ltd.,
P.O. Box 156, Dandenong, Victoria.
Telephone : 792-0431 Telex : 30816 Cables : "Perkoil" Melbourne

BRAZIL

Motores Perkins S.A.,
Caixa Postal 30,028 e Sao Paulo, Estado de Sao Paulo.
Telephone : 43-1499 Telex : 021851 Cables : "Perkoil" Sao Paulo

CANADA

Perkins Engines Canada Ltd.,
7 Meridian Road, Rexdale, Ontario.
Telephone : 677/4960 Telex : 0221225 Cables : "Perkoil" Toronto

FRANCE

Moteurs Perkins S.A.,
55 Boulevard Ornano, 93 Saint-Denis.
Telephone : 243-04-40 Telex : 62251 Saint-Denis Cables "Perkoil" Paris

GERMANY

Perkins Motoren GmbH,
8752 Kleinostheim, Postfach 12.
Telephone : 06027/291 Telex : 4188869

ITALY

Motori Perkins S.P.A.,
22100 Como-Camerlata, Via Pasquale Paoli 9/A.
Telephone : 504885 Telex : 38063 Cables : "Perkoil" Camerlata

SOUTH AFRICA

Perkins Engines (Pty) Ltd.,
6th Floor, Dunwell Building, 35 Jorissen Street, Braamfontein, Johannesburg
Telephone : 725-5715 Telex : 0037 Cables : "Perkoil"

UNITED STATES OF AMERICA

Perkins Engines Inc.,
P.O. Box 283, 24175 Research Drive, Farmington, Michigan 48024.
Telephone : 313-477-3900 Telex : 023-5300 Cables : "Perkoil" Farmington

ASSOCIATE COMPANIES & MANUFACTURING LICENSEES

ARGENTINA

Perkins Argentina S.A.I.C.,
Bolivar 368, Buenos Aires
Telephone : 33-8231/36 Telex : 121162 Cables : "Perkinsa"

INDIA

Simpson & Co. Ltd.,
P.O. Box 303, 202/203 Mount Road, Madras 2.
Telephone : Madras 83091 (PABX - 10 lines) Telex : 41-538 Cables : "Simpsons"

JAPAN

Toyo Kogyo Co. Ltd.,
6047 Fucho-Machi, Aki-gun, Hiroshima.
Telephone : Hiroshima 62-1111 Telex : Japan 652-333

MEXICO

Motores Perkins S.A.,
Tiber No. 68 1er Piso al Mexico 5 D.F.
Telephone : 528-61-67 Telex : Perkins Mex 071-71-347 Cables : "Perkoilmex"

SPAIN

Motor Iberica S.A. (Division Perkins),
Avenida de Aragon 130, Madrid 27.
Telephone : 205 00 40 Telex : 27324 Cables : "Perkoil" Madrid

YUGOSLAVIA

Industrija Motora Rakovica,
Patrijarha Dimitrija 7-13, Rakovica, Belgrade.
Telephone : 562-043/562-322/562-992 Telex : 11341 YU IMR Cables : "Indmotor" Beograd

In addition to the above, there are Perkins Distributors in the majority of leading countries throughout the world. For further details, apply to Perkins Engines Ltd., Peterborough or to one of the above companies

Introduction

This handbook has been written to assist the owner/operator in the correct starting, stopping and maintenance procedure he should use so that his engine can give him continued reliability until repairs or replacement parts become necessary, due to normal wearing of the engine component parts.

Over many years, it has been our experience that owners who conform to the maintenance periods listed in our Service Publications and to the recommended procedures, are those who obtain the best service from their engine.

We have also found that a majority of complaints raised against our engines have been associated with bad maintenance, in particular, with lack of attention to the **LUBRICATING OIL CHANGE**, the **FUEL AND OIL FILTERS** and the **AIR CLEANER**. Should you consider you are working in unusually dusty or heavy, arduous conditions then you should carry out the preventive maintenance more often than is indicated in this handbook. We cannot stress enough the importance of **KEEPING YOUR ENGINE CLEAN INSIDE** as well as outside.

For engines fitted with **DRY TYPE AIR CLEANERS**, there are devices known as **RESTRICTION INDICATORS** which can be fitted to the induction system to indicate that the air cleaner needs attention, and it is suggested that you have one fitted to your engine to warn you of the necessity to **CLEAN** your **AIR CLEANER**.

Repairs or adjustments to your engine should be carried out by a Perkins trained engineer whose services are usually available at the supplier of the vehicle or machine.

Spare parts, service, advice as well as the benefit of a trained engineer may be had at your local Industrial Distributor in the United Kingdom, or for overseas operators, our various Overseas Companies and Distributors will offer the same service.

Workshop Manuals are also available from the same sources for a reasonable charge.

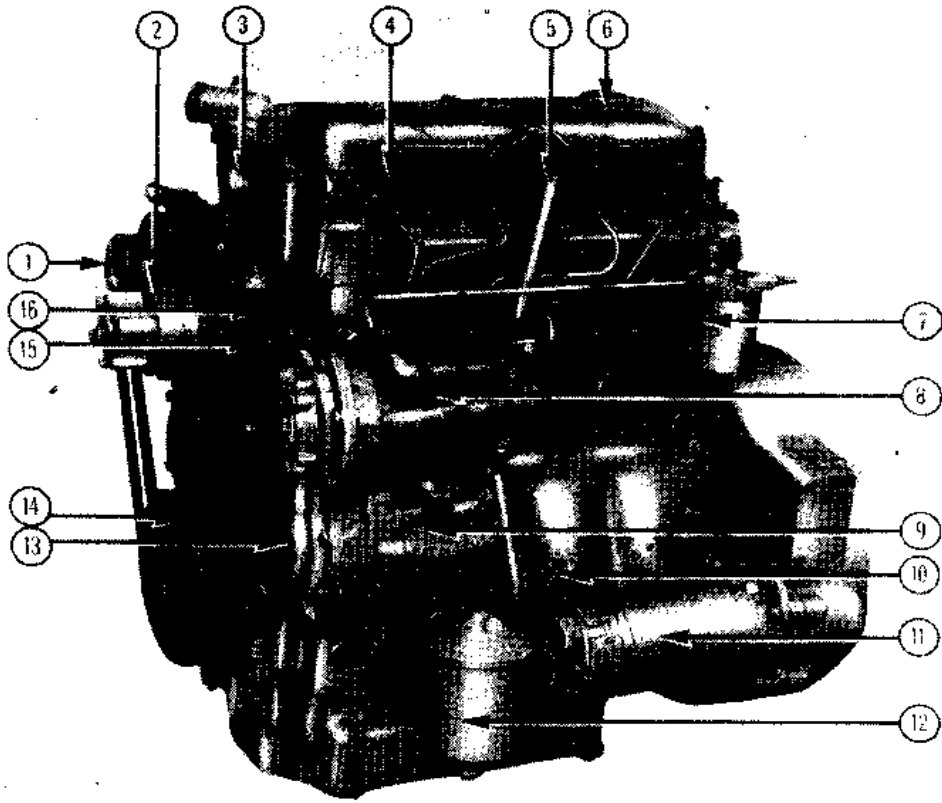
The **ANCILLARY EQUIPMENT** fitted to 4.212, 4.236 and 4.248 engines will vary in accordance with the type of application to which it is fitted.

Repairs or replacements for worn parts, or any problems concerned with the ancillary equipment can be dealt with by the supplier of the vehicle or plant. If this is not possible, you should contact your nearest U.K. Distributor or Overseas Distributor for assistance.

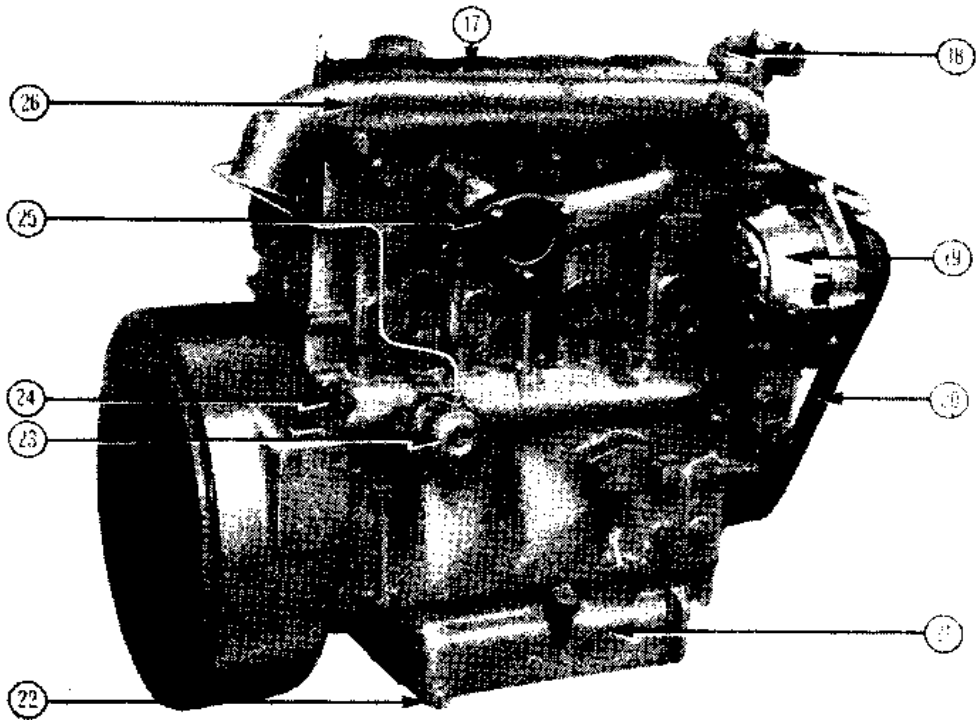
INDEX TO ENGINE PHOTOGRAPHS

- 1 Alternator Pulley
 - 2 Water Pump Pulley
 - 3 Thermostat Housing
 - 4 Atomiser
 - 5 Breather Pipe
 - 6 Lubricating Oil Filler Cap
 - 7 Fuel Oil Filter
 - 8 Fuel Injection Pump
 - 9 Exhauster
 - 10 Dipstick
 - 11 Starter Motor
 - 12 Lubricating Oil Filter
 - 13 Timing Case
-

- 14 Crankshaft Pulley
- 15 Water Pump
- 16 Water Inlet
- 17 Rocker Cover
- 18 Water Outlet
- 19 Alternator
- 20 Fan Belt
- 21 Sump
- 22 Sump Drain Plug
- 23 Fuel Lift Pump
- 24 Cylinder Block Drain Tap
- 25 Exhaust Manifold
- 26 Induction Manifold



View of Fuel Pump side of Engine.



View of Camshaft side of Engine

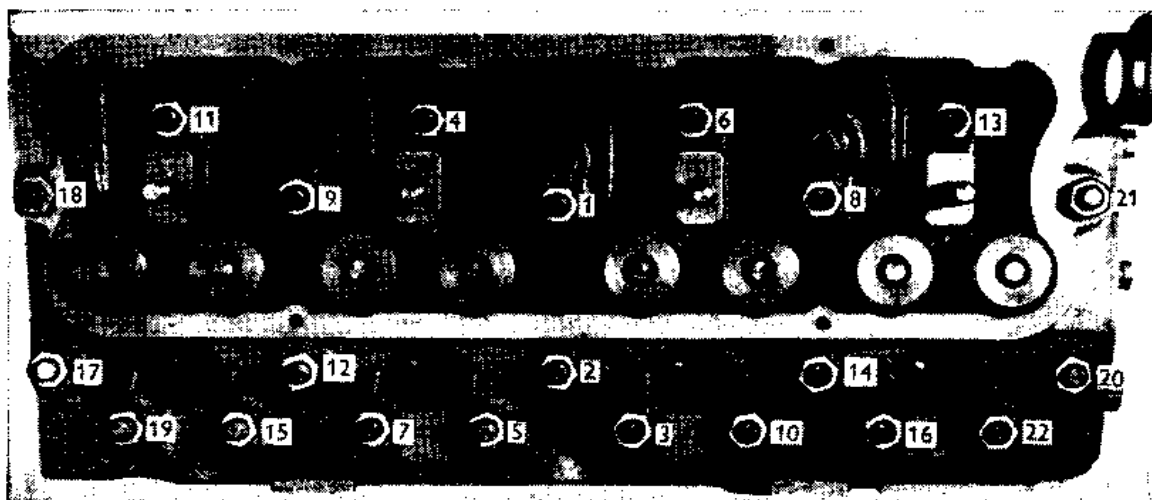


Fig. 1.

Torque tightening sequence for Cylinder Head Nuts.

(90 lbf ft (12,5 kgf m) for $\frac{1}{2}$ in studs)

(60 lbf ft (8,5 kgf m) for $\frac{3}{8}$ in studs)

YOU MUST ENSURE THAT THE MAINTENANCE JOBS ARE DONE AFTER THE CORRECT PERIOD HAS ELAPSED OR EVEN EARLIER IF CONSIDERED ADVANTAGEOUS OR NECESSARY.

ALTITUDE

If it is necessary to operate continuously at altitudes above 2,000 ft (600 metre) then it may be necessary to derate the engine by reducing the amount of fuel being fed into the engine. The C.A.V. dealer in your territory or Perkins Engines Ltd., will advise.

ENGINE IDENTIFICATION

This particular engine is known as the 4.212, 4.236 or 4.248 and if you have cause to communicate with anyone concerning Service or Parts requirements then you should always quote the type of engine, its **full** engine number and the vehicle or machine it is fitted in.

The **ENGINE NUMBER** will be found stamped on a machined pad on the side of the cylinder block to which the fuel lift pump is fitted. The exhaust manifold is on the same side.

A typical engine number would be: 236 U 1784 but there may be other letters following the letter U as well as after the last number. Please quote **all** the numbers and letters in the same sequence they are stamped on the engine.

The illustration below indicates where the engine number may be found.

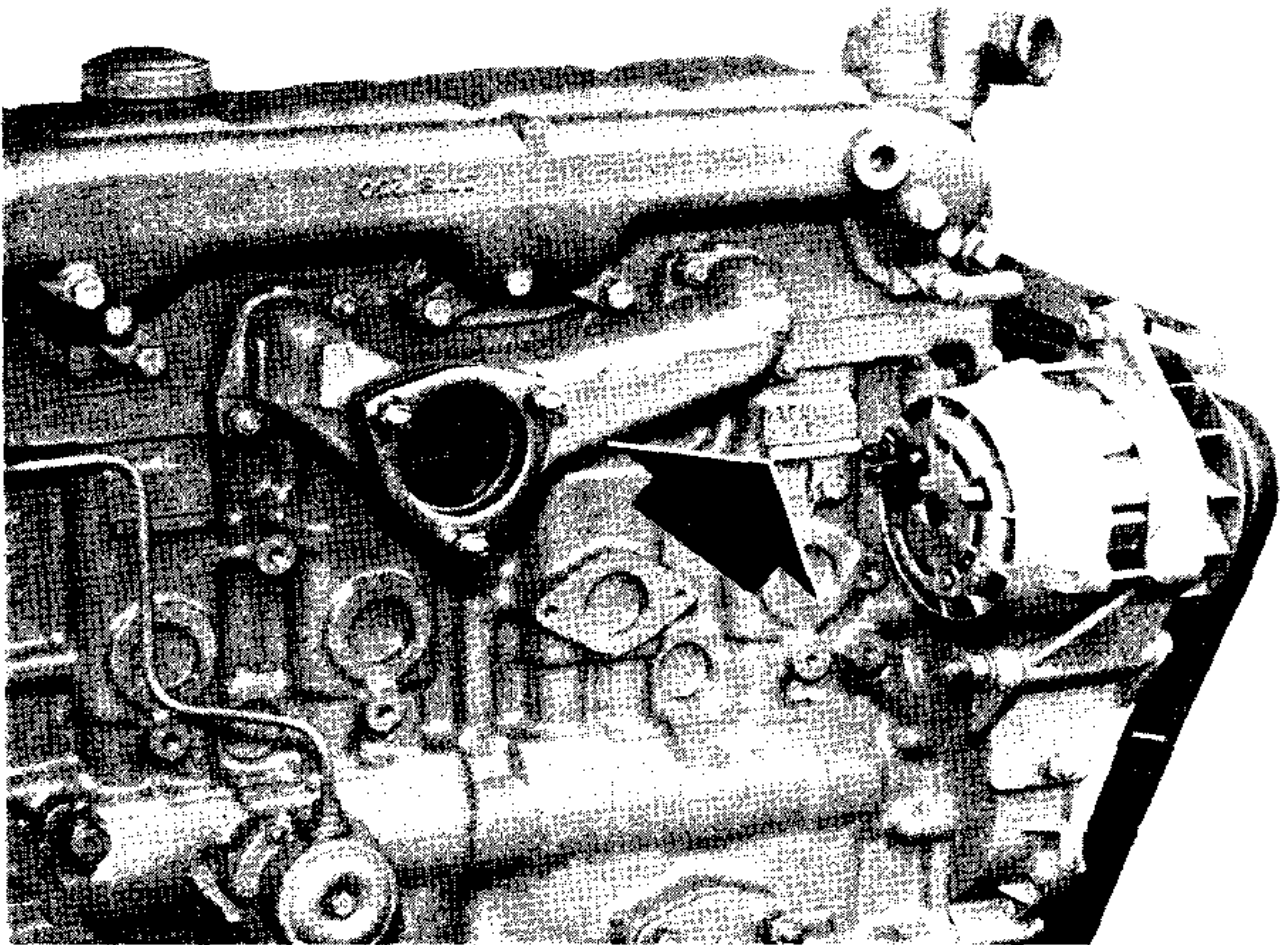


Fig. 2
Engine Number Location

approved fuel oil specifications

United Kingdom	BS.2869:1967	Class A.1 or A.2
United States	VV-F-800a A.S.T.M./D975-66T (J.O. 14/9/57)	Grades DF-A, DF-1 or DF-2 Nos. 1-D or 2-D Gas Oil or Fuel Domestique
France	(J.O. 14/9/57)	Grade Special or Grade A
India	IS: 1460/1968	—
Germany	DIN-51601 (1967)	—
Italy	CUNA-Gas Oil NC- 630-01 (1957)	—
Sweden	SIS. 15 54 32 (1969)	—
Switzerland	Federal Military Spec. 9140-335-1404 (1965)	—

Fuel Oils available in territories other than those listed above which are to an equivalent specification may be used.

engine data

Type	Four cylinder, Four Stroke, Direct Injection
Bore (4.212 and 4.236)	3.875 in (98,43 mm) Nominal
Bore (4.248)	3.975 in (100,96 mm) Nominal
Stroke	5 in (127 mm)
Compression Ratio	16 : 1
Cubic Capacity (4.212)	212.3 in ³ (3,48 litres)
Cubic Capacity (4.236)	235.9 in ³ (3,86 litres)
Cubic Capacity (4.248)	248 in ³ (4,06 litres)
Firing Order	1,3,4,2.
Valve tip clearance	0,012 in (0,30 mm) Cold
Engine Number Location	Exhaust side of engine.
Lubricating oil pressure	30—60 lbf/in ² (2,1—4,2 kgf/cm ²) at maximum speed and normal operating temperature.
Sump Capacity	Varies according to application. Use indicated level on the dipstick with vehicle or machine on level ground.

de-aerating the fuel system

This procedure is otherwise called "bleeding" the system (of air).

Air in the fuel system can cause difficult starting, erratic running and loss of power.

Air can enter the fuel system, as the result of running out of fuel, leaks in the system, changing filters or pipes, or any disturbance of any fuel connection.

Bleed the system as follows:--

Slacken the air vent screw near the top of the governor control cover (Mechanical Governor) see fig. 3; or on the control gear housing (Hydraulic Governor) see fig. 5.

Slacken the vent screw on the hydraulic head locking screw on the side of the fuel pump body, see fig. 4.

Unscrew, by two or three turns, the vent plug on the top of the fuel filter cover, see fig. 6. (Not the return pipe to the tank).

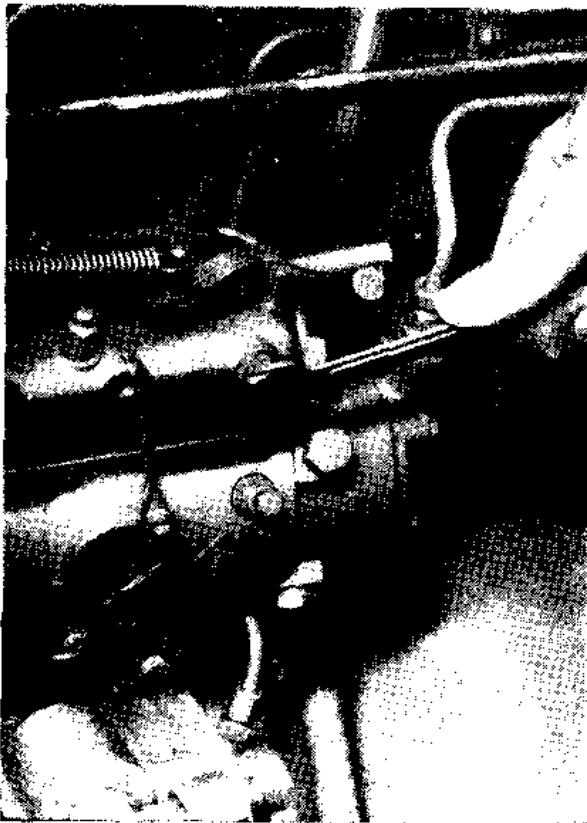


Fig. 3.

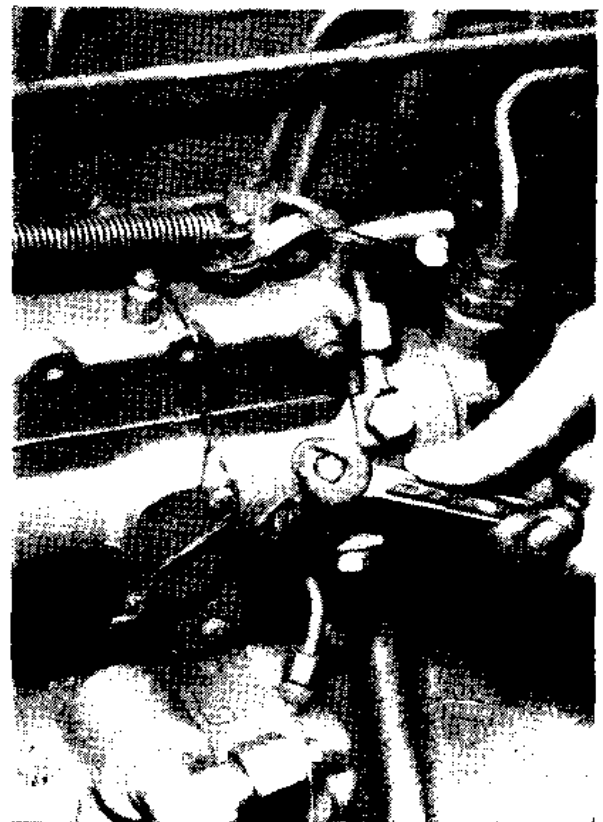


Fig 4

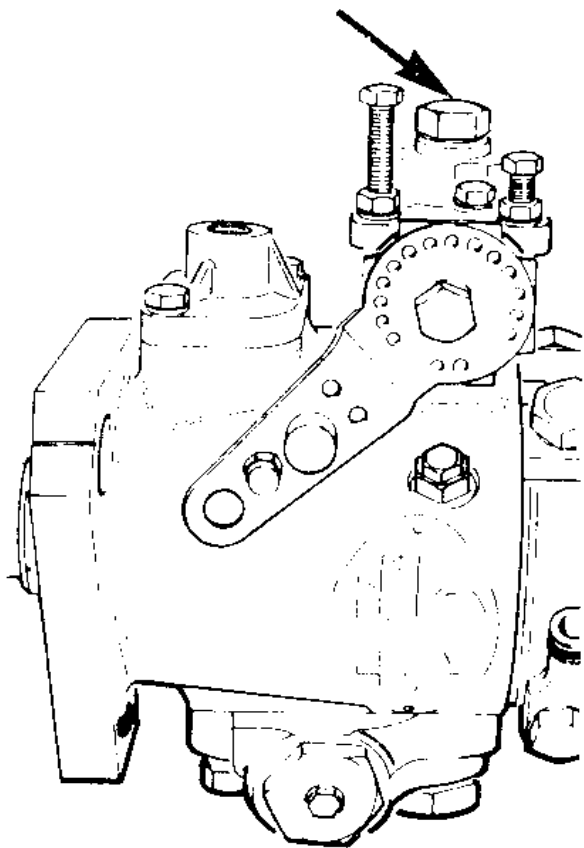


Fig. 5.



Fig. 6.

Operate the priming lever of the fuel lift pump (see fig. 7) and when fuel, free from air bubbles, issues from each venting point, tighten the screws in the following order:—

1. Fuel filter cover vent screw.
2. Head locking screw.
3. Governor vent screw.

Slacken the pipe union nut at the fuel injection pump inlet, (see fig. 8) operate the priming lever on the lift pump and re-tighten when fuel, free from air bubbles, issues from around the threads.

Slacken the unions at the atomiser ends of two of the high pressure fuel pipes.

Set the accelerator at the fully open position and ensure that the stop control is in the "run" position.

Turn the engine until fuel oil, free from air bubbles, issues from both fuel pipes.

Tighten the unions on the fuel pipes, and the engine is ready for starting.

If the cam on the engine camshaft operating the fuel lift pump is on maximum lift, it will not be possible to operate the hand primer. If such a condition arises then the engine should be turned one complete revolution.

If, after bleeding the fuel system, the engine starts and runs satisfactorily for a few moments and then the same symptoms recur and when checked the system is found to be full of air; then a leak on the suction side is indicated.

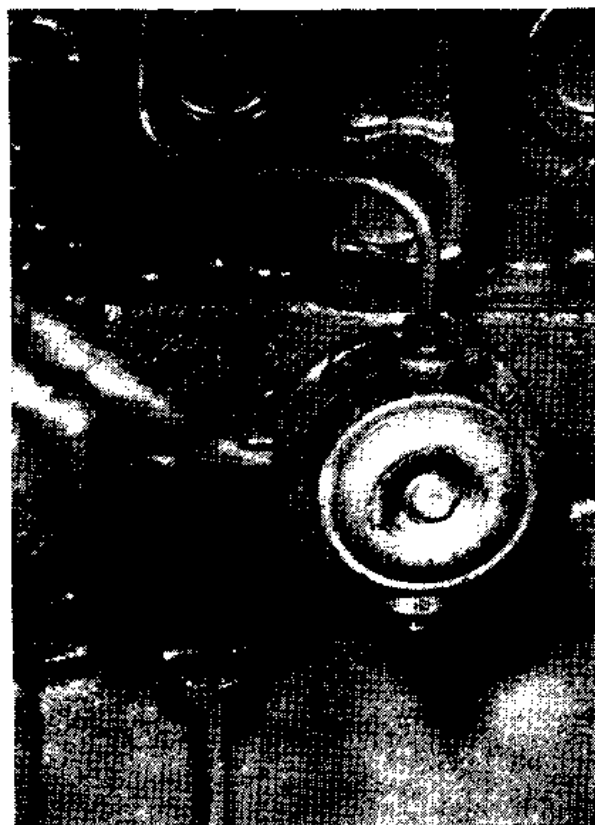


Fig. 7.

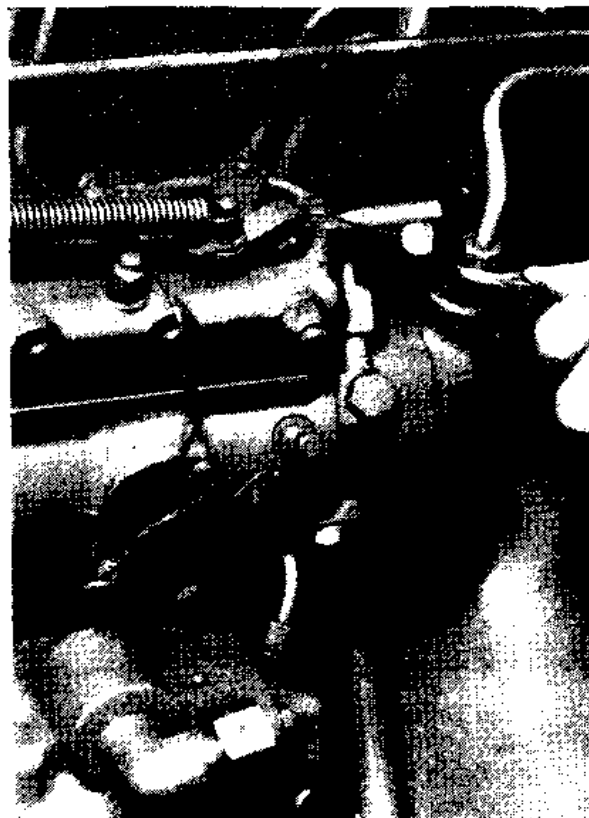


Fig. 8.

starting the engine

Under warm conditions it is only necessary to engage starter motor by turning the "ignition" type key to the position "HS" at the same time adjusting the engine speed control. On some applications a button type switch is fitted. Always ensure the stop control is in the "run" position.

As soon as the engine starts, release the starter switch or button. Always ensure that the flywheel and starter pinion have stopped rotating before attempting to re-engage the starter motor, otherwise the starter ring or pinion gear, or both, may be damaged.

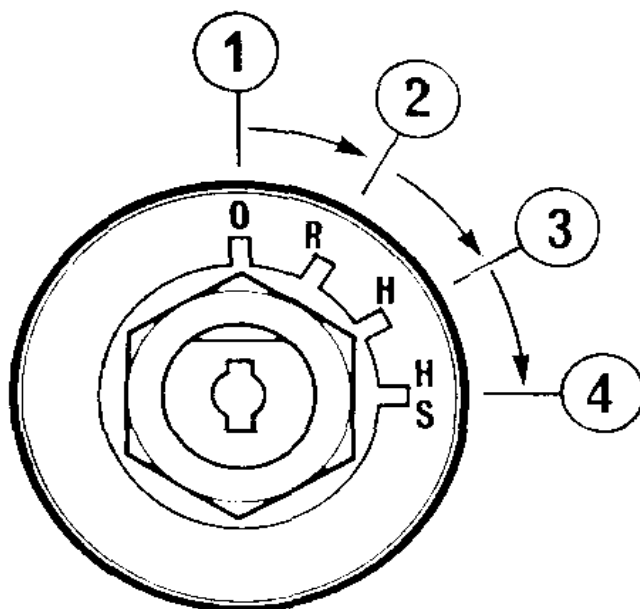


Fig. 9.
Heat/Start Switch.

- | | |
|------------------|-----------------------------|
| 1. Off Position. | 3. Heat Position. |
| 2. Run Position. | 4. Heat and Start Position. |

To Stop the Engine

A spring loaded stop control is usually situated near the normal engine controls and it is only necessary to pull out the stop control until the engine ceases to rotate. Ensure the engine movement has completely stopped before returning the control to the normal "running" condition. Turn start switch to the "O" position.

cold weather starting aids

Different types of cold starting devices may be found fitted to Perkins Diesel Engines depending upon the manufacturer of the vehicle or machine.

Cold starting aids consist of the C.A.V. Thermostart, the Start Pilot Viso-F, and the Turner Quick-Start.

To operate the Thermostart, ensure that if a tap is fitted in the fuel pipe to the unit in the induction manifold, it is turned to the "ON" position. Operation may be an electrical ignition type of rotary switch, or by push button. Turn the rotary switch to the "H" position or push the button marked "HEATER" and hold for fifteen seconds. Adjust the engine speed control to maximum speed position and turn the rotary switch key to the "HS" position or depress the "STARTER" button whilst still holding down the "HEATER" button.

If the engine fails to start after about fifteen seconds, disengage the starter and return to the heat position for a further ten seconds before re-engaging the starter motor. Under certain cold conditions i.e. temperature below 0°F (—18°C) it may be found helpful to retain the "HEAT" position for a further ten seconds after the engine has started, but with the starter disengaged. Having started the engine turn off the tap that may be fitted in the fuel supply pipe to the Thermostart.

If any difficulty is experienced, check that fuel is reaching the starting aid. Operation of the Thermostart can be seen in most cases, by removing the air cleaner or induction trunking. The unit should glow when the "Heat" position is engaged and the fuel becomes ignited on engagement of the starter motor.

To attempt to use the Thermostart without a supply of fuel will result in the unit becoming burned out.

When Start Pilot equipment is fitted, use of any heater device is strictly prohibited.

The pump should not be used until the starter motor has been engaged. In very cold conditions it may be necessary to assist engine running with a further one or two strokes of the pump to attain steady running.

To charge the container with fluid using only Start Pilot Multi-fill Can Type F, lift the hinged cover of the VISO-F reservoir. Press the can, head down, onto the filler valve and retain in a square position until fluid flows into the transparent bowl. **Do not allow the fluid level to rise above the maximum indicated by arrow markings on the bowl.**

The Start Pilot Viso-F unit incorporates an outlet check valve which minimises the risk of fluid loss during engine running time. Experience will show how much fluid is required for a single start under various temperatures and it is desirable to charge the reservoir with just sufficient fluid for a single start, especially when the unit is mounted near the engine.

Very little maintenance is required for the Start Pilot equipment but observation of the following points will ensure efficient operation.

The air filter fitted at the outward end of the V20S pump cylinder should occasionally be examined and if necessary, removed and washed in Kerosene. A thin smear of light lubricating oil may be applied to the cylinder.

The spray nozzle may become partially blocked and this can be cleaned by dismantling from the engine induction manifold and washed in Kerosene.

If any starting difficulty is experienced do not continue using the Start Pilot pump but have the problem investigated by an experienced fitter.

Turner Quick-Start devices may only be found fitted to vehicles or machines manufactured in the U.S.A. At the time of writing we have no knowledge of manufacturers outside the U.S.A. who fit Turner Quick Start but there may be some.

Procedure for using this cold starting aid is as follows:—

Crank the engine over to break the drag of the oil film and when engine flywheel has stopped rotating, inject a measure of "Quick Start" by pulling out the knob and pushing it back just once. Pull out the "Quick Start" knob prior to starting.

Engage the starter motor and after one complete revolution of the engine push in the "Quick Start" knob.

It may be necessary to assist continuous running by injecting more fluid by further strokes of the "Quick Start" knob.

CAUTION

The Start Pilot VISO-F unit and the Turner Quick Start device both use high energy fuels with low combustion temperatures or flash points, therefore you are warned that these aids should only be used to start very cold engines. If used carelessly or excessively or for the purpose of obtaining a boost of power, serious damage can occur to the engine for which we, as diesel engine manufacturers, cannot be held liable. If any damage does occur for the reasons stated, they are usually readily identified.

running in

To obtain the best results from your new or replacement 4.212, 4.236/4.248 engine, it should be operated within reasonable limits and not at maximum engine speed for the first 500 miles (800 km) or 25 hours.

FIRST 25/50 HOURS SERVICE

After a customer has taken delivery of his engine, a general service must be carried out after the first 500/1,000 miles (800/1,600 km) or 25/50 hours in service and must include the re-tightening of the cylinder head nuts in the correct sequence. With the engine thoroughly warmed through, the service should include the following:—

1. Drain the lubricating oil sump and refill to the correct level with clean new oil. See Page 38. (Do not overfill). Use correct temperature grade and specification. Renew lubricating oil filter element.
2. Remove the rocker assembly; tighten the cylinder head nuts in the correct sequence (see fig. 1) and to the correct torque of 90 lbf ft (12,5 kgf m) for $\frac{1}{2}$ in studs, 60 lbf ft (8,5 kgf m) for $\frac{5}{16}$ studs.

$\frac{1}{2}$ in studs are fitted to all 4.212 and 4.248 engines and to 4.236 engines as from the following Eng. Nos.

General	4702000
Exclusive to International Harvester Co.	4102000
Exclusive to Gebr Claas	4202000
Exclusive to Commer Cars	4402000

Later engines have studs and setscrews for securing the cylinder head.

3. Reset the valve tip clearance to 0.012 in (0,3 mm) with the engine cold (see page 28).
4. Check the tension of the fan belt (see page 24).
5. Check the tightness of all external nuts, setscrews, mountings etc.
6. Start the engine and check for any fuel, coolant or lubricating oil leaks. Check oil feed to rockers.

RUNNING ADJUSTMENT

The driver or user of this engine should not interfere with the idling or maximum speed settings. Whilst the engine unit is under the manufacturers guarantee, the breaking or interference of the fuel pump seals by an unauthorised person may possibly render the guarantee null and void, because interference with the speeds set by the manufacturer can cause considerable damage to the engine and/or transmission.

preventive maintenance

DAILY

Check coolant level.

Check sump oil level.

Check oil pressures (where gauge fitted).

In extreme dust conditions, clean oil bath air cleaner or empty dust bowl on dry type air cleaner.

EVERY 200 HOURS, 5,000 MILES (7,500 km) or 4 MONTHS (WHICHEVER OCCURS FIRST)

Drain and renew engine lubricating oil (see page 32).

Renew lubricating oil filter element.

Clean oil bath air cleaner or empty dust bowl on dry type cleaner.

Check drive belt tension.

Check for oil, water or fuel leaks

Clean fuel water trap (where fitted).

Lubricate dynamo rear bush (where fitted).

EVERY 400 HOURS, 10,000 MILES (15,000 km or 12 MONTHS) (WHICHEVER OCCURS FIRST)

Renew final fuel filter element (agricultural and industrial).

Check hoses and clips.

Clean lift pump sediment chamber.

Clean element of dry type air cleaner or renew (if not indicated earlier)

EVERY 800 HOURS, 20,000 MILES (30,000 km) — (WHICHEVER OCCURS FIRST)

Renew final fuel filter element (vehicle applications).

EVERY 2,400 HOURS, 60,000 MILES (90,000 km) — (WHICHEVER OCCURS FIRST)

Arrange for examination and service of proprietary equipment i.e. compressor/exhauster, starter motor, dynamo etc.

Service atomisers.

Check and adjust tappets.

instructions for maintenance

AIR CLEANERS

Operating conditions play an important part in deciding how frequently it is necessary to service the air cleaner. If you are working in dusty conditions then the air cleaner should be attended to every day, as indicated under "Preventive Maintenance".

If not already fitted, you should consider the fitting of a 22 in water gauge RESTRICTION INDICATOR in the air trunking between the air cleaner and the engine induction manifold. It indicates by means of a visual signal when the air cleaner element needs servicing.

A means of visual signalling for the "Rotopamic" type air cleaner failure is the use of the "DUST SIGHT". A window in this device becomes cloudy when the system has failed, but this type of indicator is usually only used with the two stage extreme heavy duty cleaners.

The type of air cleaner fitted to your vehicle or machine depends upon the manufacturer of your equipment. Usually, guidance for the method of servicing is shown on the body of the air cleaner, but the following advice will also help.

DRY TYPE TWO STAGE "CYCLOPAC" See fig. 10

The dust bowl collects the heavier particles which are thrown out by the centrifuge path of the air. This dust enters the bowl by the slot in the baffle plate. The level of dust in the bowl must not be allowed to reach to within half an inch of the slot in the baffle plate.

Some types of two stage cleaners have an upper body and a lower body, the upper body containing the replaceable dry type element and the lower body contains tubes which perform the initial separation of the dust.

With horizontal installations the slot in the baffle is located at the top.

Remove the dust bowl by releasing the pinch screwed clamp. Remove the baffle from the interior of the dust cup by lifting it out, which gives access to the dust for removal. The element can be removed by releasing the wing nut.

Renew the element or clean by back flow air pressure no more than 100 lbf/in² or washing in a non foaming detergent as recommended by

the air cleaner manufacturers. Allow the element to soak for at least ten minutes and then gently agitate. Rinse the element with clean water and allow to dry. Do not use oven heat.

WARNING. There is a danger that some of the dust remaining in the element after it is washed will be pulled through into the engine if the element is replaced in a wet condition. The reason for this is that the water acts as a carrier for the dust.

Inspect the element by placing a bright light in its centre. Any pin holes, thin spots or ruptures render the element unfit for further use. This cleaning procedure reduces the effective life of the element.

With all dry type elements, they should be renewed after six cleanings or once a year, whichever occurs first.

Never use petrol (gasoline) for cleaning.

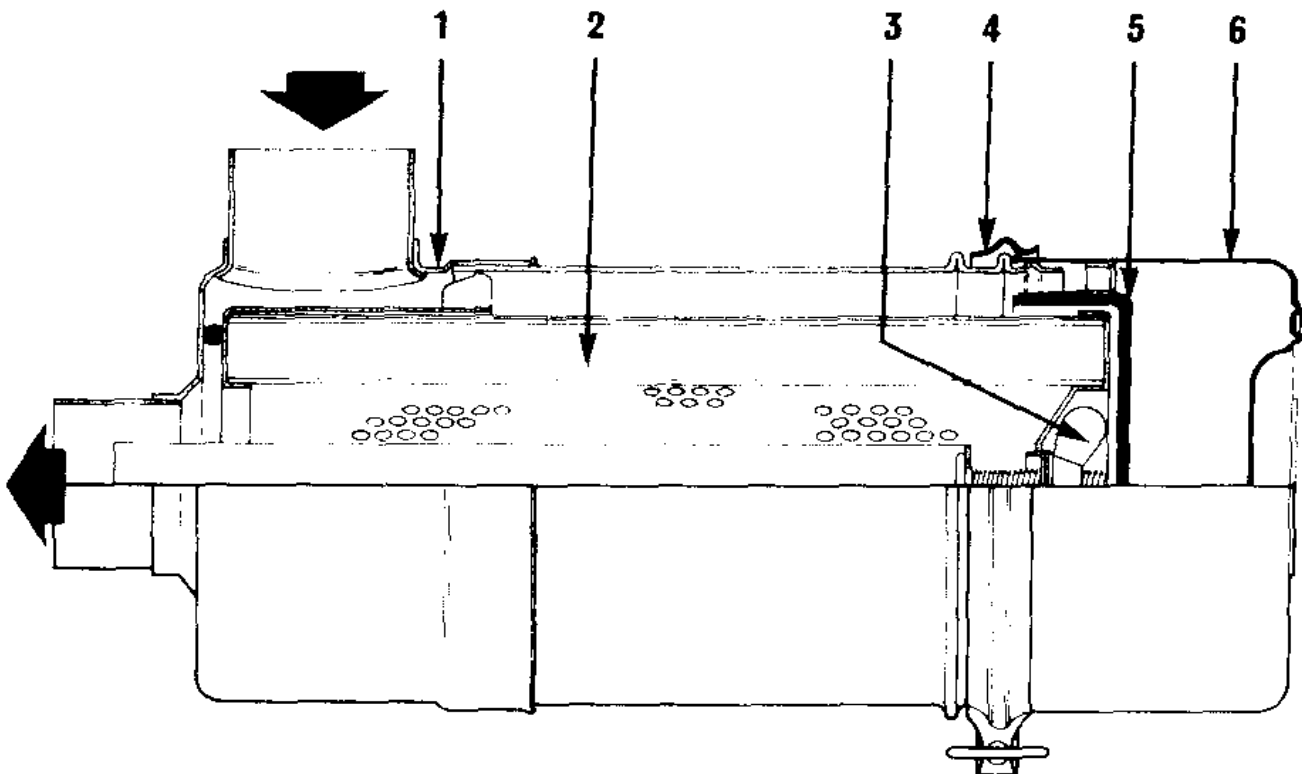


Fig. 10.

Dry Type Two Stage Air Cleaner.

- | | | |
|-------------------|---------------------|-----------------------------|
| 1. Body Assembly. | 2. Element Assembly | 3. Nut and Gasket Assembly. |
| 4. Clamp Assembly | 5. Baffle Skirt. | 6. Cup Assembly. |

EXTREME HEAVY DUTY TWO STAGE, WITH MULTIPLE ELEMENTS "ROTOPAMIC" — See Fig. 11

The "Rotopamic" type air cleaner may be fitted where the application is designed to work in heavy concentrations of dust and a restriction indicator must be fitted.

The air cleaner elements are replaceable and no attempt should be made to clean or re-use dirty elements or cartridges.

For cartridge replacement, unclamp and remove the moisture eliminator or pre-cleaner panel, pull out the dirty cartridges and insert the new ones. Refit the pre-cleaner.

Never use petrol (gasoline) for cleaning any of the air induction system.

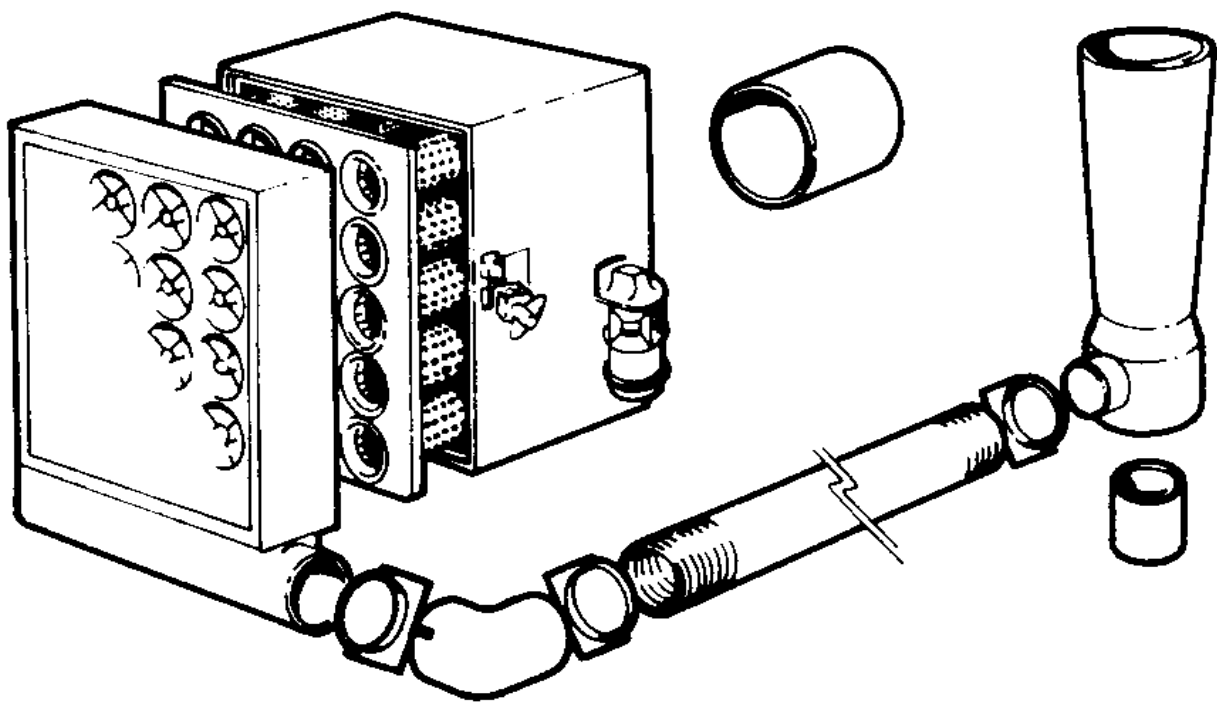


Fig. 11.

Heavy Duty, Multiple Element Air Cleaner.

OIL BATH AIR CLEANERS — See Fig. 12

To service the oil bath type cleaner, the lid should be removed and the element lifted out. The oil in the container should be drained out and the dirt and sludge thoroughly cleaned out with a proprietary cleaning fluid or Kerosene. Refill the container with clean new engine lubricating oil, grade SAE 40 to the indicated level. The woven filter element should be cleaned in a bath of Kerosene. Do not use petrol (gasolene) as this highly volatile fuel could cause explosive damage within the engine. The indicated filling mark level should never be exceeded, otherwise oil can be drawn up into the engine which could lead to uncontrolled engine speeds, and excessive engine wear.

The heavy duty oil bath air cleaners are usually fitted with a centrifugal pre-cleaner mounted on top of the main cleaner, this should be removed and the air inlet vanes in the bottom plate of the assembly, the ejection slots on the side of the cone and the vanes in the outlet tube, cleaned of dust and dirt. The detachable element is accessible by lowering the oil container which may be attached by clips or a pinch screwed clamp.

Thoroughly clean the container and refill to the indicated level with new engine lubricating oil. The separate element should be cleaned in a Kerosene bath.

The upper element which is permanently attached inside the body should be periodically cleaned by washing in a Kerosene bath. Drain the element thoroughly before reassembly and do not use petrol (gasolene) for cleaning purposes.

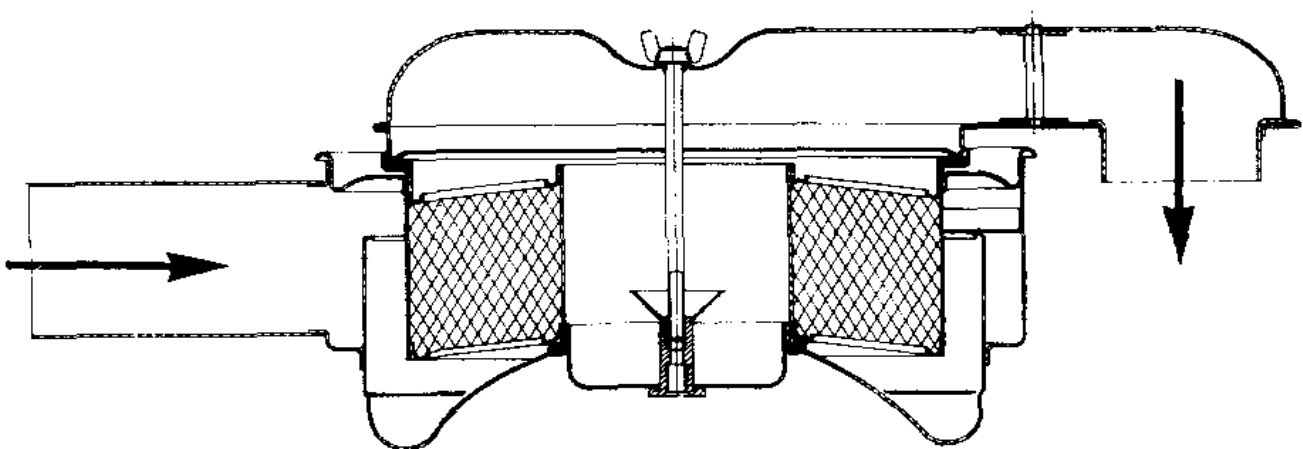


Fig. 12.
Oil Bath Air Cleaner.

TO ADJUST FAN BELT TENSION

The tension of the belt should be such that it is not loose to a degree that it can slip at the crankshaft pulley, thus preventing the full operation of the water pump and also not turning the dynamo or alternator at sufficient speeds to charge the battery.

If the belt is overtightened this can cause overloading of the bearings fitted in the water pump and alternator or dynamo. The belt itself can be damaged internally creating an early failure condition.

When fitting a belt never prise it onto a pulley by using a lever, always close in the adjustment on the dynamo or alternator and "place" the belt in position. At least "wind" the belt over the pulley by turning belt and pulley together by hand.

There is an engineering method of tensioning belts by using spring balances and correct dimensioning but the practical way as installed, is to

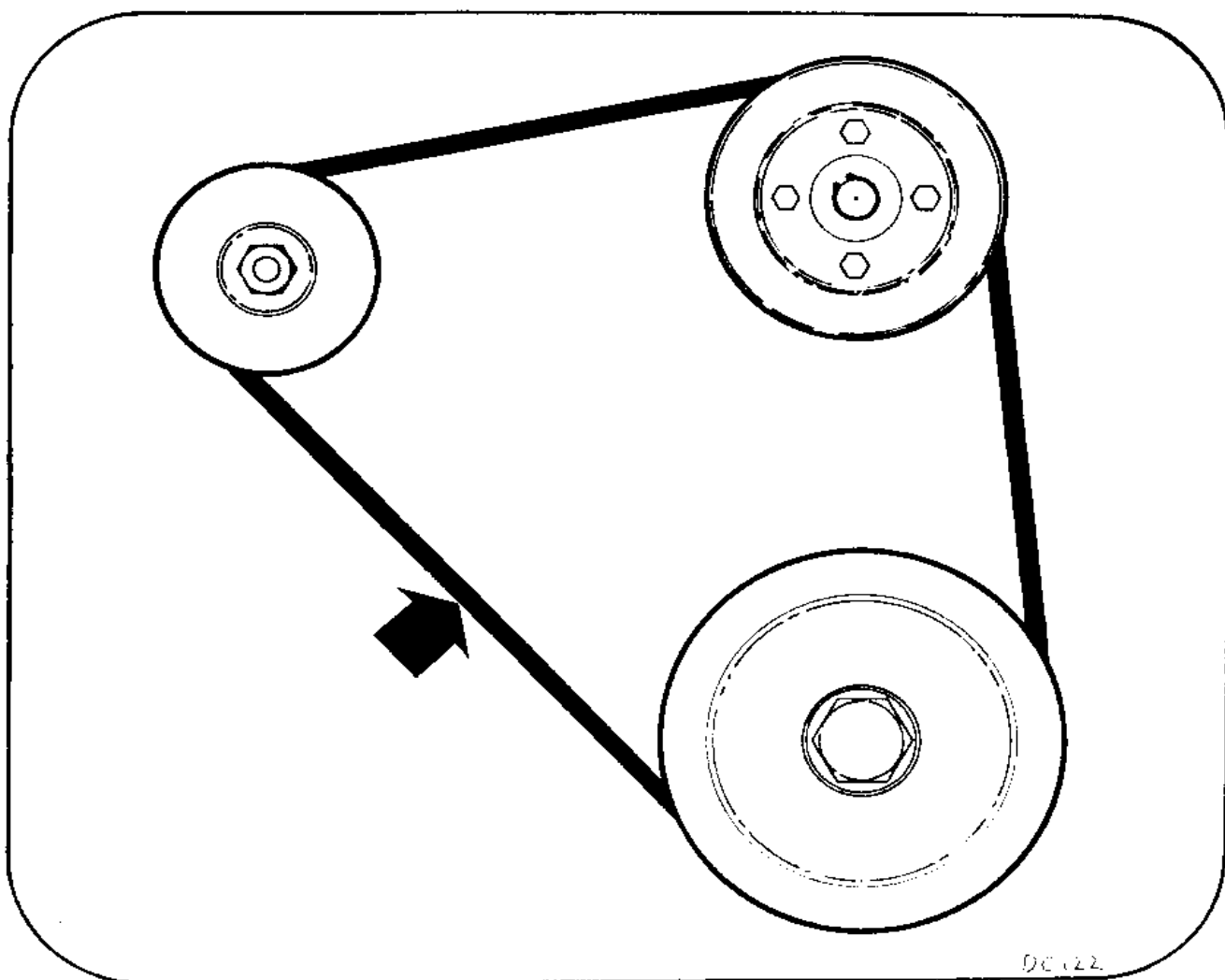


Fig. 13.
Checking Fan Belt Tension

decide which is the longest run of belt between any two pulleys and apply pressure in the centre of the run and adjust the tension until the belt deflects about $\frac{3}{8}$ in (10 mm) as shown in fig. 13.

When making adjustments loosen all the setscrews and/or nuts securing the dynamo or alternator to its brackets as well as both ends of the adjustable linkage. On obtaining the correct tension, retighten all the securing points.

When a new belt is fitted, it is necessary to recheck the adjustment after a short running period when the belt will have settled into the grooves of the pulleys and the initial stretch, if any, will have been completed.

TO LUBRICATE DYNAMO REAR BUSH

Where a dynamo is fitted, remove the rubber plug at the rear end of commutator end bearing housing and inject a few drops of S.A.E. 30 engine oil to lubricate the bush. See fig. 14.

Alternators do not need lubricating.

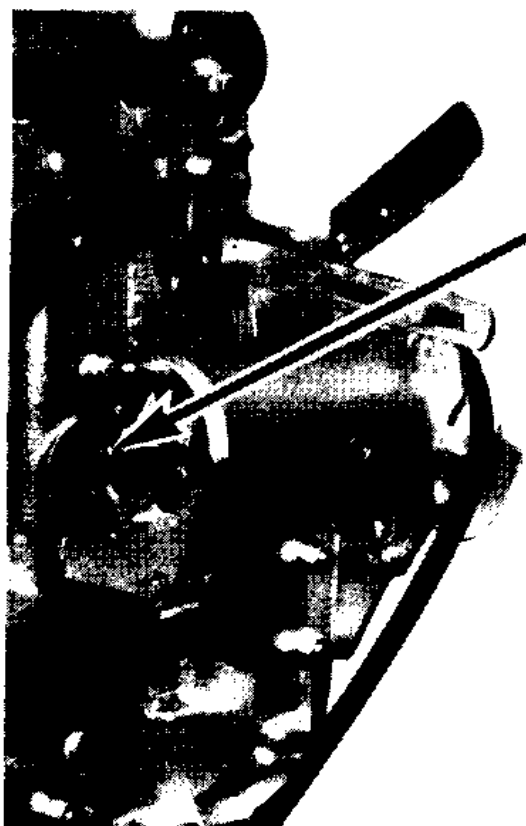


Fig. 14.

Dynamo Rear Bush Lubrication Location of Oil Hole

TO RENEW FINAL FUEL FILTER ELEMENT

- (a) Thoroughly clean the exterior of the fuel filter assembly.
- (b) Unscrew the filter bowl in the centre of the head (see fig. 15).
- (c) Lower the filter bowl clear (see fig. 16) and discard the fuel therein together with the old element.
- (d) Thoroughly clean the filter bowl in cleaning fluid.
- (e) Inspect the sealing rings and replace if damaged in any way.
- (f) Place the new element in position inside the filter bowl, fill with fresh clean fuel and offer up the bowl firmly and squarely so that the top rim of the filter bowl locates centrally against the sealing ring in the filter head.
- (g) Hold in this position whilst the securing bolt is located and screwed home. If the sealing rings are in good order and the bowl is located correctly, no excessive tightening will be required to obtain a leak proof seal.

After the fuel filter has been reassembled, it is necessary to remove air from the fuel system. Unscrew by two or three turns the vent plug on top of the filter head.

Operate the priming lever on the fuel lift pump and when fuel, free from air bubbles, issues from the vent point, tighten the vent plug.

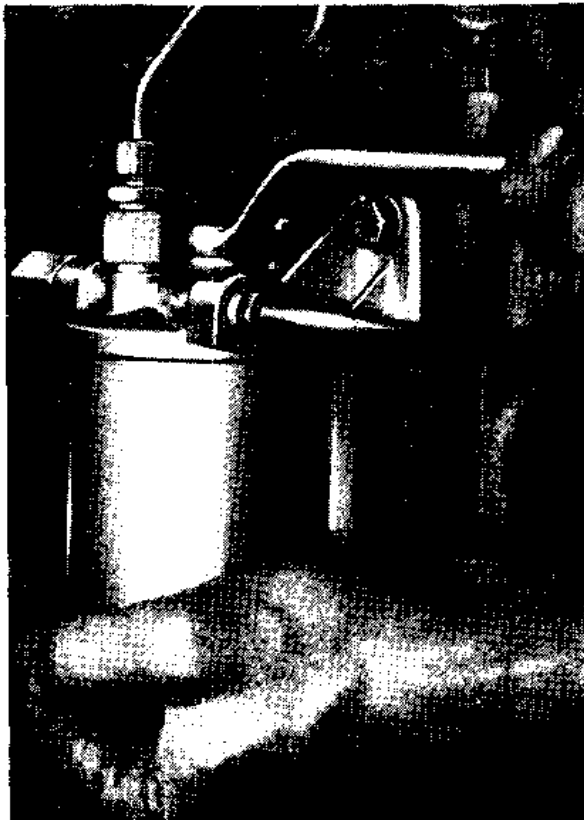


Fig. 15
Unscrewing the Fuel Oil Filter Bowl
Securing Bolt.

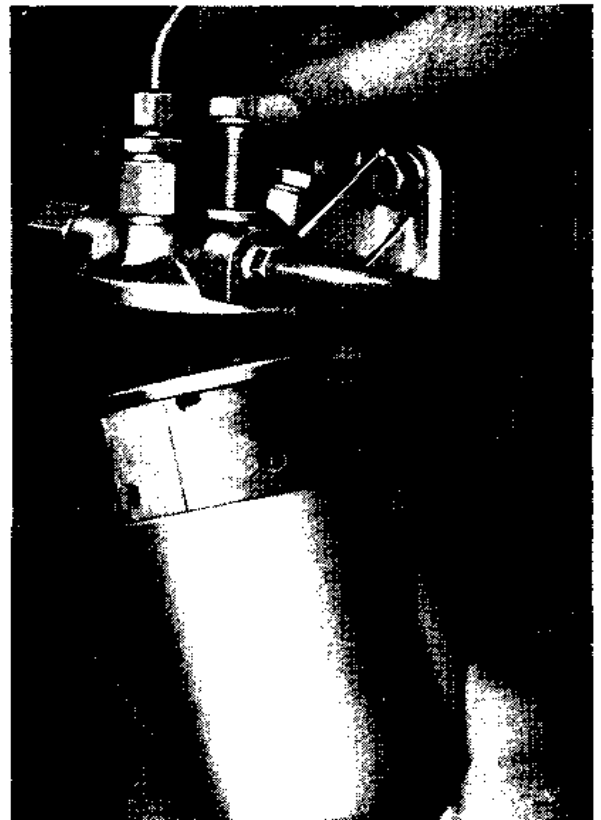


Fig. 16
Removing the Fuel Oil Filter Bowl

Slacken the pipe union at the fuel pump inlet, operate the priming lever. Retighten the nut when fuel, free from air bubbles, issues from around the threads. The engine is then ready for starting.

TO RENEW ELEMENT IN LUBRICATING OIL FILTER

- (a) Unscrew the bolt in the centre of the filter top cover (see fig. 17).
- (b) Lower filter bowl clear (see fig. 18).
- (c) Remove element from filter bowl and discard.
- (d) Clean the inside of bowl with cleaning fluid.
- (e) Fit the new rubber joint in the filter headcasting.
- (f) Re-assemble filter with new element; tighten filter bowl securing bolts.
Run engine and check for lubricating oil leaks.

NOTE: The bolt securing the filter bowl should be checked for tightness after the first 1,000 miles (1,500 km) or 50 hours running.

In some installations a gauze strainer will be found in the oil filler tube. This should be cleaned periodically.



Fig. 17.
Unscrewing the Oil Filter Bowl
Securing Bolt



Fig. 18.
Oil Filter with Filter Element Bowl
Removed.

TO CHECK VALVE TIP CLEARANCES

With the engine running at fast idling, check that the oil flow to the rocker assembly is satisfactory.

This is set between the top of the valve stem and rocker arm (see fig. 19) and should be 0.012 in (0,3 mm) with the engine cold.

When setting valve clearances the following procedure should be adopted:—

- (a) With the valves rocking on No. 4 cylinder (i.e., the period between the opening of the inlet valve and the closing of the exhaust valve), set the valve clearances on No. 1 cylinder.
- (b) With the valves rocking on No. 2 cylinder, set the valve clearances on No. 3 cylinder.
- (c) With the valves rocking on No. 1 cylinder, set the valve clearances on No. 4 cylinder.
- (d) With the valves rocking on No. 3 cylinder, set the valve clearances on No. 2 cylinder.

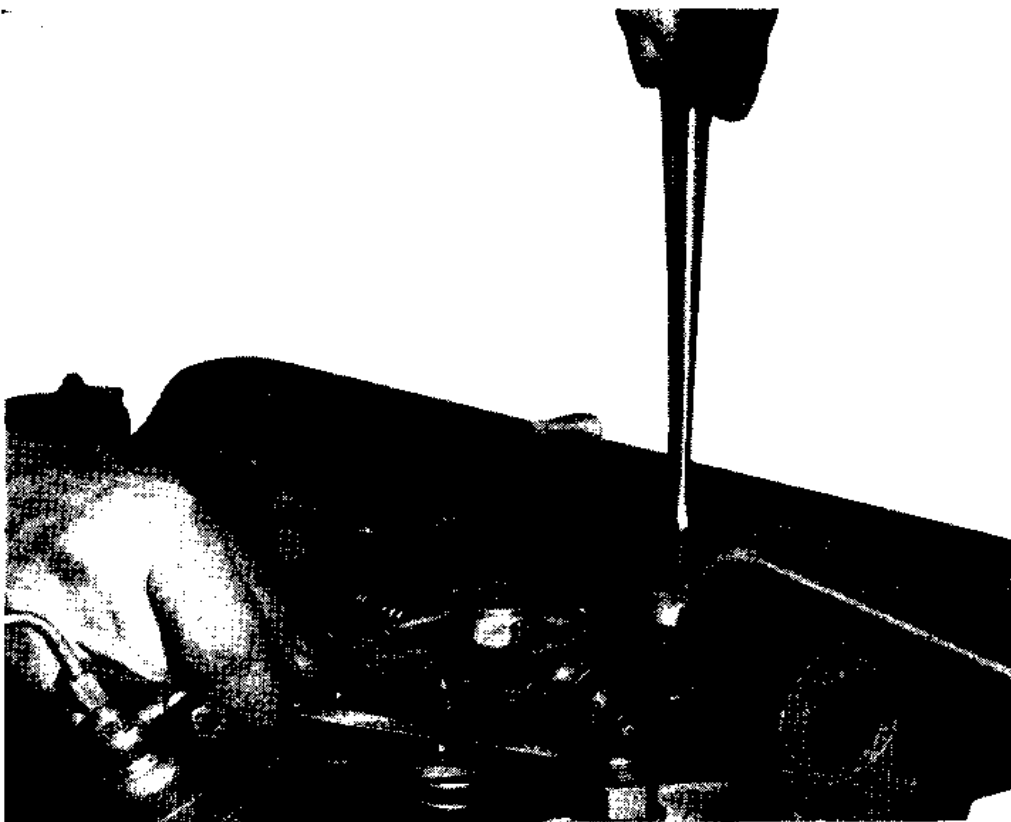


Fig. 19.
Setting Valve Clearance

general advice to the user

As you may know, a diesel engine does not rely upon an electric spark for ignition, so providing it has an adequate supply of clean air, its proper measure of clean fuel, an adequate supply of approved lubricating oil properly circulated and filtered, that each cylinder has proper compression and the engine cooling water temperature is maintained at its designed level, then the engine should give you a satisfactory service, but only if you maintain it in the proper manner as indicated in this handbook.

Never use petrol (gasoline) for cleaning any parts of the fuel system, such as filter bowls.

FUEL OIL

In order that the fuel oil is always clean and free from any water or foreign matter which can damage the finely built fuel injection pump, the fuel filters must be regularly maintained in accordance with our instructions on page 19.

The fuel oil should conform to a particular specification according to the country you are operating in. They are listed on page 10.

Never leave fuel oil stored in a container exposed to atmosphere as water and dust will be absorbed by the fuel.

Never store fuel oil in a galvanised container as a chemical reaction will take place between the fuel and the galvanised coating, considerably contaminating the fuel.

If you use large quantities of diesel fuel you may wish to install a bulk storage tank and whilst your fuel suppliers may be able to advise you we offer some guidance which is published in this handbook by the kind permission of Shell-Mex and BP who also provided the original drawings of the installations.

BULK STORAGE FOR FUEL OIL ABOVE GROUND

Before installing any storage tanks you are advised to consult your local authority when planning the storage. The feed to your vehicle or machine may be by gravity using a flow meter instead of the pumps as illustrated and the tank mounted in such a way so as to give a head of fuel.

In the installation of tanks with a capacity of 3,000 gallons (13,500 litres) and over, the tank should be mounted with a fall of $\frac{1}{4}$ in per ft. (20 mm per

metre) towards the sludge valve and in the case of smaller tanks this fall should be increased to $\frac{1}{2}$ in per ft. (40 mm per metre).

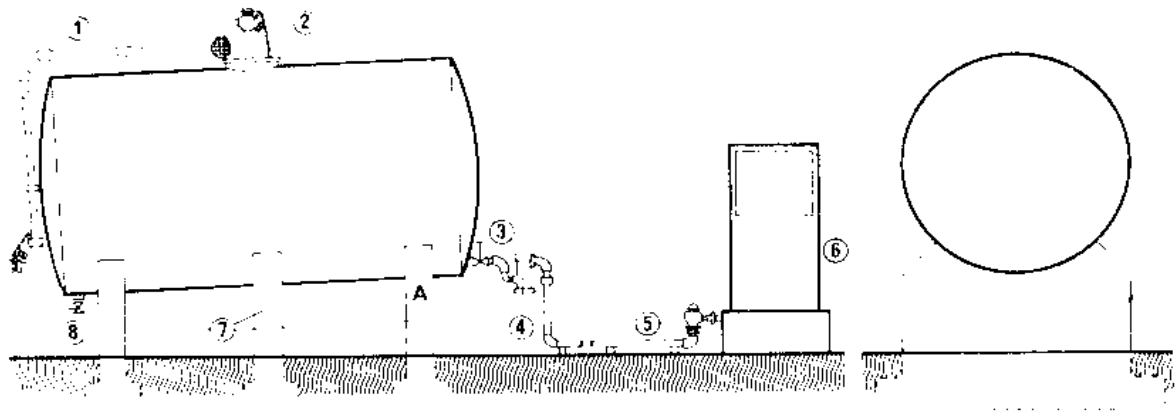


Fig. 20.

Above ground fuel storage tank

- 1 Offset fill pipe.
- 2 Combined fill pipe, dip pipe and vent.
- 3 Isolating valve
- 4 Filter.
- 5 Spring-loaded check valve.
- 6 Pump.
- 7 Tank cradle.
- 8 Sludge valve

A filter should always be fitted in the draw-off pipe. Where a pump is installed, a spring loaded check valve must be fitted between the filter and the pump, this is required to hold back the head of fuel in the tank. Metering pumps and flowmeters should always be mounted on a concrete base

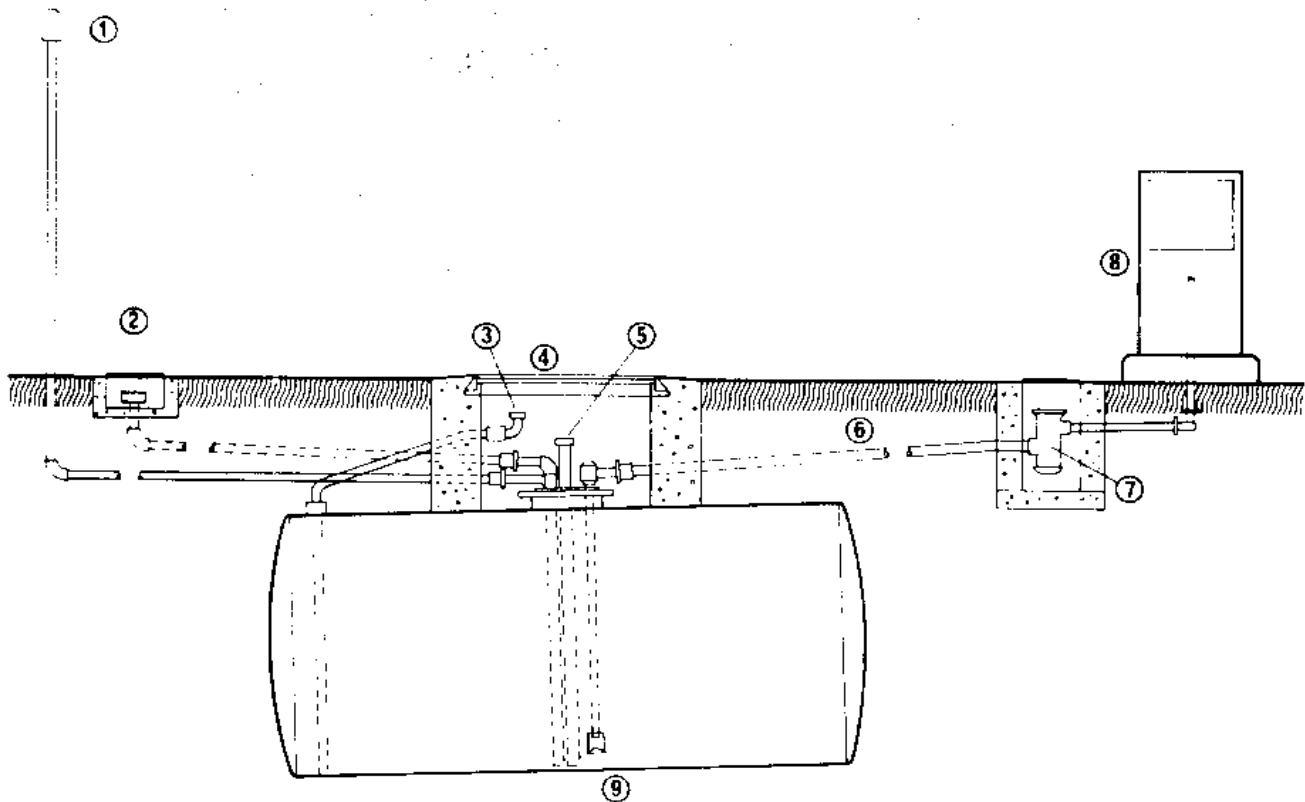


Fig. 21.

Below ground fuel storage tank.

- | | |
|--------------------------------|-----------------------------|
| 1. Vent. | 6. Suction pipe |
| 2. Offset fill (alternative). | 7. Filter. |
| 3. Top sludging pipe. | 8. Pump. |
| 4. Ground manhole. | 9. Adaptor and bottom plate |
| 5. Combined fill and dip pipe. | |

BULK STORAGE OF FUEL OIL BELOW GROUND

As with above ground storage, your local authority should be consulted when planning the installation.

The tank should be installed with a fall of $\frac{1}{4}$ in per ft. (20 mm per metre) towards the sludging pipe if its capacity is 3,000 gallons (13,500 litres) or more. Smaller tanks require a fall of $\frac{1}{2}$ in per ft. (40 mm per metre). A filter must always be fitted in the fuel oil suction pipe.

In the U.K. there are now no statutory regulations applicable to the storage and use of fuel oil, but users should be familiar with the provisions of Notice No. 75 by the Commissioners of Customs and Excise --- Heavy Hydrocarbon Oil used as a fuel for road vehicles (July 1962) or with any subsequent regulations that may be issued from time to time. Copies of the Notice No. 75 can be obtained from booksellers or the Commissioners of Customs and Excise.

Further information on the handling and storage of diesel fuel is obtainable from the Industrial Markets Division of Shell-Mex and BP Ltd. at Shell-Mex House, Strand, London, W.C.2.

AIR

Air in sufficient quantity must be allowed to reach the compression chambers to mix with the finely atomised fuel in order that ignition can take place.

If there is not sufficient air reaching the cylinders for compression, then the results could be:---

- (a) black exhaust smoke
- (b) erratic running
- (c) loss of power
- (d) bad starting.

Air entering the engine must always be adequately filtered, otherwise dust and dirt can enter the internals of the engine and cause accelerated wear conditions on the piston rings, bores, bearing surfaces and journals, thereby shortening the effective working life of the engine.

Adequate air cleaners are provided, the type will depend upon the application.

The satisfactory running of the engine will depend, among other things, upon the regular maintenance of the air cleaner as advised at the beginning of the section "Instructions for Maintenance".

LUBRICATING OILS

Do not have clean engine oil stored in open containers, as condensation and dust will contaminate the oil making it unfit for use.

The lubricating oil in the engine is filtered by a coarse filter in the sump and then by a replaceable cartridge type element filter contained in an assembly attached to the engine.

If you need to know the capacity of your sump, it may be found in the handbook supplied by the vehicle or machine manufacturer, or you should ask the supplier of the vehicle or machine.

It is important to use only those lubricating oils which come within the requirements of the U.S. Ordnance Specification MIL-L-2104B, and on page 38 will be found a list of oils which are within this requirement. Because it is not possible to list all suitable oils, care should be taken to ensure that oils not listed meet the above requirement, and have a minimum Viscosity Index of 80.

FUEL, WATER AND OIL LEAKS

It is good practice to regularly wipe the engine over with a non-fluffy rag or have it properly steam cleaned at the time the machine is cleaned. With the engine running hot check all pipe unions, joints etc. for leaks and remedy where necessary.

The fuel system from the tank to the lift pump is known as the suction side, from the lift pump to the fuel injection pump is the low pressure, from the fuel injection pump to the atomisers or injectors is the high pressure side.

Fuel leaks from the low or high pressure pipes or unions can be detected with the engine running, but leaks on the suction side are not so easily detected as they allow air to enter the point of leakage, which can cause misfiring. The suction side leaks can sometimes be seen as a weep when the engine is not running or in bad cases the drain of fuel can be detected from the evidence under the engine after overnight parking.

Watch for pipes chafing and wearing away where the fretting is taking place.

A bad leak on the suction side can cause involuntary stopping of the engine but always beware of a low level of fuel in the tank, which, of course, causes the engine to stop, but will allow air to enter the fuel system until it reaches the injectors, as would happen with a bad leak on the suction side. Such a situation means that the system must be de-aerated as described earlier in this handbook.

DIFFICULT STARTING

Some of the reasons for bad starting are:--

Poor starter cable connections.

Battery capacity low.

Stop Control still operating.

Fuel system blocked.

Air cleaner choked.

Air in fuel system.

Incorrect use of cold starting aid.

Poor compressions due to worn engine.

Blocked fuel tank vent.

Exhaust system blocked.

Incorrect grade of lubricating oil.

Any other mechanical reasons for bad starting should receive the attention of a skilled Perkins trained fitter.

FAULTY ATOMISER (INJECTOR)

A faulty atomiser may show itself as an intermittent or consistent mis-fire and can be detected by running the engine at a fast idling speed and slackening off each atomiser pipe union in turn taking particular notice of the note of the engine. The faulty atomiser will have little or no effect upon the engine note as the union is slackened off. Replace with a known good atomiser, not forgetting to replace the washer upon which the atomiser seats in the cylinder head.

REPLACING AN ATOMISER (INJECTOR)

Never bend the high pressure pipe between the atomiser and the fuel injection pump. Remove the pipe completely.

Fit the replacement atomiser as square as possible into the head by pulling down with the securing nuts a little at a time, each side in turn.

Having fitted atomiser and pipe, run the engine and listen for any “blowing” from the atomiser seat which will indicate that it is not square with the cylinder head. Carefully ease off the atomiser securing nuts in turn and retighten until the “blowing” stops. Check for fuel leaks at the pipe unions. **WARNING**—Do not start engine with loose atomiser nuts, the atomiser may fly out!

A FEW PRACTICAL HINTS

Do not run the engine with obvious fuel, water or oil leaks.

Do not use the starter motor unless the flywheel is at rest.

Do not operate the vehicle or machine with the air cleaner removed thinking you are obtaining more power, you **are obtaining more wear**.

Always check your lubricating oil and water level **EVERY DAY**.

Should you need to drain the cooling system, open the draincock in the radiator **and** on the side of the cylinder block of the engine which may be a brass type plug.

Remove the radiator cap when draining and put the cap on the drivers seat as a warning that the engine contains no coolant.

When changing the sump oil, put the drain plug in a conspicuous position as a reminder there is no lubricating oil in the engine, particularly if you go off and do another job while the oil is draining down.

Do not overtighten the sump drain plug on replacement as this can crack the sump, ensure the plug is secure.

fault finding chart

Fault	Possible Cause
Low cranking speed	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 starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33.
Lack of power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33.
Mistiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32.
Excessive 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 oil pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58.
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59.
Erratic running	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 oil pressure	4, 38, 41.
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57.
Excessive crankcase pressure	25, 31, 33, 34, 45, 55.
Poor compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59.
Starts and stops	10, 11, 12.

KEY TO FAULT FINDING CHART

1. Battery capacity low.
2. Bad electrical connections.
3. Faulty starter motor.
4. Incorrect grade of lubricating oil.
5. Low cranking speed.
6. Fuel tank empty.
7. Faulty stop control operation.
8. Blocked fuel feed pipe.
9. Faulty fuel lift pump.
10. Choked fuel filter.
11. Restriction in air cleaner.
12. Air in fuel system.
13. Faulty fuel injection pump.
14. Faulty atomisers or incorrect type.
15. Incorrect use of cold start equipment.
16. Faulty cold starting equipment.
17. Broken fuel injection pump drive.
18. Incorrect fuel pump timing.
19. Incorrect valve timing.
20. Poor compression.
21. Blocked fuel tank vent.
22. Incorrect type or grade of fuel.
23. Sticking throttle or restricted movement.
24. Exhaust pipe restriction.
25. Cylinder head gasket leaking.
26. Overheating.
27. Cold running.
28. Incorrect tappet adjustment.
29. Sticking valves.
30. Incorrect high pressure pipes.

31. Worn cylinder bores.
32. Pitted valves and seats.
33. Broken, worn or sticking piston ring/s.
34. Worn valve stems and guides.
35. Overfull air cleaner or use of incorrect grade of oil.
36. Worn or damaged bearings.
37. Insufficient oil in sump.
38. Inaccurate gauge.
39. Oil pump worn.
40. Pressure relief valve sticking open.
41. Pressure relief valve sticking closed.
42. Broken relief valve spring.
43. Faulty suction pipe.
44. Choked oil filter.
45. Piston seizure/pick up.
46. Incorrect piston height.
47. Damaged fan.
48. Faulty engine mounting (Housing).
49. Incorrectly aligned flywheel housing, or flywheel.
50. Faulty thermostat.
51. Restriction in water jacket.
52. Loose fan belt.
53. Choked radiator.
54. Faulty water pump.
55. Choked breather pipe.
56. Damaged valve stem oil deflectors (if fitted).
57. Coolant level too low.
58. Blocked sump strainer.
59. Broken valve spring.

Lubricating oils

Lubricating oils should meet the requirements of the U.S. Ordnance Specification MIL-L-2104B and below, we give a list of some of these oils. Any other oils which also conform to this specification, but are not listed here are, of course, also suitable.

The lubricating oils for use in Perkins Diesel engines should have a **minimum** Viscosity Index of 80.

Company	Brand	S.A.E. Designation		
		0 F (-18 C) to 30 F (-1 C)	30 F (-1 C) to 80 F (27 C)	Over 80 F (27 C)
B.P. Ltd.	B.P. Vanellus	10W	20W-20	30
	B.P. Vanellus	10W-30	10W-30	10W-30
	*B.P. Vanellus S3	10W	20W-20	30
Castrol Ltd.	Castrol-Deisol CRB	10W	20W-20	30
	*Castrol-Deisol CRD	10W	20W-20	30
	*Agricastrol HDD	10W	20W-20	30
A. Duckham & Co. Ltd.	*Electrol 3	3-10	3-20	3-30
Esso Petroleum Co. Ltd.	*Essolube D3.HP	10W	20W-20	30
	Essolube HDX	10W-30	10W-30	10W-30
	Essolube HDX		20W-50	20W-50
Mobil Oil Co. Ltd.	Delvac 1200 Series	1210	1220	1230
	*Delvac 1300 Series	1310	1320	1330
Shell	Shell Rotella SN	10W	20W-20	30
	*Shell Rimula CT	10W	20W-20	30

*These oils conform to both the MIL-L-2104B and Series 3 Specification and it is recommended that such oils be used in engines installed in Heavy Duty Earth Moving Equipment.

The above specifications are subject to alteration without notice.

precautions against frost

COOLING SYSTEM MAINTENANCE

Where a new engine is being used or a clean cooling system has been achieved, there should be no great difficulty in maintaining it in a good condition.

The principal features which require consideration are:—

1. Ensure that the topping up coolant is always clean and that the correct level is maintained.
2. The coolant chosen should be non-corrosive to the waterways.
3. Ensure that the hoses are maintained in a good condition and no leaks occur at the joints.
4. The water circulating pump must work efficiently and not leak.
5. Make sure that the cylinder head bolts or securing nuts are tightened to the correct torque as indicated on page 18.
6. Ensure that there are no leaks in the radiator or heaters.

PREPARING THE COOLANT

Engine coolants should, in general, be based upon water used for drinking purposes. However, certain very hard waters may reduce heat transfer from engine to coolant by depositing heavy coatings of scale, as may be seen in the ordinary domestic water heating kettle and in these cases it is preferable to use de-mineralized or distilled water. Salty water or acid water should not be used.

Rain water in most city, town or industrial areas can contain acidic contents or is contaminated in some way and its use is not recommended.

Normally, all uninhibited waters are at least slightly corrosive, therefore, all coolant solutions should contain a suitable corrosion inhibitor in the cooling system and since most engines used in territories experiencing freezing conditions use antifreeze solution during these conditions, then that antifreeze solution should contain suitable corrosion inhibitors.

In territories where freezing conditions do not occur, corrosion inhibitors should be used based upon the **British Specification 3151** in the amounts that would be present in a 25 per cent solution of the anti-freeze.

When preparing an antifreeze solution for use under freezing conditions, the concentration of the antifreeze mixture in the coolant should be chosen so that the solution will circulate freely below the expected minimum ambient temperature. It is common practice in the United Kingdom to use 25 per cent per volume of antifreeze.

A guide to an approximate concentration for a given minimum temperature is given in the following table which shows the temperature at which ice crystals first appear in aqueous solution of antifreeze of the specified concentration. The solution only freezes solid at a temperature below those quoted.

Percentage per volume	Approx. temp for initial ice crystal formation	BS3151 Specific Gravity at 60°F (15.5°C)
20	15°F (— 9°C)	1.032 — 1.035
25	10°F (— 12°C)	1.040 — 1.043
33½	— 3°F (— 19°C)	1.053 — 1.058
40	— 14°F (— 26°C)	1.064 — 1.070
50	— 35°F (— 37°C)	1.079 — 1.086

The required amount of antifreeze should be mixed with its own volume of water, poured into the empty cooling system and further water added to the required level in the header tank.

When calculating amounts of antifreeze, allowances should be made for extra capacities of heaters, heat exchangers, oil coolers, pipes, hoses etc. Air locks should be properly vented, the engine run up and after stopping, the coolant level checked.

Some form of label or tag should be attached to the radiator and at the driving position to reduce the risk of draining without replacement of the correct coolant.

MAINTAINING THE ANTIFREEZE COOLANT

It is essential that any topping up should be done with a similar coolant to that being used. Different corrosion inhibitors should not be mixed in the same engine.

It does not follow that an antifreeze solution manufactured to **BS3151** need be replaced by water as soon as freezing conditions have passed. In general, this kind of antifreeze solution may be left in the cooling system from the beginning of one winter to the beginning of the next.

The degree of frost protection a coolant affords may be assessed by measuring its specific gravity, using a hydrometer, as indicated in the earlier table.

It is much more difficult to determine whether an antifreeze solution retains an adequate degree of corrosion inhibition. There is no simple test that will reliably indicate the concentration of inhibitors in a water coolant.

Because of the difficulty in determining the safe life of antifreeze solutions in Perkins diesel engines, from the point of view of corrosion, it has been found necessary to recommend that the solution be rejected after an arbitrarily determined life.

The coolant solution containing 25 per cent antifreeze manufactured to **BS3151** in water in a properly maintained engine should maintain its antifreeze and anti-corrosive properties throughout the winter season in the U.K. and in general a safe life of 12 months may be reasonably expected.

withdrawing an engine from service

Experience has shown that insufficient care is taken by owners when they decide that they will not want the use of their Perkins engine for a few months and simply discard it in a shed or barn. Some people leave the engine and the machine out in the open air, or covered by a tarpaulin sheet, unattended for very long periods.

As a result of negligence, the owner may well be faced with heavy costs when next he puts the engine into service.

The proportion of money spent on the power unit when purchasing a machine can amount to a substantial part of its overall cost, therefore the economics in properly maintaining the engine not only in service, but also to safeguard it and its ancillary parts when taken out of service is very apparent. This safeguard is very necessary due to the corrosive effect of atmospheric conditions, and also to the acidic content of the lubricating oil which may have been in the engine for a longer period than that during which the alkaline additives in fresh oil can effectively neutralize these acidic by-products of combustion. The changing of lubricating oil at the correct periods as laid down in this handbook can help to combat the adverse effect of combustion by-products, but as you are coming towards the end of your seasonal operation of the engine, you may have considered stretching the oil change period a little further.

We have seen the interior of engines which have been left standing during an out-of-season period. In one instance investigation revealed that on completion of the last job of work, instead of "Laying-up", the machine was parked in a barn and the cooling water drain taps opened, and then left by the driver. Nothing more was done until the machine was required 9 or 10 months later.

On this particular engine the cooling system was filled with water and the driver pressed the starter button — nothing happened — the battery was flat.

The battery was replaced after considerable delay in telephoning the local garage to supply another one.

Eventually the engine was started and the driver commenced work, but after a period of about 30 minutes, the engine seized.

Investigation revealed that there was no cooling water in the radiator, although the driver had re-filled the cooling system.

What had happened was that when the driver drained the water the previous season, all he did was to open the taps on the radiator and engine cylinder block, see that water was running and then walked away. Sludge, which had built up inside the cylinder block behind the water drain hole, clogged up the drain hole, **before** all the coolant had drained away. Because of severe winter conditions during the laying-up period, the water left in the cylinder block froze, and in the process of expansion had cracked the base of the cylinder liner parent bores and it was through these cracks that the water had escaped into the sump when the engine was returned to service.

To guide owners on the proper procedure that should be adopted when taking engines out of service, we have written these instructions in the knowledge that such practice as we recommend will result in continued performance from the engine, and an overall financial saving over the years.

BEFORE PROCEEDING WITH THE WORK INVOLVED IN REMOVING THE ENGINE FROM SERVICE PROPERLY, CAREFULLY READ THROUGH THESE INSTRUCTIONS AND IT MAY BE POSSIBLE TO CARRY OUT MORE THAN ONE JOB AT ONCE.

LUBRICATION SYSTEM

Quite a lot has been written about lubricating oil and we feel that quoting "BRITISH MINISTRY TESTS" specification and "U.S. ORDNANCE SPECIFICATION" to the average owner, means very little to him, but if he buys oil in bulk, then he should consider asking his suppliers to confirm that the lubricating oil they supply for his use in Perkins engines does comply with these British and American specifications.

The latest specification at the time of writing, for oils recommended for use in normally aspirated Perkins engines are the British specification DEF 2101D or the American specification MIL-L-2104B particularly where conditions such as continuous high speeds, high ambient temperatures and frequent intermittent full loading are met with. See page 38 for a list of some of the approved oils.

Before storing the machine or vehicle the following procedure should be adopted.

1. With the engine thoroughly warm, drain off the engine oil, no matter how long it has been in use.
2. Replace the lubricating oil filter element, at the same time cleaning the bowl with Kerosene.
3. Remove the rocker cover and if heavy deposits of sludge are to be found then this could indicate that sludge may be present within the engine, in which case it is advisable to use a flushing oil. Fill the sump to the indicated level with the flushing oil and run the engine until the cooling water is at normal operating temperature, around 180 degrees F (82 degrees C). Run the engine for a further 15 to 30 minutes after which period it may be stopped and the flushing oil drained out whilst still hot. Allow plenty of time to fully drain off the flushing oil. Renew the lubricating oil filter element.
4. Refill the sump to the correct level with lubricating oil which should be of the specification referred to earlier. Run the engine to circulate this fresh oil. You should consider attending to the fuel injection system and the cooling system at the same time as this operation.
5. The engine breather pipe should be thoroughly cleaned of any sludge deposits. If possible, it is better to remove the breathing system completely for cleaning purposes.
6. Before finally storing the engine, remove all the injectors and pour into the cylinders $\frac{1}{8}$ to $\frac{1}{4}$ pint fresh engine oil divided equally to cover the piston tops. Turn the engine by hand, say 4 or 5 complete revolutions to disperse the oil over the upper part of the cylinders finally replacing the injectors using new joint washers.

FUEL INJECTION SYSTEM

1. Drain all the fuel from the main fuel tank and all filter and water trap housings and replenish the main tank with at least one gallon of oil recommended for the preservation of the fuel system (page 44). If, because of the construction of the fuel tank, one gallon of fuel is inadequate and you do not wish to buy more, the fuel feed pipe to the filter should be disconnected and an auxiliary tank fitted. In this respect it is advisable not to have too much fuel oil in the tank when nearing the laying-up period.
2. De-aerate the fuel system according to the instructions given on page 12.

3. Start the engine and run until the preserving fuel has circulated through the injection pump, feed pipe and injectors. This will take about 10 to 15 minutes with the engine running at about half speed with no load applied.

NOTE :

In choosing a suitable oil, the lowest temperature likely to be met by the engine during the Lay-up period should be estimated and the oil should be such that the temperature given in the table is as low as or lower than this estimate. No attempt should be made to restart the engine until the temperature has been at least 15 degrees F (9 degrees C) above that shown in the table for not less than 24 hours; otherwise there may be difficulty in obtaining a free flow of fuel.

Whilst the proprietary brands of oils as listed below are recommended for this specific purpose by the respective oil companies, it does not necessarily mean that they are available in all parts of the world, but suitable oils may be obtained by reference to the appropriate Companies.

For your guidance the specification for preserving oils for the fuel system should include the following:—

VISCOSITY

The viscosity should not be greater than 22 centistokes at the lowest ambient temperature likely to be experienced on restarting.

Pour Point

The pour point must be at least 15°F (9°C) lower than the lowest ambient temperature likely to be experienced on re-starting and should preferably be lower than the lowest temperature likely to be met during the lay-up period.

The oils selected below are not necessarily suitable for calibrating or testing fuel injection pumps.

Every precaution should be taken when draining oils to prevent oil falling on to electrical equipment, rubber installations or drive belts or tyres, as oils can seriously damage any rubber or rubber type materials.

OILS RECOMMENDED FOR THE PRESERVATION OF THE FUEL SYSTEM

	Lowest Temperature to be expected during lay-up
Esso IL815	25°F (— 4°C)
Esso IL1047	0°F (—18°C)
Shell Calibration Fluid "C" (U.K.)	0°F (—18°C)
Shell Calibration Fluid "B" (Overseas)	-70°F (—57°C)
Shell Fusus "A"	-15°F (—26°C)
Shell Fusus "A" R1476 (Old Type)	25°F (— 4°C)

COOLING SYSTEM

The following information and instructions for attention to the cooling system are based on British Standard 3926 : 1965 "The Use and Maintenance of Engine Coolant Solutions" by permission of the British Standards Institution, 2 Park Street, London W.1.

On all Perkins diesel engines there are facilities for draining off the coolant, usually in the form of a stop-cock or other type of valve. On the later build of engines these valves are now replaced, in some cases, by a brass plug which we feel is a safer method of draining as it affords a larger hole to allow the coolant and any deposits to flow out. Where the tap or valve arrangement is to be found, it is recommended that it should be removed completely from the cylinder block and during draining the hole should be probed to ensure it is not clogged by sludge, scale or other deposits.

At the end of every working season, the coolant can be drained from the engine and radiator. Where heater systems are fitted, these should also be drained.

A label or tag should be used to indicate clearly that the cooling system is empty and it should be placed in a conspicuous position.

The machine or vehicle may be left without any cooling water in the system throughout the lay-up period or it should be filled with a suitably inhibited antifreeze solution, the safe life of which is dependent upon the rate of depletion of the corrosion inhibitors but if the cooling system has been well cleaned and the coolant properly maintained, a safe life of 12 months may reasonably be expected. Therefore, the cooling system could be filled with an antifreeze solution to the British Standard 3151 at the beginning of the lay-up period and replaced again at the beginning of the next lay-up period or after a 12 month period has elapsed, whichever occurs first.

If an antifreeze solution has not been used and the drained liquid is discoloured by rust, or the presence of sediment or other evidence suggests deterioration of the waterways, then the whole of the cooling system should be cleaned and a corrosion inhibited antifreeze manufactured to the British Standard 3151 should be used for refilling and storing during the lay-up period. See "Precautions against Frost".

So, when laying-up your Perkins diesel engine you are advised to fill the cooling system with a suitable concentration of antifreeze to BS3151, discarding and replacing it with a similar solution at the beginning of the next years lay-up.

Throughout the lay-up, the cooling system should be periodically examined for leaks and where necessary, corrected.

ELECTRICS

1. BATTERIES

- (a) Remove the battery (or batteries) from the engine and thoroughly clean, removing all dirt, dust and moisture.
- (b) Top up the cells with distilled water, making sure that the top edges of the separators or separator guards are just covered, and replace the vent plugs.
- (c) Recharge the battery from a separate source of mains electricity supply to a state of free gassing.

At this point the operator is advised to ascertain the efficiency of his battery by checking the specific gravity of the electrolyte in each cell, taken on a suitable hydrometer. A fully charged battery should give specific gravity readings of:—

1.272 to 1.283 in temperate climates and 1.239 to 1.255 in tropical climates. If after five hours continuous charging the specific gravity fails to rise, and gassing does not take place the cells should be tested for internal short circuits.

If facilities for a high rate discharge test are not available, it is recommended that the operator seeks the assistance of a competent electrician. If it is confirmed that a cell is internally shorted the battery must be renewed or suitable repairs made.

There should be little variation in the specific gravity readings from cell to cell on any battery in good condition. If the variation is greater than 0.025, then the reason should be looked into.

A large variation in the readings from cell to cell which is not the result of loss of electrolyte, is an indication of an internal short circuit, and a high rate discharge test should be applied or the facilities of a competent electrician should be sought.

If electrolyte has been spilled, or lost owing to a leak in the casing, the addition of distilled water only will result in lowering the specific gravity.

This can be corrected by adding a diluted solution of sulphuric acid, until the specific gravity of the electrolyte is again standard.

- (d) Clean the terminals and lightly smear them with petroleum jelly.
- (e) Store in a cool, dry, dust-free place. On no account should the battery be left where there is a risk of freezing.
- (f) Re-charge the battery once a month at the normal rate of charge as in paragraph (c).

WARNING

DO NOT USE UNDILUTED ACID FOR THIS PURPOSE. ALWAYS ADD ACID TO THE WATER WHEN PREPARING ELECTROLYTE. IT IS DANGEROUS TO ADD WATER TO ACID.

2. STARTERS AND GENERATORS

Clean the terminals and lightly smear them with petroleum jelly. If the machine or vehicle is to stand in the open, it is essential that the starter, generator and control board are protected from water falling directly on to them.

SEALING THE ENGINE

- (a) Remove the air cleaner and any air intake pipe which may be fitted between the air cleaner and air intake. Carefully seal the air intake orifice with water-proofed adhesive tape.
- (b) Remove the exhaust pipe, and seal the manifold orifice with water-proofed adhesive tape.
- (c) Seal the breather pipe orifice with waterproofed adhesive tape.
- (d) Seal the air vent in the fuel tank or filler cap with waterproofed adhesive tape. This will reduce the risk of water condensation.

The water pump/fan driving belt should be removed from the engine and stored in a cool, dry place for refitment when the engine is returned to service. This should be replaced if found to be in a deteriorated state i.e. stretched, cracked or perished.

preparing the engine for return to service

Drain the lubricating oil from the sump and refill to the correct level with fresh oil to the specification referred to earlier. Remove the rocker cover and lubricate the rocker assembly and replace cover. Remove the seal from the breather pipe orifice.

Remove the adhesive tape from the fuel tank vent or filler cap, drain the fuel tank and all filter and water trap housings of the preservative fuel oil which may have become contaminated with condensed water, replace the fuel filter element(s), and refill with fresh fuel oil. If an auxiliary tank was fitted, this should be disconnected prior to refilling and connection made to the main tank.

Air vent the fuel system in accordance with the instructions to be found in this handbook.

Before starting the engine on its return to service after a period of "laying-up" ensure that the cooling system is filled with a coolant. Dependent upon the decision made at the time of storage the engine will have been stored either dry, or with an anti-freeze solution as described in the section headed Cooling System.

If the engine was stored with a solution of anti-freeze then refer back to paragraph 5 of "The Cooling System". Check for leaks and remedy where necessary.

Remove the sealing tape from air-intake. Examine the air cleaner before fitment to ensure cleanliness. See "Air Cleaners" under "Instructions for Maintenance".

Refit any pipe which may be fitted between air-intake and air cleaner, and refit air cleaner.

Remove the sealing tape from the exhaust manifold orifice and refit the exhaust pipe.

Rotate the fresh water pump by hand to ensure freedom of the seals.

Remove the petroleum jelly smeared on the terminals of the starter and generator, and where a dynamo is fitted lubricate the dynamo rear bush by means of an oil can inserted into the small aperture at the rear of dynamo, taking care not to over lubricate. Check that all terminals are sound.

The water pump fan driving belt should now be fitted to the engine. If this was not replaced at the time of storage it is advisable to re-examine the belt for deterioration to avoid failure after the first few hours of running due to perishing whilst in storage.

The engine is now ready for starting, using the procedure normally adopted when the unit is in service.

When the engine is running remove the top cover to ensure that a flow of oil is coming from and maintained in the rocker shaft assembly. If no oil flow is observed shut down the engine immediately and take steps to ascertain the cause of the stoppage and remedy it.

If the flow of oil from the rocker assembly is found to be satisfactory, refit the top rocker assembly cover, taking care that the gasket is fitted properly to prevent oil leakage.

Adjust the throttle position so that the engine is running at a fast idling speed of approximately 1000 r.p.m. for 20/30 minutes when the engine should be thoroughly warmed through.

With the engine still running, thoroughly check by visual examination that:—

- (a) No lubricating oil is leaking from sump joints, filter unions, lub. oil pipes, timing case cover joints, rocker cover joints or rear main oil seal (small drain hole in bottom of flywheel housing).
- (b) No coolant is leaking from radiator hoses, water connections, thermostat housing, water pump joints, water manifold connections, cab heater connections, cylinder head gasket.
- (c) No fuel oil is leaking at any pipe from fuel tank to lift pump, lift pump unions or lift pump joints. Lift pump to filter pipes, unions and joints. Filter to fuel injection pump pipes and unions. High pressure and leak off pipes to atomisers and pipe to the cold start reservoir (where fitted).
- (d) Excessive black exhaust smoke is not being emitted. If black smoke is found, suspect dirty atomisers or partially blocked air intake (oil bath air cleaner over filled). This symptom will occur with uneven firing and overheating.

Examination of the atomiser nozzles may reveal that it is only necessary to probe the nozzles to effect the clearance. If further attention is required it is advisable to seek expert assistance.

WARNING

CARE MUST BE EXERCISED TO PREVENT THE HANDS OR FACE FROM COMING INTO CONTACT WITH THE NOZZLE SPRAY AS THE WORKING PRESSURE WILL CAUSE FUEL OIL TO PENETRATE THE SKIN.

The engine will now be ready to give further trouble free service and at this stage we would remind the owner/operator that trouble free service can only be maintained if reasonable care is taken to carry out the "Preventive Maintenance" as laid down in this handbook at the mileage or time intervals advised.

NOTE :

If these instructions are carried out efficiently, no difficulty will be encountered, nor should the engine suffer any harm. Perkins Engines Ltd., however, cannot accept liability for direct or consequential damage that might arise following periods of laying up.

parts section

Whilst every effort is made to illustrate latest parts, owing to the company's policy of continuous improvement some slight variations may occur.

SOURCE OF SUPPLY

Parts are available from Perkins Overseas Companies, Associate Companies, Manufacturing Licensees, Distributors and the applicable Franchise holders of Perkins powered Machine Manufacturers. We are unable to deal direct with the operator and therefore, parts should be obtained by placing a firm order with one of the aforementioned sources of supply.

NOTE

When parts are required for your Perkins engine always quote the engine number, the machine name, description and serial number so that your requirements can be identified.

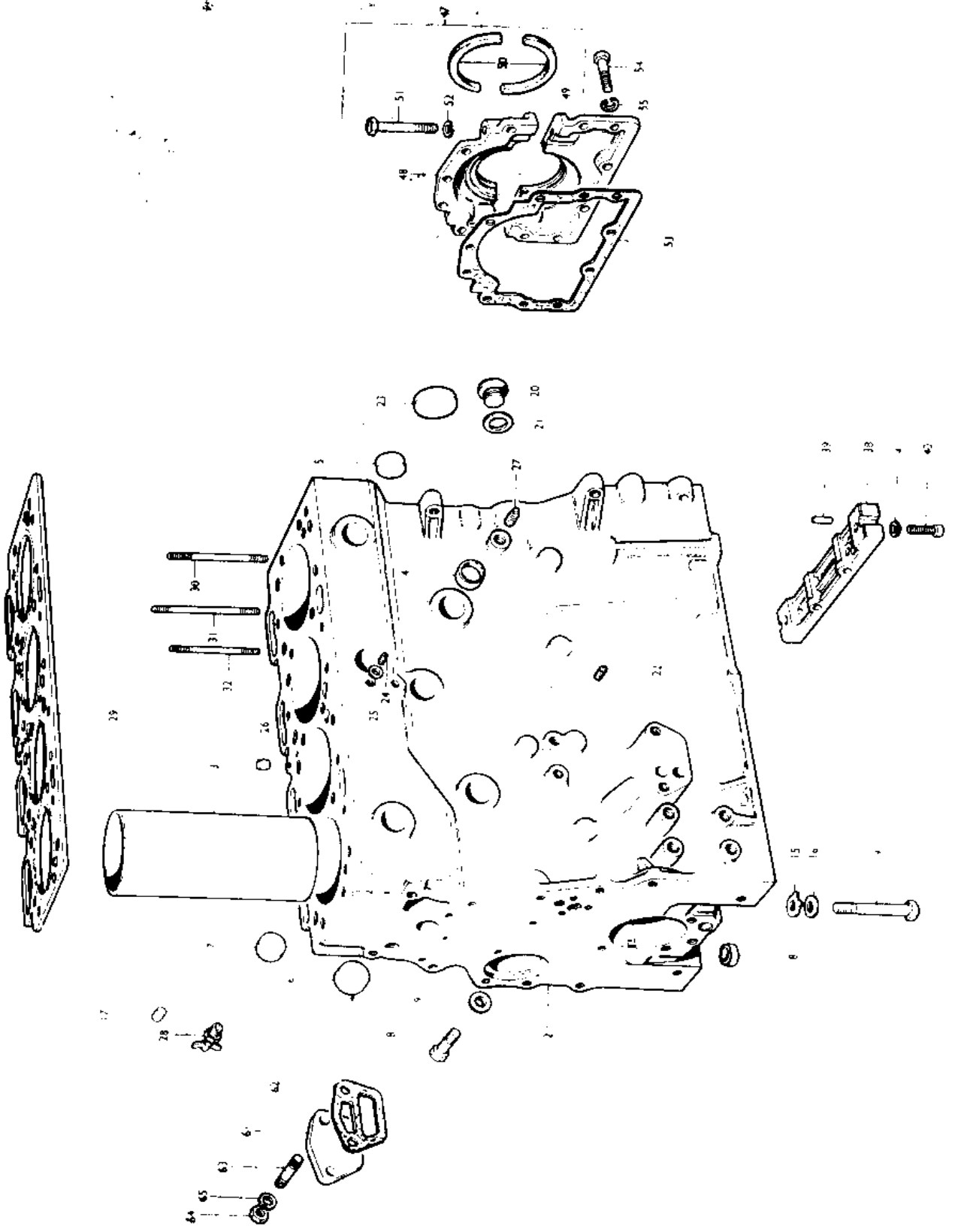


PLATE A
 CYLINDER BLOCK SECTION

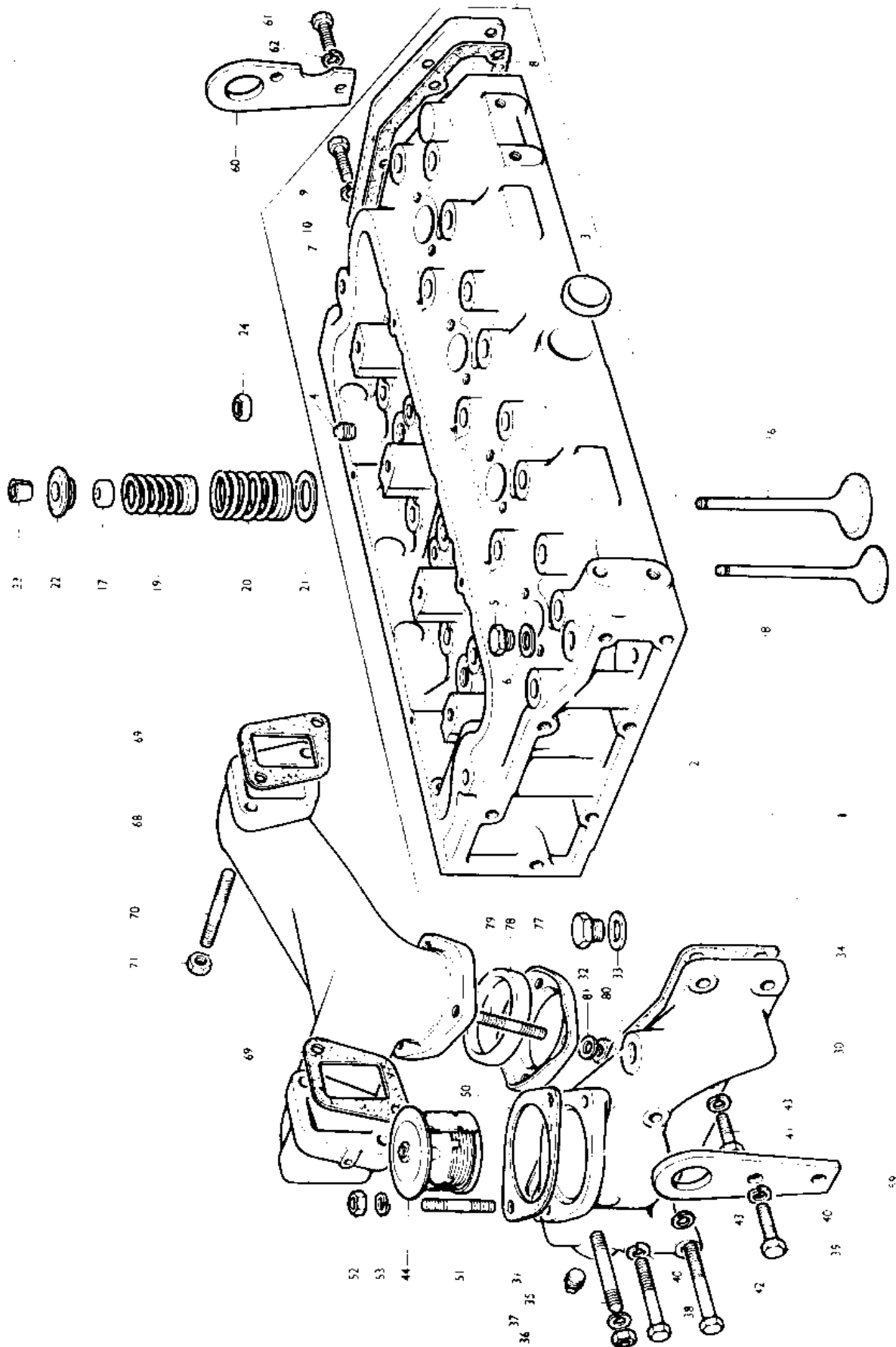


PLATE B
 CYLINDER HEAD SECTION

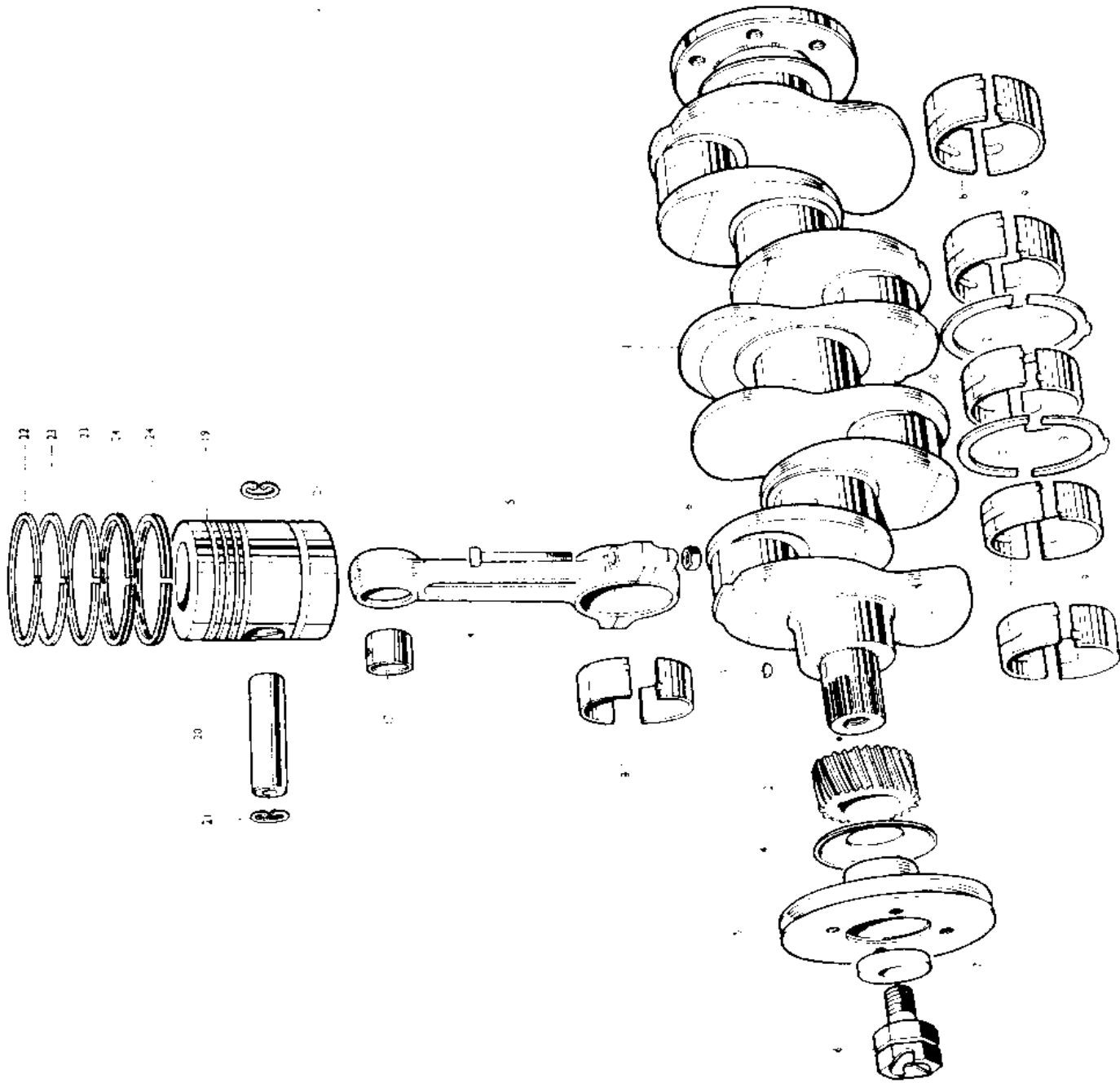


PLATE C
CRANKSHAFT SECTION

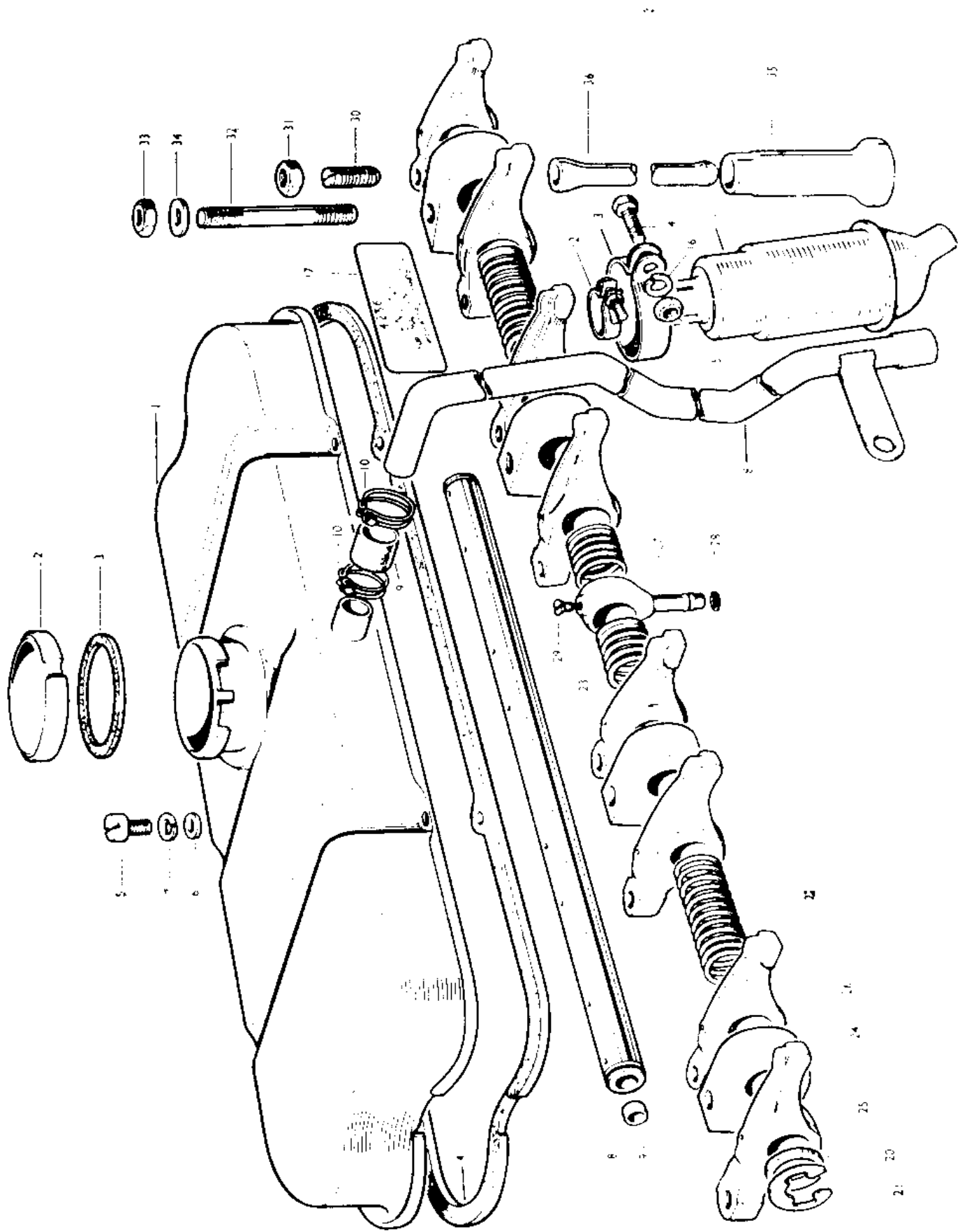


PLATE D
CYLINDER HEAD COVER SECTION

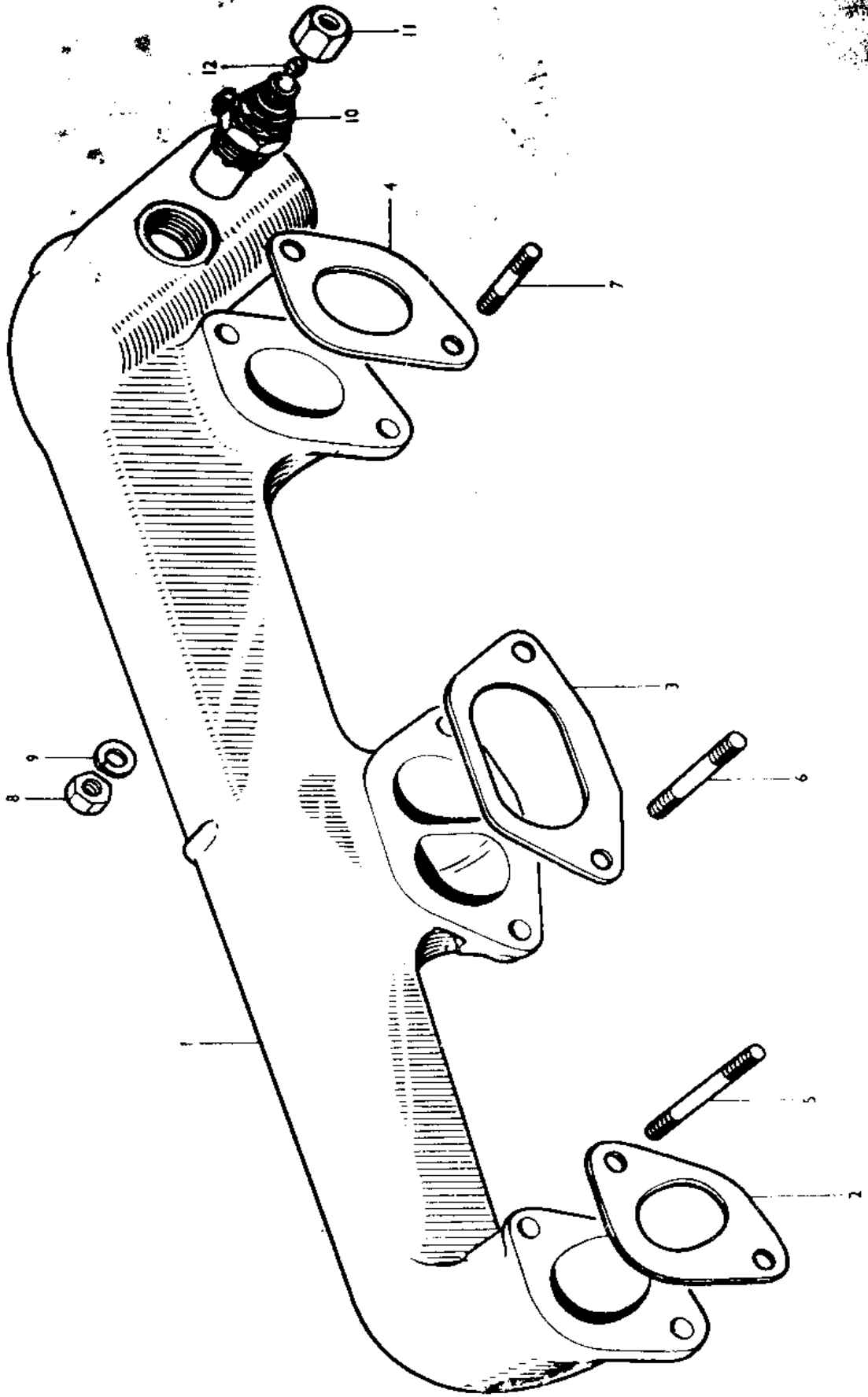


PLATE E
AIR INDUCTION SECTION

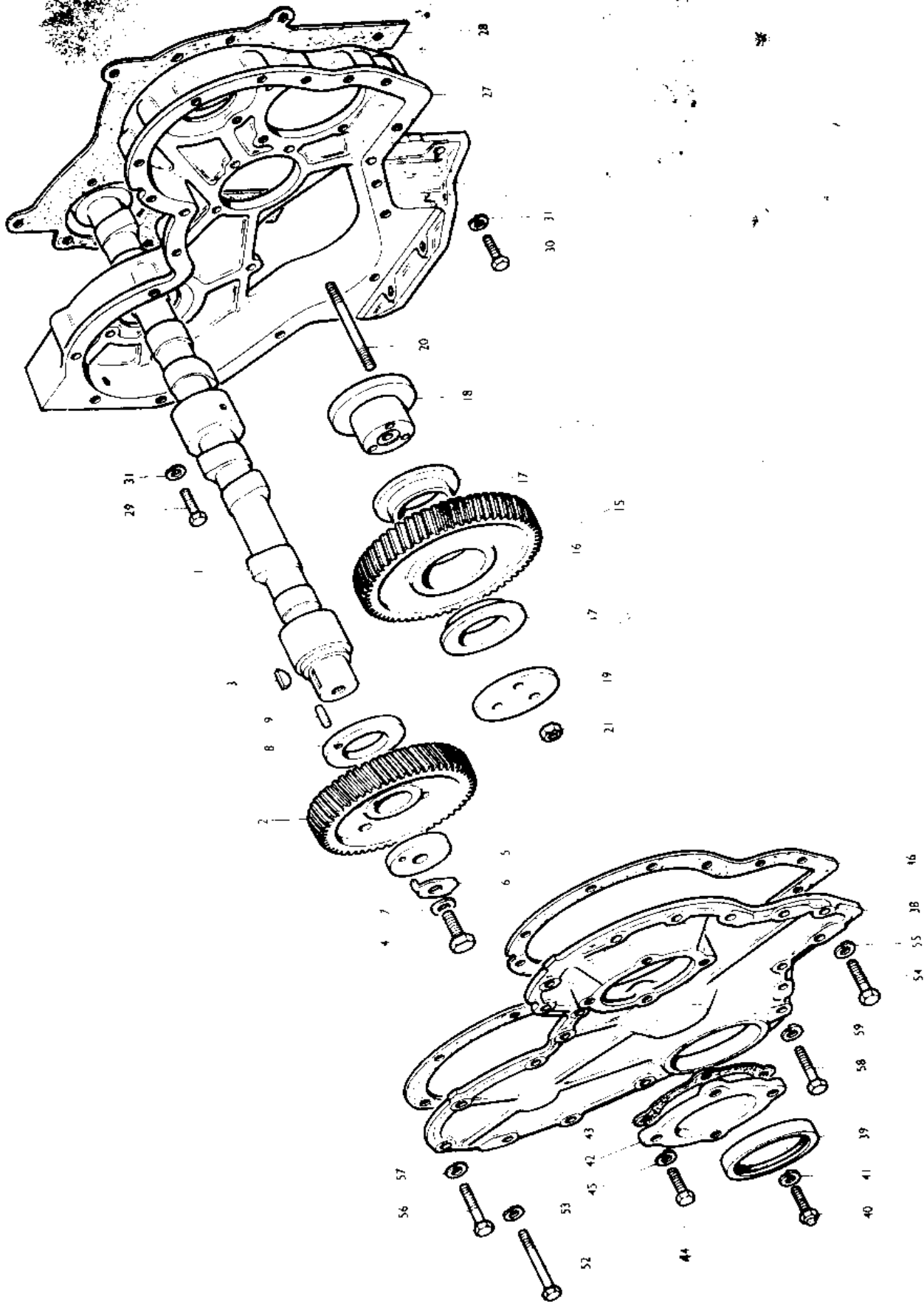


PLATE F
 TIMING GEAR SECTION

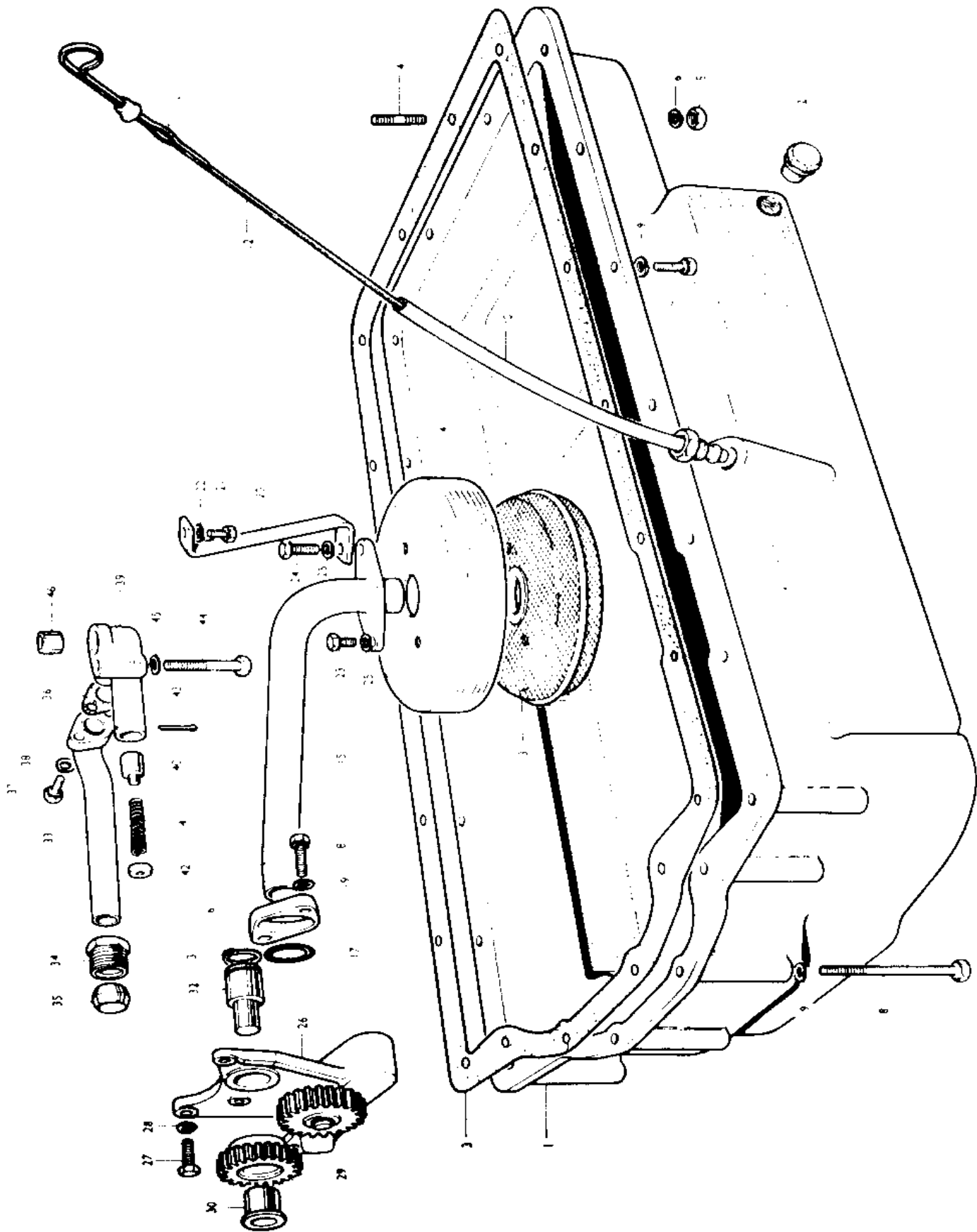


PLATE G1
LUBRICATING OIL SYSTEM SECTION

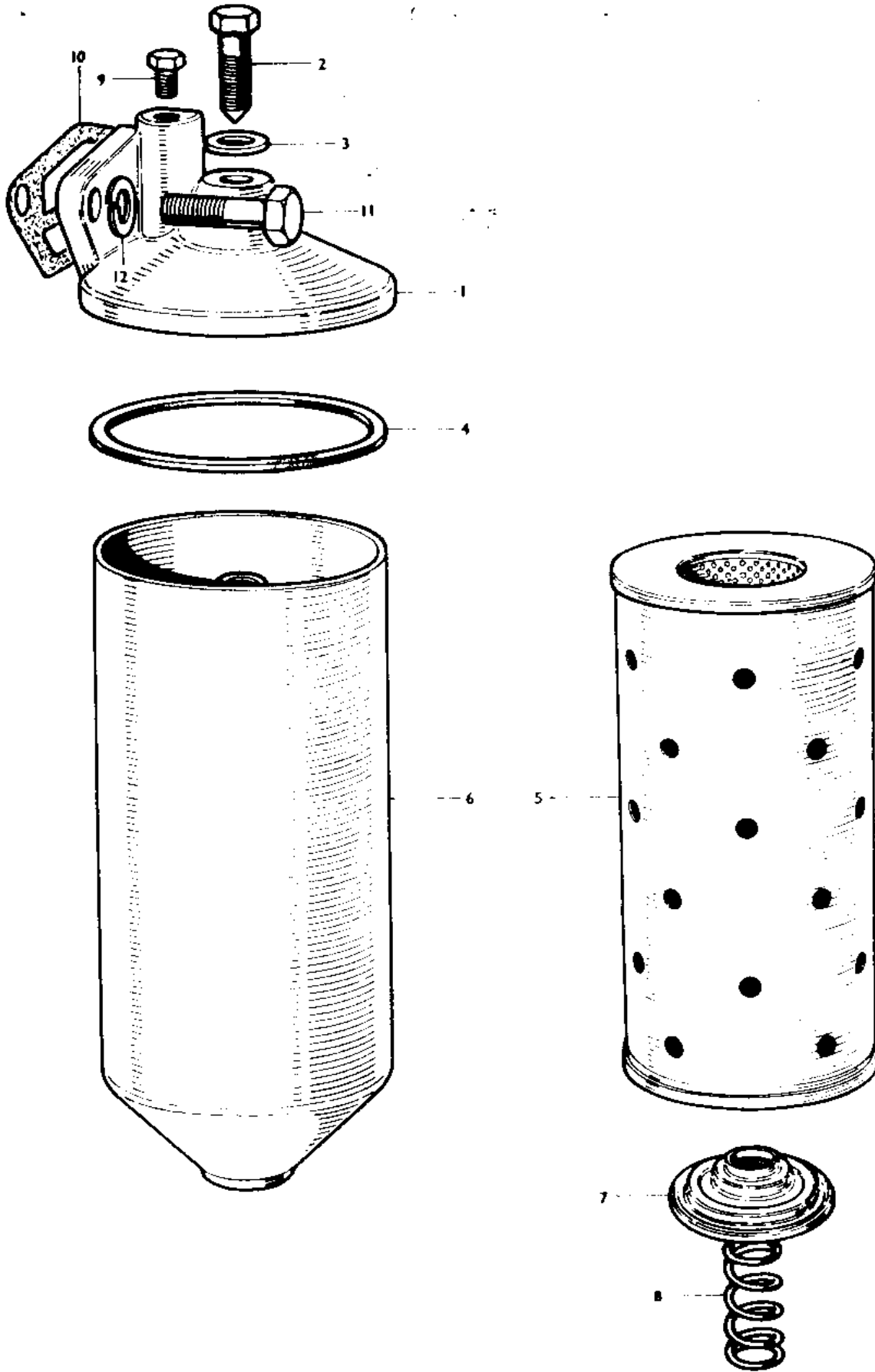


PLATE G2
LUBRICATING OIL SYSTEM SECTION

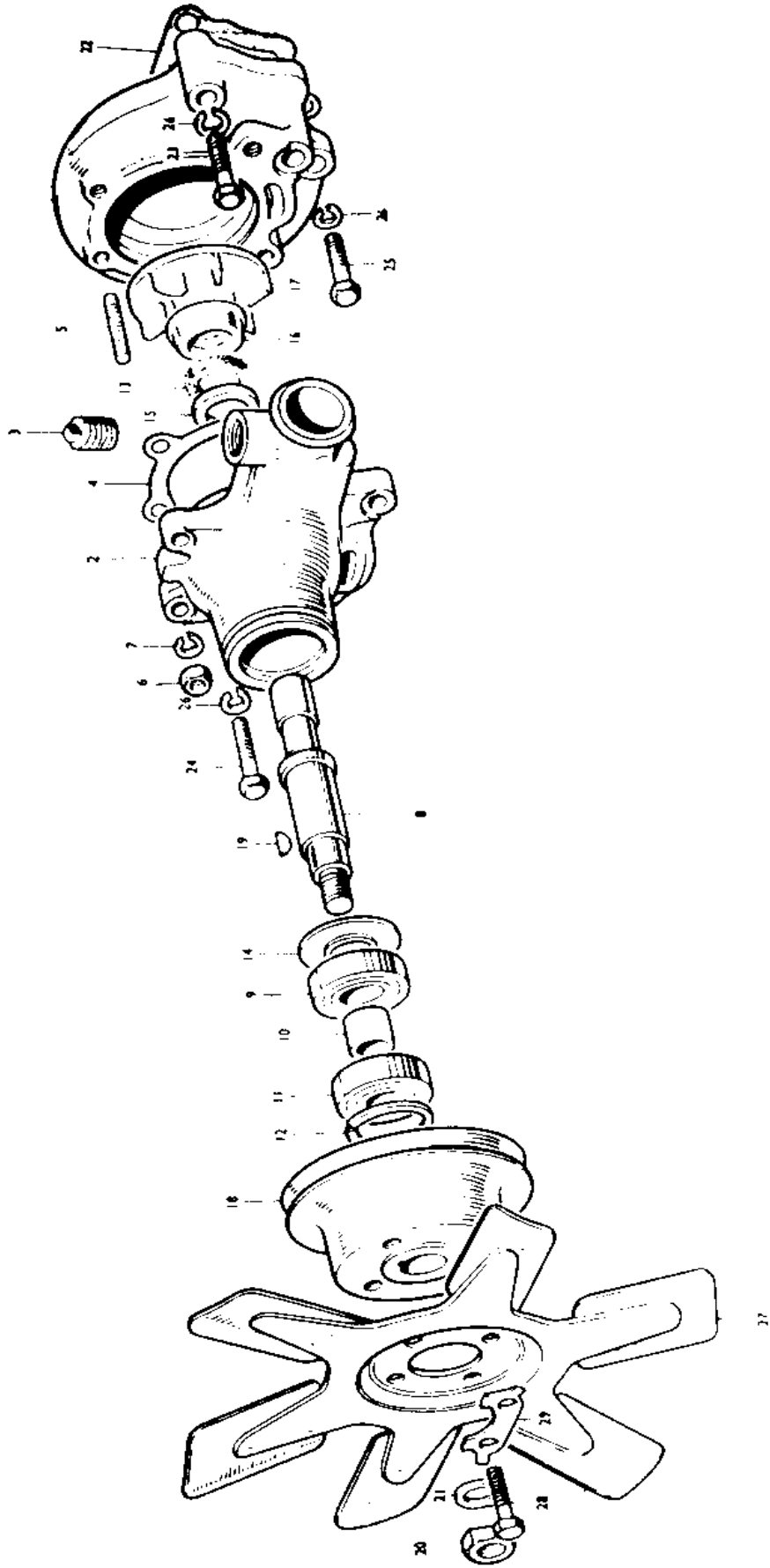


PLATE H
WATER PUMP SECTION

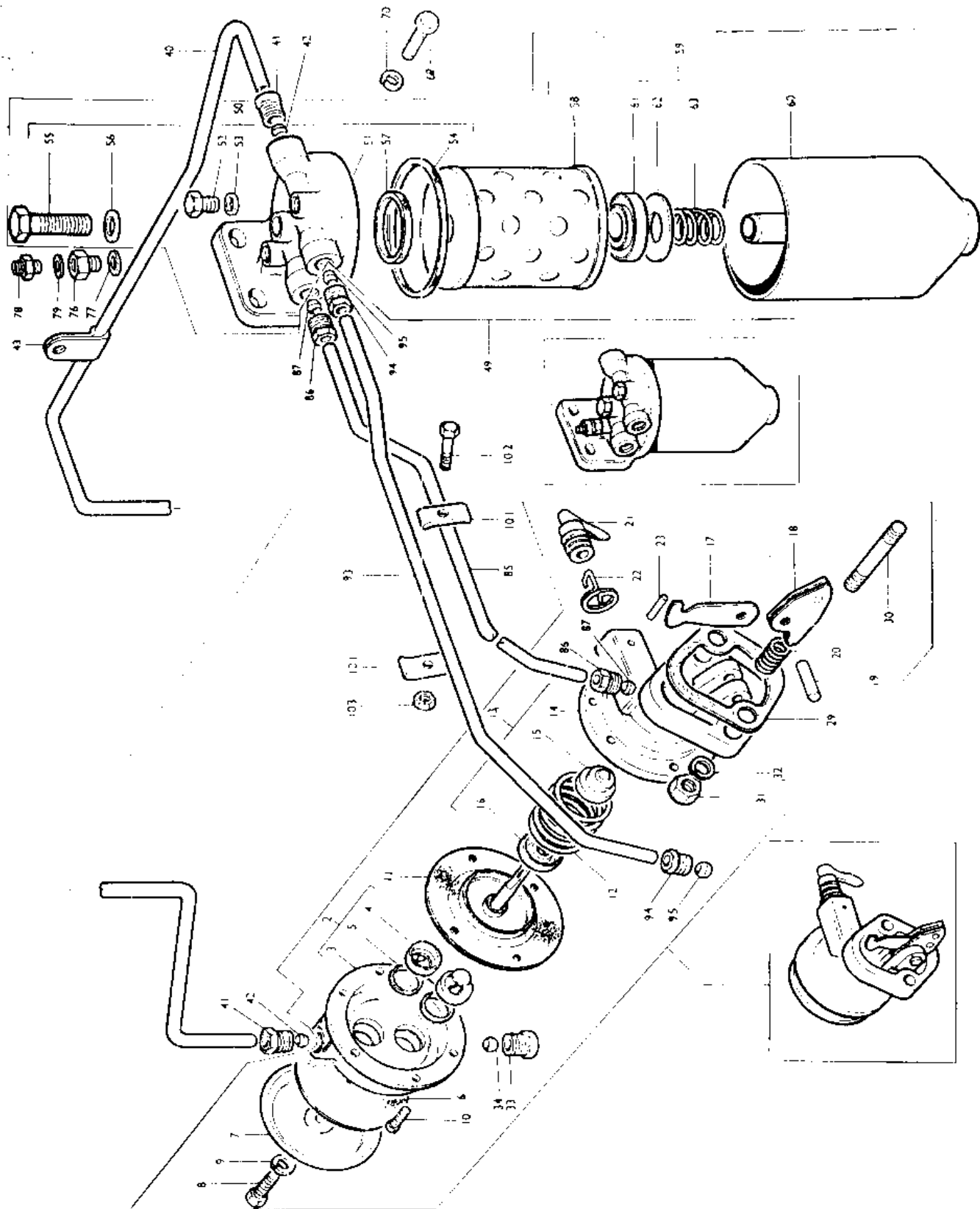


PLATE 11
 FUEL INJECTION EQUIPMENT SECTION

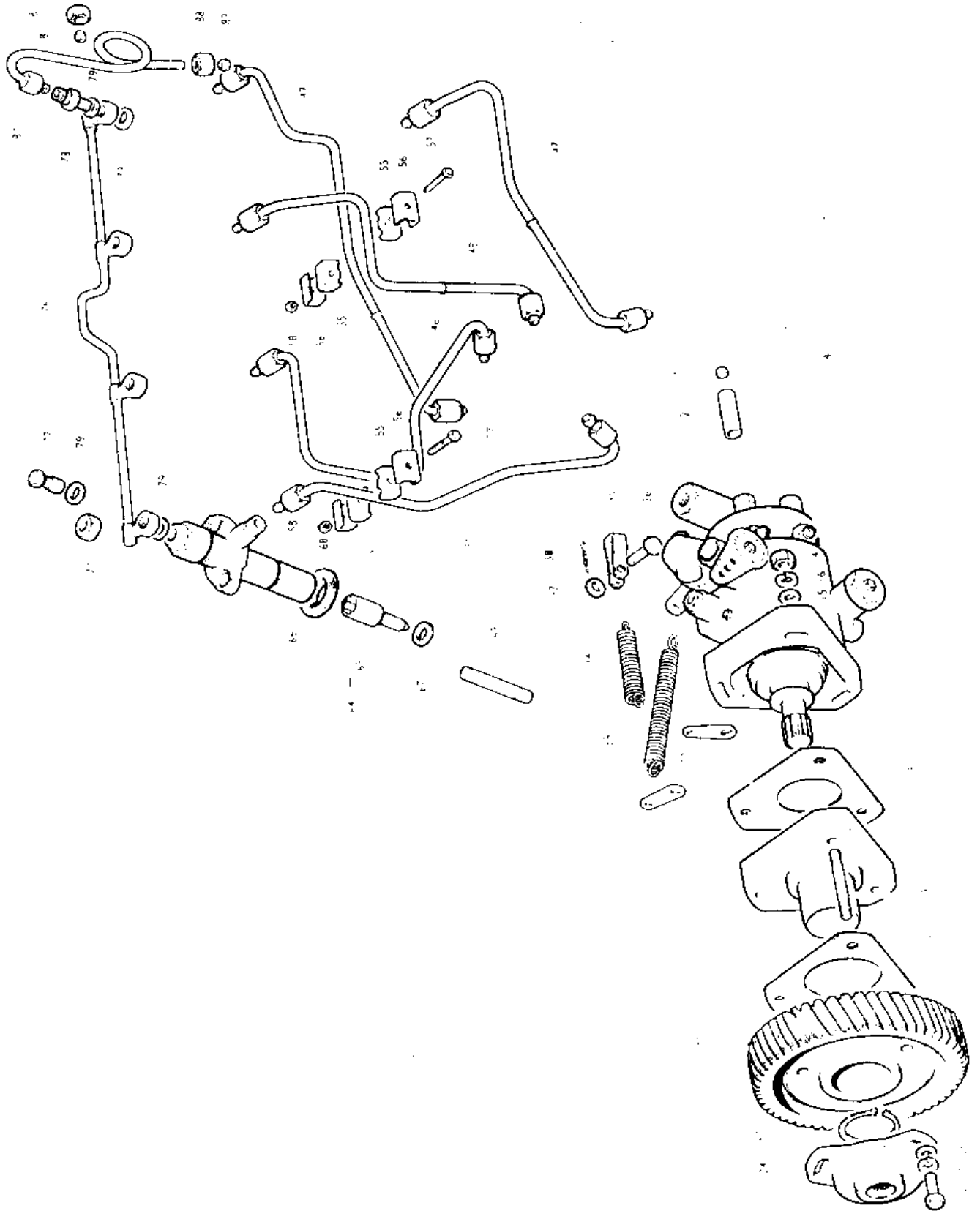


PLATE 12
SECTION FUEL INJECTION EQUIPMENT